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Technical Note & Surgical Technique

Early microsurgery in a paradigm of "intervention first" for skull base Cognard grade IV dural arteriovenous fistulas

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ABSTRACT

Background: The optimal management of skull base DAVFs remains controversial. Some groups advocate endovascular therapy, which is an efficient therapeutic option, but can be limited by inadequate access to the fistula point, non-target embolization, and recanalization risk. We report our experience in microsurgical obliteration after embolization failure, emphasizing the importance of a prompt effective treatment for the long-term clinical status improvement.

Patients and methods: This is a retrospective review, on 6 patients undergoing surgery for skull base Cognard grade IV DAVF after one or several failed embolization procedures in our institution between January 2006 and July 2016. Patients and treatments characteristics/outcomes are reported.

Results: In all patients endovascular therapy had failed prior to surgery. The mean modified Rankin scale from diagnosis to preoperative surgical cure increased from 1.8 range to 2.7. After surgical treatment, symptoms improved in 5 (83.3%), stayed the same in 1 (16.7%). In all cases total elimination of arteriovenous shunting was achieved, without hemorrhage and recurrence during the mean follow-up period of 5.4 years.

Conclusion: Surgical occlusion of skull base Cognard IV DAVFs yields excellent exclusion rate. However, complete occlusion of the shunt may not lead to clinical improvement if symptoms had been progressing for an excessively long period of time before curative treatment was initiated. Hence the patient remains at risk of rebleeding as long as the shunt is open. We do believe that a single stage endovascular attempt can be decided, but a failed procedure should lead to immediate surgery.

1. Introduction

Intracranial Dural arteriovenous fistulas (DAVFs) are pathologic shunts within the dural leaflets distinct from other arteriovenous malformations of the central nervous system [1]. The arterial supply is usually made via a dural artery, and venous drainage flow leads into a dural venous sinus, through arterialized leptomeningeal veins.

Several classifications have graded DAVFs according to their pattern of venous drainage and flow [2,3]. These classifications reflect the consensus that emerged in the 1970s that retrograde venous drainage into leptomeningeal veins, with abnormal venous flow toward the brain, conferred a higher risk of intracranial hemorrhage (ICH) [6–8]. A variety of classification systems are used, but the simple Borden classification and the more detailed Djindjian classification – later revised by Cognard (Table 1) – tend to be used to decide whether to treat DAVF [2,4]. In all classifications, low-grade DAVFs (Grade I–IIa Cognard,) have an annual risk of hemorrhage of 0%; intermediate lesions (Grade IIb, IIa + b Cognard) have a 6% of hemorrhagic risk, and high-grade lesions (Grade III–V Cognard) have an annual risk of hemorrhage of 10% [2,4,5]. In addition to the hemorrhage risk, functional outcomes must also be considered.

The optimal management of DAVF remains controversial. Some groups advocate endovascular therapy [2–4]. Although endovascular embolization is an efficient therapeutic option, it can be limited by inadequate access to the fistula point, non-target embolization, and the recanalization risk [6–8].

We report our experience, which suggest that microsurgical obliteration has to be immediately underwent in case of failure of a first attempt of endovascular treatment in deep seated Cognard grade IV

Abbreviations: CSF, cerebrospinal fluid; CT, computed tomography; CVR, cortical venous reflux.; DAVFs, dural arteriovenous fistulas; DSA, digital subtraction angiography; GCS, Glasgow coma scale; ICH, intracerebral hemorrhage; IVH, intraventricular hemorrhage; mRS, modified Rankin scale; SAH, subarachnoid hemorrhage; SRS, stereotactic radiosurgery; 3D FDSA, three dimensional fusion digital substraction angiography.

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Table 1
: Cognard classification of dural arteriovenous fistulas.

Grade		Current multidisciplinary management in our center	Number of initially treated patient	Second-line treatment (mean number of procedure)	Surgical Occlusion rates (time from symptoms to complete occlusion)
I	Venous drainage into dural venous sinus with antegrade flow	Wait and see	–	–	–
IIa	Venous drainage into dural venous sinus with retrograde flow	Embolization first	–	–	–
IIb/IIa + b	Venous drainage into dural venous sinus with antegrade flow and CVR/Venous drainage into dural venous sinus with retrograde flow and CVR	Embolization first	–	–	–
III	Venous drainage directly into subarachnoid veins (CVR only)	Embolization first	–	–	–
IV	Type III with venous ectasias of the draining subarachnoid veins	Embolization first	6	Embolization (1.3) surgery (1)	100 (mean 11.4 months (range 0.75–24))
V	Direct drainage into spinal perimedullary veins	Surgery	–	–	

CVR, cortical venous reflux.

patient, emphasizing the importance of a prompt effective treatment for the long-term clinical follow-up.

2. Material and methods

This study is a retrospective review on a prospective database, on patients initially incompletely treated by embolization for Cognard grade IV DAVFs, which required secondary surgical disconnection in our institution between January 2006 and July 2016.

Based on preoperative digital subtraction angiography (DSA), patients were divided into five groups according to the Cognard classification (Table 1). This study concern only Cognard grade IV DAVF, thus 1 DAVF Cognard grade IIb and 1 DAVF Cognard grade V were excluded from the study.

Participants gave their informed consent prior to their inclusion in this study, but their treatment and follow-up otherwise did not vary from the regular treatment provided by our center.

2.1. Data collection

The following preoperative data were collected: demographic details, Cognard grade, fistula location, clinical presentation, pre and post-treatment modified Rankin Scale (mRS), delay of treatment between diagnosis, complications, and long term follow-up. Radiological investigations such as DSA and three dimensional fusion digital substraction angiography (3D FDSA) provided the data on DAVFs before and after treatment [9]. Causes of embolization failure were also reported. The postoperative data collected were neurological exam, modified Rankin scale, time to initiate a complete exclusion following the diagnosis and complications such as ICH. We chose the term “definitive cure” to refer to DAVFs that were completely angiographically occluded without recanalization in the follow-up, and “nontarget-embolization” for an overly proximal embolization.

2.2. Surgical technique

The surgical approach was dictated by careful evaluation of the preoperative angiogram and combination of high resolution vascular and bone imaging offered by 3D–FDSA [9]. Thus the approaches were tailored to the anatomical location of the DAVF and particularly to the location of the exit site of the draining vein from the dura. The operative strategy consisted of an interruption of the arterialized leptomeningeal vein, shortly after the dural entry/exit point, by clipping (Figs. 1 and 2). No attempt was made to coagulate the feeding meningeal arteries or to excise the arterialized dura. Disconnection of the draining vein just distal to the fistula was considered the definitive operative cure. After surgery, angiography was performed in all patients either immediately after the operation or after recovery.

3. Results

3.1. Description of the population

Over the ten-years study period, we included a total of 6 patients who underwent surgical disconnection for Cognard grade IV DAVFs after one or several attempt of embolization. The mean age of the patient cohort was 50.3 years (range 28–65 years). Baseline clinical characteristics, preoperative details are summarized in Tables 1 and 2.

3.2. Embolization procedures

Transvenous embolization attempt failed in 2 petrous DAVFs (patient no 1 and no 2, tables 3 and 4) because of an inadequate access to the arterialized leptomeningeal vein (patient no 2, Tables 3 and 4) and a nontarget-embolization (patient no 1, Tables 3 and 4). 5 transarterial embolizations were reserved for cases in which the fistula could not be reached via the transvenous route. DAVFs were located at the foramen magnum (1 patient), petrous (2 patients) and anterior cranial fossa (1 patient). Concerning the patient no 3, 2 attempts of transarterial embolization successively failed, because of an inadequate access to the fistula point. Complete closure from the arterial side wasn't achieved because of the multiplicity of arterial feeders (patient no 4, no 5, no 6, tables 3 and 4). The DAVF was not completely occluded in 4 cases (patient no 3, no 4, no 5, no 6, tables 3 and 4).

3.3. Surgical results

Surgical occlusion of skull base Cognard IV DAVFs yields an exclusion of the DAVF in all cases. Symptoms improved in 5 (83.3%) of 6 patients, stayed the same in 1 (16.7%). There were no wound infections, CSF leaks, or additional permanent neurological deficits. In all cases a total elimination of arteriovenous shunting could be achieved by the microsurgical operation with a simple clip (Figs. 1 and 2). There were no hemorrhages and no recurrences during the median postoperative follow-up period of 5.4 years. The clinical results after surgery are detailed in Tables 2, 3 and 4.

3.4. Follow-up investigations and outcome

From diagnosis to surgery mean mRS increased from 1.8 (range 0–4), to 2.7 (range 1–5). 3 patients (50%) worsened neurologically. Meanwhile one or several embolization had been attempted (mean 1.2, range 1–3) without anatomical cure (Table 1). Mean time to initiate a complete exclusion following the diagnosis was 11.4 months (range 0.75–24).

3 rebleedings occurred 16 months, 2 days and 5 days after embolization (patient no 1, no 2, no 3, respectively). In the following 48 h after