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Technical note

First line direct access for transarterial embolization of a dural arteriovenous fistula: Case report and literature review

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ABSTRACT

Intracranial dural arteriovenous fistulae (DAVF) are complex vascular malformations consisting of a pathological shunt located between meningeal arteries and drainage to dural venous sinuses and/or cerebral veins. We report an unusual anatomical variation, resulting in a DAVF forming between the superior sagittal sinus and an anomalous origin of the middle meningeal artery (MMA) arising from the left ophthalmic artery. We present an atypical case requiring mini-craniotomy for catheter access, as well as cannulation of extracranial arterial supply prior to embolization of a Cognard type IIa+b fistula. Due to structural variation, transarterial endovascular embolization was deemed too high risk owing to risk of permanent blindness. We present a technical note and literature review on the first documented case of combined endovascular and surgical intervention as first line treatment for embolization of an anomalous middle meningeal artery related fistula. Our approach provided adequate obliteration of the DAVF and may be an alternative way to treat DAVF, when traditional transarterial or transvenous approaches are deemed high risk for neurological deficit.

1. Background and importance

Intracranial dural arteriovenous fistulae (DAVF) are complex vascular malformations consisting of a pathological shunt located between meningeal arteries and drainage to dural venous sinuses and/or cerebral veins. They account for 10%–15% of intracranial vascular malformations [1]. The cause of DAVF remains uncertain, however, these lesions have been associated with dural sinus or venous thrombosis and intracranial hemorrhage, with an annual mortality rate of 10.4% [2]. Assessment of DAVF is based upon the degree of cortical reflux, clinical presentation and potential risk for adverse events of treatment. Management strategies include observation, endovascular (transarterial or transvenous) obliteration or surgery. Rarely, the arteries directly supplying the fistula cannot be cannulated by conventional endovascular technique. We present an atypical case requiring mini-craniotomy for catheter access, due to anomalous bilateral origin of the middle meningeal artery (MMA) from the ophthalmic artery.

1.1. Clinical presentation

A 73-year-old woman was referred from her ophthalmologist for investigation of a palpable thrill over the left eye. The patient had noticed red color desaturation in the left eye with no change in visual acuity. Clinical examination demonstrated bilateral chemosis, proptosis and periorbital oedema (Fig. 1A). Magnetic Resonance Imaging (MRI), MR angiography and subsequent digital subtraction angiography (DSA) confirmed a bilateral DAVF, with Cognard type IIa+b fistula present on the left side (Fig. 1B) [2]. This was supplied by a combination of the MMA and the superficial temporal artery (STA) bilaterally, with drainage into the superior sagittal sinus. Abnormal venous drainage was apparent, with evidence of cortical venous hypertension in the frontal lobes, worse on the left (Fig. 1C). Remarkably, the middle meningeal artery was found to have an anomalous origin from the ophthalmic artery bilaterally, with absence of the foramen spinosum (Fig. 1D). Therefore, direct embolization could risk complete occlusion of the ophthalmic artery, causing permanent blindness in the left eye. Tortuosity of the external carotid artery precluded an endovascular approach through the STA. Microsurgical disconnection was also not feasible due to the DAVF being extensive in the A-P direction and involving both frontal lobes, as well as the high morbidity associated with a large craniotomy in an elderly patient. Therefore,

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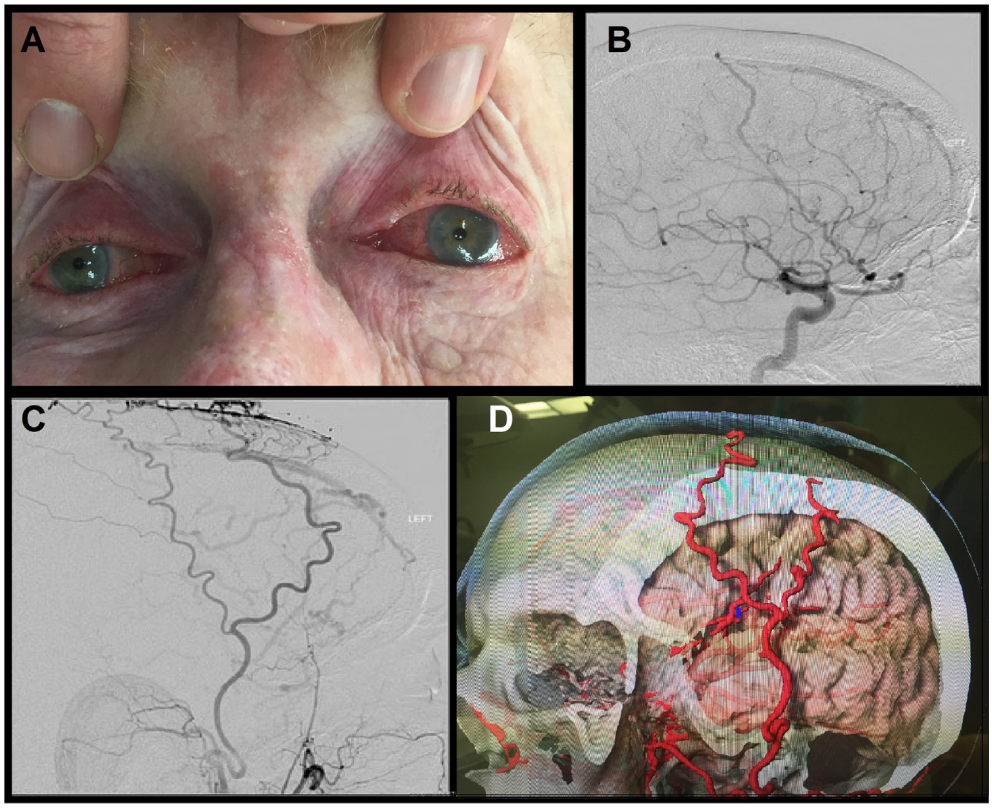

Fig. 1. A. Clinical examination of patient revealing bilateral chemosis, proptosis and periorbital oedema. B. Lateral left internal carotid injection showing the enlarged tortuous middle meningeal artery arising from the ophthalmic artery, with early opacification of the superior sagittal sinus which drains anteriorly with reflux into cortical veins. C. The reflux into cortical veins more easily appreciated on the corresponding lateral projection of the left external carotid injection, showing prominent superficial temporal supply to the fistulae along the superior sagittal sinus, which drains anteriorly with reflux into cortical veins overlying the frontal lobe. There is no filling of the MMA from external injections on either side. D. 3-D visualisation of anomalous origin of the middle meningeal artery from the ophthalmic artery, arising from the internal carotid artery.

a hybrid surgical-endovascular approach with mini-craniotomy to gain direct catheter access to the MMA and STA was considered the best option prior to embolization.

After informed patient consent for the procedure was obtained, the patient was operated under general anesthetic with the head fixed in pins. The superficial vessels were located with assistance of the stereotactic computed tomography angiography volumetric scan incorporated into the frameless navigation system (Brainlab AG, Munich). A coronal scalp incision was made and the STA was easily palpated and identified and the parietal branch was divided and tied off, leaving the frontal branch, which was the major feeding vessel superiorly, on the surface to be cannulated later. The temporalis muscle was then divided and a mini-craniotomy was performed to gain access to the MMA running on the superficial aspect of the dura. Upon removal of the bone flap, the MMA was visualised and divided. It was further coagulated, leaving the stump of the distal MMA attached to the dura. The MMA was then anchored and an endovascular catheter placed and passed superiorly into the vessel a distance of 10 cm (Fig. 2A). The bone flap was replaced and the STA was opened prior to its bifurcation at the superior temporal line. A second endovascular catheter was inserted and anchored into the STA. The temporalis muscle and wound were closed, leaving catheters in situ, and accessible via burr holes. The patient was then transferred to angiography and underwent Onyx® (Covidien, Ireland) embolization of the fistula via the introduced catheters. Onyx 34 was injected through the MMA Marathon microcatheter and Onyx 18 through the Echelon microcatheter in the STA. There was good penetration of fistulae to the level of the vein. There was near complete embolization of the DAVF with obliteration of the anterior ophthalmic meningeal and occipital meningeal supply, and minimal filling from the contralateral STA (Fig. 2B-D).

Postoperatively, the patient was noted to have a mild right tongue deviation and dysarthria. Diffusion weighted MRI demonstrated two small foci of restricted diffusion over the parafalcine anterior left frontal lobe and posterior right frontal lobe compatible with embolic stroke (Fig. 3). At six weeks' follow-up, her speech had significantly improved.

2. Discussion

The decision to embolize a DAVF is complex and must be made on a case-by-case basis taking into account age, comorbidities and symptoms [3]. Angiographic factors such as location, ease of endovascular access, feeding arteries and pattern of venous drainage are also important [2]. In the case of highly complex DAVF (Cognard type IIb and higher), combined microsurgical and endovascular methods are more commonly used [4].

DAVF involving the SSS are unusual and account for 8% of all dural fistulae [2]. Due to their location, they can present with aggressive symptoms related to raised pressure in the arteries feeding the fistula. In our case, this was hypothesised to be due to disrupted ophthalmic venous drainage, in combination with chronic arterial engorgement. The incidence of the MMA arising from the ophthalmic artery as in our case, is extremely low (0.05%) [5].

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