BÖLÜM **10**

SANTRAL SİNİR SİSTEMİ VASKÜLER MALFORMASYONLARI

Veysel KAYA [1]

GİRİŞ

Santral sinir sistemi (SSS) vasküler malformasyonları; sporadik olabilir veya bir genetik sendromun bileşeni olarak bulunabilir.Yüksek derecede morbidite-mortaliteye sebep olabilmekte ve cerrahi veya endovasküler girişim gerekebilmektedir (1). Uygun görüntüleme çalışmaları, malformasyonların tanısında ve bu hastaların tedavi planlarının düzenlenmesinde kritik bir role sahiptir. Yeni gelişmeler ve görüntüleme tekniklerinin kullanımındaki artışla kraniospinal çoğu vasküler malformasyon tespit edilebilir hale gelmiştir. Bu durum lezyonların tanısında, karakterizasyonunda ve zamanında tedavisinde uzmanlaşmayı gerekli kılmaktadır (2).

Yetişkinlerde en yaygın görülen vasküler beyin lezyonları arterio-venöz (AV) şantlar ve kavernöz malformasyonlar olup sırasıyla tahmini tespit edilme oranları yılda 100.000 yetişkinde 1.0 ve 0.5'tir (3,4). Spinal kord vasküler lezyonları nadir olup bunların %70'ten fazlasını spinal dural AV şantlar oluşturmaktadır (5). Vasküler malformasyonların altında yatan ana patoloji kapiller, venöz ve arteryel yatakların bütünlüğünün bozulmasıdır. Bu bütünlük kaybı, mekanik hasar gibi dış sebeplere bağlı olabilir ve/veya anjiogenez, damar gelişimi ve matürasyonu esnasında vasküler gelişimdeki defektlere bağlı olabilir (6).

Geçen yıllarla beraber birçok SSS vasküler malformasyonunun genetik temeli daha iyi açıklanmıştır. Bununla birlikte vasküler malformasyonların çoğu sporadik olarak oluşur. Bireyleri vasküler malformasyon oluşumuna ve komplikasyonlarına duyarlı kılan birçok genetik varyant tanımlanmıştır (7). Bu genetik varyantlar başlıca kan-beyin bariyer bütünlüğünü, tumor growth factor-B (TGF-B) sinyal yolunu, lokal enflamatuar cevabı, anjiogenezi ve doku remodelingini düzenler. Ayrıca Endoglin, activin-like kinase (ALK) receptor 1, somatic-activating KRAS ve RASA-1 geni SSS vasküler malformasyonu oluşumuna katkıda bulunurlar (8–10).

[1] Dr. Öğr. Üyesi, Harran Üniversitesi Tıp Fakültesi Radyoloji AD., Başkanlığı, drvkvkfk@gmail.com

KAYNAKLAR

1. McCormick WF. The Pathology of Vascular ("Arteriovenous") Malformations. J Neurosurg [Internet]. 1966 Apr;24(4):807–16. Available from: https://thejns.org/view/journals/j-neurosurg/24/4/article-p807.xml
2. Gross BA, Du R. Diagnosis and Treatment of Vascular Malformations of the Brain. Curr Treat Options Neurol [Internet]. 2014 Jan 10;16(1):279. Available from: http://link.springer.com/10.1007/s11940-013-0279-9
3. Stapf C, Labovitz DL, Sciacca RR, Mast H, Mohr JP, Sacco RL. Incidence of Adult Brain Arteriovenous Malformation Hemorrhage in a Prospective Population-Based Stroke Survey. Cerebrovasc Dis [Internet]. 2002;13(1):43–6. Available from: https://www.karger.com/Article/FullText/47745
4. Goldstein HE, Solomon RA. Epidemiology of cavernous malformations. In 2017. p. 241–7. Available from: https://linkinghub.elsevier.com/retrieve/pii/B9780444636409000230
5. Koch C. Spinal dural arteriovenous fistula. Curr Opin Neurol [Internet]. 2006 Feb;19(1):69–75. Available from: http://journals.lww.com/00019052-200602000-00012
6. Boon LM, Ballieux F, Vikkula M. Pathogenesis of Vascular Anomalies. Clin Plast Surg [Internet]. 2011 Jan;38(1):7–19. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0094129810000957
7. Wetzel-Strong SE, Detter MR, Marchuk DA. The pathobiology of vascular malformations: insights from human and model organism genetics. J Pathol [Internet]. 2017 Jan;241(2):281–93. Available from: https://onlinelibrary.wiley.com/doi/10.1002/path.4844
8. Leblanc GG, Golanov E, Awad IA, Young WL. Biology of Vascular Malformations of the Brain. Stroke [Internet]. 2009 Dec;40(12). Available from: https://www.ahajournals.org/doi/10.1161/STROKEAHA.109.563692
9. Nikolaev SI, Vetiska S, Bonilla X, Boudreau E, Jauhiainen S, Rezai Jahromi B, et al. Somatic Activating KRAS Mutations in Arteriovenous Malformations of the Brain. N Engl J Med [Internet]. 2018 Jan 18;378(3):250–61. Available from: http://www.nejm.org/doi/10.1056/NEJMoa1709449
10. Kim H, Su H, Weinsheimer S, Pawlikowska L, Young WL. Brain Arteriovenous Malformation Pathogenesis: A Response-to-Injury Paradigm. In 2011. p. 83–92. Available from: http://link.springer.com/10.1007/978-3-7091-0693-8_14
11. Solomon RA, Connolly ES. Arteriovenous Malformations of the Brain. Ropper AH, editor. N Engl J Med [Internet]. 2017 May 11;376(19):1859–66. Available from: http://www.nejm.org/doi/10.1056/NEJMra1607407
12. Laakso A, Hernesniemi J. Arteriovenous Malformations: Epidemiology and Clinical Presentation. Neurosurg Clin N Am [Internet]. 2012 Jan;23(1):1–6. Available from: https://linkinghub.elsevier.com/retrieve/pii/S104236801100115X
13. Gonzalez LF, Bristol RE, Porter RW, Spetzler RF. De novo presentation of an arteriovenous malformation. J Neurosurg [Internet]. 2005 Apr;102(4):726–9. Available from: https://thejns.org/view/journals/j-neurosurg/102/4/article-p726.xml
14. Mahajan A, Manchandia TC, Gould G, Bulsara KR. De novo arteriovenous malformations: case report and review of the literature. Neurosurg Rev [Internet]. 2010 Jan 29;33(1):115–9. Available from: http://link.springer.com/10.1007/s10143-009-0227-z
15. Al-Shahi R, Bhattacharya JJ, Currie DG, Papanastassiou V, Ritchie V, Roberts RC, et al. Prospective, Population-Based Detection of Intracranial Vascular Malformations in Adults. Stroke [Internet]. 2003 May;34(5):1163–9. Available from: https://www.ahajournals.org/doi/10.1161/01.STR.0000069018.90456.C9
16. Brown RD, Wiebers DO, Forbes G, O'Fallon WM, Piepgras DG, Marsh WR, et al. The natural history of unruptured intracranial arteriovenous malformations. J Neurosurg [Internet]. 1988 Mar;68(3):352–7. Available from: https://thejns.org/view/journals/j-neurosurg/68/3/article-p352.xml
17. Aoki N. Do intracranial arteriovenous malformations cause subarachnoid haemorrhage? Acta Neurochir (Wien) [Internet]. 1991 Sep;112(3–4):92–5. Available from: http://link.springer.com/10.1007/BF01405133
18. Modrego PJ, Pina MA, Eiras J. Delayed angiography alone is not enough to discard arteriovenous malformation after haemorrhagic stroke. Neurol Sci [Internet]. 2003 Feb 1;23(6):329–31. Available from: http://link.springer.com/10.1007/s100720300011
19. Kim H, Al-Shahi Salman R, McCulloch CE, Stapf C, Young WL. Untreated brain arteriovenous malformation: Patient-level meta-analysis of hemorrhage predictors. Neurology [Internet]. 2014 Aug 12;83(7):590–7. Available from: https://www.neurology.org/lookup/doi/10.1212/WNL.0000000000000688
20. Derdeyn CP, Zipfel GJ, Albuquerque FC, Cooke DL, Feldmann E, Sheehan JP, et al. Management of Brain Arteriovenous Malformations: A Scientific Statement for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke [Internet]. 2017 Aug;48(8). Available from: https://www.ahajournals.org/doi/10.1161/STR.0000000000000134
21. da Costa L, Wallace MC, ter Brugge KG, O'Kelly C, Willinsky RA, Tymianski M. The Natural History and Predictive Features of Hemorrhage From Brain Arteriovenous Malformations. Stroke [Internet]. 2009 Jan;40(1):100–5. Available from: https://www.ahajournals.org/doi/10.1161/STROKEAHA.108.524678
22. Stapf C, Mast H, Sciacca RR, Choi JH, Khaw A V., Connolly ES, et al. Predictors of hemorrhage in patients with untreated brain arteriovenous malformation. Neurology [Internet]. 2006 May 9;66(9):1350–5. Available from: https://www.neurology.org/lookup/doi/10.1212/01.wnl.0000210524.68507.87
23. Ondra SL, Troupp H, George ED, Schwab K. The natural history of symptomatic arteriovenous malfor-

mations of the brain: a 24-year follow-up assessment. J Neurosurg [Internet]. 1990 Sep;73(3):387–91. Available from: https://thejns.org/view/journals/j-neurosurg/73/3/article-p387.xml
24. Choi JH, Mohr JP. Brain arteriovenous malformations in adults. Lancet Neurol [Internet]. 2005 May;4(5):299–308. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1474442205700739
25. Sahlein DH, Mora P, Becske T, Huang P, Jafar JJ, Connolly ES, et al. Features Predictive of Brain Arteriovenous Malformation Hemorrhage. Stroke [Internet]. 2014 Jul;45(7):1964–70. Available from: https://www.ahajournals.org/doi/10.1161/STROKEAHA.114.005170
26. Josephson CB, White PM, Krishan A, Al-Shahi Salman R. Computed tomography angiography or magnetic resonance angiography for detection of intracranial vascular malformations in patients with intracerebral haemorrhage. In: Josephson CB, editor. Cochrane Database of Systematic Reviews [Internet]. Chichester, UK: John Wiley & Sons, Ltd; 2011. Available from: https://doi.wiley.com/10.1002/14651858.CD009372
27. Kim MS, Han DH, Kwon O-K, Oh C-W, Han MH. Clinical characteristics of dural arteriovenous fistula. J Clin Neurosci [Internet]. 2002 Mar;9(2):147–55. Available from: https://linkinghub.elsevier.com/retrieve/pii/S096758680191029X
28. Sarma D, ter Brugge K. Management of intracranial dural arteriovenous shunts in adults. Eur J Radiol [Internet]. 2003 Jun;46(3):206–20. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0720048X03000925
29. Kojima T, Miyachi S, Sahara Y, Nakai K, Okamoto T, Hattori K, et al. The relationship between venous hypertension and expression of vascular endothelial growth factor: hemodynamic and immunohistochemical examinations in a rat venous hypertension model. Surg Neurol [Internet]. 2007 Sep;68(3):277–84. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0090301906011499
30. Chung SJ, Kim JS, Kim JC, Lee SK, Kwon SU, Lee MC, et al. Intracranial Dural Arteriovenous Fistulas: Analysis of 60 Patients. Cerebrovasc Dis [Internet]. 2002;13(2):79–88. Available from: https://www.karger.com/Article/FullText/47755
31. van Dijk JMC, TerBrugge KG, Willinsky RA, Wallace MC. Clinical Course of Cranial Dural Arteriovenous Fistulas With Long-Term Persistent Cortical Venous Reflux. Stroke [Internet]. 2002 May;33(5):1233–6. Available from: https://www.ahajournals.org/doi/10.1161/01.STR.0000014772.02908.44
32. Borden JA, Wu JK, Shucart WA. A proposed classification for spinal and cranial dural arteriovenous fistulous malformations and implications for treatment. J Neurosurg [Internet]. 1995 Feb;82(2):166–79. Available from: https://thejns.org/view/journals/j-neurosurg/82/2/article-p166.xml
33. Cognard C, Gobin YP, Pierot L, Bailly AL, Houdart E, Casasco A, et al. Cerebral dural arteriovenous fistulas: clinical and angiographic correlation with a revised classification of venous drainage. Radiology [Internet]. 1995 Mar;194(3):671–80. Available from: http://pubs.rsna.org/doi/10.1148/radiology.194.3.7862961
34. Gandhi D, Chen J, Pearl M, Huang J, Gemmete JJ, Kathuria S. Intracranial Dural Arteriovenous Fistulas: Classification, Imaging Findings, and Treatment. Am J Neuroradiol [Internet]. 2012 Jun;33(6):1007–13. Available from: http://www.ajnr.org/lookup/doi/10.3174/ajnr.A2798
35. Bulters DO, Mathad N, Culliford D, Millar J, Sparrow OC. The Natural History of Cranial Dural Arteriovenous Fistulae With Cortical Venous Reflux—The Significance of Venous Ectasia. Neurosurgery [Internet]. 2012 Feb 1;70(2):312–9. Available from: https://academic.oup.com/neurosurgery/article/70/2/312/2743981
36. Piechowiak E, Zibold F, Dobrocky T, Mosimann PJ, Bervini D, Raabe A, et al. Endovascular Treatment of Dural Arteriovenous Fistulas of the Transverse and Sigmoid Sinuses Using Transarterial Balloon-Assisted Embolization Combined with Transvenous Balloon Protection of the Venous Sinus. Am J Neuroradiol [Internet]. 2017 Oct;38(10):1984–9. Available from: http://www.ajnr.org/lookup/doi/10.3174/ajnr.A5333
37. Barrow DL, Spector RH, Braun IF, Landman JA, Tindall SC, Tindall GT. Classification and treatment of spontaneous carotid-cavernous sinus fistulas. J Neurosurg [Internet]. 1985 Feb;62(2):248–56. Available from: https://thejns.org/view/journals/j-neurosurg/62/2/article-p248.xml
38. Miller NR. Article--Diagnosis and management of dural carotid–cavernous sinus fistulas. Neurosurg Focus [Internet]. 2007 Nov;23(5):E13. Available from: http://thejns.org/doi/abs/10.3171/FOC-07/11/E13
39. Keizer RJW. Carotid-cavernous and orbital arteriovenous fistulas: ocular features, diagnostic and hemodynamic considerations in relation to visual impairment and morbidity. Orbit [Internet]. 2003 Jan 8;22(2):121–42. Available from: http://www.tandfonline.com/doi/full/10.1076/orbi.22.2.121.14315
40. Zafar A, Quadri SA, Farooqui M, Ikram A, Robinson M, Hart BL, et al. Familial Cerebral Cavernous Malformations. Stroke [Internet]. 2019 May;50(5):1294–301. Available from: https://www.ahajournals.org/doi/10.1161/STROKEAHA.118.022314
41. Clatterbuck RE, Moriarity JL, Elmaci I, Lee RR, Breiter SN, Rigamonti D. Dynamic nature of cavernous malformations: a prospective magnetic resonance imaging study with volumetric analysis. J Neurosurg [Internet]. 2000 Dec;93(6):981–6. Available from: https://thejns.org/view/journals/j-neurosurg/93/6/article-p981.xml
42. Uranishi R, Baev NI, Ng P-Y, Kim JH, Awad IA. Expression of Endothelial Cell Angiogenesis Receptors in Human Cerebrovascular Malformations. Neurosurgery [Internet]. 2001 Feb 1;48(2):359–68. Available from: https://academic.oup.com/neurosurgery/article/48/2/359/2751644
43. Clatterbuck RE. Ultrastructural and immunocytochemical evidence that an incompetent blood-brain

barrier is related to the pathophysiology of cavernous malformations. J Neurol Neurosurg Psychiatry [Internet]. 2001 Aug 1;71(2):188–92. Available from: https://jnnp.bmj.com/lookup/doi/10.1136/jnnp.71.2.188
44. Detwiler PW, Porter RW, Zabramski JM, Spetzler RF. De novo formation of a central nervous system cavernous malformation: implications for predicting risk of hemorrhage. J Neurosurg [Internet]. 1997 Oct;87(4):629–32. Available from: https://thejns.org/view/journals/j-neurosurg/87/4/article-p629.xml
45. Aboian MS, Daniels DJ, Rammos SK, Pozzati E, Lanzino G. The putative role of the venous system in the genesis of vascular malformations. Neurosurg Focus [Internet]. 2009 Nov;27(5):E9. Available from: https://thejns.org/view/journals/neurosurg-focus/27/5/article-pE9.xml
46. Akers A, Al-Shahi Salman R, A. Awad I, Dahlem K, Flemming K, Hart B, et al. Synopsis of Guidelines for the Clinical Management of Cerebral Cavernous Malformations: Consensus Recommendations Based on Systematic Literature Review by the Angioma Alliance Scientific Advisory Board Clinical Experts Panel. Neurosurgery [Internet]. 2017 May;80(5):665–80. Available from: https://journals.lww.com/00006123-201705000-00012
47. Fisher OS, Boggon TJ. Signaling pathways and the cerebral cavernous malformations proteins: lessons from structural biology. Cell Mol Life Sci [Internet]. 2014 May 29;71(10):1881–92. Available from: http://link.springer.com/10.1007/s00018-013-1532-9
48. Flemming KD, Graff-Radford J, Aakre J, Kantarci K, Lanzino G, Brown RD, et al. Population-Based Prevalence of Cerebral Cavernous Malformations in Older Adults. JAMA Neurol [Internet]. 2017 Jul 1;74(7):801. Available from: http://archneur.jamanetwork.com/article.aspx?doi=10.1001/jamaneurol.2017.0439
49. Haasdijk RA, Cheng C, Maat-Kievit AJ, Duckers HJ. Cerebral cavernous malformations: from molecular pathogenesis to genetic counselling and clinical management. Eur J Hum Genet [Internet]. 2012 Feb 10;20(2):134–40. Available from: https://www.nature.com/articles/ejhg2011155
50. Greenberg SM, Vernooij MW, Cordonnier C, Viswanathan A, Al-Shahi Salman R, Warach S, et al. Cerebral microbleeds: a guide to detection and interpretation. Lancet Neurol [Internet]. 2009 Feb;8(2):165–74. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1474442209700134
51. Petersen TA, Morrison LA, Schrader RM, Hart BL. Familial versus Sporadic Cavernous Malformations: Differences in Developmental Venous Anomaly Association and Lesion Phenotype. Am J Neuroradiol [Internet]. 2010 Feb;31(2):377–82. Available from: http://www.ajnr.org/lookup/doi/10.3174/ajnr.A1822
52. Morris Z, Whiteley WN, Longstreth WT, Weber F, Lee Y-C, Tsushima Y, et al. Incidental findings on brain magnetic resonance imaging: systematic review and meta-analysis. BMJ [Internet]. 2009 Aug 17;339(aug17 1):b3016–b3016. Available from: https://www.bmj.com/lookup/doi/10.1136/bmj.b3016
53. Moore SA, Brown RD, Christianson TJH, Flemming KD. Long-term natural history of incidentally discovered cavernous malformations in a single-center cohort. J Neurosurg [Internet]. 2014 May;120(5):1188–92. Available from: https://thejns.org/view/journals/j-neurosurg/120/5/article-p1188.xml
54. Gross BA, Du R. Cerebral cavernous malformations: natural history and clinical management. Expert Rev Neurother [Internet]. 2015 Jul 3;15(7):771–7. Available from: http://www.tandfonline.com/doi/full/10.1586/14737175.2015.1055323
55. Maraire JN, Awad IA. Intracranial Cavernous Malformations. Neurosurgery [Internet]. 1995 Oct 1;37(4):591–605. Available from: https://academic.oup.com/neurosurgery/article/37/4/591/2798683
56. Sayama CM, Osborn AG, Chin SS, Couldwell WT. Capillary telangiectasias: clinical, radiographic, and histopathological features. J Neurosurg [Internet]. 2010 Oct;113(4):709–14. Available from: https://thejns.org/view/journals/j-neurosurg/113/4/article-p709.xml
57. Lee RR, Becher MW, Benson ML, Rigamonti D. Brain capillary telangiectasia: MR imaging appearance and clinicohistopathologic findings. Radiology [Internet]. 1997 Dec;205(3):797–805. Available from: http://pubs.rsna.org/doi/10.1148/radiology.205.3.9393538
58. Gross BA, Puri AS, Popp AJ, Du R. Cerebral capillary telangiectasias: a meta-analysis and review of the literature. Neurosurg Rev [Internet]. 2013 Apr 29;36(2):187–94. Available from: http://link.springer.com/10.1007/s10143-012-0435-9
59. McCormick PW, Spetzler RF, Johnson PC, Drayer BP. Cerebellar hemorrhage associated with capillary telangiectasia and venous angioma: A case report. Surg Neurol [Internet]. 1993 Jun;39(6):451–7. Available from: https://linkinghub.elsevier.com/retrieve/pii/0090301993900305
60. McCormick WF, Hardman JM, Boulter TR. Vascular Malformations ("Angiomas") of the Brain, with Special Reference to Those Occurring in the Posterior Fossa. J Neurosurg [Internet]. 1968 Mar;28(3):241–51. Available from: https://thejns.org/view/journals/j-neurosurg/28/3/article-p241.xml
61. Jones KM, Mulkern R V, Schwartz RB, Oshio K, Barnes PD, Jolesz FA. Fast spin-echo MR imaging of the brain and spine: current concepts. Am J Roentgenol [Internet]. 1992 Jun;158(6):1313–20. Available from: https://www.ajronline.org/doi/10.2214/ajr.158.6.1590133
62. Mulkern RV, Wong STS, Winalski C, Jolesz FA. Contrast manipulation and artifact assessment of 2D and 3D RARE sequences. Magn Reson Imaging [Internet]. 1990 Jan;8(5):557–66. Available from: https://linkinghub.elsevier.com/retrieve/pii/0730725X9090132L
63. Mooney MA, Zabramski JM. Developmental venous anomalies. In 2017. p. 279–82. Available from: https://linkinghub.elsevier.com/retrieve/pii/B9780444636409000266
64. McLaughlin MR, Kondziolka D, Flickinger JC, Luns-

ford S, Lunsford LD. The Prospective Natural History of Cerebral Venous Malformations. Neurosurgery [Internet]. 1998 Aug;43(2):195–200. Available from: https://academic.oup.com/neurosurgery/article-lookup/doi/10.1097/00006123-199808000-00001

65. Garner TB, Curling O Del, Kelly DL, Laster DW. The natural history of intracranial venous angiomas. J Neurosurg [Internet]. 1991 Nov;75(5):715–22. Available from: https://thejns.org/view/journals/j-neurosurg/75/5/article-p715.xml
66. Hammoud D, Beauchamp N, Wityk R, Yousem D. Ischemic Complication of a Cerebral Developmental Venous Anomaly: Case Report and Review of the Literature. J Comput Assist Tomogr [Internet]. 2002 Jul;26(4):633–6. Available from: http://journals.lww.com/00004728-200207000-00028
67. Hon JML, Bhattacharya JJ, Counsell CE, Papanastassiou V, Ritchie V, Roberts RC, et al. The Presentation and Clinical Course of Intracranial Developmental Venous Anomalies in Adults. Stroke [Internet]. 2009 Jun;40(6):1980–5. Available from: https://www.ahajournals.org/doi/10.1161/STROKEAHA.108.533034
68. San Millán Ruíz D, Yilmaz H, Gailloud P. Cerebral developmental venous anomalies: Current concepts. Ann Neurol [Internet]. 2009 Sep;66(3):271–83. Available from: https://onlinelibrary.wiley.com/doi/10.1002/ana.21754
69. Moriarity JL, Wetzel M, Clatterbuck RE, Javedan S, Sheppard J-M, Hoenig-Rigamonti K, et al. The Natural History of Cavernous Malformations: A Prospective Study of 68 Patients. Neurosurgery [Internet]. 1999 Jun;44(6):1166–71. Available from: http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00006123-199906000-00003
70. Brown RD, Flemming KD, Meyer FB, Cloft HJ, Pollock BE, Link MJ. Natural History, Evaluation, and Management of Intracranial Vascular Malformations. Mayo Clin Proc [Internet]. 2005 Feb;80(2):269–81. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0025619611615152
71. Akram H, Prezerakos G, Haliasos N, O'Donovan D, Low H. Sinus pericranii: an overview and literature review of a rare cranial venous anomaly (A review of the existing literature with case examples). Neurosurg Rev [Internet]. 2012 Jan 9;35(1):15–26. Available from: http://link.springer.com/10.1007/s10143-011-0325-6
72. Ohta T, Waga S, Handa H, Nishimura S, Mitani T. Sinus pericranii. J Neurosurg [Internet]. 1975 Jun;42(6):704–12. Available from: https://thejns.org/view/journals/j-neurosurg/42/6/article-p704.xml
73. Nozaki T, Nosaka S, Miyazaki O, Makidono A, Yamamoto A, Niwa T, et al. Syndromes Associated with Vascular Tumors and Malformations: A Pictorial Review. RadioGraphics [Internet]. 2013 Jan;33(1):175–95. Available from: http://pubs.rsna.org/doi/10.1148/rg.331125052
74. Bharatha A, Faughnan ME, Kim H, Pourmohamad T, Krings T, Bayrak-Toydemir P, et al. Brain Arteriovenous Malformation Multiplicity Predicts the Diagnosis of Hereditary Hemorrhagic Telangiectasia. Stroke [Internet]. 2012 Jan;43(1):72–8. Available from: https://www.ahajournals.org/doi/10.1161/STROKEAHA.111.629865
75. Oza VS, Wang E, Berenstein A, Waner M, Lefton D, Wells J, et al. PHACES Association: A Neuroradiologic Review of 17 Patients. Am J Neuroradiol [Internet]. 2008 Apr;29(4):807–13. Available from: http://www.ajnr.org/lookup/doi/10.3174/ajnr.A0937
76. Comi A. Current Therapeutic Options in Sturge-Weber Syndrome. Semin Pediatr Neurol [Internet]. 2015 Dec;22(4):295–301. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1071909115000728
77. Razek AAKA. Vascular neurocutaneous disorders: neurospinal and craniofacial imaging findings. Jpn J Radiol [Internet]. 2014 Sep;32(9):519–28. Available from: http://link.springer.com/10.1007/s11604-014-0345-6