22.

BÖLÜM

İNTRAKRANİYAL ANEVRİZMA, ARTERİOVENÖZ MALFORMASYON VE ARTERİOVENÖZ FİSTÜLLERİN TANI VE TEDAVİSİ

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GİRİŞ

Beyin, beyin sapı ve omuriliğe ait damar sistemi, merkezi sinir sisteminin (MSS) iyi çalışması için gerekli oksijeni ve besinleri sağlar. Anatomik ve anjiyografik çalışmalar, arteriyel mimarinin topografyasını ve yapısal ilişkilerini önemli ölçüde detaylandırır. Beyine ait vasküler anatominin, yaygın varyasyonlarının ve anomalilerinin bilinmesi, intrakraniyal anevrizma (İA), arteriovenöz malformasyon (AVM) ve arteriovenöz fistül (AVF) gibi vasküler problemlerin tanı ve tedavisi için kritik öneme sahiptir.

İA, AVM ve AVF tanı ve tedavisi, özellikle son 20 yılda oldukça değişmiş ve gelişmiştir. Temel olarak açık cerrahi yaklaşım, endovasküler yaklaşım ve denenmekte olan yeni teknolojiler olmak üzere üç farklı tedavi yaklaşımı mevcuttur. Biz bu bölümde, kullanımda olan eski ve yeni endovasküler tedavi yöntemlerinden bahsedeceğiz.

İNTRAKRANİAL ANEVRİZMALAR

A) Giriş

Anevrizma terimi, Yunanca'da yukarısı veya karşısı anlamında kullanılan "ana-" ile, geniş veya yaygın anlamında kullanılan "eury-" kelimelerinin birleşiminden oluşur. İntrakranial anevrizmalar genel olarak fenotipik görünümlerine göre sınıflandırılmakta olup sakküler (berry) anevrizmalar en sık görülen tipidir. Fuziform anevrizmalar damarın tüm çevresini tutan fokal dilatasyonlardır ve oldukça kısa mesafeyi ilgilendirirler. Ektaziler fokal dilatasyon olmaksızın genel arteriyel genişlemeyi tanımlar ve gerçek anevrizma değillerdir.

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D) Tedavi Komplikasyonları

Tedavi sonrası en sık görülen komplikasyonlar nörolojik problemler olup bu oran %4-5 arasındadır. Mortalite oranları ise %0-4 arasında seyretmektedir (139, 140). Anjiyografi ve vasküler aksesin kendisine ait komplikasyonlar dışında embolik ajanın anastomozlar vasıtasıyla eksternal-internal karotid arterlere veya vertebrobaziler sisteme kaçması ve buna ikincil serebral enfarkt veya kranial sinir iskemisi gibi, embolizasyon ile ilişkili komplikasyonlar da söz konusudur. Transvenöz embolizasyonun ise, serebral venöz drenajın bozulması sonucu kafa içi basınç artışı veya embolizan ajanın göçü nedeniyle retinal ven oklüzyonu gibi komplikasyonları olabilir. Hatta uygun olmayan venöz yapının kapatılması, şantın başka bir ven aracılığı ile bağlantı kurmasına sebep olarak DAVF'nin daha tehlikeli bir hale dönüşmesine sebep olabilir. Kavernöz sinüs fistüllerinin çok agresif şekilde kapatılması, geçici VI. Sinir felcine sebep olabilir (115, 141). Anterior kondiler kanal fistülünün embolizasyonu sonrası ise XII. sinir felci olası bir durumdur. Sigmoid sinüs oklüzyonlarından sonra ise, komşuluğundaki saccus endolymphaticus etkilendiğinden dolayı gelişen endolenfatik hidrops nedeniyle labirint disfonksiyonu gelişen çeşitli vakalar bildirilmiştir (142).

KAYNAKLAR

1. Anne G. Osborn M, Karen L. Salzman M, A. James Barkovich M. Diagnositc Imaging, Brain. 2nd ed2013.
2. Vinay Kumar M, Ramzi S. Cotran M, Stanley L. Robbins M. Robin's Temel Patoloji. 7th ed. Vinay Kumar M, editor2003 2003. 872 p.
3. Vlak MH, Algra A, Brandenburg R, et al. Prevalence of unruptured intracranial aneurysms, with emphasis on sex, age, comorbidity, country, and time period: a systematic review and meta-analysis. *Lancet Neurol*. 2011;10(7):626-636.
4. Bharatha A, Yeung R, Durant D, et al. Comparison of computed tomography angiography with digital subtraction angiography in the assessment of clipped intracranial aneurysms. *J Comput Assist Tomogr*. 2010;34(3):440-445.
5. Bohmfalk GL, Story JL, Wissinger JP, et al. Bacterial intracranial aneurysm. *J Neurosurg*. 1978;48(3):369-382.
6. Gobble RM, Hoang H, Jafar J, et al. Extracranial-intracranial bypass: resurrection of a nearly extinct operation. *J Vasc Surg*. 2012;56(5):1303-1307.
7. Sekhar LN, Duff JM, Kalavakonda C, et al. Cerebral revascularization using radial artery grafts for the treatment of complex intracranial aneurysms: techniques and outcomes for 17 patients. *Neurosurgery*. 2001;49(3):646-658; discussion 658-649.
8. Barrow DL, Alleyne C. Natural history of giant intracranial aneurysms and indications for intervention. *Clin Neurosurg*. 1995;42:214-244.
9. Lonjon M, Pennes F, Sedat J, et al. Epidemiology, genetic, natural history and clinical presentation of giant cerebral aneurysms. *Neurochirurgie*. 2015;61(6):361-365.
10. Yahia AM, Gordon V, Whapham J, et al. Complications of Neuroform stent in endovascular treatment of intracranial aneurysms. *Neurocrit Care*. 2008;8(1):19-30.
11. Ducruet AF, Crowley RW, Albuquerque FC, et al. Reconstructive endovascular treatment of

a ruptured vertebral artery dissecting aneurysm using the Pipeline embolization device. *J Neurointerv Surg*. 2013;5(4):e20.
12. Lee JW, Choi HG, Jung JY, et al. Surgical strategies for ruptured blister-like aneurysms arising from the internal carotid artery: a clinical analysis of 18 consecutive patients. *Acta Neurochir (Wien)*. 2009;151(2):125-130.
13. Segal HD, McLaurin RL. Giant serpentine aneurysm. Report of two cases. *J Neurosurg*. 1977;46(1):115-120.
14. Christiano LD, Gupta G, Prestigiacomo CJ, et al. Giant serpentine aneurysms. *Neurosurg Focus*. 2009;26(5):E5.
15. Zali A, Khoshnood RJ, Zarghi A. De novo aneurysms in long-term follow-up computed tomographic angiography of patients with clipped intracranial aneurysms. *World Neurosurg*. 2014;82(5):722-725.
16. Matheus MG, Castillo M. Development of de novo intracranial aneurysm in three months: case report and literature review. *AJNR Am J Neuroradiol*. 2003;24(4):709-710.
17. Rodriguez-Hernandez A, Lawton MT. End-to-end reanastomosis technique for fusiform aneurysms: 3-dimensional operative video. *Neurosurgery*. 2014;10 Suppl 1:157; discussion 157-158.
18. Moret J, Cognard C, Weill A, et al. The "Remodelling Technique" in the Treatment of Wide Neck Intracranial Aneurysms. Angiographic Results and Clinical Follow-up in 56 Cases. *Interv Neuroradiol*. 1997;3(1):21-35.
19. Pierot L, Spelle L, Leclerc X, et al. Endovascular treatment of unruptured intracranial aneurysms: comparison of safety of remodeling technique and standard treatment with coils. *Radiology*. 2009;251(3):846-855.
20. Pierot L, Cognard C, Anxionnat R, et al. Remodeling technique for endovascular treatment of ruptured intracranial aneurysms had a higher rate of adequate postoperative occlusion than did conventional coil embolization with comparable safety. *Radiology*. 2011;258(2):546-553.
21. Wakhloo AK, Mandell J, Gounis MJ, et al. Stent-assisted reconstructive endovascular repair of cranial fusiform atherosclerotic and dissecting aneurysms: long-term clinical and angiographic follow-up. *Stroke*. 2008;39(12):3288-3296.
22. Lopes DK, Wells K. Stent remodeling technique for coiling of ruptured wide-neck cerebral aneurysms: case report. *Neurosurgery*. 2009;65(5):E1007-1008; discussion E1008.
23. Hong B, Patel NV, Gounis MJ, et al. Semi-jailing technique for coil embolization of complex, wide-necked intracranial aneurysms. *Neurosurgery*. 2009;65(6):1131-1138; discussion 1138-1139.
24. Jankowitz BT, Thomas A, Jovin T, et al. Y stenting using kissing stents for the treatment of bifurcation aneurysms. *J Neurointerv Surg*. 2012;4(1):16-21.
25. Padalino DJ, Singla A, Jacobsen W, et al. Enterprise stent for waffle-cone stent-assisted coil embolization of large wide-necked arterial bifurcation aneurysms. *Surg Neurol Int*. 2013;4:9.
26. Zhao F, van Rietbergen B, Ito K, et al. Flow rates in perfusion bioreactors to maximise mineralisation in bone tissue engineering in vitro. *J Biomech*. 2018;79:232-237.
27. Zhao J, Kalaskar D, Farhatnia Y, et al. Intracranial stents past, present and the future trend: stents made with nano-particle or nanocomposite biomaterials. *Curr Med Chem*. 2014;21(37):4290-4299.
28. Zhao J, Lin H, Summers R, et al. Current Treatment Strategies for Intracranial Aneurysms: An Overview. *Angiology*. 2018;69(1):17-30.
29. Arrese I, Sarabia R, Pintado R, et al. Flow-diverter devices for intracranial aneurysms: systematic review and meta-analysis. *Neurosurgery*. 2013;73(2):193-199; discussion 199-200.
30. Wu SW, Chiu TL. Dissecting aneurysm at the A1 segment of the anterior cerebral artery presenting as visual loss and visual field defect. *Br J Neurosurg*. 2013;27(6):822-823.
31. Pierot L, Klisch J, Cognard C, et al. Endovascular WEB flow disruption in middle cerebral artery aneurysms: preliminary feasibility, clinical, and anatomical results in a multicenter study. *Neurosurgery*. 2013;73(1):27-34; discussion 34-25.

32. Lubicz B, Klisch J, Gauvrit JY, et al. WEB-DL endovascular treatment of wide-neck bifurcation aneurysms: short- and midterm results in a European study. *AJNR Am J Neuroradiol*. 2014;35(3):432-438.
33. Loh Y, Duckwiler GR, Onyx Trial I. A prospective, multicenter, randomized trial of the Onyx liquid embolic system and N-butyl cyanoacrylate embolization of cerebral arteriovenous malformations. Clinical article. *J Neurosurg*. 2010;113(4):733-741.
34. Wolfe SQ, Farhat H, Moftakhar R, et al. Intraaneurysmal balloon assistance for navigation across a wide-necked aneurysm. *J Neurosurg*. 2010;112(6):1222-1226.
35. Carlson AP, Alaraj A, Amin-Hanjani S, et al. Continued concern about parent vessel steno-occlusive progression with Onyx HD-500 and the utility of quantitative magnetic resonance imaging in serial assessment. *Neurosurgery*. 2013;72(3):341-352; discussion 352.
36. Connolly ES, Jr., Rabinstein AA, Carhuapoma JR, et al. Guidelines for the management of aneurysmal subarachnoid hemorrhage: a guideline for healthcare professionals from the American Heart Association/american Stroke Association. *Stroke*. 2012;43(6):1711-1737.
37. Thompson BG, Brown RD, Jr., Amin-Hanjani S, et al. Guidelines for the Management of Patients With Unruptured Intracranial Aneurysms: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. *Stroke*. 2015;46(8):2368-2400.
38. Miura T, Eishi K. Current treatment of active infective endocarditis with brain complications. *Gen Thorac Cardiovasc Surg*. 2013;61(10):551-559.
39. Phuong LK, Link M, Wijdicks E. Management of intracranial infectious aneurysms: a series of 16 cases. *Neurosurgery*. 2002;51(5):1145-1151; discussion 1151-1142.
40. Brathwaite S, Macdonald RL. Current management of delayed cerebral ischemia: update from results of recent clinical trials. *Transl Stroke Res*. 2014;5(2):207-226.
41. Li H, Pan R, Wang H, et al. Clipping versus coiling for ruptured intracranial aneurysms: a systematic review and meta-analysis. *Stroke*. 2013;44(1):29-37.
42. Hoh BL, Kleinhenz DT, Chi YY, et al. Incidence of ventricular shunt placement for hydrocephalus with clipping versus coiling for ruptured and unruptured cerebral aneurysms in the Nationwide Inpatient Sample database: 2002 to 2007. *World Neurosurg*. 2011;76(6):548-554.
43. Chalouhi N, Jabbour P, Starke RM, et al. Endovascular treatment of proximal and distal posterior inferior cerebellar artery aneurysms. *J Neurosurg*. 2013;118(5):991-999.
44. Shaw MD, Foy PM. Epilepsy after craniotomy and the place of prophylactic anticonvulsant drugs: discussion paper. *J R Soc Med*. 1991;84(4):221-223.
45. Lai LT, O'Donnell J, Morgan MK. The risk of seizures during the in-hospital admission for surgical or endovascular treatment of unruptured intracranial aneurysms. *J Clin Neurosci*. 2013;20(11):1498-1502.
46. Guglielmi G, Vinuela F, Dion J, et al. Electrothrombosis of saccular aneurysms via endovascular approach. Part 2: Preliminary clinical experience. *J Neurosurg*. 1991;75(1):8-14.
47. Henkes H, Lowens S, Preiss H, et al. A new device for endovascular coil retrieval from intracranial vessels: alligator retrieval device. *AJNR Am J Neuroradiol*. 2006;27(2):327-329.
48. Rouchaud A, Brinjikji W, Lanzino G, et al. Delayed hemorrhagic complications after flow diversion for intracranial aneurysms: a literature overview. *Neuroradiology*. 2016;58(2):171-177.
49. Shobayashi Y, Tateshima S, Kakizaki R, et al. Intra-aneurysmal hemodynamic alterations by a self-expandable intracranial stent and flow diversion stent: high intra-aneurysmal pressure remains regardless of flow velocity reduction. *J Neurointerv Surg*. 2013;5 Suppl 3:iii38-42.
50. Luschka H. Cavernose Blutgeshwulst des Gehirns. *Virchows Arch*. 1854;6: 458-470.
51. Virchow R. Die Krankhaften Geschwulste. In: A. Hirschwald. *Berlin*. 1863.
52. Challa VR, Moody DM, Brown WR. Vascular malformations of the central nervous system. *J Neuropathol Exp Neurol*. 1995;54(5):609-621.
53. Rhoten RL, Comair YG, Shedid D, et al. Specific repression of the preproendothelin-1 gene in intracranial arteriovenous malformations. *J Neurosurg*. 1997;86(1):101-108.

54. Maeda K, Kurita H, Nakamura T, et al. Occurrence of severe vasospasm following intraventricular hemorrhage from an arteriovenous malformation. Report of two cases. *J Neurosurg*. 1997;87(3):436-439.
55. Mast H, Mohr JP, Osipov A, et al. 'Steal' is an unestablished mechanism for the clinical presentation of cerebral arteriovenous malformations. *Stroke*. 1995;26(7):1215-1220.
56. Wilkins RH. Natural history of intracranial vascular malformations: a review. *Neurosurgery*. 1985;16(3):421-430.
57. Brown RD, Jr., Wiebers DO, Forbes G, et al. The natural history of unruptured intracranial arteriovenous malformations. *J Neurosurg*. 1988;68(3):352-357.
58. Perret G, Nishioka H. Report on the cooperative study of intracranial aneurysms and subarachnoid hemorrhage. Section VI. Arteriovenous malformations. An analysis of 545 cases of cranio-cerebral arteriovenous malformations and fistulae reported to the cooperative study. *J Neurosurg*. 1966;25(4):467-490.
59. Garrido E, Stein B. Removal of an arteriovenous malformation from the basal ganglion. *J Neurol Neurosurg Psychiatry*. 1978;41(11):992-995.
60. Stapf C, Mohr JP, Sciacca RR, et al. Incident hemorrhage risk of brain arteriovenous malformations located in the arterial borderzones. *Stroke*. 2000;31(10):2365-2368.
61. Haas DC. Arteriovenous malformations and migraine: case reports and an analysis of the relationship. *Headache*. 1991;31(8):509-513.
62. Bruyn GW. Intracranial arteriovenous malformation and migraine. *Cephalalgia*. 1984;4(3):191-207.
63. Evans RW. Diagnostic testing for the evaluation of headaches. *Neurol Clin*. 1996;14(1):1-26.
64. Kondziolka D, McLaughlin MR, Kestle JR. Simple risk predictions for arteriovenous malformation hemorrhage. *Neurosurgery*. 1995;37(5):851-855.
65. Brown RD, Jr. Simple risk predictions for arteriovenous malformation hemorrhage. *Neurosurgery*. 2000;46(4):1024.
66. Mast H, Young WL, Koennecke HC, et al. Risk of spontaneous haemorrhage after diagnosis of cerebral arteriovenous malformation. *Lancet*. 1997;350(9084):1065-1068.
67. Graf CJ, Perret GE, Torner JC. Bleeding from cerebral arteriovenous malformations as part of their natural history. *J Neurosurg*. 1983;58(3):331-337.
68. Forster DM, Steiner L, Hakanson S. Arteriovenous malformations of the brain. A long-term clinical study. *J Neurosurg*. 1972;37(5):562-570.
69. Fults D, Kelly DL, Jr. Natural history of arteriovenous malformations of the brain: a clinical study. *Neurosurgery*. 1984;15(5):658-662.
70. Jane JA, Kassell NF, Torner JC, et al. The natural history of aneurysms and arteriovenous malformations. *J Neurosurg*. 1985;62(3):321-323.
71. Itoyama Y, Uemura S, Ushio Y, et al. Natural course of unoperated intracranial arteriovenous malformations: study of 50 cases. *J Neurosurg*. 1989;71(6):805-809.
72. Johnson P, Wascher T. Definition and pathologic features. In: IA Awad, DL Barrow, IL Park Ridge (Eds) Cavernous malformation. . *American Association of Neurological Surgeons*. 1993:1-11.
73. Fisher W. Concomitant intracranial aneurysms and arteriovenous malformations. *In: RH Wilkins, SS Rengachary (Eds) Neurosurgery McGraw-Hill, New York*. 1996:2429-2432.
74. Garretson H. Intracranial arteriovenous malformations. *In: RH Wilkins, SS Rengachary (Eds) NeurosurgeryMcGraw-Hill, New York*. 1996:2433-2442.
75. Solomon R. Vascular malformations affecting the nervous system. *In: SS Rengachary, RH Wilkins (Eds) Principles of neurosurgery Mosby-Year Book, Chicago*. 1994.
76. Mullan S, Mojtahedi S, Johnson DL, et al. Embryological basis of some aspects of cerebral vascular fistulas and malformations. *J Neurosurg*. 1996;85(1):1-8.
77. Spetzler RF, Martin NA. A proposed grading system for arteriovenous malformations. *J Neurosurg*. 1986;65(4):476-483.
78. Ogilvy CS, Stieg PE, Awad I, et al. Recommendations for the management of intracranial arteriovenous malformations: a statement for healthcare professionals from a special writing

group of the Stroke Council, American Stroke Association. *Circulation*. 2001;103(21):2644-2657.
79. Fiorella D, Albuquerque FC, Woo HH, et al. The role of neuroendovascular therapy for the treatment of brain arteriovenous malformations. *Neurosurgery*. 2006;59(5 Suppl 3):S163-177; discussion S163-113.
80. Purdy PD, Batjer HH, Risser RC, et al. Arteriovenous malformations of the brain: choosing embolic materials to enhance safety and ease of excision. *J Neurosurg*. 1992;77(2):217-222.
81. Purdy PD, Batjer HH, Samson D, et al. Intraarterial sodium amytal administration to guide preoperative embolization of cerebral arteriovenous malformations. *J Neurosurg Anesthesiol*. 1991;3(2):103-106.
82. Jafar JJ, Davis AJ, Berenstein A, et al. The effect of embolization with N-butyl cyanoacrylate prior to surgical resection of cerebral arteriovenous malformations. *J Neurosurg*. 1993;78(1):60-69.
83. DeMeritt JS, Pile-Spellman J, Mast H, et al. Outcome analysis of preoperative embolization with N-butyl cyanoacrylate in cerebral arteriovenous malformations. *AJNR Am J Neuroradiol*. 1995;16(9):1801-1807.
84. n BCATI. N-butyl cyanoacrylate embolization of cerebral arteriovenous malformations: results of a prospective, randomized, multi-center trial. *AJNR Am J Neuroradiol*. 2002;23(5):748-755.
85. Hartmann A, Mast H, Mohr JP, et al. Determinants of staged endovascular and surgical treatment outcome of brain arteriovenous malformations. *Stroke*. 2005;36(11):2431-2435.
86. Marks MP, Lane B, Steinberg GK, et al. Hemorrhage in intracerebral arteriovenous malformations: angiographic determinants. *Radiology*. 1990;176(3):807-813.
87. Redekop G, TerBrugge K, Montanera W, et al. Arterial aneurysms associated with cerebral arteriovenous malformations: classification, incidence, and risk of hemorrhage. *J Neurosurg*. 1998;89(4):539-546.
88. Lasjaunias P, Piske R, Terbrugge K, et al. Cerebral arteriovenous malformations (C. AVM) and associated arterial aneurysms (AA). Analysis of 101 C. AVM cases, with 37 AA in 23 patients. *Acta Neurochir (Wien)*. 1988;91(1-2):29-36.
89. Kim EJ, Halim AX, Dowd CF, et al. The relationship of coexisting extranidal aneurysms to intracranial hemorrhage in patients harboring brain arteriovenous malformations. *Neurosurgery*. 2004;54(6):1349-1357; discussion 1357-1348.
90. Brown RD, Jr., Wiebers DO, Forbes GS. Unruptured intracranial aneurysms and arteriovenous malformations: frequency of intracranial hemorrhage and relationship of lesions. *J Neurosurg*. 1990;73(6):859-863.
91. Kwon Y, Jeon SR, Kim JH, et al. Analysis of the causes of treatment failure in gamma knife radiosurgery for intracranial arteriovenous malformations. *J Neurosurg*. 2000;93 Suppl 3:104-106.
92. Steiner L, Lindquist C, Adler JR, et al. Clinical outcome of radiosurgery for cerebral arteriovenous malformations. *J Neurosurg*. 1992;77(1):1-8.
93. Maruyama K, Kawahara N, Shin M, et al. The risk of hemorrhage after radiosurgery for cerebral arteriovenous malformations. *N Engl J Med*. 2005;352(2):146-153.
94. Pollock BE. Stereotactic radiosurgery for arteriovenous malformations. *Neurosurg Clin N Am*. 1999;10(2):281-290.
95. Flickinger JC, Kondziolka D, Lunsford LD, et al. A multi-institutional analysis of complication outcomes after arteriovenous malformation radiosurgery. *Int J Radiat Oncol Biol Phys*. 1999;44(1):67-74.
96. Gobin YP, Laurent A, Merienne L, et al. Treatment of brain arteriovenous malformations by embolization and radiosurgery. *J Neurosurg*. 1996;85(1):19-28.
97. Henkes H, Nahser HC, Berg-Dammer E, et al. Endovascular therapy of brain AVMs prior to radiosurgery. *Neurol Res*. 1998;20(6):479-492.
98. Pollock BE, Kondziolka D, Lunsford LD, et al. Repeat stereotactic radiosurgery of arteriovenous malformations: factors associated with incomplete obliteration. *Neurosurgery*.

1996;38(2):318-324.
99. Wikholm G, Lundqvist C, Svendsen P. Embolization of cerebral arteriovenous malformations: Part I--Technique, morphology, and complications. *Neurosurgery*. 1996;39(3):448-457; discussion 457-449.
100. Fournier D, TerBrugge KG, Willinsky R, et al. Endovascular treatment of intracerebral arteriovenous malformations: experience in 49 cases. *J Neurosurg*. 1991;75(2):228-233.
101. Vinuela F, Duckwiler G, Guglielmi G. Contribution of interventional neuroradiology in the therapeutic management of brain arteriovenous malformations. *J Stroke Cerebrovasc Dis*. 1997;6(4):268-271.
102. Valavanis A. Endovascular management of cerebral arteriovenous malformations. . *Neurointenterventionist*. 1999.
103. Weber W, Kis B, Siekmann R, et al. Preoperative embolization of intracranial arteriovenous malformations with Onyx. *Neurosurgery*. 2007;61(2):244-252; discussion 252-244.
104. Katsaridis V, Papagiannaki C, Aimar E. Curative embolization of cerebral arteriovenous malformations (AVMs) with Onyx in 101 patients. *Neuroradiology*. 2008;50(7):589-597.
105. Mounayer C, Hammami N, Piotin M, et al. Nidal embolization of brain arteriovenous malformations using Onyx in 94 patients. *AJNR Am J Neuroradiol*. 2007;28(3):518-523.
106. van Rooij WJ, Sluzewski M, Beute GN. Brain AVM embolization with Onyx. *AJNR Am J Neuroradiol*. 2007;28(1):172-177; discussion 178.
107. Kusske JA, Kelly WA. Embolization and reduction of the "steal" syndrome in cerebral arteriovenous malformations. *J Neurosurg*. 1974;40(3):313-321.
108. Luessenhop AJ, Mujica PH. Embolization of segments of the circle of Willis and adjacent branches for management of certain inoperable cerebral arteriovenous malformations. *J Neurosurg*. 1981;54(5):573-582.
109. Fox AJ, Girvin JP, Vinuela F, et al. Rolandic arteriovenous malformations: improvement in limb function by IBC embolization. *AJNR Am J Neuroradiol*. 1985;6(4):575-582.
110. Miyamoto S, Hashimoto N, Nagata I, et al. Posttreatment sequelae of palliatively treated cerebral arteriovenous malformations. *Neurosurgery*. 2000;46(3):589-594; discussion 594-585.
111. Han PP, Ponce FA, Spetzler RF. Intention-to-treat analysis of Spetzler-Martin grades IV and V arteriovenous malformations: natural history and treatment paradigm. *J Neurosurg*. 2003;98(1):3-7.
112. Djindjian R. [Embolization of vascular abnormalities in the head-face region using superselective arteriography of the external carotid artery]. *Fortschr Kiefer Gesichtschir*. 1977;22:164-167.
113. Cognard C, Gobin YP, Pierot L, et al. Cerebral dural arteriovenous fistulas: clinical and angiographic correlation with a revised classification of venous drainage. *Radiology*. 1995;194(3):671-680.
114. Brown RD, Jr., Wiebers DO, Nichols DA. Intracranial dural arteriovenous fistulae: angiographic predictors of intracranial hemorrhage and clinical outcome in nonsurgical patients. *J Neurosurg*. 1994;81(4):531-538.
115. Aminoff MJ. Vascular anomalies in the intracranial dura mater. *Brain*. 1973;96(3):601-612.
116. Goldberg RA, Goldey SH, Duckwiler G, et al. Management of cavernous sinus-dural fistulas. Indications and techniques for primary embolization via the superior ophthalmic vein. *Arch Ophthalmol*. 1996;114(6):707-714.
117. Al-Shahi R, Bhattacharya JJ, Currie DG, et al. Prospective, population-based detection of intracranial vascular malformations in adults: the Scottish Intracranial Vascular Malformation Study (SIVMS). *Stroke*. 2003;34(5):1163-1169.
118. Newton TH, Cronqvist S. Involvement of dural arteries in intracranial arteriovenous malformations. *Radiology*. 1969;93(5):1071-1078.
119. Barnwell SL, Halbach VV, Dowd CF, et al. Multiple dural arteriovenous fistulas of the cranium and spine. *AJNR Am J Neuroradiol*. 1991;12(3):441-445.
120. Borden JA, Wu JK, Shucart WA. A proposed classification for spinal and cranial dural arteriovenous fistulous malformations and implications for treatment. *J Neurosurg*.

1995;82(2):166-179.
121. Toma AK, Davagnanam I, Ganesan V, et al. Cerebral arteriovenous shunts in children. *Neuroimaging Clin N Am*. 2013;23(4):757-770.
122. Recinos PF, Rahmathulla G, Pearl M, et al. Vein of Galen malformations: epidemiology, clinical presentations, management. *Neurosurg Clin N Am*. 2012;23(1):165-177.
123. Krings T, Geibprasert S, Terbrugge K. Classification and endovascular management of pediatric cerebral vascular malformations. *Neurosurg Clin N Am*. 2010;21(3):463-482.
124. Gold A, Ransohoff J, Carter S. Vein of Galen Malformation. *Acta Neurol Scand Suppl*. 1964;40:SUPPL 11:11-31.
125. Lasjaunias PL, Chng SM, Sachet M, et al. The management of vein of Galen aneurysmal malformations. *Neurosurgery*. 2006;59(5 Suppl 3):S184-194; discussion S183-113.
126. Davies MA, Saleh J, Ter Brugge K, et al. The natural history and management of intracranial dural arteriovenous fistulae. Part 1: benign lesions. *Interv Neuroradiol*. 1997;3(4):295-302.
127. van Dijk JM, TerBrugge KG, Van der Meer FJ, et al. Thrombophilic factors and the formation of dural arteriovenous fistulas. *J Neurosurg*. 2007;107(1):56-59.
128. Cognard C, Houdart E, Casasco A, et al. Long-term changes in intracranial dural arteriovenous fistulae leading to worsening in the type of venous drainage. *Neuroradiology*. 1997;39(1):59-66.
129. Duffau H, Lopes M, Janosevic V, et al. Early rebleeding from intracranial dural arteriovenous fistulas: report of 20 cases and review of the literature. *J Neurosurg*. 1999;90(1):78-84.
130. van Dijk JM, terBrugge KG, Willinsky RA, et al. Clinical course of cranial dural arteriovenous fistulas with long-term persistent cortical venous reflux. *Stroke*. 2002;33(5):1233-1236.
131. Awad IA, Little JR, Akarawi WP, et al. Intracranial dural arteriovenous malformations: factors predisposing to an aggressive neurological course. *J Neurosurg*. 1990;72(6):839-850.
132. Mehta AS, Ahmed O, Jilani D, et al. Bronchial artery embolization for malignant hemoptysis: a single institutional experience. *J Thorac Dis*. 2015;7(8):1406-1413.
133. Carlson AP, Alaraj A, Amin-Hanjani S, et al. Endovascular approach and technique for treatment of transverse-sigmoid dural arteriovenous fistula with cortical reflux: the importance of venous sinus sacrifice. *J Neurointerv Surg*. 2013;5(6):566-572.
134. Miller NR. Dural carotid-cavernous fistulas: epidemiology, clinical presentation, and management. *Neurosurg Clin N Am*. 2012;23(1):179-192.
135. Miller NR. Diagnosis and management of dural carotid-cavernous sinus fistulas. *Neurosurg Focus*. 2007;23(5):E13.
136. Yu SC, Cheng HK, Wong GK, et al. Transvenous embolization of dural carotid-cavernous fistulae with transfacial catheterization through the superior ophthalmic vein. *Neurosurgery*. 2007;60(6):1032-1037; discussion 1037-1038.
137. Wakhloo AK, Perlow A, Linfante I, et al. Transvenous n-butyl-cyanoacrylate infusion for complex dural carotid cavernous fistulas: technical considerations and clinical outcome. *AJNR Am J Neuroradiol*. 2005;26(8):1888-1897.
138. Dashti SR, Fiorella D, Spetzler RF, et al. Transorbital endovascular embolization of dural carotid-cavernous fistula: access to cavernous sinus through direct puncture: case examples and technical report. *Neurosurgery*. 2011;68(1 Suppl Operative):75-83; discussion 83.
139. Kraus JA, Stuper BK, Berlit P. Association of resistance to activated protein C and dural arteriovenous fistulas. *J Neurol*. 1998;245(11):731-733.
140. Lawton MT, Jacobowitz R, Spetzler RF. Redefined role of angiogenesis in the pathogenesis of dural arteriovenous malformations. *J Neurosurg*. 1997;87(2):267-274.
141. Gerlach R, Yahya H, Rohde S, et al. Increased incidence of thrombophilic abnormalities in patients with cranial dural arteriovenous fistulae. *Neurol Res*. 2003;25(7):745-748.
142. Jellema K, Tijssen CC, Fijnheer R, et al. Spinal dural arteriovenous fistulas are not associated with prothrombotic factors. *Stroke*. 2004;35(9):2069-2071.