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Case Report

Non-Sinus-Type Laterocavernous Sinus Dural Arteriovenous Fistula Treated by Transarterial Venous Coil Embolization: A Case Report

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Objective: Laterocavernous sinus dural arteriovenous fistulas (DAVFs) are rare and not always accessible transvenously due to their angioarchitecture. We report a case of non-sinus-type laterocavernous sinus DAVF treated by endovascular transarterial venous coil embolization.

Case Presentation: A 78-year-old woman was admitted to our hospital with loss of consciousness, right hemiparesis, and motor aphasia. CT demonstrated intracerebral hematoma in the left frontal lobe and subarachnoid hemorrhage. On CTA and MRA, a DAVF was found in the left laterocavernous sinus region associated with the accessory meningeal artery (AMA) and draining directly into the superficial middle cerebral vein. The diagnosis was confirmed by DSA, which revealed a DAVF fed by the large and straight AMA and the internal carotid artery's meningohypophyseal trunk. Endovascular transarterial venous coil embolization was performed through the AMA. A microcatheter was advanced beyond the shunt point into the origin of the draining vein, and coils were placed in the venous and arterial sides of the fistula. The fistula was completely occluded, and 15-month follow-up angiography demonstrated stable obliteration of the fistula.

Conclusion: Transarterial venous coil embolization may be a treatment option for non-sinus-type laterocavernous sinus DAVF with a large fistula size and a large and straight feeding artery.

Keywords middle fossa dural arteriovenous fistula, sphenoid wing, transarterial venous embolization, coil, endovascular therapy

Introduction

Non-sinus-type greater sphenoid wing dural arteriovenous fistula (DAVF) is rare. In previous reports, transvenous embolization (TVE) was difficult due to limitation of the approach in many cases and transarterial embolization (TAE) was attempted, but a cure was not achieved and craniotomy was frequently selected.[1)] We report a patient with non-sinus-type laterocavernous sinus DAVF that developed after hemorrhage who was treated using transarterial venous coil embolization, leading to a favorable course.

Case Presentation

The patient was a 79-year-old woman. The patient had no past medical history of trauma or head surgery. She was transported for disturbance of consciousness, right hemiparesis, and motor aphasia. In the first examination, the Japan Coma Scale was II-10 and cerebral hemorrhage with a diameter of 5.5 cm was present in the left frontal lobe on CT, being accompanied by subarachnoid hemorrhage (**Fig. 1A**).

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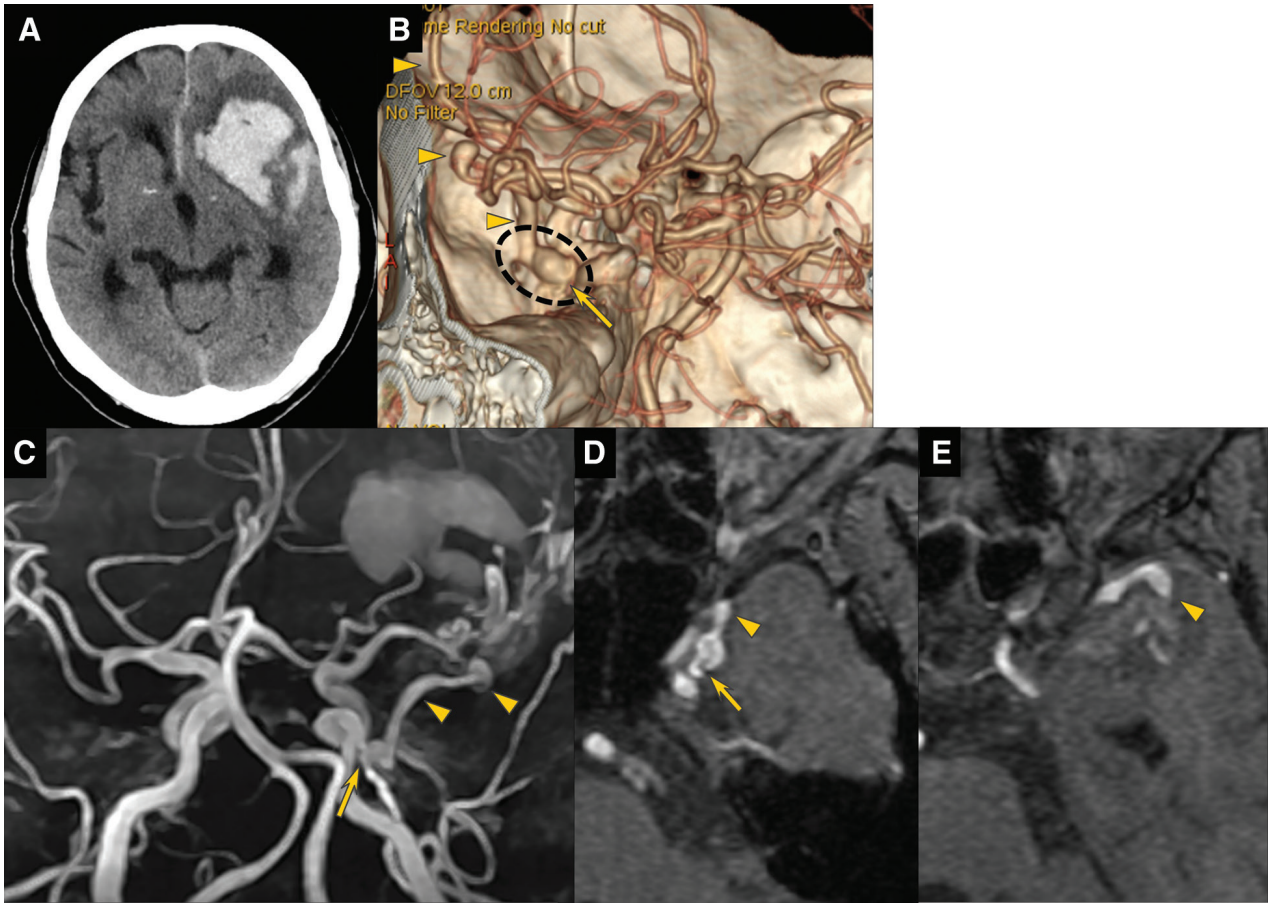

Fig. 1 (**A**) Cerebral hemorrhage was noted in the left frontal lobe on CT at the first examination. (**B**) DAVF (dashed circle) with a shunt point (arrow) inferior posterior to the left cavernous sinus was noted on 3D-CTA. Blood directly flowed into the superficial middle cerebral vein, and it was accompanied by a varix (arrowhead: drainer). (**C**–**E**): Similar findings were noted on MRA (arrow: shunt point, arrowhead: drainer). DAVF: dural arteriovenous fistula

An abnormal blood vessel was noted in the left middle cranial fossa, suggesting DAVF on CTA (**Fig. 1B**). The accessory meningeal artery (AMA) directly flowed into the superficial middle cerebral vein on the dura mater inferior posterior to the left cavernous sinus after passing through the foramen ovale (arrow), forming cortical venous reflux, and it was accompanied by a varix in the Sylvian fissure. Similar findings were observed on MRA (**Fig. 1C**–**1E**). On the 3D-CTA source image (axial plane), the left AMA formed a direct shunt in the superficial middle cerebral vein after passing through the foramen ovale and this region was located lateral and caudal to the area where the cavernous sinus is usually located, suggesting the vicinity of the laterocavernous sinus (**Fig. 2A**–**2L**). The patient was diagnosed with left laterocavernous sinus DAVF by DSA on the 4th hospital day (**Fig. 3A** and **3B**). The feeder was the AMA and left internal carotid artery meningohypophyseal trunk, directly flowing into the superficial middle cerebral vein without forming a fine feeder network, and cortical venous reflux was formed (Borden type III and Cognard type IV). The drainer was accompanied by a varix and flowed out to the superior sagittal sinus via the frontal lobe surface. The sphenoparietal sinus and cavernous sinus were not involved in the route of DAVF outflow or normal perfusion. On 3D-rotational angiography (RA), the AMA diameter immediately before the shunt point was 1 mm and the fistula diameter was approximately 1.5 mm (**Fig. 3C**). On internal carotid arteriography on the affected side (left), a feeder from the left internal carotid artery meningohypophyseal trunk was also present (**Fig. 3D**–**3E**).

Endovascular treatment was performed on the 10th hospital day. Under general anesthesia, a 5-F Fubuki Dilator Kit 80 cm (ASAHI INTECC, Aichi, Japan) was guided to the left external carotid artery from the right femoral artery. On left external carotid arteriography before treatment, a direct shunt from the AMA to the superficial middle cerebral vein was noted and joined with the feeder from the internal carotid artery meningohypophyseal trunk in

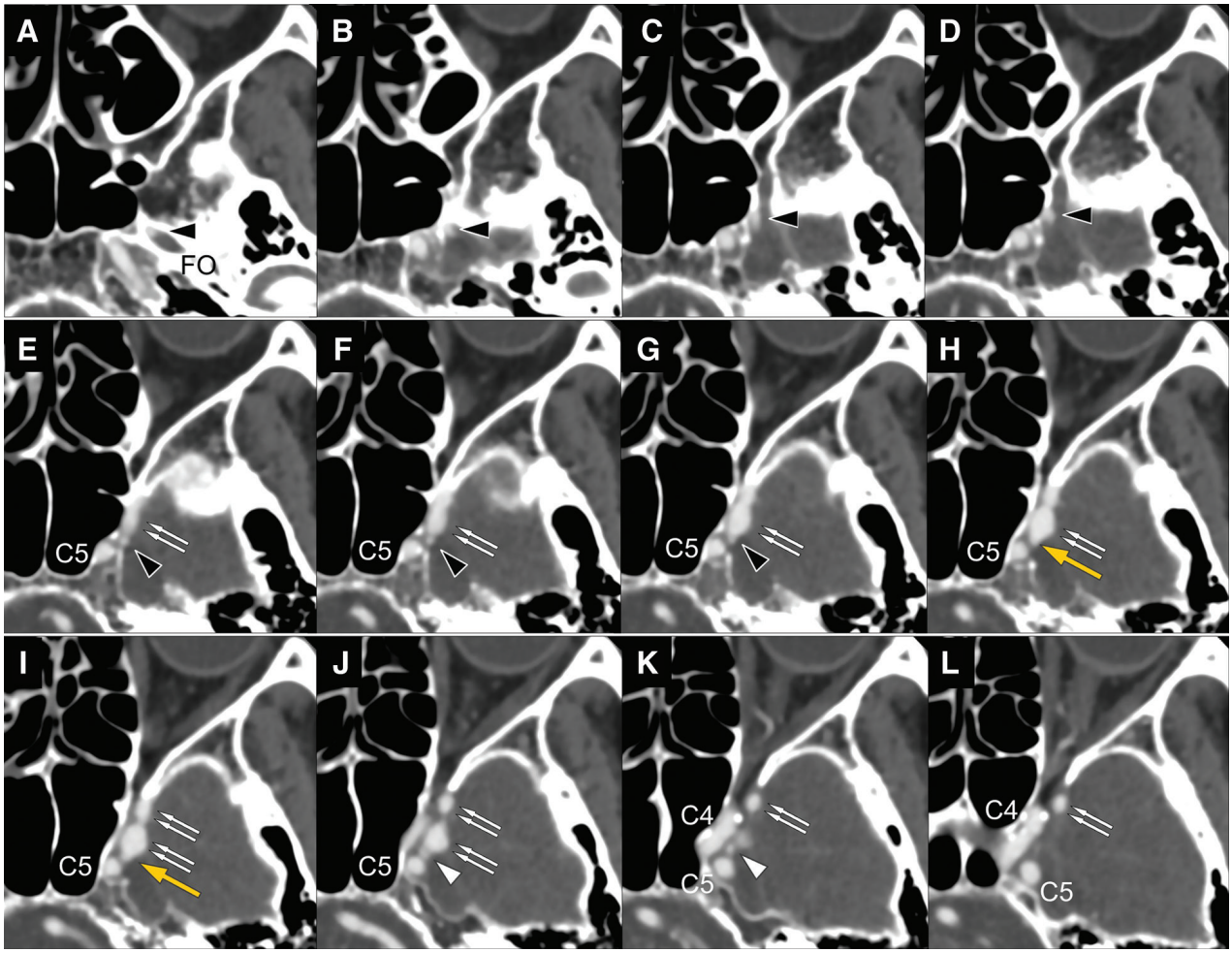

Fig. 2 (**A**–**L**) On the preoperative 3D-CTA axial source image, the left AMA (black arrowhead: proximal side, white arrowhead: distal side) formed a direct shunt with the superficial middle cerebral vein (double white arrow) in the yellow arrow region after passing through the oval foramen (FO). AMA: accessory meningeal artery; C4: internal carotid artery C4 segment; C5: internal carotid artery C5 segment; FO: foramen ovale

the distal region (**Fig. 4A**). Using a 4.2-F Fubuki 120 cm (ASAHI INTECC) as an intermediate catheter, an Excelsior XT 17 (Stryker, Kalamazoo, MI, USA) was guided to the left AMA using Traxcess 14 (TERUMO, Tokyo, Japan) and the Excelsior XT 17 was placed at the origin of the drainer beyond the shunt point (**Fig. 4B**). In the dilated portion of the origin of the drainer, a frame was prepared using a Target 360 Soft 7 mm × 15 cm (Stryker) and this portion was densely occluded with a total of 9 coils (**Fig. 4C**).

Then, the distal AMA was occluded with 2 Target Helical Ultra 2 mm × 3 cm coils (Stryker) (**Fig. 4D**); the proximal AMA was occluded with a total of 6 coils, including Target 360 Ultra 3 mm × 4 cm (Stryker) (**Fig. 4E**); and the shunt blood flow disappeared (**Fig. 4F**).

There was no marked change in the course after treatment. The patient was transferred to a hospital for recovery rehabilitation, underwent ventriculoperitoneal shunt, and was discharged to home. No recurrence was noted on MRA or DSA at 15 months after treatment, paralysis and aphasia improved although memory disturbance was present, and the patient is being treated as an outpatient (modified Rankin Scale 2).

Discussion

Laterocavernous sinus DAVF is a rare pathology, and it was previously regarded as middle cranial fossa DAVF in many cases, but it has recently been more frequently classified as sphenoid wing DAVF. Sphenoid wing DAVF accounts for approximately 1% of all intracranial DAVF cases, being rare, and only 30 cases were reported in a review in 2021.[2] The vascular architecture is also diverse and the nomenclature is not constant. Hiramatsu et al.[3] classified DAVF in the parasellar region into 4 groups

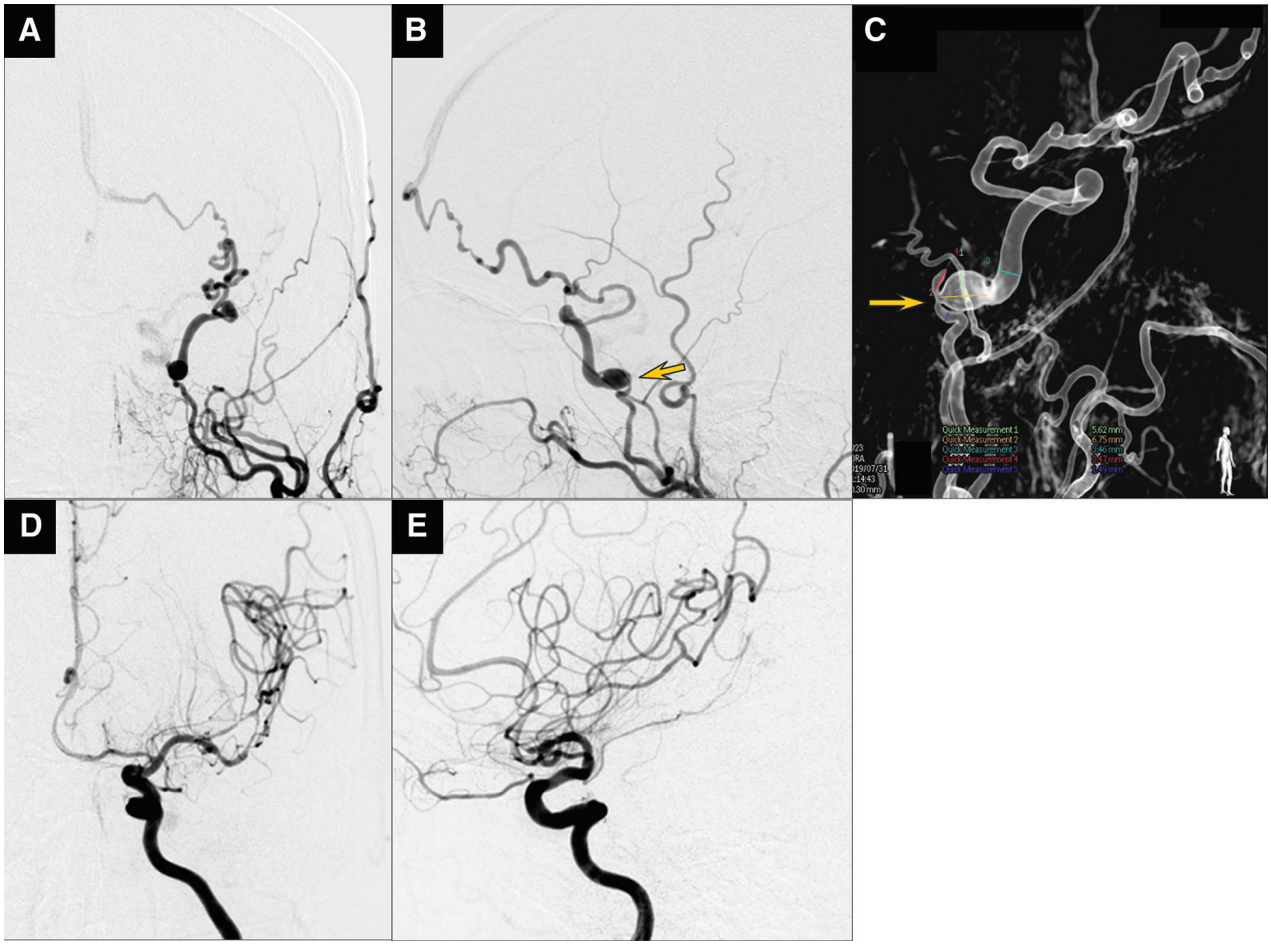

Fig. 3 Preoperative DSA. (**A** and **B**) The fistula was diagnosed as left laterocavernous sinus DAVF in the frontal view (**A**) and lateral view (**B**) on left external carotid arteriography. The feeder was the AMA. It directly flowed into the superficial middle cerebral vein, forming cortical venous reflux, and was then accompanied by a varix and flowed out to the superior sagittal sinus thorough the frontal lobe surface. (**C**) On right anterior oblique 3D-RA, the AMA diameter immediately before the shunt point (arrow) was 1 mm and the diameter was 1.5 mm (arrowhead: varix). (**D** and **E**): A feeder from the left internal carotid artery meningohypophyseal trunk was present in the frontal view (**D**) and lateral view (**E**) on angiography of the affected side (left) of the internal carotid artery. AMA: accessory meningeal artery; DAVF: dural arteriovenous fistula; RA: rotational angiography

based on the positional relationship with the cavernous sinus, and sphenoid wing DAVF was classified into the anterolateral group. Greater sphenoid wing DAVF forms a shunt in the superficial middle cerebral vein or laterocavernous sinus, and in addition to these, the sphenobasal sinus and superior petrosal sinus serve as a main route of outflow and are accompanied by a varix in many cases, whereas the sphenoparietal sinus and cavernous sinus are relatively less frequently involved. On the other hand, lesser sphenoid wind DAVF forms a shunt in the sphenoparietal sinus flowing out to the cavernous sinus in many cases. This may be similar to DAVF in the cavernous sinus on imaging, but there are exceptions. Therefore, diagnosis should be made carefully.[2,3] In the present patient, the AMA joined the feeder from the internal carotid artery's meningohypophyseal trunk in the vicinity of the laterocavernous sinus, which is considered below the normal cavernous sinus, after passing through the oval foramen, and then formed a direct shunt to the superficial middle cerebral vein. On angiography, no involvement of the sphenoparietal sinus or cavernous sinus in either route of outflow of DAVF or perfusion tract of the normal vein was noted. On the other hand, the laterocavernous sinus was also unclear because of the non-sinus type. Accordingly, the positional relationship between the shunt and these sinuses was unable to be clarified. Although there may be a possibility of reflux from the occluded cavernous sinus to the cortical vein, the above findings were considered consistent with greater sphenoid wing DAVF.

Greater sphenoid wing DAVF is considered to have a high risk of cortical venous reflux, venous hypertension, intracranial hemorrhage, and symptom manifestations

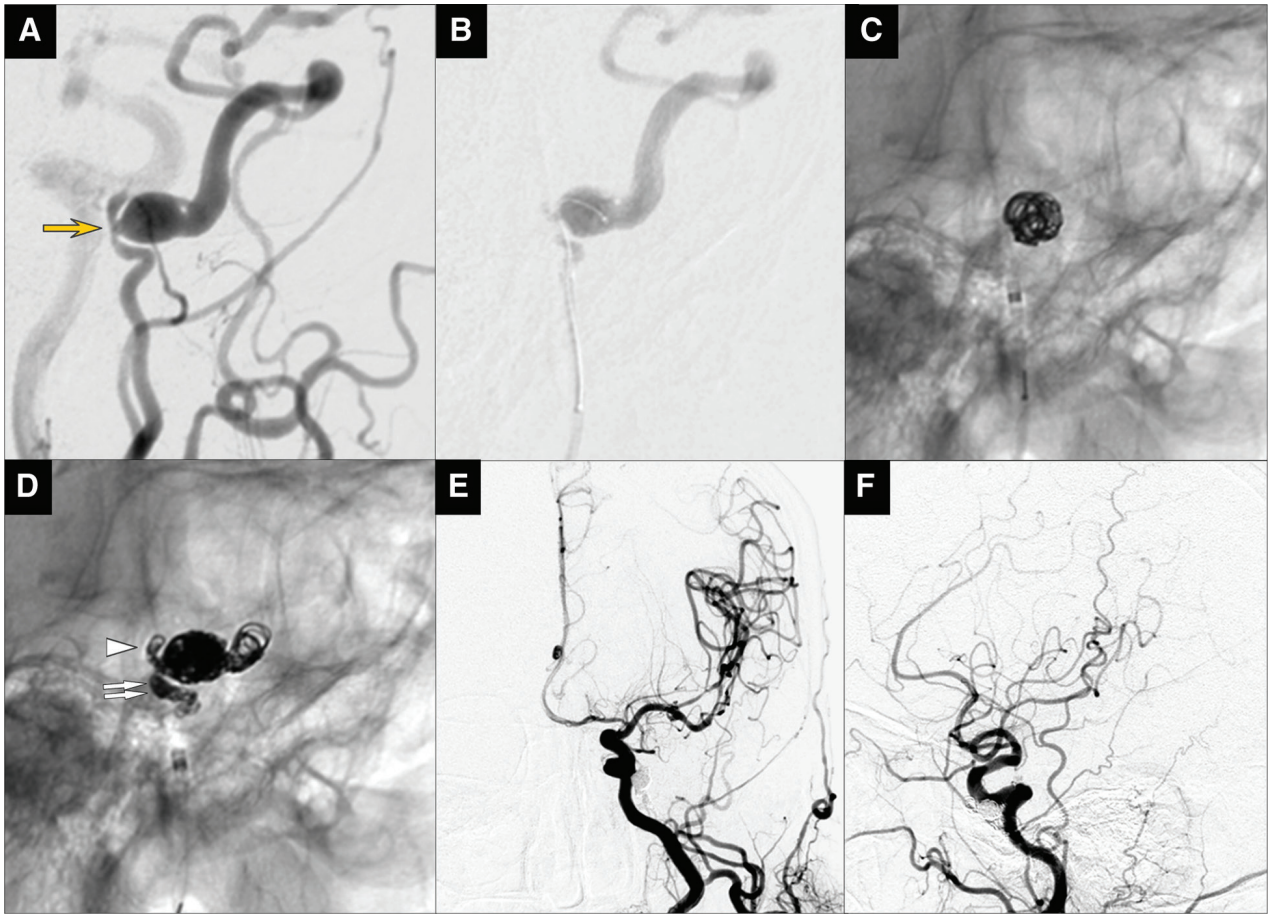

Fig. 4 Intraoperative findings. (**A**) Preoperative left external carotid arteriography, right anterior oblique view (arrow: shunt point). The distal AMA served as a joint with the feeder from the internal carotid artery's meningohypophyseal trunk. (**B**) The microcatheter was guided to the drainer side beyond the shunt point through the AMA. (**C** and **D**) Coil occlusion was applied in the order from the origin of the drainer (**C**) to the distal AMA (**D**, arrowhead) and proximal AMA (**D**, double arrow). (**E** and **F**) On postoperative left common carotid arteriography, the DAVF disappeared in the frontal view (**E**) and lateral view (**F**). AMA: accessory meningeal artery

leading to a poor course.[2,3] Surgical treatment is the conventional first choice, but embolization has recently become the standard treatment.[2]

Non-sinus-type greater sphenoid wing DAVF is especially rare and 6 cases were reported in a review by Nakamura et al.,[1] in which in endovascular treatment, TVE was unable to be performed because of limitation of the approach route. TAE with a liquid embolic agent was performed in 3 patients, but the outcome was only reduction of shunt blood flow and simplification or clarification of the lesion. Thus, no cure was acquired even though TAE was performed multiple times and craniotomy was finally performed in all 6 patients.

We treated non-sinus-type laterocavernous sinus DAVF using transarterial venous coil embolization and acquired a favorable course. According to histological studies, the fistula diameter of typical DAVF is 30–200 μm,[4] through which passing a microcatheter is difficult. In the present patient, the fistula was the single channel type without a fine feeder network. The feeder, the AMA, slightly bent immediately before the shunt point, and the diameter was 1 mm, being narrow, but overall, it was linear and favorably developed. The fistula diameter was approximately 1.5 mm, being large, and a microcatheter with an external tip diameter of 1.7 F was easily passed through.

Transarterial venous coil embolization for DAVF difficult to treat by TVE has been occasionally reported,[4–9] but for sphenoidal wing DAVF, to our knowledge, only 2 cases have been reported.[6,7] In a report from Murakami et al.,[6] transvenous approach to the sinus of the lesser sphenoid wing was unsuccessful. An SL10 (Stryker) was guided from the artery of the foramen rotundum and complete occlusion was achieved with coils alone. In a report from Shi et al.,[7] an Echelon 10 (Medtronic, Dublin, Ireland) was guided to the sphenobasal sinus through the middle meningeal artery (MMA), and complete occlusion was achieved by the concomitant use of GDC (Stryker) and Onyx 34 (Medtronic).

In a review of 16 cases treated by transarterial venous coil embolization for intracranial DAVF including other regions,[8] the fistula was present in the transverse–sigmoid sinus in 5, superior sagittal sinus and cavernous sinus in 4 each, tentorium in 2, and the sinus of the lesser sphenoid wing in 1, and the feeder used as an approach route was the middle meningeal artery in 10, AMA in 4, internal carotid artery meningohypophyseal trunk in 1, and artery of the foramen rotundum in 1. For the microcatheter, in addition to SL-10, Echelon 10, Prowler-14 (Codman, Raynham, MA, USA), Excel-14 (Stryker), Headway-17 (TERUMO), Excelsior-1018 (Stryker), Renegade-18 (Boston Scientific, Marlborough, MA, USA), and 18 catheters with a tip diameter of 0.83 mm, a Marathon (Medtronic) was used, and transarterial venous coil embolization was considered more effective and safer than other embolization methods when applicable. Ryu et al.[9] guided a Marathon into the sinus from the ascending pharyngeal artery for DAVF in the cavernous sinus region and applied occlusion.

TVE is difficult in many cases of isolated sinus-type DAVF,[2,10] and TAE with a liquid embolic agent has recently been frequently reported.[10,11] Previously, the rate of cure by TAE was inferior to that of TVE, but it was improved by the use of Onyx.[10] Kandyba et al.[11] treated lesser sphenoid wing DAVF by only TAE using Onyx, but they concomitantly performed feeder occlusion with coil (pressure cooker) and balloon protection of the internal carotid artery as an adjunctive technique. In the present patient, the feeder was occluded with coils alone, but concomitant use of a liquid embolic agent with coils may be medical economically advantageous, as reported by Shi et al.[7]. However, we refrained from its use in this patient considering the risk of occlusion of the distal drainer by the scattered embolic agent, in addition to the risk of latent anastomosis with the vasa nervorum, the internal carotid artery, and the ophthalmic artery. Moreover, the use of Onyx for cavernous sinus DAVF may cause serious complications, such as nerve palsy, due to toxicity of the solvent, dimethyl sulfoxide (DMSO), and cardiac arrest (trigeminocardiac reflex); therefore, this is not approved in Japan.[12] If the feeder is linear with a large diameter and the fistula is also large, enabling the transarterial approach, transarterial venous coil embolization is simple and effective, causing less complications[3]; thus, this method may be considered first.

Murakami et al.[6] performed treatment using coils alone, as we did, but as shunt blood flow slightly remained after isolated sinus occlusion, they occluded up to the feeder with coils and acquired complete occlusion. In the present patient, the distal AMA was the joint with the feeder from the internal carotid artery's meningohypophyseal trunk, for which residual shunt blood flow from the region and recurrence after treatment were of concern. Thus, coil embolization was applied by way of trapping in 3 directions from the origin of the drainer and distal and proximal AMA, sandwiching the fistula, by which complete disappearance of DAVF was achieved and no recurrence was noted on DSA after 15 months. For occlusion of the origin of the drainer, movement of the microcatheter was markedly limited by the fistula. By steam shaping the catheter tip to a small strong bend beforehand, dense embolization was possible (**Fig. 3B**).

Conclusion

Non-sinus-type laterocavernous sinus DAVF is rare, but treatment by transarterial venous coil embolization may be possible in cases with a large fistula diameter and a large linear feeder.

Disclosure Statement

The authors declare no conflicts of interest.

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