Angiographically negative subarachnoid hemorrhage

- Angiographically occult catastrophe: A rare case of aspergillus-induced subarachnoid hemorrhage without mycotic aneurysms following apparent bacterial abscess resolution
- Ruptured Basilar Artery Perforator Aneurysm: Nightmare of a Treating Neurosurgeon
- Prognostic Factors and Imaging Strategies in Unknown Subarachnoid Hemorrhage: A Retrospective Study
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- Differences in internal carotid artery tortuosity in ruptured and unruptured anterior circulation aneurysms. A matched case-control study
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see also Non-aneurysmal subarachnoid hemorrhage.

“Spontaneous angiogram-negative subarachnoid hemorrhage” refers to a type of subarachnoid hemorrhage (SAH) that occurs without a detectable vascular abnormality on angiography. Subarachnoid hemorrhage is bleeding into the subarachnoid space, which is the space between the arachnoid membrane and the pia mater surrounding the brain.

In some cases of subarachnoid hemorrhage, the source of bleeding can be identified through cerebral angiography, a diagnostic imaging test that visualizes the blood vessels in the brain. However, when the angiogram is negative, it means that no vascular abnormality or aneurysm is apparent.

“Spontaneous” in this context means that the hemorrhage occurred without a clear external cause, such as trauma. Identifying the cause of spontaneous angiogram-negative subarachnoid hemorrhage can be challenging, and in some cases, the source of bleeding may remain unknown.

This condition is significant because subarachnoid hemorrhage can have serious consequences, and determining its cause is crucial for appropriate management and treatment decisions. Close monitoring and additional diagnostic tests may be necessary to identify potential underlying causes or contributing factors in cases of spontaneous angiogram-negative subarachnoid hemorrhage.

In approximately 15 % of cases, nor aneurysm or other vascular malformation can be identified by cerebral angiography as origin of the hemorrhage, and these are commonly defined as idiopathic subarachnoid hemorrhage SAH (ISAH). Because of the negative angiography, limited extension of the bleeding with prevalent prepontine pattern and the benign prognosis, the venous causes has been preferred rather than the arterial ones.

In the past, several possible explanations for idiopathic subarachnoid hemorrhage (ISAH) have been proposed; however, neuroimaging studies have never provided conclusive data about the structural cause of the bleeding [1].

Idiopathic subarachnoid hemorrhage is not clearly understood, and reasons suggested include the repair of a microaneurysm, the presence of vasospasm that prevents the aneurysm from filling up, the dissection of the basilary artery or other arteries, or bleeding from the perimesencephalic or other deep veins [2].

Repeat angiogram is probably not necessary in patients with perimesencephalic subarachnoid hemorrhage and they tend to have better outcomes. Classic-SAH pattern of bleed is associated with fair chances of the underlying pathology and a repeat angiogram is recommended in these cases and they have a poorer outcome [3].

The overall incidence of true aneurysms in patients with angiographically negative subarachnoid hemorrhage is low (2.9%). Initial bleeding pattern strongly correlates with diagnostic yield and clinical outcome. The diffuse bleeding pattern is associated with significantly higher diagnostic yield, more in-hospital complications, and worse clinical outcomes. Patients with initial imaging characteristics other than diffuse pattern SAH developed few disease-related complications, with the majority of in-hospital adverse events treatment related [4].

Standard magnetic resonance imaging (MRI) rarely identifies the cause of hemorrhage in patients with an angiogram-negative, non perimesencephalic subarachnoid hemorrhage (SAH). Yet up to 10 % of these patients have recurrent hemorrhage

Vessel wall-MRI showed abnormalities in seven patients with angiogram-negative SAH. These findings did not alter patient management, but the findings may be useful for other physicians who choose to perform vessel wall-MRI in this patient population [5].

The basal vein of Rosenthal (BVR) variant is a potential origin of bleeding in angiogram-negative subarachnoid hemorrhage (AN-SAH). perimesencephalic angiographically negative subarachnoid hemorrhage patients have a higher rate and degree of BVR variants compared with patients with non-perimesencephalic subarachnoid hemorrhage . Those AN-SAH patients with bilateral normal BVRs are more likely to be of arterial origin and are at risk of suffering from rebleeding and a poor outcome [6]

Outcome

Angiographically negative subarachnoid hemorrhage outcome.

Case series

Achrén et al. retrospectively reviewed all adult patients admitted to a neurosurgical intensive care

unit during 2004-2018 due to spontaneous angiogram-negative SAH. The primary outcome was a dichotomized Glasgow Outcome Scale (GOS) at 3 months. They assessed factors that were associated with outcomes using multivariable logistic regression analysis.

Of the 108 patients included, 84% had a favorable outcome (GOS 4-5), and mortality was 5% within 1 year. The median age was 58 years, 51% were female, and 93% had a low-grade SAH (World Federation of Neurosurgical Societies grading I-III). The median number of angiograms performed per patient was two. Thirty percent of patients showed radiological signs of acute hydrocephalus, 28% were acutely treated with an external ventricular drain, 13% received active vasospasm treatment and 17% received a permanent shunt. In the multivariable logistic regression model, only acute hydrocephalus was associated with unfavorable outcomes (odds ratio = 4.05, 95% confidence interval = 1.05-15.73). Two patients had a new bleeding episode.

Subarachnoid hemorrhage complications such as hydrocephalus and vasospasm are common after angiographically negative subarachnoid hemorrhage. Still, most patients had a favorable outcome. Only acute hydrocephalus was associated with unfavorable outcomes. The high rate of SAH-related complications highlights the need for neurosurgical care in these patients [7)]

Unclassified

2: Howard BM, Hu R, Barrow JW, Barrow DL. Comprehensive review of imaging of intracranial aneurysms and angiographically negative subarachnoid hemorrhage. Neurosurg Focus. 2019 Dec 1;47(6):E20. doi: 10.3171/2019.9.FOCUS19653. PubMed PMID: 31786554.

3: Lee SH, Kwun BD, Ryu J, Chung Y, Jeong WJ, Park CK, Lee KM, Kim EJ, Choi SK. Incidental Microaneurysms During Microvascular Surgery: Incidence, Treatment, and Significance. World Neurosurg. 2020 Jan;133:e149-e155. doi: 10.1016/j.wneu.2019.08.159. Epub 2019 Aug 30. PubMed PMID: 31476473.

4: Zolnourian A, Borg N, Akhigbe T, Macdonald J, Bulters D. Vessel Wall Imaging After Subarachnoid Hemorrhage in Patients with Multiple Intracranial Aneurysms: A Cautionary Case. World Neurosurg. 2019 Jul;127:414-417. doi: 10.1016/j.wneu.2019.04.130. Epub 2019 Apr 23. PubMed PMID: 31026656.

5: Nesvick CL, Oushy S, Rinaldo L, Wijdicks EF, Lanzino G, Rabinstein AA. Clinical complications and outcomes of angiographically negative subarachnoid hemorrhage. Neurology. 2019 May 14;92(20):e2385-e2394. doi: 10.1212/WNL.0000000000007501. Epub 2019 Apr 17. PubMed PMID: 30996058.

6: Burkhardt JK, Chua MH, Winkler EA, Rutledge WC, Lawton MT. Incidence, classification, and treatment of angiographically occult intracranial aneurysms found during microsurgical aneurysm clipping of known aneurysms. J Neurosurg. 2019 Feb 22;132(2):434-441. doi: 10.3171/2018.11.JNS182416. PubMed PMID: 30797191.

7: Burke T, Hughes S, Carr A, Javadpour M, Pender N. A Systematic Review of Cognitive Outcomes in Angiographically Negative Subarachnoid Haemorrhage. Neuropsychol Rev. 2018 Dec;28(4):453-469. doi: 10.1007/s11065-018-9389-1. Epub 2018 Oct 23. PubMed PMID: 30353304.

8: Buunk AM, Groen RJM, Wijbenga RA, Ziengs AL, Metzemaekers JDM, van Dijk JMC, Spikman JM. Mental versus physical fatigue after subarachnoid hemorrhage: differential associations with outcome. Eur J Neurol. 2018 Nov;25(11):1313-e113. doi: 10.1111/ene.13723. Epub 2018 Jul 25. PubMed PMID:

29924481; PubMed Central PMCID: PMC6221080.

9: Sadigh G, Menon RK, Bhojak M, Aladi A, Mossa-Basha M, Wu L, Lehman VT, Brinjikji W, Dehkharghani S, Derakhshani A, Mossa-Basha F, Allen JW. Radiological Management of Angiographically Negative, Spontaneous Intracranial Subarachnoid Hemorrhage: A Multicenter Study of Utilization and Diagnostic Yield. Neurosurgery. 2019 Jul 1;85(1):126-133. doi: 10.1093/neuros/nyy225. PubMed PMID: 29850838.

10: Sadigh G, Holder CA, Switchenko JM, Dehkharghani S, Allen JW. Is there added value in obtaining cervical spine MRI in the assessment of nontraumatic angiographically negative subarachnoid hemorrhage? A retrospective study and meta-analysis of the literature. J Neurosurg. 2018 Sep;129(3):670-676. doi: 10.3171/2017.4.JNS163114. Epub 2017 Oct 13. PubMed PMID: 29027857; PubMed Central PMCID: PMC5899067.

11: Uneda A, Yabuno S, Kanda T, Suzuki K, Hirashita K, Yunoki M, Yoshino K. Cavernous angioma presenting with subarachnoid hemorrhage which was diffusely distributed in the basal cisterns and mimicked intracranial aneurysm rupture. Surg Neurol Int. 2017 Aug 22;8:202. doi: 10.4103/sni.sni_210_17. eCollection 2017. PubMed PMID: 28904829; PubMed Central PMCID: PMC5590347.

12: Buunk AM, Groen RJM, Veenstra WS, Metzemaekers JDM, van der Hoeven JH, van Dijk JMC, Spikman JM. Cognitive deficits after aneurysmal and angiographically negative subarachnoid hemorrhage: Memory, attention, executive functioning, and emotion recognition. Neuropsychology. 2016 Nov;30(8):961-969. doi: 10.1037/neu0000296. Epub 2016 May 19. PubMed PMID: 27195987.

13: Jalali A, Srinivasan VM, Chinnadurai P, Kan P, Arthur A, Duckworth EA. Two-color 3D-3D fusion of selective rotational cerebral angiograms: a novel approach to imaging in cerebrovascular neurosurgery. J Neurointerv Surg. 2016 Oct;8(10):1056-60. doi: 10.1136/neurintsurg-2015-011963. Epub 2015 Nov 16. PubMed PMID: 26574481.

14: Canneti B, Mosqueira AJ, Nombela F, Gilo F, Vivancos J. Spontaneous Subarachnoid Hemorrhage with Negative Angiography Managed in a Stroke Unit: Clinical and Prognostic Characteristics. J Stroke Cerebrovasc Dis. 2015 Nov;24(11):2484-90. doi: 10.1016/j.jstrokecerebrovasdis.2015.06.011. Epub 2015 Sep 12. PubMed PMID: 26375795.

15: Narvid J, Amans MR, Cooke DL, Hetts SW, Dillon WP, Higashida RT, Dowd CF, Halbach VV. Spontaneous retroclival hematoma: a case series. J Neurosurg. 2016 Mar;124(3):716-9. doi: 10.3171/2015.2.JNS142221. Epub 2015 Aug 7. PubMed PMID: 26252463.

16: Kubota H, Sanada Y, Nagatsuka K, Kato A. A case of angiographically occult, distal small anterior inferior cerebellar artery aneurysm. Surg Neurol Int. 2015 Jun 4;6:97. doi: 10.4103/2152-7806.158206. eCollection 2015. PubMed PMID: 26110079; PubMed Central PMCID: PMC4462615.

17: Williamson RW, Wilson DA, Abla AA, McDougall CG, Nakaji P, Albuquerque FC, Spetzler RF. Clinical characteristics and long-term outcomes in patients with ruptured posterior inferior cerebellar artery aneurysms: a comparative analysis. J Neurosurg. 2015 Aug;123(2):441-5. doi: 10.3171/2014.10.JNS141079. Epub 2015 Apr 17. PubMed PMID: 25884260.

18: Elhadi AM, Zabramski JM, Almefty KK, Mendes GA, Nakaji P, McDougall CG, Albuquerque FC, Preul MC, Spetzler RF. Spontaneous subarachnoid hemorrhage of unknown origin: hospital course and long-

term clinical and angiographic follow-up. J Neurosurg. 2015 Mar;122(3):663-70. doi: 10.3171/2014.10.JNS14175. Epub 2014 Dec 19. PubMed PMID: 25526276.

19: Sprenker C, Patel J, Camporesi E, Vasan R, Van Loveren H, Chen H, Agazzi S. Medical and neurologic complications of the current management strategy of angiographically negative nontraumatic subarachnoid hemorrhage patients. J Crit Care. 2015 Feb;30(1):216.e7-11. doi: 10.1016/j.jcrc.2014.08.011. Epub 2014 Aug 28. PubMed PMID: 25241932.

20: Chen M. Detection of angiographically occult, ruptured cerebral aneurysms: case series and literature review. J Neurointerv Surg. 2014 Dec;6(10):744-7. doi: 10.1136/neurintsurg-2013-010988. Epub 2013 Dec 5. Review. PubMed PMID: 24311697.

21: Bakker NA, Groen RJ, Foumani M, Uyttenboogaart M, Eshghi OS, Metzemaekers JD, Lammers N, Luijckx GJ, Van Dijk JM. Repeat digital subtraction angiography after a negative baseline assessment in nonperimesencephalic subarachnoid hemorrhage: a pooled data meta-analysis. J Neurosurg. 2014 Jan;120(1):99-103. doi: 10.3171/2013.9.JNS131337. Epub 2013 Oct 25. Review. PubMed PMID: 24160474.

22: Jagadeesan BD, Kadkhodayan Y, Delgado Almandoz JE, Wallace A, Cross DT 3rd, Derdeyn CP, Zipfel GJ, Dacey RG Jr, Moran CJ. Differences in the basilar artery bifurcation angle among patients who present with a ruptured aneurysm at the top of the basilar artery and patients with perimesencephalic subarachnoid hemorrhage: a retrospective cross-sectional study. Neurosurgery. 2013 Jul;73(1):2-7. doi: 10.1227/01.neu.0000429837.45820.9c. PubMed PMID: 23615096.

23: Serrone J, Jimenez L, Andaluz N, Abruzzo TA, Zuccarello M, Ringer AJ. Management of vasospasm in ruptured unsecured intracranial vascular lesions: review of 10 cases. J Neurointerv Surg. 2014 Mar;6(2):108-14. doi: 10.1136/neurintsurg-2012-010591. Epub 2013 Jan 29. Review. PubMed PMID: 23361616.

24: Tsermoulas G, Flett L, Gregson B, Mitchell P. Immediate coma and poor outcome in subarachnoid haemorrhage are independently associated with an aneurysmal origin. Clin Neurol Neurosurg. 2013 Aug;115(8):1362-5. doi: 10.1016/j.clineuro.2012.12.019. Epub 2013 Jan 14. PubMed PMID: 23332204.

25: Dalbjerg SM, Larsen CC, Romner B. Risk factors and short-term outcome in patients with angiographically negative subarachnoid hemorrhage. Clin Neurol Neurosurg. 2013 Aug;115(8):1304-7. doi: 10.1016/j.clineuro.2012.12.014. Epub 2013 Jan 11. PubMed PMID: 23318019.

26: Joki T, Ohashi S, Mori R, Sakai H, Fujigasaki J, Matsushima S, Abe T. [Intracranial malignant glioma presenting as subarachnoid hemorrhage]. No Shinkei Geka. 2013 Jan;41(1):37-43. Review. Japanese. PubMed PMID: 23269254.

27: Gross BA, Lin N, Frerichs KU, Du R. Vasospasm after spontaneous angiographically negative subarachnoid hemorrhage. Acta Neurochir (Wien). 2012 Jul;154(7):1127-33. doi: 10.1007/s00701-012-1383-4. Epub 2012 May 16. Review. PubMed PMID: 22588341.

28: Wang HC, Lin WC, Yang TM, Chen WF, Lin YJ, Tsai NW, Chang WN, Lu CH. Time course of cerebral hemodynamics in aneurysmal subarachnoid hemorrhage. J Clin Ultrasound. 2012 Feb;40(2):91-8. doi: 10.1002/jcu.20900. Epub 2011 Nov 21. PubMed PMID: 22102409.

29: Prestigiacomo CJ, Sabit A, He W, Jethwa P, Gandhi C, Russin J. Three dimensional CT angiography versus digital subtraction angiography in the detection of intracranial aneurysms in subarachnoid hemorrhage. J Neurointerv Surg. 2010 Dec;2(4):385-9. doi: 10.1136/jnis.2010.002246. Epub 2010 Jun 24. PubMed PMID: 21990653.

30: Hui FK, Schuette AJ, Lieber M, Spiotta AM, Moskowitz SI, Barrow DL, Cawley CM. ε-Aminocaproic acid in angiographically negative subarachnoid hemorrhage patients is safe: a retrospective review of 83 consecutive patients. Neurosurgery. 2012 Mar;70(3):702-5; discussion 705-6. doi: 10.1227/NEU.0b013e3182358cca. PubMed PMID: 21904257.

31: Kim JH, Lee SH, Kim ES, Eoh W. Angiographically occult vascular malformation of the cauda equina presenting massive spinal subdural and subarachnoid hematoma. J Korean Neurosurg Soc. 2011 Jun;49(6):373-6. doi: 10.3340/jkns.2011.49.6.373. Epub 2011 Jun 30. PubMed PMID: 21887399; PubMed Central PMCID: PMC3158484.

32: Grand W, Chamczuk AJ, Leonardo J, Snyder KV. Endoscopic third ventriculostomy for hydrocephalus after perimesencephalic subarachnoid hemorrhage: initial experience in three patients. Acta Neurochir (Wien). 2011 Oct;153(10):2049-55; discussion 2055-6. doi: 10.1007/s00701-011-1106-2. Epub 2011 Jul 31. PubMed PMID: 21805286.

33: Lazaridis C, Bodle J, Chaudry I, Hays A, Chalela J. Familial nontraumatic, nonaneurysmal subarachnoid hemorrhage: a report on three first-degree siblings. J Neurosurg. 2011 Sep;115(3):621-3. doi: 10.3171/2011.5.JNS1119. Epub 2011 Jun 3. PubMed PMID: 21639697.

34: Fontanella M, Rainero I, Panciani PP, Schatlo B, Benevello C, Garbossa D, Carlino C, Valfrè W, Griva F, Bradac GB, Ducati A. Subarachnoid hemorrhage and negative angiography: clinical course and long-term follow-up. Neurosurg Rev. 2011 Oct;34(4):477-84. doi: 10.1007/s10143-011-0323-8. Epub 2011 May 24. PubMed PMID: 21607573.

35: Hui FK, Schuette AJ, Moskowitz SI, Gupta R, Spiotta AM, Obuchowski NA, Cawley CM. Antithrombotic states and outcomes in patients with angiographically negative subarachnoid hemorrhage. Neurosurgery. 2011 Jan;68(1):125-30; discussion 130-1. doi: 10.1227/NEU.0b013e3181fd82b6. PubMed PMID: 21150758.

36: Ji C, Ahn JG, Huh HY, Park CK. Cervical schwannoma presenting with acute intracranial subarachnoid hemorrhage. J Korean Neurosurg Soc. 2010 Feb;47(2):137-9. doi: 10.3340/jkns.2010.47.2.137. Epub 2010 Feb 28. PubMed PMID: 20224714; PubMed Central PMCID: PMC2836450.

37: Weyerbrock A, Woznica M, Rosahl SK, Berlis A. Aneurysmal and non-aneurysmal SAH–is initial computed tomography predictive? Rofo. 2009 Sep;181(9):881-7. doi: 10.1055/s-0028-1109355. Epub 2009 Apr 28. PubMed PMID: 19401973.

38: Hui FK, Tumialán LM, Tanaka T, Cawley CM, Zhang YJ. Clinical differences between angiographically negative, diffuse subarachnoid hemorrhage and perimesencephalic subarachnoid hemorrhage. Neurocrit Care. 2009;11(1):64-70. doi: 10.1007/s12028-009-9203-2. Epub 2009 Mar 10. PubMed PMID: 19277905.

39: Kim GH, Kellner CP, Hahn DK, Desantis BM, Musabbir M, Starke RM, Rynkowski M, Komotar RJ, Otten ML, Sciacca R, Schmidt JM, Mayer SA, Connolly ES Jr. Monocyte chemoattractant protein-1 predicts outcome and vasospasm following aneurysmal subarachnoid hemorrhage. J Neurosurg. 2008 Jul;109(1):38-43. doi: 10.3171/JNS/2008/109/7/0038. PubMed PMID: 18593272.

40: van Rooij WJ, Peluso JP, Sluzewski M, Beute GN. Additional value of 3D rotational angiography in angiographically negative aneurysmal subarachnoid hemorrhage: how negative is negative? AJNR Am J Neuroradiol. 2008 May;29(5):962-6. doi: 10.3174/ajnr.A0972. Epub 2008 Feb 7. PubMed PMID:

18258701.

41: Little AS, Garrett M, Germain R, Farhataziz N, Albuquerque FC, McDougall CG, Zabramski JM, Nakaji P, Spetzler RF. Evaluation of patients with spontaneous subarachnoid hemorrhage and negative angiography. Neurosurgery. 2007 Dec;61(6):1139-50; discussion 1150-1. PubMed PMID: 18162892.

42: Kakarla UK, Maughan PH, Deshmukh VR, Spetzler RF. Giant, partially thrombosed aneurysm develops after remote angiographically negative subarachnoid hemorrhage: case report. Neurosurgery. 2007 Mar;60(3):E572; discussion E572. PubMed PMID: 17327766.

43: Aviv RI, Shad A, Tomlinson G, Niemann D, Teddy PJ, Molyneux AJ, Byrne JV. Cervical dural arteriovenous fistulae manifesting as subarachnoid hemorrhage: report of two cases and literature review. AJNR Am J Neuroradiol. 2004 May;25(5):854-8. Review. PubMed PMID: 15140735.

44: Parmar H, Pang BC, Lim CC, Chng SM, Tan KK. Spinal schwannoma with acute subarachnoid hemorrhage: a diagnostic challenge. AJNR Am J Neuroradiol. 2004 May;25(5):846-50. Review. PubMed PMID: 15140733.

45: Rohde V, Mayfrank L, Bertalanffy H, Mull M, Gilsbach JM. [Aneurysmal subarachnoid hemorrhage: role of computerized tomography for correct prediction of the ruptured aneurysm site]. Zentralbl Neurochir. 2003;64(3):116-22. German. PubMed PMID: 12975746.

46: Hentschel S, Toyota B. Intracranial malignant glioma presenting as subarachnoid hemorrhage. Can J Neurol Sci. 2003 Feb;30(1):63-6. PubMed PMID: 12619787.

47: Vaitkevicius G, Lukosevicius S, Gvazdaitis AR. [Diagnosis of angiographically negative spontaneous subarachnoid hemorrhage]. Medicina (Kaunas). 2002;38(2):147-50. Lithuanian. PubMed PMID: 12474731.

48: Wong SH, Yeo TT, Seow WT, Tan KK, Ong PL. Spontaneous subarachnoid haemorrhage and outcome–results from Tan Tock Seng Hospital, Singapore. Singapore Med J. 1999 Jul;40(7):459-64. PubMed PMID: 10560272.

49: Hino A, Fujimoto M, Iwamoto Y, Takahashi Y, Katsumori T. An adult case of recurrent arteriovenous malformation after “complete” surgical excision: a case report. Surg Neurol. 1999 Aug;52(2):156-8; discussion 158-9. PubMed PMID: 10447283.

50: Rogg JM, Smeaton S, Doberstein C, Goldstein JH, Tung GA, Haas RA. Assessment of the value of MR imaging for examining patients with angiographically negative subarachnoid hemorrhage. AJR Am J Roentgenol. 1999 Jan;172(1):201-6. PubMed PMID: 9888768.

51: Vespa PM, Nuwer MR, Juhász C, Alexander M, Nenov V, Martin N, Becker DP. Early detection of vasospasm after acute subarachnoid hemorrhage using continuous EEG ICU monitoring. Electroencephalogr Clin Neurophysiol. 1997 Dec;103(6):607-15. PubMed PMID: 9546487.

52: Vassilouthis J, Chrysikopoulos CH, Seferis CH. Magnetic resonance angiography demonstration of an angiographically occult anterior communicating artery aneurysm. Br J Neurosurg. 1997 Oct;11(5):448-51. PubMed PMID: 9474281.

53: Phillips J, Roberts G, Bolger C, el Baghdady A, Bouchier-Hayes D, Farrell M, Collins P. Lipoprotein (a): a potential biological marker for unruptured intracranial aneurysms. Neurosurgery. 1997 May;40(5):1112-5; discussion 1115-7. PubMed PMID: 9149281.

54: Kaim A, Proske M, Kirsch E, von Weymarn A, Radü EW, Steinbrich W. Value of repeat-angiography in cases of unexplained subarachnoid hemorrhage (SAH). Acta Neurol Scand. 1996 May;93(5):366-73. PubMed PMID: 8800349.

55: Jafar JJ, Weiner HL. Surgery for angiographically occult cerebral aneurysms. J Neurosurg. 1993 Nov;79(5):674-9. PubMed PMID: 8410246.

56: Goergen SK, Barrie D, Sacharias N, Waugh JR. Perimesencephalic subarachnoid haemorrhage: negative angiography and favourable prognosis. Australas Radiol. 1993 May;37(2):156-60. PubMed PMID: 8512504.

57: Jamjoom A. Recurrent subarachnoid haemorrhage from an angiographically occult large distal pica aneurysm. Br J Neurosurg. 1991;5(4):393-8. PubMed PMID: 1786135.

58: Iwanaga H, Wakai S, Ochiai C, Narita J, Inoh S, Nagai M. Ruptured cerebral aneurysms missed by initial angiographic study. Neurosurgery. 1990 Jul;27(1):45-51. PubMed PMID: 2377280.

59: Spallone A, Ferrante L, Palatinsky E, Santoro A, Acqui M. Subarachnoid haemorrhage of unknown origin. Acta Neurochir (Wien). 1986;80(1-2):12-7. PubMed PMID: 3706008.

60: Stober T, Kunze K. Electrocardiographic alterations in subarachnoid haemorrhage. Correlation between spasm of the arteries of the left side on the brain and T inversion and QT prolongation. J Neurol. 1982;227(2):99-113. PubMed PMID: 6180145.

61: Vincent FM, Zimmerman JE, Auer TC, Martin DB. Subarachnoid hemorrhage–the initial manifestation of bacterial endocarditis. Report of a case with negative arteriography and computed tomography. Neurosurgery. 1980 Nov;7(5):488-90. PubMed PMID: 7442996.

62: Miyazaki Y, Ando E. [On the miliary intracranial aneurysm –its significance in subarachnoid hemorrhage (author's transl)]. No Shinkei Geka. 1976 Sep;4(9):853-60. Japanese. PubMed PMID: 988491.

1) Alén JF, Lagares A, Campollo J, Ballenilla F, Kaen A, Núñez AP, Lobato RD. Idiopathic subarachnoid hemorrhage and venous drainage: are they related? Neurosurgery. 2008 Dec;63(6):1106-11; discussion 1111-2. doi: 10.1227/01.NEU.0000335777.14055.71. PubMed PMID: 19057322.

2) Boswell S, Thorell W, Gogela S, et al. Angiogramnegative subarachnoid hemorrhage: outcomes data and review of the literature. J Stroke Cerebrovasc Dis. 2013;22(6):750–757.

3) Kumar R, Das KK, Sahu RK, Sharma P, Mehrotra A, Srivastava AK, Sahu RN, Jaiswal AK, Behari S. Angio negative spontaneous subarachnoid hemorrhage: Is repeat angiogram required in all cases? Surg Neurol Int. 2014 Aug 7;5:125. doi: 10.4103/2152-7806.138367. PMID: 25140284; PMCID: PMC4135542.

4) Lin N, Zenonos G, Kim AH, Nalbach SV, Du R, Frerichs KU, Friedlander RM, Gormley WB. Angiogram-negative subarachnoid hemorrhage: relationship between bleeding pattern and clinical outcome. Neurocrit Care. 2012 Jun;16(3):389-98. doi: 10.1007/s12028-012-9680-6. PubMed PMID: 22350856.

5) Coutinho JM, Sacho RH, Schaafsma JD, Agid R, Krings T, Radovanovic I, Matouk CC, Mikulis DJ, Mandell DM. High-Resolution Vessel Wall Magnetic Resonance Imaging in Angiogram-Negative Non-Perimesencephalic Subarachnoid Hemorrhage. Clin Neuroradiol. 2015 Nov 25. [Epub ahead of print]

PubMed PMID: 26608742.
6)
Fang Y, Shao A, Wang X, Lu J, Wu H, Ren R, Huang Y, Lenahan C, Xu J, Chen S, Zhang J. Deep venous drainage variant rate and degree may be higher in patients with perimesencephalic than in non-perimesencephalic angiogram-negative subarachnoid hemorrhage. Eur Radiol. 2021 Mar;31(3):1290-1299. doi: 10.1007/s00330-020-07242-5. Epub 2020 Sep 11. Erratum in: Eur Radiol. 2020 Dec 23;: PMID: 32918092.
7)
Achrén A, Raj R, Siironen J, Laakso A, Marjamaa J. Spontaneous angiogram-negative subarachnoid hemorrhage: a retrospective single center cohort study. Acta Neurochir (Wien). 2022 Jan;164(1):129-140. doi: 10.1007/s00701-021-05069-7. Epub 2021 Dec 1. PMID: 34853936; PMCID: PMC8761132.