

Bölüm 52

TWIN REVERSED ARTERIAL PERFÜZYON (TRAP) SEKANSI

Hanife SAĞLAM⁶⁶

GİRİŞ

Twin Reversed Arterial Perfüzyon (TRAP) sekansı, monokoryonik ikiz gebeliklerde görülen nadir bir komplikasyondur.”TRAP sequence”, TRAPS veya “acardiac twinning” olarak da adlandırılabilir. TRAP sekansında, kalbi gelişmemiş veya hiç olmayan, yaşamla bağdaşmayan birçok anomaliye sahip bir fetus ile bu fetusu plasental yüzeydeki vasküler anastomozlar yoluyla besleyen pompa fetusun varlığı söz konusudur. Pompa ikiz anatomik olarak normal iken, müdahale edilmezse kalp yetmezliği ve erken doğum veya ölümle sonuçlanabilecek sık karşılaşılan diğer komplikasyonlar için risk altındadır. Deoksijenize kan ile beslenen akardiyak ikizin üst gövdesi ve başı sıklıkla kötü gelişmiştir veya bulunmayabilir. Akardiyak ikizin durumu yaşamla bağdaşmaz ve bu ikiz %100 mortaliteye sahiptir.

TRAP sekansı monokoryonik çoğul gebeliklerde, tipik olarak ikizlerde görülür. Çok nadir olmasına rağmen, TRAP sekansı monokoryonik-triamniyotik üçüz gebelikte de görülebileceği gibi dikoryonik ikiz gebelikte birlikte bildirilen vakalar da mevcuttur (1, 2). Üçüz gebeliklerde, birden fazla pompa fetusu veya birden fazla akardiyak fetus olabilir (3-10).

TRAP sekansının monokoryonik ikiz gebeliklerin yaklaşık %1’inde ve 1/35.000 gebelikte gerçekleştiği bildirilmiştir (11).

PATOGENEZ VE PATOFİZYOLOJİ

TRAP sekansının kesin patogenezi bilinmemektedir ve iki teori mevcuttur. Bir teoride, erken embriyogenezdeki anormal arteriyo-arteriyel anastomozlar, doğrudan plasental perfüzyonu olmayan bir akardiyak fetusa deoksijenize kan sağlar.

66 Uzman Dr., SBU Dr Abdurrahman Yurtaslan Eğitim ve Araştırma Hastanesi Kadın Hastalıkları Ve Doğum kliniği, hanife_saglam@windowlive.com

İntrafetal lazer uygulaması ile RFA uygulamalarının karşılaştırıldığı çalışmalar ise 32. gebelik haftasından önce PPROM gelişme riskinin intrafetal lazer ile daha az görüldüğünü göstermiştir.

İntrafetal lazer ablasyonu, ve intrafetal RFA gibi minimal invaziv teknikler daha yaygın olarak kullanılsa da son zamanlarda mikrodalga ablasyon ve non invaziv bir seçenek olan HIFU da tedavide yerini almaya başladı.

TRAP sekansı ile komplike olan gebelikler için optimal doğum zamanını destekleyecek sağlam veri bulunmamasına rağmen, veriler başka bir şekilde komplike olmayan, tedavi gerektirmeyen gebeliklerin termde sonlandırmanın makul bir yaklaşım olduğunu göstermekte, erken doğum için standart obstetrik endikasyonların gelişimi gibi komplikasyonlar ortaya çıkması durumunda potansiyel olarak daha erken sonlandırılabilir.

Başarılı kord oklüzyon tedavisinin ardından, güven verici ultrason ve maternal sürveyans ile, termde doğum hedeftir. Sezaryen ile doğum standart obstetrik endikasyonlar için düşünülmelidir.

Anahtar Kelimeler: TRAP sekansı, akardiyak ikiz gebelik, RFA, bipolar kord koagülasyonu.

KAYNAKLAR

1. Pagani G, D'Antonio F, Khalil A, et al. Intrafetal laser treatment for twin reversed arterial perfusion sequence: cohort study and meta-analysis. *Ultrasound in Obstetrics & Gynecology*. 2013;42:6–14. doi:10.1002/uog.12495.
2. Abdelrahman RM. Twin Reversed Arterial Perfusion Sequence in Dichorionic Triamniotic Triplet Pregnancy. *Case Report. J Preg Child Health* 2017, 4:3. doi: 10.4172/2376-127X.1000327
3. Pan P, Luo G, Tang L, et al. Monochorionic-Triamniotic Triplet Pregnancy Complicated by Twin Reversed Arterial Perfusion Sequence: Case Report and Literature Review. *AJP Rep* 2017; 7:e106.
4. Argoti PS, Bebbington MW, Johnson A, et al. Indirect pump: unique presentation of a monochorionic-triamniotic triplet gestation complicated by TRAP sequence and successfully managed with radiofrequency ablation of the acardiac fetus. *Ultrasound Obstet Gynecol* 2013;42:115–117.
5. Kirubamani NH. Successful pregnancy in triplet with trap sequence. *Indian J Sci Technol* 2012;5(09):3304–3306.
6. Sepulveda W, Wong AE, Bustos JC, et al. Acardiac fetus complicating a triplet pregnancy: management and outcome. *Prenat Diagn* 2009;29(08):794–799.
7. Kuran J, Niszczota C, Kolesnik A, et al. Monochorionic triamniotic triplet pregnancy complicated by twin reversed arterial perfusion (TRAP) sequence. *Ultrasound Obstet Gynecol* 2012;40(Suppl 1):259
8. López-Pérez R, Lorente M, Martínez-Urriarte J, et al. Twin- reversed arterial perfusion sequence in a triple monochorionic pregnancy with two direct pump fetuses results in significant cyclic Doppler waveform. *Fetal Diagn Ther* 2015;37(02):157–160.

9. Yuan H, Zhou Q, Li J, et al. Triplet pregnancy from the transfer of two blastocysts demonstrating a twin reversed arterial perfusion sequence with a conjoined-twins pump fetus. *Int J Gynecol Obstet* 2017; 196-197. <https://doi.org/10.1002/ijgo.12123>.
10. Gewolb IH, Freedman RM, Kleinman CS, et al. Prenatal diagnosis of a human pseudocardiac anomaly. *Obstet Gynecol.* 1983;61:657-662.
11. Gillim DL, Hendricks CH. Holoacardius; review of the literature and case report. *Obstet Gynecol* 1953;2(6):647-53.
12. Steffensen TS, Gilbert-Barness E, Spellacy W, et al. Placental pathology in trap sequence: clinical and pathogenetic implications. *Fetal Pediatr Pathol* 2008; 27:13.
13. van Gemert MJ, Ross MG, Nikkels PG, et al. Acardiac twin pregnancies part III: Model simulations. *Birth Defects Res A Clin Mol Teratol* 2016; 106:1008.
14. Van Allen MI, Smith DW, Shepard TH. Twin reversed arterial perfusion (TRAP) sequence: a study of 14 twin pregnancies with acardius. *Semin Perinatol* 1983; 7:285-93.
15. Benirschke K, Kaufman P, Baergen RN. (2006). *The pathology of the human placenta.* 5th ed. Berlin Heidelberg: Springer.
16. Yee KT, Malcomson Roger DG. (2015). *Keeling's Fetal and Neonatal Pathology.* 5th ed. Berlin Heidelberg: Springer.
17. Gilbert-Barness E. (2007). *Potter's pathology of the fetus, infant and child.* Vol. 2, 2nd edn. Philadelphia: Mosby Elsevier.
18. Healey, M. G. (1994). Acardia: Predictive risk factors for the co-twin's survival. *Teratology*, 50(3), 205-213.[doi:10.1002/tera.1420500306](https://doi.org/10.1002/tera.1420500306)
19. Chalouhi GE, Stirnemann JJ, Salomon LJ, et al. Specific complications of monochorionic twin pregnancies: twin-twin transfusion syndrome and twin reversed arterial perfusion sequence. *Semin Fetal Neonatal Med* 2010; 15(6): 349-56.
20. Lewi L, Deprest J, Hecher K. The vascular anastomoses in monochorionic twin pregnancies and their clinical consequences. *Am J Obstet Gynecol* 2013; 208(1): 19-30.
21. Napolitani FD, Schreiber I. The acardiac monster. A review of the world literature and presentation of 2 cases. *Am J Obstet Gynecol* 1960;80:582-9.
22. Bornstein E, Monteagudo A, Dong R, et al. Detection of twin reversed arterial perfusion sequence at the time of first-trimester screening: the added value of 3-dimensional volume and color Doppler sonography. *J Ultrasound Med* 2008; 27:1105.
23. Ryu A, Mun ST. A case of twin reversed arterial perfusion (TRAP) sequence misdiagnosed as a chorioangioma. *Journal of Obstetrics and Gynaecology*, 37(4), pp. 533-534.
24. Ilyas M, Bhat A. Twin reversed arterial perfusion sequence/syndrome - An insight into the ultrasonographic features for prenatal diagnosis and review of literature with obstetric importance: Case series of two reports. *Indian J Health Sci Biomed Res* 2017;10:90-93.
25. Bartha RA, Crow HC. (2000). *Callen Ultrasonography in Obstetrics and Gynecology.* 4th ed. Pennsylvania: W B Saunders.
26. Monteagudo A, Roman AS. (2005). Ultrasound in Multiple Gestations: Twins and Other Multifetal Pregnancies. *Clinics in Perinatology*, 32(2), 329-354.[doi:10.1016/j.clp.2005.02.006](https://doi.org/10.1016/j.clp.2005.02.006).
27. Egan JE, Borgida AF. (2004). Multiple gestations: the importance of ultrasound. *Obstetrics and Gynecology Clinics of North America*, 31(1), 141-158.[doi:10.1016/s0889-8545\(03\)00122-0](https://doi.org/10.1016/s0889-8545(03)00122-0).
28. Yadav R, Choudhary N. Role of Ultrasound in Diagnosis of Fetus Acardius Acephalus in Multiple Pregnancies. *Int J Recent Surg Med Sci* 2018;4:85-87.
29. Townsend R, Khalil A. (2018). Ultrasound surveillance in twin pregnancy: An update for practitioners. *Ultrasound*, 1742271X1879401.[doi:10.1177/1742271x18794013](https://doi.org/10.1177/1742271x18794013).
30. Chen CP, Shih SL, Liu FF. (1997) Skeletal deformities of acardius anceps: The gross and imaging features. *Pediatr Radiol* 27: 221-225.
31. Benson CB, Bieber FR, Genest DR, et al. Doppler demonstration of reversed umbilical blood flow in an acardiac twin. *J Clin Ultrasound* 1989; 17:291.

32. Byrne FA, Lee H, Kipps AK, et al. (2011). Echocardiographic Risk Stratification of Fetuses with Sacrococcygeal Teratoma and Twin-Reversed Arterial Perfusion. *Fetal Diagnosis and Therapy*. 30(4), 280–288. doi:10.1159/000330762.
33. Wilson RD, Hedrick H, Flake AW, et al. (2008). Sacrococcygeal Teratomas: Prenatal Surveillance, Growth and Pregnancy Outcome. *Fetal Diagnosis and Therapy*, 25(1), 15–20. doi:10.1159/000188056.
34. Moore TR, Gale S, Benirschke K. Perinatal outcome of forty-nine pregnancies complicated by acardiac twinning. *Am J Obstet Gynecol* 1990; 163:907.
35. Quintero RA, Chmait RH, Murakoshi T, et al. Surgical management of twin reversed arterial perfusion sequence. *Am J Obstet Gynecol* 2006; 194:982.
36. Ruiz-Cordero R, Birusingh RJ, Pelaez L, et al. Twin reversed arterial perfusion sequence (TRAPS): an illustrative series of 13 cases. *Fetal Pediatr Pathol* 2016;35:63-80.
37. Lee H, Wagner AJ, Sy E, et al. Efficacy of radiofrequency ablation for twin-reversed arterial perfusion sequence, *Am. J. Obstet. Gynecol.* 196 (5) (2007) 459.e1–459.e4.
38. Sugibayashi R, Ozawa K, Sumie M, et al. Forty cases of twin reversed arterial perfusion sequence treated with radio frequency ablation using the multistep coagulation method: a single-center experience. *Prenat Diagn.* 2016;36:437–443.
39. Khanduri S, Chhabra S, Raja A, et al. Twin reversedarterial perfusion sequence: a rare entity. *J Clin ImagingSci* 2015;5:9.
40. James WH. A note on the epidemiology of acardiac monsters. *Teratology* 1977;16:211-162
41. Brassard M, Fouron JC, Leduc L, et al. Prognostic markers in twin pregnancies with an acardiac fetus. *Obstet Gynecol.* 1999;94:409-14.
42. Khalil A, Rodgers M, Baschat A, et al. ISUOG practice guidelines: the role of ultrasound in twin pregnancy. *Ultrasound Obstet Gynecol* 2016; 47(2): 247–63.
43. Berg C, Holst D, Mallmann MR, et al. Early vs late intervention in twin reversed arterial perfusion sequence. *Ultrasound Obstet Gynecol* 2014;43: 60–64.
44. Lewi L, Valencia C, Gonzalez E, et al. The outcome of twin reversed arterial perfusion sequence diagnosed in the first trimester. *Am J Obstet Gynecol.* 2010;203-213.doi:10.1016/j.ajog.2010.04.018.
45. Scheier M, Molina FS. Outcome of twin reversed arterial perfusion sequence following treatment with interstitial laser: a retrospective study. *Fetal Diagn Ther.* 2012;31:35–41.
46. Suzuki, S. (2016). Single Fetal Demise at 10 - 14 Weeks of Monochorionic and Dichorionic Twin Pregnancy. *Journal of Clinical Medicine Research*, 8(4), 331–333.doi:10.14740/jocmr2479w.
47. Sullivan AE, Varner MW, Ball RH, et al. The management of acardiac twins: a conservative approach. *Am J Obstet Gynecol.* 2003;189:1310-3.
48. Wong AE, Sepulveda W. Acardiac anomaly: current issues in prenatal assessment and treatment. *Prenat Diagn.* 2005;25:796-806.
49. Zhang ZT, Yang T, Liu CX, et al (2018). Treatment of twin reversed arterial perfusion sequence with radiofrequency ablation and expectant management: A single center study in China. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, 225, 9–12. doi:10.1016/j.ejogrb.2018.03.046.
50. Seeru G, Soni A. Twin: A Friend or a Foe! *J Obstet Gynecol India* (2016) 66(Suppl 2): 714. <https://doi.org/10.1007/s13224-016-0897-8>
51. Hartge DR, Weichert J. Prenatal diagnosis and outcome of multiple pregnancies with reversed arterial perfusion (TRAP-sequence). *Arch Gynecol Obstet* 2012; 286:81.
52. Moore CA, Buehler BA, McManus BM, et al. Acephalus-acardia in twins with aneuploidy. *Am J Med Genet Suppl* 1987; 3:139.
53. Quintero RA, Reich H, Puder KS, et al. Umbilical cord ligation of an acardiac twin by fetoscopy at 19 weeks of gestation. *N Engl J Med.* 1994;330:469–71.
54. Ville Y, Hyett JA, Vandenbussche FP, et al. Endoscopic laser coagulation of umbilical cord vessels in twin reversed arterial perfusion sequence. *Ultrasound Obstet Gynecol.* 1994;4:396–398.

55. Roman A, Papanna R, Johnson A, et al. Selective reduction in complicated monochorionic pregnancies: radiofrequency ablation versus bipolar cord coagulation. *Ultrasound Obstet Gynecol.* 2010;36:37–41. doi:10.1002/uog.7567.
56. Deprest JA, Audibert F, Van Schoubroeck D, et al. Bipolar coagulation of the umbilical cord in complicated monochorionic twin pregnancy. *Am J Obstet Gynecol.* 2000;182(2), 340-345. doi:10.1016/s0002-9378(00)70221-3.
57. Hecher K, Lewi L, Gratacos E, et al. Twin reversed arterial perfusion: fetoscopic laser coagulation of placental anastomoses or the umbilical cord. *Ultrasound Obstet Gynecol.* 2006;28:688–91.
58. Stephenson CD, Temming LA, Pollack R. Microwave Ablation for Twin-Reversed Arterial Perfusion Sequence: A Novel Application of Technology, *Fetal Diagn Ther* 2015;38:35-40 doi:10.1159/000369384.
59. Seo K, Ichizuka K, Okai T, et al. (2018). Twin-Reversed Arterial Perfusion Sequence Using High-Intensity Focused Ultrasound Therapy. *Ultrasound in Obstetrics & Gynecology.* doi:10.1002/uog.20101.
60. Ichizuka K, Matsuoka R, Aoki H, et al. Basic study of less invasive high-intensity focused ultrasound(HIFU) in fetal therapy for twin reversed arterial perfusion (TRAP) sequence. *J Med Ultrason (2001)* 2016;43:487-492.
61. Okai T, Ichizuka K, Hasegawa J, et al. First successful case of non-invasive inutero treatment of twin reversed arterial perfusion sequence by high-intensity focused ultrasound. *Ultrasound Obstet Gynecol*2013;42:112-114.
62. Sepulveda W, Bower S, Hassan J, et al. Ablation of acardiac twin by alcohol injection into the intra-abdominal umbilical artery. *Obstet Gynecol* 1995; 86:680.
63. Guven MA, Koc O, Bodur H, et al. Acardiac twin pregnancy: successful intrauterine ablative treatment with alcohol at 14 weeks of gestation. *Clin Exp Obstet Gynecol* 2016; 43:460.
64. Doronjski A, Stojilković T, Spasojević S, et al. TRAP (Twin Reversed Arterial Perfusion) Sequence. *Open Medicine* 9:3, 491–494. doi: <https://doi.org/10.2478/s11536-013-0340-9>.
65. Blaicher W, Repa C, Schaller A. Acardiac twin pregnancy: associated with trisomy 2: case report. *Hum Reprod* 2000; 15:474.
66. Donnemfeld AE, van de Woestijne J, Craparo F, et al. The normal fetus of an acardiac twin pregnancy: perinatal management based on echocardiographic and sonographic evaluation. *Prenat Diagn.* 1991 Apr;11(4):235-44.
67. Livingston JC, Lim FY, Polzin W, et al. Intrafetal radiofrequency ablation for twin reversed arterial perfusion (TRAP): a single-center experience. *American Journal of Obstetrics & Gynecology* 2007;197(4):399.e1-3.
68. Tsao KJ, Feldstein VA, Albanese CT, et al. Selective reduction of acardiac twin by radiofrequency ablation. *American Journal of Obstetrics and Gynecology* 2002; 187:635-640.
69. Fisher KE, Welsh AW, Henry A. (2016). Uncommon complications of monochorionic twin pregnancies: Twin reversed arterial perfusion sequence. *Australasian Journal of Ultrasound in Medicine,* 19(4), 133–141. doi:10.1002/ajum.12024.
70. Tan TYT, Sepulveda W. Acardiac twin: A systematic review of minimally invasive treatment modalities. *Ultrasound Obstet Gynecol* 2003;22 (4):409-419.doi:10.1002/uog.224.
71. Jelin E, Hirose S, Rand L, et al. Perinatal outcome of conservative management versus fetal intervention for twin reversed arterial perfusion sequence with a small acardiac twin. *Fetal Diagn Ther* 2010;27:138–141.
72. Paramasivam G, Wimalasundera R, Wiechec M, et al. Radiofrequency ablation for selective reduction in complex monochorionic pregnancies. *BJOG* 2010;117: 1294–1298.
73. Bebbington MW, Danzer E, Moldenhauer J, et al. Radiofrequency ablation vs bipolar umbilical cord coagulation in the management of complicated monochorionic pregnancies. *Ultrasound Obstet Gynecol* 2012;40:319–324.

74. Lee H, Bebbington M, Crombleholme TM. North American Fetal Therapy Network: The North American Fetal Therapy Network registry data on outcomes of radiofrequency ablation for twin-reversed arterial perfusion sequence. *Fetal Diagn Ther* 2013;33:224–229.
75. Cabassa P, Fichera A, Prefumo F, et al.: The use of radiofrequency in the treatment of twin reversed arterial perfusion sequence: a case series and review of the literature. *Eur J Obstet Gynecol Reprod Biol* 2013;166:127–132.
76. Lu J, Ting YH, Law KM, et al. Radiofrequency ablation for selective reduction in complicated monochorionic multiple pregnancies. *Fetal Diagn Ther* 2013;34:211–216.
77. Kumar S, Paramasivam G, Zhang E, et al. Perinatal- and procedure-related outcomes following radiofrequency ablation in monochorionic pregnancy. *Am J Obstet Gynecol* 2014;210:454.e1–e6.
78. Yinon Y, Ashwal E, Weisz B, et al. (2015). Selective reduction in complicated monochorionic twins: prediction of obstetric outcome and comparison of techniques. *Ultrasound in Obstetrics & Gynecology*, 46(6), 670–677. doi:10.1002/uog.14879.
79. Wagata M, Murakoshi T, Ishii K, et al. Radiofrequency Ablation with an Internally Cooled Electrode for Twin Reversed Arterial Perfusion Sequence. *Fetal Diagnosis and Therapy*, 40(2), 110–115. doi:10.1159/000442152.
80. Sun L, Zou G, Yang Y, et al. (2018). Risk factors for fetal death after radiofrequency ablation for complicated monochorionic twin pregnancies. *Prenatal Diagnosis*, 38(7), 499–503. doi:10.1002/pd.5269.
81. Kotoh K, Nakamuta M, Morizono S, et al. A multi-step, incremental expansion method for radio frequency ablation: optimization of the procedure to prevent increases in intra-tumor pressure and to reduce the ablation time. *Liver Int* 2005;25(3):542–7.
82. Kobori S, Toshimitsu M, Nagaoka S, et al. (2019). A Case of Monochorionic-Triamniotic Triplet Pregnancy with TRAP Sequence Successfully Treated with Radiofrequency Ablation with a Parallel Circuit Consisting of Anastomosed Blood Vessels between the Direct Pump Fetus and the Indirect Pump Fetus. *Case Reports in Obstetrics and Gynecology*, 2019, 1–4. doi:10.1155/2019/5319028.
83. Takahashi Y, Iwagaki S, Chiaki R, et al. (2017). Ultrasonic identification of pump twin by dual-gate Doppler in a monochorionic-triamniotic triplet twin reversed arterial perfusion sequence before preventative radiofrequency ablation: a case report. *Journal of Medical Ultrasonics*, 45(1), 185–187. doi:10.1007/s10396-017-0792-7.
84. Chaveeva P, Poon LC, Sotiriadis A, et al. Optimal method and timing of intrauterine intervention in twin reversed arterial perfusion sequence: case study and meta-analysis. *Fetal Diagn Ther* 2014;35(4):267–79. doi:10.1159/000358593.
85. Takano M, Murata S, Fujiwara M, et al. Experience of fetoscopic laser photocoagulation and cord transection for twin-reversed arterial perfusion sequence. *J Obstet Gynecol Res*. 2015;41(9):1326–1329.
86. King JR, Conturie CL, Ouzounian JG, et al. Umbilical cord occlusion via laser coagulation in monochorionic multifetal gestations before and after 20 weeks of gestation. *Fetal Diagn Ther*. 2017;42:9–16.
87. van Gemert MJC, van den Wijngaard JPHM, Vandebussche FPHA. Twin reversed arterial perfusion sequence is more common than generally accepted. *Birth Defects Res A Clin Mol Teratol* 2015; 103: 641–643.
88. Arisoy R, Pekin O, Pakay K, et al. Intrafetal laser therapy in acardiac twin pregnancy: a case report. *Perinatal Journal* 2016;24(2):106–109 doi: 10.2399/prn.16.0242008.
89. Roethlisberger M, Strizek B, Gottschalk I, et al. First trimester intervention in twin reversed arterial perfusion (TRAP) sequence – does size matter? *Ultrasound in Obstetrics and Gynecology* 50 (1) 40–44. doi: 10.1002/uog.16013.

90. Lanna M, Rustico M, Dell'Avanzo MA, et al. (2012). Bipolar cord coagulation for selective feticide in complicated monochorionic twin pregnancies: 118 consecutive cases at a single center. *Ultrasound in Obstetrics & Gynecology*, 39(4), 407–413.doi:10.1002/uog.11073
91. Gül A, Güngördük K, Yildirim G, et al. Bipolar cord coagulation in monochorionic twins discordant for major fetal anomalies. *J Turkish Ger Gynecol Assoc*. 2008;9(1):24-28.
92. Ilagan, JG, Wilson RD, Bebbington M, et al. (2007). Pregnancy Outcomes following Bipolar Umbilical Cord Cauterization for Selective Termination in Complicated Monochorionic Multiple Gestations. *Fetal Diagnosis and Therapy*, 23(2), 153–158.doi:10.1159/000111598
93. Nicolini U, Poblete A, Boschetto C, et al. Complicated monochorionic twin pregnancies: experience with bipolar cord coagulation. *Am J Obstet Gynecol* 2001; 185:703–707.
94. Johnson MP, Cromblehome TM, Hedrick HL, et al. Bipolar umbilical cord cauterization for selective termination of complicated monochorionic pregnancies. *Am J Obstet Gynecol* 2001;185:S245.
95. Taylor MJO, Shalev E, Tanawattanchaoen S, et al. Ultrasound guided umbilical cord occlusion using bipolar diathermy for stage III/IV twin-twin transfusion syndrome. *Prenat Diagn* 2002; 22:70–76.
96. Robyr R, Yamamoto M, Ville Y. Selective feticide in complicated monochorionic twin pregnancies using ultrasound-guided bipolar cord coagulation. . *BJOG: An International Journal of Obstetrics & Gynaecology*, 112(10), 1344–1348. doi:10.1111/j.1471-0528.2005.00746.x.
97. Moldenhauer JS, Gilbert A, Johnson A: Vascular occlusion in the management of complicated multifetal pregnancies. *Clin Perinatol* 2003;30:601–621.
98. Peng R, Xie HN, Lin MF, et al. (2016). Clinical Outcomes after Selective Fetal Reduction of Complicated Monochorionic Twins with Radiofrequency Ablation and Bipolar Cord Coagulation. *Gynecologic and Obstetric Investigation*, 81(6), 552–558.doi:10.1159/000445291.
99. Poon RT, Fan S, Tsang FH, et al: Locoregional therapies for hepatocellular carcinoma: a critical review from the surgeon's perspective. *Ann Surg* 2002;235:466–486.
100. Simo KA, Sereika SE, Newton KN, et al: Laparoscopic-assisted microwave ablation for hepatocellular carcinoma: safety and efficacy in comparison with radiofrequency ablation. *J Surg Oncol* 2011;104:822–829.
101. Liang P, Wang Y: Microwave ablation of hepatocellular carcinoma. *Oncology* 2007;72: 124–131.
102. Tabuse K: Basic knowledge of a microwave tissue coagulator and its clinical applications. *J Hepatobiliary Pancreat Surg* 1998;5:165– 172.
103. Lannitti DA, Martin RCG, Simon CJ, et al.Hepatic tumor ablation with clustered microwave antennae: the US Phase II trial. *HPB (Oxford)* 2007;9:120–124.
104. Hope WW, Schmelzer TM, Newcomb WL, et al. Guidelines for power and time variables for microwave ablation in a porcine liver. *J Gastrointest Surg* 2008;12: 463–467.
105. Temming LA, Stephenson C, Franco A. (2014). Microwave Ablation for Twin-Reversed Arterial Perfusion Sequence. *Obstetrics & Gynecology*, 123, 175S.doi:10.1097/01.aog.0000447186.36690.
106. Meng X, Yuan P, Gong L, et al. (2019). Forty-five consecutive cases of complicated monochorionic multiple pregnancy treated with microwave ablation: a single-center experience. *Prenatal Diagnosis*.doi:10.1002/pd.5423
107. Ichizuka K, Hasegawa J, Nakamura M, et al. High-intensity focused ultrasound treatment for twin reversed arterial perfusion sequence. *Ultrasound Obstet Gynecol* 2012; 40 : 476–478.
108. Shaw CJ,Rivens L, Civale J, et al. 2019 Maternal and fetal cardiometabolic recovery following ultrasound-guided high-intensity focused ultrasound placental vascular occlusion. *J. R. Soc. Interface* 16: 20190013. <http://dx.doi.org/10.1098/rsif.2019.0013>
109. Nawapun K, Phithakwatchara N, Jaingam S, et al. Advanced ultrasound for prenatal interventions, *Ultrasonography* 2018;37:200-210.<https://doi.org/10.14366/usg.18011>

110. Seo K, Ichizuka K, Okai T, et al. Evaluation of second-generation HIFU systems for less-invasive fetal therapy in TRAP sequence. *Showa Univ Med Sci* 2017; 29 : 241–251.
111. Ichihara M, Sasaki K, Umemura S, et al. Blood flow occlusion via ultrasound image-guided high-intensity focused ultrasound and its effect on tissue perfusion. *Ultrasound Med Biol* 2007; 33 : 452–459.
112. Ichizuka K, Ando S, Ichihara M, et al. Application of high-intensity focused ultrasound for umbilical artery occlusion in a rabbit model. *Ultrasound Obstet Gynecol* 2007; 30 : 47–51.
113. Sebire NJ, Wong AE, Sepulveda W. Minimally invasive management of twin reversed arterial perfusion sequence (TRAP). *Fetal and Maternal Medicine review*. 2006;17:1-22.
114. Sepulveda W, Corral E, Aiello H, et al. Intra-fetal alcohol chemosclerosis of acardiac twins: a multicenter experience. *Fetal Diagn Ther*. 2004;19:448-52.
115. Ozenren S, Caliskan E, Corakci A, et al. Unsuccessful management of acardiac fetus with intrafetal alcohol injection. *Ultrasound Obstet Gynecol*. 2004;24:473-4
116. Quintero RA, Romero R, Reich H, et al. In utero percutaneous umbilical cord ligation in the management of complicated monochorionic multiple gestations. *Ultrasound Obstet Gynecol* 1996; 8 : 16–22.
117. Nakata M, Sumie M, Murata S, et al. Fetoscopic laser photocoagulation of placental communicating vessels for twin-reversed arterial perfusion sequence. *J Obstet Gynaecol Res* 2008; 34 : 649–652.
118. Sepulveda W, Sfeir D, Reyes M, et al. Severe polyhydramnios in twin reversed arterial perfusion sequence: successful management with intrafetal alcohol ablation of acardiac twin and amniodrainage. *Ultrasound Obstet Gynecol* 2000; 16 : 260–263.
119. Chang PJ, Liou JD, Hsieh CC, et al. Monopolar thermocoagulation in the management of acardiac twins. *Fetal Diagn Ther* 2004; 19 : 271–274.
120. Hirose M, Murata A, Kita N, et al. Successful intrauterine treatment with radiofrequency ablation in a case of acardiac twin pregnancy complicated with a hydroptic pump twin. *Ultrasound Obstet Gynecol* 2004; 23 : 509–512.
121. van Klink JMM, Koopman HM, MiddeldorpJM, et al. Long-term neurodevelopmental outcome after selective feticide in monochorionic pregnancies, *BJOG: An International Journal of Obstetrics & Gynaecology*122(11), 1517-1524 , doi: 10.1111/1471-0528.13490.
122. Ortibus E, Lopriore E, Deprest J, et al. The pregnancy and long-term neurodevelopmental outcome of monochorionic diamniotic twin gestations: a multicenter prospective cohort study from the first trimester onward. *Am J Obstet Gynecol* 2009;200:494.e1–8.