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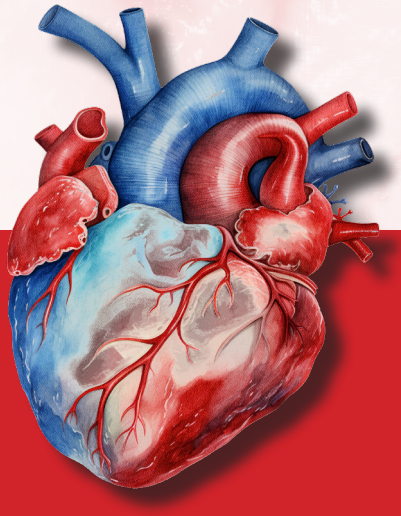

KALP ve DAMAR CERRAHİSİ

KONJENİTAL KALP CERRAHİSİ

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Pediatrik ve konjenital kalp cerrahisi, yaratıcı tasarım ve rekonstrüksiyonları ile "Kardiyak Mimari" olarak tanımlanabilir. Bilim dalımız aynı zamanda; teori ve pratiğin, estetik ve sanata dönüştüğü bir alandır.

C. Tayyar SARIOĞLU

ÖNSÖZ

Kalp damar cerrahisi, sağlık bilimlerinde insan yaşamının en kritik anlarında devreye giren, hem bilimin hem de insanlığın en ince çizgide buluştuğu bir disiplindir. Ölümlerin hala en sık nedeninin, kardiyovasküler hastalıklar olması önemini daha da artırmaktadır. Yorucu ve meşakkatli bir uzmanlık alanı olan kalp damar cerrahisini tercih edenler çalışkan, özverili ve yüce gönüllü hekimlerdir.

Bir asıra yaklaşan ulusal kalp damar cerrahisi eğitimimizle tanı ve tedavide çağdaş, evrensel ve çok iyi sonuçlara ulaştık. Bir ülkenin gelişmesi ancak bilim ve fenle mümkündür ve bu bağlamda ana dilde öğretimin rolü yadsınamaz. Bilim alanımızda özgün, ana dilimizde deneyimlerimizi de katarak bir kalp damar ve cerrahisi kitabı yazma görevimize 2000 lerin başında karar verdik. 3. Basımını çıkardığımız bu özgün eseri Türk bilim hayatına sunmanın onurunu yaşıyoruz.

Her ameliyat, yalnızca teknik becerinin değil; sezginin, deneyimin, sorumluluğun ve en önemlisi irfanın bir bileşkesidir. Çünkü "bilimde irfan olmazsa olmaz" – bilgi, ancak yüksek değerlerle birleştiğinde gerçek anlamını bulur ve insan hayatına dokunan bir değere dönüşür. Kalbin gönülle eş anlamlılığı bu eserin verilmesinde bizlere ayrıca bir motivasyon sağlamıştır.

Eserimizin tüm kalp damar ve kardiyoloji camiası, öğrenci, asistan, uzman ve öğretim görevlileri için iyi rehber olacağına inanıyoruz. Amacımız yalnızca güncel bilgi sunmak değil; aynı zamanda bu bilginin ardındaki düşünceyi, vizyonu ve mesleğin ruhunu aktarmaktır.

Kalp damar cerrahisi, teknolojiyle iç içe gelişen, her gün yeni tekniklerle ve inovasyonlarla zenginleşen bir alandır. Robotik cerrahiden yapay zekânın yönlendirdiği karar destek sistemlerine, minimal invaziv yaklaşımlardan biyomühendislik ürünlerine kadar genişleyen bu dünyada, yalnızca bilmek yetmez yenilikleri sorgulamak, anlamlandırmak ve geleceğe uyarlamak gerekir. Bu kitap, bu yolculukta sizlere hem güvenilir bir bilgi kaynağı, hem de vizyon kazandıran bir rehber olmayı amaçlamaktadır.

Bu kitabın gerçekleşmesinde büyük katkıları olan akademisyen kitabevine, değerli editörlerimize, sayın yazarlarımıza teşekkürlerimizi sunuyoruz. Bölüm yazarları, hem klinik bilgi birikimlerini hem de mesleki deneyimlerini cömertçe paylaşarak bu eseri ortaya koymuşlardır. Her biri, kalp damar cerrahisinin yalnızca bir uzmanlık alanı değil; bir duruş, bir adanmışlık ve insanlığa hizmet sorumluluğu olduğunun bilinciyle katkı sunmuştur.

Bizi yetiştiren büyüklerimize, hocalarımıza, bu yüce meslekte bize fedakarca katlanan ailemize şükranlarımızı sunuyoruz. Yaşamını kaybeden meslektaşlarımızı ve önceki yazarlarımızı şükran ve rahmetle anıyoruz.

Bilim anlam, değer ve erdemlilikle taçlandırılırsa gönülden içerikler sunar. Kalp damar cerrahisinin geleceği, bilgiyle yoğrulan ellerinizde, irfanla aydınlanan yolunuzda daha da güçlenecektir.

Prof. Dr. Mustafa PAÇ

ÖNSÖZ

Konjenital kalp cerrahisi, doğuştan kalp anomalilerinin tanı ve tedavisinde multidisipliner yaklaşımı zorunlu kılan, yüksek düzeyde uzmanlık ve deneyim gerektiren bir alandır. Bu kitap, alanın güncel bilimsel birikimini sistematik bir çerçevede sunmayı, klinik uygulamaya yönelik kanıta dayalı bilgiyi derlemeyi ve konjenital kalp cerrahisinde karşılaşılan karmaşık klinik sorunlara kapsamlı bir rehber oluşturmayı amaçlamaktadır.

Kitabın hazırlanma süreci, farklı merkezlerden çok sayıda değerli yazarın bilimsel katkılarıyla zenginleşmiştir. Her bir bölüm, yazarlarının klinik deneyimleri, literatüre hâkimiyetleri ve akademik titizlikleri doğrultusunda özenle oluşturulmuş; böylece konjenital kalp cerrahisinin tüm yönlerini kapsayan bütüncül bir yapı ortaya çıkmıştır. Bu kolektif emek, kitabın hem eğitim hem de klinik karar süreçlerinde güvenilir bir başvuru kaynağı olma niteliğini güçlendirmektedir.

Bu eserin ortaya çıkmasında, bilimsel yaklaşımını ve editoryal desteğini süreç boyunca titizlikle sürdüren baş editörümüz Prof.Dr. Mustafa Paç' a teşekkür etmek isterim. Kendilerinin vizyonu, yönlendirmeleri ve yapıcı değerlendirmeleri, kitabın akademik bütünlüğünün sağlanmasında belirleyici olmuştur.

Ayrıca katkı sunan tüm bölüm yazarlarına, bilimsel doğruluğu önceleyen yaklaşımları ve yoğun çalışma tempolarına rağmen gösterdikleri özveri için teşekkür borçluyum. Son olarak üzerimde büyük emeği olan, bu projede görev almama vesile olan, konjenital kalp cerrahisinin duayeni sayın hocam Prof.Dr. Tayyar Sarıoğlu' na minnettarlığımı belirtmek isterim.

Bu kitabın, klinik pratiğe anlamlı bir katkı sağlaması ve konjenital kalp cerrahisi alanındaki bilimsel gelişime destek vermesi en büyük dileğimdir. Değerli meslektaşlarımızın ve cerrahi uzmanlık yolculuğunda ilerleyen genç hekimlerimizin dikkatine sunulan bu kapsamlı eserin hazırlık sürecinde yer almaktan onur duyuyorum. Konjenital Kalp Cerrahisi alanında, güncel bilgi birikimini ve cerrahi tekniklerin inceliklerini bir araya getiren bu kitabın, alanındaki en önemli başvuru kaynaklarından biri olacağına yürekten inanıyorum.

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ÖNSÖZ

Kalp ve Damar cerrahisi kitabı, kendi dilimizde başlıca kaynak ve temel eser olma konumunda idi. Yenilenmiş ve genişletilmiş bu üçüncü baskı, uzmanlık öğrencileri ve genç meslektaşlarımız başta olmak üzere, kalp damar cerrahisi alanında bütün çalışanlar için kapsamlı bir başvuru eseri olmaya devam edecektir.

Kalp ve damar cerrahisinin tüm alanlarına paralel olarak, geçen 20-25 yılda pediatrik ve konjenital kalp cerrahisinde de yeni prosedür ve modifikasyonlar geliştirilmiş, bunlardan bazılarının orta- uzun vadeli sonuçları ortaya çıkmış bulunuyor. Ayrıca, yeni teknolojiler eşliğinde başka yeni uygulamalar ve tedavi metotları gündeme gelmiştir. Bütün bu konulardaki ulusal ve uluslararası bilgi ve deneyim birikimlerinin güncellenmesine gereksinim duyulmaya başlamıştır. Kitabımızın elinizdeki 3. baskısının, bu beklentiyi büyük ölçüde karşılayacağına inanıyorum. Bölüm yazarı ve editör olarak bilgi ve deneyimlerini bizimle paylaşan değerli arkadaşlarımıza, ayırdıkları zaman, beyin gücü ve el emeği için en içten teşekkürlerimi sunarım.

Prof. Dr. C. Tayyar SARIOĞLU

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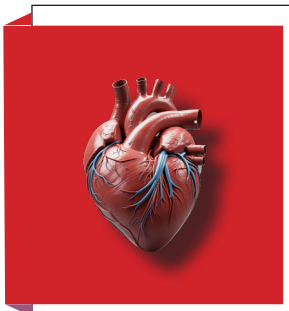

A. KARDİYAK EMBRİYOLOJİ

BÖLÜM
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fında incelir ve zamanla oyuklar meydana getirir. Başlangıçta kas dokusu olan bu yapı, süreç ilerledikçe dejenerasyona uğrayarak yerini bağ dokuya bırakır. Böylece, üzeri endokard tabakasıyla kaplı olan bağ dokusu yapıları yani kapakçıklar şekillenmiş olur. Bu kapakçıklar, kalpte kanın doğru yönde akmasını sağlamak için hayati bir görev üstlenir. Kapakçıklar, **korda tendinea** adı verilen ince bağ dokusu lifleri sayesinde ventrikül duvarındaki **papiller kaslara** tutunur. Papiller kaslar kasıldığında, bu lifler gerilerek kapakçıkların geri kaçmasını önler ve böylece kanın atriyumlara geri dönmesi engellenir. Bu hassas mekanizma, kalbin her atışında kanın doğru yönde ilerlemesini sağlar (52,53). Semilunar kapakçıklar ise kalbin çıkış yollarında, yani aorta ve pulmoner arterde yer alır. Trunkus arteriozusun bölünme süreci tamamlandığında, aorta ve trunkus pulmonalis açıklıklarının çevresinde subendokardiyal dokudan üç adet küçük şişkinlik oluşur. Bu şişkinlikler zamanla çukurlaşarak **semilunar kapakçıklara** dönüşür. Bu kapakçıklar, kanın ventriküllerden arterlere geçişini kontrol ederken, kalbe geri akışını da engeller. Böylece dolaşım sisteminin düzenli ve verimli çalışmasını sağlarlar(54,55,56,57)

Moleküler Düzenlenim

Kalbin dört odacıklı yapısını şekillendiren, **atrioventriküler septasyon** ve **ventriküler septasyon** süreçleri sırasında:

- **Tbx5:** Ventrikül ve atriyal septasyon süreçlerini düzenler. Tbx5 gen mutasyonu, **Holt-Oram sendromuna** neden olabilir.
- **Notch sinyal yolu:** Kalp kapakçıklarının oluşumundan sorumludur ve ve kalbin çıkış yollarını düzenler.
- **Endokardiyal yastıkçıklar:** Kalp kapaklarının öncüleridir ve **epitelyal-mezenkimal geçiş (EMT)** ile oluşur (58,59)

Kalbin İleti Sisteminin Gelişimi

Kalbin **pacemaker** (ritim belirleyici) işlevi, gelişimin erken dönemlerinde sol kardiyak tüpün kaudal kısmında bulunur. Zamanla bu işlev, sinüs venozus tarafından devralınır. Sinüs venozus sağ atriyuma entegre olduğunda, pacemaker dokusu vena kava superiorun açıldığı bölgenin yakınında konumlanır. Embriyonal gelişimin 5. haftasında, **sinoatriyal (SA) nod** oluşur ve kalbin ana ritim belirleyicisi haline gelir. **Atriyoventriküler (AV) nod** ve **His demeti** ise atriyoventriküler kanalın duvarındaki özel hücrelerden gelişerek ileti sisteminin geri kalan yapısını oluşturur. Bu yapıların koordineli gelişimi, kalbin elektriksel iletim sisteminin düzgün çalışmasını sağlar ve sağlıklı bir kalp ritmi için temel oluşturur(52,57,60)

Moleküler Düzenlenim

Kalbin ritmik kasılmasını sağlayan iletim sistemi, **Hcn4, Tbx3 ve Shox2** gibi genler tarafından düzenlenir:

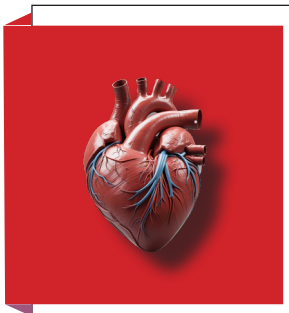
- **Hcn4:** Sinoatriyal düğümde eksprese edilir ve spontan elektriksel aktiviteyi sağlar.
- **Tbx3:** Atriyoventriküler düğümün gelişimini kontrol eder.
- **Shox2:** Sinoatriyal düğüm hücrelerini destekler (61,62,63).

KAYNAKLAR

1. T. V. N. (Vid) P. M. G. T. Keith L. Moore, "Moore Embryology 10th Edition," 2016.
2. P. Mathew, B. B. Authors, and B. Bordoni, "Embryology, Heart," Aug. 2023. (Online). Available: https://www.ncbi.nlm.nih.gov/books/NBK537313/
3. K. Remien, ; Sapan, and H. Majmundar, "Physiology, Fetal Circulation," Aug. 2023. (Online). Available: https://www.ncbi.nlm.nih.gov/books/NBK539710/
4. M. Ashworth, "Development of the Heart and Cardiovascular System in Relation to Cardiac Abnormalities," in *Fetal Medicine: Basic Science and Clinical Practice*, Elsevier, 2019, pp. 88-102.e1. doi: 10.1016/B978-0-7020-6956-7.00010-5.
5. M. JP. Angiogenesis. S. R. (CA) Adair TH, "Overview of Angiogenesis," 2010. (Online). Available: https://www.ncbi.nlm.nih.gov/books/NBK53238/
6. E. S. Noël, "Cardiac construction—Recent advances in morphological and transcriptional modeling of early heart development," in *Current Topics in Developmental Biology*, vol. 156, Academic Press Inc., 2024, pp. 121–156. doi: 10.1016/bs.ctdb.2024.02.005.
7. B. Kloesel, J. A. Dinardo, and S. C. Body, "Cardiac Embryology and Molecular Mechanisms of Congenital Heart Disease: A Primer for Anesthesiologists," Sep. 01, 2016, *Lippincott Williams and Wilkins*. doi: 10.1213/ANE.0000000000001451.
8. R. G. Kelly, M. E. Buckingham, and A. F. Moorman, "Heart fields and cardiac morphogenesis," *Cold Spring Harb Perspect Med*, vol. 4, no. 10, 2014, doi: 10.1101/cshperspect.a015750.

9. Y. Li *et al.*, "The molecular mechanisms of cardiac development and related diseases," Dec. 01, 2024, *Springer Nature*. doi: 10.1038/s41392-024-02069-8.
10. T. Brade, L. S. Pane, A. Moretti, K. R. Chien, and K. L. Laugwitz, "Embryonic heart progenitors and cardiogenesis," 2013, *Cold Spring Harbor Laboratory Press*. doi: 10.1101/cshperspect.a013847.
11. B. G. Romero Flores, L. V. Guzmán, M. S. García, and R. Lazzarini, "Normal development of the heart: a review of new findings," Mar. 01, 2023, *Permanyer Publications*. doi: 10.24875/BMHIM.22000138.
12. K. L. Waldo *et al.*, "Conotruncal myocardium arises from a secondary heart field," *Development*, vol. 128, no. 16, pp. 3179–3188, 2001, doi: 10.1242/dev.128.16.3179.
13. V. G. Laura, S. G. Marcela, J. C. Ricardo, L. Roberto, T. T. Filiberto, and C. Sánchez Gómez, "Incorporation of the first and second heart fields and prospective fate of the straight heart tube via in vivo labeling of chicken embryos," *PLoS One*, vol. 15, no. 7 July, Jul. 2020, doi: 10.1371/journal.pone.0234069.
14. P. Palmquist-Gomes, S. Meilhac, and S. M. Meilhac, "Shaping the mouse heart tube from the second heart field epithelium Title: Shaping the mouse heart tube from the second heart field epithelium," *Curr Opin Genet Dev*, vol. 73, p. 101896, 2022, doi: 10.1016/j.gde.2021.101896ï.
15. C. M. J. Tan and A. J. Lewandowski, "The Transitional Heart: From Early Embryonic and Fetal Development to Neonatal Life," May 01, 2020, *S. Karger AG*. doi: 10.1159/000501906.
16. M. F. J. Buijtendijk, P. Barnett, and M. J. B. van den Hoff, "Development of the human heart," *Am J Med Genet C Semin Med Genet*, vol. 184, no. 1, pp. 7–22, Mar. 2020, doi: 10.1002/ajmg.c.31778.
17. Y. Li *et al.*, "The molecular mechanisms of cardiac development and related diseases," Dec. 01, 2024, *Springer Nature*. doi: 10.1038/s41392-024-02069-8.
18. P. Mathew and B. Bordoni, "Embryology, Heart," 2023. (Online). Available: https://www.ncbi.nlm.nih.gov/books/NBK537313/
19. P. S. B. B. M. P. P. R. B. P. P. H. F.-W. P. Gary C. Schoenwolf, "Larsen's Human Embryology," *CrossRef Listing of Deleted DOIs*, 2015, doi: 10.1016/b978-1-4557-0684-6.01001-8.
20. A. J. Weinhaus, "Early Development of the Heart and Great Vessels," *The FASEB Journal*, vol. 34, no. S1, pp. 1–1, Apr. 2020, doi: 10.1096/fasebj.2020.34.s1.06266.
21. Y. Guo *et al.*, "The Wnt inhibitor Dkk1 is required for maintaining the normal cardiac differentiation program in Xenopus laevis," *Dev Biol*, vol. 449, no. 1, pp. 1–13, May 2019, doi: 10.1016/j.ydbio.2019.02.009.
22. L. Tirosh-Finkel *et al.*, "BMP-mediated inhibition of FGF signaling promotes cardiomyocyte differentiation of anterior heart field progenitors," *Development*, vol. 137, no. 18, pp. 2989–3000, Sep. 2010, doi: 10.1242/dev.051649.
23. J. Niderla-BieliŃska, E. Jankowska-Steifer, A. Flaht-Zabost, G. Gula, E. Czarnowska, and A. Ratajska, "Proepicardium: Current Understanding of its Structure, Induction, and Fate," Jun. 01, 2019, *Blackwell Publishing Inc.* doi: 10.1002/ar.24028.
24. M. Peralta *et al.*, "Heartbeat-driven pericardiac fluid forces contribute to epicardium morphogenesis," *Current Biology*, vol. 23, no. 18, pp. 1726–1735, Sep. 2013, doi: 10.1016/j.cub.2013.07.005.
25. A. Arackal and K. Alsayouri, "Histology, Heart," 2023. (Online). Available: https://www.ncbi.nlm.nih.gov/books/NBK545143/
26. A. Moorman, S. Webb, N. A. Brown, W. Lamers, and R. H. Anderson, "DEVELOPMENT OF THE HEART: (1) FORMATION OF THE CARDIAC CHAMBERS AND ARTERIAL TRUNKS," 2003. (Online). Available: www.heartjnl.com
27. S. Bhansali, M. S. Horenstein, and C. Phoon, "Truncus Arteriosus Continuing Education Activity," 2024. (Online). Available: https://www.ncbi.nlm.nih.gov/books/NBK534774/
28. A. Sizarov, W. H. Lamers, T. J. Mohun, N. A. Brown, R. H. Anderson, and A. F. M. Moorman, "Three-dimensional and molecular analysis of the arterial pole of the developing human heart," *J Anat*, vol. 220, no. 4, pp. 336–349, Apr. 2012, doi: 10.1111/j.1469-7580.2012.01474.x.
29. K. L. Farraj, R. Z. Authors, and R. Z. Affiliations, "Embryology, Heart Tube," 2025. (Online). Available: https://www.ncbi.nlm.nih.gov/books/NBK499934/
30. J. W. Belmont, "Genetic and Developmental Basis of Congenital Cardiovascular Malformations," in *Principles of Developmental Genetics: Second Edition*, Elsevier Inc., 2015, pp. 607–633. doi: 10.1016/B978-0-12-405945-0.00033-8.
31. J. K. Volpe, ; Amgad, and N. Makaryus, "Anatomy, Thorax, Heart and Pericardial Cavity," 2023. (Online). Available: https://www.ncbi.nlm.nih.gov/books/NBK482452/
32. R. Jain *et al.*, "Integration of Bmp and Wnt signaling by Hopx specifies commitment of cardiomyoblasts," *Science (1979)*, vol. 348, no. 6242, Jun. 2015, doi: 10.1126/science.aaa6071.
33. D. G. McFadden, A. C. Barbosa, J. A. Richardson, M. D. Schneider, D. Srivastava, and E. N. Olson, "The Hand1 and Hand2 transcription factors regulate expansion of the embryonic cardiac ventricles in a gene dosage-dependent manner," *Development*, vol. 132, no. 1, pp. 189–201, Jan. 2005, doi: 10.1242/dev.01562.
34. J. W. Vincentz, R. M. Barnes, and A. B. Firulli, "Hand factors as regulators of cardiac morphogenesis and implications for congenital heart defects," Jun. 2011. doi: 10.1002/bdra.20796.
35. D. Franco, D. Sedmera, and E. Lozano-Velasco, "Multiple roles of pitx2 in cardiac development and disease," Dec. 01, 2017, *MDPI*. doi: 10.3390/jcdd4040016.
36. D. Franco, D. Sedmera, and E. Lozano-Velasco, "Multiple roles of pitx2 in cardiac development and disease," Dec. 01, 2017, *MDPI*. doi: 10.3390/jcdd4040016.
37. M. R. Annabi, ; Connor, C. Kerndt, ; Amgad, and N. Makaryus, "Embryology, Atrioventricular Septum," 2025. (Online). Available: https://www.ncbi.nlm.nih.gov/books/NBK482372/
38. L. E. Briggs, J. Kakarla, and A. Wessels, "The pathogenesis of atrial and atrioventricular septal defects with special emphasis on the role of the dorsal mesenchymal protrusion," Jul. 2012. doi: 10.1016/j.diff.2012.05.006.
39. B. Jensen, T. Wang, and A. F. M. Moorman, "Evolution and Development of the Atrial Septum," *Anatomical Record*, vol. 302, no. 1, pp. 32–48, Jan. 2019, doi: 10.1002/ar.23914.

40. J. M. Kuijpers, B. J. M. Mulder, and B. J. Bouma, "Secundum atrial septal defect in adults: A practical review and recent developments," *Netherlands Heart Journal*, vol. 23, no. 4, pp. 205–211, Apr. 2015, doi: 10.1007/s12471-015-0663-z.
41. M. Marty, ; Connor, C. Kerndt, and F. Lui, "Embryology, Fetal Circulation," 2023. (Online). Available: https://www.ncbi.nlm.nih.gov/books/NBK537149/
42. G. Schoenwolf, "Larsen Embriologia Humana," p. 672, 2016, (Online). Available: http://www.academia.edu/download/62568352/Larsen_portugues_Embriologia_Humana_-_5ª_Ed-1-compactado20200330-84563-1hh5maa.pdf
43. J. P. J. M. Hikspoors *et al.*, "The fate of the vitelline and umbilical veins during the development of the human liver," *J Anat*, vol. 231, no. 5, pp. 718–735, 2017, doi: 10.1111/joa.12671.
44. M. K. R. H. A. M. K. R. N. A. B. Sandra Webb, "Development of the human pulmonary vein and its incorporation in the morphologically left atrium," 2001.
45. K. H. Cho, S. Hayashi, Z. W. Jin, J. H. Kim, G. Murakami, and J. F. Rodríguez-Vázquez, "The so-called absorption process of the pulmonary vein into the left atrium of the heart: a histological study using human embryos and fetuses," *Surgical and Radiologic Anatomy*, vol. 45, no. 4, pp. 469–478, Apr. 2023, doi: 10.1007/s00276-023-03100-3.
46. C. I-Ping and H. Tung, "Pulmonary Vein: Embryology, Anatomy, Function and Disease," 2022. doi: 10.5772/intechopen.100051.
47. F. Triposkiadis, A. Xanthopoulos, K. D. Boudoulas, G. Giamouzis, H. Boudoulas, and J. Skoularigis, "The Interventricular Septum: Structure, Function, Dysfunction, and Diseases," Jun. 01, 2022, *MDPI*. doi: 10.3390/jcm11113227.
48. R. E. Poelmann *et al.*, "Evolution and development of ventricular septation in the Amniote Heart," *PLoS One*, vol. 9, no. 9, Sep. 2014, doi: 10.1371/journal.pone.0106569.
49. M. Bruska, M. Rauhut-Klaban, and W. Woźniak, "Early trabeculation and closure of the interventricular foramen in staged human embryos," *Folia Morphol*, vol. 67, no. 1, pp. 13–18, 2008, (Online). Available: www.fm.viamedica.pl
50. W. Dakkak, M. H. Alahmadi, and T. I. Oliver, "Ventricular Septal Defect," 2024. (Online). Available: https://www.ncbi.nlm.nih.gov/books/NBK470330/
51. G. J. Mahler and J. T. Butcher, "Cardiac developmental toxicity," Dec. 2011. doi: 10.1002/bdrc.20219.
52. F. T. Rantin, A. L. Kalinin, and D. A. Monteiro, "Langman Medical Embryology," *Biology and Physiology of Freshwater Neotropical Fish*, pp. 185–216, 2019, doi: 10.1016/B978-0-12-815872-2.00009-9.
53. M. L. Notenboom, L. Van Hoof, A. Schuermans, J. J. M. Takkenberg, F. R. Rega, and Y. J. H. J. Taverne, "Aortic Valve Embryology, Mechanobiology, and Second Messenger Pathways: Implications for Clinical Practice," Feb. 01, 2024, *Multidisciplinary Digital Publishing Institute (MDPI)*. doi: 10.3390/jcdd11020049.
54. D. Macgrogan, G. Luxán, A. Driessen-Mol, C. Bouten, F. Baaijens, and J. L. De La Pompa, "How to make a heart valve: From embryonic development to bioengineering of living valve substitutes," *Cold Spring Harb Perspect Med*, vol. 4, no. 11, 2014, doi: 10.1101/cshperspect.a013912.
55. R. B. Hinton and K. E. Yutzey, "Heart valve structure and function in development and disease," *Annu Rev Physiol*, vol. 73, pp. 29–46, 2011, doi: 10.1146/annurev-physiol-012110-142145.
56. P. W. Riem Vis, J. Kluin, J. P. G. Sluijter, L. A. van Herwerden, and C. V. C. Bouten, "Environmental regulation of valvulogenesis: Implications for tissue engineering," Jan. 2011. doi: 10.1016/j.ejcts.2010.05.032.
57. B. M. . Carlson and P. Nik. Kantaputra, *Human embryology and developmental biology*. Elsevier, 2019.
58. J. L. Cervantes-Salazar *et al.*, "Genetic Insights into Congenital Cardiac Septal Defects—A Narrative Review," Nov. 01, 2024, *Multidisciplinary Digital Publishing Institute (MDPI)*. doi: 10.3390/biology13110911.
59. R. H. Anderson, D. E. Spicer, N. A. Brown, and T. J. Mohun, "The development of septation in the four-chambered heart," *Anatomical Record*, vol. 297, no. 8, pp. 1414–1429, 2014, doi: 10.1002/ar.22949.
60. R. A. Mohan, B. J. Boukens, and V. M. Christoffels, "Developmental Origin of the Cardiac Conduction System: Insight from Lineage Tracing," Aug. 01, 2018, *Springer New York LLC*. doi: 10.1007/s00246-018-1906-8.
61. X. Liang *et al.*, "HCN4 dynamically marks the first heart field and conduction system precursors," *Circ Res*, vol. 113, no. 4, pp. 399–407, Aug. 2013, doi: 10.1161/CIRCRESAHA.113.301588.
62. W. M. H. Hoogaars *et al.*, "Tbx3 controls the sinoatrial node gene program and imposes pacemaker function on the atria," *Genes Dev*, vol. 21, no. 9, pp. 1098–1112, May 2007, doi: 10.1101/gad.416007.
63. W. Hu, Y. Xin, Y. Zhao, and J. Hu, "Shox2: The role in differentiation and development of cardiac conduction system," 2018, *Tohoku University Medical Press*. doi: 10.1620/tjem.244.177.



B. DOĞUMSAL KALP ANOMALİLERİ

BÖLÜM 1

Merjem PURELKU [1]
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DOI: 10.37609/akya.4077.c5412

İçindekiler

» ETİYOLOJİ
» DOĞUMSAL KALP DEFEKTLERİNİN KLİNİK ÖZELLİKLERİ
» SIK GÖRÜLEN KALP DEFEKTLERİ
  » DekstrokardiaCARDIA
  » Ektopia Kordis
  » Atriyal ve Ventriküler Septal Defektler (ASD ve VSD)
  » Atriyal Septal Defektler (ASD)
  » Genetik ve Klinik Özellikler
  » Klinik Seyir
  » Ventriküler Septal Defekt (VSD)
  » Kalıcı Atriyoventriküler Kanal (AV Kanal Defekti),
  » Kalıcı Trunkus Arteriosus
  » Aortikopulmoner Septal Defekt
  » Büyük Arterlerin Transpozisyonu (BAT)
  » Klinik ve Genetik İlişki
  » Fallot Tetralojisi
  » Aort Stenozu ve Aort Atrezisi
  » Hipoplastik Sol Kalp Sendromu (Hypoplastic Left Heart Syndrome)
  » Kalp Malformasyonlarının Bilinen Genetik Nedenleri

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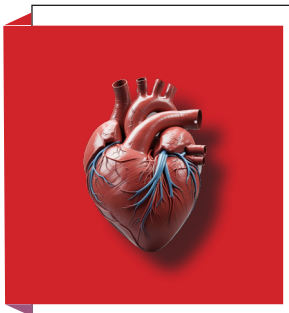
lirlenmesinde (spesifikasyonunda) görev alan bir transkripsiyon faktörü olan **TBX20** geninde görülen mutasyonlar da tanımlanmıştır. **TBX20 mutasyonları**; **atriyal ve ventriküler septal defektler**, **kapak defektleri** ve **kalp odacıklarının anormal büyümesi** ile ilişkilendirilmiştir (20).

KAYNAKLAR

1. Human Embryology and Developmental Biology.
2. Yun SW. Congenital heart disease in the newborn requiring early intervention. Vol. 54, Korean Journal of Pediatrics. Korean Pediatric Society; 2011. p. 183–91.
3. Keith L. Moore, T.V.N.Persaud, Mark G. Torchia: The Developing Human. Clinically Oriented Embryology. 11th edition.
4. Azhar M, Ware SM. Genetic and Developmental Basis of Cardiovascular Malformations. Vol. 43, Clinics in Perinatology. W.B. Saunders; 2016. p. 39–53.
5. Karunamuni GH, Ma P, Gu S, Rollins AM, Jenkins MW, Watanabe M. Connecting teratogen-induced congenital heart defects to neural crest cells and their effect on cardiac function. Birth Defects Res C Embryo Today. 2014 Sep 1;102(3):227–50.
6. 10.1016/b978-1-4557-0684-6.01001-8. CrossRef Listing of Deleted DOIs. 2000;
7. Yasuhara J, Garg V. Genetics of congenital heart disease: A narrative review of recent advances and clinical implications. Vol. 10, Translational Pediatrics. AME Publishing Company; 2021. p. 2366–86.
8. Bruce Carlson - Human Embryology and Developmental Biology.
9. Romeo FJ, Mavropoulos SA, Ishikawa K. Progress in Clinical Gene Therapy for Cardiac Disorders. Vol. 27, Molecular Diagnosis and Therapy. Adis; 2023. p. 179–91.
10. Kim Y, Landstrom AP, Shah SH, Wu JC, Seidman CE. Gene Therapy in Cardiovascular Disease: Recent Advances and Future Directions in Science: A Science Advisory From the American Heart Association. Vol. 150, Circulation. Lippincott Williams and Wilkins; 2024. p. e471–80.
11. Barnes RM, Black BL. Nodal signaling and congenital heart defects. In: Etiology and Morphogenesis of Congenital Heart Disease: From Gene Function and Cellular Interaction to Morphology. Springer Japan; 2016. p. 183–92.
12. Shad J, Budhwani K, Biswas R. Thoracic ectopia cordis. BMJ Case Rep. 2012;
13. Smith BJ, Flyer JN, Edwards EM, Soll RF, Horbar JD, Yeager SB. Outcomes for Ectopia Cordis. Journal of Pediatrics. 2020 Jan 1;216:67–72.
14. Nashat H, Montanaro C, Li W, Kempny A, Wort SJ, Dimopoulos K, et al. Atrial septal defects and pulmonary arterial hypertension. Vol. 10, Journal of Thoracic Disease. AME Publishing Company; 2018. p. S2953–65.
15. Meng X, Song M, Zhang K, Lu W, Li Y, Zhang C, et al. Congenital heart disease: types, pathophysiology, diagnosis, and treatment options. Vol. 5, MedComm. John Wiley and Sons Inc; 2024.
16. Kheiwa A, Hari P, Madabhushi P, Varadarajan P. Patent foramen ovale and atrial septal defect. Echocardiography. 2020 Dec 1;37(12):2172–84.
17. Granados-Riveron JT, Pope M, Bu'lock FA, Thornborough C, Eason J, Setchfield K, et al. Combined Mutation Screening of NKX2-5, GATA4, and TBX5 in Congenital Heart Disease: Multiple Heterozygosity and Novel Mutationsc hd_573 151..159 [Internet]. 2011. Available from: http://wileyonlinelibrary.
18. Eyileten Z, Uysalel A. Isolated ventricular septal defect in infants. E Journal of Cardiovascular Medicine. 2017 Jun 15;5(2):27–33.
19. Sadler_T_W_--_Langman_39_s_medical_embryology.
20. Larsen's Human Embryology. 10.1016/b978-1-4557-0684-6.01001-8. CrossRef Listing of Deleted DOIs. 2000



KARDİYAK MORFOLOJİNİN SEGMENTAL ANALİZİ VE KONJENİTAL KALP HASTALIKLARININ EKOKARDİYOGRAFİK TANISI

BÖLÜM

2

Ayşe SARIOĞLU [1]
Canan AYABAKAN [2]

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İçindekiler

- GİRİŞ VE GENEL BİLGİLER
- KARDİYAK LOKALİZASYON VE APEKSİN YÖNÜ
- ATRİYAL SİTUS VE ATRİYAL MORFOLOJİ
- ATRİYAL SEPTUM
- SİSTEMİK VE PULMONER VENÖZ DÖNÜŞ
- ATRİYOVENTRİKÜLER BAĞLANTI VE VENTRİKÜLER MORFOLOJİ
- ATRİYOVENTRİKÜLER KAPAKLAR
- VENTRİKÜLER İLİŞKİ
- VENTRİKÜLER SEPTUM
- VENTRİKÜLOARTERİYEL BAĞLANTI VE SEMİLUNAR KAPAKLAR
- PULMONER ARTERLER VE AORT
- KORONER ARTERLER
- VENTRİKÜL BÜYÜKLÜKLERİ
- HEMODİNAMİK PARAMETRELER VE VENTRİKÜL FONKSİYONLARI
- SOL VENTRİKÜL SİSTOLİK FONKSİYONUNUN DEĞERLENDİRİLMESİ
- KONJENİTAL KALP HASTALIĞINDA SOL VENTRİKÜLER DİYASTOLİK FONKSİYONUN DEĞERLENDİRİLMESİ
  - Sol atriyum büyüklüğü
  - Transmitral Doppler akımı
  - Pulmoner ven akımı
  - Doku Doppler hızları
  - Diyastolik disfonksiyonun evrelenmesi
- SAĞ VENTRİKÜLÜN VE FONKSİYONLARININ DEĞERLENDİRİLMESİ
- TEK VENTRİKÜLÜN DEĞERLENDİRİLMESİ
- TRANSÖZOFAJİYAL EKOKARDİYOGRAFİ
- ÜÇ BOYUTLU EKOKARDİYOGRAFİ
- FETAL EKOKARDİYOGRAFİ

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FETAL EKOKARDİYOGRAFİ

Fetal ekokardiyografi, uzun süredir fetal kalp anomalilerinin tanısında rutin olarak kullanılmaktadır. Fetal kardiyoloji pediyatrik kardiyolojinin yeni bir dalı olarak hızla ilerlemektedir.

Fetal ekokardiyografinin fetal konjenital kalp anomalilerinin değerlendirilmesindeki güvenilirliği yapılan çeşitli çalışmalarda gösterilmiştir (77). Fetal aritmilerin tanısı ve tedavisinde, riskli gebeliklerde (diabetik anne, annenin ilaç ve alkol alımı); fetüsun ebeveyinleri veya kardeşlerinde konjenital kalp anomalisi olması halinde; ekstrakardiyak anomalili fetüslerde; obstetrik ultrasonografi sırasında kalpte anormallik tespit edildiğinde veya çoğul gebeliklerde yapılması gereken bir tetkiktir.

Fetal ekokardiyografi 16. gebelik haftasından itibaren yapılabilir; genellikle 18-20. haftalardan itibaren daha iyi görüntüler elde edilmektedir. İnceleme sırasında kalp boşlukları, kalp duvar kalınlıkları, foramen ovalenin açık olup olmadığı, renkli Doppler ile foramen ovaleden akım yönü, mitral ve triküspid kapaklar, septumlar, atriyoventriküler ve ventriküloarteriyel ilişkiler, aort ve pulmoner arter ilişkileri, duktal ve aortik arkuslar, sistemik ve pulmoner venöz dönüşler tıpkı konjenital kalp hastalığında standart transtorasik ekokardiyografideki gibi segmenter analiz ışığında incelenir. Doppler ile AV kapaklar, aort, pulmoner arter akımları ve duktal akım değerlendirilir.

Pekçok konjenital kalp anomalisinin ilk 8 haftada yani embiryogenez sırasında oluşmasına karşılık bazı konjenital kardiyak defektler sonradan oluşur veya ilerler. Pulmoner stenoz veya atrezi, hipoplastik sol kalp sendromu, sol kalbin obstriktif lezyonları bu anomalilere örnek olarak gösterilebilir (78, 79). Bu nedenle konjenital kalp hastalığı tespit edilen fetüsler gebelik süresince seri olarak takip edilmelidir. Seri takipler intrauterin hayattaki konjenital kalp hastalıklarının seyri hakkındaki bilgi ve tecrübelerimizin artmasına katkı yanında, intrauterin tedavi (kateterle veya cerrahi) stratejilerinin de gelişmesinde rol oynayacaktır. Bugün fetal ekokardiyografik incelemelerle elde edilen tecrübeler sonucunda gebeliğin erken döneminde sonlanacağı düşünülen pekçok konjenital kalp anomalisinin terme kadar geldiği ve neonatal dönemde başarılı bir şekilde tedavi edilebileceği görülmüştür.

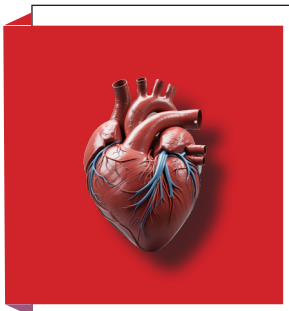
KAYNAKLAR

1. Sarıoğlu A, Türkoğlu H, Köner A, Sağın G, Aytaç A, Ertuğrul A, Demircioğlu C. Konjenital kalp hastallklanmn cerrahi tedavisinde iki boyutlu ekokardiyografinin yeri (516 hastanın analizi). Türk Kardiol Dern 18:264-268, 1990.
2. Corbett L, Forster J, Gamlin W, Duarte N, Burgess O, Harkness A, Li W, Simpson J, Bedair R. A practical guideline for performing a comprehensive transthoracic echocardiogram in the congenital heart disease patient: consensus recommendations from British Society of Echocardiography. Echo Research Practice 9: (10) 1-34, 2022.
3. Silver NH, Snider AR, Colo J, A segmental approach to the diagnosis of congenital heart disease: Usefulness of two dimensional echocardiography. In: Hunter S, Hall R (eds). Echocardiography 1. Churchill Livingstone 165-192, 1982.
4. Sarıoğlu A, Sarıoğlu T, Ertuğrul A, Aytaç A. Konjenital Kalp anomalilerinin tanımlanmasında segmental analiz. Türk Kardiyol Dern Arş 17: 203-208, 1989.
5. Sarıoğlu A, Ertuğrul A. Konjenital kalp anomalilerinin segmental analiz metoduna göre 2-boyutlu ekokardiyografi tamımlanması. Türk Kardiyol Dern Ars 18:303-307, 1990.
6. Tynan MJ, Becker AE, Macarthey FJ, Quero-Sjmenez M, Shinebourne EA, Anderson RH. Nomencalature and classification of conjenital heart disease. Br Heart J 41:544, 1977.
7. Anderson RH, Ho S Y. Sequential segmental analysis-description and categorization for the millennium, Cardiol Young 7: (98) 1-16, 1977.
8. Van Praagh, Weinbert PM, Van Praagh S: Malposition of the heart. Moss AJ, Adams F. Emmanoilides G (eds). Heart disease in infants, children and adolescents. 2nd ed, Baltimore; Williams and Wilkins p: 394-417, 1977.
9. Tajik AS, Seward JB, Hagle DJ, Ivíair DP, Lie JT. Two dimensional real time ultrasonic imaging of the heart and great vessels: technique, image orientation, structure identification and validation. Mayo Clin Proc 53:271-303, 1978.
10. Lopez L, Saurers DL, Barker PCA, Cohen MS, Colan SD, Dwyer J, Forsha D, Friedberg MK, Lai WW, Printz BF, Sachdeva R, Soni-Patel NR, Truong DT, Young LT, Altman CA. Guidelines for performing a comprehensive pediatric transthoracic echocardiogram: reccomendations from the American Society of Echocardiography. J Am Soc Echocardiogr 37: 119-170, 2024.
11. Huhta JC, Hagier DJ, Seward JB, Tajik Al. PR, Ritter DG. Two dimensional echocardiographic assesment of dextrocardia: segmantal approach. Am J Cardiol 50:1351-1360, 1982.
12. Huhta CH, Smallharn JF, Macartaey FJ. Two dimensional echocardiographic diagnosis of situs. Br Heart J, 48:97, 1982.
13. Uemura H, Ho S Y, Devine WA, Kilpatrick U, Anderson RH. Atrial appendages and venoatrial connections

in hearts from patients with visceral heterotaxy. Ann Thorac Surg 60:561-569, 1995.
14. Hagler DJ, Tajik J, Seward JB, Mair DD, Ritter DG. Atrioventricular and ventriculoarteriel discordance (corrected transposition of areat arteries: Wide angle, two dimensional echocardiographic assesment of ventricular morphology. Mayo Clin Proc 56-591, 1981..
15. Foale R, Stefaninni L, Rickards A, Somerville J. Left and right ventricular morphology in complex congenital heart disease defined by two dimensional echocardiogrphy. J Am Cardiol 49:93, 1982.
16. Rigby MI, Anderson RH, Gibson D, Jones ODH, Joseph MC, Shinebourne EA. Two dimensional echocardiographic categorisation of the univentricular heart: ventricular morphology, type and mode of connection. Br Heart J 46:603, 1981.
17. .Rice MJ, Seward JB, Edwards WD, Hagler DI, Danielson GK, Puga FJ, Tajik Al. Straddling atrioventricular valve: Two-dimensional echocardiographic diagnosis, classification and surgical implications. Am J Cardiol 55:505-513, 1985.
18. Mill G, Becker AE, Moulaert AJ, Hanrinck E. Two-dimensional echocardiographic localization of isolated ventricular septal defects. Hunter S, Hall R (eds) Echocardiography I. Churchill Livingstone p: 249-265, 1982.
19. Gatzoulis MA, Li J, Ho S Y. The echocardiographic anatomy of ventricular septal detects. Cardiol young 7:471-484, 1997.
20. Soto B, Becker Moulaert AJ, Lie JT, Anderson RH. Classification of isolated ventricular septal defects. Br Heart J 43:322-343, 1980.
21. Sarıoğlu A, Batmaz G, Bilal MS, Saltık İL, Saylam GS, Sarıoğlu T, Aytaç A, Ertuğrul A. Total correction of tetralogy of Fallot without "routine" preoperative cardiac catheterization: Management of 99 patients. Cardiol Young 4:262-266, 1994.
22. Sarıoğlu A, Batmaz G. Saltık L, Saylam GS, Samanlı ÜB. Fallot tetralojili çocuklarda koroner anomali ve ekokardiyografik tespiti. Türk Kardiyol Dern 24:474-479, 1996.
23. Sanoğlu A, Saltık İL, Saylam GS, Batmaz G, Sarıoğlu T, Aytaç A. Anomalous origin of the left coronary artery from the pulmonory artery. The Turkish Journal of Pediatrics 39:127-135, 1997.
24. Saltık IL, A, Öztunç F, Saylam GS, Ertugrul A. Konjenital koroner arter fistüllerinde 2-boyutlu, Doppler ve renkli Doppler ekokardiyografik bulgular. Türk Kardiyol Dern Arş 23:26-30, 1995.
25. Currie PJ, Seward 1B, Chan KL. Continuous wave Doppler determination of right ventricular pressure: A simultaneous Doppler catheterization study in 27 patients. J Am Coll Cardiol 6:750-756, 1985.
26. Murphy DJ, Ludomirsky A, Huhta JC. Continuous wave Doppler in children with ventricular septal defect: noninvazive estimation of interventricular pressure gradiyentent. Am J Cardiol 57:428-432, 1986.
27. Masuyama T, Kodama K, Kitabatake A. Continuous-wave Doppler echocardiographic detecion of pulmonary regurgitation and its application to noninvazive estimation of pulmonary artery pressure. Circulation 74:484-492, 1986.
28. Nascimento R, Pereira D, Freitas A, et al. Comparison of left ventricular ejection fraction in congenital heart disease by visual versus algorithmic determination. Am J Cardiol 80: 1331-1335, 1997.
29. Kimball TR, Michelfelder EC. Echocardiography: basic principles and imaging. In: Allen HD, Driscroll DJ, Shaddy RE, Feltes TF (eds). Moss and Adams'Heart Diseaase in Infants, Children and Adolescents Including the Fetus and Young Adult, 8th ed, Philadelphia, Lippencott Williams and Wilkins, pp:134-172, 2013.
30. Ayabakan C. Ekokardiyografi: Yurdakök M (ed). Yurdakök Pediatri. Cilt 3. Kalp Hastalıkları 1. Baskı, Ankara Nobel Tıp Kitabevleri, pp: 2992-3001; 2018.
31. Ayabakan C. Ekokardiyografi: Celiker A, Ayabakan C (eds). Erişkinde Konjenital Kalp Hastalığı. 1. Baskı, Ankara Nobel Tıp Kitabevleri pp: 78-96; 2022.
32. Acar P, Abair S, Aggoun Y. Transcatheter closure of perimembraneous ventricular septal defects with Amplatzer Occluder assessed by real time here dimentional echocardiography. Eur J Echocardiogr 8:110-115, 2007.
33. Ahmed MI, Gok G, Yuzbas B, Burkhart J, Amado Escanuela MG, Alli OO, et al. Incremental value of three dimentional echocardiography over the two dimentional technique in the assessment of combines sinus valsalva rupture into the right ventricle and adjacent perimembraneous ventricular septal defect. Echocardiography 31:779-782, 2014.
34. Ayabakan C, Ozkutlu S. Left ventricular myocardial velocities in healthy children: quantitative assessment by tissue Doppler echocardiography and relation to the characteristics of filling of the left ventricle. Cardiol Young 14(2):156-63, 2004.
35. Sutherland GR, DiSalvo G, Claus P, D'Hooge J, Bijnens B. Strain and strain rate imaging: new clinical approach to quantifying regional myocardial function.cJ Am Soc Echocardiogr 17: 788-802, 2004.
36. Gorcsan J 3rd, Tanaka H. Echocardiographic assessment of myocardial strain. J Am Coll Cardiol 58: 1401-1413, 2011.
37. Forsey J, Friedberg MK, Mertens L. Speckle tracking echocardiography in pediatric and congenital heart disease. Echocardiography 30: 447-459, 2013.
38. Friedberg MK, Fernandes FP, Roche SL, Grosse-Wortmann L, Manlhiot C, Fackoury C, et al. Impaired right end left ventricular diastolic myocardial machanics and filling in asymptomatic children and adolescents after repair of tetralogy of Fallot. Eur Heart J Cardiovasc Imaging 13: 905-913, 2012.
39. Diller GP, Kempny A, Liodakis E, Alonso-Gonzalez R, Inuzuka R, Uebing A, et al. Left ventricular longitudinal function predicts life-threatening ventricular arrhythmia and death in adults with repaired tetralogy of fallot. Circulation 125: 2440-2446, 2012.
40. Dragulescu A, Friedberg MK, Grosse-Wortmann L, Redington A, Mertens L. Effect of chronic right ventricular volume overload on ventricular interaction in patients after tetralogy of Fallot repair. J Am Soc Echocardiogr 27: 896-902, 2014.
41. Kawakubo M, Yamasaki Y, Toyomura D, et al. Unchanged right ventricular strain in repaired tetralogy of Fallot after pulmonary valve replacement with radial long-axis cine magnetic resonance images. Sci Rep 11: 18879, 2021.
42. Hasan BS, Lunze FI, Chen MH, Brown DW, Boudreau MJ, Rhodes J, et al. Effects of transcatheter pulmonary valve replacement on the hemodynamic and ventricular response to exercise in patients with obstructed right ventricle-to-pulmonary artery conduits. JACC Cardiovasc Interv 7:530-542, 2014.

43. Khoo NS, Smallhorn JF, Kaneko S, Myers K, Kutty S, Tham EB. Novel insights into RV adaptation and function in hypoplastic left heart syndrome between the first 2 stages of surgical palliation. JACC Cardiovasc Imaging 4: 128-137, 2011.
44. Singh GK, Cupps B, Pasque M, Woodard PK, Holland MR, Ludomirsky A. Accuracy and reproducibility of strain by speckle tracking in pediatric subjects with normal heart and single ventricular physiology: a two-dimensional speckle-tracking echocardiography and magnetic resonance imaging correlative study. J Am Soc Echocardiogr 23: 1143-1152, 2010.
45. Elliott PM, Anastasakis A, Borger MA, Borggrefe M, Cecchi F, Charron P et al. 2014 ESC Guidelines on diagnosis and management of hypertrophic cardiomyopathy. Kardiol Pol 72: 1054-1126, 2014.
46. Afonso L, Kondur A, Simegn M, Niraj A, Hari P, Kaur R, et al. Two-dimensional strain profiles in patients with physiological and pathological hypertrophy and preserved left ventricular systolic function: a comparative analyses. British Med J Open 2: 2012.
47 D'Ascenzi F, Caselli S, Solari M, Pelliccia A, Cameli M, Focardi M, et al. Novel echocardiographic techniques for the evaluation of athletes' heart: A focus on speckle-tracking echocardiography. Eur J Prev Cardiol 23: 437-46, 2016.
48. Webb MK, Auerbach SR, Younoszai AK, Patel SS, Landeck BF 2nd. Strain and strain rate Measured on echocardiogram 1-3 weeks after starting treatment is worse in acute dilated cardiomyopathy pediatric patients with poor outcomes at one year. Echocardiography 32: 1688-1696, 2015.
49. Di Salvo G, Drago M, Pacileo G, Rea A, Carrozza M, Santoro G, et al. Atrial function after surgical and percutaneous closure of atrial septal defect: a strain rate imaging study. J Am Soc Echocardiogr 18: 930-933, 2005.
50. Bos JM, Hagler DJ, Silvilairat S, Cabalka A, O'Leary P, Daniels O, et al. Right ventricular function in asymptomatic individuals with a systemic right ventricle. J Am Soc Echocardiogr 19: 1033-1037, 2006.
51. Diller GP, Radojevic J, Kempny A, Alonso-Gonzalez R, Emmanouil L, Orwat S, et al. Systemic right ventricular longitudinal strain is reduced in adults with transposition of the great arteries, relates to subpulmonary ventricular function, and predicts adverse clinical outcome. Am Heart J 163: 859-866, 2012.
52. Panesar DK, Burch M. Assessment of Diastolic Function in Congenital Heart Disease Front. Cardiovasc. Med 2017; 4: 1-10.
53. Stantens B, Van de Bruaene A, De Meester P, D'Alto M, ReddyS, Bernstein D, Koestenberger M, Hansmann G, Budts W. Diagnosis and treatment of right ventricular dysfunction in congenital heart disease. Cardiovasc Diagn Ther 10: 1625-1645, 2020.
54. Öztarhan K. Tam düzeltme ameliyatı yapılan Fallot tetralojili hastalarda sağ ve sol ventrikül sistolik ve diastolik fonksiyonlarının doku Doppler'i ile değerlendirilmesi ve transanüler yama kullanılmasının sağ ventrikül fonksiyonları üzerine etkisi. Tez, İ. U. Kardiyoloji Enstitüsü 2000.
55. Mori K, Hayabuchi Y, Kuroda Y, Nii M, Manabe T. Left ventricular wall motion velocities in healthy children measured by pulsed wave Doppler tissue echocardiography: normal values and relation to age and heart rate. J Am Soc Echocardiogr 13: 1002–1011, 2000.
56. Ayabakan C, Özkutlu S. Left Ventricular Myocardial Velocities in Healthy Children: Quantitative Assessment By Tissue Doppler Echocardiography and Relation To the Characteristics of Filling of the Left Ventricle. Cardiol Young 14: 156-163, 2004.
57. Nagueh SF, Middleton KJ, Kopelen HA, Zoghbi WA, Quiñones MA. Doppler tissue imaging: a noninvasive technique for evaluation of left ventricular relaxation and estimation of filling pressures. J Am Coll Cardiol 30:1527–1533, 1997.
58. Derrick GP, Josen M, Vogel M, Henein MY, Shinebourne EA, Redingtor, AN. Abnormalities of right ventricular long axis function after atrial repair transposition of the great arteries. Heart 86:203-206, 2001.
59. Vitarelli A, Conde Y, Cimino E, D'Angeli I, D'Orazio S, Ventriglia F, et al. Quantitative assessment of systolic and diastolic ventricular function with tissue Doppler imaging after Fontan type of operation. Int J Cardiol 1021:61–69, 2005.
60. Friedberg MK, Redington AN. Right versus left ventricular failure: differences, similarities, and interactions. Circulation 129: 1033-1044, 2014.
61. Rudski LG, Lai WW, Afilalo J, Hua L, Handschumacher MD, Chandrasekaran K, et al. Guidelines fort he echocardiographic assessment of the right heart in adults: a report from the American Society of Echocardiography endorsed by the European Association of Echocardiography, a registered branch of the European Society of Cardiology, and the Canadian Society of Echocardiography. J Am Soc Echocardiogr 23: 685-713, 2010.
62. Venkatachalam S, Wu G, Ahmad M. Echocardiographic assessment of the right ventricle in the current era: Application in clinical practice. Echocardiography 34: 1930-1937, 2017.
63. Daubeney PE, Blackstone EH, Weintraub RG, Slavik Z, Scanlon J, Webber SA. Relationship of the dimension of cardiac structures to body size: an echocardiographic study in normal infants and children. Cardiol Young 9: 402-410, 1999.
64. Koestenberger M, Avian A, Raveke W. Reference values of the right ventricular outflow tract (RVOT) proximal diameter in 665 healthy children and calculation of z-score values. Int J Cardiol 169: e99-101, 2013.
65. Mah K, Mertens L. Echocardiographic Assessment of Right Ventricular Function in Paediatric Heart Disease: A Practical Clinical Approach CJC Pediatr Congenit Heart Dis 1:136–157, 2022.
66. García-Cuenllas Álvarez L, Gutiérrez-Larraya Aguado F, Maroto Álvaro E, Rodríguez-López Domingo A, Sánchez Fernández PL, García-Guereta Silva L, Lorente Toledano F. Reference values (Z-score) of inlet and trabecular portion diameters of the right ventricle: First description in Spanish healthy children]. Pediatr (Barc) 92: 147-155, 2020.
67. Lang RM, Badano LP, Mor-Avi V, Afilalo J, Armstrong A, Ernande L, et al. Recommendations for cardiac chamber quantification by echocardiography in adults: an update from the American Society of Echocardiography and European Association of Cardiovascular Imaging. J Am Soc Echocardiogr 28: 1-39, 2015.
68. Berendoncks AV, Grootel RV, McGhie J, Kranenburg MV, Menting M, Cuypers JAAE, Bogers AJJC, Witsenburg M, Roos-Hesselink JW, van den Bosch AE. Echocardiographic parameters of severe pulmonary regurgitation after surgical repair of tetralogy of Fallot. Congenit Heart Dis14: 628-637, 2019.

69. Warnes CA, Williams RG, Bashore TM, Child JS, Connolly HM, Dearani JA, et al. ACC/AHA 2008 Guidelines fort he management of adults with congenital heart disease. J Am Coll Cardiol 52: e150-e250, 2008.
70. Sherwood MC, Geva T. Noninvasive imaging of single ventricle Progress Pediatr Cardiol 16: 11-30, 2002.
71. Khoo NS, Tham EB, Kantor PF. Newer imaging modalities in the assessment of heart function in single ventricle hearts. Canadian J Cardiol 29: 886-889, 2013.
72. Colan SD. Systolic and diastolic function of the univentricular heart. Progress Pediatr Cardiol 16: 79-87, 2002.
73. Kleitsioti P, Koulaouzidis G, Giannakopoulou P, Charisopoulou D. The role of myocardial strain imaging in the pre- and post-operative assessment of patients with single ventricle. Rev Cardiovasc Med 24: 145, 2023.
74. Davis EK, Ginde S, Stelter J, Frommelt P, Hill GD. Echocardiographic assessment of single ventricle diastolic function and its correlation to short term outcomes after the Fontan operation. Congenit Heart Dis 14: 720-725, 2019.
75. Ginde S, Goot BH, Frommelt PC. İmaging adult patients with Fontan circulaltion. Curr Opin Cardiol 32: 521-528, 2017.
76. Kitter SB. Transesophageal real-time echocardiography in infants and children with conjeaital heart disease. J Am Coll Cardiol 18:569-580, 1991.
77. Sahn DJ. Perspectives in fetal echocardiography. Cardiol Young 4:90-98, 1994.
78. Hornberger LK, Sanders SP, Rain AJ, Spevak PJ, Paners IA, Colan SD. Left heart obstructive lesions and left ventricular growth in the midtrimester fetus: a longitudinal study. Circulation 92: 1531-1538, 1995.
79. Hornberger LK, Sanders SP, Sahn DJ. In utero pulmonary artery and aortJ Am Coll Cardiol 25: 739-745, 1995.



KONJENİTAL KALP HASTALIKLARININ ANTENATAL TANISI, FETAL EKOKARDİYOGRAFİ

BÖLÜM
3

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İçindekiler

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- SONUÇ

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SONUÇ

Fetal ekokardiyografinin temel amacı, doğum öncesi mevcut kalp hastalığını tanımlamak, risklerini belirlemek ve tedavi seçeneklerine karar vermektir. Böylece ebeveynleri üçüncü basamak kardiyak bakım merkezlerine transfer etmek, planlı doğum için hazırlamak, perinatal ve postnatal tedavi planı oluşturmak için zaman sağlanmış olur. Son yıllarda fetal ekokardiyografik değerlendirmelerle birlikte pediatrik kardiyoloji ve kardiyovasküler cerrahinin, doğum öncesi ve doğum sonrası yeni tanı ve tedavi stratejilerinin gelişmesi fetal kalp hastalıklarının morbitite ve mortalite sonuçlarının iyileşmesinde etkili olmuştur.

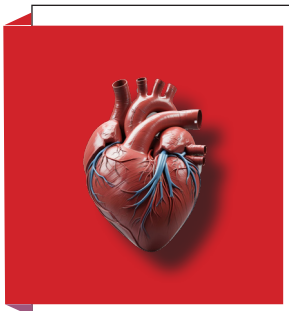
KAYNAKLAR

1. Moon-Grady AJ, Donofrio MT, Gelehrter S, Hornberger L, Kreeger J, Lee W, Michelfelder E, Morris SA, Peyvandi S, Pinto NM, Pruetz J, Sethi N, Simpson J, Srivastava S, Tian Z. Guidelines and Recommendations for Performance of the Fetal Echocardiogram: An Update from the American Society of Echocardiography. J Am Soc Echocardiogr. 2023 Jul;36(7):679-723. Epub 2023 May 24.
2. Dangel JH, Clur SA, Sharland G, Herberg U; Fetal Cardiology Working Group of the AEPC.Recommendations for the training and practice of fetal cardiology from the Association of European Paediatric Cardiology. Cardiol Young. 2024 Nov 11:1-10.
3. Meller CH, Grinenco S, Aiello H, Córdoba A, Sáenz-Tejeira MM, Marantz P, Lucas Otaño Congenital heart disease, prenatal diagnosis and management. Arch Argent Pediatr. 2020 Apr;118(2): e149-e161.
4. Deng J, Rodeck CH. New fetal cardiac imaging techniques. Prenat Diagn. 2004 Dec 30;24(13):1092-103. Revista Española de Cardiología (English Edition). Volume 65, Issue 8, August 2012, Pages 700-4
5. Medrano-Lopez C, Fouron J-C. Fetal Cardiology, the Frontier of Pediatric Cardiovascular Medicine Cardiología fetal, la frontera de la medicina cardiovascular. Revista Española de Cardiología (English Edition). Volume 65, Issue 8, August 2012, Pages 700-4.
6. Morton SU, Brodsky D. Fetal Physiology and the Transition to Extrauterine Life. Clin Perinatol. 2016 Sep;43(3):395-407. Epub 2016 Jun 11.
7. Herberg U, Breuer J, Gembruch U, Willruth A. Imaging in fetal cardiology. Minerva Pediatr. 2014 Oct;66(5):453-71.
8. Mary T Donofrio, Anita J Moon-Grady, Lisa K Hornberger, Joshua A Copel, Mark S Sklansky, Alfred Abuhamad, Bettina F Cuneo, James C Huhta, Richard A Jonas, Anita Krishnan, Stephanie Lacey, Wesley Lee, Erik C Michelfelder Sr, Gwen R Rempel, Norman H Silverman, Thomas L Spray, Janette F Strasburger, Wayne Tworetzky, Jack Rychik; American Heart Association Adults With Congenital Heart Disease Joint Committee of the Council on Cardiovascular Disease in the Young and Council on Clinical Cardiology, Council on Cardiovascular Surgery and Anesthesia, and Council on Cardiovascular and Stroke Nursing. Diagnosis and treatment of fetal cardiac disease: a scientific statement from the American Heart Association. Circulation. 2014 May 27;129(21):2183-242. Epub 2014 Apr 24.
9. Gabriel CC, Galindo A, Martínez J M, Carrera J M, Gutiérrez-Larraya F, Fuente P, Puerto B, Borrell A. Early prenatal diagnosis of major cardiac anomalies in a high-risk population. Prenat Diagn. 2002 Jul;22(7):586-93.
10. Abuhamad A. Color and pulsed Doppler in fetal echocardiography. Ultrasound Obstet Gynecol. 2004 Jul;24(1):1-9.
11. Stewart PA, Wladimiroff JW. Fetal echocardiography and color Doppler flow imaging: the Rotterdam experience. Ultrasound Obstet Gynecol. 1993 May 1;3(3):168-75.
12. Bravo-Valenzuela NJ, Peixoto AB, Araujo Júnior E. Prenatal diagnosis of congenital heart disease: A review of current knowledge. Indian Heart J. 2018 Jan-Feb;70(1):150-64. Epub 2017 Dec 16.
13. Choi JY , Noh CI, Yun YS. Study on Doppler waveforms from the fetal cardiovascular system. Fetal Diagn Ther. 1991;6(1-2):74-83.
14. Brezinka C. Fetal hemodynamics. J Perinat Med. 2001;29(5):371-80.
15. Serati L, VartaMardigyan V, Costanza Caccia Dominioni CC, Francesco Agozzino F, Bizzi E, Trotta L, Nivuori M, Maestroni S , Negro E, Imazio M, Brucato A. Pericardial Diseases in Pregnancy. Can J Cardiol. 2023 Aug;39(8):1067-77. Epub 2023 Apr 20.
16. Julien I E Hoffman, Samuel Kaplan. The incidence of congenital heart disease. J Am Coll Cardiol. 2002 Jun 19;39(12):1890-900.
17. L J Salomon, Z Alfirevic, V Berghella, C Bilardo, E Hernandez-Andrade, S L Johnsen, K Kalache, K-Y Leung, G Malinger, H Munoz, F Prefumo, A Toi, W Lee; ISUOG Clinical Standards Committee. Practice guidelines for performance of the routine mid-trimester fetal ultrasound scan. Ultrasound Obstet Gynecol. 2011 Jan;37(1):116-26.
18. Allan LD, Huggon IC. Counselling following a diagnosis of congenital heart disease. Prenat Diagn. 2004; 24:1136–42.
19. Rosenberg KB, Monk C, Glickstein JS, Levasseur SM, Simpson LL, Kleinman CS, Williams IA. Referral for fetal echocardiography is asso ciated with increased maternal anxiety. J Psychosom Obstet Gynaecol. 2010; 31: 60–9.
20. Sklansky M, Tang A, Levy D, Grossfeld P, Kashani I, Shaughnessy R, Rothman A. Maternal psychological impact of fetal echocardiography. J Am Soc Echocardiogr. 2002; 15: 159–66.
21. Huizink AC, Robles de Medina PG, Mulder EJ, Visser GH, Buitelaar JK. Stress during pregnancy is associated with developmental outcome in infancy. J Child Psychol Psychiatry. 2003; 44: 810–8.
22. Maina G, Saracco P, Giolito MR, Danelon D, Bogetto F, Todros T. Impact of maternal psychological distress on fetal weight, prematurity and intrauterine growth retardation. J Affect Disord. 2008; 111: 214–20.

23. Anita Szwast, Jack Rychik. Current concepts in fetal cardiovascular disease. Clin Perinatol. 2005 Dec;32(4):857-75, viii.
24. Deren O , Aykan HH , Ozyuncu O, Aypar E, Cagan M , Ozen O , Karagoz T. Fetal cardiac interventions: First-year experience of a tertiary referral center in Turkey. J Obstet Gynaecol Res. 2023 Jun;49(6):1525-31. Epub 2023 Apr 2.
25. Tworetzky W, McElhinney DB, Marx GR, Benson CB, Brusseau R, Morash D, Wilkins-Haug LE, Lock JE, Marshall AC. In utero valvulo plasty for pulmonary atresia with hypoplastic right ventricle: techniques and outcomes. Pediatrics. 2009;124: e510–e518.
26. Makikallio K, McElhinney DB, Levine JC, Marx GR, Colan SD, Marshall AC, Lock JE, Marcus EN, Tworetzky W. Fetal aortic valve stenosis and the evolution of hypoplastic left heart syndrome: patient selection for fetal intervention. Circulation. 2006; 113: 1401–5.
27. McElhinney DB, Marshall AC, Wilkins-Haug LE, Brown DW, Benson CB, Silva V, Marx GR, Mizrahi-Arnaud A, Lock JE, Tworetzky W. Predictors of technical success and postnatal biventricular outcome after in utero aortic valvuloplasty for aortic stenosis with evolving hypoplastic left heart syndrome. Circulation. 2009; 120:1482–90.
28. Kohl T, Sharland G, Allan LD, Gembruch U, Chaoui R, Lopes LM, Zielinsky P, Huhta J, Silverman NH. World experience of percutaneous ultrasound-guided balloon valvuloplasty in human fetuses with severe aortic valve obstruction. Am J Cardiol. 2000; 85:1230–3.
29. Tworetzky W, Wilkins-Haug L, Jennings RW, van der Velde ME, Marshall AC, Marx GR, Colan SD, Benson CB, Lock JE, Perry SB. Balloon dilation of severe aortic stenosis in the fetus: potential for prevention of hypoplastic left heart syndrome: candidate selection, technique, and results of successful intervention. Circulation. 2004; 110:2125–31.
30. Hornberger LK, Need L, Benacerraf BR. Development of significant left and right ventricular hypoplasia in the second and third trimester fetus. J Ultrasound Med. 1996; 15:655–9.
31. Rychik J, Rome JJ, Collins MH, DeCampli WM, Spray TL. The hypo plastic left heart syndrome with intact atrial septum: atrial morphology, pulmonary vascular histopathology and outcome. J Am Coll Cardiol. 1999; 34:554–60.
32. Vlahos AP, Lock JE, McElhinney DB, van der Velde ME. Hypoplastic left heart syndrome with intact or highly restrictive atrial septum: outcome after neonatal transcatheter atrial septostomy. Circulation. 2004; 109:2326–30.
33. Glatz JA, Tabbutt S, Gaynor JW, Rome JJ, Montenegro L, Spray TL, Rychik J. Hypoplastic left heart syndrome with atrial level restriction in the era of prenatal diagnosis. Ann Thorac Surg. 2007; 84:1633–8.
34. Michelfelder E, Gomez C, Border W, Gottliebson W, Franklin C. Predictive value of fetal pulmonary venous flow patterns in identifying the need for atrial septoplasty in the newborn with hypoplastic left ven tricle. Circulation. 2005; 112:2974–9.
35. Szwast A, Tian Z, McCann M, Donaghue D, Rychik J. Vasoreactive response to maternal hyperoxygenation in the fetus with hypoplastic left heart syndrome. Circ Cardiovasc Imaging. 2010; 3:172–8.
36. Marshall AC, van der Velde ME, Tworetzky W, Gomez CA, Wilkins Haug L, Benson CB, Jennings RW, Lock JE. Creation of an atrial septal defect in utero for fetuses with hypoplastic left heart syndrome and intact or highly restrictive atrial septum. Circulation. 2004; 110:253–8.
37. Marshall AC, Levine J, Morash D, Silva V, Lock JE, Benson CB, Wilkins-Haug LE, McElhinney DB, Tworetzky W. Results of in utero atrial septoplasty in fetuses with hypoplastic left heart syndrome. Prenat Diagn. 2008; 28 :1023–8.
38. Vogel M, McElhinney DB, Wilkins-Haug LE, Marshall AC, Benson CB, Juraszek AL, Silva V, Lock JE, Marx GR, Tworetzky W. Aortic stenosis and severe mitral regurgitation in the fetus resulting in giant left atrium and hydrops: pathophysiology, outcomes, and preliminary experience with pre-natal cardiac intervention. J Am Coll Cardiol. 2011; 57:348–55.
39. Rogers LS, Peterson AL, Gaynor JW, Rome JJ, Weinberg PM, Rychik J. Mitral valve dysplasia syndrome: a unique form of left-sided heart disease. J Thorac Cardiovasc Surg. 2011; 142:1381–7.
40. Roman KS, Fouron JC, Nii M, Smallhorn JF, Chaturvedi R, Jaeggi ET. Determinants of outcome in fetal pulmonary valve stenosis or atresia with intact ventricular septum. Am J Cardiol. 2007; 99:699–703.
41. Gardiner HM, Belmar C, Tulzer G, Barlow A, Pasquini L, Carvalho JS, Daubeney PE, Rigby ML, Gordon F, Kulinskaya E, Franklin RC. Morphologic and functional predictors of eventual circulation in the fetus with pulmonary atresia or critical pulmonary stenosis with intact septum. J Am Coll Cardiol. 2008;51: 1299–308.
42. Tulzer G, Arzt W, Franklin RC, Loughna PV, Mair R, Gardiner HM. Fetal pulmonary valvuloplasty for critical pulmonary stenosis or atresia with intact septum. Lancet. 2002; 360:1567–8.
43. Fesslova V, Villa L, Nava S, Mosca F, Nicolini U. Fetal and neonatal echocardiographic findings in twin-twin transfusion syndrome. Am J Obstet Gynecol. 1998; 179:1056–62.
44. Barrea C, Alkazaleh F, Ryan G, McCrindle BW, Roberts A, Bigras JL, Barrett J, Seaward GP, Smallhorn JF, Hornberger LK. Prenatal car diovascular manifestations in the twin-to-twin transfusion syndrome recipients and the impact of therapeutic amnioreduction. Am J Obstet Gynecol. 2005; 192:892–902.
45. Lougheed J, Sinclair BG, Fung Kee Fung K, Bigras JL, Ryan G, Smallhorn JF, Hornberger LK. Acquired right ventricular outflow tract obstruction in the recipient twin in twin-twin transfusion syndrome. J Am Coll Cardiol. 2001; 38:1533–8.
46. Rychik J, Tian Z, Bebbington M, Xu F, McCann M, Mann S, Wilson RD, Johnson MP. The twin-twin transfusion syndrome: spectrum of cardio vascular abnormality and development of a cardiovascular score to assess severity of disease. Am J Obstet Gynecol. 2007; 197: 392.e1–392.e8
47. Senat MV, Deprest J, Boulvain M, Paupe A, Winer N, Ville Y. Endoscopic laser surgery versus serial amnioreduction for severe twin-to-twin trans fusion syndrome. N Engl J Med. 2004; 351:136–44.
48. Van Mieghem T, Klaritsch P, Done E, Gucciardo L, Lewi P, Verhaeghe J, Lewi L, Deprest J. Assessment of

fetal cardiac function before and after therapy for twin-to-twin transfusion syndrome. Am J Obstet Gynecol. 2009; 200:400e1–400.e7.
49. Herberg U, Gross W, Bartmann P, Banek CS, Hecher K, Breuer J. Long term cardiac follow up of severe twin to twin transfusion syndrome after intrauterine laser coagulation. Heart. 2006; 92:95–100.
50. Van Mieghem T, Martin A, Weber R, Barrea C, Windrim R, Hornberger L, Jaeggi E, Ryan G. Fetal cardiac function in recipient twins under going fetoscopic laser ablation of placental anastomoses for stage IV twin-twin transfusion syndrome (TTTS). Ultrasound Obstet Gynecol. 2013; 42:64–9.
51. Halvorsen CP, Bilock SL, Pilo C, Sonesson SE, Norman M. Childhood cardiac function after twin-to-twin transfusion syndrome: a 10-year fol low up. Acta Paediatr. 2009; 98:1468–74. 520.
52. Gardiner HM, Taylor MJ, Karatza A, Vanderheyden T, Huber A, Greenwald SE, Fisk NM, Hecher K. Twin-twin transfusion syndrome: the influence of intrauterine laser photocoagulation on arterial distensi bility in childhood. Circulation. 2003; 107:1906–11.
53. Bradley S Allen Fetal cardiac surgery: simplicity versus success in a new frontier. J Thorac Cardiovasc Surg. 2003 Nov;126(5):1254-6.
54. Halley FL. Fetal cardiac surgery. Adv Card Surg. 1994:5:47-74.
55. S M Bradley , F L Hanley, B W Duncan, R W Jennings, J A Jester, M R Harrison, E D Verrier. Fetal cardiac bypass alters regional blood flows, arterial blood gases, and hemodynamics in sheep. Am J Physiol. 1992 Sep;263(3 Pt 2):H919-28.
56. Fenton KN, Zinn HE, Heinemann MK, Liddicoat JR, Hanley FL. Long-term survivors of fetal cardiac bypass in lambs. J Thorac Cardiovasc Surg. 1994 Jun;107(6):1423-7.
57. Park HK, Park YH. Fetal surgery for congenital heart disease Yonsei Med J. 2001 Dec;42(6):686-94.
58. Sabik JF, Heinemann MK, Assad RS, Hanley FL. High-dose steroids prevent placental dysfunction after fetal cardiac bypass. J Thorac Cardiovasc Surg. 1994 Jan;107(1):116-24; discussion 124-5.
59. Adzick NS. Open fetal surgery for life-threatening fetal anomalies. Semin Fetal Neonat Med. 2009; 15:1–8.
60. Rychik J, Tian Z, Cohen MS, Ewing SG, Cohen D, Howell LJ, Wilson RD, Johnson MP, Hedrick HL, Flake AW, Crombleholme TM, Adzick NS. Acute cardiovascular effects of fetal surgery in the human. Circulation. 2004; 110:1549–1556.
61. Tworetzky W, McElhinney DB, Reddy VM, Brook MM, Hanley FL, Silverman NH. Improved surgical outcome after fetal diagnosis of hypo plastic left heart syndrome. Circulation. 2001; 103:1269–73.
62. Kipps AK, Feuille C, Azakie A, Hoffman JI, Tabbutt S, Brook MM, Moon-Grady AJ. Prenatal diagnosis of hypoplastic left heart syndrome in current era. Am J Cardiol. 2011; 108:421–7.
63. Mahle WT, Clancy RR, McGaurn SP, Goin JE, Clark BJ. Impact of prena tal diagnosis on survival and early neurologic morbidity in neonates with the hypoplastic left heart syndrome. Pediatrics. 2001; 107:1277–82.
64. Bonnet D, Coltri A, Butera G, Fermont L, Le Bidois J, Kachaner J, Sidi D. Detection of transposition of the great arteries in fetuses reduces neo natal morbidity and mortality. Circulation. 1999; 99:916–8.
65. Punn R, Silverman NH. Fetal predictors of urgent balloon atrial septos tomy in neonates with complete transposition. J Am Soc Echocardiogr. 2011; 24:425–30.
66. Franklin O, Burch M, Manning N, Sleeman K, Gould S, Archer N. Prenatal diagnosis of coarctation of the aorta improves survival and reduces morbidity. Heart. 2002; 87:67–9.
67. Tzifa A, Barker C, Tibby SM, Simpson JM. Prenatal diagnosis of pulmo nary atresia: impact on clinical presentation and early outcome. Arch Dis Child Fetal Neonatal Ed. 2007; 92: F199–F203.
68. Eapen RS, Rowland DG, Franklin WH. Effect of prenatal diagnosis of critical left heart obstruction on perinatal morbidity and mortality. Am J Perinatol. 1998; 15:237–42.
69. Copel JA, Tan AS, Kleinman CS. Does a prenatal diagnosis of congeni tal heart disease alter short-term outcome? Ultrasound Obstet Gynecol. 1997; 10:237–41.
70. Jaeggi ET, Carvalho JS, De Groot E, Api O, Clur SA, Rammeloo L, McCrindle BW, Ryan G, Manlhiot C, Blom NA. Comparison of trans placental treatment of fetal supraventricular tachyarrhythmias with digoxin, flecainide, and sotalol: results of a nonrandomized multicenter study. Circulation. 2011; 124:1747–54.
71. Trucco SM, Jaeggi E, Cuneo B, Moon-Grady AJ, Silverman E, Silverman N, Hornberger LK. Use of intravenous gamma globulin and corticosteroids in the treatment of maternal autoantibody-mediated car diomyopathy. J Am Coll Cardiol. 2011; 57:715–23.
72. Patel D, Cuneo B, Viesca R, Rassanan J, Leshko J, Huhta J. Digoxin for the treatment of fetal congestive heart failure with sinus rhythm assessed by cardiovascular profile score. J Matern Fetal Neonatal Med. 2008; 21:477–82.
73. Levey A, Glickstein JS, Kleinman CS, Levasseur SM, Chen J, Gersony WM, Williams IA. The impact of prenatal diagnosis of complex congenital heart disease on neonatal outcomes. Pediatr Cardiol. 2010; 31:587–97.
74. Atz AM, Travison TG, Williams IA, Pearson GD, Laussen PC, Mahle WT, Cook AL, Kirsh JA, Sklansky M, Khaikin S, Goldberg C, Frommelt M, Krawczeski C, Puchalski MD, Jacobs JP, Baffa JM, Rychik J, Ohye RG; Pediatric Heart Network Investigators. Prenatal diagnosis and risk factors for preoperative death in neonates with single right ventricle and systemic outflow obstruction: screening data from the Pediatric Heart Network Single Ventricle Reconstruction Trial. J Thorac Cardiovasc Surg. 2010; 140:1245–50.
75. Parry S, Marder SJ. Delivery and obstetrical issues. In: Rychik J, Wernovsky G, ed. Hypoplastic Left Heart Syndrome. New York, NY: Springer; 2003:29–37.
76. Peterson AL, Quartermain MD, Ades A, Khalek N, Johnson MP, Rychik J. Impact of mode of delivery on markers of perinatal hemodynamics in infants with hypoplastic left heart syndrome. J Pediatr. 2011; 159:64–9.
77. Penny DJ, Shekerdemian LS. Management of the neonate with symp tomatic congenital heart disease. Arch Dis Child Fetal Neonatal Ed. 2001; 84: F141–F145.
78. Johnson BA, Ades A. Delivery room and early postnatal management of neonates who have prenatally diagnosed congenital heart disease. Clin Perinatol. 2005; 32:921–46, ix.

79. Rasanen J, Wood DC, Weiner S, Ludomirski A, Huhta JC. Role of the pulmonary circulation in the distribution of human fetal cardiac output during the second half of pregnancy. Circulation. 1996;94: 1068–73.
80. Berkley EM, Goens MB, Karr S, Rappaport V. Utility of fetal echocar diography in postnatal management of infants with prenatally diagnosed congenital heart disease. Prenat Diagn. 2009; 29:654–8.
81. Donofrio MT, Levy RJ, Schuette JJ, Skurow-Todd K, Sten M, Stallings C, Pike J, Krishnan A, Ratnayaka K, Sinha P, du Plessis AJ, Downing DD, Fries MI, Berger JT. Specialized delivery room planning for fetuses with critical congenital heart disease. Am J Cardiol. 2012; 111:737–47.
82. Rudolph AM. Congenital Diseases of the Heart: Clinical-Physiological Considerations. Armonk, NY: Future Publishing Co; 2001.
83. Anagnostou K, Messenger L, Yates R, Kelsall W. Outcome of infants with prenatally diagnosed congenital heart disease delivered outside specialist paediatric cardiac centres. Arch Dis Child Fetal Neonatal Ed. 2013; 98: F218–F221.
84. Glatz AC, Gaynor JW, Rhodes LA, Rychik J, Tanel RE, Vetter VL, Kaltman JR, Nicolson SC, Montenegro L, Shah MJ. Outcome of high risk neonates with congenital complete heart block paced in the first 24 hours after birth. J Thorac Cardiovasc Surg. 2008; 136:767–73.
85. Mirlesse V, Cruz A, Le Bidois J, Diallo P, Fermont L, Kieffer F, Magny JF, Jacquemard F, Levy R, Voyer M, Daffos F. Perinatal management of fetal cardiac anomalies in a specialized obstetric-pediatrics center. Am J Perinatol. 2001; 18:363–71.
86. James C Huhta , James J Paul. Doppler in fetal heart failure. Clin Obstet Gynecol. 2010 Dec;53(4):915-29.
87. Tamar Perri , Bina Cohen-Sacher, Moshe Hod, Michael Berant, Israel Meizner, Jacob Bar. Risk factors for cardiac malformations detected by fetal echocardiography in a tertiary center. J Matern Fetal Neonatal Med. 2005 Feb;17(2):123-8.
88. Rebekka Lytzen , Niels Vejlstrup , Jesper Bjerre , Olav Bjørn Petersen , Stine Leenskjold , James Keith Dodd , Finn Stener Jørgensen , Lars Søndergaard . The accuracy of prenatal diagnosis of major congenital heart disease is increasing. J Obstet Gynaecol. 2020 Apr;40(3):308-15. Epub 2019 Aug 28.
89. Nagasawa H, Hamada C, Wakabayashi M, Nakagawa Y, Nomura S, Kohno Y. Time to spontaneous ductus arteriosus closure in full-term neonates. Open Heart. 2016; 3(1): e 000413
90. Singh Y, Tissot C. Echocardiographic eval uation of transitional circulation for the neonatologists. Front Pediatr. 2018; 6:140
91. Gaynor JW, Wernovsky G, Jarvik GP, et al. Patient characteristics are important determinants of neurodevelopmental outcome at one year of age after neonatal and infant cardiac surgery. J Thorac Cardiovasc Surg. 2007; 133:1344–53, 1353.e1343
92. Kumar TK, Charpie JR, Ohye RG, et al. Timing of neonatal cardiac surgery is not associated with perioperative outcomes. J Thorac Cardiovasc Surg. 2014;147(5):1573–9
93. Anderson BR, Ciarleglio AJ, Hayes DA, Quaegebeur JM, Vincent JA, Bacha EA. Earlier arterial switch operation improves outcomes and reduces costs for neonates with transposition of the great arteries. J Am Coll Cardiol. 2014;63(5):481–7
94. Cain MT, Cao Y, Ghanayem NS, et al. Transposition of the great arteries outcomes and time interval of early neonatal repair. World J Pediatr Congenit Heart Surg. 2014;5(2):241–7
95. O'Byrne ML, Glatz AC, Song L, et al. Association between variation in preoperative care before arterial switch operation and outcomes in patients with transposition of the great arteries. Circulation. 2018;138(19):2119–29
96. Ghanayem NS, Allen KR, Tabbutt S, et al; Pediatric Heart Network Investigators. Interstage mortality after the Norwood procedure: Results of the multicenter Single Ventricle Reconstruction trial. J Thorac Cardiovasc Surg. 2012; 144(4):896–906
97. Karamlou T, Sexson K, Parrish A, et al. One size does not fit all: the influence of age at surgery on outcomes following Norwood operation. J Cardiothorac Surg. 2014;9 :100
98. Kelle AM, Backer CL, Gossett JG, Kaushal S, Mavroudis C. Total anomalous pulmonary venous connection: results of surgical repair of 100 patients at a single institution. J Thorac Cardiovasc Surg. 2010;139(6):1387–1394.e3
99. Karamlou T, Gurofsky R, Al Sukhni E, et al. Clinical perspective. Circulation. 2007; 115:1591–8
100. Lehnert A, Villemain O, Gaudin R, Meot M, Raisky O, Bonnet D. Risk factors of mortality and recoarctation after coarctation repair in infancy. Interact Car diovasc Thorac Surg. 2019;29(3):469–75
101. Mery CM, Guzman-Pruneda FA, Trost JG Jr, et al. Contemporary results of aortic coarctation repair through left thoracot omy. Ann Thorac Surg. 2015;100(3):1039–46



KONJENİTAL KALP HASTALIKLARINDA KARDİYAK KATETERİZASYON VE ANJİYOGRAFİ

BÖLÜM 4

Merve Maze AYDEMİR [1]
Feyza Ayşenur PAÇ [2]

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İçindekiler

- GİRİŞ
- TANISAL KARDİYAK KATETERİZASYON
  - Çalışmanın Planlanması
  - Premedikasyon, Sedasyon ve Anestezi
  - Vasküler Yollar
  - Femoral Yaklaşım
  - İnternal Juguler Yaklaşım
  - Subklavyen Yaklaşım
  - Umbilikal Yaklaşım
  - Hepatik Yaklaşım
  - Kateterler ve Teller
  - Kateter Manüplasyonu
  - Hemodinamik Verilerin Elde Edilmesi
  - Hemodinamik Değişkenlerin Ölçümü
  - Kardiyak Outputun Hesaplanmasında Oksijen Metodu
  - Termodilüsyon Metodu
  - İntrakardiyak Şantlar
  - Şantların Kantitatif Değerlendrilmesi
  - Şantların Kalitatif Değerlendirilmesi
  - Vasküler Rezistans
  - Oksijen ve Nitrik oksit inhalasyon çalışmaları
  - Kapak alanı ve basınç gradiyenti
- ANJİYOGRAFİ
  - Kontrast Ajanlar
  - Radyasyon Dozu ve Maruziyet
  - Hasta Dozu
  - Kateter Laboratuarı Personel Maruziyeti
  - Anjiyografi
  - Biventriküer Kalbin Görüntülenmesi
  - Spesifik Teknikler
- KOMPLİKASYONLAR
  - Aritmiler
  - Hipoventilasyon
  - Embolizm
  - Kardiyak Perforasyon
  - Hipersiyanotik Atak
  - Pulmoner Vasküler Hastalığı Olan Hastalar
  - Periferal Vasküler Hasar
  - Lateks Alerjisi

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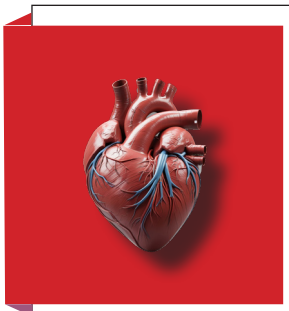
tomlara neden olabilir. Ciddi anafilaksi genellikle cerrahi sırasında lateks cerrahi eldivenlere maruz kalma sonucu ortaya çıkar. Daha önce lateksle temas sonucu hafif semptomlar yaşayan hastalarda bile bu sorun görülebilir. Ancak, intravasküler lateks kateter balonlarının kullanımından kaynaklanan anafilaksi vakası bildirilmemiştir. Lateks alerjisi öyküsü olan hastalarda kardiyak kateterizasyon yapılırken, lateks önlemleri için standart kurum protokollerine uyulmalıdır.(1)

KAYNAKLAR

1. Taggart NW, Anderson JH, Cabalka AK. Cardiac Catheterization and Angiography. In: Shaddy RE, Penny DJ, Feltes TF, Cetta F, Mital S, eds. *Moss & Adams' Heart Disease in Infants, Children, and Adolescents: Including the Fetus and Young Adult*. tenth. Wolters Kluwer Health; 2021:1272-1350.
2. Butera G, Chessa M, Eicken A, Thomson J. *Cardiac Catheterization for Congenital Heart Disease: From Fetal Life to Adulthood*. First.; 2015. doi:10.1007/978-88-470-5681-7
3. Holzer RJ, Bergersen L, Thomson J, et al. PICS/AEPC/APPCS/CSANZ/SCAI/SOLACI: Expert Consensus Statement on Cardiac Catheterization for Pediatric Patients and Adults With Congenital Heart Disease. *JACC Cardiovasc Interv*. 2024;17(2):115-216. doi:10.1016/j.jcin.2023.11.001
4. Lee J, Ratnayaka K, Moore J, El-Said H. Stenting the vertical neonatal ductus arteriosus via the percutaneous axillary approach. *Congenit Heart Dis*. 2019;14(5):791-796. doi:10.1111/chd.12786
5. Breatnach CR, Aggarwal V, Al-Alawi K, et al. Percutaneous axillary artery approach for ductal stenting in critical right ventricular outflow tract lesions in the neonatal period. *Catheter Cardiovasc Interv*. 2019;93(7):1329-1335. doi:10.1002/ccd.28302
6. Dhulipudi B, Bakhru S, Singh JR, Koneti NR. Transhepatic device closure of atrial septal defect in children associated with interrupted inferior vena cava. *Ann Pediatr Cardiol*. 2022;15(2):160-163. doi:10.4103/apc.apc_228_21
7. Hoeper MM, Maier R, Tongers J, et al. Determination of cardiac output by the Fick method, thermodilution, and acetylene rebreathing in pulmonary hypertension. *Am J Respir Crit Care Med*. 1999;160(2):535-541. doi:10.1164/ajrccm.160.2.9811062
8. LaFarge CG, Miettinen OS. The estimation of oxygen consumption. *Cardiovasc Res*. 1970;4(1):23-30.
9. Vargo T. Cardiac catheterization: hemodynamic measurements. In: Garson AJ, Bricker J, Fisher D, Neish S, eds. *The Science and Practice of Pediatric Cardiology*. 2nd ed. Williams & Wilkins; 1998:961-963.
10. Hill KD, Lim DS, Everett AD, Ivy DD, Moore JD. Assessment of pulmonary hypertension in the pediatric catheterization laboratory: Current insights from the magic registry. *Catheter Cardiovasc Interv*. 2010;76(6):865-873. doi:10.1002/ccd.22693
11. Gorlin R, Gorlin SG. Hydraulic formula for calculation of the area of the stenotic mitral valve, other cardiac valves, and central circulatory shunts. I. *Am Heart J*. 1951;41(1):1-29. doi:10.1016/0002-8703(51)90002-6
12. Gokalp S, Tanidir IC, Ozturk E, Ergul Y, Guzeltas A. Radiation dose reduction in congenital heart disease patients during cardiac catheterization by a novel protocol. *Turkish Arch Pediatr*. 2021;56(4):332-338. doi:10.5152/TurkArchPediatr.2021.20068
13. Mehta R, Lee K, Chaturvedi R, Benson L. Complications of pediatric cardiac catheterization: A review in the current era. *Catheter Cardiovasc Interv*. 2008;72(2):278-285. doi:10.1002/ccd.21580



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KONJENİTAL KALP HASTALIKLARINDA BİLGİSAYARLI TOMOGRAFİ VE MANYETİK REZONANS GÖRÜNTÜLEME

BÖLÜM 5

Serçin ÖZKÖK [1]

İçindekiler

- DOĞUMSAL KALP HASTALIKLARINDA GÖRÜNTÜLEME TEKNİKLERİ
  - Kardiyovasküler Bilgisayarlı Tomografi/Anjiografi
  - Kardiyovasküler Manyetik Rezonans Görüntüleme/ Anjiografi
- DOĞUMSAL KALP HASTALIKLARINDA GÖRÜNTÜLEME
  - Basit Şant Hastalıkları (ASD, VSD, Aortopulmoner pencere, PDA)
  - Aortik Ark Anomalileri
  - Pulmoner Arter Anomalileri
  - Trunkus Arteriozus
  - Fallot Tetralojisi
  - Çift Çıkışlı Sağ Ventrikül
  - Büyük Arter Transpozisyonu (D-TGA ve L-TGA)
  - Pumoner Atrezi- Ventriküler Septal Defekt
  - Total ve Parsiyel Anormal Pulmoner Venöz Anomalisi
  - Triküspid Kapağın Ebstein Anomalisi
  - Fonksiyone Tek Ventrikül

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ventriküler volüm yükü ve plevral effüzyon gibi etkiler yaratan aortopulmoner kolateral varlığında kollateral akış kardiyak MRG ile hesaplanabilir (70). Kardiyak MRG ayrıca 4-boyutlu akım ve hesaplamalı akışkan dinamiği uygulamaları ile karmaşık akış desenlerini ölçme ve görselleştirme imkânı sunar (71).

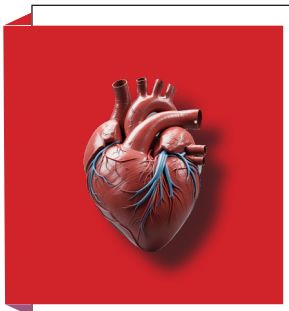
Kardiyak BT, kardiyak MRG'in kontrendike olduğu veya başarısız olduğu durumlarda tercih edilir. Yüksek intratorasik lenfatik basınç veya lenfatik akışın tıkanması sonucu oluşan lenfoalveolar fistül veya plastik bronşit gibi komplikasyonların, bunlarla ilişkili distal atelektazi ve konsolidasyonun değerlendirilmesinde tercih sebebidir (72).

KAYNAKLAR

1. Malone LJ, Morin CE, Browne LP. Coronary computed tomography angiography in children. Pediatr Radiol. 2022;52(13):2498-2509. doi:10.1007/s00247-021-05209-2
2. Pushparajah K, Duong P, Mathur S, Babu-Narayan S. Educational series in congenital heart disease: Cardiovascular MRI and CT in congenital heart disease. Echo Res Pract. 2019;6(3):R73-R85. doi:10.1530/ERP-19-0048
3. Hong SH, Goo HW, Maeda E, Choo KS, Tsai IC; Asian Society of Cardiovascular Imaging Congenital Heart Disease Study Group. User-friendly vendor-specific guideline for pediatric cardiothoracic computed tomography provided by the Asian Society of Cardiovascular Imaging Congenital Heart Disease Study Group: Part 1. Imaging techniques. Korean J Radiol. 2019;20(2):190-204. doi:10.3348/kjr.2018.0571
4. Crean A. Cardiovascular MR and CT in congenital heart disease. Heart. 2007;93(12):1637-1647. doi:10.1136/hrt.2006.104729
5. Telkar HB, Dikshit A, Rajeshkannan R. Technical aspects of pediatric cardiac CT. In: Rajeshkannan R, Raj V, Viswamitra S, eds. CT and MRI in Congenital Heart Diseases. Springer; 2021:45-67. doi:10.1007/978-981-15-6755-1_4
6. Ntsinjana HN, Hughes ML, Taylor AM. The role of cardiovascular magnetic resonance in pediatric congenital heart disease. J Cardiovasc Magn Reson. 2011;13(1):51. doi:10.1186/1532-429X-13-51
7. Valsangiacomo Buechel ER, Grosse-Wortmann L, Fratz S, et al. Indications for cardiovascular magnetic resonance in children with congenital and acquired heart disease: an expert consensus paper of the Imaging Working Group of the AEPC and the Cardiovascular Magnetic Resonance Section of the EACVI. Eur Heart J Cardiovasc Imaging. 2015;16(3):281-297. doi:10.1093/ehjci/jeu129
8. Moscatelli S, Pozza A, Leo I, et al. Importance of cardiovascular magnetic resonance applied to congenital heart diseases in pediatric age: A narrative review. Children (Basel). 2024;11(7):878. doi:10.3390/children11070878
9. Mitchell FM, Prasad SK, Greil GF, Drivas P, Vassiliou VS, Raphael CE. Cardiovascular magnetic resonance: Diagnostic utility and specific considerations in the pediatric population. World J Clin Pediatr. 2016;5(1):1-15. doi:10.5409/wjcp.v5.i1.1
10. Pushparajah K. Non-invasive imaging in the evaluation of cardiac shunts for interventional closure. Front Cardiovasc Med. 2021;8:651726. doi:10.3389/fcvm.2021.651726
11. Rajiah P, Kanne JP. Cardiac MRI: Part 1, cardiovascular shunts. AJR Am J Roentgenol. 2011;197(4):W603-W620. doi:10.2214/AJR.10.7257
12. Budts W, Miller O, Babu-Narayan SV, et al. Imaging the adult with simple shunt lesions: position paper from the EACVI and the ESC WG on ACHD. Endorsed by AEPC (Association for European Paediatric and Congenital Cardiology). Eur Heart J Cardiovasc Imaging. 2021;22(6):e58-e70. doi:10.1093/ehjci/jeaa314
13. Hellinger JC, Daubert M, Lee EY, Epelman M. Congenital thoracic vascular anomalies: evaluation with state-of-the-art MR imaging and MDCT. Radiol Clin North Am. 2011;49(5):969-996.
14. Park IS. An Illustrated Guide to Congenital Heart Disease: From Diagnosis to Treatment – From Fetus to Adult. Springer Nature Singapore Pte Ltd; 2019. doi:10.1007/978-981-13-6978-0
15. Hanneman K, Newman B, Chan F. Congenital variants and anomalies of the aortic arch. Radiographics. 2017;37(1):32-51.
16. Maldonado JA, Henry T, Gutiérrez FR. Congenital thoracic vascular anomalies. Radiol Clin North Am. 2010;48(1):85-115.
17. Hoffman JI, Kaplan S. The incidence of congenital heart disease. J Am Coll Cardiol. 2002;39(12):1890-1900.
18. Hoschtitzky JA, Anderson RH, Elliot MJ. In: Paediatric Cardiology. 3rd ed. Edinburgh: Churchill-Livingstone; 2009:945-966.
19. Roos-Hesselink JW, Scholzel BE, Heijdra RJ, et al. Aortic valve and aortic arch pathology after coarctation repair. Heart. 2003;89:1074-1077.
20. Konen E, Merchant N, Provost Y, McLaughlin PR, Crossin J, Paul NS. Coarctation of the aorta before and after correction: the role of cardiovascular MRI. AJR Am J Roentgenol. 2004;182:1333-1339.
21. Karaosmanoglu AD, Khwaja RDA, Onur MR, Kalra MK. CT and MRI of aortic coarctation: pre- and postsurgical findings. Am J Roentgenol. 2015;204(3):W224-W233.
22. Stout KK, Daniels CJ, Aboulhosn JA, et al. 2018 AHA/ACC guideline for the management of adults with congenital heart disease: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol. 2019;73(12):1494-1563. doi:10.1016/j.jacc.2018.08.1028
23. Thakkar AN, Chinnadurai P, Lin CH. Imaging adult patients with coarctation of the aorta. Curr Opin Cardiol. 2017;32(5):503-512. doi:10.1097/HCO.0000000000000430
24. Hom JJ, Ordovas K, Reddy GP. Velocity-encoded cine MR imaging in aortic coarctation: functional assessment of hemodynamic events. Radiographics. 2008;28(2):407-416. doi:10.1148/rg.282075705
25. Soler R, Rodríguez E, Requejo I, Fernández R, Raposo I. Magnetic resonance imaging of congenital abnormali-

ties of the thoracic aorta. Eur Radiol. 1998;8(4):540-546.
26. Priya S, Thomas R, Nagpal P, Sharma A, Steigner M. Congenital anomalies of the aortic arch. Cardiovasc Diagn Ther. 2018;8(Suppl 1):S26-S44.
27. Dillman JR, Yarram SG, D'Amico AR, Hernandez RJ. Interrupted aortic arch: spectrum of MRI findings. AJR Am J Roentgenol. 2008;190(6):1467-1474.
28. Goo HW, Park IS, Ko JK, Kim YH, Seo DM, Yun TJ, et al. CT of congenital heart disease: normal anatomy and typical pathologic conditions. Radiographics. 2003;23:147-165.
29. Kussman BD, Geva T, McGowan FX. Cardiovascular causes of airway compression. Paediatr Anaesth. 2004;14(1):60-74.
30. Wells TR, Gwinn JL, Landing BH, Stanley P. Reconsideration of the anatomy of sling left pulmonary artery: the association of one form with bridging bronchus and imperforate anus. Anatomic and diagnostic aspects. J Pediatr Surg. 1988;23(10):892-898.
31. Turner D, Vincent J, Epstein M. Isolated right pulmonary artery discontinuity. Images Paediatr Cardiol. 2000;2(3):24-30.
32. Sridharan S, Derrick G, Deanfield J, Taylor AM. Assessment of differential branch pulmonary blood flow: a comparative study of phase contrast magnetic resonance imaging and radionuclide lung perfusion imaging. Heart. 2006;92(7):963-968. doi:10.1136/hrt.2005.071746
33. Jacobs ML. Congenital Heart Surgery Nomenclature and Database Project: truncus arteriosus. Ann Thorac Surg. 2000;69(4):50-55.
34. Fogel MA, Crawford M. Cardiac magnetic resonance of the common arterial trunk and transposition of the great arteries. Cardiol Young. 2012;22(6):677-686.
35. Villafañe J, Feinstein JA, Jenkins KJ, et al. Adult congenital and pediatric cardiology section, American College of Cardiology. Hot topics in tetralogy of Fallot. J Am Coll Cardiol. 2013;62(23):2155-2166.
36. Apostolopoulou SC, Manginas A, Kelekis NL, Noutsias M. Cardiovascular imaging approach in pre and postoperative tetralogy of Fallot. BMC Cardiovasc Disord. 2019;19(1):7.
37. Patel DL, Rana YR, Sheth MM, et al. MSCT imaging of various shunts and grafts in post operative cases of congenital heart diseases. Int J Res Med Sci. 2019;7(3):860. doi:10.18203/2320-6012.ijrms20190937
38. Piehler JM, Danielson GK, McGoon DC, et al. Management of pulmonary atresia with ventricular septal defect and hypoplastic pulmonary arteries by right ventricular outflow construction. J Thorac Cardiovasc Surg. 1980;80(4):552-567.
39. Nakata S, Imai Y, Takanashi Y, et al. A new method for the quantitative standardization of cross-sectional areas of the pulmonary arteries in congenital heart diseases with decreased pulmonary blood flow. J Thorac Cardiovasc Surg. 1984;88(4):610-619.
40. Alex A, Ayyappan A, Valakkada J, Kramadhari H, Sasikumar D, Menon S. Major aortopulmonary collateral arteries. Radiol Cardiothorac Imaging. 2022;4(1):e210157. doi:10.1148/ryct.210157
41. Dabizzi RP, Teodori G, Barletta GA, et al. Associated coronary and cardiac anomalies in the tetralogy of Fallot. An angiographic study. Eur Heart J. 1990;11(8):692-704. doi:10.1093/oxfordjournals.eurheartj.a059784
42. Bailliard F, Anderson RH. Tetralogy of Fallot. Orphanet J Rare Dis. 2009;4:2.
43. Geva T. Repaired tetralogy of Fallot: the roles of cardiovascular magnetic resonance in evaluating pathophysiology and for pulmonary valve replacement decision support. J Cardiovasc Magn Reson. 2011;13:9. doi:10.1186/1532-429X-13-9
44. Geva T, Sandweiss BM, Gauvreau K, et al. Factors associated with impaired clinical status in long-term survivors of tetralogy of Fallot repair evaluated by magnetic resonance imaging. J Am Coll Cardiol. 2004;43(6):1068-1074. doi:10.1016/j.jacc.2003.10.045
45. Ozkok S, Ciftci HO, Kose KB, et al. Surgical and transcatheter pulmonary valve replacement in patients with repaired tetralogy of Fallot: cardiac magnetic resonance imaging characteristics and morphology of right ventricular outflow tract. Pediatr Radiol. 2023;53(9):1863-1873. doi:10.1007/s00247-023-05645-2
46. Norton KI, Tong C, Glass RB, et al. Cardiac MR imaging assessment following tetralogy of Fallot repair. Radiographics. 2006;26(1):197-211. doi:10.1148/rg.261055064
47. Vaujois L, Gorincour G, Alison M, Déry J, Poirier N, Lapierre C. Imaging of postoperative tetralogy of Fallot repair. Diagn Interv Imaging. 2016;97(5):549-560.
48. Ozkok S, Tosun O, Yucel IK, Celebi A. Cardiac MRI in surgically repaired tetralogy of Fallot: Our initial experience. North Clin Istanb. 2022;9(6):622-631. doi:10.14744/nci.2021.43799
49. Fogel MA, Anwar S, Broberg C, et al. Society for Cardiovascular Magnetic Resonance/European Society of Cardiovascular Imaging/American Society of Echocardiography/Society for Pediatric Radiology/North American Society for Cardiovascular Imaging guidelines for the use of cardiovascular magnetic resonance in pediatric congenital and acquired heart disease: Endorsed by The American Heart Association. J Cardiovasc Magn Reson. 2022;24(1):37. doi:10.1186/s12968-022-00843-7
50. Walters HL III, Mavroudis C, Tchervenkov CI, Jacobs JP, Lacour-Gayet F, Jacobs ML. Congenital heart surgery nomenclature and database project: double outlet right ventricle. Ann Thorac Surg. 2000;69:S249-S263.
51. Martins P, Castela E. Transposition of the great arteries. Orphanet J Rare Dis. 2008;3:27.
52. Donnelly LF, Higgins CB. MR imaging of conotruncal abnormalities. AJR Am J Roentgenol. 1996;166(4):925-928.
53. Tchervenkov CI, Roy N. Congenital heart disease nomenclature and database project: pulmonary atresia - ventricular septal defect. Ann Thorac Surg. 2000;69:S97-S105.
54. Tchervenkov CI, Roy N. Congenital heart disease nomenclature and database project: pulmonary atresia - ventricular septal defect. Ann Thorac Surg. 2000;69:S97-S105.
55. Liao PK, Edwards WD, Julsrud PR, Puga FJ, Danielson GK, Feldt RH. The pulmonary blood supply in patients with pulmonary atresia and ventricular septal defect. J Am Coll Cardiol. 1985;6:1343-1350.
56. Boechat MI, Ratib O, Williams PL, et al. Imaging and MR angiography for assessment of complex tetralogy of Fallot and pulmonary atresia. Radiographics. 2005;25:1535-1546.

57. Soulen RL, Donner RM, Capitanio M. Postoperative evaluation of complex congenital heart disease by magnetic resonance imaging. Radiographics. 1987;7(5):975-1000.
58. Siegel MJ, Bhalla S, Gutierrez FR, Billadello JB. MDCT of postoperative anatomy and complications in adults with cyanotic heart disease. AJR Am J Roentgenol. 2005;184:241-247.
59. Herlong JR, Jaggers JJ, Ungerleider RM. Congenital heart surgery nomenclature and database project: pulmonary venous anomalies. Ann Thorac Surg. 2000;69:S56-S69.
60. Choi YH, Park JH, Choe YH, Yoo SJ. MR imaging of Ebstein's anomaly of the tricuspid valve. AJR Am J Roentgenol. 1994;163:539-543.
61. Frescura C, Thiene G. The new concept of univentricular connection. Front Pediatr. 2014;2:62.
62. Rao PS. Tricuspid atresia. Curr Treat Options Cardiovasc Med. 2000;2:507-520.
63. Franklin RC, Spiegelhalter DJ, Anderson RH, et al. Double-inlet ventricle presenting in infancy: I: survival without definitive repair. J Thorac Cardiovasc Surg. 1991;101:767-776.
64. Weigel TJ, Driscoll DJ, Michels VV. Occurrence of congenital heart defects in siblings of patients with univentricular heart and tricuspid atresia. Am J Cardiol. 1989;64:768-771.
65. Kilner PJ, Geva T, Kaemmerer H, et al. Recommendations for cardiovascular magnetic resonance in adults with congenital heart disease from the respective working groups of the European Society of Cardiology. Eur Heart J. 2010;31:794-805.
66. Rathod RH, Prakash A, Kim YY, et al. Cardiac magnetic resonance parameters predict transplantation-free survival in patients with Fontan circulation. Circ Cardiovasc Imaging. 2014;7:502-509.
67. Monagle P, Cochrane A, Roberts R, et al. Fontan Anticoagulation Study Group. A multicenter, randomized trial comparing heparin/warfarin and acetylsalicylic acid as primary thromboprophylaxis for 2 years after the Fontan procedure in children. J Am Coll Cardiol. 2011;58:645-651.
68. Kehr E, Sono M, Chugh SS, et al. Gadolinium-enhanced magnetic resonance imaging for detection and quantification of fibrosis in human myocardium in vitro. Int J Cardiovasc Imaging. 2008;24:61-68.
69. Rathod RH, Prakash A, Powell AJ, et al. Myocardial fibrosis identified by cardiac magnetic resonance late gadolinium enhancement is associated with adverse ventricular mechanics and ventricular tachycardia late after Fontan operation. J Am Coll Cardiol. 2010;55:1721-1728.
70. Grosse-Wortmann L, Al-Otay A, Yoo SJ. Aortopulmonary collaterals after bidirectional cavopulmonary connection or Fontan completion: quantification with MRI. Circ Cardiovasc Imaging. 2009;2:219-225.
71. Lashkarinia SS, Cicek M, Kose B, et al. A novel Fontan Y-graft for interrupted inferior vena cava and azygos continuation. Interact Cardiovasc Thorac Surg. 2022;34(6):1095-1105. doi:10.1093/icvts/ivac001
72. Fredenburg TB, Johnson TR, Cohen MD. The Fontan procedure: anatomy, complications, and manifestations of failure. Radiographics. 2011;31:453-463.



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KONJENİTAL KALP HASTALIKLARINDA 3 BOYUTLU GÖRÜNTÜLEME VE MODELLEME

BÖLÜM 6

Uğur DİKKAŞ [1]
Oktay KORUN [2]

İçindekiler

» GİRİŞ
» 3B GÖRÜNTÜLEME VE MODELLEME NEDİR? NASIL YAPILIR?
  » Medikal Görüntüleme
  » Segmentasyon
  » 3B Model Dizaynı
» 3B MODELLERİN KULLANIM YÖNTEMLERİ
  » 3B Modellerin Dijital Ortamda Kullanımı
  » 3B Baskı
  » 3B Biyobaskı
» 3B MODELLERİN KULLANIM ALANLARI
  » Tıp Eğitiminde 3B Modeller
  » Asistan Eğitiminde 3B Modeller
  » İleri Tanı Tekniği Olarak Klinik Kullanımda 3B Modeller
  » Aktarımsal Araştırmalarda (Translational Research) 3B Model Kullanımı
  » 3B Biyoyazıcı Teknolojisi
» SONUÇ

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3B Biyoyazıcı Teknolojisi

3B biyoyazıcı teknolojisinin ortaya çıkışının kalp hastalıklarının tedavisinde yeni bir dönemi başlattığından söz edilebilir. Bu teknoloji sayesinde yakın gelecekte hastaya özgü kapak ve greftler üretilebilecek ve ticari olarak da kolaylıkla ulaşılabilir olacaktır. Hockaday ve arkadaşlarının yaptığı iki çalışma da bu potansiyeli vurgulamaktadır. Bu çalışmalar 3B biyoyazıcı teknolojisi kullanılarak anatomik olarak karmaşık aort kapak yapısının hidrojellerle basılabileceğini ortaya koymuştur. (51,52) Sun ve arkadaşlarının çalışmasında da 3B biyoyazıcı teknolojisindeki gelişmeler sayesinde ileri uyarlanabilirliğe sahip ve organları taklit edebilen miyokardiyal yapıların inşa edilebildiği belirtilmiştir. (53)

SONUÇ

Konjenital kalp hastalıklarının karmaşık ve değişken anatomileri, doğru tanı ve etkili cerrahi planlama için gelişmiş görüntüleme tekniklerine ihtiyaç doğurmuştur. Bu ihtiyaç doğrultusunda geliştirilen 3 boyutlu (3B) görüntüleme ve modelleme yöntemleri, son yıllarda klinik pratikte giderek artan oranda kullanılmaya başlanmıştır. Medikal görüntüleme, segmentasyon ve dijital tasarım gibi adımlardan oluşan bu süreç, BT, MR ve ekokardiyografi gibi modalitelerden elde edilen verilerle desteklenerek yüksek doğrulukta anatomik modellerin oluşturulmasına olanak tanır.

3B modeller, yalnızca görüntüleme sınırlarını aşarak tanı ve cerrahi planlamayı desteklemekle kalmaz; aynı zamanda tıp ve asistan eğitiminde, hasta-hekim iletişiminde, translasyonel araştırmalarda ve biyoyazıcı teknolojisiyle kişiye özel çözümlerde de etkin biçimde kullanılmaktadır.

Literatürdeki birçok çalışma, 3B modellerin tanısal doğruluğu artırdığını, cerrahi planlamada değişikliklere yol açabildiğini ve eğitim süreçlerinde bilgi edinimini ve teknik becerileri geliştirdiğini göstermektedir. Segmentasyon stratejilerinin ve modelleme tekniklerinin amaca uygun şekilde seçilmesi, elde edilen çıktının kalitesi açısından kritik öneme sahiptir.

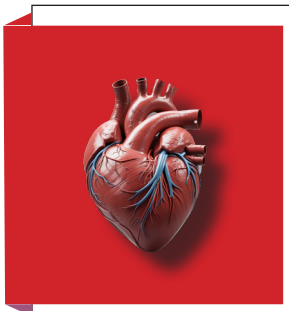
Sonuç olarak, 3B görüntüleme ve modelleme, konjenital kalp hastalıklarının değerlendirilmesinde giderek vazgeçilmez hale gelen, tanıdan tedaviye uzanan süreçte klinisyene önemli katkılar sunan güçlü bir araçtır. Yakın gelecekte yapay zeka destekli otomatik segmentasyon ve biyobaskı teknolojilerindeki ilerlemelerle bu alandaki kullanımın daha da yaygınlaşması beklenmektedir.

KAYNAKLAR

1. Anderson RH, Baker EJ, Macartney FJ, Rigby ML, Shinebourne EA, Tynan M, editors. Paediatric Cardiology. 2. Baskı. Londra: Churchill Livingstone; 2002.
2. Valverde I, Gomez-Ciriza G, Hussain T, Suarez-Mejias C, Velasco-Forte MN, Byrne N, et al. Three-dimensional printed models for surgical planning of complex congenital heart defects: an international multicentre study. Eur J Cardiothorac Surg. 2017;52(6):1139–48. DOI: 10.1093/ejcts/ezx208
3. Kurup HKN, Samuel BP, Vettukattil JJ. Hybrid 3D printing: a game-changer in personalized cardiac medicine? Expert Rev Cardiovasc Ther. 2015;13(12):1281–4. DOI: 10.1586/14779072.2015.1100076
4. Cantinotti M, Valverde I, Kutty S. Three-dimensional printed models in congenital heart disease. Int J Cardiovasc Imaging. 2017;33(1):137–44. DOI: 10.1007/s10554-016-0981-2
5. Goo HW. Cardiac MDCT in children: CT technology overview and interpretation. Radiol Clin North Am. 2011;49(5):997–1010. DOI: 10.1016/j.rcl.2011.06.001
6. Leschka S, Oechslin E, Husmann L, Desbiolles L, Marincek B, Genoni M, et al. Pre- and postoperative evaluation of congenital heart disease in children and adults with 64-section CT. Radiographics. 2007;27(3):829–46. DOI: 10.1148/rg.273065713
7. Dodge-Khatami J, Adebo DA. Evaluation of complex congenital heart disease in infants using low dose cardiac computed tomography. Int J Cardiovasc Imaging. 2021;37(4):1455–60. DOI: 10.1007/s10554-020-02118-7
8. Han BK, Lindberg J, Grant K, Schwartz RS, Lesser JR. Accuracy and Safety of High Pitch Computed Tomography Imaging in Young Children With Complex Congenital Heart Disease. American Journal of Cardiology. Elsevier; 2011;107(10):1541–6. DOI: 10.1016/j.amjcard.2011.01.065
9. Raimondi F, Warin-Fresse K. Computed tomography imaging in children with congenital heart disease: Indications and radiation dose optimization. Archives of Cardiovascular Diseases. 2016;109(2):150–7. DOI: 10.1016/j.acvd.2015.11.003
10. Puranik R, Muthurangu V, Celermajer DS, Taylor AM. Congenital Heart Disease and Multi-modality Imaging. Heart, Lung and Circulation. 2010;19(3):133–44. DOI: 10.1016/j.hlc.2010.01.001
11. Byrne N, Forte MV, Tandon A, Valverde I, Hussain T. A systematic review of image segmentation methodology, used in the additive manufacture of patient-specific 3D printed models of the cardiovascular system. JRSM Cardiovascular Disease. 2016;5:2048004016645467.

DOI: 10.1177/2048004016645467
12. Fellows KE, Hubbard AM. MRI: complacency or ascendancy in the evaluation of congenital heart disease. Pediatr Radiol. 1999;29(7):491–5. DOI: 10.1007/s002470050627
13. Smith HJ. Cardiac MR imaging. Acta Radiol. 1999;40(1):1–22. DOI: 10.1080/02841859909174396
14. Heusch A, Rübo J, Krogmann ON, Bourgeois M. Volumetric analysis of the right ventricle in children with congenital heart defects: comparison of biplane angiography and transthoracic 3-dimensional echocardiography. Cardiology in the Young. 1999;9(6):577–84. DOI: 10.1017/S1047951100005618
15. Aly DM, Shah S. Three-Dimensional Echocardiography Derived Printing: A Review of Workflow, Current, and Future Applications. Curr Cardiol Rep. 2023;25(6):597–605. DOI: 10.1007/s11886-023-01882-x
16. Khoshhal Saad. Feasibility and Effectiveness of Three-Dimensional Echocardiography in Diagnosing Congenital Heart Diseases. Pediatr Cardiol. 2013;34(7):1525–31. DOI: 10.1007/s00246-013-0718-0
17. Wu VC-C, Takeuchi M. Three-Dimensional Echocardiography: Current Status and Real-Life Applications. Acta Cardiol Sin. 2017;33(2):107–18. DOI: 10.6515/ACS20160818A
18. Fagan TE, Truong UT, Jone P-N, Bracken J, Quaife R, Hazeem AAA, et al. Multimodality 3-Dimensional Image Integration for Congenital Cardiac Catheterization. Methodist Debakey Cardiovasc J. 2014;10(2):68–76.
19. Söder S, Wällisch W, Dittrich S, Cesnjevar R, Pfammatter J-P, Glöckler M. Three-Dimensional Rotational Angiography during Catheterization of Congenital Heart Disease – A ten Years' experience at a single center. Sci Rep. Nature Publishing Group; 2020;10(1):6973. DOI: 10.1038/s41598-020-63903-x
20. Reinke G, Halbfaß J, Dittrich S, Banckwitz R, Köhler C, Achenbach S, et al. Three-Dimensional Rotational Angiography in Congenital Heart Disease: Estimation of Radiation Exposure. Open Journal of Radiology. Scientific Research Publishing; 2013;3(3):124–9. DOI: 10.4236/ojrad.2013.33020
21. Maddux JT, Wink O, Messenger JC, Groves BM, Liao R, Strzelczyk J, et al. Randomized study of the safety and clinical utility of rotational angiography versus standard angiography in the diagnosis of coronary artery disease. Catheter Cardiovasc Interv. 2004;62(2):167–74. DOI: 10.1002/ccd.20036
22. Mehta R, Lee K-J, Chaturvedi R, Benson L. Complications of pediatric cardiac catheterization: a review in the current era. Catheter Cardiovasc Interv. 2008;72(2):278–85. DOI: 10.1002/ccd.21580
23. Vitiello R, McCrindle BW, Nykanen D, Freedom RM, Benson LN. Complications associated with pediatric cardiac catheterization. J Am Coll Cardiol. 1998;32(5):1433–40. DOI: 10.1016/s0735-1097(98)00396-9
24. Townsend K, Pietila T. 3D printing and modeling of congenital heart defects: A technical review. Birth Defects Res. 2018;110(13):1091–7. DOI: 10.1002/bdr2.1342
25. [Internet]. Materialise Mimics | Healthcare Software Platform [cited 2025 Feb 10]. Available from: https://www.materialise.com/en/healthcare/mimics
26. [Internet]. AW VolumeShare 7 [cited 2025 Feb 10]. Available from: https://www.gehealthcare.com/middle-east/products/advanced-visualization/platforms/advantage-workstation?srsltid=AfmBOop_tmSblzJ6IKrr9UNvVfLbJd0CTt1oeiZkqOasEoATXHc4mKr_
27. [Internet]. 3D Slicer image computing platform | 3D Slicer [cited 2025 Feb 10]. Available from: https://www.slicer.org/
28. Fedorov A, Beichel R, Kalpathy-Cramer J, Finet J, Fillion-Robin J-C, Pujol S, et al. 3D Slicer as an image computing platform for the Quantitative Imaging Network. Magn Reson Imaging. 2012;30(9):1323–41. DOI: 10.1016/j.mri.2012.05.001
29. Galli N. Scientific Computing and Imaging Institute [Internet]. Seg3D [cited 2025 Feb 10]. Available from: https://www.sci.utah.edu/software/seg3d.html
30. Gharleghi R, Dessalles CA, Lal R, McCraith S, Sarathy K, Jepson N, et al. 3D Printing for Cardiovascular Applications: From End-to-End Processes to Emerging Developments. Ann Biomed Eng. 2021;49(7):1598–618. DOI: 10.1007/s10439-021-02784-1
31. Olivieri LJ, Krieger A, Loke Y-H, Nath DS, Kim PCW, Sable CA. Three-Dimensional Printing of Intracardiac Defects from Three-Dimensional Echocardiographic Images: Feasibility and Relative Accuracy. Journal of the American Society of Echocardiography. Elsevier; 2015;28(4):392–7. DOI: 10.1016/j.echo.2014.12.016
32. Mottl-Link S, Hübler M, Kühne T, Rietdorf U, Krueger JJ, Schnackenburg B, et al. Physical models aiding in complex congenital heart surgery. Ann Thorac Surg. 2008;86(1):273–7. DOI: 10.1016/j.athoracsur.2007.06.001
33. Kikuchi K, Togao O, Yamashita K, Momosaka D, Kikuchi Y, Kuga D, et al. Comparison of diagnostic performance of radiologist- and AI-based assessments of T2-FLAIR mismatch sign and quantitative assessment using synthetic MRI in the differential diagnosis between astrocytoma, IDH-mutant and oligodendroglioma, IDH-mutant and 1p/19q-codeleted. Neuroradiology. 2024;66(3):333–41. DOI: 10.1007/s00234-024-03288-0
34. Saha A, Bosma JS, Twilt JJ, van Ginneken B, Bjartell A, Padhani AR, et al. Artificial intelligence and radiologists in prostate cancer detection on MRI (PI-CAI): an international, paired, non-inferiority, confirmatory study. Lancet Oncol. 2024;25(7):879–87. DOI: 10.1016/S1470-2045(24)00220-1
35. Cacciamani GE, Sanford DI, Chu TN, Kaneko M, De Castro Abreu AL, Duddalwar V, et al. Is Artificial Intelligence Replacing Our Radiology Stars? Not Yet! Eur Urol Open Sci. 2022;48:14–6. DOI: 10.1016/j.euros.2022.09.024
36. Farooqi KM, Lengua CG, Weinberg AD, Nielsen JC, Sanz J. Blood Pool Segmentation Results in Superior Virtual Cardiac Models than Myocardial Segmentation for 3D Printing. Pediatr Cardiol. 2016;37(6):1028–36. DOI: 10.1007/s00246-016-1385-8
37. Liang J, Zhao X, Pan G, Zhang G, Zhao D, Xu J, et al. Comparison of blood pool and myocardial 3D printing in the diagnosis of types of congenital heart disease. Sci Rep. 2022;12(1):7136. DOI: 10.1038/s41598-022-11294-6
38. Karsenty C, Guitarte A, Dulac Y, Briot J, Hascoet S, Vincent R, et al. The usefulness of 3D printed heart models for medical student education in congenital heart disease. BMC Med Educ. 2021;21(1):480. DOI: 10.1186/s12909-021-02917-z

39. Lau I, Sun Z. The role of 3D printed heart models in immediate and long-term knowledge acquisition in medical education. RCM. IMR Press; 2022;23(1):22. DOI: 10.31083/j.rcm2301022
40. Costello JP, Olivieri LJ, Krieger A, Thabit O, Marshall MB, Yoo S-J, et al. Utilizing Three-Dimensional Printing Technology to Assess the Feasibility of High-Fidelity Synthetic Ventricular Septal Defect Models for Simulation in Medical Education. World J Pediatr Congenit Heart Surg. 2014;5(3):421–6. DOI: 10.1177/2150135114528721
41. Hussein N, Honjo O, Barron DJ, Haller C, Coles JG, Yoo S-J. The Incorporation of Hands-On Surgical Training in a Congenital Heart Surgery Training Curriculum. Ann Thorac Surg. 2021;112(5):1672–80. DOI: 10.1016/j.athoracsur.2020.11.018
42. Hussein N, Honjo O, Haller C, Coles JG, Hua Z, Van Arsdell G, et al. Quantitative assessment of technical performance during hands-on surgical training of the arterial switch operation using 3-dimensional printed heart models. J Thorac Cardiovasc Surg. 2020;160(4):1035–42. DOI: 10.1016/j.jtcvs.2019.11.123
43. Nam JG, Lee W, Jeong B, Park EA, Lim JY, Kwak Y, et al. Three-Dimensional Printing of Congenital Heart Disease Models for Cardiac Surgery Simulation: Evaluation of Surgical Skill Improvement among Inexperienced Cardiothoracic Surgeons. Korean J Radiol. 2021;22(5):706–13. DOI: 10.3348/kjr.2020.0682
44. Yoo S-J, Spray T, Austin EH, Yun T-J, van Arsdell GS. Hands-on surgical training of congenital heart surgery using 3-dimensional print models. J Thorac Cardiovasc Surg. 2017;153(6):1530–40. DOI: 10.1016/j.jtcvs.2016.12.054
45. Barron DJ, Hussein N, Yoo S-J. Training on Congenital 3D Cardiac Models - Will Models Improve Surgical Performance? Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2023;26:9–17. DOI: 10.1053/j.pcsu.2022.12.001
46. Thorn C, Ballard J, Lockhart C, Crone A, Aarvold A. The perioperative utility of 3D printed models in complex surgical care: feedback from 106 cases. annals. The Royal College of Surgeons of England; 2023;105(8):747–53. DOI: 10.1308/rcsann.2022.0127
47. Yıldız O, Köse B, Tanıdır IC, Pekkan K, Güzeltaş A, Haydin S. Single-center experience with routine clinical use of 3D technologies in surgical planning for pediatric patients with complex congenital heart disease. Diagn Interv Radiol. 2021;27(4):488–96. DOI: 10.5152/dir.2021.20163
48. Lau IWW, Liu D, Xu L, Fan Z, Sun Z. Clinical value of patient-specific three-dimensional printing of congenital heart disease: Quantitative and qualitative assessments. PLoS One. 2018;13(3):e0194333. DOI: 10.1371/journal.pone.0194333
49. Lau I, Gupta A, Ihdayhid A, Sun Z. Clinical Applications of Mixed Reality and 3D Printing in Congenital Heart Disease. Biomolecules. 2022;12(11):1548. DOI: 10.3390/biom12111548
50. Fanni BM, Gasparotti E, Vignali E, Capelli C, Positano V, Celi S. An integrated in-vitro and in-silico workflow to study the pulmonary bifurcation hemodynamics. Computers & Fluids. 2023;260:105912. DOI: 10.1016/j.compfluid.2023.105912
51. Hockaday LA, Kang KH, Colangelo NW, Cheung PYC, Duan B, Malone E, et al. Rapid 3D printing of anatomically accurate and mechanically heterogeneous aortic valve hydrogel scaffolds. Biofabrication. IOP Publishing; 2012;4(3):035005. DOI: 10.1088/1758-5082/4/3/035005
52. Duan B, Hockaday LA, Kang KH, Butcher JT. 3D Bioprinting of heterogeneous aortic valve conduits with alginate/gelatin hydrogels. Journal of Biomedical Materials Research Part A. 2013;101A(5):1255–64. DOI: 10.1002/jbm.a.34420
53. Sun Z, Zhao J, Leung E, Flandes-Iparraguirre M, Vernon M, Silberstein J, et al. Three-Dimensional Bioprinting in Cardiovascular Disease: Current Status and Future Directions. Biomolecules. 2023;13(8):1180. DOI: 10.3390/biom13081180



TRANSKATETER PATENT DUKTUS ARTERİOZUS KAPATILMASI

BÖLÜM
7

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İçindekiler

» GİRİŞ
» ENDİKASYONLAR, RİSKLER VE KAPATMA ZAMANI
» PROSEDÜR ÖNCESİ DEĞERLENDİRME
» DUKTUS MORFOLOJİSİ
» PROSEDÜR
» COİL İLE PDA KAPATILMASI
» CİHAZ İLE PDA KAPATILMASI
» KOMPLİKASYONLAR

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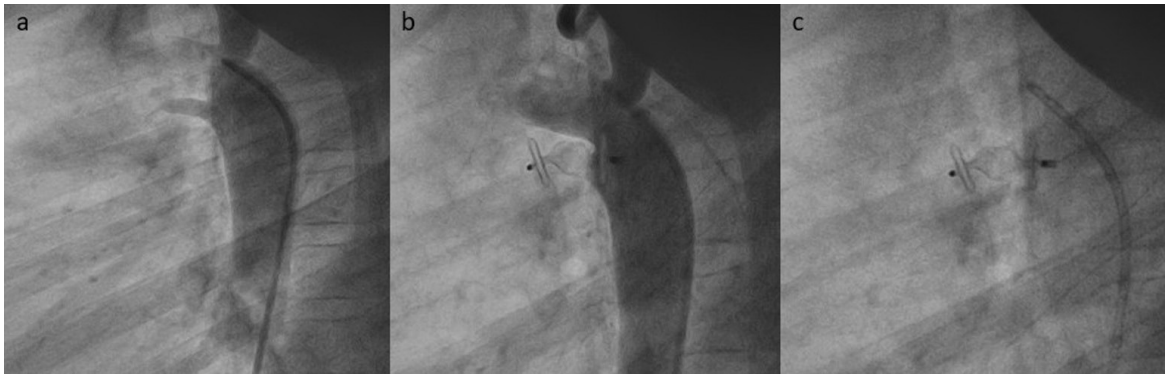


Resim 4. *PDA'nın AVP-2 ile kapatılması: a) Lateral projeksiyonda yapılan enjeksiyonda PDA görülmektedir.b)Cihaz serbestleştirildikten sonra yapılan enjeksiyonda PDA'nın kapandığı görülmektedir. c) Cihazın bırakıldıktan sonraki duruşu görülmektedir.*

3. Hemoliz: Rezidüel şantı olan hastalarda görülen bir komplikasyondur. Eritrositlerin mekanik harabiyetine bağlı olduğu düşünülür. Hemoglobin değerlerinde düşme, idrarda renk değişikliği ve bilirubin yüksekliği saptanır. Cihaz geri alınarak veya rezidüel şant başka bir coil veya cihazla kapatılarak düzeltilebilir. Bu mümkün değilse cerrahi olarak çıkarılması gerekir. Sıklıkla coil kullanımı sonrasında görülür.

4. Enfektif Endokardit: Nadir bir komplikasyondur.

5. Nikel alerjisi: Nitinolden yapılmış cihazlarda görülebilecek potansiyel bir komplikasyondur. Yüksek ateş ve ödemle kendini gösterebilir. Daha çok ASD ve PFO kapatılması sonrası rapor edilse de nikel içeren her cihaz için potansiyel bir komplikasyondur.

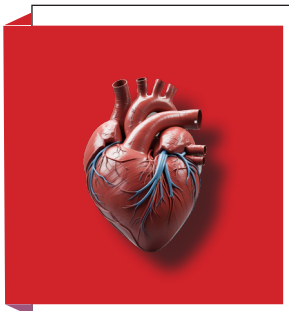
6. Diğer nadir komplikasyonlar: Bunların dışında cihaz embolizasyonu sonucu ani ölüm, geçici asistol, transfüzyon gerektirecek kan kaybı, kan kaybına bağlı ST depresyonu gibi nadir komplikasyonlar bildirilmiştir (21).

Günümüzde transkateter PDA kapatılması işlemi için tek bir ideal cihaz yoktur. Bununla beraber işlem artık çok daha güvenli ve düşük komplikasyon oranlarıyla yapılabilmektedir. Elimizde çok sayıda cihaz seçeneği bulunmaktadır. 1000 gram altı bebeklerden başlayıp erişkin hastaya kadar işlem güvenli bir şeklide yapılabilmektedir. Hastanın yaşı, vücut ağırlığı, PDA'nın ölçüleri ve maliyet hesaba katılarak en uygun cihazı seçmek doğru bir strateji olacaktır.

KAYNAKLAR

1. Eilers LF, Kyle WB, Allen HD, Qureshi AM. Patent Ductus Arteriosus. Pediatr Rev. 2021 Nov;42(11):632-634. doi: 10.1542/pir.2020-004564. PMID: 34725225.
2. Park J, Yoon SJ, Han J, Song IG, Lim J, Shin JE, Eun HS, Park KI, Park MS, Lee SM. Patent ductus arteriosus treatment trends and associated morbidities in neonates. Sci Rep. 2021 May 21;11(1):10689. doi: 10.1038/s41598-021-89868-z. PMID: 34021202; PMCID: PMC8139968.
3. Baruteau AE, Hascoët S, Baruteau J, Boudjemline Y, Lambert V, Angel CY, Belli E, Petit J, Pass R. Transcatheter closure of patent ductus arteriosus: past, present and future. Arch Cardiovasc Dis. 2014 Feb;107(2):122-32. doi: 10.1016/j.acvd.2014.01.008. Epub 2014 Feb 20. PMID: 24560920.
4. O'Byrne ML, Smith CL, Gillespie MJ. Device Closure of Patent Ductus Arteriosus in Adults. Can J Cardiol. 2020 Jun;36(6):795-796. doi: 10.1016/j.cjca.2019.10.022. Epub 2019 Oct 25. PMID: 32173055.
5. Krichenko A, Benson LN, Burrows P, Möes CA, McLaughlin P, Freedom RM. Angiographic classification of the isolated, persistently patent ductus arteriosus and implications for percutaneous catheter occlusion. Am J Cardiol. 1989 Apr 1;63(12):877-80. doi: 10.1016/0002-9149(89)90064-7. PMID: 2929450.
6. Tanıdır İC, Özcanoğlu HD, Sağlam S, Göktepe A, Yakut K, Özturk E. Evaluation of the Outcomes of Cardiac Catheterization in Newborns. Cam and Sakura Med J. 2021 Aug;1(2):52-58. doi:10.4274/csmedj.galenos.2021.2021-9-3.
7. Porstmann W, Wierny L, Warnke H. Closure of persistent ductus arteriosus without thoracotomy. Ger Med Mon. 1967 Jun;12(6):259-61. PMID: 6045537.
8. Rashkind WJ, Cuaso CC. Transcatheter closure of a patent ductus arteriosus: successful use in a 3.5 kg infant. Pediatr CardioI1979;1:3-7.

9. Bash SE, Mullins CE. Insertion of patent ductus occluder by transvenous approach; a new technique. Circulation 1984;70(Pt 2):II285).
10. Rao PS, Sideris EB, Haddad J, et al. Transcatheter occlusion of patent ductus arteriosus with adjustable buttoned device: initial clinical experience. Circulation 1993;88:1119±26.
11. Cambier PA, Kirby WC, Wortham DC, Moore JW. Percutaneous closure of the small (< 2.5 mm) patent ductus arteriosus using coil embolization. Am J Cardiol. 1992;69:815-816.
12. Tometzki AJ, Arnold R, Peart I, Sreeram N, Abdulhamed JM, Godman MJ, Patel RG, Kitchiner DJ, Bu'Lock FA, Walsh KP. Transcatheter occlusion of the patent ductus arteriosus with Cook detachable coils. Heart. 1996 Dec;76(6):531-5. doi: 10.1136/hrt.76.6.531. PMID: 9014804; PMCID: PMC484608.
13. Sharafuddin MJ, Gu X, Titus JL, Sakinis AK, Pozza CH, Coleman CC, Cervera-Ceballos JJ, Aideyan OA, Amplatz K. Experimental evaluation of a new self-expanding patent ductus arteriosus occluder in a canine model. J Vasc Interv Radiol. 1996 Nov-Dec;7(6):877-87. doi: 10.1016/s1051-0443(96)70866-7. PMID: 8951756.
14. Masura J, Walsh KP, Thanopoulous B, Chan C, Bass J, Goussous Y, Gavora P, Hijazi ZM. Catheter closure of moderate- to large-sized patent ductus arteriosus using the new Amplatzer duct occluder: immediate and short-term results. J Am Coll Cardiol. 1998 Mar 15;31(4):878-82. doi: 10.1016/s0735-1097(98)00013-8. PMID: 9525563.
15. Gruenstein DH, Bass JL. Experimental evaluation of a new articulated Amplatzer ductal occluder device without fabric. Catheter Cardiovasc Interv. 2009 Sep 1;74(3):482-7. doi: 10.1002/ccd.22059. PMID: 19405162.
16. Bhole V, Miller P, Mehta C, Stumper O, Reinhardt Z, De Giovanni JV. Clinical evaluation of the new Amplatzer duct occluder II for patent arterial duct occlusion. Catheter Cardiovasc Interv. 2009 Nov 1;74(5):762-9. doi: 10.1002/ccd.22095. PMID: 19522000.
17. Bass JL, Wilson N. Transcatheter occlusion of the patent ductus arteriosus in infants: experimental testing of a new Amplatzer device. Catheter Cardiovasc Interv. 2014 Feb;83(2):250-5. doi: 10.1002/ccd.22931. Epub 2013 Oct 23. PMID: 24446324.
18. Ng B, Schneider DJ, Hokanson JS. Closure of tubular patent ductus arteriosus in infants and small children with the Amplatzer Vascular Plug II. Congenit Heart Dis. 2011 Jan-Feb;6(1):64-9. doi: 10.1111/j.1747-0803.2010.00466.x. PMID: 21269416.
19. Banpurkar A, Koneti NR, Thakur P, Kulkarni SM, Prabhu A, Doniparti PKV. Off-label use of KONAR-MF™ occluder for transcatheter closure of patent ductus arteriosus in unusual circumstances. Ann Pediatr Cardiol. 2023 Jul-Aug;16(4):242-246. doi: 10.4103/apc.apc_49_22. Epub 2024 Jan 5. PMID: 38343511; PMCID: PMC10856615.
20. Ghasemi A, Pandya S, Reddy SV, Turner DR, Du W, Navabi MA, Mirzaaghayan MR, Kiani A, Sloan K, Forbes TJ. Trans-catheter closure of patent ductus arteriosus-What is the best device? Catheter Cardiovasc Interv. 2010 Nov 1;76(5):687-95. doi: 10.1002/ccd.22393. PMID: 20815044.
21. Jang GY, Son CS, Lee JW, Lee JY, Kim SJ. Complications after transcatheter closure of patent ductus arteriosus. J Korean Med Sci. 2007 Jun;22(3):484-90. doi: 10.3346/jkms.2007.22.3.484. PMID: 17596658; PMCID: PMC2693642.



TRANSKATETER ATRİYAL SEPTAL DEFEKT KAPATILMASI

BÖLÜM
8

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İçindekiler

- GİRİŞ
- PATOFİZYOLOJİ
- DOĞAL SEYİR
- TANI YÖNTEMLERİ
- ENDİKASYONLAR VE HASTA SEÇİMİ
- ÖZEL DURUMLAR
  - Çoklu Defektler
  - Büyük Defektler
  - Yetersiz Rimi Olan Defektler
  - İleri yaşta ASD kapatma
  - Pulmoner arteryel hipertansiyon varlığı
  - Sol Ventrikül Disfonksiyonu Olan Hastalarda
  - Superior Sinus Venozus Tipi Atriyal Septal Defekti Olan Hastalarda
- CİHAZ TİPLERİ VE ÖZELLİKLERİ
  - Amplatzer Septal Occluder ve "Cribriform"
  - Gore Cardioform ASD Occluder ve Gore Cardioform Septal Occluder
  - Occlutech Figulla Flex II ASD Occluder
  - CeraFlex ASD Occluder
  - Cocoon Septal Occluder
  - Nit-Occlud ASD-R
  - Cardi-O-Fix Septal Occluder
  - Ultracept II ASD Occluder
  - Biyoçözünür Cihazlar
- İŞLEM TEKNİĞİ
  - Venöz Erişim Yolları
  - Anestezi ve İlaçlar
  - Hemodinamik İnceleme ve Cihaz Seçimi İçin Defekt Ölçüm Yöntemleri
  - Cihaz İmplantasyonu
- KOMPLİKASYONLAR
  - Hava Embolisi
  - Kobra başı görünümü
  - Cihaz Embolizasyonu
  - Kardiyak Erozyon
  - Aritmiler
  - Tromboembolik olay
  - Nadir komplikasyonlar
- TAKİP
- CERRAHİ İLE KARŞILAŞTIRMA

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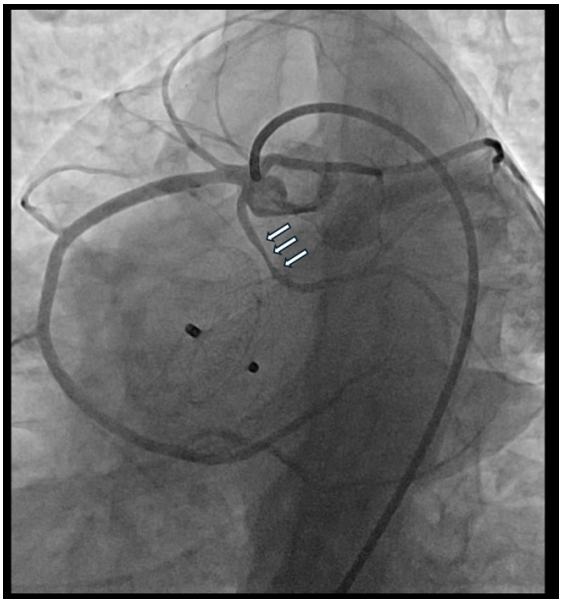


Şekil 5. *Sekundum atriyal defekt 30 mm Amplatzer Septal Occluder cihazı kullanılarak kapatıldıktan bir hafta sonra hastanın göğüs ağrısı tariflemesi üzerine bakılan troponin değerinde progresif yükselme sonrasında konvansiyonel koroner anjiyografi yapıldı. Şekilde sirkumfleks arterin retroaortik seyri sırasında ASD cihazının disklerinin arasından geçtiği ve lümeninin cihaz basısı nedeniyle daraldığı görülmektedir. Cihaz Snare ile geri alındı. Defekt cerrahi olarak kapatıldı.*

İlk 6 ay endokardit profilaksisi bütün hastalara verilir, 6. ay kontrolünde eğer tam kapanma sağlandıysa bu profilaksi kesilir.

Poliklinik kontrolleri 1,6 ve 12. Ay olarak önerilir. Bu süreç sonunda da yılda ya da iki yılda bir kontroller devam etmelidir. Her kontrolde ek bir durum olmadıkça TTE ve 12 kanallı EKG görülmelidir (35) .

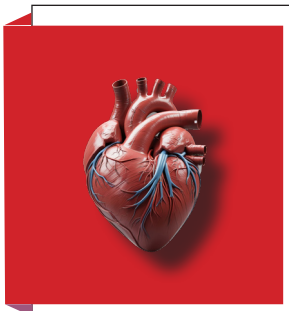
CERRAHİ İLE KARŞILAŞTIRMA

2002 yılında yapılan toplam 3.082 ASD hastası değerlendirildiği bir metaanalizde; bunların 1.270'i cerrahi, 1.812'si ise transkateter yöntemle tedavi edilmiştir. Cerrahi grubunda total ve majör komplikasyon oranları sırasıyla 5.4 ve 3.8 kat daha yüksek bulunmuş, hastanede yatış süresi de 2.5 kat daha uzun saptanmıştır (36). Ancak cerrahi tekniklerin gelişmesi ile bu oranlarda değişiklikler meydana gelmiştir. Minimal invaziv cerrahi teknik ile kapatılan ASD hastalarının değerlendirildiği bir metaanalizde, perkütan tekniğe göre majör komplikasyon oranını artmadığı ve rezidüel şant oranının daha düşük olduğu ancak hastanede yatış süresinin daha uzun olduğu belirtilmiştir (37).

KAYNAKLAR

1. Rigatelli, G., F. Gianese, and M. Zuin, *Secundum Atrial Septal Defects Transcatheter Closure: An Updated Reappraisal.* Cardiovascular Revascularization Medicine, 2022. **44**: p. 92-97.
2. Alkashkari, W., S. Albugami, and Z.M. Hijazi, *Current practice in atrial septal defect occlusion in children and adults.* Expert Rev Cardiovasc Ther, 2020. **18**(6): p. 315-329.
3. Mills, N.L. and T.D. King, *Nonoperative closure of left-to-right shunts.* J Thorac Cardiovasc Surg, 1976. **72**(3): p. 371-8.
4. Feltes, T.F., et al., *Indications for Cardiac Catheterization and Intervention in Pediatric Cardiac Disease.* Circulation, 2011. **123**(22): p. 2607-2652.
5. Sommer, R.J., Z.M. Hijazi, and J.F. Rhodes, Jr., *Pathophysiology of congenital heart disease in the adult: part I: Shunt lesions.* Circulation, 2008. **117**(8): p. 1090-9.
6. Tan, W., et al., *Transcatheter Interventions in Patients With Adult Congenital Heart Disease.* Journal of the Society for Cardiovascular Angiography & Interventions, 2022. **1**(6).
7. Behjati-Ardakani, M., et al., *The Clinical Course of Patients With Atrial Septal Defects.* Iran J Pediatr, 2016. **26**(4): p. e4649.
8. Keane, J.F., et al., *Nadas' pediatric cardiology*. 2nd / edited by John F. Keane, James E. Lock, Donald C. Fyler. ed. Pediatric cardiology. 2006, Philadelphia: Saunders Elsevier.
9. Hahn, R.T., et al., *Recommended Standards for the Performance of Transesophageal Echocardiographic Screening for Structural Heart Intervention: From the American Society of Echocardiography.* J Am Soc Echocardiogr, 2022. **35**(1): p. 1-76.
10. Giordano, M., et al., *The Role of Trans-Oesophageal Echocardiography in the Interventional Cardiology of Adult Congenital Heart Diseases.* J Clin Med, 2025. **14**(4).
11. Stout, K.K., et al., *2018 AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines.* Journal of the American College of Cardiology, 2019. **73**(12): p. e81-e192.
12. Yang, M.-C. and J.-R. Wu, *Recent review of transcatheter closure of atrial septal defect.* The Kaohsiung Journal of Medical Sciences, 2018. **34**(7): p. 363-369.
13. Blais, B.A., et al., *Transcatheter Interventions in Adult Congenital Heart Disease.* Interventional Cardiology Clinics, 2024. **13**(3): p. 385-398.
14. Wang, J.-K., et al., *Midterm follow-up results of transcatheter treatment in patients with unroofed coronary sinus.* Catheterization and Cardiovascular Interventions, 2014. **83**(2): p. 243-249.

15. Rosenthal, E., et al., *Covered Stent Correction for Sinus Venosus Atrial Septal Defects, an Emerging Alternative to Surgical Repair: Results of an International Registry.* Circulation, 2025. **151**(11): p. 744-756.
16. Ohno, N., et al., *Characteristics of secundum atrial septal defects not percutaneously closed.* Catheter Cardiovasc Interv, 2015. **85**(2): p. 234-9.
17. Houeijeh, A., et al., *Transcatheter closure of large atrial septal defects (ASDs) in symptomatic children with device/weight ratio ≥1.5.* Int J Cardiol, 2018. **267**: p. 84-87.
18. Fraisse, A., et al., *Atrial septal defect closure: indications and contra-indications.* J Thorac Dis, 2018. **10**(Suppl 24): p. S2874-s2881.
19. Jung, S.Y. and J.Y. Choi, *Transcatheter closure of atrial septal defect: principles and available devices.* J Thorac Dis, 2018. **10**(Suppl 24): p. S2909-s2922.
20. Dalvi, B., et al., *Transcatheter closure of large atrial septal defects using 40 mm amplatzer septal occluder: Single group experience with short and intermediate term follow-up.* Catheterization and Cardiovascular Interventions, 2017. **89**(6): p. 1035-1043.
21. Jain, S. and B. Dalvi, *Atrial septal defect with pulmonary hypertension: when/how can we consider closure?* J Thorac Dis, 2018. **10**(Suppl 24): p. S2890-s2898.
22. Baruteau, A.-E., et al., *Transcatheter Closure of Superior Sinus Venosus Defects.* JACC: Cardiovascular Interventions, 2023. **16**(21): p. 2587-2599.
23. Wood, K.P., G.A. Fleming, and R.C. Chamberlain, *Update on Transcatheter Device Closure of Congenital Septal Defects.* Curr Cardiol Rep, 2023. **25**(9): p. 1083-1093.
24. Gillespie, M.J., et al., *Use of the GORE® CARDIOFORM Septal Occluder for percutaneous closure of secundum atrial septal defects: Results of the multicenter U.S. IDE trial.* Catheter Cardiovasc Interv, 2020. **95**(7): p. 1296-1304.
25. Sommer, R.J., et al., *ASSURED clinical study: New GORE® CARDIOFORM ASD occluder for transcatheter closure of atrial septal defect.* Catheter Cardiovasc Interv, 2020. **95**(7): p. 1285-1295.
26. Haas, N.A., et al., *Closure of Secundum Atrial Septal Defects by Using the Occlutech Occluder Devices in More Than 1300 Patients: The IRFACODE Project: A Retrospective Case Series.* Catheter Cardiovasc Interv, 2016. **88**(4): p. 571-581.
27. Sakumoto, K., et al., *Delayed cardiac tamponade caused by erosion 5 years after percutaneous closure of atrial septal defect with Figulla Flex II: a case report.* J Surg Case Rep, 2025. **2025**(3): p. rjaf104.
28. Thanopoulos, B.D., et al., *Catheter closure of atrial septal defects using the Cocoon septal occluder: preliminary results of a European multicenter study.* Int J Cardiol, 2014. **177**(2): p. 418-22.
29. Li, Y.-F., et al., *Recent Development of Biodegradable Occlusion Devices for Intra-Atrial Shunts.* RCM, 2024. **25**(5).
30. Sievert, K., et al., *Transcatheter closure of atrial septal defect and patent foramen ovale with Carag bioresorbable septal occluder: first-in-man experience with 24-month follow-up.* EuroIntervention, 2022. **17**(18): p. 1536-1537.
31. Narin, N., et al., *Pediatric cardiologyPercutaneous atrial septal defect closure by using jugular venous access in a case with interrupted inferior vena cava.* Advances in Interventional Cardiology/Postępy w Kardiologii Interwencyjnej, 2014. **10**(4): p. 267-269.
32. Alnasser, S., et al., *Long term outcomes among adults post transcatheter atrial septal defect closure: Systematic review and meta-analysis.* International Journal of Cardiology, 2018. **270**: p. 126-132.
33. Wang, J.-K., et al., *Transcatheter closure of atrial septal defect without balloon sizing.* Catheterization and Cardiovascular Interventions, 2008. **71**(2): p. 214-221.
34. Aykan, H.H., B.A. Dinç, and T. and Karagöz, *Hidden risk behind the septum: late presentation of coronary compression following transcatheter atrial septal defect closure in a child.* Acta Cardiologica: p. 1-3.
35. Silvestry, F.E., et al., *Guidelines for the Echocardiographic Assessment of Atrial Septal Defect and Patent Foramen Ovale: From the American Society of Echocardiography and Society for Cardiac Angiography and Interventions.* J Am Soc Echocardiogr, 2015. **28**(8): p. 910-58.
36. Butera, G., et al., *Percutaneous versus surgical closure of secundum atrial septal defects: a systematic review and meta-analysis of currently available clinical evidence.* EuroIntervention, 2011. **7**(3): p. 377-85.
37. Mylonas, K.S., et al., *Minimally Invasive Surgery vs Device Closure for Atrial Septal Defects: A Systematic Review and Meta-analysis.* Pediatric Cardiology, 2020. **41**(5): p. 853-861.



TRANSKATETER VENTRİKÜLER SEPTAL DEFEKT KAPATILMASI

BÖLÜM
9

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İçindekiler

» TRANSKATETER VSD KAPATILMASI : GİRİŞ VE TARİHÇE
» PERKÜTAN CİHAZ İLE VSD KAPATILMASINDA ENDİKASYON VE HASTA SEÇİMİ
» PERİMEMBRANÖZ VSD (PM-VSD)
» PM-VSD'LERİN DOĞAL SEYRİ
» PERKÜTAN YOL İLE PM-VSD KAPATILMASI
» KAPATMA CİHAZLARI
» PERKÜTAN PM-VSD KAPATMA ÖNCESİ DEĞERLENDİRME
» PERİMEMBRANÖZ VSD KAPATMA YÖNTEMLERİ VE CİHAZ SEÇİMİ
» MUSKÜLER VSD'LERİN TRANSKATER YÖNTEM İLE KAPATILMASI
» TRANSKATETER VSD KAPATMA KOMPLİKASYONLARI
» İŞLEM BAŞARISI VE REZİDÜ ŞANT
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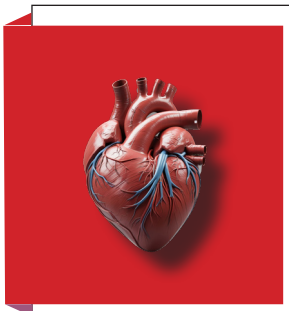
KAYNAKLAR

1. Butera G, Chessa M, Carminati M. Percutaneous closure of ventricular septal defects. Cardiol Young. 2007 Jun;17(3):243-53.
2. Lock JE, Block PC, McKay RG, Baim DS, Keane JF. Transcatheter closure of ventricular septal defects. Circulation. 1988 Aug;78(2):361-8.
3. Kalra GS, Verma PK, Dhall A, Singh S, Arora R. Transcatheter device closure of ventricular septal defects: immediate results and intermediate-term follow-up. Am Heart J. 1999 Aug;138(2 Pt 1):339-44.
4. Sideris EB, Walsh KP, Haddad JL, Chen CR, Ren SG, Kulkarni H. Occlusion of congenital ventricular septal defects by the buttoned device. "Buttoned device" Clinical Trials International Register. Heart. 1997 Mar;77(3):276-9.
5. Kalra GS, Verma PK, Singh S, Arora R. Transcatheter closure of ventricular septal defect using detachable steel coil. Heart. 1999 Sep;82(3):395-6.
6. Amin Z, Gu X, Berry JM, Bass JL, Titus JL, Urness M, et al. New device for closure of muscular ventricular septal defects in a canine model. Circulation. 1999 Jul 20;100(3):320-8
7. Thanopoulos BD, Tsaousis GS, Konstadopoulou GN, Zarayelyan AG. Transcatheter closure of muscular ventricular septal defects with the amplatzer ventricular septal defect occluder: initial clinical applications in children. J Am Coll Cardiol. 1999 Apr;33(5):1395-9.
8. Hijazi ZM, Hakim F, Al-Fadley F, Abdelhamid J, Cao QL. Transcatheter closure of single muscular ventricular septal defects using the amplatzer muscular VSD occluder: initial results and technical considerations. Catheter Cardiovasc Interv. 2000 Feb;49(2):167-72.
9. Hijazi ZM, Hakim F, Haweleh AA, Madani A, Tarawna W, Hiari A, et al. Catheter closure of perimembranous ventricular septal defects using the new Amplatzer membranous VSD occluder: initial clinical experience. Catheter Cardiovasc Interv. 2002 Aug;56(4):508-15.
10. Benson LN, Yoo D-J, Al Habshan F, Anderson RH. Ventricular septal defects. In: Anderson RH, Baker EJ, Redington A, Rigby ML,Penny D, Wernovsky G, eds. Paediatric cardiology, 3rd edn. Philadelphia: Churchill Livingstone, 2009: pp 591–624
11. Eroğlu AG, Oztunç F, Saltik L, Bakari S, Dedeoğlu S, Ahunbay G. Evolution of ventricular septal defect with special reference to spontaneous closure rate, subaortic ridge and aortic valve prolapse. Pediatr Cardiol 2003; 24:31-5.
12. Anderson RH, Lenox CC, Zuberbuhler JR. Mechanisms of closure of perimembranous ventricular septal defect. Am J Cardiol 1983; 52: 341–5.
13. Wu MH, Chang CI, Wang JK, Lue HC. Characterization of aneurysmalt ransformation in perimembranous ventricular septal defects: Anadhered anterior leaflet of tricuspid valve predisposes to the developmen of left ventricular-to-right atrial shunt. Int J Cardiol 1994; 47:117–125.
14. Eroglu, A.G., Atik, S.U., Sengenc, E, Cig G., Saltık I.L., Oztunc F. Evaluation of Ventricular Septal Defect with Special Reference to the Spontaneous Closure Rate, Subaortic Ridge, and Aortic Valve Prolapse II. Pediatr Cardiol 2017; 38:915–921.
15. Yilmaz AT, Ozal E, Arslan M, Tatar H, Oztürk OY. Aneurysm of the membranous septum in adult patients with perimembranous ventricular septal defect. Eur J Cardiothorac Surg 1997 ;11:307-11
16. Szkutnik M, Qureshi SA, Kusa J, Rosenthal E, Bialkowski J. Use of the Amplatzer muscular ventricular septal defect occluder for closure of perimembranous ventricular septal defects. Heart 2007;93:355–358.
17. Jin Y, Han B, Zhang J, Zhuang J, Yan J, Wang Y. Postimplant complications with transcatheter closure of congenital perimembranous ventricular septal defects: a single-center, longitudinal study from 2002 to 2011. Catheter Cardiovasc Interv. 2013;81:666-73.
18. Bian C, Ma J, Wang J, Xu G, Jiang J, Yao S, Liu Y. Perimembranous ventricular septal defect with aneurysm: two options for transcatheter closure. Tex Heart Inst J 2011;38:528-32.
19. El Said HG, Bratincsak A, Gordon BM, Moore JW. Closure of perimembranous ventricular septal defects with aneurysmal tissue using the Amplazter Duct Occluder I: lessons learned and medium term follow up. Catheter Cardiovasc Interv 2012 15;80:895-903.
20. Landman G, Kipps A, Moore P, Teitel D, Meadows J. Outcomes of a modified approach to transcatheter closure of perimembranous ventricular septal defects. Catheter Cardiovasc Interv 2013 1;82:143-9.
21. Koneti NR, Penumatsa RR, Kanchi V, Arramraj SK, S J, Bhupathiraju S. Retrograde transcatheter closure of ventricular septal defects in children using the Amplatzer Duct Occluder II. Catheter Cardiovasc Interv 2011 1;77:252-9.
22. Michel-Behnke I, Le TP, Waldecker B, Akintuerk H, Valeske K, Schranz D. Percutaneous closure of congenital and acquired ventricular septal defects--considerations on selection of the occlusion device. J Interv Cardiol 2005 ;18:89-99.
23. Wu MH, Wang JK, Lin MT, Wu ET, Lu FL, Chiu SN, Lue HC. Ventricular septal defect with secondary left ventricular-to-right atrial shunt is associated with a higher risk for infective endocarditis and a lower late chance of closure. Pediatrics 2006; 117:e262-7.
24. Parvez, Md. Afaque; Das, Dhritabrata. Transcatheter device closure of perimembranous ventricular septal defect associated with indirect Gerbode defect: A retrospective study. Annals of Pediatric Cardiology 14(3):p 397-400, Jul–Sep 2021.
25. Eroğlu AG, Oztunç F, Saltik L, Dedeoğlu S, Bakari S, Ahunbay G. Aortic valve prolapse and aortic regurgitation in patients with ventricular septal defect.Aortic valve prolapse and aorticregurgitation in patients with ventricular septal defect. Pediatr Cardiol 2003; 24:36-39.
26. Holzer R, de Giovanni J, Walsh KP, Tometzki A, Goh T, Hakim F, Zabal C, et al. Transcatheter closure of perimembranous ventricular septal defects using the Amplatzer membranous VSD occluder: immediate and mid-term results of an international registry. Catheter Cardiovasc Interv 2006; 68: 620–8.
27. Pinto RJ, Dalvi BV, Sharma S. Transcatheter closure of perimembranous ventricular septal defects using amplatzer asymmetric ventricular septal defect occluder: preliminary experience with 18-month follow up. Catheter Cardiovasc Interv. 2006 ;68 :145-52.

28. Carminati M, Butera G, Chessa M, De Giovanni J, Fisher G, Gewillig M, et al.; Investigators of the European VSD Registry.Eur Heart J 2007; 28: 2361-8.
29. Butera G, Carminati M, Chessa M, Piazza L, Micheletti A, Negura DG, et al. Transcatheter closure of perimembranous ventricular septal defects: early and long-term results. J Am Coll Cardiol 2007 18;50 :1189-95.
30. Zhang W, Wang C, Liu S, Zhou L, Li J, Shi J, et al Z. Safety and Efficacy of Transcatheter Occlusion of Perimembranous Ventricular Septal Defect with Aortic Valve Prolapse: A Six-Year Follow-Up Study. J Interv Cardiol. 18;2021:6634667.
31. Ghosh S, Sridhar A, Solomon N, Sivaprakasham M. Transcatheter closure of ventricular septal defect in aortic valve prolapse and aortic regurgitation. Indian Heart J.70(4):528-532.
32. Ugan Atik S, Guler EA. Aortic valve prolapse and aortic regurgitation during long-term follow up in children with ventricular septal defect. J Heart Valve Dis 26(6):616-623
33. Yucel IK, Demir IH, Kardas M, Bulut MO, Surucu M, Yilmaz EH, et al. Percutaneous Device Closure of Perimembranous Ventricular Septal Defects Associated with Aortic Valve Prolapse and Aortic Regurgitation. Pediatr Cardiol. 2024 Nov 26. doi: 10.1007/s00246-024-03725-0. Epub ahead of print
34. Song J. Percutaneous Transcatheter Closure of Congenital Ventricular Septal Defects. Korean Circ J. 2023;53(3):134-150.
35. Ghosh S, Mukherji A, Chattopadhyay A. Percutaneous closure of moderate to large perimembranous ventricular septal defect in small children using left ventricular mid-cavity approach. Indian Heart J. 2020;72(6):570-575.
36. Sagar P, Thejaswi P, Garg I, Sivakumar K. Transcatheter Closure of Ventricular Septal Defects after Upfront Transvenous Antegrade Cannulation from the Right Ventricle. Pediatr Cardiol. 2025 Jan 25.. Epub ahead of print.
37. Guo W, Li Y, Yu J, Li J, Sun L, Shi J, et al. Transcatheter Closure of Perimembranous Ventricular Septal Defect with Aneurysm: Radiologic Characteristic and Interventional Strategy. J Interv Cardiol. 2020 Dec 24;2020:6646482.
38. Tan CA, Levi DS, Moore JW. Percutaneous closure of perimembranous ventricular septal defect associated with a ventricular septal aneurysm using the Amplatzer Ductal Occluder. Catheter Cardiovasc Interv 2005;66 :427–431.
39. Anderson RH, Becker AE, Tynan M. Description of ventricular septal defects-or how long is a piece of string? Int J Cardiol. 1986; 13:267-278.
40. Tretter JT, Benson L, Crucean A, Spicer DE, Anderson RH. Ventricular Septal Defect. Anderson's Pediatric Cardiology, fourth edition. Wernovsky G, Anderson RH, Kumar K, Musatto K, Redington AN, Tweddell JS, Tretter JT (eds). Elsevier ,555-584 (2020)
41. Adan A, Eleyan L, Zaidi M, Ashry A, Dhannapuneni R, Harky A. Ventricular septal defect: diagnosis and treatments in the neonates: a systematic review. Cardiology in the Young 2021; 31: 756–761.
42. Kang SL, Tometzki A, Caputo M, Morgan G, Parry A, Martin R. Longer-Term Outcome of Perventricular Device Closure of Muscular Ventricular Septal Defects in Children. Catheter Cardiovasc Interv 2015; 85:998–1005
43. Kitagawa T, Durham III LA, Mosca RS, et al. Techniques and results in the management of multiple ventricular septal defects. J Thorac Cardiovasc Surg. 1998; 115:848-856
44. Holzer R, Balzer D, Cao QL, et al. Device closure of muscular ventricular septal defects using the Amplatzer muscular ventricular septal defect occluder: immediate and mid-term results of a U.S. registry. J Am Coll Cardiol 2004; 43:1257-1263
45. Arora R, Trehan V, Thakur AK, Mehta V, Sengupta PP, Nigam M. Transcatheter closure of congenital muscular ventricular septal defect. J Interv Cardiol 2004; 17:109-15.
46. Yang R, Kong XQ, Sheng YH, Zhou L, Xu D, Yong YH, et al. Risk factors and outcomes of post-procedure heart blocks after transcatheter device closure of perimembranous ventricular septal defect. JACC Cardiovasc Interv. 2012 Apr;5(4):422-7.
47. Bentham JR, Gujral A, Adwani S, Archer N, Wilson N. Does the technique of interventional closure of perimembranous ventricular septal defect reduce the incidence of heart block? Cardiol Young 2011 ;21:271-80.
48. Zhou T, Shen XQ, Zhou SH, Fang ZF, Hu XQ, Zhao YS, et al. Complications associated with transcatheter closure of perimembranous ventricular septal defects. Catheter Cardiovasc Interv. 2008 Mar 1;71(4):559-63.



AORT KOARKTASYONUNUN BALON VE STENT İLE TEDAVİSİ

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10

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İçindekiler

» GİRİŞ
» BALON ANJİYOPLASTİ
» YENİDOĞAN VE 3 AY'DAN KÜÇÜK İNFANTLARDA BALON ANJİYOPLASTİ
» ÜÇ AY'DAN BÜYÜK ÇOCUKLARDA, ADOLESAN VE ERİŞKİNLERDE BALON ANJİYOPLASTİ
» TEKNİK
» KOMPLİKASYONLAR
» STENT İMPLANTASYONU
» AOK TEDAVİSİNDE KULLANILAN STENTLER
» TEKNİK
  » Komplikasyonlar

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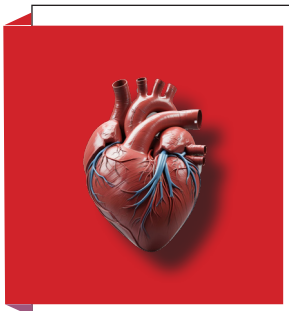
İzlemde anevrizma oluşumu, diseksiyon ve stent içi daralmaları kontrol etmek için aralıklı BT anjiyografi ile değerlendirme yapılması gerekmektedir. Klinik ve ekokardiyografik olarak rekoarktasyon, devam eden hipertansiyon veya BT'de anevrizma oluşumu kanıtı varsa rekateterizasyon yapılır. Elektif planlı rekateterizasyon, stent başlangıçta az expande edilerek bilinçli rezidüel darlık bırakıldığında redilatasyon amacıyla 6-12 ay sonra gerçekleştirilir.

KAYNAKLAR

1. van der Linde D, Konings EE, Slager MA, Witsenburg M, Helbing WA, Takkenberg JJM, et al. Birth prevalence of congenital heart disease worldwide: a systematic review and meta-analysis. J Am Coll Cardiol. 2011;58:2241-2247.
2. Hoffman JI, Kaplan S. The incidence of congenital heart disease. J Am Coll Cardiol. 2002;39:1890-1900.
3. Wren C, Reinhardt Z, Khawaja K. Twenty-year trends in diagnosis of life-threatening neonatal cardiovascular malformations. Arch Dis Child Fetal Neonatal. 2008;93:F33-F35.
4. Gross RE. Surgical correction for coarctation of the aorta. Surgery. 1945;18:673-678.
5. Crafoord, C.; Nylin, G. Congenital coarctation of the aorta and its surgical treatment. *J. Thorac. Surg.* **1945**, *14*, 347–361.
6. Isselbacher EM, Preventza O, Hamilton Black Iii J, Augoustides JG, Beck AW, Bolen MA, et al. 2022 ACC/AHA Guideline for the Diagnosis and Management of Aortic Disease: A Report of the American Heart Association/American College of Cardiology Joint Committee on Clinical Practice Guidelines. J Am Coll Cardiol. 2022 Dec 13;80(24):e223-e393.
7. Bigdelian H, Sedighi M. Repair of aortic coarctation in infancy: a 10-year clinical experience. *Asian Cardiovasc Thorac Ann.* 2016;24:417–421.
8. Padalino MA, Bagatin C, Bordin G, Tua L, Francescato A, Pradegan N, et al. Surgical repair of aortic coarctation in pediatric age: a single center two decades experience. *J Card Surg.* 2019;34:256–265.
9. Hager A, Schreiber C, Nutzl S, Hess J. Mortality and restenosis rate of surgical coarctation repair in infancy: a study of 191 patients. *Cardiology.* 2009;112:36–41.
10. Ylinen MK, Tyni VE, Pihkala JI, Salminen JT, Sairanen H, Sarkola T. Procedural risk factors, incidence and timing of reintervention after treatment for native coarctation of the aorta in children: a population-based study†. *Eur J Cardiothorac Surg.* 2019;55:564–571.
11. Baumgartner H, De Backer J, Babu-Narayan SV, Budts W, Chessa M, Diller GP, et al. ESC Scientific Document Group. 2020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J. 2021 Feb 11;42(6):563-645.
12. Singer MI, Rowen M, Dorsey TJ. Transluminal aortic balloon angio- plasty for coarctation of the aorta in the newborn. Am Heart J. 1982;103:131- 132.
13. McCrindle BW, Jones TK, Morrow WR, Hagler DJ, Lloyd TR, Nouri S, et al. Acute results of balloon angioplasty of native coarctation versus recurrent aortic obstruction are equivalent. Valvuloplasty and Angioplasty of Congenital Anomalies (VACA) Registry Investigators. J Am Coll Cardiol 1996;28:1810-7.
14. Fiore AC, Fischer LK, Schwartz T, Jureidini S, Balfour I, Carpenter D, et al. Comparison of angioplasty and surgery for neonatal aortic coarctation. Ann Thorac Surg 2005;80:1659-64.
15. Fletcher SE, Nihill MR, Grifka RG, O'Laughlin MP, Mullins CE. Balloon angioplasty of native coarctation of the aorta: midterm follow-up and prognostic factors. *J Am Coll Cardiol*. 1995;25:730–734.
16. Redington AN, Booth P, Shore DF, Rigby ML. Primary balloon dilatation of coarctation of the aorta in neonates. *Br Heart J.* 1990;64:277–281.
17. Rao PS, Chopra PS, Koscik R, Smith PA, Wilson AD. Surgical versus balloon therapy for aortic coarctation in infants < or = 3 months old. *J Am Coll Cardiol.* 1994;23:1479–1483.
18. Francis E, Gayathri S, Vaidyanathan B, Kannan BR, Kumar RK. Emergency balloon dilation or stenting of critical coarctation of aorta in newborns and infants: An effective interim palliation. Ann Pediatr Cardiol 2009;2:111-5.
19. Parra-Bravo JR, Reséndiz-Balderas M, Francisco-Candelario R, García H, Chávez-Fernández MA, Beirana-Palencia LG, et al. Balloon angioplasty for native aortic coarctation in children younger than 12 months: immediate and medium- term results. *Arch Cardiol Mex.* 2007;77:217–225.
20. Sen S, Garg S, Rao SG, Kulkarni S. Native aortic coarctation in neo- nates and infants: immediate and midterm outcomes with balloon angioplasty and surgery. *Ann Pediatr Cardiol.* 2018;11:261–266.
21. Sandoval JP, Kang SL, Lee KJ, Benson L, Asoh K, Chaturvedi RR. Balloon Angioplasty for Native Aortic Coarctation in 3- to 12-Month-Old Infants. Circ Cardiovasc Interv. 2020 Nov;13(11):e008938.
22. Ovaert C, McCrindle BW, Nykanen D, MacDonald C, Freedom RM, Benson LN. Balloon angioplasty of native coarctation: clinical outcomes and predictors of success. *J Am Coll Cardiol.* 2000;35:988–996.
23. Mullins CE. *Cardiac Catheterization in Congenital Heart Disease: Pediatric and Adult*. Malden, Massachusetts: Blackwell Publishing, 2006. pp. 454–71.
24. Holzer R, Qureshi S, Ghasemi A, Vincent J, Sievert H, Gruenstein D, et al. Stenting of aortic coarctation: acute, intermediate, and long-term results of a prospective multi-institutional registry--Congenital Cardiovascular Interventional Study Consortium (CCISC). Catheter Cardiovasc Interv. 2010 Oct 1;76(4):553-63.
25. Forbes TJ, Garekar S, Amin Z, Zahn EM, Nykanen D, Moore P, et al. Congenital Cardiovascular Interventional Study Consortium (CCISC). Procedural results and acute complications in stenting native and recurrent coarctation of the aorta in patients over 4 years of age: a multi-institutional study. Catheter Cardiovasc Interv. 2007 Aug 1;70(2):276-85.
26. Cowley CG, Orsmond GS, Feola P, McQuillan L, Shaddy RE. Long-term, randomized comparison of balloon angioplasty and surgery for native coarctation of the aorta in childhood. Circulation. 2005 Jun 28;111(25):3453-6.

27. Peter Ewert, Thomas Berger, Thomas Daehnert, et al. Complications of balloon angioplasty of native coarctation of the aorta. *Heart*, 2004; 90(3):310–314.
28. Vermilion RP, Snider AR, Bengur AR, Beekman RH. Doppler evaluation of femoral arteries in children after aortic balloon valvuloplasty or coarctation balloon angioplasty. Pediatr Cardiol. 1993 Jan;14(1):13-8.
29. Koerselman J, de Vries H, Jaarsma W, Muyldermans L, Ernst JM, Plokker HW. Balloon angioplasty of coarctation of the aorta: a safe alternative for surgery in adults: immediate and mid-term results. Catheter Cardiovasc Interv. 2000 May;50(1):28-33.
30. Oliver JM, Gallego P, Gonzalez A, Aroca A, Bret M, Mesa JM. Risk factors for aortic complications in adults with coarctation of the aorta. J Am Coll Cardiol. 2004 Oct 19;44(8):1641-7.
31. Sealy WC. Paradoxical hypertension after repair of coarctation of the aorta: a review of its causes. Ann Thorac Surg. 1990 Aug;50(2):323-9.
32. O'Laughlin MP, Perry SB, Lock JE, Mullins CE. Use of endovascular stents in congenital heart disease. Circulation. 1991;83:1923–39.
33. Zahn EM, Abbott E, Tailor N, Sathanandam S, Armer D. Preliminary testing and evaluation of the renata minima stent, an infant stent capable of achieving adult dimensions. Catheter Cardiovasc Interv. 2021 Jul 1;98(1):117-127.
34. Berman DP, Morray B, Sullivan P, Shahanavaz S, Zahn EM. Results of the multicenter early feasibility study (EFS) of the Renata Minima stent as treatment for branch pulmonary artery stenosis and coarctation of aorta in infants. Catheter Cardiovasc Interv. 2024 Jul;104(1):61-70.
35. De Lezo JS, Sancho M, Pan M, Romero M, Olivera C, Luque M. Angiographic follow-up after balloon angioplasty for coarctation of the aorta. *J Am Coll Cardiol* 1989;13:689–95.
36. Shaddy RE, Boucek MM, Sturtevant JE, Ruttenberg HD, Jaffe RB, Tani LY, et al. Comparison of angioplasty and surgery for unoperated coarctation of the aorta (see comments). *Circulation* 1993;87:793–9.
37. Trent MS, Parsonnet V, Shoenfeld R, Brener BJ, Eisenbud DE, Novick AS, et al. A balloon-expandable intravascular stent for obliterating experimental aortic dissection. *J Vasc Surg* 1990;11:707–17.
38. Ohkubo M, Takahashi K, Kishiro M, Akimoto K, Yamashiro Y. Histological findings after angioplasty using conventional balloon, radiofrequency thermal balloon and stent for experimental aortic coarctation. *Pediatr Int* 2004;46:39–47.
39. Forbes TJ, Kim DW, Du W, Turner DR, Holzer R, Amin Z, et al. Comparison of surgical, stent, and balloon angioplasty treatment of native coarctation of the aorta: an observational study by the CCISC (Congenital Cardiovascular Interventional Study Consortium). J Am Coll Cardiol. 2011 Dec 13;58(25):2664-74.
40. Stegeman R, Breur JMPJ, Heuser J, Jansen NJG, de Vries WB, Vijlbrief DC, et al. Primary coronary stent implantation is a feasible bridging therapy to surgery in very low birth weight infants with critical aortic coarctation. Int J Cardiol. 2018 Jun 15;261:62-65
41. Sadeghipour P, Pouraliakbar HR, Farrashi M, Habibi Khorasani S, Mohebbi B, Iranian M, et al. Balloon-expandable versus self-expanding stents in native coarctation of the aorta: three-year results of a randomised controlled trial. EuroIntervention. 2024 May 10;20(9):613-615.
42. Tyagi S, Singh S, Mukhopadhyay S, Kaul UA. Self- and balloon-expandable stent implantation for severe native coarctation of aorta in adults. Am Heart J. 2003 Nov;146(5):920-8.
43. Qureshi AM, McElhinney DB, Lock JE, Landzberg MJ, Lang P, Marshall AC. Acute and intermediate outcomes, and evaluation of injury to the aortic wall, as based on 15 years' experience of implanting stents to treat aortic coarctation *Cardiol Young* 2007;17:307–18
44. Mahadevan VS, Vondermuhll IF, Mullen MJ. Endovascular aortic coarctation stenting in adolescents and adults: Angiographic and hae- modynamic outcomes. *Catheter Cardiovasc Interv* 2006;67:268–75.
45. Holzer R, Qureshi S, Ghasemi A, Vincent J, Sievert H, Gruenstein D. Stenting of aortic coarctation: Acute, intermediate, and long-term results of a prospective multi-institutional registry—Congenital cardiovascular interventional study consortium (CCISC). *Catheter Cardiovasc Interv* 2010;76;553–63.
46. Li R, Li Q, Li X, Li Y, Chen Z, He Q, Zhao ZG, Feng Y. Long-Term Results of Transcatheter Intervention of Coarctation of the Aorta: A 12-Year Single-Center Experience. Am J Cardiol. 2025 Feb 15;237:65-71.
47. Chessa M, Carminati M. "Stenting of native and recurrent coarctation of the aorta." *Heart*. 2005;91(7):987-992.
48. Ing FF, Khan M, Balzer D, et al. "Neurologic complications after cardiac catheterization and intervention in children and adults with congenital heart disease." *Catheter Cardiovasc Interv*. 2013;82(3):454-459.
49. Faggioni M, Biondi-Zoccai G, Versaci F, et al. "Spinal cord ischemia after endovascular thoracic aortic repair." *Am J Cardiol*. 2012;110(4):588-593.
50. Pan M, Pericet C, González-Manzanares R, Díaz MA, Suárez de Lezo J, Hidalgo F, et al. Very long-term follow-up after aortic stenting for coarctation of the aorta. Rev Esp Cardiol (Engl Ed). 2024 Apr;77(4):332-341. English, Spanish.
51. Sohrabi B, Jamshidi P, Yaghoubi A, Habibzadeh A, Hashemi-Aghdam Y, Moin A, et al. Comparison between covered and bare Cheatham-Platinum stents for endovascular treatment of patients with native post-ductal aortic coarctation: immediate and intermediate-term results. JACC Cardiovasc Interv. 2014 Apr;7(4):416-23.



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DUKTUS ARTERİOSUSA BAĞIMLI PULMONER DOLAŞIMDA DUKTAL STENT İMPLANTASYONU

BÖLÜM 11

İbrahim Halil DEMİR [1]
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İçindekiler

» GİRİŞ
» SİYANOTİK KONJENİTAL KALP HASTALIKLARINDA DUKTUS ARTERİOZUS
» PROSEDÜR ÖNCESİ DEĞERLENDİRME VE HAZIRLIK
» PROSEDÜR
» SONUÇLAR
  » Komplikasyonlar
  » Akut Komplikasyonlar
  » Geç Komplikasyonlar ve İzlem

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Bazen işlem sırasında bir pulmoner arter hapsedilebilir. Genellikle hapsedilen tarafın zamanla gelişiminin yeterli olduğu düşünülse de işlem sırasında hipoksemi varsa ya da kontrol enjeksiyonlarında o pulmoner artere kontrast geçişi az ise bu tip durumlarda stent implantasyonu sonrasında stentin "strut"ları arasından geçilerek balon dilatasyon ile sorun giderilebilir. Ancak erken dönemde bu işlemin stent malpozisyonu ya da emboli-zasyonu açısından riskli olduğu unutulmamalıdır.

Geç Komplikasyonlar ve İzlem

Duktal stent implantasyonu yapılmış olan hastalara antiagregan olarak sadece aspirin verilebilir ancak ikili (aspirin, clopidogrel) tedavi daha güvenlidir (27,33). Bu tedavi duktal stent ihtiyacının geçici olduğu durumlarda ihtiyaç ortadan kalktığında kesilebilir diğer hastalarda cerrahi operasyona kadar devamı edilir. Kontrollerde oksijen satürasyonu ve muayenede devamlı üfürüm duyulup duyulmadığı not edilmelidir. Ekokardiyografik incelemede duktal stent akımı, pulmoner arterlerin dolumu, konfluensi ve pulmoner yatağın gelişimi değerlendirilmelidir. İzlemde subakut stent trombozu, intimal profilerasyona bağlı stent stenozu ve bazen hapsedilmiş pulmoner arter tarafında diskonneksiyon gelişebilir (25,27,33). İzlemde ilerleyici satürasyon düşüklüğü ve üfürümün niteliğinin değişimi uyarıcı olmalıdır. Bu hastalarda yeniden girişim yapılarak balon angioplasti veya stent implantasyonu ile stent akımı arttırılabilir. Özellikle tek ventrikül tamiri adayı olan hastalarda bir pulmoner arterde başlangıçta doğal darlık ya da damarın hapsedilmesine bağlı pulmoner arter gelişimi istenen düzeyde gerçekleşmiyorsa zaman kaybetmeden bu damar görüntülenmeli ve gerekirse transkateter girişimler ya da cerrahi şant ile sonraki evrelere daha iyi pulmoner yatak oluşturmaya gayret edilmelidir.

Özetle, Pulmoner dolaşımın DA'ya bağımlı olduğu durumların bazılarında örneğin kritik PS veya IVS-pulmoner atrezili olgularda duktus morfolojilerinin genellikle stent için en uygun biçimlerde olması, bu hastaların pulmoner kan akımını ilave olarak artıracak palyasyona geçici olarak ihtiyaçlarının olması ve de çoğunlukla tekrar düzeltici cerrahi gerektirmeyecekleri için en ideal adaylardır. Duktal stent bu hastalarda sağ ventrikül hipoplazik olmayanlarda komplians düzelene kadar, hipoplazik olanlarda ise sağ ventrikül gelişene kadar güvenli bir palyasyon sağlar. Belirtilen gerekçelerle birinci seçenek olarak tercih edilmelidir. Akciğer kan akımı kaynağı tek olan univent-riküler tamir adayı hastalar ile kompleks VSD'li pulmoner atrezilerde de duktusa stent implantasyonu oldukça güvenlidir. Cerrahi şantla karşılaştırıldığında sonuçlar en azından benzer hatta bazı çalışmalarda daha üstündür. Cerrahi şantla karşılaştırıldığında DSİ'nunun birçok avantajı vardır. Bu nedenle pulmoner kan akımını garantiye almak veya artırmak amaçlı bu hasta grubunda da yine birinci seçenek olabilir.

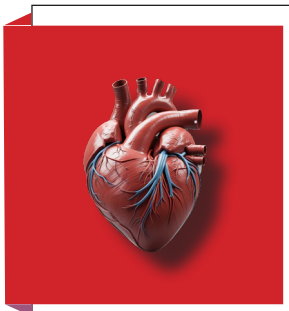
KAYNAKLAR

1. Rana JS, Ahmad KA, Shamim AS, Hassan SB, Ahmed MA. Blalock-Taussig shunt: experience from the developing world. Heart Lung Circ. 2002;11(3):152-6.
2. Sasikumar N, Hermuzi A, Fan CS, Lee KJ, Chaturvedi R, Hickey E, et all. Outcomes of Blalock-Taussig shunts in current era: A single center experience. Congenit Heart Dis. 2017 Dec;12(6):808-814.
3. Amelia P, Advani N, Pulungan AB, Djer MM, Hegar B, Prawira Y, et all. Predicting Factors for Mortality in Patients After the Modified Blalock-Taussig Shunt Procedure in Developing Countries: A Retrospective Study. Int J Gen Med. 2023;16:5291-5300
4. Yilmaz M, Turkcan BS, Ecevit AN, Şahan YÖ, Atalay A. Comparative Analysis of Modified BT Shunt and Central Shunt in Pediatric Patients. Braz J Cardiovasc Surg. 2024 May 15;39(3):e20230376.
5. Sasikumar N, Hermuzi A, Fan CS, Lee KJ, Chaturvedi R, Hickey E, et all. Outcomes of Blalock-Taussig shunts in current era: A single center experience. Congenit Heart Dis. 2017 Dec;12(6):808-814. doi: 10.1111/chd.12516. Epub 2017 Jul 24. PMID: 28736841.
6. Glatz AC, Petit CJ, Goldstein BH, Kelleman MS, McCracken CE, McDonnell A, et all. Comparison Between Patent Ductus Arteriosus Stent and Modified Blalock-Taussig Shunt as Palliation for Infants With Ductal-Dependent Pulmonary Blood Flow: Insights From the Congenital Catheterization Research Collaborative. Circulation. 2018 Feb 6;137(6):589-601. doi: 10.1161/CIRCULATIONAHA.117.029987. Epub 2017 Oct 17. PMID: 29042354.
7. Rehman R, Marhisham MC, Alwi M. Stenting the complex patent ductus arteriosus in tetralogy of Fallot with pulmonary atresia: challenges and outcomes. Future Cardiol. 2018 Jan;14(1):55-73. doi: 10.2217/fca-2017-0053. Epub 2017 Dec 4. PMID: 29199861.

8. Onalan MA, Odemis E, Saygi M, Temur B, Aydin S, Demir IH, et all. Early and midterm results of ductal stent implantation in neonates with ductal-dependent pulmonary circulation: a single-centre experience. Cardiol Young. 2020 Dec;30(12):1772-1782. doi: 10.1017/S1047951120002670X. Epub 2020 Sep 3. PMID: 32880245.
9. Downing TE, Boucek DM, Glatz AC, Qureshi AM, Zampi JD, Petit CJ, et all. Congenital Cardiac Research Collaborative. Stenting the Ductus Arteriosus in Neonates with Ductal-Dependent Pulmonary Blood Flow: Technical and Anatomic Considerations. Pediatr Cardiol. 2025 Apr 10. doi: 10.1007/s00246-025-03834-4. Epub ahead of print. PMID: 40210778.
10. Gibbs JL, Rothman MT, Rees MR, Parsons JM, Blackburn ME, Ruiz CE. Stenting of the arterial duct: a new approach to palliation for pulmonary atresia. Br Heart J. 1992 Mar;67(3):240-5. doi: 10.1136/hrt.67.3.240. PMID: 1372815; PMCID: PMC1024799.
11. Alwi M, Mood MC. Stenting of Lesions in Patent Ductus Arteriosus with Duct-Dependent Pulmonary Blood Flow: Focus on Case Selection, Techniques and Outcome. Interv Cardiol Clin. 2013 Jan;2(1):93-113. doi: 10.1016/j.iccl.2012.09.011. Epub 2012 Dec 3. PMID: 28581990.
12. Gewillig M, Boshoff DE, Dens J, Mertens L, Benson LN. Stenting the neonatal arterial duct in duct-dependent pulmonary circulation: new techniques, better results. J Am Coll Cardiol. 2004 Jan 7;43(1):107-12. doi: 10.1016/j.jacc.2003.08.029. PMID: 14715191.
13. Roggen M, Cools B, Brown S, Boshoff D, Heying R, Eyskens B, et all. Can ductus arteriosus morphology influence technique/outcome of stent treatment? Catheter Cardiovasc Interv. 2020 May 1;95(6):1149-1157. doi: 10.1002/ccd.28725. Epub 2020 Jan 17. PMID: 31951315.
14. Erek E, Aydın S, Temur B, Önalan MA, Suzan D, İyigün M, et all. Outcomes of hybrid and Norwood Stage I procedures for the treatment of hypoplastic left heart syndrome and its variants. Turk Gogus Kalp Damar Cerrahisi Derg. 2020 Apr 22;28(2):282-293. doi: 10.5606/tgkdc.dergisi.2020.18605. PMID: 32551158; PMCID: PMC7298388.
15. Schranz D. Duct Stenting in Duct-Dependent Systemic Blood Flow, Past, Present, and Future. Pediatr Cardiol. 2025 Mar;46(3):515-524. doi: 10.1007/s00246-024-03492-y. Epub 2024 Apr 25. PMID: 38664298; PMCID: PMC11842478.
16. Feltes TF, Bacha E, Beekman RH 3rd, Cheatham JP, Feinstein JA, Gomes et all. American Heart Association Congenital Cardiac Defects Committee of the Council on Cardiovascular Disease in the Young; Council on Clinical Cardiology; Council on Cardiovascular Radiology and Intervention; American Heart Association. Indications for cardiac catheterization and intervention in pediatric cardiac disease: a scientific statement from the American Heart Association. Circulation. 2011 Jun 7;123(22):2607-52. doi: 10.1161/CIR.0b013e31821b1f10. Epub 2011 May 2. PMID: 21536996.
17. Raval A, Thakkar B, Madan T, Oswal N, Garg R, Umalkar R, et all. Ductus arteriosus stenting: A promising percutaneous palliation in patients with duct-dependent pulmonary circulation. Rev Port Cardiol. 2016 Nov;35(11):583-592. doi: 10.1016/j.repc.2016.06.010. Epub 2016 Oct 14. PMID: 27746039.
18. Bauser-Heaton H, Price K, Weber R, El-Said H. Erratum: Stenting of the Patent Ductus Arteriosus: A Meta-analysis and Literature Review. J Soc Cardiovasc Angiogr Interv. 2023 Jul 27;2(4):101052. doi: 10.1016/j.jscai.2023.101052. Erratum for: doi: 10.1016/j.jscai.2022.100392. Erratum for: doi: 10.1016/j.jscai.2023.101051. PMID: 39131650; PMCID: PMC11307754.
19. Aggarwal V, Petit CJ, Glatz AC, Goldstein BH, Qureshi AM. Stenting of the ductus arteriosus for ductal-dependent pulmonary blood flow-current techniques and procedural considerations. Congenit Heart Dis. 2019 Jan;14(1):110-115. doi: 10.1111/chd.12709. PMID: 30811792.
20. Celebi A, Yucel IK, Bulut MO, Kucuk M, Balli S. Stenting of the ductus arteriosus in infants with functionally univentricular heart disease and ductal-dependent pulmonary blood flow: A single-center experience. Catheter Cardiovasc Interv. 2017 Mar 1;89(4):699-708. doi: 10.1002/ccd.26796. Epub 2016 Nov 10. PMID: 27862912.
21. Ratnayaka K, Nageotte SJ, Moore JW, Guyon PW, Bhandari K, Weber RL, et all. Patent Ductus Arteriosus Stenting for All Ductal-Dependent Cyanotic Infants: Waning Use of Blalock-Taussig Shunts. Circ Cardiovasc Interv. 2021 Mar;14(3):e009520. doi: 10.1161/CIRCINTERVENTIONS.120.009520. Epub 2021 Mar 9. PMID: 33685211.
22. Alwi M. Stenting the ductus arteriosus: Case selection, technique and possible complications. Ann Pediatr Cardiol. 2008 Jan;1(1):38-45. doi: 10.4103/0974-2069.41054. PMID: 20300236; PMCID: PMC2840730.
23. Aldudak B, Akdeniz O, Doyurgan O, Matur Okur N, Sivaslı ÖG, Salık F. A Better Way for Ductal Stenting in Patients with Duct-Dependent Pulmonary Flow and Vertical and Tortuous Patent Ductus Arteriosus. Anatol J Cardiol. 2022 Dec;26(12):872-879. doi: 10.5152/AnatolJCardiol.2022.1866. PMID: 35949124; PMCID: PMC9797832.
24. Zanjani KS, Zeinaloo A, Rad EM, Norouzi S, Mirnia K, Gorji M. Impact of Drug Elution on Infectious Outcomes after Ductal Stenting in Newborns. Pediatr Cardiol. 2024 Sep 5. doi: 10.1007/s00246-024-03625-3. Epub ahead of print. PMID: 39231824.
25. Aggarwal V, Dhillon GS, Penny DJ, Gowda ST, Qureshi AM. Drug-Eluting Stents Compared With Bare Metal Stents for Stenting the Ductus Arteriosus in Infants With Ductal-Dependent Pulmonary Blood Flow. Am J Cardiol. 2019 Sep 15;124(6):952-959. doi: 10.1016/j.amjcard.2019.06.014. Epub 2019 Jun 26. PMID: 31350000.
26. Li D, Zhou X, Li M. Arterial duct stent versus surgical shunt for patients with duct-dependent pulmonary circulation: a meta-analysis. BMC Cardiovasc Disord. 2021 Jan 6;21(1):9. doi: 10.1186/s12872-020-01817-2. PMID: 33407150; PMCID: PMC7789398.
27. Valdeomillos E, Jalal Z, Boudjemline Y, Thambo JB; Filiale de cardiologie pédiatrique et congénitale de la Société française de cardiologie. Transcatheter ductus arteriosus stenting in paediatric cardiology: Indications, results and perspectives. Arch Cardiovasc Dis. 2020 Feb;113(2):129-141. doi: 10.1016/j.acvd.2019.10.004. Epub 2019 Nov 18. PMID: 31753586.
28. Aditi D, Satish K, Neeraj A. The efficacy and safety of patent ductus arteriosus stent versus surgical aorto-pulmonary shunt in the management of babies with

ductdependent circulation: a meta-analysis and review of literatüre. Int J Contemp Pediatr. 2024 Jun;11(6):812-819. DOI: https://dx.doi.org/10.18203/2349-3291.ijcp20241369

29. Qureshi AM, Goldstein BH, Glatz AC, Agrawal H, Aggarwal V, Ligon RA, McCracken C, McDonnell A, Buckey TM, Whiteside W, Metcalf CM, Petit CJ. Classification scheme for ductal morphology in cyanotic patients with ductal dependent pulmonary blood flow and association with outcomes of patent ductus arteriosus stenting. Catheter Cardiovasc Interv. 2019 Apr 1;93(5):933-943. doi: 10.1002/ccd.28125. Epub 2019 Feb 21. PMID: 30790426.
30. Mini N, Schneider MBE, Asfour B, Mikus M, Zartner PA. Duct Stenting vs. Modified Blalock-Taussig Shunt: New Insights Learned From High-Risk Patients With Duct-Dependent Pulmonary Circulation. Front Cardiovasc Med. 2022 Jun 23;9:933959. doi: 10.3389/fcvm.2022.933959. PMID: 35811693; PMCID: PMC9261874.
31. Bentham JR, Zava NK, Harrison WJ, Shauq A, Kalantre A, Derrick G, Chen RH, Dhillon R, Taliotis D, Kang SL, Crossland D, Adesokan A, Hermuzi A, Kudumula V, Yong S, Noonan P, Hayes N, Stumper O, Thomson JDR. Duct Stenting Versus Modified Blalock-Taussig Shunt in Neonates With Duct-Dependent Pulmonary Blood Flow: Associations With Clinical Outcomes in a Multicenter National Study. Circulation. 2018 Feb 6;137(6):581-588. doi: 10.1161/CIRCULATIONAHA.117.028972. Epub 2017 Oct 30. PMID: 29084734.
32. McMullan DM, Permut LC, Jones TK, Johnston TA, Rubio AE. Modified Blalock-Taussig shunt versus ductal stenting for palliation of cardiac lesions with inadequate pulmonary blood flow. J Thorac Cardiovasc Surg. 2014 Jan;147(1):397-401. doi: 10.1016/j.jtcvs.2013.07.052. Epub 2013 Sep 23. PMID: 24071469.
33. Shahanavaz S, Qureshi AM, Petit CJ, Goldstein BH, Glatz AC, Bauser-Heaton HD, et all. Factors Influencing Reintervention Following Ductal Artery Stent Implantation for Ductal-Dependent Pulmonary Blood Flow: Results From the Congenital Cardiac Research Collaborative. Circ Cardiovasc Interv. 2021 Dec;14(12):e010086. doi: 10.1161/CIRCINTERVENTIONS.120.010086. Epub 2021 Nov 18. PMID: 34789017.



A. BALON PULMONER VALVÜLOPLASTİ

BÖLÜM 12

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Mete Han KIZILKAYA [2]

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İçindekiler

» GİRİŞ
» TARİHÇE
» ANATOMİ VE FİZYOPATOLOJİ
» İŞLEM ÖNCESİ GÖRÜNTÜLEME
» ENDİKASYONLAR
» TEKNİK
» BALONLAR VE ÖZELLİKLERİ
» PROSEDÜR SONRASI AKUT İZLEM VE POLİKLİNİK TAKİBİ
» KOMPLİKASYONLAR VE YÖNETİMİ
» PROSEDÜR SIRASINDA İPUÇLARI VE DİKKATLİ OLUNMASI GEREKEN KONULAR
» UZUN DÖNEM SONUÇLAR

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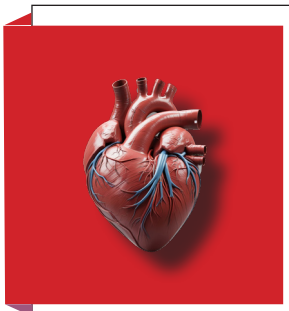
KAYNAKLAR

1. Cheng TO. The History of Balloon Valvuloplasty. Journal of Interventional Cardiology. 2000;13:365–73.
2. Kan JS, White RI Jr, Mitchell SE, Gardner TJ. Percutaneous balloon valvuloplasty: a new method for treating congenital pulmonary-valve stenosis. N Engl J Med. 1982;307(9):540-2.
3. Fathallah M, Krasuski RA. Pulmonic Valve Disease: Review of Pathology and Current Treatment Options. Curr Cardiol Rep. 2017;19(11):108.
4. Ettedgui JA, Ho SY, Tynan M, Jones OD, Martin RP, Baker EJ, Reidy JF. The pathology of balloon pulmonary valvoplasty. Int J Cardiol. 1987;16(3):285-93.
5. Feltes TF, Bacha E, Beekman RH, Cheatham JP, Feinstein JA, Gomes AS, et al. Indications for cardiac catheterization and intervention in pediatric cardiac disease: a scientific statement from the American Heart Association. Circulation. 2011;123(22):2607-52.
6. Stout KK, Daniels CJ, Aboulhosn JA, Bozkurt B, Broberg CS, Colman JM, et al. 2018 AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol. 2019;73(12):1494-1563.
7. Liu T, Gao Wei. Pulmonary Valve Stenosis. In: Butera G, Chessa M, Eicken A, Thomson J, editors. Cardiac Catheterization for Congenital Heart Disease. 2nd ed. Springer Nature Switzerland AG; 2021. p. 319–34.
8. Prieto LR, Latson LA. Pulmonary Stenosis. In: Shaddy RE, Penny DJ, Feltes TF, Cetta F, Mital S, editors. Moss and Adam's Heart Disease in Infants, Children and Adolescents. 10th ed. Wolters Kluwer; 2022. p. 3418–68.
9. McCrindle BW. Independent predictors of long-term results after balloon pulmonary valvuloplasty. Valvuloplasty and Angioplasty of Congenital Anomalies (VACA) Registry Investigators. Circulation. 1994; 89(4):1751–9.
10. Rao PS. Balloon pulmonary valvuloplasty: A systematic review. Indian Heart J. 2024;76(2):86–93.
11. Pathak SJ, Pockett CR, Moore JW, El-Said HG. Effect of Balloon: Annulus Ratio on Incidence of Pulmonary Insufficiency Following Valvuloplasty. Congenit Heart Dis. 2016;11(5):415–9.
12. Hansen RL, Naimi I, Wang H, Atallah N, Smith F, Byrum C, et al. Long-term outcomes up to 25 years following balloon pulmonary valvuloplasty: A multicenter study. Congenit Heart Dis. 2019;14(6):1037–45.
13. Devanagondi R, Peck D, Sagi J, Donohue J, Yu S, Pasquali SK, et al. Long-Term Outcomes of Balloon Valvuloplasty for Isolated Pulmonary Valve Stenosis. Pediatr Cardiol. 2017;38(2):247–54.
14. Karagoz T, Asoh K, Hickey E, Chaturvedi R, Lee KJ, Nykanen D, et al. Balloon dilation of pulmonary valve stenosis in infants less than 3 kg: A 20-year experience. Catheterization and Cardiovascular Interventions. 2009;74(5):753–61.
15. Mercer-Rosa L, Ingall E, Zhang X, McBride M, Kawut S, Fogel M, et al. The Impact of Pulmonary Insufficiency on the Right Ventricle: A Comparison of Isolated Valvar Pulmonary Stenosis and Tetralogy of Fallot. Pediatr Cardiol. 2015;36(4):796–801.
16. Morray BH, McElhinney DB. Semilunar Valve Interventions for Congenital Heart Disease: JACC State-of-the-Art Review. J Am Coll Cardiol. 2021;77(1):71-79.



B. TRANSKATETER PULMONER KAPAK REPLASMANI

BÖLÜM
12

Ender ÖDEMİŞ [1]
Berk KABADAYI [2]
Zeynep Bengi EREN [3]

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İçindekiler

» GİRİŞ
» TARİHÇE
» DEĞERLENDİRME
  » TPKR'nin zamanlaması
  » Ekokardiyografi
  » Kardiyak MR
  » Bilgisayarlı Tomografi
  » Kardiyak Manyetik Rezonans Görüntüleme (MRG)
  » Endikasyonlar
» VAR OLAN KAPAKLAR
  » Balonla Şişirilen Kapaklar
  » Kendiliğinden Genişleyebilen Kapaklar
» TRANSKATETER İMPLANTASYON TEKNİĞİ
  » Genel Yaklaşım
  » Konduit İçerisine İmplantasyon
» NATİVE ÇIKIM YOLUNA İMPLANTASYON
  » Balonla şişirilen kapakların Native Sağ Ventrikül Çıkım yoluna İmplantasyon Tekniği
  » Kendiliğinden genişleyen kapakların Native Sağ Ventrikül Çıkım yoluna İmplantasyon Tekniği
  » Komplikasyonlar
  » Etkinlik ve İzlem

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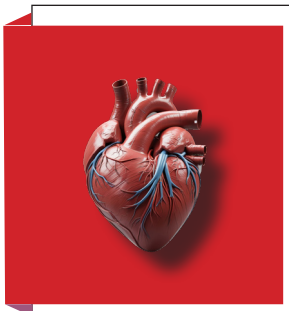
KAYNAKLAR

1. van der Linde D, Konings EE, Slager MA, Witsenburg M, Helbing WA, Takkenberg JJ, et al. Birth prevalence of congenital heart disease worldwide: a systematic review and meta-analysis. J Am Coll Cardiol. 2011;58(21):2241-7.
2. Verheugt CL, Uiterwaal CS, van der Velde ET, Meijboom FJ, Pieper PG, van Dijk AP, et al. Mortality in adult congenital heart disease. Eur Heart J. 2010;31(10):1220-9.
3. Yuan SM, Mishaly D, Shinfeld A, Raanani E. Right ventricular outflow tract reconstruction: valved conduit of choice and clinical outcomes. J Cardiovasc Med. 2008;9(4):327-37.
4. Boethig D, Thies WR, Hecker H, Breymann T. Mid term course after pediatric right ventricular outflow tract reconstruction: a comparison of homografts, porcine xenografts and Contegras. Eur J Cardiothorac Surg. 2005;27(1):58-66.
5. Rodefeld MD, Ruzmetov M, Turrentine MW, Brown JW. Reoperative right ventricular outflow tract conduit reconstruction: risk analyses at follow up. J Heart Valve Dis. 2008 Jan;17(1):119-26.
6. Alonso-González R, Dimopoulos K, Ho S, Oliver JM, Gatzoulis MA. The right heart in adults with congenital heart disease. Revista Española de Cardiología (English Edition). 2010;63(9):1070–86.
7. Swartz MF, Schiralli MP, Angona R, Cholette JM, Gensini F, Alfieris GM. The effect of repeat Sternotomy during right ventricular outflow tract reconstruction. Congenital heart disease. 2013;8(2):142–8.
8. Yin C hua, Yan J, Li S jun, Li D yuan, Wang Q, Wang E, et al. Effect analysis of repeat sternotomy in pediatric cardiac operations. Journal of Cardiothoracic Surgery. 2015;10:1–5.
9. Bonhoeffer P, Boudjemline Y, Saliba Z, Merckx J, Aggoun Y, Bonnet D, et al. Percutaneous replacement of pulmonary valve in a right-ventricle to pulmonary-artery prosthetic conduit with valve dysfunction. The Lancet. 2000;356(9239):1403–5.
10. Sharma V, Griffiths ER, Eckhauser AW, Gray RG, Martin MH, Zhang C, et al. Pulmonary valve replacement: a single-institution comparison of surgical and transcatheter valves. The Annals of Thoracic Surgery. 2018;106(3):807–13.
11. Georgiev S, Ewert P, Eicken A, Hager A, Hörer J, Cleuziou J, et al. Munich comparative study: prospective long-term outcome of the transcatheter melody valve versus surgical pulmonary bioprosthesis with up to 12 years of follow-up. Circulation: Cardiovascular Interventions. 2020;13(7):e008963.
12. Baumgartner H, de Backer J, Babu-Narayan S, Budts W, Chessa M, Diller GP, et al. 2020 ESC Guidelines for the management of adult congenital heart disease. European Heart Journal. 2021 Feb 7;42(6):563–645.
13. Stout KK, Daniels CJ, Aboulhosn JA, Bozkurt B, Broberg CS, Colman JM, et al. 2018 AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease. Journal of the American College of Cardiology. 2019;73(12):1494–563.
14. Cabalka AK, Asnes JD, Balzer DT, Cheatham JP, Gillespie MJ, Jones TK, et al. Transcatheter pulmonary valve replacement using the melody valve for treatment of dysfunctional surgical bioprostheses: a multicenter study. The Journal of Thoracic and Cardiovascular Surgery. 2018;155(4):1712–24.
15. Gales J, Krasuski RA, Fleming GA. Transcatheter Valve Replacement for Right-sided Valve Disease in Congenital Heart Patients. Progress in Cardiovascular Diseases. 2018;61(3):347–59.
16. Khambadkone S, Coats L, Taylor A, Boudjemline Y, Derrick G, Tsang V, et al. Percutaneous Pulmonary Valve Implantation in Humans. Circulation. 2005; 23;112(8):1189–97.
17. Zahn EM, Hellenbrand WE, Lock JE, McElhinney DB. Implantation of the Melody Transcatheter Pulmonary Valve in Patients With a Dysfunctional Right Ventricular Outflow Tract Conduit: Early Results From the U.S. Clinical Trial. Journal of the American College of Cardiology. 2009;54(18):1722–9.
18. Garay F, Webb J, Hijazi ZM. Percutaneous replacement of pulmonary valve using the Edwards-Cribier percutaneous heart valve: First report in a human patient. Catheterization and Cardiovascular Interventions. 2006;67(5):659–62.
19. Meadows JJ, Moore PM, Berman DP, Cheatham JP, Cheatham SL, Porras D, et al. Use and Performance of the Melody Transcatheter Pulmonary Valve in Native and Postsurgical, Nonconduit Right Ventricular Outflow Tracts. Circulation: Cardiovascular Interventions. 2014;7(3):374–80.
20. Kenny D, Rhodes JF, Fleming GA, Kar S, Zahn EM, Vincent J, et al. 3-Year Outcomes of the Edwards SAPIEN Transcatheter Heart Valve for Conduit Failure in the Pulmonary Position From the COMPASSION Multicenter Clinical Trial. JACC: Cardiovascular Interventions. 2018;11(19):1920–9.
21. Odemis E, Guzeltas A, Saygi M, Ozyilmaz I, Momenah T, Bakir I. Percutaneous pulmonary valve implantation using Edwards SAPIEN transcatheter heart valve in different types of conduits: initial results of a single center experience. Congenit Heart Dis. 2013;8(5):411-7.
22. Cesnjevar R, Harig F, Raber A, Strecker T, Fischlein T, Koch A, et al. Late Pulmonary Valve Replacement after Correction of Fallot's Tetralogy. Thoracic and Cardiovascular Surgeon. 2004;52:23–8.
23. Carminati M, Pluchinotta FR, Piazza L, Micheletti A, Negura D, Chessa M, et al. Echocardiographic assessment after surgical repair of tetralogy of Fallot. Frontiers in Pediatrics. 2015;3(3):1-9.
24. Nyström A, Berntsson C, Mandalenakis Z, Lagerstrand K, Dangardt F, de Lange C. Cardiovascular magnetic resonance in Tetralogy of Fallot—state of the art. Cardiovascular Diagnosis and Therapy. 2025;15(1):173–94.
25. Kochav J, Simprini L, Weinsaft JW. Imaging of the right heart - CT and CMR. Echocardiography. 2015;32(S1):53–68.
26. di Salvo G, Miller O, Babu Narayan S, Li W, Budts W, Valsangiacomo Buechel ER, et al. Imaging the adult with congenital heart disease: a multimodality imaging approach—position paper from the EACVI. European Heart Journal - Cardiovascular Imaging. 2018;19(10):1077–98.
27. Babu-Narayan SV, Kilner PJ, Li W, Moon JC, Goktekin O, Davlouros PA, et al. Ventricular Fibrosis Sugges-

ted by Cardiovascular Magnetic Resonance in Adults With Repaired Tetralogy of Fallot and Its Relationship to Adverse Markers of Clinical Outcome. Circulation. 2006;113(3):405–13.
28. Valente AM, Cook S, Festa P, Ko HH, Krishnamurthy R, Taylor AM, et al. Multimodality Imaging Guidelines for Patients with Repaired Tetralogy of Fallot. Journal of the American Society of Echocardiography. 2014;27(2):111–41.
29. Bonnichsen C, Ammash N. Choosing Between MRI and CT Imaging in the Adult with Congenital Heart Disease. Curr Cardiol Rep. 2016;18(5):45.
30. Saremi F, Gera A, Yen Ho S, Hijazi ZM, Sánchez-Quintana D. CT and MR Imaging of the Pulmonary Valve. RadioGraphics. 2014; 1;34(1):51–71.
31. Ahmed S, Johnson PT, Fishman EK, Zimmerman SL. Role of Multidetector CT in Assessment of Repaired Tetralogy of Fallot. RadioGraphics. 2013;33(4):1023–36.
32. Marelli A, Beauchesne L, Colman J, Ducas R, Grewal J, Keir M, et al. Canadian Cardiovascular Society 2022 Guidelines for Cardiovascular Interventions in Adults With Congenital Heart Disease. Canadian Journal of Cardiology. 2022;38(7):862–96.
33. McElhinney DB, Hennesen JT. The Melody® valve and Ensemble® delivery system for transcatheter pulmonary valve replacement. Annals of the New York Academy of Sciences. 2013;1291(1):77–85.
34. Cheatham SL, Holzer RJ, Chisolm JL, Cheatham JP. The medtronic melody® transcatheter pulmonary valve implanted at 24-mm diameter—it works. Catheterization and Cardiovascular Interventions. 2013;82(5):816–23.
35. Odemis E, Yenidogan I. First experiences with Myval Transcatheter Heart Valve System in the treatment of severe pulmonary regurgitation in native right ventricular outflow tract and conduit dysfunction. Cardiol Young. 2022;32(10):1609-1615.
36. Benson LN, Gillespie MJ, Bergersen L, Cheatham SL, Hor KN, Horlick EM, et al. Three-Year Outcomes From the Harmony Native Outflow Tract Early Feasibility Study. Circulation: Cardiovascular Interventions. 2020;13(1):e008320.
37. Gillespie MJ, McElhinney DB, Jones TK, Levi DS, Asnes J, Gray RG, et al. 1-Year Outcomes in a Pooled Cohort of Harmony Transcatheter Pulmonary Valve Clinical Trial Participants. JACC Cardiovasc Interv. 2023;16(15):1917-1928.
38. Gillespie MJ, Bergersen L, Benson LN, Weng S, Cheatham JP. 5-Year Outcomes From the Harmony Native Outflow Tract Early Feasibility Study. JACC Cardiovasc Interv. 2021;14(7):816-817.
39. Shabana S, David B, Vasilis B, Dennis K, Vivian D, R VRS, et al. Alterra Adaptive Prestent and SAPIEN 3 THV for Congenital Pulmonic Valve Dysfunction. JACC: Cardiovascular Interventions. 2020;13(21):2510–24.
40. Morgan GJ, Praichasilchai P, Promphan W, Rosenthal E, Sivakumar K, Kappanayil M, et al. Medium-term results of percutaneous pulmonary valve implantation using the Venus P-valve: international experience. EuroIntervention. 2019;14(13):1363–70.
41. Sivakumar K, Sagar P, Qureshi S, Promphan W, Sasidharan B, Awasthy N, et al. Outcomes of Venus P-valve for dysfunctional right ventricular outflow tracts from Indian Venus P-valve database. Ann Pediatr Cardiol. 2021;14(3):281-292.
42. Shang X, Dong N, Zhang C, Wang Y. The Clinical Trial Outcomes of Med-Zenith PT-Valve in the Treatment of Patients With Severe Pulmonary Regurgitation. Front Cardiovasc Med. 2022;16(9):887886.
43. Kim GB, Song MK, Bae EJ, Park EA, Lee W, Lim HG, et al. Successful Feasibility Human Trial of a New Self-Expandable Percutaneous Pulmonary Valve (Pulsta Valve) Implantation Using Knitted Nitinol Wire Backbone and Trileaflet □-Gal–Free Porcine Pericardial Valve in the Native Right Ventricular Outflow Tract. Circulation: Cardiovascular Interventions. 2018;11(6):e006494.
44. Lee SY, Kim GB, Kim SH, Jang SI, Choi JY, Kang IS, et al. Mid-term outcomes of the Pulsta transcatheter pulmonary valve for the native right ventricular outflow tract. Catheterization and Cardiovascular Interventions. 2021;98(5):E724–32.
45. Center KFC. Extended application of self-fabricated covered stents for interventions in adults with congenital heart disease. Journal of Structural Heart Disease. 2016;2(3):79–86.
46. Khambadkone S, Coats L, Taylor A, Boudjemline Y, Derrick G, Tsang V, et al. Percutaneous Pulmonary Valve Implantation in Humans. Circulation. 2005;112(8):1189–97.
47. Shah N, Cheng VE, Cox N, Soon K. Percutaneous coronary intervention of an anomalous left Main coronary artery arising from the right sinus of Valsalva. Heart, Lung and Circulation. 2015;24(8):e123–6.
48. Morray BH, McElhinney DB, Cheatham JP, Zahn EM, Berman DP, Sullivan PM, et al. Risk of Coronary Artery Compression Among Patients Referred for Transcatheter Pulmonary Valve Implantation. Circulation: Cardiovascular Interventions. 2013;6(5):535–42.
49. Sridharan S, Coats L, Khambadkone S, Taylor AM, Bonhoeffer P. Transcatheter right ventricular outflow tract intervention: The risk to the coronary circulation. Circulation. 2006;113(25):e934–5.
50. Biermann D, Schönebeck J, Rebel M, Weil J, Dodge-Khatami A. Left coronary artery occlusion after percutaneous pulmonary valve implantation. The Annals of Thoracic Surgery. 2012;94(1):e7–9.
51. McElhinney DB, Cheatham JP, Jones TK, Lock JE, Vincent JA, Zahn EM, et al. Stent fracture, valve dysfunction, and right ventricular outflow tract reintervention after transcatheter pulmonary valve implantation: patient-related and procedural risk factors in the US Melody Valve Trial. Circulation: Cardiovascular Interventions. 2011;4(6):602–14.
52. Law MA, Chatterjee A. Transcatheter pulmonic valve implantation: techniques, current roles, and future implications. World Journal of Cardiology. 2021;13(5):117.
53. Alkashkari W, Alsubei A, Hijazi ZM. Transcatheter pulmonary valve replacement: current state of art. Current cardiology reports. 2018;20:1–13.
54. Chatterjee A, Bajaj NS, McMahon WS, Cribbs MG, White JS, Mukherjee A, et al. Transcatheter Pulmonary Valve Implantation: A Comprehensive Systematic Review and Meta□Analyses of Observational Studies. Journal of the American Heart Association. 2025;6(8):e006432.
55. Boudjemline Y, Malekzadeh-Milani S, Patel M, Thambo JB, Bonnet D, Iserin L, et al. Predictors and outcomes of right ventricular outflow tract conduit rupture

during percutaneous pulmonary valve implantation: a multicentre study. EuroIntervention. 2016;11(9):1053-62.
56. Jones TK, McElhinney DB, Vincent JA, Hellenbrand WE, Cheatham JP, Berman DP, et al. Long-Term Outcomes After Melody Transcatheter Pulmonary Valve Replacement in the US Investigational Device Exemption Trial. Circulation: Cardiovascular Interventions. 2022;15(1):e010852.
57. McElhinney DB, Sondergaard L, Armstrong AK, Bergersen L, Padera RF, Balzer DT, et al. Endocarditis After Transcatheter Pulmonary Valve Replacement. Journal of the American College of Cardiology. 2018;72(22):2717–28.
58. Abdelghani M, Nassif M, Blom NA, van Mourik MS, Straver B, Koolbergen DR, et al. Infective Endocarditis After Melody Valve Implantation in the Pulmonary Position: A Systematic Review. Journal of the American Heart Association. 2018;7(13):e008163.
59. McElhinney DB, Hellenbrand WE, Zahn EM, Jones TK, Cheatham JP, Lock JE, et al. Short- and Medium-Term Outcomes After Transcatheter Pulmonary Valve Placement in the Expanded Multicenter US Melody Valve Trial. Circulation. 2010;122(5):507–16.
60. Cheatham JP, Hellenbrand WE, Zahn EM, Jones TK, Berman DP, Vincent JA, et al. Clinical and Hemodynamic Outcomes up to 7 Years After Transcatheter Pulmonary Valve Replacement in the US Melody Valve Investigational Device Exemption Trial. Circulation. 2015;131(22):1960–70.
61. Houeijeh A, Batteux C, Karsenty C, Ramdane N, Lecerf F, Valdeolmillos E, et al. Long-term outcomes of transcatheter pulmonary valve implantation with melody and SAPIEN valves. International Journal of Cardiology. 2023;370:156–66.
62. Kenny D, Hijazi ZM, Kar S, Rhodes J, Mullen M, Makkar R, et al. Percutaneous Implantation of the Edwards SAPIEN Transcatheter Heart Valve for Conduit Failure in the Pulmonary Position: Early Phase 1 Results From an International Multicenter Clinical Trial. Journal of the American College of Cardiology. 2011;58(21):2248–56.
63. Haas NA, Moysich A, Neudorf U, Mortezaeian H, Abdel-Wahab M, Schneider H, et al. Percutaneous implantation of the Edwards SAPIEN™ pulmonic valve: initial results in the first 22 patients. Clinical Research in Cardiology. 2013;102(2):119–28.
64. Odemis E, Celikyurt A, Kizilkaya MH, Demir İH. Evaluating the Sapien® XT Valve in Native Right Ventricular Outflow Tracts After Tetralogy of Fallot Repair: Mid- and Long-Term Results. Pediatr Cardiol. 2025(online ahead of print).



BALON AORTİK VALVÜLOPLASTİ

BÖLÜM
13

Kürşad TOKEL [1]

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İçindekiler

- GİRİŞ
- TANISAL TESTLER
- TEDAVİ İLKELERİ
- BALON AORTİK VALVÜLOPLASTİ
  - Komplikasyonlar
- BALON AORTİK VALVÜLOPLASTİ İLE İLGİLİ TARTIŞMA KONULARI
  - Aort yetersizliği
  - Yeniden girişim
  - Aort kapak replasmanı
  - Tekrarlayan balon aortik valvüloplasti

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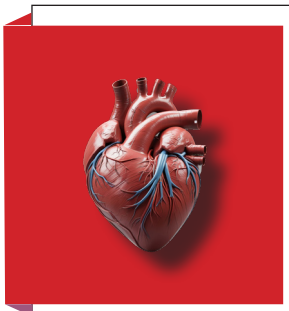
Bölümüzde yenidoğan döneminde balon aortik valvüloplasti yapılan hastaların 27 yıllık izleminde; 1998-2024 yılları arasında 85 yenidoğanda (YD) 118 BAV yapıldı. Olgular 0-30 (median 14) gün, 26'sı (%40) kritik aort darlığı, 23'ünde (%27.1) değişik sol ventrikül çıkım yolu darlıkları (LVOTO), 45'inde (%52.9) endokardiyal fibroelastosis (EFE), 35'inde (%41.2)sol ventrikül (LV) işlev bozukluğuna sahipti. İşlem 78 (%92) olguda başarılı oldu. İzlem süresi 8.84 +/- 7.7 yıldır. 30 olgu 10 yıl, 49 olgu 5 yıldan fazla izlenmiştir. İzlem süresince toplam mortalite 13 (%15)'dir. İlk bir ayda olan erken mortalite 3 olgudur (1'i işlem sonrası, 2'si yaygın EFE nedeni ile kontrol edilemeyen kalp yetersizliği nedeni ile). Geç dönemde 2 olgu cerrahi sonrası, 7 olgu median 3 ayda EFE, ağır MY, shone kompleksi nedeni ile oldu. Mortaliteyi etkileyen faktörler; yaş, işlem öncesi LV disfonksiyonu ve diğer LVOTO eşlik etmesidir. Son yaş 7 ay-26.5 yaştır. Birinci yılın sonunda sağ kalım %85.8, girişim yapılmama oranı %70.6 bulunmuştur. İlk 1 yılda 5 yeniden balon aortik valvüloplasti, 7 cerrahi işlem yapılmıştır. Tüm izlem süresinde 22 cerrahi, 8 recerrahi, 2 rerecerrahi uygulanmıştır. İlk 5 yılda 12, 5 yıldan sonra da 10 cerrahi işlem gerekmiştir. Cerrahi nedenleri; 4 olguda restenoz, 4 olguda aort yetersizliği, 8 olguda mixt, 6 olguda (3 aort koarktasyonu, 2 endokardit, 1 VSD kapatılması) diğerleridir.

Sonuç olarak balon aortik valvüloplasti ile valvüler aort stenozlu hastaların %70'inde iyi sonuçlar alınır, göreceli önemli yan etki azdır. Yaşamın ilk ayında bu işleme giden hastalarda komplikasyon gelişmesi daha sık olmasına rağmen güvenli ve etkin bir tedavi yöntemidir. Bu tedavinin cerrahi valvatomi ve kapak onarımı gibi palyatif bir girişim olduğu yaşamın ilerleyen dönemlerinde yeniden girişimlere gerek duyulacağı akıldan çıkarılmamalı, bu olasılığı azaltmak için belli bir gradient kalması önemli aort yetersizliği gelişmesine tercih edilmelidir.

KAYNAKLAR

1. Therrien J, Webb GD. Congenital Heart Disease in Adults. Heart Disease: A textbook of Cardiovascular Medicine. Edited by E. Braunwald, Zipes DP, Libby P. 6th ed. WB Saunders Company 2001: pp.1592-1619
2. ACC/AHA guidelines for the management of patients with valvular heart disease. A Report of the American College of Cardiology/ American Heart Association. Task Force on practice guidelines (Committee on management of patients with valvular heart disease) J Am Coll Cardiol 1998;37: 1486-588.
3. www.cachnet.org. : Mananing Congenital Heart Defects. Recommendations for the Management of Adults with Congenital Hert Disease- 2001 (Part 2) Section V and VI.
4. Singh GK. Aortic stenosis. Indian J Pediatr 2002;69: 351-358.
5. Eicken A, Georgiev S, Balling G, Schreiber C, Hager A, Hess J. Neonatal balloon aortic valvuloplasty-predictive value of current risk score algorithms for treatment strategies. Catheter Cardiovasc Interv. 2010;76(3):404-10.
6. Keane JF, Driscoll DJ, Gersony WM, Hayes CJ, Kidd L, O'Fallon WM, et al. Second natural history study of congenital heart defects: Results of treatment of patients with aortic valvar stenosis. Circulation 1996; 87: I-16-27.
7. Kelly TA, Rothbart RM, Cooper CM, Kaiser DL, Smucker ML, Gibson RS. Comparison of outcome of asymptomatic to symptomatic patients older than 20 years of age with valvular aortic stenosis. Am J Cardiol 1988; 61: 123-130.
8. Yener N, Oktar GL, Erer D, Yardımcı MM, Yener A. Bicuspid aortic valve. Ann Thorac Cardiovasc Surg 2002; 8: 264-7
9. Anderson RC. Congenital cardiac malformation in 109 sets of twins and triplets. Am J Cardiol 1977;39:1045.
10. Stapleton GE. Transcatheter management of neonatal aortic stenosis. Cardiol Young. 2014;24(6):1117-20.
11. Porras D, Brown DW, Rathod R, Friedman K, Gauvreau K, Lock JE,et al. Acute outcomes after introduction of a standardized clinical assessment and management plan (SCAMP) for balloon aortic valvuloplasty in congenital aortic stenosis. Congenit Heart Dis. 2014;9:316–325.
12. McCrindle BW Independent predictors of immediate results of percutaneous balloon aortic valvotomy in children. Valvuloplasty and Angioplasty of Congenital Anomalies (VACA) Registry Investigators. Am J Cardiol. 1996;77:286-93
13. Sandhu SK, Silka MJ, Reller MD. Balloon aortic valvuloplasty for aortic stenosis in neonates, children, and young adults. J Interv Cardiol. 1995;8(5):477-86.
14. Pellikka PA, Nishimura RA, Bailey KR, Tajik AJ. The natural history of aortic stenosis in adults with asymptomatic, hemodynamically significant aortic stenosis. J Am Coll Cardiol 1990; 15:1012- 1017.
15. Awasthy N, Garg R, Radhakrishnan S, Shrivastava S. Long-term results of percutaneous balloon valvuloplasty of congenital aortic stenosis in adolescents and young adults. Indian Heart J. 2016;68(5):604-611.

16. Boe BA, Zampi JD, Kennedy KF, Jayaram N, Porras D, Foerster SR, et al. Acute Success of Balloon Aortic Valvuloplasty in the Current Era: A National Cardiovascular Data Registry Study. JACC Cardiovasc Interv. 2017;10(17):1717-1726.
17. Kallio M, Rahkonen O, Mattila I, Pihkala J. Congenital aortic stenosis: treatment outcomes in a nationwide survey. Scand Cardiovasc J. 2017;51(5):277-283.
18. Sullivan PM, Rubio AE, Johnston TA, Jones TK. Long-term outcomes and re-interventions following balloon aortic valvuloplasty in pediatric patients with congenital aortic stenosis: A single-center study. Catheter Cardiovasc Interv. 2017;89(2):288-296
19. Loomba RS, Bowman JL, Cao Y, Tweddell J, Dearani JA, Simpson PM, et al. Is Aortic Valve Leaflet Morphology Predictive of Outcome in Pediatric Aortic Valve Stenosis? Congenit Heart Dis. 2015;10(6):552-60.
20. Hagler DJ. The Lababidi Procedure: Is Neonatal Balloon Aortic Valvotomy Worth the Risk? Catheter Cardiovasc Interv. 2017;89(2):296-297
21. Auld B, Carrigan L, Ward C, Justo R, Alphonso N, Anderson B. Balloon Aortic Valvuloplasty for Congenital Aortic Stenosis: A 14-Year Single Centre Review. Heart Lung Circ. 2019;28(4):632-636.
22. Hochstrasser L, Ruchat P, Sekarski N, Hurni M, von Segesser LK. Long-term outcome of congenital aortic valve stenosis: predictors of reintervention. Cardiol Young. 2015;25(5):893-902.
23. Brown DW, Dipilato AE, Chong EC, Lock JE, McElhinney DB. Aortic valve reinterventions after balloon aortic valvuloplasty for congenital aortic stenosis intermediate and late follow-up. J Am Coll Cardiol. 2010;56(21):1740-9
24. Rao PR. Balloon aortic valvuloplasty. Indian Heart Journal 2016;68 (5): 592-595.
25. Soulatges C, Momeni M, Zarrouk N, Moniotte S, Carbonez K, Barrea C, et al. Long-Term Results of Balloon Valvuloplasty as Primary Treatment for Congenital Aortic Valve Stenosis: a 20-Year Review. Pediatr Cardiol. 2015;36(6):1145-52.
26. Torres A, Vincent JA, Everett A, Lim S, Foerster SR, Marshall AC, et al. Balloon valvuloplasty for congenital aortic stenosis: Multi-center safety and efficacy outcome assessment. Catheter Cardiovasc Interv. 2015; 86(5):808-20.
27. Petit CJ, Gao K, Goldstein BH, Lang SM, Gillespie SE, Kim SI, et al. Relation of Aortic Valve Morphologic Characteristics to Aortic Valve Insufficiency and Residual Stenosis in Children With Congenital Aortic Stenosis Undergoing Balloon Valvuloplasty. Am J Cardiol. 2016;117(6):972-9.
28. Petit CJ, Maskatia SA, Justino H, Mattamal RJ, Crystal MA, Ing FF. Repeat balloon aortic valvuloplasty effectively delays surgical intervention in children with recurrent aortic stenosis. Catheter Cardiovasc Interv. 2013;82(4):549-55.
29. Yakut K, Tokel NK, Varan B, Erdoğan İ, Özkan M. Results of balloon and surgical valvuloplasty in congenital aortic valve stenosis: A 19-year, single-center, retrospective study. Turkish Journal of Thoracic and Cardiovascular Surgery 2021;29(2):158-165.



ANORMAL VASKÜLER BAĞLANTILAR VE TRANSKATETER KAPATILMASI

BÖLÜM
14

Hüseyin KARADAĞ [1]
Ahmet ÇELEBİ [2]

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İçindekiler

» GİRİŞ
» AORTOPULMONER KOLLATERAL ARTERLER (APKA)
» KORONER ARTER FİSTÜLLERİ (KAF)
» PULMONER ARTERİOVENÖZ MALFORMASYONLAR (PAVM)
» VENÖVENÖZ ANORMAL BAĞLANTILAR
  » Kavopulmoner Anastomozlar Sonrası Gelişen Veno-Venöz Bağlantılar
  » Konjenital porto-sistemik şant/fistül (KPSS)

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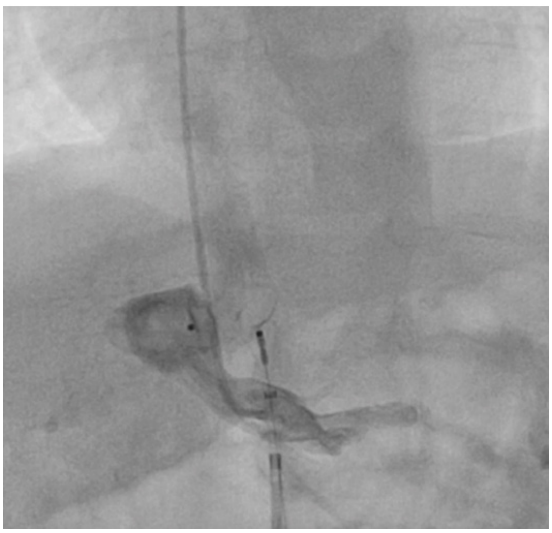
namadığında kesinleştirmek, perkütan teknikle tedaviye uygunluğu belirlemek ve tedavi etmek amaçlı yapılır.

İntrahepatik portal sistemin tam aplazisi söz konusu olan tip I KPSS'da tedavi karaciğer transplantasyonudur. Parsiyel porto-sistemik şantın söz konusu olduğu tip II KPSS hastalarının bir kısmında transkateter olarak port-sistemik fistüller kapatılabilir. Bu amaçla anatomi ve bağlantı çapları göz önüne alınarak vasküler "plug'lar, kaplı stentler, coiller, PDA veya defekt kapatıcı cihazlar kullanılabilir (21-22-23) Şekil 19'de hiperamonyemi ile presente olan bir çocukta parsiyel portal-inferior vena kaval şanta yol açan KPSS'ın ADO II ile juguler venden yaklaşılarak kapatılması gösterilmiştir.



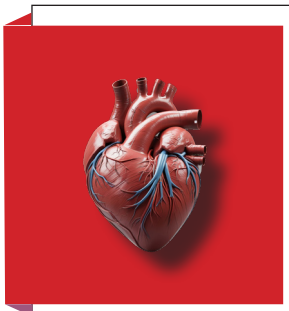
Şekil 19. *Konjenital portosistemik şant kapatılması örneği*

KPSS'ı kapatmadan önce balon oklüzyon testi ile portal ven basıncının kontrol edilmesi önerilmektedir. Balon ile geçici oklüde edildiğinde portal ven basıncı 25 mmHg altında olduğunda güvenle kapatılabileceği genel olarak kabul görmektedir, buna karşın testte basınç >30-32 mmHg olduğunda perkütan kapatılmayıp transplanta verilmesi veya önce cerrahi olarak bant yapılması hipoplazik portal ven dallarının gelişmesinin beklenmesi daha sonraki seansta iki aşamalı yaklaşımla kapatılması önerilmektedir. (23-24) Balon oklüzyon testinde 25-30 mmHg düzeyinde portal ven basıncı tartışmalıdır; direkt kapatanlar veya cerrahi bandı tercih eden yaklaşımlar mevcuttur (24).

KAYNAKLAR

1. Schmiel M, Kido T, Georgiev S, Burri M, Heinisch PP, Vodiskar J, Strbad M, Ewert P, Hager A, Hörer J, Ono M. Aortopulmonary collaterals in single ventricle: incidence, associated factors and clinical significance. Interact Cardiovasc Thorac Surg. 2022 Jul 9;35(2):ivac190. doi: 10.1093/icvts/ivac190.
2. Bauser-Heaton H, Borquez A, Asija R, Wise-Faberowski L, Zhang Y, Downey L, Perry SB, Koth A, Peng LF, Algaze CA, Hanley FL, McElhinney DB. Pulmonary reinterventions after complete unifocalization and repair in infants and young children with tetralogy of Fallot with major aortopulmonary collaterals. J Thorac Cardiovasc Surg. 2018 Apr;155(4):1696-1707. doi: 10.1016/j.jtcvs.2017.11.086. Epub 2017 Dec 13.
3. Mohammad Nijres B, Aregullin EO, Al-Khatib Y, Samuel BP, Abdulla RI, Hijazi ZM, Vettukattil JJ. Aortopulmonary Collaterals in Single Ventricle Physiology: Variation in Understanding Occlusion Practice Among Interventional Cardiologists. Pediatr Cardiol. 2020 Dec;41(8):1608-1616. doi: 10.1007/s00246-020-02418-8. Epub 2020 Jul 27.
4. Suresh Kumar S, Agrawal S, Velagapudi P, Aeddula NR. Coronary Arteriovenous Fistula. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan–. Available from:
5. Saad M, El-Sayed H, Abdelaal M, et al. Multidetector computed tomography coronary angiography in the detection and characterization of coronary artery fistulas: experience in 2263 patients. Egypt J Radiol Nucl Med. 2023;54(1):232. doi:10.1186/s43055-023-00956-8
6. Wu S, Fares M, Zellers TM, Jyothinagaram M, Reddy SRV. Diagnosis and Management of Congenital Coronary Artery Fistulas in Infants and Children. Curr Cardiol Rep. 2023 Dec;25(12):1921-1932. doi: 10.1007/s11886-023-02007-0. Epub 2023 Dec 5.
7. Mohammed Al-Hijji, MD,a,b Abdallah El Sabbagh, MD,c Stephanie El Hajj, MD,a Mohamad AlKhouli, MD,a Bassim El Sabawi, MD,a Allison Cabalka, MD,a William R. Miranda, MD,a David R. Holmes, MD,a Charanjit S. Rihal, MdaIndications. STATE-OF-THE-ART REVIEW: Coronary Artery Fistulas. Techniques, Outcomes, and Complications of Transcatheter Fistula Closure. JACC 2021,14, 13,
8. Hsieh KS, Huang TC, Lee CL. Coronary artery fistulas in neonates, infants, and children: clinical findings and outcome. Pediatr Cardiol. 2002 Jul-Aug;23(4):415-9. doi: 10.1007/s00246-002-1334-6.
9. Gowda ST, Latson LA, Kutty S, Prieto LR. Intermediate to long-term outcome following congenital coronary artery fistulae closure with focus on thrombus formation. Am J Cardiol 2011;107:302–308.
10. Kawasaki T, Sato R, Matsumoto N, et al. Coronary artery fistulas: Pathophysiology, diagnosis, and mana-

gement. J Cardiol. 2022;79(5):487–493. doi: 10.1016/j.jjcc.2021.09.016
11. Cartin-Ceba R, Swanson KL, Krowka MJ. Pulmonary Arteriovenous Malformations. In: Krowka MJ, Fallon MB, Kawut SM, editors. Pulmonary Vascular Disease. New York: Springer; 2022. p. 249–264. (PAVM'nin patofizyolojisi, hipoksemi, emboli riski gibi temel konuları içeren kitap bölümü.)
12. Shovlin CL. Pulmonary arteriovenous malformations. Am J Respir Crit Care Med. 2023;207(5):573–587. doi:10.1164/rccm.202204-0702CI (PAVM'ların HHT ile ilişkisi, paradoksal emboli riski ve tedavi algoritmaları açısından en güncel klinik derleme.)
13. Faughnan ME, Mager JJ, Hetts SW, et al. Second International Guidelines for the Diagnosis and Management of Hereditary Hemorrhagic Telangiectasia. Ann Intern Med. 2022;176(6):774–787. doi:10.7326/M22-0486
14. McElhinney DB, Kreutzer J, Lang P, et al. Post-Glenn and Kawashima pulmonary arteriovenous malformations: mechanisms and management. Pediatr Cardiol. 2022;43(4):840–849. doi:10.1007/s00246-021-02733-9
15. Shovlin CL. Pulmonary arteriovenous malformations and their mimics. Clin Radiol. 2023;78(1):10–21.doi:10.1016/j.crad.2022.09.014
16. Andersen PE, Duvnjak S, Gerke O, Kjeldsen AD. Long-term single-center retrospective follow-up after embolization of pulmonary arteriovenous malformations treated over a 20-year period: frequency of recanalization with various embolization materials and clinical outcome. Cardiovascular Intervent Radiol. 2019;42(8):1102–9.
17. Lim AYL, Ratjen F. Pulmonary arteriovenous malformation in children. Pediatr Pulmonol. 2025 Mar;60 Suppl 1:S80-S81. doi: 10.1002/ppul.27354. Epub 2024 Oct 22.
18. Fahey JT, Pollak JS, White RI. Complications of catheter-based interventions for pulmonary arteriovenous malformations. In: Hijazi ZM,Feldman T, Cheatham JP, Sievert H, editors. Complications during percutaneous interventions for congenital and structural heart disease. London: Informa; 2009. p. 195–204.
19. Lambert V, Ladarre D, Fortas F, Durand P, Hervé P, Gonzales E, Guérin F, Savale L, McLin VA, Ackermann O, Franchi-Abella S; International Registry of Congenital Portosystemic Shunts (IRCPSS). Cardiovascular disorders in patients with congenital portosystemic shunts: 23 years of experience in a tertiary referral centre. Arch Cardiovasc Dis. 2021 Mar;114(3):221-231. doi: 10.1016/j.acvd.2020.10.003. Epub 2020 Dec 3.
20. Zhang JS, Li L. Surgical ligation of a portosystemic shunt for the treatment of type II Abernethy malformation in 12 children. J Vasc Surg Venous Lymphat Disord. 2021 Mar;9(2):444-451. doi: 10.1016/j.jvsv.2020.08.001. Epub 2020 Aug 10.
21. Franchi-Abella S, Gonzales E, Ackermann O, et al. Congenital portosystemic shunts: diagnosis and treatment. Abdom Radiol (NY). 2023;48(1):17–31. doi:10.1007/s00261-022-03669-3
22. Papamichail M, Pizanias M, Heaton N. Congenital portosystemic venous shunt. Eur J Pediatr. 2022;181(3):1053–1063.doi:10.1007/s00431-021-04229-9
23. Meyburg J, Westhoff-Bleck M, Klee D, et al. Interventional closure of congenital portosystemic shunts in children: indications, techniques and outcomes. Pediatr Radiol. 2022;52(12):2345–2353.doi:10.1007/s00247-022-05412-z
24. Cieślik W, Walczak M, Grenda R, et al. Interventional management of congenital portosystemic shunts in children: A review of indications and outcomes. Cardiovasc Intervent Radiol. 2022;45(7):1093–1102. doi:10.1007/s00270-022-03152-6
25. Baker DW, Uthayakumaran G, Polwart N, Lee MGY, Wilson W, Ayer J, Tanous D, D'Udekem Y, Celermajer DS, O'Donnell C, Cordina R. Transcatheter occlusion of venovenous collaterals in the total cavopulmonary Fontan circulation. Cardiol Young. 2024 Oct;34(10):2201-2206. doi: 10.1017/S1047951124025708. Epub 2024 Sep 30.
26. Abdel-Aziz D, Tanase D, Ewert P, Georgiev S, Cleuziou J, Renner D, Borgmann K, Eicken A. Catheter interventional closure of veno-venous collaterals in cyanotic patients after partial cavopulmonary shunts in pediatric patients: clinical practice review. Cardiovasc Diagn Ther. 2023 Jun 30;13(3):599-608. doi: 10.21037/cdt-23-69. Epub 2023 May 30.



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ERKEN POSTOPERATİF KALP KATETERİZASYONU VE TRANSKATETER GİRİŞİMLER

BÖLÜM 15

Emine HEKİM YILMAZ [1]
Ahmet ÇELEBİ [2]

İçindekiler

» GİRİŞ
» ENDİKASYONLAR VE ZAMANLAMA
» ERKEN POSTOPERATİF KATETERİZASYONDA PROSEDÜREL ÖZELLİKLER VE GENEL PRENSİPLER
» ERKEN POSTOPERATİF DÖNEME ÖZGÜ TRANSKATETER GİRİŞİM ÇEŞİTLERİ VE YAKLAŞIMLAR
  » İşlem Başarısı
  » Komplikasyonlar
  » Postoperatif Seyire Etkileri ve Erken Sonuçlar

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Tablo 5. Dr. Siyami Ersek Göğüs Kalp ve Damar Cerrahisi Eğitim Araştırma Hastanesi Çocuk ve Konjenital Kalp Hastalıkları Merkezi'nde son 10 yılda kardiyak cerrahi sonrası erken postoperatif (<6 hafta) dönemde kalp kateterizasyonu ve transkateter girişim deneyimi

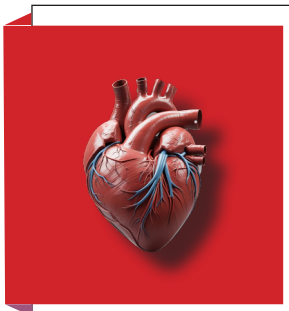
	N	TANILAR	CERRAHİ PROSEDÜR	ANA ENDİKASYON	PATOLOJİ/ LEZYON*	GİRİŞİM ÇEŞİTLERİ*
Univentriküler Tamir Grubu	82	HLHS (24) AVV atrezisi (16) U-KAVSD (14) Diğer (28)	Fontan (45) Glenn (18) NWD evre I (10) SP Şant (6) Diğer (3)	Persistan efüzyon (40) O2 satürasyonu (20) DKO (16) MV'den ayrılamama (5) Diğer (1)	PA darlığı (43) Fontan yolunda darlık (18) MAPKA/ Fistül (9) PA'de trombüs (9) Diğer (40)	PA balon/stent (38) Fontan fenestrasyonu açma/ genişletme (20) MAPKA kapama (9) Lokal TPA uygulama (9) Diğer (32)
Biventriküler Tamir Grubu	78	PA-VSD (23) TOF (16) BAT (11) Diğer (28)	Palyasyon (18) - Arkus rekonst + PAB (6) - Unifokalizasyon-SP şant (7) - İzole SP şant (5) Düzeltme (60) -TOF/PA-VSD tamiri (27) -JatenVSD kapama (13) -Diğer (20)	Persistan efüzyon (38) MV'den ayrılamama (22) DKO (11) O2 satürasyonu (3) Diğer (4)	IAS restrikte (27) PA darlıkları (25) MAPKA (22) Rezidü VSD (11) Diğer (22)	Septostomi/ plasti (27) MAPKA kapama (22) PA balon/stent (19) Rezidü VSD kapama (6) Diğer (16)
Toplam	160	160	160	160	226	198

*Bazı hastalarda birden fazla patoloji saptanmış ve birden fazla girişim yapılmıştır.
Arkus rekonst: Arkus rekonstrüksiyonu, AVV: Atrioventriküler kapak, BAT: Büyük arter transpozisyonu, DKO: Düşük kardiyak output, HLHS: Hipoplastik sol kalp sendromu, IAS: İnteratriyal septum, MAPKA: Majör aortopulmoner kollateral, MV: Mekanik ventilatör, NWD: Norwood, PAB: Pulmoner artere band, O2: Oksijen, PA-VSD: Pulmoner atrezi ventriküler septal defekt, RV: Sağ ventrikül, SP: sistemik-pulmoner, TPA: Doku plazminojen aktivatörü, TTE: Transtorasik ekokardiyografi, TOF: Fallot tetralojisi, U-KAVSD: Unbalanse komplet atrioventriküler septal defekt,

KAYNAKLAR

1. Murphy SL, Mathews TJ, Martin JA, Minkovitz CS, Strobino DM. Annual Summary of Vital Statistics: 2013-2014. Pediatrics. 2017; 139:e20163239.
2. Asoh K, Hickey E, Dorostkar PC, Chaturvedi R, van Arsdell G, Humpl T et al. Outcomes of emergent cardiac catheterization following pediatric cardiac surgery. Catheter Cardiovasc Interv 2009;73:933-40.
3. Burke CR, Chan T, Rubio AE, McMullan DM. Early cardiac catheterization leads to shortened pediatric extracorporeal membrane oxygenation run duration. J Interv Cardiol 2017;30:170-6.
4. Boscamp NS, Turner ME, Crystal M, Anderson B, Vincent JA, Torres AJ. Cardiac catheterization in pediatric patients supportedby extracorporeal membrane oxygenation: a 15-year experience. Pediatr Cardiol 2017; 38: 332-7.
5. Raimondi F, Warin-Fresse K. Computed tomography imaging in children with congenital heart disease: indications and radiation dose optimization. Arch Cardiovasc Dis 2016;109:150-7.
6. Andrews RE, Tulloh RM. Interventional cardiac catheterization in congenital heart disease. Arch Dis Child 2004; 89: 1168-73.
7. Zahn EM, Dobrolet NC, Nykanen DG, Ojito J, Hannan RL, Burke RP. Interventional catheterization performed in the early postoperative period after congenital heart surgery in children. J Am Coll Cardiol 2004; 43:1264-9.
8. Nicholson GT, Kim DW, Vincent RN, Kogon BE, Miller BE, Petit CJ. Cardiac catheterization in the early post-operative period after congenital cardiac surgery. JACC Cardiovasc Interv 2014; 7:1437-43.
9. Kojima T, Imamura T, Osada Y, Muraji S, Nakano M, Oyanagi T et al. Efficacy of catheter interventions in the early and very early postoperative period after CHD operation. Cardiol Young 2018;28:1426-30.
10. Eraso-Diaz Del Castillo AM, Escobar-Dıaz MC, Lince Varela R, Dıaz Medina LH, Canas Arenas EM. Catheterization performed in the early postoperative period after congenital heart surgery in children. Pediatr Cardiol 2019;40:827-33.
11. Callahan R, Trucco SM, Wearden PD, Beerman LB, Arora G, Kreutzer J. Outcomes of pediatric patients undergoing cardiac catheterization while on extracorporeal membrane oxygenation. Pediatr Cardiol 2015;36: 625-32.
12. Haddad RN, Lange JM, Raisky O, Gaudin R, Barbanti C, Bonnet D, Malekzadeh-Milani S. Indications and

outcomes of cardiac catheterization following congenital heart surgery in children. Eur J Cardiothorac Surg. 2022 May 2;61(5):1056-65.
13. Siehr SL, Martin MH, Axelrod D, Efron B, Peng L, Roth SJ et al. Outcomes following cardiac catheterization after congenital heart surgery. Catheter Cardiovasc Interv 2014;84:622-8.
14. Nykanen DG, Forbes TJ, Du W, Divekar AA, Reeves JH, Hagler DJ et al. CRISP: catheterization risk score for pediatrics: a report from the congenital cardiac interventional study consortium (CCISC). Catheter Cardiovasc Interv 2016; 87(2):302-309
15. Rosales AM, Lock JE, Perry SB, Geggel RL. Interventional catheterization management of perioperative peripheral pulmonary stenosis: balloon angioplasty or endovascular stenting. Catheter Cardiovasc Interv 2002; 56:272-7.
16. Nicholson GT, Kim DW, Vincent RN, Petit CJ. Transcatheter interventions across fresh suture lines in infants and children: an 8-year experience. Catheter Cardiovasc Interv 2015;86:271-7.
17. Pagowska-Klimek I, Pychynska-Pokorska M, Krajewski W, Moll JJ. Predictors of long intensive care unit stay following cardiac surgery in children. Eur J Cardiothorac Surg 2011;40:179-84.
18. Jayaram N, Beekman RH, Benson L, Holzer R, Jenkins K, Kennedy KF et al. Adjusting for risk associated with pediatric and congenital cardiac catheterization: a report from the NCDR IMPACT Registry. Circulation 2015;132:1863-70.
19. Feltes TF, Bacha E, Beekman RH 3rd, Cheatham JP, Feinstein JA, Gomes AS et al. American Heart Association. Indications for cardiac catheterization and intervention in pediatric cardiac disease: a scientific statement from the American Heart Association. Circulation 2011; 123:2607-52.
20. Demir IH, Ozdemir DM, Yucel IK, Yılmaz EH, Bulut MO, Surucu M et al. The Lifesaving Impact of Transcatheter Interventions in the Early Post-Fontan Palliation Period. Pediatr Cardiol 2024; 45:986-997.
21. Abdelmohsen G, Al-Ata J, Alkhushi N, Bahaidarah S, Baho H, Abdelsalam M .Cardiac Catheterization During Extracorporeal Membrane Oxygenation After Congenital Cardiac Surgery: A Multi-Center Retrospective Study. Pediatric Cardiology 2022; 43:92-103.
22. Thibault D, Wallace AS, Jacobs ML, Hornik CP, Costello JM, Fleming GF et al. Postoperative transcatheter interventions in children undergoing congenital heart surgery. Circ Cardiovasc Interv 2019;12:e007853.
23. Costello JM, Monge MC, Hill KD, Kim S, Pasquali SK, Yerokun BA et al. Associations Between Unplanned Cardiac Reinterventions and Outcomes After Pediatric Cardiac Operations. Ann Thorac Surg. 2018;105:1255-63.
24. Kamel Shibbani, Jess T. Randall, Bassel Mohammad Nijres, Osamah Aldoss. Medium-Term Outcomes in Pediatric Patients Undergoing Cardiac Catheterization Early After Congenital Cardiac Surgery. Pediatr Cardiol 2023; 44:1808-14.



KONJENİTAL KALP HASTALIKLARINDA HİBRİT GİRİŞİMLERİN YERİ

BÖLÜM
16

Abdullah ERDEM [1]

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İçindekiler

- GİRİŞ
- HİPOPLASTİK SOL KALP SENDROMU İÇİN HYBRİT EVRE 1 PROSEDÜRÜ
- HİBRİT VENTRİKÜLER SEPTAL DEFEKT KAPATILMASI
- HİBRİT PULMONER KAPAK İMPLANTASYONU
- HYBRİT STENT İMPLANTASYONU
- HYBRİT INTRAVASKÜLER VE INTRAKARDİYAK GİRİŞLER

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mak veya stent yerleştirmek mümkün olmaktadır (11,12). Örneğin ana PA'e cerrahi olarak yerleştirilen bir kılıf içinden çok küçük çocuklarda bile erişkin boyutlara ulaşabilecek stentler PA dallarına daha kolay yerleştirilebilmektedir. Bu işlemler özellikle küçük kilolu hastalarda ve sınırlı vasküler erişimi olanlarda tercih edilebilir. Doğrudan, görerek stent implantasyonu teknik olarak daha kolay ve etkilidir. Bunlarda kardiyopulmoner baypasa girilecek ise bile süre oldukça kısalır (12). İşlem sonrası damar açıklığını göstermek ve/veya residü lezyonları ortaya çıkarmak için intraoperatif floroskopik veya anjiyografik görüntülemenin yalnızca stent implantasyonundan sonra değil, aynı zamanda standart cerrahi onarımdan sonra da avantajları olduğu gösterilmiştir (48,49).

HYBRİT INTRAVASKÜLER VE INTRAKARDİYAK GİRİŞLER

Yenidoğanlarda, duktus stenti implantasyonu, aort koarktasyonu ve aort stenozu için balon yapılabilmesi amacıyla cutdown yapılarak carotis arterine ulaşarak işlemlerin gerçekleştirilmesi bir bakıma cerrahın ve invaziv kardiyoloğun işbirliğine dayalı hybrit girişimlerdir. Yenidoğanlarda karotis arter çapı femoral arter çapından daha geniş olduğundan bu yol femoral arterlerin yaralanması ihtimalini azaltır (50). Hatta bu yolla prematüre bebeklerde dahi bu işlemler gerçekleştirile bilinir.

Atriyotomi yapılarak HLHS lu bebeklerde septostomi yapılmasını kolaylaştırılması veya Fontan olgularında atriyuma ulaşılarak Valve –in–Valve prosedürlerinin uygulana bilmesi de intrakardiyak giriş yolu oluşturularak gerçekleştirilen hybrit girişimlere örnektirler (51,52).

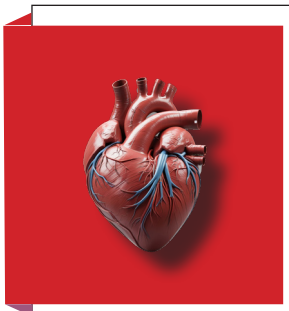
Sonuç olarak cerrahlar ile girişimsel kardiyologlar arasındaki iş birliğinin artması ve işlemlerin birlikte yapılır hale gelmesi ile kompleks işlemler daha az invaziv bir şekilde gerçekleşir hale gelmiştir. Hibrit yapılan işlemler sayesinde işlem süreleri kısalmış, kardiyopulmoner baypas sayısı azalmış, vasküler erişimler kolaylaşmış daha küçük kilolu veya daha yüksek riskli hastalara daha kolay ve daha az risk ile müdahale edilme olanakları ortaya çıkmıştır.

KAYNAKLAR

1. Hjortdal V.E, Redington AN, de Leval MR, et al. Hybrid approaches to complex congenital cardiac surgery, Eur J Cardiothorac Surg. 2002;22(6):885–890.
2. Bacha E. A, Hijazi Z.M. Hybrid pediatric cardiac surgery is an emerging field. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2005; 8:78–85.
3. Bacha E. A, Hijazi Z.M, Cao Q-L, et al. Hybrid Pediatric Cardiac Surgery. Pediatr Cardiol. 2005; 26:315–322.
4. Gibbs J. L, Wren C, Watterson K.G, et al. Stenting of the arterial duct combined with banding of the pulmonary arteries and atrial septectomy or septostomy: a new approach to palliation for the hypoplastic left heart syndrome. Br Heart J. 1993;69:551–555
5. Akintuerk H, Michel-Behnke I, Valeske K, et al. Stenting of the arterial duct and banding of the pulmonary arteries: basis for combined Norwood stage I and II repair in hypoplastic left heart. Circulation 2002; 105:1099–1103.
6. Galantowicz M, Cheatham JP, Phillips A, et al. Hybrid approach for hypoplastic left heart syndrome: intermediate results after the learning curve. Ann Thorac Surg 2008; 85:70–71 [discussion 70–71].
7. Bacha EA, Cao QL, Galantowicz ME, et al. Multicenter experience with perventricular device closure of muscular ventricular septal defects. Pediatr Cardiol 2005; 26:169–175.
8. Diab KA, Hijazi ZM, Cao QL et al. A truly hybrid approach to perventricular closure of multiple muscular ventricular septal defects, J Thorac Cardiovasc Surg, 2005;130(3):892–893.
9. Gupta A, Kenny D, Caputo M, et al Initial experience with elective perventricular melody valve placement in small patients. Pediatr Cardiol. 2017; 38:575–581.
10. Mollet A, Basquin A, Stos B et al. Off-pump replacement of the pulmonary valve in large right ventricular outflow tracts: a transcatheter approach using an intravascular infundibulum reducer. Pediatr Res. 2007; 62:428–433.
11. Bondanza S, Calevo MG, Derchi ME, et al. Hybrid procedure of right ventricle outflow tract stenting in small infants with pulmonary atresia and ventricular septal defect: early and mid-term results from a single centre. Cardiol Young 2019; 29:375–379.
12. Bokenkamp R, Blom NA, De Wolf Det al. Intraoperative stenting of pulmonary arteries. Eur J Cardiothorac Surg 2005; 27:544–547.
13. Haas NA, Happel CM, Blanz U, et al. Intraoperative hybrid stenting of recurrent coarctation and arch hypoplasia with large stents in patients with univentricular hearts''. Int J Cardiol. 2016;204:156–163.
14. Samanek M, Slavik Z, Zborilova B, et al. Prevalence, treatment, and outcome of heart disease in live-born children: a prospective analysis of 91,823 live-born children. Pediatr Cardiol. 1989; 10:205–211.
15. McBride KL, Marengo L, Canfield M, et al. Epidemiology of noncomplex left ventricular outflow tract obstruction malformations (aortic valve stenosis, coarctation of the aorta, hypoplastic left heart syndrome) in Texas, 1999–2001. Birth Defects Res A Clin Mol Teratol. 2005; 73:555–561.

16. Norwood WI, Kirklin JK, Sanders SP. Hypoplastic left heart syndrome: experience with palliative surgery. Am J Cardiol 1980; 45:87–91.
17. Norwood W.I, Lang P, Hansen D.D. Physiologic repair of aortic atresia-hypoplastic left heart syndrome. N Engl J Med. 1983; 308:23–26
18. Galantowicz M, Cheatham JP, Phillips A, et al. Hybrid approach for hypoplastic left heart syndrome: intermediate results after the learning curve. Ann Thorac Surg. 2008; 85:2063–2070. – discussion 2070–1.
19. Gelehrter S, Fifer CG, Armstrong A, et al. Outcomes of hypoplastic left heart syndrome in low-birth-weight patients. Pediatr Cardiol. 2011; 32:1175–1181.
20. Murphy MO, Bellsham-Revell H, Morgan GJ, et al. Hybrid procedure for neonates with hypoplastic left heart syndrome at high-risk for norwood: midterm outcomes. Ann Thorac Surg. 2015; 100:2286–2290. – discussion 2291–2292.
21. Goreczny S, Qureshi S, Rosenthal E, et al. Self-expanding stent implantation in arterial duct during hybrid palliation of hypoplastic left heart syndrome: midterm experience with a specially designed stent. EuroIntervention. 2015 Mar;10(11):1318–25.
22. Goreczny S, Qureshi S, Rosenthal E et all. Comparison of self-expandable and balloon-expanding stents for hybrid ductal stenting in hypoplastic left heart complex. Cardiol Young. 2017 Jul;27(5):837-845.
23. Stoica SC, Philips AB, Egan M, et al. The retrograde aortic arch in the hybrid approach to hypoplastic left heart syndrome. Ann Thorac Surg 2009; 88:46–7 [discussion 46–7].
24. Baba K, Honjo O, Chaturvedi R et al. Reverse Blalock-Taussig shunt": application in single ventricle hybrid palliation. J Thorac Cardiovasc Surg. 2013 Aug;146(2):352–7.
25. Schaeffler R, Sarikouch S, Peuster M. Anterograde stent implantation for treatment of recurrent coarctation after Norwood operation. Pediatr Cardiol. 2008; 29:388–392
26. Morse A K, Podgorsek B, Dobrila J et al. Open-Hybrid Aortic Stent Placement for Recurrent Coarctation in Complex Single Ventricles. Ann Thorac Surg Short Rep. 2024;16;3(1):109–112.
27. Yerebakan C, Josephine Murray J, Valeske K et al. Long-term results of biventricular repair after initial Giessen hybrid approach for hypoplastic left heart variants. J Thorac Cardiovasc Surg. 2015;149(4):1112–1120; discussion 1120–1122.e2.
28. DiBardino DJ, Gomez-Arostegui J, Kemp A, et al. Intermediate Results of Hybrid Versus Primary Norwood Operation. Thorac Surg. 2015;99(6):2141-2147; discussion 2147–2149.
29. Iskander C, Nwankwo U, Kumanan K K, et al. Comparison of Morbidity and Mortality Outcomes between Hybrid Palliation and Norwood Palliation Procedures for Hypoplastic Left Heart Syndrome: Meta-Analysis and Systematic Review. J Clin Med. 2024;13(14):4244.
30. Oreto L, Mandrafinno G, Calaciura R E, et al. Hybrid Palliation for Hypoplastic Borderline Left Ventricle: One More Chance to Biventricular repair. Children (Basel). 2023;10(5): 859.
31. Nwankwo UT, Morell EM, Trucco SM, et al. Hybrid Strategy for Neonates With Ductal-Dependent Systemic Circulation at High Risk for Norwood. Ann Thorac Surg. 2018;106:595–601.
32. Simsic JM, Phelps C, Kirchner K, et al. Interstage outcomes in single ventricle patients undergoing hybrid stage 1 palliation. Congenit Heart Dis 2018; 13:757–63.
33. Baba K, Chaturvedi R, Lee KJ, et al. Fate of the ductal stent after hybrid palliation for hypoplastic left heart syndrome. Ann Thorac Surg 2013; 95:1660–4.
34. Martin GR, Perry LW, Ferencz C. Increased prevalence of ventricular septal defect: epidemic or improved diagnosis. Pediatrics. 1989;83:200–203.
35. Anderson RH, Becker AE, Tynan M. Description of ventricular septal defects–or how long is a piece of string? Int J Cardiol 1986; 13:267–78.
36. Rougin N, Du ZD, Barak M et al. High prevalance of muscular septal defect in neonates . J Am Coll Cardioll. 1995:15;26(6):1545–1548
37. Serraf A, Lacour-Gayet F, Bruniaux J, et al. Surgical management of isolated multiple ventricular septal defects. Logical approach in 130 cases. J Thorac Cardiovasc Surg 1992; 103:437-442 [discussion 43].
38. R Roussin, A Serraf, J Bruniaux et al. Surgical treatment of isolated multiple ventricular septal defects. apropos of a series of 175 consecutive cases. Arch Mal Coeur Vaiss. 1996 May;89(5):571–577.
39. Amin Z, Gu X, Berry JM et al. Perventricular [correction of Periventricular] closure of ventricular septal defects without cardiopulmonary bypass. Ann Thorac Surg. 1999;68:149–153.
40. Aoki M, Forbess JM, Jonas RA et al. Result of biventricular repair for double-outlet right ventricle. J Thorac Cardiovasc Surg. 1994;107:49–50 [discussion 49–50].
41. Roy M, Gangopadhyay D, Goyal N. Transcatheter closure of ventricular septal defects in children less than 10 kg: experience from a tertiary care referral hospital in Eastern India. Cardiol Young. 2022;32(1):48–54.
42. Hong ZN, Chen Q, Huang LQ et al. A meta-analysis of perventricular device closure of perimembranous ventricular septal defect. Cardiothorac Surg. 2019 Jun 27;14(1):119.
43. Bonhoeffer P, Boudjemline Y, Saliba Z et al. Percutaneous replacement of pulmonary valve in a right-ventricle to pulmonary-artery prosthetic conduit with valve dysfunction. Lancet; 2000; 356:1403–5
44. Mollet A, Basquin A, Stos B, et al. Off-pump replacement of the pulmonary valve in large right ventricular outflow tracts: a transcatheter approach using an intravascular infundibulum reducer. Pediatr Res. 2007; 62:428–33.
45. Phillips AB, Nevin P, Shah A, et al. Development of a novel hybrid strategy for transcatheter pulmonary valve placement in patients following transannular patch repair of tetralogy of fallot. Catheter Cardiovasc Interv. 2016; 87:403–10.
46. Porras D, Gurvitz M, Marshall AC, et al. Hybrid approach for off-pump pulmonary valve replacement in patients with a dilated right ventricular outflow tract. Ann Thorac Surg. 2015;100:e99–101.
47. Sosnowski C, Matella T, Fogg L, et al. Hybrid pulmonary artery plication followed by transcatheter pulmonary valve replacement: Comparison with surgical PVR. Catheter Cardiovasc Interv. 2016;88:804–810.

48. Shuhaiber J H, Bergersen L, Pigula F, et al. Intraoperative assessment after pediatric cardiac surgical repair: initial experience with C-arm angiography. J Thorac Cardiovasc Surg. 2010;140:1:e1–3.
49. Lamers L, Jimenez E E, Allen C, et al. Intraoperative completion angiogram may be superior to transesophageal echocardiogram for detection of pulmonary artery residual lesions in congenital heart surgery. Pediatr Cardiol.2018; 39 :884–891
50. Justino H, Petit CJ. Percutaneous common carotid artery access for pediatric interventional cardiac catheterization. Circ Cardiovasc Interv. 2016;9:e003003.
51. Hill K, Fudge JC, Barker P, et al. Transatrial septoplasty technique for neonates with hypoplastic left heart syndrome and an intact or highly restrictive atrial septum. Pediatr Cardiol. 2010;31:545–549.
52. Ho AB, Kaarne M, Mullen M, et al. Hybrid transcatheter tricuspid valve-in-valve placement of an Edwards Sapien XT valve in palliated hypoplastic left heart syndrome. Catheter Cardiovasc Interv. 2019;93:481–483.



TRANSKATETER NADİR UYGULAMALAR

BÖLÜM
17

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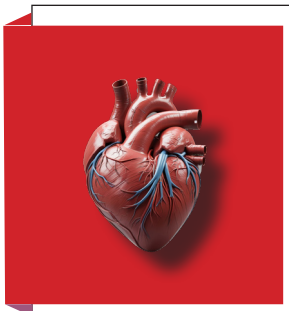
KAYNAKLAR

1. Emmel M, Sreeram N. Total anomalous pulmonary vein connection: diagnosis, management, and outcome. Curr Treat Options Cardiovasc Med. 2004;6:423-9.
2. Kilgore A, Lucas V, Collins T, Snyder CS. Stent implantation as a stabilization technique in supracardiac total anomalous pulmonary venous connection. Catheter Cardiovasc Interv. 2006;68:629-31.
3. Kyser JP, Bengur AR, Siwik ES. Preoperative palliation of new born obstructed total anomalous pulmonary venous connection by endovascular stent placement. Catheter Cardiovasc Interv. 2006;67:473-6.
4. Lo-A-Njoe SM, Blom NA, Bo¨kenkamp R, Ottenkamp J. Stent ing of the vertical vein in obstructed total anomalous pulmonary venous return as rescue procedure in a neonate. Catheter Cardiovasc Interv. 2006;67:668-70.
5. Rothman A, Galindo A, Evans WN. Temporary transumbilical stenting of the ductus venosus in neonates with obstructed infra diaphragmatic total anomalous pulmonary venous return. Pediatr Cardiol. 2011;32:87-90.
6. Kobayashi D, Forbes TJ, Aggarwal S. Palliative Stent Placement in Vertical Vein in a 1.4 Kg Infant with Obstructed Supracardiac Total Anomalous Pulmonary Venous Connection. Catheterization and Cardiovascular Interventions. 2013;82:574-80.
7. Jhang WK, Chang YJ, Park CS, Oh YM, Kim YH, Yun TJ. Hybrid palliation for right atrial isomerism associated with obstructive total anomalous pulmonary venous drainage. Interact Cardiovasc Thorac Surg. 2008;7:282-4.
8. Kitano M, Hoashi T, Kakuta T, Fujimoto K, Miyake A, Kurosaki K, Ichikawa H, Shiraishi I. Primary Draining Vein Stenting for Obstructive Total Anomalous Pulmonary Venous Connection in Neonates with Right Atrial Isomerism and Functional Single Ventricle Improves Outcome. Pediatric Cardiology. 2018;39:1355-65.
9. Moszura T, Dryżek P, Góreczny S, Bobkowski W, Mazurek Kula A, Surmacz R, Moll JA, Siwińska A, Sysa A. Stent implantation into the interatrial septum in patients with univentricular heart and a secondary restriction of interatrial communication. Kardiol Pol. 2011;69(11):1137-41.
10. Sivakumar, K. Atrial septal stenting- How I do it? Ann. Pediatr. Cardiol. 2015;8(1):37-43.
11. Neves JR, Pedra SRF, Ferreiro CR, Jatene I, Cortez TM, Jatene M, Souza LCB, Assad R, Fontes VF. New transcatheter techniques for creation or enlargement of atrial septal defects in infants with complex congenital heart disease. Catheter Cardiovasc Interv. 2007;70(5):731-9.
12. Prakoso R, Kurniawati Y, Siagian SN, Sembiring AA, Aulia Sakti DD, Mendel B, Lelya O, Lilyasari O. Inter-atrial Septum Stenting in Congenital Heart Disease Patient: A Case Series in Indonesia. Cardiovasc Hematol Disord Drug Targets. 2024;24(3):163-71.
13. Konertz W, Schneider M, Herwig V, Kampmann C, Waldenberger F, Hausdorf G. Modified hemi-Fontan operation and subsequent non surgical Fontan completion. J Thorac Cardiovasc Surg. 1995;110(3):865-7.
14. Hausdorf G, Schneider M, Konertz W. Surgical preconditioning and completion of total cavopulmonary connection by interventional cardiac catheterisation: a new concept. Heart. 1996;75(4):403-9.
15. Alsoufi B, Alfadley F, Al-Omrani A, et al. Hybrid management strategy for percutaneous Fontan completion without surgery: early results. Ann Thorac Surg. 2011;91(2):566-73.
16. Gerelli S, Van Steenberghe M, Patel M, Van Aerschot I, Boudjemline Y. Feasibility of creating a novel animal heart model to test transcatheter techniques for a cavocaval connection that mimics a Fontan completion. J Thorac Cardiovasc Surg. 2013;146(2):408-12.
17. Boudjemline Y, Gerelli S, Van Steenberghe M, Patel M, Malekzadeh Milani S, Bonnet D. Feasibility of transcatheter techniques for intracardiac and extracardiac cavocaval connection in principle for Fontan completion in chronic animal models. Eur J Cardiothorac Surg. 2013;43(4):856-60.
18. Boudjemline Y, Malekzadeh-Milani S, Van Steenberghe M, et al. Novel method of surgical preparation for transcatheter completion of Fontan circulation: creation of an extracardiac pathway. Arch Cardiovasc Dis. 2014;107(6-7):371-80.
19. Prabhu S, Anderson B, Ward C, Karl T, Alphonso N. A simplified technique for interventional extracardiac fontan. World J Pediat Cong Heart Surg. 2017;8(1):92-8.
20. Prabhu S, Maiya S, Shetty R, Murthy K, Ramachandra P, Karl TR. Improved technique for interventional extracardiac fontan. World J Pediat Cong Heart Surg. 2020;11(4):488-92.
21. Sizarov A, Raimondi F, Bonnet D, Boudjemline Y. Cardiovascular anatomy in children with bidirectional Glenn anastomosis, regarding the transcatheter Fontan completion. Arch Cardiovasc Dis. 2018;111(4):257-69.
22. Sivaprakasam MC, Ganesan R, Ramkishore S, Saranya A, Girija H, Arun V, Mahitha V, Solomon N. Catheter-Based Fontan Completion Without Prior Surgical Preparation: Is This the Way Forward? JACC Case Rep. 2024:6;29(21):102657.
23. Fontan F, Baudet E. Surgical repair of tricuspid atresia. Thorax. 1971;26:240-8.
24. Bridges ND, Mayer JE Jr, Lock JE, Jonas RA, Hanley FL, Keane JF, et al. Effect of baffle fenestration on outcome of the modified Fontan operation. Circulation. 1992;86:1762-9.
25. Lemler MS, Scott WA, Leonard SR, Stromberg D, Ramaciotti C. Fenestration improves clinical outcome of the fontan procedure: A prospective, randomized study. Circulation. 2002;105:207-12.
26. Airan B, Sharma R, Choudhary SK, Mohanty SR, Bhan A, Chowdhari UK, et al. Univentricular repair: Is routine fenestration justified? Ann Thorac Surg. 2000;69:1900-6.
27. Laks H, Pearl JM, Haas GS, Drinkwater DC, Milgalter E, Jarmakani JM, et al. Partial Fontan: advantages of an adjustable interatrial communication. Ann Thorac Surg. 1991;52:1084-94.
28. Bridges ND, Lock JE, Castaneda AR. Baffle fenestration with subsequent catheter closure: modification of the Fontan operation for patients with increased risk. Circulation. 1990;82:1681-9.
29. Do-Nguyen CC, Kilcoyne MF, Gray P, Jonas RA. The evolution of surgical technique of the fenestrated Fontan procedure. J Card Surg. 2020;35:1407-9.
30. Guariento A, Pradegan N, Castaldi B, Cattapan C, Weixler V, Blitzer D, et al. Modified extracardiac Fon-

tan with a fenestrated pericardial patch. J Card Surg. 2020;35:1618-20.
31. Atz AM, Travison TG, McCrindle BW, Mahony L, Quartermain M, Williams RV, et al. Late status of Fontan patients with persistent surgical fenestration. J Am Coll Cardiol. 2011;57:2437-43.
32. Ono M, Boethig D, Goerler H, Lange M, Westhoff-Bleck M, Breymann T. Clinical outcome of patients 20 years after Fontan operation effect of fenestration on late morbidity. Eur J Cardiothorac Surg. 2006;30:923-9.
33. Hijazi ZM. Extracardiac fenestrated Fontan operation: To close or not to close the fenestration? Catheter Cardiovasc Interv. 2001;54:93-4.
34. Thatte N, Dimas V, Nugent A, Zellers T, Forbess J, Zabala L, Zhang S, Surendranath SRV. Use of institutional criteria for transcatheter device closure of Fontan fenestration - Midterm outcomes. Ann Pediatr Cardiol. 2020;13(4):327-33.
35. Greenleaf CE, Lim ZN, Li W, LaPar DJ, Salazar JD, Corno AF. Impact on clinical outcomes from transcatheter closure of the Fontan fenestration: A systematic review and meta-analysis. Front Pediatr. 2022;10(4):915045.
36. Goreczny S, Dryzek P, Morgan GJ, Mazurek-Kula A, Moll JJ, Moll JA, et al. Fenestration closure with Amplatzer duct occlude II in patients after total cavo pulmonary connection. Arch Med Sci. 2017;13:337-45.
37. Bridges ND, Lock JE, Mayer JE, Burnett J, Castaneda AR. Cardiac catheterization and test occlusion of the interatrial communication after the fenestrated Fontan operation. J Am Coll Cardiol. 1995;25:1712-7.
38. Kawasaki Y, Sasaki T, Forbes TJ, Ross RD, Kobayashi D. Optimal criteria for transcatheter closure of Fontan fenestration: a single-center experience with a review of literature. Heart Vessels. 2021;36:1246-55.
39. Ozawa H, Hoashi T, Ohuchi H, Kurosaki K, Ichikawa H. Long-termoutcomes after fenestration closure in high-risk Fontan candidates. Pediatr Cardiol. 2021;42:1356-64.
40. Webb MK, Hunter LE, Kremer TR, Huddleston CB, Fiore AC, Danon S. Extracardiac Fontan fenestration device closure with Amplatzer Vascular Plug II and septal occluder: procedure results and medium-term follow-up. Pediatr Cardiol. 2020;41(4):703-8.
41. Vanagt WY, Cools B, Boshoff DE, et al. Use of covered Cheatham Platinum stents in congenital heart disease. Int J Cardiol. 2014;175(1):102-7.
42. Malekzadeh-Milani S, Ladouceur M, Bajolle F, Bonnet D, Boudjemline Y. Closure of Fontan fenestration with the use of covered stents: short and mid-term results in a cohort of 50 patients. Cardiol Young. 2015;25(5):868-73.
43. Haddad RN, Bonnet D, Malekzadeh-Milani S. Transcatheter closure of extracardiac Fontan conduit fenestration using new promising materials. J Card Surg. 2021;36(11):4381-5.
44. Pradhan S, Batlivala SP, Pombo LR, Ollberding N, Gao Z, Szugye N, Shahanavaz S, Hirsch R. A Single-Center Review of Clinical Outcomes After Transcatheter Relief of Superior Vena Cava Stenosis in a Pediatric and Young Adult Population. J Soc Cardiovasc Angiogr Interv. 2024;3(10):102245.
45. Aldoss O, Arain N, Menk J, Kochilas L, Gruenstein D. Endovascular stent provides more effective early relief of SVC obstruction compared to balloon angioplasty. Catheter Cardiovasc Interv. 2014;83:E272-6.
46. Tzifa A, Marshall AC, McElhinney DB, Lock JE, Geggel RL. Endovascular treatment for superior vena cava occlusion or obstruction in a pediatric and young adult population: A 22-year experience. J Am Coll Cardiol. 2007;49:1003-9.
47. Islam N, Saha S. Transcatheter management of superior vena cava obstruction following cardiac surgery: A case report from a resource-limited set-up. Ann Pediatr Cardiol. 2024;17(2):152-5.
48. Nossair F, Schoettler P, Starr J, Chan AK, Kirov I, Paes B, et al. Pediatric superior vena cava syndrome: An evidence-based systematic review of the literature. Pediatr Blood Cancer 2018;65:e27225.
49. Rizvi AZ, Kalra M, Bjarnason H, Bower TC, Schleck C, Gloviczki P. Benign superior vena cava syndrome: Stenting is now the first line of treatment. J Vasc Surg. 2008;47:372-80.
50. Yamanaka O, Hobbs RE. Coronary artery anomalies in 126,595 patients undergoing coronary arteriography. Cathet Cardiovasc Diagn. 1990;21:28-40.
51. Gillebert C, Van Hoof R, Van de Werf F, Piessens J, De Geest H. Coronary artery fistulas in an adult population. Eur Heart J. 1986;7:437-43.
52. Bassim El-Sabawi, Mohammed A Al-Hijji, Mackram F Eleid, Allison K Cabalka, Naser M Ammash, Joseph A Dearani, Haraldur Bjarnason, David R Holmes, Charanjit S Rihal. Transcatheter closure of coronary artery fistula: A 21-year experience. Catheter Cardiovasc Interv. 2020;96(2):311-9.
53. Martin Christmann, Ricarda Hoop, Hitendu Dave, Daniel Quandt, Walter Knirsch, Oliver Kretschmar. Closure of coronary artery fistula in childhood: treatment techniques and long-term follow-up Clin Res Cardiol. 2017;106(3):211-8.
54. Yakut K, Tokel NK, Varan B, Erdoğan İ, Ozkan M. Coronary artery fistulae and treatment in children. The Turkish Journal of Pediatrics. 2020;62:614-22.
55. Cardiac Catheterization for Congenital Heart Disease From Fetal Life to Adulthood, Second Edition, Gianfranco Butera Massimo Chessa Andreas Eicken John Thomson Editors, Springer Nature Switzerland AG 2021, Catheter Closure of Coronary Artery Fistula Kothandam Sivakumar, Ajit Mullasari, and Bharat Dalvi, 619-637.
56. Stout KK, Daniels CJ, Aboulhosn JA, et al. 2018 AHA/ACC guideline for the management of adults with congenital heart disease: executive summary. A report of the American College of Cardiology/American Heart Association Task Force on clinical practice guidelines. J Am Coll Cardiol. 2019;73:1494-563
57. Alsoufi B, Schlosser B, McCracken C, Kogon B, Kanter K, Border W, et al. Current Outcomes of Surgical Management of Aortopulmonary Window and Associated Cardiac Lesions. Ann Thorac Surg. 2016;102(2):608-14.
58. Demir IH, Erdem A, Sarıtaş T, Demir F, Erol N, Yücel IK, et al. Diagnosis, treatment and outcomes of patients with aortopulmonary window. Balkan Med J. 2013;30(2):191-6.
59. Naik AV, Salvi P, Mhatre A, Soomar SM, Joshi S. Aortopulmonary window: a single institution surgical expe-

rience. Asian Cardiovasc Thorac Ann. 2014;22(3):272-5.
60. Backer CL, Mavroudis C. Surgical management of aortopulmonary window: a 40-year experience. Eur J Cardiothorac Surg. 2002;21(5):773-9.
61. Anderson RH, Cook A, B rown NA, Henderson DJ, Chaudhry B, Mohun T. Development of the outflow tracts with reference to aortopulmonary windows and aortoventricular tunnels. Cardiol Young. 2010;20(3):92-9.
62. Anderson RH, Brown N, Webb S, Henderson D. Lessons learnt with regard to aortopulmonary window. Cardiol Young. 2008;18(5):451-7.
63. Ho SY, Gerlis LM, Anderson C, Devine WA, Smith A. The mor phology of aortopulmonary window with regard to their classifi cation and morphogenesis. Cardiol Young. 1994;4:146-55.
64. Yakut K, Tokel NK, Ozkan M, Varan B, Erdogan I, Aslamaci S. Diagnosis and surgical treatment of aortopulmonary window: Our single-center experience. Turkish Journal of Thoracic and Cardiovascular Surgery. 2018;26(1):30-7.
65. Trehan V, Nigam A, Tyagi S. Percutaneous closure of nonrestrictive aortopulmonary window in three infants. Catheter Cardiovasc Interv. 2008;71(3):405-11.
66. Marini D, Ferraro G, Agnoletti G, Iatrogenic "aortopulmonary window": percutaneous rescue closure as a bridge to surgical repair. Cardiol Young. 2016;26(3):609-11.
67. Marini D, Calcagni G, Ou P, Bonnet D, Agnoletti G. Percutaneous treatment of aorto-pulmonary window in a one year old child. Int J Cardiol. 2008;129(3):91-3.
68. Gurav AP, Kumar S, Kumar RK. Percutaneous closure of aortopulmonary window in a preterm infant. Ann Pediatr Cardiol. 2024;17(3):204-6.
69. Fiszer R, Zbroński K, Szkutnik M. Percutaneous closure of an aortopulmonary window using Amplatzer Duct Occluder II: Additional Sizes: the first reported case. Cardiol Young. 2017;27(4):812-5.
70. Faughnan ME, Thabet A, Mei-Zahav M, Colombo M, Maclusky I, Hyland RH, Pugash RA, Chait P, Henderson KJ, White RI Jr. Pulmonary arteriovenous malformations in children: outcomes of transcatheter embolotherapy. J Pediatr. 2004;145(6):826-31.
71. Ghelani SJ, Rathod RH. Pulmonary arteriovenous malformations: the consequences of bypassing the capillary bed. J Thorac Cardiovasc Surg. 2015;150:717-9.
72. Wu Z, Lin J, Yang W, Jiang N, Huang N, Clavijo LC. Evaluation of percutaneous transcatheter embolization for pulmonary arteriovenous malformations. BMC Pulm Med. 2021 Mar 5;21(1):77.
73. Cartin-Ceba R, Swanson KL, Krowka MJ. Pulmonary arteriovenous malfor mations. Chest. 2013;144:1033-44.
74. Hsu CC, Kwan GN, Evans-Barns H, et al. Embolisation for pul monary arteriovenous malformation. Cochrane Database Syst Rev 2018;1:CD008017.
75. Fahey JT, Pollak JS, White RI. Complications of catheter-based interven tions for pulmonary arteriovenous malformations. In: Hijazi ZM, Feldman T, Cheatham JP, Sievert H, editors. Complications during percu taneous interventions for congenital and structural heart disease. London: Informa; 2009. p. 195-204.
76. Jones TK. Closure of coronary artery fistula, pulmonary arteriovenous malformation and patent ductus arteriosus. In: Carroll JD, Webb JG, edi tors. Structural heart disease interventions. Philadelphia: Lippincott Williams & Wilkins; 2012. p. 215-8.
77. Feltes TF, Bacha E, Beekman RR. Indications for cardiac catheterization and intervention in pediatric cardiac disease: a scientific statement from the American Heart Association. Circulation. 2011;123(22):2607-52.
78. Andersen PE, Duvnjak S, Gerke O, Kjeldsen AD. Long-term single- center retrospective follow-up after embolization of pulmonary arteriove nous malformations treated over a 20-year period: frequency of recanalization with various embolization materials and clinical outcome. Cardiovasc Intervent Radiol. 2019;42(8):1102-9.
79. Haydin S, Ödemiş E, Öztürk E, Onan S, Güzeltaş A. Hipoplastik sol kalp sendromu tanısı ile hibrid palyasyon sonrası genişletilmiş evre II Norwood ameliyatı yapılan olgu: Ülkemizdeki ilk deneyim. Turk Gogus Kalp Dama. 2015;23(1):146-9.
80. Berman DP, Cheatham JP. Part VII Hypoplastic Left Heart Syndrome (HLHS) / General Principles of the Hybrid Approach in Hypoplastic Left Heart Syndrome In: Butera G, Cheatham J, Pedra CAC, Schranz D, Tulzer G, editors. Fetal and Hybrid Procedures in Congenital Heart Diseases. Switzerland: Springer International Publishing; 2016. p 203-8.
81. Michel-Behnke I. Part VII Hypoplastic Left Heart Syndrome (HLHS) / Hypoplastic Left Heart Syndrome: Natural and Surgical History. In: Butera G, Cheatham J, Pedra CAC, Schranz D, Tulzer G, editors. Fetal and Hybrid Procedures in Congenital Heart Diseases. Switzerland: Springer International Publishing; 2016. p 187-96.
82. Gibbs JL, Wren C, Watterson KG, Hunter S, Hamilton JR. Stenting of the arterial duct combined with banding of the pulmonary arteries and atrial septectomy or septostomy: a new approach to palliation for the hypoplastic left heart syndrome. Br Heart J. 1993;69(6):551-5.
83. Akinturk H, Michel-Behnke I, Valeske K, Mueller M, Thul J, Bauer J, et al. Stenting of the arterial duct and banding of the pulmonary arteries: basis for combined Norwood stage I and II repair in hypoplastic left heart. Circulation. 2002;105(9):1099-103.
84. Michel-Behnke I, Akintuerk H, Marquardt I, Mueller M, Thul J, Bauer J, et al. Stenting of the ductus arteriosus and banding of the pulmonary arteries: basis for various surgical strategies in newborns with multiple left heart obstructive lesions. Heart. 2003;89(6):645-50.
85. Yerebakan C, Valeske K, Elmontaser H, Yoruker U, Mueller M, Thul J, et al. Hybrid therapy for hypoplastic left heart syndrome: Myth, alternative, or standard? J Thorac Cardiovasc Surg. 2016;151(4):1112-23 e5.
86. Biglino G, Schievano S, Hsia T-Y, Taylor AM. Part VII Hypoplastic Left Heart Syndrome (HLHS) / The Engineering Perspective. In: Butera G, Cheatham J, Pedra CAC, Schranz D, Tulzer G, editors. Fetal and Hybrid Procedures in Congenital Heart Diseases. Switzerland: Springer International Publishing; 2016. p 197-202.
87. Sungur M. Erken Neonatal, İnfant ve Çocukluk Dönemindeki Uygulamalar. Turkiye Klinikleri J Cardiovasc Surg-Special Topics 2013;5(1):55-8.
88. Akinturk H. Hypoplastic Left Heart Syndrome: The Giessen Approach – History, Technique, and Results. In: Butera G, Cheatham J, Pedra CAC, Schranz D, Tulzer G, editors. Fetal and Hybrid Procedures in Congenital Heart Diseases. Switzerland: Springer International Publishing. 2016. p 209-20.
89. Cheatham JP. Hybrid Approach: The Columbus Way In: Butera G, Cheatham J, Pedra CAC, Schranz D, Tul-

zer G, editors. Fetal and Hybrid Procedures in Congenital Heart Diseases. Switzerland: Springer International Publishing. 2016. p 221-9.
90. Benson L. Canadian Approach to Hybrid HLHS. In: Butera G, Cheatham J, Pedra CAC, Schranz D, Tulzer G, editors. Fetal and Hybrid Procedures in Congenital Heart Diseases. Switzerland: Springer International Publishing; 2016. p 243-51.
91. Carlos A. C. Pedra SFP, Marcelo B. Jatene. The Brazilian Hybrid Approach for Hypoplastic Left Heart Syndrome. In: Butera G, Cheatham J, Pedra CAC, Schranz D, Tulzer G, editors. Fetal and Hybrid Procedures in Congenital Heart Diseases. Switzerland: Springer International Publishing; 2016. p 229-43.
92. Schranz D. Hybrid Approach in Hypoplastic Left Heart Syndrome (HLHS). In: Butera G, Eicken A, Chessa M, Thomson J, editors. Cardiac Catheterization for Congenital Heart Disease. İtalya-Milan: Springer-Verlag Mailand; 2015. p 649-66.
93. Aydemir NA, Erdem A. Doğumsal Kalp Hastalıklarında Hibrid Yaklaşımlar. Turkiye Klinikleri J Cardiovasc Surg-Special Topics 2011;3(1):71-7.
94. Bacha EA. Individualized approach in the management of patients with hypoplastic left heart syndrome (HLHS). Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2013;16(1):3-6.
95. Tanıdır İC, Güzeltaş A. Pediatrik Kardiyak Yoğun Bakım Hastasında Kardiyak Girişimsel İşlemler. Pediatrik Kardiyak Yoğun Bakım Editör Hakan Ceyran. İstanbul Tıp Kitapevi, 2022, sayfalar 483-509 ISBN: 978-625-8103-06-9
96. Diab KA, Hijazi ZM, Cao QL, et al. A truly hybrid approach to perventricular closure of multiple muscular ventricular septal defects. J Thorac Cardi ovasc Surg. 2005;130(3):892-3.
97. Diab KA, Cao QL, Mora BN, et al. Device closure of muscular ventricular septal defects in infants less than one year of age using the Amplatzer devices: feasibility and outcome. Catheter Cardiovasc Interv. 2007;70(1):90-7.
98. Haponiuk I, Chojnicki M, Jaworski R, et al. Hybrid technique for muscular ventricular septal defect closure. J Card Surg. 2013;28(4):453-5.
99. Bacha EA, Cao QL, Starr JP, et al. Perventricular de vice closure of muscular ventricular septal defects on the beating heart: technique and results. J Thorac Cardiovasc Surg. 2003;126(6):1718-23.
100. Crossland DS, Wilkinson JL, Cochrane AD, et al. Initial results of primary device closure of large muscular ventricular septal defects in early infancy using perventricular access. Catheter Cardiovasc Interv. 2008;72(3):386-91.
101. Gan C, Lin K, An Q, et al. Perventricular device closure of muscular ventricular septal defects on beating hearts: initial experience in eight children. J Thorac Cardiovasc Surg. 2009;137(4):929-33.
102. Fouilloux V, Bonello B, Gran C, et al. Perventricular closure of muscular ventricular septal defects in in fants with echocardiographic guidance only. World J Pediatr Congenit Heart Surg. 2012;3(4):446-51.
103. Bendaly EA, Hoyer MH, Breinholt JP. Mid-term follow up of perventricular device closure of muscular ventricular septal defects. Catheter Cardi ovasc Interv. 2011;78(4):577-82.
104. Thakkar B, Patel N, Shah S, et al. Perventricular de vice closure of isolated muscular ventricular septal defect in infants: a single centre experience. Indian Heart J. 2012;64(6):559-67.
105. Kang SL, Tometzki A, Caputo M, et al. Longer-term outcome of perventricular device closure of muscular ventricular septal defects in children. Catheter Cardiovasc Interv. 2015;85(6):998-1005.
106. Karimi M, Hulsebus E, Murdison K, et al. A case of hybrid closure of a muscular ventricular septal defect: anatomical complexity and surgical man agement. Cardiol Young. 2012;22(3):356-9.
107. Tanıdır İC, Güzeltaş A. Pediatrik Kardiyak Yoğun Bakım Hastasında Kardiyak Girişimsel İşlemler. Pediatrik Kardiyak Yoğun Bakım Editör Hakan Ceyran. İstanbul Tıp Kitapevi, 2022, sayfalar 483-509 ISBN: 978-625-8103-06-9
108. Wagner K, Oliver MC, Boyle GJ, et al. Endomyocardial biopsy in pediatric heart transplant recipients: a useful exercise? (Analysis of 1169 biopsies). Pediatr Transplant. 2000;4(3):186-92.
109. Porcari A, Baggio C, Fabris E, Merlo M, Bussani R, Perkan A, Sinagra G. Endomyocardial biopsy in the clinical context: current indications and challenging scenarios. Heart Fail Rev. 2023;28(1):123-35.
110. Ammirati E, Buono A, Moroni F, Gigli L, Power JR, Ciabatti M, Garascia A, Adler ED, Pieroni M. State-of-the-Art of Endomyocardial Biopsy on Acute Myocarditis and Chronic Inflammatory Cardiomyopathy. Curr Cardiol Rep. 2022;24(5):597-609.
111. Narula N, Narula J, Dec GW. Endomyocardial biopsy for non-transplant related disorders. Am J Clin Pathol. 2005;123(Suppl 1):1-13.
112. Mueller GC, Michel-Behnke I, Knirsch W, et al. Feasibility, safety and diagnostic impact of endomyocardial biopsies for the diagnosis of myocardial disease in children and adolescents. EuroIntervention. 2018;14(10):1089-95.
113. Hauck A, Kearney D, Edwards W. Evaluation of postmortem endomyocardial biopsy specimens from 38 patients with lymphocytic myocarditis: implications for role of sampling error. Mayo Clin Proc. 1989;64:1235-45.
114. Brighenti M, Donti A, Giulia Gagliardi M, et al. Endomyocardial biopsy safety and clinical yield in pediatric myocarditis: an Italian perspective. Catheter Cardiovasc Interv. 2016;87(4):762-7.
115. Yilmaz A, Kindermann I, Kindermann M, Mahfoud F, Ukena C, Athanasiadis A, Hill S, Mahrholdt H, Voehringer M, Schieber M, Klingel K, Kandolf R, Böhm M, Sechtem U (2010) Comparative evaluation of left and right ventricular endomyocardial biopsy. Circulation 122:900-9.
116. Chimenti C, Frustaci A (2013) Contribution and risks of left ventricular endomyocardial biopsy in patients with cardiomyopathies: a retrospective study over a 28-year period. Circulation 128:1531-41.
117. Daly KP, Marshall AC, Vincent JA, et al. Endomyocardial biopsy and selective coronary angiography are low-risk procedures in pediatric heart transplant recipients: results of a multicenter experience. J Heart Lung Transplant. 2012;31(4):398-409.
118. Guzeltas A, Kasar T, Tanidir IC, Ozturk E, Yildiz O, Haydin S. Cardiac catheterization procedures in pediatric patients undergoing extracorporeal membrane oxygenation cardiac catheterization, ECMO. Anatol J Cardiol. 2017;18(6):425-30.



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ÇOCUKLARDA KARDİYAK CERRAHİ SONRASI RİTİM BOZUKLUKLARI VE KALICI KALP PİLİ UYGULAMASI

BÖLÜM
18

Musa ÖZTÜRK [1]
Alpay ÇELİKER [2]

İçindekiler

» GİRİŞ
  » Yapısal Kalp Hastalıklarında İletim Sisteminin Anatomisi
» TAŞİARİTMİLER
  » Dar QRS Kompleksli Taşikardiler
  » Ventriküler Ekstrasistoller
  » Ventriküler Taşikardi
  » Ventriküler Fibrilasyon
» BRADİARİTMİLER
  » Sinüs Düğümü Disfonksiyonu
  » Kalp Bloğu
  » Çocuklarda kalıcı kalp pili uygulaması
  » Epikardiyal yaklaşım
  » Endokardiyal yaklaşım
  » Uyarım modunun seçimi
  » Lead implantasyon bölgesi
  » Ventiküler Asistol

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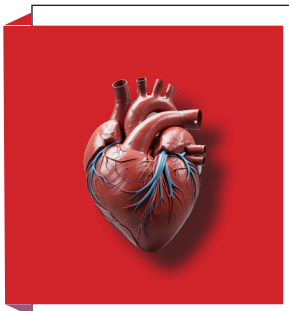
daha düşük hızda bir kaçış(escape) ritmi devreye girebilir. Kaçış ritmi genellikle normal sinüs ritminden daha yavaştır ve atriyum ile ventrikül arasındaki sıralı senkronizasyonu bozar ve yetersiz kardiyak debiye yol açar. Tam AV bloğu olan bir kalp, nadiren kaçış ritmi göstermez ve ventriküler asistol olur. Cerrahi sonrası ventriküler asistolü olan çocuk, kardiyak debi için tamamen kalp piline bağımlıdır. Steroid, teofilin, atropin ve izoproterenol, ventriküler kaçış ritmini ve AV düğüm iletimini uyarmak için denenmiştir. Ameliyattan birkaç gün sonra çoğu çocukta normal AV iletimiyle normal sinüs ritmine döner. Cerrahi sonrası 10-14 gün içinde iyileşme belirtisi göstermeyen ya da yetersiz ritim iyileşmesi gösteren hastalarda kalıcı kalp pili uygulaması düşünülmelidir.

KAYNAKLAR

1. Ishaque S, Akhtar S, Ladak AA, Martins RS, Memon MKY, Kazmi AR, vd. Early postoperative arrhythmias after pediatric congenital heart disease surgery: a 5-year audit from a lower- to middle-income country. Acute Crit Care. 31 Mayıs 2022;37(2):217-23.
2. Alotaibi RK, Saleem AS, Alsharef FF, Alnemer ZA, Saber YM, Abdelmohsen GA, vd. Risk factors of early postoperative cardiac arrhythmia after pediatric cardiac surgery: A single-center experience. Saudi Med J. Ekim 2022;43(10):1111-9.
3. Grosse-Wortmann L, Kreitz S, Grabitz RG, Vazquez-Jimenez JF, Messmer BJ, Von Bernuth G, vd. Prevalence of and risk factors for perioperative arrhythmias in neonates and children after cardiopulmonary bypass: continuous holter monitoring before and for three days after surgery. J Cardiothorac Surg. Aralık 2010;5(1):85.
4. Talwar S, Patel K, Juneja R, Choudhary SK, Airan B. Early postoperative arrhythmias after pediatric cardiac surgery. Asian Cardiovasc Thorac Ann. Eylül 2015;23(7):795-801.
5. Anselmi A. Myocardial ischemia, stunning, inflammation, and apoptosis during cardiac surgery: a review of evidence. Eur J Cardiothorac Surg. Mart 2004;25(3):304-11.
6. Skippen PW, Sanatani S, Gow RM, Froese N. Diagnosis of Postoperative Arrhythmias following Paediatric Cardiac Surgery. Anaesth Intensive Care. Eylül 2009;37(5):705-19.
7. Polderman KH, Girbes AR. Severe electrolyte disorders following cardiac surgery: a prospective controlled observational study. Crit Care. 22 Ekim 2004;8(6):R459.
8. He D, Sznycer-Taub N, Cheng Y, McCarter R, Jonas RA, Hanumanthaiah S, vd. Magnesium Lowers the Incidence of Postoperative Junctional Ectopic Tachycardia in Congenital Heart Surgical Patients: Is There a Relationship to Surgical Procedure Complexity? Pediatr Cardiol. Ağustos 2015;36(6):1179-85.
9. Delaney JW, Moltedo JM, Dziura JD, Kopf GS, Snyder CS. Early postoperative arrhythmias after pediatric cardiac surgery. J Thorac Cardiovasc Surg. Haziran 2006;131(6):1296-300.
10. Batra A, Balaji S. Post operative temporary epicardial pacing: When, how and why? Ann Pediatr Cardiol. 2008;1(2):120.
11. Nelson JS, Vanja S, Maul TM, Whitham JK, Ferns SJ. Early arrhythmia burden in pediatric cardiac surgery fast-track candidates: Analysis of incidence and risk factors. Prog Pediatr Cardiol. Mart 2019;52:8-12.
12. Dodge-Khatami A, Miller OI, Anderson RH, Goldman AP, Gil-Jaurena JM, Elliott MJ, vd. Surgical substrates of postoperative junctional ectopic tachycardia in congenital heart defects. J Thorac Cardiovasc Surg. Nisan 2002;123(4):624-30.
13. Rękawek J, Kansy A, Miszczak-Knecht M, Manowska M, Bieganowska K, Brzezinska-Paszke M, vd. Risk factors for cardiac arrhythmias in children with congenital heart disease after surgical intervention in the early postoperative period. J Thorac Cardiovasc Surg. Nisan 2007;133(4):900-4.
14. Bharucha DB, Bozorgnia B, Kowey PR. Postoperative Arrhythmias After Cardiac Surgery. Içinde: Electrophysiological Disorders of the Heart [Internet]. Elsevier; 2012 [a.yer 22 Nisan 2025]. s. 855-63. Erişim adresi: https://linkinghub.elsevier.com/retrieve/pii/B9781437702859000624
15. Cools E, Missant C. Junctional ectopic tachycardia after congenital heart surgery. Acta Anaesthesiol Belg. 2014;65(1):1-8.
16. Haas NA, Plumpton K, Pohlner P, Justo R, Jalali H. Postoperative junctional ectopic tachycardia (JET). Z Für Kardiologie. 01 Mayıs 2004;93(5):371-80.
17. Klautz RJM, Baan J, Teitel DF. Contribution of Synchronized Atrial Systole to Left Ventricular Contraction in the Newborn Pig Heart. Pediatr Res. Mart 1998;43(3):331-7.
18. Abdelaziz O, Deraz S. Anticipation and management of junctional ectopic tachycardia in postoperative cardiac surgery: Single center experience with high incidence. Ann Pediatr Cardiol. 2014;7(1):19.
19. Laird WP, Snyder CS, Kertesz NJ, Friedman RA, Miller D, Fenrich AL. Use of Intravenous Amiodarone for Postoperative Junctional Ectopic Tachycardia in Children. Pediatr Cardiol. 01 Mart 2003;24(2):133-7.
20. Kadam S, Tailor K, Kulkarni S, Mohanty S, Joshi P, Rao S. Effect of dexmeditomidine on postoperative junctional ectopic tachycardia after complete surgical repair of tetralogy of Fallot: A prospective randomized controlled study. Ann Card Anaesth. 2015;18(3):323.
21. Chrysostomou C, Sanchez-de-Toledo J, Wearden P, Jooste EH, Lichtenstein SE, Callahan PM, vd. Perioperative use of dexmedetomidine is associated with decreased incidence of ventricular and supraventricular tachyarrhythmias after congenital cardiac operations. Ann Thorac Surg. Eylül 2011;92(3):964-72; discussion 972.
22. Lee HY, Ghimire S, Kim EY. Magnesium Supplementation Reduces Postoperative Arrhythmias After Cardiopulmonary Bypass in Pediatrics: A Metaanalysis of Randomized Controlled Trials. Pediatr Cardiol. Ağustos 2013;34(6):1396-403.
23. Entenmann A, Michel M, Herberg U, Haas N, Kumpf M, Gass M, vd. Management of postoperative junctional ectopic tachycardia in pediatric patients: a survey

of 30 centers in Germany, Austria, and Switzerland. Eur J Pediatr. Eylül 2017;176(9):1217-26.
24. El Amrousy DM, Elshmaa NS, El□Kashlan M, Hassan S, Elsanosy M, Hablas N, vd. Efficacy of Prophylactic Dexmedetomidine in Preventing Postoperative Junctional Ectopic Tachycardia After Pediatric Cardiac Surgery. J Am Heart Assoc. Mart 2017;6(3):e004780.
25. Penslar J, Udupa S. Ivabradine in the Management of Pediatric Arrhythmias. Can J Cardiol. Ocak 2023;39(1):11-3.
26. López Fernández E, Montañes Delmas E, Granados Ruiz MÁ, Oviedo Melgares L, Ramos Casado V. Use of ivabradine in pediatric post-operative junctional ectopic tachycardia. An Pediatría Engl Ed. Ağustos 2021;95(2):118-20.
27. Saul JP, Scott WA, Brown S, Marantz P, Acevedo V, Etheridge SP, vd. Intravenous Amiodarone for Incessant Tachyarrhythmias in Children: A Randomized, Double-Blind, Antiarrhythmic Drug Trial. Circulation. 29 Kasım 2005;112(22):3470-7.
28. Adamson PC, Rhodes LA, Saul JP, Dick M, Epstein MR, Moate P, vd. The Pharmacokinetics of Esmolol in Pediatric Subjects with Supraventricular Arrhythmias. Pediatr Cardiol. Ağustos 2006;27(4):420-7.
29. Nieminen HP, Jokinen EV, Sairanen HI. Causes of Late Deaths After Pediatric Cardiac Surgery. J Am Coll Cardiol. Eylül 2007;50(13):1263-71.
30. Peretto G, Durante A, Limite LR, Cianflone D. Postoperative arrhythmias after cardiac surgery: incidence, risk factors, and therapeutic management. Cardiol Res Pract. 2014;2014:615987.
31. Huikuri HV, Yli-Mäyry S, Korhonen UR, Juhani Airaksinen KE, Ikäheimo MJ, Linnaluoto MK, vd. Prevalence and prognostic significance of complex ventricular arrhythmias after coronary arterial bypass graft surgery. Int J Cardiol. Haziran 1990;27(3):333-9.
32. Smith RC, Leung JM, Keith FM, Merrick S, Mangano DT. Ventricular dysrhythmias in patients undergoing coronary artery bypass graft surgery: Incidence, characteristics, and prognostic importance. Am Heart J. Ocak 1992;123(1):73-81.
33. Pinto RP, Romerill DB, Nasser WK, Schier JJ, Surawicz B. Prognosis of patients with frequent premature ventricular complexes and nonsustained ventricular tachycardia after coronary artery bypass graft surgery. Clin Cardiol. Nisan 1996;19(4):321-4.
34. Topol EJ, Lerman BBL, Baughman KL, Platia EV, Griffith LSC. De novo refractory ventricular tachyarrhythmias after coronary revascularization. Am J Cardiol. Ocak 1986;57(1):57-9.
35. King FG, Addetia AM, Peters SD, Peachey GO. Prophylactic lidocaine for postoperative coronary artery bypass patients, a double-blind, randomized trial. Can J Anaesth. Nisan 1990;37(3):363-8.
36. Chung MK. Cardiac surgery: Postoperative arrhythmias: Crit Care Med. Ekim 2000;28(Supplement):N136-44.
37. Topjian AA, Raymond TT, Atkins D, Chan M, Duff JP, Joyner BL, vd. Part 4: Pediatric Basic and Advanced Life Support: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation [Internet]. 20 Ekim 2020 [a.yer 04 Mayıs 2025];142(16_suppl_2). Erişim adresi: https://www.ahajournals.org/doi/10.1161/CIR.0000000000000901
38. Sameer M, Baruah SD, Menon S, Dharan BS, Ramanan SV, Raja JS, vd. Overdrive suppression of postoperative sustained ventricular tachycardia by atrial pacing and its hemodynamic effect. Ann Pediatr Cardiol. Ocak 2021;14(1):88-90.
39. Kardelen F, Celiker A, Ozer S, Ozme S, Oto A. Sinus node dysfunction in children and adolescents: treatment by implantation of a permanent pacemaker in 26 patients. Turk J Pediatr. 2002;44(4):312-6.
40. Pace Napoleone C, Mariucci E, Angeli E, Oppido G, Gargiulo GD. Sinus node dysfunction after partial anomalous pulmonary venous connection repair. J Thorac Cardiovasc Surg. Mayıs 2014;147(5):1594-8.
41. Ayyildiz P, Kasar T, Ozturk E, Ozyilmaz I, Tanidir IC, Guzeltas A, vd. Evaluation of Permanent or Transient Complete Heart Block after Open Heart Surgery for Congenital Heart Disease. Pacing Clin Electrophysiol. Şubat 2016;39(2):160-5.
42. Graham TP, Bernard YD, Mellen BG, Celermajer D, Baumgartner H, Cetta F, vd. Long-term outcome in congenitally corrected transposition of the great arteries. J Am Coll Cardiol. Temmuz 2000;36(1):255-61.
43. Silka MJ, Shah MJ, Silva JNA, Balaji S, Beach CM, Benjamin MN, vd. 2021 PACES Expert Consensus Statement on the Indications and Management of Cardiovascular Implantable Electronic Devices in Pediatric Patients: Executive Summary. Heart Rhythm. Kasım 2021;18(11):1925-50.
44. Sachweh J. Twenty years experience with pediatric pacing: epicardial and transvenous stimulation. Eur J Cardiothorac Surg. 01 Nisan 2000;17(4):455-61.
45. Cohen MI, Bush DM, Vetter VL, Tanel RE, Wieand TS, Gaynor JW, vd. Permanent Epicardial Pacing in Pediatric Patients: Seventeen Years of Experience and 1200 Outpatient Visits. Circulation. 29 Mayıs 2001;103(21):2585-90.
46. Papadopoulos N, Rouhollapour A, Kleine P, Moritz A, Bakhtiary F. Long-term follow-up after steroid-eluting epicardial pacemaker implantation in young children: a single centre experience. Europace. 01 Nisan 2010;12(4):540-3.
47. Silvetti MS, Drago F, De Santis A, Grutter G, Ravà L, Monti L, vd. Single-centre experience on endocardial and epicardial pacemaker system function in neonates and infants. EP Eur. 01 Haziran 2007;9(6):426-31.
48. Figa FH, McCrindle BW, Bigras JL, Hamilton RM, Gow RM. Risk factors for venous obstruction in children with transvenous pacing leads. Pacing Clin Electrophysiol PACE. Ağustos 1997;20(8 Pt 1):1902-9.
49. Wilkoff BL, Bello D, Taborsky M, Vymazal J, Kanal E, Heuer H, vd. Magnetic resonance imaging in patients with a pacemaker system designed for the magnetic resonance environment. Heart Rhythm. 01 Ocak 2011;8(1):65-73.
50. Wilkoff BL, Cook JR, Epstein AE, Greene HL, Hallstrom AP, Hsia H, vd. Dual-chamber pacing or ventricular backup pacing in patients with an implantable defibrillator: the Dual Chamber and VVI Implantable Defibrillator (DAVID) Trial. JAMA. 25 Aralık 2002;288(24):3115-23.
51. Horenstein MS, Karpawich PP, Tantengco MVT. Single versus dual chamber pacing in the young: noninvasive comparative evaluation of cardiac function. Pacing Clin Electrophysiol PACE. Mayıs 2003;26(5):1208-11.

52. Vanagt WY, Verbeek XA, Delhaas T, Mertens L, Daenen WJ, Prinzen FW. The Left Ventricular Apex is the Optimal Site for Pediatric Pacing: Correlation with Animal Experience. Pacing Clin Electrophysiol. Haziran 2004;27(6p2):837-43.
53. Janousek J, Gebauer RA, Abdul-Khaliq H, Turner M, Kornyei L, Grollmuss O, vd. Cardiac resynchronisation therapy in paediatric and congenital heart disease: differential effects in various anatomical and functional substrates. Heart. 15 Temmuz 2009;95(14):1165-71.
54. Cecchin F, Frangini PA, Brown DW, Fynn-Thompson F, Alexander ME, Triedman JK, vd. Cardiac Resynchronization Therapy (and Multisite Pacing) in Pediatrics and Congenital Heart Disease: Five Years Experience in a Single Institution. J Cardiovasc Electrophysiol. Ocak 2009;20(1):58-65.
55. Rosenthal D, Chrisant MRK, Edens E, Mahony L, Canter C, Colan S, vd. International Society for Heart and Lung Transplantation: Practice guidelines for management of heart failure in children. J Heart Lung Transplant Off Publ Int Soc Heart Transplant. Aralık 2004;23(12):1313-33.
56. Khairy P, Landzberg MJ, Lambert J, O'Donnell CP. Long-term outcomes after the atrial switch for surgical correction of transposition: a meta-analysis comparing the Mustard and Senning procedures. Cardiol Young. Haziran 2004;14(3):284-92.
57. Dubin AM, Janousek J, Rhee E, Strieper MJ, Cecchin F, Law IH, vd. Resynchronization Therapy in Pediatric and Congenital Heart Disease Patients. J Am Coll Cardiol. Aralık 2005;46(12):2277-83.



PEDİYATRİK KARDİYAK ANESTEZİ

BÖLÜM
19

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İçindekiler

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Konjenital kateter laboratuvarında önemli komplikasyonların görülme sıklığının %7 ila %24 arasında olduğu ve komplikasyonların tanısal vakalara göre girişimsel prosedürlerde daha sık görüldüğü bildirilmiştir. Konjenital kateter laboratuvarında mortalite %1'den az olarak bildirilmeye devam etmektedir. En sık bildirilen komplikasyonlar vasküler yaralanmalar ve disritmilerdir. Daha az sıklıkta bildirilen ancak önemli komplikasyonlar arasında kanama, felç, vasküler rüptür, kardiyak tamponad, kapak hasarı, vasküler tromboz, hava embolisi, yabancı cisim/kateter için tutulma, cihaz embolisi, kontrast reaksiyonu veya anafilaksi ve brakialpleksus yaralanması bulunur. (140) Kateter laboratuvarında majör morbidite veya komplikasyon için en önemli risk faktörleri 1 yaşından küçük yaş, daha küçük hasta boyutu ve müdahalenin karmaşıklığıdır. Aritmiler yaygındır ve genellikle geçicidir. Aritmiler için risk faktörleri arasında hiperkarbi, elektrolit bozuklukları, kateter manipülasyonu, kardiyak iskemi, ilaçlar, koroner hava embolisi ve miyokardiyal ve iletim dokusu hasarı bulunur.(141) Defibrilatörler ve antiaritmik ilaçların yanı sıra kalp pili kapasitesi de mevcut olmalıdır. Şiddetli PHT'si olan hastalar da kateter laboratuvarında ölüm açısından önemli risk altındadır. Periprosedürel kardiyak arrest riski, KKH'lı hastalarda iyi belgelenmiştir. Kardiyak arrestlerin yaklaşık üçte birinin KKH'lıçocuklarda meydana geldiğini ve bunların %17'sinin kardiyak kateter prosedürleri sırasında meydana geldiğini göstermektedir.Kateter laboratuvarında prosedürel kardiyak arrest için risk faktörleri arasında 1 yaşından küçük yaş, tek ventrikül fizyolojisi ve ameliyat öncesi kateter prosedürleri yer alır. Doğuştan kateterizasyon laboratuvarında kardiyak dekompansasyon riski, olası kurtarma ve mekanik dolaşım desteğinin hızlı bir şekilde konuşlandırılması için cerrahi desteğin hemen mevcut olmasını gerektirir. (139)

Hibrit prosedürler, KKH'yı tedavi etmek için tek bir operatif prosedürün parçası olarak, hem cerrahi hem de transkateter teknikleri içerir. En sık olarak, hibrit prosedürler, bir PDA stentin konuşlandırıldığı ve bilateral PA bantlarının açık bir sternotomi ile yerleştirildiği HLHS tedavi etmek için kullanılır. KPB kullanımı ertelenir ve aort krosklempleme, açık kalp prosedürleriyle ilişkili miyokardiyal yaralanmayı ve inflamatuar yanıtı ve olası nörolojik yaralanmayı önler. Hibrit prosedürler ayrıca VSD'leri kapatmak, pulmoner kapaklar ve PA dallarının stentleri implante etmek ve ayrıca bir dizi başka minimal invaziv prosedür için kullanılır. Bir hibrit prosedürün anestezi yönetimi, prosedürün doğasına göre belirlenir. Hibrit ameliyathanesi, tam kateter laboratuvarı olanaklarının yanı sıra kardiyak ameliyathane olanaklarına sahip bir ameliyathanedir. Açık cerrahiye geçişle kateter tabanlı bir müdahaleyi deneme olanağı, hibrit ameliyathanesinin bir diğer avantajıdır.(139)

KAYNAKLAR

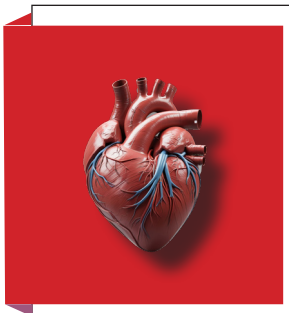
1. The Fetal to Neonatal Circulatory Transition. Daniel Bernstein. Nelson Textbook of Pediatrics, 2025; 470: 2735-2736.e1
2. Arima Y, Fukuoka H. Developmental origins of health and disease theory in cardiology. J Cardiol 2020; 76: pp. 14-17.
3. Donofrio MT, Levy RJ, Schuette JJ, et al. Specialized delivery room planning for fetuses with critical congenital heart disease. Am J Cardiol 2013; 111: pp. 737-7473.
4. Freud LR, McElhinney DB, Marshall AC, et al. Fetal aortic valvuloplasty for evolving hypoplastic left heart syndrome: postnatal outcomes of the first 100 patients. Circulation 2014; 130: pp. 638-645.
5. Friedman KG, Sleeper LA, Freud LR, et al. Improved technical success, postnatal outcome and refined predictors of outcome for fetal aortic valvuloplasty. Ultrasound Obstet Gynecol 2018; 52: pp. 212-220.
6. Frommelt MA. Challenges and controversies in fetal diagnosis and treatment: hypoplastic left heart syndrome. Clin Perinatol. 2014; 41: pp. 787-798.
7. Khalil M, Jux C, Rueblinger L, Behrje J, Esmaeili A, Schranz D. Acute therapy of newborns with critical congenital heart disease. Transl Pediatr 2019; 2: pp. 114-126.
8. AndropoulosDB. Physiology and molecular biology of the developing circulation. Andropoulos D.B. Anesthesia for Congenital Heart Disease.2015.Wiley Blackwell Oxford, UK: pp. 84-105.
9. Noori S, Seri I. Pathophysiology of newborn hypotension outside the transitional period. Early Hum Dev 2005; 81: pp. 399-404.
10. Fanaroff JM, Fanaroff AA. Blood pressure disorders in the neonate: hypotension and hypertension. Semin Fetal Neonatal Med 2006; 11: pp. 174-181
11. Lang JA, Pearson JT, te Pas AB, et al. Ventilation/perfusion mismatch during lung aeration at birth. J Appl Physiol 2014; 117: pp. 535-543.
12. AdlerAC, Litman RS. Congenital Heart Disease. Litman's Basics of PediatricAnesthesia,2022; 3: 13-22.

13. SpicerDE,Hsu HH, Co-Vu J, Anderson RH, Fricker FJ. Ventricular septal defect. Orphanet J RareDis. 2014;9:144.
14. Breitbart RE, Fyler DC. Tetralogy of Fallot. In: Nadas' pediatric cardiology, 2nd Ed, Keane JF, Lock JE, Fyler DC (Eds), Saunders, Philadelphia 2006. p.559.
15. Güler T. Anesthesia for pediatric cardiac surgery. Türkiye Klinikleri J Pediatr Sci 2006;2(12),6-14
16. Majani NG, Koster JR, Kalezi ZE, et al. Spectrum of Heart Diseases in Children in a National Cardiac Referral Center Tanzania, Eastern Africa: A Six-Year Overview. Glob Heart.2024:29;19(1):61.
17. Sergin D, Kocabaş S, Aşkar F. Konjenital Kalp Cerrahisinde Preoperatif Anestezik Yaklaşım. Konjenital Kalp Cerrahisinde Anestezi.2014;3:85-110. ISBN: 978-605-338-034-4. KONTROL
18. Fletke KJ, Kaysin A, Jones S. Preoperative Evaluation in Children. Am Fam Physician. 2022;105(6):640-64.
19. Zheng Y, Lin Z, Chen Y, et al. Factors related to pre-operative cough strength in cardiac surgical patients: a cross-sectional study. Heart & Lung: The Journal of Cardiopulmonary and Acute Care, 2024:63;128-135.
20. Stout KK, Daniels CJ, Aboulhosn JA. 2018 AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Circulation.2019:139;(14); e698-e800.
21. Kim SY, Kim JM, Lee JH. Perioperative respiratory adverse events in children with active upper respiratory tract infection who received general anesthesia through an orotracheal tube and inhalation agents. Korean J Anesthesiol. 2013: 65(2): 136-141.
22. Thomas M, Morrison C, Newton R, Schindler E. Consensus statement on clear fluids fasting for elective pediatric general anesthesia. Pediatric Anesthesia.2018;28(5):411-14.
23. BatesKE, Hall M, Shah SS, Hill KD, Pasquali SK. Trends in infective endocarditis hospitalisations at United States children's hospitals from 2003 to 2014: impact of the 2007 American Heart Association antibiotic prophylaxis guidelines. Cardiol Young. 2017 May;27(4):686-690.
24. Yavuz Y. Yoğun bakımda monitörizasyon ve rutin tetkikler. Pediyatrik kardiyak yoğun bakım.2022;3:31-45. ISBN:978-625-8103-06-9.
25. Kamra K, Russell I, Miller-Hance WC. Role of transesophageal echocardiography in the management of pediatric patients with congenital heart disease. Paediatr Anaesth 2011; 21: pp. 479-493.
26. Kussman BD, Laussen PC, Benni PB, et al. Cerebral oxygen saturation in children with congenital heart disease and chronic hypoxemia. Anesth Analg 2017; 125: pp. 234-240.
27. Vuran C, Kılıç SÇ. Çocuk kalp cerrahisinde kan ve kan ürünleri yönetimi.Pediyatrik kardiyak yoğun bakım.2022;16:287-299.ISBN:978-625-8103-06-9.
28. Faraoni D, Meier J, Van der Linden PJ, Hunt BJ. Patient Blood Management for Neonates and Children Undergoing Cardiac Surgery: 2019 NATA Guidelines. Journal of Cardiothoracic and Vascular Anesthesia.2019:33(12);3249-3263.
29. Kussman BD, McGowan FX, Powell AJ, DiNardo JA. Anesthesia for congenital heart disease. Smith's Anesthesia for Infants and Children, 2022; 30: 732-831.e27
30. Hoffman JI, Kaplan S. The incidence of congenital heart disease. J Am Coll Cardiol. 2002;39:1890–1900.
31. Edmund H. Jooste, Anshuman Sharma. Anesthesia for Pediatric Cardiac Surgery. Miller's Anesthesia,2025; 73: 2300-2353.e9
32. Bali A, Dang AK, Gonzalez DA.ClinicalUses of Ketamine in Children: A Narrative Review.Cureus.2022;20;14(7):e27065
33. Lin R, Ansermino J.M. Dexmedetomidine in paediatric anaesthesia. BJA Education. 2020;20(10):348-353.
34. Salihoğlu E, Kucur M. Kardiyopulmoner Baypas. Turkiye Klinikleri J Anest Reanim-Special Topics 2017;10(3):178-85
35. Greeley WI, Berkowitz DH, Nathan AT. Anesthesia for Pediatric surgery. In, Miller's Anesthesia Edited Miller RD. 7th edition. Churchill Livingstone Elsevier, Philadelphia, 2010,p:2599-652.
36. Laurie K. Davis, S. Adil Husain, Nathaen S. Weitzel. Konjenital Kalp Hastalığı Olan Hastalarda Anestezi Yönetimi: Pediatrik Popülasyon In Frederick A. Hensley, Jr. Donald E. Martin, Glenn P. Gravlee. Pratik Yaklaşım ile Kardiyak Anestezi Güneş Tıp Kitapevleri 2014
37. De Wachter D, De Somer F, Verdonck P. Hemodynamic comparison of two different pediatric aortic cannulas. Int J ArtifOrgans. 2002;25(9):867–74.
38. Hirata Y. Cardiopulmonary bypass for pediatric cardiac surgery. General Thoracic and Cardiovascular Surgery. 2018; 66:65–70.
39. Somer FD. Cardiopulmonary Bypass in Children and Infants. In Dabbagh A, Conte AH, Lorraine N, editors. Congenital Heart Disease in Pediatric and Adult Patients Anesthetic and Perioperative Management 2nd Edition. Cham: Springer; 2023.
40. Medikonda R, Ong C.S, Wadia R, et al. Trends and Updates on Cardiopulmonary Bypass Setup in Pediatric Cardiac Surgery. J Cardiothorac Vasc Anesth. 2019;33(10):2804-2813.
41. Neptune WB, Bougas JA, Panico FG. Open heart surgery without the need for donor blood priming in the pump oxygenator. N Engl J Med. 1960; 263:111-5
42. Sungurtekin H, Cook DJ, Orszulak TA, Daly RC, Mullany CJ. Cerebral response to hemodilution during hypothermic cardiopulmonary bypass in adults. Anesth Analg. 1999;89(5):1078-83
43. Jonas R, Wypij D, Roth SJ, et al. The influence of hemodilution on outcome after hypothermic cardiopulmonary bypass: results of a randomized trial in infants. J Thorac Cardiovasc Surg. 2003;126(6):1765–74.
44. Salihoğlu E, Salihoğlu Z. Konjenital Kalp Cerrahisinde Nörolojik Monitörizasyon ve Beyin Koruma. Turkiye Klinikleri J Anest Reanim-Special Topics. 2017;10(3):205-10.
45. Xiong Y, Sun Y, Ji B, Liu J, Wang G, Zheng Z. Systematic Review and Meta-Analysis of benefits and risks between normothermia and hypothermia during cardiopulmonary bypass in pediatric cardiac surgery. Pediatric Anesthesia. 2014; 25(2): 135–142.
46. Durandy Y. The Impact of Vacuum-Assisted Venous Drainage and Miniaturized Bypass Circuits on Blood Transfusion in Pediatric Cardiac Surgery. ASAIO Journal 2009; 55(1):117-120.

47. Laussen PC. Optimal blood gas management during deep hypothermic paediatric cardiac surgery: alpha-stat is easy, but pH-stat may be preferable. Paediatr Anaesth 2002;12(3): 199-204.
48. Pasquali SK, Hall M, Li JS., et al. Corticosteroids and out come in children undergoing congenital heart surgery: analysis of the pediatric health information systems database. Circulation. 2010;122(21):2123–30.
49. Raja SG, Yousufuddin S, Rasool F, Nubi A, Danton M, Pollock J. Impact of modified ultrafiltration on morbidity after pediatric cardiac surgery. Asian Cardiovasc Thorac Ann 2006;14(4):341-50.
50. Mimic B, Ilica S, Vulicevic I., et al. Comparison of high glucose concentration blood and crystalloid cardioplegia in paediatric cardiac surgery: a randomized clinical trial. Interactive CardioVascular and Thoracic Surgery 22 (2016) 553–560
51. Bojar RM. Erişkin Kalp Cerrahisinde Perioperatif Yaklaşım El Kitabı, altıncı baskı 2025, İstanbul Tıp Kitapevi çevirisi, p: 325-333.
52. Smigla G. JaquissR, Walczak R. Assessing the safety of del Nido cardioplegia solution in adult congenital cases. Perfusion 2014;29:554-8.
53. Kim WK, Kim HR, Kim JB., et al. del Nido cardioplgia in adult cardiac surgery: beyond single-valve surgery. Interact Cardiovasc Thorac surg 2018;27:81-7.
54. Matte GS, del nido PJ. History and use of del Nido cardioplegia solution at Boston Children's Hospital. J Extra Corpor Technol. 2012;44(3):98-103. Erratum in: J Extra Corpor Technol 2013;45(4):262.
55. Salihoğlu E, Kucur M. Kardiyopulmoner Baypas, Türkiye Klinikleri J Anest ReanimSpecial Topics 2017;10(3): 178-85.
56. Viaro F, Dalio MB, Evora PR. Catastrophic cardiovascular adverse reactions to protamine are nitric oxide/cyclic guanosine monophosphate dependent and endothelium mediated: Should methylene blue be the treatment of choice? Chest, 2002;122:1061-6.
57. Kindler CH, Bircher AJ. Anaphylactoid reactions to protamine. Anesthesiology, 1996;85:1209-10.
58. Chopski SG, Murad NM, Fox CS, Stevens RM, Throckmorton AL. Mechanical Circulatory Support of the Right Ventricle for Adult and Pediatric Patients With Heart Failure. ASAIO J. 2019 Feb;65(2):106-116
59. Choudhury M, Saxena N. Inotropic agents in pediatric cardiac surgery patients: current practice, concerns and controversies. Indian J Anesth. 2003;47 (4):246-253.
60. Z Kayhan. Klinik anestezi (2004), Logos yayıncılık; p.186-187.
61. Hoffman TM, et al. Efficacy and safety of milrinone in preventing low cardiac output syndrome in infants and children after corrective surgery for congenital heart disease. Circulation. 2003;25:107(7):996-1002.
62. Jenkins J, Lynn A, Edmonds J., et al. Effects of mechanic ventilation on cardiopulmonary function in children after open heart surgery. Crit Care Med, 1985;13; 77-80.
63. Kuo S, Camerini V, Boyle R et al. Pulmonary hypertension-hyperventilation versus alkali infusion. Pediatrics. 2001;107(2):452.
64. Thunberg CA, Morozowich ST, Ramakrishna H. Inhaled therapy for the management of perioperative pulmonary hypertension. Ann Card Anaesth. 2015;18(3);394-402.
65. Cookson MW, Kinsella JP. Inhaled nitric oxide in neonatal pulmonary hypertension. Clin Perinatol. 2024;51(1);95-111.
66. Atz AM, Aidaita I, Wessel DL. Rebound pulmonary hypertension after inhalation of nitric oxide. Ann Thorac Surg. 1996;62:1759-64.
67. L Bauman Kreuziger et al. Antithrombotic therapy management of adult end pediatric cardiac surgery patients. J Thromb Haemost. 2018;16(11):2133-2146.
68. Vacharaksa K, Prakanrattana U, Suksompong S, Chumpathong S. Tranexamic acid as a means of reducing the need for blood and blood component therapy in children undergoing open heart surgery for congenital cyanotic heart disease. Ann Thorac Surg, 2002;85(suppl 3):904-9.
69. Miller BE, Guzetta Na, Tosone SR, Levy JH. Rapid evaluation of coagulopathies after cardiopulmonary bypass in children using modified tromboelastography. Anesth Analg, 2000;90:1324-30.
70. Jhang WK, Park JJ, Seo DM., et al. Perioperative evaluation of airways in patients with arch obstruction and intracardiac defects. Ann Thorac Surg 2008; 85:1753–8.
71. Şahin AS, Şahin M, Salihoğlu Z. Konjenital Kalp Cerrahisi Anestezisinde Preoperatif Değerlendirme. Turkiye Klinikleri J Anest Reanim-Special Topics 2017;10(3):216-20
72. Morgan GE, Mikhail MS, Murray MJ, Larson CP. Kardiyovasküler Cerrahide Anestezi. In Klinik Anesteziyoloji 3. Basım Ankara Güneş Kitabevi,2004. p.433-474
73. Karaaslan P, Demiraran Y. Konjenital Kalp Cerrahisinde Monitorizasyon. Turkiye Klinikleri J Anest Reanim-Special Topics 2017;10(3):201-4
74. Diaz KD. Anesthesia and Postoperative Analgesia in Pediatric Patients Undergoing Cardiac Surgery. Pediatr Drugs 2006; 8:223-33.
75. White MC, Peyton JM. Approach to managing children with heart disease for noncardiac surgery. Paediatr Anaesth 2011;21(5):522-9.
76. Reusz G, Csomos A. The role of ultrasound guidance for vascular access. Curr Opin Anaesthesiol. 2015; 28:710–6.
77. Jijeh AM, Omran AS, Najm HK, Abu-Sulaiman RM.Role of intraoperative transesophageal echocardiography in pediatric cardiac surgery. J Saudi Heart Assoc. 2016;28(2):89-94
78. Backer CL, Eltayeb O, Mongé MC, Mazwi ML, Costello JM. Shunt lesions part I: Patent ductus arteriosus, atrial septal defect, ventricular septal defect, and atrioventricular septal defect. Pediatr Crit Care Med 2016;17(8 Suppl 1):302-9
79. Dabbagh A. Atrial Septal Defect, Ventricular Septal Defect. In Dabbagh A, Conte AH, Lorraine N, editors. Congenital Heart Disease in Pediatric and Adult Patients Anesthetic and Perioperative Management 2nd Edition. Cham: Springer; 2023.P.417-437.
80. Hayırlıoğlu MB, Salihoğlu Z. Konjenital Kalp Cerrahisinde Spesifik Lezyonlarda Anestezi-IV: Sol-Sağ Şantlar. Turkiye Klinikleri J Anest Reanim-Special Topics 2017;10(3):243-50
81. Reller MD, Strickland MJ, Riehle-Colarusso T, et al. Prevalence of congenital heart defects in metropolitan Atlanta, 1998-2005. J Pediatr 2008; 153:807.
82. Dabbagh A, Adachi I. Atrioventricular Septal Defect (AVSD). In Dabbagh A, Conte AH, Lorraine N, editors.

Congenital Heart Disease in Pediatric and Adult Patients Anesthetic and Perioperative Management 2nd Edition. Cham: Springer; 2023.p. 405-417.
83. El-Khuffash AF, Jain A, McNamara PJ. Ligation of the patent ductus arteriosus in preterminfants: understanding the physiology. J Pediatr 2013; 162:1100.
84. Ohlsson A, Walia R, Shah SS. Ibuprofen for the treatment of patent ductus arteriosus in preterm or low birth weight (or both) infants. Cochrane Database Syst-Rev 2020; 11;2(2):CD003481.
85. Leahy BF, Edwards EM, Ehret DEY., et al. Transcatheter and Surgical Ductus Arteriosus Closure in Very Low Birth Weight Infants: 2018-2022. Pediatrics 2024; 1;154(2):e2024065905.
86. Rosenkranz ER. Congenital HeartDefects. In: Soltoski P, Karamanoukian H, Salerno T, eds. Cardiothoracic Surgical Secrets. 2nd ed. Hanleyand Belfus; 2004. p.61-73.
87. Montero JV, Nieto EM, Vallejo IR, Montero SV. Intranasal midazolam for the emergency management of hypercyanotic spells in tetralogy of Fallot. Pediatr Emerg Care 2015; 31:269.
88. Montero JV, Nieto EM, Vallejo IR, Montero SV. Intranasal midazolam for the emergency management of hypercyanotic spells in tetralogy of Fallot. Pediatr Emerg Care 2015; 31:269.
89. Çağıran Z, Derbent A. Konjenital Kalp Cerrahisinde Spesifik Lezyonlarda Anestezi-I: Sol Obstrüktif Lezyonlar, Sağ Obstrüktif Lezyonlar. Turkiye Klinikleri J Anest Reanim-Special Topics 2017;10(3):225-30
90. Hoffman J, Kaplan S. The incidence of congenital heart disease. J Am Coll Cardiol. 2002;39:1890–900.
91. Van der Laan ME, Verhagen EA, Bos AF, et al. Effect of balloon atrial septostomy on cerebral oxygenation in neonates with transposition of the great arteries. Pediatr Res 2013; 73(1):62-7
92. Wernovsky G. Transposition of the great arteries. In: Moss AJ, Allen HD, eds. Moss and Adams' Heart Disease in Infants, Children, and Adolescents: Including the Fetus and Young Adult. 7th ed. Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2008. p.1038-87.
93. Villafane J, Lantin-Hermoso MR, Bhatt AB, et al; American College of Cardiology's Adult Congenital and Pediatric Cardiology Council. D-transposition of the great arteries: the current era of the arterial switch operation. J Am Coll Cardiol. 2014;64:498-511.
94. Çağıran Z, Derbent A. Konjenital Kalp Cerrahisinde Spesifik Lezyonlarda Anestezi-II: Büyük Arter Transpozisyonunda Anestezi. Turkiye Klinikleri J AnestReanim-Special Topics 2017;10(3):231-5.
95. Legendre A, Losay J, Touchot-Koné A, et al. Coronary events after arterial switch operation for transposition of the great arteries. Circulation 2003; 9:108 Suppl 1:II186-90
96. Vejlstrup N, Sørensen K, Mattsson E, et al. Long-Term Outcome of Mustard/Senning Correction for Transposition of the Great Arteries in Sweden and Denmark. Circulation 2015; 132:633.
97. Toyoda Y, Hiramatsu T, Nagashima M, et al. Long-term Effect of Enlargement of a Ventricular Septal Defect in the Rastelli Procedure. Semin Thorac Cardiovasc Surg 2017; 29:215.
98. Hatipoglu S, Almogheer B, Mahon C., et al. Clinical Significance of Partial Anomalous Pulmonary Venous Connections (Isolated and Atrial Septal Defect Associated) Determined by Cardiovascular Magnetic Resonance. Circ Cardiovasc Imaging 2021; 14(8):e012371.
99. Ward KE, Mullins CE. Anomalous pulmonary venous connections, pulmonary vein stenosis, and atresia of the common pulmonary vein. In: The Science and Practice of Pediatric Cardiology, Garson A Jr, Bricker JT, Fisher DJ, Neish SR (Eds), Williams and Wilkins, Baltimore 1998. p.1431.
100. Karamlou T, Gurofsky R, Al Sukhni E, et al. Factors associated with mortality and reoperation in 377 children with total anomalous pulmonary venous connection. Circulation 2007; 27;115(12):1591-8.
101. Ishino K, Alexi-Meskishvili V, Hetzer R. Preoperative extracorporeal membrane oxygenation in newborns with total anomalous pulmonary venous connection. CardiovascSurg 1999; 7(4):473-5.
102. Ing RJ, Twite MD. Theyear in review: anesthesia for congenital heart disease 2013. Semin Cardiothorac Vasc Anesth. 2014;18(1): 17-23.
103. Leyvi G, Wasnick JD. Single-ventricle patient: pathophysiology and anesthetic management. J Cardiothorac Vasc Anesth 2010;24(1):121- 30
104. Gökay BV, Salihoğlu Z. Konjenital Kalp Cerrahisinde Spesifik Lezyonlarda Anestezi-III: Tek Ventrikül. Turkiye Klinikleri J Anest Reanim-Special Topics 2017;10(3):236-42
105. Mamazhakypov A, Sommer N, Assmus B., et al. Novel Therapeutic Targets for the Treatment of Right Ventricular Remodeling: In sights from the Pulmonary Artery Banding Model. Int. J. Environ. Res. PublicHealth 2021, 5;18(16):8297.
106. Cua CL, Thiagarajan RR, Gauvreau K., et al. Early postoperative outcomes in a series of infants with hypoplastic left heart syndrome undergoing stage I palliation operation with either modified Blalock-Taussig shunt or right ventricle to pulmonary artery conduit. Pediatr CritCareMed. 2006;7:238–44.
107. Sano S, Ishino K, Kawada M., et al. Right ventricle-pulmonary artery shunt in first-stage palliation of hypoplastic left heart syndrome. J Thorac Cardiovasc Surg 2003; 126(2):504-9
108. Karamlou T, Overman D, Hill KD., et al. Stage 1 hybrid palliation for hypoplastic left heart syndrome--assessment of contemporary patterns of use: an analysis of The Society of Thoracic Surgeons Congenital Heart Surgery Database. J Thorac Cardiovasc Surg 2015; 149(1):203-4.
109. Menon SC, McCandless RT, Mack GK., et al. Clinical outcomes and resource use for infants with hypoplastic left heart syndrome during bidirectional Glenn: summary from the Joint Council for Congenital Heart Disease National Pediatric Cardiology Quality Improvement Collaborative registry. Pediatr Cardiol 2013;34(1):143-8
110. Ballweg JA, Dominguez TE, Ravishankar C, et al. A contemporary comparison of the effect of shunt type in hypoplastic left heart syndrome on the hemodynamics and outcome at Fontan completion. J Thorac CardiovascSurg 2010; 140(3):537-44.

111. Collazo LR., Ramin BT, Fani K,Dabbagh A. Truncus Arteriosus In Dabbagh A, Conte AH, Lorraine N, editors. Congenital Heart Disease in Pediatric and Adult Patients Anesthetic and Perioperative Management 2nd Edition. Cham: Springer; 2023.p.499-511
112. Ziyaeifard M, Azarfarin R, Ferasatkish R. New aspects of anesthetic management in congenital heart disease "common arterial trunk". J Res Med Sci. 2014;19:368–74.
113. Mille FK, Shankar VR. Truncus arteriosus survival outcomes: does 22q 11.2 deletion matter? J Card Surg. 2020;35:3263–5.
114. Vohra HA, Whistance RN, Chia AX., et al. Long-term follow-up after primaryc omplete repair of common arterial trunk with homograft: a 40-year experience. J Thorac Cardiovasc Surg. 2010;140:325–9.
115. Johnson BN, Fierro JL, Panitch HB. Pulmonary manifestations of congenital heart disease in children. Pediatr Clin N Am. 2021;68:25–40.
116. Affolter JT, Ghanayem NS. Preoperative management of the neonate with critical aortic valvar stenosis. Cardiol Young. 2014;24(6):1111–6.
117. Hill GD, Ginde S, Rios R, Frommelt PC, Hill KD. Surgical valvotomy versus balloon valvuloplasty for congenital aortic valve stenosis: a systematic review and meta- analysis. J Am Heart Assoc.2016;8;5(8):e003931
118. Denny C. Trivedi PM. Congenital Anomalies of the AorticValve. In Dabbagh A, Conte AH, Lorraine N, editors. Congenital Heart Disease in Pediatric and Adult Patients Anesthetic and Perioperative Management 2nd Edition. Cham: Springer; 2023.p.547-567
119. Dabbagh A, Rao SO. Anomalies of the Aortic Arch, Aortic Coarctation, Interrupted Aortic Arch, and Vascular Rings. In Dabbagh A, Conte AH, Lorraine N, editors. Congenital Heart Disease in Pediatric and Adult Patients Anesthetic and Perioperative Management 2nd Edition. Cham: Springer; 2023.p.567-597
120. Fox EB, Latham GJ, Ross FJ, Joffe D. Perioperative and anesthetic management of coarctation of the aorta. Semin Cardiothorac Vasc Anesth. 2019;23:212–24.
121. Familiari A, Morlando M, Khalil A., et al. Risk factors for Coarctation of the aorta on prenatal ultrasound: a systematic review and meta- analysis. Circulation. 2017;135:772–85.
122. Freedom RM, Lock J, Bricker JT. Pediatric cardiology and cardiovascular surgery: 1950–2000. Circulation. 2000;14;102(20 Suppl 4):IV58-68.
123. Murakami T, Nakazawa M, Nakanishi T, Momma K. Prediction of postoperative left ventricular pump function in congenital mitral regurgitation. Pediatr Cardiol. 1999;20:418–21.
124. Ostman-Smith I, Wettrell G, Riesenfeld T. A cohort study of childhood hypertrophic cardiomyopathy: improved survival following high-dose beta-adrenoceptor antagonist treatment. J Am Coll Cardiol 1999; 15;34(6):1813-22.
125. Kirklin JK. Current challenges in pediatric heart transplantation for congenital heart disease. Curr Opin Organ Transplant 2015, 20:577–583
126. Rossano JW, Singh TP, Cherikh WS, et al. The International Thoracic Organ Transplant Registry of the International Society for Heart and Lung Transplantation: Twenty-second pediatric heart transplantation report - 2019; Focus theme: Donor and recipient size match. J HeartLung Transplant 2019; 38(10):1028-1041
127. Barnes A, Gibson W. Pediatric heart transplant. Semin Pediatr Surg. 2021;30(2):151039.
128. Daftari B, Alejos JC, Perens G. Initial experience with sildenafil, bosentan, and nitric oxide for pediatric cardiomyopathy patients with elevated pulmonary vascular resistance before and after orthotopic heart transplantation. J Transplant. 2010;2010:656984.
129. Thangappan K, Morales DLS, Vu Q., et al. Impact of mechanical circulatory support on pediatric heart transplant candidates with elevated pulmonary vascular resistance. ArtifOrgans. 2021;45(1):29–37
130. Gajarski RJ, Pearce BF. Recipient evaluation: medical and psychosocial morbidities. In: Canter CE, Kirklin JK, editors. ISHLT monograph series: pediatric heart transplantation. Philadelphia, PA: Elsevier; 2007. p. 19–32.
131. Kaydu A. Pediatrik transplantasyon anestezisi. Haspolat YK, Baysal Yıldırım Z, editörler. Pediatrik Anestezi. 1. Baskı. Ankara: Türkiye Klinikleri; 2023. p.52-61.
132. Thul J, Klauwer D. HeartTransplantation. Klauwer D, Neuhaeuser C, Thul J, Zimmermann R. editors A Practical Handbook on Pediatric Cardiac Intensive Care Therapy Springer International Publishing AG, part of Springer Nature 2019 p.473-490
133. Rossano JW, Cherikh WS, Chambers DC., et al. The Registry of the International Society for Heart and Lung Transplantation: Twentieth Pediatric Heart Transplantation Report-2017; FocusTheme: Allograf tischemic time. J HeartLung Transplant 2017; 36(10):1060-1069.
134. Oliva M, Singh TP, Gauvreau K., et al. Impact of medication nonadherence on survival after pediatric heart transplantation in the USA. J HeartLung Transplant 2013; 32:881–888
135. Kendirli T, Gün E. Kalp transplantasyonu. Anıl AB, editör. Pediatrik Kardiyak Yoğun Bakım. 1. Baskı. Ankara: Türkiye Klinikleri; 2021. p.110-8.
136.ErkalpK. Konjenital Kalp Cerrahisinde Ameliyathane Dışı Anestezi Uygulamaları. Turkiye Klinikleri J Anest Reanim-Special Topics 2017;10(3):251-4.
137. Warner MA, Lunn RJ, O'Leary PW, Schroeder DR. Outcomes of noncardiac surgical procedures in children and adults with congenital heart disease. Mayo Clin Proc. 1998;73:728734.
138. Faraoni D, Vo D, Nasr VG, Dinardo JA. Development and validation of a risk stratification score for children with congenital heart disease undergoing noncardiac surgery. Anesth Analg.2016;123:824830.
139. Lubin LN, Wong R. PerioperativeCare of the Congenital Cardiac Patient in the Cardiac Catheterization Laboratory In Dabbagh A, Conte AH, Lorraine N, editors. Congenital Heart Disease in Pediatric and Adult Patients Anesthetic and Perioperative Management 2nd Edition. Cham: Springer; 2023 p.153-161.
140. Ramamoorthy C, Haberkern C, Bhananker SM., et al. Anesthesia-related cardiac arrest in children with heart disease: data from the pediatric perioperative cardiac arrest (POCA) registry. Anesth Analg. 2010;110:1376–82.
141. Mehta R, Lee KJ, Chaturvedi R., et al. Complications of pediatric cardiac catheterization: a review in the current era. Catheter Cardiovasc Interv. 2008;72:278–85.



PEDİATRİK KARDİYOPULMONER BYPASS VE MİYOKARD KORUNMASI

BÖLÜM
20

Yiğit KILIÇ [1]

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İçindekiler

- GİRİŞ
- TARİHÇE
- KARDİYOPULMONER BYPASS İÇİN HAZIRLIK VE PEDİATRİK KARDİYOPULMONER BYPASSA ÖZEL FARKLILIKLAR
  - Kalp-Akciğer Makinesi
  - Pompalar
  - Pediatrik kardiyopulmoner bypass devresi
  - Oksijenatörler
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- PEDİATRİK KARDİYOPULMONER BYPASSA ÖZEL FARKLILIKLAR
- PEDİATRİK KARDİYOPULMONER BYPASS'TA SİSTEMİK İNFLAMATUAR YANIT
- PEDİATRİK KARDİYOPULMONER BYPASS'A GİRİŞ
  - Neden hasta heparinize edilir ve Heparin etki mekanizması nedir?
  - Hastam yeterli perfüze oluyor mu? / Monitorizasyon/ NIRS
  - Hematokrit Hemodilusyon
  - Ultrafiltrasyon
  - Hipotermi
  - Bölgesel Perfüzyon Stratejileri
  - pH-stat mı alfa-stat mı?
- PEDİATRİK MİYOKARDİYAL KORUMA
- TARİHÇE
- KARDİYOPLEJİ ÇEŞİTLERİ
- DEL NİDO KARDİYOPLEJİ
- MİKROPLEJİ
- KARDİYOPLEJİ UYGULAMA YOLLARI
  - Antegrad Yol
  - Retrograd Yol
  - Kombine (Antegrad+Retrograd) Yol
  - Tek doz/Multipl Doz Kardiyopleji
  - Aralıklı kardiyopleji infüzyonu mu devamlı kardiyopleji infüzyonu mu?
  - Kardiyoplejiyi hangi basınçta, ne kadar sürede verelim?
- ÖZEL DURUMLAR
- KPB'NİN SONLANDIRILMASI

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KAYNAKLAR

1. Lewis FJ, Taufic M. Closure of atrial septal defects with the aid of hypothermia; experimental accomplishments and the report of one successful case. Surgery. 1953;33:52-59.
2. Lewis FJ, Varco RL, Taufic M. Repair of atrial septal defects in man under direct vision with the aid of hypothermia. Surgery. 1954;36: 538-556. 4. Lewis FJ, Taufic M, Varco RL, Niazi S. The surgical anatomy of atrial septal defects: experiences with repair under direct vision. Ann Surg. 1955;142:401-415.
3. Gibbon JH Jr. Artificial maintenance of circulation during experimental occlusion of pulmonary artery. Arch Surg. 1937;34:1105-1131.
4. Gibbon JH Jr, Miller BJ, Dobell AR, et al. The closure of interventricular septal defects in dogs during open cardiotomy with the maintenance of the cardiorespiratory functions by a pump-oxygenator. J Thorac Surg. 1954;28:235-240.
5. Miller BJ, Gibbon JH, Fineberg C. An improved mechanical heart and lung apparatus; its use during open cardiotomy in experimental animals. Med Clin North Am. 1953;1:1603-1624.
6. Gibbon JH Jr. Application of a mechanical heart and lung apparatus to cardiac surgery. Minn Med. 1954;37:171–185.
7. Cohn LH. Fifty years of open-heart surgery. Circulation. 2003;107:2168–2170.
8. Lillehei CW, Cohen M, Warden HE, et al. The results of direct vision closure of ventricular septal defects in eight patients by means of controlled cross circulation. Surg Gynecol Obstet. 1955;101:446-466.
9. Lillehei CW. Controlled cross circulation for direct-vision intracardiac surgery; correction of ventricular septal defects, atrioventricularis communis, and tetralogy of Fallot. Postgrad Med. 1955;17:388-396.
10. Kirklin JW, Dushane JW, Patrick RT, et al. Intracardiac surgery with the aid of a mechanical pump-oxygenator system (Gibbon type): report of eight cases. Proc Staff Meet Mayo Clin. 1955;30:201-206.
11. Lillehei CW, Dewall RA, Read RC, et al. Direct vision intracardiac surgery in man using a simple, disposable artificial oxygenator. Dis Chest. 1956;29:1-8.
12. Erek E, Yalçınbaş YK, Sarıoğlu T. Pediatrik Ve Konjenital Kalp Cerrahisi : Temel Bilgiler Ve Prensipler. Genişletilmiş ve güncellenmiş 2. baskı. Acıbadem Üniversitesi; 2016; pp. 197-225.
13. Barrett CS, Jaggers JJ, Cook EF, et al. Pediatric ECMO outcomes: comparison of centrifugal versus roller blood pumps using propensity score matching. ASAIO J. 2013;59:145-151.
14. Barrett CS, Thiagarajan RR. Centrifugal pump circuits for neonatal extra corporeal membrane oxygenation. Pediatr Crit Care Med. 2012;13: 492-493.
15. Lawson S, Ellis C, Butler K, et al. Neonatal extracorporeal membrane oxygenation devices, techniques and team roles: 2011 survey results of the United States' Extracorporeal Life Support Organization centers. J Extra Corpor Technol. 2011;43:236-244.
16. Meyer AD, Wiles AA, Rivera O, et al. Hemolytic and thrombocytopathic characteristics of extracorporeal membrane oxygenation systems at simulated flow rate for neonates. Pediatr Crit Care Med. 2012;13:e255-e261.
17. Groom RC, Froebe S, Martin J, et al. Update on pediatric perfusion practice in North America: 2005 survey. J Extra Corpor Technol. 2005;37: 343-350.
18. Mostafavi, A. H., Mishra, A. K., Ulbricht, M., Denayer, J., Hosseini, S. S. Oxygenation and Membrane Oxygenators: Emergence, Evolution and Progress in Material Development and Process Enhancement for Biomedical Applications. *Journal of Membrane Science and Research*, 2021; 7(4): 230-259. doi: 10.22079/jmsr.2021.521505.1431.
19. Albes JM, Stöhr IM, Kaluza M, et al. Physiological coagulation can be maintained in extracorporeal circulation by means of shed blood separation and coating. J Thorac Cardiovasc Surg. 2003;126:1504-1512.
20. Suzuki Y, Daitoku K, Minakawa M, et al. Poly-2-methoxyethylacrylate coated bypass circuits reduce activation of coagulation system and inflammatory response in congenital cardiac surgery. J Artif Organs. 2008;11:111-116.
21. Greely WJ, Cripe CC, Nathan AT. Anesthesia for pediatric cardiac surgery. In: Miller RD, Cohen NH, Eriksson LI, et al. Miller's Anesthesia. 8th ed. Philadelphia: Elsevier Saunders; 2015:2820.
22. Berkowitz DH, Gaynor JW, in Pediatric Cardiac Surgery, 4th ed. Chichester: Wiley-Blackwell; 2013, pp. 169–213.
23. Brix-Christensen V. The systemic inflammatory response after cardiac surgery with cardiopulmonary bypass in children. Acta Anaesthesiol Scand. 2001;45:671–679.
24. Quinonez L, del Nido PJ. Surgical approaches and cardiopulmonary bypass in pediatric cardiac surgery. In: Sellke FW, del Nido PJ, Swanson SJ (eds.), Sabiston and Spencer Surgery of the Chest, 9th ed. Philadelphia, PA: Elsevier; 2016, pp. 1966–1982.
25. Neuhof C, Walter O, Dapper F, et al. Bradykinin and histamine generation with generalized enhancement of microvascular permeability in neonates, infants, and children undergoing cardiopulmonary bypass surgery. Pediatr Crit Care Med. 2003;4:299–304.
26. Anand KJ, Hansen DD, Hickey PR. Hormonal-metabolic stress responses in neonates undergoing cardiac surgery. Anesthesiology. 1990;73:661–670.
27. Kozik DJ, Tweddell JS. Characterizing the inflammatory response to cardiopulmonary bypass in children. Ann Thorac Surg. 2006;81:S2347–S2354.
28. Appachi E, Mossad E, Mee RB, Bokesch P. Perioperative serum interleukins in neonates with hypoplastic left-heart syndrome and transposition of the great arteries. J Cardio thorac Vasc Anesth. 2007;21:184–190.
29. Seghaye MC, Duchateau J, Grabitz RG, et al. Complement activation during cardiopulmonary bypass in infants and children. Relation to postoperative multiple system organ failure. J Thorac Cardiovasc Surg. 1993;106:978–987.
30. Seghaye MC, Grabitz RG, Duchateau J, et al. Inflammatory reaction and capillary leak syndrome related to cardiopulmonary bypass in neonates undergoing cardiac operations. J Thorac Cardiovasc Surg. 1996;112:687–697.
31. Madhok AB, Ojamaa K, Haridas V, et al. Cytokine response in children undergoing surgery for congenital heart disease. Pediatr Cardiol. 2006;27:408–413.
32. Poon KS, Palanisamy K, Chang SS, et al.Plasmaexosomal miR-223 expression regulates inflammatory responses during cardiac surgery with cardiopulmo-

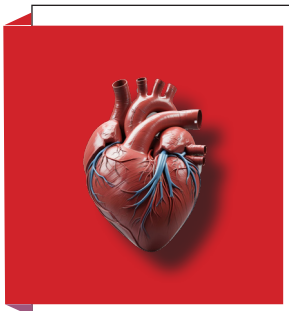
nary bypass. Sci Rep. 2017;7:10807.
33. Zhang Q, Raoof M, Chen Y, et al. Circulating mitochondrial DAMPs cause inflammatory responses to injury. Nature. 2010;464(7285):104–107.
34. Sandler N, Kaczmarek E, Itagaki K, et al. Mitochondrial DAMPs are released during cardiopulmonary bypass surgery and are associated with postoperative atrial fibrillation. Heart Lung Circ. 2018;27:122–129.
35. Bull BS, Huse WM, Brauer FS, Korpman RA. Heparin therapy during extracorporeal circulation. II. The use of a dose-response curve to individualize heparin and protamine dosage. J Thorac Cardiovasc Surg. 1975;69:685–689.
36. Zajonz T, Edinger F, Hofmann J, Yoerueker U, Akintürk H, Markmann M, Müller M. Evaluation of Point-of-Care-Directed Coagulation Management in Pediatric Cardiac Surgery. Thorac Cardiovasc Surg. 2024 Aug 13.
37. Harnish J, Beyer K, Collins J. Anticoagulation Strategies in Pediatric Cardiopulmonary Bypass, Weight-Based vs. Concentration-Based Approaches. J Extra Corpor Technol. 2022 Jun;54(2):153-160.
38. Guzzetta NA, Miller BE, Todd K, et al. An evaluation of the effects of a standard heparin dose on thrombin inhibition during cardiopulmonary bypass in neonates.
39. Grosse-Wortmann L, Drolet C, Dragulescu A, et al. Aortopulmonary collateral flow volume affects early postoperative outcome after Fontan completion: a multimodality study. J Thorac Cardiovasc Surg. 2012;144:1329–1336.
40. Munoz R, Laussen PC, Palacio G, et al. Changes in whole blood lactate levels during cardiopulmonary bypass for surgery for congenital cardiac disease: an early indicator of morbidity and mortality. J Thorac Cardiovasc Surg. 2000;119:155–162.
41. Kussman BD, Wypij D, Laussen PC, et al. Relationship of intraoperative cerebral oxygen saturation to neurodevelopmental outcome and brain magnetic resonance imaging at 1 year of age in infants undergoing biventricular repair. Circulation. 2010;122:245–254.
42. Sakamoto T, Zurakowski D, Duebener LF, et al. Interaction of temperature with hematocrit level and pH determines safe duration of hypothermic circulatory arrest. J Thorac Cardiovasc Surg. 2004;128:220–232.
43. Hoffman GM, Brosig CL, Mussatto KA, et al. Perioperative cerebral oxygen saturation in neonates with hypoplastic left heart syndrome and childhood neurodevelopmental outcome. J Thorac Cardiovasc Surg. 2013;146:1153-1164.
44. Matte GS.The bypass plan. In:Matte GS(ed.), Perfusion for Congenital Heart Surgery: Notes on Cardiopulmonary Bypass for a Complex Patient Population. Hoboken, NJ: WileyBlack well; 2015, pp. 33–71.
45. Anttila V, Hagino I, Zurakowski D, et al. Specific bypass conditions determine safe minimum flow rate. AnnThorac Surg. 2005;80:1460–1467.
46. Hickey E, Karamlou T, You J, Ungerleider RM. Effects of circuit miniaturization in reducing inflammatory response to infant cardiopulmonary bypass by elimination of allogeneic blood products. Ann Thorac Surg. 2006;81:S2367–S2372.
47. O'Connor MJ, Lind C, Tang X, et al. Persistence of anti-human leukocyte antibodies in congenital heart disease late after surgery using allografts and whole blood. J Heart Lung Transplant. 2013;32:390–397.
48. Stein JI, Gombotz H, Rigler B, et al. Open heart surgery in children of Jehovah'sWitnesses: extreme hemodilution on cardiopulmonary bypass. Pediatr Cardiol. 1991;12:170–174.
49. Liam BL, Plochl W, Cook DJ, Orszulak TA, Daly RC. Hemodilution and whole body oxygen balance during normothermic cardiopulmonary bypass in dogs. J Thorac Cardiovasc Surg. 1998;115:1203–1208.
50. Cook DJ, Orszulak TA, Daly RC, MacVeigh I. Minimum hematocrit for normothermic cardiopulmonary bypass in dogs. Circulation. 1997;96(9 suppl):II-200–II204.
51. Duebener LF, Sakamoto T, Hatsuoka S, et al. Effects of hematocrit on cerebral microcirculation and tissue oxygenation during deep hypothermic bypass. Circulation. 2001;104(12 suppl 1):I260–I264.
52. Jonas RA,Wypij D,RothSJ, et al. The influence of hemodilution on outcome after hypothermic cardiopulmonary bypass: results of a randomized trial in infants. J Thorac Cardiovasc Surg. 2003;126:1765–1774.
53. Newburger JW, Jonas RA, Soul J, et al. Randomized trial of hematocrit 25% versus 35% during hypothermic cardiopulmonary bypass in infant heart surgery. J Thorac Cardiovasc Surg. 2008;135:347–354.
54. Wypij D, Jonas RA, Bellinger DC, et al. The effect of hematocrit during hypothermic cardiopulmonary bypass in infant heart surgery: results from the combined Boston hematocrit trials J Thorac Cardiovasc Surg. 2008;135:355–360.
55. Shimpo H, Shimamoto A, Sawamura Y, et al. Ultrafiltration of the priming blood before cardiopulmonary bypass attenuates inflammatory response and improves postoperative clinical course in pediatric patients. Shock. 2001;16(suppl 1):51–54.
56. Naik SK, Knight A, Elliott MJ. A successful modification of ultrafiltration for cardiopulmonary bypass in children. Perfusion. 1991;6:41-50.
57. Bando K, Turrentine MW, Vijay P, et al. Effect of modified ultrafiltration in high-risk patients undergoing operations for congenital heart disease. Ann Thorac Surg. 1998;66:821–828.
58. Berdat PA, Eichenberger E, Ebell J, et al. Elimination of proinflammatory cytokines in pediatric cardiac surgery: analysis of ultrafiltration method and filter type. J Thorac Cardiovasc Surg. 2004;127:1688–1696.
59. Davies MJ, Nguyen K, Gaynor JW, Elliott MJ. Modified ultrafiltration improves left ventricular systolic function in infants after cardiopulmonary bypass. J Thorac Cardio vasc Surg. 1998;115:361–370.
60. Raja SG, Yousufuddin S, Rasool F, et al. Impact of modified ultrafiltration on morbidity after pediatric cardiac surgery. Asian Cardiovasc Thorac Ann. 2006;14:341–350.
61. Gaynor JW, Kuypers M, van Rossem M, et al. Haemodynamic changes during modified ultrafiltration immediately following the first stage of the Norwood reconstruction. Cardiol Young. 2005;15:4–7.
62. Friesen RH, Campbell DN, Clarke DR, Tornabene MA. Modified ultrafiltration attenuates dilutional coagulopathy in pediatric open heart operations. Ann Thorac Surg. 1997;64:1787–1789.

63. KoutlasTC, GaynorJW, NicolsonSC, et al. Modified ultrafiltration reduces postoperative morbidity after cavopulmonary connection. Ann Thorac Surg. 1997;64:37–43.
64. Huang H, Yao T, Wang W, et al. Continuous ultrafiltration attenuates the pulmonary injury that follows open heart surgery with cardiopulmonary bypass. Ann Thorac Surg. 2003;76:136–140.
65. Bando K, Vijay P, Turrentine MW, et al. Dilutional and modified ultrafiltration reduces pulmonary hypertension after operations for congenital heart disease: a prospective randomized study. J Thorac Cardiovasc Surg. 1998;115:517–527.
66. Yndgaard S, Andersen LW, Andersen C, Petterson G, Baek L. The effect of modified ultrafiltration on the amount of circulating endotoxins in children undergoing cardiopulmonary bypass. J Cardiothorac Vasc Anesth. 2000;14:399–401.
67. Liu J, Ji B, Long C, Li C, Feng Z. Comparative effectiveness of methylprednisolone and zero-balance ultrafiltration on inflammatory response after pediatric cardiopulmonary bypass. Artif Organs. 2007;31:571–575.
68. Zhu X, Ji B, Wang G, Liu J, Long C. The effects of zero-balance ultrafiltration on postoperative recovery after cardiopulmonary bypass: a meta-analysis of ran domized controlled trials. Perfusion. 2012;27:386–392.
69. Zhou G, Feng Z, Xiong H, Duan W, Jin Z. A combined ultrafiltration strategy during pediatric cardiac surgery: a prospective, randomized, controlled study with clinical outcomes. J Cardiothorac Vasc Anesth. 2013;27:897–902.
70. Bigelow WG, Callaghan JC, Hopps JA. General hypothermia for experimental intracardiac surgery: the use of electrophrenic respirations, an artificial pacemaker for cardiac standstill, and radio-frequency rewarming in general hypothermia. Ann Surg. 1950;132:531-537.
71. Sealy WC, Brown IW Jr, Young WG Jr. A report on the use of both extracorporeal circulation and hypothermia for open heart surgery. Ann Surg. 1958;147:603-613.
72. Penrod KE. Oxygen consumption and cooling rates in immersion hypothermia in the dog. Am J Physiol. 1949; 157:436–444.
73. Ross DN. Hypothermia. 2. Physiological observations during hypothermia. Guys Hosp Rep. 1954;103:116–138.
74. Pua HL, Bissonnette B. Cerebral physiology in paediatric cardiopulmonary bypass. Can J Anaesth. 1998;45:960–978.
75. Burrows FA, Bissonnette B. Cerebral blood flow velocity patterns during cardiac surgery utilizing profound hypothermia with low-flow cardiopulmonary bypass or circulatory arrest in neonates and infants. Can J Anaesth. 1993;40:298–307.
76. Taylor RH, Burrows FA, Bissonnette B. Cerebral pressure flow velocity relationship during hypothermic cardiopulmonary bypass in neonates and infants. Anesth Analg. 1992;74:636–642.
77. Wong PC, Barlow CF, Hickey PR, et al. Factors associated with choreoathetosis after cardiopulmonary bypass in children with congenital heart disease. Circulation. 1992;86(5 suppl):II118–II126.
78. Bellinger DC, Wernovsky G, Rappaport LA, et al. Cognitive development of children following early repair of transposition of the great arteries using deep hypothermic circulatory arrest. Pediatrics. 1991;87:701–707.
79. Grigore AM, Murray CF, Ramakrishna H, Djaiani G. A core review of temperature regimens and neuroprotection during cardiopulmonary bypass: does rewarming rate matter? Anesth Analg. 2009;109:1741–1751.
80. Enomoto S, Hindman BJ, Dexter F, Smith T, Cutkomp J. Rapid rewarming causes an increase in the cerebral metabolic rate for oxygen that is temporarily unmatched by cerebral blood flow. A study during cardiopulmonary bypass in rabbits. Anesthesiology. 1996;84:1392–1400.
81. de Lange F, Jones WL, Mackensen GB, Grocott HP. The effect of limited rewarming and postoperative hypothermia on cognitive function in a rat cardiopulmonary bypass model. Anesth Analg. 2008;106:739–745.
82. Greeley WJ, Kern FH, Ungerleider RM, et al. The effect of hypothermic cardiopulmonary bypass and total circulatory arrest on cerebral metabolism in neonates, infants, and children. J Thorac Cardiovasc Surg. 1991;101:783–794.
83. Baos S, Sheehan K, Culliford L, et al. Normothermic versus hypothermic cardiopulmonary bypass in children undergoing open heart surgery (thermic-2): study protocol for a randomized controlled trial. JMIR Res Protoc. 2015;4:e59.
84. Rundgren M, Engstrom M. A thromboelastometric evaluation of the effects of hypothermia on the coagulation system. Anesth Analg. 2008;107:1465–1468.
85. Rajagopalan S, Mascha E, Na J, Sessler DI. The effects of mild perioperative hypothermia on blood loss and transfusion requirement. Anesthesiology. 2008;108:71–77.
86. Shamsuddin AM, Nikman AM, Ali S,et al. Normothermia for pediatric and congenital heart surgery: an expanded horizon. Front Pediatr. 2015;3:23.
87. Pouard P, Mauriat P, Ek F, et al. Normothermic cardiopulmonary bypass and myocardial cardioplegic protection for neonatal arterial switch operation. Eur J Cardiothorac Surg. 2006;30:695–699.
88. Ali Aydemir N, Harmandar B, Karaci AR, et al. Randomized comparison between mild and moderate hypothermic cardiopulmonary bypass for neonatal arterial switch operation. Eur J Cardiothorac Surg. 2012;41: 581–586.
89. Caputo M, Patel N, Angelini GD, et al. Effect of normothermic cardiopulmonary bypass on renal injury in pediatric cardiac surgery: a randomized controlled trial. J Thorac Cardiovasc Surg. 2011;142:1114–1121.
90. Poncelet AJ, van Steenberghe M, Moniotte S, et al. Cardiac and neurological assessment of normothermia/warm blood cardioplegia vs hypothermia/cold crystalloid cardioplegia in pediatric cardiac surgery: insight from a prospective randomized trial. Eur J Cardiothorac Surg. 2011;40:1384–1390.
91. Xiong Y, Sun Y, Ji B, et ak. Systematic review and meta-analysis of benefits and risks between normothermia and hypothermia during cardiopulmonary bypass in pediatric cardiac surgery. Paediatr Anaesth. 2015;25: 135–142.
92. Corno AF. Normal temperature and flow: are the "physiological" values so scary? Eur J Cardiothorac Surg. 2007;31:756 [letter to the editor]; 757 [author reply].

93. Durandy Y, Hulin S, Lecompte Y. Normothermic cardiopulmonary bypass in pediatric surgery. J Thorac Cardiovasc Surg. 2002;123:194. ,
94. Durandy Y. Rationale for Implementation of warm cardiac surgery in pediatrics. Front Pediatr. 2016;4:43.
95. Kirklin JW, Barratt-Boyes BG. Cardiac Surgery, 2nd ed. NewYork: Churchill Livingstone; 1993.
96. Newburger JW, Jonas RA, Wernovsky G, et al. A comparison of the perioperative neurologic effects of hypothermic circulatory arrest versus low-flow cardiopulmonary bypass in infant heart surgery. NEngl J Med. 1993;329:1057–1064.
97. Wypij D, Newburger JW, Rappaport LA, et al. The effect of duration of deep hypothermic circulatory arrest in infant heart surgery on late neurodevelopment: the Boston Circulatory Arrest Trial. J Thorac Cardiovasc Surg. 2003;126:1397–1403.
98. Forbess JM, Visconti KJ, Hancock-Friesen C, et al. Neurodevelopmental outcome after congenital heart surgery: results from an institutional registry. Circulation. 2002;106(12 suppl 1):I95–I102.
99. Pigula FA, Nemoto EM, Griffith BP, Siewers RD. Regional low-flow perfusion provides cerebral circulatory support during neonatal aortic arch reconstruction. J Thorac Cardiovasc Surg. 2000;119:331–339.
100. Tsai JY, Pan W, Lemaire SA, et al. Moderate hypothermia during aortic arch surgery is associated with reduced risk of early mortality. J Thorac Cardiovasc Surg. 2013;146:662-667.
101. Zierer A, El-Sayed Ahmad A, Papadopoulos N, et al. Selective antegrade cerebral perfusion and mild (28°C–30°C) systemic hypothermic circulatory arrest for aortic arch replacement: results from 1002 patients. J Thorac Cardiovasc Surg. 2012;144:1042-1049.
102. Goldberg CS, Bove EL, Devaney EJ, et al. A randomized clinical trial of regional cerebral perfusion versus deep hypothermic circulatory arrest: outcomes for infants with functional single ventricle. J Thorac Cardiovasc Surg. 2007;133:880–887.
103. Algra SO, Jansen NJ, van der Tweel I, et al. Neurological injury after neonatal cardiac surgery: a randomized, controlled trial of 2 perfusion techniques. Circulation. 2014;129:224–233.
104. Ortmann E, Klein AA, Sharples LD, et al. Point-of-care assessment of hypothermia and protamine-induced platelet dysfunction with multiple electrode aggregom etry (Multiplate(R)) in patients undergoing cardiopulmonary bypass. Anesth Analg. 2013;116:533–540.
105. Algra SO, Schouten AN, van Oeveren W, et al. Low-flow antegrade cerebral perfusion attenuates early renal and intestinal injury during neonatal aortic arch reconstruction. J Thorac Cardiovasc Surg. 2012;144:1323-1328, 8.e1-2.
106. Wang J, Ginther RM, Riegel M, et al. The impact of temperature and pump flow rate during selective cerebral perfusion on regional blood flow in piglets. J Thorac Cardiovasc Surg. 2013;145:188-194, discussion 94-95.
107. Carlson AM, Tcheng JW, Holgren SE, Turek JW. Beating-heart sliding arch aortoplasty for arch hypoplasia beyond infancy. Innovations (Phila). 2015;10:441–443.
108. Kılıç Y, Selçuk A, Korun O, Ceyda H, Çiçek M, Yurdakök O, Altın F, Erdem H, Aydemir NA, Şaşmazel A. Comparison of cases with and without additional lower body perfusion in newborns undergoing aortic arch reconstruction with antegrade selective cerebral perfusion method. Turk Gogus Kalp Damar Cerrahisi Derg. 2022 Apr 27;30(2):192-198.
109. Rajagopal SK, Emani SM, Roy N, Westgate L, Bacha EA. Acute kidney injury and regional abdominal perfusion during neonatal aortic arch reconstruction. J Thorac Cardiovasc Surg. 2010;140:453–458.
110. Raees MA, Morgan CD, Pinto VL, et al. Neonatal aortic arch reconstruction with direct splanchnic perfusion avoids deep hypothermia. Ann Thorac Surg. 2017;104: 2054–2063.
111. Karavas AN, Deschner BW, Scott JW, Mettler BA, Bichell DP. Three-region perfusion strategy for aortic arch reconstruction in the Norwood. Ann Thorac Surg. 2011;92:1138–1140.
112. Turek JW, Hanfland RA, Davenport TL, et al. Norwood reconstruction using continuous coronary perfusion: a safe and translatable technique. Ann Thorac Surg. 2013;96:219–224.
113. Abdul Aziz KA, Meduoye A. Is pH-stat or alpha-stat the best technique to follow in patients undergoing deep hypothermic circulatory arrest? Interact Cardiovasc Thorac Surg. 2010;10:271-282.
114. Jonas RA. Conduct of cardiopulmonary bypass. In: Jonas RA. Comprehensive Surgical Management of Congenital Heart Disease, 2nd ed. Boca Raton, FL: CRC Press; 2014, pp 181–206.
115. Greeley WJ, Ungerleider RM, Smith LR, Reves JG. The effects of deep hypothermic cardiopulmonary bypass and total circulatory arrest on cerebral blood flow in infants and children. J Thorac Cardiovasc Surg. 1989;97:737–745.
116. Aoki M, Nomura F, Stromski ME, et al. Effects of pH on brain energetics after hypothermic circulatory arrest. Ann Thorac Surg. 1993;55:1093–1103.
117. du Plessis AJ, Jonas RA, Wypij D, et al. Perioperative effects of alpha-stat versus pH-stat strategies for deep hypothermic cardiopulmonary bypass in infants. J Thorac Cardiovasc Surg. 1997;114:991–1001.
118. Jonas RA, Bellinger DC, Rappaport LA, et al. Relation of pH strategy and developmental outcome after hypothermic circulatory arrest. J Thorac Cardiovasc Surg. 1993;106:362–368.
119. NagyZL, CollinsM, SharpeT, et al. Effect of two different bypass techniques on the serum troponin-T levels in new borns and children: does pH-stat provide better protection? Circulation. 2003;108:577–582.
120. Kirshbom PM, Skaryak LA, DiBernardo LR, et al. Effects of aortopulmonary collaterals on cerebral cooling and cerebral metabolic recovery after circulatory arrest. Circulation. 1995;92(9 suppl):II490–II494.
121. Reimer KA, Jennings RB, Tatum AH. Pathobiology of acute myocardial ischemia: metabolic, functional and ultrastructural studies. Am J Cardiol. 1983;52:72A–81A.
122. Spieckermann PG, Braun U, Hellberg K, et al. [Survival and resuscitation time of the heart during ketamine, barbiturates and halothane anesthesia]. Z Prakt Anasth. 1970;5:365–372.
123. Melrose DG, Dreyer B, Bentall HH, Baker JB. Elective cardiac arrest. Lancet. 1955;269:21-22.

124. Shiroishi MS. Myocardial protection: the rebirth of potassium-based cardioplegia. Tex Heart Inst J. 1999;26:71-86.
125. Gott VL, Gonzalez JL, Zuhdi MN, Varco RL, Lillehei CW. Retrograde perfusion of the coronary sinus for direct vision aortic surgery. Surg Gynecol Obstet. 1957;104:319–328.
126. Lillehei CW, DeWall RA, Gott VL, Varco RL. The direct vision correction of calcific aortic stenosis by means of a pump-oxygenator and retrograde coronary sinus perfusion. Dis Chest. 1956;30:123–132.
127. Hoelscher B, Just OH, Merker HJ. Studies by electron microscope on various forms of induced cardiac arrest in dog and rabbit. Surgery. 1961;49:492–499.
128. Allen P, Lillehei CW. Use of induced cardiac arrest in open heart surgery; results in seventy patients. Minn Med. 1957;40:672–676.
129. Shumway NE, Lower RR. Topical cardiac hypothermia for extended periods of anoxic arrest. Surg Forum. 1960;10:563–566.
130. Hultgren HN, Miyagawa M, Buch W, Angell WW. Ischemic myocardial injury during cardiopulmonary bypass surgery. Am Heart J. 1973;85:167176.
131. Follette DM, Mulder DG, Maloney JV, Buckberg GD. Advantages of blood cardioplegia over continuous coronary perfusion or intermittent ischemia. Experimental and clinical study. J Thorac Cardiovasc Surg. 1978;76:604-619.
132. Rosenkranz ER, Vinten-Johansen J, Buckberg GD, et al. Benefits of normothermic induction of blood cardioplegia in energy-depleted hearts, with maintenance of arrest by multidose cold blood cardioplegic infusions. J Thorac Cardiovasc Surg. 1982;84: 667–677.
133. Rosenkranz ER, Okamoto F, Buckberg GD, et al. Safety of prolonged aortic clamping with blood cardioplegia. III. Aspartate enrichment of glutamate-blood cardioplegia in energy-depleted hearts after ischemic and reperfusion injury. J Thorac Cardiovasc Surg. 1986;91:428–435.
134. Barner HB. Blood cardioplegia: a review and comparison with crystalloid cardioplegia. Ann Thorac Surg. 1991;52:1354-1367.
135. Chambers DJ, Fallouh HB. Cardioplegia and cardiac surgery: pharmacological arrest and cardioprotection during global ischemia and reperfusion. Pharmacol Ther. 2010;127:41-52.
136. Kotani Y, Tweddell J, Gruber P, et al. Current cardioplegia practice in pediatric cardiac surgery: a North American multiinstitutional survey. Ann Thorac Surg. 2013;96:923-929.
137. Matte GS, del Nido PJ. History and use of del Nido cardioplegia solution at Boston Children's Hospital. J Extra Corpor Technol. 2012;44:98-103.
138. Ginther RM Jr, Gorney R, Forbess JM. Use of del Nido cardioplegia solution and a low-prime recirculating cardioplegia circuit in pediatrics. J Extra Corpor Technol. 2013;45:46-50.
139. Liu J, Feng Z, Zhao J, Li B, Long C. The myocardial protection of HTK cardioplegic solution on the long-term ischemic period in pediatric heart surgery. ASAIO J. 2008;54:470–473.
140. Korun O, Özkan M, Terzi A, et al. The comparison of the effects of Bretschneider's histidine-tryptophan ketoglutarate and conventional crystalloid cardioplegia on pediatric myocardium at tissue level. Artif Org. 2013;37:76–81.
141. Bojan M, Peperstraete H, Lilot M, et al. Cold histidine tryptophan-ketoglutarate solution and repeated oxygenated warm blood cardioplegia in neonates with arterial switch operation. Ann Thorac Surg. 2013;95:1390–1396.
142. Giordano R, Arcieri L, Cantinotti M, et al. Custodiol solution and cold blood cardioplegia in arterial switch operation: retrospective analysis in a single center. Thorac Cardiovasc Surg. 2016;64:53–58.
143. Talwar, S., Jha, A.J., Hasija, S. *et al.* Paediatric myocardial protection-strategies, controversies and recent developments. *Indian J Thorac Cardiovasc Surg* **29**, 114–123 (2013).
144. Mishra P, Jadhav RB., Mohapatra CKR, et al. [Comparison of del Nido cardioplegia and St. Thomas Hospital solution—two types of cardioplegia in adult cardiac surgery]. Kardiochir Torakochirurgia Pol. 2016;13:295.
145. Waterford SD, Ad N. Del Nido cardioplegia: Questions and (some) answers. J Thorac Cardiovasc Surg. 2023 Mar;165(3):1104-1108.
146. Talwar S, Bhoje A, Sreenivas V, et al. Comparison of del Nido and St Thomas cardioplegia solutions in pediatric patients: a prospective randomized clinical trial. Semin Thorac Cardiovasc Surg. 2017;29:366–374.
147. Talwar S, Chatterjee S, Sreenivas V, et al. Comparison of del Nido and histidine-tryptophan-ketoglutarate cardioplegia solutions in pediatric patients undergoing open heart surgery: a prospective randomized clinical trial. J Thorac Cardiovasc Surg. 2019;157:1182–1192.
148. Menasché P. Blood cardioplegia: do we still need to dilute? Ann Thorac Surg. 1996;62:957–960.
149. Ahmed AA, Mahboobi SK. Warm Blood Cardioplegia. [Updated 2023 Jun 5]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-.
150. Falcoz PE, Kaili D, Chocron S, et al. Warm and tepid cardioplegia: do they provide equal myocardial protection? Ann Thorac Surg. 2002;74:2156–2160.
151. Modi P, Suleiman MS, Reeves B, Pawade A, Parry AJ, Angelini GD, Caputo M. Myocardial metabolic changes during pediatric cardiac surgery: a randomized study of 3 cardioplegic techniques. J Thorac Cardiovasc Surg. 2004 Jul;128(1):67-75.
152. Gates RN, Laks H, Drinkwater DC, et al. The microvascular distribution of cardioplegic solution in the piglet heart: retrograde versus antegrade delivery. J THORAC CARDIO VASC SURG 1993;105:845-53.
153. Stirling MC, McClanahan TB, Schott RJ, et al. Distribution of cardioplegic solution infused antegradely and retrogradely in normal canine hearts. J THORAC CARDIOVASC SURG 1989;98:1066-76.
154. Crooke GA, Harris LJ, Grossi EA, et al. Biventricular distribution of cold blood cardioplegic solution administered by different retrograde techniques. J THORAC CARDIOVASC SURG 1991;102:631-8.
155. Kohman LJ, Veit LJ. Single-dose versus multidose cardioplegia in neonatal hearts. J Thorac Cardiovasc Surg. 1994;107:1512–1518.
156. Floh AA, Das S, Haranal M, Laussen PC, Crawford-Lean L, Fan CS, Mertens LL, Runeckles K, Honjo O. Comparison between Del Nido and conventional blood car-

dioplegia in pediatric open-heart surgery. Perfusion. 2023 Mar;38(2):337-345.
157. Castaneda AR, Jonas RA, Mayer JE, Hanley FL. Myocardial preservation in the immature heart. In: CastanedaAR, JonasRA, MayerJE, HanleyFL (eds.), Cardiac Surgery of the Neonate and Infant. Philadelphia, PA: WB Saunders; 1994, pp. 41–54.
158. Buckberg GD. Studies of hypoxemic/reoxygenation injury: I. Linkage between cardiac function and oxidant damage. J Thorac Cardiovasc Surg. 1995;110(4Pt 2):1164–1170.
159. Sawatari K, Kadoba K, Bergner KA, Daitch JA, Mayer JE Jr. Influence of initial reperfusion pressure after hypothermic cardioplegic ischemia on endothelial modulation of coronary tone in neonatal lambs. Impaired coronary vasodilator response to acetylcholine. J Thorac Cardiovasc Surg. 1991;101:777–782.
160. Kronon M, Bolling KS, Allen BS, et al. The importance of cardioplegic infusion pressure in neonatal myocardial protection. Ann Thorac Surg. 1998;66:1358–1364.



PEDİATRİK KARDİYAK YOĞUN BAKIM

BÖLÜM
21

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İçindekiler

» KARDİYAK YOĞUN BAKIMA GİRİŞ
» CERRAHİ SONRASI İLK DEĞERLENDİRME VE ANA PRENSİPLER
» SİSTEMATİK OLARAK CERRAHİ SONRASI BAKIM
  » Kardiyovasküler Sistem
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  » Taşikardi
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  » Kalp Atım Hacmi: Art yük
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  » JET Tedavisi
  » Pulmoner Hipertansiyon ve Tedavisi
  » Mekanik Destek Tedavileri
  » Ek Tablolar

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Tablo 12. Başlıca ilaç ve elektriksel müdahalelerin dozları ve yan etkileri - Devamı

İlaç/girişim	Doz	Yan etkiler
Ibutelide	0.01-0.025 mg/kg 50 cc SF içinde 10 dk'da IV Tekrarı 1 kere 10 dk sonra, sinus izlendiğinde sonlandır	Aritmi, uzun QTc(beklenilir), 1a veya 3 sınıfı antiaritmikler ile kullanılmaz.
Isoproterenol	0.01-1 mcg/kg/dk IV perfüzyon	Hipotansiyon, taşikardi
Kaptopril	< 6 ay: 0.3 mg/kg/gün (3 doza bölünerek), yavaşca 2 mg/kg/güne çıkartılır >6 ay: 0.5-4 mg/kg/gün	Hipotansiyon, öksürük, renal disfonksiyon
Kardiyoversiyon (senkronize)	İlk doz: 0.5-1 J/kg, Tekrar: 2-4 J/kg, Maksimum: 300 J	Aritmi, yanık
Lidokain	1 mg/kg/doz IV bolus 20-50 mcg/kg/dk IV perfüzyon	Havale, hipotansiyon, aritmi Kan düzeyi: 2-5 mcg/ml
Magnezyum sulfat	50 mg/kg/doz IV yavaş bolus(5-10 dk) Maksimum: 2 g	Hipotansiyon, apne, nöromüsküler blokaj
Milrinon	Yükleme: 50-100 mcg/kg IV İdame: 0.5-1.0 mcg/kg/dk	Aritmi, hipotansiyon
Nitroprussid	0.01-5 mcg/kg/dk IV perf.	Hipotansiyon, bulantı, siyanür tiyosiyanat zehirlenmesi
Prokainamid	Yükleme: 5-10 mg/kg IV İdame: 20-80 mcg/kg/dk IV perf	Hipotansiyon, aritmi Kan düzeyi: 4-10 mcg/ml Prokainamid+NAPA 10-30 mcg/ml
Propranolol	0.01-0.1 mg/kg/doz IV	Hipotansiyon, bradikardi, bronkospazm 1-4 mg/kg/gün PO (4 doza bölünür)
Prostaglandin E1	Başlangıç dozu 0.05-0.1 mcg/kg/dk IV perfüzyon, etkiye gore azaltılır Min doz 0.01 mcg/kg/dk	Apne, ateş, hipotansiyon, havale, döküntü

KAYNAKLAR

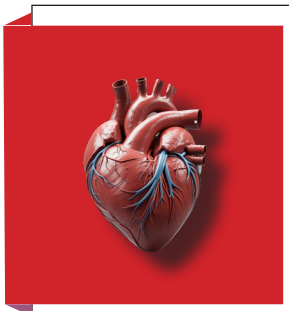
1. Downes JJ. The historical evolution, current status and prospective development of pediatric critical care. Crit Care Clin 1992,8:1-22.
2. Fuster V. 50th Anniversary historical article. Myocardial infarction and coronary care units. J Am Coll Cardiol 1999,34:1851-3.
3. Raskind WJ. Historical aspects of surgery for conjenital heart disease. J Thorac Cardiovasc Surg,1982;84:619-25.
4. Chang AC. Pediatric cardiac intensive care: Current state of the art and beyond the millenium. Curr Opin Pediatr, 2000;12:238-46.
5. Wernovsky G, Hoffman T. Pediatric heart failure management: Solving the puzzle. Crit Care Med, 2001;29:212-3.
6. Chang AC, Hanley FL, Lock JE et al. Management and outcome of low birthweight neonates with congenital heart disease. J Pediatr, 1994;124:461-6
7. Rossi AF, Seiden HS, Sadeghi AM et al. The outcome of cardiac operations in infants weighing two kilograms and less. J Thorac Cardiovasc Surg,1998,116:28-35.
8. Weinstein S, Gaynor JW, Bridges ND et al. Early survival of infants weighing 2.5 kilograms or less undergoing first-stage reconstruction for hypoplastic left heart syndrome. Circulation, 1999,100:167-70.
9. Parr GV, Blackstone EH, Kirklin JW. Cardiac performance and mortality early after intracardiac surgery in infants and young children. Circulation, 1975;51:867-74.
10. Flores, S., Su, E., Moher, J. M., Adler, A. C., & Riley, A. F. (2024). Point-of-Care-Ultrasound in Pediatrics: A Review and Update. Seminars in ultrasound, CT, and MR, 45(1), 3–10.
11. Wessel D. Managing low cardiac output syndrome after congenital heart surgery. Crit Care Med Oct, 2001;29:220-30.
12. Wernovsky G, Wypij D, Jonas RA et al. Postoperative course and hemodynamic profile after an arterial switch operation in neonates and infants: A comparison of low flow cardiopulmonary bypass versus circulatory arrest. Circulation, 1995;92:2226-35.
13. Wessel D. Managing low cardiac output syndrome after congenital heart surgery. Crit Care Med Oct, 2001;29:220-30.
14. Friedman WF, George BL. Treatment of congestive heart failure by altering loading conditions of the heart. J Pediatr, 1985;106:697-706.
15. Tobias J. Pediatric Critical Care: The Essentials. Futura Publishing Co Inc Armonk NY, 1999.
16. Chew, M.S., Poelaert, J. Accuracy and repeatability of pediatric cardiac output measurement using Doppler: 20-year review of the literature. Intensive Care Med 29, 1889–1894 (2003)
17. María V. Fraga, Kevin C. Dysart, Natalie Rintoul, et al; Cardiac Output Measurement Using the Ultraso-

nic Cardiac Output Monitor: A Validation Study in Newborn Infants. Neonatology 8 October 2019; 116 (3): 260–268
18. Electrical velocimetry for measuring cardiac output in children with congenital heart disease Norozi, K. et al. British Journal of Anaesthesia, Volume 100, Issue 1, 88 – 94
19. Fox ML, Burrows FA, Reid RW et al. The influence of cardiopulmonary bypass on ionized magnesium in neonates, infants, and children undergoing repair of congenital heart lesions. Anesth Analg, 1997;84:497-500.
20. Friedman WF, George BL. Treatment of congestive heart failure by altering loading conditions of the heart. J Pediatr, 1985;106:697-706.
21. Bohn DJ, Poirer CS, Demonds JF. Efficacy of epinephrine during emergence from cardiopulmonary bypass in children. Crit Care Med, 1980;8:367-71.
22. Habib DM, Padbury JF, Anas NG. Dobutamine pharmacokinetics and pharmacodynamics in pediatric intensive care patients. Crit Care Med, 1992;20:601-8.
23. Berg RA, Donnerstein RL, Padbury JF. Dobutamine infusions in stable, critically ill children: Pharmacokinetics and hemodynamic actions. Crit Care Med, 1993;21:678-86.
24. Butterworth JF. Use of amrinone in cardiac surgery patients. J Cardiothorac Vasc Anesth 1993;7(Suppl):1-7.
25. Steen PA, Tinker JH, Pluth JR et al. Efficacy of dopamine, dobutamine, and epinephrine during emergence from cardiopulmonary bypass in man. Circulation1978;57:378-84.
26. Berner M, Jaccard C, Oberhansli I. Hemodynamic effects of amrinone in children after cardiac surgery. Intensive Care Med, 1990;16:85-8.
27. Robinson BW, Gelband H, Mas MS. Selective pulmonary and systemic vasodilator effects of amrinone in children: New therapeutic implications. J Am Coll Cardiol, 1993;21:1461-5.
28. Chang AC, Atz AM, Wernovsky G et al. Milrinone: Systemic and pulmonary hemodynamic effects in neonates after cardiac surgery. Crit Care Med, 1995;23:1907-14.
29. Bailey JM, Miller BE, Lu W et al. The pharmacokinetics of milrinone in pediatric patients after cardiac surgery. Anesthesiology, 1999;90:1012-8.
30. Ramamoorthy C, Anderson GD, Williams GD et al. Pharmacokinetics and side effects of milrinone in infants and children after open heart surgery. Anesth Anal, 1998;86:283-9.
31. Hoffman TM, Wernowsky G, Atz AM et al. Efficacy and safety of milrinone in preventing low cardiac output syndrome in infants and children after corrective surgery for congenital heart disease. Circulation, 2003;107:996-1002.
32. Garcia Guerra, G., Joffe, A. R., Senthilselvan, A., Kutsogiannis, D. J., & Parshuram, C. S. (2013). Incidence of milrinone blood levels outside the therapeutic range and their relevance in children after cardiac surgery for congenital heart disease. Intensive care medicine, 39(5), 951–957.
33. BurkhardtBEU, RückerG, StillerB. Prophylactic milrinone for the prevention of low cardiac output syndrome and mortality in children undergoing surgery for congenital heart disease. Cochrane Database of Systematic Reviews 2015, Issue 3. Art. No.: CD009515.
34. Mahle, William T. MD; Cuadrado, Angel R. MD; Kirshbom, Paul M. MD; Kanter, Kirk R. MD; Simsic, Janet M. MD. Nesiritide in infants and children with congestive heart failure. Pediatric Critical Care Medicine 6(5):p 543-546, September 2005
35. Magliola R, Moreno G, Vassallo JC et al. Levosimendan, a new inotropic drug: Experience in children with acute heart failure. Arch Argent Pediatr, 2009;107:139-45.
36. HummelJ, RückerG, StillerB. Prophylactic levosimendan for the prevention of low cardiac output syndrome and mortality in paediatric patients undergoing surgery for congenital heart disease. Cochrane Database of Systematic Reviews 2017, Issue 8. Art. No.: CD011312
37. Laussen PC. Pediatric cardiac intensive care. In: Jonas RA ed. Comprehensive Surgical Management of Congenital Heart Disease.1st ed. London: Arnold, 2004;p:65-115.
38. Raithel SC, Pennington DG, Boegner E et al. Extracorporeal membrane oxygenation in children after cardiac surgery. Circulation, 1992;86:305-10.
39. Duncan BW, Hraska V, Jonas RA et al. Mechanical circulatory support in children with cardiac disease. J Thorac Cardiovasc Surg, 1999;117:529-42.
40. Kloth RL, Baum VC. Very early extubation after cardiac surgery. Crit Care Med, 2002;30:787-91.
41. Heinle JS, Diaz UL, Fox LS. Early extubation after cardiac operations in neonates and young infants. J Thorac Cardiovasc Surg, 1997;114:413-8.
42. Shuller JL, Bovill JG, Nijveld A et al. Early extubation of the trachea after open heart surgery for conjenital heart disease. A review of three years experience. Brit J Anesth, 1984;56:1101-8.
43. Reyes A, Vega G, Blancas R et al. Early versus conventional extubation after cardiac surgery with cardiopulmonary bypass. Chest, 1997;112:193-201.
44. Cray SH, Holtby HM, Kartha VM et al. Early tracheal extubation after pediatic cardiac surgery: the use of propofol to supplement low dose opioid anesthesia. Pediatr Anesth, 2001;11:465-71.
45. Barash PG, Lescovich F, Katz JD et al. Early extubation following pediatric cardiothoracic operations: a viable alternative. Ann Thorac Surg, 1980;29:228-33.
46. Heard GG, Lamberti JJ Jr., Park SM et al. Early extubation following surgical repair of congenital heart disease. Crit Care Med, 1985;13:830-2
47. Connell RS, Page US, Bartley TD et al. The effect on pulmonary ultrastructure of dacron wool filtration during cardipulmonay bypass. Ann Thorac Surg, 1973;15:217-29.
48. DiCarlo JV, Raphaely RC, Steven JM et al. Pulmonary mechanics in infants after cardiac surgery. Crit Care Med, 1992;20:22-7.
49. Levin DL, Morris FC. Essentials of Pediatric Intensive Care. 2nd ed. St. Louis: Quality Medical Publishing, 1997.
50. Farias JA, Alia I, Esteban A et al. Weaning from mechanical ventilation in pediatric intensive care patients. Intensive Care Med, 1998;24:1070-5.
51. Khan N, Brown A, Venkataraman ST. Predictors of extubation success and failure in mechanically ventilated infants and children. Crit Care Med, 1996;1568-79.

52. Baumeister BL, El-Katib M, Smith PG et al. Evaluation of predictors of weaning from mechanical ventilation in pediatric patients. Pediatr Pulmonol, 1997;24:344-52.
53. Ventataraman ST, Khan N, Brown A. Validation of predictors of extubation success and failure in mechanically ventilated infants and children, Crit Care Med, 2000;28:2991-6.
54. Iyer NP, Rotta AT, Essouri S, et al. Association of Extubation Failure Rates With High-Flow Nasal Cannula, Continuous Positive Airway Pressure, and Bilevel Positive Airway Pressure vs Conventional Oxygen Therapy in Infants and Young Children: A Systematic Review and Network Meta-Analysis. JAMA Pediatr. 2023;177(8):774-781.
55. Heffner JE. Tracheotomy: Indications and timing. Respir care, 1999;44:807-15.
56. Liu Y, Bian W, Liu P, Zang X, Gu X, Chen W. Dexmedetomidine improves the outcomes in paediatric cardiac surgery: a meta-analysis of randomized controlled trials. Interact CardioVasc Thorac Surg 2018;26:852–8
57. Pan, W., Wang, Y., Lin, L., Zhou, G., Hua, X. and Mo, L. (2016), Outcomes of dexmedetomidine treatment in pediatric patients undergoing congenital heart disease surgery: a meta-analysis. Paediatr Anaesth, 26:
58. Alvarez RV, Palmer C, Czaja AS, Peyton C, Silver G, Traube C, et al. Delirium is a common and early finding in patients in the pediatric cardiac intensive care unit. J Pediatr. 2018;195:206-12
59. Traube C, Silver G, Gerber LM, Mauer E, Silver G, Chai P, et al. Delirium and mortality in critically ill children: epidemiology and outcomes of pediatric delirium. Crit Care Med. 2017;45:891-8.
60. Fuller S, Kumar SR, Roy N, et al. The American Association for Thoracic Surgery Congenital Cardiac Surgery Working Group 2021 consensus document on a comprehensive perioperative approach to enhanced recovery after pediatric cardiac surgery. J Thorac Cardiovasc Surg. 2021;162(3):931-954
61. Kurth CD, Steven JL, Montenegro LM, et al. Cerebral oxygen saturation before congenital heart surgery. Ann Thorac Surg. 2001;72(1):187-192.
62. Franceschini, M., Thaker, S., Themelis, G. et al. Assessment of Infant Brain Development with Frequency-Domain Near-Infrared Spectroscopy. Pediatr Res 61, 546–551 (2007)
63. Öztürk NY, Aygün B, Uyar E, Girgin Fİ. Comparison of Bilateral Cerebro-Renal Tissue Oxygenations in Healthy Children. Indian J Pediatr. 2020;87(2):99-104.
64. Kurth CD, Levy WJ, McCann J. Near-infrared spectroscopy cerebral oxygen saturation thresholds for hypoxia-ischemia in piglets. J Cereb Blood Flow Metab 2002;22:335–41.
65. Zaleski KL, Kussman BD. Near-Infrared Spectroscopy in Pediatric Congenital Heart Disease. J Cardiothorac Vasc Anesth. 2020;34(2):489-500.
66. Nagdyman N, Ewert P, Peters B, Miera O, Fleck T, Berger F. Comparison of different near-infrared spectroscopic cerebral oxygenation indices with central venous and jugular venous oxygenation saturation in children. Paediatr Anaesth. 2008;18(2):160-166
67. Jonas RA. Hypothermia, circulatory arrest, and the pediatric brain. J Cardiothorac Vasc Anesth, 1996;10:66-74
68. Moritz ML, Ayus JC. Prevention of hospital-acquired hyponatremia: A case for using isotonic saline. Pediatrics, 2003;111:227-30.
69. Singh N, Kissoon N, Al Mofada S et al. Comparison of continuous versus intermittent furosemide administration in postoperative pediatric cardiac patients. Crit Care Med, 1992;20:17-21.
70. Klinge JM, Scharf J, Hofbeck M et al. Intermittent administration of furosemide versus continuous infusion in the postoperative management of children following open heart surgery. Intensive Care Med, 1997;23:693-7.
71. Luciani GB, Nichani S, Chang AC et al. Continuous versus intermittent furosemide infusion in critically ill infants after open heart operations. Ann Thorac Surg, 1997;64:1133-9.
72. Lochan, S. R., Adeniyi-Jones, S., Assadi, F. K., Frey, B. M., Marcus, S., & Baumgart, S. (1998). Coadministration of theophylline enhances diuretic response to furosemide in infants during extracorporeal membrane oxygenation: a randomized controlled pilot study. The Journal of pediatrics, 133(1), 86–89
73. Park, K., Trout, L. C., Xu, C., Wang, M., Tamburro, R. F., & Halstead, E. S. (2018). No Requirement for Targeted Theophylline Levels for Diuretic Effect of Aminophylline in Critically Ill Children. Pediatric critical care medicine : a journal of the Society of Critical Care Medicine and the World Federation of Pediatric Intensive and Critical Care Societies, 19(8), e425–e432.
74. England MR, Gordon G, Salem M, Chernow B. Magnesium administration and dysrythmias after cardiac surgery. A placebo controlled, double- blind, randomized trial. JAMA, 1992;268:2395-402.
75. Munoz R, Laussen PC, Palacio G et al. Whole blood ionized magnesium levels: age related differences in normal values and clinical implications of ionized hypomagnesemia in patients undergoing surgery for congenital cardiac disease. J Thorac Cardiovasc Surg, 2000;119:891-8.
76. Hoffman TM, Bush DM, Wernovsky G et al. Postoperative junctional ectopic tachycardia in children: Incidence, risk factors, and treatment. Ann Thorac Surg, 2002;74:1607-11.
77. Dorman BH, Sade RM, Burnette JS et al. Magnesium supplementation in the prevention of arrythmias in pediatric patients undergoing for congenital heart defects. Am Heart J, 2000;139:533-8.
78. Tsay W, Shen MC. Experience of desmopressin (DDAVP) administration in patients with congenital and aquired bleeding disorders. J Formos Med Assoc, 1992;91:962-9.
79. Erstad BL. Antifibrinolytic agents and desmopressin as hemostatic agents in cardiac surgery. Ann Pharmacother, 2001;35:1075-84.
80. Henry DA, Moxey AJ, Carless PA et al. Anti-fibrinolytic use for minimizing perioperative allogenic blood transfusion. Cochrane Database Syst Rev, 2000;(1):CD001886.
81. Chauhan S, Kumar BA, Rao BH et al. Efficacy of aprotinin or epsilon aminocaproic acid, or combination in cyanotic heart disease. Ann Thorac Surg, 2000;70:1308- 12.
82. Pasquali SK, Hall M, Li JS et al. Safety of aprotinin in congenital heart operations: results from a large mul-

ticenter database. Ann Thorac Surg, 2010;90:14-21.61. Backer CL, Kelle AM, Stewart RD et al. Aprotinin is safe in pediatric patients undergoing cardiac surgery. J Thorac Cardiovasc Surg, 2007;134:1421-6.
83. Mangano D, Tudor IC, Dietzel C. Group MSoPIR, Foundation IRaE. The risk associated with aprotinin in cardiac surgery. N Engl J Med, 2006;354:353-65.
84. Fergusson DA, Hébert PC, Mazer CD et al. A comparison of aprotinin and lysine analogues in high-risk cardiac surgery. N Engl J Med, 2008;358:2319-31.
85. Kylasam S, Mos K, Fijtin S et al. Recombinant activated factor VII following pediatric cardiac surgery. J Intensive Care Med, 2009;24:116-21.
86. Karsies TJ, Nicol KK, Galantowicz ME et al. Thromboticr isk of recombinant factor seven in pediatric cardiac surgery: A single institution experience. Ann Thorac Surg, 2010;89:570-6.
87. Alten JA, Benner K, Green K et al. Pediatric off-label use of recombinant factor VIIa. Pediatrics 2009;123:1066-72.
88. Levi M, Peters M, Buller HR. Efficacy and safety of recombinant factor VIIa for treatment of severe bleeding: A systematic review. Crit Care Med, 2005;33:883-90.
89. Goelzer SL, Farin-Rush C, Coursin DB. Ranitidine produces minimal hemodynamic depression in stable intensive care patients: A double blind, prospective study. Crit Care Med, 1988;16:8-10.
90. Lopez-Hence J, Velasco LA, Codoceo R et al. Ranitidine prophylaxis in acute gastric mucosal damage in critically ill pediatric patients. Crit Care Med, 1988;16:591-3.
91. Apte NM, Karnad DR, Methekar TP et al. Gastric colonization and pneumonia in intubated critically ill patients receiving stress ulcer prophylaxis: A randomized controlled trial. Crit Care Med, 1992;20:590-3.
92. Driks MR, Craven DE, Celli BR et al. Nosocomial pneumonia in intubated patients given sucralfate as compared with antacids of histamine type 2 blockers. N Eng J Med, 1987;317:1376-82.
93. Duffett M, Chan A, Closs J, et al. Stress Ulcer Prophylaxis in Critically Ill Children: A Multicenter Observational Study. Pediatr Crit Care Med. 2020;21(2):e107-e113.
94. Pingleton SK. Enteral nutrition and infection in the intensive care unit. Semin Respir Infec 1990;5:185-190.
95. Minard G, Kudsk KA. Nutritional support and infection: does the route matter? World J Surg, 1998;22:213-9.
96. Pollock EM, Ford-Jones EL, Rebeyka I et al. Early nosocomial infections in pediatric cardiovascular surgery patients. Crit Care Med, 1990;18:378-84.
97. McBride WT, Armstrong MA, Crockard AD et al. Cytokine balance and immunosuppressive changes at cardiac surgery: Contrasting response between patients and isolated CPB circuits. Br J Anaesth, 1995;75:724-33.
98. Hauser GJ, Chan MM, Casey WF et al. Immune dysfunction in children after corrective surgery for congenital heart disease. Crit Care Med, 1991;18:874-81.
99. Lin E, Lowry SF. Inflammatory cytokines in major surgery: A functional perspective. Intensive Care Med, 1999;25:255-7.
100. Van Dissel JT, van Langevelde P, Westendorp RGJ et al. Anti-inflammatory cytokine profile and mortality in febrile patients. Lancet, 1998;351:950-3.
101. Allen M, Peters M, Goldman A et al. Early postoperative monocyte deactivation predicts systemic inflammation and prolonged stay in pediatric cardiac intensive care. Crit Care Med, 2002;30:1140-5.
102. Friedman RA, Collins E, Fenrich AL. Pacing in children: Indications and techniques. Prog Pediatr Cardiol, 1995;4:21-9.
103. Sorof J, Stromberg D, Brewer E et al. Early initiation of peritoneal dialysis after surgical repair of congenital heart disease. Pediatr Nephrol, 1999;13;641-5.
104. Vande Walle J, Raes A, Castillo D et al. New perspectives for PD in renal failure related to new catheter techniques and introduction of APD. Adv Perit Dial 1997;13:190-4.
105. Flynn J. Causes, management approaches and outcome of acute renal failure in children. Curr Opin Pediatr 1998;10:184-9.
106. Hand MM, McManus ML, Harmon WE. Renal disorders in pediatric intensive care. In Rogers M, ed. Textbook of pediatric intensive care. Baltimore:Williams&Wilkins, 1996.
107. Smoyer W, Maxvold N, Remenapp R et al. Pediatric renal replacement therapy. In Fuhrman B, Zimmerman J, eds. Pediatric critical care, 2nd ed. Saint Louis: Mosby, 1998.
108. Walsh EP, Saul JP, Sholler GF et al. Evaluation of a staged protocol for rapid automatic junctional tachycardia after operation for congenital heart disease. J Am Coll Cardiol, 1997;29:1046-53.
109. Perry JC, Fenrich A, Hulse JE et al. Pediatric use of intravenous amiodarone: Efficacy and safety in critically ill patients from a multicenter protocol. J Am Coll Cardiol, 1996;27:1246-50.
110. Laird WP, Snyder CS, Kertesz NJ et al. Use of intravenous amiodarone for postoperative junctional ectopic tachycardia in children. Pediatr Cardiol. 2003;24:133-7.
111. Saul JP, Scott WA, Brown S, et al. Intravenous amiodarone for incessant tachyarrhythmias in children: a randomized, double-blind, antiarrhythmic drug trial. Circulation. 2005;112(22):3470-3477.
112. Gautam, N. K., Turiy, Y., & Srinivasan, C. (2017). Preincision Initiation of Dexmedetomidine Maximally Reduces the Risk of Junctional Ectopic Tachycardia in Children Undergoing Ventricular Septal Defect Repairs. Journal of cardiothoracic and vascular anesthesia, 31(6), 1960–1965.
113. Krishna, M. R., Kunde, M. F., Kumar, R. K., & Balaji, S. (2019). Ivabradine in Post-operative Junctional Ectopic Tachycardia (JET): Breaking New Ground. Pediatric cardiology, 40(6), 1284–1288.
114. Kumar, V., Kumar, G., Tiwari, N., Joshi, S., Sharma, V., & Ramamurthy, R. (2019). Ivabradine as an Adjunct for Refractory Junctional Ectopic Tachycardia Following Pediatric Cardiac Surgery: A Preliminary Study. World journal for pediatric & congenital heart surgery, 10(6), 709–714.
115. Koul B, Willen H, Sjöberg T et al. Pulmonary sequela of prolonged total venoarterial bypass: Evaluation with a new experimental model. Ann Thorac Surg, 1991;51:794-9.
116. Koul B, Wollmer P, Willen H et al. Veno arterial extracorporeal membrane oxygenation: How safe is it? J Thorac Cardiovasc Surg, 1992;104:579-84.
117. The Neonatal Inhaled Nitric Oxide Study Group: Inhaled nitric oxide in full term and nearly full term infants with hypoxic respiratory failure. N Eng J Med, 1997,336:597.

118. Goldman AP, Delius RE, Deanfield JE et al. Nitric oxide might reduce the need for extracorporeal support in children with critical postoperative pulmonary hypertension. Ann Thorac Surg, 1996,62:750-5.
119. Atz AM, Wessel DL. Sildenafil ameliorates effects of inhaled nitric oxide withdrawal from inhaled nitric oxide withdrawal. Anest 1999;91:307-10.,
120. Siberry G, Iannone R. The Harriet Lane Handbook. 15th ed. St Louis: Mosby, 2000.
121. Park MK. Pediatric Cardiology for Practitioners. 3rd ed. St Louis: Mosby, 1996.



PALYATİF OPERASYONLAR

BÖLÜM
22

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İçindekiler

» GİRİŞ
» SİSTEMİK PULMONER ŞANTLAR
» MODİFİYE BLALOCK TAUSSİNG THOMAS ŞANT
  » Endikasyonlar
  » Patofizyoloji
  » Prosedür Tekniği
» KOMPLİKASYONLAR
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  » Komplikasyonlar
  » Myokard Enfarktüsü Sonrası VSD
  » Hipoplastik Sol Kalp Sendromu
  » Dilate Kardiyomyopati

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(DKMP) nedeniyle şiddetli kalp yetmezliği olan çocuklar için potansiyel bir seçenek olarak ortaya çıkmıştır. Bu açıdan PAB, bu hasta grubunda uygulanabilirliliği ile akılda tutulması gereken bir palyatif tekniktir.

Yapılan bazı çalışmalarda korunan sağ ventrikül fonksiyonuna sahip küçük çocuklarda (<6 yaş) DKMP'ye bağlı son evre kalp yetmezliğini hafifletmek için PAB önerilmektedir (105,106). Ancak, pediyatrik DKMP'de PAB'nin endikasyonları hakkında tartışmalar devam etmektedir. Bu tedavinin kalp nakline bir köprü mü yoksa bir hedef tedavi mi olduğu da değerlendirilmeyi beklemektedir.

Son olarak; konjenital kalp cerrahisi tarihçesinde PAB ilk tanımlandığı günlerde sıklıkla başvurulan bir teknik olmasına rağmen bilginin ve teknolojik olanakların artmasına paralel olarak kullanımı azalmıştır. Diğer taraftan ilk tanımlandığı hasta grubu dışındaki hastalarda band ameliyatı tanımlanmış olması ve günümüzde halen genel kondisyonu düşük hastalarda tercih edilebilir olması prosedürü vazgeçilmez kılmaktadır. Uygulaması basit olmasına karşın başarılı sonuçlar için belirli bir deneyim gerektirmesi tekniğin akılda tutulması gereken bir diğer tarafıdır.

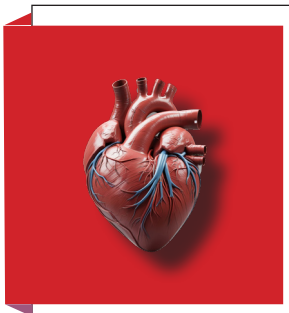
KAYNAKLAR

1. Godart F, Qureshi SA, Simha A, et al. Effects of modified and classic Blalock-Taussig's shunts on the pulmonary arterial tree. Ann Thorac Surg 1998;66:512-7
2. Mainwaring RD, Mainwaring S. The retirement years of Doctor Helen B. Taussig: an intersection of art and medicine. Cardiol Young. 2024;34:334-47.
3. BlalockAlfred, TaussigHelenB. The surgical treatment of malformations of the heart in which there is pulmonary stenosis or pulmonary atresia. JAMA.1945;128:189–92.
4. Brogan TV, Alfieris GM. Has the time come to rename the Blalock-Taussig shunt? Pediatr Crit Care Med. 2003;4:450-3.
5. KarpawichPP,BushCP,AntillonJR,AmatoJJ,MarbeyML,Agar- wal KC. Modified Blalock-Taussig's shunt in infants and young children. Clinical and catheterization assessment. J Thorac Cardiovasc Surg 1985;89:275-9
6. Watterson KG, Wilkinson JL, Karl TR, Mee RB. Very small pulmonary arteries: central end-to-side shunt. Ann Thorac Surg 1991;52:1132–7
7. Shumacker Jr HB, Mandelbaum I. Ascending aorticpulmonary artery shunts in cyanotic heart disease. Surgery 1962;52:675—8.
8. Redo SF, Ecker RR. Intrapericardial aorticopulmonary artery shunt. Circulation 1963;28:520-4.
9. Nanton MA, Roy DL, Murphy DM, et al. Polytetrafluoroethylene shunts in congenital heart disease. Can J Surg 1982;25:134-8
10. Ruiz CE, Bailey LL. Stenting the ductus arteriosus: a ''wanna- be'' Blalock-Taussig. Circulation 1999;99:2608-9
11. Elliott MP, Gazzaniga AB, Thomas JM, Haiduc NJ, Rosen SM. Use of expanded polytetrafluoroethylene grafts for vascular access in hemodialysis: laboratory and clinical evaluation. Am Surg. 1977;43:455-9.
12. Odim J, Portzky M, Zurakowski D et al. Sternotomy approach for the modified Blalock-Taussig shunt. Circulation 1995;92:256–61
13. Kyger 3rd ER, Reul Jr GJ, Sandiford FM, et al.. Surgical palliation of tricuspid atresia. Circulation. 1975;52:685–90.
14. LambertiJJ,CarlisleJ,WaldmanJD,etal..Systemic-pulmonaryshuntsininfants and children. Early and late results. J Thorac Cardiovasc Surg. 1984;88:76–81.
15. Jacobs Jeffrey Phillip et al.. Initial application in the EACTS and STS congenital heart surgery databases of an empirically derived methodology of complexity adjustment to evaluate surgical case mix and results. Eur J Cardiothorac Surg. 2012;42:775–80.
16. Jacobs Marshall L, Jacobs Marshall Lewis, Maruszewski Bohdan, et al.. An empirically based tool for analyzing morbidity associated with operations for congenital heart disease. J Thorac Cardiovasc Surg. 2013;145:1046-57.
17. Ismail SR, Almazmi MM, Khokhar R, AlMadani W, Hadadi A, Hijazi O, Kabbani MS, Shaath G, Elbarbary M. Effects of protocol-based management on the post-operative outcome after systemic to pulmonary shunt. Egypt Heart J. 2018;70:271-8.
18. Petrucci O, O'Brien SM, Jacobs ML et al. Risk factors for mortality and morbidity after the neonatal Blalock-Taussig shunt procedure. Ann Thorac Surg 2011;92:642–51
19. O'Connor MJ, Ravishankar C, Ballweg JA et al. Early sys- temic-to-pulmonary artery shunt intervention in neonates with congenital heart disease. J Thorac Cardiovasc Surg 2011;142:106–12
20. Zahorec M, Hrubsova Z, Skrak P et al. A comparison of Blalock-Taussig shunts with and without closure of the duc- tus arteriosus in neonates with pulmonary atresia. Ann Thorac Surg 2011;92:653–8
21. Odim J, Portzky M, Zurakowski D et al. Sternotomy approach for the modified Blalock-Taussig shunt. Circulation 1995;92:256–61
22. Talwar S, Kumar MV, Muthukkumaran S, Airan B. Is sternotomy superior to thoracotomy for modified Blalock-Taussig shunt? Interact Cardiovasc Thorac Surg. 2014;18:371–5.
23. Dirks V, Prêtre R, KnirschW Modified, et al.. Blalock Taussig shunt: a not-so- simple palliative procedure. Eur J Cardiothorac Surg. 2013;44:1096–102.
24. Odim Jonah, Portzky M, Zurakowski D, Wernovsky G, et al.. Sternotomy approach for the modified Blalock-Taussig shunt. Circulation. 1995;92:256–61.
25. Alsoufi Bahaaldin, Gillespie Scott, Kogon Brian, et al.. Results of palliation with an initial modified blalock-taussig shunt in neonates with single ventricle anomalies associated with restrictive pulmonary blood flow. Ann Thoracic Surg. 2015;99:1639–47

26. Mullen JC, Lemermeyer G, Bentley MJ. Modified Blalock-Taussig shunts: to heparinize or not to heparinize? Can J Cardiol. 1996;12:645–7.
27. Guzzetta NA, Foster GS, Mruthinti N, et al.. In-hospital shunt occlusion in infants undergoing a modified blalock-taussig shunt. Ann Thorac Surg. 2013;96:176–82.
28. Jones HE, Dolton EG: Bacterial endocarditis after a Taussig-Blalock operation in a case of unusual pathology. Arch Dis Child 1952;27:157-60.
29. Kostolny M, Kaemmerer H, Schreiber C: Dysphagia asso- ciated with an aneurysm decades after Blalock-Taussig anastomosis. Eur Heart J 2006;27:1684.
30. Liu P, Williams WG, Webb G, et al: Fatal esophageal-arterial fistula 17 years following tetralogy of Fallot repair. Can J Cardiol 1992;8:200-3.
31. Sethia B, Pollock JC: False aneurysm formation: A complication following the modified Blalock-Taussigshunt. Ann Thorac Surg 1986;41:667-8.
32. Carrel T, Winklehner H, Pasic M, et al: Spontaneous expectoration of a prosthetic graft nine years after a Blalock-Taussig shunt procedure. N Engl J Med 1993;329:1899.
33. Stevenson JG, Kawabori I, Bailey WW: Noninvasive evaluation of Blalock-Taussig shunts: Determination of patency and differentiation from patent ductus arterio- sus by doppler echocardiography. Am Heart J 1983;106:1121-32
34. Fermanis GG, Ekangaki AK, Salmon AP, et al: Twelve year experience with the modified Blalock-Taussig shunt in neonates. Eur J Cardiothorac Surg 1992;6:586-9.
35. Hofbeck M, Singer H, Wild F, et al: Color Doppler imag- ing of modified Blalock-Taussig shunts during infancy. Pediatr Cardiol 1994;15:163-6
36. Horiguchi Y, Hiraishi S, Misawa H, et al: Cross sectional and Doppler echocardiographic evaluation of aortopul- monary shunts. Br Heart J 1992;67:312-5.
37. Dorobantu DM, Pandey R, Sharabiani MT, et al. Indications and results of systemic to pulmonary shunts:results from a national database.Eur J Cardiothorac Surg. 2016;49:1553-63
38. Brown KL, Crowe S, Franklin R, et al. Trends in 30-day mortality rate and case mix for paediatric cardiac surgery in the UK between 2000 and 2010. Open Heart. 2015;2:e000157.
39. Bove T, Vandekerckhove K, Panzer J, De Groote K, De Wolf D, François K. Disease-specific outcome analysis of palliation with the modified Blalock-Taussig shunt. World J Pediatr Cong Heart Surg. 2015;6:67–74.
40. Petrucci O, O'Brien SM, Jacobs ML, Jacobs JP, Manning PB, Eghte- sady P. Risk factors for mortality and morbidity after the neonatal Blalock-Taussig shunt procedure. Ann Thorac Surg. 2011;92:642–52
41. Gibbs JL, Rothman MT, Rees MR, Parsons JM, Blackburn ME, Ruiz CE. Stenting of the arterial duct: a new approach to palliation for pulmonary atresia. Br Heart J. 1992;67:240–5.
42. Santoro G, Capozzi G, Caianiello G, Palladino MT, Marrone C, Farina G, Russo MG, Calabrò R. Pulmonary artery growth after palliation of congen- ital heart disease with duct-dependent pulmonary circulation: arterial duct stenting versus surgical shunt. J Am Coll Cardiol. 2009;54:2180–6.
43. Santoro G, Gaio G, Capozzi G, Giugno L, Palladino MT, Capogrosso C, D'Aiello AF, Caianiello G, Russo MG. Fate of hypoplastic pulmonary ar- teries after arterial duct stenting in congenital heart disease with duct- dependent pulmonary circulation. JACC Cardiovasc Interv. 2015;8:1626–32.
44. Santoro G, Palladino MT, Capozzi G, Iacono C, Russo MG, Calabrò R. Pul- monary artery growth following arterial duct stenting in congenital heart disease with duct-dependent pulmonary circulation. Catheter Cardiovasc Interv. 2009;74:1072–6.
45. Sivakumar K, Bhagyavathy A, Coelho R, Satish R, Krishnan P. Longevity of neonatal ductal stenting for congenital heart diseases with duct-depen- dent pulmonary circulation. Congenit Heart Dis. 2012;7:526–33.
46. Vida VL, Speggiorin S, Maschietto N, Padalino MA, Tessari C, Biffanti R, Cerutti A, Milanesi O, Stellin G. Cardiac operations after patent ductus arteriosus stenting in duct-dependent pulmonary circulation. Ann Thorac Surg. 2010;90:605–9.
47. Amoozgar H, Cheriki S, Borzoee M, Ajami G, Soltani M, Ahmadipour M, Peiravian F, Amirghofran A. Short-term result of ductus arteriosus stent implantation compared with surgically created shunts. Pediatr Cardiol. 2012;33:1288–94.
48. Mallula K, Vaughn G, El-Said H, Lamberti JJ, Moore JW. Comparison of ductal stenting versus surgical shunts for palliation of patients with pul- monary atresia and intact ventricular septum. Catheter Cardiovasc Interv. 2015;85:1196–202.
49. McMullan DM, Permut LC, Jones TK, Johnston TA, Rubio AE. Modified Blalock-Taussig shunt versus ductal stenting for palliation of cardiac le- sions with inadequate pulmonary blood flow. J Thorac Cardiovasc Surg. 2014;147:397–401.
50. Glatz AC, Petit CJ, Goldstein BH, Kelleman MS, McCracken CE, McDonnell A, Buckey T, Mascio CE, Shashidharan S, Ligon RA, Ao J, Whiteside W, Wallen WJ, Metcalf CM, Aggarwal V, Agrawal H, Qureshi AM. Comparison Between Patent Ductus Arteriosus Stent and Modified Blalock-Taussig Shunt as Palliation for Infants With Ductal-Dependent Pulmonary Blood Flow: Insights From the Congenital Catheterization Research Collaborative. Circulation. 2018;137:589-601.
51. M. Ghaderian, A. Ahmadi, M.R. Sabri, et al. Clinical outcome of right ventricular outflow tract stenting versus Blalock-Taussig shunt in tetralogy of Fallot: a systematic review and meta-analysis. Curr Probl Cardiol, 2021;46:1-14
52. Sandoval JP, Chaturvedi RR, Benson L, Morgan G, Van Arsdell G, Honjo O, et al. Right ventricular outflow tract stenting in tetralogy of Fallot infants with risk factors for early primary repair. Circ Cardiovasc Interv 2016;9:e003979.
53. Barron DJ, Ramchandani B, Murala J, Stumper O, De Giovanni JV, Jones TJ, Stickley J, Brawn WJ. Surgery following primary right ventricular outflow tract stenting for Fallot's tetralogy and variants: rehabilitation of small pulmonary arteries. Eur J Cardiothorac Surg. 2013;44:656–62.
54. Joffs C, Sade RM. Congenital Heart Surgery Nomenclature and Database Project: palliation, correction or repair? Ann Thorac Surg. 2000;69:369-72.
55. Valente AS, Mesquita F, Mejia JAC, Maia ICL, Maior MS, Branco KC, et al. Pulmonary artery banding: a simple procedure? A critical analysis at a tertiary

center. Brazilian Journal of Cardiovascular Surgery. 2009 24:327–33.
56. Muller WH, Jr, Danimann JF, Jr. The treatment of certain congenital malformations of the heart by the creation of pulmonic stenosis to reduce pulmonary hypertension and excessive pulmonary blood flow a preliminary report. Surgery, Gynecology & Obstetrics. 1952 95:213–9.
57. Ghoussaini R, Zareef R, Makarem A, Younis N, Al Hassan S, El Rassi I, Obeid M, Bitar F and Arabi M (2024) Pulmonary artery banding: a 20-year experience at a tertiary care center in a developing country. Front Cardiovasc Med 2024;29;11:1368921.
58. Alsoufi B. Commentary: pulmonary artery banding in infants with atrioventricular septal defect, valid strategy or backward move? J Thorac Cardiovasc Surg,2020159: 1504–6.
59. Inohara T, Ichihara N, Kohsaka S, et al. The effect of body weight in infants undergoing ventricular septal defect closure: a report from the Nationwide Japanese Congenital Surgical Database. J Thorac Cardiovasc Surg 2019;157:1132–41.
60. Afifi ARSA, Seale AN, Chaudhari M, Khan NE, Jones TJ, Stumper O, and Botha P. Pulmonary artery banding: still a role for staged bi-ventricular repair of intracardiac shunts? Cardiology in the Young. 2023;33:1627–33.
61. Rodefeld MD, Ruzmetov M, Schamberger MS, Girod DA, Turrentine MW, Brown JW. Staged surgical repair of functional single ventricle in infants with unobstructed pulmonary blood flow. European Journal of Cardio-thoracic Surgery: Official Journal of the European Association for Cardio-thoracic Surgery. 2005 27:949–55
62. Zhang H, Li G, Li Q, Zuo Y, Wang Q. Impact of Pulmonary Artery Banding in Patients with Congenital Heart Disease and Pulmonary Hypertension. Rev Cardiovasc Med. 2024;25:253.
63. Takayama H, Sekiguchi A, Chikada M, Noma M, Ishizawa A, Takamoto S. Mortality of pulmonary artery banding in the current era: recent mortality of PA banding. Ann Thorac Surg. 2002;74:1219–23.
64. Steussy HF, Caldwell RL, Wills ER, Waller BF. High takeoff of the left main coronary artery from the pulmonary trunk: potentially fatal combination with pulmonary trunk banding. Am Heart J. 1984;108:619–21.
65. Sharma D, Murki S. Making neonatal intensive care: cost effective. The Journal of Maternal-fetal & Neonatal Medicine: the Official Journal of the European Association of Perinatal Medicine, the Federation of Asia and Oceania Perinatal Societies, the International Society of Perinatal Obstetricians. 2021 34:2375–83.
66. Akyüz M., Işık O., Mercan I., Cakmak M. Limited upper mini-sternotomy approach for closed heart surgery in the newborns and infants // General Thoracic and Cardiovascular Surgery. 2021;69:1527-31.
67. Nagashima M, Okamura T, Shikata F, Chisaka T, Takata H, Ohta M, et al. Pulmonary artery banding for neonates and early infants with low body weight. The Tohoku Journal of Experimental Medicine. 2011 225:255–62.
68. Trusler GA, Mustard WT. A method of banding the pulmonary artery for large isolated ventricular septal defect with and without transposition of the great arteries. The Annals of Thoracic Surgery. 1972 13:351–5.
69. Ergün S, Çilsal E, Genç SB, Yıldız O, Tanıdır IC, Onan IS, Güzeltaş A, Haydin S. Univentricular Pulmonary Artery Banding: How Tight is Tight Enough for Successful Progress? Pediatr Cardiol. 2021;42:840-8.
70. Sharma R. Pulmonary artery banding: Rationale and possible indicationsin the current era. Ann Pediatr Cardiol 2012;5:40–3.
71. Albus RA, Trusler GA, Izakawa T, Williams W.Pulmonary artery banding. J Thorac Cardiovasc Surg 1984;88:645–53.
72. Baslaim G.Modifcation of Trusler's formula for the pulmonary artery banding. Heart Lung Circ 2009;18:353–7.
73. Kajihara N, Asou T, Takeda Y, Kosaka Y, Onakatomi Y, Nagafuchi H, Yasui S (2010) Pulmonary artery banding for functionally single ventricles: ımpact of tighter banding in staged fontan era. Ann Thorac Surg 2010;89:174–9.
74. Wernovsky G, Bove EL.Single ventricle lesions. In: Chang AC, Hanley FL, Wernovsky G, Wessel DL (eds) Pediatric cardiac intensive care. Lippincott Williams and Wilkins, Philadelphia, 1998, pp 275–276.
75. Kotani Y, Coles M, Desai ND, Honjo O, Caldarone CA, Coles JG, et al. The utility of aortic blood fow measurements in the prediction of pulmonary artery banding outcome. Ann Thorac Surg 2015;99:2096–100
76. Changizi A, Yaghoubi A, Azarasa M, Ghaffari S, Montazerghaem H. A studyon the mortality and complication rates following percutaneously adjustable-pulmonary artery banding. J Cardiovasc Thorac Res 2014;6:253–5.
77. Agasthi P, Graziano JN. Pulmonary Artery Banding. StatPearls, 2021.
78. Soler R, Rodríguez E, Álvarez M, Raposo I. Postoperative imaging in cyanoticcongenital heart diseases: part 2, Complications. AJR Am J Roentgenol 2007;189:1361–9
79. Rajiah PS, Sardá MJ, Ashwath R, Goerne H. Palliative Procedures for Congenital Heart Disease: Imaging Findings and Complications. Radiographics. 2023;43:e220049
80. St Louis JD, Jodhka U, Jacobs JP, He X, Hill KD, Pasquali SK, et al. Contemporary outcomes of complete atrioventricular septal defect repair: analysis of the Society of Thoracic Surgeons Congenital Heart Surgery Database. J Thorac Cardiovasc Surg. 2014;148:2526-31.
81. Overman DM, Dummer KB, Moga FX, Gremmels DB. Unbalanced atrioventricular septal defect: defining the limits of biventricular repair. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2013;16:32-6.
82. Cohen MS, Jegatheeswaran A, Baffa JM, Gremmels DB, Overman DM, Caldarone CA, et al. Echocardiographic features defining right dominant unbalanced atrioventricular septal defect: a multi-institutional Congenital Heart Surgeons' Society study. Circ Cardiovasc Imaging. 2013;6:508-13.
83. Jegatheeswaran A, Pizarro C, Caldarone CA, Cohen MS, Baffa JM, Gremmels DB, et al. Echocardiographic definition and surgical decisionmaking in unbalanced atrioventricular septal defect: a Congenital Heart Surgeons' Society multiinstitutional study. Circulation. 2010;122:209-15.
84. Meza JM, Devlin PJ, Overman DM, Gremmels D, Baffa G, Cohen MS, et al. The Congenital Heart Surgeons'

Society complete atrioventricular septal defect cohort: baseline, preintervention echocardiographic characteristics. Semin Thorac Cardiovasc Surg. 2019;31:80-6
85. Shuhaiber J, Shin, AY, Gossett JG. Surgical management of neonatal atrioventricular septal defect with aortic arch obstruction Ann Thorac Surg. 2013;95:2071-7
86. Bisoi AK, Sharma P, Chauhan S, et al. Primary arterial switch operation in children presenting late with d-transposition of great arteries and intact ventricular septum. When is it too late for a primary arterial switch operation? Eur J Cardiothorac Surg 2010;38:707–13.
87. Sarris GE, Balmer C, et al. Clinical guidelines for the management of patients with transposition of the great arteries with intact ventricular septum. Cardiol Young 2017;27:530–69.
88. Yacoub M, Radley-Smith R, McLaurin R. Two-stage operation for anatomical correction of transposition of the great arteries with an intact interventricular septum. Lancet 1977;1:1275–8.
89. Jonas R, Giglia T, Sanders S, et al. Rapid, two-stage arterial switch for transposition of the great arteries and intact ventricular septum beyond the neonatal period. Circulation 1989;80:203–8.
90. Cevik A, Karaci AR, Polat B, Erturk M, Yalcin Y, Yazicioglu V, and Salihoglu E. Pulmonary artery banding and venous bidirectional cava-pulmonary shunt for twostage arterial switch procedure in late referral of patients with transposition of the great arteries and intact ventricular septum: midterm results. Cardiology in the Young 2019;29:649–54.
91. Ma K, Hua Z, Yang K, et al. Arterial switch for transposed great vessels with intact ventricular septum beyond one month of age. Ann Thorac Surg 2014;97:189–95.
92. Lacour-Gayet F, Piot D,Zoghbi J, et al. Surgical management and the indication of left ventricular retraining in the arterial switch for transposition of the great arteries with intact ventricular septum. Eur J Cardiothorac Surg 2001;20:824–9.
93. Sarris GE, Balmer C, et al. Clinical guidelines for the management of patients with transposition of the great arteries with intact ventricular septum. Cardiol Young 2017;27:530–69.
94. Di Donato RM, Fujii AM, Jonas RA, Castaneda AR. Age-dependent ven- ˜ tricular response to pressure overload. Considerations for the arterial switch operation. J Thorac Cardiovasc Surg 1992;104:713–22
95. Pascall E, Tulloh RM. Pulmonary hypertension in congenital heart disease. Future Cardiology. 2018□14:343–53
96. Dimopoulos K, Peset A, Gatzoulis MA. Evaluating operability in adults with congenital heart disease and the role of pretreatment with targeted pulmonary arterial hypertension therapy. Int J Cardiol. 2008;129:163–71.
97. Moreyra AE, Huang MS, Wilson AC, Deng Y, Cosgrove NM, Kostis JB, et al. Trends in incidence and mortality rates of ventricular septal rupture during acute myocardial infarction. Am J Cardiol 2010;106:1095–100.
98. Koichi Y, Kitahara H, Wakabayashi N, Ise H, Tanaka C, Nakanishi S, Ishikawa N, Kamiya H. Pulmonary artery banding for initial treatment of ventricular septal rupture. J Surg Case Rep. 2020;3:105-7.
99. O'Gara PT, Kushner FG, Ascheim DD, Casey DE Jr, Chung MK, de Lemos JA. et al. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: a report of the American College of Cardiology Foundation/American Heart Association task force on practice guidelines. Circulation 2013;127:362–425
100. Lundblad R, Abdelnoor M, Geiran OR, Svennevig JL. Surgical repair of postinfarction ventricular septal rupture: risk factors of early and late death. J Thorac Cardiovasc Surg 2009;137:862–8.
101. Newburger JW, Sleeper LA, Gaynor JW, Hollenbeck-Pringle D, Frommelt PC, Li JS, et al. Transplant-free survival and interventions at 6 years in the SVR trial. Circulation. 2018;137:2246-53.
102. Wernovsky G, Tweddell JS. Physiologic Principles to Maximize Outcome in Pa tients With a Functionally Univentricular Heart. Chapter 70, pp 1261-1272. In: Wernovsky G, Anderson RH, Kumar K, Mussatto KA, Redington AN, Tweddell JS, eds. Anderson'sPediatric Cardiology.FourthEdition. Philadelphia: Elsevier Publishing; 2020.
103. Michel-Behnke I, Akinturk H, Schranz D. Fate of the stented arterial duct. Cir culation. 2000;102:178.
104. Hoashi T, Imai K, Okuda N, Komori M, Kurosaki K, Ichikawa H. Intermediate term outcomes of deferred Norwood strategy. Eur J Cardio Thorac Surg. 2022;62:99
105. Schranz, D.; Rupp, S.; Müller, M.; Schmidt, D.; Bauer, A.; Valeske, K.; Michel-Behnke, I.; Jux, C.; Apitz, C.; Thul, J.; et al. Pulmonary artery banding ininfants and young children with left ventricular dilated cardiomyopathy: A novel therapeutic strategy before heart transplantation. J. Heart Lung Transplant. 2013;32:475–81.
106. Spigel, Z.A.; Razzouk, A.; Nigro, J.J.; Karamlou, T.B.; Kavarana, M.N.; Roeser, M.E.; Adachi, I. Pulmonary Artery Banding for Children With Dilated Cardiomyopathy: US Experience. Semin. Thorac. Cardiovasc. Surg. Pediatr. Card. Surg. Annu. 2020;23:69-76.



PATENT DUKTUS ARTERİOZUS

BÖLÜM
23

Dilek SUZAN [1]

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İçindekiler

- TANIM VE TARİHÇE
- ETİYOLOJİ VE İNSİDANS
- ANATOMİ VE HİSTOLOJİ
- FİZYOLOJİ- PATOFİZYOLOJİ
- KLİNİK ÖZELLİKLER
  - Fizik Muayene Bulguları
- TANI YÖNTEMLERİ
  - Elektrokardiyogram (EKG)
  - Radyolojik Bulgular
  - Ekokardiyografi
  - Bilgisayarlı Tomografi (BT) ve Manyetik Rezonans Görüntüleme (MRG)
  - Kardiyak Kateterizasyon
  - Klinik Değerlendirme
  - Ayırıcı Tanı
- TEDAVİ
  - Endikasyon, Strateji ve Zamanlama
- CERRAHİ TEDAVİ

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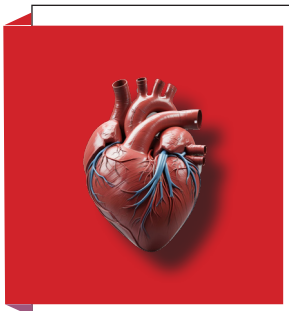
KAYNAKLAR

1. Backer, C. L., & Mavroudis, C. (2000). Congenital Heart Surgery Nomenclature and Database Project: patent ductus arteriosus, coarctation of the aorta, interrupted aortic arch. The Annals of thoracic surgery, 69(4 Suppl), S298–S307. https://doi.org/10.1016/s0003-4975(99)01280-1
2. Garrison, F. H. (1929). An introduction to the history of medicine with medical, chronology, suggestions for study and bibliographic data (pp. 105-121). WB Saunders.
3. Mettler, C. C. (1947). History of medicine. The Blackiston Company.
4. Richardson, R. G. (1970). First operations of the heart. In The scalpel and the heart (pp. 105-107). Charles Scribner's Sons.
5. Baillie, M. (1820). The morbid anatomy of some of the most important parts of the human body (5th ed.). Hickman and Hazzard.
6. Ma I., TierneyLM. Name that murmur—eponyms for the astute auscultician. N Engl J Med. 2010; 363:2164–8.
7. Gibson GA. Diseases of the heart and aorta. Edinburgh: Pentland; 1898. p. 566.
8. Tynan M. The murmur of the persistently patent arterial duct, or "The colonel is going to a dance". Cardiol Young. 2003; 13:559–62.
9. Comroe JH. Exploring the heart: discoveries in heart disease and high blood pressure. New York: WW Norton; 1983. p. 192–94.
10. Gross RE, Hubbard JP. Surgical ligation of a ductus arteriosus: report of first successful case. JAMA. 1939; 112:729–31.
11. Porstmann W, Wierny L, Warnke H. Closure of persistent ductus arteriosus without thoracotomy. German Med Monthly 1967; 15:109–203.
12. Schneider, D. J., & Moore, J. W. (2006). Patent ductus arteriosus. Circulation, 114(17), 1873-1882.
13. Hajjar, M. E., Vaksmann, G., Rakza, T., Kongolo, G., & Storme, L. (2005). Severity of the ductal shunt: a comparison of different markers. Archives of Disease in Childhood- Fetal and Neonatal Edition, 90(5), F419-F422.
14. Fanaroff, A. A., Hack, M., & Walsh, M. C. (2003). The NICHD Neonatal Research Network: changes in practice and outcomes during the first 15 years. Seminars in Perinatology, 27(4), 281-287.
15. Pegoli, W. (2005). Pericardium and great vessels. In K. T. Oldham, P. M. Colombiani, R. P. Foglia, & M. A. Skinner (Eds.), Principles and Practice of Pediatric Surgery (4th ed., p. 1019). Lippincott Williams & Wilkins.
16. Satoda M, Zhao F, Diaz GA, Burn J, Goodship J, Davidson HR, Pierpont ME, Gelb BD. Mutations in TFAP2B cause Char syndrome, a familial form of patent ductus arteriosus. Nat Genet. 2000 May;25(1):42-6. doi: 10.1038/75578. PMID: 10802654.
17. Hamrick SE, Hansmann G. Patent ductus arteriosus of the preterm infant. Pediatrics. 2010 May;125(5):1020-30. doi: 10.1542/peds.2009-3506. Epub 2010 Apr 26. PMID: 20421261.
18. Congdon ED. Transformation of the aortic arch system during the development of the human embryo. Contributions to Embryology. (1922) 14:47–110.
19. Mielke, G.; Benda, N. Reference Ranges for Two-Dimensional Echocardiographic Examination of the Fetal Ductus Arteriosus. Ultrasound Obstet. Gynecol. 2000, 15, 219–225.
20. Rudolph, A.M. Congenital Cardiovascular Malformations and the Fetal Circulation. Arch. Dis. Child. —Fetal Neonatal Ed. 2010, 95, F132–F136.
21. Philip R, Waller BR 3rd, Agrawal V, Wright D, Arevalo A, Zurakowski D, Sathanandam S. Morphologic characterization of the patent ductus arteriosus in the premature infant and the choice of transcatheter occlusion device. Catheter Cardiovasc Interv. 2016 Feb 1;87(2):310-7. doi: 10.1002/ccd.26287. Epub 2015 Nov 3. PMID: 26525611.
22. Achiron R, Rotstein Z, Heggesh J, Bronshtein M, Zimand S, Lipitz S, Yagel S. Anomalies of the fetal aortic arch: a novel sonographic approach to in-utero diagnosis. Ultrasound Obstet Gynecol. 2002 Dec;20(6):553-7. doi: 10.1046/j.1469-0705.2002.00850.x. PMID: 12493043.
23. Reese J. Towards a greater understanding of the ductus arteriosus. Semin Perinatol. (2018) 42:199–202. doi: 10.1053/j.semperi.2018.05.001
24. Fay FS, Kooke PH. Guinea pig ductus arteriosus, II: irreversible closure after birth. Am J Physiol. (1972) 222:841– 9. doi: 10.1152/ajplegacy.1972.222.4.841
25. Achiron R, Rotstein Z, Heggesh J, et al. Anomalies of the fetal aortic arch: a novel sonographic approach to in-utero diagnosis. Ultrasound Obstet Gynecol 2002;20(6):553–7.
26. Backer CL, Ilbawi MN, Idriss FS, et al. Vascular anomalies causing tracheoesophageal compression. Review of experience in children. J Thorac Cardiovasc Surg 1989;97(5):725–31.
27. Ishida, H.; Kawazu, Y.; Kayatani, F.; Inamura, N. Prognostic Factors of Premature Closure of the Ductus Arteriosus in Utero: A Systematic Literature Review. Cardiol. Young 2017, 27, 634–638.
28. Zielinsky, P.; Piccoli, A.L.; Manica, J.L.L.; Nicoloso, L.H.S. New Insights on Fetal Ductal Constriction: Role of Maternal Ingestion of Polyphenol-Rich Foods. Expert Rev. Cardiovasc. Ther. 2010, 8, 291–298.
29. Heymann MA, Rudolph AM. Control of the ductus arteriosus. Physiol Rev 1975;55(1):62–78.
30. Clyman RI. Mechanisms regulating the ductus arteriosus. Biol Neonate 2006;89 (4):330–5.
31. Kajino H, Chen YQ, Seidner SR, Waleh N, Mauray F, Roman C, et al. Factors that increase the contractile tone of the ductus arteriosus also regulate its anatomic remodeling. Am J Physiol 2001;281(1): R291–301. 32.
Coceani F, Liu Y, Seidlitz E, Kelsey L, Kuwaki T, Ackerley C, Yanagisawa M. Endothelin A receptor is necessary for O (2) constriction but not closure of ductus arteriosus. Am J Physiol. 1999 Oct;277(4):H1521-31. doi: 10.1152/ajpheart.1999.277.4.H1521. PMID: 10516191.
33. Bouayad A, Kajino H, Waleh N, Fouron JC, Andelfinger G, Varma DR, Skoll A, Vazquez A, Gobeil F Jr, Clyman RI, Chemtob S. Characterization of PGE2 receptors in fetal and newborn lamb ductus arteriosus. Am J Physiol Heart Circ Physiol. 2001 May;280(5):H2342-9. doi: 10.1152/ajpheart.2001.280.5.H2342. PMID: 11299240.
34. Seidner SR, Chen YQ, Oprysko PR, Mauray F, Tse MM, Lin E, Koch C, Clyman RI. Combined prostaglandin and nitric oxide inhibition produces anatomic remodeling and closure of the ductus arteriosus in the prema-

ture newborn baboon. Pediatr Res. 2001 Sep;50(3):365-73. doi: 10.1203/00006450-200109000-00012. PMID: 11518824.
35. Crockett, S.L.; Berger, C.D.; Shelton, E.L.; Reese, J. Molecular and Mechanical Factors Contributing to Ductus Arteriosus Patency and Closure. Congenit. Heart Dis. 2019, 14, 15–20.
36. Ivey KN, Srivastava D. The paradoxical patent ductus arteriosus. J Clin Invest Nov 2006;116(11):2863–5.
37. Chiruvolu A, Jaleel MA. Pathophysiology of patent ductus arteriosus in premature neonates. Early Hum Dev. 2009 Mar;85(3):143-6. doi: 10.1016/j.earlhumdev.2008.12.006. Epub 2009 Feb 14. PMID: 19223128.
38. Giliberti P, De Leonibus C, Giordano L, Giliberti P. The physiopathology of the patent ductus arteriosus J Matern Fetal Neonatal Med. 2009(22 Suppl 3):6–9
39. Ovalı, F. Molecular and Mechanical Mechanisms Regulating Ductus Arteriosus Closure in Preterm Infants. Front. Pediatr. 2020, 8, 516.
40. Clyman RI, Mauray F, Heymann MA, Roman C. Cardiovascular effects of patent ductus arteriosus in preterm lambs with respiratory distress. J Pediatr. 1987 Oct;111(4):579-87. doi: 10.1016/s0022-3476(87)80126-9. PMID: 3655990.
41. Hinton R, Michelfelder E. Significance of reverse orientation of the ductus arteriosus in neonates with pulmonary outflow tract obstruction for early intervention. Am J Cardiol 2006; 97:716–9.
42. Clyman RI, Mauray F, Heymann MA, Roman C. Cardiovascular effects of patent ductus arteriosus in preterm lambs with respiratory distress. J Pediatr. 1987 Oct;111(4):579-87. doi: 10.1016/s0022-3476(87)80126-9. PMID: 3655990.
43. Köksal, N., Aygün, C., & Uraş, N. (2016). Prematüre bebekte patent duktus arteriosus'a yaklaşım rehberi. Türk Neonatoloji Derneği Yayınları.
44. Khan SS, Sithisarn T, Bada HS, Vranicar M, Westgate PM, Hanna M. Urinary NT-proBNP levels and echocardiographic parameters for patent ductus arteriosus. J Perinatol. 2017 Dec; 37(12): 1319–24.
45. Kulkarni M, Gokulakrishnan G, Price J, Fenandes JC, Leeflang M, Pammi M. Diagnosing significant PDA using natriuretic peptides in preterm neonates: a systematic review. Pediatrics 2015;135: e510-e525.
46. Bell EF, Acaregui MJ. Restricted versus liberal water intake for preventing morbidity and mortality in preterm infants. Cochrane Database Syst Rev. 2008;1:CD000503.
47. Clyman R, Wickremasinghe A, Jhaveri N, Hassinger DC, AttridgeJT, Sanocka U, et al; Ductus Arteriosus Feed or Fast with Indomethacin or Ibuprofen (DAFFII) Investigators. Enteral feeding during indomethacin and ibuprofen treatment of patent ductus arteriosus. J Pediatr. 2013; 163:406-11.
48. Hundscheid, T., Onland, W., van Overmeire, B., Dijk, P., van Kaam, A. H. L. C., Dijkman, K. P., Kooi, E. M. W., Villamor, E., Kroon, A. A., Visser, R., Vijlbrief, D. C., de Tollenaer, S. M., Cools, F., van Laere, D., Johansson, A. B., Hocq, C., Zecic, A., Adang, E., Donders, R., de Vries, W., … de Boode, W. P. (2018). Early treatment versus expectative management of patent ductus arteriosus in preterm infants: a multicentre, randomised, non-inferiority trial in Europe (BeNeDuctus trial). BMC pediatrics, 18(1), 262. https://doi.org/10.1186/s12887-018-1215-7
49. Heuchan AM, Clyman RI. Managing the patent ductus arteriosus: current treatment options. Arch Dis Child Fetal Neonatal Ed. 2014;99(5): F431-6. doi: 10.1136/archdischild-2014-306176.
50. Oncel MY, Yurttutan S, Erdeve O, Uras N, Altug N, Oguz SS, Canpolat FE, Dilmen U. Oral paracetamol versus oral ibuprofen in the management of patent ductus arteriosus in preterm infants: a randomized controlled trial. J Pediatr. 2014;164(3):510-4.e1. doi: 10.1016/j.jpeds.2013.11.008.
51. Zahn EM, Peck D, Phillips A, Nevin P, Basaker K, simmons C, et al. Transcatheter Closure of Patent Ductus Arteriosus in Extremely Premature Newborns: Early Results and Midterm Follow-Up. JACC Cardiovasc Interv. 2016;9 (23):2429-37.
52. Chien YH, Wang HH, lin MT, lin HC, lu CW, Chiu sN, et al. Device deformation and left pulmonary artery obstruction after transcatheter patent ductus arteriosus closure in preterm infants. Int J Cardiol. 2020 Feb 27. pii: s0167-5273 (19)34577-2. doi: 10.1016/j.ijcard.2020.02. 065.
53. Tomasulo CE, Gillespie MJ, Munson D, Demkin T, O'Byrne MI, Dori Y, et al. Incidence and Fate of Device-Related left Pulmonary Artery stenosis and Aortic Coarctation in small Infants Un dergoing Transcatheter Patent Ductus Arteriosus Closure. Catheter Cardiovasc Interv. 2020 Apr 27. doi: 10.1002/ ccd.28942.
54. Narin N., Pamukçu, Ö. (2021). Prematür Patent Duktus Arteriozus Yönetimi. Türkiye Klinikleri Pediatric Cardiology-Special Topics, 2(1), 34-39.
55. Giesinger RE, Bischoff AR, McNamara PJ. Anticipatory perioperative management for patent ductus arteriosus surgery: Understanding postligation cardiac syndrome. Congenit Heart Dis 2019; 14:311-6.
56. Qasim A, Dasgupta S, Jain SK, Jiwani AK, Aly AM. Coarctation of the aorta as a complication of surgical ligation of patent ductus arteriosus in a premature infant. Case Rep Pediatr 2017; 2017:2647353.
57. Neema PK, Sinha PK, Rathod RC. Inadvertent interruption of descending thoracic aorta on cardiopulmonary bypass during repair of a ventricular septal defect and interruption of a patent ductus arteriosus: Its recognition, consequences, and prevention. J Cardiothorac Vasc Anesth 2004; 18:469-71.
58. Omari, B. O., Shapiro, S., Ginzton, L., Milliken, J. C., & Baumgartner, F. J. (1998). Closure of short, wide patent ductus arteriosus with cardiopulmonary bypass and balloon occlusion. The Annals of thoracic surgery, 66(1), 277–278. https://doi.org/10.1016/s0003-4975(98)00362-2
59. Gurcun, U., Boga, M., Badak, M. I., Ozkisacik, E. A., & Discigil, B. (2005). Transpulmonary surgical closure of patent ductus arteriosus with hypothermic circulatory arrest in an adult patient. Texas Heart Institute journal, 32(1), 88–90.
60. (Laborde F, Noirhomme P, Karam J, Batisse A, Bourel P, Saint MO. A new video-assisted thoracoscopic surgical technique for interruption of patent ductus arteriosus in infants and children. J Thorac Cardiovasc Surg. 1993; 105:278-280.)



AORT KOARKTASYONU

BÖLÜM
24

Atakan ATALAY [1]
Ahmet Kuddusi İRDEM [2]

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» GİRİŞ
» EMBRİYOLOJİ VE ANATOMİ
» EMBRİYOLOJİ
» ANATOMİ
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» REZEKSİYON VE GENİŞLETİLMİŞ (EXTENDED) UÇ UCA ANASTOMOZ
» PERKÜTAN BALON ANJİYOPLASTİ
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» REKOARKTASYON
» SONUÇ

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Rekoarktasyon riskini artıran birçok faktör gösterilmiştir. Bunlar arasında hastanın 2–3 aydan küçük olması, ağırlığın 2 kg'dan düşük olması(125), polipropilen yerine ipek sütur kullanımı ve kalıntı duktal doku bırakılması yer alır.(126) Rekoarktasyon, ameliyat sonrası kol-bacak arasındaki sistolik basınç farkının 20 mmHg'yi aşması olarak tanımlanır.(127) İstirahat halindeki basınç farkı, egzersizle ortaya çıkan belirgin hipertansiyonu eleme için yeterince hassas olmayabilir. Egzersiz sonrası aynı anda kol/bacak basınç ölçümleri, koarktasyon onarım bölgesindeki rezidü olasılığını dışlamanın en iyi yoludur.(128)

Rezidü koarktasyonu tespit etmek için MRI, dijital subtraksiyon anjiyografisi ve bisiklet egzersiz testi de faydalı olabilir.(129) MRI değerlendirmesi, koarktasyon onarımındaki gecikmenin uzun süreli anormal hemodinamik maruziyete neden olabileceğini ve bunun aort duvarının sertleşmesini artırabileceğini göstermiştir.(130) Uç uca genişletilmiş anastomoz, en düşük rekoarktasyon oranına (%5) sahip görünmektedir.(131,132)

Balon anjiyoplasti bölümünde tartışıldığı üzere, bu prosedür rezidü aort koarktasyonu olan çoğu çocuk için tercih edilen ilk prosedür olarak kabul edilmektedir.(102) Başarı oranı yüksektir ve komplikasyon insidansı düşüktür. Balon dilatasyonu başarılı olmazsa veya uygun görülmezse, yeniden ameliyat gerekebilir. Çoğu durumda yeniden ameliyat, önceki onarım bölgesindeki yoğun skar dokusu nedeniyle oldukça zordur. Reoperasyonlar için tek bir teknik tüm hastalar için geçerli olmayabilir, hastaların çoğu yama ile genişletme, rezeksiyon ve araya greft interpozisyonu veya baypas greft tekniği ile yönetilebilirler.(133)

SONUÇ

Aort koarktasyonu olan bebek ve çocukların yönetimi büyük ölçüde standart hale gelmiştir. Ekokardiyografi ilk tanı aracı olarak kullanılmaktadır. BT görüntüleme, anatomiyi kesin bir şekilde ortaya koymada önemli bir rol oynamaktadır. Prostaglandin E1 (PGE1) kullanımı, kritik koarktasyonu olan yenidoğanlarda cerrahiye zaman kazandırmış ve sonuçları önemli ölçüde iyileştirmiştir. Koarktasyonun, geç dönem hipertansiyon riskini en aza indirmek için tanı konulduğu anda onarılması gerekmektedir. Yenidoğanlar, bebekler ve küçük çocuklar için rezeksiyon ile uç uca genişletilmiş (extended) anastomozu önermekteyiz. Önemli intrakardiyak lezyonları olan hastalar için, kardiyak defektin sternotomi ile onarımı yapılabilir. Büyük çocuklar, balon dilatasyonu ve stent yerleştirmeden fayda görebilir. Transkateter tedaviye uygun olmayan büyük çocuklar için rezeksiyon ile greft interpozisyonu yapılması önerilmektedir. Büyük çocuklarda femoral arter basıncı izlenmeli ve paraplejiyi önlemek için sol kalp bypassı akılda bulundurulmalıdır. Rekoarktasyon için balon dilatasyonu, ilk tercih edilen işlemdir. Bu başarılı olmazsa, yama aortoplasti veya greft yerleştirilmesi ile yapılan reoperasyonlar mükemmel sonuçlar vermektedir. Bu hastalarda da anastomoz süresi uzun olabileceği için kısmi sol kalp baypası düşünülmelidir.

KAYNAKLAR

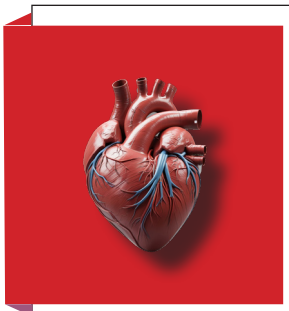
1. Keith JD. Coarctation of the aorta. In: Keith JD, Rowe RD, Vlad P (eds.), Heart Disease in Infancy and Childhood, 3rded. New York: Macmillan; 1978, pp. 736–760.
2. Rudolph AM. Congenital Diseases of the Heart. Chicago: Year Book Medical Publishers; 1974.
3. Tawes RL Jr, Aberdeen E,Waterston DJ, Carter RE. Coarctation of the aorta in infants and children. A review of 333 operative cases, including 179 infants. Circulation. 1969;39(5 suppl 1):I-173–I-184.
4. Gross RE, Hufnagel CA. Coarctation of the aorta. Experimental studies regarding its surgical correction. N Engl J Med. 1945;233:287–293.
5. Crafoord C, Nylin G. Congenital coarctation of the aorta and its surgical treatment. J Thorac Surg. 1945;14:347–361.
6. Backer CL. Coarctation: the search for the Holy Grail. J Thorac Cardiovasc Surg. 2003;126:329–331.
7. Vossschulte K. Surgical correction of coarctation of the aorta by an "isthmusplastic" operation. Thorax. 1961;16:338–345.
8. Waldhausen JA, Nahrwold DL. Repair of coarctation of the aorta with a subclavian flap. J Thorac Cardiovasc Surg. 1966;51:532–533.
9. Amato JJ, Rheinlander HF, Cleveland RJ. A method of enlarging the distal transverse arch in infants with hypoplasia and coarctation of the aorta. Ann Thorac Surg. 1977;23:261–263.
10. Lansman S, Shapiro AJ, SchillerMS, et al. Extended aortic arch anastomosis for repair of coarctation in infancy. Circulation. 1986;74(3 Pt 2):I-37–I-41.

11. Sarioglu, Tayyar, et al. "A new surgical technique for repair of aortic coarctation." Vascular surgery 26.2 (1992): 103-108.
12. Asano M, Mishima A, Yamamoto S, Saito T, Manabe T. Modified subclavian flap aortoplasty for coarctation repair in patients less than three months of age. Ann Thorac Surg. 1998;66:588–589.
13. van Heurn LW, Wong CM, Spiegelhalter OJ, et al. Surgical treatment of aortic coarctation in infants younger than three months: 1985 to 1990. Success of extended end-to-end arch aortoplasty. J Thorac Cardiovasc Surg. 1994;107:74–86.
14. Rajasinghe HA, Reddy VM, van Son JAM, et al. Coarctation repair using end-to-side anastomosis of descending aorta to proximal aortic arch. Ann Thorac Surg. 1996;61:840–844.
15. Mery CM, Guzmán-Pruneda FA, Carberry KE, et al. Aortic arch advancement for aortic coarctation and hypoplastic aortic arch in neonates and infants. Ann Thorac Surg. 2014;98:625–633.
16. De Léon LE, McKenzie ED. Aortic arch advancement and ascending sliding arch aortoplasty for repair of complex primary and recurrent aortic arch obstruction. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2017;20:63–66.
17. Meadows J, Minahan M, McElhinney DB, McEnaney K, Ringel R; the COAST Investigators. Intermediate outcomes in the prospective, multicenter Coarctation Of the Aorta Stent Trial (COAST). Circulation. 2015;131:1656–1664.
18. Morgagni JB. De sedibus et causis morborum. Epist XVIII: Article 6, 1760.
19. Bonnet LM. Stenose congenitale de l'aorte. Rev Med Paris. 1903;23:108–225.
20. Vouhé PR, Trinquet F, Lecompte Y, et al. Aortic coarctation with hypoplastic aortic arch. Results of extended end-to-end aortic arch anastomosis. J Thorac Cardiovasc Surg. 1988;96;557–563.
21. Backer CL, Mavroudis C, Zias EA, Amin Z, Weigel TJ. Repair of coarctation with resection and extended end-to-end anastomosis. Ann Thorac Surg. 1998;66: 1365–1370.
22. Conte S, Lacour-Gayet F, Serraf A, et al. Surgical management of neonatal coarctation. J Thorac Cardiovasc Surg. 1995;109:663–674.
23. Moulaert AJ, Bruins CC, Oppenheimer-Dekker A. Anomalies of the aortic arch and ventricular septal defects. Circulation. 1976;53:1011–1015.
24. Machii M, Becker AE. Hypoplastic aortic arch morphology pertinent to growth after surgical correction of aortic coarctation. Ann Thorac Surg. 1997;64:516–520.
25. Karl TR, Sano S, Brawn W, Mee RB. Repair of hypoplastic or interrupted aortic arch via sternotomy. J Thorac Cardiovasc Surg. 1992;104:688–695.
26. Rudolph AM, Heymann MA, Spitznas U. Hemodynamic considerations in the development of narrowing of the aorta. Am J Cardiol. 1972;30:514–525.
27. Skoda J. Demonstration eines Falles von Obliteration der Aorta.Wochenblatt der Zeitschrift der Kaiserlichen-Königliche Gesellschaft der Aertze zur Wein. 1855;1:710.
28. Elzenga NJ, Gittenberger-de Groot AC, Oppenheimer-Dekker A. Coarctation and other obstructive aortic arch anomalies: their relationship to the ductus arteriosus. Int J Cardiol. 1986;13:289–308.
29. Atalay A, Pac A, Avci T, et al. Histopathological evaluation of aortic coarctation after conventional balloon angioplasty in neonates. Cardiology in the Young. 2018;28(5):683-687. doi:10.1017/S1047951117002967
30. Callahan PF, Quivers ES, Bradley LM, Sell JE, Martin GR. Echocardiographic evidence for a ductal tissue sling causing discrete coarctation of the aorta in the neonate: case report. Pediatr Cardiol. 1998;19:182–184.
31. Kappetein AP, Gittenberger-de Groot AC, Zwinderman AH, et al. The neural crest as a possible pathogenic factor in coarctation of the aorta and bicuspid aortic valve. J Thorac Cardiovasc Surg. 1991;102:830–836.
32. Sybert VP. Cardiovascular malformations and complications in Turner syndrome. Pediatrics. 1998;101:E11–E18.
33. Hoeffel JC, Henry M, Mentre B, Louis JP, Pernot C. Pseudocoarctation or congenital kinking of the aorta: radiologic considerations. Am Heart J. 1975;89:428–436.
34. Kessler RM, Miller KB, Pett S, Wernly JA. Pseudocoarctation of the aorta presenting as a mediastinal mass with dysphagia. Ann Thorac Surg. 1993;55:1003–1005.
35. Gay WA Jr, Young WG Jr. Pseudocoarctation of the aorta. A reappraisal. J Thorac Cardiovasc Surg. 1969;58:739–745.
36. Bahabozorgui S, Bernstein RG, Frater RWM. Pseudocoarctation of the aorta associated with aneurysm formation. Chest. 1971;60:616–617.
37. Riemenschneider TA, Emmanouilides GC, Hirose F, Linde LM. Coarctation of the abdominal aorta in children: report of three cases and review of the literature. Pediatrics. 1969;44:716–726.
38. Scott HW Jr, Dean RH, Boerth R, et al. Coarctation of the abdominal aorta: pathophysiologic and therapeutic considerations. Ann Surg. 1979;189:746–757.
39. Pierce WS, Vincent WR, Fitzgerald E, Miller FJ. Coarctation of the abdominal aorta with multiple aneurysms. Operative correction. Ann Thorac Surg. 1975;20:687 693.
40. Bergamini TM, Bernard JD, Mavroudis C, et al. Coarctation of the abdominal aorta. AnnVasc Surg. 1995;9:352–356.
41. Elliott RB, StarlingMB, Neutze JM.Medical manipulation of the ductus arteriosus. Lancet. 1975;1:140–142.
42. Cokkinos DV, Leachman RD, Cooley DA. Increased mortality rate from coronary artery disease following operation for coarctation of the aorta at a late age. J Thorac Cardiovasc Surg. 1979;77:315–318.
43. Reifenstein GH, Levine SA, Gross RE. Coarctation of the aorta; a review of 104 autopsied cases of the adult type, 2 years of age or older. Am Heart J. 1947;33:146–168.
44. Connolly HM, Huston J 3rd, Brown RD Jr, et al. Intracranial aneurysms in patients with coarctation of the aorta: a prospective magnetic resonance angiographic study of 100 patients. Mayo Clin Proc. 2003;78:1491–1499.
45. Abbott ME. Coarctation of the aorta of the adult type; statistical study and historical retrospect of 200 recorded cases with autopsy, of stenosis or obliteration of descending arch in subjects above age of 2 years. Am Heart J. 1928;3:574–615.
46. Weyman AE, Caldwell RL, Hurwitz RA, et al. Cross-

sectional echocardiographic detection of aortic obstruction. 2. Coarctation of the aorta. Circulation. 1978;57: 498–502.
47. Shaddy RE, Snider AR, Silverman NH, Lutin W. Pulsed Doppler findings in patients with coarctation of the aorta. Circulation. 1986;73:82–88.
48. Simpson IA, Sahn DJ, Valdes-Cruz LM, et al. Color Doppler flow mapping in patients with coarctation of the aorta: new observations and improved evaluation with color flow diameter and proximal acceleration as predictors of severity. Circulation. 1988;77:736–744.
49. Kaushal S, Backer CL, Patel JN, et al. Coarctation of the aorta: midterm outcomes of resection with extended end-to-end anastomosis. Ann Thorac Surg. 2009;88:1932–1938.
50. Lock JE, Castaneda-Zuniga WR, Bass JL, et al. Balloon dilation of excised aortic coarctations. Radiology. 1982;143:689–691.
51. Egan M, Holzer RJ. Comparing balloon angioplasty, stenting and surgery in the treatment of aortic coarctation. Expert Rev Cardiovasc Ther 2009;7:1401–12.)
52. Lerberg DB. Abbott's artery. Ann Thorac Surg. 1982;33: 415–416.
53. Marini CP, Grubbs PE, Toporoff B, et al. Effect of sodium nitroprusside on spinal cord perfusion and paraplegia during aortic cross-clamping. Ann Thorac Surg. 1989;47:379–383.
54. Watterson KG, Dhasmana JP, O'Higgins JW,Wisheart JD. Distal aortic pressure during coarctation operation. Ann Thorac Surg. 1990;49:987–990.
55. Backer CL, Stewart RD, Kelle AM, Mavroudis C. Use of partial cardiopulmonary bypass for coarctation repair through a left thoracotomy in childrenwithout collaterals. Ann Thorac Surg. 2006;82:964–972.
56. Wong CH, Watson B, Smith J, Hamilton JR, Hasan A. The use of left heart bypass in adult and recurrent coarctation repair. Eur J Cardiothorac Surg. 2001;20:1199–1201.
57. Christenson JT, Sierra J, Didier D, Beghetti M, Kalangos A. Repair of aortic coarctation using temporary ascending to descending aortic bypass in children with poor colateral circulation. Cardiol Young. 2004;14:39–45.
58. Gross RE. Treatment of certain aortic coarctations by homologous grafts; report of nineteen cases. Ann Surg. 1951;134:753–768.
59. Brouwer MHJ, Kuntze CEE, Ebels T, TalsmaMD, Eijgelaar A. Repair of aortic coarctation in infants. J Thorac Cardiovasc Surg. 1991;101:1093–1098.
60. Kappetein AP, Zwinderman AH, Bogers AJJC, Rohmer J, Huysmans HA. More than thirty-five years of coarctation repair. An unexpected high relapse rate. J Thorac Cardiovasc Surg. 1994;107:87–95.
61. Quaegebeur JM, Jonas RA, Weinberg AD, Blackstone EH, Kirklin JW; Congenital Heart Surgeons Society. Outcomes in seriously ill neonates with coarctation of the aorta. A multiinstitutional study. J Thorac Cardiovasc Surg. 1994;108:841–854.
62. Ala-Kulju K, Heikkinen L. Aneurysms after patch graft aortoplasty for coarctation of the aorta: long-term results of surgical management. Ann Thorac Surg. 1989;47:853–856.
63. Bergdahl L, Ljungqvist A. Long-term results after repair of coarctation of the aorta by patch grafting. J Thorac Cardiovasc Surg. 1980;80:177–181.
64. Roth M, Lemke P, Schönburg M, Klövekorn WP, Bauer EP. Aneurysm formation after patch aortoplasty repair (Vossschulte): reoperation in adults with and without hypothermic circulatory arrest. Ann Thorac Surg. 2002;74:2047–2050.
65. Hehrlein FW, Mulch J, Rautenburg HW, Schlepper M, Scheld HH. Incidence and pathogenesis of late aneurysm after patch graft aortoplasty for coarctation. J Thorac Cardiovasc Surg. 1986;92:226–230.
66. Walhout RJ, Lekkerkerker JC, Oron GH, et al. Comparison of polytetrafluoroethylene patch aortoplasty and end-to-end anastomosis for coarctation of the aorta. J Thorac Cardiovasc Surg. 2003;126:521–528.
67. Clarkson PM, Brandt PWT, Barratt-Boyes BG, et al. Prosthetic repair of coarctation of the aorta with particular reference to Dacron onlay patch grafts and late aneurysm formation. Am J Cardiol. 1985;56:342–346.
68. Heikkinen L, Sariola H, Salo J, Ala-Kulju K. Morphological and histopathological aspects of aneurysms after patch aortoplasty for coarctation. Ann Thorac Surg. 1990;50:946–948.
69. Moulton AL, Brenner JI, Roberts G, et al. Subclavian flap repair of coarctation of the aorta in neonates. Realization of growth potential? J Thorac Cardiovasc Surg. 1984;87:220–235.
70. Bergdahl LAL, Blackstone EH, Kirklin JW, Pacifico AD, Bargeron LM Jr. Determinants of early success in repair of aortic coarctation in infants. J Thorac Cardiovasc Surg. 1982;83:736–742.
71. Milliken JC, Brawn WJ, Mee RB. Neonatal coarctation: clinical spectrum and improved results. J Am CoII Cardiol. 1990;15:78A.
72. Geiss D, Williams WG, Lindsay WK, Rowe RD. Upper extremity gangrene: a complication of subclavian artery division. Ann Thorac Surg. 1980;30:487–489.
73. Wells WJ, Castro LJ. Arm ischemia after subclavian flap angioplasty: repair by carotid-subclavian bypass. Ann Thorac Surg. 2000;69:1574–1576.
74. Diemont FF, Chemla ES, Julia PL, Sirieix D, Fabiani JN. Upper limb ischemia after subclavian flap aortoplasty: unusual long-term complication. Ann Thorac Surg. 2000;69:1576–1578.
75. Todd PJ, Dangerfield PH, Hamilton DI, Wilkinson JL. Late effects on the left upper limb of subclavian flap aortoplasty. J Thorac Cardiovasc Surg. 1983;85:678–681.
76. Martin MM, Beekman RH, Rocchini AP, Crawley DC, Rosenthal A. Aortic aneurysms after subclavian angioplasty repair of coarctation of the aorta. Am J Cardiol. 1988;61:951–953.
77. Penkoske PA, Williams WG, Olley PM, et al. Subclavian arterioplasty. Repair of coarctation of the aorta in the first year of life. J Thorac Cardiovasc Surg. 1984;87:894–900.
78. Pandey R, Jackson M, Ajab S, Gladman G, Pozzi M. Subclavian flap repair: review of 399 patients at median follow-up of fourteen years. Ann Thorac Surg. 2006;81:1420–1428.
79. Metzdorff MT, Cobanoglu A, Grunkemeier GL, Sunderland CO, Starr A. Influence of age at operation on late results with subclavian flap aortoplasty. J Thorac Cardiovasc Surg. 1985;89:235–241.
80. Brown JW, Fiore AC, King H. Isthmus flap aortoplasty: an alternative to subclavian flap aortoplasty for

long-segment coarctation of the aorta in infants. Ann Thorac Surg. 1985;40:274–279.
81. Zannini L, Gargiulo G, Albanese SB, et al. Aortic coarctation with hypoplastic arch in neonates: a spectrum of anatomic lesions requiring different surgical options. Ann Thorac Surg. 1993;56:288–294.
82. Lacour-Gayet F, Bruniaux J, Serraf A, et al. Hypoplastic transverse arch and coarctation in neonates. Surgical reconstruction of the aortic arch: a study of sixty-six patients. J Thorac Cardiovasc Surg. 1990;100:808–816.
83. Brouwer MHJ, Cromme-Dijkhuis AH, Ebels T, Eijgelaar A. Growth of the hypoplastic aortic arch after simple coarctation resection and end-to-end anastomosis. J Thorac Cardiovasc Surg. 1992;104:426–433.
84. Myers JL, McConnell BA, Waldhausen JA. Coarctation of the aorta in infants: does the aortic arch grow after repair? Ann Thorac Surg. 1992;54:869–875.
85. Siewers RD, Ettedgui J, Pahl E, Tallman T, del Nido PJ. Coarctation and hypoplasia of the aortic arch:will the arch grow? Ann Thorac Surg. 1991;52:608–614.
86. Sos T, Sniderman KW, Rettek-Sos B, Strupp A, Alonso DR. Percutaneous transluminal dilatation of coarctation of thoracic aorta post mortem. Lancet. 1979;2:970–971.
87. Lock JE, Castaneda-Zuniga WR, Bass JL, et al. Balloon dilation of excised aortic coarctations. Radiology. 1982;143:689–691.
88. Lababidi ZA, Daskalopoulos DA, Stoeckle H Jr. Transluminal balloon coarctation angioplasty: experience with 27 patients. Am J Cardiol. 1984;54:1288–1291.
89. Marvin WJ, Mahoney LT, Rose EF Pathologic sequelae of balloon dilation angioplasty for unoperated coarctation of the aorta in children. J Am Coll Cardiol. 1986;7:117A.
90. Brandt B 3rd, Marvin WJ Jr, Rose EF, Mahoney LT. Surgical treatment of coarctation of the aorta after balloon angioplasty. J Thorac Cardiovasc Surg. 1987;94:715–719.
91. Cooper RS, Ritter SB, Rothe WB, et al. Angioplasty for coarctation of the aorta: long-term results. Circulation. 1987;75:600–604.
92. Aydogan, Umrah, et al. "Late development of dissecting aneurysm following balloon angioplasty of native aortic coarctation." Catheterization and cardiovascular diagnosis 36.3 (1995): 226-229.
93. Ringel RE, Vincent J, Jenkins KJ, et al. Acute outcome of stent therapy for coarctation of the aorta: results of the Coarctation of the Aorta Stent Trial. Catheter Cardiovasc Interv. 2013;82:503–510.
94. Varma C, Benson LN, Butany J, McLaughlin PR. Aortic dissection after stent dilatation for coarctation of the aorta: a case report and literature review. Catheter Cardiovasc Interv. 2003;59:528–535.
95. Korkola SJ, Tchervenkov CI, Shum-Tim D, Roy N. Aortic rupture after stenting of a native coarctation in an adult. Ann Thorac Surg. 2003;74:936.
96. Forbes TJ, Moore P, Pedra CA, et al. Intermediate follow-up following intravascular stenting for treatment of coarctation of the aorta. Catheter Cardiovasc Interv. 2007;70:569–577.
97. Forbes TJ, Garekar S, Amin Z, et al. Congenital Cardiovascular Interventional Study Consortium (CCISC). Procedural results and acute complications in stenting native and recurrent coarctation of the aorta in patients over 4 years of age: a multi-institutional study. Catheter Cardiovasc Interv. 2007;70:276–285.
98. Taggart NW, Minahan M, Cabalka AK, et al.; COAST II Investigators. Immediate outcomes of covered stent placement for treatment or prevention of aortic wall injury associated with coarctation of the aorta (COAST II). JACC Cardiovasc Interv. 2016;9:484–493.
99. Hess J, Mooyaart EL, Busch HJ, Bergstra A, Landsman ML. Percutaneous transluminal balloon angioplasty in restenosis of coarctation of the aorta. Br Heart J. 1986;55:459–461.
100. Hijazi ZM, Fahey JT,KleinmanCS, Lock JE. Balloon angioplasty for recurrent coarctation of the aorta. Immediate and long-term results. Circulation. 1991;84:1150–1156.
101. Saul JP, Keane JF, Fellows KE, et al. Balloon dilation angioplasty of postoperative aortic obstructions. Am J Cardiol. 1987;59:943–948.
102. Hellenbrand WE, Allen HD, Golinko RJ, et al. Balloon angioplasty for aortic recoarctation: results of Valvuloplasty and Angioplasty of Congenital Anomalies Registry. Am J Cardiol. 1990;65:793–797.
103. Yetman AT, Nykanen D, McCrindle BW, et al. Balloon angioplasty of recurrent coarctation: a 12-year review. J Am Coll Cardiol. 1997;30:811–816.
104. Reich O, Tax P, Bartáková H, et al. Long-term (up to 20 years) results of percutaneous balloon angioplasty of recurrent aortic coarctation without use of stents. Eur Heart J. 2008;29:2042–2048.
105. SealyWC, Harris JS, YoungWG Jr, Callaway HA Jr. Paradoxical hypertension following resection of coarctation of aorta. Surgery. 1957;42:135–147.
106. SealyWC. Paradoxical hypertension after repair of coarctation of the aorta: a review of its causes. Ann Thorac Surg. 1990;50:323–329.
107. Goodall MC, Sealy WC. Increased sympathetic nerve activity following resection of coarctation of the thoracic aorta. Circulation. 1969;39:345–351.
108. SealyWC. Coarctation of the aorta and hypertension. Ann Thorac Surg. 1967;3:15–28.
109. Rocchini AP, Rosenthal A, Barger AC, Castaneda AR, Nadas AS. Pathogenesis of paradoxical hypertension after coarctation resection. Circulation. 1976;54:382–387.
110. Fox S, Pierce WS, Waldhausen JA. Pathogenesis of paradoxical hypertension after coarctation repair. Ann Thorac Surg. 1980;29:135–141.
111. Lober PH, Lillehei CW. Necrotizing panarteritis following repair of coarctation of aorta; report of two cases. Surgery. 1954;35:950–956.
112. Benson WR, Sealy WC. Arterial necrosis following resection of coarctation of the aorta. Lab Invest. 1956;5:359–376.
113. Tabbutt S, Nicolson SC, Adamson PC, et al. The safety, efficacy, and pharmacokinetics of esmolol for blood pressure control immediately after repair of coarctation of the aorta in infants and children: a multicenter, double-blind, randomized trial. J Thorac Cardiovasc Surg. 2008;136:321–328.
114. Leenen FHH, Balfe JA, Pelech AN, et al. Postoperative hypertension after repair of coarctation of aorta in children: protective effect of propranolol? Am Heart J. 1987;113:1164–1173.
115. Gidding SS, Rocchini AP, Beekman R, et al. Therapeu-

tic effect of propranolol on paradoxical hypertension after repair of coarctation of the aorta. N Engl J Med. 1985;312:1224–1228.
116. Presbitero P,Demarie D, Villani M, et al. Long term results (15-30 years) of surgical repair of aortic coarctation. Br Heart J. 1987;57:462–469.
117. Warnes CA. Bicuspid aortic valve and coarctation: two villains part of a diffuse problem. Heart. 2003;89:965–966.
118. Cohen M, Fuster V, Steele PM, Driscoll D, McGoon DC. Coarctation of the aorta: long-term follow-up and prediction of outcome after surgical correction. Circulation. 1989;80:840–845.
119. Bing RJ, Handelsman JC, Campbell JA, Griswold HE, Blalock A. The surgical treatment and physiopathology of coarctation of the aorta. Ann Surg. 1948; 128:803–824.
120. Brewer LA 3rd, Fosburg RG, Mulder GA, Verska JJ. Spinal cord complications following surgery for coarctation of the aorta. A study of 66 cases. J Thorac Cardiovasc Surg. 1972;64:368–381.
121. Lerberg DB, Hardesty RL, Siewers RD, Zuberbuhler JR, Bahnson HT. Coarctation of the aorta in infants and children: 25 years of experience. Ann Thorac Surg. 1982;33:159–170.
122. Crawford FA Jr, Sade RM. Spinal cord injury associated with hyperthermia during aortic coarctation repair. J Thorac Cardiovasc Surg. 1984;87:616–618.
123. Nguyen DM, Tsang J, Tchervenkov CI. Aneurysm after subclavian flap angioplasty repair of coarctation of the aorta. Ann Thorac Surg. 1999;68:1392–1394.Rekoarktasyon
124. IJsselhof R, Liu H, Pigula F, et al. Rates of interventions in isolated coarctation repair in neonates versus infants: does age matter? Ann Thorac Surg. 2019;107:180–186.
125. Sudarshan CD, Cochrane AD, Jun ZH, Soto R, Brizard CP. Repair of coarctation of the aorta in infants weighing less than 2 kilograms. Ann Thorac Surg. 2006;82:158–163.
126. Goldman S, Hernandez J, Pappas G. Results of surgical treatment of coarctation of the aorta in the critically ill neonate. Including the influence of pulmonary artery banding. J Thorac Cardiovasc Surg. 1986;91:732–737.
127. Kirklin JW, Barratt-Boyes BG. Cardiac Surgery. New-York: Wiley; 1986.
128. Freed MD, RocchiniA, Rosenthal A, Nadas AS, Castaneda AR. Exercise-induced hypertension after surgical repair of coarctation of the aorta. Am J Cardiol. 1979;43:253–258.
129. Kappetein PA, Guit GL, Bogers AJJC, et al. Noninvasive long-term follow-up after coarctation repair. Ann Thorac Surg. 1993;55:1153–1159.
130. Juffermans JF,Nederend I, van den Boogaard PJ, et al. The effect of age at correction of aortic coarctation and recurrent obstruction on adolescent patients: MRI evaluation of wall shear stress and pulse wave velocity. Eur Radiol Exp.2019;3:24.
131. Wright GE, Nowak CA, Goldberg CS, Ohye RG, Bove EL, Rocchini AP. Extended resection and end-to-end anastomosis for aortic coarctation in infants: results of a tailored surgical approach. Ann Thorac Surg. 2005 Oct;80(4):1453-9. doi: 10.1016/j.athoracsur.2005.04.002. PMID: 16181886.
132. Bakhshaliyev S, Genç SB, Çitoğlu G, et al. Isolated coarctation repair through a left thoracotomy in children. Cardiology in the Young. 2023;33(10):2054-2059. doi:10.1017/S1047951122003663
133. Sweeney MS, Walker WE, Duncan JM, et al. Reoperation for aortic coarctation: techniques, results, and indications for various approaches. Ann Thorac Surg. 1985;40:46–49.



VASKÜLER HALKALAR

BÖLÜM
25

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Abdullah Arif YILMAZ [2]
Fatih TOMRUKÇU [3]

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İçindekiler

» TANIM
» TARİHÇE
» EMBRİYOLOJİ, MORFOLOJİ VE SINIFLAMA
  » Rathke Diyagramı
  » Edwards Diyagramı
» KOMPLET VASKÜLER HALKALAR
» INKOMPLET VASKÜLER HALKALAR
» KLİNİK VE BULGULAR
» TANI VE GÖRÜNTÜLEME
» DOĞAL SEYİR
» CERRAHİ TEDAVİ
  » Vasküler Halka Onarımı
  » Postoperatif bakım
  » Sonuçlar
» VASKÜLER SLİNG
  » Morfoloji
  » Klinik Özellikler Ve Tanı Kriterleri
» CERRAHİ TEDAVİ
» SONUÇLAR
  » Sol Pulmoner Arter Patensisi
  » Ameliyat Sonrası Respiratuar Obstruksiyondan Kurtulma
  » Yaşam Kalitesi ve Fonksiyonel Sonuçlar

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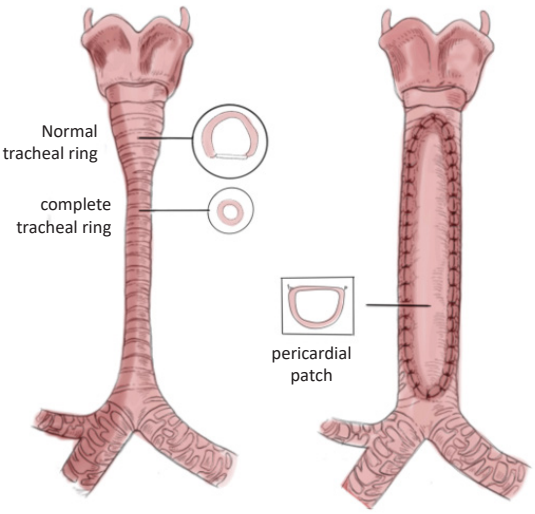
dönemde tıkalı izlenmiştir. Günümüzde kullanılan yöntemlerle (medyan sternotomi, kardiyopulmoner baypas desteği, anastomoz bölgesinde endotel-endotel devamlılığının sağlanması, antikoagülasyon monitörizasyonu gibi) anastomoz patensisi daha yüksek oranda sağlanmaktadır.(52)



Şekil 23. *Trakeal Rekonstrüksiyon*

Ameliyat Sonrası Respiratuar Obstruksiyondan Kurtulma

Solunum tıkanıklığı yalnızca kompresyondan kaynaklandığında, arterin basit reimplantasyonundan sonra rahatlama görülür. Trakeal stenoz solunum yolu tıkanıklığının bir bileşeni olduğunda, trakea rezeksiyonu ve kardiyopulmoner baypas ile desteklenen LPA'nın relokasyonu semptomların tamamen rahatlamasını sağlar.(53) Tam kıkırdak halkalarla ilişkili yaygın anatomik trakeal stenoz olduğunda, solunum yolu tıkanıklığının rahatlaması değişken olmuştur, ancak perikardiyal yama trakeoplastisinden sonra sonuçlar daha iyi olabilir.(54) Uzun vadeli sonuçlar genellikle olumludur ve hastaların çoğu ameliyattan sonraki haftalar içinde asemptomatik hale gelir. Ancak, yakın izleme esastır çünkü bebeklerin yaklaşık %10'u, çözülmesi aylar sürebilen kalıcı gürültülü solunum yaşayabilir. Ayrıca, cerrahi müdahale geçiren konjenital trakeal stenozu olan hastalar artan ölüm riskleriyle karşı karşıyadır ve anastomotik dehisens, tekrarlayan stenoz ve granülasyon dokusunu değerlendirmek için bronkoskopi gerekliliği gibi olası komplikasyonlar nedeniyle dikkatli takip gerektirir.

Yaşam Kalitesi ve Fonksiyonel Sonuçlar

Hastaların çoğu genellikle ameliyattan sonraki haftalar içinde normal aktivitelerine döner, birçoğu semptomlar düzeldikçe yaşam kalitelerinin iyileştiğini bildirir. Bununla birlikte, hastaların bir alt grubu, özellikle trakeal stenozu, hava yolunu tutan enfeksiyonları ve solunum komplikasyonları ile ilgili olarak daha yakın takip ve tedavi gerektiren devam eden semptomlar yaşayabilir.(55)

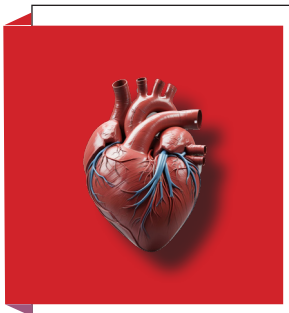
Vasküler halka ameliyatlarında hastalar genellikle özofageal kompresyonla ilişkili semptomlarda azalma görürler, ancak katı gıdalara geçişte geç başlangıçlı disfaji görülebilir. Ameliyat sonrası semptomsuzluk oranları cesaret vericidir ve çalışmalar hastaların önemli bir kısmının prosedürlerinden sonraki aylar içinde semptomsuz olduğunu göstermektedir.

KAYNAKLAR

1. Turner W. On irregularities of the pulmonary artery, arch of the aorta and the primary branches of the arch with an attempt to illustrate their mode of origin by reference to development. Br Foreign Med Chir Rev 1962; 30:173.
2. Bayford D. An account of a singular case of obstructed deglutition. Mem Med Soc Lond 1794; 2:275
3. Kommerell B. Verlagerung des Ösophagus durch eine abnorm verlaufende Arteria subclavia dextra (Arteria lusoria). Fortschr Geb Roentgenstrahlen 1936; 54:590–5.
4. Wolman IJ. Syndrome of constricting double aortic arch in infancy. Report of case. J Pediatr 1939; 14:527
5. Gross RE. Surgical relief for tracheal obstruction from a vascular ring. N Engl J Med 1945; 233:586
6. Gross RE, Ware PF. The surgical significance of aortic arch anomalies. Surg Gynecol Obstet 1946; 83:435
7. Gross RE, Neuhauser EB. Compression of the trachea or esophagus by vascular anomalies. Surgical therapy in 40 cases. Pediatrics 1951; 7:69.
8. Gross RE. Surgical treatment for dysphagia lusoria. Ann Surg 1946; 124:532.
9. Neuhauser EB. The roentgen diagnosis of double aortic arch and other anomalies of the great vessels. Am J Roentgenol Radium Ther Nucl Med 1946; 56:1
10. Edwards JE. Anomalies of the derivatives of the aortic arch system. Med Clin North Am 1948; 32:925-49.
11. Kirklin JW, Clagett OT. Vascular "rings" producing

respiratory obstruction in infants. Proc Mayo Clin 1950; 25:360
12. Stewart JR, Kincaid OW, Edwards JE. An atlas of vascular rings and related malformations of the aortic arch system. Springfield, Ill.: Charles C. Thomas, 1964.
13. Momma K, Matsuoka R, Takao A. Aortic arch anomalies associated with chromosome 22q11 deletion (CATCH 22). Pediatr Cardiol 1999; 20:97.
14. McElhinney DB, Clark BJ 3rd, Weinberg PM, Kenton ML, McDonald-McGinn D, Driscoll DA, et al. Association of chromosome 22q11 deletion with isolated anomalies of aortic arch laterality and branching. J Am Coll Cardiol 2001; 37:2114.
15. Kirklin, Barrat-Boyes (2013). Cardiac Surgery; Vascular Ring and Sling. Elsevier ISBN: 978-1-4160-6391-9
16. Backer CL, Mavroudis C. Congenital heart surgery nomenclature and database project: vascular rings, tracheal stenosis, pectus excavatum. Ann Thorac Surg 2000;69: S308.
17. Mavroudis, Backer (2023). Pediatric Cardiac Surgery: Vascular Rings and Pulmonary Artery Sling. Wiley ISBN: 9781119282310
18. Van Praagh R., Van Praagh S. Persistent fifth arterial arch in man. Congenital double-lumen aortic arch. Am J Cardiol. 1969; 24:279–282.
19. Van Praaagh (2023). Congenital Heart DiseaseA Clinical, Pathological, Embryological, and Segmental Analysis. ElsevierISBN: 978-1-56053-368-9
20. Hanneman K, Newman B, Chan F. Congenital variants and anomalies of the aortic arch. Radiographics 2017; 37:32-51.
21. Bae SB, Kang EJ, Choo KS, Lee J, Kim SH, Lim KJ, Kwon H. Aortic Arch Variants and Anomalies: Embryology, Imaging Findings, and Clinical Considerations. J Cardiovasc Imaging. 2022 Oct;30(4):231-262.
22. Anderson's Pediatric Cardiology (2020) Fourth Edition. Elsevier ISBN: 978-0-7020-7608-4
23. Berdon WE, Baker DH, Wung JT, et al. Complete cartilage-ring tracheal stenosis associated with anomalous left pulmonary artery: the ring-sling complex. Radiology. 1984; 152:57–64.
24. Sade RM, Rosenthal A, Fellows K, Castaneda AR. Pulmonary artery sling. J Thorac Cardiovasc Surg. 1975; 69:333–346.
25. Binet JP, Conso JF, Losay J, Narcy P, Raynaud EJ, Beaufils F, et al. Ductus arteriosus sling: report of a newly recognized anomaly and its surgical correction. Thorax 1978; 33:72.
26. Kouchoukos NT, Masetti P. Aberrant subclavian artery and Kommerell aneurysm: surgical treatment with a standard approach. J Thorac Cardiovasc Surg. 2007; 133:888–892.
27. Priya S, Thomas R, Nagpal P, Sharma A, Steigner M. Congenital anomalies of the aortic arch. Cardiovasc Diagn Ther. 2018 Apr;8(Suppl 1): S26-S44.
28. K Rahmath MR, Durward A. Pulmonary artery sling: An overview. Pediatr Pulmonol. 2023 May;58(5):1299-1309. doi: 10.1002/ppul.26345. Epub 2023 Feb 24. PMID: 36790334.
29. Labuz DF, Kamran A, Jennings RW, Baird CW. Reoperation to correct unsuccessful vascular ring and vascular decompression surgery. J Thorac Cardiovasc Surg. 2022 Jul;164(1):199-207. doi: 10.1016/j.jtcvs.2021.08.089. Epub 2021 Nov 11. PMID: 34922756.
30. Worhunsky DJ, Levy BE, Stephens EH, Backer CL. Vascular rings. Semin Pediatr Surg. 2021 Dec;30(6):151128. doi: 10.1016/j.sempedsurg.2021.151128. Epub 2021 Oct 23. PMID: 34930596.
31. Gross RE. Arterial malformations which cause compression of the trachea or esophagus. Circulation 1955; 11:124.
32. Burke RP, Rosenfeld HM, Wernovsky G, Jonas RA. Video-assisted thoracoscopic vascular ring division in infants and children. J Am Coll Cardiol 1995; 25:943.
33. Karcaaltincaba M, Haliloglu M, Ozkan E, Kocak M, Akinci D, Ariyurek M. Non-invasive imaging of aberrant right subclavian artery pathologies and aberrant right vertebral artery. Br J Radiol. 2009; 82:73–78.
34. Backer CL, Mavroudis C. Vascular rings and pulmonary artery sling. In: Mavroudis C, ed. Pediatric cardiac surgery. St. Louis: Mosby, 1994, p. 645.
35. Whitman G, Stephenson LW, Weinberg P. Vascular ring: left cervical aortic arch, right descending aorta, and right ligamentum arteriosum. J Thorac Cardiovasc Surg 1982; 83:311.
36. Hawkins JA, Bailey WW, Clark SM. Innominate artery compression of the trachea: treatment by reimplantation of the innominate artery. J Thorac Cardiovasc Surg 1992; 103:678.
37. Stewart S 3rd, Edmunds LH Jr, Kirklin JW, Allarde RR. Spontaneous breathing with continuous positive airway pressure after open intracardiac operations in infants. J Thorac Cardiovasc Surg 1973; 65:37.
38. Backer CL, Ilbawi MN, Idriss FS, DeLeon SY. Vascular anomalies causing tracheoesophageal compression. Review of experience in children. J Thorac Cardiovasc Surg 1989; 97:725.
39. Alsenaidi K, Gurofsky R, Karamlou T, Williams WG, McCrindle BW. Management and outcomes of double aortic arch in 81 patients. Pediatrics. 2006;118: e1336–e1341.
40. Glaevecke H, Doehle H. Uber eine seltene angeborene Anomalie der Pulmonalarterie. Munch Med Wochenschr 1897; 44:950.
41. Jue KL, Raghib G, Amplatz K, Adams P Jr, Edwards JE. Anomalous origin of the left pulmonary artery from the right pulmonary artery. Report of 2 cases and review of the literature. Am J Roentgenol Radium Ther Nucl Med 1965; 95:598.
42. Neill CA, Ferencz C, Sabiston DC, Sheldon H. The familial occurrence of hypoplastic right lung with systemic arterial supply and venous drainage "scimitar syndrome." Bull Johns Hopkins Hosp 1960; 107:1-21
43. Le Bret E, Fauroux B, Sigal-Cinqualbre A, de Labriolle-Vaylet C, Batisse A, Roussin R, et al. Improved lung perfusion with surgical correction of pulmonary artery sling. J Thorac Cardiovasc Surg 2007; 133:815-6.
44. Aytac A, Ozme S, Sarikayalar F, Saylam A. Pulmonary artery sling. Ann Thorac Surg 1976; 22:596.
45. Han BK, Dunbar JS, Bove K, Rosenkrantz JG. Pulmonary vascular sling with tracheobronchial stenosis and hypoplasia of the right pulmonary artery. Pediatr Radiol 1980; 9:113.
46. Binet JP, Conso JF, Losay J, Narcy P, Raynaud EJ, Beaufils F, et al. Ductus arteriosus sling: report of a newly recognized anomaly and its surgical correction. Thorax 1978; 33:72.
47. Brandt PW, Clarkson PM, Barratt-Boyes BG, Neutze

JM. An unusual esophageal indentation caused by a long tortuous patent ductus arteriosus. Australas Radiol 1973; 17:394.
48. Backer C.L., Rigsby C.K.: Vascular rings: to scope or not to scope. J Thorac Cardiovasc Surg 2017; 154: pp. 616-617.
49. Tsang V, Murday A, Gillbe C, Goldstraw P. Slide tracheoplasty for congenital funnel-shaped tracheal stenosis. Ann Thorac Surg 1989; 48:632-5.
50. Hazekamp MG, Koolbergen DR, Kersten J, Peper J, de Mol B, Konig-Jung A. Pediatric tracheal reconstruction with pericardial patch and strips of autologous cartilage. Eur J Cardiothorac Surg 2009; 36:344-51.
51. Konstantinov IE, d'Udekem Y, Saxena P. Interposition pericardial flap after slide tracheoplasty in pulmonary artery sling complex. Ann Thorac Surg 2010; 89:289-91.
52. Dunn JM, Gordon I, Chrispin AR, de Leval MR, Stark J. Early and late results of surgical correction of pulmonary artery sling. Ann Thorac Surg 1979; 28:230.
53. Jonas RA, Spevak PJ, McGill T, Castaneda AR. Pulmonary artery sling: primary repair by tracheal resection in infancy. J Thorac Cardiovasc Surg 1989; 97:548.
54. Backer CL, Idriss FS, Holinger LD, Mavroudis C. Pulmonary artery sling. Results of surgical repair in infancy. J Thorac Cardiovasc Surg 1992;103:683.
55. Porcaro F, Ciliberti P, Petreschi F, Secinaro A, Allegorico A, Coretti A, Cutrera R. Long term respiratory morbidity in patients with vascular rings: a review. Ital J Pediatr. 2023 Feb 17;49(1):24. doi: 10.1186/s13052-023-01430-x. PMID: 36797770; PMCID: PMC9936697.



ATRİYAL SEPTAL DEFEKT

BÖLÜM
26

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DOI: 10.37609/akya.4077.c5438

İçindekiler

» TANIM
» EMBRİYOLOJİ
» ANATOMİ
  » Eşlik Eden Lezyonlar
» PATAFİZYOLOJİ
» SEMPTOM VE BULGULAR
» LABARATUVAR BULGULARI
  » EKG
  » Teleradyografi
  » Ekardiografi
  » Kateter
  » Diğer diagnostik çalışmalar
» AYIRICI TANI
» PROGNOZ
  » Pulmoner vasküler hastalık
  » Kalp yetersizliği
  » Aritmiler
  » Enfektif endokardit
» OPERATİF YAKLAŞIM
» SONUÇLAR

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riminde bu risk söz konusudur.(33,34) Eğer sol SVK ile beraber koroner sinüs çatısı oluşmamışsa çok kompleks onarım gerekmektedir. Genelde sol SVK sol atriyuma sol üst pulmoner venin açılma yerinin tam üstünde açılır. Sol SVK ile sağ SVK arası herhangi bir bağlantı yoksa, ki çoğu vakada böyledir. Bunların onarımında nativ atriyal septal doku kesilerek işe başlanır. Kesilen perikardiyal patch'le devamlı sütürle pulmoner venöz dönüşler sola ve patch'in altına, mitral kapak orifisine denk gelecek şekilde onarılır. Diğer taraftan vena kava inferior, her iki süperior vena kavanın sağ atriyuma triküspid kapağa doğru yönelmesine dikkat edilmelidir. Atriyal doku kesilirken, Koch üçgeni içindeki önemli yapı olan atriyoventriküler noda dikkat edilmelidir. Patch kesilirken de, iyi ölçülmelidir. Alternatif metod olarak, sol SVK'nın soldan sağ atriyuma drenajı için "Tunnel metodu" önerilmiştir. Ancak bu metod oklüde olma riskinden dolayı çok küçük bebeklerde pek tavsiye edilmemektedir.(3,26)

Sol SVK varlığında eğer bu veni diğer sağ SVK ile konnekte eden ven varsa bu kalbe yakın taraftan bağlanır ve koroner sinüs patch ile onarılır. Ancak bu ven ligasyonu, konnekte eden ven yokluğunda veya yetersizliğinde tavsiye edilmez.(35)

SONUÇLAR

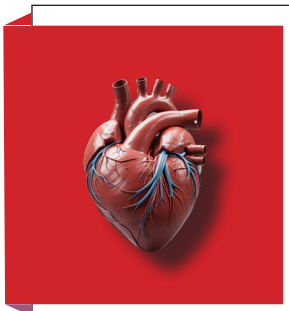
Postoperatif periyod genellikle sorunsuzdur ve hastalar 5-7 gün sonra taburcu edilirler. Pekçok kardiyak cerrahi merkezinde ASD'nin elektif kapatılmasındaki mortalite %1'den azdır.(1,3)

Bazen meydana gelen mortalitede ve morbiditede önemli neden, hava embolisi ve supraventriküler taşiaritmilerdir. Kalp bloğu genelde AV nodun travmaya uğraması sonucudur. Süperior kava tipi defektin tamirini takiben oluşan hasta sinüs sendromu SA nodun hasara uğraması sonucudur. Erişkinlerde preoperatif atriyal aritmiler varsa, atriyal fibrilasyon operasyondan sonra da devam eder. Kronik antikoagülan kullanımı embolizasyon riskini azaltır. ASD'den dolayı mortalite, erişkinlerde uzun süren sağ ventrikül yetmezliği ve pulmoner hipertansiyona bağlıdır. Önceden var olan kardiyomegali, hayatın ikinci dekadından sonra yapılan tamirlerde pek gerilemez. Atriyal aritmiler sağ interventriküler iletim bozukluğuna bağlıdır. Bu aritmiler, EKG'de sağ ventrikül hipertrofi bulgularıyla beraber görülürler.(36)

KAYNAKLAR

1. Glenn's Thoracic and Cardiovascular Surgery. 6th edition, 1996; p:1115-27.
2. Stark de Leval. Surgery for Congenital Heart Defects. 2th edition, 1994; p:343-53.
3. Castaneda AR, Jonas RA, Mayer JE, Hanley FL. Cardiac Surgery of the Neonate and Infant, 1994; p:143-5 4.Hamilton WT,Haffajee CI,Dalen JE, et al. Atrial septal defect secundum: Clinical profile with physiologic correlates in children and adults. Congenital Heart Disease in Adult, 1979; p:257-77.
5. Tandon R, Edwards JE. ASD in infancy. Common association with other defects. Circulation, 1974;49:1005
6. Braunwald E. A Textbook of CV Medicine Heart Disease.5th edition, 1997; p:896.
7. Clark EB,Kugler JD. Preoperative secundum ASD with coexisting sinus node and atrioventrikular node dysfunction. Circulation, 1982;65;976.
8. Alexander RW, Schlant RC. Hurst's The Heart (volüm 2), 9th edition, 1998;p:2008.
9. Konstantinides S, Kasper W, Geibel A et al. Detection of left to right shunt in ASD by negative contrast echocardiography. Am Heart J, 1993;126:909.
10. Freed MD, Nadas AS, Norwood WI, Castaneda AR. Is routine preoperati ve cardiac catheterization necessary before repaire of secundum and sinus venosus ASD? J Am Coll Cardiol, 1984;4:333.
11. Taketa RM, Sahn DS, Simon AL et all. Catheter positi- on in congenital cardiac malformations. Circulation, 1975;51:749
12. Bedford DE. The anatomical type of ASD, their incidence and clinical diagnosis. Am J Cardiol, 1960;6:568.
13. Hellenbrand WE, Mullins CE. Catheter closure of congenital cardiac defects. Card Clin, 1989;7:351-68.
14. Epstein SE, Beiser GD, Goldstein RE. Hemodynamic abnormalities in response to mild and intense upright exercise following operative correction of an ASD or tetralogy of Fallot. Circulation, 1973;42:1065.
15. Levin AR, Liebson PR, Ehlers KH, Daimant B. Assesment of left ventricular function in ASD. Pediatr Res, 1975;9:894.
16. Bink-Boelkens MTE, Meuzelaar KJ, Eygelaar A. Arrhytmias after repaire of secundum ASD; The influ- ence of surgical modification. Am Heart J, 1988; 115:629.
17. Perloff JD. Ostium secundum ASD. Survival for 87-94 years. Am J Cardiol, 1984;53:388-9.
18. Ellis FH, Brandenburg RO, Swan HJC. Defect of the atrial septum in the elderly. Report of successful surgical coorection in 5 patients 60 years of age or older. N Engl J Med, 1960;262:219.
19. Gault JH, Morow AG, Gay WA et al. ASD in patients over the age of forty years: Clinical and hemodynamic studies and the effects of operation. Circulation, 1968; 37:261.

20. Baumgartner H. Et al. 2020 ESC guidelines fort he management of adult congenital heart disease. European Heart Journal (2021) 42, 563_645
21. Richmond DE,Lowe JB, Barrat-Boyes BG. Results of surgical repair of atrial and septal defects in the middle-aged and elderly. Thorax, 1969;24:536.
22. Sellers RD, Ferlic RM, Sterns LP, Lillehei CW. Secundum type ASD: Early and late results of surgical repair using extracorporeal circulation in 275 patients. Surgery, 1966;59:155.
23. Liava'a M., Kalfa D. Surgical closure of atrial septal defects. J Thorac Dis 2018;10(Suppl 24):S2931-S2939.
24. Konstantinov IE et. al. Atrial septal defect closure via ministernotomy in children. Heart, Lung and Circulation (2021) 30, e98–e100
25. Nguyen UH. Et.al.Intermediate-term outcomes of totally endoscopic atrial septal defect repair on beating Heart in Small Children. Innovations 2022, Vol. 17(3) 223–230
26. Kaiser LR, Kron IL, Spray TL. Mastery of Cardiothoracic Surgery. Lippincott-Raven publishers. 1998;677-86.
27. Glen WW, Toole AL, Longo E et al. Induced fibrillatory arrest in open-heart surgery. N Engl J Med, 1960;262:852.
28. Kyger ER, Frazier OH, Cooley DA et al. Sinus venosus ASD: Early and late results following closure in 109 patients. Ann Thorac Surg, 1978;25:44.
29. Sondergaard T. Closure of ASD: Report of three cases. Acta Chir Scand, 1954;107:492.
30. Stansel HC, Talner NS, Deren M et al. Surgical treatment of ASD. Analysis of 150 corrective operations. Am J Surg, 1971;121:485.
31. Ross JK, Johnson DC. Complications following closure of ASD of the inferior vena caval type. Thorax, 1972;27:754.
32. Nasrallah AT, Hall RJ, Garcia E et al. Surgical repair of ASD in patients over 60 years of age. Circulation, 1978; 41:354.
33. Helset HK, Peterson CR. ASD with termination of left süperior vena cava in the left atrium and absence of the coronary sinus. Ann Thorac Surg, 1974;17:186.
34. Raghib G, Ruttenberg HD, Anderson RC et al. Termination of left süperior vena cava in left atrium, ASD and absence of coronary sinus. Circulation, 1965; 31:906.
35. Lewis FJ, Warco RL, Taufil M, Niazi SA. Direct vision repair of triatrial heart and total anomalous pulmonary venous drainage. Surg Gynecol Obstet, 1956;102:713.
36. Spangler JG, Feldt RH, Danielson GK. Secundum ASD encountered in infancy. J Thorac Cardiovasc Surg, 1976;71:398.



PARSİYEL PULMONER VENÖZ DÖNÜŞ ANOMALİLERİ

BÖLÜM
27

Mehmet Akif ÖNALAN [1]

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İçindekiler

- GİRİŞ
- TARİHÇESİ
- SINIFLANDIRILMASI
  - Sağ Pulmoner Venlerin Vena Cava Superior'a Bağlandığı PAPVD
  - Sağ Pulmoner Venlerin Sağ Atriuma Bağlandığı PAPVD
  - Sol Pulmoner Venlerin İnnominate Vene veya Sol VCS'a Bağlandığı PAPVD
  - Sağ Pulmoner Venlerin Vena Cava İnferior'a Bağlandığı PAPVD (Scimitar Sendromu)
  - Diğer Nadir Pulmoner Venöz Bağlantılar
- KLİNİK ÖZELLİKLER VE TANI YÖNTEMLERİ
- TEDAVİ
- CERRAHİ TEKNİKLER
  - Sağ Pulmoner Venlerin VCS'a Bağlandığı PAPVD Tamiri
  - Sağ Pulmoner Venlerin Sağ Atriyuma Bağlandığı PAPVD Tamiri
  - Sol Pulmoner Venlerin İnnominate Vene veya Sol VCS'a Bağlandığı PAPVD Tamiri
  - Sağ Pulmoner Venlerin VCİ'a Bağlandığı PAPVD (Scimitar Sendromu) Tamiri
  - Diğer Nadir Pulmoner Venöz Bağlantıların Tamiri
- SONUÇLAR

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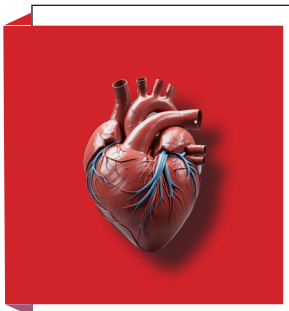
rekmeyecektir (14). Yama kullanılmadan yapılan direkt anastomozun, diğer onarım yöntemlerine göre venöz stenoza daha fazla yatkınlık oluşturduğu görülmektedir (3).

Kaplı stentler ile kateterizasyon yoluyla tedavi edilen sinüs venozus defektin eşlik ettiği PAPVD hastalarının uzun dönem sonuçları bilinmemektedir. Yetmiş beş hastayı içeren ve ortanca 1,8 yıllık takip süresi olan bir çalışmada mortalite olmamakla birlikte 4 hastada stent embolizasyonu, sağ üst pulmoner ven oklüzyonu ve perikardiyal efüzyon gibi major komplikasyonlar bildirilmiştir (35). Bu prosedürün rolünü belirlemede daha geniş hasta sayılarına ve daha uzun takip sürelerine ihtiyaç vardır.

KAYNAKLAR

1. Herlong JR, Jaggers JJ, Ungerleider RM. Congenital heart surgery nomenclature and database project: pulmonary venous anomalies. Ann Thorac Surg. 2000;69(4 suppl): 56-69.
2. Kirklin JW, Barratt-Boyes BG. Cardiac Surgery, 4th ed. Elsevier; 2013, p. 1150–1181.
3. Fragata J, Magalhães M, Baquero L, Trigo C, Pinto F, Fragata I. Partial anomalous pulmonary venous connections: surgical management. World J Pediatr Congenit Heart Surg. 2013;4(1):44-9.
4. Healey JE Jr. Ananatomicsurveyofanomalous pulmonary veins: their clinical significance. JThorac Surg. 1952;23(5):433–44.
5. Drake EH, Lynch JP. Bronchiectasis associated with anomaly of the right pulmonary vein and right diaphram. J Thorac Surg, 1950;19:433.
6. Neptune WB, Bailey CP, Goldberg H. The surgical correction of atrial septal defects associated with transposition of the pulmonary veins. J Thorac Cardiovasc Surg, 1953;25:623.
7. Kirklin JW. Surgical treatment of anomalous pulmonary venous connection (partial anomalous pulmonary venous drainage). Mayo Clin Proc 1953;28:476.
8. Murphy JW, Kerr AR, Kirklin JW. Intracardiac repair for anomalous pulmonary venous connection of right lung to inferior vena cava. Ann Thorac Surg 1971;11:38.
9. Lewis FJ. High defects of the atrial septum. JThorac Surg. 1958;36(1):1–11.
10. Stiver C, Ball MK, Cua CL. Pulmonary Venous Anomalies. In: Abdulla R, AndersonH, Backer CL, Berger S, Blom NA, Holzer RF, Robinson JD editors. Pediatric Cardiology: Fetal, Pediatric and Congenital Heart Diseases, 2024th ed. Springer; 2024, p.1377-1420
11. Van Praagh S, Carrera ME, Sanders SP, Mayer JE, Van Praagh R. Sinus venosus defects: unroofing of the right pulmonary veins--anatomic and echocardiographic findings and surgical treatment. Am Heart J. 1994;128(2):365-79.
12. Park HM, Summerer MH, Preuss K, Armstrong WF, Mahomed Y, Hamilton DJ. Anomalous drainage of the right superior vena cava into the left atrium. J Am Coll Cardiol. 1983 ;2(2):358-62.
13. Haramati LB, Moche IE, Rivera VT, Patel PV, Heyneman L, McAdams HP, et al. Computed tomography of partial anomalous pulmonary venous connection in adults. J Comput Assist Tomogr. 2003;27(5):743-9.
14. Vida VL, Padalino MA, Boccuzzo G, Tarja E, Berggren H, Carrel T, et al. Scimitar syndrome: a European Congenital Heart Surgeons Association (ECHSA) multicentric study. Circulation. 2010;122(12):1159-66.
15. Çiçek S, Arslan AH, Ugurlucan M, Yildiz Y, Ay S. Scimitar syndrome: the curved Turkish sabre. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2014;17(1):56-61.
16. Backer CL, Tannous P, Mavroudis C. Atrial Septal Defect, Partial Anomalous Pulmonary Venous Connection, and Scimitar Syndrome. In: Mavroudis C, Backer CL editors. Pediatric Cardiac Surgery, 5th ed. Wiley-Blackwell; 2023, p. 299–315.
17. Shibuya K, Smallhorn JE, McCrindle BW. Echocardiographic clues and accuracy in the diagnosis of scimitar syndrome. J Am Soc Echocardiogr. 1996;9: 174–181.
18. Pelletier GJ, Spray TL. Repair of scimitar syndrome. Oper Tech Thorac Cardiovasc Surg. 2001;6:32–49.
19. Onalan MA, Temur B, Aydın S, Erek E. Successful Repair of Infantile Scimitar Syndrome with Contralateral Pulmonary Vein Stenosis in an Infant. Braz J Cardiovasc Surg. 2021;36(1):133-136.
20. Erdoğan E, Cap M, Efe S. An unusual cause of pulmonary hypertension; partial anomalous pulmonary venous return to coronary sinus detected on transesophageal echocardiography. Anatol J Cardiol. 2019 ;21(6): E14-E15.
21. El-Kersh K, Homsy E, Daniels CJ, Smith JS. Partial anomalous pulmonary venous return: A case series with management approach. Respir Med Case Rep. 2019 ;27:100833.
22. Heller J, Hagège AA, Besse B, Desnos M, Marie FN, Guerot C. "Crochetage" (notch) on R wave in inferior limb leads: a new independent electrocardiographic sign of atrial septal defect. J Am Coll Cardiol. 1996;27(4):877-82.
23. Ngai C, Freedberg RS, Latson L, Argilla M, Benenstein RJ, Vainrib AF, Donnino R, Saric M. Multimodality imaging of scimitar syndrome in adults: A report of four cases. Echocardiography. 2018;35(10):1684-1691.
24. Vyas HV, Greenberg SB, Krishnamurthy R. MR imaging and CT evaluation of congenital pulmonary vein abnormalities in neonates and infants. Radiographics. 2012;32(1):87-98.
25. Al Rukban H, Al Ghaihab M, Tamimi O, Al-Saleh S. Clinical spectrum of infantile scimitar syndrome: A tertiary center experience. Ann Pediatr Cardiol. 2014 Jan;7(1):29-33.
26. Stout KK, Daniels CJ, Aboulhosn JA, Bozkurt B, Broberg CS, Colman JM, et al. 2018 AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol. 2019 ;73(12):1494-1563.
27. Konstantinov IE, Kotani Y, Buratto E, Schulz A, Ivanov Y. Minimally invasive approaches to atrial septal defe-

ct closure. JTCVS Tech. 2022 ;14:184-190.
28. Warden HE, Gustafson RA, Tarnay TJ, Neal WA. An alternative method for repair of partial anomalous pulmonary venous connection to the superior vena cava. Ann Thorac Surg. 1984;38(6): 601-605.
29. Tao K, Pan W, Lin K, Shi Y, Zhu P, Guo Y, Gan C, An Q. Modified cavoatrial anastomosis in Warden procedure. Ann Thorac Surg. 2010 Jun;89(6):2047-8. doi: 10.1016/j.athoracsur.2009.07.092. PMID: 20494089.
30. Park CS, Kwak JG, Lee C, Lee CH, Lee SY, Choi EY, et al. Partial anomalous pulmonary venous connection to the superior vena cava: the outcome after the Warden procedure. Eur J Cardiothorac Surg. 2012;41(2):261-5.
31. Iyer AP, Somanrema K, Pathak S, Manjunath PY, Pradhan S, Krishnan S. Comparative study of single- and double-patch techniques for sinus venosus atrial septal defect with partial anomalous pulmonary venous connection. J Thorac Cardiovasc Surg. 2007;133(3):656-9.
32. Okonta KE, Agarwal V. Does Warden's procedure reduce sinus node dysfunction after surgery for partial anomalous pulmonary venous connection? Interact Cardiovasc Thorac Surg. 2012 ;14(6):839-42.
33. Stewart RD, Bailliard F, Kelle AM, Backer CL, Young L, Mavroudis C. Evolving surgical strategy for sinus venosus atrial septal defect: effect on sinus node function and late venous obstruction. Ann Thorac Surg. 2007;84(5):1651-55.
34. Brown JW, Ruzmetov M, Minnich DJ, Vijay P, Edwards CA, Uhlig PN, Fiore AC, Turrentine MW. Surgical management of scimitar syndrome: an alternative approach. J Thorac Cardiovasc Surg. 2003;125(2):238-45.
35. Rosenthal E, Qureshi SA, Jones M, Butera G, Sivakumar K, Boudjemline Y, et al. Correction of sinus venosus atrial septal defects with the 10 zig covered Cheatham-platinum stent - An international registry. Catheter Cardiovasc Interv. 2021;98(1):128-136.
36. Abdullah HAM, Alsalkhi HA, Khalid KA. Transcatheter closure of sinus venosus atrial septal defect with anomalous pulmonary venous drainage: Innovative technique with long-term follow-up. Catheter Cardiovasc Interv. 2020;95(4):743-747.
37. Alsoufi B, Cai S, Van Arsdell GS, Williams WG, Caldarone CA, Coles JG. Outcomes after surgical treatment of children with partial anomalous pulmonary venous connection. Ann Thorac Surg. 2007;84(6):2020-6; discussion 2020-6.
38. Griffeth EM, Dearani JA, Mathew J, Graham GC, Connolly HM, King KS,et al. Early and Late Outcomes of the Warden and Modified Warden Procedure. Ann Thorac Surg. 2022;114(5):1723-1729.
39. Lin H, Yan J, Wang Q, Li S, Sun H, Zhang Y, et al. Outcomes of the Warden Procedure for Partial Anomalous Pulmonary Venous Drainage. Pediatr Cardiol. 2020;41(1):134-140.
40. Wang CC, Wu ET, Chen SJ, Lu F, Huang SC, Wang JK, et al. Scimitar syndrome: incidence, treatment, and prognosis. Eur J Pediatr. 2008 ;167(2):155-60.
41. Najm HK, Williams WG, Coles JG, Rebeyka IM, Freedom RM. Scimitar syndrome: twenty years' experience and results of repair. J Thorac Cardiovasc Surg. 1996;112(5):1161-8; 1168-9.



VENTRİKÜLER SEPTAL DEFEKT

BÖLÜM
28

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Sait AŞLAMACI [3]

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İçindekiler

» GİRİŞ
» SINIFLAMA
» CERRAHİ TEDAVİ ENDİKASYONLARI VE HASTA SEÇİMİ
  » Doğal Seyir
  » Tanı
  » Tedavi
  » Cerrahi Endikasyonlar ve Hasta Seçimi
» CERRAHİ TEKNİK
  » Sağ Atrial Yaklaşım
  » Transpulmoner Yaklaşım
  » Transaortik Yaklaşım
  » Sağ Ventriküler Yaklaşım
  » Sol Ventriküler Yaklaşım
  » Pulmoner Banding
» VENTRİKÜLER SEPTAL DEFEKT VE EŞLİK EDEN LEZYONLAR
  » Patent Duktus Arteriozus
  » Aort Kapak Yetmezliği
  » Aort Koarktasyonu
» CERRAHİ SONUÇLAR
  » Komplikasyonlar
» SONUÇLAR

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rebral enfarktti. Musküler trabeküler VSD'si olan bir diğer hastaya rezidü VSD nedeniyle pulmoner banding yapıldı, çoklu organ yetmezliği nedeniyle kaybedildi.

Ameliyat sonrası iki hastada erken reoperasyon gerekliliği ortaya çıkmıştır. Sağ ventrikülü küçük olan bir hasta yetersiz hemodinami nedeniyle ikinci gün tekrar ameliyata alınmış ve take-down yapılmıştır. Ameliyat öncesi mekanik ventilasyon gerekliliği olan bir hasta ameliyat sonrası yetersiz hemodinami nedeniyle değerlendirilmiş, ekokardiyografi ile koroner fistülden şüphe edilmiş ve ameliyat sonrası birinci gün kardiyak tomografi ile ALCAPA (pulmoner arter ile ilişkili sol koroner arter) tanısı konmuş ve ALCAPA tamiri yapılmıştır. Her iki hasta da taburcu edilmiştir.

Bir hastada tamir sonrası transesofageal ekokardiyografi ile ameliyat öncesi bilinmeyen ikinci müsküler VSD tespit edilmiş ve aynı işlemde kapatılmıştır. Bunun dışında erken tekrar girişim gereken rezidü VSD görülmemiştir.

Onbir hastada kalıcı pacemaker ihtiyacı olmuştur (% 1,4). Ameliyattan sinüs ritmiyle çıkan iki hastada yoğun bakım izleminde AV blok gelişmiştir. Sinüs ritmi ile taburcu edilen iki AV blok ve sinüs nod disfonksiyonu nedeniyle, 40. ve 18. günde pacemaker yerleştirilmiştir. Altıncı ve onuncu gün pacemaker yerleştirilen iki hastada işlem sonrası normal sinüs ritmi görülmüştür. Diğer beş hastada postoperatif ortalama 11. günde pacemaker yerleştirilmiştir. Posoperatif AV blok nedeniyle pacemaker yerleştirmek için yedi gün beklemekteyiz. Bununla birlikte sinüs ritmi ile taburcu edilen hastalarda sonradan da AV blok gelişebileceği görülmektedir. Bu nedenle VSD kapatılan hastalar postoperatif kontrollerde mutlaka elektrokardiyografi ile değerlendirilmelidir.

Geç cerrahi komplikasyon olarak subarteriyel VSD'si kapatılan bir hastada aort ile sağ ventrikül arasında fistül gelişmiş, altıncı ayda fistül cerrahi olarak onarılmıştır. Multipl VSD'si olan 4 yaşında bir diğer hasta, VSD'nin cerrahi olarak cihaz ile kapatılması sonrası sebat eden çoklu VSD'ler nedeniyle 3 ay sonra pulmoner banding yapılmıştır. İki yaşında VSD kapatılan bir hasta sol ventrikül-sağ atrium ilişkili rekürren VSD nedeniyle 2.5 yıl sonra ameliyat edilmiştir.

Cerrahi olarak VSD kapatılmasının sonuçları hem erken dönemde hem geç dönemde yüz güldürücü olarak kabul edilmektedir. Az riskli olarak kabul edilen, pulmoner hipertansiyonu ağır olmayan büyük çocuklarda mortalite sıfıra yakındır. Ancak ağır pulmoner hipertansiyonu olan büyük çocuklarda pulmoner vasküler direnç dikkatli hesaplanmalı, operabilite doğru değerlendirilmelidir. İnfant yaş grubunda dahi hastane mortalitesi % 1 seviyesindedir. Bu cerrahinin en önemli iki komplikasyonu olan girişim gerektiren rezidü VSD ve pacemaker gerektiren kalıcı AV blok ise % 1'ler oranında görülmektedir. Şüphesiz cerrahi risk analizi yaparken her merkez kendi mortalite ve morbidite sonuçlarını göz önünde bulundurmalıdır.

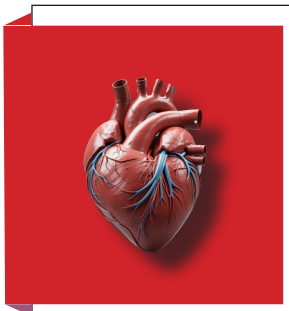
KAYNAKLAR

1. Global birth prevalence of congenital heart defects 1970-2017: updated systematic review and meta-analysis of 260 studies. Liu Y, Chen S, Zühlke L, Black GC, Choy MK, Li N, Keavney BD. Int J Epidemiol. 2019 Apr 1;48(2):455-463. doi: 10.1093/ije/dyz009.
2. Defect of the ventricular septum; summary of twelve cases and review of the literature. Selzer a. Arch Intern Med (Chic). 1949 Nov;84(5):798-823. doi:10.1001/archinte.1949.00230050134007.
3. The results of direct vision closure of ventricular septal defects in eight patients by means of controlled cross circulation. Lillehei CW, Cohen M, Warden HE, Ziegler NR, Varco RL. Surg Gynecol Obstet. 1955 Oct;101(4):446-66.
4. Ventricular septal defects with pulmonary hypertension; surgical treatment by means of a mechanical pump-oxygenator. Dushane JW, Kirklşn JW, Patrick RT, Donald DE, Terry Jr HR, Burchell HB, Wood EH. J Am Med Assoc. 1956 Mar 17;160(11):950-3. doi: 10.1001/jama.1956.02960460028007.
5. The effects of cardiac bypass and ventriculotomy upon right ventricular function; with report of successful closure of ventricular septal defect by use of atriotomy. Stirling GR, Stanley PH, Lillehei CW. Surg Forum. 1957:8:433-8.
6. Repair of ventricular septal defect in infancy. Kirklin JW, Dushane JW. Pediatrics. 1961 Jun:27(6):961-6. doi: 10.1542/peds.27.6.961.
7. Early surgical correction of large ventricular septal defects. Sigmann JM, Stern AM, Sloan HE. Pediatrics. 1967 Jan;39(1):4-13. doi: 10.1542/peds.39.1.4.
8. Classification of ventricular septal defects. B Soto, A E Becker, A J Moulaert, J T Lie, R H Anderson. Br Heart J 1980 Mar;43(3):332-43. doi: 10.1136/hrt.43.3.332.

9. Congenital Heart Surgery Nomenclature and Database Project: overview and minimum dataset. Mavroudis C, Jacobs JP. Ann Thorac Surg. 2000 Apr;69(4 Suppl):S2-17. doi: 10.1016/s0003-4975(99)01321-1.
10. Classification of Ventricular Septal Defects for the Eleventh Iteration of the International Classification of Diseases-Striving for Consensus: A Report From the International Society for Nomenclature of Paediatric and Congenital Heart Disease. Lopez L, Houyel L, Colan SD, Anderson RH, Béland MJ, Aiello VD,Bailliard F, et al. Ann Thorac Surg. 2018 Nov;106(5):1578-1589. doi: 10.1016/j.athoracsur.2018.06.020.
11. Nomenclature for Pediatric and Congenital Cardiac Care: Unification of Clinical and Administrative Nomenclature - The 2021 International Paediatric and Congenital Cardiac Code (IPCCC) and the Eleventh Revision of the International Classification of Diseases (ICD-11). Jacobs JP, Franklin RCG, Béland MJ, Spicer DE, Colan SD, Walters 3rd HL, Bailliard F, et al. World J Pediatr Congenit Heart Surg. 2021 Sep;12(5):E1-E18. doi: 10.1177/21501351211032919.
12. A review of spontaneous closure of ventricular septal defect. Zhang J, Ko JM, Guileyardo JM, Roberts WC. Proc (Bayl Univ Med Cent). 2015 Oct;28(4):516-20. doi: 10.1080/08998280.2015.11929329.
13. The Prevalence and Spontaneous Closure of Ventricular Septal Defects the First Year of Life. Pihl C, Sillesen AS, Norsk JB, Vøgg ROB, Vedel C, Boyd HA, Vejlstrup N, Axelsson Raja A, Bundgaard H, Iversen KK. Neonatology. 2024;121(6):742-751. doi: 10.1159/000538810.
14. The changes in the circulation after birth. Their importance in congenital heart disease. Rudolph AM. Circulation. 1970 Feb;41(2):343-59. doi: 10.1161/01.cir.41.2.343.
15. New device for closure of muscular ventricular septal defects in a canine model. Amin Z, Gu X, Berry JM, Bass JL, Titus JL, Urness M, Han YM, Amplatz K. Circulation. 1999 Jul 20;100(3):320-8. doi: 10.1161/01.cir.100.3.320.
16. Percutaneous closure of ventricular septal defects. State of the art. Butera G, Chessa M, Carminati M. J Cardiovasc Med (Hagerstown). 2007 Jan;8(1):39-45. doi:10.2459/01.JCM.0000247434.59451.d7.
17. A meta-analysis of perventricular device closure of perimembranous ventricular septal defect. Hong ZN, Chen Q, Huang LQ, Cao H. J Cardiothorac Surg. 2019 Jun 27;14(1):119. doi: 10.1186/s13019-019-0936-5.
18. Intraoperative Device Closure of Isolated Ventricular Septal Defects: Experience on 1,090 Cases. Chen Q, Hong ZN, Zhang GC, Chen LW, Zhang QL, Lin ZW, Cao H. Ann Thorac Surg. 2018 Jun;105(6):1797-1802. doi: 10.1016/j.athoracsur.2018.02.059.
19. Pediatric Pulmonary Arterial Hypertension. Frank BS, Ivy DD. Pediatr Clin North Am. 2020 Oct;67(5):903-921. doi: 10.1016/j.pcl.2020.06.005.
20. Measurement, interpretation and use of haemodynamic parameters in pulmonary hypertension associated with congenital cardiac disease. Lopes AA, O'Leary PW. Cardiol Young. 2009 Sep;19(5):431-5. doi: 10.1017/S1047951109990771.
21. Comparison of incisions and outcomes for closure of ventricular septal defects. Li J, Liu Y, Yu C, Cui B, Du M. Ann Thorac Surg. 2008 Jan;85(1):199-203. doi: 10.1016/j.athoracsur.2007.08.049.
22 Evaluation of Different Minimally Invasive Techniques in Surgical Treatment for Ventricular Septal Defect. Liu H, Wang Z, Xia J, Hu R, Wu Z, Hu X, Ren W. Heart Lung Circ. 2018 Mar;27(3):365-370. doi: 10.1016/j.hlc.2017.01.014.
23. Tricuspid Valve Detachment in Ventricular Septal Defect Closure Does Not Impact Valve Function. Fraser CD 3rd, Zhou X, Palepu S, Lui C, Suarez-Pierre A, Crawford TC, Magruder JT, Jacobs ML, Cameron DE, Hibino N, Vricella LA. Ann Thorac Surg. 2018 Jul;106(1):145-150. doi: 10.1016/j.athoracsur.2018.02.075.
24. Does tricuspid valve detachment improve outcomes compared with the non-tricuspid valve detachment approach in ventricular septal defect closure? Ling Y, Bian X, Wang Y, Qian Y. Interact Cardiovasc Thorac Surg. 2021 Apr 8;32(3):483-488. doi: 10.1093/icvts/ivaa289.
25. Detachment of the tricuspid valve for ventricular septal defect closure in infants younger than 3 months. Bang JH, Park CS, Park JJ, Yun TJ, Baek JS, Yu JJ, Kim YH, Ko JK. J Thorac Cardiovasc Surg. 2016 Aug;152(2):491-6. doi: 10.1016/j.jtcvs.2016.03.067.
26. Closure of muscular ventricular septal defects through a left ventriculotomy. Wollenek G, Wyse R, Sullivan I, Elliott M, de Leval M, Stark J. Eur J Cardiothorac Surg. 1996;10(8):595-8. doi: 10.1016/s1010-7940(96)80371-x.
27. Surgical repair of multiple muscular ventricular septal defects: the role of re-endocardialization strategy. Alsoufi B, Karamlou T, Osaki M, Badiwala MV, Ching CC, Dipchand A, McCrindle BW, Coles JG, Caldarone CA, Williams WG, Van Arsdell GS. J Thorac Cardiovasc Surg. 2006 Nov;132(5):1072-80. doi: 10.1016/j.jtcvs.2006.07.011.
28. Repair of multiple muscular ventricular septal defects: septal obliteration technique.Cetin G, Ozkara A, Akcevin A, Korkut AK, Soyler I, Koner O, Tireli E. J Card Surg. 2005 May-Jun;20(3):274-7. doi: 10.1111/j.1540-8191.2005.200468.x.
29. Surgical closure of multiple large apical ventricular septal defects: how we do it. Perez-Negueruela C, Carretero J, Mayol J, Caffarena JM. Cardiol Young. 2017 Apr;27(3):588-591. doi: 10.1017/S1047951116001517.
30. Long-term complications following surgical patch closure of multiple muscular ventricular septal defects. Hofmeyr L, Pohlner P, Radford DJ. Congenit Heart Dis. 2013 Nov,Dec;8(6):541-9. doi: 10.1111/chd.12038.
31. Surgical management of trabecular ventricular septal defects: the sandwich technique. Ootaki Y, Yamaguchi M, Yoshimura N, Oka S, Yoshida M, Hasegawa T. J Thorac Cardiovasc Surg. 2003 Mar;125(3):508-12. doi: 10.1067/mtc.2003.56.
32. Apical right ventriculotomy for closure of apical ventricular septal defects. Myhre U, Duncan BW, Mee RB, Joshi R, Seshadri SG, Herrera-Verdugo O, Rosenthal GL. Ann Thorac Surg. 2004 Jul;78(1):204-8. doi: 10.1016/j.athoracsur.2003.12.054.
33. Left ventricular function after left ventriculotomy for surgical treatment of multiple muscular ventricular septal defects. Shin HJ, Jhang WK, Park JJ, Yu JJ, Kim YH, Ko JK, Park IS, Seo DM. Ann Thorac Surg. 2011 Oct;92(4):1490-3. doi: 10.1016/j.athoracsur.2011.04.026.
34. Current topics in surgery for multiple ventricular septal defects. Yoshimura N, Fukahara K, Yamashita

A, Doki Y, Takeuchi K, Higuma T, Senda K, Toge M, Matsuo T, Nagura S, Aoki M, Sakata K, Sakai M. Surg Today. 2016 Apr;46(4):393-7. doi: 10.1007/s00595-015-1180-9.

35. The morphology of ventricular septal defects as related to the mechanics associated with aortic regurgitation. Anderson RH, de Leval MR. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2006:140-6. doi: 10.1053/j.pcsu.2006.02.025.
36. Ventricular septal defect and aortic valve regurgitation: pathophysiology and indications for surgery. Tweddell JS, Pelech AN, Frommelt PC. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2006:147-52. doi: 10.1053/j.pcsu.2006.02.020.
37. Outflow Ventricular Septal Defect With Aortic Regurgitation: Optimal Timing of Surgery? Giridhara P, Poonia A, Sasikumar D, Krishnamoorthy KM, Sivasubramonian S, Valaparambil A. Ann Thorac Surg. 2022 Sep;114(3):873-880. doi: 10.1016/j.athoracsur.2021.05.080.
38. Timing of repair in ventricular septal defect with aortic insufficiency. Kostolny M, Schreiber C, von Arnim V, Vogt M, Wottke M, Lange R. Thorac Cardiovasc Surg. 2006 Dec;54(8):512-5. doi: 10.1055/s-2006-924326.
39. Ventricular septal defect and left sided obstructive lesions in infants. Gersony WM. Curr Opin Pediatr. 1994 Oct;6(5):596-9. doi: 10.1097/00008480-199410000-00016.
40. Coarctation of the aorta and ventricular septal defect: should we perform a single-stage repair? Isomatsu Y, Imai Y, Shin'oka T, Aoki M, Sato K. J Thorac Cardiovasc Surg. 2001 Sep;122(3):524-8. doi: 10.1067/mtc.2001.115425.
41. Management of infants with coarctation and ventricular septal defect. Kanter KR. Semin Thorac Cardiovasc Surg. 2007 Fall;19(3):264-8. doi: 10.1053/j.semtcvs.2007.07.003.
42. Outcomes of different surgical strategies in the treatment of neonates with aortic coarctation and associated ventricular septal defects. Alsoufi B, Cai S, Coles JG, Williams WG, Van Arsdell GS, Caldarone CA. Ann Thorac Surg. 2007 Oct;84(4):1331-6; discussion 1336-7. doi: 10.1016/j.athoracsur.2007.05.002.
43. Median sternotomi yoluyla aort koarktasyonu ve intrakardiyak anomalilerin tek seansta onarımı. Erek E, Yalçınbaş YK, Salihoğlu E, Öztürk N, Tekin S, Sarıoglu A, Sarloglu T. Türk Kardiyol Dern Arş 2003;31:331-7.
44. Complete heart block after occlusion and repair for perimembranous ventricular septal defect. Lin L, Chen W, Chen H, Liu J, Chen K, Chen L, Chen L, Chen Z. Acta Cardiol. 2025 May;80(3):266-273. doi: 10.1080/00015385.2025.2480961.
45. Predictive Value of Intraoperative Diagnosis of Residual Ventricular Septal Defects by Transesophageal Echocardiography. Hanna BM, El-Hewala AA, Gruber PJ, Gaynor JW, Spray TL, Seliem MA. Ann Thorac Surg. 2010 Apr;89(4):1233-7. doi:10.1016/j.athoracsur.2009.10.058.
46. Residual Shunts Following Isolated Surgical Ventricular Septal Defect Closure: Risk Factors and Spontaneous Closure. Deng X, Huang P, Luo J, Chen R, Yang G, Chen W, Liu Q, He C. Pediatr Cardiol. 2020 Jan;41(1):38-45. doi: 10.1007/s00246-019-02218-9.
47. Left Ventricular Dysfunction Following Repair of Ventricular Septal Defects in Infants. Faraji E, Bolin EH, Bond EG, Collins RT 2nd, Greiten L, Daily JA. Pediatr Cardiol. 2025 Feb;46(2):296-304. doi: 10.1007/s00246-023-03391-8.
48. Postoperative Recovery of Left Ventricular Function following Repair of Large Ventricular Septal Defects in Infants. Adamson GT, Arunamata A, Tacy TA, Silverman NH, Ma M, Maskatia SA, Punn R. J Am Soc Echocardiogr. 2020 Mar;33(3):368-377. doi: 10.1016/j.echo.2019.10.003.
49. The effect of body weight in infants undergoing ventricular septal defect closure: A report from the Nationwide Japanese Congenital Surgical Database. Inohara T, Ichihara N, Kohsaka S, Miyata H, Hirata Y, Murakami A, Shimizu H, Aeba R. J Thorac Cardiovasc Surg. 2019 Mar;157(3):1132-1141.e7. doi: 10.1016/j.jtcvs.2018.11.111.
50. Contemporary outcomes of surgical ventricular septal defect closure. Anderson BR, Stevens KN, Nicolson SC, Gruber SB, Spray TL, Wernovsky G, Gruber PJ. J Thorac Cardiovasc Surg. 2013 Mar;145(3):641-7. doi: 10.1016/j.jtcvs.2012.11.032.
51. Associated atrial septal defects increase perioperative morbidity after ventricular septal defect repair in infancy. Knott-Craig CJ, Elkins RC, Ramakrishnan K, Hartnett DA, Lane MM, Overholt ED, Ward KE, Razook JR. Ann Thorac Surg. 1995 Mar;59(3):573-8. doi: 10.1016/0003-4975(94)01005-6.
52. Results for Surgical Closure of Isolated Ventricular Septal Defects in Patients Under One Year of Age. Aydemir NA, Harmandar B, Karacı AR, Şaşmazel A, Bölükçü A, Sarıtaş T, Yücel İK, Coşkun Fİ, Bilal MS, Yekeler İ. J Card Surg. 2013 Mar;28(2):174-9. doi: 10.1111/jocs.12073.
53. Risk Factors for Major Adverse Events after Surgical Closure of Ventricular Septal Defect in Patients Less than 1 Year of Age: A Single-Center Retrospective. Ergün S, Genç SB, Yildiz O, Öztürk E, Kafalı HC, Ayyıldız P, Haydin S. Braz J Cardiovasc Surg. 2019 Jun 1;34(3):335-343. doi: 10.21470/1678-9741-2018-0299.
54. İnfant Ventriküler Septal Defekt Cerrahisinde Risk Faktörleri. Mercan AŞ, Saygılı A, Sezgin A, Akay T, Tokel K, Varan B, Aşlamacı S. Türk Göğüs Kalp Damar Cer Derg 2001;9:149-152.
55. Surgical Repair of Ventricular Septal Defect; Contemporary Results and Risk Factors for a Complicated Course. Schipper M, Slieker MG, Schoof PH, Breur JMP. Pediatr Cardiol. 2017 Feb;38(2):264-270. doi: 10.1007/s00246-016-1508-2.



ATRİYOVENTRİKÜLER SEPTAL DEFEKTLER (AVSD)

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29

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» SONUÇ

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Kompleks Kardiyak Anomalilerle Birlikte AVSD

Bazı hastalarda AVSD, diğer karmaşık kardiyak anomalilerle birlikte görülebilir (örneğin, Fallot tetralojisi, çift çıkışlı sağ ventrikül). Bu hastalarda cerrahi planlama eşlik eden anomalilerin doğasına göre belirlenir. Öncelikli olarak yaşamı tehdit eden defektler düzeltilir. Kombine cerrahiler sırasında kardiyopulmoner bypass süresi uzayabilir ve komplikasyon riski artabilir. Cerrahi sırasında tüm anomalilerin anatomik uyumu sağlanmalıdır. (3, 11, 63)

SONUÇ

AVSD'nin cerrahi yönetimi yıllar içinde önemli ölçüde gelişerek sağkalımın artmasına ve perioperatif mortalitenin azalmasına yol açmıştır. Ancak AV kapak yetersizliği, rezidüel septal defektler, aritmiler ve pulmoner hipertansiyon gibi komplikasyonlar uzun süreli takip gerektiren zorluklar olmaya devam etmektedir. Hastaların bir alt kümesinde yeniden ameliyat ihtiyacı, cerrahi ve ameliyat sonrası yönetim stratejilerini iyileştirmek için devam eden araştırmaların önemini vurgulamaktadır. Erken tanı ve müdahalede gelecekte kaydedilecek ilerlemeler hasta sonuçlarını ve yaşam kalitesini daha da iyileştirecektir.

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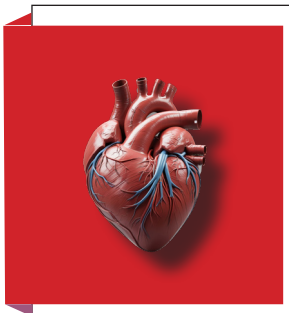
KAYNAKLAR

1. Rigby M. Atrioventricular Septal Defect: What Is in a Name? J Cardiovasc Dev Dis. 2021; 8.
2. Annabi MR, Kerndt CC, Makaryus AN. Embryology, Atrioventricular Septum. In: StatPearls. Treasure Island (FL) ineligible companies. Disclosure: Connor Kerndt declares no relevant financial relationships with ineligible companies. Disclosure: Amgad Makaryus declares no relevant financial relationships with ineligible companies.; 2025.
3. Ahmed I, Anjum F. Atrioventricular Septal Defect. In: StatPearls. Treasure Island (FL) ineligible companies. Disclosure: Fatima Anjum declares no relevant financial relationships with ineligible companies.; 2025.
4. Taqatqa AS, Vettukattil JJ. Atrioventricular Septal Defects: Pathology, Imaging, and Treatment Options. Curr Cardiol Rep. 2021; 23: 93.
5. Umapathi KK, Agasthi P. Atrioventricular Canal Defects. In: StatPearls. Treasure Island (FL) with ineligible companies. Disclosure: Pradyumna Agasthi declares no relevant financial relationships with ineligible companies.; 2025.
6. Nayak S, Kanakriyeh M, Varadarajan P. Echocardiographic assessment of atrioventricular canal defects. Echocardiogr-J Card. 2020; 37: 2199-2210.
7. Agarwal D, Lakhdhir S, Reveler E, et al. Common Atrium or Atrioventricular Septal Defect: What Is in a Name? CASE (Phila). 2021; 5: 412-416.
8. Daene M, De Pauw L, De Meester P, et al. Outcome of Down patients with repaired versus unrepaired atrioventricular septal defect. Int J Cardiol Congenit Heart Dis. 2023; 12: 100452.
9. Overman DM, Dummer KB, Moga FX, et al. Unbalanced atrioventricular septal defect: defining the limits of biventricular repair. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2013; 16: 32-36.
10. Mavroudis C, Jacobs JP. Congenital Heart Surgery Nomenclature and Database Project: overview and minimum dataset. Ann Thorac Surg. 2000; 69: S2-17.
11. Calkoen EE, Hazekamp MG, Blom NA, et al. Atrioventricular septal defect: From embryonic development to long-term follow-up. Int J Cardiol. 2016; 202: 784-795.
12. Mathew P, Bordoni B. Embryology, Heart. In: StatPearls. Treasure Island (FL) ineligible companies. Disclosure: Bruno Bordoni declares no relevant financial relationships with ineligible companies.; 2025.
13. Farraj KL, Zeltser R. Embryology, Heart Tube. In: StatPearls. Treasure Island (FL) ineligible companies. Disclosure: Roman Zeltser declares no relevant financial relationships with ineligible companies.; 2025.
14. Yamagishi T, Ando K, Nakamura H. Roles of TGFbeta and BMP during valvulo-septal endocardial cushion formation. Anat Sci Int. 2009; 84: 77-87.
15. Garside VC, Chang AC, Karsan A, et al. Co-ordinating Notch, BMP, and TGF-beta signaling during heart valve development. Cell Mol Life Sci. 2013; 70: 2899-2917.
16. Mai CT, Isenburg JL, Canfield MA, et al. National population-based estimates for major birth defects, 2010-2014. Birth Defects Res. 2019; 111: 1420-1435.
17. Mamasoula C, Bigirumurame T, Chadwick T, et al. Maternal age and the prevalence of congenital heart defects in Europe, 1995-2015: A register-based study. Birth Defects Res. 2023; 115: 583-594.
18. Wang T, Li Q, Chen L, et al. Maternal Viral Infection in Early Pregnancy and Risk of Congenital Heart Disease in Offspring: A Prospective Cohort Study in Central China. Clin Epidemiol. 2022; 14: 71-82.
19. Meng X, Song M, Zhang K, et al. Congenital heart disease: types, pathophysiology, diagnosis, and treatment options. MedComm (2020). 2024; 5: e631.
20. Malik M, Khalid Nuri M. Surgical Considerations in Atrioventricular Canal Defects. Semin Cardiothorac Vasc Anesth. 2017; 21: 229-234.
21. Korten MA, Helm PC, Abdul-Khaliq H, et al. Eisenmenger syndrome and long-term survival in patients with Down syndrome and congenital heart disease. Heart. 2016; 102: 1552-1557.

22. Cohen SS, Nageshwaran SK, Murthy R, et al. To Be or Not to Be Eisenmenger: The Different Shades of Blue. JACC Case Rep. 2021; 3: 230-235.
23. Houck CA, Evertz R, Teuwen CP, et al. Dysrhythmias in patients with a complete atrioventricular septal defect: From surgery to early adulthood. Congenit Heart Dis. 2019; 14: 280-287.
24. Havers-Borgersen E, Jons C, Butt JH, et al. Arrhythmias in congenital heart disease: A nationwide cohort study. Am Heart J. 2024; 278: 139-149.
25. Mammen A, Tewari P, Horo P, et al. Partial atrioventricular septal defect associated with wolff-parkinson-white syndrome: Perioperative dysrhythmias during the intracardiac repair. Ann Card Anaesth. 2021; 24: 479-482.
26. Haas NA, Driscoll DJ, Rickert-Sperling S. Clinical Presentation and Therapy of Atrioventricular Septal Defect. Adv Exp Med Biol. 2024; 1441: 553-558.
27. Patlolla SH, Dearani JA, Connolly HM, et al. Repair of Partial Atrioventricular Septal Defects in Adults: A Single Center Experience. Semin Thorac Cardiovasc Surg. 2021; 33: 469-478.
28. Jain CC, Miranda WR, Connolly HM, et al. Clinical Features and Outcomes in Adults With Childhood Repair of Partial Atrioventricular Septal Defect. JACC Adv. 2022; 1: 100007.
29. Kown MH, Vricella L, Salerno CT, et al. Adult presentation of complete atrioventricular septal defect. Asian Cardiovasc Thorac Ann. 2002; 10: 356-358.
30. Andersen ND, Turek JW. Echocardiographic Assessment of Complete Atrioventricular Canal Defects: A Balancing Act. Semin Thorac Cardiovasc Surg. 2019; 31: 87-88.
31. Lim ZS, Vettukattil JJ. Role of echocardiography in the assessment of adolescents and adults with congenital heart disease. Minerva Cardioangiol. 2009; 57: 389-413.
32. Munesh T. Assessment of Atrioventricular Septal Defect on Echocardiography. Journal of The Indian Academy of Echocardiography & Cardiovascular Imaging. 2020; 4: 267-275.
33. Magoon R, Choudhury A, Sharma A, et al. Transesophageal echocardiography in an atrioventricular septal defect. Ann Card Anaesth. 2016; 19: 587-588.
34. Wang ZJ, Reddy GP, Gotway MB, et al. Cardiovascular shunts: MR imaging evaluation. Radiographics. 2003; 23 Spec No: S181-194.
35. Reddy VM. Low birth weight and very low birth weight neonates with congenital heart disease: timing of surgery, reasons for delaying or not delaying surgery. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2013; 16: 13-20.
36. Damkjaer M, Garne E, Loane M, et al. Timing of Cardiac Surgical Interventions and Postoperative Mortality in Children With Severe Congenital Heart Defects Across Europe: Data From the EUROlinkCAT Study. J Am Heart Assoc. 2023; 12: e029871.
37. Kwiatkowski DM, Ball MK, Savorgnan FJ, et al. Neonatal Congenital Heart Disease Surgical Readiness and Timing. Pediatrics. 2022; 150.
38. Daymont C, Neal A, Prosnitz A, et al. Growth in children with congenital heart disease. Pediatrics. 2013; 131: e236-242.
39. Olariu IC, Popoiu A, Ardelean AM, et al. Challenges in the Surgical Treatment of Atrioventricular Septal Defect in Children With and Without Down Syndrome in Romania-A Developing Country. Front Pediatr. 2021; 9: 612644.
40. Chikada M, Sekiguchi A, Miyamoto T, et al. Direct closure of ostium primum defect in the repair of atrioventricular septal defect. Ann Thorac Surg. 2001; 72: 430-432; discussion 432-433.
41. Talwar S, Siddharth CB, Choudhary SK, et al. The use of an autologous right atrial free wall as a patch for closure of atrial septal defects. J Card Surg. 2020; 35: 1414-1419.
42. Wu Y, Kuang H, Wang G, et al. Surgical Management for Complete Atrioventricular Septal Defects: A Systematic Review and Meta-Analysis. Pediatr Cardiol. 2020; 41: 1445-1457.
43. Complete Atrioventricular Canal. In: Jonas RA, ed. Comprehensive Surgical Management of Congenital Heart Disease. New-York; 2014: 517-534.
44. Mills NL, Ochsner JL, King TD. Correction of Type C complete atrioventricular canal. Surgical considerations. J Thorac Cardiovasc Surg. 1976; 71: 20-28.
45. Geoffrion TR, Singappuli K, Murala JSK. A review of the Nunn modified single patch technique for atrioventricular septal defect repair. Transl Pediatr. 2018; 7: 91-103.
46. Gholamreza Omrani KH. Surgical outcome of atrioventricular septal defect: A 10 years review. Biomedical Research. 2018; 29: 1425-1436.
47. Juaneda I, Pizzulli L, Ferrari P, et al. Outcomes of Atrioventricular Septal Defect Repair: Two-Institutions, 10-Year Experience in Cordoba, Argentina. World J Pediatr Congenit Heart Surg. 2025: 21501351241305135.
48. St Louis JD, Jodhka U, Jacobs JP, et al. Contemporary outcomes of complete atrioventricular septal defect repair: analysis of the Society of Thoracic Surgeons Congenital Heart Surgery Database. J Thorac Cardiovasc Surg. 2014; 148: 2526-2531.
49. Cai Y, Chen R, Chen G, et al. Middle to long-term outcomes of surgical repair for atrioventricular septal defect: a single-center study. J Thorac Dis. 2022; 14: 3706-3718.
50. Rafik Fekry Barsoom Soliman ARA, Abdulhamid Alnajjarorcid, Syed Aitizaz Outcomes of Complete Atrioventricular Septal Defect Surgical Repair in Down Patients. The Egyptian Journal Of Hospital Medicine. 2021; 84: 2184-2191.
51. Schumacher K, Marin Cuartas M, Meier S, et al. Long-term results following atrioventricular septal defect repair. J Cardiothorac Surg. 2023; 18: 250.
52. Jacobs JP, Jacobs ML, Mavroudis C, et al. Atrioventricular septal defects: lessons learned about patterns of practice and outcomes from the congenital heart surgery database of the society of thoracic surgeons. World J Pediatr Congenit Heart Surg. 2010; 1: 68-77.
53. Rakesh Donthula AR, P. Syamasundar Rao. Atrioventricular Septal Defects. In: Rao PS, ed. Congenital Heart Defects - Recent Advances. 2022.
54. Ginde S, Lam J, Hill GD, et al. Long-term outcomes after surgical repair of complete atrioventricular septal defect. J Thorac Cardiovasc Surg. 2015; 150: 369-374.
55. Boening A, Scheewe J, Heine K, et al. Long-term results after surgical correction of atrioventricular septal defects. Eur J Cardiothorac Surg. 2002; 22: 167-173.

56. Özlem Sarısoy CA, Niyazi Kürşad Tokel, Murat Özkan, Rıza Türköz, Sait Aşlamacı. Outcomes of Operated Partial-Intermediate Atrioventricular Septal Defect Patients. koşuyolu Heart Journal. 2021; 24: 45-50.
57. Xie O, Brizard CP, d'Udekem Y, et al. Outcomes of repair of complete atrioventricular septal defect in the current era. Eur J Cardiothorac Surg. 2014; 45: 610-617.
58. Aly S, Qattea I, Othman H, et al. Outcomes of atrioventricular septal defects with and without down syndrome: analysis of the national inpatient database. Cardiol Young. 2024; 34: 614-623.
59. Atz AM, Hawkins JA, Lu M, et al. Surgical management of complete atrioventricular septal defect: associations with surgical technique, age, and trisomy 21. J Thorac Cardiovasc Surg. 2011; 141: 1371-1379.
60. Alsoufi B, McCracken C, Kanter K, et al. Outcomes of Multistage Palliation of Infants With Single Ventricle and Atrioventricular Septal Defect. World J Pediatr Congenit Heart Surg. 2020; 11: 39-48.
61. Arrigoni SC, R IJ, Postmus D, et al. Long-term outcomes of atrioventricular septal defect and single ventricle: A multicenter study. J Thorac Cardiovasc Surg. 2022; 163: 1166-1175.
62. Nathan M, Emani S, R IJ, et al. Mid-term outcomes in unbalanced complete atrioventricular septal defect: role of biventricular conversion from single-ventricle palliation. Eur J Cardiothorac Surg. 2017; 52: 565-572.
63. Alhawri KA, Mcmahon CJ, Alrih MM, et al. Atrioventricular septal defect and tetralogy of Fallot - A single tertiary center experience: A retrospective review. Ann Pediat Cardiol. 2019; 12: 103-109.



AORTO-PULMONER PENCERE DEFEKTİ

BÖLÜM
30

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Kenan ÖZTÜRKER [2]

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İçindekiler

» TANIMLAMA
» TARİHÇE
» EMBRİYOLOJİ VE ANATOMİ
» KLİNİK BULGULAR VE TANI
» CERRAHİ TEDAVİ
» KOMPLİKASYONLAR, KISA VE UZUN DÖNEM SONUÇLAR

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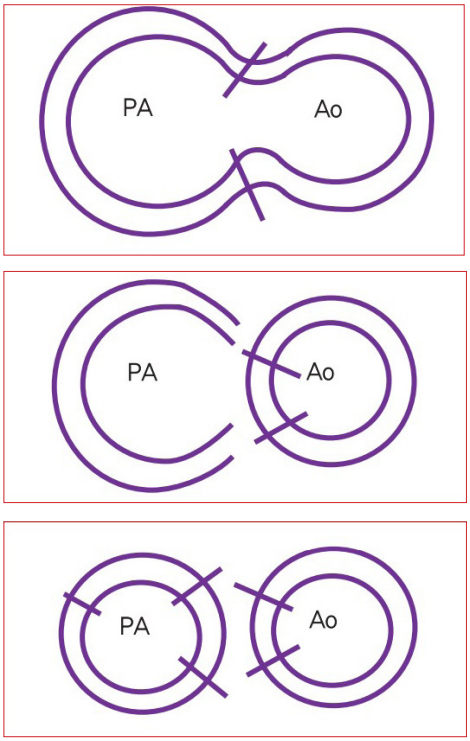


Şekil 7. *İki taraflı pulmoner arter duvarı flebi ile defektin tamiri. A) Ana pulmoner arter aortiko-pulmoner septal defekt hizasında ön ve arka taraftan kesilirken, iki kenarın ortada birleşebilecek şekilde olmasına dikkat edilmelidir. B) Pulmoner arter flepleri birbirlerine dikilerek aort devamlılığı sağlanır. C) Pulmoner arterdeki defekt yama ile onarılır.*

Pulmoner arteriyotomi ile yaklaşım, koroner ostiumların defekte uzaklığı ve aort kapağın değerlendirilmesi pencere içerisinden zor olacağı için tercih edilmez. Bunun yerine transaortik yaklaşım ve yama ile kapatma tekniği kullanılır. Pencere seviyesinden transvers aortotomi yapılır. Her iki koroner ostium değerlendirilir. Küçük defektler primer süturasyon ile kapatılabilir ama büyük defektler mutlaka perikard veya sentetik yama kullanılarak kapatılmalıdır. Aortotomi insizyonu primer olarak kapatılır (32).

KOMPLİKASYONLAR, KISA VE UZUN DÖNEM SONUÇLAR

Postoperatif süreç, aortopulmoner pencerenin kapatılmasının ardından genellikle rutin bir seyir izler. İntraoperatif transözofageal ekokardiyografi, defektin tam kapanmasının doğrulanmasında ve pulmoner arterlerin daralmadığının garanti altına alınmasında faydalıdır. Ancak bazı vakalarda, şiddetli pulmoner hipertansiyon gelişebilir. Bu durum, postoperatif dönemde ani olarak meydana gelebilir ve artmış pulmoner arter basıncı, hipoksi, hipotansiyon ve kötüleşen periferik perfüzyon ile karakterizedir. Tedavi, sedasyon, paralizi ve %100 oksijen ile hipervantilasyon uygulanmasını içerir. Tedaviye dirençli vakalarda, inhale nitrik oksit tedavisi veya ekstrakorporeal membran oksijenasyonu desteği faydalı olabilir.

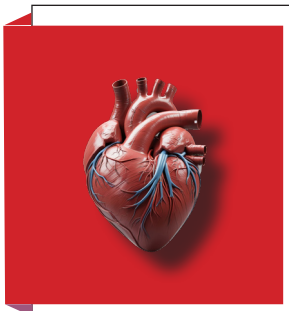
Eşlik eden ek anomali varlığında veya düşük doğum kilosu olan hastalarda bile hastane içi mortalite çok yüksek değildir (33). Uzun dönem sağ kalımı etkileyen en önemli faktör hastalığın erken tanı alması ve hastaların pulmoner vasküler hastalık gelişmeden opere edilebilmesidir (34).

Tekrar cerrahi girişim gerekliliği teknik olarak çok zor bir operasyon olmaması nedeniyle nadirdir. Bildirilen reoperasyon nedenlerinin başında rezidü defekt kalması, pulmoner arterde darlık ve distorsiyon olması gelir (35).

KAYNAKLAR

1. Talner CN. Report of the New England Regional Infant Cardiac Program, by Donald C. Fyler, MD, Pediatrics, 1980;65(suppl):375-461. Pediatrics 1998;102:258-259
2. Backer CL, Mavroudis C. Surgical management of aortopulmonary window: a 40-year experience. Eur J Cardiothorac Surg 2002;21:773- 779
3. Berry TE, Bharati S, Muster AJ, et al. Distal aortopulmonary septal defect, aortic origin of the right pulmonary artery, intact ventricular septum, patent ductus arteriosus and hypoplasia of the aortic isthmus: a newly recognized syndrome. Am J Cardiol 1982;49:108- 116
4. Elliotson J. Case of malformation of the pulmonary artery and aorta. Lancet 1830;1:247.
5. Dodds JH, Hoyle C. Congenital aortic septal defect. Br Heart J 1949;11:390
6. Gross RE. Surgical closure of an aortic septal defect. Circulation 1952;5:858.
7. Scott HW Jr, Sabiston DC Jr. Surgical treatment for congenital aorticopulmonary fistula. Experimental and clinical aspects. J Thorac Surg 1953;25:26.
8. Cooley DA, McNamara DG, Latson JR. Aorticopulmonary septal defect: diagnosis and surgical treatment. Surgery 1957;42:101.
9. Putnam TC, Gross RE. Surgical management of aortopulmonary fenestration. Surgery 1966;59:727.
10. Wright JS, Freeman R, Johnston JB. Aortopulmonary fenestration. A technique of surgical management. J

Thorac Cardiovasc Surg 1968;55:280.
11. Deverall PB, Lincoln JC, Aberdeen E, Bonham-Carter RE, Waterston DJ. Aortopulmonary window. J Thorac Cardiovasc Surg 1969;57:479.
12. Chidambarathanu S, Agarwal R, Hussain ZM, Brown NA, Anderson RH. A tubular aortopulmonary window: an embryological curiosity. World J Pediatr Congenit Heart Surg. 2016;7:411–413
13. Anderson RH, Brown N, Webb S, Henderson D. Lessons learnt with regard to aortopulmonary window. Cardiol Young. 2008;18:451–457
14. Richardson JV, Doty JB, Rossi NP, Ehrenhaft JL. The spectrum of anomalies of aortopulmonary septation. J Thorac Cardiovasc Surg, 1979;78:21-7.
15. Jacobs JP, Quintessenza JA, Gaynor JW, Burke RP, Mavroudis C. Congenital heart surgery nomenclature and database project: aortopulmonary window. Ann Thorac Surg 2000;69:S44-9.
16. Neufeld HN, Lester RG, Adams P Jr, Anderson RC, Lillehei CW, Edwards JE. Aorticopulmonary septal defect. Am J Cardiol 1962; 9:12.
17. D'Souza VJ, Chen MY. Anomalous origin of coronary artery in association with aorticopulmonary window. Pediatr Cardiol 1996; 17:316.
18. Freitas I, Parames F, Rebelo M, Martins JD, Pinto MF, Kaku S. Aortopulmonary window. Experience of eleven cases. Rev Port Cardiol 2008;27:1597-603.
19. Bhan A, Gupta M, Abraham S, Sharma R, Kothari SS, Juneja R. Surgical experience of aortopulmonary window repair in infants. Interact Cardiovasc Thorac Surg 2007;6:200-3
20. Ho SY, Gerlis LM, Anderson C, Devine WA, Smith A. The morphology of aortopulmonary window with regard to classification and morphogenesis. Cardiol Young 1994;4:146-55.
21. Marini D, Ferraro G, Agnoletti G. Iatrogenic "aortopulmonary window": percutaneous rescue closure as a bridge to surgical repair. Cardiol Young. 2016;26(3):609–611.
22. Le Bret E, Lupoglazoff JM, Bachet J, et al. Pulmonary artery dissection and rupture associated with aortopulmonary window. Ann Thorac Surg. 2004;78(4):e67–e68.
23. Fotaki A, Novaes J, Jicinska H, Carvalho JS. Fetal aortopulmonary window: case series and review of the literature. Ultrasound Obstet Gynecol. 2017;49(4):533–539.
24. Kutsche LM, Van Mierop LH. Anatomy and pathogenesis of aorticopulmonary septal defect. Am J Cardiol. 1987;59(5):443–447.
25. Jacobs JP, Quintessenza JA, Gaynor JW, Burke RP, Mavroudis C. Congenital Heart Surgery Nomenclature and Database Project: aortopulmonary window. Ann Thorac Surg. 2000;69(4 suppl):S44–S49.
26. Nayak HK, Islam N, Bansal BK. Transcatheter closure of aortopulmonary window with Amplatzer duct occluder II. Ann Pediatr Cardiol. 2017;10:93–94.
27. Tkebuchava T, von Segesser LK, Vogt PR, et al. Congenital aortopulmonary window: diagnosis, surgical technique and long-term results. Eur J Cardiothorac Surg. 1997;11:293–297.
28. Johansson L, Michaelsson M, Westerholm CJ, Aberg T. Aortopulmonary window: A new operative approach. Ann Thorac Surg, 1978;25:564-7.
29. Matsuki O, Yagihara T, Yamamoto F et al. New surgical technique for total-defect aortopulmonary window. Ann Thorac Surg, 1992;54:991-2.
30. Di Bella I, Gladstone DJ. Surgical management of aortopulmonary window. Ann Thorac Surg, 1998;65:768-70.
31. Aizaz K, Al Qethamy H, Al Jubair K, Al Faraidi Y, Al Faigh MR. Aortopulmonary window repair: 15-year surgical experience. Asian Cardiovasc Thorac Ann 8 2001;9:111-4.
32. Richardson JV, Doty DB, Rossi NP, Ehrenhaft JL. The spectrum of anomalies of aortopulmonary septation. J Thorac Cardiovasc Surg 1979;78:21.
33. Konstantinov IE, Karamlou T, Williams WG, Quaegebeur JM, del Nido PJ, Spray TL, et al. Surgical management of aortopulmonary window associated with interrupted aortic arch: a Congenital Heart Surgeons Society study. J Thorac Cardiovasc Surg 2006; 131:1136-41.
34. McElhinney DB, Reddy VM, Tworetzky W, Silverman NH, Hanley FL. Early and late results after repair of aortopulmonary septal defect and associated anomalies in infants <6 months of age. Am J Cardiol 1998;81:195.
35. Jansen C, Hruda J, Rammeloo L, Ottenkamp J, Hazekamp MG. Surgical repair of aortopulmonary window: thirty-seven years of experience. Pediatr Cardiol 2006;27:552-6.



FALLOT TETRALOJİSİ

BÖLÜM
31

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Mehmet BİÇER [2]
Arda DEMİR [3]
Atıf AKÇEVİN [4]

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İçindekiler

» GİRİŞ
» PATOLOJİ
» PULMONER ATREZİ İLE BİRLİKTELİK GÖSTEREN TOF
» PULMONER KAPAK YOKLUĞU İLE BİRLİKTELİK GÖSTEREN TOF
» KOMPLET ATRİOVENTRİKÜLER KANAL İLE BİRLİKTELİK GÖSTEREN TOF
» FİZYOLOJİ
» KLİNİK BULGULAR VE TANI
» MEDİKAL TEDAVİ
» CERRAHİ TEDAVİ
» PALYATİF CERRAHİ
» TAM DÜZELTME AMELİYATI
» AMELİYAT SONRASI MORTALİTE VE MORBİDİTENİN DEĞERLENDİRİLMESİ
» AMELİYAT SONRASI MEDİKAL TEDAVİ

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tercih edilmektedir. Ventilatör desteği sırasında ve sonrasında gelişebilecek ventriküler taşiaritmilerin önlenmesi veya tedavisi için amiodaron başta olmak üzere antiaritmik ajanlar kullanılmaktadır. Hemodinamik stabilitenin sağlanabilmesi için yeterli analjezi ve sedasyon uygulanması büyük önem taşırken, pulmoner hipertansiyon riski taşıyan hastalarda ise inhaler nitrik oksit (NO) veya fosfodiesteraz inhibitörleri (sildenafil) tedavi protokolüne dahil edilmektedir. Geç postoperatif dönemde ise sağ ventrikül çıkış yolu obstrüksiyonu veya aritmi öyküsü olan hastalarda beta bloker tedavisi önerilmekte, infektif endokardit riskine karşı dental veya girişimsel işlemler öncesinde antibiyotik profilaksisi uygulanmaktadır (64).

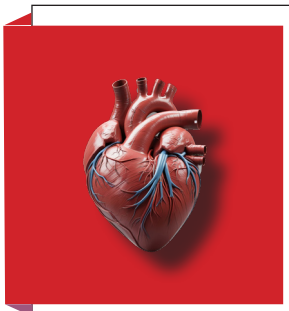
Fallot Tetralojisini düzeltme ameliyatı yapılan olgularda görülebilecek bir diğer durum da sağ ventriküler restriktif fizyolojidir. Sağ ventriküler restriktif fizyoloji, kabaca geç diyastol fazında görülen antegrad pulmoner arteryel kan akımının olması şeklinde özetlenebilir. Patofizyolojisinde uzun süre basınç yüküne maruz kalan sağ ventrikülün kompliyansını kaybetmesi ve gerginliğinin (stifness) artmasına bağlı olarak pasif bir şekilde adeta sağ atrium – Pulmoner arter arasında konduit gibi davranması rol alır. Restriktif fizyolojisi olan hastalarda sistemik venöz basınç yüksekliği, tekrarlayan plevral efüzyonlar, düşük kardiyak output, uzamış yoğun bakım ihtiyacı görülebilir (65). Sandeep ve ark. Tarafından yapılan 50 tetraloji hastasının incelendiği bir çalışmada sağ restriktif fizyolojik patern izlenen hastalarda daha düşük SPO2, transanuler yama ile onarım, daha uzun kardiyopulmoner baypas süresi ve kross klemp süresi, hipertrofi, daha düşük TAPSE değeri ile ilişkili bulunmuştur (66). Düzeltme yapılan TOF hastalarında görülebilecek Restriktif fizyolojinin geçici olarak görülebileceği gibi ilerleyici ve kalıcı olarak da görülebileceği unutulmamalıdır. Bu hasta grubunda postoperatif dönemde uzamış yoğun bakım süreci, inotrop ihtiyacı ECMO desteği gereksinimi olabilir.

KAYNAKLAR

1. Van Praagh R (2009) The First Stella Van Praagh Memorial Lecture: the history and anatomy of tetralogy of Fallot. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu 12:19–38
2. Fallot A (1888) Contribution a l'anatomie pathologique de la maladie bleue (cyanose cardiaque). Marseille Med J 25:77–93, 138–158, 207–223, 270–286, 341–354, 403–420
3. The clinical classification of congenital cardiac disease, with remarks upon its pathological anatomy, diagnosis and treatment. Int Clin 4:156–188
4. Wu MH, Lu CW, Chen HC, Kao FY, Huang SK. Adult Congenital Heart Disease in a Nationwide Population 2000-2014: Epidemiological Trends, Arrhythmia, and Standardized Mortality Ratio. J Am Heart Assoc. 2018 Feb 08;7(4)
5. Goldmuntz E, Geiger E, Benson DW. NKX2.5 mutations in patients with tetralogy of fallot. Circulation 2001; 104:2565.
6. Greenway SC, Pereira AC, Lin JC, et al. De novo copy number variants identify new genes and loci in isolated sporadic tetralogy of Fallot. Nat Genet 2009; 41:931.
7. Di Felice V, Zummo G. Tetralogy of fallot as a model to study cardiac progenitor cell migration and differentiation during heart development.Trends Cardiovasc Med 2009; 19:130.
8. Griffin HR, Töpf A, Glen E, et al. Systematic survey of variants in TBX1 in non-syndromic tetralogy of Fallot identifies a novel 57 base pair deletion that reduces transcriptional activity but finds no evidence for association with common variants. Heart 2010; 96:1651.
9. Rauch R, Hofbeck M, Zweier C, et al. Comprehensive genotype phenotype analysis in 230 patients with tetralogy of Fallot. J Med Genet 2010; 47:321.
10. Wei D, Bao H, Liu XY, et al. GATA5 loss-of-function mutations underlie tetralogy of fallot. Int J Med Sci 2013; 10:34.
11. Marinho C, Alho I, Guerra A, et al. The methylenetetrahydrofolate reductase gene variant (C677T) as a susceptibility gene for tetralogy of Fallot. Rev Port Cardiol 2009; 28:809.
12. Kramer HH, Majewski F, Trampisch HJ, et al. Malformation patterns in children with congenital heart disease. Am J Dis Child 1987; 141:789.
13. Freeman SB, Taft LF, Dooley KJ, et al. Population-based study of congenital heart defects in Down syndrome. Am J Med Genet 1998; 80:213.
14. Krantz ID, Smith R, Colliton RP, et al. Jagged1 mutations in patients ascertained with isolated congenital heart defects. Am J Med Genet 1999; 84:56.
15. Takahashi K, Kido S, Hoshino K, et al. Frequency of a 22q11 deletion in patients with conotruncal cardiac malformations: a prospective study. Eur J Pediatr 1995; 154:878.
16. Webber SA, Hatchwell E, Barber JC, et al. Importance of microdeletions of chromosomal region 22q11 as a cause of selected malformations of the ventricular outflow tracts and aortic arch: a three-year prospective study. J Pediatr 1996; 129:26.

17. Goldmuntz E, Clark BJ, Mitchell LE, et al. Frequency of 22q11 deletions in patients with conotruncal defects. J Am Coll Cardiol 1998; 32:492.
18. Lammer EJ, Chak JS, Iovannisci DM, et al. Chromosomal abnormalities among children born with conotruncal cardiac defects. Birth Defects Res A Clin Mol Teratol 2009; 85:30.
19. Bauer RC, Laney AO, Smith R, et al. Jagged1 (JAG1) mutations in patients with tetralogy of Fallot or pulmonic stenosis. Hum Mutat 2010; 31:594.
20. Kessler-Icekson G, Birk E, Weintraub AY, et al. Association of tetralogy of Fallot with a distinct region of del22q11.2. Am J Med Genet 2002; 107:294.
21. Bristow JD, Bernstein HS. Counseling families with chromosome 22q11 deletions: the catch in CATCH-22. J Am Coll Cardiol 1998; 32:499.
22. van Engelen K, Topf A, Keavney BD, et al. 22q11.2 Deletion Syndrome is under-recognised in adult patients with tetralogy of Fallot and pulmonary atresia. Heart 2010; 96:621.
23. Anderson RH, Weinberg PM. The clinical anatomy of tetralogy of Fallot. Cardiol Young. 2005;15(suppl 1):38–47.
24. Anderson RH, Allwork SP, Ho SY, et al. Surgical anatomy of tetralogy of Fallot. J Thorac Cardiovasc Surg. 1981;81:887-896.
25. Brickner ME, Hillis LD, Lange RA. Congenital heart disease in adults. Second of two parts. N Engl J Med. 2000 Feb 03;342(5):334- 42
26. Altrichter PM, Olson LJ, Edwards WD, et al. Surgical pathology of the pulmonary valve: a study of 116 cases spanning 15 years. Mayo Clin Proc. 1989;64:1352–1360.
27. Van Praagh R, Van Praagh S, Nebesar RA, et al. Tetralogy of Fallot: underdevelopment of the pulmonary infundibulum and its sequelae. Am J Cardiol. 1970;26:25-33.
28. Liao PK, Edwards WD, Julsrud PR, et al. Pulmonary blood supply in patients with pulmonary atresia and ventricular septal defect. J Am Coll Cardiol 1985; 6:1343.
29. Goo HW. Double Outlet Right Ventricle: In-Depth Anatomic Review Using Three-Dimensional Cardiac CT Data. Korean J Radiol. 2021 Nov;22(11):1894-1908. https://doi.org/10.3348/kjr.2021.0248
30. Dabizzi, RP, Caprioli G, Aiazzi L, et al. Distribution and anomalies of coronary arteries in tetralogy of Fallot. Circulation. 1980;61:95–102.
31. Van Son JA. Repair of tetralogy of Fallot with anomalous origin of left anterior descending coronary artery. J Thorac Cardiovasc Surg. 1995;110:561–562.
32. Chiariello L, Meyer J, Wukasch DC, et al. Intracardiac repair of tetralogy of Fallot.Five–year review of 403 patients. J Thorac Cardiovasc Surg. 1975;70:529–535.
33. Digilio MC, Marino B, Grazioli S, et al. Comparison of occurrence of genetic syndromes in ventricular septal defect with pulmonic stenosis (classic tetralogy of Fallot) versus ventricular septal defect with pulmonic atresia. Am J Cardiol. 1996;77:1375-1376.
34. Kevin G. Friedman; Edward P. Walsh; Tal Geva Nadas' Pediatric Cardiology, Tetrology of Fallot 26, 336-350
35 . Perloff JK. The Clinical Recognition of Congenital Heart Disease, 4th ed, WB Saunders, Philadelphia 1994.
36. van Roekens CN, Zuckerberg AL. Emergency management of hypercyanotic crises in tetralogy of Fallot. Ann Emerg Med. 1995 Feb;25(2):256-8. doi: 10.1016/s0196-0644(95)70335-7. PMID: 7832359.
37. Tsze DS, Vitberg YM, Berezow J, Starc TJ, Dayan PS. Treatment of tetralogy of Fallot hypoxic spell with intranasal fentanyl. Pediatrics. 2014;134[1]:e266-9.
38. Kothari SS. Mechanism of cyanotic spells in tetralogy of Fallot--the missing link? Int J Cardiol 1992; 37:1.
39. Dadlani GH, John JB, Cohen MS. (2008) Echocardiography in tetralogy of Fallot. Cardiol Young 18(Suppl 3), 22–28. 35. Gatzoulis MA, Soukias N, Ho SY, et al. (1999)
40. Echocardiographic and morphological correlations in tetralogy of Fallot. Eur Heart J 20, 221–231.
41. Tongsong T, Sittiwangkul R, Chanprapaph P, et al. (2005) Prenatal sonographic diagnosis of tetralogy of Fallot. J Clin Ultrasound 33, 427–431. 38.
42. Lee W, Smith RS, Comstock CH, et al. (1995) Tetralogy of Fallot: prenatal diagnosis and postnatal survival. Obstet Gynecol 86, 583–588.
43. Kreutzer J, Perry SB, Jonas RA, Mayer JE, Castañeda AR, Lock JE. Tetralogy of Fallot with diminutive pulmonary arteries: preoperative pulmonary valve dilation and transcatheter rehabilitation of pulmonary arteries. J Am Coll Cardiol. 1996;27: 1741-1747.
44. Sluysmans T, Neven B, Rubay J, et al. Early balloon dilatation of the pulmonary valve in infants with tetralogy of Fallot: risks and benefits. Circulation. 1995;91:1506-1511.
45. Lapierre C, Dubois J, Rypens F, et al. Tetralogy of Fallot: Preoperative assessment with MR and CT imaging. Diagn Interv Imaging 2016; 97:531.
46. Stout KK et al: 2018 AHA/ACC guideline for the management of adults with congenital heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol. 73(12):e81-192, 2019
47. Gartner RD et al: MRI and computed tomography of cardiac and pulmonary complications of tetralogy of Fallot in adults. J Thorac Imaging. 25(2):183-90, 2010
48. Oosterhof T et al: Cardiovascular magnetic resonance in the follow-up of patients with corrected tetralogy of Fallot: a review. Am Heart J. 151(2):265-72, 2006
49. Geva T, Powell AJ, Crawford EC, et al. (1998) Evaluation of regional differences in right ventricular systolic function by acoustic quantification echocardiography and cine magnetic resonance imaging. Circulation 98, 339–345.
50. Exercise MR imaging in the assessment of pulmonary regurgitation and biventricular function in patients after tetralogy of Fallot repair. Radiology 223, 204–211. 42. van den Berg J, Wielopolski PA, Meijboom FJ, et al. (2007)
51. Diastolic function in repaired tetralogy of Fallot at rest and during stress: assessment with MR imaging. Radiology 243, 212–219
52. van der Ven JPG, van den Bosch E, Bogers AJCC, Helbing WA. Current outcomes and treatment of tetralogy of Fallot. F1000Res. 2019 Aug 29;8:F1000 Faculty Rev-1530. doi: 10.12688/f1000research.17174.1. PMID: 31508203; PMCID: PMC6719677.
53. Bailliard, F., Anderson, R.H. Tetralogy of Fallot. Orphanet J Rare Dis 4, 2 (2009).

54. Gil-Jaurena JM, Ferreiros M, Castillo R, Conejo L, Cuenca V, Zabala JI. Use of a pulmonary neovalve with a transannular patch for repair of tetralogy of fallot. Rev Esp Cardiol. 2010 Dec;63(12):1438-43. English, Spanish. doi: 10.1016/s1885-5857(10)70278-4. PMID: 21144404.
55. Ayman Almousa, Andrew Behrmann, Paighton Miller, Shamik Bhattacharya, Dilip Nath, Jacob R. Miller, Pirooz Eghtesady, Use of Right Atrial Appendage Tissue for Pulmonary Valve Reconstruction in Tetralogy of Fallot, Seminars in Thoracic and Cardiovascular Surgery: Pediatric Cardiac Surgery Annual, Volume 28, 2025, Pages 60-67, ISSN 1092-9126, https://doi.org/10.1053/j.pcsu.2025.02.010.
56. Amirghofran A, Edraki F, Edraki M, Ajami G, Amoozgar H, Mohammadi H, Emaminia A, Ghasemzadeh B, Borzuee M, Peiravian F, Kheirandish Z, Mehdizadegan N, Sabri M, Cheriki S, Arabi H. Surgical repair of tetralogy of Fallot using autologous right atrial appendages: short- to mid-term results. Eur J Cardiothorac Surg. 2021 Apr 13;59(3):697-704. doi: 10.1093/ejcts/ezaa374. PMID: 33164039.
57. Aytaç A, Saylam A, Yurdakul Y, İkizler C, Olga R. Total correction for tetralogy of Fallot in adolescents and adults. The Turkish Journal of Pediatrics, 1980;22:3-4.
58. Harrison DA, Siu SC, Hussain F et al. Sustained atrial arrythmias in adults late after repair of tetralogy of Fallot. Am J Cardiol, 2001;87:584-8.
59. Gatzoulis MA, Balaji S, Webb GD, Redington AN. Risk factors for arrythmia and sudden cardiac death late after repair of tetralogy of Fallot: A multicenter study. Lancet, 2000;356:975-81.
60. Aytac A, The role of extensive reconstruction of pulmonary artery and main branches for survival in total repair of tetralogy of Fallot. Current Practice of Cardiology, 1991;3:303-8.
61. Steiner MB, Tang X, Gossett JM, et al. Timing of complete repair of non-ductal-dependent tetralogy of Fallot and short-term postoperative outcomes, a multicenter analysis. J Thorac Cardiovasc Surg 2014; 147:1299.
62. Savla JJ, Faerber JA, Huang YV, et al. 2-Year Outcomes After Complete or Staged Procedure for Tetralogy of Fallot in Neonates. J Am Coll Cardiol 2019; 74:1570.
63. Hövels-Gürich HH, Konrad K, Skorzenski D, et al. Long-term neurodevelopmental outcome and exercise capacity after corrective surgery for tetralogy of Fallot or ventricular septal defect in infancy. Ann Thorac Surg 2006; 81:958.
64. Forman J, Beech R, Slugantz L, Donnellan A. A Review of Tetralogy of Fallot and Postoperative Management. Crit Care Nurs Clin North Am. 2019 Sep;31(3):315-328. doi: 10.1016/j.cnc.2019.05.003. Epub 2019 Jul 5. PMID: 31351553.
65. Ahmad N, Kantor PF, Grosse-Wortmann L, Seller N, Jaeggi ET, Friedberg MK, et al. Influence of rv restrictive physiology on lv diastolic function in children after tetralogy of fallot repair. J Am Soc Echocardiogr. 2012;25(8): 866–73.
66. Sandeep B, Huang X, Xu F, Su P, Wang T, Sun X. Etiology of right ventricular restrictive physiology early after repair of tetralogy of Fallot in pediatric patients. J Cardiothorac Surg. 2019;14:84. https://doi.org/10.1186/s13019-019-0909-8
67. van Roekens CN, Zuckerberg AL. Emergency management of hypercyanotic crises in tetralogy of Fallot. Ann Emerg Med. 1995 Feb;25(2):256-8. doi: 10.1016/s0196-0644(95)70335-7. PMID: 7832359.
68. Tsze DS, Vitberg YM, Berezow J, Starc TJ, Dayan PS. Treatment of tetralogy of Fallot hypoxic spell with intranasal fentanyl. Pediatrics. 2014;134[1]:e266-9.



ÇİFT ÇIKIŞLI SAĞ VENTRİKÜL

BÖLÜM
32

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İçindekiler

- GİRİŞ
  - Tanımlama
  - Tarihçe
- MORFOLOJİ
- SINIFLAMA
- PATOFİZYOLOJİ
- GENETİK
- TANI
  - Elektrokardiogram (EKG)
  - Fetal Ekokardiografı
  - Transtorasik Ekokardiyografi
  - Bilgisayarlı Tomografi (BT)
  - Anjiyogram/Kardiyak Kateterizasyon/BT
- AMELİYAT ÖNCESİ YÖNETİM
- CERRAHİ TEDAVİ
  - DORV-VSD Tip (Intravenriküler tünel)
  - DORV-Fallot Tip
  - DORV Noncommitted VSD Tip
  - DORV-TGA Tip
  - Cerrahi Karar ve Anatomik Kriterler
  - DORV-AVSD-Heterotaxy
  - Tek Ventrikül Yaklaşımı
- POSTOPERATİF KOMPLİKASYONLAR VE UZUN DÖNEM SONUÇLAR
- GEÇ DÖNEM KOMPLİKASYONL

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(95% GA: %17,4–33,9; n=29) ve REV grubunda %22,2 (95% GA: %2,8–60,0; n=2) olarak tespit edilmiştir. Beklenmeyen reoperasyon oranı, Rastelli/RV–PA konduit yerleştirilen hastalarda %11,9 (95% GA: %7,3–17,9), Nikaidoh hastalarında ise %19,8 (95% GA: %13,0–28,9) olarak bildirilmiştir.

GEÇ DÖNEM KOMPLİKASYONLAR

Rastelli prosedüründe, oluşturulan tünelin uzunluğu zamanla obstrüksiyona neden olabilir ve konduit, hastanın somatik büyümesine bağlı olarak yetersiz hale gelebilir. Bu durum, genellikle RV–PA konduit değişimini gerektirir; ancak cerrahi öncesinde kateter yoluyla balon dilatasyon veya stentleme ile geçici rahatlama sağlanabilir. Uzun dönemli obstrüksiyon gelişen olgularda sağ ventrikül fonksiyonlarında bozulma gözlenebilir. Nikaidoh prosedüründe ise koroner arter anomalileri, olumsuz sonuç riskini artıran önemli bir faktördür.

Kreutzer ve ark. (51), Rastelli prosedürünün düşük erken mortalite ile uygulanabileceğini bildirmiştir. Bununla birlikte, geç dönemde RVOT (sağ ventrikül çıkım yolu) ve LVOT (sol ventrikül çıkım yolu) obstrüksiyonu gelişen olgularda mortalite artmıştır. Avrupa Konjenital Kalp Cerrahları Derneği (ECHSA) verileri, Rastelli prosedürü sonrası beklenen şekilde yüksek reoperasyon oranları bildirmiştir; bu durum, konduitlerin zamanla büyüyen çocuklarda yetersiz hale gelmesiyle ilişkilidir. Aynı kaynaktan alınan verilere göre, REV prosedürü sonrası 1., 5. ve 10. yıllarda sırasıyla mortaliteden, reoperasyondan veya yeniden müdahaleden bağımsızlık oranları %90, %78 ve %64 olarak rapor edilmiştir (52).

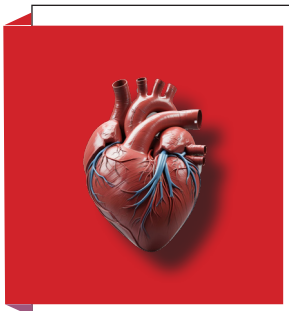
Her ne kadar bu cerrahi tekniklerin tümüyle başarılı sonuçlar elde edilebilse de, hasta seçimi ve patoanatomik özelliklerle uyumlu en uygun operasyonun belirlenmesi büyük önem taşır. Ayrıca, cerrahi prosedür seçimi cerrahın deneyimi ve konfor düzeyiyle de uyumlu olmalıdır. Gerektiğinde, daha deneyimli merkezlerle konsültasyon yapılması hasta güvenliği açısından önerilir.

KAYNAKLAR

1. Lev M, Bharati S, Meng CC, Liberthson RR, Paul MH, Idriss F. A concept of double-outlet right ventricle. J Thorac Cardiovasc Surg. (1972) 64:271–81. doi: 10.1016/S0022-5223(19)41769-8
2. Goor DA, Massini C, Shem-Tov A, Neufeld HN. Transatrial repair of double- outlet right ventricle in infants. Thorax. (1982) 37:371–5. doi: 10.1136/thx.37.5.37
3. İkemoto Y, Nogi S, Teraguchi M, Imamura H, Kobayashi Y. Double-outlet right ventricle with intact ventricular septum. Acta Paediatr Jpn, 1997;39:233-6.
4. Jacobs JP, Franklin RCG, Beland MJ, Spicer DE, Colan SD, Walters HL, et al. Nomenclature for pediatric and congenital cardiac care: unification of clinical and administrative nomenclature—the 2021 international paediatric and congenital cardiac code (IPCCC) and the eleventh revision of the international classification of diseases (ICD-11). World J Pediatr Congenit Heart Surg. (2021) 12:E1–18. doi: 10.1177/21501351211032919
5. Walters HL 3rd. Conuses and discontinuities: to be or not to be in double-outlet right ventricle. J Thorac Cardiovasc Surg. (2017) 154:605–6. doi: 10.1016/j.jtcvs.2017.04.006
6. Vierordt H. Die angeborenen herzkrankheiten. In: Nothnagel's Spez. Path. Therapie, 1898, 15:244.
7. Taussig HB, Bing RJ. Complete transposition of the aorta and a levoposition of the pulmonary artery. Am Heart J, 1949;37:551-9.
8. LevM,VolkBM.ThepathologicanatomyoftheTaussig-Bing heart: Riding pulmonary artery. Report of a case. Bull Internal Assoc Med Museums, 1950;31:54-64.
9. Braun K, DeVries A, Feingold DS et al. Complete dextroposition of the aorta, pulmonary stenosis, interventricular septal defect, and patent foramen ovale. Am Heart J, 1952;43:773-80.
10. Witham AC. Double-outlet right ventricle: A partial transposition complex. Am Heart J, 1957;53:928-39.
11. H L Walters 3rd [1], C Mavroudis, C I Tchervenkov, J P Jacobs, F Lacour-Gayet, M L Jacobs Congenital Heart Surgery Nomenclature and Database Project: double outlet right ventricle Ann Thorac Surg 2000 Apr;69(4 Suppl):S249-63.
12. McGoon DC. Origin of both great vessels from the right ventricle. Surg Clin N America 1961;41:1113–20.
13. Kirklin JW, Harp RA, McGoon DC. Surgical treatment of origin of both vessels from the right ventricle, including cases of pulmonary stenosis. J Thorac Cardiovasc Surg 1964;48:1026–36.
14. Daicoff GR, Kirklin JW. Surgical correction of Taussig-Bing malformation. Report of three cases. Am J Cardiol 1967;19: 125.
15. Patrick DL, McGoon DC. Operation for double-outlet right ventricle with transposition of the great arteries. J Cardiovasc Surg 1968;9:537–42.
16. Kawashima Y, Fujita T, Miyamoto T, Manabe H. Intraventricular rerouting of blood for the correction of Taussig-Bing malformation. J Thorac Cardiovasc Surg 1971;62:825–9.
17. Metin Demircin. Konu 23-Çift Çıkışlı sağ ventrikül. Kalp ve Damar cerrahisi kitabı 2013, editör Mustafa Paç.
18. Praagh RV. Normally and abnormally related great arteries: what have we learned? World J Pediatr

Congenit Heart Surg. (2010) 1:364–85. doi: 10.1177/2150135110380239
19. Wenink ACG. Double outlet right ventricle in a human embryo. Virchows Archiv A. (1978) 379:313–20. doi: 10.1007/BF00464474
20. Van Praagh S, Davidoff A, Chin A, Shiel F, Reynolds J, Van Praagh R. Double outlet right ventricle: anatomic types and developmental implications based on a study of 101 autopsied cases. Coeur. (1982) 13:389–439.
21. Van Praagh R, Van Praagh S. Chapter 3—morphologic anatomy. In: Keane JF, Lock JE, Fyler DC, editors. Nadas' pediatric cardiology. 2nd ed. Philadelphia, PA: W.B. Saunders (2006). p. 27–37.
22. Ebadi A, Spicer DE, Backer CL, Fricker FJ, Anderson RH. Double-outlet right ventricle revisited. J Thorac Cardiovasc Surg. (2017) 154:598–604. doi: 10.1016/j.jtcvs.2017.03.049
23. Martins P, Castela E. Transposition of the great arteries. Orphanet J Rare Dis. (2008) 3(27). doi: 10.1186/1750-1172-3-27
24. Bharucha T, Hlavacek AM, Spicer DE, Theocharis P, Anderson RH. How should we diagnose and differentiate hearts with double-outlet right ventricle? Cardiol Young. (2017) 27:1–15. doi: 10.1017/S1047951116001190
25. Anderson RH. How best can we define double outlet right ventricle when describing congenitally malformed hearts? Anat Rec. (2013) 296: 993–4. doi: 10. 1002/ar.22716
26. Yolandee Bell-Cheddar , William A Devine , Carlos-Eduardo Diaz-Castrillon , Laura Seese , Mario Castro-Medina , Raymond Morales , Christopher W Follansbee , Tarek Alsaied , Jiuann-Huey I Lin. Double outlet right ventricle. Front Pediatr 2023 Sep 25:11:1244558. doi: 10.3389/fped.2023.1244558.
27. Gottschalk I, Abel JS, Menzel T, Herberg U, Breuer J, Gembruch U, et al. Prenatal diagnosis, associated findings and postnatal outcome of fetuses with double outlet right ventricle (DORV) in a single center. J Perinat Med. (2019) 47:354–64. doi: 10.1515/jpm-2018-0316
28. Anderson RH, Webb S, Brown NA, Lamers W, Moorman A. Development of the heart: (3) formation of the ventricular outflow tracts, arterial valves, and intrapericardial arterial trunks. Heart. (2003) 89:1110–8. doi: 10.1136/heart.89.9. 1110
29. Obler D, Juraszek AL, Smoot LB, Natowicz MR. Double outlet right ventricle: aetiologies and associations. J Med Genet. (2008) 45:481–97. doi: 10.1136/jmg.2008.057984
30. Krongrad E, Ritter DG, Weidman WH, DuShane JW. Hemodynamic and anatomic correlation of electrocardiogram in double-outlet right ventricle. Circulation. (1972) 46:995–1004. doi: 10.1161/01.CIR.46.5.995
31. Lin JH, Chang CI, Wang JK, Wu MH, Shyu MK, Lee CN, et al. Intrauterine diagnosis of heterotaxy syndrome. Am Heart J. (2002) 143:1002–8. doi: 10.1067/mhj.2002.122873
32. Berg C, Geipel A, Smrcek J, Krapp M, Germer U, Kohl T, et al. Prenatal diagnosis of cardiosplenic syndromes: a 10-year experience. Ultrasound Obstet Gynecol. (2003) 22:451–9. doi: 10.1002/uog.904
33. Kumar P, Bhatia M. Role of computed tomography in pre- and postoperative evaluation of a double-outlet right ventricle. J Cardiovasc Imaging. (2021) 29:205–27. doi: 10.4250/jcvi.2020.0196
34. Jette J Peek,Wouter Bakhuis,,Kevin M Veen,Arno A W Roest,Nico Bruining,Theo van Walsum,Mark G Hazekamp ,Ad J J C Bogers Optimized preoperative planning of double outlet right ventricle patients by 3D printing and virtual reality: a pilot studyInterdiscip Cardiovasc Thorac Surg 2023 Aug 3;37(2):ivad072. doi: 10.1093/icvts/ivad072
35. Lecompte Y, Zannini L, Hazan E, Jarreau MM, Bex JP, Tu TV, et al. Anatomic correction of transposition of the great arteries. J Thorac Cardiovasc Surg. (1981) 82:629–31. doi: 10.1016/S0022-5223(19)39303-1
36. Sakata R, Lecompte Y, Batisse A, Borromee L, Durandy Y. Anatomic repair of anomalies of ventriculoarterial connection associated with ventricular septal defect. I. Criteria of surgical decision. J Thorac Cardiovasc Surg. (1988) 95:90–5. doi: 10.1016/S0022-5223(19)35391-7
37. Hu S, Yang Y, Wu Q, Rwakaryebe M, Liu Z, Deng Y, et al. Results of two different approaches to closure of subaortic ventricular septal defects in children. Eur J Cardiothorac Surg. (2014) 46:648–53. doi: 10.1093/ejcts/ezu019
38. Devlin PJ, Russell HM, Monge MC, Patel A, Costello JM, Spicer DE, et al. Doubly committed and juxtaarterial ventricular septal defect: outcomes of the aortic and pulmonary valves. Ann Thorac Surg. (2014) 97:2134–40; discussion 2140–1. doi: 10.1016/j.athoracsur.2014.01.059
39. Belli E, Serraf A, Lacour-Gayet F et al. Double-outlet right ventricle with non-committed ventricular septal defect. Eur J Cardiothorac Surg, 1999;15:747-52.
40. Lacour-Gayet F, Haun C, Ntalakoura K et al. Biventricular repair of double-outlet right ventricle with noncommitted ventricular septal defect (VSD) by VSD rerouting to the pulmonary artery and arterial switch. Eur J Cardiothorac Surg, 2002;21:1042-8.
41. Barbero-Marcial M, Tanamati C, Atik E, Ebaid M. Intraventricular repair of double-outlet right ventricle with noncommitted ventricular septal defect: advantages of multiple patches. J Thorac Cardiovasc Surg. (1999) 118:1056–67. doi: 10.1016/S0022-5223(99)70102-9
42. Lacour-Gayet F. Biventricular repair of double outlet right ventricle with noncommitted ventricular septal defect. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. (2002) 5:163–72. doi: 10.1053/pcsu.2002.31491
43. Hu S, Xie Y, Li S, Wang X, Yan F, Li Y, et al. Double-root translocation for double-outlet right ventricle with noncommitted ventricular septal defect or double- outlet right ventricle with subpulmonary ventricular septal defect associated with pulmonary stenosis: an optimized solution. Ann Thorac Surg. (2010) 89:1360–5. doi: 10.1016/j.athoracsur.2010.02.007
44. Wauthy P, Demanet H, Sanoussi A, Deuvaert FE. Ventricular septal defect closure in Taussig-Bing Heart: The "Pulmonic Rule". Ann Thorac Surg, 2009;88:313-4.
45. Mair R, Sames-Dolzer E, Innerhuber M, Tulzer A, Grohmann E, Tulzer G. Anatomic repair of complex transposition with en bloc rotation of the truncus arteriosus: 10-year experience. Eur J Cardiothorac Surg. (2016) 49:176–82. doi: 10. 1093/ejcts/ezv056
46. Victor O. Morell Is a double better than a single in root translocation? JTCVS Volume 164, Issue 5P1261-1262November 2022

47. Koshiyama H, Aoki M, Akiyama S, Nakamura Y, Hagino I, Fujiwara T. Successful biventricular repair of double-outlet right ventricle with transposition of the great arteries, pulmonary stenosis, and straddling mitral valve. Ann Thorac Surg. (2014) 97:1431–3. doi: 10.1016/j.athoracsur.2013.07.063
48. Li S, Ma K, Hu S, Hua Z, Yang K, Yan J, et al. Surgical outcomes of 380 patients with double outlet right ventricle who underwent biventricular repair. J Thorac Cardiovasc Surg. (2014) 148:817–24. doi: 10.1016/j.jtcvs.2014.06.020
49. Shim M-s, Jun T-G, Yang J-H, Park PW, Kang IS, Huh J, et al. Current expectations of the arterial switch operation in a small volume center: a 20-year, single-center experience. J Cardiothorac Surg. (2016) 11:34. doi: 10.1186/s13019- 016-0428-9
50. Seese L, Turbendian HK, Thibault D, Da Fonseca Da Silva L, Hill K, Castro- Medina M, et al. Utilization and outcomes of the Nikaidoh, Rastelli, and REV procedures: an analysis of the society of thoracic surgeons congenital heart surgery database. Ann Thorac Surg. (2022) 114:800–8. doi: 10.1016/j.athoracsur. 2021.06.019
51. Kreutzer C, De Vive J, Oppido G, Kreutzer J, Gauvreau K, Freed M, et al. Twenty-five-year experience with Rastelli repair for transposition of the great arteries. J Thorac Cardiovasc Surg. (2000) 120:211–23. doi: 10.1067/mtc.2000.108163
52. Hazekamp MG, Gomez AA, Koolbergen DR, Hraska V, Metras DR, Mattila IP, et al. Surgery for transposition of the great arteries, ventricular septal defect and left ventricular outflow tract obstruction: European Congenital Heart Surgeons Association multicentre study. Eur J Cardiothorac Surg. (2010) 38:699–706. doi: 10. 1016/j.ejcts.2010.03.030



VENTRİKÜLER SEPTAL DEFEKT, PULMONER ATREZİ

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İçindekiler

- GİRİŞ VE GENEL BİLGİLER
- ANATOMİ VE PATOFİZYOLOJİ
- SINIFLANDIRMA
- KLİNİK ÖZELLİKLER
- TANI YÖNTEMLERİ
- TAMİR İÇİN UYGUNLUK
- MEDİKAL TEDAVİ
- CERRAHİ TEDAVİ
  - 1- Duktus Bağımlı Pulmoner Sirkulasyon ve Konfluent Pulmoner Arterleri Olan VSD/PA
  - 2-Majör Aortopulmoner Kollateral Arterlerle Birlikte Görülen Hipoplastik Santral Pulmoner Arterler.
  - 3-Santral Pulmoner Arterlerin Yokluğu ve Majör Aortopulmoner Kollateral Arterlerin Varlığı.
- TEK AŞAMALI TAMİR
- ÇOK AŞAMALI ONARIM STRATEJİSİ
- TRANSPLANTASYON
- POSTOPERATİF YÖNETİM
  - Primer Unifokalizasyon Sonrası Postoperatif İzlem
- POSTOPERATİF DEĞERLENDİRME VE YÖNETİM
- CERRAHİ BAŞARI ORANLARI VE UZUN DÖNEM SONUÇLAR

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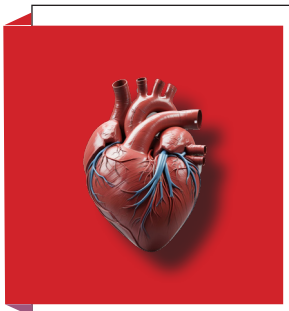
KAYNAKLAR

1. Anderson RH, Devine WA, del Nido P. The surgical anatomy of tetralogy of Fallot with pulmonary atresia rather than pulmonary stenosis. *J Cardiac Surg*. 1991;6:41–59.
2. Rossi RN, Hislop A, Anderson RH,et al. Systemic-to-pulmonary blood supply in tetralogy of Fallot with pulmonary atresia. *Cardiol Young*. 2002;12:373–388.
3. Leonard H, Derrick G, O'Sullivan J, et al. Natural and unnatural history of pulmonary atresia. *Heart*. 2000;84:499–503.
4. Bauser-Heaton H, Borquez A, Han B, et al. Programmatic approach to management of tetralogy of Fallot with major aortopulmonary collateral arteries: a 15-year experience with 458 patients. *Circ Cardiovasc Interv*. 2017;10:e004952.
5. Soquet J, Barron DJ, d'Udekem Y. A review of the management of pulmonary atresia, ventricular septal defect, and major aortopulmonary collateral arteries. *Ann Thorac Surg*. 2019;108:601–612.
6. Liava'a M, d'Udekem Y. Tetralogy of Fallot with pulmonary atresia and major aortopulmonary collateral, In: C Mavroudis, CL Backer (eds.) *Pediatric Cardiac Surgery*. 5th ed. JohnWiley & Sons Ltd, 2023; USA S:463-481.
7. NE. Drury, WJ. Brawn Pulmonary atresia with ventricular septal defect. In: Moorjani N, Viola N, & Caldarone C, (eds.) *Key questions in cardiac surgery*. TFM, 2022; 704-729.
8. Tchervenkov CI, Roy N. Congenital Heart Surgery Nomenclature and Database Project: pulmonary atresia–ventricular septal defect.*Ann Thorac Surg*. 2000;69:S97–S105.
9. Mahle WT, Crisalli J, Coleman K, et al. Deletion of chromosome 22q11.2 and outcome in patients with pulmonary atresia and ventricular septal defect. *Ann Thorac Surg*. 2003;76:567–571.
10. Liava'a M, Brizard CP, Konstantinov IE, et al. Pulmonary atresia, ventricular septal defect, and major aortopulmonary collaterals: neonatal pulmonary artery rehabilitation without unifocalization. *Ann Thorac Surg*.2012;93:185–191.
11. Bull K, Somerville J, Ty E, et al. Presentation and attrition in complex pulmonary atresia. *J Am Coll Cardiol*. 1995;25:491–499.
12. Pasquali SK, Li JS, Burstein DS, et al. Association of center volume with mortality and complications in pediatric heart surgery. *Pediatrics*. 2012;129:e370–e376.
13. Kothari SS. Mechanism of cyanotic spells in tetralogy of Fallot—the missing link? *Int J Cardiol*. 1992;37:1–5.
14. Wise-Faberowski L, Irvin M, Sidell DR, et al. Assessment of airway abnormalities in patients with tetralogy of Fallot, pulmonary atresia, and major aortopulmonary collaterals. *Cardiol Young*.2019;29:610–614.
15. Geva T, Greil GF, Marshall AC, et al. Gadolinium-enhanced 3-dimensional magnetic resonance angiography of pulmonary blood supply in patients with complex pulmonary stenosis or atresia: comparison with x-ray angiography. *Circulation*. 2002;106:473–478.
16. Ryan JR, Moe TG, Richardson R, et al. A novel approach to neonatal management of tetralogy of Fallot, with pulmonary atresia, and multiple aortopulmonary collaterals. *JACC: Cardiovasc Imaging*. 2015;8:103–104.
17. Ghosh RM, Mascio CE, Silvestro E, et al. A road map for collaterals: Use of 3-dimensional techniques in tetralogy of Fallot pulmonary atresia with major aortopulmonary collateral arteries. *JTCVS Tech*. 2020 Jan 21;1:82-85.
18. Biglino G, Capelli C, Wray J, et al. 3D-manufactured patient-specific models of congenital heart defects for communication in clinical practice: feasibility and acceptability. *BMJ Open*. 2015 Apr 30;5(4):e007165.
19. Fouilloux V, Bonello B, Kammache I, et al. Management of patients with pulmonary atresia, ventricular septal defect, hypoplastic pulmonary arteries and major aorto-pulmonary collaterals: focus on the strategy of rehabilitation of the native pulmonary arteries. *Arch CardiovascDis*. 2012;105:666–675.
20. Grosse-Wortmann L, Yoo SJ, van Arsdell G, et al. Preoperative total pulmonary blood flow predicts right ventricular pressure in patients early after complete repair of tetralogy of Fallot and pulmonary atresia with major aortopulmonary collateral arteries. *J Thorac Cardiovasc Surg*. 2013;146:1185–1190.
21. Blalock A, TaussigHB. The surgical treatment of malformations of the heart: in which there is pulmonary stenosis or pulmonary atresia. *JAMA*. 1945;128:189–202.
22. Lillehei CW, Cohen M, Warden HE, et al. Direct vision intracardiac surgical correction of the tetralogy of Fallot, pentalogy of Fallot, and pulmonary atresia defects: reportof first ten cases. *Ann Surg*. 1955;142:418–442.
23. Ross DN, Somerville J. Correction of pulmonary atresia with a homograft aortic valve. *Lancet*. 1966;2:1446–1447.
24. Haworth SG, Rees PG, Taylor JF, et al. Pulmonary atresia with ventricular septal defect and major aortopulmonary collateral arteries. Effect of systemic pulmonary anastomosis. *Br Heart J*. 1981;45:133–141.
25. Puga FJ, Leoni FE, Julsrliva PR,et al. Complete repair of pulmonary atresia, ventricular septal defect, and severe peripheral arborization abnormalities of the central pulmonary arteries. Experience with preliminary unifocalization procedures in 38 patients. *J Thorac Cardiovasc Surg*.1989;98:1018–1029.
26. Kanter KR, Kogon BE, Kirshbom PM, et al. Symptomatic neonatal tetralogy of Fallot: repair or shunt? *Ann Thorac Surg*. 2010;89:858–863.
27. Balasubramanya S, Zurakowski D, Borisuk M, et al. Right ventricular outflow tract reintervention after primary tetralogy of Fallot repair in neonates and young infants. *J Thorac Cardiovasc Surg*. 2018;155(2):726–734.
28. Gerelli S, van Steenberghe M, Murtuza B, et al. Neonatal right ventricle to pulmonary connection as a palliative procedure for pulmonary atresia with ventricular septal defect or severe tetralogy of Fallot. *Eur J Cardiothorac Surg*. 2014;45:278–288.
29. Amark KM, Karamlou T, O'Carroll A, et al. Independent factors associated with mortality, reintervention, and achievement of complete repair in children with pulmonary atresia with ventricular septal defect. *J Am Coll Cardiol*. 2006;47:1448–1456.
30. Aurigemma D, Moore JW, Vaughn G, et al. Perforation and right ventricular outflow tract stenting: alternative palliation for infants with pulmonary atresia/ventricular septal defect. *Congenit Heart Dis*. 2017;13:226–231.
31. Glatz AC, Petit CJ, Goldstein BH, et al. Comparison between patent ductus arteriosus stent and modified Blalock-Taussig Shunt as palliation for infants with du-

ctal-dependent pulmonary blood flow: insights from the congenital catheterization research collaborative. *Circulation*. 2018;137(6):589–601.
32. Quandt D, Ramchandani B, Stickley J, et al. Stenting of the right ventricular outflow tract promotes better pulmonary arterial growth compared with modified Blalock-Taussig shunt palliation in tetralogy of Fallot-type lesions. *JACC Cardiovasc Interv*.2017;10(17):1774–1784.
33. Santoro G, Capozzi G, Caianiello G, et al. Pulmonary artery growth after palliation of congenital heart disease with ductdependent pulmonary circulation: arterial duct stenting versus surgical shunt. *J Am Coll Cardiol*. 2009;54:2180–2186.
34. Alwi M, Choo KK, Latiff HA, et al. Initial results and mediumterm follow-up of stent implantation of patent ductus arteriosus in duct-dependent pulmonary circulation. *J Am Coll Cardiol*. 2004;44:438–445.
35. Ramakrishnan KV, Zurakowski D, Pastor W, et al. Symptomatic tetralogy of Fallot in young infants: primary repair or shunt-pediatric health information system database analysis. *World J Pediatr Congenit Heart Surg*. 2018;9(5):539–545.
36. Carotti A. Surgical management of Fallot's tetralogy with pulmonary atresia and major aortopulmonary collateral arteries: multistage versus one-stage repair. *World J Pediatr Congenit Heart Surg*. 2020;11(1):34–38.
37. Soquet J, Liava'a M, Eastaugh L, et al. Achievements and limitations of a strategy of rehabilitation of native pulmonary vessels in pulmonary atresia, ventricular septal defect, and major aortopulmonary collateral arteries. *Ann Thorac Surg*. 2017;103(5):1519–1526.)
38. Zheng S, Yang K, Li K, et al. Establishment of right ventriclepulmonary artery continuity as the first-stage palliation in older infants with pulmonary atresia with ventricular septal defect may be preferable to use of an arterial shunt. *Interact Cardiovasc Thorac Surg*. 2014;19:88–94.
39. Mainwaring RD, Patrick WL, Roth SJ, et al. Surgical algorithm and results for repair of pulmonary atresia with ventricular septal defect and major aortopulmonary collaterals. *J Thorac Cardiovasc Surg*. 2018;156(3):1194–1204.
40. Watanabe N, Mainwaring RD, Reddy VM, et al. Early complete repair of pulmonary atresia with ventricular septal defect and major aortopulmonary collaterals. *Ann Thorac Surg*. 2014;97:909– 915; discussion 914–915.
41. Cho JM, Puga FJ, Danielson GK, et al. Early and long-term results of the surgical treatment of tetralogy of Fallot with pulmonary atresia, with or without major aortopulmonary collateral arteries. *J Thorac Cardiovasc Surg*. 2002;124:70–81.
42. Honjo O, Al-Radi OO, MacDonald C, et al. The functional intraoperative pulmonary blood flow study is a more sensitive predictor than preoperative anatomy for right ventricular pressure and physiologic tolerance of ventricular septal defect closure after complete unifocalization in patients with pulmonary atresia, ventricular septal defect, and major aortopulmonary collaterals. *Circulation*. 2009;120:S46–S52.
43. Carotti A, Albanese SB, Minniti G, et al. Increasing experience with integrated approach to pulmonary atresia with ventricular septal defect and major aortopulmonary collateral arteries. *Eur J Cardiothorac Surg*. 2003;23:719–726; discussion 726–727.
44. Mainwaring RD, Patrick WL, Rosenblatt TR, et al. Surgical results of unifocalization revision. *J Thorac Cardiovasc Surg*.2019;158(2):534–545.
45. Van de Woestijne P, Mokhles M, van Beynum I, et al. A. Staged correction of pulmonary atresia, ventricular septal defect, and collateral arteries. *J Card Surg*. 2022;37(4):960–966.
46. Grosse-Wortmann L, Yoo SJ, van Arsdell G, et al. Preoperative total pulmonary blood flow predicts right ventricular pressure in patients early after complete repair of tetralogy of Fallot and pulmonary atresia with major aortopulmonary collateral arteries. *J Thorac Cardiovasc Surg*. 2013;146:1185–1190
47. Hofferberth SC, Esch JJ, Zurakowski D, et al. Pulmonary atresia with ventricular septal defect and major aortopulmonary collaterals: collateral vessel disease burden and unifocalisation strategies. *Cardiol Young*. 2018;28(9):1091–1098.
48. Luciani GB, Wells WJ, Khong A, et al. The clamshell incision for bilateral pulmonary artery reconstruction in tetralogy of Fallot with pulmonary atresia. *J Thorac Cardiovasc Surg*. 1997;113:443–452.
49. Januszewska K, Malec E, Juchem G, et al. Heart-lung transplantation in patients with pulmonary atresia and ventricular septal defect. *J Thorac Cardiovasc Surg*. 2009;138(3):738–743.
50. Schulze-Neick I, Ho SY, Bush A, et al. Severe airflow limitation after the unifocalization procedure: clinical and morphological correlates. *Circulation*. 2000;102(19 suppl3): 142–147.
51. Asija R, Roth SJ, Hanley FL, et al. Reperfusion pulmonary edema in children with tetralogy of Fallot, pulmonary atresia, and major aortopulmonary collateral arteries undergoing unifocalization procedures: a pilot study examining potential pathophysiologic mechanisms and clinical significance. *J Thorac Cardiovasc Surg*. 2014;148:1560–1565.
52. Griselli M, McGuirk SP, Winlaw DS, et al. The influence of pulmonary artery morphology on the results of operations for major aortopulmonary collateral arteries and complex congenital heart defects. *J Thorac Cardiovasc Surg*. 2004;127:251–258.
53. Egbe AC, Crestanello J, Dearani JA, et al. Long-term outcomes in adults with repaired tetralogy of Fallot and pulmonary atresia. *Cardiol Young*. 2019;29:1078–1081.
54. Carotti A, Albanese SB, Filippelli S, et al. Determinants of outcome after surgical treatment of pulmonary atresia with ventricular septal defect and major aortopulmonary collateral arteries. *J Thorac Cardiovasc Surg*. 2010;140:1092–1103.
55. Malhotra SP, Hanley FL. Surgical management of pulmonary atresia with ventricular septal defect and major aortopulmonary collaterals: a protocol-based approach. *Semin Thorac Cardiovasc Surg*. 2009:145–15.
56. Mainwaring RD, Reddy VM, Peng L, et al. Hemodynamic assessment after complete repair of pulmonary atresia with major aortopulmonary collaterals. *Ann Thorac Surg*. 2013;95:1397–1402.
57. Ganigara M, Sagiv E, Buddhe S,et al Tetralogy of Fallot with pulmonary atresia: anatomy, physiology, imaging, and perioperative management. *Semin Cardiothorac Vasc Anesth*. 2021;25(3):208–217.
58. Ishibashi N, Shin'oka T, Ishiyama M, et al. Clinical results of staged repair with complete unifocalization for pulmonary atresia with ventricular septal defect and major aortopulmonary collateral arteries. *Eur J Cardiothorac Surg*. 2007;32:202–208.



PULMONER ATREZİ VE İNTAKT VENTRİKÜLER SEPTUM

BÖLÜM
34

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- PA-İVS DA YAŞAM SONUÇLARI

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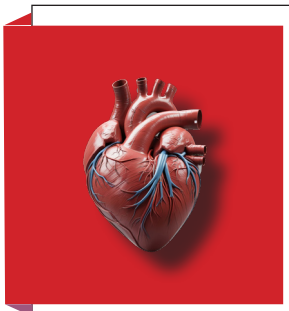
başlanan hastaların 1,2 ve 4 yıllık yaşam oranları sırası ile %60, %60 ve % 58 olarak bildirilmektedir (20). Tek ventriküllü tamir yolağındaki hastalarda BVT'e göre mortalitenin daha çok olduğu (%35' e karşı % 4,7) ve yine RVDCC ve koroner fistüllerin olması da uzun dönemde yüksek mortalite riski olarak bildirilmektedir (sırası ile risk oranı : 7,32 ve 6,63 dür). Patolojinin tüm gruplarının olduğu bir çalışmada 1, 3, 10 yıl yaşamın %82, %81, %80 olarak bildirilmiştir. Yaşam süresinin hastanın ulaştığı son düzeltme durumu ile yakın ilişkisi vardır. (23)

KAYNAKLAR

1. LaPar DJ,Bacha E.Pulmonary atresia with intact ventricular septum with borderline tricuspid valve. Semin Thorac Cardiovasc Surg Pediatr Card Surg Ann 2019;22:27-31
2. Kouchoukos NT,Blackstone EH,Hanley FL,Kirklin JK.Pulmonary atresia with intact ventricular septum. In:Kirklin/Barratt-Boyes cardiac surgery,4th ed.Philadelphia,Elsevier-Saunders 2013;1487-1501
3. Peacock TB.Malformation of the heart:atresia of the orifice of the pulmonary artery. Trans Pathol Soc Lond 1869;20:61
4. Flaxman N.Peacock and congenital heart disease:Thomas Bevill Peacock(1812-1882).Bulletin of the history of medicine 1939;7(9):1061-1103
5. Goor DA,Lillehei CW.Congenital malformation of the heart,New York,Grune&Stratton Inc.1975;1-37
6. Bull C,de Leval MR,Mercanti C,Macartney FJ,Anderson RH.Pulmonary atresia and intact ventricular septum:A revised classification.Circulation 1982;66:266-72
7. Greenwold WE,DuShane JW,Burchell HB,Bruwer A,Edwards JE.Congenital pulmonary atresia with intact ventricular septum.Two anatomic types (abstract).Circulation 1956;14:945
8. Davignon AL,Greenwold WE,DuShane JW,Edwards JE.Congenital pulmonary atresia with intact ventricular septum-clinicopathologic correlation of two anatomic types.Am Heart J 1961;62:591
9. Bowman FO Jr,Malm JR,Hayes CJ,Gersony WM,Ellis K.Pulmonary atresia with intact septum.J Thorac Cardiovasc Surg 1971;61:85
10. Trusler GA,Yamamoto N,Williams WG,Izukawa T,Rowe RD,Mustard WT.Surgical treatment of pulmonary atresia with intact ventricular septum.Br Heart J 1976;38:957
11. Latson LA.Non surgical treatment of a neonate with pulmonary atresia and intact ventricular septum by transcatheter puncture and baloon dilatation of the atretic valve membrane.Am J Cardiol 1991;68:277-9
12. Qureshi SA,Rosenthal E,Tynan M,Anjos R,Baker EJ.Transcatheter laser-assisted baloon pulmonary valve dilatation in pulmonic valve atresia.Am J Cardiol 1991;67:428-31
13. Tulzer G, Arzt W, Franklin RCG, Loughna PV, Mair R, Gardiner HM.Fetal pulmonary valvuloplasty for critical pulmonary stenosis or atresia with intact ventricular septum.Lancet 2002; 360: 1567–68
14. Furtun BY.Morris SA.Catheter-Based fetal cardiac interventions.J Cardiovasc Dev Dis 2024;11(6):167
15. Mavroudis C,Backer CL.Pediatric Cardiac Surgery,Isolated right ventricular outflow tract obstruction, 4 th ed,Wiley-Blackwell publication 2013,Ch.21,385-410
16. Hascoet S,Borrhomee S ,Tahhan N,Petit J,Boet A,Houyel L,et al.Transcatheter pulmonary valvuloplasty in neonates with pulmonary atresia and intact ventricular septum.Arch Cardiovasc Dis 2019;112:323-33
17. Daubeney PE,Delany DJ,Anderson RH,Sander GG,Slavik Z,Keeton BR,et al.Pulmonary atresia with intact ventricular septum:range of morphology in a population-based study.J Am Coll Cardiol 2002;39:1670-9
18. Kim MJ,Yu JJ,Kang SY,Seo CD,Baek JS,Kim YH,Ko JK.Comparison of the offset distance of the tricuspid septal leaflet in neonates with Estein's anomaly and neonates with pulmonary atresia with intact ventricular septum.Cardiol Young 2015;25:129-136
19. Anderson RH,Silverman NH,Zuberbuhler JR.Congenitally unguarded tricuspid orifice;its differentiation from Ebstein's malformation in association with pulmonary atresia and intact ventricular septum.Pediatr Cardiol 1990;11:86
20. Hanley FL,Sade RM,Blackstone EH,Kirklin JW,Freedom RM,Nanda NC.Outcomes in neonatal pulmonary atresia with intact ventricular septum:a multiinstitutional study.J Thorac Cardiovasc Surg 1993;105:406-23
21. Daubeney PE,Wang D,Delany DJ,Keeton BR,Anderson RH,Slavic Z, et al.Pulmonary atresia with intact ventricular septum:predictors of early and medium-term outcome in a population-based study.J Thorac Cardiovasc Surg 2005;130:1071
22. Dyamenahalli U,McCrindle BW,McDonald C,at al.Pulmonary atresia with intact ventricular septum:management of,and outcomes for, a cohort of 210 consecutive patients.Cardiol Young 2004;14:299-308
23. Sukhavasi A,McHugh-Grant S,Glatz AC,Mondal A,et al.Pulmonary atresia with intact ventricular septum:Intended strategies.J Thorac Cardiovasc Surg 2022;164:1277-88
24. LaPar DJ,Bacha E.pulmonary atresia with intact ventricular septum with borderline tricuspid valve:How small is too small.Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu 2019;22:27-31
25. Awari MN,Finucane K,Gentles TL.Optimal normative pediatric cardiac structure dimentions for clinical use. World J Pediatr Congenital Heart Surg 2011;2:85-9
26. Awari MN,Mehta NP,Mitema FO,Kebba N.Optimal z-score use in surgical decision-making in pulmonary atresia with intact ventricular septum. World J Pediatr Congenital Heart Surg 2017;8:385-8
27. Giglia TM,Mandell VS,Connor AR, Mayer JE,Jr.Lock JE. Diagnosis and management of right ventricul –dependant coronary circulation in pulmonary atresia with intact ventricular septum.Circulation 1992;86(5):1516-28
28. Gleich S,Latham GJ,Joffe D,Ross FJ.Perioperative and anesthetic considerations in pulmonary atresia and intact ventricular septum.Semin Cardiothorac Vasc Anesth 2018;22(3):256-64
29. Cleuzion J, Schreiber C, Eicken A, Hörer J, Busch R, Holper K, et al.Predictors for biventriculer repair in

pulmonary atresia with intact ventriculer septum. Thorac Cardiovasc Surg. 2010;56(6):339-44
30. Alwi M. Management algorhtm in pulmonary atresia with intact ventriculer septum. Catheter Cardiovasc nterv 2006;67(5):679-86
31. Hirata Y, Chen JM, Quaegebeur JM, Hellenband WE, Mosca RS. Pulmonary atresia with intact ventriculer septum:limitations of catheter –based intervention. Ann Thorac Surg 2007;84(2):574-9; discussion 9-80
32. Hasan BS, Bautista –Hernandez V, McElhinney DB, Salv,n J, Laussen PC, Prakash A, etal. Outcomes of transcatheter approach for initial treatment of pulmonary atresia with intact ventriculer septum. Catheter Cardiovasc İnter 2013 ;8(1):111-8
33. Bradley SM, Simsic JM, Mulhivill DM. Hypoventilation improves oxygenation after bidirectional superior cavopulmonary connection. J Thorac Cardiovasc Surg 2003 ;126(4):1033-9



BÜYÜK ARTERLERİN TRANSPOZİSYONU

BÖLÜM
35

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  » Rastelli, Lecompte ve Nikaidoh prosedürleri sonrası erken ve geç dönem sonuçlar

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lara inmiştir (89,90). Rastelli ameliyatlarından sonra hastalar normal –normale yakın (klas I-II) fonksiyonel kapasite ile yaşamlarını sürdürebilirler. Ancak yaşayan hastaların %70 den fazlası 5-10 yıl içinde RV-PA kondüitin dejenerasyon nedeniyle değiştirilmesi için reoperasyona ihtiyaç gösterebilirler (89-91). Ancak günümüzde RV-PA kondüit reoperasyonları çok düşük morbidite ve mortalite riski ile gerçekleştirilebilmektedir. Ayrıca transkateter balon dilatasyon-stent-kapak uygulamaları da kondüit ömrünün uzatılmasına önemli katkı sağlamıştır. Orta- uzun vadede bir diğer önemli problem, sol ventrikül çıkış yolunda oluşabilecek darlıklardır. İntrakardiyak tünel bölgesinde görülebilen bu darlıklar için, günümüzde reoperasyon riski yüksek değildir (89). İlk ameliyat sırasında restriktif veya sınırda olan VSD' lerin genişletilmesi, bu riski azaltabilir. Ancak VSD' nin genişletilmesinin de ileride sol ventrikül disfonksiyonuna yol açabileceği öne sürülmektedir. Geç dönemde ortaya çıkabilecek bir diğer problem ise, aritmi sorunlarıdır. Ekstrakardiyak RV-PA kondüitinin zaman içinde kaçınılmaz olarak rereplasman gerektireceği açıktır (91) (Şekil 18). Nikaidoh ve diğer aortik root translokasyon teknikleri hakkındaki erken ve uzun dönem sonuçları sınırlıdır.

Rastelli, Lecompte, Nikaidoh ve diğer aortic root translokasyon prosedürlerinin Teknik detayları ile erken ve orta dönem sonuçları kitabın ilgili bölümünde anlatılmaktadır.

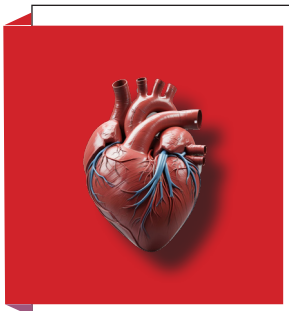
KAYNAKLAR

1. Martins P, Castela E. Transposition of the great arteries. Orphanet J Rare Diseases 2008; 3:27-37
2. Lillehei CW, Varco RL. Certain physiologic, pathologic, and surgical features of complete transposition of the great vessels. Surgery. 1953;34(3):376-400.
3. Albert HM. Surgical correction of transposition of the great vessels. Surg Forum. 1955;5:74-7.
4. Bianca S, Ettore G: Sex ratio imbalance in transposition of the great arteries and possible agricultural environmental risk factors. Images Paediatr Cardiol 2001, 8:10-14.
5. Sampayo F, Pinto FF: The sex distribution of congenital cardiopathies. Acta Med Port 1994, 7:413.
6. Samánek M: Boy girl ratio in children born with different forms of cardiac malformation: a population-based study. Pediatr Cardiol 1994, 15:53-7.
7. Güçer S, Ince T, Kale G, Akçören Z, Ozkutlu S, Talim B, Cağlar M: Noncardiac malformations in congenital heart disease: a retrospective analysis of 305 pediatric autopsies. Turk J Pediatr 2005, 47:159-66.
8. Blalock A, Hanlon CR. The surgical treatment of complete transposition of the aorta and the pulmonary artery. Surg Gynecol Obstet. 1950;90(1):1-15.
9. Rashkind WJ, Miller WW. Creation of an atrial septal defect without thoracotomy. A palliative approach to complete transposition of the great arteries. JAMA. 1966;196(11):991-2.
10. Bilgiç A. Balon atriyal septostominin Hacettepe çocuk hastanesinde uygulaması ve sonuçları. Çocuk Sağlığı ve Hastalıkları Dergisi. 1982; 25:13.
11. Senning A. Surgical correction of transposition of the great vessels. Surgery. 1959;45(6):966-80.
12. Mustard WT. Successful two-stage correction of transposition of the great vessels. Surgery. 1964; 55: 469-72.
13. Quaegebeur JM, Rohmer J, Brom AG. Revival of the Senning operation in the treatment of transposition of the great arteries. Preliminary report on recent experience. Thorax. 1977;32(5):517-24.
14. Rastelli GC, Wallace RB, Ongley PA. Complete repair of transposition of the great arteries with pulmonary stenosis. A review and report of a case corrected by using a new surgical technique. Circulation. 1969;39(1):83-95.
15. Jatene AD, Fontes VF, Paulista PP, Souza LC, Neger F, Galantier M, et al. Anatomic correction of transposition of the great vessels. J Thorac Cardiovasc Surg. 1976;72(3):364-70.
16. Aytaç A, Tekdoğan M, Erbil D. Hacettepe tıp merkezinde ameliyat edilen 100 konjenital kalp anomalisi. Çocuk Sağlığı Hastalıkları Dergisi. 1963; 6:37.
17. Aytaç A. Büyük damarların transpozisyonunda ''Mustard'' ameliyatı. Türk Kardiyoloji Cemiyeti Arşivi. 1972; 4:134.
18. Aytaç A, Sarıoğlu T, Bilgiç A. Senning operation for transposition of the great arteries. Türk J Pediatr. 1985; 27:161-8.
19. Sarıoğlu T, Doğan A. Kalp cerrahisinin tarihsel gelişimi. Ertin H, Salduz A, Salduz Y, editörler. Tıp Dallarındaki Gelişmelerin Tarihi. 1. Baskı. İstanbul: Betim Kitaplığı; 2022. p.673-701.
20. Sarıoğlu CT. Büyük arterlerin transpozisyonunda cerrahi tedavinin evrimi ve Türkiye serüveni. Sarıoğlu CT, editör. Transpozisyon Cerrahisi (Dünü, Bugünü ve Geleceği). 1. Baskı. Ankara: Türkiye Klinikleri; 2022. p.1-17.
21. Taussig HB, Bing RJ. Complete transposition of the aorta and a levoposition of the pulmonary artery; clinical, physiological, and pathological findings. *Am Heart J*. 1949;37:551–559.
22. Griselli M, McGuirk SP, Ko CS, Clarke AJ, Barron DJ, Brawn WJ. Arterial switch operation in patients with Taussig–Bing anomaly—influence of staged repair and coronary anatomy on outcome. Eur J Cardiothorac Surg. 2007;31:229–235
23. Erek E, Suzan D, Aydın A, Yıldız O, Kırat B, Demir İH, Ödemiş E. Outcomes after arterial switch operation for Taussig Bing anomaly versus transposition of the great arteries andventricular septal defect. Turk Gogus Kalp Dama 2019; 27:266-73
24. Castaneda A, Jonas RA, Mayev J, Hanley F. Transposition of the great arteries. Cardiac Surgery of the Neonates and Infants. 1st ed. Philadelphia: WB Saunders; 1994. p.409-34.
25. Jacobs JP, Jacobs ML, Mavroudis C, Chai PJ, Tchervenkov CI, Lacour- Gayet FG, et al. Transposition of the

great arteries: lessons learned about patterns of practice and outcomes from the congenital heart surgery database of the society of thoracic surgeons. World J Pediatr Con- genit Heart Surg. 2011;2(1):19-31.
26. Sarıoğlu T, Kinoğlu B, Bilal MS, Sarıoğlu A, Sağbaş E, Yalçınbaş Y, et al Arteryel switch ameliyatlarında koroner arterlerin translokasyon metodları. Turk Gogus Kalp Dama. 1997; 5: 88-97.
27. Castaneda AR, Norwood WI, Jonas RA, Colon SD, Sanders SP, Lang P. Transposition of the great arteries and intact ventricular septum: anatomical repair in the neonate. Ann Thorac Surg. 1984;38(5):438-43.
28. Villafañe J, Lantin-Hermoso MR, Bhatt AB, Tweddell JS, Geva T, Nathan M, et al; American College of Cardiology's Adult Congenital and Pediatric Cardiology Council. D-transposition of the great arteries: the current era of the arterial switch operation. J Am Coll Cardiol. 2014;64(5):498-511.
29. Sivakumar K, Francis E, Krishnan P, Shahani J. Ductal stenting retrains the left ventricle in transposition of great arteries with intact ventricular septum. J Thorac Cardiovasc Surg. 2006; 132(5): 1081-6.
30. Jonas RA, Giglia TM, Sanders SP, Wernovsky G, Nadal-Ginard B, Mayer JE Jr, et al. Rapid, two-stage arterial switch for transposition of the great arteries and intact ventricular septum beyond the neonatal period. Circulation. 1989; 80: I203-8.
31. Yacoub MH, Radley-Smith R, Maclaurin R. Two-stage operation for anatomical correction of transposition of the great arteries with intact interventricular septum. Lancet. 1977;1(8025):1275-8.
32. Kınoğlu B, Sarıoğlu T, Çalık MK, Sarıoğlu A, Tekin S, Turan T, et al. Büyük arterlerin transpozisyonunda iki aşamalı arteryel switch. Turk Gogus Kalp Dama. 1997; 5: 11-8.
33. Ilbawi MN, Idriss FS, DeLeon SY, Muster AJ, Gidding SS, Duffy CE, et al. Preparation of the left ventricle for anatomical correction in patients with simple transposition of the great arteries. Surgical guidelines. J Thorac Cardiovasc Surg. 1987; 94: 87-94.
34. Haydin S, Onan İ.S. Geç dönemde primer ya da iki aşamalı arteriyel switch operasyonu. Sarıoğlu CT, editör. Transpozisyon Cerrahisi (Dünü, Bugünü ve Geleceği). 1. Baskı. Ankara: Türkiye Klinikleri; 2022. p.83-90.
35. Kang N, de Leval MR, Elliott M, Tsang V, Kocyildirim E, Sehic I, Foran J, Sullivan I. Extending the boundaries of the primary arterial switch operation in patients with transposition of the great arteries and intact ventricular septum. Circulation. 2004 Sep 14;110(11 Suppl 1):II123-7. doi: 10.1161/01.CIR.0000138221.68312.33. PMID: 15364850.
36. Duan Y, Sun Y, Dong S, Du C, Yan J. Two-Stage Arterial Switch for Transposition of the Great Vessels in Older Children. Ann Thorac Surg. 2022 Jul;114(1):193-200.
37. Erek E, Yalçınbaş YK, Sarıoğlu T. Acute aortic insufficiency and its surgical treatment after arterial switch operation: a report of two cases. Turk Gogus Kalp Dama 2009; 17:117-9
38. Lecompte Y, Neveux JY, Leca F, zannini L, Tu TV, Duboys Y, et al. Reconstruction of the pulmonary outflow tract without prosthetic conduit. J Thorac Cardiovasc Surg. 1982;84(5):727-33.
39. Nikaidoh H. Aortic translocation and biventricular outflow tract recon- struction: a new surgical repair for transposition of the great arteries as- sociated with ventricular septal defect and pulmonary stenosis. J Thorac Cardiovasc Surg. 1984;88(3):365-72.
40. Erek E, Yalcinbas YK, Turkekul Y, Saygılı A, Ulukol A, Sarioglu A, Sarioglu CT. Indication and risks of delayed sternal closure after open heart surgery in neonates and early infants. World J Pediatr Congenit Heart Surg 2012; 3: 229-35
41. Kwiatkowski DM, Menon S, Krawczeski CD, Goldstein SL, Morales DLS, Philips A, Manning PB, Eghtesady P, Wang Y, Nelson DP, Cooper DS. Improved outcomes with peritoneal dialysis catheter placement after cardiopulmonary bypass in infants. J Thorac Cardiovasc Surg 2015; 149: 230-6
42. Sarıoğlu T, Salihoğlu E, Erek E, Yalçınbaş YK. Pericardial tube for translocation in anomalous origin of coronary arteries. Ann Thorac Surg. 2008; 86(5):1722.
43. Arnaz A, Sarioglu T, Yalcinbas Y, Erek E, Turkoz R, Oktay A, et al. Coronary artery bypass grafting in children. J Card Surg. 2018; 33(1) :29-34.
44. Sarıoğlu T, Doğan A, Yalçınbaş Y, Erek E, Arnaz A, Türköz R, et al. Surgical procedures for coronary arteries in pediatric cardiac surgery: risk factors and outcomes. J Card Surg. 2021; 36(7): 2289-99.
45. Pasquali SK, Hasselblad V, Li JS, Kong DF, Sanders SP. Coronary artery pattern and outcome of arterial switch operation for transposition of the great arteries: a meta-analysis. Circulation. 2002; 106(20): 2575-80.
46. Jonas RA. Management of high risk coronary arteries, transposition of the great arteries. Comprehensive Surgical Management of Congenital Heart Disease. 2nd ed. CRC Press; 2014. p.383-5.
47. Sarıoğlu CT, Doğan A. Arteriyel switch operasyonunda anormal koroner arterlerin translokasyon yöntemleri. Sarıoğlu CT, editör. Transpozisyon Cerrahisi (Dünü, Bugünü ve Geleceği). 1. Baskı. Ankara: Türkiye Klinikleri; 2022. p.50-63.
48. Erek E, Başgöze S, Yıldız O, Sarıosmanoğlu Osman N, Yalçınbaş Kenan Y, Turköz R, et al. Second harvest of Congenital Heart Surgery Database in Türkiye: Current outcomes. Turk Gogus Kalp Dama 2024;32:162-178
49. Sarris GE, Balmer C, Bonou P, Comas JV, da Cruz E, Chiara LD, et al. Clinical guidelines for the management of patients with transposition of the great arteries with intact ventricular septum. Eur J Cardiothorac Surg. 2017; 51(1): e1-e32.
50. Sarıoğlu T, Erek E. Büyük arterlerin transpozisyonunda anatomik düzeltme. Türkiye Klinikleri Kardiyoloji Dergisi. 2003; 16(4): 347-54.
51. Vargo P, Mavroudis C, Stewart RD, Backer CL. Late complications following the arterial switch operation. World J Pediatr Congenit Heart Surg. 2011; 2(1): 37-42.
52. Olds A, Nakamura Y, Levasseur S, Shah A, Freud L, Chelliah A, et al. Outcomes of surgical repair of complex d-transposition of the great arteries. World J Pediatr Congenit Heart Surg. 2018; 9(6): 605-12.
53. Erek E, Yalçınbaş YK, Salihoğlu E, Turan T, Mamur Y, Çolakoğlu A, Sarıoğlu A, Sarıoğlu T. Reoperations in congenital heart surgery: Causes, surgical techniques and results in 108 patients. Turk Kardiyol Dern Arş 2006; 34: 1-9
54. Tokel NK, Özkan M. Arteriyel switch operasyonlarından sonra geç dönem takip yöntemleri, karşılaşılan komplikasyonlar ve tedavi yöntemleri: Girişimsel tedavi ve cerrahi tedavi. Sarıoğlu CT, editör. Transpozisyon Cerrahisi (Dünü, Bugünü ve Geleceği). 1. Baskı. Ankara: Türkiye Klinikleri; 2022. p.91-102.
55. McMahon CJ, Ravekes WJ, Smith EO, et al. Risk factors

for neo-aortic root enlargement and aortic regurgitation following arterial switch operation. Pediatr Cardiol. 2004;25:329-35.
56. Stout KK, Daniels CJ, Aboulhosn JA, et al. 2018 AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol. 2019; 73:e81-e192.
57. Villafañe J, Lantin-Hermoso MR, Bhatt AB, et al.; American College of Cardiology's Adult Congenital and Pediatric Cardiology Council. D-transposition of the great arteries: the current era of the arterial switch operation. J Am Coll Cardiol. 2014;64:498-511.
58. Tsuda T, Bhat AM, Robinson BW, Baffa JM, Radtke W. Coronary artery problems late after aretrial switch operation for transposition of the great arteries. Circulation J 2015; 79: 2372-9
59. Ou P, Moussaux E, Azarine A, Dupont P, Agnoletti G, Vouhe P, Sidi D, Bonnet D. Detection of coronary complications after the arterial switch operation for transposition of the great arteries: First experience with multislice computed tomography in children. J Thorac Cardiovasc Surg 2006; 131: 639-43
60. Engele LJ, Mulder BJM, Schoones JW, Kies P, Egorova AD, Vliegen HW, Hazekamp MG, Bouma BJ, Jongbloed MRM. The coronary arteries in adults after the arterial switch operation: A systematic review. J Cardiovasc Dev Dis. 2021; 26: 102
61. Van Wijk SWH, van der Stelt F, Heide T, Schoof PH, Doevendans PAFM, Meijboom FJ, Breur JMPJ. Sudden death due to coronary artery lesions long-term after the arterial switch operation: A systematic review. Can J Cardiol 2017; 33: 1180-7
62. Kordopati-Zilou K, Sergentanis T, Pervanidou P, Sofianou-Petraki D, Panoulis K, Vlahos N, Eleftheriades M. Dextro-Transposition of Great Arteries and Neurodevelopmental Outcomes: A Review of the Literature. Children (Basel). 2022;9:502.
63. Yalçınbaş YK. Büyük arter transpozisyonunda fizyolojik düzeltme ameliyatlarının güncel yeri: Teknik sorunlar ve alternatif çözümler. Sarıoğlu CT, editör. Transpozisyon Cerrahisi (Dünü, Bugünü ve Geleceği). 1. Baskı. Ankara: Türkiye Klinikleri; 2022. p.34-40.
64. Dos L, Teruel L, Ferreira IJ, Rodriguez-Larrea J, Miro L, Girona J, Albert DC, Gonçalves A, Murtra M, Casaldaliga J. Late outcome of Senning and Mustard procedures for correction of transposition of the great arteries. Heart. 2005;91:652-6.
65. Warnes CA. Transposition of the great arteries. Circulation. 2006;114:2699-709.
66. Silini A, Avesani M, Houyel L, Thambo JB, Iriart X. The pivotal role of tricuspid regurgitation in the failing systemic right ventricle: The "chicken and egg story". Arch Cardiovasc Dis. 2022;115:476-486.
67. Cochrane AD, Karl TR, Mee RB. Staged conversion to arterial switch for late failure of the systemic right ventricle. Ann Thorac Surg. 1993;56: 854–861; discussion 861–862.
68. Mee RB. Severe right ventricular failure after Mustard or Senning operation: two-stage repair: pulmonary artery banding and switch. J Thorac Cardiovasc Surg. 1986;92:385–390.
69. Helvind MH, McCarthy JF, Imamura M, Prieto L, Sarris GE, Drummond-Webb JJ, Mee RB. Ventriculo-arterial discordance: switching the morphologically left ventricle into the systemic circulation after 3 months of age. Eur J Cardiothorac Surg. 1998;14:173–178.
70. Poirier NC, Yu JH, Brizard CP, Mee RB. Long-term results of left ventricular reconditioning and anatomic correction for systemic right ventricular dysfunction after atrial switch procedures. J Thorac Cardiovasc Surg. 2004;127:975–981.
71. van Son JA, Reddy VM, Silverman NH, Hanley FL. Regression of tricuspid regurgitation after two-stage arterial switch operation for failing systemic ventricle after atrial inversion operation. J Thorac Cardiovasc Surg. 1996;111:342–347.
72. Inoue M, Oba O, Arai S, Shichijo T, Takasaki T. Successful arterial switch operation for post-Mustard pulmonary venous obstruction and secondary pulmonaryhypertension. Ann Thorac Surg. 2002;73:975-7.
73. Shimada S, Uyeda T, Maeda Y, Kobayashi T, Kishiki K, Hamamichi Y, Yazaki S, Wada N, Takahashi Y, Park IS, Yoshikawa T. Single-stage arterial switch operation conversion with dextro-transposition of the great arteries and pulmonary arterial hypertension due to baffle leak after a Senning procedure. J Cardiol Cases. 2022; 28:345-347.
74. Gillette PC, Kugler JD, Garson A Jr, Gutgesell HP, Duff DF, McNamara DG. Mechanisms of cardiac arrhythmias after the Mustard operation for transposition of the great arteries. Am J Cardiol. 1980;45:1225–1230.
75. Gelatt M, Hamilton RM, McCrindle BW, Connelly M, Davis A, Harris L, Gow RM, Williams WG, Trusler GA, Freedom RM. Arrhythmia and mortality after the Mustard procedure: a 30-year single-center experience. J Am Coll Cardiol. 1997;29:194–201.
76. Ansari Ramandi MM, Yarmohammadi H, Gareb B, Voors AA, van Melle JP. Long-term outcome of patients with transposition of the great arteries and a systemic right ventricle: A systematic review and meta-analysis. Int J Cardiol. 2023; 15:389
77. Sarıoğlu T, Türkoğlu H, Akçevin A, Paker T, Kınoğlu B, Yalçınbaş Y, et al. Büyük arterlerin transpozisyonunda senning ameliyatı. Turk Gogus Kalp Dama. 1992; 1:74-9.
78. Gürsu HA, Varan B, Özkan M, Tokel K, Erdoğan İ. Mid-term results of patients with transposition of the great arteries who underwent Senning procedure. Turk Gogus Kalp Dama 2014; 22:717-22
79. Hörer J, Schneiber C, Cleuziou J, Vogt M, Prodan Z, Busch R, Holper K, Lange R. Improvement in long-term survival after hospital discharge but not in freedom from reoperation after the change from atrial to arterial switch for transposition of the great arteries J Thorac Cardiovasc Surg 2018; 137:347-354
80. Huang ES, Herrmann JL, Rodefeld MD, Turrentine MW, Brown JW. Rastelli operation for D-Transposition of the great arteries, ventricular septal defect and pulmonary stenosis. World J Pediatr Congenit Heart Surg. 2019; 10: 157-63.
81. Özyüksel A, Bilal MS. Büyük arterlerin çıkış yollarının yeniden yapılandırılması (intraventriküler rerouting ve aortik translokasyon): Teknikler, sorunlar, alternatif yaklaşımlar, erken ve geç dönem sonuçlar. Sarıoğlu CT, editör. Transpozisyon Cerrahisi (Dünü, Bugünü ve Geleceği). 1. Baskı. Ankara: Türkiye Klinikleri; 2022. p.72-82.
82. Dearani JA, Danielson GK, Puga FJ, Mair DD, Schleck CD. Late results of the rastelli operation for transposition of the great arteries. Semin Thorac Cardiovasc Surg

Pediatr Card Surg Annu. 2001; 4: 3-15.
83. Ando, Makoto et al.Trileaflet Polytetrafluoroethylene Valved Conduit for Pulmonary Reconstruction. Operative Techniques in Thoracic and Cardiovascular Surgery, 2011; 16: 168 - 178
84. Miyazaki T, Yamagishi M, Nakashima A, Fukae K, Nakano T, Yaku H, Kado H. Expanded polytetrafluoroethylene valved conduit and patch with bulging sinuses in right ventricular outflow tract reconstruction. J Thorac Cardiovasc Surg. 2007;134:327-32.
85. Hazekamp MG, Nevvazhay T, Sojak V. Nikaidoh vs reparation a l'etage ventriculaire vs Rastelli. Semin Thorac Cardiovasc Surg Pediart Card Ann. 2017; 21: 58-63.
86. Bautista-Hernandez V, Marx GR, Bacha EA, del Nido PJ. Aortic root translocation plus arterial switch for transposition of the great arteries with left ventricular outflow tract obstruction: intermediate-term results. J Am Coll Cardiol. 2007; 49: 485-90.
87. Ugurlucan M, Sayin OA, Tireli E. Modified Nikaidoh procedure in a patient with transposition of the great arteries, ventricular septal defect, and left ventricular outflow tract obstruction with unusual coronary anatomy. Cardiol Young. 2011; 21: 703-6.
88. Korun O, Yurdakök O, Çiçek M, Altın FH, Selçuk A, Kılıç Y, et al. Aortic translocation procedure: Early outcomes from a single center. J Card Surg. 2019; 34(10): 1024-30.
89. Cleveland D, Kirklin J, Jozef P, Tresler MA, Kukreja M, Dabal RJ, et al. Late left ventricular outflow tract obstruction following the rastelli operation: Expectations out to 20 years. World J Pediatr Congenital Heart Surg. 2016; 7(5): 605-10.
90. Hörer J, Schreiber C, Dworak E, Cleuziou J, Prodan z, Vogt M, et al. Long-term results after the Rastelli repair for transposition of the great arteries. Ann Thorac Surg. 2007;83(6):2169-75.
91. Erek E, Yalcinbas YK, Salihoglu E, Colakoglu A, Sarioglu A, Sarioglu T. Stentless heterograft conduits for pulmonic ventricle to pulmonary artery connection: is it the right option? J Heart Valve Dis. 2006; 15(3): 433-40.



BÜYÜK ARTERLERİN DÜZELTİLMİŞ TRANSPOZİSYONU

BÖLÜM
36

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İçindekiler

» TANIM VE İNSİDANS
» PATOFİZYOLOJİ
» KLİNİK BULGULAR VE TANI
» CERRAHİ ENDİKASYON VE TAMİR STRATEJİSİ
  » Fizyolojik (Konvansiyonel; Klasik) Tamir
  » Anatomik tamir (Double switch ameliyatları)
» SONUÇLAR

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Shin'oka ve ark' nın 189 hastalık serisinde ise, benzer şekilde anatomik tamir uygulanan grupta belirgin bir sağkalım veya reoperasyon avantajı bulunamamıştır (44). Ancak sadece preoperatif triküspit yetersizliği olanlarda anatomik tamir sonuçları daha iyi olarak saptanmıştır.

Ülkemizde ise, ilk double switch ameliyatlarını gerçekleştiren, T.Sarıoğlu ve çalışma grubu tarafından 1995 – 2017 yılları arasında toplam 20 hastaya double switch operasyonları uygulanmıştır (Şekil 4). Bunlardan 3 tanesi atriyal ve arteryel switch ameliyatı, diğerleri ise Senning + Rastelli operasyonlarıdır. Ortanca yaş 6 yıl (4 ay – 13 yaş) olan bu hastalarda, erken mortalite 3 hasta ile %15 olarak gerçekleşmiştir (45). Bilal ve ark' nın 16 hastalık serisinde ise toplam 11 hastaya atrial ve arteryel switch ile double switch prosedürü uygulanmış, erken mortalite 1 hastada gözlenmiştir. Toplam 67 aylık takipler sonucunda bir hasta hariç tüm hastaların fonksiyonel kapasitelerinin klas 1-2 olduğu bildirilmiştir (46).

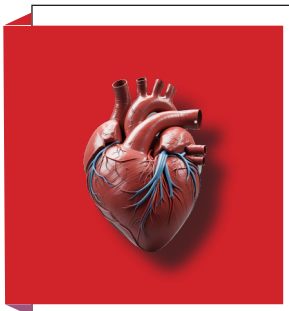
Sonuç olarak, nadir görülen bir patoloji olması ve sonuçların sınırlı olması nedeniyle halen C-TGA' lı hastaların tedavi şeklinde tam bir konsensus sağlanmış değildir. Son yıllarda özellikle triküspit kapak patolojisi ve yetersizliği olan hastalarda anatomik tamirin tercih edilmesi yönünde fikir birliği olmakla birlikte, fizyolojik tamir alternatifleri ve kompleks hastalarda Fontan modifikasyonları, güncelliğini korumaktadır. Aşamalı sol ventrikül training yapılarak uygulanacak anatomik tamir hastalarının erken yaşlarda olması önerilmekte, geç yaşlarda hem erken dönem sonuçlarının , hem de uzun dönemde sol ventrikül disfonksiyonu gelişme riski nedeniyle sağkalım oranının tatminkar olmadığı ileri sürülmektedir (47-50).

KAYNAKLAR

1. Rokitansky C: In: Braumuller W, ed. Die Defecte der Scheidewande des Herzens. Wilhelm Braumuller; 1875
2. Wallis GA, Debich-Spicer D, Anderson RH: Congenitally corrected transposition. Orphanet J Rare Dis 2011;6:22
3. Spigel Z, Binsalamah ZM, Caldarone C. Congenitally Corrected Transposition of the Great Arteries: Anatomic, Physiologic Repair, and Palliation. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2019;22:32-42
4. Mavroudis C, Backer CL. Pediatric Cardiac Surgery, 5th ed. Wiley-Blackwell; 2023, pp. 581–600.
5. Kouchoukos NT, Blackstone EH, Hanley FL, Kirklin JK, editors. Kirklin/Barratt-Boyes Cardiac Surgery. Philadelphia: Elsevier Saunders; 2013. Congenitally corrected transposition of the great arteries and other forms of atrioventricular discordant connection; pp. 1971–2003.
6. Jonas RA, editor. Comprehensive surgical management of Congenital heart disease. 2. Boca Raton: CRC Press; 2014. Congenitally corrected transposition of the great arteries; pp. 644–646. p. 483-498
7. Brawn WJ, Jones TJJ, Anderson RH, Barron DJ. Anderson RH, Baker EJ, Penny D, Redington AN, Rigby ML, Wernonovsky G. Pediatric Cardiology. Philadelphia: Churchill Livingstone Elsevier; 2010. Congenitally corrected transposition; pp. 819–835.
8. Beauchesne LM, et al: Outcome of the unoperated adult who presents with congenitally corrected transposition of the great arteries. J Am Coll Cardiol 2002;40:285–290
9. Osakada K, Ohya M, Waki K, Nasu H, Kadota K. Congenitally Corrected Transposition of the Great Arteries at Age 88 Years. CJC Open. 2020;18:726-728.
10. Aljuayli A, Galinier M. Late Presentation of a Congenitally Corrected Transposition of Great Arteries and Hemodynamically Balanced Ventricles Associated with a Large Ventricular Septal Defect and Severe Pulmonary Stenosis: A Case Report and a Multi-Imaging Approach. Am J Case Rep. 2020;29;21:e920822
11. Mavroudis C, Backer CL. Physiologic versus anatomic repair of congenitally corrected transposition of the great arteries. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2003; 6: 16–26.
12. Kumar TKS. Congenitally corrected transposition of the great arteries. J Thorac Dis. 2020 ;12 :1213-1218.
13. Kral Kollars CA, Gelehrter S, Bove EL, Ensing G. Effects of morphologic left ventricular pressure on right ventricular geometry and tricuspid valve regurgitation in patients with congenitally corrected transposition of the great arteries. Am J Cardiol. 2010; 105: 735–739.
14. Erek E, Abud B, Oz K, Güzeltas A. Preservation of systemic tricuspid valve function by pulmonary conduit banding in a patient with corrected transposition of the great arteries. Interact Cardiovasc Thorac Surg. 2012; 15: 332-4.
15. Biliciler-Denktas G, et al: Early and late results of operations for defects associated with corrected transposition and other anomalies with atrio- ventricular discordance in a pediatric population. J Thorac Cardiovasc Surg 2001;122:234–241
16. Hirose K, et al: The long-term outcomes of physiologic repair for ccTGA (congenitally corrected transposition of the great arteries). Gen Thorac Cardiovasc Surg 2015;63:496–501
17. van Son JA, Danielson GK, Huhta JC, Warnes CA, Edwards WD, Schaff HV, et al. Late results of systemic atrioventricular valve replacement in corrected transposition. J Thorac Cardiovasc Surg. 1995; 109: 642–652.
18. Abdelrehim AA, Stephens EH, Miranda WR, Todd AL, Connolly HM, Egbe AC, Burchill LJ, Ashikhmina EA,

Dearani JA. Systemic Atrioventricular Valve Surgery in Patients With Congenitally Corrected Transposition of the Great Vessels. J Am Coll Cardiol. 2023 Dec 5;82(23):2197-2208.
19. Ma K, Gao H, Hua Z, Yang K, Hu S, Zhang H, et al. Palliative pulmonary artery banding versus anatomic correction for congenitally corrected transposition of the great arteries with regressed morphologic left ventricle: long-term results from a single center. J Thorac Cardiovasc Surg. 2014; 148: 1566–1571.
20. El-Zein C, Subramanian S, Ilbawi M. Evolution of the surgical approach to congenitally corrected transposition of the great arteries. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2015; 18: 25–33.
21. Ilbawi MN, DeLeon SY, Backer CL, Duffy CE, Muster AJ, Zales VR, et al. An alternative approach to the surgical management of physiologically corrected transposition with ventricular septal defect and pulmonary stenosis or atresia. J Thorac Cardiovasc Surg. 1990; 100: 410–415
22. Yamagishi M, Imai Y, Hoshino S, Ishihara K, Koh Y, Nagatsu M, et al.Anatomic correction of atrioventricular discordance. J Thorac Cardiovasc Surg. 1993;105: 1067-76.
23. Karl TR, Weintraub RG, Brizard CP, Cochrane AD, Mee RB. Senning plus arterial switch operation for discordant (congenitally corrected) transposition. Ann Thorac Surg. 1997;64:495-502.
24. Stumper O, Wright JG, De Giovanni JV, Silove ED, Sethia B, Brawn WJ. Combined atrial and arterial switch procedure for congenital corrected transposition with ventricular septal defect. Br Heart J. 1995;73:479-82.
25. Karl TR, Quintessenza J, Jacobs J. Anatomic repair for congenitally corrected transposition: the promise and the reality. Eur J Cardiothorac Surg. 2016; 49: 528–529.
26. Hoashi T, Kagisaki K, Miyazaki A, Kurosaki K, Shiraishi I, Yagihara T, et al. Anatomic repair for corrected transposition with left ventricular outflow tract obstruction. Ann Thorac Surg. 2013; 96: 611-20.
27. Quinn DW, McGuirk SP, Metha C, Nightingale P, de Giovanni JV, Dhillon R, et al. The morphologic left ventricle that requires training by means of pulmonary artery banding before the double-switch procedure for congenitally corrected transposition of the great arteries is at risk of late dysfunction. J Thorac Cardiovasc Surg. 2008; 135: 1137–1144.
28. Ly M, Belli E, Leobon B, Kortas C, Grollmüss OE, Piot D, et al. Results of the double switch operation for congenitally corrected transposition of the great arteries. Eur J Cardiothorac Surg. 2009; 35: 879–883.
29. Tweddell, James S. What do we really know about the management of patients with congenitally corrected transposition of the great arteries? The Journal of Thoracic and Cardiovascular Surgery, 2017; 154: 1023 - 1025
30. Graham TP Jr, Bernard YD, Mellen BG, Celermajer D, Baumgartner H, Cetta F, et al. Long-term outcome in congenitally corrected transposition of the great arteries: a multi-institutional study. J Am Coll Cardiol 2000; 36: 255.
31. Bove EL. Congenitally corrected transposition of the great arteries: ventricle to pulmonary artery connection strategies. Semin Thorac Cardiovasc Surg 1995; 7: 139-44.
32. Da Silva JP, Da Silva LF, Baumgratz JF, Castro RM, Bezerra RF, Guilhen JC. Root translocation in congenitally corrected transposition of the great arteries with ventricular septal defect and pulmonary stenosis, and other lesions. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2015; 18: 34–39
33. Yamagishi M, Shuntoh K, Matsushita T, Fujiwara K, Shinkawa T, Miyazaki T, et al. Half-turned truncal switch operation for complete transposition of the great arteries with ventricular septal defect and pulmonary stenosis. J Thorac Cardiovasc Surg. 2003; 125: 966-8.
34. Malhotra SP, Reddy VM, Qiu M, Pirolli TJ, Barboza L, Reinhartz O, et al. The hemi-Mustard/bidirectional Glenn atrial switch procedure in the double-switch operation for congenitally corrected transposition of the great arteries: rationale and midterm results. J Thorac Cardiovasc Surg. 2011; 141: 162-70.
35. Karl TR. The role of the Fontan operation in the treatment of congenitally corrected transposition of the great arteries. Ann Pediatr Cardiol. 2011; 4: 103–110.
36. Erek E, Yalcinbas YK, Salihoglu E, Ozturk N, Arat S, Sarioglu A, et al. Fate of stentless bioprostheses on right side of the heart. Asian Cardiovasc Thorac Ann. 2003; 11: 58–62.
37. Hraska V, Duncan BW, Mayer JE Jr, Freed M, del Nido PJ, Jonas RA. Long-term outcome of surgically treated patients with corrected transposition of the great arteries. J Thorac Cardiovasc Surg. 2005; 129: 182–191.
38. Lim HG, Lee JR, Kim YJ, Park YH, Jun TG, Kim WH, et al. Outcomes of biventricular repair for congenitally corrected transposition of the great arteries. Ann Thorac Surg. 2010; 89: 159–167.
39. Jacob KA, Hörer J, Hraska V, Agbor VN, Duchateau S, van Wijk A, Barron DJ, Schoof PH. Anatomic and Physiologic Repair of Congenitally Corrected Transposition of the Great Arteries. Journal of the American College of Cardiology 2024; 25: 2471-2486
40. Abdelrehim AA, Stephens EH, Miranda WR, Todd AL, Connolly HM, Egbe AC, Burchill LJ, Ashikhmina EA, Dearani JA. Systemic Atrioventricular Valve Surgery in Patients With Congenitally Corrected Transposition of the Great Vessels. J Am Coll Cardiol. 2023;82: 2197-2208.
41. Ono Y, Hoashi T, Imai K, Okuda N, Komori M, Tanimoto K, Kurosaki K, Ichikawa H. Comparison of long term outcomes of atrial switch with Rastelli and physiological repair using left ventricle to pulmonary artery conduit for levo transposition of the great arteries. J Thorac Cardiovasc Surg 2023; 165:1205-15
42. Anzai I, Zhao Y, Dimagli A, Pearsall C, LaForest M, Bacha E, Kalfa D. Outcomes after anatomic versus physiologic repair of congenitally corrected transposition of the great arteries: A systematic review and metaanalysis. World J Pediatr Congenit Heart Surg 2023; 14:70-76
43. . Alomair M, Morgan C, Al Jughiman M, Caldarone C, Mertens L, Van Arsdell G. Should all patients with congenitally corrected transposition of great arteries undergo anatomic repair? AATS annual meeting 2016 .
44. Shin'oka T, Kurosawa H, Imai Y, Aoki M, Ishiyama M, Sakamoto T, et al. Outcomes of definitive surgical repair for congenitally corrected transposition of the great arteries or double outlet right ventricle with discordant atrioventricular con- nections: risk analyses in 189 patients. J Thorac Cardiovasc Surg. 2007;133: 1318-28.

45. Sarıoğlu T, Arnaz A. Double switch operations: Should we perform physiologic or anatomic repair in congenitally corrected transposition of the great arteries. Turk Gogus Kalp Dama 2018; 26: 511-8
46. Bilal MS, Avşar MK, Yıldırım Ö, Özyüksel A, Zeybek C, Küçükosmanoğlu O, et al. Double Switch Procedure and Surgical Alternatives for the Treatment of Congenitally Corrected Transposition of the Great Arteries. J Card Surg. 2016; 31: 231–236.
47. Sano T, Riesenfeld T, Karl TR, Wilkinson JL. Intermediate term outcome after intracardiac repair of associated cardiac defects in patients with atrioventricular and ventriculoarterial discordance. Circulation. 1995; 92: 272–278.
48. Brawn WJ. The double switch for atrioventricular discordance. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2005: 51–56.
49. Murtuza B, Barron DJ, Stumper O, Stickley J, Eaton D, Jones TJ, et al. Anatomic repair for congenitally corrected transposition of the great arteries: a single-institution 19-year experience. J Thorac Cardiovasc Surg. 2011; 142: 1348–1357.
50. Hraska V, Vergnat M, Zartner P, Hart C, Suchowerskyj P, Bierbach B, et al. Promising Outcome of Anatomic Correction of Corrected Transposition of the Great Arteries. Ann Thorac Surg. 2017; 104: 650–656.



RASTELLİ, REV VE AORTİK TRANSLOKASYON PROSEDÜRLERİ

BÖLÜM
37

Ahmet ŞAŞMAZEL [1]
Serhat BAHADIR [2]

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İçindekiler

» GİRİŞ
» BAT,VSD, LVOT-D
» RASTELLİ PROSEDÜRÜ
» HASTA SEÇİMİ VE CERRAHİ HAZIRLIK
  » Cerrahi Teknik:
» RASTELLİ OPERASYONU SONUÇLAR VE KOMPLİKASYONLAR
  » "Réparation à l'Etage Ventriculaire": REV Prosedürü
  » Cerrahi Teknik;
  » Aort Translokasyonu (Bex-Nikaidoh prosdürü);
  » Nikaidoh prosedürü uygulanmasına karar vermek, Endikasyonlar ve Cerrahi Hazırlık:
  » Cerrahi Teknik (Video 1)
  » Cerrahi Teknik

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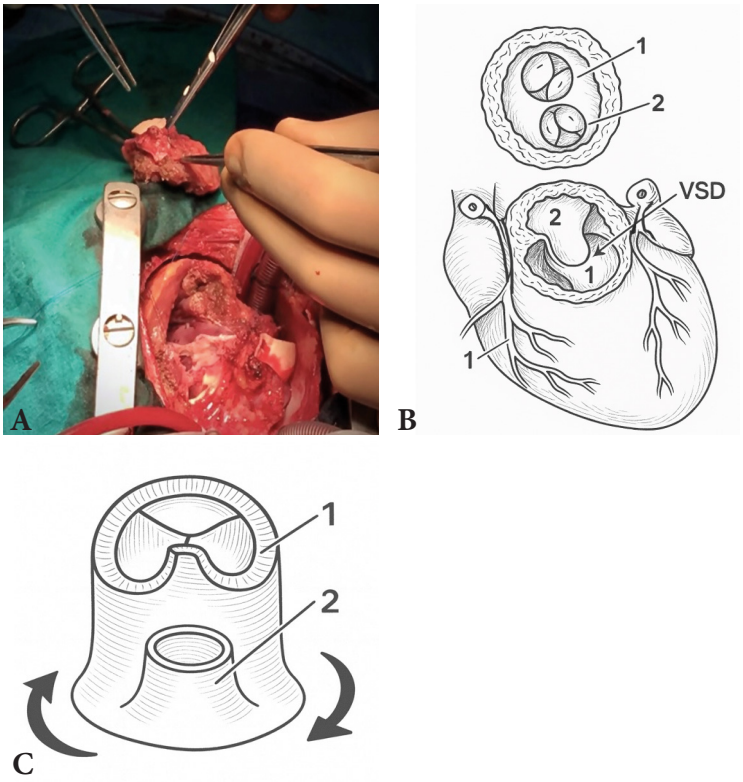
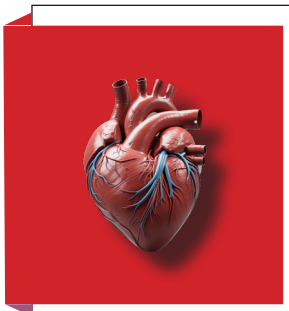


Resim 5. *(Trunkal kapakların enblok translokasyonu) A: Trunkal kapaklar en bloc olarak çıkarılması (cerrahi sırasında alınan fotoğraf) B: Şematik olarak trunkal kapakların çıkarılması C: Trunkal switch yapılarak aortik kapağın sol ventrikül çıkım yoluna ve pulmoner kapağın sağ ventikül çıkım yoluna doğru döndürülmesi D: VSD nin yama ile alt riminin kapatılması ve sonra aortik kapağın posteriorda sol ventikül çıkım yoluna dikilerek Sol ventrikül- Aorta devamlılığının sağlanması. E: Pulmoner kapak ile RVOT devamlılığın sağlanması*

KAYNAKLAR

1. Centers for Disease Control and Prevention (CDC). Improved national prevalence estimates for 18 selected major birth defects--United States, 1999-2001. MMWR Morb Mortal Wkly Rep. 2006;54: 1301–1305.
2. Reller MD, Strickland MJ, Riehle-Colarusso T, Mahle WT, Correa A. Prevalence of congenital heart defects in metropolitan Atlanta, 1998-2005. J Pediatr. 2008;153: 807–813.
3. Seese L, Turbendian HK, Thibault D, Da Fonseca Da Silva L, Hill K, Castro-Medina M, et al. Utilization and Outcomes of the Nikaidoh, Rastelli, and REV Procedures: An Analysis of The Society of Thoracic Surgeons Congenital Heart Surgery Database. Ann Thorac Surg. 2022;114: 800–808.
4. Furuta A, Yamagishi M, Matsumura G, Shinkawa T, Niinami H. Long-term surgical results of transposition of the great arteries with left ventricular outflow tract obstruction. J Cardiothorac Surg. 2022;17: 111.
5. Kramer P, Ovroutski S, Hetzer R, Hübler M, Berger F. Modified Nikaidoh procedure for the correction of complex forms of transposition of the great arteries with ventricular septal defect and left ventricular outflow tract obstruction: mid-term results. Eur J Cardiothorac Surg. 2014;45: 928–934.
6. Hazekamp MG, Nevvazhay T, Sojak V. Nikaidoh vs Réparation à l'Etage Ventriculaire vs Rastelli. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2018;21: 58–63.
7. Kreutzer C. TGA-VSD and LVOTO: Rastelli Procedure. Surgery of Conotruncal Anomalies. Cham: Springer International Publishing; 2016. pp. 303–316.
8. Emani SM, Beroukhim R, Zurakowski D, Pigula FA, Mayer JE, del Nido PJ, et al. Outcomes after anatomic repair for d-transposition of the great arteries with left ventricular outflow tract obstruction. Circulation. 2009;120: S53–8.
9. Rastelli GC. A new approach to "anatomic" repair of transposition of the great arteries. Mayo Clin Proc. 1969;44: 1–12.
10. Kreutzer C, De Vive J, Oppido G, Kreutzer J, Gauvreau K, Freed M, et al. Twenty-five-year experience with rastelli repair for transposition of the great arteries. J Thorac Cardiovasc Surg. 2000;120: 211–223.
11. Huang ES, Herrmann JL, Rodefeld MD, Turrentine MW, Brown JW. Rastelli Operation for D-Transposition of the Great Arteries, Ventricular Septal Defect, and

Pulmonary Stenosis. World J Pediatr Congenit Heart Surg. 2019;10: 157–163.
12. Backer CL, Mavroudis C. The Rastelli operation. Oper Tech Thorac Cardiovasc Surg. 2003;8: 121–130.
13. Alsoufi B, Awan A, Al-Omrani A, Al-Ahmadi M, Canver CC, Bulbul Z, et al. The rastelli procedure for transposition of the great arteries: resection of the infundibular septum diminishes recurrent left ventricular outflow tract obstruction risk. Ann Thorac Surg. 2009;88: 137–42; discussion 142–3.
14. Hu S, Xie Y, Li S, Wang X, Yan F, Li Y, et al. Double-root translocation for double-outlet right ventricle with noncommitted ventricular septal defect or double-outlet right ventricle with subpulmonary ventricular septal defect associated with pulmonary stenosis: an optimized solution. Ann Thorac Surg. 2010;89: 1360–1365.
15. Korun O, Yurdakök O, Çiçek M, Altın FH, Selçuk A, Kılıç Y, et al. Aortic translocation procedure: Early outcomes from a single center. J Card Surg. 2019;34: 1024–1030.
16. Hazekamp M, Portela F, Bartelings M. The optimal procedure for the great arteries and left ventricular outflow tract obstruction. An anatomical study. Eur J Cardiothorac Surg. 2007;31: 879–887.
17. Vigil C, Lasso A, Ghosh RM, Pinter C, Cianciulli A, Nam HH, et al. Modeling Tool for Rapid Virtual Planning of the Intracardiac Baffle in Double-Outlet Right Ventricle. Ann Thorac Surg. 2021;111: 2078–2083.
18. Bhatla P, Tretter JT, Chikkabyrappa S, Chakravarti S, Mosca RS. Surgical planning for a complex double-outlet right ventricle using 3D printing. Echocardiography. 2017;34: 802–804.
19. Yıldız O, Köse B, Tanıdır IC, Pekkan K, Güzeltaş A, Haydin S. Single-center experience with routine clinical use of 3D technologies in surgical planning for pediatric patients with complex congenital heart disease. Diagn Interv Radiol. 2021;27: 488–496.
20. Barron DJ, Mehsood DK, Kutty RS, Stickley J, Botha P, Khan NE, et al. Fate of the Left Ventricular Outflow Tract After Rastelli With Selective Infundibular Muscle Resection. Ann Thorac Surg. 2019;107: 1226–1231.
21. Hazekamp MG, Gomez AA, Koolbergen DR, Hraska V, Metras DR, Mattila IP, et al. Surgery for transposition of the great arteries, ventricular septal defect and left ventricular outflow tract obstruction: European Congenital Heart Surgeons Association multicentre study. Eur J Cardiothorac Surg. 2010;38: 699–706.
22. Mair R, Sames-Dolzer E, Vondrys D, Lechner E, Tulzer G. En bloc rotation of the truncus arteriosus--an option for anatomic repair of transposition of the great arteries, ventricular septal defect, and left ventricular outflow tract obstruction. J Thorac Cardiovasc Surg. 2006;131: 740–741.
23. Yamagishi M, Shuntoh K, Matsushita T, Fujiwara K, Shinkawa T, Miyazaki T, et al. Half-turned truncal switch operation for complete transposition of the great arteries with ventricular septal defect and pulmonary stenosis. J Thorac Cardiovasc Surg. 2003;125: 966–968.
24. Lecompte Y, Vouhé P. Réparation à l'Etage ventriculaire (REV procedure): Not a Rastelli procedure without conduit. Oper Tech Thorac Cardiovasc Surg. 2003;8: 150–159.
25. Turrentine MW, McCarthy RP, Vijay P, McConnell KW, Brown JW. PTFE monocusp valve reconstruction of the right ventricular outflow tract. Ann Thorac Surg. 2002;73: 871–9; discussion 879–80.
26. Bex JP, Lecompte Y, Baillot F, Hazan E. Anatomical correction of transposition of the great arteries. The Annals of thoracic surgery. 1980;29. doi:10.1016/s0003-4975(10)61636-0
27. Nikaidoh H. Aortic translocation and biventricular outflow tract reconstruction. A new surgical repair for transposition of the great arteries associated with ventricular septal defect and pulmonary stenosis. J Thorac Cardiovasc Surg. 1984;88: 365–372.
28. Nikaidoh H. Nikaidoh procedure: a perspective. Eur J Cardiothorac Surg. 2016;50: 1001–1005.
29. Odawara Y, Kawamura N, Yamasaki Y, Hashimoto J, Ishikawa S, Honda H. Evaluation of coronary artery variations using dual-source coronary computed tomography angiography in neonates with transposition of the great arteries. Jpn J Radiol. 2019;37: 308–314.
30. Ugurlucan M, Sayin OA, Tireli E. Modified Nikaidoh procedure in a patient with transposition of the great arteries, ventricular septal defect, and left ventricular outflow tract obstruction with unusual coronary anatomy. Cardiol Young. 2011;21: 703–706.
31. Tan J, Bi S, Li J, Gu J, Wang Y, Xiong J, et al. Comparative effects of different types of cardioplegia in cardiac surgery: A network meta-analysis. Front Cardiovasc Med. 2022;9: 996744.
32. Lacour-Gayet F, Haun C, Ntalakoura K, Belli E, Houyel L, Marcsek P, et al. Biventricular repair of double outlet right ventricle with non-committed ventricular septal defect (VSD) by VSD rerouting to the pulmonary artery and arterial switch. Eur J Cardiothorac Surg. 2002;21: 1042–1048.
33. Belli E, Serraf A, Lacour-Gayet F, Hubler M, Zoghby J, Houyel L, et al. Double-outlet right ventricle with non-committed ventricular septal defect. Eur J Cardiothorac Surg. 1999;15: 747–752.



TOTAL PULMONER VENÖZ DÖNÜŞ ANOMALİSİ

BÖLÜM
38

Nihat ÇİNE [1]

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İçindekiler

- TANIM VE TERMİNOLOJİ
- EMBRİYOLOJİ VE GENETİK
- ANATOMİK SINIFLANDIRMA
  - 1.Suprakardiyak Tip
  - 2.Kardiyak Tip
  - 3.İnfrakardiyak Tip
  - 4.Mikst Tip
- PATOFİZYOLOJİ
  - EŞLİK EDEN ANOMALİLER
  - Klinik Prezentasyon
  - Yenidoğan Döneminde Belirtiler
  - İnfant ve Çocukluk Döneminde Belirtiler
  - Pulmoner Venöz Obstrüksiyon Bulguları
- TANI
  - Ayırıcı Tanı:
- CERRAHİ ÖNCESİ HAZIRLIK VE DEĞERLENDİRME
  - Preoperatif Stabilizasyon
  - Anestezi Yönetimi
  - Medikal Tedavi Yaklaşımları
- CERRAHİ TEKNİKLER
  - Kardiyopulmoner Bypass Stratejileri
  - Suprakardiyak Tipte Cerrahi Yaklaşım
  - Kardiyak Tipte Cerrahi Yaklaşım
  - İnfrakardiyak Tipte Cerrahi Yaklaşım
  - Kompleks Tipte Cerrahi Yaklaşım
  - Pulmoner Venöz Stenoz Tedavisi
- POSTOPERATİF YÖNETİM
  - Erken Postoperatif Bakım
  - Komplikasyonların Yönetimi
  - Hemodinamik Monitorizasyon
- SONUÇLAR VE PROGNOZ

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Pulmoner hipertansif krizde iNO tedavisine yanıtsız vakalarda, sildenafil, bosentan veya prostasiklin analogları gibi alternatif pulmoner vazodilatatörler eklenebilir.

Düşük kardiyak output sendromu, TPVDA cerrahisi sonrası görülebilir ve sıklıkla postoperatif 6-12. saatlerde ortaya çıkar. NIRS monitörizasyonu erken dönemde düşük kardiyak outputu tespit etmemizi sağlayabilir.

Özellikle kardiyak tip TPVDA sonrası Junctional ektopik taşikardi ve atriyoventrikül blok en sık görülen ritim bozukluklarıdır.

Hemodinamik Monitorizasyon

İntraoperatif olarak yerleştirilen sol atriyal kateter ile basınç monitörizasyonu yapılabilir ve pulmoner venöz akımın değerlendirilmesinde önemlidir. Yüksek değerler pulmoner venöz obstrüksiyon veya sol ventrikül disfonksiyonunu düşündürür.

SONUÇLAR VE PROGNOZ

TPVDA cerrahisi sonrası sonuçlar heterojenlik gösterir. Erken dönem mortalite için en önemli risk faktörleri arasında; preoperatif pulmoner venöz obstrüksiyon varlığı, cerrahi öncesi şiddetli metabolik asidoz, düşük doğum ağırlığı (<2.5 kg), eşlik eden kompleks kardiyak anomaliler ve pulmoner hipertansiyon bulunmaktadır (1). Karamlou ve ark. (41) 377 hastayı içeren çalışmalarında mortalite için risk faktörlerini kardiyak bağlantı tipi, erken yaşta ameliyat, inotrop kullanımı ve onarım sonrası gelişen obstrüksiyon olarak değerlendirmişlerdir. Ameliyat sonrası sağkalım ameliyattan 1 yıl sonra %68 ve 14 yıl sonra %65 olarak bildirilmiştir.

Biventriküler fizyolojiye sahip olgular cerrahi sonrası uzun dönem sağkalım açısından daha avantajlıdır; buna karşın tek ventriküllü anatomilerde mortalite ve morbidite oranları daha yüksektir (14).

Cerrahi sonrası PVO gelişimi, hastaların yeniden operasyon ya da girişimsel tedavi gereksinimini doğuran en ciddi komplikasyonlardan biridir. Preoperatif pulmoner hipertansiyon, acil cerrahi gereksinimi ve uzun kardiyopulmoner bypass süresi, PVO için bağımsız risk faktörleri olarak tanımlanmıştır (37). Bu durumu önlemede "sutureless" teknik gibi modern cerrahi yaklaşımların avantajlı olduğu bildirilmektedir (34-37).

Uzun Dönem sağkalıma baktığımızda biventriküler fizyolojiye sahip hastalarda 5–10 yıllık izlemde sağkalım oranları %85'in üzerindedir (42). Ancak PVO gelişen olgularda sağkalım düşmekte, yeniden müdahale ve kalp yetersizliği riski artmaktadır (37, 42). Anastomoz bölgesinde gelişen darlık, en sık reoperasyon nedeni olup, genellikle cerrahi sonrası ilk 6-12 ay içinde ortaya çıkar. Geniş anastomoz oluşturulmasına ve dikiş tekniklerine gösterilen tüm özene rağmen, özellikle infant döneminde opere edilen hastalarda, fibrotik doku reaksiyonu ve büyümeyle orantısız anastomoz genişliği bu komplikasyonun gelişiminde rol oynar. Reoperasyon stratejisi, darlığın lokalizasyonuna ve yaygınlığına göre belirlenir. Lokalize darlıklarda "patch plasty", yaygın stenozlarda ise "sutureless" teknikler tercih edilir.

TPVDA onarımı sonrası erken postoperatif dönemi atlatan hastaların uzun vadede iyi bir prognoza sahip olduğu görülmektedir.

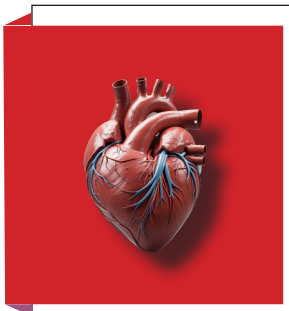
Klinik sonuçların iyileşmesinde "sutureless" teknikler, preoperatif stabilizasyon protokolleri ve postoperatif pulmoner hipertansiyon yönetimindeki gelişmeler belirleyici olmuştur.

KAYNAKLAR

1. Seale AN, Uemura H, Webber SA, et al. Total anomalous pulmonary venous connection: morphology and outcome from an international population-based study. Circulation. 2010;122:2718-2726.
2. Mavroudis C, Backer CL. "Pediatric Cardiac Surgery", 5th Ed. Ch35 Total Anomalous Pulmonary Venous Connection. Wiley-Blackwell, 2023.
3. Muller WH. The surgical treatment of transposition of the pulmonary veins. Ann Surg. 1951;134:683-693.
4. Hoashi T, Kagisaki K, Oda T, et al. Long-term results of treatments for functional single ventricle associated with extracardiac type total anomalous pulmonary venous connection. Eur J Cardiothorac Surg. 2013 May;43(5):965-70.
5. Jaworski R, Kansy A, Friedman-Gruszczynska J, et al. Surgical Outcomes of Total Anomalous Pulmonary Venous Connection Repair. Medicina (Kaunas). 2022 May 23;58(5):687.

6. Moorman A, Webb S, Brown NA, Lamers W, Anderson RH. Development of the heart: formation of the cardiac chambers and arterial trunks. Heart. 2003;89:806–814.
7. Correa-Villasenor A, Ferencz C, Boughman JA, Neill CA. Total anomalous pulmonary venous return: familial and environmental factors. The Baltimore-Washington Infant Study Group. Teratology. 1991;44:415–428.
8. Darling RC, Rothney WB, Craig JM. Total pulmonary venous drainage into the right side of the heart: report of 17 autopsied cases not associated with other major cardiovascular anomalies. Lab Invest. 1957;6:44-64.
9. Seale AN, Webber SA, Uemura H, et al. Pulmonary vein stenosis: the UK, Ireland and Sweden collaborative study. Heart. 2009;95:1944-1949.
10. Kelle AM, Backer CL, Gossett JG, Kaushal S, Mavroudis C. Total anomalous pulmonary venous connection: results of surgical repair of 100 patients at a single institution. J Thorac Cardiovasc Surg 2010;139:1387-94.
11. Jonas RA. Total anomalous pulmonary venous connection and other anomalies of pulmonary veins. In: Comprehensive Surgical Management of Congenital Heart Disease. 2nd ed. CRC Press; 2014. p.535-47.
12. Morales DL, Braud BE, Booth JH, Graves DE, Heinle JS, McKenzie ED, et al. Heterotaxy patients with total anomalous pulmonary venous return: improving surgical results. Ann Thorac Surg 2006;82:1621-7.
13. Kirklin JW, Barratt-Boyes BG. Total anomalous pulmonary venous connection. In: Cardiac Surgery. 4th ed. Philadelphia: Elsevier; 2013. p. 1182-1208.
14. Shi G, Zhu Z, Chen J, et al. Total anomalous pulmonary venous connection: the current management strategies in a pediatric cohort of 768 patients. Circulation. 2017;135(1):48-58.
15. Hyde JA, Stumper O, Barth MJ, et al. Total anomalous pulmonary venous connection: outcome of surgical correction and management of recurrent venous obstruction. Eur J Cardiothorac Surg. 1999;15(6):735-41.
16. Ricci M, Elliott M, Cohen GA, et al. Management of pulmonary venous obstruction after correction of TAPVC: risk factors for adverse outcome. Eur J Cardiothorac Surg. 2003;24(1):28-36.
17. Viola N, Alghamdi AA, Perrin DG, et al. Primary pulmonary vein stenosis: the impact of sutureless repair on survival. J Thorac Cardiovasc Surg. 2011;142(2):344-50.
18. Murphy AM, Greeley WJ. Total anomalous pulmonary venous connection. In: Nichols DG, Cameron DE, Greeley WJ (eds.), Critical Heart Disease in Infants and Children. St Louis, MO: Mosby; 1995.
19. PatelCR,LaneJR,SpectorML,SmithPC,CraneSS.Totally anomalous pulmonary venous connection and complex congenital heart disease: prenatal echocardiographic diag- nosis and prognosis. J Ultrasound Med. 2005;24:1191–1198.
20. Gözgeç E, Kantarci M, Guven F, Ogul H, Ceviz N, Eren S. Determination of anomalous pulmonary venous return with high-pitch low-dose computed tomography in paediatric patients. Folia Morphol (Warsz). 2021;80(2):336-343.
21. Fratz S, Chung T, Greil GF, et al. Guidelines and protocols for cardiovascular magnetic resonance in children and adults with congenital heart disease. J Cardiovasc Magn Reson. 2013;15:51.
22. Mulia EPB, Rahman MA. Treatment considerations in total anomalous pulmonary venous connection. Proceedings of Singapore Healthcare. 2023;32. doi:10.1177/20101058231188865
23. Lakshminrusimha S, Saugstad OD. The fetal circulation, pathophysiology of hypoxemic respiratory failure and pulmonary hypertension in neonates, and the role of oxygen therapy. J Perinatol. 2016;36(2)
24. Husain SA, Maldonado E, Rasch D, et al. Total anomalous pulmonary venous connection: factors associated with mortality and recurrent pulmonary venous obstruction. Ann Thorac Surg. 2012;94(3):825-32.
25. Abman SH, Hansmann G, Archer SL, et al. Pediatric pulmonary hypertension: guidelines from the American Heart Association and American Thoracic Society. Circulation. 2015;132(21):2037-99.
26. Cope JT, Banks D, McDaniel NL, et al. Is vertical vein ligation necessary in repair of total anomalous pulmonary venous connection? Ann Thorac Surg. 1997;64(1):23-9.
27. Michielon G, Di Donato RM, Pasquini L, et al. Total anomalous pulmonary venous connection: long-term appraisal with evolving technical solutions. Eur J Cardiothorac Surg. 2002;22(2):184-91.
28. Andropoulos DB, Mossad EB, Gottlieb EA. Anesthesia for Congenital Heart Disease. 4th ed. Wiley-Blackwell; 2023. p. 869-99.
29. Miller OI, Tang SF, Keech A, et al. Inhaled nitric oxide and prevention of pulmonary hypertension after congenital heart surgery: a randomised double-blind study. Lancet. 2000;356(9240):1464-9.
30. Fraser, Charles D. Lateral Approach to Surgical Repair of Total Anomalous Pulmonary Venous Return. Operative Techniques in Thoracic and Cardiovascular Surgery, 2006;11(4):275-285.
31. Tucker BL, Lindesmith GG, Stiles QR, Meyer BW. The superior approach for correction of the supracardiac type of total anomalous pulmonary venous return. Ann Thorac Surg. 1976 Oct;22(4):374-7.
32. Feng Z, He Q, Yuan J, Dou Z, Wu D, Liu Y, Rui L, He F, Wu Z, Li S. Modified L-shaped incision technique for supracardiac total anomalous pulmonary venous connection as an alternative to sutureless technique. Int J Surg. 2023;109(12):3788-95.
33. Laux D, Houyel L, Bajolle F, Bonnet D. Total anomalous pulmonary venous connection to the unroofed coronary sinus in a neonate. Pediatr Cardiol. 2013;34(8):2006-8.
34. Lacour-Gayet F, Rey C, Planché C. Pulmonary vein stenosis. Description of a sutureless surgical procedure using the pericardium in situ. Arch Mal Coeur Vaiss. 1996;89(5):633-636.
35. Yanagawa B, Alghamdi AA, Dragulescu A, et al. Primary sutureless repair for "simple" total anomalous pulmonary venous connection: midterm results in a single institution. J Thorac Cardiovasc Surg. 2011;141(6):1346-1354.
36. Wu, Y., Xin, L., Zhou, Y. et al. Is Sutureless Technique Beneficial in the Primary Repair of Total Anomalous Pulmonary Venous Connection? A Systematic Review and Meta-Analysis. Pediatr Cardiol 2019;40:881–891.
37. Zhang H, Shi G, Chen H. Risk factors for postoperative pulmonary venous obstruction after surgical repair of total anomalous pulmonary venous connection: a systemic review and meta-analysis. Interact Cardiovasc

Thorac Surg. 2022 Jul 9;35(2):ivac162. doi: 10.1093/icvts/ivac162.
38. Qiu, ZH., Liao, LM., Xiao, J. et al. A Modified Approach with Caval Transection for Supracardiac Total Anomalous Pulmonary Venous Connection: Comparison Between Conventional and Sutureless Surgery in 173 Patients. Pediatr Cardiol 2021;42:1002-09.
39. Najm HK, Caldarone CA, Smallhorn J, Coles JG. A sutureless technique for the relief of pulmonary vein stenosis with the use of in situ pericardium. J Thorac Cardiovasc Surg. 1998;115(2):468-470.
40. Hibino N, McGillicuddy E, Matsumura G, et al. Late-term results of tissue-engineered vascular grafts in humans. J Thorac Cardiovasc Surg. 2010;139(2):431-436.
41. Karamlou T, Gurofsky R, Al Sukhni E, et al. Factors associated with mortality and reoperation in 377 children with total anomalous pulmonary venous connection. Circulation. 2007;115(12):1591-1598.
42. Wang Z, Li X, Zhang W, et al. Longterm outcomes of repair in children with total anomalous pulmonary venous connection. *Cardiol Young*. 2024;34(2):145-151. doi:10.1017/S1047951124025204



COR TRİATRİATUM

BÖLÜM
39

Işık ŞENKAYA SIĞNAK [1]

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İçindekiler

- GİRİŞ
- ETYOLOJİ
- EPİDEMİYOLOJİ
- PROGNOZ
- EMBRİYOLOJİ
- ANATOMİ
- KLİNİK ÖZELLİKLER VE TANI YÖNTEMLERİ
  - Semptomatoloji
  - TANI
  - Göğüs Radyografisi
  - Elektrokardiyografi
  - Ekokardiyografi
  - Kardiyak Kateterizasyon ve Anjiyografi
  - Bilgisayarlı Tomografi ve Manyetik Rezonans Görüntüleme
  - Ayırıcı Tanı
- TEDAVİ
  - Cerrahi Tedavi
  - Postoperatif Bakım
- SONUÇ

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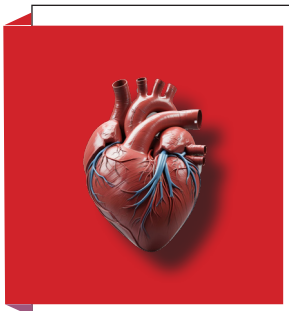
tedir. Son yıllarda, gelişmiş prognostik öngörüler sunan yeni sınıflandırma sistemleri ortaya çıkmıştır. Transtorasik ekokardiyografi tanısal olarak önemini korumaktadır. Multimodalite görüntüleme yöntemleri artık bu tür atriyal alt bölümleri diğer kardiyak anomalilerden ayırt etmek, operatif stratejilerin çizilebilmesi için gittikçe yaygınlaşarak kullanılmaktadır. Tercihen kardiyopulmoner baypas altında cerrahi rezeksiyon, temel tedavi yöntemidir ve olumlu uzun vadeli sonuçlarla ilişkilidir. Bununla birlikte, balon dilatasyonu anatomik olarak uyumlu varyantlarda ve kalp yetmezliği, gebelik veya kesin tedaviye geçiş gibi özel durumlarda düşünülebilir.

KAYNAKLAR

1. Jegier W, Gibbons JE, Wiglesworth FW. Cor triatriatum: clinical, hemodynamic and pathological studies surgical correction in early life. *Pediatrics*. 1963;31:255-267.
2. Humpl T, Reineker K, Manlhiot C, Dipchand AI, Coles JG, McCrindle BW. Cor triatriatum sinistrum in childhood. A single institution's experience. Can J Cardiol. 2010;26: 371-376.
3. Jha AK, Makhija N. Cor triatriatum:A Review . Seminars in Cardiothoracic and Vascular Anestesia,2017;21(2):178-85
4. Goel A, Viswamitra S, Reddy BN, Gaduputi J. Computed tomography features of cor triatriatum: an institutional review. Br J Radiol. 2021 Mar 01;94(1119):20201252.
5. Kilkenny K, Frishman W. Cor Triatriatum: A Review. Cardiol Rev. 2023 Nov 15;
6. Nassar PN, Hamdan RH. Cor Triatriatum Sinistrum: Classification and Imaging Modalities. Eur J Cardiovasc Med. 2011 Jan;1(3):84-87.
7. Aldawoodi NN, Arora H, Kumar PA. Incidental discovery of an unusual right atrial membrane in an adult patient. Ann Card Anaesth. 2012 Oct-Dec;15(4):309-11.
8. Thakrar A, Shapiro MD, Jassal DS, Neilan TG, King ME, Abbara S. Cor triatriatum: the utility of cardiovascular imaging. *Can J Cardiol*. 2007 Feb. 23(2):143-5.
9. Vallakati A, Nerella N, Chandra P, Sadiq A, Shani J. Incidental diagnosis of cor triatriatum in 2 elderly patients. *J Am Coll Cardiol*. 2012 May 29. 59(22):e43.
10. PARSONS CG. Cor triatriatum; concerning the nature of an anomalous septum in the left auricle. Br Heart J. 1950 Oct;12(4):327-38.
11. Niwayama G. Cor triatriatum. Am Heart J. 1960;59:291-317.
12. Van Pragh R, Corsini I. Cor triatriatum: pathologic anatomy and a consideration of morphogenesis based on 13 postmortem cases and a study of normal development of the pulmonary vein and atrial septum in 83 human embryos. Am Heart J. 1969;78:379-405.
13. Narayanapillai J. Cor triatriatum sinister with severe obstruction: a rare presentation in an adult. BMJ Case Rep. 2016 Aug 05;2016
14. Geva T, Van Praagh S. İn:Allen HD, Clark EB, Gutgessel HB, Driscoll DJ eds. Moss and Adam's heart disease in infants, children and adolescents including the fetus and young adults. 6th edition. Philedelphia:Lippincott Williamsand Wilkins. 2001:736-72
15. Loeffler E. Unusual malformations of the left atrium. *Arch Pathol*. 1949;48:371-376.
16. Lam CR, Green E, Drake E. Diagnosis and surgical correction of 2 types of triatrial heart. *Surgery*. 1962;51:127-137.
17. Herlong JR, Jaggers JJ, Ungerleider RM. Congenital Heart Surgery Nomenclature and Database Project: pulmonary venous anomalies. *Ann Thorac Surg*. 2000;69:S56-S69.
18. Marin-Garcia J, Tandon R, Lucas RV Jr, Edwards JE. Cor triatriatum: study of 20 cases. Am J Cardiol. 1975;35:57-66.
19. Rodefeld MD, Brown JW, Heimansohn DA, et al. Cor triatriatum: clinical presentation and surgical results in 12 patients. Ann Thorac Surg. 1990;50:562-568.
20. Humpl T, Reineker K, Manlhiot C, Dipchand AI, Coles JG, McCrindle BW. Cor triatriatum sinistrum in childhood. A single institution's experience. Can J Cardiol. 2010 Aug-Sep;26(7):371-6.
21. Chen Q, Guhathakurta S, Vadalapali G, Nalladaru Z, Easthope RN, Sharma AK. Cor triatriatum in adults: three new cases and a brief review. Tex Heart Inst J. 1999;26(3):206-10.
22. Narayanapillai J. Cor triatriatum sinister with severe obstruction: a rare presentation in an adult. BMJ Case Rep. 2016 Aug 05;2016
23. Ilhan E, Ergelen M, Soylu O, et al. Severe right heart failure and pulmonary hypertension because of cor triatriatum sinister in a 54-year-old patient. Int J Cardiol. 2011;151:e29-e31
24. Mendez AB, Colchero T, Garcia-Picart J, Vila M, Subirana MT, Sionis A. Unusual case of new-onset heart failure due to cor triatriatum sinister. Eur J Heart Fail. 2013;15:237-239.
25. Kokotsakis J, Anagnostakou V, Almpanis G, et al. Cor triatriatum presenting as heart failure with reduced ejection fraction: a case report. J Cardiothorac Surg. 2011;6:83.
26. Slight RD, Nzewi OC, Buell R, Mankad PS. Cor-triatriatum sinister presenting in the adult as mitral stenosis: an analysis of factors which may be relevant in late presentation. Heart Lung Circ. 2005;14:8-12.
27. Schusterova I, Czerny M, Jurko A Jr, Minarik M. A very rare case of late diagnosis of cor triatriatum sinistrum. J Geriatr Cardiol. 2015;12:185-186.
28. Kokotsakis J, Anagnostakou V, Almpanis G, et al. Cor triatriatum presenting as heart failure with reduced ejection fraction: a case report. J Cardiothorac Surg. 2011;6:83.
29. Velasco E, Corros C, García A, et al. Adult cor triatriatum and transient ischemic attack. Does this rare congenital heart defect augment embolic risk? Int J Cardiol. 2015;185: 153-154.
30. Spengos K, Gialafos E, Vassilopoulou S. Ischemic stroke as an uncommon complication of cor triatriatum. J Stroke Cerebrovasc Dis. 2008;17:436-438.
31. Choudhary D, Sivasankaran S, Venkateshwaran S, Sasidharan B. Cor triatiratum dexter: a rare cause of isolated right atrial enlargement. Pediatr Cardiol. 2013;34: 198-199.

32. Martınez-Quintana E, Rodrıguez-Gonzalez F. Cor triatriatum dexter: more than a simple membrane. J Thorac Cardiovasc Surg. 2016;151:276-277
33. Ostman-Smith I, Silverman NH, Oldershaw P, Lincoln C, Shinebourne EA. Cor triatriatum sinistrum. Diagnostic features on cross sectional echocardiography. Br Heart J. 1984 Feb;51(2):211-9.
34. Thakrar A, Shapiro MD, Jassal DS, Neilan TG, King ME, Abbara S. Cor triatriatum: the utility of cardiovascular imaging. Can J Cardiol. 2007 Feb;23(2):143-5.
35. Moral S, Ballesteros E, Huguet M, Panaro A, Palet J, Evangelista A. Differential diagnosis and clinical implications of remnants of the right valve of the sinus venosus. J Am Soc Echocardiogr. 2016;29:183-194.
36. Hwang SH, Oh YW. Assessment of cor triatriatum dexter and giant eustachian valve with cardiac magnetic resonance. Circulation. 2014;130:1727-1729.
37. Hamdan R, Mirochnik N, Celermajer D, Nassar P, Iserin L. Cor triatriatum sinister diagnosed in adult life with three dimensional transesophageal echocardiography. BMC Cardiovasc Disord. 2010;10:54.
38. Reese DB. Images in clinical medicine. Cor triatriatum. N Engl J Med. 2004;350:1989.
39. Gonzalez Lengua CA, Kumar P, Cham M, Sanz J. Thrombosed cor triatriatum sinistrum mimicking left atrial mass and causing unilateral pulmonary edema. J Cardiovasc Comput Tomogr. 2016;10:186-187.
40. Sentilhes L, Verspyck E, Bauer F, Marpeau L. Management of maternal cor triatriatum during pregnancy. Obstet Gynecol. 2004 Nov;104(5 Pt 2):1212-5.
41. Hayes C, Liu S, Tam JW, Kass M. Cor Triatriatum Sinister: An Unusual Cause of Atrial Fibrillation in Adults. Case Rep Cardiol. 2018;2018:9242519.
42. Park KJ, Park IK, Sir JJ, Kim HT, Park YI, Tsung PC, Chung JM, Park KI, Cho WH, Choi SK. Adult cor triatriatum presenting as cardioembolic stroke. Intern Med. 2009;48(13):1149-52.
43. Saxena P, Burkhart HM, Schaff HV, Daly R, Joyce LD, Dearani JA. Surgical repair of cor triatriatum sinister: the Mayo Clinic 50-year experience. Ann Thorac Surg. 2014;97:1659-1663.
44. Erden EC, Erden I, Kayapinar O. Cor triatriatum sinister with significant pressure gradient in an adult patient. Turkish J Thorac Cardiovasc Surg 2013;21:143–5.



SİSTEMİK VENÖZ DÖNÜŞ ANOMALİLERİ

BÖLÜM
40

Mustafa KARAÇELİK [1]

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İçindekiler

- GİRİŞ
- EMBRİYOGENEZ
- PATOFİZYOLOJİ VE KLİNİK SUNUM
- SİSTEMİK VENÖZ DÖNÜŞ ANOMALİLERİNİ
- HEMODİNAMİK SONUÇLARI NELERDİR?
- TANISAL GÖRÜNTÜLEME
- SİSTEMİK VENÖZ DÖNÜŞ ANOMALI TİPLERİ
  - 1. Persistan Sol Superior Vena Kava
  - 2. Inferior Vena Kava Yokluğu
  - 3. Konjenital Porto-Sistemik Şantlar (Kpsş)
  - 4. İnferior Vena Kava'nın Azigos Devamlılığı
  - 5. Sağ Süperior Vena Kavanın Sol Atriuma Açılması
  - 6. İnferior Vena Kavanın Direkt Sol Atriuma Açılması
  - 7. İnferior Vena Kavanın İndirekt Sol Atriuma Açılması
  - 8. Çift Süperior Vena Kava
  - 9. Koroner Sinüs Anomalileri
- TEDAVİ
- CERRAHİ TEDAVİ YAKLAŞIMLARI
- PERSİSTAN SOL SUPERİOR VENA KAVA VE CERRAHI TEDAVISI
- İNFERIOR VENA KAVA (IVK) YOKLUĞU VE TEDAVI YAKLAŞIMLARI
- CERRAHİ TEDAVİ SEÇENEKLERİ:
- KONJENİTAL PORTO-SİSTEMİK ŞANTLARIN (KPSŞ)TEDAVİSİ
- KORONER SİNÜS ANOMALİLERI
- DOĞRUDAN YAMA KAPATMA
- PSSVK YENİDEN YÖNLENDİRME
- KORONER SİNÜS BAFFLE PROSEDÜRÜ
  - Minimal İnvaziv Yaklaşımlar
  - Prognoz

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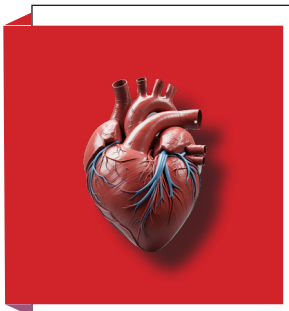
KAYNAKLAR

1. Kırali K. Sistemik Venöz Sistem Anomalileri, Turkiye Klinikleri J Cardiol. 2003;16,3:182-8.
2. Oliveira JD, Martins I. Congenital systemic venous return anomalies to the right atrium review. Insights Imaging. 2019,4;10:1:115.
3. Ömeroğlu S, Mansuroğlu D, Kırali K, Kayalar N, Mutlu B, Ardal H, et al. Parsiyel Pulmoner Venöz Dönüş Anomalisinin Cerrahi Tedavisi ve Geç Dönem Sonuçları. Turk Gogus Kalp Dama 2005;13:103-6.
4. Gupta SK, Juneja R, Anderson RH, Gulati GS, Devagorou V. Clarifying the anatomy and physiology of totally anomalous systemic venous connection. Ann Pediatr Cardiol. 2017;10(3):269-77.
5. Shetkar SS, Gupta SK, Gulati GS, Juneja R. Right superior vena cava to left atrium: Importance of "bubbling it right". Echocardiography. 2014;31:161–2.
6. Korff S, Mostaguir K, Beghetti M, D'Antiga L, Debray D, Franchi-Abella S, et al. International registry of congenital porto-systemic shunts: a multi-centre, retrospective and prospective registry of neonates, children and adults with congenital porto-systemic shunts. Orphanet J Rare Dis. 2022 :19;17(1):284.
7. Azizova A, Onder O, Arslan S, Ardali S, Hazirolan T. Persistent left superior vena cava: clinical importance and differential diagnoses. Insights Imaging. 2020;15;11(1):110.
8. Singh K, Poliquin J, Syversten G, Kohler DO. A rare cause of venous thrombosis: Congenital absence (agenesis) of the inferior vena cava. Int J Angiol. 2010;19:3:110-2.
9. Bartram U, Fischer G, Kramer HH. Congenitally interrupted inferior vena cava without other features of the heterotaxy syndrome: report of five cases and characterization of a rare entity. Pediatr Dev Pathol. 2008;11:4:266-73.
10. Algaly G, Alsuyihili A, Parveen A. Extensive deep vein thrombosis in a young girl with absent inferior vena cava and iliac veins: a case report. Oxf Med Case Reports. 2023:2:008.
11. Bahadori A, Kuhlmann B, Debray D, Franchi-Abella S, Wacker J, Beghetti M, et al. Presentation of Congenital Portosystemic Shunts in Children. Children. 2022:11;9:2:243.
12. Papamichail M, Pizanias M, Heaton N. Congenital portosystemic venous shunt. Eur J Pediatr. 2018;177:3:285-94.
13. Korff S, Mostaguir K, Beghetti M, D'Antiga L, Debray D, Franchi-Abella S, et al. International registry of congenital porto-systemic shunts: a multi-centre, retrospective and prospective registry of neonates, children and adults with congenital porto-systemic shunts. Orphanet J Rare Dis. 2022:19;17(1):284.
14. Knol WG, Oei FB, Budde RPJ, Ter Horst M. A case report of an interrupted inferior vena cava and azygos continuation: implications for preoperative screening in minimally invasive cardiac surgery. Eur Heart J Case Rep. 2021:29;58:308.
15. Ghandour A, Partovi S, Karuppasamy K, Rajiah P. Congenital anomalies of the IVC-embryological perspective and clinical relevance. Cardiovasc Diagn Ther. 2016;6:6:482-92.
16. Notsu E, Ono K, Horie S, Morris JF, Toida K. Double superior venae cavae with absence of the coronary sinus and anomalies of the azygos venous system. Anat Sci Int. 2020;95:3:420-24.
17. Chen, Y.A, Nguyen, E.T, Dennie, C. et al. Computed Tomography and Magnetic Resonance Imaging of the Coronary Sinus: Anatomic Variants and Congenital Anomalies. Insights Imaging.2014: 5,547–57.
18. Cinteză EE, Filip C, Duică G, Nicolae G, Nicolescu AM, Bălgrădean M. Unroofed coronary sinus: update on diagnosis and treatment. Rom J Morphol Embryol. 2019;60:1:33-40.
19. Ma J, Zheng Y, Xu S, Teng H, Lv L, Li Y, et al. The value of cardiac CT in the diagnosis of unroofed coronary sinus syndrome. BMC Cardiovasc Disord. 2022: 2;22:1:516.
20. Loomba RS, Tretter JT, Spicer DE, Anderson RH. Systemic Venous Anomalies, In: Abdulla Ri, Berger S, Backer C, Anderson RH, Holzer R, Blom N et al. Editors. Pediatric Cardiology, Springer Nature; 2023 p. 1-23.
21. Pojar M, Timbilla S, Cerny S, Karalko M, Vojacek J. Case report: Robotic repair of unroofed coronary sinus. Front Cardiovasc Med. 2022:28;9: 1-5.
22. Bilal Ms, Sarıoglu T, Kınoglu B, Erek E, Saltık L, Sarıoglu A, Aytaç A. Konjenital Kalp Anomalilerine Eşlik Eden Persistan Sol Superior Vena Kava'ya Yönelik Cerrahi Stratejiler. Türk Kardiyol Dern Arş. 1995;23:369-74.
23. Osborne T, Sheehan F. An unusual case of deep venous thrombosis in a young patient: congenital absence of the infrarenal portion of the inferior vena cava. Oxf Med Case Reports. 2019: 28;6:053.
24. İnan B, Aydın U, Erkalp K, Yaşar T, Başel H. Surgical approach for the treatment of inferior vena cava injuries. Turk Gogus Kalp Dama. 2011;19:3:366-70.
25. Fernández LG. Inferior Vena Caval Thrombosis Treatment & Management. Available at: https://emedicine.medscape.com/article/1933035-treatment?form=fpf. Accessed: April 29, 2024
26. Papamichail M, Pizanias M, Heaton N. Congenital portosystemic venous shunt. Eur J Pediatr. 2018;177:3:285-94.
27. Raghib G, Ruttenberg Hd, Anderson Rc, Amplatz K, Adams P Jr, Edwards Je. Termination Of Left Superior Vena Cava in Left Atrium, Atrıal Septal Defect, And Absence Of Coronary Sinus; a Developmental Complex. Circulation. 1965;31:906-18.



KONJENİTAL AORT DARLIĞI

BÖLÜM
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  - Supravalvüler aort darlığı

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KAYNAKLAR

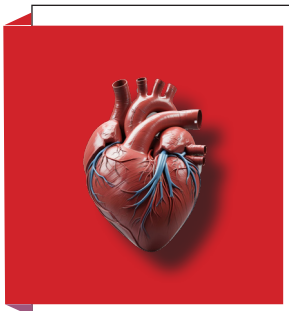
1. Specier DE, Hraska V, Anderson RH, Ginde S, Block JR. Congenital anomalies of the aortic valve and left ventricular outflow tract In: Wernovsky G, editor. Anderson's Pediatric Cardiology. 1. 49780702076084 ed. Philadelphia, PA, USA: Elsevier; 2020. p. 819-42.
2. Jenkins KJ, Correa A, Feinstein JA, Botto L, Britt AE, Daniels SR, et al. Noninherited Risk Factors and Congenital Cardiovascular Defects: Current Knowledge. Circulation. 2007;115(23):2995-3014.
3. Basso C, Boschello M, Perrone C, Mecenero A, Cera A, Bicego D, et al. An echocardiographic survey of primary school children for bicuspid aortic valve. American Journal of Cardiology. 2004;93(5):661-3.
4. Nistri S, Basso C, Marzari C, Mormino P, Thiene G. Frequency of Bicuspid Aortic Valve in Young Male Conscripts by Echocardiogram. American Journal of Cardiology. 2005;96(5):718-21.
5. Roberts WC. The structure of the aortic valve in clinically isolated aortic stenosis: an autopsy study of 162 patients over 15 years of age. Circulation. 1970;42(1):91-7.
6. Carrel A. VIII. On the Experimental Surgery of the Thoracic Aorta and Heart. Ann Surg. 1910;52(1):83-95.
7. Congenital aortic stenosis. In: Kouchoukos NT, Blackstone EH, Hanley FL, Kirklin JK, editors. Kirklin/Barratt-Boyes Cardiac Surgery. 2. 4 ed. Philadelphia, PA, USA: Elsevier Saunders; 2013. p. 1673-716.
8. Marquis RM, Logan A. Congenital aortic stenosis and its surgical treatment. Br Heart J. 1955;17(3):373-90.
9. Downing DF. Congenital aortic stenosis; clinical aspects and surgical treatment. Circulation. 1956;14(2):188-99.
10. Benjamin RB, Lewis FJ, Niazi SA, Shumway NE. Aortic valvulotomy under direct vision during hypothermia. J Thorac Surg. 1956;32(4):481-92; discussion, 92-9.
11. Kortz AB, Swan H. Direct vision trans-aortic approach to the aortic valve during hypothermia; experimental observations and report of successful clinical case. Ann Surg. 1956;144(2):205-14.
12. Spencer FC, Neill CA, Bahnson HT. The treatment of congenital aortic stenosis with valvotomy during cardiopulmonary bypass. Surgery. 1958;44(1):109-24.
13. Lababidi Z, Wu JR, Walls JT. Percutaneous balloon aortic valvuloplasty: results in 23 patients. Am J Cardiol. 1984;53(1):194-7.
14. Ross DN. Replacement of aortic and mitral valves with a pulmonary autograft. Lancet. 1967;2(7523):956-8.
15. N. C. Observations on the diseases of the orifice and valves of the aorta. Guys Hospital Reports. 1842;7:387-92.
16. Brock R, Fleming PR. Aortic subvalvar stenosis; a report of 5 cases diagnosed during life. Guys Hosp Rep. 1956;105(4):391-408.
17. Brock R. Aortic subvalvar stenosis: surgical treatment. Guys Hosp Rep. 1959;108:144-58.
18. Spencer FC, Neill CA, Sank L, Bahnson HT. Anatomical variations in 46 patients with congenital aortic stenosis. Am Surg. 1960;26:204-16.
19. Reis RL, Peterson LM, Mason DT, Simon AL, Morrow AG. Congenital fixed subvalvular aortic stenosis. An anatomical classification and correlations with operative results. Circulation. 1971;43(5 Suppl):I11-8.
20. Konno S, Imai Y, Iida Y, Nakajima M, Tatsuno K. A new method for prosthetic valve replacement in congenital aortic stenosis associated with hypoplasia of the aortic valve ring. J Thorac Cardiovasc Surg. 1975;70(5):909-17.
21. Rastan H, Koncz J. [Plastic enlargement of the left ventricular outflow tract. A new operative method (author's transl)]. Thoraxchir Vask Chir. 1975;23(3):169-75.
22. Cooley DA, Norman JC, Mullins CE, Grace RR. Left Ventricle to Abdominal Aorta Conduit for Relief of Aortic Stenosis. Cardiovasc Dis. 1975;2(4):376-83.
23. Nishimura RA, Otto CM, Bonow RO, Carabello BA, Erwin JP, 3rd, Guyton RA, et al. 2014 AHA/ACC guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol. 2014;63(22):e57-185.
24. Rashed ER, Dembar A, Riasat M, Zaidi AN. Bicuspid Aortic Valves: an Up-to-Date Review on Genetics, Natural History, and Management. Curr Cardiol Rep. 2022;24(8):1021-30.
25. Hinton RB, Martin LJ, Tabangin ME, Mazwi ML, Cripe LH, Benson DW. Hypoplastic Left Heart Syndrome Is Heritable. Journal of the American College of Cardiology. 2007;50(16):1590-5.
26. Roos-Hesselink JW, Schölzel BE, Heijdra RJ, Spitaels SEC, Meijboom FJ, Boersma E, et al. Aortic valve and aortic arch pathology after coarctation repair. Heart. 2003;89(9):1074-7.
27. Carlson M, Silberbach M. Dissection of the aorta in Turner syndrome: two cases and review of 85 cases in the literature. BMJ Case Rep. 2009;2009:bcr0620091998.
28. MacCarrick G, Black JH, III, Bowdin S, El-Hamamsy I, Frischmeyer-Guerrerio PA, Guerrerio AL, et al. Loeys–Dietz syndrome: a primer for diagnosis and management. Genetics in Medicine. 2014;16(8):576-87.
29. Rafique AM, Biner S, Ray I, Forrester JS, Tolstrup K, Siegel RJ. Meta-Analysis of Prognostic Value of Stress Testing in Patients With Asymptomatic Severe Aortic Stenosis. American Journal of Cardiology. 2009;104(7):972-7.
30. Schulte HD, Borisov K, Gams E, Gramsch-Zabel H, Losse B, Schwartzkopff B. Management of symptomatic hypertrophic obstructive cardiomyopathy--long-term results after surgical therapy. Thorac Cardiovasc Surg. 1999;47(4):213-8.
31. Karamlou T, Gurofsky R, Bojcevski A, Williams WG, Caldarone CA, Van Arsdell GS, et al. Prevalence and Associated Risk Factors for Intervention in 313 Children With Subaortic Stenosis. The Annals of Thoracic Surgery. 2007;84(3):900-6.
32. Sarioğlu T, Arnaz A, Saygili A. Accessory Miniature Mitral Valve Causing Subaortic Obstruction. The Annals of Thoracic Surgery. 2015;99(5):1868-9.
33. Bonow RO, Carabello BA, Chatterjee K, de Leon AC, Faxon DP, Freed MD, et al. ACC/AHA 2006 Guidelines for the Management of Patients With Valvular Heart Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 1998 Guidelines for the Management of Patients With Valvular Heart Disease) Developed in Collaboration With the Society of Cardiovascular Anesthesiologists

Endorsed by the Society for Cardiovascular Angiography and Interventions and the Society of Thoracic Surgeons. Journal of the American College of Cardiology. 2006;48(3):e1-e148.
34. Kitchiner DJ, Jackson M, Walsh K, Peart I, Arnold R. Incidence and prognosis of congenital aortic valve stenosis in Liverpool (1960-1990). British Heart Journal. 1993;69(1):71-9.
35. Wagner HR, Ellison RC, Keane JF, Humphries OJ, Nadas AS. Clinical course in aortic stenosis. Circulation. 1977;56(1 Suppl):I47-56.
36. Keane JF, Driscoll DJ, Gersony WM, Hayes CJ, Kidd L, O'Fallon WM, et al. Second natural history study of congenital heart defects. Results of treatment of patients with aortic valvar stenosis. Circulation. 1993;87(2 Suppl):I16-27.
37. Beppu S, Suzuki S, Matsuda H, Ohmori F, Nagata S, Miyatake K. Rapidity of progression of aortic stenosis in patients with congenital bicuspid aortic valves. Am J Cardiol. 1993;71(4):322-7.
38. Kelly TA, Rothbart RM, Cooper CM, Kaiser DL, Smucker ML, Gibson RS. Comparison of outcome of asymptomatic to symptomatic patients older than 20 years of age with valvular aortic stenosis. Am J Cardiol. 1988;61(1):123-30.
39. Brown DW, Dipilato AE, Chong EC, Gauvreau K, McElhinney DB, Colan SD, et al. Sudden unexpected death after balloon valvuloplasty for congenital aortic stenosis. J Am Coll Cardiol. 2010;56(23):1939-46.
40. Pellikka PA, Sarano ME, Nishimura RA, Malouf JF, Bailey KR, Scott CG, et al. Outcome of 622 adults with asymptomatic, hemodynamically significant aortic stenosis during prolonged follow-up. Circulation. 2005;111(24):3290-5.
41. Gersony WM, Hayes CJ, Driscoll DJ, Keane JF, Kidd L, O'Fallon WM, et al. Bacterial endocarditis in patients with aortic stenosis, pulmonary stenosis, or ventricular septal defect. Circulation. 1993;87(2 Suppl):I121-6.
42. Michelena HI, Katan O, Suri RM, Baddour LM, Enriquez-Sarano M. Incidence of Infective Endocarditis in Patients With Bicuspid Aortic Valves in the Community. Mayo Clin Proc. 2016;91(1):122-3.
43. Gale AW, Cartmill TB, Bernstein L. Familial subaortic membranous stenosis. Aust N Z J Med. 1974;4(6):576-81.
44. Maron BJ, Redwood DR, Roberts WC, Henry WL, Morrow AG, Epstein SE. Tunnel subaortic stenosis: left ventricular outflow tract obstruction produced by fibromuscular tubular narrowing. Circulation. 1976;54(3):404-16.
45. Freedom RM, Pelech A, Brand A, Vogel M, Olley PM, Smallhorn J, et al. The progressive nature of subaortic stenosis in congenital heart disease. Int J Cardiol. 1985;8(2):137-48.
46. Strong W, Perrin E, Liebman J, Silbert D. Systemic and pulmonary artery dysplasia associated with unexpected death in infancy. . J Pediatr. 1970;77:233.
47. Wren C, Oslizlok P, Bull C. Natural history of supravalvular aortic stenosis and pulmonary artery stenosis. J Am Coll Cardiol. 1990;15:1625.
48. Pasengrau D, Kioshos J, RE RD, Kroetz F. Supravalvular aortic stenosis in adults. . Am J Cardiol. 1973;31:635.
49. Hickey EJ, Jung G, Williams WG, Manlhiot C, Van Arsdell GS, Caldarone CA, et al. Congenital supravalvular aortic stenosis: defining surgical and nonsurgical outcomes. Ann Thorac Surg. 2008;86(6):1919-27; discussion 27.
50. Kitchiner D, Jackson M, Walsh K, Peart I, Arnold R. Prognosis of supravalve aortic stenosis in 81 patients in Liverpool (1960-1993). Heart. 1996;75(4):396-402.
51. Schulz A, Taylor L, Buratto E, Ivanov Y, Zhu M, Brizard CP, et al. Aortic Valve Repair in Neonates With Aortic Stenosis and Reduced Left Ventricular Function. Seminars in Thoracic and Cardiovascular Surgery. 2023;35(4):713-21.
52. Hraška V, Sinzobahamvya N, Haun C, Photiadis J, Arenz C, Schneider M, et al. The Long-Term Outcome of Open Valvotomy for Critical Aortic Stenosis in Neonates. The Annals of Thoracic Surgery. 2012;94(5):1519-26.
53. Brown SC, Boshoff D, Eyskens B, Gewillig M. Hybrid approach as bridge to biventricular repair in a neonate with critical aortic stenosis and borderline left ventricle. Eur J Cardiothorac Surg. 2009;35(6):1080-2.
54. Hammel JM, Duncan KF, Danford DA, Kutty S. Two-stage biventricular rehabilitation for critical aortic stenosis with severe left ventricular dysfunction. European Journal of Cardio-Thoracic Surgery. 2012;43(1):143-8.
55. Corno AF. Borderline left ventricle. European Journal of Cardio-Thoracic Surgery. 2005;27(1):67-73.
56. Colan SD, McElhinney DB, Crawford EC, Keane JF, Lock JE. Validation and re-evaluation of a discriminant model predicting anatomic suitability for biventricular repair in neonates with aortic stenosis. J Am Coll Cardiol. 2006;47(9):1858-65.
57. Alsoufi B, Karamlou T, McCrindle BW, Caldarone CA. Management options in neonates and infants with critical left ventricular outflow tract obstruction. Eur J Cardiothorac Surg. 2007;31(6):1013-21.
58. Kovalchin JP, Brook MM, Rosenthal GL, Suda K, Hofman JI, Silverman NH. Echocardiographic hemodynamic and morphometric predictors of survival after two-ventricle repair in infants with critical aortic stenosis. J Am Coll Cardiol. 1998;32(1):237-44.
59. Lam CZ, Yoo S-J, Honjo O, Barron DJ. Borderline Left Ventricle: Criteria for Surgical Decision Making With an Emphasis on Cardiac Magnetic Resonance Imaging. Seminars in Thoracic and Cardiovascular Surgery: Pediatric Cardiac Surgery Annual. 2025.
60. Kido T, Guariento A, Doulamis IP, Porras D, Baird CW, del Nido PJ, et al. Aortic Valve Surgery After Neonatal Balloon Aortic Valvuloplasty in Congenital Aortic Stenosis. Circulation: Cardiovascular Interventions. 2021;14(6):e009933.
61. Pfeifer J, Rentzsch A, Poryo M, Abdul-Khaliq H. Balloon Valvuloplasty in Congenital Critical Aortic Valve Stenosis in Neonates and Infants: A Rescue Procedure for the Left Ventricle. J Cardiovasc Dev Dis. 2024;11(5).
62. Varan B, Yakut K, Erdogan I, Ozkan M, Tokel K. Aortic balloon valvuloplasty and mid-term results in newborns: a single center experience. Turk J Pediatr. 2020;62(2):233-43.
63. Dan Mihai D, Demetris T, Robert Michael T, Mansour Thagavi Azar S, Eltayeb Mohamed A, Gianni Davide A, et al. Surgical versus balloon valvotomy in neonates and infants: results from the UK National Audit. Open Heart. 2019;6(1):e000938.

64. Yakut K, Tokel NK, Varan B, Erdogan I, Ozkan M. Results of balloon and surgical valvuloplasty in congenital aortic valve stenosis: A 19-year, single-center, retrospective study. Turk Gogus Kalp Damar Cerrahisi Derg. 2021;29(2):158-65.
65. McCrindle BW, Blackstone EH, Williams WG, Sittiwangkul R, Spray TL, Azakie A, et al. Are outcomes of surgical versus transcatheter balloon valvotomy equivalent in neonatal critical aortic stenosis? Circulation. 2001;104(12 Suppl 1):I152-8.
66. Robinson BV, Brzezinska-Rajszys G, Weber HS, Ksiazyk J, Fricker FJ, Fischer DR, et al. Balloon aortic valvotomy through a carotid cutdown in infants with severe aortic stenosis: results of the multi-centric registry. Cardiol Young. 2000;10(3):225-32.
67. Pickard SS, Wong JB, Bucholz EM, Newburger JW, Tworetzky W, Lafranchi T, et al. Fetal Aortic Valvuloplasty for Evolving Hypoplastic Left Heart Syndrome. Circulation: Cardiovascular Quality and Outcomes. 2020;13(4):e006127.
68. Sarıoğlu T, Arnaz A, Erek E, Yalçınbaş Y. Ross procedure after aortic balloon valvuloplasty: the youngest case in Turkey. Cardiovascular Surgery and Interventions. 2014;1(1):9-11.
69. Desai M. Small and borderline left ventricular outflow tract - a perplexing maladie. Indian J Thorac Cardiovasc Surg. 2021;37(Suppl 1):123-30.
70. Warnes CA, Williams RG, Bashore TM, Child JS, Connolly HM, Dearani JA, et al. ACC/AHA 2008 guidelines for the management of adults with congenital heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Develop Guidelines on the Management of Adults With Congenital Heart Disease). Developed in Collaboration With the American Society of Echocardiography, Heart Rhythm Society, International Society for Adult Congenital Heart Disease, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons. J Am Coll Cardiol. 2008;52(23):e143-e263.
71. McMahon CJ, Gauvreau K, Edwards JC, Geva T. Risk factors for aortic valve dysfunction in children with discrete subvalvar aortic stenosis. Am J Cardiol. 2004;94(4):459-64.
72. Marathe SP, Baird CW. Surgical Management of Congenital Aortic and Truncal Valve Disease: A Comprehensive Review. Seminars in Thoracic & Cardiovascular Surgery: Pediatric Cardiac Surgery Annual.
73. Olofsson CK, Hanseus K, Ramgren JJ, Synnergren MJ, Sunnegårdh J. Outcomes in neonatal critical and non-critical aortic stenosis: a retrospective cohort study. Archives of Disease in Childhood. 2023;108(5):398-404.
74. Auld BC, Donald JS, Lwin N, Betts K, Alphonso NO, Venugopal PS, et al. Balloon dilatation versus surgical valvotomy for congenital aortic stenosis: a propensity score matched study. Cardiology in the Young. 2021;31(12):1984-90.
75. Chiariello L, Vlad P, Subramanian S. Surgical treatment of congenital valvular aortic stenosis. Thorax. 1976;31(4):398-404.
76. McMullan DM, Oppido G, Davies B, Kawahira Y, Cochrane AD, d'Udekem d'Acoz Y, et al. Surgical strategy for the bicuspid aortic valve: tricuspidization with cusp extension versus pulmonary autograft. J Thorac Cardiovasc Surg. 2007;134(1):90-8.
77. Chiu P, Higgins HA, Baird CW. State of the Art Review: Aortic Valve Repair in Infants and Children. Ann Thorac Surg. 2025;119(3):697-707.
78. Schäfers H-J, Aicher D, Riodionycheva S, Lindinger A, Rädle-Hurst T, Langer F, et al. Bicuspidization of the Unicuspid Aortic Valve: A New Reconstructive Approach. The Annals of Thoracic Surgery. 2008;85(6):2012-8.
79. Schäfers H-J, Konstantinov IE. Surgical anatomy of aortic root: Toward precise and durable aortic, neo-aortic, and truncal valve repairs. The Journal of Thoracic and Cardiovascular Surgery.
80. d'Udekem Y. Aortic valve surgery in children. Heart. 2011;97(14):1182-9.
81. Chiu P, Chavez M, Zubair MM, Friedman KG, Marx GR, Del Nido PJ, et al. Symmetric bicuspidizing repair for patients with congenital aortic or truncal valve disease. J Thorac Cardiovasc Surg. 2023;166(2):283-91.
82. Fujikawa T, Ozaki S, Kiyohara N, Goda M, Takatoo M, Shimura S. New Ozaki Procedure Overview. Operative Techniques in Thoracic and Cardiovascular Surgery.
83. Baird CW, Cooney B, Chávez M, Sleeper LA, Marx GR, del Nido PJ. Congenital aortic and truncal valve reconstruction using the Ozaki technique: Short-term clinical results. The Journal of Thoracic and Cardiovascular Surgery. 2021;161(5):1567-77.
84. Wiggins LM, Mimic B, Issitt R, Ilic S, Bonello B, Marek J, et al. The utility of aortic valve leaflet reconstruction techniques in children and young adults. The Journal of Thoracic and Cardiovascular Surgery. 2020;159(6):2369-78.
85. Chivers SC, Pavy C, Vaja R, Quarto C, Ghez O, Daubeney PEF. The Ozaki Procedure With CardioCel Patch for Children and Young Adults With Aortic Valve Disease: Preliminary Experience – a Word of Caution. World Journal for Pediatric and Congenital Heart Surgery. 2019;10(6):724-30.
86. Polito A, Albanese SB, Cetrano E, Forcina S, Cicenia M, Rinelli G, et al. Aortic Valve Neocuspidalization May Be a Viable Alternative to Ross Operation in Pediatric Patients. Pediatric Cardiology. 2021;42(3):668-75.
87. Marathe SP, Chávez M, Sleeper LA, Marx G, del Nido PJ, Baird CW. Modified Ozaki Procedure Including Annular Enlargement for Small Aortic Annuli in Young Patients. The Annals of Thoracic Surgery. 2020;110(4):1364-71.
88. Marathe SP, Chávez M, Sleeper LA, Marx GR, Friedman K, Feins EN, et al. Single-Leaflet Aortic Valve Reconstruction Utilizing the Ozaki Technique in Patients With Congenital Aortic Valve Disease. Seminars in Thoracic and Cardiovascular Surgery. 2022;34(4):1262-72.
89. Frankel WC, Robinson JA, Roselli EE, Unai S, Tretter JT, Fuller S, et al. Lifetime Management of Adolescents and Young Adults with Congenital Aortic Valve Disease. The Annals of Thoracic Surgery. 2025;119(1):59-69.
90. Yang B. A novel simple technique to enlarge the aortic annulus by two valve sizes. JTCVS Techniques. 2021;5:13-6.
91. Vouhe PR, Ouaknine R, Poulain H, Vernant F, Mauriat P, Pouard P, et al. Diffuse subaortic stenosis: modified Konno procedures with aortic valve preservation. Eur J Cardiothorac Surg. 1993;7(3):132-6.
92. Brown JW, Ruzmetov M, Vijay P, Turrentine MW. Sur-

gical repair of congenital supravalvular aortic stenosis in children. European Journal of Cardio-Thoracic Surgery. 2002;21(1):50-6.
93. Lang X, Lv L, Zhang S, Zhi A, Wang C, Wang Q. Effectiveness and Safety of Different Patch Materials for Supravalvar Aortic Stenosis (Middle-Term Outcomes). Rev Cardiovasc Med. 2024;25(1):14.
94. Lv L, Lang X, Zhang S, Wang C, Wang Q. Assessment of three types of surgical procedures for supravalvar aortic stenosis: A systematic review and meta-analysis. Front Cardiovasc Med. 2022;9:987522.
95. Lv L, Sun Y, Zhang S, Zhi A, Wang C, Wang Q. Prognostic Effects of Operation Age for Pediatric Patients with Supravalvar Aortic Stenosis. Rev Cardiovasc Med. 2024;25(10):384.
96. van Son JAM, Danielson GK, Puga FJ, Schaff HV, Rastogi A, Edwards WD, et al. Supravalvular aortic stenosis: Long-term results of surgical treatment. The Journal of Thoracic and Cardiovascular Surgery. 1994;107(1):103-15.
97. Zinyandu T, Knight JH, Thomas AS, Claxton J, Montero A, Shaw FR, et al. Long-term Outcomes After Surgical Intervention for Congenital Supravalvar Aortic Stenosis in Children. Ann Thorac Surg. 2024;117(5):965-72.
98. Greutmann M, Tobler D, Sharma NC, Vonder Muhll I, Mebus S, Kaemmerer H, et al. Cardiac outcomes in adults with supravalvar aortic stenosis. European Heart Journal. 2012;33(19):2442-50.
99. Eicken A, Georgiev S, Balling G, Schreiber C, Hager A, Hess J. Neonatal balloon aortic valvuloplasty—predictive value of current risk score algorithms for treatment strategies. Catheterization and Cardiovascular Interventions. 2010;76(3):404-10.
100. Ewert P, Bertram H, Breuer J, Dähnert I, Dittrich S, Eicken A, et al. Balloon valvuloplasty in the treatment of congenital aortic valve stenosis — A retrospective multicenter survey of more than 1000 patients. International Journal of Cardiology. 2011;149(2):182-5.
101. Hill GD, Ginde S, Rios R, Frommelt PC, Hill KD. Surgical Valvotomy Versus Balloon Valvuloplasty for Congenital Aortic Valve Stenosis: A Systematic Review and Meta-Analysis. J Am Heart Assoc. 2016;5(8).
102. Ren Q, Yu J, Chen T, Qiu H, Liu T, Cen J, et al. Surgical aortic valvuloplasty is a better primary intervention for isolated congenital aortic stenosis in children with bicuspid aortic valve than balloon aortic valvuloplasty. Hellenic Journal of Cardiology. 2024;77:54-62.
103. Schulz A, Buratto E, Wallace FRO, Fulkoski N, Weintraub RG, Brizard CP, et al. Outcomes of aortic valve repair in children resulting in bicuspid anatomy: Is there a need for tricuspidization? The Journal of Thoracic and Cardiovascular Surgery. 2022;164(1):186-96.e2.
104. Brown DW, Dipilato AE, Chong EC, Lock JE, McElhinney DB. Aortic Valve Reinterventions After Balloon Aortic Valvuloplasty for Congenital Aortic Stenosis: Intermediate and Late Follow-Up. Journal of the American College of Cardiology. 2010;56(21):1740-9.
105. Torres A, Vincent JA, Everett A, Lim S, Foerster SR, Marshall AC, et al. Balloon valvuloplasty for congenital aortic stenosis: Multi-center safety and efficacy outcome assessment. Catheterization and Cardiovascular Interventions. 2015;86(5):808-20.
106. Balmer C, Beghetti M, Fasnacht M, Friedli B, Arbenz U. Balloon aortic valvoplasty in paediatric patients: progressive aortic regurgitation is common. Heart. 2004;90(1):77-81.
107. Brown DW, Chong EC, Gauvreau K, Keane JF, Lock JE, Marshall AC. Aortic wall injury as a complication of neonatal aortic valvuloplasty: incidence and risk factors. Circ Cardiovasc Interv. 2008;1(1):53-9.
108. Bacha EA, McElhinney DB, Guleserian KJ, Colan SD, Jonas RA, del Nido PJ, et al. Surgical aortic valvuloplasty in children and adolescents with aortic regurgitation: acute and intermediate effects on aortic valve function and left ventricular dimensions. J Thorac Cardiovasc Surg. 2008;135(3):552-9, 9 e1-3.
109. Matsushima S, Heß A, Lämmerzahl JR, Karliova I, Abdul-Khaliq H, Schäfers H-J. Unicuspid aortic valve repair with bicuspidization in the paediatric population. European Journal of Cardio-Thoracic Surgery. 2020;59(1):253-61.
110. Nosal M, Poruban R, Valentik P, Sagat M, Nagi AS, Kantorova A. Initial experience with polytetrafluoroethylene leaflet extensions for aortic valve repair. Eur J Cardiothorac Surg. 2012;41(6):1255-7; discussion 8.
111. Odim J, Laks H, Allada V, Child J, Wilson S, Gjertson D. Results of aortic valve-sparing and restoration with autologous pericardial leaflet extensions in congenital heart disease. Ann Thorac Surg. 2005;80(2):647-53; discussion 53-4.
112. Polimenakos AC, Sathanandam S, Elzein C, Barth MJ, Higgins RS, Ilbawi MN. Aortic cusp extension valvuloplasty with or without tricuspidization in children and adolescents: long-term results and freedom from aortic valve replacement. J Thorac Cardiovasc Surg. 2010;139(4):933-41; discussion 41.
113. Wallace FRO, Buratto E, Naimo PS, Brink J, d'Udekem Y, Brizard CP, et al. Aortic valve repair in children without use of a patch. The Journal of Thoracic and Cardiovascular Surgery. 2021;162(4):1179-89.e3.
114. Schlein J, Kaider A, Gabriel H, Wiedemann D, Hornykewycz S, Simon P, et al. Aortic Valve Repair in Pediatric Patients: 30 Years Single Center Experience. The Annals of Thoracic Surgery. 2023;115(3):656-62.
115. Myers PO, Mokashi SA, Horgan E, Borisuk M, Mayer JE, del Nido PJ, et al. Outcomes after mechanical aortic valve replacement in children and young adults with congenital heart disease. The Journal of Thoracic and Cardiovascular Surgery. 2019;157(1):329-40.
116. Cicek M, Ozdemir F. Aortic valve neocuspidization with the Ozaki procedure in congenital aortic valve disease: Early results. Turk Gogus Kalp Damar Cerrahisi Derg. 2023;31(4):431-9.
117. Zhu MZL, Buratto E, Wu DM, Ishigami S, Schulz A, Brizard CP, et al. Long-Term Outcomes of Mechanical Aortic Valve Replacement in Children. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2024;27:52-60.
118. Saleeb SF, Newburger JW, Geva T, Baird CW, Gauvreau K, Padera RF, et al. Accelerated degeneration of a bovine pericardial bioprosthetic aortic valve in children and young adults. Circulation. 2014;130(1):51-60.
119. Horke A, Bobylev D, Avsar M, Cvitkovic T, Meyns B, Rega F, et al. Paediatric aortic valve replacement using decellularized allografts: a multicentre update following 143 implantations and five-year mean follow-up. Eur J Cardiothorac Surg. 2024;65(4).
120. Fuller SM, Borisuk MJ, Sleeper LA, Bacha E, Burchill

L, Guleserian K, et al. Mortality and Reoperation Risk After Bioprosthetic Aortic Valve Replacement in Young Adults With Congenital Heart Disease. Seminars in Thoracic and Cardiovascular Surgery. 2021;33(4):1081-92.
121. Parry AJ, Kovalchin JP, Suda K, McElhinney DB, Wudel J, Silverman NH, et al. Resection of subaortic stenosis; can a more aggressive approach be justified? Eur J Cardiothorac Surg. 1999;15(5):631-8.
122. Mazurek AA, Yu S, Lowery R, Ohye RG. Routine Septal Myectomy During Subaortic Stenosis Membrane Resection: Effect on Recurrence Rates. Pediatr Cardiol. 2018;39(8):1627-34.
123. Hirata Y, Chen JM, Quaegebeur JM, Mosca RS. The role of enucleation with or without septal myectomy for discrete subaortic stenosis. J Thorac Cardiovasc Surg. 2009;137(5):1168-72.
124. Turhan S, Ayık MF, Işık O, Akyüz M, Levent E, Özyürek R, et al. Short- and mid-term results of resection of discrete subaortic stenosis in children. Turk Gogus Kalp Dama. 2016;24(1):10-4.
125. Griffeth EM, Dearani JA, Hassler KR, Todd A, Johnson JN, Miranda WR, et al. Late Outcomes of Konno-Rastan and Modified Konno for Left Ventricular Outflow Tract Obstruction. Ann Thorac Surg. 2024;117(5):973-81.
126. Alpat S, Sabuncu T, Aydin A, Guvener M, Dogan R, Yilmaz M. The Konno-Rastan Procedure in the Current Era: Still A Feasible Option? Braz J Cardiovasc Surg. 2025;40(1):e20240002.
127. Sarıoğlu T, Bilal M, Kınoğlu B, Sarıoğlu A, Akçevin A, Özkara A, et al. Konno -Rastan Operasyonu ile Sol Ventrikül Çıkım Yolu Rekonstrüksiyonu. Turk Gogus Kalp Dama. 1995;3:226-31.
128. Amirghofran AA, Salimi M, Kamran H, Bazrafshan H, Navaei MR, Shokrollahi A, et al. Long-term outcomes of the classic Konno-Rastan procedure in paediatric and adult patients: impact of aortic annulus size on patient outcomes. Interdiscip Cardiovasc Thorac Surg. 2023;37(4).
129. Suri RM, Dearani JA, Schaff HV, Danielson GK, Puga FJ. Long-term results of the Konno procedure for complex left ventricular outflow tract obstruction. J Thorac Cardiovasc Surg. 2006;132(5):1064-71.
130. Laredo M, Khraiche D, Raisky O, Gaudin R, Bajolle F, Maltret A, et al. Long-term results of the modified Konno procedure in high-risk children with obstructive hypertrophic cardiomyopathy. J Thorac Cardiovasc Surg. 2018;156(6):2285-94.e2.
131. Roughneen PTF, DeLeon SYMD, Cetta FMD, Vitullo DAMD, Bell TJMD, Fisher EAMD, et al. Modified Konno-Rastan Procedure for Subaortic Stenosis: Indications, Operative Techniques, and Results. The Annals of Thoracic Surgery. 1998;65(5):1368-76.
132. Sharma BK, Fujiwara H, Hallman GL, Ott DA, Reul GJ, Cooley DA. Supravalvar aortic stenosis: a 29-year review of surgical experience. Ann Thorac Surg. 1991;51(6):1031-9.
133. Fricke TA, d'Udekem Y, Brizard CP, Wheaton G, Weintraub RG, Konstantinov IE. Surgical repair of supravalvular aortic stenosis in children with williams syndrome: a 30-year experience. Ann Thorac Surg. 2015;99(4):1335-41.
134. Stamm C, Kreutzer C, Zurakowski D, Nollert G, Friehs I, Mayer JE, et al. Forty-one years of surgical experience with congenital supravalvular aortic stenosis. J Thorac Cardiovasc Surg. 1999;118(5):874-85.



ÇOCUKLARDA AORT KAPAK TAMİRİ VE NEOKÜSPİDİZASYON

BÖLÜM
42

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İçindekiler

» GİRİŞ
» AORT KAPAK EMRİYOLOJİ VE HİSTOLOJİSİ
» AORT KAPAK VE KÖKÜNÜN CERRAHİ ANATOMİSİ, HEMODİNAMİSİ
» PEDİATRİK AORT KAPAK DARLIĞI VE YETMEZLİĞİNİN NEDENLERİ
» PREOPERATİF DEĞERLENDİRME
» AORT KAPAK TAMİRİ
» KOMİSSÜROTOMİ
» KAPAKCIK UZATIMI
» SERBEST UC KISALTILMASI
» KAPAKCIK DEBRİDMANI
» KOMİSSÜROPLASTİ
» SİMETRİK BİKÜSPİDİZASYON
» ANÜLOPLASTİ
» AORT KÖK REKONSTRİKSİYONU
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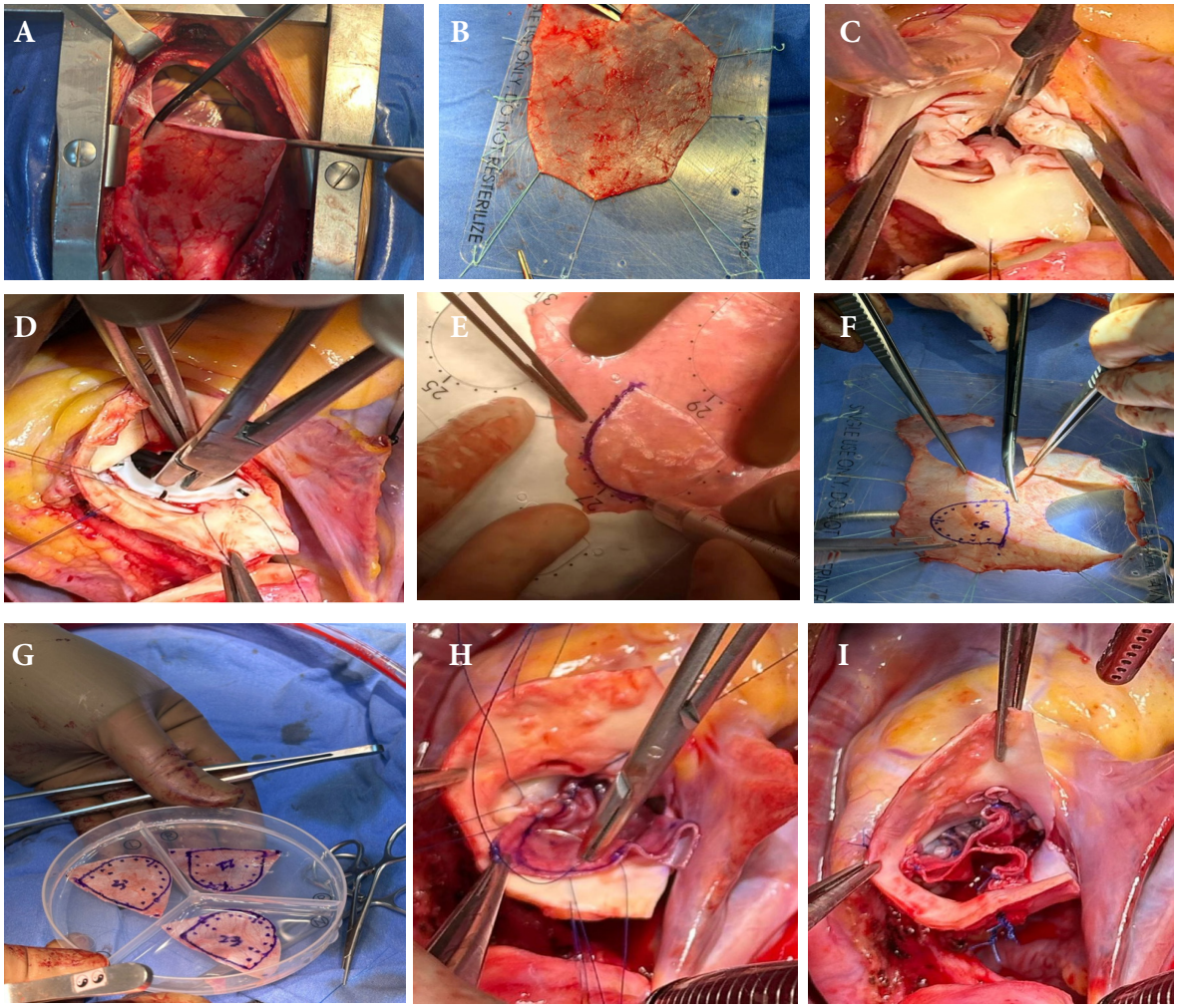


Resim 9. ***a.*** *Otojen perikardın geniş olarak çıkarılması.* ***b.*** *otojen perikardın temizlenip, gerilerek hazırlanması.* ***c.*** *onarıma uygun olmayan aort kapağın rezeke edilmesi. fot 9-d neo cusp için komissürler arası boyutlarının belirlenmesi.* ***e.*** *ozaki şablonu ile ölçülen boyuta uygun neocusp çizilmesi.* ***f.*** *neocusp hazırlanması.* ***g.*** *hazırlanmış neocusplar.* ***h.*** *neocusplaın sütüre edilmesi.* ***ı.*** *neocüspidizasyonun tamamlanmış hali.*

KAYNAKLAR

1. Kitchiner DJ, Jackson M, Walsh K, Peart I, Arnold R. Incidence and prognosis of congenital aortic valve stenosis in Liverpool (1960-1990). Br Heart J. 1993;69:71-79.
2. Dhanantwari P, Lee E, Krishnan A, Samtani R, Yamada S, Anderson S, et al. Human cardiac development in the first trimester: a high-resolution magnetic resonance imaging and episcopic fluorescence image capture atlas. Circulation. 2009;120(4):343–51.
3. Liebner S, Cattelino A, Gallini R, Rudini N, Iurlaro M, Piccolo S, et al. Beta-catenin is required for endothelial-mesenchymal transformation during heart cushion development in the mouse. J Cell Biol. 2004;166(3):359–67.
4. Nakajima Y, Yamagishi T, Hokari S, Nakamura H. Mechanisms involved in valvuloseptal endocardial cushion formation in early cardiogenesis: roles of transforming growth factor (TGF)-beta and bone morphogenetic protein (BMP). Anat Rec. 2000;258(2):119–27.
5. Délot EC, Bahamonde ME, Zhao M, Lyons KM. BMP signaling is required for septation of the outflow tract of the mammalian heart. Development. 2003;130(1):209–20.
6. Alfieri CM, Cheek J, Chakraborty S, Yutzey KE. Wnt signaling in heart valve development and osteogenic gene induction. Dev Biol. 2010;338(2):127–35. [DOI] [PMC free article] [PubMed] [Google Scholar]
7. Gessert S, Kühl M. The multiple phases and faces of Wnt signaling during cardiac differentiation and development. Circ Res. 2010;107(2):186–99. 10.1161/circresaha.110.221531 [DOI] [PubMed] [Google Scholar]
8. Timmerman LA, Grego-Bessa J, Raya A, Bertrán E, Pérez-Pomares JM, Díez J, et al. Notch promotes epithelial-mesenchymal transition during cardiac development and oncogenic transformation. Genes Dev.

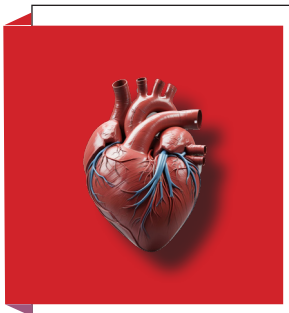
2004;18(1):99–115. 10.1101/gad.276304 [DOI] [PMC free article] [PubMed] [Google Scholar]
9. Luxán G, D'Amato G, MacGrogan D, de la Pompa JL. Endocardial Notch signaling in cardiac development and disease. Circ Res. 2016;118(1):e1–e18. 10.1161/circresaha.115.305350 [DOI] [PubMed] [Google Scholar]
10. Dor Y, Camenisch TD, Itin A, Fishman GI, McDonald JA, Carmeliet P, et al. A novel role for VEGF in endocardial cushion formation and its potential contribution to congenital heart defects. Development. 2001;128(9):1531–8. 10.1242/dev.128.9.1531 [DOI] [PubMed] [Google Scholar]
11. von Gise A, Pu WT. Endocardial and epicardial epithelial to mesenchymal transitions in heart development and disease. Circ Res. 2012;110(12):1628–45. 10.1161/circresaha.111.259960 [DOI] [PMC free article] [PubMed] [Google Scholar
12. Koenig SN, Lincoln J, Garg V. Genetic basis of aortic valvular disease. Curr Opin Cardiol. 2017;32(3):239–45. 10.1097/hco.0000000000000384 [DOI] [PMC free article] [PubMed] [Google Scholar]
13. Latif N, Sarathchandra P, Taylor PM, Antoniw J, Brand N, Yacoub MH. Characterization of molecules mediating cell-cell communication in human cardiac valve interstitial cells. Cell Biochem Biophys. 2006;45(3):255–64. 10.1385/cbb:45:3:255 [DOI] [PubMed] [Google Scholar]
14. Anstine LJ, Bobba C, Ghadiali S, Lincoln J. Growth and maturation of heart valves leads to changes in endothelial cell distribution, impaired function, decreased metabolism and reduced cell proliferation. J Mol Cell Cardiol. 2016;100:72–82. 10.1016/j.yjmcc.2016.10.006 [DOI] [PMC free article] [PubMed] [Google Scholar]
15. Majumdar U, Manivannan S, Basu M, Ueyama Y, Blaser MC, Cameron E, et al. Nitric oxide prevents aortic valve calcification by S-nitrosylation of USP9X to activate NOTCH signaling. Sci Adv. 2021;7(6):eabe3706. 10.1126/sciadv.abe3706 [DOI] [PMC free article] [PubMed] [Google Scholar]
16. Kim AJ, Xu N, Yutzey KE. Macrophage lineages in heart valve development and disease. Cardiovasc Res. 2021;117(3):663–73. 10.1093/cvr/cvaa062 [DOI] [PMC free article] [PubMed] [Google Scholar]
17. Levine RA, Hagége AA, Judge DP, Padala M, Dal-Bianco JP, Aikawa E, et al. Mitral valve disease–morphology and mechanisms. Nat Rev Cardiol. 2015;12(12):689–710. 10.1038/nrcardio.2015.161 [DOI] [PMC free article] [PubMed] [Google Scholar]
18. Meier LA, Auger JL, Engelson BJ, Cowan HM, Breed ER, Gonzalez-Torres MI, et al. CD301b/MGL2(+) mononuclear phagocytes orchestrate autoimmune cardiac valve inflammation and fibrosis. Circulation. 2018;137(23):2478–93. 10.1161/circulationaha.117.033144 [DOI] [PMC free article] [PubMed] [Google Scholar]
19. Kim AJ, Xu N, Umeyama K, Hulin A, Ponny SR, Vagnozzi RJ, et al. Deficiency of circulating monocytes ameliorates the progression of myxomatous valve degeneration in Marfan syndrome. Circulation. 2020;141(2):132–46. 10.1161/circulationaha.119.042391 [DOI] [PMC free article] [PubMed] [Google Scholar]
20. Sybert VP, McCauley E. Turner's syndrome. N Engl J Med. 2004;351(12):1227–38. 10.1056/NEJMra030360 [DOI] [PubMed] [Google Scholar]
21. Jacobsen P, Hauge M, Henningsen K, Hobolth N, Mikkelsen M, Philip J. An (11;21) translocation in four generations with chromosome 11 abnormalities in the offspring. A clinical, cytogenetical, and gene marker study. Hum Hered. 1973;23(6):568–85. 10.1159/000152624 [DOI] [PubMed] [Google Scholar]
22. Balderston SM, Shaffer EM, Washington RL, Sondheimer HM. Congenital polyvalvular disease in trisomy 18: echocardiographic diagnosis. Pediatr Cardiol. 1990;11(3):138–42. 10.1007/bf02238843 [DOI] [PubMed] [Google Scholar]
23. Loeys BL, Chen J, Neptune ER, Judge DP, Podowski M, Holm T, et al. A syndrome of altered cardiovascular, craniofacial, neurocognitive and skeletal development caused by mutations in TGFBR1 or TGFBR2. Nat Genet. 2005;37(3):275–81. 10.1038/ng1511 [DOI] [PubMed] [Google Scholar]
24. Garg V, Muth AN, Ransom JF, Schluterman MK, Barnes R, King IN, et al. Mutations in NOTCH1 cause aortic valve disease. Nature. 2005;437(7056):270–4. 10.1038/nature03940 [DOI] [PubMed] [Google Scholar]
25. McBride KL, Riley MF, Zender GA, Fitzgerald-Butt SM, Towbin JA, Belmont JW, et al. NOTCH1 mutations in individuals with left ventricular outflow tract malformations reduce ligand-induced signaling. Hum Mol Genet. 2008;17(18):2886–93. 10.1093/hmg/ddn187 [DOI] [PMC free article] [PubMed] [Google Scholar]
26. De Paulis A, Salica A. Surgical anatomy of the aortic valve and root—implications for valve repair. Ann Cardiothorac Surg. 2019;8(3):313–21. Doi: 10.21037/acs.2019.04.16
27. Matalanis G. Valve sparing aortic root repairs – an anatomical approach. Heart Lung Circ. 2004;13:S13–18.
28. Buratto E, Konstantinov IE. Valve-sparing aortic root surgery in children and adults with congenital heart disease. J Thorac Cardiovasc Surg. 2021;162:955–962.
29. Schäfers HJ, Schmied W, Marom G, Aicher D. Cusp height in aortic valves. J Thorac Cardiovasc Surg. 2013;146:269–74.
30. Bierbach BO, Aicher D, Issa OA, Bomberg H, Gräber S, Glombitza P, et al. Aortic root and cusp configuration determine aortic valve function. Eur J Cardiothorac Surg. 2010;38:400–6.
31. Tamer S, Mastrobuoni S, van Dyck M, Navarra E, Bollen X, Poncelet A, et al. Free margin length and geometric height in aortic root dilatation and leaflet prolapse: implications for aortic valve repair surgery. Eur J Cardiothorac Surg. 2020;57:124–32.
32. Matsushima S, Karliova I, Gauer S, Miyahara S, Schäfers HJ. Geometry of cusp and root determines aortic valve function. Indian J Thorac Cardiovasc Surg. 2020;36(Suppl 1):64–70.
33. Bouhout I, Chauvette V, Rong W, Raboisson M-J, El-Hamamsy I, Poirier N. The normal aortic valve leaflets effective height in pediatric patients: a guide to aortic valve repair. J Thorac Cardiovasc Surg Tech. 2021;8:135–7.
34. Singh GK. Congenital aortic valve stenosis. Children (Basel). 2019 May 13;6(5):69.
35. Niaz T, Poterucha JT, Johnson JN, Craviari C, Nienaber T, Palfreeman J, et al. Incidence, morphology, and progression of bicuspid aortic valve in pediatric and young adult subjects with coexisting congenital heart defects. Congenit Heart Dis. 2017;12:261–9. *doi: 10.1111/*

chd.12429. [DOI] [PubMed] [Google Scholar]
36. Fernandes SM, Sanders SP, Khairy P, Jenkins KJ, Gauvreau K, Lang P, et al. Morphology of bicuspid aortic valve in children and adolescents. J Am Coll Cardiol. 2004;44:1648–51. *doi: 10.1016/j.jacc.2004.05.063.* [DOI] [PubMed] [Google Scholar]
37. Nappi F, Giacinto O, Lusini M, Garo M, Caponio C, Nenna A, et al. Patients with bicuspid aortopathy and aortic dilatation. J Clin Med. 2022;11:6002. *doi: 10.3390/jcm11206002.* [DOI] [PMC free article] [PubMed] [Google Scholar]
38. Grattan M, Prince A, Ruman R, Morgan C, Petrovic M, Hauck A, et al. Predictors of bicuspid aortic valve-associated aortopathy in childhood: a report from the MIBAVA consortium. Circ Cardiovasc Imaging. 2020;13:e009717. *doi: 10.1161/CIRCIMAGING.119.009717.* [DOI] [PubMed] [Google Scholar]
39. Blais S, Meloche-Dumas L, Fournier A, Fournier A, Dallaire F, Dahdah N. Long-term risk factors for dilatation of the proximal aorta in a large cohort of children with bicuspid aortic valve. Circ Cardiovasc Imaging. 2020;13:e009675. *doi: 10.1161/CIRCIMAGING.119.009675.* [DOI] [PubMed] [Google Scholar]
40. Niaz T, Poterucha JT, Olson TM, Johnson JN, Craviari C, Nienaber T, et al. Characteristic morphologies of the bicuspid aortic valve in patients with genetic syndromes. J Am Soc Echocardiogr. 2018;31:194–200. *doi: 10.1016/j.echo.2017.10.008.* [DOI] [PubMed] [Google Scholar]
41. Sievers HH, Schmidtke C. A classification system for the bicuspid aortic valve from 304 surgical specimens. J Thorac Cardiovasc Surg. 2007;133:1226–33.
42. Fernandes S, Khairy P, Graham DA, Colan SD, Galvin TC, Sanders SP, et al. Bicuspid aortic valve and associated aortic dilation in the young. Heart. 2012;98:1014–9. *doi: 10.1136/heartjnl-2012-301773.* [DOI] [PubMed] [Google Scholar]
43. Jackson V, Petrini J, Caidahl K, Eriksson MJ, Liska J, Eriksson P, et al. Bicuspid aortic valve leaflet morphology in relation to aortic root morphology: a study of 300 patients undergoing open-heart surgery. Eur J Cardiothorac Surg. 2011;40:e118–24. *doi: 10.1016/j.ejcts.2011.04.014.* [DOI] [PubMed] [Google Scholar]
44. Nappi F, Giacinto O, Lusini M, Garo M, Caponio C, Nenna A, et al. Patients with bicuspid aortopathy and aortic dilatation. J Clin Med. 2022;11:6002. *doi: 10.3390/jcm11206002.* [DOI] [PMC free article] [PubMed] [Google Scholar]
45. Fernandes SM, Sanders SP, Khairy P, Jenkins KJ, Gauvreau K, Lang P, et al. Morphology of bicuspid aortic valve in children and adolescents. J Am Coll Cardiol. 2004;44:1648–51. *doi: 10.1016/j.jacc.2004.05.063.* [DOI] [PubMed] [Google Scholar]
46. Rathore KS. Aortic regurgitation with ventricular septal defect in the young. Asian Cardiovasc Thorac Ann. 2006;14(2):93–7. doi:10.1177/021849230601400202
47. Kaewpechsanguan A, Chungsomprasong P, Durongpisitkul K, Vijarnsorn C, Chanthong P, Kanjanauthai S, et al. Manifestations of rheumatic carditis, regression of valvular regurgitation, and independent predictors of mitral regurgitation improvement after rheumatic carditis in Thai children. Glob Heart. 2024;19(1):16. Available at: https://doi.org/10.5334/gh.1295
48. Shanthi C, Madathil RS, Saldanha R, Vakamudi M, Balakrishnan K. Ventricular septal defect complicated by infective endocarditis of the aortic valve causing severe aortic regurgitation: the role of aortic valve repair. J Heart Valve Dis. 2002 May;11(3):389–91.
49. Tinkle BT, Lacro RV, Burke LW, Council on Genetics. Health supervision for children and adolescents with Marfan syndrome. Pediatrics. 2023 Apr;151(4):e2023061450. 10.1542/peds.2023-061450
50. Schlein J, Wollmann F, Kaider A, Wiedemann D, Gabriel H, Hornykewycz S, et al. Long-term outcomes after surgical repair of subvalvular aortic stenosis in pediatric patients. Front Cardiovasc Med. 2022 Dec 2;9:1033312. doi: 10.3389/fcvm.2022.1033312.
51. Schäfers HJ, Konstantinov IE. Surgical anatomy of aortic root: toward precise and durable aortic, neo-aortic, and truncal valve repairs. J Thorac Cardiovasc Surg. 2024 Oct 22:S0022-5223(24)00912-7. Epub ahead of print.
52. Lababidi Z. Aortic balloon valvuloplasty. Am Heart J. 1983;106:751–2.
53. Maskatia SA, Justino H, Ing FF, Crystal MA, Mattamal RJ, Petit CJ. Aortic valve morphology is associated with outcomes following balloon valvuloplasty for congenital aortic stenosis. Catheter Cardiovasc Interv. 2013;81:90–5.
54. Brown JW, Rodefeld MD, Ruzmetov M, Eltayeb O, Yurdakok O, Turrentine MW. Surgical valvuloplasty versus balloon aortic dilation for congenital aortic stenosis: are evidence-based outcomes relevant? Ann Thorac Surg. 2012;94:146–53; discussion 153–5.
55. Brown DW, Dipilato AE, Chong EC, Lock JE, McElhinney DB. Aortic valve reinterventions after balloon aortic valvuloplasty for congenital aortic stenosis: intermediate and late follow-up. J Am Coll Cardiol. 2010;56:1740–9.
56. Saung MT, McCracken C, Sachdeva R, Petit CJ. Outcomes following balloon aortic valvuloplasty versus surgical valvotomy in congenital aortic valve stenosis: a meta-analysis. J Invasive Cardiol. 2019 Jun;31(6):E133–42.
57. Vida VL, Bottio T, Milanesi O, et al. Critical aortic stenosis in early infancy: surgical treatment for residual lesions after balloon dilation. Ann Thorac Surg. 2005;79:47–51; discussion 51–2.
58. Mahmoud M, Johansson B, Rinnstrom D, Sandberg C, Christersson C, Sörensson P, et al. Reinterventions in patients with congenital aortic stenosis and a commissurotomy. Open Heart. 2025 Mar 3;12(1):e003128. doi: 10.1136/openhrt-2024-003128. PMID: 40032608; PMCID: PMC11877264.
59. Boe BA, Zampi JD, Kennedy KF, et al. Acute success of balloon aortic valvuloplasty in the current era. JACC Cardiovasc Interv. 2017;10(17):1717–26.
60. Hill GD, Ginde S, Rios R, Frommelt PC, Hill KD. Surgical valvotomy versus balloon valvuloplasty for congenital aortic valve stenosis: a systematic review and meta-analysis. J Am Heart Assoc. 2016;5(6):e003931.
61. Kalangos A, Myers PO. Aortic cusp extension for surgical correction of rheumatic aortic valve insufficiency in children. World J Pediatr Congenit Heart Surg. 2013;4(4):385–91. doi:10.1177/2150135113498785
62. Jonas RA. Aortic valve repair for congenital and balloon-induced aortic regurgitation. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2010;13(1):60–5.

63. Bacha EA, Satou GM, Moran AM, et al. Valve-sparing operation for balloon-induced aortic regurgitation in congenital aortic stenosis. J Thorac Cardiovasc Surg. 2001;122:162–8.
64. Schäfers HJ, Bierbach B, Aicher D. A new approach to the assessment of aortic cusp geometry. J Thorac Cardiovasc Surg. 2006;132:436–8.
65. Sengupta A, Beroukhim R, Baird CW, et al. Outcomes of repair of congenital aortic valve lesions using autologous pericardium vs porcine intestinal submucosa. J Am Coll Cardiol. 2022;80:1060–8.
66. Hu K, Siddiqi U, Lee B, et al. Pediatric aortic valve repair: any development in the material for cusp extension valvuloplasty? J Card Surg. 2021;36:4054–60.
67. Matsushima S, Heß A, Lämmerzahl JR, Karliova I, Abdul-Khaliq H, Schäfers HJ. Unicuspid aortic valve repair with bicuspidization in the paediatric population. Eur J Cardiothorac Surg. 2021;59:253–61.
68. Myers PO, Tissot C, Christenson JT, Cikirikcioglu M, Aggoun Y, Kalangos A. Aortic valve repair by cusp extension for rheumatic aortic insufficiency in children: long-term results and impact of extension material. J Thorac Cardiovasc Surg. 2010;140:836–44.
69. Halees ZA, Shahid MA, Sanei AA, Sallehuddin A, Duran C. Up to 16 years follow-up of aortic valve reconstruction with pericardium: a stentless readily available cheap valve? Eur J Cardiothorac Surg. 2005;28:200–5.
70. Bianchi G. Autologous pericardium is superior to conventional bovine patch in congenital heart disease reconstructive surgery: an appraisal for tissueengineered xenograft [eComment]. Interact Cardiovasc Thorac Surg. 2013;17:702-3.
71. Jiang WJ, Cui YC, Li JH, et al. Is autologous or heterologous pericardium better for valvuloplasty? A comparative study of calcification propensity. Tex Heart Inst J. 2015;42:202-8.
72. Chiu P, Higgins HA, Baird CW. State of the art review: Aortic valve repair in infants and children. Ann Thorac Surg. 2025 Mar;119(3):697-707. doi: 10.1016/j.athoracsur.2024.07.043. Epub 2024 Aug 22. PMID: 39178932.
73. Schäfers HJ, Langer F, Glombitza P, Kunihara T, Fries R, Aicher D. Aortic valve reconstruction in myxomatous degeneration of aortic valves: are fenestrations a risk factor for repair failure? J Thorac Cardiovasc Surg. 2010;139:660-4.
74. Tamer S, Mastrobuoni S, Van Dyck M, et al. Free margin length and geometric height in aortic root dilatation and leaflet prolapse: implications for aortic valve repair surgery. Eur J Cardiothorac Surg. 2020;57:124-32.
75. Dudkiewicz D, Zhingre Sanchez JD, Hołda J, et al. Aortic valve fenestrations: macroscopic assessment and functional anatomy study. Clin Anat. 2023;36:612-7.
76. Miller DC. Reprint of: Rationale and results of the Stanford modification of the David V reimplantation technique for valve-sparing aortic root replacement. J Thorac Cardiovasc Surg. 2015;149:S18-20.
77. Langer F, Graeter T, Nikoloudakis N, Aicher D, Wendler O, Schäfers HJ. Valve-preserving aortic replacement: does the additional repair of leaflet prolapse adversely affect the results? J Thorac Cardiovasc Surg. 2001;122:270-7.
78. Trusler GA, Williams WG, Smallhorn JF, Freedom RM. Late results after repair of aortic insufficiency associated with ventricular septal defect. J Thorac Cardiovasc Surg. 1992;103:276-81.
79. Svensson LG. The art of aortic valve repair. JTCVS Tech. 2021;7:121-5.
80. Cameron DE, Vricella LA. Valve-sparing aortic root replacement in Marfan syndrome. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2005;8:103-11.
81. Cosgrove DM, Rosenkranz ER, Hendren WG, Bartlett JC, Stewart WJ. Valvuloplasty for aortic insufficiency. J Thorac Cardiovasc Surg. 1991;102:571-7.
82. de Kerchove L, Boodhwani M, Glineur D, Poncelet A, Rubay J, Watremez C, Vanoverschelde JL, Noirhomme P, El Khoury G. Cusp prolapse repair in trileaflet aortic valves: free margin plication and free margin resuspension techniques. Ann Thorac Surg. 2009 Aug;88(2):455-61; discussion 461. doi: 10.1016/j.athoracsur.2009.04.064. PMID: 19632393.
83. de Kerchove L, Glineur D, Poncelet A, Boodhwani M, Rubay J, Dhoore W, Noirhomme P, El Khoury G. Repair of aortic leaflet prolapse: a ten-year experience. Eur J Cardiothorac Surg. 2008 Oct;34(4):785-91. doi: 10.1016/j.ejcts.2008.06.030. Epub 2008 Jul 26. PMID: 18657983.
84. Carlson L, Pickard S, Gauvreau K, et al. Preoperative factors that predict recurrence after repair of discrete subaortic stenosis. Ann Thorac Surg. 2021;111:1613-9.
85. Wallace FRO, Buratto E, Naimo PS, et al. Aortic valve repair in children without use of a patch. J Thorac Cardiovasc Surg. 2021;162:1179-89.e3.
86. Baumgartner F, Pearsall P, Omari K, Robertson J. Aortic and mitral annular remodeling using ultrasonic decalcification. Herz. 1996;21:179-82.
87. Kellner HJ, Pracki P, Hildebrandt A, Binner C, Eisele G, Struck E. Aortic valve debridement by ultrasonic surgical aspirator in degenerative, aortic valve stenosis: follow-up with Doppler echocardiography. Eur J Cardiothorac Surg. 1996;10:498-504.
88. Duran CG. Reconstructive techniques for rheumatic aortic valve disease. J Card Surg. 1988;3:23-8.
89. Cosgrove DM, Rosenkranz ER, Hendren WG, Bartlett JC, Stewart WJ. Valvuloplasty for aortic insufficiency. J Thorac Cardiovasc Surg. 1991;102:571-7.
90. Siddiqui J, Brizard CP, Galati JC, et al. Surgical valvotomy and repair for neonatal and infant congenital aortic stenosis achieves better results than interventional catheterization. J Am Coll Cardiol. 2013;62:2134-40.
91. Matsushima S, Heß A, Lämmerzahl JR, Karliova I, Abdul-Khaliq H, Schäfers HJ. Unicuspid aortic valve repair with bicuspidization in the paediatric population. Eur J Cardiothorac Surg. 2021;59:253-61.
92. Igarashi T, Matsushima S, Shimizu A, Ehrlich T, Karliova I, Schäfers HJ. Bicuspidization and annuloplasty provide a functioning configuration to the unicuspid aortic valve. Ann Thorac Surg. 2020;110:111-9.
93. Jahanyar J, El Khoury G, de Kerchove L. Commissural geometry and cusp fusion insights to guide bicuspid aortic valve repair. JTCVS Tech. 2021;7:83-92.
94. Schulz A, Buratto E, Wallace FRO, et al. Outcomes of aortic valve repair in children resulting in bicuspid anatomy: is there a need for tricuspidization? J Thorac Cardiovasc Surg. 2022;164:186-96.e2.
95. Chiu P, Chavez M, Zubair MM, et al. Symmetric bicuspidizing repair for patients with congenital aortic or truncal valve disease. J Thorac Cardiovasc Surg. 2023;166:283-91.

96. Myers JL, Clark JB, James TW, et al. Use of aortic wall patches as leaflet replacement material during aortic valve repair. JTCVS Tech. 2023;19:30-7.
97. Everitt MD, Pinto N, Hawkins JA, Mitchell MB, Kouretas PC, Yetman AT. Cardiovascular surgery in children with Marfan syndrome or Loeys-Dietz syndrome. J Thorac Cardiovasc Surg. 2009;137(6):1327-32; discussion 1332-3. doi:10.1016/j.jtcvs.2009.02.007.
98. Buratto E, Konstantinov IE. Valve-sparing aortic root surgery in children and adults with congenital heart disease. J Thorac Cardiovasc Surg. 2021;162(3):955-62.
99. Chiu P, Chavez M, Zubair MM, et al. Symmetric bicuspidizing repair for patients with congenital aortic or truncal valve disease. J Thorac Cardiovasc Surg. 2023;166:283-91.
100. Schneider U, Hofmann C, Aicher D, Takahashi H, Miura Y, Schäfers HJ. Suture annuloplasty significantly improves the durability of bicuspid aortic valve repair. Ann Thorac Surg. 2017;103:504-10.
101. Igarashi T, Matsushima S, Shimizu A, Ehrlich T, Karliova I, Schäfers HJ. Bicuspidization and annuloplasty provide a functioning configuration to the unicuspid aortic valve. Ann Thorac Surg. 2020;110(1):111-9.
102. Drysdale ND, Andersen ND, Meza JM, Lodge AJ, Rankin JS, Turek JW. Initial application of a bicuspid aortic annuloplasty ring in pediatric cardiac surgery. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2020;23:29-33.
103. Lancaster TS, Romano JC, Si MS, Ohye RG. Aortic valve repair using geometric ring annuloplasty in pediatric and congenital heart disease patients. J Thorac Cardiovasc Surg. 2023;166:294-303.
104. Si MS, Conte JV, Romano JC, et al. Unicuspid aortic valve repair using geometric ring annuloplasty. Ann Thorac Surg. 2021;111:1359-66.
105. Mazzitelli D, Fischlein T, Rankin JS, Choi YH, Stamm C, Pfeiffer S, et al. Geometric ring annuloplasty as an adjunct to aortic valve repair: clinical investigation of the HAART 300 device. Eur J Cardiothorac Surg. 2016;49:987-93.
106. Konstantinov IE, Zubritskiy A. Do we all need to learn aortic valve repair the HAART way? J Thorac Cardiovasc Surg. 2024;167(3):e74-e75.
107. Lansac E, et al. Remodeling root repair with an external aortic ring annuloplasty. J Thorac Cardiovasc Surg. 2017;153(5):1033-42.
108. Russell HM, Mavroudis CD, Backer CL, Mavroudis C. Long-term follow-up after truncal valve repair. Cardiol Young. 2012;22:718-23.
109. Konstantinov IE, Perrier SL, Naimo PS, d'Udekem Y. Neonatal quadricuspid truncal valve repair with left coronary artery unroofing. J Thorac Cardiovasc Surg. 2019;157:710-1.
110. David TE, Feindel CM. An aortic valve-sparing operation for patients with aortic incompetence and aneurysm of the ascending aorta. J Thorac Cardiovasc Surg. 1992;103:617-21.
111. Sarsam MA, Yacoub M. Remodeling of the aortic valve anulus. J Thorac Cardiovasc Surg. 1993;105:435-8.
112. Myers PO, del Nido PJ, Emani SM, Marx GR, Baird CW. Valve-sparing aortic root replacement and remodeling with complex aortic valve reconstruction in children and young adults with moderate or severe aortic regurgitation. J Thorac Cardiovasc Surg. 2014;147:1768-74.
113. Leyh RG, Schmidtke C, Sievers HH, Yacoub MH. Opening and closing characteristics of the aortic valve after different types of valve-preserving surgery. Circulation. 1999;100:2153-60.
114. Lansac E, Lim HS, Shomura Y, Lim KH, Rice NT, Goetz W, et al. A four-dimensional study of the aortic root dynamics. Eur J Cardiothorac Surg. 2002;22:497-503.
115. Matsushima S, Karliova I, Gauer S, Miyahara S, Schäfers HJ. Geometry of cusp and root determines aortic valve function. Indian J Thorac Cardiovasc Surg. 2019. doi:10.1007/s12055-019-00813-2.
116. Le Polain de Waroux JB, Pouleur AC, Robert A, Pasquet A, Gerber BL, Noirhomme P, et al. Mechanisms of recurrent aortic regurgitation after aortic valve repair: predictive value of intraoperative transesophageal echocardiography. JACC Cardiovasc Imaging. 2009;2:931-9.
117. Kisamori E, Kotani Y, Suzuki H, Kasahara S. Sinus plication technique for neoaorta dilation and regurgitation in patients with repaired congenital heart diseases. Eur J Cardiothorac Surg. 2022;62:ezac456.
118. Boodhwani M, de Kerchove L, Glineur D, et al. Repair-oriented classification of aortic insufficiency: impact on surgical techniques and clinical outcomes. J Thorac Cardiovasc Surg. 2009;137:286-94.
119. Tan CW, Marathe SP, Kwon MH, et al. Ascending aortoplasty in pediatric patients undergoing aortic valve procedures. Ann Thorac Surg. 2021;112:855-61.
120. Shraer N, Youssefi P, Zacek P, Debauchez M, Leprince P, Raisky O, Lansac E. Bicuspid valve repair outcomes are improved with reduction and stabilization of sinotubular junction and annulus with external annuloplasty. J Thorac Cardiovasc Surg. 2024 Jul;168(1):60-73.e6. doi: 10.1016/j.jtcvs.2022.11.021. Epub 2022 Nov 25. PMID: 36535821.
121. Ozaki S, Kawase I, Yamashita H, et al. Aortic valve reconstruction using self-developed aortic valve plasty system in aortic valve disease. Interact Cardiovasc Thorac Surg. 2011;12:550-3.
122. Baird CW, Cooney B, Chavez M, Sleeper LA, Marx GR, del Nido PJ. Congenital aortic and truncal valve reconstruction using the Ozaki technique: short-term clinical results. J Thorac Cardiovasc Surg. 2021;161:1567-73.
123. Wiggins LM, Mimic B, Issitt R, et al. The utility of aortic valve leaflet reconstruction techniques in children and young adults. J Thorac Cardiovasc Surg. 2020;159:2369-78.
124. Çiçek M, Özdemir F. Aortic valve neocuspidization with the Ozaki procedure in congenital aortic valve disease: Early results. Turk Gogus Kalp Damar Cerrahisi Derg. 2023 Oct 19;31(4):431-439. doi: 10.5606/tgkdc.dergisi.2023.25537. PMID: 38075996; PMCID: PMC10704538.
125. Chivers SC, Pavy C, Vaja R, Quarto C, Ghez O, Daubeney PEF. The Ozaki procedure with CardioCel patch for children and young adults with aortic valve disease: preliminary experience and a word of caution. World J Pediatr Congenit Heart Surg. 2019;10:724-30.
126. Marathe SP, Chavez M, Sleeper LA, et al. Single-leaflet aortic valve reconstruction utilizing the Ozaki technique in patients with congenital aortic valve disease. Semin Thorac Cardiovasc Surg. 2022;34:1262-72.

127. Marathe SP, Chavez M, Sleeper LA, Marx G, del Nido PJ, Baird CW. Modified Ozaki procedure including annular enlargement for small aortic annuli in young patients. Ann Thorac Surg. 2020;110:1364-71.
128. Myers PO, Mokashi SA, Horgan E, et al. Outcomes after mechanical aortic valve replacement in children and young adults with congenital heart disease. J Thorac Cardiovasc Surg. 2019;157:329-40.
129. Fuller SM, Borisuk MJ, Sleeper LA, et al. Mortality and reoperation risk after bioprosthetic aortic valve replacement in young adults with congenital heart disease. Semin Thorac Cardiovasc Surg. 2022;33:1081-92.
130. Donald N Ross. Replacement of aortic and mitral valves with a pulmonary autograft. Lancet. 1967;290:956-8.
131. Zhu MZL, Konstantinov IE, Wu DM, Wallace FRO, Brizard CP, Buratto E. Aortic valve repair versus the Ross procedure in children. J Thorac Cardiovasc Surg. 2023 Nov;166(5):1279-88.e1. doi: 10.1016/j.jtcvs.2023.03.028. Epub 2023 May 9. PMID: 37169064.
132. Redondo A, Austin C. Our 7-year experience supporting the Ross autograft with the novel technique of Personalized external Aortic Root Support. JTCVS Tech. 2024;24:121-7.
133. Skillington PD, Mokhles MM, Takkenberg JJM, et al. The Ross procedure using autologous support of the pulmonary autograft: techniques and late results. J Thorac Cardiovasc Surg. 2015;149:S46-52.
134. Jacobsen RM, Earing MG, Hill GD, et al. The externally supported Ross operation: early outcomes and intermediate follow-up. Ann Thorac Surg. 2015;100:631-8.
135. Buratto E, Konstantinov IE. Commentary: aortic valve surgery in children: repair now, Ross procedure later. J Thorac Cardiovasc Surg. 2022;163:1193-9.
136. Danial P, Naily A, Pontailler M, et al. Ross procedure or complex aortic valve repair using pericardium in children: A real dilemma. J Thorac Cardiovasc Surg. 2022;163:1180-91.e6.
137. Hraska V, Mitchell ME, Woods RK. Roadmap for Ross procedure: Staged strategy. J Thorac Cardiovasc Surg. 2022 Feb;163(2):379-82. doi: 10.1016/j.jtcvs.2020.12.141. Epub 2021 Jan 13. PMID: 33581898.



ROSS OPERASYONU

BÖLÜM
43

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İçindekiler

» GİRİŞ
» TARİHÇE:
» HASTA SEÇİMİ
» CERRAHİ TEKNİK:
  » Pulmoner otogreftlere PEARS (The personalized external aortic root support)
» ERKEN DÖNEM SONUÇLARI
  » Takip ve geç dönem sonuçları

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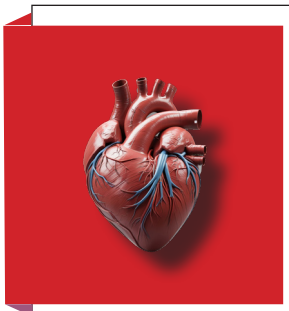
KAYNAKLAR

1. Takkenberg JJ, Klieverik LM, Schoof PH, van Suylen RJ, van Herwerden LA, Zondervan PE, Roos-Hesselink JW, Eijkemans MJ, Yacoub MH, Bogers AJ. The Ross procedure: A systematic review and meta-analysis. *Circulation*. 2009;119:222–228.
2. Sharabiani MT, Dorobantu DM, Mahani AS, Turner M, Tometzki AJP, Angelini GD, Parry AJ, Caputo M, Stoica SC. Aortic valve replacement and the Ross operation in children and young adults. *J Am Coll Cardiol*. 2016;67:2858–2870.
3. Otto CM, Nishimura RA, Bonow RO, Carabello BA, Gentile F, Jneid H, Krieger EV, Mack M, McLeod C, O'Gara PT, et al. 2020 ACC/AHA Guideline for the Management of Patients with Valvular Heart Disease: Executive Summary. *Circulation*.
4. Vahanian A, Beyersdorf F, Praz F, Milojevic M, Baldus S, Bauersachs J, et al. 2021 ESC/EACTS Guidelines for the management of valvular heart disease. *Eur Heart J*. 2022;43:561–632.
5. Bilodeau KS, Mauchley DC, DeRoo S, Burke CR. *The Cardiothoracic Surgeon*. 2023;31:28.
6. Mookhoek A, Charitos EI, Hazekamp MG, Bogers AJ, Hörer J, Lange R, et al. Ross procedure in neonates and infants: A European multicenter experience. *Ann Thorac Surg*. 2015;100:2278–2284.
7. Ross D. Replacement of aortic and mitral valves with a pulmonary autograft. *Lancet*. 1967;2:956–958.
8. El-Hamamsy I, Eryigit Z, Stevens LM, Sarang Z, George R, Clark L, et al. Long-term outcomes after autograft vs homograft aortic root replacement. *Lancet*. 2010;376:524–531.
9. Elkins RC, Thompson DM, Lane MM, Elkins CC, Peyton MD. Ross operation: 16-year experience. *J Thorac Cardiovasc Surg*. 2008;136:623–630.e5.
10. Stelzer P. The Ross procedure: State of the art 2011. *Semin Thorac Cardiovasc Surg*. 2011;23:115–123.
11. Bilal MS, Aydemir NA, Cine N, Turan T, Yildiz Y, Yalcin Y, Celebi A. Medtronic Freestyle valve in the Ross procedure. *J Heart Valve Dis*. 2006;15(5):696–701.
12. Bilal MS, Aydemir NA, Turan T. Ross-Konno and ostial plasty in homozygous hypercholesterolemia. *J Heart Valve Dis*. 2005;14(6):855–858.
13. Bilal MS, Yerebakan C, Karaci AR, Eren M. Ross-Konno for prosthesis-patient mismatch. *J Card Surg*. 2013;28(6):666–669.
14. Ouzounian M, Mazine A, David TE. Ross procedure in aortic stenosis of young adults. *J Thorac Cardiovasc Surg*. 2017;154:778–782.
15. Williams EE, El-Hamamsy I. The Ross Procedure. *Oper Tech Thorac Cardiovasc Surg*. 2014;26:189–209.
16. Al-Halees Z, Kumar N, Gallo R, Gometza B, Duran CM. Pulmonary autograft in rheumatic disease. *Ann Thorac Surg*. 1995;60(Suppl 2):S172–S176.
17. Chauvette V, Lefebvre L, Chamberland M, Williams EE, El-Hamamsy I. Review of the Ross procedure. *Struct Heart*. 2021;5:11–23.
18. *J Am Coll Cardiol*. 2021;77(11):1412–1422.
19. David TE. Long-term outcomes of the Ross procedure. *J Thorac Cardiovasc Surg*. 2019;157(1).
20. Pepper J, et al. The Ross procedure. *J Thorac Cardiovasc Surg*. 2024 Jul 13.
21. Nappi F, Nassif A, Schoell T. External scaffold for autograft in Ross procedure. *Biomimetics*. 2024;9:674.
22. Bouhot I. Ross procedure outcomes. *Eur J Cardiothorac Surg*. 2019;56(5):959–967.
23. Konstantinov IE, Bacha E, Barron D, et al. Optimal timing of Ross operation in children. *J Thorac Cardiovasc Surg*. 2024;168:1310–1320.
24. Stelzer P, Mejia J, Varghese R. Operative risks of the Ross procedure. *J Thorac Cardiovasc Surg*. 2021;161:905–915.e3.
25. Rajab TK, Zorrilla-Vaca A, Kavarana MN, et al. Ross operation in neonates: Meta-analysis. *Ann Thorac Surg*. 2022;113:192–199.
26. Multi-institutional analysis of Ross procedure in neonates. *J Thorac Cardiovasc Surg*. 2024;168(6):1720–1730.e3.
27. Ryan WH, Squiers JJ, Harrington KB, et al. Long-term outcomes in adults. *Ann Cardiothorac Surg*. 2021;10:499–508.
28. El-Hamamsy I, Toyoda N, Itagaki S, et al. Ross vs prosthetic AVR in adults. *J Am Coll Cardiol*. 2022;79(8).
29. Network meta-analysis: Ross vs mechanical vs bioprosthetic AVR. *J Am Heart Assoc*. 2023;12:e027715.
30. Mazine A, David TE, Stoklosa K, et al. Improved outcomes after Ross procedure. *J Am Coll Cardiol*. 2022;79(10).
31. Ross procedure offers survival benefit. *Eur J Cardiothorac Surg*. 2022;61:1357–1365.
32. Autograft reoperation strategies post-Ross. *World J Pediatr Congenit Heart Surg*. 2024;15(5):571–580.
33. Autograft reoperations after Ross procedure. *Eur J Cardiothorac Surg*. 2023;63(5):ezad117.
34. Chauvette V, Bouhout I, Tarabzoni M, et al. Pulmonary homograft dysfunction post-Ross. *J Thorac Cardiovasc Surg*. 2020;160(4):959–967.
35. Rowe G, Gill G, Zubair MM, et al. Ross procedure in children: STS database analysis. *Ann Thorac Surg*. 2023;115:119–125



İNTERRUPTED (KESİNTİLİ) AORTİK ARK

BÖLÜM
44

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İçindekiler

- GİRİŞ
- TARİHİ GELİŞİMİ
- SINIFLANDIRMA
- ANATOMİ
- EŞLİK EDEN KARDİYAK VE DİĞER ANOMALİLER
- FİZYOLOJİ
- KLİNİK ÖZELLİKLER
- TANI
- MEDİKAL TEDAVİ
- PREOPERATİF STRATEJİ
- SOL VENTRİKÜL ÇIKIŞ YOLU (LVOT) DARLIĞININ BELİRLENMESİ
- CERRAHİ TEDAVİ
- VSD KAPATILMASI
- SOL VENTRİKÜL ÇIKIŞ YOLU DARLIĞINDA (LVOTO) YAKLAŞIM
  - Örnek vaka 1: Interruption Tip B, VSD ve Hipoplastik Aort
  - Örnek vaka 2: IAA Tip-C ve Aberran Sağ Subklavian Arter
- IAA İLE BİRLİKTE DİĞER ANOMALİLER
- POSTOPERATİF BAKIM
- ERKEN POSTOPERATİF KOMPLİKASYONLAR
- GEÇ KOMPLİKASYONLAR
- MORTALİTE

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%91.7 olarak bulunmuş ve kademeli operasyonun komplike vakalarda bir avantaj olduğu ve bu vakalarda son yıllarda kademeli operasyonu daha çok kullandıklarını belirtmişlerdir (68). Yüksek riskli ve kompleks kardiak anomalilerin (sol ventrikül çıkış yolu darlığı gibi) eşlik ettiği olgularda mortaliteyi düşürmek için kademeli operasyon son yıllarda önerilmektedir (69). 2004-2019 arasında 1283 IAA vakasını içeren bir database çalışmasında DiGeorge sendromunun (22q11.2 deletion) eşlik etmesinin hastane komplikasyonunu (sepsis, gastrostomi tüpü yerleştirilmesi) arttırdığı gösterilmiştir (70).

20 yıl öncesinde kullanım alanı bulan greft interpozisyonunun takiplerinde çoğunun tekrar müdahale gerektirdiği ve 16 yıllık takiplerinde çoğunun öldüğü saptanmıştır (9). IAA tamiri sırasında ne zaman LVOT darlığına müdahale edileceği tartışmalı bir konu olduğu ve yine bu patolojide ne tip bir girişimde bulunulacağı cerrahi tekniğin anlatıldığı kısımda tartışılmıştı. LVOT darlık için miyotomi ve miyektomi uygulanması sonuçları klinikler arasında çok farklı sonuçları ortaya koymuştur. Bu tekniği geliştiren Michigan Üniversitesi serisinde erken mortalitenin %13 olduğu bildirilirken, bu 15 hastanın 6'sına 9 reoperasyon ortalama 5,4 yıllık takipte gerektiğini belirtmiştir (43). Buna karşılık Serraf ve ark. (37) ise infundibular septuma miyektomi sonrası yüksek mortalite (%80) bildirmişlerdir.

Tablo 1: Interrupted (kesintili) Aortik Ark Sınıflaması

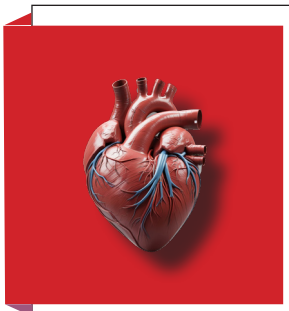
Tip	Lokalizasyonu
A	Kesinti sol subklavian arterin distalinde
B	Kesinti sol karotis ile sol subklavian arasında
C	Kesinti innominat arter ile sol karotis arasında

KAYNAKLAR

1. Collins-Nakai RL, Dick M, Parisi-Buckley L, et al. Interrupted aortic arch in infancy. J Pediatr 1976;88:959–62.
2. Fyler D, Buckley D, Hellendrand W et al. Report of the New England Regional Infant Cardiac Program. Pediatrics 1980;65:375–461.
3. Van Praagh R, Bernhard WF, Rosenthal A, et al: Interrupted aortic arch: Surgical treatment. Am J Cardiol 1971;27:200-11.
4. Elliott RB, Starling MB, Neutze JM: Medical manipulation of the ductus arteriosus. Lancet 1975;1:140-2.
5. DiGeorge AM. Discussions on a new concept of the cellular basis of immunology. J Pediatr 1965; 67: 907.
6. Barratt-Boyes BG, Nicholls N, Brandt PW, et al: Aortic arch interruption associated with patent ductus arteriosus, ventricular septal defect, and total anomalous pulmonary venous connection. J Thorac Cardiovasc Surg 1972;63:367-73.
7. Trusler GA, Izukawa T. Interrupted aortic arch and ventricular septal defect. Direct repair through a median sternotomy incision in a 13-day-old infant. J Thorac Cardiovasc Surg 1975;69:126.
8. Celoria GC, Patton RB. Congenital absence of the aortic arch. Am Heart J 1959;58:407.
9. McCrindle BW, Tchervenkov CI, Konstantinov IE, Williams WG, Neirotti RA, Jacobs ML, et al. Risk factors associated with mortality and interventions in 472 neonates with interrupted aortic arch: a Congenital Heart Surgeons Society study. J Thorac Cardiovasc Surg 2005;129:343-50.
10. Dische MR, Tsai M, Baltaxe HA: Solitary interruption of the arch of the aorta: Clinicopathologic review of eight cases. Am J Cardiol 35:271-7,1975.
11. Oppenheimer-Dekker A, Gittenberger-de Groot AC, Roozendaal H: The ductus arteriosus and associated cardiac anomalies in interruption of the aortic arch. Ped Cardiol 1982;2:185-93.
12. Jonas RA, Quaegebeur JM, Kirklin JW, et al: Outcomes in patients with interrupted aortic arch and ventricular septal defect. A multiinstitutional study. Congenital Heart Surgeons Society. J Thorac Cardiovasc Surg 1994;107:1099-113.
13. Freedom RM, Bain HH, Esplugas E et al. Ventricular septal defect in interruption of aortic arch. Am J Cardiol 1977;39:572–82.
14. Ho SY, Wilcox BR, Anderson RH, Lincoln JC. Interrupted aortic arch – anatomical features of surgical significance. Thorac Cardiovasc Surg 1983;31:199–205.
15. Freedom RM, Yoo SJ. Interruption of the Aortic Arch. In: Freedom RM, Yoo SJ, Mikailian H, Williams WG editors. The Natural and Modified History of Congenital Heart Disease. New York: Blackwell Publishing, Inc./Futura Division 2004. p. 276-81.
16. Moulaert AJ, Oppenheimer-Dekker A. Anterolateral muscle bundles of the left ventricle, bulboventricular flange, and subaortic stenosis. Am J Cardiol 1976;37:78–81.
17. Jonas RA. Management of Interrupted Aortic Arch. Semin Thorac Cardiovasc Surg. 2015;27:177-88.
18. Freedom RM, Rosen FS, Nadas AS. Congenital cardiovascular disease and anomalies of the third and fourth pharyngeal pouch. Circulation 1972; 46: 165–72.
19. Van Mierop LHS, Kutsche LM. Interruption of the aor-

tic arch and coarctation of the aorta: pathogenetic relations. Am J Cardiol 1984; 54: 829–34.
20. Van Mierop LHS, Kutsche LM. Cardiovascular anomalies in DiGeorge syndrome and importance of neural crest as a possible pathogenic factor. Am J Cardiol 1986; 58: 133–7.
21. Freedom RM, Moes CAF, Pelech A et al. Bilateral ductus arteriosus (or Remnant): an analysis of 27 patients. Am J Cardiol 1984; 53: 884–91.
22. Ma JS, Choe G, Hwang TJ, Oh BS, Nam JH. Anomalous origin of the left anterior descending coronary artery from the pulmonary trunk associated with type B interrupted aortic arch. Pediatr Cardiol 1994;15: 143–5.
23. Chu MWA, Jutras LF, Tchervenkov CI. Neonatal repair of right interrupted aortic arch, aberrant left subclavian artery, ventricular septal defect and retroaortic innominate vein. Eur J Cardiothorac Surg 2007;31:555–7.
24. Zhang D, Zhang Y, Ren W, Sun F, Guo Y, Sun W, Wang Y, Huang L, Cai A. Prenatal Diagnosis of Fetal Interrupted Aortic Arch Type A by Two-Dimensional Echocardiography and Four-Dimensional Echocardiography with B-Flow Imaging and Spatiotemporal Image Correlation. Echocardiography. 2016;33:90-8.
25. Vogel M, Vernon MM, McElhinney DB, Brown DW, Colan SD, Tworetzky W. Fetal diagnosis of interrupted aortic arch. Am J Cardiol. 2010;105:727-34.
26. Chaoui R, Kalache KD, Heling KS, Tennstedt C, Bommer C, Körner H. Absent or hypoplastic thymus on ultrasound: a marker for deletion 22q11.2 in fetal cardiac defects. Ultrasound Obstet Gynecol 2002;20:546-52.
27. Lewin MB, Lindsay EA, Jurecic V et al. A genetic etiology for interruption of the aortic arch type B. Am J Cardiol 1997;80:493–7.
28. Portnoï MF, Joyé N, Gonzales M, Demczuk S, Fermont L, Gaillard G, Bercau G, Morlier G, Taillemite JL. Prenatal diagnosis by FISH of a 22q11 deletion in two families. J Med Genet 1998;35:165-8.
29. Yasui H, Kado H, Nakano E, Yonenaga K, Mitani A, Tomita Y, Iwao H, Yoshii K, Mizoguchi Y, Sunagawa H. Primary repair of interrupted aortic arch and severe aortic stenosis in neonates.J Thorac Cardiovasc Surg. 1987;93:539-45.
30. Fulton JO, Mas C, Brizard CPR, et al: Does left ventricular outflow tract obstruction influence outcome of interrupted aortic arch repair? Ann Thorac Surg 1999;67:177-81.
31. Schreiber C, Eicken A, Vogt M, Günther T, Wottke M, Thielmann M, Paek SU, Meisner H, Hess J, Lange R. Repair of interrupted aortic arch: results after more than 20 years. Ann Thorac Surg. 2000;70:1896-9.
32. Geva T, Hornberger LK, Sanders SP, et al: Echocardiographic predictors of left ventricular outflow tract obstruction after repair of interrupted aortic arch. J Am Coll Cardiol 1993;22:1953-60.
33. Ilbawi MN, Idriss FS, DeLeon SY, Muster AJ, Benson DW Jr, Paul MH. Surgical management of patients with interrupted aortic arch and severe subaortic stenosis. Ann Thorac Surg. 1988;45:174-80.
34. Jonas RA. Comprehensive surgical management of congenital heart disease. 2nd ed. London: CRC Press; 2014.
35. Bove EL, Minich LL, Pridjian AK, Lupinetti FM, Snider AR, Dick M, et al. The management of severe subaortic stenosis, ventricular septal defect, and aortic arch obstruction in the neonate. J Thorac Cardiovasc Surg. 1993;105:289-96.
36. Minich LL, Snider AR, Bove EL, Lupinetti FM. Echocardiographic predictors of the need for infundibular wedge resection in infants with aortic arch obstruction, ventricular septal defect and subaortic stenosis. Am J Cardiol. 1992 15;70:1626-7.
37. Serraf A, Lacour-Gayet F, Robotin M, Bruniaux J, Sousa-Uva M, Roussin R, Planche C. Repair of interrupted aortic arch: a ten-year experience. J Thorac Cardiovasc Surg 1996;112:1150-60.
38. Tchervenkov CI, Jacobs JP, Sharma K, Ungerleider RM. Interrupted aortic arch: surgical decision making. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2005:8;92-102.
39. Apfel HD, Levenbraun J, Quaegebeur JM, Allan LD. Usefulness of preoperative echocardiography in predicting left ventricular outflow obstruction after primary repair of interrupted aortic arch with ventricular septal defect. Am J Cardiol. 1998;15;82:470-3.
40. Bacha EA, Sawaqed R. Use of the aberrant right subclavian artery in complex aortic arch reconstruction. Ann Thorac Surg. 2007;83:1566-8.
41. Todman SH, Eltayeb O, Ruzmetov M, Rodefeld MD, Turrentine MW, Brown JW, et al. Outcomes of interrupted aortic arch repair using the carotid artery turndown procedure. J Thorac Cardiovasc Surg. 2013;145:176-82.
42. Menahem S, Brawn WJ, Mee RB. Severe subaortic stenosis in interrupted aortic arch in infancy and childhood. J Card Surg. 1991;6:373-80.
43. Suzuki T1, Ohye RG, Devaney EJ, Ishizaka T, Nathan PN, Goldberg CS, Gomez CA, Bove EL. Selective management of the left ventricular outflow tract for repair of interrupted aortic arch with ventricular septal defect: management of left ventricular outflow tract obstruction. J Thorac Cardiovasc Surg. 2006;131:779-84.
44. Luciani GB, Ackerman RJ, Chang AC, et al. One-stage repair of interrupted aortic arch, ventricular septal defect, and subaortic obstruction in the neonate: a novel approach. J Thorac Cardiovasc Surg 1996;111:348-58.
45. Nathan M, Rimmer D, del Nido PJ, et al. Aortic atresia or severe left ventricular outflow tract obstruction with ventricular septal defect: results of primary biventricular repair in neonates. Ann Thorac Surg 2006;82:2227-32.
46. Moorthy PS, McGuirk SP, Jones TJ, Brawn WJ, Barron DJ. Damus-Rastelli procedure for biventricular repair of aortic atresia and hypoplasia. Ann Thorac Surg 2007;84:142-6.
47. Kanter KR, Kirshbom PM, Kogon BE. Biventricular repair with the Yasui operation (Norwood/Rastelli) for systemic outflow tract obstruction with two adequate ventricles. Ann Thorac Surg. 2012;93:1999-2005.
48. Ohye RG, Kagisaki K, Lee LA, Mosca RS, Goldberg CS, Bove EL. Biventricular repair for aortic atresia or hypoplasia and ventricular septal defect. J Thorac Cardiovasc Surg 1999;118:648–53.
49. Erez E, Tam VK, Kanter KR, Fyfe DA. Successful biventricular repair after initial Norwood operation for interrupted aortic arch with severe left ventricular outflow tract obstruction. Ann Thorac Surg. 2001;71:1974-7.
50. Matitiau A, Geva T, Colan SD, Sluysmans T, Parness IA, Spevak PJ, Van Der Velde M, Mayer JE Jr, Sanders SP. Bulboventricular foramen size in infants with

double-inlet left ventricle or tricuspid atresia with transposed great arteries: influence on initial palliative operation and rate of growth. J Am Coll Cardiol. 1992;19:142-8.
51. Türköz A, Tunçay E, Balci ŞT, Can MG, Altun D, Türköz R, Ündar A. The effect of modified ultrafiltration duration on pulmonary functions and hemodynamics in newborns and infants following arterial switch operation. Pediatr Crit Care Med. 2014;15:600-7.
52. Sato S, Akiba T, Nakasato M, et al: Percutaneous balloon aortoplasty for restenosis after extended aortic arch anastomosis for type B interrupted aortic arch. Pediatr Cardiol 1996;17: 275-7.
53. Siblini G, Rao PS, Nouri S, et al: Long-term follow-up results of balloon angioplasty of postoperative aortic recoarctation. Am J Cardiol 1998;81:61-7.
54. Jegatheeswaran A, McCrindle BW, Blackstone EH, Jacobs ML, Lofland GK, Austin EH 3rd, et al. Persistent risk of subsequent procedures and mortality in patients after interrupted aortic arch repair: a Congenital Heart Surgeons Society study. J Thorac Cardiovasc Surg 2010;140:1059-75.
55. Hussein A, Iyengar AJ, Jones B, Donath SM, Konstantinov IE, Grigg LE, Wheaton G, Bullock A, Brizard CP, d'Udekem Y.Twenty-three years of single-stage end-to-side anastomosis repair of interrupted aortic arches. J Thorac Cardiovasc Surg. 2010;139:942-7.
56. Morales DL, Scully PT, Braud BE, Booth JH, Graves DE, Heinle JS, McKenzie ED, Fraser CD Jr. Interrupted aortic arch repair: aortic arch advancement without a patch minimizes arch reinterventions. Ann Thorac Surg. 2006;82:1577-83.
57. Roussin R, Belli E, Lacour-Gayet F: Aortic arch reconstruction with pulmonary autograft patch aortoplasty. J Thorac Cardiovasc Surg 2002;123: 443-50.
58. Salem MM, Starnes VA, Wells WJ, Acherman RJ, Chang RK, Luciani GB, Wong PC. Predictors of left ventricular outflow obstruction following single stage repair of interrupted aortic arch andventricular septal defect. Am J Cardiol. 2000;86:1044-7.
59. Chen PC, Cubberley AT, Reyes K, et al: Predictors of reintervention after repair of interrupted aortic arch with ventricular septal defect. Ann Thorac Surg 2013;96:621-8.
60. Ou P, Bonnet D, Auriacombe L, Pedroni E, Balleux F, Sidi D, Mousseaux E. Late systemic hypertension and aortic arch geometry after successful repair of coarctation of the aorta. Eur Heart J. 2004;25:1853-9.
61. Ou P, Mousseaux E, Celermajer DS, Pedroni E, Vouhe P, Sidi D, Bonnet D. Aortic arch shape deformation after coarctation surgery: effect on blood pressure response. J Thorac Cardiovasc Surg. 2006;132:1105-11.
62. Joynt CA, Robertson CM, Cheung PY, Nettel-Aguirre A, Joffe AR, Sauve RS, Biggs WS, Leonard NJ, Ross DB, Rebeyka IM; Western Canadian Complex Pediatric Therapies Follow-up Group. Two-year neurodevelopmental outcomes of infants undergoing neonatal cardiac surgery for interrupted aortic arch: a descriptive analysis. J Thorac Cardiovasc Surg. 2009;138:924-32.
63. Wypij D, Newburger JW, Rappaport LA, duPlessis AJ, Jonas RA, Wernovsky G, Lin M, Bellinger DC. The effect of duration of deep hypothermic circulatory arrest in infant heart surgery on late neurodevelopment: the Boston Circulatory Arrest Trial. J Thorac Cardiovasc Surg. 2003;126:1397-403.
64. Turkoz R, Saritas B, Ozker E, Vuran C, Yoruker U, Balci S, Altun D, Turkoz A. Selective cerebral perfusion with aortic cannulation and short-term hypothermic circulatory arrest in aortic arch reconstruction. Perfusion. 2014 ;29:70-4.
65. Brown JW, Ruzmetov M, Okada Y, Vijay P, Rodefeld MD, Turrentine MW. Outcomes in patients with interrupted aortic arch and associated anomalies: a 20-year experience. Eur J Cardiothorac Surg. 2006;29:666-73.
66. Andrianova EI, Naimo PS, Fricke TA, Robertson T, Bullock A, Brink J, d'Udekem Y, Brizard CP, Konstantinov IE. Outcomes of Interrupted Aortic Arch Repair in Children With Biventricular Circulation. Ann Thorac Surg. 2021;111:2050-8.
67. Miller JC, Velani RN, Miller WD, Thomas AS, Shaw FR, Kochilas L. Long-term Outcomes After Interrupted Aortic Arch Repair. Ann Thorac Surg. 2024;118:469-77.
68. Harada T, Ando Y, Nakano T. Outcomes of Surgical Interrupted Aortic Arch Repair in 181 Patients With Biventricular Circulation. Ann Thorac Surg. 2025;119:152-9.
69. Alsoufi B. Hybrid First-stage Palliation and Other Strategies to Achieve Biventricular Repair in High-Risk Neonates With Complex Heart Anomalies and Aortic Arch Obstruction. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2023;26:40-9.
70. Sanchez Mejia AA, Cambronero N, Dongarwar D, Salihu HM, Vigil-Mallette MA, Garcia BY, Morris SA. Hospital Outcomes Among Infants With Interrupted Aortic Arch With Simple and Complex Associated Heart Defects. Am J Cardiol. 2022;166:97-106.



TRUNKUS ARTERİOSUS

BÖLÜM
45

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İçindekiler

» GİRİŞ
» EMBRİYOLOJİ
» ANATOMİ
» EŞLİK EDEN PATOLOJİLER
» PATOFİZYOLOJİ
» KLİNİK PREZENTASYON VE TANI
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» CERRAHİ TEKNİK
» KESİNTİLİ AORTİK ARKLI TRUNKUS ARTERİOZUS ONARIMI
» TRUNKAL KAPAK YETERSİZLİĞİNDE CERRAHİ
» POSTOPERATİF BAKIM
» TAM DÜZELTME AMELİYATININ SONUÇLARI

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sinde ileri trunkal kapak yetersizliği mevcut olup 80 hastada sağ ventrikül – pulmoner arter devamlılığı kapaklı kondüit ile sağlanmış kalan 3 hastada başka bir yöntem kullanılmıştır. Eş zamanlı olarak aynı operasyonda 14 hastanın kesintili aortik arkusuna 8 hastanın trunkal kapağına müdahale edilmiştir. Genel mortalite % 23 (n=9) saptanmıştır. Bu hastaların % 69 u (n=57) 10.9 yıl boyunca takip edilmiş uzun dönem hasta takibiyle birlikte kondüit değişimi , trunkal kapak replasmanı , kateterle girişim ihtiyacı gözlemlenmiştir. Pulmoner homogreftler en uzun süre girişim ihtiyacı gerektirmemekle birlikte istatistiksel olarak kullanılan kondüitler arasında anlamlı bir fark bulunmamıştır. Orta uzun dönemde risk faktörlerine bakıldığında düşük doğum ağırlığı , kesintili aortik ark, ileri trunkal yetersizliği , koroner arter anomalisi , tekrarlayan girişimler ,Digeorge sendromu , uzun süre hastane yatışı sayılabilir. Sağ ventrikül – pulmoner arter kondüitlerinin obstrüksiyon ve dejenerasyonu sonrası değişim ihtiyacı sık görülmüş olup ortalama süresi 5.5 yıl bulunmuştur. Konduit değişim ihtiyacı ilk yerleştirilen kondüitin çapı ile ilişkili bulunmamakla birlikte Tek merkezli bir çalışmada ≤11 mm altı kondüit kullanılan hastalarda daha yüksek mortalite saptanmış (48), çok merkezli yapılan başka bir çalışmada geniş kondüit kullanımının (kondüit çapının VKİ ye oranı 50 mm/m 2) olan hastalarda mortalite oranı daha yüksek saptanmıştır(49).

Trunkus arteriosus onarımı sonrasında gelişebilecek geç dönem komplikasyonlar, hastaların takibinde dikkatle izlenmesi gereken önemli klinik sorunlardır. Bu komplikasyonlar arasında, özellikle pulmoner arter ve dallarında oluşan obstrüktif lezyonlar öne çıkmakta olup, bu lezyonlara yönelik balon anjiyoplasti veya stent yerleştirme gibi minimal invaziv girişimsel yöntemlerle başarılı müdahaleler yapılabilmektedir.

Öte yandan, trunkal kapakta gelişen ilerleyici darlık ya da yetersizlik vakalarında, uzun dönem takiplerde kapak replasmanı gereksinimi ortaya çıkabilmektedir. Bu durum, özellikle çocukluk çağında yapılan tamir sonrası büyüme sürecinde kapak yapısının yetersiz hale gelmesiyle ilişkili olabilir. Ayrıca, hastaların önemli bir kısmında cerrahi olarak yeniden oluşturulmuş aortik kökte zamanla dilatasyon gelişebildiği bilinmektedir. Bu dilatasyon, ilerleyen dönemde aortik köke yönelik cerrahi müdahale gerekliliğini doğurabilir ve hasta yönetiminde ayrı bir dikkat alanı oluşturur.

Dolayısıyla, trunkus arteriosus onarımı yapılan hastalarda yalnızca erken dönem sonuçlar değil, geç dönemde ortaya çıkabilecek pulmoner damar obstrüksiyonları, kapak disfonksiyonları ve aortik kök patolojileri de multidisipliner bir yaklaşımla izlenmeli ve uygun zamanda müdahale edilmelidir.

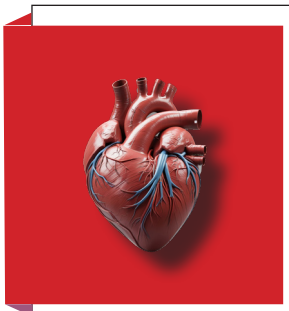
Cerrahi düzeltme ameliyatı yapılan hastaların uzun dönem takibinde çoğu hastada fizik aktivitede kısıtlılık izlenmemiş veya minimal kısıtlılık izlenmiştir (NYHA Sınıf 1 veya 2) (50-51) . 25 hastada yapılan kesitsel bir çalışmada hastaların fiziksel ve ruhsal sağlıklarında genel popülasyona göre daha düşük bulunmuştur (52).

KAYNAKLAR

1. COLLETT RW, EDWARDS JE. Persistent truncus arteriosus; a classification according to anatomic types. Surg Clin North Am 1949; 29:1245.
2. Fyler DC. Truncus arteriosus. In Fyler DC (ed.), Nadas' Pediatric Cardiology.Philadelphia, PA: Hanley & Belfus; 1992.
3. Rowe RD, Freedom RM, Mehrizi A, Bloom KR. The Neonate with Congenital Heart Disease. Philadelphia, PA: W.B. Saunders; 1981.
4. Schaff HV, Danielson GK, Puga FJ. Truncus arteriosus. In: Arciniegas E (ed.), Pediatric Cardiac Surgery. Chicago, IL: Year Book Medical; 1985
5. de la Cruz MV, da Rocha JP. An ontogenetic theory for the explanation of congenital malformations involving the truncus and conus. Am Heart J. 1956;51:782-805.
6. Kirby ML. Cellular and molecular contributions of the cardiac neural crest to cardiovascular development. Trends Cardiovasc Med. 1993;3:18-23
7. Radford DJ, Perkins L, Lachman R, Thong YH. Spectrum of Di George syndrome in patients with truncus arteriosus: expanded Di George syndrome. Pediatr Cardiol. 1988;9:95–101.
8. Carr I, Bharati S, Kusnoor VS, Lev M. Truncus arteriosus communis with intact ventricular septum. Heart. 1979;42: 97-102.
9. Naimo PS, Bell D, Fricke TA, et al. Truncus arteriosus repair: a 40-year multicenter perspective. J Thorac Cardiovasc Surg. 2021; 161:230-240.
10. Naimo PS, Fricke TA, Yong MS, et al. Outcomes of truncus arteriosus repair in children: 35 years of experience from a single institution. Semin Thorac Cardiovasc Surg. 2016;28: 500-511.

11. Gellis L, Binney G, Alshawabkeh L, et al. Long-term fate of the truncal valve. J Am Heart Assoc. 2020;9:e019104. 10. Guariento A, Doulamis IP, Staffa SJ, et al. Long-term outcomes of truncus arteriosus repair: a modulated renewal competing risks analysis. J Thorac Cardiovasc Surg. 2022;163:224-236.e6
12. Van Praagh R, Van Praagh S. The anatomy of common aorticopulmonary trunk (truncus arteriosus communis) and its embryologic implications. A study of 57 necropsy cases. The American journal of cardiology. 16 (3): 406-25.
13. Bharati S, McAllister HA, Rosenquist GC, et al. The surgical anatomy of truncus arteriosus communis. J Thorac Cardiovasc Surg. 1974;67:501-510.
14. Calder L, Praagh R Van, Praagh S Van, et al. Clinical, angiocardiographic, and pathologic findings in 100 patients. Am Heart J. 1976;92:23-38.
15. Ferencz C. A case-control study of cardiovascular malformations in liveborn infants: The morphogenetic relevance of epidemiologic findings. In: Clark EB, Takao A (eds); Developmental Cardiology; Morphogenesis and Function. Mount Kisco, NY, Futura, 1999;526-51.
16. Mavroudis C, Backer CL. Truncus arteriosus. In: Mavroudis C, Backer CL (eds.), Pediatric Cardiac Surgery, 4th ed. Oxford: Wiley-Blackwell; 2013, pp. 361–375.
17. Espinola-Zavaleta N, Munoz-Castellanos L, Gonzalez-Flores R, et al. (2008) [Common truncus arteriosus in adults]. Arch Cardiol Mex 78, 210–216.
18. Marcelletti C, McGoon DC, Mair DD. (1976) The natural history of truncus arteriosus. Circulation 54, 108–111.
19. Espínola-Zavaleta N, Muñoz-Castellanos L, GonzálezFlores R, Kuri-Nivón M. [Common truncus arteriosus in adults]. Arch Cardiol Mex. 2008;78:210–216.
20. Rodefeld MD, Hanley FL. Neonatal truncus arteriosus repair: surgical techniques and clinical management. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu 2002; 5:212.
21. Castaneda AR, Mayer JE Jr, Jonas RA et al. The neonate with critical congenital heart disease: Repair-A surgical challenge. J Thorac Cardiovasc Surg, 1989;98:869-75.
22. Turley K. Current method of repair of truncus arteriosus. J Cardiovasc Surg, 1992;7:1-4.
23. A Rastelli GC, Titus JL, McGoon DC. Homograft of ascending aorta and aortic valve as a right ventricular outflow: An experimental approach to the repair of truncus arteriosus.Arch Surg, 1967;95:698-708.
24. S Harris JP, Stewart S, Anderson V et al. Coronary artery injury by a valved external conduit. Ann Thorac Surg, 1981;31:271-3.
25. A Kyburz A, Bauersfeld U, Schinzel A et al. The fate of children with microdeletion 22qll.2 syndrome and congenital heart defect: Clinical course and cardiac outcome. Pediatr Cardiol, 2008;29:76-83.
26. Castaneda AR. Truncus arteriosus. Ann Thorac Surg. 1989; 47(4):491–492.
27. Hanley FL, Heinemann MK, Jonas RA, et al. Repair of truncus arteriosus in the neonate. J Thorac Cardiovasc Surg. 1993;105:1047–1056.
28. Pearl JM, Laks H, Drinkwater DC Jr, et al. Repair of conotruncal abnormalities with the use of the valved conduit: improved early and midterm results with the cryopreserved homograft. J Am Coll Cardiol. 1992; 20:191–196.
29. Heinemann MK, Hanley FL, Fenton KN, et al. Fate of small homograft conduits after early repair of truncus arteriosus. Ann Thorac Surg. 1993;55:1409–1412.
30. Lacour-Gayet F, Serraf A, Komiya T, et al. Truncus arteriosus repair: influence of techniques of right ventricular outflow tract reconstruction. J Thorac Cardiovasc Surg. 1996;111:849–856.
31. Losay J, Planché C, Lacour-Gayet F, Touchot A, Bruniaux J. [Immediate and mid-term results of complete repair of truncus arteriosus during the first year of life]. Arch Mal Coeur Vaiss. 1991;84:691–695.
32. Slavik Z, Keeton BR, Salmon AP, et al. Persistent truncus arteriosus operated during infancy: long-term follow-up. Pediatr Cardiol. 1994;15:112–115.
33. McKay R, Miyamoto S, Peart 1 et al. Truncus arteriosus with interrupted aortic arch: Successful correction in a neonate, Ami Thorac Surg,1989;48:587
34. Tlaskal T, Hucin B, KosteJka M et al. Successful reoperation for severe left bronchus compression after repair of persistent truncus arteriosus with interrupted aortic arch, Eur J Cardiothorac Surg, 1998;13:306.
35. Imamura M, D rummo nd-Webb JJ, Sarris GE et al. Improving early and intermediate results of truncus arteriosus repair: A new technique of truncal valve repair, Ann Thorac Surg, 1999;67:1142.
36. McElhinney DB, Reddy VM, Rajasinghe HA et al. Trends in the management of truncal valve insufficiency, Ann Thorac Surg,1998;65:517.
37. Bove EL, Beekman RH, Snider AR et al. Repair of truncus arteriosus in the neonate and young infant, Ann Thorac Surg,1989;47:499.
38. Jahangiri M, Zurakowski D, Mayer JE, et al: Repair of the truncal valve and associated interrupted arch in neonates with truncus arteriosus, J Thorac Cardiovasc Surg, 2000;119:508.
39. Mavroudis C, Backer CL. Surgical management of severe truncal insufficiency: Experience with truncal valve remodeling techniques, Ann Thorac Surg, 2001;72:396.
40. Tlaskal T, Vojtovic P, Reich O, et al. Improved results after the primary repair of interrupted aortic arch: impact of a new management protocol with isolated cerebral perfusion. Eur J Cardiothorac Surg. 2010;38:52–58.
41. Castaneda AR. Truncus arteriosus, Ann Thorac Surg,1989;47:491.
42. Marcelletti C, McGoon DC, Danielson GK et al. Early and late results of surgical repair of truncus arteriosus. Circulation, 1972;55.636.
43. Ebert PA. Truncus arteriosus. In Glenn WWL, Baue AE, Geha AS, eds. Thoracic and cardiovascular surgery, ed 4, Norwalk, CF, Appleton-Century-Crofts, 1983.
44. Bove EL, Lupinetti FM, PridJian AK et al. Results of a policy of primary repair of truncus arteriosus in the neonate, J Thorac Cardiovasc Surg, 1993;205:1057.
45. Pearl JM, Laks H, Drinkwater DC Jr et al. Repair of conotruncal abnormalities with the use of the valved conduit: Improved early and mid-term results with the cryopreserved homograft. J Am Coll Cardiol, 1992;20: 191-6.

46. Bove EL, Lupinetti FM, PridJian AK et al. Results of a policy of primary repair of truncus arteriosus in the neonate, J Thorac Cardiovasc Surg, 1993;205:1057.
47. McKay R, Miyamoto S, Peart 1 et al. Truncus arteriosus with interrupted aortic arch: Successful correction in a neonate, Ami Thorac Surg,1989;48:587.
48. Guariento A, Doulamis IP, Staffa SJ, et al. Long-term outcomes of truncus arteriosus repair: A modulated renewal competing risks analysis. J Thorac Cardiovasc Surg 2022; 163:224.
49. Mastropietro CW, Amula V, Sassalos P, et al. Characteristics and operative outcomes for children undergoing repair of truncus arteriosus: A contemporary multicenter analysis. J Thorac Cardiovasc Surg 2019; 157:2386.
50. Naimo PS, Fricke TA, Yong MS, et al. Outcomes of Truncus Arteriosus Repair in Children: 35 Years of Experience From a Single Institution. Semin Thorac Cardiovasc Surg 2016; 28:500.
51. Asagai S, Inai K, Shinohara T, et al. Long-term Outcomes after Truncus Arteriosus Repair: A Single-center Experience for More than 40 Years. Congenit Heart Dis 2016; 11:672.
52. O'Byrne ML, Mercer-Rosa L, Zhao H, et al. Morbidity in children and adolescents after surgical correction of truncus arteriosus communis. Am Heart J 2013; 166:512.



SİNÜS VALSALVA ANEVRİZMALARI

BÖLÜM
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İçindekiler

- SİNÜS VALSALVA ANEVRİZMASI
  - Tanım ve Epidemiyoloji
  - Etyopatogenez
  - Tarihçe
- SİNUS VALSALVA ANEVRİZMA OLUŞUM MORFOLOJİSİ
- SİNÜS VALSALVA ANEVRİZMASI RÜPTÜRÜ
- SİNÜS VALSALVA ANEVRİZMASINA EŞLİK EDEN KARDİYAK ANOMALİLER
  - Ventriküler septal defekt (VSD)
  - Aort Kapak Anormallikleri ve Aort Yetersizliği
  - Pulmoner Darlık
  - Diğer Patolojiler
- TANIDA YARDIMCI KLİNİK BULGULAR VE KESİN TEŞHİS
  - Ekokardiyografik bulgular;
  - Kontrastlı Bilgisayarlı Tomografi (BT) ve Magnetik Rezonans inceleme (MRI) bulguları
  - Histolojik bulgular
  - Sinüs Valsalva Anevrizmasının Ayırıcı Tanısı
  - Sinüs Valsalva Anevrizmalarının Doğal Seyri
  - Sinüs Valsalva anevrizmalarına Tedavi Yaklaşımı:
- CERRAHİ TEDAVİ
  - Ameliyat Endikasyonu
  - Cerrahi yaklaşımda özellikli olgularda teknikler: Rüptüre Sağ Sinüs Valsalva anevrizması ile birlikte VSD'li olgular;
  - Rüptüre Sağ Sinüs Valsalva anevrizması (VSD'siz);
  - Cerrahi Onarım Sonrası Beklenen Yaşam Süresi ve Postoperatif Seyir
  - Postoperatif Dönemi Etkileyen Faktörler ve Geç Dönem Mortalite
  - Komplikasyonlar

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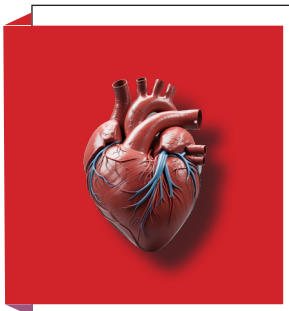
kateter, gerekse cerrahi yaklaşımşlarda düşük girişimsel mortalite ve uzun vadeli takiplerde de düşük morbidite ve mortaliteye sahiptir. SVA'a erken tanı ile hastaya ve anatomopatolojik tanıya uygun optimal girişim metodu ile yaklaşım tedavide esastır.

KAYNAKLAR

1. Weinreich M, Yu PJ, Trost B. Sinus of valsalva aneurysms: review of the literature and an update on management. Clin Cardiol. 2015 ;38(3):185-9.
2. Ring SW. Sinus of Valsalva aneurysm. In: Mavroudis C, Backer CL, editors. Pediatric Cardiac Surgery. Philadelphia:Mosby; 2003. p. 650-6.
3. Bricker AO, Avutu B, Mohammed TL, Williamson EE, Syed IS, Julsrud PR, et al. Valsalva sinus aneurysm findings at CT and MR imaging. Radiographics. Jan-Feb 2010;30(1):99-110.
4. Golzari M, Riebman JB. The four seasons of ruptured sinus of valsalva aneurysms: case presentations and review. Heart Surg Forum. 2004;7(6):E577-83.
5. Nguyen Q, Vervoort D, Phan K, Luc JGY. Surgical management for unruptured sinus of Valsalva aneurysms: a narrative review of the literature. J Thorac Dis. 2021;13(3):1833-50.
6. Ring WS. Congenital Heart Surgery Nomenclarture and Database Project: aortic aneurysm, sinus of Valsalva aneurysm, and aortic dissection. Ann Thorac Surg. 2000;69(4 Suppl):S147-63.
7. Hoey ET, Kanagasingam A, Sivananthan MU: Sinus of valsalva aneurysms: assessment with cardiovascular MRI. AJR Am J Roentgenol. 2010, 194:W495-504.
8. Perloff J, Marelli A, editors. Clinical Recognition of Congenital Heart Disease. 6th ed. Saunders Elsevier; 2012.
9. Doost A, Craig JA, Soh SY. Acute rupture of a sinus of Valsalva aneurysm into the right atrium: a case report and a narrative review. BMC Cardiovasc Disord. 2020;20(1):84.
10. Agarwal S, Atalay MK. Aorta-cameral fistulas: Spectrum of CT findings and review. Clin Imaging. 2021;80:193-8.
11. Lee ST, Lin TH, Su HM, Chiu CC, Voon WC, Lai WT, et al. Ruptured aneurysm of the sinus of valsalva into the right atrium without ventricular septal defect: a case report and literature review. Kaohsiung J Med Sci. 2005;21(11):517-21.
12. Abad C. Congenital aneurysm of the sinus of Valsalva dissecting into the interventricular septum. Cardiovasc Surg. 1995;3(5):563-4.
13. Chu SH, Hung CR, How SS, Chang H, Wang SS, Tsai CH, et al. Ruptured aneurysms of the sinus of Valsalva in Oriental patients. J Thorac Cardiovasc Surg. 1990;99(2):288-98.
14. Falholt W, Thomsen G. Congenital aneurysm of the right sinus of Valsalva, diagnosed by aortography. Circulation. 1953;8(4):549-53.
15. Oram S, East T. Rupture of aneurysm of aortic sinus (of Valsalva) into the right side of the heart. Br Heart J. 1955;17(4):541-51.
16. Lillehei CW, Stanley P, Varco RL. Surgical treatment of ruptured aneurysms of the sinus of Valsalva. Ann Surg 1957;146:459.
17. McGoon DC, Edwards JE, Kirklin JW. Surgical treament of ruptured aneurysm of aortic sinus. Ann Surg 1958;147:387.
18. Royal Collection Trust : "LEONARDO DA VINCI (1452-1519) The aortic valve c.1512-13. Pen and ink on blue paper | 28.3 x 20.4 cm (sheet of paper) | RCIN 919082."
19. Ott DA. Aneurysm of the sinus of valsalva. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2006:165-76.
20. Kouchoukos NT, Blackstone EH, Doty DB, Hanley FL, Karp RB.Congenital sinus valsalva aneurysms.In:Kouchoukos NT, Blackstone EH, Doty DB, Hanley FL, Karp RB, 4thEds. Kirklin/Barrat-Boyes Cardiac Surgery. Philadelphia: Churchill Livingstone; 2013, S: 1326-42.
21. Chaganti YS, Husain SM, Iyer VR, Desai N. Sinus of valsalva aneurysm: A single institutional experience with 216 patients over 30 years. J Card Surg. 2022;37(12):4448-55.
22. Wang ZJ, Zou CW, Li DC, Li HX, Wang AB, Yuan GD, et al. Surgical repair of sinus of Valsalva aneurysm in Asian patients. Ann Thorac Surg. 2007;84(1):156-60.
23. Ravishankar M, Ghergherehchi A, Liu J, Jimenez E, Khalid U. Large Sinus of Valsalva Aneurysm Complicated by Thrombus Formation. Methodist Debakey Cardiovasc J. 2020 Jul-Sep;16(3):e8-e10.
24. Edwards JE, Burchell HB. The pathological anatomy of deficiencies between the aortic root and the heart, including aortic sinus aneurysms. Thorax. 1957;12(2):125-39.
25. Abralov K, Alimov A. Short-Term Results of Sinus of Valsalva Aneurysm Repair. World J Pediatr Congenit Heart Surg. 2017;8(1):13-7.
26. Dayco JS, Dsouza A, Baciewicz F, Cardozo S. A rare variant of a ruptured sinus of valsalva aneurysm forming an aorto-atrial fistula: a case report and review of literature. Eur Heart J Case Rep. 2023;7(2):ytad018.
27. Sakakibara S, Konno W. Congenital aneurysms of sinus of Valsalva: A clinical study. Am Heart J 1962;63:708.
28. Xin-Jin L, Xuan L, Bo P, Hong-Wei G, Wei W, Shou-Jun L, et al. Modified Sakakibara classification system for ruptured sinus of Valsalva aneurysm. J Thorac Cardiovasc Surg. 2013;146(4):874-8.
29. Zeng YH, Calderone A, Rousseau-Saine N, Elmi-Sarabi M, Jarry S, Couture ÉJ, et al. Right Ventricular Outflow Tract Obstruction in Adults: A Systematic Review and Meta-analysis. CJC Open. 2021 9;3(9):1153-68.
30. Taguchi K, Sasaki N, Matsuura Y, Uemura R. Surgical correction of aneurysm of the sinus of Valsalva. A report of forty-five consecutive patients including eight with total replacement of the aortic valve. Am J Cardiol. 1969;23(2):180-91.
31. Kiefaber RW, Tabakin BS, Coffin LH, Gibson TC. Unruptured sinus of Valsalva aneurysm with right ventricular outflow obstruction diagnosed by two-dimensional and Doppler echocardiography. J Am Coll Cardiol. 1986;7(2):438-42.
32. Sridhar GS, Sadiq MA, Ahmad WA, Supuramaniam C, Watson T, Abidin IZ, et al. Unruptured Sinus of Valsalva Aneurysm with Right Ventricular Outflow Tract Obstruction and Supracristal Ventricular Septal Defect: A Rare Case. Tex Heart Inst J. 2015;1;42(5):462-4.

33. Angelini P. Aortic sinus aneurysm and associated defects: can we extrapolate a morphogenetic theory from pathologic findings? Tex Heart Inst J. 2005;32(4):560-2.
34. Azakie A, David TE, Peniston CM, Rao V, Williams WG. Ruptured sinus of valsalva aneurysm: early recurrence and fate of the aortic valve. Ann Thorac Surg. 2000 Nov;70(5):1466-70; discussion 1470-1.
35. Diwakar A, Patnaik SS, Hiremath CS, Chalam KS, Dash P. Rupture of sinus of valsalva - A 15 years single institutional retrospective review: Preoperative heart failure has an impact on post operative outcome? Ann Card Anaesth. 2019;22(1):24-9.
36. Feldman DN, Roman MJ. Aneurysms of the sinuses of Valsalva. Cardiology. 2006;106(2):73-81.
37. Athauda Arachchi P, Malik M, Dev K. Unruptured sinus of Valsalva aneurysms - Multimodality imaging correlation helps determine indications and approaches for repair. J Cardiol Cases. 2022;26(4):276-8.
38. Jia B, Shi Q. Timing for Outflow Ventricular Septal Defect, With or Without Aortic Insufficiency. Ann Thorac Surg. 2022;114(3):1094-5.
39. Giridhara P, Poonia A, Sasikumar D, Krishnamoorthy KM, Sivasubramonian S, Valaparambil A. Outflow Ventricular Septal Defect With Aortic Regurgitation: Optimal Timing of Surgery? Ann Thorac Surg. 2022;114(3):873-80.
40. Phan QT, Kim SW, Nguyen HL. Percutaneous closure of congenital Gerbode defect using Nit-Occlud® Lê VSD coil. World J Cardiol. 2017 ;9(7):634-9.
41. Imazio M. The 2023 new European guidelines on infective endocarditis: main novelties and implications for clinical practice. J Cardiovasc Med (Hagerstown). 2024;25(10):718-26.
42. Nascimbene A, Joggerst S, Reddy KJ, Cervera RD, Ott DA, Wilson JM, et al. Aortic valve regurgitation that resolved after a ruptured coronary sinus aneurysm was patched. Tex Heart Inst J. 2013;40(4):489-92.
43. Nakamura Y, Burkhart HM. Sinus of Valsalva aneurysm: Defining the optimal approach. J Card Surg. 2022;37(12):4456-58.
44. Morch JE, Greenwood WF. Rupture of the sinus of valsalva. A study of eight cases with discussion on the differential diagnosis of continuous murmurs. Am J Cardiol. 1966;18(6):827-36.
45. Choudhary SK, Bhan A, Sharma R, Airan B, Kumar AS, Venugopal P. Sinus of Valsalva aneurysms: 20 years' experience. J Card Surg. 1997 Sep-Oct;12(5):300-8.
46. English K. Diagnosis and treatment options for sinus of Valsalva aneurysms: A narrative review. World J Cardiol. 2025;17(6):102722.
47. Kuriakose EM, Bhatla P, McElhinney DB. Comparison of reported outcomes with percutaneous versus surgical closure of ruptured sinus of Valsalva aneurysm. Am J Cardiol. 2015;115:392-8.
48. Lee JH, Yang JH, Park PW, Song J, Huh J, Kang IS, et al. Surgical Repair of a Sinus of Valsalva Aneurysm: A 22-Year Single-Center Experience. Thorac Cardiovasc Surg. 2021;69(1):26-33.
49. Li XE, McElhinney DB, Lui GK, Clark DE, Woo JP. Percutaneous Closure of a Ruptured Sinus of Valsalva Aneurysm under Transesophageal Echocardiography Guidance. CASE (Phila). 2024 ;8(3Part A):186-92.
50. Lin CY, Chung FP, Lin YJ, Chong E, Chang SL, Lo LW, et al. Radiofrequency catheter ablation of ventricular arrhythmias originating from the continuum between the aortic sinus of Valsalva and the left ventricular summit: Electrocardiographic characteristics and correlative anatomy. Heart Rhythm. 2016;13(1):111-21.
51. Ozkara A, Cetin G, Mert M, Erdem CC, Okcün B, Günay I. Sinus of Valsalva aneurysm: surgical approaches to complicated cases. ANZ J Surg. 2005 Jan-Feb;75(1-2):51-4.
52. Yan F, Abudureheman M, Huo Q, Shabiti A, Zhu T, Liu Z. Surgery for sinus of Valsalva aneurysm: 33-year of a single center experience. Chin Med J (Engl). 2014;127(23):4066-70.
53. Pólos M, ulea CM, Benke K, Ágg B, Kovács A, Hartyánszky I, et al. Giant unruptured sinus of Valsalva aneurysm successfully managed with valve-sparing procedure - a case report. J Cardiothorac Surg. 2020 ;15(1):6.
54. van Son JA, Danielson GK, Schaff HV, Orszulak TA, Edwards WD, Seward JB. Long-term outcome of surgical repair of ruptured sinus of Valsalva aneurysm. Circulation. 1994;90(5Pt2):II20-9.
55. Wingo M, de Angelis P, Worku BM, Leonard JR, Khan FM, Hameed I, et al. Sinus of Valsalva aneurysm repairs: Operative technique and lessons learned. J Card Surg. 2019;34(6):400-3.
56. Cheng TO, Yang YL, Xie MX, Wang XF, Dong NG, Su W, et al. Echocardiographic diagnosis of sinus of Valsalva aneurysm: a 17-year (1995-2012) experience of 212 surgically treated patients from one single medical center in China. Int J Cardiol. 2014;173(1):33-9.
57. Kirali K, Güler M, Daglar B, Yakut N, Mansuroglu D, Balkanay M, et al. Surgical repair in ruptured congenital sinus of Valsalva aneurysms: a 13-year experience. J Heart Valve Dis. 1999;8(4):424-9.
58. Vural KM, Sener E, Tasdemir O, Bayazit K. Aproach to sinus of Valsalva aneurysms: A review of 53 cases. Eur J Cardiothorac Surg 2001;20(1):71-6.
59. Sarikaya S, Adademir T, Elibol A, Büyükbayrak F, Onk A, Kirali K. Surgery for ruptured sinus of Valsalva aneurysm: 25-year experience with 55 patients. Eur J Cardiothorac Surg. 2013;43(3):591-6.
60. Moliterno E, Rovere G, Giarletta L, Brancasi A, Larici AR, Savino G, et al. The role of coronary CT angiography in athletes. Radiol Med. 2024;129(7):1008-24.
61. Moustafa S, Mookadam F, Cooper L, Adam G, Zehr K, Stulak J, et al. Sinus of Valsalva aneurysms--47 years of a single center experience and systematic overview of published reports. Am J Cardiol. 2007;99(8):1159-64.
62. Pollak AL, Vega E, Whitacre M, Nicoara A. Ruptured sinus of Valsalva aneurysm with dynamic aortic regurgitation. Echocardiography. 2023 ;40(1):74-81.
63. Abe T, Komatsu S. Surgical repair and long-term results in ruptured sinus of Valsalva aneurysm. Ann Thorac Surg. 1988;46(5):520-5.
64. Takach TJ, Reul GJ, Duncan JM, Cooley DA, Livesay JJ, Ott DA, et al. Sinus of Valsalva aneurysm or fistula: management and outcome. Ann Thorac Surg. 1999;68(5):1573-7.
65. Lansac E, Di Centa I, Varnous S, Rama A, Jault F, Duran CM, et al. External aortic annuloplasty ring for valve-sparing procedures. Ann Thorac Surg. 2005 ;79(1):356-8.
66. Regeer MV, van der Zwaan HB, Schoof PH, van Aarnhem EEHL. Surgical Repair of a Sinus of Valsalva

Aneurysm. World J Pediatr Congenit Heart Surg. 2022;13(6):807-9.
67. Finocchiaro G, Westaby J, Sheppard MN, Papadakis M, Sharma S. Sudden Cardiac Death in Young Athletes: JACC State-of-the-Art Review. J Am Coll Cardiol. 2024 16;83(2):350-70.
68. Galeczka M, Glowacki J, Yashchuk N, Ditkivskyy I, Rojczyk D, Knop M, et al. Medium- and long-term follow-up of transcatheter closure of ruptured sinus of Valsalva aneurysm in Central Europe population. J Cardiol. 2019;74(4):381-7.
69. Cullen S, Somerville J, Redington A. Transcatheter closure of a ruptured aneurysm of the sinus of Valsalva. Br Heart J. 1994;71: 479-80.
70. Mao Y, Wang C, Li Y, Guan X, Zhang X, Wu X. Percutaneous closure versus surgical repair for ruptured sinus of valsalva aneurysm: A systematic review and meta-analysis. Front Cardiovasc Med. 2023 ;10:1158906.
71. Ayati A, Toofaninejad N, Hosseinsabet A, Mohammadi F, Hosseini K. Transcatheter closure of a ruptured sinus of valsalva: a systematic review of the literature. Front Cardiovasc Med. 2023;10:1227761.
72. Hussain S, Qadir F, Sheeraz P, Awan MAB. Un-ruptured Non-Coronary Sinus of Valsalva Aneurysm with Complete Heart Block. Pak J Med Sci. 2017 Nov-Dec;33(6):1531-3.



AORTO-SOL VENTRİKÜL TÜNEL ANOMALİSİ

BÖLÜM
47

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DOI: 10.37609/akya.4077.c5459

İçindekiler

» GİRİŞ VE GENEL BİLGİLER
» MORFOLOJİ
» AYIRICI TANI
» ETYOLOJİ
» KLİNİK BULGULAR VE TANI KRİTERLERİ
» DOĞAL SEYİR
» TEDAVİ
  » Ameliyat Endikasyonları
» AMELİYAT TEKNİĞİ
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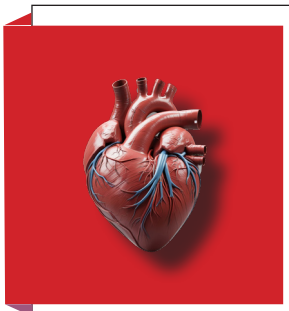
KAYNAKLAR

1. Kirklin JW, Barratt-Boyes GB. Congenital aneurysm of the sinus of Valsalva. In: Kirklin JW, Barratt-Boyes GB, eds. Cardiac surgery. New-York: Churchill Livingstone; 1993. p. 825-836.
2. Levy MJ, Lillehei CW, Anderson RC, Amplatz K, Edwards JE. Aortico-left ventricular tunnel. Circulation 1963;27:841.
3. Dominique ST, Tchervenkov CI. Aortic-left ventricular tunnel.In:Mavroudis C, Backer CL, eds. Pediatric Cardiac Surgery. Philadelphia: Mosby; 2003. p. 575-578.
4. Turley K, Silverman NH, Teitel D, et al. Repair of aortico-left ventricular tunnel in the neonate; surgical, anatomic and echocardiographic considerations, Circulation 1982;65:1015.
5. Kouchoukos NT, Karp RB, Blackstone EH, et al, eds. Kirklin/Barratt-Boyes Cardiac Surgery. 3rd ed. Philadelphia, PA: Churchill Livingstone; 2003.
6. Jonas RA. Comprehensive Surgical Management of Congenital Heart Disease. 1st edition. London, England: Arnold; 2004.
7. Graham A, Hikspoors JPJM, Lamers WH, Anderson RH, Bamforth SD. Morphogenetic processes in the development and evolution of the arteries of the pharyngeal arches: their relations to congenital cardiovascular malformations. Front Cell Dev Biol. 2023; 12;11:1259175.
8. McKay R, Anderson RH, Cook AC. The aorto-ventricular tunnels. Cardiol Young. 2002;12(6):563-80.
9. Grant P, Abrams LD, DEGiovanni JV, et al. Aortico-left ventricular tunnel arising from the left aortic sinus, Am J Cardiol 1985;55:1657.
10. Saylam A, Tuncali T, Ikizler C, Aytaç A. Aorto-right ventricular tunnel: a new concept in congenital cardiac malformations. Ann Thorac Surg 1974; 18(6):634-7.
11. Bharati S, Lev M, Cassels DE. Aortico-right ventricular tunnel. Chest 1973;63:198.
12. Morgan RI, Mazur JH. Congenital aneurysm of aortic root with fistula to left ventricle: a case report with autopsy findings. Circulation 1963;28:589.
13. Ho SY, Muriago M, Cook AC, Thiene G, Anderson RH. Surgical anatomy of aorto-left ventricular tunnel. Ann Thorac Surg 1998;65:509–514.
14. McKay R. Aorto-ventricular tunnel. Orphanet J Rare Dis 2007; 8;2:41.
15. Somerville J. English T, Ross DN. Aorto- Left ventriküler tunnel: clinical features and surgical management; Br heart J 1974;36:321.
16. Fripp RR, Werner JC ,Whitman V, Nordenberg A, Waldhausen J A. Pulsed Doppler and two-dimensional echocardiographic findings in aortico-left ventricular tunnel. J Am Coll Cardiol 1984;4;102.
17. Humes RA, Hagler DJ, Julsrud, Levy JM, Feld RH, Schaff HV. Aortico- left ventricular tunnel: Diagnosis based on two-dimensional echocardiography, color flow doppler imaging and magnetic resonance imaging, Mayo Clin proc 1986;61:901.
18. Hovaguimian H, Cobanoglu A, Starr A. Aortico-left ventricular tunnel: a clinical review and new surgical classification. Ann Thorac Surg 1988;45(1):106-12.
19. Yildirim A, Erek E, Uslu Z, Saygili A, Karaagac AT. Aorto-left ventricular tunnel originating from the left coronary sinus with aortic aneurysm in an 11-year-old boy. Tex Heart Inst J 2013;40(1):91-4.
20. Bash SE, Huhta JC, Nihill MR, Vargo TA, Hallman GL. Aortico-left ventricular tunnel with ventricular septal defect: two-dimensional/Doppler echocardiographic diagnosis. J Am Coll Cardiol 1985;5(3):757-60.
21. Perez-Martinez V, Quero M, Castro C, Moreno F, Brito JM, Merino G. Aortico-left ventricular tunnel: A clinical and pathologic review of this uncommon entity. Am Heart J 1973;85:237.
22. Villani M, Tiraboschi R, Marino A, De Tommasi M, Velitti F, Giani PC, et al. Aortico-left ventricular tunnel in infancy. Two surgical cases. Scand J Thorac Cardiovasc Surg 1980;14(2):169-75.
23. Sousa-Uva M, Touchout A, Fermont L, et al. Aortico-left ventricular tunnel in fetuses and infants. Ann Thorac Surg. 1996;61:1805–1810.
24. Sousa-Uva M, Touchot A, Fermont L, Piot D, Delezoide AL, Serraf A, et al. Aortico-left ventricular tunnel in fetuses and infants. Ann Thorac Surg 1996;61(6):1805-10.
25. Martins JD, Sherwood MC, Mayer JE Jr, Keane JF. Aortico-left ventricular tunnel: 35-year experience. J Am Coll Cardiol 2004; 21;44(2):446-50.
26. Chen LL, Zhang CQ, Gong LG. A special type aortico-left ventricular tunnel with bicuspid aortic valve. Int J Cardiovasc Imaging 2020; 36(1):55-57.
27. Levy MJ, Schachner A, Blieden LC. Aortico- left ventricular tunnel. Collective review: J Thorac Cardiovasc Surg 1982;84;102.
28. Jimenez MJ, Diegues GCC, Jimenez QC, Gomez RF, Canete BR, Jimenez QM. Aotrtico-left ventricular tunnel associated with pulmonary valve stenosis. Rev Esp Cardiol 1996;49:921-4.
29. Bove KE, Schwartz DC. Aortico-left ventricular tunnel:A new concept. Am J Cardiol 1967;19:696.
30. Cooley RN, Harris LC, Rodin AE. Abnormal communication between the aorta and left ventricle: Aortico-left ventricular tunnel. Circulation 1965;31:564.
31. Ziesenitz VC, Gorenflo M, Loukanov T. Repair of an aorto-right ventricular tunnel in a newborn. Cardiol Young 2016;26(1):147-8.
32. Grab D, Paulus WE, Terinde R, Lang D. Prenatal diagnosis of an aortico-left ventricular tunnel. Ultrasound Obstet Gynecol 2000 ;15(5):435-8.
33. Palacio J, Peralta A, Sanchez B, Alperovich M. Intrapericardial congenital supravalvular aortic aneurysm communicating with the outflow tract of the left ventricle. J Cardiovasc Surg 1964;5:401–404.
34. Okoroma EO, Perry LW, Scott LP, McClenathan JE. Aortico-left ventricular tunnel. Clinical profile, diagnostic features, and surgical consideration. J Thorac Cardiovasc Surg 1976;71(2):238-44.
35. Chen HM, Chang PC, Chen YF. Aortic-left ventricular tunnel with late incompetence after 18-year follow-up. Thorac Cardiovasc Surg 2008;56(4):234-6.
36. Serino W, Andrade JL, Ross D, de Leval M, Somerville J. Aorto-left ventricular communication after closure: Late post-operative problems. Br Heart J 1983;49:501–506.
37. Meldrum-Hanna W, Schroff R, Ross DN. Aortico-left ventricular tunnel: Late follow-up. Ann Thorac Surg 1986;42:304–306.
38. Chessa M, Chaudhari M, De Giovanni JV. Aorto-left ventriculatr tunnel: transcatheter closure using an amplatzer duct occluder device. Am J Cardiol 2000;86:253-4.

39. Saritas T, Erol N, Erdem A, Karaci A, Celebi A. Aortico-left ventricular tunnel experience on three different ages. J Cardiovasc Dis Res 2010;1(4):206-9.
40. Rocha LA, Zielinsky P, Nicoloso LHS, Araujo Junior E. Development of the Z-score for the measurement of myocardial thickness by two-dimensional echocardiography in normal fetuses. Echocardiography 2021;38(1):97-102.
41. García-Saldivia M, Jiménez-Santos M, Zamorano-Velazquez NF, Riera-Kinkel C, Martínez-Sánchez A, Necoechea-Osuna Y, et al. Left Aorto-Ventricular Tunnel: A Very Rare Pathology in Adults. Circ Cardiovasc Imaging 2020;13(2):e009777.
42. Riberio P, Bun-Tan LB, Oakley CM. Management of aortic left ventricular tunnel. Br heart J 1985;54:333.
43. Horvath P, Balaji S, Skavranek S, Hucin B, deLeval MR, Stark J. Surgical treatment of aortico-left ventricular tunnel: Eur J cardio- thorac Surg 1991;5:113.
44. Stark J. Congenital anomalies of sinuses of Valsalva and aortico-ventricular tunnel. In: Stark J, deLeval M, eds. Surgery for congenital heart defects. Philadelphia:WB Saunders; 1994. p. 629-33.
45. Protopapas EM, Anderson RH, Backer CL, Fragata J, Hakim N, Vida VL, et al. Surgical Management of Aorto-Ventricular Tunnel. A Multicenter Study. Semin Thorac Cardiovasc Surg 2020;32(2):271-279.
46. Duveau D, Baron O, Michaud JL, Lefèvre M, Laboux L, Dupon H. Tunnel aorto-ventriculaire. Suivi à long terme, implications thérapeutiques [Aortico-left ventricular tunnel. Long-term follow-up, therapeutic implications]. Arch Mal Coeur Vaiss 1989;82(5):785-9.
47. Beckerman Z, Mery CM. Aorto-left ventricular tunnel: directing the spotlight to the aortic valve. Eur J Cardiothorac Surg 2021; 14;59(6):1320-1321.
48. Lou Y, Hu Y, Tao X. Diagnosis of an aortico-left ventricular tunnel in a fetus: a case report. J Int Med Res 2023 ;51(10):3000605231207756.
49. Liang Y, Wang J, Li D, Wan L, Gao Y, Liu R, et al. Mid-term outcome of surgical treatment in patients with aorto-left ventricular tunnel. Eur J Cardiothorac Surg 2021;14;59(6):1312-1319.
50. Kathare P, Subramanyam RG, Dash TK, Muthuswamy KS, Raghu K, Koneti NR. Diagnosis and management of aorto-left ventricular tunnel. Ann Pediatr Cardiol 2015;8(2):103-7.
51. Turley K. Aortico-left ventricular tunnel. In: Mavroudis C, Backer CL, eds. Pediatric Cardiac Surgery. St. Louis, Missouri: Mosby; 1994. p. 454-457.



KONJENİTAL MİTRAL KAPAK ANOMALİLERİ

BÖLÜM
48

Nejat SARIOSMANOĞLU [1]

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İçindekiler

- GİRİŞ
- TARİHÇE
- KAPAK MORFOLOJİSİ VE KAPAK ANALİZİ
- DOĞUMSAL MİTRAL KAPAK DARLIĞI
- TİP A- PAPİLLER KASLARIN NORMAL OLDUĞU MİTRAL KAPAK DARLIĞI
  - Fazla Kapak dokusu ve Çift Mitral Kapak Orifisi
  - Supravalvüler Halka
  - Anuler Hipoplazi
- TİP B- ANORMAL PAPİLLER KAS VARLIĞINDA MİTRAL KAPAK DARLIĞI
  - Paraşüt Mitral Kapak
  - Hamak Mitral Kapak
  - Papiller Kas Yokluğu
- DOĞUMSAL MİTRAL KAPAK YETMEZLİĞİ
- TİP 1- NORMAL KAPAKÇIK HAREKETİ
  - Anuler dilatasyon ve deformasyon
  - Ön kapakçıkta kleft (yarık)
  - Üç kapakçıklı mitral kapak
  - Arka kapakçıkta kleft (yarık)
  - Kapakçık defekti
- TİP-2 KAPAKÇIK PROLAPSUSU
  - Korda yokluğu
  - Uzamış korda tendinea
  - Uzamış papiller kas
- TİP-3 KISITLANMIŞ KAPAKÇIK HAREKETİ / PAPİLLER KASLARIN NORMAL OLDUĞU GRUP
  - Komissüral Füzyon
  - Kısa korda
  - Ebstein tipi mitral kapak
- TİP-3 KISITLANMIŞ KAPAKÇIK HAREKETİ / PAPİLLER KASLARIN ANORMAL OLDUĞU GRUP
  - Paraşüt Mitral Kapak
  - Hamak Kapak
  - Papiller Kas Hipoplazisi/Agenezisi
  - Aksesuar Mitral Kapakçık
- MİTRAL KAPAK ONARIMI
- KAPAK REPLASMANI
- SONUÇLAR

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pakların tromboembolik komplikasyonları ve antikoagülan ilaç kullanımı önemli bir sorundur(33). Mitral pozisyonunda biyoprotez kullanımına ait klinik sonuçlar iyi değildir(27,34). Biyoprotez mitral kapak yerleştirilmiş vakalarda 5 yıllık izlemde %50 oranında kireçlenmeye bağlı kapak disfonksiyonu tespit edilmiştir(27). Gelecekte yeni kalsiyum koruyucu maddelerin eklenmesi ile dayanıklılık oranları arttırılabilir. Cerrahide amaç, nihai girişim uygulanana kadar zaman kazanmak ve çocuğun büyümesine izin vermektir. Mitral kapak onarımı uygulanan hastaların %70'inde 15 yıl boyunca replasman gerekmediği bildirilmektedir(26). Mitral kapak replasmanı yapılmak zorunda kalınırsa anatomik pozisyonda supraanuler pozisyonda yerleştirme tekniği uygulanabilir(35). Bu uygulamada kapağın hareketinin en serbest olduğu pozisyonun sağlanması çok önemlidir.

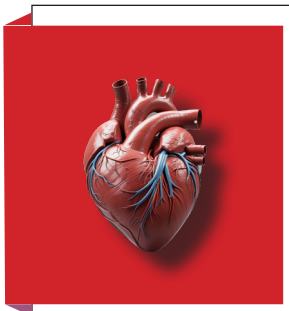
SONUÇLAR

Doğuştan mitral kapak darlığı tespit edilen hastalarda ilk 2 yaş içinde cerrahi girişim gereksinimi ortaya çıkmışsa mortalite ve morbiditenin ileri derecede arttığı bildirilmiştir(26). Doğuştan mitral darlığı olan yenidoğanlarda, balon dilatasyon uygulanabilir, ama restenoz ve ciddi yetmezlik gelişimi sıktır. Çocuk yaş grubunda mitral kapağın anomalilerinin onarım ve replasmanı ile ilgili birçok yayın bulunmaktadır(6,21,22,28). Mitral kapak darlığı hastalarının %94'ünde mitral kapak onarımı yapılabilmiştir. Protez halka mitral stenozu olan hastalarda kullanılmazken, mitral yetmezliği olan hastaların yarısında kullanılmıştır. Doğuştan mitral kapak darlığı yaratan hastalarda en sık ölüm sebebi pulmoner hipertansiyon gelişmesi ve kapak lezyonunun ciddi olmasıdır. Doğuştan mitral kapak yetmezliğinde ise en sık görülen ölüm sebebi ise düşük kalp debisi sendromu gelişmesidir. Kapak replasmanı sonuçları son yıllarda iyileşme gösterse de perioperatif mortalite %20-40 olarak bildirilmektedir(35). Mitral kapak onarımında bu oran %5 civarındadır(30,31). Pulmoner hipertansiyon gelişmeden uygulanacak olan onarım ile erken ve geç dönem sonuçlarının daha iyi olduğu tespit edilmiştir.

KAYNAKLAR

1. Keith JD, Rowe RD, Vlad P. Heart disease in infancy and childhood. New York:Mac Millan, 1958:577-84.
2. Mitchell SC, Korones SB, Berendes HW. Congenital heart disease in 56.109 Births, incidence and natural history. Ciculation 1971;43:323-32.
3. Hoffman JI, Kaplan S. The incidence of congenital heart disease. J Am Coll Cardiol 2002;39:1890-900.
4. Fann J, Ingels NJ, Miller D. Pathophysiology of mitral valve disease In: Cohn L, Edmunds L(eds). Cardiac Surgery in the Adult. New York: Mc Graw Hill, 2003:901-31.
5. Ruckman RN, van Praagh R. Anatomic types of congenital mitral stenosis: Report of 49 autopsy cases with consideration of diagnosis and surgical implications. Am J Cardiol 1978;42:592-601.
6. Oppido G, Davies B, Mc Mullan DM, Cochrane AD, Cheung MM, d'Udekem Y, et al. Surgical treatment of congenital mitral valve disease: Midterm results of a repair- oriented policy. J Thorac Cardiovasc Surg 2008;135:1313-21.
7. Smith E. Premature occlusion of the foramen ovale, large pulmonary artery and duct and contracted left heart. Trans Pathol Soc London, 1846;1:52.
8. Ayrolles P. Malformations congenitales des visceres et des mentres. Rev Mens Mal Enf 1885;3:222.
9. Fisher T. Two cases of congenital disease of the left side of the heart. Br Med J 1902;1:639.
10. Schiebler GL, Edwards JE, Burchell HB, et al. Congenital corrected transposition of the great vessels: A study of 33 cases. Pediatrics 1961;27:851.
11. Shone JD, Sellers RD, Anderson RC et al. The developmental complex of "parachute mitral valve" supravalvular ring of left atrium, subaortic stenosis and coarctation of the aorta. Am J Cardiol 1963;11:714-25.
12. Bower BD, Gerrard JW, D'Abreu AL et al. Two cases of congenital mitral stenosis treated by valvotomy. Arch Dis Child 1953;28:91.
13. Lillehei CW, Gott VL, Dewall RA, Varco RL. J Lancet 1957;77(11):446-49.
14. Starkey GWB. Surgical experience in the treatment of congenital mitral stenosis and mitral insufficiency. J Thorac Cardiovasc Surg 1959;38:336.
15. Carpentier A. La valvuloplastie reconstitutive. Une nouvelle technique de valvuloplastie mitrale. Presse Med 1969:251-3.
16. Carpentier A, Branchini B, Cour JC, Asfaou E, Villani M, Deloche A, et al. Congenital malformations of the mitral valve in children: Pathology and surgical treatment. J Thorac Cardiovasc Surg 1976;72:856-66.
17. Smallhorn JF, Anderson RH. Anomalies of the morphologically mitral valve. In: Anderson RH, Baker EJ, eds. Paediatric Cardiology. Philadelphia: Churchill Livingstone, Elsevier; 2010.
18. Castaneda AR, Anderson RC, Edwards JE. Congenital mitral stenosis resulting from anomalous arcade and obstructing muscles. Am J Cardiol 1969;24:237-40.
19. Davachi F, Moller JH, Edwards JE. Diseases of mitral valve in infancy. An anatomic analysis of 55 cases. Circulation 1971;43:565-79.
20. Banerjee A, Kohl T, Silverman NH. Echocardiographic evaluation of congenital mitral valve anomalies in children. Am J Cardiol 1995;76:1284-91.

21. Zias EA, Mavroudis C, Backer CL, Kohr LM, Gotteiner NL, Rocchini AP. Surgical repair of the congenital malformed mitral valve in infants and children. Ann Thorac Surg 1998;66:1551-9.
22. Chauvaud S, Fuzellier JF, Howel R, Berebi A, Mihaileanu S, Carpentier A. Reconstructive surgery in congenital mitral valve insufficiency (Carpentier techniques): Long-term results. J Thorac Cardiovasc Surg 1998;115:84-93.
23. Carney EK, Braunwald E, Robert WC et al. Congenital mitral regurgitation: Clinical, hemodynamic and angiographic findings in nine patients. Am J Med 1962;33:233.
24. Carpentier A, Brizard CP. Congenital malformations of the mitral valve. In: Stark J, de Leval M, Tsang V, editors. Surgery for congenital heart defects. London: Wiley; 2006. pp.573-90.
25. Carpentier A. Mitral valve reconstructive surgery. In: Jamieson SW, Shumway NE, eds. Operative Surgery. Butterworths:London, 1986;405.
26. Serraf A, Zoghbi J, Belli E, Lacour-Gayet F, Aznag H, Houyel L, et al. Congenital mitral stenosis with or without associated defects: An evolving strategy. Circulation 2000;102(19 Suppl 3):66-71.
27. Antunes MJ, Santos LP. Performance of glutaraldehyde-preserved porcine bioprosthesis as a mitral valve substitute in a young population group. Ann Thorac Surg 1984;37:387-92.
28. Hoashi T, Bove EL, Devaney EJ, Hirsch JC, Ohye RG. Mitral valve repair for congenital mitral valve stenosis in the pediatric population. Ann Thorac Surg 2010;90:36-41.
29. Mc Carthy JF, Neligan MC, Wood AE. Ten years' experience of an aggresive reparative approach to congenital mitral valve anomalies. Eur J Cardiothorac Surg 1996;10:534-9.
30. Ahoron AS, Laks H, Drinkwater DC, Permut LC, Ardehali A, Rudis E. Early and late results of mitral valve repair in children. J Thorac Cardiovasc Surg 1994;107:1262-71.
31. Stellin G, Padalino MA, Vida VL, Boccuzzo G, Orru E, Biffanti R, et al. Surgical repair of congenital mitral valve malformations in infancy and childhood: A single- center 36-year experience. J Thorac Cardiovasc Surg 2010;140:1238-44.
32. Antunes MJ, Vanderdonck KM, Sussman MJ. Mechanical valve replacement in children and teenagers. Eur J Cardiothorac Surg 1989;3:222-8.
33. Beierlein W, Becker V, Yates R, Tsang V, Elliott M, de Leval M, et al. Long-term follow-up after mitral valve replacement in childhood: Poor event-free survival in the young child. Eur J Cardiothorac Surg. 2007;31:860-5.
34. Günther T, Mazzitelli D, Schreiber C, Wottke M, Paek SU, Meisner H, et al. Mitral valve replacement in children under 6 years of age. Eur J Cardiothorac Surg. 2000;17:426-30.
35. Kadoba K, Jonas RA, Mayer JE, Castenada AR. Mitral valve replacement in the first year of life. J Thorac Cardiovasc Surg 1990;100:762-8.



PULMONER ARTERDEN ÇIKAN ANORMAL SOL VE SAĞ KORONER ARTERLER (ALCAPA VE ARCAPA)

BÖLÜM
49

Sertaç HAYDIN [1]
Ismihan Selen ONAN [2]

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İçindekiler

- GİRİŞ
- TARİHÇE
- ANATOMİ VE PATOFİZYOLOJİ
- KLİNİK BULGULAR VE TANI
- TANI YÖNTEMLERİ:
  - Transtorasik Ekokardiyografi (TTE)
  - BT koroner anjiyografi (CCTA)
  - Manyetik Rezonans Görüntüleme (CMR)
  - İnvazif koroner anjiyografi
  - Fonksiyonel Testler (Stres Ekokardiyografi, Nükleer perfüzyon görüntüleme)
- EŞLİK EDEN ANOMALİLER
- CERRAHİ TEDAVİ
  - Endikasyon
  - ALCAPA Cerrahi Yönetimi:
  - ARCAPA Cerrahi Yönetimi:
  - ASCAPA Cerrahi Yönetimi:
  - Operasyon Teknikleri
  - İki arterli koroner sistemin geliştirilmesi
  - Miyokardiyal Koruma:
  - Özel Durumlar
  - Uzun Dönem Takip
  - Sonuç

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Özel Durumlar

- **ASCAPA'da KPB Stratejisi:** Tek koroner arter trunkusunun pulmoner arterden ayrılması ve aortaya yönlendirilmesi daha uzun KPB süreleri ve özelleştirilmiş miyokardiyal koruma stratejileri gerektirir. Bu vakalarda, ek kannülasyon ve retrograd kardiyopleji sıklıkla kullanılır.(28)
- **Yenidoğan ve Bebeklerde KPB:** Düşük vücut ağırlığı ve immatür organ sistemleri nedeniyle, yenidoğan ve bebeklerde KPB yönetimi daha dikkatli olmalıdır. Düşük akış hızları ve hipotermik stratejiler tercih edilir.(21)
- **Postoperatif Bakım:** İnotropik destek, mekanik ventilasyon ve yakın hemodinamik izlem gereklidir. Miyokardiyal iyileşme genellikle hızlıdır ancak ciddi sol ventrikül disfonksiyonu olan hastalarda ek destek olarak erken dönem stabiliteyi sağlamak için ECMO veya ventrikül destek cihazı gerekebilir.(29)

Uzun Dönem Takip

Cerrahi sonrası uygulanan yönteme bağlı olarak miyokardiyal perfüzyon, LV fonksiyonları, greft açıklığı değerlendirilmelidir. Tünelleme yöntemi kullanıldı ise ana pulmoner arter açıklığı, pulmoner ve aort kapak yetersizlikleri değerlendirilmelidir. Tedavi sonrası LV fonksiyonlarında iyileşme, remodelling ile birlikte düzelme görülmektedir. ALCAPA 'da erken tanı ve cerrahi tedavi ile uzun dönem sonuçlar genellikle iyidir. Ancak, geç tanı alan vakalarda sol ventrikül disfonksiyonu ve mitral yetmezlik kalıcı olabilir.(29) Güncel çalışmalar, cerrahi tedavi sonrası 10 yıllık sağkalım oranlarının %95'in üzerinde olduğunu göstermektedir.(26) ARCAPA'da ise prognoz genellikle daha iyidir ve cerrahi tedavi sonrası komplikasyonlar nadirdir. Uzun dönem takiplerde, hastaların büyük çoğunluğu asemptomatiktir ve normal bir yaşam sürerler.(21)

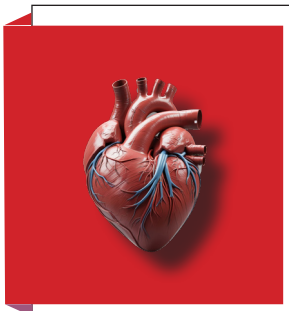
SONUÇ

ALCAPA ve ARCAPA, erken tanı ve cerrahi tedavi ile başarılı bir şekilde yönetilebilen konjenital kalp anomalileridir. İleri derecede bozuk sol ventrikül fonksiyonları durumunda dahi mortalite ve morbidite düşüktür.(18,27) Sonuçlar mükemmel derecede iyi olsa da ameliyat sonrası mekanik destek gerektiren hastalar transplantasyon, özellikle mitral yetersizlik nedenli reoperasyon için yüksek risklidir.(19) Mitral yetersizliğinin çoğu fonksiyoneldir ve reperfüzyon sonrası düzelmektedir ancak yapısal mitral kapak anomalileri operasyon sırasında düzeltilmelidir.(20) Güncel literatür, direkt implantasyon tekniğinin uzun dönem sonuçlarının mükemmel olduğunu ve bu hastaların multidisipliner bir yaklaşımla değerlendirilmesi gerektiğini vurgulamaktadır. Uzun dönem takip özellikle sol ventrikül fonksiyonları ve mitral kapağın durumu açısından önemlidir. Reimplantasyon sonrası uzun dönem mortalite düşük olsa da hastaların prognozu belli değildir. Myokardiyal skarlar ve perfüzyon problemleri genel sol ventrikül fonksiyonlarına bakan standart ekokardiyografik inceleme ile tespit edilemeyebilir ya da gözden kaçabilir. Bu nedenle manyetik rezonans incelemesi dahil olmak üzere hastaların ömür boyu takibi önerilebilir.(28)

KAYNAKLAR

1. Peña E, Nguyen ET, Merchant N, Dennie C. ALCAPA syndrome: not just a pediatric disease. Radiographics. 2009 Mar-Apr;29(2):553-65.
2. Pena E., Nguyen E. T., Merchant N., Dennie, C. ALCAPA syndrome: Not just a pediatric disease. Radiographics 2012, 32(2), 517-530
3. Brooks SJ, Two cases of an abnormal coronary artery of the heart arising from the pulmonary artery: with some remarks upon the effect of this anomaly in producing cirsoid dilatation of the vessels. J Anat Physiol 1886;20:2
4. Abbott ME. Congenital heart disease. In Osler's modern medicine. Vol. IV. Philadelphia,1927.
5. Bland EF, White PD, Garland J. Congenital anomalies of the coronary arteries: report of an unusual case associated with cardiac hypertrophy. Am Heart J 1933;8:787.
6. Edwards JE. Functional pathology of congenital cardiac disease. Pediatr Clin North Am 1954;1:13.
7. Case RB, Morrow AG, Stainsby W, Nestor JO. Anomalous origin of the left coronary artery: the physiologic defect and suggested surgical treatment. Circulation 1958; 17:1062.
8. Sabiston DC, Neill CA Jr, Taussig HB. The direction of blood flow in anomalous left coronary artery arising from the pulmonary artery. Circulation 1960;22:591.
9. Rowe GG, Young WP. Anomalous origin of the coronary arteries with special reference to surgical treatment. J Thorac Cardiovasc Surg 1960;39:777.

10. Mustard WT. Anomalies of the coronary arteries. In Pediatric Surgery, Vol. 1. Chicago: Year Book, 1953,p.433.
11. Alley J, Horton RE, Wilson MG. The possible role of surgery in the treatment of anomalous left coronary artery. Thorax 1957;12:23.
12. Meyer BW, Stefanie G, Stiles QR, Lindesmith GG, Jones JC. A method of definitive surgical treatment of anomalous of left coronary artery. A case report. J Thorac Cardiovasc Surg 1968;56:104.
13. Takeuchi S, Imamura H, Katsumoto J, Hayashi I, Katohgi T, Yozu R, et. al. New surgical method for repair of anomalous left coronary artery from the pulmonary artery. J Thorac Cardiovasc Surg 1979; 78:7.
14. Hamilton Dİ, Ghosh PK, Donnelly RJ. An operation for anomalous origin of left coronary artery. Br Heart J 1979;41:121.
15. Wesselhoeft H, Fawcett JS, Johnson AL. Anomalous origin of the left coronary artery from the pulmonary trunk. Its clinical spectrum, pathology, and pathophysiology, based on a review of 140 cases with seven further cases. Circulation. 1968 Aug;38(2):403-25.
16. Schwartz ML, Jonas RA, Colan SD. Anomalous origin of left coronary artery from pulmonary artery: recovery of left ventricular function after dual coronary repair. J Am Coll Cardiol. 1997 Aug;30(2):547-53.
17. Williams I.A., Gersony W.M., Hellenbrand W.E. Anomalous right coronary artery arising from the pulmonary artery: A report of 7 cases and a review of the literature. Pediatric Cardiology 2015, 36(3), 543-549.
18. Lange R., Cleuziou J., Krane M., Schreiber C. Long-term results after repair of ALCAPA. European Journal of Cardio-Thoracic Surgery 2016, 50(3), 480-485.
19. Katsetos M.C., Toole R,S., Jedeikin R. ARCAPA: A case series and review of the literature. Congenital Heart Disease 2018, 13(2), 251-256.
20. Frommelt P.C., Frommelt M.A., Tweddell J.S. Echocardiographic diagnosis of anomalous left coronary artery. Journal of the American Society of Echocardiography 2011, 24(3), 249-255.
21. Chen Y., Li J., Wang H., Surgical outcomes of anomalous right coronary artery from the pulmonary artery: A single-center experience. Journal of Cardiac Surgery 2020, 35(7), 1567-1572.
22. Greil G. F., Seeger A., Miller S. Imaging of coronary artery anomalies in children. Pediatric Radiology 2014, 44(6), 675-684.
23. Angelini P., Velasco J.A., Flamm S. Coronary anomalies: Incidence, pathophysiology, and clinical relevance. Circulation 2013, 107(20), 2636-2641.
24. Writing Committee Members; Gulati M, Levy PD, Mukherjee D, Amsterdam E, Bhatt DL, Birtcher KK, Blankstein R, Boyd J, Bullock-Palmer RP, Conejo T, Diercks DB, Gentile F, Greenwood JP, Hess EP, Hollenberg SM, Jaber WA, Jneid H, Joglar JA, Morrow DA, O'Connor RE, Ross MA, Shaw LJ. 2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain: A Report of the American College of Cardiology/ American Heart Association Joint Committee on Clinical Practice Guidelines. J Cardiovasc Comput Tomogr. 2022, Jan-Feb;16(1):54-122.
25. Kottayil BP., Jayakumar K., Dharan BS., Pillai VV., Ajitkumar V., Menon S., Sanjay G. Anomalous origin of left coronary artery from pulmonary artery in older children and adults: direct aortic implantation. Ann Thorac Surg. 2011, Feb;91(2):549-53.
26. Azakie A., Russell J.L., McCrindle B.W. Anatomic repair of anomalous left coronary artery from the pulmonary artery by aortic reimplantation: Early and late outcomes. J Thorac Cardiovasc Surg 2017, 154(2), 569-576.
27. Amanda S. Thomas, MSPH, Alice Chan, MD, Bahaaldin Alsoufi, MD, Jeffrey M. Vinocur, MD, and Lazaros Kochilas, MD, MSCR. Favorable long-term outcomes can be expected after coronary artery reimplantation for ALCAPA, even in patients with severe LV dysfunction at presentation. MV operation predicted decreased risk for in-hospital mortality in patients with moderate/severe MR, but MR severity predicted neither in-hospital nor longer-term outcomes. Ann Thorac Surg 2022,113:1223-30.
28. Belli E., Roussin R., Ly M., Roubertie F., Le Bret E., Basaran M., Serraf A. Anomalous origin of the left coronary artery from the pulmonary artery associated with severe left ventricular dysfunction: results in normothermia. Ann Thorac Surg. 2010, Sep;90(3):856-60.
29. Alsoufi B., Karamlou T., McCrindle B.W. Management outcomes of anomalous left coronary artery from the pulmonary artery. Ann Thorac Surg. 2015, 99(5):1701-1708.



KORONER ARTER ÇIKIŞ ANOMALİLERİ (AAOCA)

BÖLÜM
50

Çağla CANBAY SARILAR [1]
Mehmet Sertaç ÇİÇEK [2]

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İçindekiler

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  - 7. Sonuç ve Klinik Öneriler

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4. Uzun Dönem Sonuçlar:
    - » CHSS serisine göre unroofing ve reimplantasyon sonrası 10 yıllık sağkalım oranı %95'in üzerindedir.
    - » Reoperasyon oranları %5'in altındadır.
    - » MR'da fibrozis saptanan ancak yeniden iskemi göstermeyen hastalarda klinik prognoz genellikle iyidir.

7. Sonuç ve Klinik Öneriler

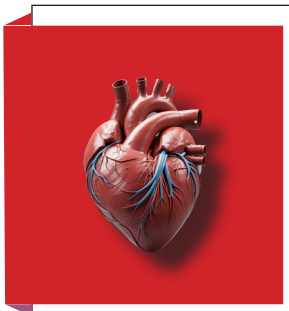
Koroner arter çıkış anomalilerinin cerrahi yönetimi, anatomik varyantlara ve hastanın fonksiyonel bulgularına göre dikkatle planlanmalıdır. Her bir cerrahi teknik kendi içinde belirli avantajlar taşısa da, seçim hasta bazında bireyselleştirilmelidir.

1. En fizyolojik ve anatomik düzeltme sağlayan teknik reimplantasyondur. Bu kitap bölümünün yazarları, yeterli deneyim ve uygun anatomik şartlar sağlandığında reimplantasyonu öncelikli seçenek olarak kabul etmektedir.
2. Unroofing, özellikle intramural segmenti olan ve anatomik olarak uygun olgularda güvenilir ve etkili bir tekniktir. Teknik olarak daha kısa sürede uygulanabilir ve başarı oranı yüksektir.
3. Ostiyoplasti, slit ostiumu olan ve açıklığın yeterince genişletilemediği durumlarda tamamlayıcı bir yöntem olarak değerlidir.
4. Pulmoner arter transpozisyonu, intramural segmenti olmayan ancak ostiumların birbirine yakın olduğu veya tek koroner arter varlığında iskemi saptanan olgularda seçilmiş bir cerrahi opsiyondur.
5. Koroner arter bypass greftleme (CABG), rekonstrüktif tekniklerin uygulanamadığı, intraoperatif komplikasyon gelişen veya erişkin hastalarda eşlik eden aterosklerotik hastalık varlığında düşünülebilecek sınırlı bir yöntemdir.

Sonuç olarak, cerrahi tedavi planı anatomik tip, fonksiyonel değerlendirme, cerrahi tecrübe ve hasta yaşına göre şekillendirilmelidir. Amacımız, anatomik düzeltmeyi fizyolojik bütünlük içinde sağlayarak, uzun dönem sağkalımı ve yaşam kalitesini artırmaktır.

KAYNAKLAR

1. WC Roberts , AH Kragel. Anomalous origin of either the right or left main coronary artery from the aorta without coursing of the anomalistically arising artery between aorta and pulmonary trunk. Am J Cardiol 1988; 62(17):1263-7.
2. Brothers JA, Frommelt MA, Jaquiss RDB et al. Expert consensus guidelines: Anomalous aortic origin of a coronary artery. J Thorac Cardiovasc Surg. 2017; 153(6):1440-1457.
3. Cheezum MK, Liberthson RR, Shah NR et al. Anomalous Aortic Origin of a Coronary Artery From the Inappropriate Sinus of Valsalva. J Am Coll Cardiol. 2017; 69(12):1592-1608.
4. Basso C, Maron BJ, Corrado D et al. Clinical profile of congenital coronary artery anomalies with origin from the wrong aortic sinus leading to sudden death in young competitive athletes. J Am Coll Cardiol. 2000; 35(6):1493–1501.
5. Van Hare GF, Ackerman MJ, Evangelista JK et al. Eligibility and Disqualification Recommendations for Competitive Athletes With Cardiovascular Abnormalities: Task Force 4: Congenital Heart Disease: A Scientific Statement From the American Heart Association and American College of Cardiology. J Am Coll Cardiol 2015; 66(21):2372–2384.
6. Angelini P, Walmsley RP, Liberos A et al. Symptomatic Anomalous Origination of the Left Coronary Artery from the Opposite Sinus of Valsalva. Tex Heart Inst J 2006;33(2):171–179.
7. Stout KK, Daniels CJ, Aboulhosn JA et al. 2018 AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Circulation. 2019; 73(12):1494-1563
8. Baumgartner H, De Backer J, Babu-Narayan SV et al. ESC Guidelines for the management of congenital heart disease. Eur Heart J 2021; 42(6):563-645.
9. Mainwaring RD, Reddy VM, Reinhartz O et al. Surgical repair of anomalous aortic origin of a coronary artery. Eur J Cardiothorac Surg 2014;46(1):20-6.
10. Jegatheeswaran A, Devlin PJ, Williams GW et al. Outcomes after anomalous aortic origin of a coronary artery repair: A Congenital Heart Surgeons' Society Study. J Thorac Cardiovasc Surg. 2020;160(3):757-771.
11. Mery CM, De Leon LE, Molossi S et al. Outcomes of surgical intervention for anomalous aortic origin of a coronary artery: A large contemporary prospective cohort study J Thorac Cardiovasc Surg. 2018; 155(1):305-319.
12. Fedoruk LM, Kern JA, Peeler BB et al. Anomalous origin of the right coronary artery: right internal thoracic artery to right coronary artery bypass is not the answer. J Thorac Cardiovasc Surg. 2007; (133):456-60.



A. KORONER ARTER ANEVRİZMALARI

BÖLÜM
51

Hakan CEYRAN [1]
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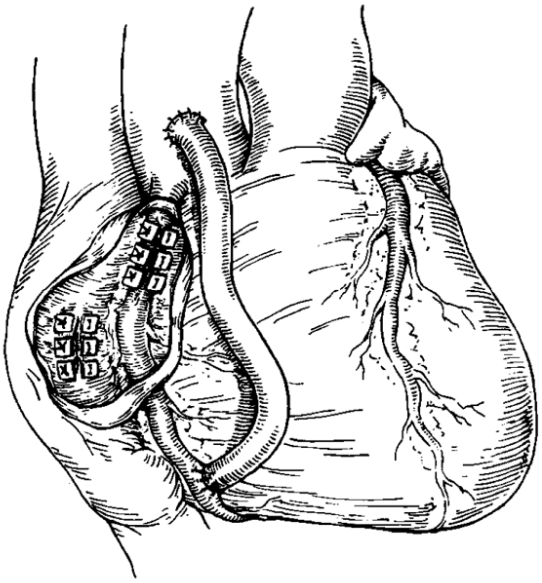
rülebilir. Elektrokardiyografide iskemik değişikliğe sekonder sonuçlar saptanabilir.



Şekil 3. *Sağ koroner arterdeki ve sağ atriyumdaki defektin aralıklı pledgetli sütürlerle kapatılmış hali. Koroner arterin devamlılığı safen ven bypass greft ile sağlanmıştır.*

Koroner arter anevrizmasının komplikasyonları arasında tromboz, embolizasyon, rüptür,- miyokardiyal iskemi ve vazospazm yer alır(1). Sakküler anezrizmaların komplikasyon oranı fusiforma göre daha yüksektir. Koroner arter anevrizmalarının üçte biri obstrüktif koroner arter hastalığına neden olur ve miyokard enfarktüsü, aritmi veya ani kardiyak ölüme yol açabilir(16). Bunun altında yatan mekanizma genelde anevrizma içinde türbülan akım gelişip tromboz oluşturduktan sonra distal embolizasyona neden olmasıdır.

Tedavi seçenekleri medikal, perkütan transkateter ya da cerrahidir. Medikal olarak antikoagülan ve antitrombosit ilaçlar kullanılır ve amaç tromboembolik komplikasyonları önlemektir. Perkütan girişimler uygun hastalarda kullanılabilir fakat anevrizma bölgesinin yanındaki koroner arter dalların kapanması, stent trombozu ve tekrarlayan restenoz gibi komplikasyonlar nispeten yüksek oranda görülür(17,18). İlaç salınımlı stentlerin kendisinin de anevrizma oluşumuna neden olduğu gösterilmiştir(19).

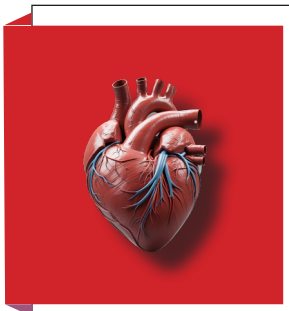
Cerrahi tedavi güvenilir ve sonuçları iyi(9,19-21) olup endikasyonları şunlardır: ciddi koroner stenoz, fistül oluşumu, kalp odacıklarına bası, anevrizma veya psödoanevrizmanın hızla artan boyutu nedeniyle yüksek rüptür olasılığı ve transkateter koroner müdahaleden sonra gelişen her türlü anevrizma(22,23).

Rekonstruksiyon, rezeksiyon, ligasyon ve eşlik eden koroner bypass gibi çeşitli cerrahi stratejiler benimsenmiştir(11,12,19,24-26). En sık kullanılan teknik şöyledir; anevrizma rezeke edilir, genellikle o segmentteki patolojik koroner arter duvarının rekonstruksiyonu mümkün olmadığı için koroner arter sütür ligasyonunu takiben koroner bypass yapılır(27). Greft olarak; patent kalma oranı yüksek olmasına ek olarak çocuklarda kullanıldığında büyüme potansiyeli olduğu için ilk tercih uygunsa internal mammarian arterdir. Kawasaki hastalarında koroner arter stenozu da sık görüldüğü için bypass daha yaygın bir seçenektir(28). Ters safen ven greftinin interpozisyonu da tekniklerden biridir; laminer koroner arter akımın korunmasını sağlar, böylece proksimal veya distal ligasyon nedeniyle miyokardiyal iskemi oluşma riskini ortadan kaldırır(29). Bu tekniğin uygulayabilmek için, anevrizmektomiden sonra koroner arterin proksimal ve distal uçlarının anatomisinin uygun ve koroner arter ile safen ven greftinin boyutlarının benzer olması önemlidir.

KAYNAKLAR

1. Syed M, Lesch M. Coronary artery aneurysm: A review. Prog Car- diovasc Dis. 1997;40:77-84.
2. Nunez-Gil IJ, Nombela-Franco L, Bagur R, Bollati M, Cerrato E, Alfonso E, et al. Rationale and design of a multicenter, international and collaborative Coronary Artery Aneurysm Registry. Clin Cardiol. 2017;40:580-5.
3. Mawatari T, Koshino T, Morishita K, Komatsu K, Abe T. Successful surgical treatment of giant coronary artery aneurysm with fistula. Ann Thorac Surg. 2000;70:1394-7.
4. Chen CC, Hwang B, Husing MC, Chiang BN, Meng, LC, Wang DJ, et al. Recognition of coronary fistula by Doppler two-dimensional echo- cardiography. Am J Cardiol. 1984;53:392-4.
5. Lepojarvi M, Salmela E, Huikuri H, Karkola P. Repair of an aneurysm of the left main coronary artery. Ann Thorac Surg. 1996;61:1247-9.

6. Topaz O, DiSciascio G, Cowley MJ, Goudreau E, Soffer A, Nath A, et al. Angiographic features of the left main coronary artery aneurysms. Am J Cardiol. 1991;67:1139-42.
7. Tadokoro N, Fukushima S, Shimahara Y, Saito T, Kawamoto N, Shimizu H, Fujita T. Surgical exclusion of an idiopathic saccular aneurysm in the left main trunk of the coronary artery. Surg Today. 2021;51:1464-70.
8. Turkay C, Golbasi I, Sahin N, Kabukcu M, Bayezid O. Surgical management of an atherosclerotic aneurysm of the left main coronary artery. J Thorac Cardiovasc Surg. 2001;122:626-7.
9. Gziut AI, Gil RJ. Coronary aneurysms. Pol Arch Med Wewn. 2008;118:741-6.
10. Nichols L, Lagana S, Parwani A. Coronary artery aneurysm: a review and hypothesis regarding etiology. Arch Pathol Lab Med. 2008;132:823-8.
11. Kawsara A, Nunez Gil IJ, Alqahtani F, Moreland J, Rihal CS, Alkhouli M. Management of Coronary Artery Aneurysms. JACC Cardiovasc Interv. 2018;11:1211-23.
12. Murthy PA, Mohammed TL, Read K, Gilkeson RC, White CS. MDCT of coronary artery aneurysms. AJR Am J Roentgenol. 2005;184:19-20.
13. Li D, Wu Q, Sun L, Song Y, Wang W, Pan S, Luo G, Liu Y, Qi Z, Tao T, Sun JZ, Hu S. Surgical treatment of giant coronary artery aneurysm. J Thorac Cardiovasc Surg. 2005;130:817-21.
14. Indolfi C, Achille F, Tagliamonte G, Spaccarotella C, Mongiardo A, Ferraro A. Polytetrafluoroethylene stent deployment for a left anterior descending coronary aneurysm complicated by late acute anterior myocardial infarction. Circulation. 2005;112:70–1.
15. Bell MR, Garratt KN, Bresnahan JF, Edwards WD, Holmes DR Jr. Relation of deep arterial resection and coronary artery aneurysms after directional coronary atherectomy. J Am Coll Cardiol. 1992;20:1474–81.
16. Mavroudis C, Backer CL, Duffy CE, Pahl E, Wax DF. Pediatric coronary artery bypass for Kawasaki congenital, post arterial switch, and iatrogenic lesions. Ann Thorac Surg. 1999;68:506-12.
17. Yamaguchi H, Yamauchi H, Yamada T, Ariyoshi T. Surgical repair of coronary artery aneurysm after percutaneous coronary intervention. Jpn Circ J. 2001;65:52–5.
18. Harandi S, Johnston SB, Wood RE, Roberts WC. Operative therapy of coronary arterial aneurysm. Am J Cardiol. 1999;83:1290-3.
19. Schachinger V, Hamm CW, Munzel T, Haude M, Baldus S, Grube E, et al. A randomized trial of polytetrafluoroethylenemembrane covered stents compared with conventional stents in aortocoronary saphenous vein grafts. J Am Coll Cardiol. 2003;42:1360–9.
20. Bajaj S, Parikh R, Hamdan A, Bikkina M. Covered-stent treatment of coronary aneurysm after drug-eluting stent placement: case report and literature review. Tex Heart Inst J. 2010;37:449–54.
21. Li H, Yu H, Song Y, Tong L, Zhao M, Borovjagin AV, Dong N, Wu L. Successful Surgical Treatment of a Giant Left Coronary Artery Aneurysm with Fistula. Heart Surg Forum. 2021;24:868-9.
22. Abou Sherif S, Ozden Tok O, Taşköylü Ö, Goktekin O, Kilic ID. Coronary Artery Aneurysms: A Review of the Epidemiology, Pathophysiology, Diagnosis, and Treatment. Front Cardiovasc Med. 2017;4:24.
23. Beckmann E, Rustum S, Marquardt S, Merz C, Shrestha M, Martens A, Haverich A, Ismail I. Surgical treatment of coronary artery aneurysms. J Card Surg. 2017;32:674-9.
24. Singh SK, Goyal T, Sethi R, Chandra S, Devenraj V, Rajput NK, Kaushal D, Tewarson V, Gupta S, Kumar S. Surgical treatment for coronary artery aneurysm: a single-centre experience. Interact Cardiovasc Thorac Surg. 2013;17:632-6.
25. Yanase Y, Ohkawa A, Numaguchi R, Sato H, Yasuda N, Kuroda Y, Harada R, Ito T, Doi H, Kawaharada N. Surgical resection of the giant right coronary artery aneurysm. J Card Surg. 2019;34:143-6.
26. Soletti GJ, Lau C, Cancelli G, Robinson NB, Audisio K, Girardi LN, Gaudino M. Surgical repair of a giant coronary artery aneurysm. J Card Surg. 2021;36:3396-8.
27. Rizzo M, Davoli G, Montesi G. Giant right coronary artery aneurysm: the saphenous vein bridge technique. Multimed Man Cardiothorac Surg. 2023;28:2023.
28. Špunda R, Horák J, Tomašov P, Lambert L, Špaček M, Slautin A, Prskavec T, Lindner J. Surgical repair of a coronary artery aneurysm associated with coronary artery fistula - a case report. J Int Med Res. 2021;49:3000605211053228.
29. Kuroda Y, Uchida T, Hamasaki A, Yamashita A, Mizumoto M, Akabane K, Ishizawa A, Sadahiro M. Surgical Treatment for a Super-Giant Right Coronary Artery Aneurysm Induced by Kawasaki Disease. Braz J Cardiovasc Surg. 2021;36:433-5.



B. KORONER ARTER FİSTÜLLERİ

BÖLÜM
51

Hakan CEYRAN [1]
Görkem ÇİTOĞLU [2]

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İçindekiler

» GIRIŞ
» ETİYOLOJİ
» EPİDEMİYOLOJİ
» MORFOLOJİ
» HİSTOPATOLOJİ
» PATOFİZYOLOJİ
» SEMPTOMLAR
» KOMPLİKASYONLAR
» TEŞHİS
» AYIRICI TANI
» TEDAVİ
» CERRAHİ TEKNİK
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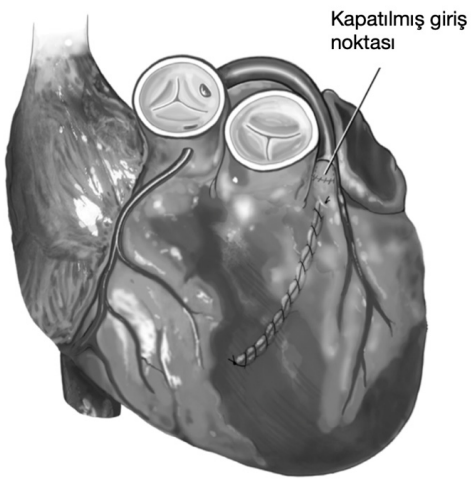
lıdır, eğer lümen dışından kapatılırsa rekürrens gelişebilir (41).

Kameral fistüllerde, fistül tam lokalize edilemiyor ya da fistülün kapatılması bir koroner arter dalını riske ediyorsa KPB kullanılarak fistülün sonlandığı odacık içinden fistül kapatılmalıdır. Buna örnek olarak; fistül sağ atriyuma, sağ ventriküle veya pulmoner artere açılıyorsa, KPB kullanarak distal açıklığı direkt görerek kapatmak gerekebilir. Fistül; sağ atriyuma ya da sağ ventriküle açılıyorsa bikaval venöz kanülasyon, pulmoner artere açılıyorsa atriyokaval tek venöz kanülasyon genellikle yeterlidir. Standart oblik sağ atriyotomi ya da vertikal pulmoner arteriyotomi yapılır ve fistülün orifisi lokalize edilir. Bazen birden çok orifis olabilir. Bu segment devamlı dikiş tekniği ya da tek tek pledgetli horizontal matriks sütür tekniği ile kapatılır. Aortik kross klemp koymadan fistüle kan akımını görerek bu işlem yapılabilir ya da alternatif olarak aort klempe edilir. Sol atriyum ya da sol ventriküle açılan fistüllerde fistül odacık içinden kapatılacaksa atriyokaval tek venöz kanülasyon yeterli olup her koşulda aort klempe edilmelidir. Kardiyopleji verirken fistülü manuel basısı ile kapatmak koroner arterlere kardiyoplejik solüsyonun debisini artıracağı için miyokardın korunmasına katkı sağlar. Kardiyak arrest sonrası fistülün sonlandığı yeri tespit etmekte ek antegrad kardiyopleji vermek kolaylık sağlar.



Şekil 3. *Sol koroner arterden sağ ventriküle açılan fistülün, sağ ventrikül insizyonu ile lokalize edildikten sonra, kapatılmış hali.*

Büyük bir anevrizma mevcut ise eksize edilmelidir. Koroner arter fistülden sonra devam ediyorsa anevrizma duvarı eksize edildikten sonra tekrar sütüre edilerek koroner arterin ön duvarı uygun çapta oluşturulur. Anevrizma koroner arterin uzun bir segmentini içeriyorsa, anevrizma duvarı eksize edildikten sonra koroner arter anevrizmanın proksimalinden ve distalinden kapatılır, sonrasında da fistülün distalindeki sağlıklı segmente koroner arter bypass yapılması seçenekler arasındadır. Koroner arter devam etmiyorsa anevrizma tamamen çıkarılır ve güdük kapatılır.

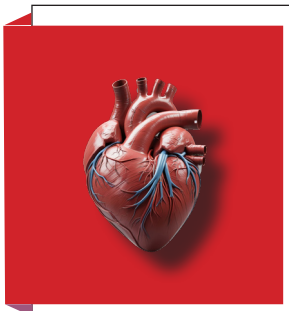
SONUÇ

Koroner arter fistülleri hem çocuklarda hem de yetişkinlerde görülen nadir anomalilerdir. Çoğunluğu konjenitaldir ve komplikasyonları önlemek için müdahale gerektirir. Fistülün kateter ile kapatılması mümkün olmayan hastalarda düşük mortalite ve morbidite ile cerrahi tedavi uygulanabilinir. En çok kullanılan yöntem ligasyon olup endokardiyal kapatma, KPB ve gerekirse aortik kross klemp kullanılarak fistülün kardiyak odacık ya da büyük vasküler yapının içerisinden kapatma dahil olmak üzere bir dizi cerrahi teknik mevcuttur.

KAYNAKLAR

1. Qureshi SA. Coronary arterial fistulas. Orphanet J Rare Dis. 2006;1:51.
2. Sunkara A, Chebrolu LH, Chang SM, Barker C. Coronary Artery Fistula. Methodist Debakey Cardiovasc J. 2017;13:78-80.
3. Reidy JF, Anjos RT, Qureshi SA, Baker EJ, Tynan MJ. Transcatheter embolization in the treatment of coronary artery fistulas. J Am Coll Cardiol. 1991;18:187-92.
4. Somers JM, Verney GI. Coronary cameral fistulae following heart transplantation. Clin Radiol. 1991;44:419-21.
5. Lim JJ, Jung JI, Lee BY, Lee HG. Prevalence and types of coronary artery fistulas detected with coronary CT angiography. AJR Am J Roentgenol. 2014;203:237-43.
6. Wilde P, Watt I. Congenital coronary artery fistulae: six new cases with a collective review. Clin Radiol. 1980;31:301-11.
7. McNamara JJ, Gross RE. Congenital coronary artery fistula. Surgery. 1969;65:59-69.
8. Levin DC, Fellows KE, Abrams HL. Hemodynamically significant primary anomalies of the coronary arteries. Angiographic aspects. Circulation. 1978;58:25-34.

9. Verdini D, Vargas D, Kuo A, Ghoshhajra B, Kim P, Murillo H, Kirsch J, Lane M, Restrepo C. Coronary-Pulmonary Artery Fistulas: A Systematic Review. J Thorac Imaging. 2016;31:380-90.
10. Kamiya H, Yasuda T, Nagamine H, Sakakibara N, Nishida S, Kawasuji M, Watanabe G. Surgical treatment of congenital coronary artery fistulas: 27 years' experience and a review of the literature. J Card Surg. 2002;17:173-7.
11. Black IW, Loo CK, Allan RM. Multiple coronary artery-left ventricular fistulae: clinical, angiographic, and pathologic findings. Cathet Cardiovasc Diagn. 1991;23:133-5.
12. Dodd JD, Ferencik M, Liberthson RR, Nieman K, Brady TJ, Hoffmann U, Cury RC, Abbara S. Evaluation of efficacy of 64-slice multidetector computed tomography in patients with congenital coronary fistulas. J Comput Assist Tomogr. 2008;32:265-70.
13. Brown MA, Balzer D, Lasala J. Multiple coronary artery fistulae treated with a single Amplatzer vascular plug: check the back door when the front is locked. Catheter Cardiovasc Interv. 2009;73:390-4.
14. Sakata N, Minematsu N, Morishige N, Tashiro T, Imanaga Y. Histopathologic Characteristics of a Coronary-pulmonary Artery Fistula with a Coronary Artery Aneurysm. Ann Vasc Dis. 2011;4:43-6.
15. Muthusamy R, Gupta G, Ahmed RA, de Giovanni J, Singh SP. Fistula between a branch of left anterior descending coronary artery and pulmonary artery with spontaneous closure. Eur Heart J. 1990;11:954-6.
16. Said SA. Current characteristics of congenital coronary artery fistulas in adults: A decade of global experience. World J Cardiol. 2011;3:267-77.
17. Liberthson RR, Sagar K, Berkoben JP, Weintraub RM, Levine FH. Congenital coronary arteriovenous fistula. Report of 13 patients, review of the literature and delineation of management. Circulation. 1979;59:849-54.
18. Said SA, Lam J, van der Werf T. Solitary coronary artery fistulas: a congenital anomaly in children and adults. A contemporary review. Congenit Heart Dis. 2006;1:63-76.
19. Skimming JW, Walls JT. Congenital coronary artery fistula suggesting a "steal phenomenon" in a neonate. Pediatr Cardiol. 1993;14:174-5.
20. Oshiro K, Shimabukuro M, Nakada Y, Chibana T, Yoshida H, Nagamine F, Sunagawa R, Gushiken M, Murakami K, Mimura G. Multiple coronary LV fistulas: demonstration of coronary steal phenomenon by stress thallium scintigraphy and exercise hemodynamics. Am Heart J. 1990;120:217-9.
21. Rämö OJ, Tötterman KJ, Harjula AL. Thrombosed coronary artery fistula as a cause of paroxysmal atrial fibrillation and ventricular arrhythmia. Cardiovasc Surg. 1994;2:720-2.
22. Challoumas D, Pericleous A, Dimitrakaki IA, Danelatos C, Dimitrakakis G. Coronary arteriovenous fistulae: a review. Int J Angiol. 2014;23:1-10.
23. Khan MD, Qureshi SA, Rosenthal E, Sharland GK. Neonatal transcatheter occlusion of a large coronary artery fistula with Amplatzer duct occluder. Catheter Cardiovasc Interv. 2003;60:282-6.
24. Hobbs RE, Millit HD, Raghavan PV, Moodie DS, Sheldon WC. Coronary artery fistulae: a 10-year review. Cleve Clin Q. 1982;49:191-7.
25. Bauer HH, Allmendinger PD, Flaherty J, Owlia D, Rossi MA, Chen C. Congenital coronary arteriovenous fistula: spontaneous rupture and cardiac tamponade. Ann Thorac Surg. 1996;62:1521-3.
26. Alkhulaifi AM, Horner SM, Pugsley WB, Swanton RH. Coronary artery fistulas presenting with bacterial endocarditis. Ann Thorac Surg. 1995;60:202-4.
27. Vitarelli A, De Curtis G, Conde Y, Colantonio M, Di Benedetto G, Pecce P, De Nardo L, Squillaci E. Assessment of congenital coronary artery fistulas by transesophageal color Doppler echocardiography. Am J Med. 2002;113:127-33.
28. Sharland GK, Tynan M, Qureshi SA. Prenatal detection and progression of right coronary artery to right ventricle fistula. Heart. 1996;76:79-81.
29. Varghese A, Keegan J, Pennell DJ. Cardiovascular magnetic resonance of anomalous coronary arteries. Coron Artery Dis. 2005;16:355-64.
30. Hofbeck M, Wild F, Singer H. Improved visualisation of a coronary artery fistula by the "laid-back" aortogram. Br Heart J. 1993;70:272-3.
31. Reidy JF, Jones OD, Tynan MJ, Baker EJ, Joseph MC. Embolisation procedures in congenital heart disease. Br Heart J. 1985;54:184-92.
32. Perry SB, Rome J, Keane JF, Baim DS, Lock JE. Transcatheter closure of coronary artery fistulas. J Am Coll Cardiol. 1992;20:205-9.
33. Kassaian SE, Mahmoodian M, Salarifar M, Alidoosti M, Abbasi SH, Rasekh A. Stent-graft exclusion of multiple symptomatic coronary artery fistulae. Tex Heart Inst J. 2007;34:199-202.
34. Sadiq M, Wilkinson JL, Qureshi SA. Successful occlusion of a coronary arteriovenous fistula using an Amplatzer duct occluder. Cardiol Young. 2001;11:84-7.
35. Van Den Brand M, Pieterman H, Suryapranata H, Bogers AJ. Closure of a coronary fistula with a transcatheter implantable coil. Cathet Cardiovasc Diagn. 1992;25:223-6.
36. Skimming JW, Gessner IH, Victorica BE, Mickle JP. Percutaneous transcatheter occlusion of coronary artery fistulas using detachable balloons. Pediatr Cardiol. 1995;16:38-41.
37. Albeyoglu S, Aldag M, Ciloglu U, Sargin M, Oz TK, Kutlu H, Dagsali S. Coronary Arteriovenous Fistulas in Adult Patients: Surgical Management and Outcomes. Braz J Cardiovasc Surg. 2017;32:15-21.
38. Mavroudis C, Backer CL, Rocchini AP, Muster AJ, Gevitz M. Coronary artery fistulas in infants and children: a surgical review and discussion of coil embolization. Ann Thorac Surg. 1997;63:1235-42.
39. Wang S, Wu Q, Hu S, Xu J, Sun L, Song Y, Lu F. Surgical treatment of 52 patients with congenital coronary artery fistulas. Chin Med J (Engl). 2001;114:752-5.
40. Said SM, Burkhart HM, Schaff HV, Connolly HM, Phillips SD, Suri RM, Eidem B, Rihal CS, Dearani JA. Late outcome of repair of congenital coronary artery fistulas--a word of caution. J Thorac Cardiovasc Surg. 2013;145:455-60.
41. Urrutia-S CO, Falaschi G, Ott DA, Cooley DA. Surgical management of 56 patients with congenital coronary artery fistulas. Ann Thorac Surg. 1983;35:300-7.



HETEROTAKSİ SENDROMU VE DİĞER LATERALİTE BOZUKLUKLARI

BÖLÜM
52

Serdar BAŞGÖZE [1]

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İçindekiler

- GİRİŞ
- ATRİYAL YERLEŞİM
- ATRİYUMLARIN DEĞİL ATRİYUM APENDAJLARININ İZOMERZMİ
- VENTRİKÜLER TOPOLOJİ (VENTRİKÜLER LOOP) VE ATRİYOVENTRİKÜLER BAĞLANTI
- VENTRİKÜLO-ARTERYEL BAĞLANTI
- KALBİN POZİSYONU VE APEKSİN ORYANTASYONU
- VENO-ATRİYAL BAĞLANTI
- SOL İZOMERİZM
- SAĞ İZOMERİZM
- SİTUS AMBİGUOUS
- DİĞER LATERALİTE BOZUKLUKLARI
- CERRAHİ YÖNETİM
- SİSTEMİK VENÖZ DRENAJ
- PULMONER VENÖZ DRENAJ
- ORTAK ATRİYOVENTRİKÜLER KAPAK
- POSTOPERATİF ARİTMİ

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bağlı olarak pacemaker implantasyon ihtiyacı görülürken, sağ izomerik hastalarda sıklıkla atriyal flutter ve fibrilasyon ile junctional ve ventriküler taşiaritmiler görülmektedir (21). Bu nedenle Heterotaksi hastalarında özellikle Fontan sonrası aritmiler prognozu kötüleştirmektedir (20,22).

Literatürde heterotaksi hastalarının Fontan sonuçları çelişkilidir. Çoğunlukla Fontana kadar olan dönem ve Fontan sonrası erken dönem sonuçlarının, non-heterotaksi Fontanlara nisbeten daha kötü olduğu ancak Fontan sonrası sağkalımın yine daha kötü olmakla birlikte yakın olduğu bildirilmiştir (22,24).

KAYNAKLAR

1- Solomons TWG (University of South Florida). Organic Chemistry, 2nd edn. John Wiley and Sons, Inc., New York, 1980, pp 282–283.

2- Jacobs JP, Anderson RH, Weinberg PM, Walters HL 3rd, Tchervenkov CI, Del Duca D, et al. The nomenclature, definition and classification of cardiac structures in the setting of heterotaxy. Cardiol Young. 2007 Sep;17 Suppl 2:1-28.

3- Van Praagh S, Kreutzer J, Van Praagh R. Systemic and pulmonary venous connections in visceral heterotaxy, with emphasis on the diagnosis of the atrial situs: a study of 109 postmortem cases. In: Clark EB, Takao A (eds). Developmental Cardiology: Morphogenesis and Function, 1st edn. Futura Publishing Co., Inc., Mount Kisco, NY, 1990, pp 671–727.

4- ZhuL, BelmontJW, WareSM. Geneticsofhumanheterotaxias. Eur J Hum Genet 2006; 14: 17–25.

5- Berg C, Geipel A, Kamil D, Krapp M, Breuer J, Baschat AA, et al. The syndrome of right isomerism -- prenatal diagnosis and outcome. Ultraschall Med. 2006 Jun;27(3):225-33. doi: 10.1055/s-2005-858639. Epub 2006 May 15. PMID: 16703488.

6- Huhta JC, Smallhorn JF, Macartney FJ. Two dimensional echocardiographic diagnosis of situs. Br Heart J. 1982 Aug;48(2):97-108. doi: 10.1136/hrt.48.2.97. PMID: 7093090; PMCID: PMC481212.

7- Macartney FJ. Classification and nomenclature of congenital heart defects. In: Stark J, deLeval M (eds). Surgery for congenital heart defects, 2nd edn. WB Saunders, Philadelphia, 1994,

8- Ho SY, Seo JW, Brown NA, Cook AC, Fagg NL, Anderson RH. Morphology of the sinus node in human and mouse hearts with isomerism of the atrial appendages. Br Heart J. 1995 Oct;74(4):437-42. doi: 10.1136/hrt.74.4.437. PMID: 7488461; PMCID: PMC484053.

9- Uemura H, Ho SY, Devine WA, Kilpatrick LL, Anderson RH. Atrial appendages and venoatrial connections in hearts with patients with visceral heterotaxy. Ann Thorac Surg 1995; 60: 561–569.

10- Uemura H, Ho SY, Anderson RH, Devine WA, Smith A, Shinohara T, et al. The surgical anatomy of coronary venous return in hearts with isomeric atrial appendages. J Thorac Cardiovasc Surg. 1995 Aug;110(2):436-44. doi: 10.1016/S0022-5223(95)70240-7. PMID: 7637362.

11- Anderson RH, Spicer DE, Hlavacek AM, Cook AC, Backer CL. *Wilcox's Surgical Anatomy of the Heart*. 4th ed. Cambridge University Press; 2013.

12- Banka P, Adar A, Schaetzle B, Sleeper LA, Emani S, Geva T. Changes in Prognosis of Heterotaxy Syndrome Over Time. Pediatrics. 2020 Aug;146(2):e20193345. doi: 10.1542/peds.2019-3345. Epub 2020 Jul 9. PMID: 32647064.

13- Jacobs ML, Mavroudis C. Challenges of univentricular physiology in heterotaxy. World J Pediatr Congenit Heart Surg. 2011 Apr;2(2):258-63. doi: 10.1177/2150135110396733. PMID: 23804982.

14- Chen W, Ma L, Cui H, Yang S, Xia Y, Zou M, et al. Early- and Middle-Term Surgical Outcomes in Patients with Heterotaxy Syndrome. Cardiology. 2016;133(3):141-6. doi: 10.1159/000440947. Epub 2015 Nov 17. PMID: 26571485.

15- Basgoze S, Temur B, Guvenc O, Aydin S, Guzelmeric F, Onalan MA, Erek E. Analysis of outcomes in patients with abnormal laterality undergoing congenital heart surgery. Cardiol Young. 2022 Jul;32(7):1129-1135. doi: 10.1017/S1047951121003899. Epub 2021 Oct 1. PMID: 34593080.

16- Tang E, Restrepo M, Haggerty CM, Mirabella L, Bethel J, Whitehead KK, et al. Geometric characterization of patient-specific total cavopulmonary connections and its relationship to hemodynamics. JACC Cardiovasc Imaging. 2014 Mar;7(3):215-24. doi: 10.1016/j.jcmg.2013.12.010. Epub 2014 Feb 13. PMID: 24529885; PMCID: PMC3962724.

17- Weixler VHM, Zurakowski D, Kheir J, Guariento A, Kaza AK, Baird CW, et al. Fontan with lateral tunnel is associated with improved survival compared with extracardiac conduit. J Thorac Cardiovasc Surg. 2020;159:1480-91.

18- Wei ZA, Johnson C, Trusty P, Stephens M, Wu W, Sharon R, et al. Comparison of Fontan Surgical Options for Patients with Apicocaval Juxtaposition. Pediatr Cardiol. 2020 Jun;41(5):1021-1030. doi: 10.1007/s00246-020-02353-8. Epub 2020 May 6. PMID: 32377893; PMCID: PMC7325867.

19- Rubino M, Van Praagh S, Kadoba K, Pessotto R, Van Praagh R. Systemic and pulmonary venous connections in visceral heterotaxy with asplenia. Diagnostic and surgical considerations based on seventy-two autopsied cases. J Thorac Cardiovasc Surg. 1995 Sep;110(3):641-50. doi: 10.1016/S0022-5223(95)70095-1. PMID: 7564430.

20- Kim SJ, Kim WH, Lim HG, Lee CH, Lee JY. Improving results of the Fontan procedure in patients with heterotaxy syndrome. Ann Thorac Surg. 2006 Oct;82(4):1245-51. doi: 10.1016/j.athoracsur.2006.04.082. PMID: 16996916.

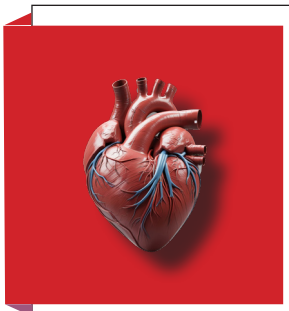
21- Loomba RS, Willes RJ, Kovach JR, Anderson RH. Chronic Arrhythmias in the Setting of Heterotaxy: Differences between Right and Left Isomerism. Congenit Heart Dis. 2016 Jan-Feb;11(1):7-18. doi: 10.1111/chd.12288. Epub 2015 Jul 29. PMID: 26219620.

22- Marathe SP, Zannino D, Cao JY, du Plessis K, Marathe SS, Ayer J, et al. Heterotaxy Is Not a Risk Factor for Adverse Long-Term Outcomes After Fontan Completion. Ann Thorac Surg. 2020 Aug;110(2):646-653. doi:

10.1016/j.athoracsur.2019.11.015. Epub 2019 Dec 28. PMID: 31891693.

23- Pundi KN, Johnson JN, Dearani JA, Pundi KN, Li Z, Hinck CA, et al. 40-Year Follow-Up After the Fontan Operation: Long-Term Outcomes of 1,052 Patients. J Am Coll Cardiol. 2015 Oct 13;66(15):1700-10. doi: 10.1016/j.jacc.2015.07.065. PMID: 26449141.

24- Marathe SP, Cao JY, Celermajer D, Ayer J, Sholler GF, d'Udekem Y, et al. Outcomes of the Fontan Operation for Patients With Heterotaxy: A Meta-Analysis of 848 Patients. Ann Thorac Surg. 2020 Jul;110(1):307-315. doi: 10.1016/j.athoracsur.2019.11.027. Epub 2020 Jan 8. PMID: 31926157.



FONKSİYONEL TEK VENTRİKÜL VE FONTAN OPERASYONU

BÖLÜM
53

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Mustafa YILMAZ [2]

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İçindekiler

» MORFOLOJİ
» FİZYOLOJİ VE HEMODİNAMİ
» PREOPERATİF DEĞERLENDİRME
» FONTAN CERRAHİSİ GELİŞİMİ
» KLASİK FONTAN
» LATERAL TÜNEL FONTAN
» EKSTRAKARDİYAK KONDUİT FONTAN
» Y-GREFT FONTAN
» İNTRA-EKSTRAKARDİYAK FONTAN
» FENESTRASYON
» ERKEN VE GEÇ DÖNEM FONTAN SONUÇLARI
  » Erken dönem
  » Geç dönem
» FONTAN YETERSİZLİĞİNDE CERRAHİ TEDAVİ
» HACETTEPE ÜNİVERSİTESİ FONTAN TECRÜBESİ

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Tablo 1. Hacettepe Üniversitesi'nde tek ventrikül hastalarında takip ettiğimiz postoperatif bakım protokolü.
Ameliyat sonrası 1. gün, 6-8 saatte bir intravenöz furosemid (1 mg/kg/doz) başlanmalı, taburcu edilmeden önce günde 2 kez oral olarak devam edilmelidir
Oral sıvılar alınmaya başlandığında: Spironolakton + Tiyazid (1 mg/kg/doz) 12 saatte bir Enalapril başlangıç dozu (0,05 mg/kg/doz) her 12 saatte bir
Enoksaparin 1 mg/kg/doz 12 saatte bir ve ASA 5 mg/kg. Taburculukta enoksaparin dozu 1 mg/kg/doz günde 1 kere ve ASA 10 mg/kg.
4 hafta boyunca sıvı ve düşük yağlı diyet (günlük kalorinin %30'u yağdan)
Sıvı kısıtlaması idamenin %80'i olacak şekilde
Tüm göğüs tüpleri çıkana kadar en az 0,5 L nazal kanül oksijen verilir
Plevral göğüs tüpleri, hasta düşük yağlı diyet alabildiğini ve minimum göğüs tüpü çıkış kriterlerini (24 saatte < 5 mL/kg) karşıladığını gösterene kadar çıkarılmaz

KAYNAKLAR

1. Anderson RH, Macartney FJ, TynanM, et al.Univentricular atrioventricular connexion—the single ventricle trap unsprung. Pediatr Cardiol 1983; 4: 273–80.
2. Anderson RH, Becker AE, Tynan M, et al. The univentricular atrioventricular connection: getting to the root of a thorny problem. Am J Cardiol 1984; 54: 822–8.
3. Jacobs ML, Mayer JE. Congenital Heart Surgery Nomenclature and Database Project: single ventricle. Ann Thorac Surg. 2000; 69(3 Suppl 1):197–204.
4. Wilkonson JL, Anderson RH. Anatomy of Functionally Single Ventricle. World J Pediatr Congenit Heart Surg. 2012; 3(2):159-64.
5. Cook AC, Anderson RH. The functionally univentricular circulation: anatomic substrates as related to function. Cardiol Young. 2005; 15(Suppl. 3):7-16.
6. Kiraly L, Hubay M, Cook AC, Ho SY, Anderson RH. Morphologic features of the uniatrial but biventricular atrioventricular connection. J Thorac Cardiovasc Surg 2007; 133: 229–34.
7. Gewillig M, Brown SC, Eyskens B, et. al. The Fontan circulation: who controls cardiac output? Interact Cardiovasc Thorac Surg. 2010;10(3):428-33.
8. Gewillig M, Brown SC. The Fontan circulation after 45 years: update in physiology. Heart. 2016;102(14):1081-6.
9. Gewillig M, Goldberg DJ. Failure of the Fontan circulation. Heart Fail Clin. 2014;10(1):105-16.
10. Gewillig M, Salaets T, Van de Bruaene A, et al. How cardiac output is controlled in a Fontan circulation: an update. Interdisciplinary CardioVascular and Thoracic Surgery. 2025;40(2), ivae183.
11. Van Puyvelde J, Rega F, Budts W, et al. Defining the causes for Fontan circulatory failure in total cavopulmonary connection patients. Interdisciplinary CardioVascular and Thoracic Surgery. 2024;39(5), ivae188.
12. Choussat A, Fontan F, Besse P, et al. Selection criteria for Fontan's procedure. In: Anderson RH, Shinebourne EA, editors. Paediatric cardiology. Edinburgh: Churchill Livingstone; 1977. p. 559–66.
13. Wallace MC, Jaggers J, Li JS, et al.Center variation in patient age and weight at Fontan operation and impact on postoperative outcomes. Ann Thorac Surg 2011;91(5):1445–52
14. Schwartz L, Mc Cracken CE, et al. Late outcomes after the Fontan procedure in patients with single ventricle: a meta-analysis. Heart Br Card Soc 2018;104(18):1508–14.
15. Cao JY, Marathe SP, Zannino D, et al. Fontan operation at less than 3 years of age is not a risk factor for long-term failure. Eur J CardioThorac Surg 2022;61(3):497–504.
16. Lemley BA, Okunowo O, Ampah SB, et al. Effect of patient factors, center, and era on Fontan timing: An observational study using the Pediatric Health Information Systems Database. Am Heart J. 2024 May;271:156-163.
17. Mahle WT, Wernovsky G, Bridges ND, et al. Impact of early ventricular unloading on exercise performance in preadolescents with single ventricle Fontan physiology. J Am Coll Cardiol 1999;34(5):1637–43.
18. Bolin EH, Maskatia SA, Tate AL, et al. Older age at completion of Fontan procedure is associated with improved percentage of predicted maximum oxygen uptake. Tex Heart Inst J 2015;42(4):333–40.
19. Shiraishi S, Yagihara T, Kagisaki K, et al. Impact of age at Fontan completion on postoperative hemodynamics and long-term aerobic exercise capacity in patients with dominant left ventricle. Ann Thorac Surg 2009;87(2):555–60.
20. Van Hare GF. Challenges in ablation of complex congenital heart disease. Card Electrophysiol Clin2019;11(4):711–8.
21. Sughimoto K, Konstantinov IE, Brizard CP, et al. Polytetrafluoroethylene bridge for atrioventricular valve repair in single-ventricle palliation. J Thorac Cardiovasc Surg. 2015;149(2): 641–643.
22. King G, Ayer J, Celermajer D, et al. Atrioventricular valve failure in Fontan palliation. J Am Coll Cardiol. 2019;73(7):810–822.
23. Stephens EH, Dearani JA. Management of the bad atrioventricular valve in Fontan time for a change. J Thorac Cardiovasc Surg. 2019;158(6):1643–1648.
24. Hosein RB, Clarke AJ, McGuirk SP, et al. Factors influencing early and late outcome following the Fontan procedure in the current era. The 'Two Commandments'? Eur J Cardiothorac Surg. 2007 Mar;31(3):344-52.

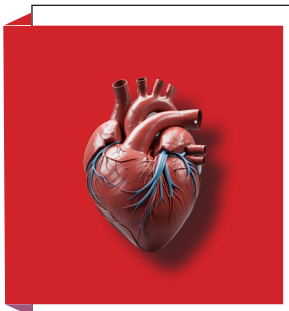
25. Lam CZ, Nguyen ET, Yoo SJ, Wald RM. Management of patients with single-ventricle physiology across the lifespan: contributions from magnetic resonance and computed tomography imaging. Can J Cardiol 2022;38(7):946–62.
26. Ro PS, Rychik J, Cohen MS, Mahle WT, Rome JJ. Diagnostic assessment before Fontan operation in patients with bidirectional cavopulmonary anastomosis: are noninvasive methods sufficient? J Am Coll Cardiol 2004;44(1):184–7.
27. Mohammad Nijres B, Murphy JJ, Diab K, Awad S, Abdulla RI. Routine cardiac catheterization prior to Fontan operation: is it a necessity? Pediatr Cardiol 2018;39(4):818–23.
28. Banka P, McElhinney DB, Bacha EA, Mayer JE, Gauvreau K, Geva T, et al. What is the clinical utility of routine cardiac catheterization before a Fontan operation? Pediatr Cardiol 2010;31(7):977–85.
29. Hill G, Wu D, Ferguson M, et al. Preoperative hemodynamics impact the benefit of fenestration on Fontan postoperative length of stay. JACC Adv 2024;3, 100846.
30. Ro PS, Rychik J, Cohen MS, et al. Diagnostic assessment before Fontan operation in patients with bidirectional cavopulmonary anastomosis: are noninvasive methods sufficient? J Am Coll Cardiol 2004;44(1):184–7.
31. Tabbutt S, Ghanayem N, Ravishankar C, et al. Risk factors for hospital morbidity and mortality after the Norwood procedure: a report from the Pediatric Heart Network Single Ventricle Reconstruction trial. J Thorac Cardiovasc Surg 2012;144(4):882–95.
32. Peacock TB. Malformations consisting in arrest of development ocurring at an early period of foetal life. In: On malformations of the human heart, etc: with original cases and illustrations. London: John Churchill and Sons; 1866. p. 14–32.
33. Abbott M. Atlas of congenital heart disease. New York Heart Association, New York; 1936.
34. Taussig H, Blalock A. Surgery of congenital heart disease. Br Med J. 1947;2(4524):462.
35. Gibbon JH Jr, et al. The closure of interventricular septal defects in dogs during open cardiotomy with the maintenance of the cardiorespiratory functions by a pump-oxygenator. J Thorac Surg. 1954;28(3):235–40.
36. Kirklin JW, et al. Studies in extracorporeal circulation. I. Applicability of Gibbon-type pump-oxygenator to human intracardiac surgery: 40 cases. Ann Surg. 1956;144(1):2–8.
37. Starr I, Jeffers W, Meade R. The absence of conspicuous increments of venous pressure after severe damage to the right ventricle of the dog, with a discussion of the relation between clinical congestive failure and heart disease. Am Heart J. 1943;26(3):291–301.
38. Bakos ACP. The question of the function of the right ventricular myocardium: an experimental study. Circulation. 1950;1(4):724–32.
39. Rodbard S, Wagner D. By-passing the right ventricle. Proc Soc Exp Biol Med. 1949;71:69–70.
40. Glenn W, Patino J. Circulatory by-pass of the right heart. 1. Preliminary observations on the direct deliv- ery of vena caval blood into the pulmonary arterial circulation. Azygous vein-pulmonary artery shunt. Yale J Biol Med. 1954;27:147–51.
41. Glenn WWL. Circulatory bypass of the right side of the heart. N Engl J Med. 1958;259(3):117–20.
42. Azzolina G, Eufrate S, Pensa P. Tricuspid atresia: experience in surgical management with a modified cavopulmonary anastomosis. Thorax. 1972;27(1):111–5.
43. di Carlo D, et al. The role of cava-pulmonary (Glenn) anastomosis in the palliative treatment of congenital heart disease. J Thorac Cardiovasc Surg. 1982;83(3):437–42.
44. Kopf GS, et al. Thirty-year follow-up of superior vena cava-pulmonary artery (Glenn) shunts. J Thorac Cardiovasc Surg. 1990;100(5):662–71.
45. Meijboom FJ., Bogers AJJC. Univentriculair hart en de Fontan-circulatie. Aangeboren hartafwijkingen bij volwassenen. 2013; 169-184.
46. Fontan F, Baudet E. Surgical repair of tricuspid atresia. Thorax. 1971;26(3):240–8.
47. Said SM, Burkhart HM, Dearani JA. The Fontan connections: past, present, and future. World Journal for Pediatric and Congenital Heart Surgery. 2012; 3(2), 171-182.
48. Kreutzer G, Galíndez E, Bono H, De Palma C, Laura JP. An operation for the correction of tricuspid atresia. J Thorac Cardiovasc Surg. 1973;66:613–21.
49. Björk VO, Olin CL, Bjarke BB, Thore ´n CA. Right atrial-right ven- tricular anastomosis for correction of tricuspid atresia. J Thorac Cardiovasc Surg. 1979;77(3):452-458.
50. Fontan F, Deville C, Quaegebeur J, Ottenkamp J, Sourdille N, Choussat A, Brom GA. Repair of tricuspid atresia in 100 patients. J Thorac Cardiovasc Surg. 1983;85:647–60.
51. de Leval MR, et al. Total cavopulmonary connection: a logical alternative to atriopulmonary connection for complex Fontan operations. Experimental studies and early clinical experience. J Thorac Cardiovasc Surg. 1988;96(5):682–95.
52. Puga FJ, Chiavarelli M, Hagler DJ. Modifications of the Fontan operation applicable to patients with left atrioventricular valve atresia or single atrioventricular valve. Circulation. 1987;76:III53–60.
53. Douglas WI, Goldberg CS, Mosca RS, Law IH, Bove EL. Hemi- Fontan procedure for hypoplastic left heart syndrome: outcome and suitability for Fontan. Ann Thorac Surg. 1999;68(4):1361–1367.
54. Hirsch-Romano JC, Bove EL, Si MS, Ohye RG. Modified Hemi-Fontan procedure. Oper Tech. Thorac Cardiovasc Surg. 2013;18(2):117–123.
55. Spray, TL. Hemi-Fontan procedure. Operative Techniques in Thoracic and Cardiovascular Surgery. 2013;18(2), 124-137.
56. d'Udekem Y, Iyengar AJ, Galati JC, et al. Redefining expectations of long-term survival after the Fontan procedure: twenty-five years of follow-up from the entire population of Australia and New Zealand. Circulation. 2014;130:S32–8.
57. Jacobs JP, Maruszewski B. Functionally univentricular heart and the fontan operation: lessons learned about patterns of practice and outcomes from the congenital heart surgery databases of the European association for cardio-thoracic surgery and the society of thoracic surgeons. World J Pediatr Congenit Heart Surg. 2013;4:349–55.
58. Ota N, Fujimoto Y, Murata M, Tosaka Y, Ide Y, Tachi M, Ito H, Sugimoto A, Sakamoto K. Impact of postoperative hemodynamics in patients with functional single

ventricle undergoing Fontan com- pletion before weighing 10 kg. Ann Thorac Surg. 2012;94:1570–7.
59. Lasa JJ, Glatz AC, Daga A, Shah M. Prevalence of arrhythmias late after the Fontan operation. Am J Cardiol. 2014;113:1184–8.
60. Balaji S, Daga A, Bradley DJ, et al. An international multicenter study comparing arrhythmia prevalence between the intracardiac lateral tunnel and the extracardiac conduit type of Fontan operations. J Thorac Cardiovasc Surg. 2014;148:576–81.
61. Weixler VHM, Zurakowski D, Kheir J, Guariento A, Kaza AK, Baird CW, Del Nido PJ, Emani SM. Fontan with lateral tunnel is associated with improved survival compared with extracardiac conduit. J Thorac Cardiovasc Surg. 2020 Apr;159(4):1480-1491.e2.
62. Daley M, d'Udekem Y. The optimal Fontan operation: Lateral tunnel or extracardiac conduit? J Thorac Cardiovasc Surg. 2021 Dec;162(6):1825-1834.
63. Humes RA, Feldt RH, Porter CJ, Julsrud PR, Puga FJ, Danielson GK. The modified Fontan operation for asplenia and polysplenia syndromes. J Thorac Cardiovasc Surg. 1988;96:212–8.
64. Marcelletti C, Mazzera E, Olthof H, Sebel PS, Düren DR, Losekoot TG, Becker AE. Fontan's operation: an expanded horizon. J Thorac Cardiovasc Surg. 1980;80:764–9.
65. Marcelletti C, et al. Inferior vena cava-pulmonary artery extracardiac conduit. A new form of right heart bypass. J Thorac Cardiovasc Surg. 1990;100(2):228–32.
66. van Brakel TJ, Schoof PH, de Roo F, Nikkels PGJ, Evens FCM, Haas F. High incidence of Dacron con- duit stenosis for extracardiac Fontan procedure. J Thorac Cardiovasc Surg. 2014;147:1568–72.
67. Alexi-Meskishvili V, Ovroutski S, Ewert P, et al. Optimal conduit size for extracardiac Fontan operation. Eur J Cardiothorac Surg. 2000;18(6):690–695.
68. Itatani K, Miyaji K, Tomoyasu T, et al. Optimal conduit size of the extracardiac Fontan operation based on energy loss and flow stag- nation. Ann Thorac Surg. 2009;88(2):565–572; discussion 572–573.
69. Cetta F, Burkhart HM. The Fontan extracardiac conduit: one size does not fit all. Transl Pediatr. 2018;7(3):233–234.
70. Goksel OS, Gok E, Tireli E, Dayioglu E. Extracardiac off-pump fontan completion for single ventricle with dextrocardia. Innovations (Phila). 2013 Jan-Feb;8(1):73-5.
71. Daley M, Reid B, d'Udekem Y. Pitfalls in extracardiac conduit Fontan technique. Operative Techniques in Thoracic and Cardiovascular Surgery. 2022;27(1), 78-90.
72. Masters JC, Ketner M, Bleiweis MS, Mill M, Yoganathan A, Lucas CL. The effect of incorporat- ing vessel compliance in a computational model of blood flow in a total cavopulmonary connection (TCPC) with caval centerline offset. J Biomech Eng. 2004;126:709–13.
73. Tang E, Restrepo M, Haggerty CM, Mirabella L, Bethel J, Whitehead KK, Fogel MA, Yoganathan AP. Geometric characterization of patient-specific total cavopulmonary connections and its relationship to hemodynamics. JACC Cardiovasc Imaging. 2014;7:215–24.
74. Hong H, Menon PG, Zhang H, Ye L, Zhu Z, Chen H, Liu J. Postsurgical comparison of pulsatile hemodynamics in five unique total cavopulmonary connections: identifying ideal connection strategies. Ann Thorac Surg. 2013 Oct;96(4):1398-1404.
75. Michielon G, Gharagozloo F, Julsrud PR, Danielson GK, Puga FJ. Modified Fontan operation in the presence of anomalies of systemic and pulmonary venous connection. Circulation. 1993;88:II141–8.
76. Morizumi S, Kato H, Kanemoto S, Noma M, Abe M, Sakakibara Y, Hiramatsu Y. Appropriate route selection for extracardiac total cavopulmonary connection in apicocaval juxtaposition. Ann Thorac Surg. 2012 Jul;94(1):179-84.
77. Imai K, Hoashi T, Shimada M, Komori M, Nakata T, Kurosaki K, Ichikawa H. Long-term Outcomes of Extracardiac Total Cavopulmonary Connection for Apicocaval Juxtaposition. Ann Thorac Surg. 2021 Oct;112(4):1326-1333.
78. Kanter KR. Alternative techniques for the Fontan operation, vol. 19. Operative Techniques; 2014. p. 64–79.
79. Vargas FJ, Mayer JE Jr, Jonas RA, Castaneda AR. Anomalous systemic and pulmonary venous connections in conjunction with atriopulmonary anastomosis (Fontan-Kreutzer). Technical considerations. J Thorac Cardiovasc Surg. 1987; 93:523-32.
80. Jonas RA. The intra/extra cardiac conduit fenestrated fontan. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2011;14:11–8.
81. Sinha P, Zurakowski D, He D, et al. Intra/extracardiac fenestrated modification leads to lower incidence of arrhythmias after the Fontan operation. J Thorac Cardiovasc Surg. 2013;145:678–82.
82. Sinha L, Ozturk M, Zurakowski D, et al. Intra-extracardiac versus extracardiac fontan modifications: comparison of early outcomes. Ann Thorac Surg. 2019;107:560–6.
83. Talwar S, Sengupta S, Choudhary SK. The intra-extracardiac Fontan: preliminary results. Indian J Thorac Cardiovasc Surg. 2020 May;36(3):193-198.
84. Menon N, Lin C, Mesia C , et al. Hemodynamic Changes and Clinical Outcomes after the Intra/Extracardiac Fenestrated Fontan Procedure. World Journal of Cardiovascular Surgery. 2018; 8, 29-39.
85. Şimşek B, Özyüksel A, Demiroluk Ş, et al. Early outcomes of fenestrated intra-extracardiac Fontan procedure: Insights, experiences, and expectations. J Card Surg. 2022 May;37(5):1301-1308.
86. Hirose K, Ikai A, Murata M, Ito H, Koshiyama H, Ishidou M, Ota K, Watanabe K, Nakatani E, Sakamoto K. Intra-Extracardiac Total Cavopulmonary Connection for Patients With Anatomical Complexity. Ann Thorac Surg. 2021 Mar;111(3):958-965.
87. Yilmaz M, Alpat S, Sabuncu T, Aydin A. Routine Use Of Intra-extracardiac Fontan Technique In Single Ventricle Palliation Pathway. Cardiology in the Young. 2023;34(1):S560.
88. Laks H, Pearl JM, Haas GS, et al. Partial Fontan: advantages of an adjustable interatrial communication. Ann Thorac Surg. 1991;52(5):1084–95.
89. Lemler MS, Scott WA, Leonard SR, et al. Fenestration improves clinical outcome of the fontan procedure: a prospective, randomized study. Circulation. 2002;105:207–12.
90. Petrossian E, Reddy VM, Collins KK, et al. The extracardiac conduit Fontan operation using minimal ap-

proach extracorporeal circulation: early and midterm outcomes. J Thorac Cardiovasc Surg. 2006;132:1054–63.
91. Rogers LS, Glatz AC, Ravishankar C, Spray TL, Nicolson SC, Rychik J, Rush CH, Gaynor JW, Goldberg DJ. 18 years of the Fontan operation at a single institution: results from 771 consecutive patients. J Am Coll Cardiol. 2012 Sep 11;60(11):1018-25.
92. Venna A, Deshpande S, Downing T, John A, d'Udekem Y. Are dynamic measurements of cen- tral venous pressure in Fontan circulation during exercise or volume loading superior to resting measurements? Cardiol Young. 2023:1–12.
93. Hill GD, Wu DTY, Ferguson ME, et al. Preoperative hemodynamics impact the benefit of fenes- tration on fontan postoperative length of stay. JACC: Adv. 2024;3:100846.
94. d'Udekem Y, Venna A. The Annoying Act of Creating a Fenestration. JACC Adv. 2024 Feb 2;3(3):100844.
95. https://www.ctsnet.org/article/modified-fontan sitesinden alınmıştır. En son 01.06.2025 tarihinde ulaşılmıştır.
96. Iyengar AJ, Winlaw DS, Galati JC, et al. Trends in Fontan surgery and risk factors for early adverse outcomes after Fontan surgery: the Australia and New Zealand Fontan Registry experience. J Thorac Cardiovasc Surg. 2014;148(2):566–575.
97. Salazar JD, Zafar F, Siddiqui K, et al. Fenestration during Fontan palliation: now the exception instead of the rule. J Thorac Cardiovasc Surg. 2010;140(1):129–136.
98. Sunstrom RE, Muralidaran A, Gerrah R, et al. A defined manage- ment strategy improves early outcomes after the Fontan procedure: the PORTLAND protocol. Ann Thorac Surg. 2015;99(1):148–155.
99. Lemler MS, Scott WA, Leonard SR, Stromberg D, Ramaciotti C. Fenestration improves clinical outcome of the Fontan procedure: a prospective, randomized study. Circulation. 2002;105(2):207–212.
100. Egbe AC, Connolly HM, McLeod CJ, Ammash NM, Niaz T, Yogeswaran V, Poterucha JT, Qureshi MY, Driscoll DJ. Thrombotic and Embolic Complications Associated With Atrial Arrhythmia After Fontan Operation: Role of Prophylactic Therapy. J Am Coll Cardiol. 2016 Sep 20;68(12):1312-9.
101. Deshaies C, Hamilton RM, Shohoudi A, Trottier H, Poirier N, Aboulhosn J, Broberg CS, Cohen S, Cook S, Dore A, Fernandes SM, Fournier A, Kay J, Mondésert B, Mongeon FP, Opotowsky AR, Proietti A, Ting J, Zaidi A, Khairy P; Alliance for Adult Research in Congenital Cardiology (AARCC). Thromboembolic Risk After Atriopulmonary, Lateral Tunnel, and Extracardiac Conduit Fontan Surgery. J Am Coll Cardiol. 2019 Aug 27;74(8):1071-1081.
102. Cheung YF, Chay GW, Chiu CS, Cheng LC. Long-term anticoagulation therapy and thromboembolic complications after the Fontan procedure. Int J Cardiol. 2005 Jul 20;102(3):509-13.
103. Firdouse M, Agarwal A, Chan AK, Mondal T. Thrombosis and thromboembolic complications in fontan patients: a literature review. Clin Appl Thromb Hemost. 2014 Jul;20(5):484-92.
104. Almond CSD, Mayer JE, Thiagarajan RR, Blume ED, del Nido PJ, McElhinney DB. Outcome after Fontan failure and take- down to an intermediate palliative circulation. Ann Thorac Surg. 2007;84(3):880–887.
105. Marathe SP, Iyengar AJ, Betts KS, et al. Long-term outcomes following Fontan takedown in Australia and New Zealand. J Thorac Cardiovasc Surg. 2021;161(3):1126–1135.
106. Khairy P, Fernandes SM, Mayer JE, et al. Long-term survival, modes of death, and predictors of mortality in patients with Fontan surgery. Circulation. 2008;117(1):85–92.
107. Pundi KN, Johnson JN, Dearani JA, et al. 40-year follow-up after the Fontan operation: long-term outcomes of 1,052 patients. J Am Coll Cardiol. 2015;66(15):1700–1710.
108. Downing TE, Allen KY, Glatz AC, et al. Long-term survival after the Fontan operation: twenty years of experience at a single center. J Thorac Cardiovasc Surg. 2017;154(1):243–253.
109. Wilson TG, Shi WY, Iyengar AJ, et al. Twenty-five year outcomes of the lateral tunnel Fontan procedure. Semin Thorac Cardiovasc Surg. 2017;29(3):347–353.
110. Hebson CL, McCabe NM, Elder RW, et al. Hemodynamic phenotype of the failing Fontan in an adult population. Am J Cardiol. 2013;112(12):1943–1947.
111. Poh C, Hornung T, Celermajer DS, et al. Modes of late mortality in patients with a Fontan circulation. Heart Br Card Soc. 2020;106(18):1427–1431.
112. Lee J, Park JJ, Goo HW, Ko JK. Fontan revision with y-graft in a patient with unilateral pulmonary arteriovenous malformation. Korean J Thorac Cardiovasc Surg. 2017;50(3):207–210.
113. Hsia TY. Taming the Fontan with the Y-graft: a nod and a wink to the great Yu. J Thorac Cardiovasc Surg. 2016;151(6):1537–1539.
114. McElhinney DB, Marshall AC, Lang P, Lock JE, Mayer JE. Creation of a brachial arteriovenous fistula for treatment of pulmonary arteriovenous malformations after cavopulmonary anastomosis. Ann Thorac Surg. 2005;80(5):1604–1609.
115. King G, Buratto E, Celermajer DS, et al. Natural and modified his- tory of atrioventricular valve regurgitation in patients with Fontan circulation. J Am Coll Cardiol. 2022;79(18):1832–1845.
116. Moon J, Shen L, Likosky DS, et al. Relationship of ventricu- lar morphology and atrioventricular valve function to long- term outcomes following Fontan procedures. J Am Coll Cardiol. 2020;76(4):419–431.
117. Menon SC, Dearani JA, Cetta F. Long-term outcome after atrio- ventricular valve surgery following modified Fontan operation. Cardiol Young. 2011;21(1):83–88.
118. Stephens EH, Dearani JA, Niaz T, Arghami A, Phillips SD, Cetta F. Effect of earlier atrioventricular valve intervention on survival after the Fontan operation. Am J Cardiol. 2020;137:103–110.
119. Stephens EH, Dearani JA. Management of the bad atrioventricular valve in Fontan…time for a change. J Thorac Cardiovasc Surg. 2019 Dec;158(6):1643-1648.
120. Carins TA, Shi WY, Iyengar AJ, et al. Long-term outcomes after first-onset arrhythmia in Fontan physiology. J Thorac Cardiovasc Surg. 2016;152(5):1355–1363.
121. Williams RV, Travison T, Kaltman JR, et al. Comparison of Fontan survivors with and without pacemakers: a report from the Pediatric Heart Network Fontan Cross-Sectional Study. Congenit Heart Dis.

2013;8(1):32–39.
122. Poh CL, Celermajer DS, Grigg LE, et al. Pacemakers are associ- ated with a higher risk of late death and transplantation in the Fontan population. Int J Cardiol. 2019;282:33–37.
123. Al-Khatib SM, Stevenson WG, Ackerman MJ, et al. 2017 AHA/ ACC/HRS guideline for management of patients with ventricular arrhythmias and the prevention of sudden cardiac death: executive summary. Circulation. 2018;138(13):e210–271.
124. Odegard KC, McGowan FX, Zurakowski D, et al. Procoagulant and anticoagulant factor abnormalities following the Fontan procedure: increased factor VIII may predispose to thrombosis. J Thorac Cardiovasc Surg. 2003;125(6):1260–1267.
125. Rosenthal DN, Friedman AH, Kleinman CS, Kopf GS, Rosenfeld LE, Hellenbrand WE. Thromboembolic complications after Fontan operations. Circulation. 1995;92(9):287–293.
126. Kawamatsu N, Ishizu T, Machino-Ohtsuka T, et al. Direct oral anticoagulant use and outcomes in adult patients with Fontan circulation: a multicenter retrospective cohort study. Int J Cardiol. 2021;327:74–79.
127. McCrindle BW, Michelson AD, Van Bergen AH, et al. Throm- boprophylaxis for children post-Fontan procedure: insights from the UNIVERSE study. J Am Heart Assoc. 2021;10(22):e021765.
128. Kazerouninia A, Georgekutty J, Kendsersky P, Byrne RD, Seto B, Chu PY, Wang Y, Rodriguez FH 3rd, Smith C, Saraf A, Lloyd MS, Frischhertz BP, Parekh DR, Ermis PR, Franklin WJ, Lam WW. A Multisite Retrospective Review of Direct Oral Anticoagulants Compared to Warfarin in Adult Fontan Patients. Cardiovasc Drugs Ther. 2023 Jun;37(3):519-527.
129. Rychik J. Forty years of the Fontan operation: a failed strategy. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2010;13(1):96-100.
130. Mackie AS, Veldtman GR, Thorup L, Hjortdal VE, Dori Y. Plastic Bronchitis and Protein-Losing Enteropathy in the Fontan Patient: Evolving Understanding and Emerging Therapies. Can J Cardiol. 2022 Jul;38(7):988-1001.
131. Itkin M, Piccoli DA, Nadolski G, et al. Protein-losing enteropathy in patients with congenital heart disease. J Am Coll Cardiol. 2017;69(24):2929–2937.
132. Schumacher KR, Yu S, Butts R, et al. Fontan-associated protein- losing enteropathy and post-heart transplant outcomes: a multi- center study. J Heart Lung Transplant. 2019;38(1):17–25.
133. John AS, Johnson JA, Khan M, Driscoll DJ, Warnes CA, Cetta F. Clinical outcomes and improved survival in patients with protein-losing enteropathy after the Fontan operation. J Am Coll Cardiol. 2014;64(1):54–62.
134. Itkin MG, McCormack FX, Dori Y. Diagnosis and treatment of lymphatic plastic bronchitis in adults using advanced lymphatic imaging and percutaneous embolization. Ann Am Thorac Soc. 2016;13(10):1689–1696.
135. Rychik J. The Relentless Effects of the Fontan Paradox. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2016;19(1):37-43.
136. Patel N, Patel M, Inja R, Krvavac A, Lechner AJ. Plastic Bronchitis in Adult and Pediatric Patients: A Review of its Presentation, Diagnosis, and Treatment. Mo Med. 2021 Jul-Aug;118(4):363-373.
137. Allen KY, Downing TE, Glatz AC, et al. Effect of Fontan- associated morbidities on survival with intact Fontan circulation. Am J Cardiol. 2017;119(11):1866–1871.
138. Gordon-Walker TT, Bove K, Veldtman G. Fontan-associated liver disease: a review. J Cardiol. 2019;74(3):223–232.
139. Wilson TG, Iyengar AJ, Hardikar W, Sood S, d'Udekem Y. Prevalence of hepatocellular carcinoma in the entire Fontan pop- ulation of Australia and New Zealand. JTCVS Tech. 2020;2:128–130.
140. Kisamori E, Venna A, Chaudhry HE, Desai M, Tongut A, Mehta R, Clauss S, Yerebakan C, d'Udekem Y. Alarming rate of liver cirrhosis after the small conduit extracardiac Fontan: A comparative analysis with the lateral tunnel. J Thorac Cardiovasc Surg. 2024 Oct;168(4):1221-1227.e1.
141. Puente BN, Desai M, Donofrio M, Yerebakan C, Tongut A, d'Udekem Y. Upsizing the extracardiac Fontan conduit-the fourth staged procedure for the single-ventricle palliation? JTCVS Tech. 2024 Feb 6;24:177-181.
142. Lee D, Levin A, Kiess M, et al. Chronic kidney damage in the adult Fontan population. Int J Cardiol. 2018;257:62–66.
143. Kukreja M, Bryant AS, Cleveland DC, Dabal R, Hingorani N, Kirklin JK. Health-related quality of life in adult survivors after the Fontan operation. Semin Thorac Cardiovasc Surg. 2015;27(3):299–306.
144. Goldberg CS, Schwartz EM, Brunberg JA, et al. Neurodevelopmental outcome of patients after the Fontan operation: a comparison between children with hypoplastic left heart syndrome and other functional single ventricle lesions. J Pediatr. 2000;137(5): 646–652.
145. Egbe AC, Driscoll DJ, Khan AR, et al. Cardiopulmonary exercise test in adults with prior Fontan operation: the prognostic value of serial testing. Int J Cardiol. 2017;235:6–10.
146. Khoury M, Cordina R. Exercise training for people living with Fontan circulation: an underutilized intervention. Can J Cardiol. 2022;38(7):1012–1023.
147. Chung ST, Hong B, Patterson L, Petit CJ, Ham JN. High over- weight and obesity in Fontan patients: a 20-year history. Pediatr Cardiol. 2016;37(1):192–200.
148. O'Leary ET, Gauvreau K, Alexander ME, et al. Dual-site ventric- ular pacing in patients with Fontan physiology and heart block: does it mitigate the detrimental effects of single-site ventricular pacing? JACC Clin Electrophysiol. 2018;4(10):1289–1297.
149. Backer CL, Deal BJ, Mavroudis C, Franklin WH, Stewart RD. Conversion of the failed Fontan circulation. Cardiol Young. 2006; 16(S1):85–91.
150. Backer CL, Mavroudis C. 149 Fontan conversions. Methodist DeBakey Cardiovasc J. 2019;15(2):105–110.
151. Mavroudis C, Deal BJ. Fontan Conversion: Literature Review and Lessons Learned Over 20 Years. World J Pediatr Congenit Heart Surg. 2016 Mar;7(2):192-8.
152. Poh CL, Cochrane A, Galati JC, et al. Ten-year outcomes of Fontan conversion in Australia and New Zealand demonstrate the superiority of a strategy of early conversion. Eur J Cardiothorac Surg. 2016;49(2):530–535.
153. Villa CR, Lorts A, Morales DLS. Ventricular Assist Device Therapy in the Fontan Circulation. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2021;24:19-25.

154. Villa CR, Alsaied T, Morales DLS. Ventricular Assist Device Therapy and Fontan: A Story of Supply and Demand. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2020;23:62-68.
155. Cedars A, Kutty S, Danford D, et al. Systemic ventricular assist device support in Fontan patients: A report by ACTION. J Heart Lung Transplant. 2021 May;40(5):368-376.
156. Bleiweis MS, Philip J, Fudge JC, et al. Support with Single Ventricle-Ventricular Assist Device (sVAD) in Patients with Functionally Univentricular Circulation Prior to Fontan Operation. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2023;26:26-39.
157. Backer CL, Russell HM, Pahl E, et al. Heart transplantation for the failing Fontan. Ann Thorac Surg. 2013;96(4):1413–1419.
158. Rajab TK, Jaggers J. Transplantation in Fontan failure: The final stage. JTCVS Open. 2020 May 13;3:154-159.
159. Konstantinov IE, Schulz A, Buratto E. Heart transplantation after Fontan operation. JTCVS Tech. 2022 Feb 15;13:182-191.
160. Padalino MA, Ponzoni M, Castaldi B, Leoni L, Chemello L, Toscano G, Gerosa G, Di Salvo G, Vida VL. Surgical management of failing Fontan circulation: results from 30 cases with 285 patient-years follow-up. Eur J Cardiothorac Surg. 2022 Jan 24;61(2):338-345.
161. Alpat S, Yilmaz M. Fontan Circulation in Heterotaxy Syndrome and Comparison of Fenestrated-Nonfenestrated Subtypes. Dogan R, editor. Fontan Circulation. 1st Edition. Ankara: Turkish Clinics; 2020. p.36-9.
162. Yilmaz M, Alpat S, Sabuncu T, Aydin A. Intra-extracardiac fontan technique in heterotaxy patients. Cardiology in the Young. 2023;34(1):S609.
163. Bayraktar NA. Evaluation of certain biochemical results and nutritional status regarding patients with biventricular and univentricular congenital heart disease. Doctoral Thesis. Başkent University Institute of Health Sciences, Department of Dietetics. 2020
164. Alpat S, Aydin A, Aykan H, Yilmaz M. Fontan Completion in Adult Patients with Functionally Univentricular Hearts. Thorac Cardiovasc Surg. 2025 Mar;73(2):141-147.



TRİKÜSPİD KAPAK DİSPLAZİSİ VE EBSTEIN ANOMALİSİ

BÖLÜM
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Cemal Levent BİRİNCİOĞLU [1]

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İçindekiler

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düşük kalp debisi sendromu gelişen hastalarda ASD oluşturulması gerekebildiği bildirilmiştir. (141)

Triküspid kapak replasmanı

EA olan hastalarda, miyopatik ventrikülün üzerine yüklenen uzun süreli TV yetersizliği nedeniyle önemli RV disfonksiyonu olabilir. Sonuç olarak, ciddi TV yetersizliği ortamında RV önemli ölçüde genişlediğinde, daha fazla RV dilatasyonu veya disfonksiyonunu önlemek ve olumlu RV yeniden şekillenme olasılığını optimize etmek için triküspid kapak onarımından sonra gelişebilecek yetersizliği hafif veya orta dereceden daha fazla azaltma önemlidir. Bu sonuç elde edilemezse, miyopatik RV üzerindeki hacim yükünün mümkün olduğunca düşük olması için trküspit kapak replasmanı (genellikle biyoprotez) gerekebilir. TV replasmanının geç dönem sonuçları TV onarımınınkilerle karşılaştırılabilir düzeydedir.(120)

TV replasmanı sırasında eşzamanlı bir BCPS uygulandığında, TV'dan geçen kan akışı azalır. Bu nedenle, tüm biyoprotez yaprakçıkların veya mekanik disklerin normal şekilde açılıp kapanması için büyük boyutlu olmayan bir TV protezi (yani, kalbin sağ tarafındaki azalmış akışa uyan bir kapak) yerleştirmek önemlidir.(141) BCPS'den sonra biyoprotez kapakçıkların yaprakçıklarının hareketliliğinin azaldığını zaman zaman gözlemlediği için, artık rutin olarak 3 ila 6 aylık bir süre boyunca veya ekokardiyografide tüm yaprakçıkların tam hareketliliği gösterilinceye kadar varfarin ile antikoagüle edilir. Aspirin, günde 81 mg, ile bundan sonra devam edilir. Artan tromboz riski ve antikoagülasyon ihtiyacı, EA onarımında eş zamanlı BCPS'nin potansiyel dezavantajlarıdır.

Depresif sol ventrikül

LV fonksiyonu deprese olan bir hastanın preoperatif değerlendirmesi, hemodinaminin bir BCPS eklemek için uygun olup olmadığını belirlemek amacıyla pulmoner arteriyel ve sol taraf dolum basınçlarını öğrenmek için hemodinamik bir kalp kateterizasyonu içerebilir. Aynı zamanda koroner anjiyografi de yapılabilir. Kalp transplantasyonu, önemli LV disfonksiyonu (LVEF %25) olan hastalar için önerilir. Orta derecede depresyonu olan hastalar (LV EF %40) genellikle konvansiyonel bir operasyon geçirebilir (BCPS ile veya BCPS olmadan). LV EF'si %25 ila %35 arasında olan hastaların cerrahi yönetimi en zor olanıdır ve artık BCPS kullanımı daha fazla tercih edilmektedir. Hemodinamik kateterizasyon bir BCPS gerçekleştirilebileceğini doğrularsa, BCPS'i de içerebilecek geleneksel bir operasyon uygulanır. Bu hastalarda önce intraoperatif doğrudan basınç ölçümleri yapılır. Bu şanta, depresif LV fonksiyonu ortamında ancak LV diyastol sonu basıncının 15 mm Hg'den az olması, transpulmoner gradiyentin 10 mm Hg'den az olması ve ortalama PAP'nin 18 ila 20 mm Hg'den az olması koşuluyla, izin verilebilir[141].

Öncesinde ventriküler fonksiyonu optimize etmek için atriyal taşiaritmilerin ritim ve hız kontrolünü içeren agresif bir tıbbi kalp yetmezliği rejimi LV EF ni arttırarak hastayı BCPS ne uygun hale getirebilir[141]. Atriyal taşikardi öyküsü olan hastalarda, ameliyat sonrası sinüs ritmini yeniden sağlamak veya korumak için ameliyat sırasında bir maze prosedürü uygulanmasıda önemlidir.

KAYNAKLAR

1. Stephens EH, Dearani JA, Qureshi MY, Ammash N, Maleszewski JJ. The congenital tricuspid valve spectrum: from Ebstein to dysplasia. World J Pediatr Congenit Heart Surg 2020;11:783–91.
2. Varrica A, Lo Rito M. Tricuspid valve dysplasia in children: should we forget the forgotten valve? Eur J Cardiothorac Surg 2022; 62(3): ezac278.
3. Gupta A, Grover V, Gupta V. Congenital tricuspid regurgitation: review and a proposed new classification. Cardiol Young 2011;21:121–9.
4. Cleuziou J, Pringsheim M, Stroh A, Burri M, Lange R, Ho¨rer J. Surgical treatment of tricuspid valve dysplasia in children. Eur J Cardiothorac Surg 2022:1–5.
5. Lo Rito M, Grandinetti M, Muzio G, Varrica A, Frigiola A, Micheletti A et al. Results for tricuspid valve surgery in adults with congenital heart disease other than Ebstein's anomaly. Eur J Cardiothorac Surg 2019;56: 706–13.
6. Dahou A, Levin D, Reisman M, Hahn RT. Anatomy and physiology of the tricuspid valve. JACC Cardiovasc Imaging 2019;12:458–68
7. Freud LR, McElhinney DB, Kalish BT, Escobar-Diaz MC, Komarlu R, Puchalski MD et al. Risk factors for mortality and circulatory outcome among neonates prenatally diagnosed with Ebstein anomaly or tricuspid valve dysplasia: a multicenter study. J Am Heart Assoc 2020;9:e016684.

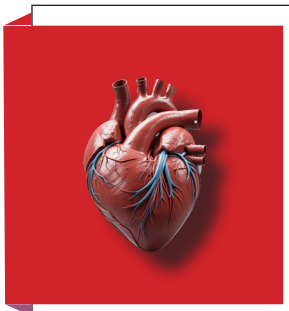
8. Mizuno M, Hoashi T, Sakaguchi H, Kagisaki K, Kitano M, Kurosaki K et al. Application of cone reconstruction for neonatal Ebstein anomaly or tricuspid valve dysplasia. Ann Thorac Surg 2016;101:1811–7.
9. Kumar S, Kung G, Noh N, Castillo N, Fagan B, Wells W et al. Single Ventricle outcomes after neonatal palliation of severe Ebstein anomaly with modified Starnes procedure. Circulation 2016;134:1257–64.
10. Dearani JA, Danielson GK. Congenital heart surgery nomenclature and database project: Ebstein's anomaly and tricuspid valve disease. Ann Thorac Surg. 2000;69(4 Suppl):S106–17.
11. Attenhofer Jost CH, Connolly HM, Edwards WD, Hayes D, Warnes CA, Danielson GK. Ebstein's anomaly - review of a multifaceted congenital cardiac condition. Swiss Med Wkly. 2005;135(19–20):269–81
12. van Son JA, Konstantinov IE, Zimmermann V. Wilhelm Ebstein and Ebstein's malformation. Eur J Cardiothorac Surg 2001;20:1082-5.
13. Anderson KR, Lie JT. The right ventricular myocardium in Ebstein's anomaly: a morphometric histopathologic study. Mayo Clin Proc 1979;54:181-4.
14. Pradat P, FrancannetC, Harris JA, Robert E. The epidemiology of cardiovascular defects, part 1: a study based on data from three large registries of congenital malformations. Pediatr cardiol. 2003;24:195-221
15. Connolly HM, Dearani JA, Miranda WR. Ebstein anomaly: we should do better. J Am Coll Cardiol. 2023;81(25):2431-3
16. Celermajer DS, Bull C, Till JA, Cullen S, Vassillikos VP, Sullivan ID et al. Ebstein's anomaly: presentation and outcome from fetus to adult. J Am Coll Cardiol 1994;23:170-6
17. Attenhofer Jost CH, Connolly HM, Dearani JA, Edwards WD, Danielson GK. Ebstein's anomaly. Circulation. 2007 Jan 16;115(2):277-85
18. Pasqualin G, Boccellino A, Chessa M, Ciconte G, Marcolin C, Micaglio E, et al. Ebstein's anomaly in children and adults: multidisciplinary insights into imaging and therapy. Heart 2024;**110**:235–44
19. Lamers WH, Virágh S, Wessels A, Moorman AF, Anderson RH. Formation of the Tricuspid valve in the human heart. Circulation 1995;91:111–21.
20. Attie F, Rosas M, Rijlaarsdam M, Buendia A, Zabal C, Kuri J, Granados N. The adult patient with Ebstein's anomaly. Outcome in 72 unoperated patients. Medicine (Baltimore). 2000 Jan;79(1):27-36
21. Dearani JA, Danielson GK. Ebstein's anomaly of the tricuspid valve. In: Mavroudis C, Backer CL, eds. Pediatric Cardiac Surgery. 3rd ed. Philadelphia, Pa: Mosby; 2003:524 –536.
22. Steinmetz M, Broder M, Hösch O, Lamata P, Kutty S, Kowallick JT, et al. Atrio-ventricular deformation and heart failure in Ebstein's anomaly - A cardiovascular magnetic resonance study. Int J Cardiol 2018;257:54–61.
23. Ciepłucha A, Trojnarska O, Kociemba A, Łanocha M, Barczynski M, Rozmiarek S, et al. Clinical aspects of myocardial fibrosis in adults with Ebstein's anomaly. Heart Vessels 2018;33:1076–85.
24. Baessato F, Furtmüller C, Shehu N, Ferrari I, Reich B, Nagdyman N, et al. Detection of early signs of right ventricular systolic impairment in Unoperated Ebstein's anomaly by cardiac magnetic resonance feature tracki ng. Cardiovasc Diagn Ther 2022;12:278–88.
25. Goleski PJ, Sheehan FH, Chen SS, Kilner PJ, Gatzoulis MA. The shape and function of the left ventricle in Ebstein's anomaly. Int J Cardiol 2014;171:404–12.
26. Ibrahim M, Tsang VT, Caruana M, Hughes ML, Jenkyns S, Perdreau E, et al. Cone reconstruction for Ebstein's anomaly: patient outcomes, biventricular function, and cardiopulmonary exercise capacity. J Thorac Cardiovasc Surg 2015;149:1144–50.
27. Carpentier A, Chauvaud SM, Mace L, Relland J, Mihaileanu S, Marino JP, et al. A new reconstrictive operation for Ebstein's anomaly of the tricuspid valve. J Thorac Cardiovasc Surg 1988; 96:92-101
28. Oosthoek PW, Wenink AC, Vrolijk BC, Wisse LJ, DeRuiter MC, Poelmann RE, Gittenberger-de Groot AC. Development of the atrioventricular valve tension apparatus in the human heart. Anat Embryol 1998;198:317-29
29. Pexeider T. Cell death in the morphogenesis and teratogenesis of the heart. Advances in the Anatomy, Embryology and Cell Biology 1975; 51:1-100
30. Sicko RJ, Browne ML, Rigler SL, Druschel CM, Liu G, Fan R, et al. Genetic Variants in Isolated Ebstein Anomaly Implicated in Myocardial Development Pathways. PLoS One 2016;11:e0165174.
31. Abu-Halima M, Wagner V, Becker LS, Ayesh BM, Abd El-Rahman M, Fischer U, et al. Integrated microRNA and mRNA Expression Profiling Identifies Novel Targets and Networks Associated with Ebstein's Anomaly. Cells 2021;10.
32. Mercer CL, Andreoletti G, Carroll A, Salmon AP, Temple IK, Ennis S. Familial Ebstein Anomaly: Whole Exome Sequencing Identifies Novel Phenotype Associated With *FLNA*. Circ Cardiovasc Genet. 2017;10(6):e001683.
33. Patorno E, Huybrechts KF, Bateman BT, Cohen JM, Desai RJ, Mogun H, et al. Lithium Use in Pregnancy and the Risk of Cardiac Malformations. N Engl J Med. 2017;376(23):2245-2254.
34. Boyle B, Garne E, Loane M, Addor MC, Arriola L, Cavero-Carbonell C, et al. The changing epidemiology of Ebstein's anomaly and its relationship with maternal mental health conditions: a European registry-based study. Cardiol Young 2017;27:677-85.
35. Zhao L, Chen L, Yang T, Wang L, Wang T, Zhang S, et al. Parental smoking and the risk of congenital heart defects in offspring: An updated meta-analysis of observational studies. Eur J Prev Cardiol 2020;27:1284-93.
36. Hornberger LK, Sahn DJ, Kleinman CS, Copel JA, Reed KL. Tricuspid valve disease with significant tricuspid insufficiency in the fetus: diagnosis and outcome. J Am Coll Cardiol 1991;17:167–73.
37. Freud LR, Escobar-Diaz MC, Kalish BT, Komarlu R, Puchalski MD, Jaeggi ET, et al. Outcomes and predictors of perinatal mortality in fetuses with Ebstein anomaly or tricuspid valve dysplasia in the current era: a multicenter study. Circulation 2015;132:481–9.
38. Geerdink LM, Delhaas T, Helbing WA, du Marchie Sarvaas GJ, Heide HT, Rozendaal L, et al. Paediatric Ebstein's anomaly: how clinical presentation predicts mortality. Arch Dis Child 2018;103:859–63.
39. Ferrari I, Shehu N, Nagdyman N, Martinoff S, Ewert P, Stern H, Meierhofer C. Improved Tricuspid Valve Function, Preload Recruitment and Ventricular Efficiency During Submaximal Exercise in Patients with Unoperated Ebstein's Anomaly: An MRI Study. J Magn Reson Imaging 2022;55:1843-50

40. Pornprasertchai V, Vijarnsorn C, Kanjanauthai S, Chungsomprasong P, Chanthong P, Durongpisitkul K, Soongswang J. Contemporary outcomes and mortality risks of Ebstein anomaly: A single-center experience in Thailand. Congenit Heart Dis 2019;14:619–27
41. Beroukhim RS, Jing L, Harrild DM, Fornwalt BK, Mejia-Spiegeler A, Rhodes J, et al. Impact of the cone operation on left ventricular size, function, and dyssynchrony in Ebstein anomaly: a cardiovascular magnetic resonance study. J Cardiovasc Magn Reson 2018;20:32.
42. Radojevic J, Inuzuka R, Alonso-Gonzalez R, Borgia F, Giannakoulas G, Prapa M,et al. Peak oxygen uptake correlates with disease severity and predicts outcome in adult patients with Ebstein's anomaly of the tricuspid valve. Int J Cardiol 2013;163:305-8.
43. Budts W, Pieles GE, Roos-Hesselink JW, Sanz de la Garza M, D'Ascenzi F, et al. Recommendations for participation in competitive sport in adolescent and adult athletes with Congenital Heart Disease (CHD): position statement of the Sports Cardiology & Exercise Section of the European Association of Preventive Cardiology (EAPC), the European ociety of Cardiology (ESC) Working Group on Adult Congenital Heart Disease and the Sports Cardiology, Physical Activity and Prevention Working Group of the Association for European Paediatric and Congenital Cardiology (AEPC). Eur Heart J 2020;41:4191-9.
44. Baumgartner H, De Backer J, Babu-Narayan SV, Budts W, Chessa M, Diller GP, et al. 2020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J 2021;42:563-645.
45. Stout KK, Daniels CJ, Aboulhosn JA, Bozkurt B, Broberg CS, Colman JM, et al. 2018 AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol 2019;73:1494-563.
46. Lima FV, Koutrolou-Sotiropoulou P, Yen TY, Stergiopoulos K. Clinical characteristics and outcomes in pregnant women with Ebstein anomaly at the time of delivery in the USA: 2003-2012. Arch Cardiovasc Dis 2016;109:390-8.
47. Katsuragi S, Kamiya C, Yamanaka K, Yoshimatsu J, Niwa K, Ikeda T, et al. Risk factors for maternal and fetal outcome in pregnancy complicated by Ebstein anomaly. Am J Obstet Gynecol 2013;209:452.e1-6.
48. Attenhofer Jost CH, Edmister WD, Julsrud PR, Dearani JA, Savas Tepe M, Warnes CA, et al. Prospective comparison of echocardiography versus cardiac magnetic resonance imaging in patients with Ebstein's anomaly. Int J Cardiovasc Imaging 2012;28:1147–59.
49. Connolly HM, Dearani JA, Miranda WR. Ebstein anomaly: we should do better. J Am Coll Cardiol. 2023;81(25):2431-3
50. Gussenhoven EJ, Stewart PA, Becker AE, Essed CE, Ligtvoet KM, De Villeneuve VH. Offsetting" of the septal Tricuspid leaflet in normal hearts and in hearts with Ebstein's anomaly. Am J Cardiol 1984;54:172–6.
51. Pérez-Riera AR, Barbosa-Barros R, Daminello-Raimundo R, de Abreu LC, Nikus K. Electro-vectorcardiographic and electrophysiological aspects of Ebstein's anomaly. Ann Noninvasive Electrocardiol. 2019 May;24(3):e12590.
52. Park SJ, Chung S, On YK, Kim JS, Yang JH, Jun TG, et al. Fragmented QRS complex in adult patients with Ebstein anomaly and its association with arrhythmic risk and the severity of the anomaly. Circulation: Arrhythmia and Electrophysiology 2013;6(6):1148–1155.
53. Gupta A, Prabhu MA, Anderson RD, Prasad SB, Campbell T, Turnbull S, et al. Ebstein's anomaly: an electrophysiological perspective. J Interv Card Electrophysiol. 2024 Jun;67(4):887-900.
54. Katritsis DG, Boriani G, Cosio FG, Hindricks G, Jais P, Josephson ME, et al. European Heart Rhythm Association (EHRA) consensus document on the management of supraventricular arrhythmias, endorsed by Heart Rhythm Society (HRS), Asia-Pacific Heart Rhythm Society (APHRS), and Sociedad Latinoamericana de Estimulacion Cardiaca y Electrofisiologia (SOLAECE). Europace 2017;19(3): 465–511.
55. Ueshima K, Nakamura Y, Takeno S, Miyake, T, Takemura T. Atriofascicular Mahaim with Ebstein anomaly: A case report. J Arrhythm. 2017;33(5):508–510.
56. He BJ, Merriman AF, Cakulev I, Stambler BS, Srivastava D, Scheinman MM. Ebstein's Anomaly: Review of Arrhythmia Types and Morphogenesis of the Anomaly. J Am Coll Cardiol EP. 2021 Sep, 7 (9) 1198–1206.
57. Wackel P, Cannon B, Dearani J, Sessions K, Holst K, Johnson J, Cetta F. Arrhythmia after cone repair for Ebstein anomaly: the Mayo Clinic experience in 143 young patients. Congenit Heart Dis. 2018;13:26–30.
58. Hassan A, Tan NY, Aung H, Connolly HM, Hodge DO, Vargas ER,et al. Outcomes of atrial arrhythmia radiofrequency catheter ablation in patients with Ebstein's anomaly. Europace. 2018;20:535–40.
59. Khositseth A, Danielson GK, Dearani JA, Munger TM, Porter CJ. Supraventricular tachyarrhythmias in Ebstein anomaly: management and outcome. J Thorac Cardiovasc Surg. 2004;128: 826–33.
60. Attenhofer Jost CH, Tan NY, Hassan A, Vargas ER, Hodge DO, Dearani JA, et al. Sudden death in patients with Ebstein anomaly. Eur Heart J. 2018;39:1970–1977a.
61. Iturralde P, Nava S, Sálica G, Medeiros A, Márquez MF, Colin L, et al. Electrocardiographic characteristics of patients with Ebstein's anomaly before and after ablation of an accessory atrioventricular pathway. J Cardiovasc Electrophysiol. 2006;17:1332–6
62. Marcondes L, Sanders SP, Del Nido PJ, Walsh EP. Examination of pathologic features of the right atrioventricular groove in hearts with Ebstein anomaly and correlation with arrhythmias. Heart Rhythm. 2020;17:1092–8.
63. Guo XG, Liu XU, Zhou GB, Ma J, Ouyang F, Zhang S. Frequency of fractionated ventricular activation and atrial/ventricular electrogram amplitude ratio at successful ablation target of accessory pathways in patients with Ebstein's anomaly. J Cardiovasc Electrophysiol. 2015;26: 404–11. Circulation. 1996;94:376–83.
64. Orczykowski M, Derejko P, Bodalski R, Urbanek P, Zakrzewska-Koperska J, Sierpiński R, et al. Radiofrequency catheter ablation of accessory pathways in patients with Ebstein's anomaly: at 8 years of follow-up. Cardiol J. 2017;24:1–8.
65. Ergul Y, Koca S, Akdeniz C, Tuzcu V. Electroanatomic mapping-guided catheter ablation of supraventricular tachycardia in children with Ebstein's anomaly. Pediatr Cardiol. 2018;39: 1445–52.

66. Ho SY, Goltz D, McCarthy K, Cook AC, Connell MG, Smith A, et al. The atrioventricular junctions in Ebstein malformation. Heart. 2000;83(4):444–9.
67. Sánchez-Quintana D, Picazo-Angelín B, Cabrera A, Murillo M, Cabrera JA. Koch's triangle and the atrioventricular node in Ebstein's anomaly: implications for catheter ablation. Rev Esp Cardiol. 2010;63(6):660–7.
68. Miguel IMd, Miranda WR, Madhavan M, Connolly HM, Dearani JA, Egbe AC. Risk factors for atrial arrhythmias in adults with Ebstein anomaly. JACC: Advances. 2022;1(3):1–11.
69. Rydman R, Shiina Y, Diller GP, Niwa K, Li W, Uemura H, et al. Major adverse events and atrial tachycardia in Ebstein's anomaly predicted by cardiovascular magnetic resonance. Heart. 2018;104(1):37–44
70. Iliodromitis KE, Bonsels M, Borchard R, Dorszewski A. Radiofrequency ablation of atrial fibrillation in patients with Ebstein's anomaly: a two-case report. Cardiology. 2018;139(1):33–6.
71. Warnes CA, Williams RG, Bashore TM, Child JS, Connolly HM, Dearani JA, et al. ACC/AHA 2008 Guidelines for the Manage ment of Adults with Congenital Heart Disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (writing committee to develop guidelines on the management of adults with congenital heart disease). Circulation. 2008;118(23):e714-833.
72. Papagiannis J, Beissel DJ, Krause U, Cabrera M, Telishevska M, Seslar S, et al. Atrioventricular Nodal Reentrant Tachycardia in Patients With Congenital Heart Disease: Outcome After Catheter Ablation. Circ Arrhythm Electrophysiol. 2017;10(7):e004869.
73. Walsh EP. Ebstein's anomaly of the tricuspid valve: a natural laboratory for re-entrant tachycardias. JACC Clin Electrophysiol. 2018;4(10):1271–88.
74. Roten L, Lukac P, de Groot N, Nielsen JC, Szili-Torok T, Jensen HK, et al. Catheter ablation of arrhythmias in Ebstein's anomaly: a multicenter study. J Cardiovasc Electrophysiol. 2011;22(12):1391–6
75. Wei W, Zhan X, Xue Y, Fang X, Liao H, Deng H, et al. Features of accessory pathways in adult Ebstein's anomaly. Europace. 2014;16(11):1619–25.
76. El-Assaad I, DeWitt ES, Mah DY, Gauvreau K, Abrams DJ, Alexander ME, et al. Accessory pathway ablation in Ebstein anomaly: a challenging substrate. Heart Rhythm. 2021;18(11):1844–51.
77. Moore JP, Shannon KM, Gallotti RG, McLeod CJ, Chiriac A, Walsh EP, et al. Catheter ablation of ventricular arrhythmia for Ebstein's anomaly in unoperated and post-surgical patients. JACC Clin Electrophysiol. 2018;4:1300–7
78. Shivapour JK, Sherwin ED, Alexander ME, Cecchin F, Mah DY, Triedman JK, et al. Utility of preoperative electrophysiologic studies in patients with Ebstein's anomaly undergoing the cone procedure. Heart Rhythm. 2014;11(2):182–6.
79. Allen MR, Hayes DL, Warnes CA, Danielson GK. Permanent pacing in Ebstein's anomaly. Pacing Clin Electrophysiol. 1997;20(5 Pt 1):1243–6.
80. Khairy P, Landzberg MJ, Gatzoulis MA, Mercier LA, Fernandes SM, Côté JM, et al. Transvenous pacing leads and systemic thromboemboli in patients with intracardiac shunts: a multicenter study. Circulation. 2006;113(20):2391–7.
81. Patel N, Bauch T, Calkins H, Vijayaraman P. Selective His bundle pacing in a patient with Ebstein's anomaly and atrioventricular block. JACC: Clin Electrophysiol. 2021;7(2):275–6.
82. Yoshimoto D, Sakamoto Y, Yamaguchi R, Naganawa H, Suzuki T. Left bundle branch area pacing in a patient with Ebstein's anomaly from a functional right atrium using the sheath-in-sheath tech nique. HeartRhythm Case Rep. 2023;9(5):310–3
83. O'Leary PW, Dearani JA, Anderson RH. Disease of tricuspid valve. In: Anderson RH, Baker EJ, Penny DJ, Redington AN, Rigby ML, Wernovsky G, ed. Paediatric cardiology, 3rd edition. Philadelphia: Churchill Livingstone, an imprint of Elsevier Ltd. 2010:712-30
84. Hösch O, Sohns JM, Nguyen TT, Lauerer P, Rosenberg C, Kowallick JT, et al. The total right/left-volume index: a new and simplified cardiac magnetic resonance measure to evaluate the severity of Ebstein anomaly of the Tricuspid valve: a comparison with heart failure markers from various modalities. Circ Cardiovasc Imaging 2014;7:601–9.
85. Hughes ML, Bonello B, Choudhary P, Marek J, Tsang V. A simple measure of the extent of Ebstein valve rotation with cardiovascular magnetic resonance gives a practical guide to feasibility of surgical cone reconstruction. J Cardiovasc Magn Reson 2019;21:34.
86. Starnes VA, Pitlick PT, Bernstein D, Griffin ML, Choy M, Shumway NE. Ebstein 's anomaly appearing in the neonate: a new surgical approach. J Thorac Cardiovasc Surg. 1991;0:1082-7.
87. Davies RR, Pasquali SK, Jacobs ML, Jacobs JJ, Wallace AS, Pizarro C. Current spectrum of surgical procedures performed for Ebstein's malformation: an analysis of the Society of Thoracic Surgeons Congenital Heart Surgery Database. Ann Thorac Surg. 2013 Nov;96(5):1703-9; discussion 1709-10.
88. Boston US, Goldberg SP, Ward KE, Overholt ED, Spentzas T, Chin TK et al. Complete repair of Ebstein anomaly in neonates and young infants: a 16-year follow-up. J Thorac Cardiovasc Surg 2011;141:1163–9.
89. Bove EL, Hirsch JC, Ohye RG, Devaney EJ. How I manage neonatal Ebstein's anomaly. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu 2009;12: 63–5.
90. Goldberg SP, Jones RC, Boston US, Haddad LM, Wetzel GT, Chin TK, Knott-Craig CJ. Current trends in the management of neonates with Ebstein's anomaly. World J Pediatr Congenit Heart Surg. 2011; 2:554–557.
91. Rato J, Sousa AR, Teixeira A, Anjos R. Ebstein's anomaly with 'reversible' functional pulmonary atresia. BMJ Case Rep 2019;**12**:e229809. doi:10.1136/bcr-2019-229809
92. Kumar TKS, Boston US, Knott-Craig CJ. Neonatal Ebstein anomaly. Semin Thorac Cardiovasc Surg 2017;29:331–7.
93. Badiu CC, Schreiber C, Hörer J, Ruzicka DJ, Wottke M, Cleuziou J, et al. Early timing of surgical intervention in patients with Ebstein's anomaly predicts superior long-term outcome. Eur J Cardiothorac Surg. 2010; 37:186 -192.
94. da Silva JP, Baumgratz JF, da Fonseca L, Franchi SM, Lopes LM, Tavares GMP, et al. The cone reconstruction of the tricuspid valve in Ebstein's anomaly. The operation: early and midterm results. J Thorac Cardiovasc Surg. 2007; 133:215–223.

95. Quaegebeur JM, Sreeram N, Fraser AG, Bogers AJ, Stumper OF, Hess J, et al. Surgery for Ebstein's anomaly: the clinical and echocardiographic evaluation of a new technique. J Am Coll Cardiol. 1991;17(3):722-8.
96. Katırcıoğlu F, Şener E, Küçükaksu S, Birincioğlu L, Mavitaş B, Tarcan O et al. Ebstein anomalisinin cerrahi tedavisinde longitudinal plikasyon tekniği. Türk Kardiyol Dern Arş 1995; 23:263-266
97. Wald RM, Adatia I, Van Arsdell GS, Hornberger LK. Relation of limiting ductal patency to survival in neonatal Ebstein's anomaly. Am J Cardiol 2005;96:851-6
98. Aiello S, Loomba RS. Factors Associated with the Need for, and the Impact of, Extracorporeal Membrane Oxygenation in Children with Congenital Heart Disease during Admissions for Cardiac Surgery. Children (Basel) 2017. doi: 10.3390/children4110101.
99. Hasegawa M, Iwai S, Yamauchi S, Kugo Y, Kayatani F, Takahashi K, Kawata H. Bilateral Pulmonary Artery Banding in Ebstein's Anomaly With Circular Shunting. Ann Thorac Surg 2019;107:e317-9.
100. Sano S, Fujii Y, Kasahara S, Kuroko Y, Tateishi A, Yoshizumi K, Arai S. Repair of Ebstein's anomaly in neonates and small infants: impact of right ventricular exclusion and its indications. Eur J Cardiothorac Surg 2014;45:549-55; discussion 555.
101. Reemtsen BL, Fagan BT, Wells WJ, Starnes VA. Current surgical therapy for Ebstein anomaly in neonates. J Thorac Cardiov Surg. 2006; 132:1285–1290.
102. Knott-Craig CJ, Boston US. Current surgical techniques in the management of the symptomatic neonate with severe Ebstein anomaly: too much, too little, or just enough?. JTCVS Techniques 2021;9:128-34
103. Knott-Craig CJ, Overholt ED, Ward KE, Ringewald JM, Baker SS, Razook JD. Repair of Ebstein's anomaly in the symptomatic neonate: an evolution of technique with 7-year follow-up. Ann Thorac Surg. 2002;73:1786-92.
104. Augustin N, Schmidt-Habelmann P, Wottke M, Meisner H, Sebening F. Results after surgical repair of Ebstein's anomaly. Ann Thorac Surg 1997;63:1650-6.
105. Huang SC, Wu ET, Chen SJ, Huang CH, Shih JC, Chou HW, et al. Surgical Strategy Toward Biventricular Repair for Severe Ebstein Anomaly in Neonates and Infancy. Ann Thorac Surg 2017;104:917-25
106. Freud LR, McElhinney DB, Kalish BT, Escobar-Diaz MC, Komarlu R, Puchalski MD, et al. Risk factors for mortality and circulatory outcome among neonates prenatally diagnosed with Ebstein anomaly or tricuspid valve dysplasia: a multicenter study. J Am Heart Assoc. 2020;9:e016684
107. Knott-Craig CJ, Kumar TK, Arevalo AR, Joshi VM. Surgical management of symptomatic neonates with Ebstein's anomaly: choice of operation. Cardiol Young 2015;25:1119-23.
108. Dearani JA, Said SM, Burkhart HM, Pike RB, O'Leary PW, Cetta F. Strategies for tricuspid re-repair in Ebstein malformation using the cone technique. Ann Thorac Surg 2013;96:202-8: discussion 208-10
109. Tanaka T, Yamaki S, Ohno T, Ozawa A, Kakizawa H, Iinuma K. The histology of the lung in neonates with tricuspid valve disease and gross cardiomegaly due to severe regurgitation. Pediatr Cardiol 1998;19:133–8.
110. Kajihara N, Asou Takeda Y, Yasui S, Kosaka Y, Onakatomi Y, Miyata D, et al. Rapid two-stage Starnes procedure for a symptomatic neonate with Ebstein anomaly. Ann Thorac Surg. 2010;90:2073-5.
111. Asou T, Kawataki M, Takeda Y, Asai H, Tachibana T, Toyoshima K et al. Rapid two-stage Starnes approach in high-risk neonates with Ebstein anomaly. Eur J Cardiothorac Surg 2020;58:957–63.
112. Sano S, Fujii Y, Kasahara S, Kuroko Y, Tateishi A, Yoshizumi K et al.Repairof Ebstein's anomaly in neonates and small infants: impact of right ventricular exclusion and its indications. Eur J Cardiothorac Surg 2013;45:449–55.
113. Dearani J, Bacha E, da Silva JP. Cone reconstruction of the tricuspid valve for Ebstein's anomaly: anatomic repair. Oper Tech Thorac Cardiovasc Surg. 2008; 13:109-25.
114. Raju V, Dearani JA, Burkhart HM, Grogan M, Phillips SD, Ammash N, et al. Right ventricular unloading for heart failure related to Ebstein malformation. Ann Thorac Surg 2014;98:167-73; discussion 173-4.
115. Liu J, Qiu L, Zhu Z, Chen H, Hong H. Cone reconstruction of the tricuspid valve in Ebstein anomaly with or without one and a half ventricle repair. J Thorac Cardiovasc Surg 2011;141:1178-83
116. Danielson GK, Driscoll DJ, Mair DD, Warnes CA, Oliver WC Jr. Operative treatment of Ebstein's anomaly. J Thorac Cardiovasc Surg 1992;104:1195-202.
117. Jonas RA. Comprensive surgical management of congenital heart disease. London: Arnold, a member of the Holder Headline Group Publishing, 2004: 316-7
118. Mitchell ME, Hraska V, Kouretas PC. 360-Degree Cone Reconstruction for Ebstein's Anomaly. Ann Thorac Surg 2018;106:e155-8.
119. Silva JP, Silva Lda F, Moreira LF, Lopez LM, Franchi SM, Lianza AC, et al. Cone reconstruction in Ebstein's anomaly repair: early and long-term results. Arq Bras Cardiol 2011;97:199-208.
120. Kiziltan HT, Theodoro DA, Warnes CA, O'Leary PW, Anderson BJ, Danielson GK. Late results of bioprosthetic tricuspid valve replacement in Ebstein's anomaly. *Ann Thorac Surg*. 1998;66:1539 –1545
121. Chen JM, Mosca RS, Altmann K, Printz BF, Targoff K, Mazzeo PA, Quaegebeur JM. Early and medium-term results for repair of Ebstein anomaly. J Thorac Cardiovasc Surg. 2004;127:990 –998
122. Taggart NW, Cabalka AK, Eicken A, Aboulhosn JA, Thomson JDR, Whisenant B, et al. Outcomes of Transcatheter Tricuspid Valve-in-Valve Implantation in Patients With Ebstein Anomaly. Am J Cardiol 2018;121:262-8.
123. Kumor M, Lipczyńska M, Biernacka EK, Klisiewicz A, Wójcik A, Konka M, et al. Cardiac arrest and ventricular arrhythmia in adults with Ebstein anomaly and left ventricular non-compaction. J Cardiol 2018;71:484-7
124. Mrad Agua K, Burri M, Cleuziou J, Beran E, Meierhofer C, Nagdyman N, Lange R. Preoperative predictability of right ventricular failure following surgery for Ebstein's anomaly. Eur J Cardiothorac Surg 2019;55:1187-93
125. Billingsley AM, Laks H, Boyce SW, George B, Santulli T, Williams RG. Definitive repair in patients with pulmonary atresia and intact ventricular septum. J Thorac Cardiovasc Surg. 1989; 97:746–54.
126. Anderson RH, Ho SY. Pathologic substrates for 1.5 ventricular repair. Ann Thorac Surg. 1998; 66:673–7.
127. Gentles TL, Mayer JE Jr, Gauvreau K, Newburger JW,

Lock JE, Kupferschmid JP, et al. Fontan operation in five hundred consecutive patients: Factors influencing early and late outcome. J Thorac Cardiovasc Surg. 1997;114:376–91.
128. DeliusR, Rademecker M, deLeval M,Elliott M, Stark J. Is a high risk biventricular repair always preferable to conversion to a single ventricle repair?. J Thorac Cardiovasc Surg. 1996;112:1561–69.
129. Van Arsdell GS, Williams WG, Freedom RM. Practical approach to 1 1/2 ventricle repairs. Ann Thorac Surg. 1998;66:678–80
130. King DH, Smith EO, Huhta JC, Gutgesell HP. Mitral and tricuspid valve anular diameter in normal children determined by two-dimensional echocardiography. Am J Cardiol. 1985;55:787–9.
131. Rowlatt U, Rimoldi H, Lev M. The quantitative anatomy of the normal child's heart. Pediatr Clin North Am. 1963;10:499–588.
132. Kim H, Park EA, Lee W, Chung JW, Park JH, Kim GB, Kim WH. Magnetic resonance imaging findings of isolated ventricular hypoplasia. Int J Cardiovsc Imaging. 2012;28:149–52.
133. Chowdhury UK, Airan B, Talwar S, Kothari SS, Saxena A, Singh R. One and one-half ventricle repair : results and concerns. Ann Thorac Surg. 2005; 80:2293-300.
134. Malhotra A, Agrawal V, Patel K, Shah M, Sharma K, Sharma P, et al. Ebstein's Anomaly: "The One and a Half Ventricle Heart". Braz J Cardiovasc Surg 2018;33(4):353-61
135. Kim S, Al-Radi O, Friedberg MK, Caldarone CA, Coles JG, Oechslin E, et al. Superior vena cava to pulmonary artery anastomosis as an adjunct to biventricular repair: 38-Year Follow-Up. Ann Thorac Surg. 2009;87:1475–83
136. Kreutzer C, Mayorquim RC, Kreutzer GO, Conejeros W, Roman MI, Vazquez H, et al. Experience with one and a half ventricle repair. J Thorac Cardiovasc-Surg.1999;117: 662–8
137. Gentles TL, Keane JF, Jonas RA, Marx GE, Mayer JE Jr. Surgical alternatives to the Fontan procedure incorporating a hypoplastic right ventricle. Circulation. 1994;90:II1–6.
138. Lee YO, Kim YJ, Lee JR, Kim WH. Long-term results of one-and a-half ventricle repair in complex cardiac anomalies. Eur J Cardiothorac Surg. 2011;39:711–715.
139. Numata S, Uemura H, Yagihara T, Kagisaki K, Takahashi M, Ohuchi H. Long-term functional results of the one and one half ventricular repair for the spectrum of patients with pulmonary atresia/stenosis with intact ventricular septum. Eur J Cardiothorac Surg. 2003;24:516–520.
140. Talwar S, Siddharth B, Choudhary SK, Airan B. One and half ventricle repair: rationale, indications, and results. Indian J Thorac Cardiovasc Surg. 2018;34(3):370–380
141. Quinonez LG, Dearani JA, Puga FJ, O'Leary PW, Driscoll DJ, Connolly HM, Danielson GK. Results of the1.5-ventricle repair for Ebstein anomaly and the failing right ventricle. J Thorac Cardiovasc Surg 2007;133:1303-10



HİPOPLASTİK SOL KALP SENDROMU

BÖLÜM
55

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İçindekiler

» GİRİŞ
» ETYOPATOGENEZ
» ANATOMİK ÖZELLİKLER
» KLİNİK BULGULAR VE TANI
» PREOPERATİF YÖNETİM
» CERRAHİ TEDAVİ SEÇENEKLERİ
  » Norwood Cerrahisi: 3 Aşamalı Palyasyon
  » Hibrit Palyasyon
  » Kalp Transplantasyonu
» SONUÇ

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trüktif cerrahilere alternatif bir tedavi seçeneği olarak ortaya çıkmıştır. İlk başarılı kalp nakli, 1985 yılınında Leonard Bailey ve meslektaşları tarafından gerçekleştirilmiştir.(5) Transplantasyonun en önemli avantajı olarak tek bir ameliyatla anatomik ve fizyolojik açılardan normal, dört odacıklı bir kalp sağlaması gösterilebilir. Ancak, bu yaklaşımın önemli dezavantajları vardır. Bunlar sınırlı donör mevcudiyeti, ömür boyu immünsüpresyon ihtiyacı ve geç dönem kronik rejeksiyon riski olarak sıralanabilir.

ABD'de kalp bekleyen bebek ve çocuklar, bekleme listesi mortalitesi en yüksek organ alıcıları arasındadır ve transplantasyon listesine alınan bebeklerin %25'i donör kalp beklerken hayatını kaybetmektedir.(92) Birinci aşama palyasyonun çoğu merkezde kabul edilebilir sonuçlar vermesi nedeniyle, primer kalp transplantasyonu günümüzde nadiren uygulanmakta ve genellikle şiddetli sağ ventrikül (RV) disfonksiyonu ve/veya orta-şiddetli triküspit kapak yetersizliği olan yüksek riskli yenidoğanlarla sınırlı kalmaktadır. Yenidoğan döneminde konjenital kalp hastalıkları nedeniyle primer transplantasyonun 10 yıllık ve 25 yıllık sağkalım oranları sırasıyla %73,9 ve %55.8 olarak bildirilmiştir.(93)

Transplantasyona giden hastaların daha büyük bölümü ise palyasyon sonrası başarısız olunan hastalardan oluşmaktadır. Fontan prosedürü sonrası transplantasyona giden hastalarda klinik iyileşme sağlanmakta, protein kaybettiren enteropati gibi önemli komplikasyonlar düzelebilmektedir.(94) Ancak bu gruptaki hastalarda daha önceki kan transfüzyonları veya homograft materyali nedeniyle pre-sensitizasyon gelişebilmekte, bu da nakil sonrası antikor aracılı rejeksiyon ve allogreft vaskülopatisi riskini beraberinde getirmektedir.(95)

Tüm bu nedenlerle kalp transplantasyonu, sadece bazı seçilmiş HLHS vakalarında, donör havuzunun izin verdiği ölçülerde primer tedavi seçeneği olarak düşünülebilmektedir. HLHS tanılı hastaların daha büyük bölümünde ise, cerrahi palyasyonun başarısız olduğu durumlarda son tedavi seçeneği olarak düşünülmektedir.

SONUÇ

Hipoplastik sol kalp sendromunun yönetimi, günümüzde de konjenital kalp cerrahisinin en zorlu alanlarından biri olmayı sürdürmektedir. Norwood prosedürünün uygulanması, yalnızca teknik bilgi değil, aynı zamanda yenidoğan kardiyak fizyolojiye hakimiyet, yoğun bakım desteği ve multidisipliner koordinasyon gerektirir. İlk başarılı Norwood prosedürünün gerçekleştirilmesinden bu yana, cerrahi tekniklerdeki ilerlemeler, yoğun bakım uygulamalarındaki gelişmeler, antenatal tanı olanakları ve multidisipliner yönetim sayesinde sağkalım oranlarında belirgin artış sağlanmıştır. Son yıllardaki gelişmeler sağkalımı artırmakla birlikte, uzun dönem yaşam kalitesinin yükseltilmesi için hâlâ önemli bir yol kat edilmesi gerekmektedir. Fetal müdahaleler, genetik çözümler, invaziv ve cerrahi tekniklerdeki yeni gelişmeler sayesinde; bu kompleks sendromun gelecekte daha etkin şekilde tedavi edilerek yüz güldürücü sonuçlar alınabileceğine dair umutlar artmaktadır.

KAYNAKLAR

1. Watson DG, Rowe RD. Aortic-valve atresia. Report of 43 cases. *J AmMed Assoc* 1962; 179: 14–18.doi:10.1001/jama.1962.03050010016003
2. Lev M. Pathologic anatomy and interrelationship of hypoplasia of the aortic tract complexes. *Lab Invest* 1952; 1: 61–70.
3. Noonan JA, Nadas AS. The hypoplastic left heart syndrome; an analysis of 101 cases. *Pediatr ClinNAm*1958; 5: 1029–1056
4. Norwood WI, Lang P, Casteneda AR, Campbell DN. Experience with operations for hypoplastic left heart syndrome. *J Thorac Cardiovasc Surg*. 1981;82(4):511-519.
5. Bailey LL, Nehlsen-Cannarella SL, Doroshow RW, *et al.* (1986) Cardiac allotransplantation in newborns as therapy for hypoplastic left heart syndrome. N Engl J Med 315, 949–951
6. Makikallio K, McElhinney DB, Levine JC, *et al.* (2006) Fetal aortic valve stenosis and the evolution of hypoplastic left heart syndrome: patient selection for fetal intervention. Circulation 113, 1401–1405
7. Mustafa HJ, Aghajani F, Jawwad M, Shah N, Abuhamad A, Khalil A. Fetal cardiac intervention in hypoplastic left heart syndrome with intact or restrictive atrial septum, systematic review, and meta-analysis. Prenat Diagn. 2024 Jun;44(6-7):747-757. doi: 10.1002/pd.6420. Epub 2023 Aug 19. PMID: 37596875
8. Freud LR, McElhinney DB, Marshall AC, Marx GR, Friedman KG, del Nido PJ, Emani SM, Lafranchi T, Sil-

va V, Wilkins-Haug LE, Benson CB, Lock JE, Tworetzky W. Fetal aortic valvuloplasty for evolving hypoplastic left heart syndrome: postnatal outcomes of the first 100 patients. Circulation. 2014 Aug 19;130(8):638-45. doi: 10.1161/CIRCULATIONAHA.114.009032. Epub 2014 Jul 22. PMID: 25052401; PMCID: PMC4299861.

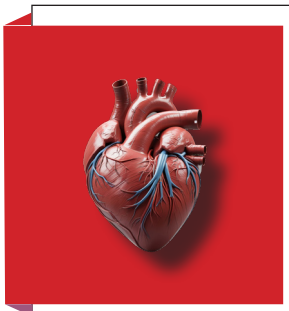
9. Hinton RB Jr., Martin LJ, Tabangin ME, Mazwi ML, Cripe LH, Benson DW. Hypoplastic left heart syndrome is heritable. J Am Coll Cardiol 2007;50:1590 –5
10. Natowicz M, Chatten J, Clancy R et al. Genetic disorders and major extracardiac anomalies with hypoplastic left heart syndrome. *Pediatrics* 1988;**82**:698–706.
11. Glauser TA, Rorke LB, Weinberg PM, Clancy RR. Congenital brain anomalies associated with the hypoplastic left heart syndrome. *Pediatrics*. 1990;85(6):984-990.
12. Onohara D, Hagen M, Louey S, Giraud G, Jonker S, Padala M. Chronic in utero mitral inflow obstruction unloads left ventricular volume in a novel late gestation fetal lamb model. JTCVS Open. 2023 Oct 4;16:698-707. doi: 10.1016/j.xjon.2023.09.036. PMID: 38204723; PMCID: PMC10775114
13. Maxwell D, Allan L, Tynan MJ. Balloon dilatation of the aortic valve in the fetus: a report of two cases. Brit Heart J 1991;65:256–8.
14. McElhinney DB, Marshall AC, Wilkins-Haug LE et al. Predictors of technical success and postnatal biventricular outcome after in utero aortic valvuloplasty for aortic stenosis with evolving hypoplastic left heart syndrome. *Circulation* 2009;**120**:1482–90.
15. Friedman KG, Margossian R, Graham DA et al. Postnatal left ventricular diastolic function after fetal aortic valvuloplasty. *Am J Cardiol* 2011;**108**:556–60.
16. Bharati S, Lev M. (1984) The surgical anatomy of hypoplasia of aortic tract complex. J Thorac Cardiovasc Surg 88, 97–101.
17. Özdemir F, Korun O, Dedemoğlu M, et al. Outcomes of Norwood procedure with hypoplastic left heart syndrome: Our 12-year single-center experience. *Turk Gogus Kalp Damar Cerrahisi Derg*. 2022;30(1):26-35. Published 2022 Jan 28. doi:10.5606/tgkdc.dergisi.2022.22397
18. Michalowski AK, Gauvreau K, Kaza A, et al. Technical Performance Score: A Predictor of Outcomes After the Norwood Procedure. *Ann Thorac Surg*. 2021;112(4):1290-1297. doi:10.1016/j.athoracsur.2020.07.039
19. Vida VL, Bacha EA, Larrazabal A, et al. Surgical outcome for patients with the mitral stenosis-aortic atresia variant of hypoplastic left heart syndrome. *J Thorac Cardiovasc Surg*. 2008;135(2):339-346. doi:10.1016/j.jtcvs.2007.09.007
20. Ohye RG, Sleeper LA, Mahony L, et al. Comparison of shunt types in the Norwood procedure for single-ventricle lesions. *N Engl J Med*. 2010;362(21):1980-1992. doi:10.1056/NEJMoa0912461
21. Barber G, Helton JG, Aglira BA, *et al.* (1988) The significance of tricuspid regurgitation in hypoplastic left-heart syndrome. Am Heart J 116(6 Pt 1), 1563–1567
22. Bradshaw EA, Cuzzi S, Kiernan SC et al. Feasibility of implementing pulse oximetry screening for congenital heart disease in a community hospital. *J Perinatol* 2012;**32**:710–15.
23. Martinez Crespo JM, Del Rio M, Gomez O et al. Prenatal diagnosis of hypoplastic left heart syndrome and trisomy 18 in a fetus with normal nuchal translucency and abnormal ductus venosus blood flow at 13 weeks of gestation. *Ultrasound Obstet Gynecol* 2003;**21**:490–3
24. Tworetzky W, McElhinnney DB, Reddy VM, Brook MM, Hanley FL, Silverman NH. Improved surgical outcome after fetal diagnosis of hypoplastic left heart syndrome. Circulation 2001;103:1269–73
25. Stieh J, Fischer G, Scheewe J, et al. Impact of preoperative treatment strategies on the early perioperative outcome in neonates with hypoplastic left he]art syndrome. J Thorac Cardiovasc Surg 2006;131: 1122–9.e2
26. Mahle WT, Clancy RR, McGaurn SP, Goin JE, Clark BJ. Impact of prenatal diagnosis on survival and early neurologic morbidity in neonates with the hypoplastic left heart syndrome. Pediatrics 2001; 107:1277– 82.
27. Verheijen PM, Lisowski LA, Stoutenbeek P, et al. Prenatal diagnosis of congenital heart disease affects preoperative acidosis in the newborn patient. J Thorac Cardiovasc Surg 2001;121:798–803.
28. Marshall AC, Marx GR, Friedman KG, del Nido PJ, Emani SM, Lafranchi T, Silva V, Wilkins-Haug LE, Benson CB, Lock JE, Tworetzky W. Fetal aortic valvuloplasty for evolving hypoplastic left heart syndrome: postnatal outcomes of the first 100 patients. Circulation. 2014 Aug 19;130(8):638-45. doi: 10.1161/CIRCULATIONAHA.114.009032. Epub 2014 Jul 22. PMID: 25052401; PMCID: PMC4299861.
29. Day TG, Budd S, Tan J, et al. Prenatal diagnosis of hypoplastic left heart syndrome on ultrasound using artificial intelligence: How does performance compare to a current screening programme?. *Prenat Diagn*. 2024;44(6-7):717-724. doi:10.1002/pd.6445
30. Shin, Youn Jeong, et al. "A False Diagnosis of Hypoplastic Left Heart Syndrome in a Fetus." *Clinical and Experimental Pediatrics* 45.2 (2002): 267-272.
31. Cheatham JP. (2001) Intervention in the critically ill neonate and infant with hypoplastic left heart syndrome and intact atrial septum. J Interv Cardiol 14, 357–366.
32. Freed MD, Heymann MA, Lewis AB, Roehl SL, Kensey RC. Prostaglandin E1 infants with ductus arteriosus-dependent congenital heart disease. Circulation 1981;64:899 –905.
33. Linday LA, Engle MA. Prostaglandin treatment of newborns with ductal-dependent congenital heart disease. Pediatr Ann 1981;10: 29–38.
34. Hallidie-Smith KA. Prostaglandin E1 in suspected ductus dependent cardiac malformation. Arch Dis Child 1984; 59: 1020–1026.
35. Yucel IK, Cevik A, Bulut MO, Dedeoğlu R, Demir İH, Erdem A, et al. Efficacy of very low-dose prostaglandin E1 in duct-dependent congenital heart disease. Cardiol Young 2015;25:56-62
36. Hoffman GM, Ghanayem NS, Scott JP, Tweddell JS, Mitchell ME, Mussatto KA. Postoperative Cerebral and Somatic Near-Infrared Spectroscopy Saturations and Outcome in Hypoplastic Left Heart Syndrome. *Ann Thorac Surg*. 2017;103(5):1527-1535. doi:10.1016/j.athoracsur.2016.09.100
37. Erek E, Aydın S, Temur B, et al. Outcomes of hybrid and Norwood Stage I procedures for the treatment of hypoplastic left heart syndrome and its variants. *Turk Gogus Kalp Damar Cerrahisi Derg*. 2020;28(2):282-293
38. Karavas AN, Deschner BW, Scott JW, Mettler BA, Bichell DP. Three-region perfusion strategy for aortic arch reconstruction in the Norwood. *Ann Thorac*

Surg. 2011;92(3):1138-1140. doi:10.1016/j.athoracsur.2011.03.122
39. Myers PO, Emani SM, Baird CW. Ring-reinforced Sano right ventricular to pulmonary artery conduit at Norwood stage I. *Multimed Man Cardiothorac Surg*. 2016;2016:mmv038. Published 2016 Jan 14. doi:10.1093/mmcts/mmv038
40. Sano S, Ishino K, Kawada M, et al. Right ventricle-pulmonary artery shunt in first-stage palliation of hypoplastic left heart syndrome. *J Thorac Cardiovasc Surg*. 2003;126(2):504-510. doi:10.1016/s0022-5223(02)73575-7
41. Harada T, Nakano T, Fujita S. Aortic arch configurations according to reconstruction methods following the Norwood procedure for hypoplastic left heart syndrome†. *Eur J Cardiothorac Surg*. 2025;67(6):ezaf143. doi:10.1093/ejcts/ezaf143
42. Schroeder vA, pearl JM, Schwartz SM, Shanley Tp, Manning pB, Nelson Dp. Combined steroid treatment for congenital heart surgery improves oxygen delivery and reduces postbypass inflammatory mediator expression. Circulation. 2003;107(22):2823-8.
43. Pasquali SK, li JS, He X, Jacobs Ml, O'brien SM, Hall M, et al. Perioperative methylprednisolone and outcome in neonates undergoing heart surgery. pediatrics. 2012;129(2):e385-91
44. Gaynor JW, Kuypers M, van Rossem M, et al. Haemodynamic changes during modified ultrafiltration immediately following the first stage of the Norwood reconstruction. *Cardiol Young*. 2005;15(1):4-7. doi:10.1017/S1047951105000028
45. Tabbutt S, Ghanayem N, Ravishankar C, et al. Risk factors for hospital morbidity and mortality after the Norwood procedure: A report from the Pediatric Heart Network Single Ventricle Reconstruction trial. *J Thorac Cardiovasc Surg*. 2012;144(4):882-895. doi:10.1016/j.jtcvs.2012.05.019
46. Bacha E, del Nido P. Introduction to the Single Ventricle Reconstruction trial. *J Thorac Cardiovasc Surg*. 2012;144(4):880-881. doi:10.1016/j.jtcvs.2012.08.031
47. Patel RD, Weld J, Flores S, et al. The Acute Effect of Packed Red Blood Cell Transfusion in Mechanically Ventilated Children after the Norwood Operation. *Pediatr Cardiol*. 2022;43(2):401-406. doi:10.1007/s00246-021-02735-6
48. Henry BM, Borasino S, Ortmann L, et al. Perioperative serum albumin and its influence on clinical outcomes in neonates and infants undergoing cardiac surgery with cardiopulmonary bypass: a multi-centre retrospective study. *Cardiol Young*. 2019;29(6):761-767. doi:10.1017/S1047951119000738
49. Strauss KM, Dongas A, Hein U, Goelnitz F, Thies WR, Breymann T, Inoue K. Stage 1 palliation of hypoplastic left heart syndrome: implications of blood gases. J Cardiothorac Vasc Anesth. 2001 Dec;15(6):731-5. doi: 10.1053/jcan.2001.28318. PMID: 11748522.
50. Murtuza B, Wall D, Reinhardt Z, et al. The importance of blood lactate clearance as a predictor of early mortality following the modified Norwood procedure. *Eur J Cardiothorac Surg*. 2011;40(5):1207-1214. doi:10.1016/j.ejcts.2011.01.081
51. Friedland-Little JM, Hirsch-Romano JC, Yu S, et al. Risk factors for requiring extracorporeal membrane oxygenation support after a Norwood operation. *J Thorac Cardiovasc Surg*. 2014;148(1):266-272. doi:10.1016/j.jtcvs.2013.08.051
52. Neumayr TM. Peritoneal Dialysis in Infants After Cardiopulmonary Bypass: Is Sooner Better Than Later?. *Pediatr Crit Care Med*. 2019;20(2):197-198. doi:10.1097/PCC.0000000000001823
53. Ugaki S, Kasahara S, Kotani Y, et al. Extracorporeal membrane oxygenation following Norwood stage 1 procedures at a single institution. *Artif Organs*. 2010;34(11):898-903. doi:10.1111/j.1525-1594.2010.01141.x
54. Santro T, d'Udekem Y, Zannino D, et al. Determinants of acute events leading to mortality after shunt procedure in univentricular palliation. *J Thorac Cardiovasc Surg*. 2019;158(4):1144-1153.e6. doi:10.1016/j.jtcvs.2019.03.126
55. Polimenakos AC, Sathanandam SK, Blair C, El Zein CF, Husayni TS, Ilbawi MN. Shunt reintervention and time-related events after Norwood operation: impact of shunt strategy. *Ann Thorac Surg*. 2012;94(5):1551-1561. doi:10.1016/j.athoracsur.2012.04.036]
56. Gaynor JW, Jarvik GP, Bernbaum J, et al. The relationship of postoperative electrographic seizures to neurodevelopmental outcome at 1 year of age after neonatal and infant cardiac surgery. *J Thorac Cardiovasc Surg*. 2006;131(1):181-189. doi:10.1016/j.jtcvs.2005.08.062
57. Pizarro C, Norwood WI. (2003) Right ventricle to pulmonary artery conduit has a favorable impact on postoperative physiology after Stage I Norwood: preliminary results. Eur J Cardiothorac Surg 23, 991–995
58. Goldberg CS, Gaynor JW, Mahle WT, et al. The pediatric heart network's study on long-term outcomes of children with HLHS and the impact of Norwood Shunt type in the single ventricle reconstruction trial cohort (SVRIII): Design and adaptations. *Am Heart J*. 2022;254:216-227. doi:10.1016/j.ahj.2022.09.005
59. Tweddell JS, Mitchell ME, Woods RK, Spray TL, Quintessenza JA. Construction of the right ventricle-to-pulmonary artery conduit in the Norwood: the "Dunk" technique. Oper Tech Thorac Cardiovasc Surg 2012;17:81–98
60. Barron DJ, Brooks A, Stickley J, et al. The Norwood procedure using a right ventricle-pulmonary artery conduit: comparison of the right-sided versus left-sided conduit position. *J Thorac Cardiovasc Surg*. 2009;138(3):528-537. doi:10.1016/j.jtcvs.2009.05.004
61. Beqaj H, Goldshtrom N, Linder A, et al. Valved Sano conduit improves immediate outcomes following Norwood operation compared with nonvalved Sano conduit. J Thorac Cardiovasc Surg. 2024;167(4):1404-1413. doi:10.1016/j.jtcvs.2023.08.036
62. Kalfa, David et al. Valved Conduit for Norwood-Sano Procedure. Operative Techniques in Thoracic and Cardiovascular Surgery, Volume 29, Issue 1, 25 – 36
63. Lamers LJ, Frommelt PC, Mussatto KA, Jaquiss RD, Mitchell ME, Tweddell JS. Coarctectomy combined with an interdigitating arch reconstruction results in a lower incidence of recurrent arch obstruction after the Norwood procedure than coarctectomy alone. *J Thorac Cardiovasc Surg*. 2012;143(5):1098-1102. doi:10.1016/j.jtcvs.2011.09.037
64. Vitanova K, Cleuziou J, Pabst von Ohain J, Burri M, Eicken A, Lange R. Recoarctation After Norwood I Procedure for Hypoplastic Left Heart Syndrome: Impact

of Patch Material. *Ann Thorac Surg*. 2017;103(2):617-621. doi:10.1016/j.athoracsur.2016.10.030
65. Karavas AN, Deschner BW, Scott JW, Mettler BA, Bichell DP. Three-region perfusion strategy for aortic arch reconstruction in the Norwood. *Ann Thorac Surg*. 2011;92(3):1138-1140. doi:10.1016/j.athoracsur.2011.03.122
66. Siffring T, Prabhu N, Evans A, Dauch W, Smigla G, Kaemmer D. Sustained Total All-Region (STAR) Perfusion: An Optimized Perfusion Strategy for Norwood Reconstruction. *J Extra Corpor Technol*. 2020;52(4):332-336. doi:10.1182/ject-2000038
67. Photiadis J, Asfour B, Sinzobahamvya N, et al. Improved hemodynamics and outcome after modified Norwood operation on the beating heart. *Ann Thorac Surg*. 2006;81(3):976-981. doi:10.1016/j.athoracsur.2005.09.037
68. Ghanayem NS, Allen KR, Tabbutt S, Atz AM, Clabby ML, Cooper DS, et al. Interstage mortality after the Norwood procedure: Results of the multicenter Single Ventricle Reconstruction trial. J Thorac Cardiovasc Surg 2012;144:896-906
69. Hehir DA, Dominguez TE, Ballweg JA, Ravishankar C, Marino BS, Bird GL et al. Risk factors for interstage death after stage 1 reconstruction of hypoplastic left heart syndrome and variants. J Thorac Cardiovasc Surg 2008;136:94–9
70. Feinstein JA, Benson DW, Dubin AM, Cohen MS, Maxey DM, Mahle WT, et al. Hypoplastic left heart syndrome: Current considerations and expectations. J Am Coll Cardiol 2012;59(1 Suppl):S1-42
71. Ghanayem NS, Hoffman GM, Mussatto KA, et al. Home surveillance program prevents interstage mortality after the Norwood procedure. *J Thorac Cardiovasc Surg*. 2003;126(5):1367-1377. doi:10.1016/s0022-5223(03)00071-0
72. *Rudd NA, Frommelt MA, Tweddell JS, Hehir DA, Mussatto KA, Frontier KD, Slicker JA, Bartz PJ, Ghanayem NS. Improving interstage survival after Norwood operation: outcomes from 10 years of home monitoring. J Thorac Cardiovasc Surg. 2014;148:1540–1547*
73. Siehr SL, Norris JK, Bushnell JA, et al. Home monitoring program reduces interstage mortality after the modified Norwood procedure. *J Thorac Cardiovasc Surg*. 2014;147(2):718-23.e1. doi:10.1016/j.jtcvs.2013.04.006.
74. Staehler H, Schaeffer T, Wasner J, et al. Impact of home monitoring program on interstage mortality after the Norwood procedure. *Front Cardiovasc Med*. 2023;10:1239477. Published 2023 Oct 11. doi:10.3389/fcvm.2023.1239477]
75. Michielon G, DiSalvo G, Fraisse A, Carvalho JS, Krupickova S, Slavik Z et al. In-hospital interstage improves interstage survival after the Norwood stage 1 operation . Eur J Cardiothorac Surg 2020; doi:10.1093/ejcts/ezaa074
76. Buelow MW, Rudd N, Tanem J, Simpson P, Bartz P, Hill G. Reintervention following stage 1 palliation: A report from the NPC-QIC Registry. *Congenit Heart Dis*. 2018;13(6):919-926. doi:10.1111/chd.12655
77. Fraisse A, Colan S, Jonas R, Gauvreau K, Geva T. Accuracy of echocardiography for detection of aortic arch obstruction after stage I Norwood procedure. Am Heart J. 1998;135:230-6.
78. Larrazabal LA, Selamet Tierney ES, Brown DW, et al. Ventricular function deteriorates with recurrent coarctation in hypoplastic left heart syndrome. *Ann Thorac Surg*. 2008;86(3):869-874. doi:10.1016/j.athoracsur.2008.04.074
79. Whiteside W, Hancock HS, Pasquali SK, et al. Recurrent Coarctation After Neonatal Univentricular and Biventricular Norwood-Type Arch Reconstruction. *Ann Thorac Surg*. 2016;102(6):2087-2094. doi:10.1016/j.athoracsur.2016.04.099
80. Aiyagari R, Rhodes JF, Shrader P, et al. Impact of pre-stage II hemodynamics and pulmonary artery anatomy on 12-month outcomes in the Pediatric Heart Network Single Ventricle Reconstruction trial. *J Thorac Cardiovasc Surg*. 2014;148(4):1467-1474. doi:10.1016/j.jtcvs.2013.10.057
81. Ohye RG, Gomez CA, Goldberg CS, Graves HL, Devaney EJ, Bove EL. Tricuspid valve repair in hypoplastic left heart syndrome. *J Thorac Cardiovasc Surg*. 2004;127(2):465-472. doi:10.1016/j.jtcvs.2003.07.053
82. Elmi M, Hickey EJ, Williams WG, et al. Long-term tricuspid valve function after Norwood operation. J Thorac Cardiovasc Surg 2011;142: 1341-1347]
83. Kverneland L.S., Kramer P., Ovroutski S. Five decades of the Fontan operation: a systematic review of international reports on outcomes after univentricular palliation. Congenit Heart Dis. 2018;13:181–193. doi: 10.1111/chd.12570
84. Lee J, Song MK, Lee SY, et al. Long-term outcomes of extracardiac Gore-Tex conduits in Fontan patients. *Int J Cardiol Congenit Heart Dis*. 2024;16:100505. Published 2024 Mar 8. doi:10.1016/j.ijcchd.2024.100505
85. Khairy P, Fernandes SM, Mayer JE Jr, et al. Long-term survival, modes of death, and predictors of mortality in patients with Fontan surgery. *Circulation*. 2008;117(1):85-92. doi:10.1161/CIRCULATIONAHA.107.738559
86. Gaynor JW, Mahle M, Ittenbach RF, et al. Long-Term Survival and Patient-Reported Outcomes After Staged Reconstructive Surgery for Hypoplastic Left Heart Syndrome. *J Am Coll Cardiol*. 2025;85(24):2386-2398. doi:10.1016/j.jacc.2025.04.028
87. Galantowicz M, Cheatham JP, Phillips A, Cua CL, Hoffman TM, Hill SL, Rodeman R. Hybrid approach for hypoplastic left heart syndrome: intermediate results after the learning curve. Ann Thorac Surg. 2008 Jun;85(6):2063-70; discussion 2070-1. doi: 10.1016/j.athoracsur.2008.02.009. PMID: 18498821.
88. Yörüker U, Akintürk H. Giessen Procedure as Comprehensive Stage II Palliation With Aortic Arch Reconstruction After Hybrid Bilateral Pulmonary Artery Banding and Ductal Stenting for Hypoplastic Left Heart Syndrome. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2018 Mar;21:19-27. doi: 10.1053/j.pcsu.2017.11.007. PMID: 29425520
89. Akintürk H, Yörüker U, Schranz D. Hypoplastic Left Heart Syndrome Palliation: Technical Aspects and Common Pitfalls of the Hybrid Approach. World J Pediatr Congenit Heart Surg. 2022 Sep;13(5):588-592. doi: 10.1177/21501351221099935. PMID: 36053094.
90. Iskander C, Nwankwo U, Kumanan KK, et al. Comparison of Morbidity and Mortality Outcomes between Hybrid Palliation and Norwood Palliation Procedures for Hypoplastic Left Heart Syndrome: Meta-Analysis

and Systematic Review. *J Clin Med*. 2024;13(14):4244. Published 2024 Jul 20. doi:10.3390/jcm13144244]

91. Schranz D, Esmaeili A, Akintuerk H. Hypoplastic Left Heart: Stage-I Will be Performed Interventionally, Soon. Pediatr Cardiol. 2021 Apr;42(4):727-735. doi: 10.1007/s00246-021-02597-y. Epub 2021 Apr 19. PMID: 33871681; PMCID: PMC8110497
92. Chrisant MR, Naftel DC, Drummond-Webb J, *et al.* (2005) Fate of infants with hypoplastic left heart syndrome listed for cardiac transplantation: a multicenter study. J Heart Lung Transplant 24, 576–582
93. John MM, Razzouk AJ, Chinnock RE, et al. Primary Transplantation for Congenital Heart Disease in the Neonatal Period: Long-term Outcomes. *Ann Thorac Surg*. 2019;108(6):1857-1864. doi:10.1016/j.athoracsur.2019.06.022
94. Michielon G, Parisi F, Di Carlo D, et al. Orthotopic heart transplantation for failing single ventricle physiology. Eur J Cardiothorac Surg 2003;24:502–10.
95. Wu GW, Kobashigawa JA, Fishbein MC, et al. Asymptomatic antibody-mediated rejection after heart transplantation predicts poor outcomes. J Heart Lung Transplant 2009;28:417–22



ÇOCUKLARDA GÖRÜLEN KARDİYAK TÜMÖRLER

BÖLÜM
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Nur DİKMEN [1]
Zeynep EYİLETEN [2]

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İçindekiler

- GİRİŞ
- EPİDEMİYOLOJİ
- GÖRÜLME SIKLIĞI VE İNSİDANS
- YAŞ VE CİNSİYET DAĞILIMI
- TÜMÖR TÜRLERİNİN DAĞILIMI
- GENETİK FAKTÖRLER VE EŞLİK EDEN HASTALIKLAR
- NÜKS ORANI VE UZUN DÖNEM SONUÇLAR
- COĞRAFİ DAĞILIM
- SEMPTOMLAR VE BULGULAR
- TÜMÖR YERLEŞİMİNE GÖRE KLİNİK BULGULAR
- FETAL VE NEONATAL DÖNEMDE KLİNİK BULGULAR
- EŞLİK EDEN DURUMLAR VE KOMPLİKASYONLAR
  - Klinik Yönetim ve İzlem
- TANI
- BİLGİSAYARLI TOMOGRAFİ (BT)
- ANJİYOGRAFİ
- BİYOPSİ
- FETAL EKOKARDİYOGRAFİ
  - Takip ve İzlem
  - Takip Planının Bileşenleri
- ÖZEL TÜMÖR TİPLERİ
- TEDAVİ YÖNTEMLERİ
  - Medikal Tedavi
  - Rabdomiyomlarda Medikal Tedavi
  - Aritmi Yönetimi İçin Medikal Tedavi
  - Cerrahi Tedavi
  - Cerrahi Komplikasyonlar
  - Cerrahi Sonrası İzlem
  - Postoperatif İzleme ve Bakım
- SONUÇ
- GELECEKTEKİ ARAŞTIRMA ALANLARI VE İLERİ TEKNOLOJİLER
- YENİLİKÇİ TANI YÖNTEMLERİ
  - Gelecek Perspektifleri ve Hastalık Yönetimi
  - Sonuç

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ca, uluslararası düzeyde pediatrik kalp tümörleri kayıtları oluşturularak hastalığın doğal seyri, tedavi sonuçları ve uzun dönem takip verileri daha kapsamlı şekilde değerlendirilmelidir.

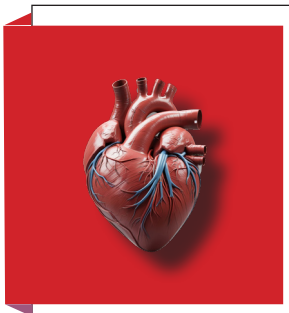
Sonuç

Pediatrik kalp tümörleri nadir görülmesine rağmen, erken tanı ve uygun tedavi ile prognozları genellikle iyidir. Rabdomiyomlar gibi benign tümörler çoğunlukla kendiliğinden küçülme eğiliminde olup, cerrahi gerektirmezken, fibromlar ve miksomalar gibi daha büyük ve semptomatik tümörler cerrahi müdahale gerektirebilir. Malign tümörler daha agresif seyretmekte ve genellikle cerrahi sonrası kemoterapi ve radyoterapi gibi ek tedaviler gerektirmektedir.

Gelecekteki araştırmalar, pediatrik kalp tümörlerinin genetik ve moleküler temellerinin daha iyi anlaşılmasını sağlayarak, hedefe yönelik tedavi stratejilerinin geliştirilmesine olanak tanıyabilir. Yeni tanı ve tedavi yaklaşımları, özellikle malign tümörlerde hastaların yaşam sürelerini uzatabilir ve yaşam kalitelerini artırabilir. Pediatrik kalp tümörlerinin nadirliği nedeniyle, daha geniş çaplı çok merkezli çalışmaların yapılması ve uluslararası iş birliklerinin artırılması bu hastalıkların yönetiminde önemli adımlar olacaktır.

KAYNAKLAR

1. Fournier E, Seguela PE, Sauvestre F, Jalal Z, Thomas J, Iriart X, Bonello B, Thambo JB. Imaging aspects of pediatric cardiac tumors. 2020; 13 (10): 2245-2253.
2. Tzani A, Doulamis IP, Mylonas KS, Avgerinos DV, Nasioudis D. Cardiac tumors in pediatric patients: a systematic review. World J Pediatr Congenit Heart Surg. 2017; 8: 624–632.
3. Burke A, Virmani R. Pediatric heart tumors. Cardiovascular Pathology. 2008; 17: 193-198.
4. Uzun O, Wilson DG, Vujanic GM, Parsons JM, De Giovanni JV. Cardiac tumours in children. Orphanet J Rare Dis. 2007; 2: 11.
5. Moradian M, Zadeh BH, Ghader FR, Khorgami MR, Mozaffari K, Sadeghi FM, Pouraliakbar H. Iran J Pediatr. 2020; 30 (6): 108865.
6. Shi L, Wu L, Fang H, Han B, Yang J, Ma X, et al. Identification and clinical course of 166 pediatric cardiac tumors. Eur J Pediatr. 2017; 176(2): 253– 260.
7. Allen HD, Shaddy RE, Penny DJ, Feltes TF, Cetta F. Cardiac tumors. In: Marx GR, Moran AM, editors. Moss and Adams' heart disease in infants, children, and adolescents including the fetus and young adults. 9th ed. Lippincott Williams & Wilkins (LWW); 2016.
8. Beroukhim RS, Prakash A, Buechel ERV, et al. Characterization of cardiac tumors in children by cardiovascular magnetic resonance imaging: a multicenter experience. J Am Coll Cardiol 2011; 58: 1044–1054.
9. Freedom RM, Lee KJ, MacDonald C, Taylor G. Selected aspects of cardiac tumors in infancy and childhood. Pediatr Cardiol 2000; 21: 299–316.
10. Padalino MA, Reffo E, Cerutti A, Favero V, Biffanti R, Vida V, et al. Medical and surgical management of primary cardiac tumours in infants and children. Cardiol Young. 2014; 24(2): 268–274.
11. Ying L, Lin R, Gao Z, Qi J, Zhang Z, Gu W. Primary cardiac tumors in children: a center's experience. J Cardiothorac Surg. 2016; 11(1): 52.
12. Paramés F, Freitas I, Martins JD, Trigo C, Pinto MF. Cardiac tumors: the 17-year experience of pediatric cardiology department. Rev Port Cardiol. 2009; 28(9):929–40.
13. Mda MB, Gow RM, Haney I, Mawson J, Williams WG, Freedom RM. Pediatric primary benign cardiac tumors: A 15-year review. Am Heart J. 1997; 134(6): 1107–1114.
14. Elderkin RA, Radford DJ. Primary cardiac tumours in a paediatric population. J Paediatr Child Health. 2002; 38(2): 173–177.
15. Takach TJ, Reul GJ, Ott DA, Cooley DA. Primary cardiac tumors in infants and children: immediate and long-term operative results. Ann Thorac Surg. 1996; 62: 559–564.
16. Isaacs H. Fetal and neonatal cardiac tumors. Pediatr Cardiol 2004;25: 252–273.
17. Tao TY, Yahyavi-Firouz-Abadi N, Singh GK, Bhalla S. Pediatric cardiac tumors: clinical and imaging features. Radiographics. 2014; 34(4): 1031– 1046.
18. Di Liang C, Ko SF, Huang SC. Echocardiographic evaluation of cardiac rhabdomyoma in infants and children. J Clin Ultrasound 2000; 28:381–386.
19. Beghetti M, Gow RM, Haney I, Mawson J, Williams WG, Freedom RM. Pediatric primary benign cardiac tumors: a 15-year review. Am Heart J 1997; 134: 1107–1114.
20. Yuan SM, Yan SL, Wu N. Unusual aspects of cardiac myxoma. Anatol J Cardiol. 2017; 17(3): 241–247.
21. Itoh K, Matsumura T, Egawa Y, Watanabe M, Ohshio T, Ohta A, Hayabuchi Y, Seki K. Primary mitral valve sarcoma in infancy. Pediatr Cardiol 1998; 19: 174–177.
22. Lee JR, Chang JM, Lee C, Kim CJ. Undifferentiated sarcoma of the mitral valve with unique clinicopathologic presentation. J Cardiovasc Surg (Torino) 2003; 44: 621–623.
23. Becker AE. Primary heart tumors in the pediatric age group: a review of salient pathologic features relevant for clinicians. Pediatr Cardiol 2000; 21: 317–323.
24. Wang JN, Yao CT, Chen JS, Yang YJ, Tsai YC, Wu JM. Cardiac tumors in infants and children. Acta Paediatr Taiwan. 2003; 44(4): 215–219.
25. Delmo Walter EM, Javier MF, Sander F, Hartmann B, Ekkernkamp A, Hetzer R. Primary cardiac tumors in infants and children: Surgical strategy and long-term outcome. Ann Thorac Surg. 2016; 102(6): 2062–2069.
26. Jayaprakash S. Clinical presentations, diagnosis, and management of arrhythmias associated with cardiac tumors. J Arrhythm. 2018; 34(4): 384–393.



KONJENİTAL KALP CERRAHİSİNDE MİNİMAL İNVAZİV AMELİYATLAR

BÖLÜM
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Serkan SEÇİCİ [1]

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İçindekiler

- GİRİŞ
- MİNİ ALT STERNOTOMİ
  - Cerrahi Teknik
  - Avantajları
  - Dezavantajları
- TORAKOTOMİ İLE YAKLAŞIM
  - Sağ Aksiller/Vertikal Torakotomi
  - Cerrahi Teknik
  - Sağ Anterior Torakotomi
  - Cerrahi teknik
  - Sağ Anterolateral Torakotomi
  - Cerrahi Teknik
  - Sağ Posterolateral Torakotomi
  - Cerrahi Teknik
- SONUÇ
- VİDEO DESTEKLİ TORAKOSKOPİK CERRAHİ
  - Ekstrakardiyak VATS Prosedürleri
  - İntrakardiyak Defektlerin Torakoskopik Kapatılması
  - Cerrahi Teknik
- ROBOTİK CERRAHİ
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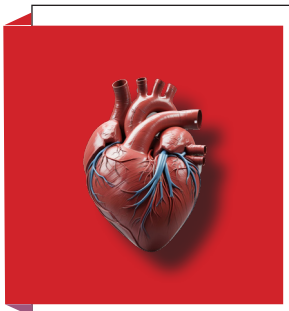
KAYNAKLAR

1. Liu, H., et al., *Evaluation of different minimally invasive techniques in surgical treatment for ventricular septal defect.* Heart, Lung and Circulation, 2018. **27**(3): p. 365-370.
2. Heinisch, P.P., et al., *Vertical right axillary mini-thoracotomy for correction of ventricular septal defects and complete atrioventricular septal defects.* The Annals of thoracic surgery, 2018. **106**(4): p. 1220-1227.
3. Yan, L., et al., *Right vertical infra-axillary mini-incision for repair of simple congenital heart defects: a matched-pair analysis.* European Journal of Cardio-Thoracic Surgery, 2013. **43**(1): p. 136-141.
4. Dodge-Khatami, J., et al., *Minimal invasive approaches for pediatric & congenital heart surgery: safe, reproducible, more cosmetic than through sternotomy, and here to stay.* Translational Pediatrics, 2023. **12**(9): p. 1744.
5. Bacha, E. and D. Kalfa, *Minimally invasive paediatric cardiac surgery.* Nature Reviews Cardiology, 2014. **11**(1): p. 24-34.
6. Dodge-Khatami, A. and J.D. Salazar, *Right axillary thoracotomy for transatrial repair of congenital heart defects: VSD, partial AV canal with mitral cleft, PAPVR or Warden, cor triatriatum, and ASD.* Operative Techniques in Thoracic and Cardiovascular Surgery, 2015. **20**(4): p. 384-401.
7. Ding, C., et al., *Anterolateral minithoracotomy versus median sternotomy for the treatment of congenital heart defects: a meta-analysis and systematic review.* Journal of Cardiothoracic Surgery, 2012. **7**: p. 1-6.
8. Hu, C.-X., et al., *Comparison of clinical outcomes and postoperative recovery between two open heart surgeries: minimally invasive right subaxillary vertical thoracomy and traditional median sternotomy.* Asian Pacific journal of tropical medicine, 2014. **7**(8): p. 625-629.
9. An, G., et al., *Mid-term outcomes of common congenital heart defects corrected through a right subaxillary thoracotomy.* Heart, Lung and Circulation, 2017. **26**(4): p. 376-382.
10. Hong, Z.-N., et al., *Surgical repair via submammary thoracotomy, right axillary thoracotomy and median sternotomy for ventricular septal defects.* Journal of Cardiothoracic Surgery, 2018. **13**: p. 1-6.
11. Zhu, J., et al., *Individualized strategy of minimally invasive cardiac surgery in congenital cardiac septal defects.* Journal of cardiothoracic surgery, 2022. **17**(1): p. 5.
12. Jacobs, J.P., E.Y. Pruitt, and V. Badhwar, *Robotic Surgery for pediatric and congenital cardiac disease.* The Annals of Thoracic Surgery, 2021. **112**(6): p. 2028.
13. Liu, G., et al., *Totally thoracoscopic surgical treatment for atrial septal defect: mid-term follow-up results in 45 consecutive patients.* Heart, Lung and Circulation, 2013. **22**(2): p. 88-91.
14. Hagl, C., et al., *Evaluation of different minimally invasive techniques in pediatric cardiac surgery: is a full sternotomy always a necessity?* Chest, 2001. **119**(2): p. 622-627.
15. Kadner, A., et al. *Inferior partial sternotomy for surgical closure of isolated ventricular septal defects in children*. in *The Heart Surgery Forum*. 2004.
16. Ono, M., et al., *The clinical pathway for fast track recovery of school activities in children after minimally invasive cardiac surgery.* Cardiology in the Young, 2003. **13**(1): p. 44-48.
17. Vida, V.L., et al., *Minimally invasive surgical options in pediatric heart surgery.* Expert Review of Cardiovascular Therapy, 2011. **9**(6): p. 763-769.
18. Mishaly, D., P. Ghosh, and S. Preisman, *Minimally invasive congenital cardiac surgery through right anterior minithoracotomy approach.* The Annals of thoracic surgery, 2008. **85**(3): p. 831-835.
19. Luo, H., et al., *Evaluation of different minimally invasive techniques in the surgical treatment of atrial septal defect.* The Journal of Thoracic and Cardiovascular Surgery, 2014. **148**(1): p. 188-193.
20. Divya, G., et al., *Musculoskeletal and esthetic complications after neonatal thoracotomy: revisited.* Journal of Indian Association of Pediatric Surgeons, 2022. **27**(3): p. 293-296.
21. Bleiziffer, S., et al., *The influence of right anterolateral thoracotomy in prepubescent female patients on late breast development and on the incidence of scoliosis.* The Journal of thoracic and cardiovascular surgery, 2004. **127**(5): p. 1474-1480.
22. Blitzer, D., I. Bouhout, and E. Bacha, *Lower Partial Mini-Sternotomy for Congenital Cardiac Surgery.* Operative Techniques in Thoracic and Cardiovascular Surgery, 2022. **27**(3): p. 289-293.
23. Palma, G., et al., *Anterolateral minithoracotomies for the radical correction of congenital heart diseases.* Texas Heart Institute Journal, 2009. **36**(6): p. 575.
24. Dodge-Khatami, J. and A. Dodge-Khatami, *Advantages of a mini right axillary thoracotomy for congenital heart defect repair in children.* Cardiology in the Young, 2022. **32**(2): p. 276-281.
25. Chiem, H.D., et al., *Surgery for the right vertical infra-axillary thoracotomy in treatment of outlet ventricular septal defect in children.* Progress in Pediatric Cardiology, 2024. **75**: p. 101749.
26. Li, G., et al., *Safety and efficacy of ventricular septal defect repair using a cosmetic shorter right lateral thoracotomy on infants weighing less than 5 kg.* Heart, Lung and Circulation, 2015. **24**(9): p. 898-904.
27. Ho Quoc, C., et al., *Breast asymmetry and pectus excavatum improvement with fat grafting.* Aesthetic surgery journal, 2013. **33**(6): p. 822-829.
28. Quoc, C.H., et al. *Lipofilling, an efficient solution for breast sequelae after cardiothoracic surgery*. in *Annales de Chirurgie Plastique Esthétique*. 2015. Elsevier.
29. Ishii, N., et al., *Reconstructive surgery for severe breast asymmetry post-paediatric cardiovascular operation by anterolateral thoracotomy.* Interdisciplinary CardioVascular and Thoracic Surgery, 2023. **37**(5): p. ivad191.
30. Eby, S.F., et al., *Thoracogenic spinal deformity: a rare cause of early-onset scoliosis.* Journal of Neurosurgery: Spine, 2018. **29**(6): p. 674-679.
31. Cherup, L.L., R.D. Siewers, and J.W. Futrell, *Breast and pectoral muscle maldevelopment after anterolateral and posterolateral thoracotomies in children.* The Annals of thoracic surgery, 1986. **41**(5): p. 492-497.
32. Vida, V.L., et al., *Minimally invasive operation for congenital heart disease: a sex-differentiated approach.* The Journal of thoracic and cardiovascular surgery, 2009. **138**(4): p. 933-936.
33. Bal, S., et al., *Thoracic sequels after thoracotomies in children with congenital cardiac disease.* Cardiology in the young, 2003. **13**(3): p. 264-267.

34. Safa, N., et al., *Musculoskeletal deformities after thoracic surgery in children: an observational long-term follow-up study.* Journal of Pediatric Surgery, 2021. **56**(1): p. 136-141.
35. Panda, S.S., et al., *A survey of musculoskeletal and aesthetic abnormalities after thoracotomy in pediatric patients.* Journal of Indian Association of Pediatric Surgeons, 2013. **18**(4): p. 136-142.
36. Lawal, T.A., et al., *Thoracoscopy versus thoracotomy improves midterm musculoskeletal status and cosmesis in infants and children.* The Annals of thoracic surgery, 2009. **87**(1): p. 224-228.
37. Metras, D. and B. Kreitmann, *Correction of cardiac defects through a right thoracotomy in children.* The Journal of Thoracic and Cardiovascular Surgery, 1999. **117**(5): p. 1040-1041.
38. Shivaprakasha, K., et al., *Role of limited posterior thoracotomy for open-heart surgery in the current era.* The Annals of thoracic surgery, 1999. **68**(6): p. 2310-2313.
39. Kiblawi, R., et al., *Video-assisted thoracoscopic or conventional thoracic surgery in infants and children: current evidence.* European Journal of Pediatric Surgery, 2021. **31**(01): p. 054-064.
40. Bawazir, O.A., *Thoracoscopy in pediatrics: Surgical perspectives.* Annals of Thoracic Medicine, 2019. **14**(4): p. 239-247.
41. Kugler, C., *Minimal-invasive thoracic surgery in pediatric patients.* Journal of Visualized Surgery, 2018. **4**: p. 10.
42. Rothenberg, S.S., *Thoracoscopic closure of patent ductus arteriosus in infants and children.* Pediatric Endosurgery and Innovative Techniques, 2001. **5**(2): p. 109-112.
43. Liem, N.T., T.M. Tuan, and N.V. Linh, *A safe technique of thoracoscopic clipping of patent ductus arteriosus in children.* Journal of Laparoendoscopic & Advanced Surgical Techniques, 2012. **22**(4): p. 422-424.
44. Slater, B.J. and S.S. Rothenberg, *Thoracoscopic management of patent ductus arteriosus and vascular rings in infants and children.* Journal of Laparoendoscopic & Advanced Surgical Techniques, 2016. **26**(1): p. 66-69.
45. Muller, C.O., et al., *Thoracoscopy versus open surgery for persistent ductus arteriosus and vascular ring anomaly in neonates and infants.* Journal of Laparoendoscopic & Advanced Surgical Techniques, 2018. **28**(8): p. 1008-1011.
46. Stankowski, T., et al., *Minimally invasive thoracoscopic closure versus thoracotomy in children with patent ductus arteriosus.* Journal of Surgical Research, 2017. **208**: p. 1-9.
47. Suematsu, Y., et al., *Totally endoscopic robotic-assisted repair of patent ductus arteriosus and vascular ring in children.* The Annals of thoracic surgery, 2005. **80**(6): p. 2309-2313.
48. Ma, Z.-S., et al., *Totally thoracoscopic closure of ventricular septal defect without a robotically assisted surgical system: a summary of 119 cases.* The Journal of thoracic and cardiovascular surgery, 2014. **147**(3): p. 863-868.
49. Tang, Y., et al., *Total endoscopic repair of atrial septal defect under on-pump beating heart.* Journal of thoracic disease, 2018. **10**(12): p. 6557.
50. Ma, Z.-S., et al., *Totally thoracoscopic closure for atrial septal defect on perfused beating hearts.* European journal of cardio-thoracic surgery, 2012. **41**(6): p. 1316-1319.
51. Wang, F., et al., *Totally thoracoscopic surgical closure of atrial septal defect in small children.* The Annals of thoracic surgery, 2011. **92**(1): p. 200-203.
52. Ma, Z.-S., et al., *Quality of life in patients undergoing totally thoracoscopic closure for atrial septal defect.* The Annals of thoracic surgery, 2011. **92**(6): p. 2230-2234.
53. Dang, Q.-H., et al., *Totally endoscopic cardiac surgery for atrial septal defect repair on beating heart without robotic assistance in 25 patients.* Innovations, 2017. **12**(6): p. 446-452.
54. Lee, M.E., et al., *Robotic Congenital Cardiac Surgery Practice Worldwide: A Systematic Review.* Journal of Cardiac Surgery, 2025. **2025**(1): p. 4692522.
55. Denning, N.-L., M.P. Kallis, and J.M. Prince, *Pediatric robotic surgery.* Surgical Clinics, 2020. **100**(2): p. 431-443.
56. Varda, B.K., et al., *Has the robot caught up? National trends in utilization, perioperative outcomes, and cost for open, laparoscopic, and robotic pediatric pyeloplasty in the United States from 2003 to 2015.* Journal of pediatric urology, 2018. **14**(4): p. 336. e1-336. e8.
57. Kato, D., et al., *First pediatric pelvic surgery with the Senhance® robotic surgical system: A case series.* Asian Journal of Endoscopic Surgery, 2024. **17**(4): p. e13379.
58. Suematsu, Y. and P.J. del Nido, *Robotic pediatric cardiac surgery: present and future perspectives.* The American journal of surgery, 2004. **188**(4): p. 98-103.
59. Le Bret, E., et al., *Interruption of patent ductus arteriosus in children: robotically assisted versus videothoracoscopic surgery.* The Journal of thoracic and cardiovascular surgery, 2002. **123**(5): p. 973-976.
60. Gutt, C., et al., *Early experiences of robotic surgery in children.* Surgical endoscopy, 2002. **16**: p. 1083-1086.
61. Casale, P. and Y. Kojima, *Robotic-assisted laparoscopic surgery in pediatric urology: an update.* Scandinavian Journal of Surgery, 2009. **98**(2): p. 110-119.
62. Fuchs, M.E. and D.G. DaJusta, *Robotics in pediatric urology.* International braz j urol, 2020. **46**: p. 322-327.
63. Mei, H. and S. Tang, *Robotic-assisted surgery in the pediatric surgeons' world: Current situation and future prospectives.* Frontiers in pediatrics, 2023. **11**: p. 1120831.
64. Poffo, R., et al., *Robotic cardiac surgery in Brazil.* Annals of Cardiothoracic Surgery, 2017. **6**(1): p. 17.
65. Onan, B. and I.S. Onan, *Early results of robotically assisted congenital cardiac surgery: analysis of 242 patients.* The Annals of Thoracic Surgery, 2021. **112**(6): p. 2020-2027.
66. Kim, J.E., et al., *Surgical outcomes of congenital atrial septal defect using da VinciTM surgical robot system.* The Korean journal of thoracic and cardiovascular surgery, 2013. **46**(2): p. 93.
67. Garg, R.K., et al., *Fast tracking after repair of congenital heart defects.* Indian Journal of Thoracic and Cardiovascular Surgery, 2021. **37**(Suppl 1): p. 183-189.
68. Baehner, T., et al., *Effects of on-table extubation after pediatric cardiac surgery.* Journal of Clinical Medicine, 2022. **11**(17): p. 5186.
69. Altun, D., et al., *A retrospective analysis of dexmedetomidine and morphine in the fast-track and ultra-fast-track extubation protocol after congenital cardiac surgery.* Journal of Cardiac Surgery, 2022. **37**(12): p. 4234-4242.
70. Dhole, S., et al., *Comparison of continuous thoracic epidural and paravertebral blocks for postoperative analgesia after minimally invasive direct coronary artery bypass surgery.* Journal of cardiothoracic and vascular anesthesia, 2001. **15**(3): p. 288-292.

71. Hill, S.E., et al., *Efficacy of single-dose, multilevel paravertebral nerve blockade for analgesia after thoracoscopic procedures.* Anesthesiology, 2006. **104**(5): p. 1047-1053.
72. Blanco, R., et al., *Serratus plane block: a novel ultrasound-guided thoracic wall nerve block.* Anaesthesia, 2013. **68**(11): p. 1107-1113.
73. Khalil, A.E., et al., *Ultrasound-guided serratus anterior plane block versus thoracic epidural analgesia for thoracotomy pain.* Journal of Cardiothoracic and Vascular Anesthesia, 2017. **31**(1): p. 152-158.
74. Lucente, M., et al., *Erector spinae plane block in children: a narrative review.* Korean Journal of Anesthesiology, 2022. **75**(6): p. 473-486.
75. Luo, R., et al., *Effects of erector spinae plane block on postoperative pain in children undergoing surgery: A systematic review and meta-analysis of randomized controlled trials.* Pediatric Anesthesia, 2021. **31**(10): p. 1046-1055.
76. Sahajanandan, R., et al., *Efficacy of paravertebral block in "Fast-tracking" pediatric cardiac surgery-Experiences from a tertiary care center.* Annals of Cardiac Anaesthesia, 2021. **24**(1): p. 24-29.
77. Feng, J., et al., *Effects of thoracic paravertebral block on postoperative analgesia in infants and small children undergoing ultra-fast track cardiac anesthesia: A randomized controlled trial.* Journal of Cardiothoracic and Vascular Anesthesia, 2023. **37**(4): p. 539-546.
78. Kaushal, B., et al., *Comparison of the efficacy of ultrasound-guided serratus anterior plane block, pectoral nerves II block, and intercostal nerve block for the management of postoperative thoracotomy pain after pediatric cardiac surgery.* Journal of cardiothoracic and vascular anesthesia, 2019. **33**(2): p. 418-425.
79. He, Y., et al., *Safety and feasibility of ultrasound-guided serratus anterior plane block and intercostal nerve block for management of post-sternotomy pain in pediatric cardiac patients: a prospective, randomized trial.* Anaesthesia Critical Care & Pain Medicine, 2023. **42**(6): p. 101268.
80. Victoria, N.C. and A.Z. Murphy, *Exposure to early life pain: long term consequences and contributing mechanisms.* Current opinion in behavioral sciences, 2016. **7**: p. 61-68.
81. Pollak, U. and A. Serraf, *Pediatric cardiac surgery and pain management: after 40 years in the desert, have we reached the promised land?* World Journal for Pediatric and Congenital Heart Surgery, 2018. **9**(3): p. 315-325.
82. Beltrán-Campos, V., et al., *Effects of morphine on brain plasticity.* Neurología (English Edition), 2015. **30**(3): p. 176-180.
83. Anand, K., et al., *Effects of morphine analgesia in ventilated preterm neonates: primary outcomes from the NEOPAIN randomised trial.* The Lancet, 2004. **363**(9422): p. 1673-1682.
84. Winch, P.D., et al., *Learning from experience: improving early tracheal extubation success after congenital cardiac surgery.* Pediatric Critical Care Medicine, 2016. **17**(7): p. 630-637.
85. Vadivelu, N., et al., *Ketorolac tromethamine–routes and clinical implications.* Pain practice, 2015. **15**(2): p. 175-193.
86. Saini, A., K.O. Maher, and S.R. Deshpande, *Nonopioid analgesics for perioperative and cardiac surgery pain in children: current evidence and knowledge gaps.* Annals of Pediatric Cardiology, 2020. **13**(1): p. 46-55.
87. Gillis, J.C. and R.N. Brogden, *Ketorolac: a reappraisal of its pharmacodynamic and pharmacokinetic properties and therapeutic use in pain management.* Drugs, 1997. **53**(1): p. 139-188.
88. Moffett, B.S., et al., *Safety of ketorolac in neonates and infants after cardiac surgery.* Pediatric Anesthesia, 2006. **16**(4): p. 424-428.
89. Dawkins, T.N., et al., *Safety of intravenous use of ketorolac in infants following cardiothoracic surgery.* Cardiology in the Young, 2009. **19**(1): p. 105-108.
90. Smith, H.S., *Perioperative intravenous acetaminophen and NSAIDs.* Pain medicine, 2011. **12**(6): p. 961-981.
91. Lucas, S.S., et al., *Pediatric Cardiac Intensive Care Society 2014 consensus statement: pharmacotherapies in cardiac critical care: sedation, analgesia and muscle relaxant.* Pediatric Critical Care Medicine, 2016. **17**(3_suppl): p. S3-S15.



ERİŞKİN KONJENİTAL KALP CERRAHİSİ

BÖLÜM
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İçindekiler

- ERİŞKİN DOĞUMSAL KALP HASTALIĞI (EDKH) GİRİŞ
- EDKH'DA CERRAHİ ÖNCESİ TANISAL İŞLEMLER
- EDKH'DA CERRAHİ ENDİKASYONLAR VE RİSK SINIFLAMASI
- ERİŞKİN DOĞUMSAL KALP CERRAHİSİNDE SIK YAPILAN GİRİŞİMLER
  - Girişim yapılmamış veya rezidüye bağlı intrakardiyak şant oluşturan septal defektler
- PATENT DUCTUS ARTERİOSUS (PDA)
- KAPAK&KONDUİT REKONSTRÜKSİYONU VEYA REPLASMANI, ÇIKIM YOLU REKONSTRÜKSİYONU
  - Subvalvular Aort Darlığı
  - Konduit Darlığı
- AORT KOARKTASYONU
- EBSTEİN ANOMALİSİ
- BÜYÜK ARTERLERİN TRANSPOZİSYONU (BAT)
  - Atriyal switch yapılmış Bat
  - Arteriyal switch yapılmış Bat
  - Rastelli operasyonu yapılmış Bat
- BÜYÜK ARTERLERİN KONJENİTAL DÜZELTİLMİŞ TRANSPOZİSYONU
- MARFAN SENDROMU
- TEK VENTRİKÜL FİZYOLOJİLİ VE FONTAN SİRKÜLASYONU YAPILMIŞ HASTALAR
- KALP TRANSPLANTASYONU
- TARTIŞMA

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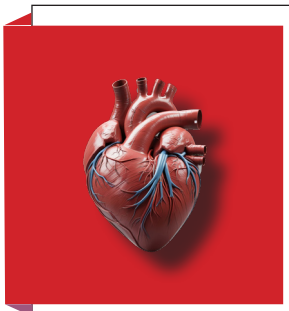
KAYNAKLAR

1. Hoffman JI, Christianson R. Congenital heart disease in a cohort of 19,502 births with long-term follow-up. Am J Cardiol 1978; 42:641±7.
2. Warnes CA, Liberthson R, Danielson GK, et al. Task force 1: the changing profile of congenital heart disease in adult life. *J Am Coll Cardiol*. 2001;37(5):1170-1175. doi:10.1016/s0735-1097(01)01272-4
3. Schmaltz AA, Bauer U, Baumgartner H, et al. Medizinische Leitlinie zur Behandlung von Erwachsenen mit angeborenen Herzfehlern (EMAH): der deutsch-österreichisch-schweizerischen kardiologischen Fachgesellschaften *Clin Res Cardiol*. 2008;97(3):194-214. doi:10.1007/s00392-008-0639-8
4. Marelli A. The Future of Adult Congenital Heart Disease Research: Precision Health Services Delivery for the Next Decade. *Can J Cardiol*. 2019;35(12):1609-1619. doi:10.1016/j.cjca.2019.09.015
5. Egidy Assenza G, Krieger EV, Baumgartner H, et al. AHA/ACC vs ESC Guidelines for Management of Adults With Congenital Heart Disease: JACC Guideline Comparison. *J Am Coll Cardiol*. 2021;78(19):1904-1918. doi:10.1016/j.jacc.2021.09.010
6. Marelli A, Beauchesne L, Colman J, et al. Canadian Cardiovascular Society 2022 Guidelines for Cardiovascular Interventions in Adults With Congenital Heart Disease. *Can J Cardiol*. 2022;38(7):862-896. doi:10.1016/j.cjca.2022.03.021
7. Constantine A, Costola G, Bianchi P, et al. Enhanced Assessment of Perioperative Mortality Risk in Adults With Congenital Heart Disease. *J Am Coll Cardiol*. 2021;78(3):234-242. doi:10.1016/j.jacc.2021.04.096
8. Baumgartner H, De Backer J, Babu-Narayan SV, et al. 2020 ESC Guidelines for the management of adult congenital heart disease. *Eur Heart J*. 2021;42(6):563-645. doi:10.1093/eurheartj/ehaa554
9. Konstantinov IE, Kotani Y, Buratto E, Schulz A, Ivanov Y. Minimally invasive approaches to atrial septal defect closure. *JTCVS Tech*. 2022;14:184-190. Published 2022 Apr 2. doi:10.1016/j.xjtc.2022.02.037
10. Campbell A, Carere R.G. Surgical and interventional management of adult congenital heart disease. BCMJ, vol. 58 , No. 7 , September 2016 , Pages 373-380
11. van de Sandt FM, Boekholdt SM, Bouma BJ, et al. Patent ductus arteriosus in adults - indications and possibilities for closure. Neth Heart J. 2011;19(6):297-300. doi:10.1007/s12471-011-0138-9
12. Khan I, Tufail Z, Afridi S, Iqbal M, Khan T, Waheed A. Surgery for Tetralogy of Fallot in Adults: Early Outcomes. *Braz J Cardiovasc Surg*. 2016;31(4):300-303. doi:10.5935/1678-9741.20160063
14. Ozaki S, Kawase I, Yamashita H, et al. Aortic valve reconstruction using autologous pericardium for patients aged less than 60 years. *J Thorac Cardiovasc Surg*. 2014;148(3):934-938. doi:10.1016/j.jtcvs.2014.05.041
15. Cesnjeva R., Dittrich S. Chirurgische Therapie angeborener Herzfehler im Erwachsenenalter Besondere chirurgische und interdisziplinäre HerausforderungZ-Herz- Thorax- Gefäßchir 2019· 33:327–343 https://doi.org/10.1007/s00398-019-00330-9
16. Zubrzycki M, Schramm R, Costard-Jäckle A, et al. Pathogenesis and Surgical Treatment of Congenitally Corrected Transposition of the Great Arteries (ccTGA): Part III. *J Clin Med*. 2024;13(18):5461. Published 2024 Sep 14. doi:10.3390/jcm13185461
17. Cesnjevar, R., Schweiger, M. Chirurgische Therapie angeborener Herzfehler im Erwachsenenalter. *Z Herz- Thorax- Gefäßchir* 38, 269–271 (2024). https://doi.org/10.1007/s00398-024-00657-y
18. Michielon G, van Melle JP, Wolff D, et al. Favourable mid-term outcome after heart transplantation for late Fontan failure. *Eur J Cardiothorac Surg*. 2015;47(4):665-671. doi:10.1093/ejcts/ezu280
19. Brida M, Lovrić D, Griselli M, Riesgo Gil F, Gatzoulis MA. Heart failure in adults with congenital heart disease. *Int J Cardiol*. 2022;357:39-45. doi:10.1016/j.ijcard.2022.03.018
20. Saef J, Montgomery R, Cedars A, et al. Durable Mechanical Circulatory Support in Adult Congenital Heart Disease: Reviewing Clinical Considerations and Experience. *J Clin Med*. 2022;11(11):3200. Published 2022 Jun 3. doi:10.3390/jcm11113200
21. Karamlou T, Diggs BS, Person T, Ungerleider RM, Welke KF. National practice patterns for management of adult congenital heart disease: operation by pediatric heart surgeons decreases in-hospital death. *Circulation*. 2008;118(23):2345-2352. doi:10.1161/CIRCULATIONAHA.108.776963



ÇOCUKLARDA EKSTRAKORPOREAL YAŞAM DESTEĞİ (ECMO)

BÖLÜM
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Okan YILDIZ [1]

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İçindekiler

- GİRİŞ
- KARDİYAK HASTALARDA ECMO KULLANIMI
- POSTKARDİYOTOMİ ECMO ENDİKASYONLARI:
- EKSTRAKORPOREAL KARDİYOPULMONER RESÜSİTASYON (ECPR)
- PEDİATRİK ECMO'DA RİSK TAHMİNİ: SKORLAMA SİSTEMLERİ VE BELİRLEYİCİ FAKTÖRLER
- ECMO DESTEK MODLARI VE TEKNİK HUSUSLAR
- KANÜLASYON STRATEJİLERİ (18,48)
- ECMO DEVRE YÖNETİMİ (48)
- HASTA YÖNETİMİ VE KOMPLİKASYONLAR
- WEANİNG VE DEKANÜLASYON (18)
- KOMPLİKASYONLAR (48)
- SONUÇ VE GELECEK PERSPEKTİFİ

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olarak ECMO'nun yeri daha net tanımlanacaktır . Ayrıca, ECMO'nin yüksek riskli doğası ve kalp yetmezliği olan çocukların kapsamlı sağlık ihtiyaçları göz önüne alındığında, komplikasyonların ve sonuçların değerlendirilmesi hasta bakımının temel unsurlarındandır. Kardiyak ECMO uygulanan çocukların yaklaşık yarısı hastaneden taburcu olurken, sağkalımın kalan kısmı uzun vadeli nörogelişimsel problemlerle sonuçlanabilmektedir. Bu çocuklarda beyin yaralanmalarının mekanizmalarını, zamanlamasını ve sonuçlarını daha iyi anlamak, yaralanmaların önlenmesi veya etkilerinin azaltılmasına yönelik müdahalelerin geliştirilmesi açısından büyük önem taşımaktadır. ECMO merkezleri arasındaki takip uygulamalarındaki farklılıklar göz önüne alınarak, ELSO neonatal ve pediatrik ECMO sonrası taburculuktan ergenliğe kadar olan izleme için uluslararası yönergeler yayınlamış olup, ECMO programlarının bu önerileri benimsemeleri önerilmektedir.

KAYNAKLAR

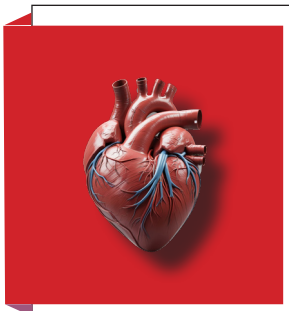
1. Thiagarajan RR, Barbaro RP, Rycus PT, et al. Extracorporeal life support organization registry international report 2016. ASAIO J. 2017;63(1):60–67.
2. Barbaro RP, Paden ML, Guner YS, et al. Pediatric extracorporeal life support organization registry international report 2016. ASAIO J. 2017;63(4):456–463.
3. Horak RV, Alexander PM, Amirnovin R, et al: Pediatric Cardiac Intensive Care Distribution, Service Delivery, and Staffing in the United States in 2018. Pediatr Crit Care Med 2020, 21(9):797-803.
4. Paediatric Congenital Heart Disease Standards: Level 1 - Specialist Children's Surgical Centres [www.england.nhs.uk/wp-content/uploads/2018/08/ Congenital-Heart-Disease-Standards-Level-1- Specialist-Childrens-Surgical-Centres-Paediatric.pdf].
5. Onan İS, Timur B, Yıldız O, Öztürk E, Haydin S. Outcomes of the 10th Istanbul Symposium on pediatric extracorporeal life support systems and cardiopulmonary perfusion. *Artif Organs*. 2020;44(2):187-190. doi:10.1111/aor.13600
6. Haydin S, Ündar A. Updates on extracorporeal life support in the world and challenges in Turkey. Anadolu Kardiyol Derg 2013; 13: 580– 8.
7. Tonna JE, Boonstra PS, MacLaren G, Paden M, Brodie D, Anders M, Hoskote A, Ramanathan K, Hyslop R, Fanning JJ, Rycus P, Stead C, Barrett NA, Mueller T, Gómez RD, Malhotra Kapoor P, Fraser JF, Bartlett RH, Alexander PMA, Barbaro RP; Extracorporeal Life Support Organization (ELSO) Member Centers Group. Extracorporeal Life Support Organization Registry International Report 2022: 100,000 Survivors. ASAIO J. 2024 Feb 1;70(2):131-143. DOI: 10.1097/MAT.0000000000002128. Epub 2024 Jan 5. PMID: 38181413; PMCID: PMC10962646.
8. Reed-Thurston D, Qiu F, Ündar A, Haidet KK, Shenberger J. Pediatric and neonatal extracorporeal life support technology component utilization: are US clinicians implementing new technology? Artif Organs 2012;36:607–15
9. Perry T, Cooper DS, Sweberg T, Jacobs ML, Jacobs JP, Huang B, Chen C, Thiagarajan RR, Brunetti MA, Lasa JJ, Cheung EW, Ram Kumar S, Adachi I, Ashfaq A, Maeda K, Zafar F, Morales DLS. Outcomes in Children Who Undergo Postcardiotomy Extracorporeal Membrane Oxygenation: A Report From the STS-CHSD. Ann Thorac Surg. 2025 Feb;119(2):413-422. DOI: 10.1016/j.athoracsur.2024.07.020. Epub 2024 Aug 3. PMID: 39102932.
10. Wu Y, Zhao T, Li Y, Wu S, Wu C, Wei G. Use of Extracorporeal Membrane Oxygenation After Congenital Heart Disease Repair: A Systematic Review and Meta-Analysis. Front Cardiovasc Med. 2020 Nov 11;7:583289. DOI: 10.3389/fcvm.2020.583289. PMID: 33263008; PMCID: PMC7686034.
11. Jin Y, Gao P, Zhang P, Bai L, Li Y, Wang W, Feng Z, Wang X, Liu J. Mortality prediction in pediatric postcardiotomy veno-arterial extracorporeal membrane oxygenation: A comparison of scoring systems. Front Med (Lausanne). 2022 Aug 4;9:967872. DOI: 10.3389/fmed.2022.967872. PMID: 35991647; PMCID: PMC9386139.
12. Zhou J, Wang H, Zhao Y, Shao J, Jiang M, Yue S, Lin L, Wang L, Xu Q, Guo X, Li X, Liu Z, Chen Y, Zhang R. Short-Term Mortality Among Pediatric Patients With Heart Diseases Undergoing Veno-Arterial Extracorporeal Membrane Oxygenation: A Systematic Review and Meta-Analysis. J Am Heart Assoc. 2023 Dec 19;12(24):e029571. DOI: 10.1161/JAHA.123.029571. Epub 2023 Dec 8. PMID: 38063152; PMCID: PMC10863771.
13. Cho HJ, Choi I, Kwak Y, Kim DW, Habimana R, Jeong IS. The Outcome of Post-cardiotomy Extracorporeal Membrane Oxygenation in Neonates and Pediatric Patients: A Systematic Review and Meta-Analysis. Front Pediatr. 2022 Apr 25;10:869283. DOI: 10.3389/fped.2022.869283. PMID: 35547551; PMCID: PMC9083359.
14. ELSO Registry Committee: ELSO Registry Data Definitions. Ann Arbor, MI, Extracorporeal Life Support Organization, 2020, p. 113. Available at: ELSO/RegistryData/2001/Definitions. Accessed January 19, 2022
15. Aharon AS, Drinkwater DC, Jr, Churchwell KB, et al. Extracorporeal membrane oxygenation in children after repair of congenital cardiac lesions. Ann Thorac Surg 2001; 72: 2095– 101.
16. Chaturvedi RR, Macrae D, Brown KL, et al. Cardiac ECMO for biventricular hearts after paediatric open heart surgery. Heart 2004; 90: 545– 51.
17. Cashen K, Hollis TK, Delius RE, Meert KL. Extracorporeal membrane oxygenation for pediatric cardiac failure: review with a focus on unique subgroups. Prog Pediatr Cardiol 2016; 43: 105– 11.
18. Brown G, Moynihan KM, Deatrick KB, Hoskote A, Sandhu HS, Aganga D, Deshpande SR, Menon AP, Rozen T, Raman L, Alexander PMA. Extracorporeal Life Support Organization (ELSO): Guidelines for Pediatric

Cardiac Failure. ASAIO J. 2021 May 1;67(5):463-475.
19. Nadkarni, A.S., Delany, D.R., Schramm, J. et al. ECMO Considerations in the Pediatric Cardiac Population. Curr Pediatr Rep 11, 86–95 (2023).
20. Mayr B, Kido T, Holder S, Wallner M, Vodiskar J, Strbad M, et al. Single-centre outcome of extracorporeal membrane oxygenation after the neonatal Norwood procedure. Eur J Cardiothorac Surg. 2022;62(3)
21. Brunetti MA, Gaynor JW, Retzloff LB, Lehrich JL, Banerjee M, Amula V, et al. Characteristics, risk factors, and outcomes of extracorporeal membrane oxygenation use in pediatric cardiac ICUs: a report from the Pediatric Cardiac Critical Care Consortium Registry. Pediatr Crit Care Med. 2018;19(6):544–52.
22. Ergün S, Yildiz O, Güneş M, Akdeniz HS, Öztürk E, Onan İ, et al. Use of extracorporeal membrane oxygenation in postcardiotomy pediatric patients: parameters affecting survival. Perfusion. 2020;35(7):608–20.
23. Ford MA, Gauvreau K, McMullan DM, Almodovar MC, Cooper DS, Rycus PT, et al. Factors associated with mortality in neonates requiring extracorporeal membrane oxygenation for cardiac indications: analysis of the Extracorporeal Life Support Organization Registry Data. Pediatr Crit Care Med. 2016;17(9):860–70.
24. Alten J, Cooper DS, Klugman D, Raymond TT, Wooton S, Garza J, et al. Preventing cardiac arrest in the pediatric cardiac intensive care unit through multicenter collaboration. JAMA Pediatr. 2022;176(10):1027–36.
25. Roeleveld PP, Mendonca M. Neonatal cardiac ECMO in 2019 and beyond. Front Pediatr. 2019;7:327.
26. Agarwal HS, Hardison DC, Saville BR, Donahue BS, Lamb FS, Bichell DP, et al. Residual lesions in postoperative pediatric cardiac surgery patients receiving extracorporeal membrane oxygenation support. J Thorac Cardiovasc Surg. 2014;147(1):434–41.
27. Howard TS, Kalish BT, Wigmore D, Nathan M, Kulik TJ, Kaza AK, et al. Association of extracorporeal membrane oxygenation support adequacy and residual lesions with outcomes in neonates supported after cardiac surgery. Pediatr Crit Care Med. 2016;17(11):1045–54.
28. Kato A, Lo Rito M, Lee KJ, Haller C, Guerguerian AM, Sivarajan VB, et al. Impacts of early cardiac catheterization for children with congenital heart disease supported by extracorporeal membrane oxygenation. Catheter Cardiovasc Interv. 2017;89(5):898–905.
29. Panda BR, Alphonso N, Govindasamy M, Anderson B, Stocker C, Karl TR. Cardiac catheter procedures during extracorporeal life support: a risk-benefit analysis. World J Pediatr Congenit Heart Surg. 2014;5(1):31–7.
30. Allan CK, Thiagarajan RR, del Nido PJ, Roth SJ, Almodovar MC, Laussen PC. Indication for initiation of mechanical circulatory support impacts survival of infants with shunted single-ventricle circulation supported with extracorporeal membrane oxygenation. J Thorac Cardiovasc Surg. 2007;133(3):660–7.
31. Grant S, Faraoni D, DiNardo J, Odegard K. Predictors of mortality in children with pulmonary atresia with intact ventricular septum. Pediatr Cardiol. 2017;38(8):1627–32.
32. Amodeo A, Stojanovic M, Dave H, Cesnjevar R, Konetzka A, Erdil T, et al. Bridging with veno-arterial extracorporeal membrane oxygenation in children: a 10-year single-center experience. Life. 2022;12(9) .
33. Bautista-Hernandez V, Thiagarajan RR, Fynn-Thompson F, Rajagopal SK, Nento DE, Yarlagadda V, et al. Preoperative extracorporeal membrane oxygenation as a bridge to cardiac surgery in children with congenital heart disease. Ann Thorac Surg. 2009;88(4):1306–11.
34. Mayr B, Kido T, Holder S, Wallner M, Vodiskar J, Strbad M, et al. Single-centre outcome of extracorporeal membrane oxygenation after the neonatal Norwood procedure. Eur J Cardiothorac Surg. 2022;62(3) .
35. Mitchell EA, Gomez D, Joy BF, Fernandez RP, Cheatham JP, Galantowicz M, et al. ECMO: incidence and outcomes of patients undergoing the hybrid procedure. Congenit Heart Dis. 2016;11(2):169–74.
36. Ravishankar C, Dominguez TE, Kreutzserder J, Wernovsky G, Marino BS, Godinez R, et al. Extracorporeal membrane oxygenation after stage I reconstruction for hypoplastic left heart syndrome. Pediatr Crit Care Med. 2006;7(4):319–23.
37. Roeleveld PP, Wilde R, Hazekamp M, Rycus PT, Thiagarajan RR. Extracorporeal membrane oxygenation in single ventricle lesions palliated via the hybrid approach. World J Pediatr Congenit Heart Surg. 2014;5(3):393–7.
38. Sherwin ED, Gauvreau K, Scheurer MA, Rycus PT, Salvin JW, Almodovar MC, et al. Extracorporeal membrane oxygenation after stage 1 palliation for hypoplastic left heart syndrome. J Thorac Cardiovasc Surg. 2012;144(6):1337–43.
39. Botha P, Deshpande SR, Wolf M, Heard M, Alsoufi B, Kogon B, et al. Extracorporeal membrane oxygenator support in infants with systemic-pulmonary shunts. J Thorac Cardiovasc Surg. 2016;152(3):912–8.
40. Jaggers JJ, Forbess JM, Shah AS, Meliones JN, Kirshbom PM, Miller CE, et al. Extracorporeal membrane oxygenation for infant postcardiotomy support: significance of shunt management. Ann Thorac Surg. 2000;69(5):1476–83.
41. Booth KL, Roth SJ, Thiagarajan RR, Almodovar MC, del Nido PJ, Laussen PC. Extracorporeal membrane oxygenation support of the Fontan and bidirectional Glenn circulations. Ann Thorac Surg. 2004;77(4):1341–8.
42. Gomez D, Duffy V, Hersey D, Backes C, Rycus P, McConnell P, et al. Extracorporeal membrane oxygenation outcomes after the comprehensive stage II procedure in patients with single ventricles. Artif Organs. 2017;41(1):66–70.
43. Jolley M, Thiagarajan RR, Barrett CS, Salvin JW, Cooper DS, Rycus PT, et al. Extracorporeal membrane oxygenation in patients undergoing superior cavopulmonary anastomosis. J Thorac Cardiovasc Surg. 2014;148(4):1512–8.
44. Schubert S, Opgen-Rhein B, Boehne M, Weigelt A, Wagner R, Müller G, et al. Severe heart failure and the need for mechanical circulatory support and heart transplantation in pediatric patients with myocarditis: Results from the prospective multicenter registry "MYKKE". Pediatr Transplant. 2019;23(7):e13548.
45. Teele SA, Allan CK, Laussen PC, Newburger JW, Gauvreau K, Thiagarajan RR. Management and outcomes in pediatric patients presenting with acute fulminant myocarditis. J Pediatr. 2011;158(4):638–43.e1.
46. Gutierrez ME, Anders M, Guffey D, Denfield SW, Deshpande SR, Rajagopal SK, et al. Extracorporeal membrane oxygenation cannulation timing in the pediatric

myocarditis population: an exploratory analysis from the Extracorporeal Life Support Organization Registry. Crit Care Explor. 2023;5(1):e0826.
47. Choudhury TA, Ofori-Amanfo G, Choi J, Eisenberg RE, Rycus P, Medar SS, et al. Left heart decompression on veno-arterial extracorporeal membrane oxygenation in children with dilated cardiomyopathy and myocarditis: an Extracorporeal Life Support Organization Registry review. Pediatr Crit Care Med. 2021;22(12):1026–32.
48. Extracorporeal life support. The ELSO red book. 6th ed. Ann Arbor, Michigan: Extracorporeal Life Support Organization; 2022.
49. Paden ML, Conrad SA, Rycus PT, Thiagarajan RR. Extracorporeal life support organization registry report 2012. ASAIO J. 2013;59(3):202–10.
50. Nasr VG, Faraoni D, DiNardo JA, Thiagarajan RR. Adverse outcomes in neonates and children with pulmonary artery hypertension supported with ECMO. ASAIO J. 2016;62(6):728–31.
51. Kaestner M, Schranz D, Warnecke G, Apitz C, Hansmann G, Miera O. Pulmonary hypertension in the intensive care unit. Expert consensus statement on the diagnosis and treatment of paediatric pulmonary hypertension. The European Paediatric Pulmonary Vascular Disease Network, endorsed by ISHLT and DGPK. Heart. 2016;102(Suppl 2):ii57–66.
52. Dhillon R, Pearson GA, Firmin RK, Chan KC, Leanage R. Extracorporeal membrane oxygenation and the treatment of critical pulmonary hypertension in congenital heart disease. Eur J Cardiothorac Surg. 1995;9(10):553–6.
53. Chiel LE, Winthrop ZA, Fynn-Thompson F, Midyat L. Extracorporeal membrane oxygenation and paracorporeal lung assist devices as a bridge to pediatric lung transplantation. Pediatr Transplant. 2022;26(5):e14289.
54. Hoopes CW, Kukreja J, Golden J, Davenport DL, Diaz-Guzman E, Zwischenberger JB. Extracorporeal membrane oxygenation as a bridge to pulmonary transplantation. J Thorac Cardiovasc Surg. 2013;145(3):862–7; discussion 7-8.
55. Rehder KJ, Turner DA, Hartwig MG, Williford WL, Bonadonna D, Walczak RJ, et al. Active rehabilitation during extracorporeal membrane oxygenation as a bridge to lung transplantation. Respir Care. 2013;58(8):1291–8.
56. Thompson K, Staffa SJ, Nasr VG, Zalieckas JM, Fynn-Thompson F, Boyer D, et al. Mortality after lung transplantation for children bridged with extracorporeal membrane oxygenation. Ann Am Thorac Soc. 2022;19(3):415–23.
57. Bembea MM, Loftis LL, Thiagarajan RR, Young CC, McCadden TP, Newhams MM, et al. Extracorporeal membrane oxygenation characteristics and outcomes in children and adolescents with COVID-19 or multisystem inflammatory syndrome admitted to U.S. ICUs. Pediatr Crit Care Med. 2023; .
58. Di Nardo M, Hoskote A, Thiruchelvam T, Lillie J, Horan M, Belda Hofheinz S, et al. Extracorporeal membrane oxygenation in children with coronavirus disease 2019: preliminary report from the Collaborative European Chapter of the Extracorporeal Life Support Organization Prospective Survey. ASAIO J. 2021;67(2):121–4.
59. Registry Dashboard of ECMO-Supported COVID-19 Patient Data. (2023).
60. Dyamenahalli U, Tuzcu V, Fontenot E, Papagiannis J, Jaquiss RD, Bhutta A, et al. Extracorporeal membrane oxygenation support for intractable primary arrhythmias and complete congenital heart block in newborns and infants: short-term and medium-term outcomes. Pediatr Crit Care Med. 2012;13(1):47–52.
61. Ghaleb S, Thiagarajan RR, Cooper DS, Czosek RJ. Outcomes of pediatric patients treated with extracorporeal membrane oxygenation for intractable supraventricular arrhythmias. Pediatr Crit Care Med. 2020;21(8):e547–e56.
62. Guerguerian, Anne-Marie*; Sano, Minako†; Todd, Mark*; Honjo, Osami‡; Alexander, Peta§; Raman, Lakshmi¶. Pediatric Extracorporeal Cardiopulmonary Resuscitation ELSO Guidelines. ASAIO Journal 67(3):p 229-237, March 2021. | DOI: 10.1097/MAT.0000000000001345
63. Melvan JN, Davis J, Heard M, et al. Factors Associated With Survival Following Extracorporeal Cardiopulmonary Resuscitation in Children. World Journal for Pediatric and Congenital Heart Surgery 2020;11:265-74.
64. Jolley M, Yarlagadda VV, Rajagopal SK, et al. Extracorporeal membrane oxygenation-supported cardiopulmonary resuscitation following stage 1 palliation for hypoplastic left heart syndrome. Pediatric critical care medicine 2014;15:538-45
65. International Summary ECLS Registry Report. Ann Arbor, MI: Extracorporeal Life Support Organization; 2021 October 2021.
66. Duff JP, Topjian AA, Berg MD, et al. 2019 American Heart Association Focused Update on Pediatric Advanced Life Support: An Update to the American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 2019;140:e904-e14.
67. Maconochie IK, Aickin R, Hazinski MF, et al. Pediatric Life Support: 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation 2020;156:A120-a55
68. Richardson ASC, Tonna JE, Nanjayya V, et al. Extracorporeal Cardiopulmonary Resuscitation in Adults. Interim Guideline Consensus Statement From the Extracorporeal Life Support Organization. ASAIO journal 2021;67:221-8.
69. Lasa JJ, Rogers RS, Localio R, Shults J, Raymond T, Gaies M, et al. Extracorporeal cardiopulmonary resuscitation (E-CPR) during pediatric in-hospital cardiopulmonary arrest is associated with improved survival to discharge: a report from the American Heart Association's Get With The Guidelines-Resuscitation (GWTG-R) Registry. Circulation. 2016;133(2):165–76.
70. Bembea MM, Ng DK, Rizkalla N, Rycus P, Lasa JJ, Dalton H, et al. Outcomes after extracorporeal cardiopulmonary resuscitation of pediatric in-hospital cardiac arrest: a report from the Get With the Guidelines-Resuscitation and the Extracorporeal Life Support Organization Registries. Crit Care Med. 2019;47(4):e278–e85.
71. Marino BS, Tabbutt S, MacLaren G, Hazinski MF, Adatia I, Atkins DL, et al. Cardiopulmonary resuscitation in infants and children with cardiac disease: a scientific statement from the American Heart Association. Circulation. 2018;137(22):e691–782.
72. Jin Y, Gao P, Zhang P, Bai L, Li Y, Wang W, Feng Z, Wang X, Liu J. Mortality prediction in pediatric post-

cardiotomy veno-arterial extracorporeal membrane oxygenation: A comparison of scoring systems. Front Med (Lausanne). 2022 Aug 4;9:967872. DOI: 10.3389/fmed.2022.967872. PMID: 35991647; PMCID: PMC9386139.
73. Okan Y, Sertac H, Erkut O, Taner K, Selen OI, FiratAH,et al. Initial Clinical Experiences With Novel Diagonal ECLS System in Pediatric Cardiac Patients. Artif Organs 2017;41:717-26.
74. Aydin SI, Duffy M, Rodriguez D, Rycus PT, Friedman P, Thiagarajan RR, et al. Venovenous extracorporeal membrane oxygenation for patients with single-ventricle anatomy: a registry report. J Thorac Cardiovasc Surg. 2016;151(6):1730–6.
75. Nair AB, Oishi P. Venovenous extracorporeal life support in single-ventricle patients with acute respiratory distress syndrome. Front Pediatr. 2016;4:66.
76. Sperotto F, Polito A, Amigoni A, Maschietto N, Thiagarajan RR. Left atrial decompression in pediatric patients supported with extracorporeal membrane oxygenation for failure to wean from cardiopulmonary bypass: a propensity-weighted analysis. J Am Heart Assoc. 2022;11(23):e023963.
77. Extracorporeal Membrane Oxygenation (ECMO): Initiation and Management - Pediatric/Neonatal - Inpatient/Emergency Department Clinical Practice Guideline, 2020 University of Wisconsin Hospitals and Clinics
78. Diehl A, Burrell AJC, Udy AA, et al. Association between arterial carbon dioxide tension and clinical outcomes in venoarterial extracorporeal membrane oxygenation. Crit Care Med. 2020; 48:977–984
79. Totapally A, Bridges BC, Selewski DT, Zivick EE. Managing the kidney - The role of continuous renal replacement therapy in neonatal and pediatric ECMO. Semin Pediatr Surg. 2023 Aug;32(4):151332. DOI: 10.1016/j.sempedsurg.2023.151332. Epub 2023 Oct 17. PMID: 37871460.
80. Bridges, Brian C.*; Dhar, Archana†; Ramanathan, Kollengode‡; Steflik, Heidi J.§; Schmidt, Matthieu¶,||; Shekar, Kiran#. Extracorporeal Life Support Organization Guidelines for Fluid Overload, Acute Kidney Injury, and Electrolyte Management. ASAIO Journal 68(5):p 611-618, May 2022. | DOI: 10.1097/MAT.0000000000001702
81. Lin JJ, Banwell BL, Berg RA, et al. Electrographic seizures in children and neonates undergoing extracorporeal membrane oxygenation. Pediatr Crit Care Med. 2017; 18:249–257
82. Pandiyan, Poornima*; Cvetkovic, Mirjana†; Antonini, Marta Velia‡,§; Shappley, Rebekah K. H.¶; Karmakar, Swati A.||; Raman, Lakshmi#. Clinical Guidelines for Routine Neuromonitoring in Neonatal and Pediatric Patients Supported on Extracorporeal Membrane Oxygenation. ASAIO Journal 69(10):p 895-900, October 2023. | DOI: 10.1097/MAT.0000000000001896
83. Lee AE, Munoz E, Al Dabbous T, Harris E, O'Callaghan M, Raman L. Extracorporeal Life Support Organization Guidelines for the Provision and Assessment of Nutritional Support in the Neonatal and Pediatric ECMO Patient. ASAIO J. 2022 Jul 1;68(7):875-880. DOI: 10.1097/MAT.0000000000001767. Epub 2022 Jun 24. PMID: 35703144.
84. 30-Bizzarro MJ, Conrad SA, Kaufman DA, Rycus P. Infections acquired during extracorporeal membrane oxygenation in neonates, children, and adults. Pediatric critical care medicine : a journal of the Society of Critical Care Medicine and the World Federation of Pediatric Intensive and Critical Care Societies. 2011;12(3):277-281.
85. Kao LS, Fleming GM, Escamilla RJ, Lew DF, Lally KP. Antimicrobial prophylaxis and infection surveillance in extracorporeal membrane oxygenation patients: a multi-institutional survey of practice patterns. ASAIO journal (American Society for Artificial Internal Organs : 1992). 2011;57(3):231-238
86. Ayyıldız P, Kasar T, Ozturk E, Yildiz O, Ozturk S, Ergul Y, Haydin S, Guzeltas A. The Evaluation of Nosocomial Infections in Pediatric Patients with Extracorporeal Membrane Oxygenation Support. Braz J Cardiovasc Surg. 2017 Nov-Dec;32(6):468-474.
87. Annich GM. Extracorporeal life support: The precarious balance of hemostasis. J Thromb Haemost. 2015;13(suppl 1):S336–S342
88. Bembea MM, Annich G, Rycus P, Oldenburg G, Berkowitz I, Pronovost P. Variability in anticoagulation management of patients on extracorporeal membrane oxygenation: An international survey. Pediatr Crit Care Med. 2013;14(2):e77–e84.
89. Murphy DA, Hockings LE, Andrews RK, et al. Extracorporeal membrane oxygenation-hemostatic complications. Transfus Med Rev 2015; 29: 90– 101.
90. Valencia E, Nasr VG. Updates in Pediatric Extracorporeal Membrane Oxygenation. J Cardiothorac Vasc Anesth. 2020 May;34(5):1309-1323. DOI: 10.1053/j.jvca.2019.09.006.
91. Dalton HJ, Garcia-Filion P, Holubkov R, et al.; Eunice Kennedy Shriver National Institute of Child Health and Human Development Collaborative Pediatric Critical Care Research Network. Association of bleeding and thrombosis with outcome in extracorporeal life support. Pediatr Crit Care Med. 2015; 16:167–174
92. Liveris A, Bello RA, Friedmann P, et al. Anti-factor Xa assay is a superior correlate of heparin dose than activated partial thromboplastin time or activated clotting time in pediatric extracorporeal membrane oxygenation*. Pediatr Crit Care Med. 2014;15(2):e72-79.
93. Bembea MM, Schwartz JM, Shah N, et al. Anticoagulation monitoring during pediatric extracorporeal membrane oxygenation. ASAIO journal (American Society for Artificial Internal Organs : 1992). 2013;59(1):63-68
94. Extracorporeal Life Support O. ELSO Anticoagulation Guideline. In. Ann Arbor,MI2014
95. Appel IM, Grimminck B, Geerts J, Stigter R, Cnossen MH, Beishuizen A. Age dependency of coagulation parameters during childhood and puberty. Journal of thrombosis and haemostasis : JTH. 2012;10(11):2254-2263.
96. Wong TE, Delaney M, Gernsheimer T, et al. Antithrombin concentrates use in children on extracorporeal membrane oxygenation: a retrospective cohort study. Pediatric critical care medicine : a journal of the Society of Critical Care Medicine and the World Federation of Pediatric Intensive and Critical Care Societies. 2015;16(3):264-269
97. Niebler RA, Punzalan RC, Marchan M, Lankiewicz MW. Activated recombinant factor VII for refractory bleeding during extracorporeal membrane oxygenation. Pediatr Crit Care Med. 2010;11(1):98–102

98. Long MT, Wagner D, Maslach-Hubbard A, Pasko DA, Baldridge P, Annich GM. Safety and efficacy of recombinant activated factor VII for refractory hemorrhage in pediatric patients on extracorporeal membrane oxygenation: A single center review. Perfusion. 2014;29(2):163–170.
99. Güzeltaş A, Kasar T, Tanıdır İC, Öztürk E, Yıldız O, Haydin S. Cardiac catheterization procedures in pediatric patients undergoing extracorporeal membrane oxygenation cardiac catheterization, ECMO. Anatol J Cardiol. 2017 Dec;18(6):425-430.
100. Callahan R, Trucco SM, Wearden PD, Beerman LB, Arora G, Kreutzer J. Outcomes of pediatric patients undergoing cardiac catheterization while on extracorporeal membrane oxygenation. Pediatr Cardiol. 2015; 36:625–632
101. Werho DK, Pasquali SK, Yu S, et al. Hemorrhagic complications in pediatric cardiac patients on extracorporeal membrane oxygenation: an analysis of the Extracorporeal Life Support Organization Registry. Pediatr Crit Care Med. 2015;16(3):276-288.
102. Dalton HJ, Garcia-Filion P, Holubkov R, et al. Association of bleeding and thrombosis with outcome in extracorporeal life support. Pediatr Crit Care Med. 2015;16(2):167-174.
103. McMichael ABV, Ryerson LM, Ratano D, et al. 2021 ELSO Adult and Pediatric Anticoagulation Guidelines. ASAIO J. 2022; 68:303-310
104. Elella RA, Habib E, Mokrusova P, et al. Incidence and outcome of acute kidney injury by the pRIFLE criteria for children receiving extracorporeal membrane oxygenation after heart surgery. Ann Saudi Med. 2017;37(3):201-206.
105. Gupta P, Beam B, Schmitz ML. Outcomes associatedwith the use of renal replacement therapy in children receiving extracorporeal membrane oxygenation after heart surgery: a multi-institutional analysis. Pediatr Nephrol. 2015;30(6):1019-1026
106. Fleming GM, Sahay R, Zappitelli M, et al. The Incidence of Acute Kidney Injury and Its Effect on Neonatal and Pediatric Extracorporeal Membrane Oxygenation Outcomes: A Multicenter Report From the Kidney Intervention During Extracorporeal Membrane Oxygenation Study Group. Pediatr Crit Care Med. 2016;17(12):1157-1169
107. Bell JL, Saenz L, Domnina Y, et al. Acute Neurologic Injury in Children Admitted to the Cardiac Intensive Care Unit. Ann Thorac Surg. 2019;107(6):1831-1837
108. Polito A, Barrett CS, Rycus PT, et al. Neurologic injury in neonates with congenital heart disease during extracorporeal membrane oxygenation: an analysis of extracorporeal life support organization registry data. ASAIO J. 2015;61(1):43-48.
109. LaRovere KL, Vonberg FW, Prabhu SP, et al. Patterns of Head Computed Tomography Abnormalities During Pediatric Extracorporeal Membrane Oxygenation and Association With Outcomes. Pediatr Neurol. 2017;73:64-70.
110. Nasr DM, Rabinstein AA. Neurologic Complications of Extracorporeal Membrane Oxygenation. J Clin Neurol. 2015;11(4):383-389
111. Ijsselstijn H, Hunfeld M, Schiller RM, et al. Improving Long-Term Outcomes After Extracorporeal Membrane Oxygenation: From Observational Follow-Up Programs Toward Risk Stratification. Front Pediatr. 2018;6:177.
112. Ijsselstijn H, Schiller RM, Holder C, et al. Extracorporeal Life Support Organization (ELSO) Guidelines for Follow-up After Neonatal and Pediatric Extracorporeal Membrane Oxygenation. ASAIO J. 2021;67(9):955-963.
113. Marino BS, Lipkin PH, Newburger JW, et al. Neurodevelopmental Outcomes in Children With Congenital Heart Disease: Evaluation and Management: A Scientific Statement From the American Heart Association. Circulation. 2012;126(9):1143-1172
114. Boyle K, Felling R, Yiu A, Battarjee W, Schwartz JM, Salorio C, et al. Neurologic outcomes after extracorporeal membrane oxygenation: a systematic review. Pediatr Crit Care Med. 2018;19(8):760–6.
115. Sadhwani A, Cheng H, Stopp C, Rollins CK, Jolley MA, Dunbar-Masterson C, et al. Early neurodevelopmental outcomes in children supported with ECMO for cardiac indications. Pediatr Cardiol. 2019;40(5):1072–83.
116. Zamora IJ, Shekerdemian L, Fallon SC, Olutoye OO, Cass DL, Rycus PL, et al. Outcomes comparing dual-lumen to multisite venovenous ECMO in the pediatric population: the Extracorporeal Life Support Registry experience. J Pediatr Surg. 2014;49(10):1452–7.
117. Aydin SI, Duffy M, Rodriguez D, Rycus PT, Friedman P, Thiagarajan RR, et al. Venovenous extracorporeal membrane oxygenation for patients with single-ventricle anatomy: a registry report. J Thorac Cardiovasc Surg. 2016;151(6):1730–6.
118. Öztürk E, Yıldız O, Çine N, et al. The use of neonatal extracorporeal life support in pediatric cardiac intensive care unit. *J Matern Fetal Neonatal Med*. 2017;30(12):1397-1401. doi:10.1080/14767058.2016.1214706
119. Kasar T, Cansaran Tanidir I, Ozturk E, Kafali C, Sahin M, Yildiz O, Haydin S, Guzeltas A. Cardiac Catheterization in the Early Post-Operative Period after Congenital Heart Surgery. Acta Cardiol Sin. 2018 Nov;34(6):481-487. doi: 10.6515/ACS.201811_34(6).20180524B.
120. Erek E, Aydın S, Suzan D, Yıldız O, Altın F, Kırat B, Demir IH, Ödemiş E. Extracorporeal cardiopulmonary resuscitation for refractory cardiac arrest in children after cardiac surgery. Anatol J Cardiol. 2017 Apr;17(4):328-333. 0.14744/AnatolJCardiol.2016.6658.
121. Basgoze S, Temur B, Aydın S, Guzelmeric F, Guvenc O, Cevik A, Iyigun M, Erek E. Outcomes of Extracorporeal Membrane Oxygenation in Patients After Repair of Congenital Heart Defects. Pediatr Cardiol. 2022 Dec;43(8):1811-1821. doi: 10.1007/s00246-022-02918-9.
122. Basgoze S, Temur B, Ozcan ZS, Gokce I, Guvenc O, Aydin S, Guzelmeric F, Altan Kus A, Erek E. The effect of extracorporeal membrane oxygenation on neurodevelopmental outcomes in children after repair of congenital heart disease: A pilot study from Turkey. Front Pediatr. 2023 Apr 3;11:1131361. doi: 10.3389/fped.2023.1131361.
123. Erek E, Başgöze S, Yıldız O, Sarıosmanoğlu NO, Yalçınbaş YK, Turköz R, Kutsal A, Seçici S, Ergün S, Chadikovski V, Arnaz A, Koç M, Korun O, Şenkaya I, Özdemir F, Biçer M, Sarıtaş B, Atay Y, Haydın S, Bilen Ç, Onan İS, Tuncer ON, Citoglu G, Dogan A, Temur B, Özkan M, Sarioglu CT. Second harvest of Congenital Heart Surgery Database in Türkiye: Current outcomes. Turk Gogus Kalp Damar Cerrahisi Derg. 2024 Apr 30;32(2):162-178. doi: 10.5606/tgkdc.dergisi.2024.25758. PMID: 38933312; PMCID: PMC11197406.



ÇOCUKLARDA VENTRİKÜL DESTEK CİHAZLARI VE YAPAY KALP

BÖLÜM
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İçindekiler

- PEDİATRİK MEKANİK DOLAŞIM DESTEK SİSTEMLERİNİN TARİHSEL EVRİMİ VE TEKNOLOJİK GELİŞMELERİ
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- GELECEK PERSPEKTİFİ
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KAYNAKLAR

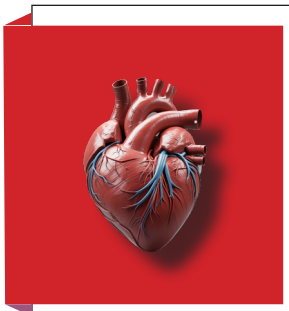
1. Shaddy RE, George AT, Jaecklin T, et al. Systematic Literature Review on the Incidence and Prevalence of Heart Failure in Children and Adolescents. Pediatr Cardiol. 2018; 39: 415-436.
2. Rossano JW, Kim JJ, Decker JA, et al. Prevalence, morbidity, and mortality of heart failure-related hospitalizations in children in the United States: a population-based study. J Card Fail. 2012; 18: 459-470.
3. Jayaprasad N. Heart Failure in Children. Heart Views. 2016; 17: 92-99.
4. Watanabe K, Shih R. Update of Pediatric Heart Failure. Pediatr Clin North Am. 2020; 67: 889-901.
5. DeBakey ME. Left ventricular bypass pump for cardiac assistance. Clinical experience. Am J Cardiol. 1971; 27: 3-11.
6. Danielle S. Burstein JWR. Pediatric ventricular assist devices: Trends in device utilization. Progress in Pediatric Cardiology. 2017; 47: 2-6.
7. Hetzer R, Loebe M, Potapov EV, et al. Circulatory support with pneumatic paracorporeal ventricular assist device in infants and children. Ann Thorac Surg. 1998; 66: 1498-1506.
8. Hetzer R, Potapov EV, Stiller B, et al. Improvement in survival after mechanical circulatory support with pneumatic pulsatile ventricular assist devices in pediatric patients. Ann Thorac Surg. 2006; 82: 917-924; discussion 924-915.
9. Konertz W, Hotz H, Schneider M, et al. Clinical experience with the MEDOS HIA-VAD system in infants and children: a preliminary report. Ann Thorac Surg. 1997; 63: 1138-1144.
10. Hetzer R, Alexi-Meskishvili V, Weng Y, et al. Mechanical cardiac support in the young with the Berlin Heart EXCOR pulsatile ventricular assist device: 15 years' experience. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2006: 99-108.
11. Chu MW, Sharma K, Tchervenkov CI, et al. Berlin Heart ventricular assist device in a child with hypoplastic left heart syndrome. Ann Thorac Surg. 2007; 83: 1179-1181.
12. VanderPluym CJ, Rebeyka IM, Ross DB, et al. The use of ventricular assist devices in pediatric patients with univentricular hearts. J Thorac Cardiovasc Surg. 2011; 141: 588-590.
13. Pearce FB, Kirklin JK, Holman WL, et al. Successful cardiac transplant after Berlin Heart bridge in a single ventricle heart: use of aortopulmonary shunt as a supplementary source of pulmonary blood flow. J Thorac Cardiovasc Surg. 2009; 137: e40-42.
14. Blume ED, Naftel DC, Bastardi HJ, et al. Outcomes of children bridged to heart transplantation with ventricular assist devices: a multi-institutional study. Circulation. 2006; 113: 2313-2319.
15. Frazier OH, Gregoric ID, Messner GN. Total circulatory support with an LVAD in an adolescent with a previous Fontan procedure. Tex Heart Inst J. 2005; 32: 402-404.
16. Morales DL, Adachi I, Heinle JS, et al. A new era: use of an intracorporeal systemic ventricular assist device to support a patient with a failing Fontan circulation. J Thorac Cardiovasc Surg. 2011; 142: e138-140.
17. Pretre R, Haussler A, Bettex D, et al. Right-sided univentricular cardiac assistance in a failing Fontan circulation. Ann Thorac Surg. 2008; 86: 1018-1020.
18. Rosenthal DN, Almond CS, Jaquiss RD, et al. Adverse events in children implanted with ventricular assist devices in the United States: Data from the Pediatric Interagency Registry for Mechanical Circulatory Support (PediMACS). J Heart Lung Transplant. 2016; 35: 569-577.
19. Rossano JW, Lorts A, VanderPluym CJ, et al. Outcomes of pediatric patients supported with continuous-flow ventricular assist devices: A report from the Pediatric Interagency Registry for Mechanical Circulatory Support (PediMACS). J Heart Lung Transplant. 2016; 35: 585-590.
20. Hetzer R, Delmo Walter EM. Mechanical Circulatory Support Devices - In Progress. N Engl J Med. 2017; 376: 487-489.
21. Hetzer R, Javier M, Dandel M, et al. Mechanical circulatory support systems: evolution, the systems and outlook. Cardiovasc Diagn Ther. 2021; 11: 309-322.
22. Irving CA, Cassidy JV, Kirk RC, et al. Successful bridge to transplant with the Berlin Heart after cavopulmonary shunt. J Heart Lung Transplant. 2009; 28: 399-401.
23. Weinstein S, Bello R, Pizarro C, et al. The use of the Berlin Heart EXCOR in patients with functional single ventricle. J Thorac Cardiovasc Surg. 2014; 147: 697-704; discussion 704-695.
24. Russo P, Wheeler A, Russo J, et al. Use of a ventricular assist device as a bridge to transplantation in a patient with single ventricle physiology and total cavopulmonary anastomosis. Paediatr Anaesth. 2008; 18: 320-324.
25. Morales DL, Zafar F, Rossano JW, et al. Use of ventricular assist devices in children across the United States: analysis of 7.5 million pediatric hospitalizations. Ann Thorac Surg. 2010; 90: 1313-1318; discussion 1318-1319.
26. Hetzer R, Javier M, Delmo Walter EM. Role of paediatric assist device in bridge to transplant. Ann Cardiothorac Surg. 2018; 7: 82-98.
27. Fynn-Thompson F, Almond C. Pediatric ventricular assist devices. Pediatr Cardiol. 2007; 28: 149-155.
28. Krokstrom AK, Higgins T, Johansson S, et al. Use of pediatric Berlin Heart EXCOR biventricular device as a bridge to retransplantation in a 10-month-old infant with acute graft failure after cardiac transplantation. ASAIO J. 2009; 55: 525-526.
29. Merritt T, Gazit AZ, Carvajal H, et al. Evolution of Ventricular Assist Device Support Strategy in Children With Univentricular Physiology. Ann Thorac Surg. 2022; 114: 1739-1744.
30. Schweiger M, Dave H, Lemme F, et al. Paediatric ventricular assist devices: current achievements. Swiss Med Wkly. 2013; 143: w13804.
31. Medtronic to Stop Distribution and Sale of HVAD™ System. 2021.
32. FDA Alerts Health Care Providers to Stop New Implants of Certain Ventricular Assist Device System. 2021.
33. Griffiths ER, Profsky MP, Mokshagundam D, et al. Eighth Annual Society of Thoracic Surgeons Pedimacs Report. Ann Thorac Surg. 2025; 119: 513-522.
34. Zafar F, Castleberry C, Khan MS, et al. Pediatric heart transplant waiting list mortality in the era of ventricular assist devices. J Heart Lung Transplant. 2015; 34: 82-88.

35. Rossano JW, VanderPluym CJ, Peng DM, et al. Fifth Annual Pediatric Interagency Registry for Mechanical Circulatory Support (Pedimacs) Report. Ann Thorac Surg. 2021; 112: 1763-1774.
36. Navaratnam M, Maeda K, Hollander SA. Pediatric ventricular assist devices: Bridge to a new era of perioperative care. Pediatr Anesth. 2019; 29: 506-518.
37. Friedland-Little JM, Joong A, Shugh SB, et al. Patient and Device Selection in Pediatric MCS: A Review of Current Consensus and Unsettled Questions. Pediatric Cardiology. 2022; 43: 1193-1204.
38. Conway J, St Louis J, Morales DLS, et al. Delineating survival outcomes in children <10 kg bridged to transplant or recovery with the Berlin Heart EXCOR Ventricular Assist Device. JACC Heart Fail. 2015; 3: 70-77.
39. Tunuguntla H, Conway J, Villa C, et al. Destination-Therapy Ventricular Assist Device in Children: "The Future Is Now". Can J Cardiol. 2020; 36: 216-222.
40. Mukku RB, Fonarow GC, Watson KE, et al. Heart Failure Therapies for End-Stage Chemotherapy-Induced Cardiomyopathy. J Card Fail. 2016; 22: 439-448.
41. Adachi I, Burki S, Zafar F, et al. Pediatric ventricular assist devices. J Thorac Dis. 2015; 7: 2194-2202.
42. Butto A, Teele SA, Sleeper LA, et al. The impact of pre-implant illness severity on the outcomes of pediatric patients undergoing durable ventricular assist device. J Heart Lung Transplant. 2020; 39: 666-674.
43. Almond CS, Morales DL, Blackstone EH, et al. Berlin Heart EXCOR pediatric ventricular assist device for bridge to heart transplantation in US children. Circulation. 2013; 127: 1702-1711.
44. Almond CSD, Thiagarajan RR, Piercey GE, et al. Waiting List Mortality Among Children Listed for Heart Transplantation in the United States. Circulation. 2009; 119: 717-727.
45. Shugh SB, Riggs KW, Morales DLS. Mechanical circulatory support in children: past, present and future. Transl Pediatr. 2019; 8: 269-277.
46. Adachi I. Continuous-flow ventricular assist device support in children: A paradigm change. J Thorac Cardiov Sur. 2017; 154: 1358-1361.
47. Gandolfo F, De Rita F, Hasan A, et al. Mechanical circulatory support in pediatrics. Ann Cardiothorac Surg. 2014; 3: 507-512.
48. Katapadi A, Umland M, Khandheria BK. Update on the Practical Role of Echocardiography in Selection, Implantation, and Management of Patients Requiring Left Ventricular Assist Device Therapy. Curr Cardiol Rep. 2022; 24: 1587-1597.
49. Gorbea M. A Review of Physiologic Considerations and Challenges in Pediatric Patients With Failing Single- Ventricle Physiology Undergoing Ventricular Assist Device Placement. J Cardiothorac Vasc Anesth. 2022; 36: 1756-1770.
50. Ninke T, Eifer A, Dieterich HJ. Fetal and pediatric cardiovascular physiology Things you should know as an (pediatric) anesthesiologist. Anaesthesiologie. 2022; 71: 811-820.
51. Lichtenstein KM, Tunuguntla HP, Peng DM, et al. Pediatric ventricular assist device registries: update and perspectives in the era of miniaturized continuous-flow pumps. Ann Cardiothorac Sur. 2021; 10: 329-338.
52. Chivukula VK, Beckman JA, Prisco AR, et al. Small Left Ventricular Size Is an Independent Risk Factor for Ventricular Assist Device Thrombosis. ASAIO J. 2019; 65: 152-159.
53. Fouilloux V, El Louali F, Gran C, et al. Berlin Heart EXCOR Paediatric Ventricular Assist Device: Does Weight Matter? Heart Lung Circ. 2021; 30: 585-591.
54. Townsend M, Jeewa A, Adachi I, et al. Ventricular Assist Device Use in Patients With Single-Ventricle Circulation. Can J Cardiol. 2022; 38: 1086-1099.
55. Rohde S, Sandica E, Veen K, et al. Outcomes in small children on Berlin Heart EXCOR support: age and body surface area as clinical predictive factors. Eur J Cardio-Thorac. 2022; 63.
56. Bielka A, Kalinowski M, Hawranek M, et al. Mechanical circulatory support restores eligibility for heart transplant in patients with significant pulmonary hypertension. Kardiol Pol. 2020; 78: 1008-1014.
57. Rohde S, Miera O, Sandica E, et al. Ventricular assist device support in paediatric patients with restrictive cardiomyopathy-clinical outcomes and haemodynamics. Eur J Cardiothorac Surg. 2024; 66.
58. Fraser CD, Jr., Jaquiss RD, Rosenthal DN, et al. Prospective trial of a pediatric ventricular assist device. N Engl J Med. 2012; 367: 532-541.
59. Burki S, Adachi I. Pediatric ventricular assist devices: current challenges and future prospects. Vasc Health Risk Manag. 2017; 13: 177-185.
60. Yarlagadda VV, Maeda K, Zhang Y, et al. Temporary Circulatory Support in U.S. Children Awaiting Heart Transplantation. J Am Coll Cardiol. 2017; 70: 2250-2260.
61. O'Connor MJ, Lorts A, Davies RR, et al. Early experience with the HeartMate 3 continuous-flow ventricular assist device in pediatric patients and patients with congenital heart disease: A multicenter registry analysis. J Heart Lung Transpl. 2020; 39: 573-579.
62. Lorts A, Conway J, Schweiger M, et al. ISHLT consensus statement for the selection and management of pediatric and congenital heart disease patients on ventricular assist devices Endorsed by the American Heart Association. J Heart Lung Transplant. 2021; 40: 709-732.
63. Escher A, Strauch C, Hubmann EJ, et al. A Cavopulmonary Assist Device for Long-Term Therapy of Fontan Patients. Semin Thorac Cardiovasc Surg. 2022; 34: 238-248.
64. Chet Villa JB, Raheel Rizwan, Angela Lorts. Utilization of VADs in children with restrictive and hypertrophic cardiomyopathy: Are we there yet? Progress in Pediatric Cardiology. 2018; 49: 47-49.
65. Giridharan GA, Ising M, Sobieski MA, et al. Cavopulmonary assist for the failing Fontan circulation: impact of ventricular function on mechanical support strategy. ASAIO J. 2014; 60: 707-715.
66. Su JA, Menteer J. Outcomes of Berlin Heart EXCOR((R)) pediatric ventricular assist device support in patients with restrictive and hypertrophic cardiomyopathy. Pediatr Transplant. 2017; 21.
67. Morales DLS, Lorts A, Rizwan R, et al. Worldwide Experience with the Syncardia Total Artificial Heart in the Pediatric Population. ASAIO J. 2017; 63: 518-519.
68. Stahovich M, Sundareswaran KS, Fox S, et al. Reduce Driveline Trauma Through Stabilization and Exit

Site Management: 30 Days Feasibility Results from the Multicenter RESIST Study. Asaio Journal. 2016; 62: 240-245.
69. Karimova A, Pockett CR, Lasuen N, et al. Right ventricular dysfunction in children supported with pulsatile ventricular assist devices. J Thorac Cardiovasc Surg. 2014; 147: 1691-1697 e1691.
70. Adachi I, Peng DM, Hollander SA, et al. Sixth Annual Pediatric Interagency Registry for Mechanical Circulatory Support (Pedimacs) Report: The Society Of Thoracic Surgeons Pedimacs Annual Report. Ann Thorac Surg. 2023; 115: 1098-1108.
71. Wu EL, Stevens MC, Pauls JP, et al. First-generation ventricular assist devices. Acad Pr Ser Biom Eng. 2018: 93-115.
72. Graefe R, Gross-Hardt S. Second-generation ventricular assist devices. Acad Pr Ser Biom Eng. 2018: 117-150.
73. Rose EA, Gelijns AC, Moskowitz AJ, et al. Long-term use of a left ventricular assist device for end-stage heart failure. N Engl J Med. 2001; 345: 1435-1443.
74. Slaughter MS, Rogers JG, Milano CA, et al. Advanced heart failure treated with continuous-flow left ventricular assist device. N Engl J Med. 2009; 361: 2241-2251.
75. Dorken Gallastegi A, Hoscoskun EB, Kahraman U, et al. Long-Term Outcomes in Ventricular Assist Device Outflow Cannula Anastomosis to the Descending Aorta. Ann Thorac Surg. 2022; 114: 1377-1385.
76. Dalia AA, Cronin B, Stone ME, et al. Anesthetic Management of Patients With Continuous-Flow Left Ventricular Assist Devices Undergoing Noncardiac Surgery: An Update for Anesthesiologists. J Cardiothorac Vasc Anesth. 2018; 32: 1001-1012.
77. Oleyar M, Stone M, Neustein SM. Perioperative management of a patient with a nonpulsatile left ventricular-assist device presenting for noncardiac surgery. J Cardiothorac Vasc Anesth. 2010; 24: 820-823.
78. Conway J, Miera O, Adachi I, et al. Worldwide Experience of a Durable Centrifugal Flow Pump in Pediatric Patients. Semin Thorac Cardiovasc Surg. 2018; 30: 327-335.
79. Kleiman Z, Navaratnam M. Coming Soon to an OR Near You: a Child with a Ventricular Assist Device. Curr Anesthesiol Rep. 2023; 13: 172-180.
80. Baldwin JT, Adachi I, Teal J, et al. Closing in on the PumpKIN Trial of the Jarvik 2015 Ventricular Assist Device. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2017; 20: 9-15.
81. Selzman CH, Koliopoulou A, Glotzbach JP, et al. Evolutionary Improvements in the Jarvik 2000 Left Ventricular Assist Device. ASAIO J. 2018; 64: 827-830.
82. de By T, Schoenrath F, Veen KM, et al. The European Registry for Patients with Mechanical Circulatory Support of the European Association for Cardio-Thoracic Surgery: third report. Eur J Cardiothorac Surg. 2022; 62.
83. Botha P, Solana R, Cassidy J, et al. The impact of mechanical circulatory support on outcomes in paediatric heart transplantation. Eur J Cardiothorac Surg. 2013; 44: 836-840.
84. Pekkan K, Aka IB, Tutsak E, et al. In vitro validation of a self-driving aortic-turbine venous-assist device for Fontan patients. J Thorac Cardiovasc Surg. 2018; 156: 292-301 e297.
85. Cho J, Tunuguntla HP, Tume SC, et al. Long-term implantable ventricular assist device support in children. J Thorac Cardiovasc Surg. 2024; 167: 1417-1426 e1411.
86. Peng DM, Koehl DA, Cantor RS, et al. Outcomes of children with congenital heart disease implanted with ventricular assist devices: An analysis of the Pediatric Interagency Registry for Mechanical Circulatory Support (Pedimacs). J Heart Lung Transplant. 2019; 38: 420-430.
87. Auerbach SR, Simpson KE, on Behalf of the Action Learning Network I. HVAD Usage and Outcomes in the Current Pediatric Ventricular Assist Device Field: An Advanced Cardiac Therapies Improving Outcomes Network (ACTION) Analysis. ASAIO J. 2021; 67: 675-680.
88. Cao I, Italiano EG, Bertelli F, et al. Intracorporeal LVAD implantation in pediatric patients: A single-center 10 years' experience. Artif Organs. 2024; 48: 408-417.
89. Hollander SA, Pyke-Grimm KA, Shezad MF, et al. End-of-Life in Pediatric Patients Supported by Ventricular Assist Devices: A Network Database Cohort Study. Pediatr Crit Care Med. 2023; 24: 41-50.
90. Dogan E, Ulger Tutar Z, Tuncer ON, et al. Outcomes of HeartMate 3 in pediatric patients with end-stage heart failure: a single-center preliminary experience from Turkey. Front Cardiovasc Med. 2024; 11: 1472663.
91. O'Connor MJ, Shezad M, Ahmed H, et al. Expanding use of the HeartMate 3 ventricular assist device in pediatric and adult patients within the Advanced Cardiac Therapies Improving Outcomes Network (ACTION). J Heart Lung Transplant. 2023; 42: 1546-1556.
92. Morales DLS, Adachi I, Peng DM, et al. Fourth Annual Pediatric Interagency Registry for Mechanical Circulatory Support (Pedimacs) Report. Ann Thorac Surg. 2020; 110: 1819-1831.
93. Urbanska EK, Pawlak S, Grzybowski A, et al. Temporary left ventricular assistance for extreme postoperative heart failure in two infants with Bland-White-Garland syndrome. Kardiochir Torakochirurgia Pol. 2016; 13: 269-272.
94. Morales DLS, Rossano JW, VanderPluym C, et al. Third Annual Pediatric Interagency Registry for Mechanical Circulatory Support (Pedimacs) Report: Preimplant Characteristics and Outcomes. Ann Thorac Surg. 2019; 107: 993-1004.
95. Guo A, Subramanian MP, Vader J, et al. HeartMate 3 Implantation Through Left Atrial e-PTFE Conduit for Restrictive Cardiomyopathy. Ann Thorac Surg Short Rep. 2023; 1: 191-193.
96. Loforte A, Bottio T, Attisani M, et al. Conventional and alternative sites for left ventricular assist device inflow and outflow cannula placement. Ann Cardiothorac Surg. 2021; 10: 281-288.
97. Miller JR, Lancaster TS, Eghtesady P. Current approaches to device implantation in pediatric and congenital heart disease patients. Expert Rev Cardiovasc Ther. 2015; 13: 417-427.
98. Almond CS, Buchholz H, Massicotte P, et al. Berlin Heart EXCOR Pediatric ventricular assist device Investigational Device Exemption study: study design and rationale. Am Heart J. 2011; 162: 425-435 e426.
99. George AN, Hsia TY, Schievano S, et al. Complications in children with ventricular assist devices: systematic review and meta-analyses. Heart Fail Rev. 2022; 27: 903-913.

100. Bansal N, Auerbach SR, Shezad MF, et al. The Initial Analysis of Infectious Adverse Events in Pediatric Ventricular Assist Devices Reported to the ACTION Registry. J Heart Lung Transpl. 2022; 41: S77-S78.
101. Horsley M, Pathak S, Morales D, et al. Nutritional outcomes of patients with pediatric and congenital heart disease requiring ventricular assist devices. JPEN J Parenter Enteral Nutr. 2022; 46: 1553-1558.
102. Lorts A, Smyth L, Gajarski RJ, et al. The Creation of a Pediatric Health Care Learning Network: The ACTION Quality Improvement Collaborative. Asaio Journal. 2020; 66: 441-446.
103. Shah R, Qayed E. Outcomes and Predictors of Readmissions with GI Bleeding in Patients with Left Ventricular Assist Devices. South Med J. 2018; 111: 666-673.
104. Kataria R, Jorde UP. Gastrointestinal Bleeding During Continuous-Flow Left Ventricular Assist Device Support State of the Field. Cardiol Rev. 2019; 27: 8-13.
105. Sharp MK, Gregg M, Brock G, et al. Comparison of Blood Viscoelasticity in Pediatric and Adult Cardiac Patients. Cardiovasc Eng Techn. 2017; 8: 182-192.
106. Mehra MR, Netuka I, Uriel N, et al. Aspirin and Hemocompatibility Events With a Left Ventricular Assist Device in Advanced Heart Failure: The ARIES-HM3 Randomized Clinical Trial. JAMA. 2023; 330: 2171-2181.
107. Aslam S. Ventricular Assist Device Infections. Cardiol Clin. 2018; 36: 507-517.
108. Kormos RL. Response by Kormos to Letter Regarding Article, "Left Ventricular Assist Device Malfunctions: It Is More Than Just the Pump". Circulation. 2018; 137: 2300-2301.
109. Shah P, Yuzefpolskaya M, Hickey GW, et al. Twelfth Interagency Registry for Mechanically Assisted Circulatory Support Report: Readmissions After Left Ventricular Assist Device. Ann Thorac Surg. 2022; 113: 722-737.
110. Imamura T, Narang N, Kim G, et al. Aortic Insufficiency During HeartMate 3 Left Ventricular Assist Device Support. J Card Fail. 2020; 26: 863-869.
111. van der Heiden CW, Zijderhand CF, Veen KM, et al. Mechanical Device Malfunction of the HeartMate II Versus the HeartMate 3 Left Ventricular Assist Device: The Rotterdam Experience. ASAIO J. 2023; 69: e80-e85.
112. Castrodeza J, Ortiz-Bautista C, Fernandez-Aviles F. Continuous-flow left ventricular assist device: Current knowledge, complications, and future directions. Cardiol J. 2022; 29: 293-304.
113. Lammers AE, Sprenger KS, Diller GP, et al. Ventricular assist devices in paediatric cardiomyopathy and congenital heart disease: An analysis of the German National Register for Congenital Heart Defects. International Journal of Cardiology. 2021; 343.
114. Simpson KE, Kirklin JK, Cantor RS, et al. Right heart failure with left ventricular assist device implantation in children: An analysis of the Pedimacs registry database. J Heart Lung Transplant. 2020; 39: 231-240.
115. Zhang Q, Gao B, Yu C. The Effects of Left Ventricular Assist Device Support Level on the Biomechanical States of Aortic Valve. Med Sci Monit. 2018; 24: 2003-2017.
116. Sparrow CT, LaRue SJ, Schilling JD. Intersection of Pulmonary Hypertension and Right Ventricular Dysfunction in Patients on Left Ventricular Assist Device Support: Is There a Role for Pulmonary Vasodilators? Circ Heart Fail. 2018; 11: e004255.
117. Peng DM, Yu S, Lowery R, et al. Self-reported quality of life in children with ventricular assist devices. Pediatr Transplant. 2022; 26: e14237.
118. Jorde UP, Saeed O, Koehl D, et al. The Society of Thoracic Surgeons Intermacs 2023 Annual Report: Focus on Magnetically Levitated Devices. Ann Thorac Surg. 2024; 117: 33-44.
119. Baez Hernandez N, Kirk R, Sutcliffe D, et al. Utilization and outcomes in biventricular assist device support in pediatrics. J Thorac Cardiovasc Surg. 2020; 160: 1301-1308 e1302.
120. Miller JR, Epstein DJ, Henn MC, et al. Early Biventricular Assist Device Use in Children: A Single-Center Review of 31 Patients. ASAIO J. 2015; 61: 688-694.
121. Bravo CA, Navarro AG, Dhaliwal KK, et al. Right heart failure after left ventricular assist device: From mechanisms to treatments. Front Cardiovasc Med. 2022; 9: 1023549.
122. Frankfurter C, Molinero M, Vishram-Nielsen JKK, et al. Predicting the Risk of Right Ventricular Failure in Patients Undergoing Left Ventricular Assist Device Implantation: A Systematic Review. Circ Heart Fail. 2020; 13: e006994.
123. Sert DE, Karahan M, Aygun E, et al. Prediction of right ventricular failure after continuous flow left ventricular assist device implantation. J Card Surg. 2020; 35: 2965-2973.
124. Kanwar MK, Rajagopal K, Itoh A, et al. Impact of left ventricular assist device implantation on mitral regurgitation: An analysis from the MOMENTUM 3 trial. J Heart Lung Transpl. 2020; 39: 529-537.
125. Nair PK, Kormos RL, Teuteberg JJ, et al. Pulsatile left ventricular assist device support as a bridge to decision in patients with end-stage heart failure complicated by pulmonary hypertension. J Heart Lung Transpl. 2010; 29: 201-208.
126. Zimpfer D, Zrunek P, Roethy W, et al. Left ventricular assist devices decrease fixed pulmonary hypertension in cardiac transplant candidates. J Thorac Cardiov Sur. 2007; 133: 689-695.
127. Gandhi SK, Huddleston CB, Balzer DT, et al. Biventricular assist devices as a bridge to heart transplantation in small children. Circulation. 2008; 118: S89-S93.
128. Zafar F, Jefferies JL, Tjossem CJ, et al. Biventricular Berlin Heart EXCOR pediatric use across the united states. Ann Thorac Surg. 2015; 99: 1328-1334.
129. Abdelshafy M, Caliskan K, Guven G, et al. Temporary Right-Ventricular Assist Devices: A Systematic Review. J Clin Med. 2022; 11.
130. Lenoir M, Quessard A, N'Guyen A, et al. Simplified temporary right ventricular support after implantation of a left ventricular assist device. Heart Surg Forum. 2013; 16: E152-154.
131. Folino G, Piperata A, Bejko J, et al. Biventricular assistance with 2 hm3 in a small chest patient: extra-pericardial implant. J Artif Organs. 2021; 24: 261-264.
132. Lo Coco V, De Piero ME, Massimi G, et al. Right ventricular failure after left ventricular assist device implantation: a review of the literature. J Thorac Dis. 2021; 13: 1256-1269.
133. Stein ML, Yeh J, Reinhartz O, et al. HeartWare HVAD for Biventricular Support in Children and Adolescents: The Stanford Experience. ASAIO J. 2016; 62: e46-51.
134. Arabia FA, Milano CA, Mahr C, et al. Biventricular

Support With Intracorporeal, Continuous Flow, Centrifugal Ventricular Assist Devices. Ann Thorac Surg. 2018; 105: 548-555.
135. Stevens MC, Wilson S, Bradley A, et al. Physiological Control of Dual Rotary Pumps as a Biventricular Assist Device Using a Master/Slave Approach. Artificial Organs. 2014; 38: 766-774.
136. Veen KM, Ahmed M, Stark C, et al. The fourth report of the European Registry for Patients with Mechanical Circulatory Support (EUROMACS) of the European Association for Cardiothoracic Surgery: focus on standardized outcome ratios. Eur J Cardiothorac Surg. 2025; 67.
137. VanderPluym CJ, Adachi I, Niebler R, et al. Outcomes of children supported with an intracorporeal continuous-flow left ventricular assist system. J Heart Lung Transplant. 2019; 38: 385-393.
138. Rea KE, McCormick AM, Lim HM, et al. Psychosocial outcomes in pediatric patients with ventricular assist devices and their families: A systematic review. Pediatr Transplant. 2021; 25: e14001.
139. Hope KD, Bhat PN, Dreyer WJ, et al. Pediatric Palliative Care in the Heart Failure, Ventricular Assist Device and Transplant Populations: Supporting Patients, Families and Their Clinical Teams. Children-Basel. 2021; 8.
140. Pockett CR, LaFrance R, Moore J, et al. Psychiatric Disorders Following Ventricular Assist Device Implantation in Pediatric Patients. J Heart Lung Transpl. 2012; 31: S278-S278.
141. Rydell AM, Bohlin G, Thorell LB. Representations of attachment to parents and shyness as predictors of children's relationships with teachers and peer competence in preschool. Attach Hum Dev. 2005; 7: 187-202.
142. Takano K, Tsutsui J, Oshibuchi H, et al. Psychological support for an adolescent awaiting heart transplantation: A case report on psychological intervention using the Stanford Integrated Psychosocial Assessment for Transplant. Psych Clin Neuro Rep. 2025; 4.
143. Abela KM, Wardell D, Rozmus C, et al. Impact of Pediatric Critical Illness and Injury on Families: An Updated Systematic Review. J Pediatr Nurs. 2020; 51: 21-31.
144. Hollander SA, Callus E. Cognitive and Psycholologic Considerations in Pediatric Heart Failure. J Card Fail. 2014; 20: 782-785.
145. Cousino MK, Hazen RA. Parenting Stress Among Caregivers of Children With Chronic Illness: A Systematic Review. J Pediatr Psychol. 2013; 38: 809-828.
146. Stuber ML, Shemesh E. Post-traumatic stress response to life-threatening illnesses in children and their parents. Child Adol Psych Cl. 2006; 15: 597-+.
147. Mehegan M, Oldenburg G, Lantz J. Pediatric VAD Discharge and Outpatient Care. ASAIO J. 2018; 64: e156-e160.
148. Schumann A, Vatne TM, Fjermestad KW. What challenges do siblings of children with chronic disorders express to their parents? A thematic analysis of 73 sibling-parent dialogues. Journal of Pediatric Nursing-Nursing Care of Children & Families. 2024; 76: 91-98.
149. Hallman ML, Bellury LM. Communication in Pediatric Critical Care Units: A Review of the Literature. Crit Care Nurse. 2020; 40: e1-e15.
150. de Sonnaville ESV, Oosterlaan J, Ghiassi SA, et al. Long-term neurocognitive outcomes after pediatric intensive care: exploring the role of drug exposure. Pediatr Res. 2023; 94: 603-610.
151. Davidson JE, Aslakson RA, Long AC, et al. Guidelines for Family-Centered Care in the Neonatal, Pediatric, and Adult ICU. Crit Care Med. 2017; 45: 103-128.
152. O'Toole S, Suarez C, Adair P, et al. A Systematic Review of the Factors Associated with Post-Traumatic Growth in Parents Following Admission of Their Child to the Intensive Care Unit. J Clin Psychol Med S. 2022; 29: 509-537.
153. Ekim A. The Post-Intensive Care Syndrome in Children. Compr Child Adolesc Nurs. 2020; 43: 15-21.
154. Choong K, Fraser D, Al-Harbi S, et al. Functional Recovery in Critically Ill Children, the "WeeCover" Multicenter Study. Pediatr Crit Care Med. 2018; 19: 145-154.
155. Merk L, Merk R. A Parents' Perspective on the Pediatric Intensive Care Unit Our Family's Journey. Pediatr Clin N Am. 2013; 60: 773-+.
156. Weil CM, Rodgers S, Rubovits S. School re-entry of the pediatric heart transplant recipient. Pediatr Transplant. 2006; 10: 928-933.
157. Lewis M, Noyes J. Discharge management for children with complex needs. Paediatr Nurs. 2007; 19: 26-30.
158. MacDonald S, Du Pont-Thibodeau G, Thibault C, et al. Outcomes of patients supported by mechanical ventilation and their families two months after discharge from pediatric intensive care unit. Frontiers in Pediatrics. 2024; 12.
159. Albright DK, Gornik A, Andersen M, et al. Evaluation of Standardized Psychological Screening for Pediatric Inpatients. Clin Pract Pediat Ps. 2022; 10: 66-78.
160. Gundugurti PR, Bhattacharyya R, Koneru A. Management of Psychiatric Disorders in Patients with Cardiovascular Diseases. Indian J Psychiatry. 2022; 64: S355-S365.
161. Stein ML, Bruno JL, Konopacki KL, et al. Cognitive outcomes in pediatric heart transplant recipients bridged to transplantation with ventricular assist devices. J Heart Lung Transplant. 2013; 32: 212-220.
162. Burns S, Doering K, Koller D, et al. School reintegration following hospitalisation for children with medical complexity and chronic disease diagnoses: a scoping review protocol. BMJ Open. 2021; 11: e052493.
163. Noguera JM. The principles of biomedical ethics. Med Balear. 2008; 23: 38-39.
164. Dalton HJ, Dodge-Khatami A, MacLaren G. Pediatric Mechanical Circulatory Support: Future Directions. Pediatr Crit Care Me. 2013; 14: S94-S95.
165. Javier Delmo EM, Javier M, Hetzer R. The role of ventricular assist device in children. Cardiovasc Diagn Ther. 2021; 11: 193-201.
166. Ayik F, Oguz E, Engin C, et al. Surgical therapy of end-stage heart failure in pediatric patients. Transplant Proc. 2011; 43: 935-937.
167. Ozbaran M, Yagdi T, Engin C, et al. New circulatory support system: heartware. Transplant Proc. 2012; 44: 1726-1728.
168. Ozbaran M, Yagdi T, Engin C, et al. New era of pediatric ventricular assist devices: let us go to school. Pediatr Transplant. 2015; 19: 82-86.



ÇOCUKLARDA KALP VE KALP/AKCİĞER TRANSPLANTASYONU

BÖLÜM
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İçindekiler

- KALP TRANSPLANTASYONU
  - Giriş
  - Tanım
  - Tarihçe
  - Takip ve Tedavi
- AKUT KALP YETERSİZLİĞİ YÖNETİMİ
- MEKANİK DOLAŞIM DESTEK CİHAZLARI
- SINIFLAMA VE ENDİKASYONLAR
  - Kardiyomiyopatiler
- DOĞUMSAL KALP HASTALIKLARI
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- KONTRENDİKASYONLAR
- ALICI DEĞERLENDİRME VE BAKIMI
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  - Donör Kalbinin Korunması
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- KALP TRANSPLANTASYONU PROSEDÜRÜ
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- İMMÜNSÜPRESYON
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  - Kalsinörin inhibitörleri
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- REJEKSİYON TANI VE TEDAVİSİ
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- SONUÇ
- KALP-AKCİĞER TRANSPLANTASYONU
  - Endikasyonlar
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  - Uzun Dönem Takip ve Komplikasyonlar
  - Geç Komplikasyonlar
- SONUÇ

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ner baypas, nefrotoksik antibiyotik kullanımı ve hemodinamik sorunlarla ilişkili olarak nakil sonrası erken dönemde böbrek fonksiyonunda bazı zorluklar yaşanır. Bu durum genellikle düzelse de, zamanla böbrek yetmezliği derecesi kalsinörin ilaçlarının (siklosporin veya takrolimus) uzun süreli kullanımıyla ilişkili olduğu için kötüleşir. Nakil sonrası beşinci yılda, tüm hastaların yaklaşık %10'unda bir dereceye kadar böbrek yetmezliği olur ve bu oran on yılda %29'a çıkabilir. Beş yıl içinde çocukların %60'ından fazlası hipertansiyon tedavisine ihtiyaç duyar, %17'sinde hiperlipidemi ve %36'sında diabetes mellitus vardır. Diyabetli hastaların çoğu, nakil öncesi glikoz intoleransına sahiptir. Bu hastalıkların tedavisi uzun dönem sağ kalım için gereklidir (242).

Kalp-akciğer alıcılarında posttransplant koroner arter vaskülopatisi izole kalp nakli alıcılarına göre çok daha az görülmektedir. Bu farklılığın nedeninden emin olmak zor olsa da, kalp-akciğer nakli alıcıları kalp nakli alıcılarına göre daha yoğun İmmünsüpresyon almaları önemli bir sebep olabilir (243).

SONUÇ

Kalp-Akciğer transplantasyonu için donör havuzunu artırma, immünsüpresyon, PGD ve bronşiolit obliterans alanlarında çok sayıda araştırma devam etmektedir. Cesaret verici raporlar olmasına rağmen, bu endişe verici alanların hiçbirinde klinik olarak uygulanabilir bir ilerleme kaydedilmemiştir. Bu nedenle çocuklarda kalp-akciğer nakli sonrası sağ kalım oranı diğer torasik organ nakillerine göre daha kötüdür. Son dönemdeki verilerde sağ kalım biraz daha düzelse de 1 yılda %73, 3 yılda %63 ve 5 yılda %52 seviyelerindedir (244). Ölüm oranı genellikle akciğerle ilişkilidir. Erken dönemde akciğer greft yetmezliği, geç dönemde bronşiolitis obliterans en önemli mortalite nedenleridir.

KAYNAKLAR

1. Heidenreich PA, Bozkurt B, Aguilar D, et al. 2022 AHA/ACC/HFSA guideline for the management of heart failure: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Circulation 2022;145:e895-1032.
2. Ross RD. The Ross classification for heart failure in children after 25 years: a review and an age-stratified revision. Pediatr Cardiol. 2012 Dec;33(8):1295-300. doi: 10.1007/s00246-012-0306-8. Epub 2012 Apr 5. PMID: 22476605.
3. Amdani S, Conway J, George K, Martinez HR, Asante-Korang A, Goldberg CS; American Heart Association Council on Lifelong Congenital Heart Disease and Heart Health in the Young; Council on Arteriosclerosis, Thrombosis and Vascular Biology; Council on Cardiovascular Surgery and Anesthesia; and Council on Cardiovascular and Stroke Nursing. Evaluation and Management of Chronic Heart Failure in Children and Adolescents With Congenital Heart Disease: A Scientific Statement From the American Heart Association. Circulation. 2024 Jul 9;150(2):e33-e50. doi: 10.1161/CIR.0000000000001245. Epub 2024 May 29. PMID: 38808502.
4. Bogle C, Colan SD, Miyamoto SD, Choudhry S, Baez-Hernandez N, Brickler MM; American Heart Association Young Hearts Pediatric Heart Failure and Transplantation Committee of the Council on Lifelong Congenital Heart Disease and Heart Health in the Young (Young Hearts). Treatment Strategies for Cardiomyopathy in Children: A Scientific Statement From the American Heart Association. Circulation. 2023 Jul 11;148(2):174-195. doi: 10.1161/CIR.0000000000001151. Epub 2023 Jun 8. Erratum in: Circulation. 2023 Jul 11;148(2):e3. doi: 10.1161/CIR.0000000000001170. PMID: 37288568.
5. Lopaschuk GD, Karwi QG, Tian R, Wende AR, Abel ED. Cardiac Energy Metabolism in Heart Failure. Circ Res. 2021 May 14;128(10):1487-1513. doi: 10.1161/CIRCRESAHA.121.318241. Epub 2021 May 13. PMID: 33983836; PMCID: PMC8136750.
6. Carrel A. Suture of blood-vessels and transplantation of organs. In: Nobel Lectures, Physiology or Medicine 1901-1921. Amsterdam: Elsevier Publishing Company, 1967. http:// nobelprize.org/medicine/laureates/1912/carrel-lecture.html. Accessed July 29, 2005.
7. Anonymous. The Nobel Prize in Physiology or Medicine 1912. http://nobelprize.org/medicine/laureates/1912. Accessed July 29, 2005.
8. Shumway NE. The experimental basis for heart transplantation. Bull Am Coll Surg. June 1981; 66:6-10.
9. Konstantinov IE. A mystery of Vladimir P. Demikhov: the 50th anniversary of the first intrathoracic transplantation. Ann Thorac Surg. 1998 Apr;65(4):1171-7. doi: 10.1016/s0003-4975(97)01308-8. PMID: 9564962.
10. Hardy JD. The world of surgery, 1945-1985: memoirs of one participant. University of Pennsylvania Press, 2017.
11. Lower RR, Shumway NE. Studies on orthotopic homotransplantation of the canine heart. Surg Forum. 1960;11:18–19.

12. Lower RR, Stofer RC, Hurley EJ, et al. Successful homotransplantations of the canine heart after anoxic preservation for seven hours.Am J Surg. 1962;104:302–306.
13. Barnard CN. The operation. A human cardiac transplant: an interim report of a successful operation performed at Groote Schuur Hospital, Cape Town. S Afr Med J. 1967;41:1271–1274.
14. Griepp RB. A decade of human heart transplantation. Transplant Proc 1979;11:285-92.
15. Caves PK, Stinson EB, Graham AF, et al. Percutaneous transvenous endomyocardial biopsy. JAMA.1973;225:288–291.
16. Caves PK, Stinson EB, Billingham ME, Shumway NE. Serial transvenous biopsy of the transplanted human heart.Improved management of acute rejection episodes. Lancet. 1974;1:821–826.
17. Oyer PE, Stinson EB, Jamieson SW, et al. Cyclosporin-A in cardiac allografting: a preliminary experience. Transplant Proc. 1983;3:172.
18. Kobashigawa JA. Controversies in heart and lung transplantation immunosuppression: tacrolimus versus cyclosporine.Transplant Proc. 1998;30:1095–1097.
19. Dipchand AI, Benson L, McCrindle BW, Coles J, West L. Mycophenolate mofetil in pediatric heart transplant recipients: a single-center experience. Pediatr Transplant. 2001;5:112–118.
20. Canter CE,Moorhead S,Saffitz JE,Huddelston CB,Spray TL. Steroid withdrawal in the pediatric heart transplant recipient initially treated with triple immunosuppression. J Heart Lung Transplant. 1994;13(1Pt 1):74–80.
21. Beniaminovitz A, Itescu S, Lietz K, et al. Prevention of rejection in cardiac transplantation by blockade of the interleukin-2 receptor with a monoclonal antibody.N Engl J Med. 2000;342:613–619.
22. Kantrowitz A, Haller JD, Joos H, Cerruti MM, Carstensen HE. Transplantation of the heart in an infant and an adult. Am J Cardiol. 1968;22:782-90.
23. Cooley DA, Frazier OH, Van Buren CT, Bricker JT, Radovancevic B. Cardiac transplantation in an 8-month-old female infant with subendocardial fibroelastosis. JAMA. 1986;256:1326-9.
24. Bailey LL, Nehlsen-Cannarella SL, Doroshow RW, et al. Cardiac allotransplantation in newborns as therapy for hypoplastic left heart syndrome. N Engl J Med. 1986;315:949–951.
25. Vazquez Alvarez MDC, Cantor R, Koehl D, Nandi D, Kemna MS, Urschel S, et al. The evolution of pediatric heart retransplantation over three decades: An analysis from the PHTS. J Heart Lung Transplant. 2022 Jun;41(6):791-801. doi: 10.1016/j.healun.2022.02.018. Epub 2022 Mar 14. PMID: 35400589.
26. Ahmed H, VanderPluym C. Medical management of pediatric heart failure. Cardiovasc Diagn Ther. 2021 Feb;11(1):323-335. doi: 10.21037/cdt-20-358. PMID: 33708503; PMCID: PMC7944205.
27. Mullens W, Damman K, Harjola VP, Mebazaa A, Brunner-La Rocca HP, Martens P, et al. The use of diuretics in heart failure with congestion - a position statement from the Heart Failure Association of the European Society of Cardiology. Eur J Heart Fail. 2019 Feb;21(2):137-155. doi: 10.1002/ejhf.1369. Epub 2019 Jan 1. PMID: 30600580.
28. McMurray JJ, Packer M, Desai AS, Gong J, Lefkowitz MP, Rizkala AR, Rouleau JL, Shi VC, Solomon SD, Swedberg K, Zile MR; PARADIGM-HF Investigators and Committees. Angiotensin-neprilysin inhibition versus enalapril in heart failure. N Engl J Med. 2014 Sep 11;371(11):993-1004. doi: 10.1056/NEJMoa1409077. Epub 2014 Aug 30. PMID: 25176015.
29. Shaddy R, Burch M, Kantor PF, Solar-Yohay S, Garito T, Zhang S; PANORAMA-HF Investigators. Sacubitril/Valsartan in Pediatric Heart Failure (PANORAMA-HF): A Randomized, Multicenter, Double-Blind Trial. Circulation. 2024 Nov 26;150(22):1756-1766. doi: 10.1161/CIRCULATIONAHA.123.066605. Epub 2024 Sep 25. PMID: 39319469; PMCID: PMC11593999.
30. Zannad F, Gattis Stough W, Rossignol P, Bauersachs J, McMurray JJ, Swedberg K, et al. Mineralocorticoid receptor antagonists for heart failure with reduced ejection fraction: integrating evidence into clinical practice. Eur Heart J. 2012 Nov;33(22):2782-95. doi: 10.1093/eurheartj/ehs257. Epub 2012 Aug 31. PMID: 22942339.
31. Garcia AM, Beatty JT, Nakano SJ. Heart failure in single right ventricle congenital heart disease: physiological and molecular considerations. Am J Physiol Heart Circ Physiol. 2020 Apr 1;318(4):H947-H965. doi: 10.1152/ajpheart.00518.2019. Epub 2020 Feb 28. PMID: 32108525; PMCID: PMC7191494.
32. Kumar SS, Gopalakrishnan A, Krishnamoorthy KM, Naik S, Sivadasanpillai H. The efficacy and safety of dapagliflozin in pediatric heart failure. Int J Cardiol. 2025 Sep 15;435:133384. doi: 10.1016/j.ijcard.2025.133384. Epub 2025 May 22. PMID: 40412628.
33. Brown DW, Mangeot C, Anderson JB, Peterson LE, King EC, Lihn SL; National Pediatric Cardiology Quality Improvement Collaborative. Digoxin Use Is Associated With Reduced Interstage Mortality in Patients With No History of Arrhythmia After Stage I Palliation for Single Ventricle Heart Disease. J Am Heart Assoc. 2016 Jan 11;5(1):e002376. doi: 10.1161/JAHA.115.002376. PMID: 26755552; PMCID: PMC4859359.
34. Luxford JC, Casey CE, Roberts PA, Irving CA. Iron deficiency and anemia in pediatric dilated cardiomyopathy are associated with clinical, biochemical, and hematological markers of severe disease and adverse outcomes. J Heart Lung Transplant. 2024 Mar;43(3):379-386. doi: 10.1016/j.healun.2023.11.014. Epub 2023 Nov 25. PMID: 38012978.
35. Shaddy RE, George AT, Jaecklin T, et al. Systematic Literature Review on the Incidence and Prevalence of Heart Failure in Children and Adolescents. Pediatr Cardiol 2018;39:415-36.
36. Kirk R, Dipchand AI, Rosenthal DN, et al. The International Society for Heart and Lung Transplantation Guidelines for the management of pediatric heart failure: Executive summary. J Heart Lung Transplant 2014;33:888-909.
37. Felker GM, Benza RL, Chandler AB, et al. Heart failure etiology and response to milrinone in decompensated heart failure: results from the OPTIME-CHF study. J Am Coll Cardiol 2003;41:997-1003.
38. Robel-Tillig E, Knupfer M, Pulzer F, et al. Cardiovascular impact of dobutamine in neonates with myocardial dysfunction. Early Hum Dev 2007;83:307-12.
39. Lipshultz SE, Sleeper LA, Towbin JA, et al: The incidence of pediatric cardiomyopathy in two regions of

the United States. N Engl J Med 348:1647, 2003.
40. Tsirka AE, Trinkaus K, Chen SC, et al: Improved outcomes of pediatric dilated cardiomyopathy with utilization of heart transplantation. J Am Coll Cardiol 44:391, 2004.
41. Sugiyama H, Hoshiai M, Naitoh A, et al: Outcome of non-transplant surgical strategy for end-stage dilated cardiomyopathy in young children. Circ J 73:1045, 2009.
42. Nield LE, McCrindle BW, Bohn DJ, et al. Outcomes for children with cardiomyopathy awaiting transplantation. Cardiol Young 10:358, 2000.
43. Fiser WP, Yetman AT, Gunselman RJ, et al: Pediatric arteriovenous extracorporeal membrane oxygenation (ECMO) as a bridge to cardiac transplantation. J Heart Lung Transplant 22:770, 2003.
44. Kirshbom PM, Bridges ND, Myung RJ, et al: Use of extracorporeal membrane oxygenation in pediatric thoracic organ transplantation. J Thorac Cardiovasc Surg 123:130, 2002.
45. Pollock JC, Charlton MC, Williams WG, et al: Intraaortic balloon pumping in children. Ann Thorac Surg 29:522, 1980.
46. Karl TR, Sano S, Horton S, et al: Centrifugal pump left heart assist in pediatric cardiac operations. Indication, technique, and results. J Thorac Cardiovasc Surg 102:624, 1991.
47. Hetzer R, Loebe M, Potapov EV, et al: Circulatory support with pneumatic paracorporeal ventricular assist device in infants and children. Ann Thorac Surg 66:1498, 1998.
48. Baldwin JT, Borovetz HS, Duncan BW, et al: The National Heart, Lung, and Blood Institute Pediatric Circulatory Support Program. Circulation 113:147, 2006.
49. Arabía FA, Tsau PH, Smith RG, et al: Pediatric bridge to heart transplantation: application of the Berlin Heart, Medos and Thoratec ventricular assist devices. J Heart Lung Transplant 25:16, 2006.
50. Duncan BW, Bohn DJ, Atz AM, et al: Mechanical circulatory support for the treatment of children with acute fulminant myocarditis. J Thorac Cardiovasc Surg 122:440, 2001.
51. del Nido PJ, Armitage JM, Fricker FJ, et al: Extracorporeal membrane oxygenation support as a bridge to pediatric heart transplantation. Circulation 90:66, 1994.
52. Bastardi HJ, Naftel DC, Webber SA, et al: Ventricular assist devices as a bridge to heart transplantation in children. J Cardiovasc Nur 23:25, 2008.
53. Yarlagadda VV, Maeda K, Zhang Y, et al. Temporary Circulatory Support in U.S. Children Awaiting HTx. J Am Coll Cardiol. 2017; 70: 2250–2260.
54. Kocabas S, Askar FZ, Yagdi T, Engin C, Ozbaran M. Anesthesia for ventricular assist device placement in pediatric patients: experience from a single center. Transplant Proc. 2013 Apr;45(3):1009-12. doi: 10.1016/j.transproceed.2013.02.068. PMID: 23622610.
55. Warnecke H, Berdjis F, Hennig E, et al: Mechanical left ventricular support as a bridge to cardiac transplantation in childhood. Eur J Cardiothorac Surg 5:330, 1991.
56. Rossano JW, Singh TP, Cherikh WS, et al. The International Thoracic Organ Transplant Registry of the International Society for Heart and Lung Transplantation: Twenty-second pediatric heart transplantation report – 2019; Focus theme: Donor and recipient size match. J Heart Lung Transplant. 2019;38:1028–1041.
57. Rossano JW, Lorts A, VanderPluym CJ, Jeewa A, Guleserian KJ, Bleiweis MS, et al. Outcomes of pediatric patients supported with continuous-flow ventricular assist devices: A report from the Pediatric Interagency Registry for Mechanical Circulatory Support (PediMACS). J Heart Lung Transplant 2016;35:585-90.
58. Almond CS, Morales DL, Blackstone EH, et al. Berlin Heart EXCOR pediatric ventricular assist device for bridge to heart transplantation in US children. Circulation. 2013; 127: 1702–1711.
59. Soslow JH, Patel AR, Abraham JR, et al. Neurological outcomes in pediatric LVAD patients. Pediatr Neurol. 2020; 107: 54–60.
60. Doğan E, Ulger Tutar Z, Tuncer ON, Levent RE, Engin Ç, Yağdı T, et al. Outcomes of HeartMate 3 in pediatric patients with end-stage heart failure: a single-center preliminary experience from Turkey. Front Cardiovasc Med. 2024 Oct 14;11:1472663. doi: 10.3389/fcvm.2024.1472663. PMID: 39469126; PMCID: PMC11513339.
61. Fraser CD Jr, Jaquiss RD, Rosenthal DN, et al. Prospective trial of pediatric VAD. N Engl J Med. 2012; 367: 532–541.
62. Miller JR, Lancaster TS, Eghtesady P. Current approaches to device implantation in pediatric and congenital heart disease patients. Expert Rev Cardiovasc Ther. 2015; 13: 417-427.
63. Ayik F, Oguz E, Engin C, Yagdi T, Ulger Z, Atay Y, et al. Surgical therapy of end-stage heart failure in pediatric patients. Transplant Proc. 2011 Apr;43(3):935-7.
64. Kirklin JK, Naftel DC. Mechanical circulatory support: registering a therapy in evolution. Circ Heart Fail 2008;1:200-5.
65. Damasceno A, Mayosi BM, Sani M, Ogah OS, Mondo C, et al. The causes, treatment, and outcome of acute heart failure in 1006 Africans from 9 countries. Arch Intern Med. 2012 Oct 8;172(18):1386-94. doi: 10.1001/archinternmed.2012.3310. PMID: 22945249.
66. Rossano JW, Shaddy RE. Heart failure in children: etiology and treatment. J Pediatr. 2014 Aug;165(2):228-33. doi: 10.1016/j.jpeds.2014.04.055. Epub 2014 Jun 11. PMID: 24928699.
67. Lipshultz SE, Sleeper LA, Towbin JA, Lowe AM, Orav EJ, Cox GF, et al. The incidence of pediatric cardiomyopathy in two regions of the United States. N Engl J Med. 2003 Apr 24;348(17):1647-55. doi: 10.1056/NEJMoa021715. PMID: 12711739.
68. Lee TM, Hsu DT, Kantor P, et al. Pediatric cardiomyopathies.Circ Res. 2017;121:855–873.
69. Wilkinson JD, Landy DC, Colan SD, Towbin JA, Sleeper LA, Orav EJ, et al. The pediatric cardiomyopathy registry and heart failure: key results from the first 15 years. Heart Fail Clin. 2010 Oct;6(4):401-13, vii. doi: 10.1016/j.hfc.2010.05.002. PMID: 20869642; PMCID: PMC2946942.
70. Andrews RE, Fenton MJ, Ridout DA, Burch M; British Congenital Cardiac Association. New-onset heart failure due to heart muscle disease in childhood: a prospective study in the United kingdom and Ireland. Circulation. 2008 Jan 1;117(1):79-84. doi: 10.1161/CIRCULATIONAHA.106.671735. Epub 2007 Dec 17. PMID: 18086928.
71. Kantor PF, Abraham JR, Dipchand AI, Benson LN, Redington AN. The impact of changing medical therapy

on transplantation-free survival in pediatric dilated cardiomyopathy. J Am Coll Cardiol. 2010;55:1377–1384.
72. Connuck DM, Sleeper LA, Colan SD, et al.; Pediatric Cardiomyopathy Registry Study Group. Characteristics and outcomes of cardiomyopathy in children with Duchenne or Becker muscular dystrophy: a comparative study from the Pediatric Cardiomyopathy Registry. Am Heart J. 2008;155:998–1005.
73. McCarthy RE 3rd, Boehmer JP, Hruban RH, et al. Long-term outcome of fulminant myocarditis as compared with acute (nonfulminant) myocarditis. N Engl J Med. 2000;342:690–695.
74. Colan SD, Lipshultz SE, Lowe AM, Sleeper LA, Messere J, Cox GF, et al. Epidemiology and cause-specific outcome of hypertrophic cardiomyopathy in children: findings from the Pediatric Cardiomyopathy Registry. Circulation. 2007 Feb 13;115(6):773-81. doi: 10.1161/CIRCULATIONAHA.106.621185. Epub 2007 Jan 29. PMID: 17261650.
75. Webber SA, Lipshultz SE, Sleeper LA, Lu M, Wilkinson JD, Addonizio LJ; Pediatric Cardiomyopathy Registry Investigators. Outcomes of restrictive cardiomyopathy in childhood and the influence of phenotype: a report from the Pediatric Cardiomyopathy Registry. Circulation. 2012 Sep 4;126(10):1237-44. doi: 10.1161/CIRCULATIONAHA.112.104638. Epub 2012 Jul 27. PMID: 22843787.
76. Russo LM, Webber SA. Idiopathic restrictive cardiomyopathy inchildren. Heart 2005;91:1199–1202.
77. Gerecke BJ, Engberding R. Noncompaction Cardiomyopathy-History and Current Knowledge for Clinical Practice. J Clin Med. 2021 Jun 1;10(11):2457. doi: 10.3390/jcm10112457. PMID: 34206037; PMCID: PMC8199228.
78. Maron BJ, Towbin JA, Thiene G, et al. Contemporary definitions and classification of the cardiomyopathies: an American Heart Association Scientific Statement from the Council on Clinical Cardiology, Heart Failure and Transplantation Committee; Quality of Care and Outcomes Research and Functional Genomics and Translational Biology Interdisciplinary Working Groups; and Council on Epidemiology and Prevention. Circulation. 2006;113:1807–1816.
79. Towbin JA, McKenna WJ, Abrams DJ, Ackerman MJ, Calkins H, Darrieux FCC, et al. 2019 HRS expert consensus statement on evaluation, risk stratification, and management of arrhythmogenic cardiomyopathy. Heart Rhythm. 2019 Nov;16(11):e301-e372. doi: 10.1016/j.hrthm.2019.05.007. Epub 2019 May 9. PMID: 31078652.
80. Varr BC, Zarafshar S, Coakley T, Liedtke M, Lafayette RA, Arai S, et al. Implantable cardioverter-defibrillator placement in patients with cardiac amyloidosis. Heart Rhythm. 2014 Jan;11(1):158-62. doi: 10.1016/j.hrthm.2013.10.026. Epub 2013 Oct 10. PMID: 24121001.
81. Crosson JE, Nies M. Brugada syndrome in children. Expert Rev Cardiovasc Ther. 2015 Feb;13(2):173-81. doi: 10.1586/14779072.2015.999765. Epub 2015 Jan 13. PMID: 25583159.
82. Xiong Q, Cao Q, Zhou Q, Xie J, Shen Y, Wan R, et al. Arrhythmogenic cardiomyopathy in a patient with a rare loss-of-function KCNQ1 mutation. J Am Heart Assoc. 2015 Jan 23;4(1):e001526. doi: 10.1161/JAHA.114.001526. PMID: 25616976; PMCID: PMC4330077.
83. Cheung CC, Healey JS, Hamilton R, Spears D, Gollob MH, Mellor G, et al. Phospholamban cardiomyopathy: a Canadian perspective on a unique population. Neth Heart J. 2019 Apr;27(4):208-213. doi: 10.1007/s12471-019-1247-0. PMID: 30806910; PMCID: PMC6439019.
84. Dipchand A, Kirk R, Mahle W, Tresler M, et al. Ten years of pediatric heart transplantation: a report from the pediatric heart transplant study. Pediatr Transplant. 2013;17:99-111.
85. Hsu DT, Naftel DC, Webber SA, Morrow WR, Canter CE, Chinnock RE, et al. Lessons learned from the pediatric heart transplant study. Congenit Heart Dis. 2006 May;1(3):54-62. doi: 10.1111/j.1747-0803.2006.00011.x. PMID: 18377548.
86. Morrow WR, Frazier E, Naftel DC. Survival after listing for cardiac transplantation in children. Prog Pediatr Cardiol. 2001;11:99–105.
87. Norwood WI, Lang P, Hansen D. Physiologic repair of aortic atresia-hypoplastic left heart syndrome. N Engl J Med. 1983;308:23-26.
88. Ohye RG, Sleeper LA, Mahony L, et al.; Pediatric Heart Network Investigators. Comparison of shunt types in the Norwood procedure for single-ventricle lesions. N Engl J Med. 2010;362:1980–1992.
89. Dipchand AI, Webber SA. Pediatric heart transplantation: Looking forward after five decades of learning. Pediatr Transplant. 2024 Feb;28(1):e14675. doi: 10.1111/petr.14675. Epub 2023 Dec 8. PMID: 38062996.
90. Dipchand AI. Current state of pediatric cardiac transplantation. Ann Cardiothorac Surg. 2018;7:31-35.
91. Siehr SL, Maeda K, Connolly AA, etal. Mitral stenosis and Aortic atresia — a risk factor for mortality after the modified Norwood operation in hypoplastic left heart syndrome. Ann Thorac Surg. 2016;101:162–167.
92. Ekman-Joelsson BM, Berggren H, Boll AB, Sixt R, Sunnegårdh J. Abnormalities in myocardial perfusion after surgical correction of pulmonary atresia with intact ventricular septum. Cardiol Young. 2008;18:89–95.
93. Larsen RL, Eguchi JH, Mulla NF, et al. Usefulness of cardiac transplantation in children with visceral heterotaxy (asplenic and polysplenic syndromes and single right-sided spleen with levocardia) and comparison of results with cardiac transplantation in children with dilated cardiomyopathy. Am J Cardiol. 2002;89:1275–1279.
94. Nollert G, Fischlein T, Bouterwek S, et al. Long-term survival in patients with repair of tetralogy of Fallot: 36-year follow-up of 490 survivors of the first year after surgical repair. J Am Coll Cardiol. 1997;30:1374–1383.
95. Graham TP, Bernard YD, Mellen BG, etal. Long-term outcome in congenitally corrected transposition of the great arteries: a multi-institutional study. J Am Coll Cardiol. 2000;36:255–261.
96. Backer CL, Russell HM, Pahl E, et al. Heart transplantation for the failing Fontan. Ann Thorac Surg. 2013;96:1413–1419.
97. Mavroudis C, Deal BJ, Backer CL, et al. J.MaxwellChamberlain Memorial Paper for congenital heart surgery.111 Fontan conversions with arrhythmia surgery: surgical lessons and outcomes. Ann Thorac Surg. 2007;84:1457–1466.
98. Deal BJ, Costello JM, Webster G, et al. Intermediate-term outcome of 140 consecutive Fontan conversions with arrhythmia operations. Ann Thorac Surg.

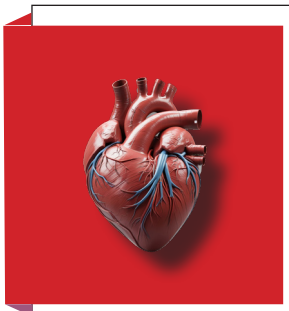
2016;101:717–724.
99. Ridderbos FJ, Wolff D, Timmer A, et al. Adverse pulmonary vascular remodeling in the Fontan circulation. J Heart Lung Transplant. 2015;34:404 413.
100. Greenway SC, Crossland DS, Hudson M, et al. Fontan- associated liver disease: implications for heart transplantation. J Heart Lung Transplant. 2016;35:26–33.
101. Webber SA, Fricker FJ, Michael M, et al. Orthotopic heart transplantation in children with congenital heart disease. Ann Thorac Surg 1994;58(6):1664-1669.
102. Lamour JM, Kanter KR, Naftel DC, et al. The effect of age, diagnosis, and previous surgery in children and adults undergoing heart transplantation for congenital heart disease. J Am Coll Cardiol 2009;54(2):160-165.
103. Rychik J, Atz AM, Celermajer DS, et al. Evaluation and manage- ment of the child and adult with Fontan circulation: a scientific statement from the American Heart Association. Circulation. 2019;140(6):e234-e284.
104. Conway J, Manlhiot C, Kirk R, Edwards LB, McCrindle BW, Dipchand AI. Mortality and morbidity after retransplantation after primary heart transplant in childhood: an analysis from the registry of the International Society for Heart and Lung Transplantation. J Heart Lung Transplant 2014;33:241–51.
105. Bock MJ, Nguyen K, Malerba S, Harrison K, Bagiella E, Gelb BD, et al. Pediatric cardiac retransplantation: waitlist mortality stratified by age and era. J Heart Lung Transplant. 2015;34:530–7.
106. Mahle WT, Vincent RN, Kanter KR. Cardiac retransplantation in childhood: analysis of data from the United Network for Organ Sharing. J Thorac Cardiovasc Surg. 2005;130:542–6.
107. Mongé MC, Kulat BT, Eltayeb O, et al. Successful bridge-to-transplant of functionally univentricular patients with a modified continuous-flow ventricular assist device. Artif Organs. 2017;41:25–31.
108. Dipchand AI, Rossano JW, Edwards LB, et al.; International Society for Heart and Lung Transplantation. The Registry of the International Society of Heart and Lung Transplantation: eighteenth official pediatric heart transplantation report—2015: Focus theme: early graft failure.
J Heart Lung Transplant. 2015;34:1233–1243.
109. Uriel N, Nahumi H, Colombo PC, et al. Advanced heart failure in patients infected with human immunodeficiency virus: is there equal access to care? J Heart Lung Transplant. 2014;33:924–930.
110. Ozturk P, Engin AY, Nalbantgil S, Oguz E, Ayik F, Engin C, et al. Comparison of continuous-flow and pulsatile-flow blood pumps on reducing pulmonary artery pressure in patients with fixed pulmonary hypertension. Artif Organs. 2013 Sep;37(9):763-7. doi: 10.1111/aor.12164. Epub 2013 Sep 11. PMID: 24033601.
111. Goldfarb SB, Benden C, Edwards LB, et al.The Registry of the International Society for Heart and Lung Transplantation: eighteenth official pediatric lung and heart-lung transplantation report—2015; Focus them: early graft failure. J Heart Lung Transplant. 2015;34:1255–1263.
112. Schumacher KR, Almond C, Singh TP, et al.; PHTS Study Group Investigators. Predicting graft loss by 1 year in pediatric heart transplantation candidates: an analysis of the Pediatric Heart Transplant Study database. Circulation. 2015;131:890–898.
113. Holt DB, Lublin DM, Phelan DL, et al. Mortality and morbidity in pre-sensitized pediatric heart transplant recipients with a positive donor crossmatch utilizing peri-operative plasmapheresis and cytolytic therapy. J Heart Lung Transplant. 2007;26:876–882.
114. Razzouk AJ, Johnston JK, Larsen RL, et al. Effect of oversizing cardiac allografts on survival in pediatric patients with congenital heart disease. J Heart Lung Transplant. 2005;24:195–199.
115. Chin C, Miller J, Robbins R, Reitz B, Bernstein D. The use of advanced-age donor hearts adversely affects survival in pediatric heart transplantation. Pediatr Transplant. 1999;3:309–314.
116. Cooper DK, Novitzky D, Wicomb WN. The pathophysiological effects of brain death on potential donor organs, withparticularreferencetotheheart. Ann R Coll Surg Engl. 1989;71:261–266.
117. Copeland H, Knezevic I, Baran DA, Rao V, Pham M, Gustafsson F, et al. Donor heart selection: Evidence-based guidelines for providers. J Heart Lung Transplant. 2023 Jan;42(1):7-29. doi: 10.1016/j.healun.2022.08.030. Epub 2022 Sep 20. PMID: 36357275; PMCID: PMC10284152.
118. Bailey LL, Razzouk AJ, Hasaniya NW, Chinnock RE. Pediatric transplantation using hearts refused on the basis of donor quality. Ann Thorac Surg. 2009;87:1902–1909.
119. West LJ. ABO-incompatible hearts for infant transplantation. Curr Opin Organ Transplant. 2011;16:548–554.
120. Buckberg GD. Update on current tecniques of miyocardial protection. Ann Thorac Surg 1995;60:805-14.
121. Novitzky D, Cooper DK, Reichart B. Hemodynamic and metabolic responses to hormonal therapy in brain-dead potential organ donors. Transplantation 1987;43:852-4.
122. Macdonald P, Dhital K. Heart transplantation from donation-after-circulatory-death (DCD) donors: Back to the future—Evolving trends in heart transplantation from DCD donors. The Journal of Heart and Lung Transplantation . 2019;38:599–600.
123. Pettit SJ, Petrie MC. Transplantation of Hearts Donated after Circulatory-Determined Death. Circulation: Heart Failure . 2019;12:e005991.
124. Croome KP, Taner CB. Warm Ischemia Time. Donation after Circulatory Death (DCD) Liver Transplantation . 2020;85:61–71.
125. Anguela-Calvet L, Moreno-Gonzalez G, Sbraga F, Gonzalez-Costello J, Tsui S, Oliver-Juan E. Heart Donation from Donors after Controlled Circulatory Death. Transplantation . 2021;105:1482–1491.
126. Noterdaeme T, Detry O, Hans M, Nellessen E, Ledoux D, Joris J, et al. What is the potential increase in the heart graft pool by cardiac donation after circulatory death. Transplant International . 2013;26:61–66.
127. Messer S, Page A, Rushton S, Berman M, Tsui S, Catarino P, et al. The potential of heart transplantation from donation after circulatory death donors within the United Kingdom. The Journal of Heart and Lung Transplantation . 2019;38:872–874.
128. Watson CJE, Hunt F, Messer S, Currie I, Large S, Sutherland A, et al. In situ normothermic perfusion of livers in controlled circulatory death donation may prevent ischemic cholangiopathy and improve

graft survival. American Journal of Transplantation . 2019;19:1745–1758.
129. Antoine C, Savoye E, Gaudez F, Cheisson G, Badet L, Videcoq M, et al. Kidney Transplant from Uncontrolled Donation after Circulatory Death: Contribution of Normothermic Regional Perfusion. Transplantation . 2020;104:130–136.
130. Smith DE, Kon ZN, Carillo JA, Chen S, Gidea CG, Piper GL, et al. Early experience with donation after circulatory death heart transplantation using normothermic regional perfusion in the United States. The Journal of Thoracic and Cardiovascular Surgery . 2022;164:557–568.
131. Messer S, Page A, Axell R, Berman M, Hernández-Sánchez J, Colah S, et al. Outcome after heart transplantation from donation after circulatory-determined death donors. The Journal of Heart and Lung Transplantation . 2017;36:1311–1318.
132. Messer S, Page A, Colah S, Axell R, Parizkova B, Tsui S, et al. Human heart transplantation from donation after circulatory-determined death donors using normothermic regional perfusion and cold storage. The Journal of Heart and Lung Transplantation . 2018;37:865–869.
133. Hoffman JRH, McMaster WG, Rali AS, Rahaman Z, Balsara K, Absi T, et al. Early us experience with cardiac donation after circulatory death (DCD) using normothermic regional perfusion. The Journal of Heart and Lung Transplantation . 2021;40:1408–1418.
134. Beaupré RA, Morgan JA. Donation after Cardiac Death: a Necessary Expansion for Heart Transplantation. Seminars in Thoracic and Cardiovascular Surgery . 2019;31:721–725.
135. Page AA, Messer S, Tsui SS, Large SR. Early Results Using Donation after Circulatory Death (DCD) Donor Hearts. Current Transplantation Reports . 2016;3:199–206.
136. Hameed AM, Hawthorne WJ, Pleass HC. Advances in organ preservation for transplantation. ANZ Journal of Surgery . 2017;87:976–980.
137. Sponga S, Benedetti G, de Manna ND, Ferrara V, Vendramin I, Lechiancole A, et al. Heart transplant outcomes in patients with mechanical circulatory support: cold storage versus normothermic perfusion organ preservation. Interactive CardioVascular and Thoracic Surgery . 2021;32:476–482.
138. Pahuja M, Case BC, Molina EJ, Waksman R. Overview of the FDA's Circulatory System Devices Panel virtual meeting on the TransMedics Organ Care System (OCS) Heart – portable extracorporeal heart perfusion and monitoring system. American Heart Journal . 2022;247:90–99.
139. Monteagudo Vela M, García Sáez D, Simon AR. Current approaches in retrieval and heart preservation. Annals of Cardiothoracic Surgery . 2018;7:67–74.
140. Rojas SV, Avsar M, Ius F, Schibilsky D, Kaufeld T, Benk C, et al. Ex-vivo Preservation with the Organ Care System in High Risk Heart Transplantation. Life . 2022;12:247.
141. Beuth J, Falter F, Pinto Ribeiro RV, Badiwala M, Meineri M. New Strategies to Expand and Optimize Heart Donor Pool. Anesthesia & Analgesia . 2019;128:406–413.
142. García Sáez D, Zych B, Sabashnikov A, Bowles CT, De Robertis F, Mohite PN, et al. Evaluation of the Organ Care System in Heart Transplantation with an Adverse Donor/Recipient Profile. The Annals of Thoracic Surgery . 2014;98:2099–2106.
143. Ardehali A, Esmailian F, Deng M, Soltesz E, Hsich E, Naka Y, et al. Ex-vivo perfusion of donor hearts for human heart transplantation (PROCEED II): a prospective, open-label, multicentre, randomised non-inferiority trial. The Lancet . 2015;385:2577–2584.
144. Kaliyev R, Lesbekov T, Bekbossynov S, Nurmykhametova Z, Bekbossynova M, Novikova S, et al. Heart transplantation of patients with ventricular assist devices: impact of normothermic ex-vivo preservation using organ care system compared with cold storage. Journal of Cardiothoracic Surgery . 2020;15:323.
145. Schroder JN, Patel CB, DeVore AD, Bryner BS, Casalinova S, Shah A, et al. Transplantation Outcomes with Donor Hearts after Circulatory Death. N Engl J Med. 2023 Jun 8;388(23):2121-2131.
146. Fleck TPK, Ayala R, Kroll J, Siepe M, Schibilsky D, Benk C, et al. Ex vivo Allograft Perfusion for Complex Pediatric Heart Transplant Recipients. The Annals of Thoracic Surgery . 2021;112:1275–1280.
147. Neyrinck A, Van Raemdonck D, Monbaliu D. Donation after circulatory death. Current Opinion in Anaesthesiology . 2013;26:382–390.
148. Backer CL, Idriss FS, Zales VR, Mavroudis C. Cardiac transplantation for hypoplastic left heart syndrome: a modified technique. Ann Thorac Surg. 1990;50:894–898.
149. Borel JF, Feurer C, Gubler HU, Stähelin H. Biological effects of cyclosporin A: a new antilymphocytic agent. Agents Actions. 1976;6:468–475.
150. Boucek RJ Jr, Naftel D, Boucek MM, et al. Induction immunotherapy in pediatric heart transplant recipients: a multicenter study. J Heart Lung Transplant. 1999;18:460–469.
151. Caves PK, Billingham ME, Stinson EB, Shumway NE. Serial transvenous biopsy of the transplanted human heart. Improved management of acute rejection episodes. Lancet 1974;821-26
152. Reitz BA, Bieber CP, Raney AA, et al. Orthotopic heart and combined heart-lung transplantation with cyclosporine A immunosuppression. Transplant Proc 1981;13:393-6.
153. Trehan S, Taylor DO, Renlund DG. New pharmacologic immunsuppressive agents. In: Cooper DKC, Miller LW, Patterson GA, editors. The transplantation and replacement of thoracic organs: the Present Status of Biological and Mechanical Replacement of the Heart and Lungs. Lancaster: Kluwer Academic Publishers; 1996:35-60.
154. Perico N, Remuzzi G. Prevention of transplant rejection. Current treatment guidelines and future developments. Drugs 1997;54:533-70..
155. Engin Ç, Yağdı T, Nalbantgil S, Zoghi M, Özbaran M, "İmmunsupressif tedavi", Türkiye Klinikleri Cerrahi Tıp Bilimleri 2006;2, 53-61.
156. Canter CE, Shaddy RE, Bernstein D, et al. Indications for heart transplantation in pediatric heart disease: a scientific statement from the American Heart Association Council on cardiovascular disease in the young; the Councils on Clinical Cardiology, Cardiovascular Nursing, and Cardiovascular Surgery and Anesthesia;

and the Quality of Care and Outcomes Research Interdisciplinary Working Group. Circulation 2007;115(5), 658–676.
157. Di Filippo S, Boissonnat P, Sassolas F, et al. Rabbit antithymocyte globulin as induction immunotherapy in pediatric hearttransplantation. Transplantation 2003;75(3), 354–358.
158. Irving CA, Webber SA. Immunosuppression therapy for pediatric heart transplantation. Curr. Treat. Options Cardiovasc. Med. 2010;12(5),489–502.
159. Butts RJ, Dipchand AI, Sutcliffe D, et al. Comparison of basiliximab vs antithymocyte globulin for induction in pediatric hearttransplant recipients: an analysis of the International Society for Heart and Lung Transplantation database. Pediatr. Transplant. 2018;22(4),e13190.
160. Cochrane AB, Lyster H, Lindenfeld J, Doligalski C, Baran D, Yost C, et al. Report from the 2018 consensus conference on immunomodulating agents in thoracic transplantation: Access, formulations, generics, therapeutic drug monitoring, and special populations. J Heart Lung Transplant. 2020 Oct;39(10):1050-1069. doi: 10.1016/j.healun.2020.06.024. Epub 2020 Jul 10. PMID: 32883559.
161. Simmonds J, Dewar C, Dawkins H, Burch M, Fenton M. Tacrolimus in pediatric heart transplantation: ameliorated side effects in thesteroid-free, statin era. Clin. Transplant. 2009;23(3), 415–419.
162. Robinson BV, Boyle GJ, Miller SA et al. Optimal dosing of intravenous tacrolimus following pediatric heart transplantation. J. HeartLung Transplant. 1999;18(8), 786–791.
163. D'addese L, Joong A, Burch M, Pahl E. Pediatric heart transplantation in the current era. Curr. Opin. Pediatr. 2019;31(5), 583–591.
164. Ye F, Ying-Bin X, Yu-Guo W, Hetzer R. Tacrolimus versus cyclosporine microemulsion for heart transplant recipients: a meta-analysis. J Heart Lung Transplant 2009; 28: 58–66.
165. Eisen HJ, Kobashigawa J, Keogh A et al. Three-year results of a randomized, double-blind, controlled trial of mycophenolate mofetilversus azathioprine in cardiac transplant recipients. J. Heart Lung Transplant. 2005;24(5), 517–525.
166. Gajarski RJ, Crowley DC, Zamberlan MC, Lake KD. Lack of correlation between MMF dose and MPA level in pediatric and youngadult cardiac transplant patients: does the MPA level matter? Am. J. Transplant. 2004;4(9), 1495–1500.
167. Gustafsson F, Andreassen AK, Andersson B et al. Everolimus initiation with early calcineurin inhibitor withdrawal in de novo hearttransplant recipients: long-term follow-up from the randomized SCHEDULE study. Transplantation 2020;104(1), 154–164.
168. Raichlin E, Bae JH, Khalpey Z et al. Conversion to sirolimus as primary immunosuppression attenuates the progression of allograftvasculopathy after cardiac transplantation. Circulation 2007;116(23), 2726–2733.
169. Asante-Korang A, Carapellucci J, Krasnopero D, Doyle A, Brown B, Amankwah E. Conversion from calcineurin inhibitors to mTORinhibitors as primary immunosuppressive drugs in pediatric heart transplantation. Clin. Transplant.2017;31(10).
170. Rosenthal LM, Nordmeyer J, Kramer P et al. Long-term experience using CNI-free immunosuppression in selected paediatric hearttransplant recipients. Pediatr. Transplant. 2021;25(8), e14111.
171. Smith RR, Wray J, Khaghani A, Yacoub M. Ten year survival after paediatric heart transplantation: a single centre experience. Eur. J.Cardiothorac. Surg. 2005;27(5), 790–794.
172. Singh TP, Faber C, Blume ED et al. Safety and early outcomes using a corticosteroid-avoidance immunosuppression protocol inpediatric heart transplant recipients. J. Heart Lung Transplant. 2010;29(5), 517–522.
173. Kaposztas Z, Podder H, Mauiyyedi S et al. Impact of rituximab therapy for treatment of acute humoral rejection. Clin. Transplant. 2009;23(1),63–73.
174. Morrow WR, Frazier EA, Mahle WT et al. Rapid reduction in donor-specific anti-human leukocyte antigen antibodies and reversal ofantibody-mediated rejection with bortezomib in pediatric heart transplant patients. Transplantation 2012;93(3), 319–324.
175. Patel JK, Kobashigawa JA. Should we be doing routine biopsy after heart transplantation in a new era of anti-rejection? Curr Opin Cardiol. 2006;21:127–31.
176. From AM, Maleszewski JJ, Rihal CS. Current status of endomyocardial biopsy. Mayo Clin Proc. 2011;86:1095–102.
177. Aggarwal S, Blake J, Sehgal S. Right ventricular dysfunction as an echocardiographic measure of acute rejection following heart transplantation in children. Pediatr Cardiol. 2017;38:442–7.
178. Pham MX, Deng MC, Kfoury AG, Teuteberg JJ, Starling RC, Valentine H. Molecular testing for long-term rejection surveillance in heart transplant recipients: design of the invasive monitoring attenuation through gene expression (IMAGE) trial. J Heart Lung Transplant. 2007;26:808–14.
179. Pascual-Figal DA, Garrido IP, Blanco R, Minguela A, Lax A, Ordoñez-Llanos J, et al. Soluble ST2 is a marker for acute cardiac allograft rejection. Ann Thorac Surg. 2011;92:2118–24.
180. Dyer AK, Barnes AP, Fixler DE, Shah TK, Sutcliffe DL, Hashim I, et al. Use of a highly sensitive assay for cardiac troponin T and N-terminal probrain natriuretic peptide to diagnose acute rejection in pediatric cardiac transplant recipients. Am Heart J. 2012;163:595–600.
181. Daly KP, Seifert ME, Chandraker A, Zurakowski D, Nohria A, Givertz MM, et al. VEGF-C, VEGF-A and related angiogenesis factors as biomarkers of allograft vasculopathy in cardiac transplant recipients. J Heart Lung Transplant. 2013;32:120–8.
182. Daly KP. Emerging science in paediatric heart transplantation: donor allocation, biomarkers, and the quest for evidence-based medicine. Cardiol Young. 2015;25 Suppl 2(Suppl 2):117–23.
183. Martinez-Dolz L, Almenar L, Reganon E, Vila V, Sanchez-Soriano R, Martinez-Sales V, et al. What is the best biomarker for diagnosis of rejection in the heart transplantation? Clin Tranplant. 2009;23:672–80.
184. Mathews LR, Lott JM, Isse K, Lesniak A, Landsittel D, Demetris AJ, et al. Elevated ST2 distinguishes incidences of pediatric heart and small bowel transplant rejection. Am J Transplant. 2016;16:938–50.
185. Deng MC, Eisen HJ, Mehra MR, Billingham M, Marboe CC, Berry G, et al. Noninvasive discrimination of rejection in cardiac allograft recipients using gene expression profiling. Am J Transplant. 2006;6:150–60.

186. VanBuskirk AM, Pidwell DJ, Adams PW, Orosz CG. Transplantation immunology. JAMA. 1997;278:1993–9.
187. Agbor-Enoh S, Tunc I, Vlaminck ID, Fideli U, Davis A, Cuttin K, et al. Applying rigor and reproducibility standards to assay donor-drived cell-free DNA as a non-invasive method for detection of acute rejection and graft injury after heart transplantation. J Heart Lung Transplant. 2017;36:1004–12.
188. Khush KK, Patel J, Pinney S, Kao A, Alharethi R, DePasquale E, et al. Noninvasive detection of graft injury after heart transplant using donor-drived cell-free DNA: a prospective multicenter study. Am J Transplant. 2019;19:2889–99.
189. Phelps CM, Tissort C, Buckvold S, Gralla J, Ivy DD, Pietra BA, et al. Outcome of acute graft rejection associated with hemodynamic compromise in pediatric heart transplant recipients. Pediatr Cardiol. 2011;32:1–7.
190. Costanza MR. Special feature: The international society of heart and lung transplantation: Guidelines for the care of heart transplant recipients. J Heart Lung Transplant. 2010;29:914–56.
191. Stoica S, Math FC, Pauriah M, Taylor CJ, Sharples LD, Wallwork J, et al. The cumulative effect of acute rejection on development of cardiac allograft vasculopathy. J Heart Lung Transplant. 2006;25:420–5.
192. Pollock-Barziv SM, Den Hollander N, Ngan BY et al. Pediatric heart transplantation in human leukocyte antigen sensitized patients:evolving management and assessment of intermediate-term outcomes in a high-risk population. Circulation 2007;116(Suppl. 11), I172–178.
193. Reed EF, Demetris AJ, Hammond E, Itescu S, Kobashigawa JA, Rainsmoen NL, et al. Acute antibody mediated rejection of cardiac transplants. J Heart Lung Transplant. 2006;25:153–9.
194. Rossano JW, Dipchand AI, Edwards LB, et al. The Registry of the International Society for Heart and Lung Transplantation: nineteenth Pediatric Heart Transplantation Report—2016: Focus theme: primary diagnostic indications for transplant. J Heart Lung Transplant. 2016;35:1185–1195.
195. Morales DLS, Adachi I, Peng DM,et al.; Pedimacs Investigators. Fourth Annual Pediatric Interagency Registry for Mechanical Circulation Support (Pedimacs) Report. Ann Thorac Surg. 2020;110:1819–1831.
196. Ozbaran M, Yagdi T, Engin C, Ulger Z, Ozbaran B, Kose S, et al. New era of pediatric ventricular assist devices: let us go to school. Pediatr Transplant. 2015 Feb;19(1):82-6. doi: 10.1111/petr.12399. Epub 2014 Nov 22. PMID: 25418779.
197. Jacobs JP, Jacobs ML, Mavroudis C, et al. Executive summary: The Society of Thoracic Surgeons Congenital Heart Surgery Database – Twenty-seventh Harvest – (July 1, 2013 – June 30, 2017). The Society of Thoracic Surgeons (STS) and Duke Clinical Research Institute (DCRI), Duke University Medical Center, Durham, North Carolina, United States, Fall 2017 Harvest.
198. Dipchand AI, Kirk R, Mahle WT, et al. Ten yr of pediatric heart transplantation: a report from the Pediatric Heart Transplant Study. Pediatr Transplant. 2013;17:99–111.
199. Kobayashi D, Du W, L'Ecuyer TJ. Predictors of cardiac allograft vasculopathy in pediatric heart transplant recipients. Pediatr Transplant. 2013;17:436–440.
200. Pahl E, Naftel DC, Kuhn MA, et al. The impact and outcome of transplant coronary artery disease in a pediatric population: a 9-year multi-institutional study. J Heart Lung Transplant. 2005;24:645–651.
201. Rossano JW, Cherikh WS, Chambers DC, et al. The Registry of the International Society for Heart and Lung Transplantation : Twentieth Pediatric Heart Transplantation Report — 2017 ; Focus Theme : Allograft ischemic time. J Heart Lung Transplant. 2017;36:1060–1069.
202. Mahle WT, Vincent RN, Berg AM, Kanter KR. Pravastatin therapy is associated with reduction in coronary allograft vasculopathy in pediatric heart transplantation. J Heart Lung Transplant. 2005;2:63–66.
203. Greenway SC, Butts R, Naftel DC, et al. Statin therapy is not associated with improved outcomes after heart transplantation in children and adolescents. J Heart Lung Transplant. 2016;35:457–465.
204. Eisen HJ, Tuzcu EM, Dorent R, et al. Everolimus for the prevention of allograft rejection and vasculopathy in cardiac-transplant recipients. N Engl J Med. 2003;349:847–858.
205. Keogh A, Richardson M, Ruygrok P, et al. Sirolimus in de novo heart transplant recipients reduces acute rejection and prevents coronary artery disease at 2 years: a randomized clinical trial. Circulation. 2004;110:2694–2700.
206. Arora S, Ueland T, Wennerblom B, et al. Effect of everolimus introduction on cardiac allograft vasculopathy-results of a randomized, multicenter trial. Transplantation. 2011;92:235–243.
207. Kindel SJ, Pahl E. Current therapies for cardiac allograft vasculopathy in children. Congenit Heart Dis. 2012;7:324–335.
208. Wright EJ, Fiser WP, Edens RE, et al. Cardiac transplant outcomes in pediatric patients with pre-formed anti-human leukocyte antigen antibodies and/or positive retrospective crossmatch. J Heart Lung Transplant. 2007;26:1163–1169.
209. Feingold B, Zheng J, Law YM, et al. Risk factors for late renal dysfunction after pediatric heart transplantation: a multi-institutional study. Pediatr Transplant. 2011;15:699–705.
210. Rostad CA, Wehrheim K, Kirklin JK, et al. Bacterial infections after pediatric heart transplantation: epidemiology, risk factors and outcomes. J Heart Lung Transplant. 2017;36:996–1003.
211. Mahle WT, Fourshee MT, Naftel DM, et al. Does cytomegalovirus serology impact outcome after pediatric heart transplantation? J Heart Lung Transplant. 2009;28:1299–1305.
212. Dipchand AI, Kirk R, Naftel DC, et al. Ventricular assist device support as a bridge to transplantation in pediatric patients. J Am Coll Cardiol. 2018;72:402–415.
213. Ng B, Dipchand A, Naftel D, et al. Outcomes of Pneumocystis jiroveci pneumonia infections in pediatric heart transplant recipients. Pediatr Transplant. 2011;15:844–848.
214. Hayes EA, Nandi D, Lewis M, Ouellette CP, Wright LK. Pneumocystis jiroveci Pneumonia Infections in Pediatric Solid Organ Transplant Recipients. Pediatr Transplant. 2025 Jun;29(4):e70107.
215. Hayes EA, Koehl D, Cantor R, Fisher LA, Azeka E, Mokshagundam D, et al. Long-Term Survival in Children Following Heart Transplantation. Pediatr Transplant. 2025 Mar;29(2):e70042.

216. Webber SA, Naftel DC, Fricker FJ, et al. Lymphoproliferative disorders after paediatric heart transplantation: a multi-institutional study. Lancet. 2006;367:233–239.
217. Spahr JE, West SC. Heart-lung transplantation: pediatric indications and outcomes. J Thorac Dis. 2014 Aug;6(8):1129-37. doi: 10.3978/j.issn.2072-1439.2014.07.05. PMID: 25132980; PMCID: PMC4133540.
218. Beaty CA, George TJ, Kilic A, Conte JV, Shah AS. Pre‐transplant malignancy: an analysis of outcomes after thoracic organ transplantation. J Heart Lung Transplant. 2013; 32:202–211.
219. Kern RM, Seethamraju H, Blanc PD, et al. The feasibility of lung transplantation in HIV‐seropositive patients. Ann Am Thorac Soc. 2014; 11:882–889.
220. Faro A, Shepherd R, Huddleston CB, et al. Lower incidence of bronchiolitis obliterans in pediatric liver‐lung transplant recipients with cystic fibrosis. Transplantation. 2007; 83:1435–1439.
221. De Soyza A, Meachery G, Hester KL, et al. Lung transplantation for patients with cystic fibrosis and Burkholderia cepacia complex infection: a single‐center experience. J Heart Lung Transplant. 2010; 29:1395–1404.
222. Charles B. Huddleston, Andrew C. Fiore. (2023) Lung and Heart–Lung Transplantation In: Constantine Mavroudis, Carl L. Backer, Pediatric Cardiac Surgery, Fifth Edition, John Wiley & Sons, Ltd, p:941 Print ISBN:9781119282310 |Online ISBN:9781119282327.
223. Bhorade S, Stern E. Immunosuppression for lung transplantation. Proc Am Thorac Soc. 2009; 6:47–53.
224. Danziger‐Isakov LA, delaMorena M, Hayashi RJ, et al. Cytomegalovirus viremia associated with death or retransplantation in pediatric lung‐transplant recipients. Transplantation. 2003; 75:1538–1543.
225. Christie JD, Carby M, Bag R, et al.; ISHLT Working Group on Primary Lung Graft Dysfunction. Report of the ISHLT Working Group on Primary Lung Graft Dysfunction part II: definition. A consensus statement of the International Society for Heart and Lung Transplantation. J Heart Lung Transplant. 2005; 24:1454–1459.
226. Christie JD, Kofloff RM, Ahya VN, et al. The effect of primary graft dysfunction on survival after lung transplantation. Am J Resp Crit Care Med. 2005; 171:1312–1316.
227. Shargall Y, Guenther G, Ahya VN, et al.; ISHLT Working Group on Primary Lung Graft Dysfunction. Report of the ISHLT Working Group on Primary Lung Graft Dysfunction part VI: treatment. J Heart Lung Transplant. 2005; 24:1489–1500.
228. Choong CK, Sweet SC, Zoole JB, et al. Bronchial airway anastomotic complications after pediatric lung transplantation: incidence, cause, management, and outcome. J Thorac Cardiovasc Surg. 2006; 131:198–203.
229. Ferdinande P, Bruyninckx F, Van Raemdonck D, Daenen W, Verleden G; Leuven Lung Transplant Group. Phrenic nerve dysfunction after heart‐lung and lung transplantation. J Heart Lung Transplant. 2004; 23:105–109.
230. Benden C, Aurora P, Curry J, et al. High prevalence of gastroesophageal reflux in children after lung transplantation. Pediatr Pulmonol. 2005; 40:68–71.
231. Gandhi SK, Bromberg BI, Mallory GB, Huddleston CB. Atrial flutter: a newly recognized complication of pediatric lung transplantation. J Thorac Cardiovasc Surg. 1996; 112:992–1001.
232. Wong M, Mallory GB Jr, Goldstein J, Goyal M, Yamada KA. Neurologic complications of pediatric lung transplantation. Neurology. 1999; 53:1542–1549.
233. Verleden GM, Dupont LJ, Van Raemdonck DE. Is it bronchiolitis obliterans syndrome or is it chronic rejection: a reappraisal? Eur Respir J. 2005; 25:221–224.
234. Scott AI, Sharples LD, Stewart S. Bronchiolitis obliterans syndrome: risk factors and therapeutic strategies. Drugs. 2005; 65:761–771
235. Daud SA, Yusen RD, Meyers BF, et al. Impact of immediate primary lung allograft dysfunction on bronchiolitis obliterans syndrome. Am J Respir Crit Care Med. 2007; 175:507–513.
236. Cantu E 3rd, Appel JZ 3rd, Hartwig MG, et al. J. Maxwell Chamberlain Memorial Paper. Early fundoplication prevents chronic allograft dysfunction in patients with gastroesophageal reflux disease. Ann Thorac Surg. 2004; 78:1142–1151.
237. Gottlieb J, Szangolies J, Koehnlein T, et al. Long-term azithromycin for bronchiolitis obliterans syndrome after lung transplantation. Transplantation. 2008; 85:36–41.
238. Jaksch P, Scheed A, Keplinger M, et al. A prospective interventional study on the use of extracorporeal photopheresis in patients with bronchiolitis obliterans syndrome after lung transplantation. J Heart Lung Transplant. 2012; 31:950–957.
239. Glanville AR. Antibody‐mediated rejection in lung transplantation: turning myth into reality. J Heart Lung Transplant. 2013; 32:12–13.
240. Reams BD, McAdams HP, Howell DN, et al. Posttransplant lymphoproliferative disorder: incidence, presentation, and response to treatment in lung transplant recipients. Chest. 2003; 124:1242–1249.
241. Gross TG, Orjuela MA, Perkins SL, et al. Low‐dose chemotherapy and rituximab for posttransplant lymphoproliferative disease (PTLD): a Children's Oncology Group Report. Am J Transplant. 2012; 12:30693075.
242. Hayes D Jr, Cherikh WS, Chambers DC, et al. The International Thoracic Organ Transplant Registry of the International Society for Heart and Lung Transplantation: twenty‐second pediatric lung and heart‐lung transplantation report—2019; focus theme: donor and recipient size match. J Heart Lung Transplant. 2019; 38:1015–1027.
243. Barlow CW, Robbins RC, Moon MR, et al. Heart‐lung versus double‐lung transplantation for suppurative lung disease. J Thorac Cardiovasc Surg. 2000; 119:466–476.
244. Carvajal HG, Meritt TC, Pourney AN, Canter MW, Miller PJR. Pediatric Heart-Lung Transplantation Throug the Decades: A Single-Center Analysis. J Heart Lung Transplant. 2022; 41(4):S168.



PEDİATRİK VE KONJENİTAL KALP CERRAHİSİNDE KALİTE YÖNETİMİ

BÖLÜM
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Tablo 1. STAT kategorilerine göre gözlenen ve beklenen mortalite oranları

STAT Category	Category 1	Category 2	Category 3	Category 4	Category 5
No of procedures % (n)	31.8 (n=1275)	28.6 (n=1146)	12.6 (n=504)	25.1 (n=1005)	1.9 (n=77)
Observed Mortality % [CI 95%] (n)	0.8 [0.3-1.5] (n=10)	3.75 [2.7-5.1] (n=43)	5.7 [3.9-8.2] (n=29)	14.8 [12.7-17.2] (n=149)	51.9 [40.3-63.3] (n=40)
Expected Mortality (%)	0.8	2.6	5.0	9.9	23.1

CKCV veritabanının ikinci çalışmasında ise 2024 yılında 4000 den fazla hastayı kapsayan analiz sonuçları yayınlanmıştır. Bu çalışmada güncel konjenital kalp cerrahisi sonuçları, dünya veritabanı sonuçları ile karşılaştırılmıştır (26). STAT kategori 4 ve 5 hastaların sonuçlarının beklenen mortalite oranlarının üzerinde olduğu saptanmıştır. (Tablo 1).

Merkezin, kendi sonuçlarını bilmesi ve iyileştirilecek noktalara ağırlık vermesi ile önemli ilerlemeler sağlanabileceği görülmektedir. Özellikle daha küçük çapta merkezlerin, kapsamlı merkezlerden destek almalarının sağlanması, süreci hızlandırabilir. Kalite standartlarının geliştirilmesi, bu konuya ilgili derneklerin destek olması ve tarafsız biçimde yapılan değerlendirmeler ile merkezlerin sonuçlarının iyileştirilmesi yolunda önemli adımlar atılabilir. Veritabanına dahil olmak ve dürüstçe sonuçlarını paylaşmak, kalite iyileştirmesinin ilk ve en önemli aşamasıdır. Yapılan çalışmalar, bir merkezin veritabanına dahil olur olmaz, daha hiçbir değerlendirme yapılmadan dahi, sonuçlarında kendiliğinden iyileşme sağlanmaya başladığını göstermektedir (27). ABD' de veritabanı sonuçları toplumla da paylaşılmaktadır. Bu durumun iyi ve olumsuz taraflarının olduğu, merkezlerin sonuçlarını düzeltmek konusunda çok zorlayıcı bir ortam yarattığı kuşkusuzdur. Riskli prosedürlerden kaçınma yaratması gibi, bir olumsuz tarafı olduğu da kabul edilmektedir (28). Ancak hastalar ve ailelerinin en iyi sonuçların alındığı merkezlere yönelmesi, hak ettikleri en iyi hizmete ulaşabilmeleri en doğal haklarıdır. Bu konuda sosyal medyada yanıltıcı bilgilendirmelerin önüne geçilebilmesi, ancak, tarafsız, dürüst ve sağlıklı bilgilendirme yapılabilmesi sayesinde gerçekleşebilir. Hastalara en iyi hizmeti sunabilmenin yolu, iyi bir kalite yönetimi yapılabilmesi ile mümkündür.

KAYNAKLAR

1. Sarıoğlu CT, Erek E, Yalçınbaş YK. Why national database are necessary for pediatric and congenital heart surgery practise? Turk Gogus Kalp Dama 2019; 27:418-22
2. Sarıoğlu T. Genel değerlendirme. Türkiye I. Çocuk kalp sağlığı platformu. İstanbul: Çocuk Kalp Vakfı Yayınları 2013
3. Erek E, Yalçınbaş YK, Sarıoğlu CT. Pediatrik ve konjenital kalp cerrahisinde kalite yönetimi. İn Pediatrik ve Konjenital Kalp Cerrahisi: Temel Bilgiler ve Prensipler. 2. Baskı. İstanbul Tıp Kitabevi 2024; p 271
4. Sarıoğlu CT, Sarıoğlu A. Hasta güvenliği ve kalite geliştirme programı. Çocuk kalp merkezlerinin standartları. Çocuk kalp vakfı yayınları, İstanbul, 2021; Sayfa: 40-43
5. Backer CL, Overman DM, Dearani JA, Romano JC, Tweddell JS, Kumar R, et al. Recommendations for centers performing pediatric heart surgery in the United States. World J Pediatr Cong Heart Surg. 2023; 14: 642-79
6. Congenital heart disease standards and specifications. Accessed November 1, 2022. https://www.england.nhs.uk/wp-content/ uploads/2018/08/Congenital-heart-disease-standards-and- specifications.pdf
7. Daenen W, Lacour-Gayet F, Aberg T. Optimal structure of a congenital heart surgery department in Europe, by EACTS congenital heart disease committee. Eur J Cardiothorac Surg. 2003; 24(3): 343-351.
8. American College of Surgeons: Optimal resources for children's surgical care. Accessed November 1, 2022. https://www.facs.org/ quality-programs/accreditation-and-verification/childrens-surgery- verification/standards/standards-and-resources/
9. Lacour-Gayet F, Maruszewski B, Mavroidids C, Jacops JP, Elliott MJ. Presentation of the international nomenclature for congenital heart surgery. The long way from nomenclature to collection of validated data at the EACTS. Eur J. Cardiothoracic Surg. 2000; 18: 128-35
10. Jenkins KJ, Gauvreau K, Newburger JW, Sprey TL, Moler JH, Iezzoni LI. Consensus-based method for risk adjustment for surgery for congenital heart disease. J Thorac Cardiovasc Surg 2002; 123: 110-8
11. Lacour-Gayet F, Clarke D, Jacops J, Comas J, Daebritz

S, Daenen W, et al. The Aristotle score: a complexity-adjusted method to evaluate surgical results. Eur J. Cardiothorac Surg 2004; 25: 911-24
12. O'Brian SM, Clarke DR, Jacops JP, Jacops ML, Lacour-Gayet FG, Pizarro C, et al. An empirically based tool for analysing mortality associated with congenital heart surgery. J Thorac Cardiovasc Surg 2009; 138: 1139-53
13. Pasquali SK, Dimick JB, Ohye RG. Time for a more united approach to pediatric health care policy?: The case of congenital heart care. JAMA. 2015; 314(16): 1689-1690.
14. Pasquali SK,Thibault D, O'Brien SM, et al. National variation in congenital heart surgery outcomes. Circulation. 2020; 142(14): 1351-1360.
15. Pasquali SK, Ohye RG, Lu M, et al. For the pediatric heart network investigators. Variation in perioperative care across centers for infants undergoing the Norwood procedure. J Thorac Cardiovasc Surg. 2012; 144(4): 915-921.
16. Welke KF, O'Brien SM, Peterson ED, et al. The complex relationship between pediatric cardiac surgical case volumes and mortality rates in a national clinical database. J Thorac Cardiovasc Surg. 2009; 137(5): 1133-1140.
17. Hirsch JC, Gurney JG, Donohue JE, et al. Hospital mortality for Norwood and arterial switch operations as a function of institution volume. Pediatr Cardiol. 2008; 29(4): 713-717.
18. Checchia PA, McCollegan M, Daher N, et al. The effect of surgical case volume on outcome after the Norwood procedure. J Thorac Cardiovasc Surg. 2005; 129(4): 754-759.
19. Kansy A, Eulenburg C, Sarris G, et al. Higher programmatic volume in neonatal heart surgery is associated with lower early mortality. Ann Thorac Surg. 2018; 105(5): 1436-1440.
20. Jacobs JP, Jacobs ML, Austin EH, et al. Quality measures for congenital and pediatric cardiac surgery. World J Pediatr Congenit Heart Surg. 2012; 3(1): 32-47.
21. Jacobs ML, Jacobs JP, Thibault D, Hill KD, Anderson BR, Eghtesady P, et al. Updating an empirically based tool for analyzing congenital heart surgery mortality. World J Pediatr Congenit Heart Surg 2021; 12: 246-81
22. Sciarra AM, Croti UA, Batigalia F. Information technology implementing globalization on strategies for quality care provided to children submitted to cardiac surgery: International Quality Improvement Collaborative Program--IQIC. Rev Bras Cir Cardiovasc. 2014; 29: 89-92.
23. Erek E, Yılmaz B, Kaya M, Onan IS, Şen O, Oz K, et al. Analysis of results according to the Aristotle scoring system in congenital heart surgery. Turk Gogus Kalp Dama 2014; 22: 509-16
24. Yıldız O, Kasar T, Ozturk E, Tuzun B, Altin HF, Onan IS, et al. Analysis of congenital heart surgery disease. A comparison of four systems. Turk Gogus Kalp Dama 2018; 26:200-6
25. Erek E, Yalçınbaş YK, Sarıosmanoğlu J, Özkan M, Yıldız O, Şenkaya I, et al. First harvest of pediatric and congenital heart surgery multicenter database in Turkey: Novel application of real-time online reporting. World J Pediatr Cong Heart Surg. 2021; 12: 377-86
26. Erek E, Başgöze S, Yıldız O, Sarıosmanoğlu Osman N, Yalçınbaş Kenan Y, Turköz R, et al. Second harvest of Congenital Heart Surgery Database in Türkiye: Current outcomes. Turk Gogus Kalp Dama 2024;32:162-178
27. Pasquali SK, Banerjee M, Romano JC, Normand ST. Hospital performance assessment in congenital heart surgery: where do we go from here? Ann Thorac Surg. 2020; 109(3): 621!626.
28. Pasquali SK, Gaynor JW. The path forward in congenital heart surgery public reporting. Ann Thorac Surg. 2022; 114(2): 534-535.