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Case Report

Transcranial embolization of a transverse-sigmoid sinus dural arteriovenous fistula carried out through a decompressive craniectomy

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Summary

We report a case of dural arteriovenous fistula (DAVF) of the transverse-sigmoid sinus presenting with intraventricular hemorrhage. Cerebellar infarction developed after transarterial embolization, and decompressive craniectomy was performed to relieve the mass effect. Through the bone window of the decompressive craniectomy, transcranial puncture of the transverse sinus and coil occlusion of the fistula were successfully performed. Decompressive craniectomy may provide an opportunity to occlude DAVFs which cannot be occluded by the transarterial or transvenous approach.

Keywords: Dural arteriovenous fistula; direct puncture; endovascular embolization; craniectomy.

Introduction

Dural arteriovenous fistulas (DAVFs) with retrograde leptomeningeal venous drainage carry a high risk of severe neurological consequences including intracranial hemorrhage, intracranial hypertension, focal neurological deficit, and seizure [1]. The aggressive behavior of these DAVFs are therefore unanimously considered to require radical curative treatment. Transarterial embolization seldom obliterates these DAVFs because of multiple feeding arteries. By contrast, the transvenous approach may completely and permanently occlude fistula flow [2]. However, the transvenous approach may not be possible if the involved sinus is isolated or inaccessible because of sinus occlusion or purely leptomeningeal drainage. We present a case in whom transcranial puncture of the transverse sinus was performed through a decompressive craniectomy window to access and embolize an isolated transverse-sigmoid DAVF which presented with cerebellar infarctions.

Case report

A 64-year-old woman was admitted because of sudden onset of a change in consciousness. On admission, her Glasgow coma scale (GCS) rating was E3V2M4. Brain computed tomography (CT) revealed diffuse intraventricular hemorrhage (Fig. 1). Cerebral angiography disclosed a DAVF at the left transverse-sigmoid sinus fed by the left occipital, middle meningeal artery (Fig. 2) as well as marginal tentorial artery of the internal carotid artery (ICA) and draining into the ipsilateral transverse-sigmoid sinus with reflux into the leptomeningeal veins; in addition, occlusion of the left internal jugular vein was found as well, which prevented transjugular access. A transvenous approach through the contralateral internal jugular vein was attempted but failed because of irregular narrowing or occlusion at the torcular herophili. The patient underwent transarterial embolization of the fistula and a 20% N-butyl 2-cyano-acrylate (NBCA, Melsungen AG, Melsungen, Germany)/Lipiodol mixture was injected into left occipital and middle meningeal

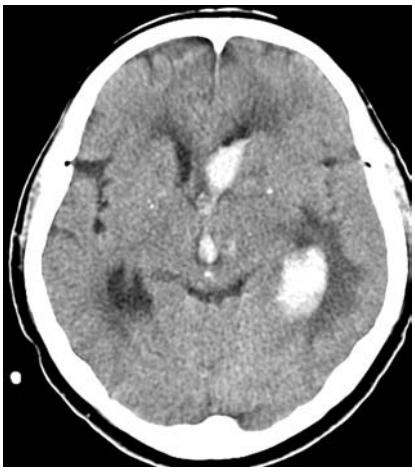

Fig. 1. CT of brain at admission revealed intraventricular haemorrhage with slight ventricular dilatation

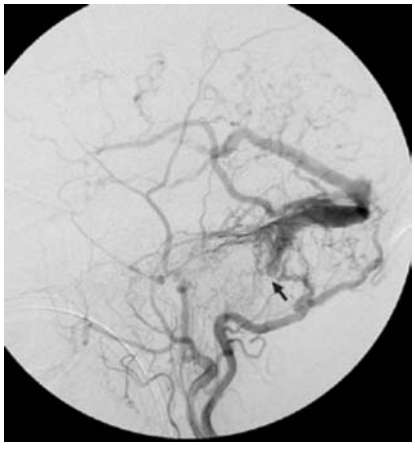

Fig. 2. Left lateral external carotid angiogram demonstrated left transverse-sigmoid sinus dural arteriovenous fistulae (*DAVF*) with cortical veins reflux as well as occlusion of the jugular vein (arrow)

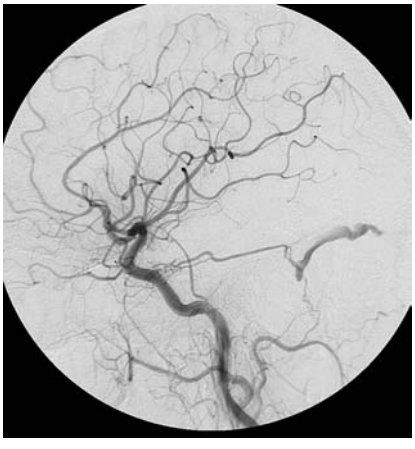

Fig. 3. Left lateral common carotid angiogram after transarterial embolization depicted a residual DAVF (fed exclusively by left marginal tentorial artery) and retrograde cerebellar venous drainage with venous congestion

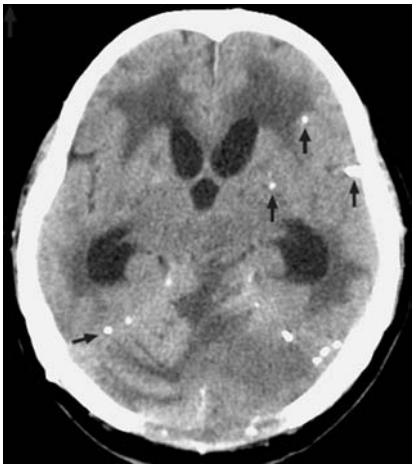

Fig. 4. Follow-up brain CT after retro-cerebellar decompression revealed cerebellar infarctions with mass effect; there were several tiny NBCA mixtures retentions at the draining veins (arrows)

arteries. This resulted in more than 80% reduction of the shunting flow (Fig. 3). The patient's consciousness improved and GCS rating improved to E4V3M5 in the next 10 days. Unfortunately, she had severe vomiting and progressive deterioration of the level of consciousness later. Her GCS rating fell to E2V2M3. Serial brain CT scans revealed bilateral cerebellar infarctions with progressive brain swelling and brain stem compression; in addition, multiple new intracranial highly dense spots appeared (Fig. 4), resulting from the migration of the NBCA mixtures into the leptomeningeal veins. She underwent retro-cerebellar craniectomy to relieve the mass effect on the posterior fossa. Follow-up cerebral angiography demonstrated residual DAVF at the left transverse-sigmoid sinus, which resulted in retrograde cerebellar venous drainage and congestion. The residual DAVF was fed exclusively by the marginal tentorial artery of the ICA (which was too narrow to be selected for embolization) (Fig. 3). The affected sinus was isolated and found to no longer communicate with the contralateral dural sinus. As the patient's symptoms did not resolve, recanalization of the ipsilateral thrombotic internal jugular vein and contralateral lateral sinus was unsuccessfully attempted. Though CT showed that the transverse sinus was covered by skull bone and approximately 1 centimeter above bony defect left by craniectomy, percutaneous direct-puncture of the transverse sinus was considered to be a feasible approach. After general anesthesia, the patient was put in the supine position with head turned to the left side; the left isolated transverse sinus was targeted via transfemoral injection of contrast media into the carotid artery. An 18-guage angiocatheter was inserted into the middle occipital region of the scalp with the tip

pointing 45 degrees toward the transverse sinus and advanced along the uppermost part of the bony defect. The needle tip was tilted until it was 35 degrees to target the left transverse sinus. Successful puncture was confirmed by the observation of good flow and pressure of arterialized blood in the angiocatheter as well as good contrast opacification of the transverse sinus. Following puncture, a new roadmap was created by the angiocatheter system, then a microcatheter (Excel 14, Boston Scientific, Fremont, CA, USA) was navigated over 0.014-inch guide wire into the fistula site (Fig. 5). A total of 8 Guglielmi detachable coils (GDC-18, Boston Scientific, Fremont, CA, USA) were placed into the affected sinus from distal to proximal. The final control angiogram demonstrated total occlusion of the fistula (Fig. 6). Hemostasis at the puncture site was then easily achieved by using direct pressure. Ten days after the last embolization, her neurological status was improved, with GCS rating returning to E3V2M4 and her brain CT scan showing much improvement in the mass effect. She was discharged 50 days after her admission with GCS rating of E4V3M4.

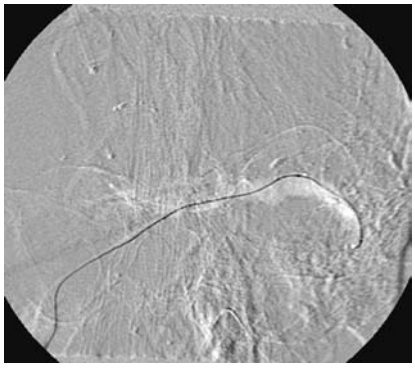

Fig. 5. Patient underwent direct percutaneous transcranial puncture of the transverse sinus through the decompressive craniectomy, after meticulous manipulation, the microcatheter and microguide wire were successfully navigated into the DAVF

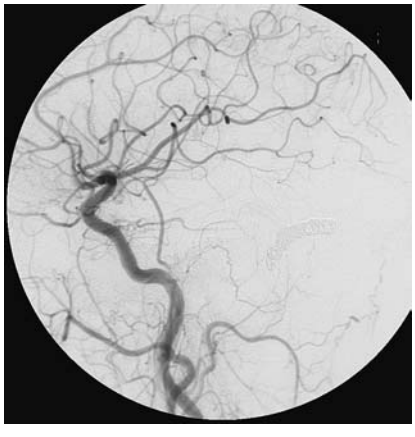

Fig. 6. Final control angiography revealed total obliteration of the DAVFs after detachment of 8 electrodetachable coils into the DAVF

Discussion

Transarterial or transvenous embolization has a major role to play in the management of aggressive DAVFs. Moreover, transarterial embolization may not be successful when the feeding artery is too tortuous or small to be catheterized as occurred in our case. Using the transjugular venous approach, it may be impossible to access the involved sinus owing to sinus occlusion and/or severe sinus stenosis as seen in our case.

In 1986, Mickle *et al.* reported three cases of vein of Galen malformations that were successfully occluded with coils using a combination of intra-operative transcranial embolization and direct puncture of the dural sinus in the operating room [3]. Later, a few published case series reported the success of a similar technique to obliterate DAVFs of transverse and superior sagittal sinus rather than the conventional transarterial and transvenous approaches, which had failed [4–6]. In these series, techniques varied in the size of craniectomy, staging procedure for craniectomy and embolization, puncture methods, as well as selection of embolic materials. Generally, the affected sinus should be in a superficial location close to the cranium, isolated, and located near another sinus. The advantages of these combined approaches are: ease of fistula access after direct surgical exposure, ease of direct sinus coil packing in a small craniectomy, and ability to perform endovascular treatment without any intradural surgical manipulation. The disadvantage of this technique is the potential complications of craniectomy including blood loss and infection; on occasion, the craniectomy may be too small or defective to provide access.

In the present patient, the DAVF could not be accessed from either route because the feeding artery was too small to be catheterized and the involved sinus was isolated. In addition, the access was more difficult and complex in this case than in cases described previously in which intra-operative transcranial approaches were used. The difficulty stems from the facts that decompressive craniectomy is not intended for embolization and the targeted sinus may remain covered by the cranial bone. Furthermore, the scalp was not incised and the dural sinus was not directly exposed to puncture as in previously described simpler transcranial approaches. Technically, the puncture site should not be targeted directly

over the affected sinus itself because of difficulty in redirecting the microcatheter while coiling and may cause insufficient coil packing. In addition, the needle should enter the affected sinus at an angle of 45° to avoid kinking of the microguide wire and/or microcatheter during advancement. The potential risks of direct percutaneous transcranial puncture of the dural sinus are inadvertent puncture the brain parenchyma, artery, penetrate high-flow venous drains or dural sinus, and thereby cause intracranial hemorrhage. High-quality digital subtraction angiography and the road-mapping technique can minimize the risks by enabling the safe performance and monitoring of direct sinus puncture and packing. If an artery or venous drain is inadvertently punctured or the direction of the needle catheter is away from the dural sinus, a second puncture catheter can be used; the first catheter should be left until completion of DAVF embolization. Furthermore, over-manipulation of microcatheter and wires in a diseased/stenotic sinus may run the risk of dislodging of the puncture catheter causing intracranial hemorrhage.

Theoretically, transarterial embolisation with subtotal occlusion of the fistula is very effective in reducing the impact of shunting to the venous circulation and should relieve the patient's symptoms as well as decreasing the potential risk of intracranial hemorrhage or ischemia. In the case presented, transarterial NBCA embolisation did obliterate more than 80% of the shunting, however the patient developed cerebellar infarction 10 days after embolisation. The cerebellar infarction was presumed to be progressive venous thrombosis unrelated to the NBCA treatment or due to excessive embolisation by liquid adhesives with distal migration and occlusion of leptomeningeal venous outflows which diverted residual fistula flows to the cerebellar vein and caused venous hypertension and infarction.

In conclusion, direct percutaneous transcranial puncture of dural sinus via a decompressive craniectomy may be an alternative way to treat a DAVF, when traditional transarterial or transvenous approaches have failed.

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Comment

In their paper the authors describe a case of percutaneous embolisation of an arteriovenous dural fistula. These are notoriously difficult to treat. The special situation reported here is that the isolated fistula was approached percutaneously via a formerly performed craniotomy. This is discussed as an extension to the until now know treatment approaches. The paper is clearly written and the discussion hits the point. It is an interesting case.

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