Efficacy of microsurgery for dural arteriovenous fistula
A systematic review protocol
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Abstract
Background: Microsurgery is a treatment option for dural arteriovenous fistula (DAF), but its efficacy is still unclear. This study aims to assess the efficacy and safety of microsurgery for the treatment of patients with DAF.

Methods: We will carry out this study assessing the use of microsurgery in patients with DAF from the following electronic databases: PUBMED, EMBASE, Cochrane Library, CINAHL, PsycoINFO, Allied and Complementary Medicine Database, Chinese Biomedical Literature Database, and China National Knowledge Infrastructure. All those databases will be searched from inception to the present without language limitations. Two independent authors will perform study selection, data extraction, and methodological quality assessment. RevMan 5.3 Software will be applied for statistical analysis.

Results: This study will assess the efficacy and safety of microsurgery for the treatment of patients with DAF through measuring initial treatment failure, late recurrence, neurological improvement, quality of life, and complications.

Conclusion: This study will provide most recent evidence of microsurgery for the treatment of patients with DAF.

Dissemination and ethics: The findings of this systematic review will be published in peer-reviewed journals. This systematic review does not need ethic approval, because it just analyzes the published data without individual information involvement.

Systematic review registration: PROSPERO CRD42019144851.

Abbreviations: CI = confidence interval, DAF = dural arteriovenous fistula.

Keywords: dural arteriovenous fistula, efficacy, microsurgery, safety, systematic review

1. Introduction
Dural arteriovenous fistula (DAF) is a very abnormal disorder, which directs connections between arteries and veins in the dura mater. It often occurs at the dura mater and its accessory tissues, such as the cerebral palsy and cerebellum, accounting for 10% to 15% of intracranial vascular malformations. This condition consists of 5 different types according to the position of the fistula. The highest incidence of DAF often occurred in the cavernous sinus area, accounting for 45.5%, followed by the areas of transverse sinus-sigmoid sinus, sacral, superior sagittal sinus, anterior cranial fossa, and the posterior fossa.[4–7] A variety of clinical trials have reported that microsurgery can help to treat DAF effectively.[8–19] Its efficacy and complications are, however, still inconclusive, and no systematic review has investigated this issue. Thus, this study will systematically explore the efficacy and safety of microsurgery for patients with DAF.

2. Methods and analysis

2.1. Eligibility criteria
2.1.1. Participants/population. Patients with DAF, regardless the sex, age, and race will be included in this study.

2.1.2. Interventions/exposure. Patients with DAF, regardless any types of microsurgery.

2.1.3. Study types. All randomized controlled trials assessing the efficacy and safety of microsurgery for the treatment of DAF will be considered for inclusion.

2.1.4. Outcome measurements. Outcome measurements consist of initial treatment failure, late recurrence, neurological improvement (as measured by National Institute of Health Stroke Scale score or other related scales), quality of life (as assessed by...
2.2. Literature search
The current research collects and analyses studies on assessing the efficacy and safety of microsurgery for DAF from PUBMED, EMBASE, Cochrane Library, CINAHL, PsycINFO, Allied and Complementary Medicine Database, Chinese Biomedical Literature Database, and China National Knowledge Infrastructure. We will search all those databases from inception to the present without language restrictions. The example of search strategy for PUBMED is shown in Table 1. We will also apply similar search strategy to any other electronic databases.

In addition, we will search any conference materials, dissertations, reports, and reference lists of relevant reviews.

2.3. Data selection
Two independent authors will scrutinize the titles or abstracts firstly, and any irrelevant and duplicated studies will be excluded. Secondly, remaining studies will be carefully examined the full texts according to all eligibility criteria. The process of study selection will be presented in the flowchart in Figure 1. The reason for each study will be excluded at different stages. Any disagreements will be solved through discussion with the help of a third author.

2.4. Data extraction and management
Two authors will independently collect data from all eligible studies using previous data extracted sheet. Any different opinions between 2 authors will be solved by a third author. The extracted information comprises of characteristics of study (such as title, author, country, etc), sample size, study design, study methods, treatment details, outcome measurements, funding, and any other relevant information.

2.5. Dealing with missing data
If there is insufficient information or unclear data, we will contact original authors to request them. We will analyze the available data if these additional data cannot be achieved and we will discuss its impacts on the results of this study.

2.6. Risk of bias assessment
Two independent authors will utilize Cochrane risk of bias tool to assess the methodological quality for each eligible study. Any divergences between 2 authors will be settled down by a third author through discussion. This tool covers 7 domains, and each one is further classified as low, unclear, and high risk of bias.

2.7. Reporting bias assessment
Funnel plot and Egger regression test will be used to assess any possible reporting bias among eligible studies if >10 trials are included.

2.8. Assessment of heterogeneity
We will use $I^2$ test to identify heterogeneity among eligible studies. If there is low heterogeneity ($I^2 \leq 50\%$), a fixed-effect model will be applied for data pooling. On the contrary, if there is significant heterogeneity ($I^2 > 50\%$), a random-effect model will be used for data pooling.

2.9. Measurement of treatment effect
We will calculate the continuous data as mean difference or standardized mean difference and 95% confidence intervals (CIs), and dichotomous data as risk ratio and 95% CIs.

2.10. Statistical analysis
We will use RevMan 5.3 software to analyze all outcome data. According to the results of heterogeneity, we will pool the data using a fixed-effect model, and will carry out meta-analysis if $I^2 \leq 50\%$. However, if $I^2 > 50\%$, we will pool the data using a random-effect model and will conduct subgroup analysis at the same time. If there is still substantial heterogeneity after subgroup analysis, we will not perform meta-analysis, but will report outcome results with a narrative summary instead.

2.11. Subgroup analysis
Subgroup analysis will be performed based on the different forms of treatments, comparators, and outcome measurement tools.

2.12. Sensitivity analysis
We will conduct sensitivity analysis to identify the robustness of pooled outcomes by removing studies with high risk of bias.

3. Discussion
DAF is a rare disorder in the clinical practice. Although several studies have reported that microsurgery can help patients with DAF, no confirmed conclusion is made. Thus, this study firstly tries to investigate the efficacy and safety of microsurgery for patients with DAF. Its results may provide systematic and
comprehensive assessment for the efficacy and safety of microsurgery for the patients with DAF. Such study will also provide help to make decisions regarding the future practice of microsurgery for DAF.

**Author contributions**

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**References**

[1] Stiebel-Kalish H, Setton A, Nimii Y, et al. Cavernous sinus dural arteriovenous malformations: patterns of venous drainage are related to clinical signs and symptoms. Ophthalmology 2002;109:1685–91.

[2] Miller NR. Dural carotid-cavernous fistulas: epidemiology, clinical presentation, and management. Neurosurg Clin N Am 2012;23:179–92.
[3] Colby GP, Coon AL, Huang J, et al. Historical perspective of treatments of cranial arteriovenous malformations and dural arteriovenous fistulas. Neurosurg Clin N Am 2012;23:15–25.

[4] Bret P, Salzmann M, Bascoulergue Y, et al. Dural arteriovenous fistula of the posterior fossa draining into the spinal medullary veins—an unusual cause of myelopathy: case report. Neurosurgery 1994;35:965–9.

[5] Versari PP, D’Aliberti G, Talamonti G, et al. Progressive myelopathy caused by intracranial dural arteriovenous fistula: report of two cases and review of the literature. Neurosurgery 1993;33:914–9.

[6] Trop I, Roy D, Raymond J, et al. Craniocervical dural fistula associated with cervical myelopathy: angiographic demonstration of normal venous drainage of the thoracolumbar cord does not rule out diagnosis. AJNR Am J Neuroradiol 1998;19:583–6.

[7] Brunereau L, Gobin YP, Meder JF, et al. Intracranial dural arteriovenous fistulas with spinal venous drainage: relation between clinical presentation and angiographic findings. AJNR Am J Neuroradiol 1996;17:1549–54.

[8] Kawaguchi S, Sakaki T, Morimoto T, et al. Surgery for dural arteriovenous fistula in superior sagittal sinus and transverse sigmoid sinus. J Clin Neurosci 2000;7(suppl 1):47–9.

[9] Sheehan J. Gamma knife surgery for dural arteriovenous fistula. J Neurosurg 2006;104:864–5.

[10] Giller CA, Barnett DW, Thacker IC, et al. Multidisciplinary treatment of a large cerebral dural arteriovenous fistula using embolization, surgery, and radiosurgery. Proc (Bayl Univ Med Cent) 2008;21:255–7.

[11] Niizuma K, Sakata H, Koyama S, et al. Childhood transverse sinus dural arteriovenous fistula treated with endovascular and direct surgery: a case report. No Shinkei Geka 2012;40:1015–20.

[12] Shen SC, Tsuei YS, Chen WH, et al. Hybrid surgery for dural arteriovenous fistula in the neurosurgical hybrid operating suite. BMJ Case Rep 2014;2014: bcr2013011060.

[13] Shen SC, Tsuei YS, Chen WH, et al. Hybrid surgery for dural arteriovenous fistula in the neurosurgical hybrid operating suite. J Neurointerv Surg 2015;7:66.

[14] Shi W, Qiao G, Sun Z, et al. Quantitative assessment of hemodynamic changes during spinal dural arteriovenous fistula surgery. J Clin Neurosci 2015;22:1155–9.

[15] Della Puppa A, Rustemi O, Scienza R. Intraoperative flow measurement by microflow probe during spinal dural arteriovenous fistula surgery. World Neurosurg 2016;89:413–9.

[16] Kawahara I, Fujimoto T, Hirose M, et al. A case of dural arteriovenous fistula in the anterior cranial fossa that developed remote from the craniotomy site after surgery. No Shinkei Geka 2017;45:519–26.

[17] Wu CA, Yang HC, Hu YS, et al. Venous outflow restriction as a predictor of cavernous sinus dural arteriovenous fistula obliteration after Gamma Knife surgery. J Neurosurg 2019;25:1–8.

[18] Ozono K, Morofuji Y, Sadakata E, et al. Open surgery following transarterial embolization for cavernous sinus dural arteriovenous fistula. No Shinkei Geka 2019;47:433–40.

[19] Yokoyama S, Nakagawa I, Kotsugi M, et al. Dural arteriovenous fistula arising after intracranial surgery in posterior fossa of nondominant sinus: two cases and literature review. Asian J Neurosurg 2019;14:602–6.