Treatment options for intracranial aneurysm: update searches and screening for Universitätsklinikum Schleswig-Holstein/Campus Kiel

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1. PROJECT OBJECTIVES

A key aim of the research project "Making SDM a reality" is to inform patients as part of shared decision making (SDM).

Kleijnen Systematic Reviews (KSR) Ltd has prepared an evidence report with a synthesis of the evidence of the treatment options for intracranial aneurysm.

2. METHODS

LITERATURE SEARCHES

Literature searches were conducted to identify systematic reviews and evidence-based guidelines about intracranial aneurysm to update the 2019 evidence report.

The search strategies were developed specifically for each database and the keywords adapted according to the configuration of each database. Searches were limited by date range to update earlier searches: 2019-2021. Searches were not limited by language or publication status.

SEARCH SOURCES

Systematic reviews and guidelines

The following systematic review and health technology assessment specific databases were searched:

- Cochrane Database of Systematic Reviews (CDSR) (Wiley): issue 9 of 12, September 2021
- KSR Evidence (Internet) (https://ksrevidence.com/): 2019-2021
- Epistemonikos (Internet) (https://www.epistemonikos.org/): 2019-2021
- International HTA Database (INAHTA) (https://database.inahta.org/): 2019-2021

The following guidelines resources were searched:

- Guidelines International Network (GIN) (Internet) (https://www.g-i-n.net/home): 2019-2021
- NICE Evidence (Internet) (www.evidence.nhs.uk/): 2019-2021
- NICE Guidance (Internet) (https://www.nice.org.uk/guidance): 2019-2021
- ECRI Guidelines Trust (Internet) (https://guidelines.ecri.org/): 2019-2021
- Trip Database (https://www.tripdatabase.com/): 2019-2021
- Canadian Agency for Drugs and Technologies in Health (CADTH) (www.cadth.ca): 2019-2021

Full details of all search strategies are presented in Appendix 1.

Handling of citations

References identified from the searches were downloaded into EndNote bibliographic management software for further assessment and handling.

Supplementary searches

The bibliographies of included studies and review articles were also checked for additional relevant articles.

Prioritisation

During formal screening of titles and abstracts, studies were subject to a prioritisation process whereby the recency e.g., to most up-to-date clinical practice guidelines (CPG), methodological quality e.g., Cochrane systematic review (CSR), quality of the analyses per outcome (e.g., ratio of RCTs to observational studies), the number of included RCTs, the breadth of the timepoints reported etc. were considered to further prioritise which studies would be used to inform analyses. Studies were categorised into the following three categories: '1' = German, American, European or similar CPG; '2' = CSR or similar quality SR; '3' = potentially lower/other quality SR.

3. RESULTS

The original EBSCO searches were conducted on November 18th, 2019; and of the 93 references screened, 6 studies were deemed eligible. In the current update, a total of 489 records were retrieved from the electronic literature searches (Table 3). After the removal of duplicate records 241 titles and abstracts were screened by two reviewers. 28 records were found to be potentially eligible and were longlisted after a consensus. Of those, five were short-listed and included in the analyses (Table 1).[1-5] See also Table 2 for an overview of primary studies included in the identified SRs/CPGs.

UPDATE – Concluding Assessment by SHARE-TO-CARE Evidence Team (19/04/22)

Based on the update searches conducted by KSR Ltd in September 2021, we want to highlight the following aspects: When deciding between watchful waiting or an interventional treatment of an intracranial aneurysm, underpinning evidence in form of direct comparisons between the two options is scarce, the Cochrane SR by Pontes et al. (2021) corroborating this. Research on (modern devices for) endovascular procedures is thriving and so the focus is on comparisons to neurosurgical methods such as clipping (NICE, 2021; Krag et al., 2021; Toccaceli et al., 2020; Telles et al., 2021). Toccaceli et al. for instance, report higher rates of good neurological outcomes for patients treated with coiling. Still, to decide for a preferred handling of the aneurysm, many individual factors (e.g., age and comorbidities, aneurysm morphology) must be considered, jointly between patient and physicians.

Conclusion regarding the evidence report: No evidence update required. The present evidence report (November 18, 2019) remains valid until further notice.

Table 1 Evidence sources

Study/year	Evidence type	Primary studies	Number of studies	Intervention	Comparator	Outcome	Date searched	Conclusions
NICE 2021[1]	CPG	SR, non-RCT, CS, CR	13	Intrasaccular wire-mesh blood-flow disruption device	Various	Multiple	April 30, 2019	"Current evidence on the safety and efficacy of endovascular insertion of an intrasaccular wire-mesh blood-flow disruption device for intracranial aneurysms is adequate to support the use of this procedure provided that standard arrangements are in place for clinical governance, consent and audit."
Pontes 2021[2]	CSR	RCTs	2	Endovascular coiling, microsurgical clipping	Conservative treatment, endovascular coiling	Morbidity	May, 25 2020	"There is currently insufficient good-quality evidence to support either conservative treatment or interventional treatments (microsurgical clipping or endovascular coiling) for individuals with unruptured intracranial aneurysms."
Krag 2021[3]	SR	Non-RCTs	13	Neurosurgical clipping	Endovascular coiling	Morbidity, mortality	March, 1 2020	"This systematic review and meta-analysis reports benefits and drawbacks of simple coiling versus neurosurgical clipping of unruptured intracranial aneurysms. Future studies with longer follow-up time should account for differences in coiling techniques and confounding factors such as size and location of unruptured intracranial aneurysms."

Study/year	Evidence type	Primary studies	Number of studies	Intervention	Comparator	Outcome	Date searched	Conclusions
Toccaceli 2020[4]	SR	OS	29	Microsurgical clipping	Endovascular treatment (Flow-diverter or Woven EndoBridge)	Occlusion rate; treatment-related complications	December 2018	"Treatment-related complication and mortality are comparable among these techniques and the risk of aneurysm rupture seems very low for both strategies. The endovascular approach seems to increase the probability of good functional outcome after treatment, compared with surgery."
Telles 2021[5]	SR	OS	29	Microsurgery (clippings, clip-wrappings, and saccular bleb clipped)	Endovascular procedures	Morbidity	March 3, 2020	"There were no differences between morbidity of surgical and endovascular treatments, regardless of aneurysm location. Size and initial mRS were correlated with functional outcomes, whereas age and rupture status were not. Microsurgery seems to yield better long-term angiographic results compared to endovascular procedures."
CGP = clinical practice guideline; CR = case report; CS = case series; CSR = Cochrane systematic review; NICE = National Institute for Health and Care Excellence; OS = observational study; RCT = randomised controlled trial								

Table 2 Overview of primary studies included in the identified SRs/CPGs

Study/year	Primary study(ies)	Reference (first author & journal)
NICE 2021[1]	SR, non-RCT, CS, CR	1. Tau N, Sadeh-Gonik U, Aulagner G et al. (2018) The Woven EndoBridge (WEB) for endovascular therapy of intracranial aneurysms: Update of a systematic review with meta-analysis. Clinical Neurology & Neurosurgery 166: 110–5.

Study/year	Primary study(ies)	Reference (first author & journal)
		2. Pierot L, Moret J, Barreau X et al. (2018) Safety and efficacy of aneurysm treatment with WEB in the cumulative population of three prospective, multicenter series. Journal of Neurointerventional Surgery 10: 553–9. 3. Kabbasch C, Goertz L, Siebert E et al. (2018) Factors that determine aneurysm occlusion after embolization with the Woven EndoBridge (WEB). Journal of Neurointerventional Surgery 24. 4. Mine B, Goutte A, Brisbois D et al. (2018) Endovascular treatment of intracranial aneurysms with the Woven EndoBridge device: mid term and long term results. Journal of Neurointerventional Surgery 10: 127–32 5. Lawson A, Molyneux A, Sellar R et al. (2018) Safety results from the treatment of 109 cerebral aneurysms using the Woven EndoBridge technique: preliminary results in the United Kingdom. Journal of Neurosurgery 128: 144–53 6. Herbreteau D, Bibi R, Narata AP et al. (2016) Are anatomic results influenced by WEB shape modification? Analysis in a prospective, singlecenter series of 39 patients with aneurysms treated with the WEB. American Journal of Neuroradiology 37: 2280–6 7. Khalid Z, Sorteberg W, Nedregaard B et al. (2018) Efficiency and complications of Woven EndoBridge (WEB) devices for treatment of larger, complex intracranial aneurysms-a single-center experience. Acta Neurochirurgica 13: Dec 13 8. Fiorella D, Molyneux A, Coon A et al. (2017) Demographic, procedural and 30-day safety results from the WEB Intra-saccular Therapy Study (WEB-IT). Journal of Neurointerventional Surgery 9: 1191–6 9. Tikka J, Gardberg M, Rautio R et al. (2018) Left cerebral hemisphere hydrophilic polymer embolism associated with endovascular WEB treatment of a ruptured aneurysm of the anterior cerebral artery. Legal Medicine 35: 66–8 10. Arthur AS, Molyneux A, Coon AL et al. (2019) The safety and effectiveness of the Woven EndoBridge (WEB) system for the treatment of wide necked bifurcation aneurysms: final 12-month results of the pivotal WEB Intrasaccular Therapy (WEBIT) Study. J NeuroIntervent Surg 0:1–7. doi:10.1136/neurintsurg-2019-014815 11. Goertz L, Liebig T, Siebert E et al. (2019) Risk factors of procedural complications related to Woven EndoBridge (WEB) embolization of intracranial aneurysms. Clinical Neuroradiology https://doi.org/10.1007/s00062-019- 00762-8 12. Kabbasch C, Goertz L, Siebert E et al. (2019) WEB embolization versus stent-assisted coiling: Comparison of complication rates and angiographic outcomes. Journal of NeuroInterventional Surgery Published Online First: 23 January 2019. doi: 10.1136/neurintsurg-2018-014555 13. Kabbasch C, Goertz L, Siebert E et al. (2019) Comparison of WEB embolization and coiling in unruptured intracranial aneurysms: safety and efficacy based on a propensity score analysis. World Neurosurgery 126: e937–e943
Pontes 2021[2]	RCTs	1. Darsaut TE, Findlay JM, Magro E, Kotowski M, Roy D, Weill A, et al. Surgical clipping or endovascular coiling for unruptured intracranial aneurysms: a pragmatic randomised trial. Journal of Neurology, Neurosurgery, and Psychiatry 2017;88(8):663-8.

Study/year	Primary study(ies)	Reference (first author & journal)
		2. Raymond J, Darsaut TE, Molyneux AJ, on behalf of the TEAM collaborative group. A trial on unruptured intracranial aneurysms (the TEAM trial): results, lessons from a failure and the necessity for clinical trials. Trials 2011;12:64.
Krag 2021[3]	Non-RCTs	1. Kim Y.D., Bang J.S., Lee S.U., et al., Long-term outcomes of treatment for unruptured intracranial aneurysms in South Korea: clipping versus coiling. J. NeuroInterven. Surg. 2018; 10: 1218-1222 2. Gonda D.D., Khalessi A.A., McCutcheon B.A., et al., Long-term follow-up of unruptured intracranial aneurysms repaired in California. J. Neurosurg. 2014; 120: 1349-1357 3. Pyysalo L., Luostarinen T., Keski-Nisula L., Ohman J., Long-term excess mortality of patients with treated and untreated unruptured intracranial aneurysms. J. Neurol. Neurosurg. Psychiatry. 2013; 84: 888-892 4. Gallas S, Drouineau J, Gabrillargues J, Pasco A, Cognard C, Pierot L, Herbreteau D. Feasibility, procedural morbidity and mortality, and long-term follow-up of endovascular treatment of 321 unruptured aneurysms. AJNR Am J Neuroradiol. 2008 Jan;29(1):63-8. 5. O.N. Naggara, P.M. White, F. Guilbert, D. Roy, A. Weill, J. Raymond, Endovascular treatment of intracranial unruptured aneurysms: systematic review and metaanalysis of the literature on safety and efficacy, Radiology 256 (3) (2010) 887–897. 6. M. Koyanagi, A. Ishii, H. Imamura, et al., Long-term outcomes of coil embolization of unruptured intracranial aneurysms, J. Neurosurg. 129 (6) (2018) 1492–1498. 7. T.E. Darsaut, J.M. Findlay, E. Magro, et al., Surgical clipping or endovascular coiling for unruptured intracranial aneurysms: a pragmatic randomised trial, J. Neurol. Neurosurg. Psychiatry 88 (8) (2017) 663–668. 8. T. Sorimachi, Y. Ito, K. Morita, et al., Long-term follow-up of intra-aneurysmal coil embolization for unruptured paraclinoid aneurysms, Neurol. Res. 34 (9) (2012) 864–870. 9. H. Standhardt, H. Boecher-Schwarz, A. Gruber, T. Benesch, E. Knosp, G. Bavinzski, Endovascular treatment of unruptured intracranial aneurysms with Guglielmi detachable coils: short- and long-term results of a single-Centre series, Stroke 39 (3) (2008) 899–904. 10. M. Kozba-Gosztyła, B. Czapiga, W. Jarmundowicz, Ł. Tomiałowicz, Unruptured intracranial aneurysms: surgery still safe as a treatment option, Adv. Clin. Exp. Med. 25 (5) (2016) 911–916. 11. K. Mori, K. Wada, N. Otani, et al., Long-term neurological and radiological results of consecutive 63 unruptured anterior communicating artery aneurysms clipped via lateral supraorbital keyhole minicraniotomy, Oper. Neurosurg. 14 (2) (2018) 95–102. 12. A.A. Pereira-Filho, A.G. Pereira, N.A. Pereira-Filho, et al., Long-term behavioral and cognitive outcomes following clipping for incidental unruptured intracranial aneurysms, Neuropsychology 28 (1) (2014) 75–83.

Study/year	Primary study(ies)	Reference (first author & journal)
		13. J.M. van Dijk, R.J. Groen, M. Ter Laan, J.R. Jeltema, J.J. Mooij, J. D. Metzemaekers, Surgical clipping as the preferred treatment for aneurysms of the middle cerebral artery, Acta Neurochir. 153 (11) (2011) 2111–2117. 14. Holmin S, Krings T, Ozanne A, Alt JP, Claes A, Zhao W, Alvarez H, Rodesch G, Lasjaunias P. Intradural saccular aneurysms treated by Guglielmi detachable bare coils at a single institution between 1993 and 2005: clinical long-term follow-up for a total of 1810 patient-years in relation to morphological treatment results. Stroke. 2008 Aug;39(8):2288-97.
Toccaceli 2020[4]	OS	1. Bhogal P, AlMatter M, Bäzner H, et al. Flow diversion for the treatment of MCA bifurcation aneurysmsea single centre experience. Front Neurol. 2017;8:20. 2. Möhlenbruch MA, Kizilkilic O, Killer- Oberpfalzer M, et al. Multicenter experience with FRED Jr flow re-direction endoluminal device for intracranial aneurysms in small arteries. AJNR Am J Neuroradiol. 2017;38:1959-1965. 3. De Vries J, Boogaarts J, Van Norden A, Wakhloo AK. New generation of Flow Diverter (surpass) for unruptured intracranial aneurysms: a prospective single-center study in 37 patients. Stroke. 2013;44:1567-1577. 4. Iosif C, Mounayer C, Yavuz K, et al. Middle cerebral artery bifurcation aneurysms treated by extrasaccular flow diverters: midterm angiographic evolution and clinical outcome. AJNR Am J Neuroradiol. 2017;38:310-316. 5. Gory B, Aguilar-Pérez M, Pomero E, et al. One year angiographic results after stent assisted coiling of 40 wide-neck middle cerebral artery aneurysms. Neurosurgery. 2017;80:925-933. 6. Kim BM, Kim DI, Park SI, Kim DJ, Suh SH, Won YS. Coil embolization of unruptured middle cerebral artery aneurysms. Neurosurgery. 2011;68: 346-353 7. Mühl-Benninghaus R, Simgen A, Reith W, Yilmaz U. The Barrel stent: new treatment option for stent-assisted coiling of wide-necked bifurcation aneurysms-results of a single-center study. J Neurointerv Surg. 2017;9:1219-1222. 8. Yang P, Liu J, Huang Q, et al. Endovascular treatment of wide-neck middle cerebral artery aneurysms with stents: a review of 16 cases. AJNR Am J Neuroradiol. 2010;31:940-946. 9. Topcuoglu OM, Akgul E, Daglioglu E, et al. Flow diversion in middle cerebral artery aneurysms: is it really an all-purpose treatment? World Neurosurg. 2016;87:317-327. 10. Gory B, Aguilar-Pérez M, Pomero E, et al. pCONus device for the endovascular treatment of wideneck middle cerebral artery aneurysms. AJNR Am J Neuroradiol. 2015;36:1735-1740. 11. Akgul E, Balli T, Aksungur EH. Hybrid, Yconfigured, dual stent-assisted coil embolization in the treatment of wide-necked bifurcation aneurysms. Interv Neuroradiol. 2015;21:29-39. 12. Gawlitza M, Januel AC, Tall P, Bonneville F, Cognard C. Flow diversion treatment of complex bifurcation aneurysms beyond the circle of Willis: a single-center series with special emphasis on covered cortical branches and perforating arteries. J Neurointerv Surg. 2016;8:481-487.

Study/year	Primary study(ies)	Reference (first author & journal)
		13. Cekirge HS, Yavuz K, Geyik S, Saatci I. A novel "Y" stent flow diversion technique for the endovascular treatment of bifurcation aneurysms without endosaccular coiling. AJNR Am J Neuroradiol. 2011; 32:1262-1268. 14. Fields JD, Brambrink L, Dogan A, et al. Stent assisted coil embolization of unruptured middle cerebral artery aneurysms. J Neurointerv Surg. 2013; 5:15-19. 15. Johnson AK, Heiferman DM, Lopes DK. Stentassisted embolization of 100 middle cerebral artery aneurysms. J Neurosurg. 2013;118:950-955. 16. Yavuz K, Geyik S, Saatci I, Cekirge HS. Endovascular treatment of middle cerebral artery aneurysms with flow modification with the use of the pipeline embolization device. AJNR Am J Neuroradiol. 2014;35:529-535. 17. Möhlenbruch M, Herweh C, Behrens L, et al. The LVIS Jr. microstent to assist coil embolization of wide-neck intracranial aneurysms: clinical study to assess safety and efficacy. Neuroradiology. 2014; 56:389-395. 18. Aguilar Perez M, Bhogal P, Martinez Moreno R, Bäzner H, Ganslandt O, Henkes H. The Medina Embolic Device: early clinical experience from a single center. J Neurointerv Surg. 2017;9:77-87. 19. Briganti F, Delehaye L, Leone G, et al. Flow diverter device for the treatment of small middle cerebral artery aneurysms. J Neurointerv Surg. 2016; 8:287-294. 20. 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;73:27-34. 21. Yeon JY, Kim JS, Hong SC. Angiographic characteristics of unruptured middle cerebral artery aneurysms predicting perforator injuries. Br J Neurosurg. 2011;25:497-502. 22. Morgan MK, Mahattanakul W, Davidson A, Reid J. Outcome for middle cerebral artery aneurysm surgery. Neurosurgery. 2010;67:755-761 23. Nanda A, Patra DP, Bir SC, Maiti TK, Kalakoti P, Bollam P. Microsurgical clipping of unruptured intracranial aneurysms: a single surgeon's experience over 16 years. World Neurosurg. 2017; 100:85-99. 24. Chung J, Hong CK, Shim YS, et al. Microsurgical clipping of unruptured middle cerebral artery bifurcation aneurysms: incidence of and risk factors for procedure-related complications. World Neurosurg. 2015;83:666-672. 25. Diaz OM, Rangel-Castilla L, Barber S, Mayo RC, Klucznik R, Zhang YJ. Middle cerebral artery aneurysms: a single-center series comparing endovascular and surgical treatment. World Neurosurg. 2014;81:322-329. 26. Haug T, Sorteberg A, Sorteberg W, Lindegaard KF, Lundar T, Finset A. Surgical repair of unruptured and ruptured middle cerebral artery aneurysms: impact on cognitive functioning and health-related quality of life. Neurosurgery. 2009;64:412-420.

Study/year	Primary study(ies)	Reference (first author & journal)
		27. Tenjin H, Yamamoto H, Goto Y, Tanigawa S, Takeuchi H, Nakahara Y. Factors for achieving safe and complete treatment for unruptured saccular aneurysm smaller than 10 mm by simple clipping or simple coil embolization. World Neurosurg. 2016;91:308-316. 28. Bruneau M, Amin-Hanjani S, Koroknay-Pal P, et al. Surgical clipping of very small unruptured intracranial aneurysms: a multicenter international study. Neurosurgery. 2016;78:47-52. 29. Feng Z, Li Q, Zhao R, et al. Endovascular treatment of middle cerebral artery aneurysm with the LVIS Junior stent. J Stroke Cerebrovasc Dis. 2015;24: 1357-1362.
Telles 2021[5]	OS	1. Byoun HS, Yi HJ, Choi KS, Chun HJ, Ko Y, Bak KH (2016) Comparison of endovascular treatments of ruptured dissecting neurysms of the intracranial internal carotid artery and vertebral artery with a review of the literature. J Korean Neurosurg Soc 59: 449–457. 2. Dabus G, Lin E, Linfante I (2014) Endovascular treatment of fusiform intracranial vertebral artery aneurysms using econstructive techniques. J Neurointerv Surg 6:589–594. 3. Deshmukh VR, Kakarla UK, Figueiredo EG, Zabramski JM, Spetzler RF (2006) Long-term clinical and angiographic followup of unclippable wrapped intracranial aneurysms. Neurosurgery 58:434–441 4. Ertl L, HoltmannspötterM, Patzig M, Brückmann H, Fesl G (2014) Use of flow-diverting devices in fusiform vertebrobasilar giant aneurysms: a report on periprocedural course and long-term followup. Am J Neuroradiol 35:1346–1352 5. Findlay JM, Hao C, Emery D (2002) Non-atherosclerotic fusiform cerebral aneurysms. Can J Neurol Sci 29:41–48. 6. Hu P, Zhang HQ, Li XY, Tong XZ (2019) Double-barrel superficial temporal artery to proximal middle cerebral artery bypass to treat complex intracranial aneurysms: a reliable high blood flow bypass. World Neurosurg 125:e884–e890. 7. Joo SP, Kim TS, Choi JW, Lee JK, Kim YS, Moon KS, Kim JH, Kim SH (2007) Characteristics and management of ruptured distal middle cerebral artery aneurysms. Acta Neurochir 149:661– 667. 8. Kalani MYS, Zabramski JM, Nakaji P, Spetzler RF (2013) Bypass and flow reduction for complex basilar and vertebrobasilar junction aneurysms. Neurosurgery 72:763–775. 9. Kivipelto L, Niemelä M, Meling T, Lehecka M, Lehto H, Hernesniemi J (2014) Bypass surgery for complex middle cerebral artery aneurysms: impact of the exact location in the MCA tree. J Neurosurg 120:398–408. 10. Laukka D, Rautio R, Rahi M, Rinne J (2019) Acute treatment of ruptured fusiform posterior circulation posterior cerebral, superior cerebellar, and posterior inferior cerebellar artery aneurysms with fred flow diverter: report of 5 cases. Oper Neurosurg 16:549–556.

Study/year	Primary study(ies)	Reference (first author & journal)
		11. Leibowitz R, Do HM, Marcellus ML, Chang SD, Steinberg GK, Marks MP (2003) Parent vessel occlusion for vertebrobasilar fusiform and dissecting aneurysms. Am J Neuroradiol 24:902–907 12. Lin N, Brouillard AM, Keigher KM, Lopes DK, Binning MJ, Liebman KM, Veznedaroglu E, Magarik JA, Mocco J, Duckworth EA, Arthur AS, Ringer AJ, Snyder KV, Levy EI, Siddiqui AH (2015) Utilization of pipeline embolization device for treatment of ruptured intracranial aneurysms: US multicenter experience. J Neurointerv Surg 7:808–815. 13. Lin N, Lanzino G, Lopes DK, Arthur AS, Ogilvy CS, Ecker RD, Dumont TM, Turner RD, Gooch MR, Boulos AS, Kan P, Snyder KV, Levy EI, Siddiqui AH (2016) Treatment of distal anterior circulation aneurysms with the pipeline embolization device: a US multicenter experience. Neurosurgery 79:14–22. 14. Lubicz B, Collignon L, Raphaeli G, Pruvo JP, Bruneau M, De Witte O, Leclerc X (2010) Flow-diverter stent for the endovascular treatment of intracranial aneurysms: a prospective study in 29 patients with 34 aneurysms. Stroke 41:2247–2253. 15. Meckel S, McAuliffe W, Fiorella D, Taschner CA, Phatouros C, Phillips TJ, Vasak P, Schumacher M, Klisch J (2013) Endovascular treatment of complex aneurysms at the vertebrobasilar junction with flow-diverting stents: initial experience. Neurosurgery 73: 386–394. 16. Monteith SJ, Tsimpas A, Dumont AS, Tjoumakaris S, Fernando Gonzalez L, Rosenwasser RH, Jabbour P (2014) Endovascular treatment of fusiform cerebral aneurysms with the Pipeline Embolization Device. J Neurosurg 120:945–954. 17. Munich SA, Tan LA, Keigher KM, Chen M, Moftakhar R, Lopes DK (2014) The Pipeline Embolization Device for the treatment of posterior circulation fusiform aneurysms: lessons learned at a single institution. J Neurosurg 121:1077–1084. 18. Murchison AG, Young V, Djurdjevic T, Cellerini M, Corkill R, Küker W (2018) Stent placement in patients with acute subarachnoid haemorrhage: when is it justified? Neuroradiology 60:735– 744 19. Natarajan SK, Lin N, Sonig A, Rai AT, Carpenter JS, Levy EI, Siddiqui AH (2016) The safety of pipeline flow diversion in fusiform vertebrobasilar aneurysms: a consecutive case series with longer-term follow-up from a single US center. J Neurosurg 125: 111–119. 20. Park W, Kwon DH, Ahn JS, Lee SH, Park JC, Kwun BD (2015) Treatment strategies for dissecting aneurysms of the posterior cerebral artery. Acta Neurochir 157:1633–1643. 21. Pumar JM, Arias-Rivas S, Rodríguez-Yáñez M, Blanco M, Ageitos M, Vazquez-Herrero F, Castiñeira-Mourenza JA, Masso A (2013) Using Leo Plus stent as flow diverter and endoluminal remodeling in endovascular treatment of intracranial fusiform aneurysms. J Neurointerv Surg 5:iii22–iii27. 22. Qu S, Lv X, Wu Z (2009) Clinical outcomes of basilar artery aneurysms. Neuroradiol J 22:228–238.

Study/year	Primary study(ies)	Reference (first author & journal)
		23. Rho, M.H., Park, H.J., Chung, E.C. et al. Various techniques of stent-assisted coil embolization of wide-necked or fusiform artherosclerotic and dissecting unruptured vertebrobasilar artery aneurysms for reducing recanalization: mid-term results. Acta Neurochir 155, 2009–2017 (2013). 24. Roh HG, Kim SS, Han H, Kang HS, Moon WJ, Byun HS (2008) Endovascular treatment of posterior cerebral artery aneurysms using detachable coils. Neuroradiology 50:237–242. 25. Seo BR, Kim TS, Joo SP, Lee JM, Jang JW, Lee JK, Kim JH, Kim SH (2009) Surgical strategies using cerebral revascularization in complex middle cerebral artery aneurysms. Clin Neurol Neurosurg 111:670–675. 26. Stroke T, Gates MF, Carolina N (2012) S 1258. 116:1258–1266 50. Suh SH, Kim BM, Chung TS, Kim DI, Kim DJ, Hong CK, Kim CH, Ahn JY, Kim SS (2010) Reconstructive endovascular treatment of intracranial fusiform aneurysms: a 1-stage procedure with stent and balloon. Am J Neuroradiol 31:155–160. 27. Wang Q, Leng B, Song D, Chen G (2010) Fusiform aneurysms of the vertebrobasilar arterial trunk: choice of endovascular methods and therapeutic efficacy. Acta Neurochir 152:1467–1476. 28. Xu F, Xu B, Huang L, Xiong J, Gu Y, Lawton MT (2018) Surgical treatment of large or giant fusiform middle cerebral artery aneurysms: a case series. World Neurosurg 115:e252–e262.
CGP = clinical practice guideline; CR = case report; CS = case series; NICE = National Institute for Health and Care Excellence; OS = observational study; RCT = randomised controlled trial; SR = systematic review		

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APPENDIX 1: SEARCH STRATEGIES

Shared Decision Making: Intracranial aneurysm update (EBSCO)

Systematic reviews and guidelines

Table 3. Systematic reviews and guideline search results

Database	Dates	Results
CDSR	2019 - Issue 9, September 2021	2
KSR Evidence	2019-2021	125
Epistemonikos	2019-2021	173
INAHTA	2019-2021	0
NICE Evidence	01/01/2019 - 17/09/2021	54
NICE Guidance	2019-2021	2
GIN	2019-2021	0
ECRI	2019-2021	0
Trip	2019-2021	133
CADTH	2019-2021	0
Total		**489**
Total after de-duplication		**241**

Search strategies

Cochrane Database of Systematic Reviews (CDSR) (Wiley): Issue 9 of 12, September 2021
Searched: 17.9.21

#1 MeSH descriptor: [Intracranial Aneurysm] explode all trees 451
#2 ((intracran* or intra-cran* or cerebral or brain or communicating or berry or basilar) near/3 (aneurysm* or aneurism*)):ti,ab,kw 1205
#3 #1 or #2 with Cochrane Library publication date Between Jan 2019 and Dec 2021, in Cochrane Reviews, Cochrane Protocols 2

KSR Evidence (Internet): Database last updated 17 September 2021
www.ksrevidence.com
Searched: 17.9.21

1 (intracran* or intra-cran* or cerebral or brain or communicating or berry or basilar) near/3 (aneurysm* or aneurism*) in Title Date published: 2019 - 2021 125 results
2 (intracran* or intra-cran* or cerebral or brain or communicating or berry or basilar) near/3 (aneurysm* or aneurism*) in Bottom line 8 results
3 #1 or #2 in All text Date published: 2019 - 2021 125 results
Search run Fri Sep 17 2021

Epistemonikos (Internet): up to 17 September 2021
https://www.epistemonikos.org/en/
Searched: 17.9.21

(title:("intracranial aneurysm" OR "intracranial aneurysms" OR "intracranial aneurism" OR "intracranial aneurisms" OR "cerebral aneurysm" OR "cerebral aneurysms" OR "brain aneurysm" OR "brain aneurysms" OR "berry aneurysm" OR "berry aneurysms" OR "basilar aneurysm" OR "basilar aneurysms") OR abstract:("intracranial aneurysm" OR "intracranial aneurysms" OR "intracranial aneurism" OR "intracranial aneurisms" OR "cerebral aneurysm" OR "cerebral aneurysms" OR "brain aneurysm" OR "brain aneurysms" OR "berry aneurysm" OR "berry aneurysms" OR "basilar aneurysm" OR "basilar aneurysms"))
Publication year: Custom year range: From 2019 To 2021; Publication Type: Systematic Review
Total: 173

International HTA Database (INAHTA): up to 17 September 2021
https://database.inahta.org/
Searched: 17.9.21

("intracranial aneurysm" OR "intracranial aneurysms" OR "intracranial aneurism" OR "intracranial aneurisms" OR "cerebral aneurysm" OR "cerebral aneurysms" OR "brain aneurysm" OR "brain aneurysms" OR "berry aneurysm" OR "berry aneurysms" OR "basilar aneurysm" OR "basilar aneurysms") OR ("Intracranial Aneurysm"[mh]) YEAR 2019 TO 2021
0 records retrieved

NICE Evidence Search (Internet): up to 17 September 2021
https://www.evidence.nhs.uk/
Searched: 17.9.21

Search terms	**Results (Guidance; Systematic Reviews): 01/01/2019-17/09/2021**
"intracranial aneurysm"	26 (G 7; SR 19)
"intracranial aneurysms"	38 (G 8; SR 30)
"cerebral aneurysm"	7 (G 4; SR 3)
"cerebral aneurysms"	17 (G 7; SR 10)
"brain aneurysm"	0
"brain aneurysms"	1 (G 1; SR 0)
"berry aneurysm"	1 (G 1; SR 0)
"berry aneurysms"	1 (G 1; SR 0)
"basilar aneurysm"	0
"basilar aneurysms"	0
Total retrieved	**91**
Total (without duplicates)	**62**
Sifted for relevance	**54**

National Institute for Health and Care Excellence (NICE): Guidelines
https://www.nice.org.uk/
Searched: 17.9.21

NICE Guidance; Conditions and diseases; Cardiovascular conditions; Cranial aneurysms

2019-2021

Guidance 1
Advice 1
Quality standards 0
Pathways 0
Total 2

Guidelines International Network (GIN). International Guidelines Library (Internet): up to 17 September 2021
https://g-i-n.net/international-guidelines-library/
Searched: 17.9.21

intracranial aneurysm
intracranial aneurysms
2019-2021
0 record retrieved

ECRI Institute Guidelines Trust (Internet): up to 17 September 2021
https://guidelines.ecri.org/
Searched: 17.9.21

intracranial aneurysm
2019-2021
0 records retrieved

Trip Database: up to 17 September 2021
https://www.tripdatabase.com/
Searched: 17.9.21

"intracranial aneurysm" OR "intracranial aneurysms" OR "cerebral aneurysm" OR "cerebral aneurysms" OR "brain aneurysm" OR "brain aneurysms" OR "berry aneurysm" OR "berry aneurysms" OR "basilar aneurysm" OR "basilar aneurysms"" in the Document; 2019, 2021
Guidelines: 23 records retrieved

"intracranial aneurysm" OR "intracranial aneurysms" OR "cerebral aneurysm" OR "cerebral aneurysms" OR "brain aneurysm" OR "brain aneurysms" OR "berry aneurysm" OR "berry aneurysms" OR "basilar aneurysm" OR "basilar aneurysms" in the Title; 2019, 2021
Systematic Reviews: 110 records retrieved

Total recorded retrieved: 133

Canadian Agency for Drugs and Technologies in Health (CADTH): up to 17 September 2021
https://www.cadth.ca/
Searched: 17.9.21

"intracranial aneurysm"

"intracranial aneurysms"
"cerebral aneurysm"
"cerebral aneurysms"
"brain aneurysm"
"brain aneurysms"
Advanced Search; Project Line; Health Technology Assessment; 2019-2021
0 records retrieved