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Transvenous Embolization for Isolated Superior Petrosal Sinus Dural Arteriovenous Fistula

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Abstract

Isolated superior petrosal sinus dural arteriovenous fistula (SPSdAVF) is a rare condition for which transvenous embolization is a safe treatment, even if accessing the isolated sinus can be challenging. A 39-year-old female patient with dizziness and right facial palsy underwent magnetic resonance imaging, revealing a venous infarction at the posterior fossa and a dural arteriovenous fistula. Digital subtraction angiography showed an isolated SPSdAVF. The shunt point was posterior to the isolated superior petrosal sinus, and the shunt flowed only through the petrosal vein. Contrast-enhanced magnetic resonance imaging showed thrombosis at the anterior segment of the superior petrosal sinus. Transvenous embolization was successfully performed via the thrombosed anterior segment of the superior petrosal sinus without associated complications. This case shows that transvenous embolization through a thrombosed superior petrosal sinus is an alternative treatment option for isolated SPSdAVF.

Keywords: superior petrosal sinus, dural arteriovenous fistula, transvenous embolization

Introduction

A superior petrosal sinus dural arteriovenous fistula (SPSdAVF) is a rare arteriovenous shunt, representing 0.9% of all dAVFs.[1)] Isolated SPSdAVF usually shows an aggressive clinical course owing to the regurgitation of blood present in the shunt into the veins around the brainstem via the mesencephalic and petrosal veins.[2)] Although transvenous embolization (TVE) can effectively treat isolated dAVFs,[3)] approaching the isolated sinus through an occluded sinus is complicated.[4)] Thus, there are only a few reports on using TVE for isolated SPSdAVF.[2,5,6)] Transarterial embolization (TAE) can be an alternative, but it has a higher risk of cranial neuropathy and/or embolic agent transmission across extracranial-intracranial anastomoses than TVE.[3)] To our knowledge, the usefulness of TVE via the cavernous sinus (CS) to an isolated SPS for treating isolated SPSdAVF has not been previously reported. Here, we present a novel approach for treating isolated SPSdAVF and highlight the importance of evaluating the anatomical structure before treatment.

Case Report

A 39-year-old female experiencing dizziness for one month and right facial palsy for a few days underwent computed tomography (CT), which showed a low-density area at the right cerebellar and mesencephalic and pons. Her magnetic resonance imaging (MRI) (Fig. 1a) findings indicated venous infarction of the right cerebellar, brain stem, and dilated cerebellar veins. Time-of-flight magnetic resonance image (Fig. 1b) indicated high-intensity signals in the right superior petrosal sinus. Additionally, the venous infarction of the brain stem caused right facial palsy. Digital subtraction angiography (DSA, Fig. 2) of the right external carotid artery demonstrated the right isolated SPSdAVF, fed by the right middle/posterior meningeal and occipital artery. The right SPS was separated from the CS and transverse sinus. The shunt drained only through the petrosal veins, and the anterior and posterior segments of

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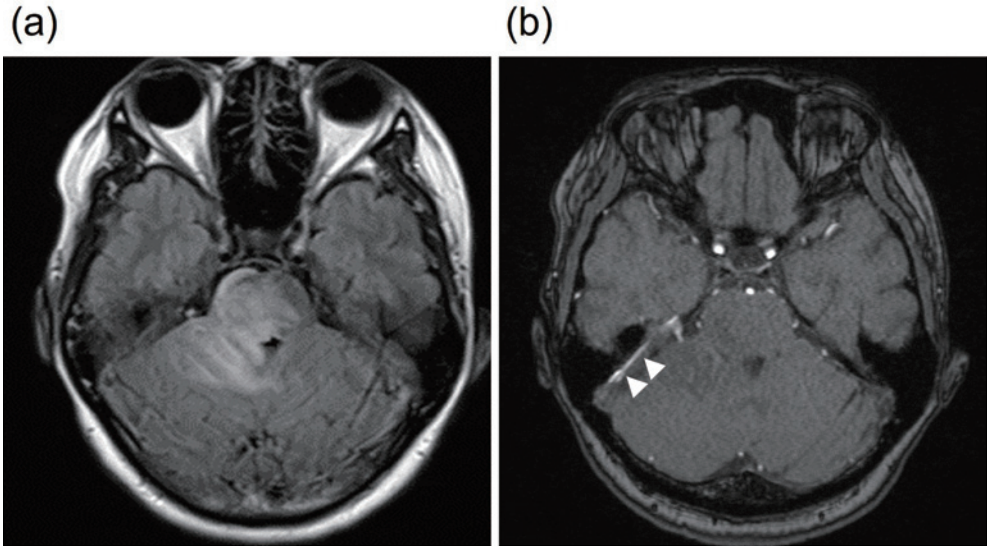

Fig. 1 Magnetic resonance images (a) and time-of-flight magnetic resonance image (b) on admission showing venous infarction at the brain stem and cerebellum, including high-intensity signals in the right superior petrosal sinus (arrowhead).

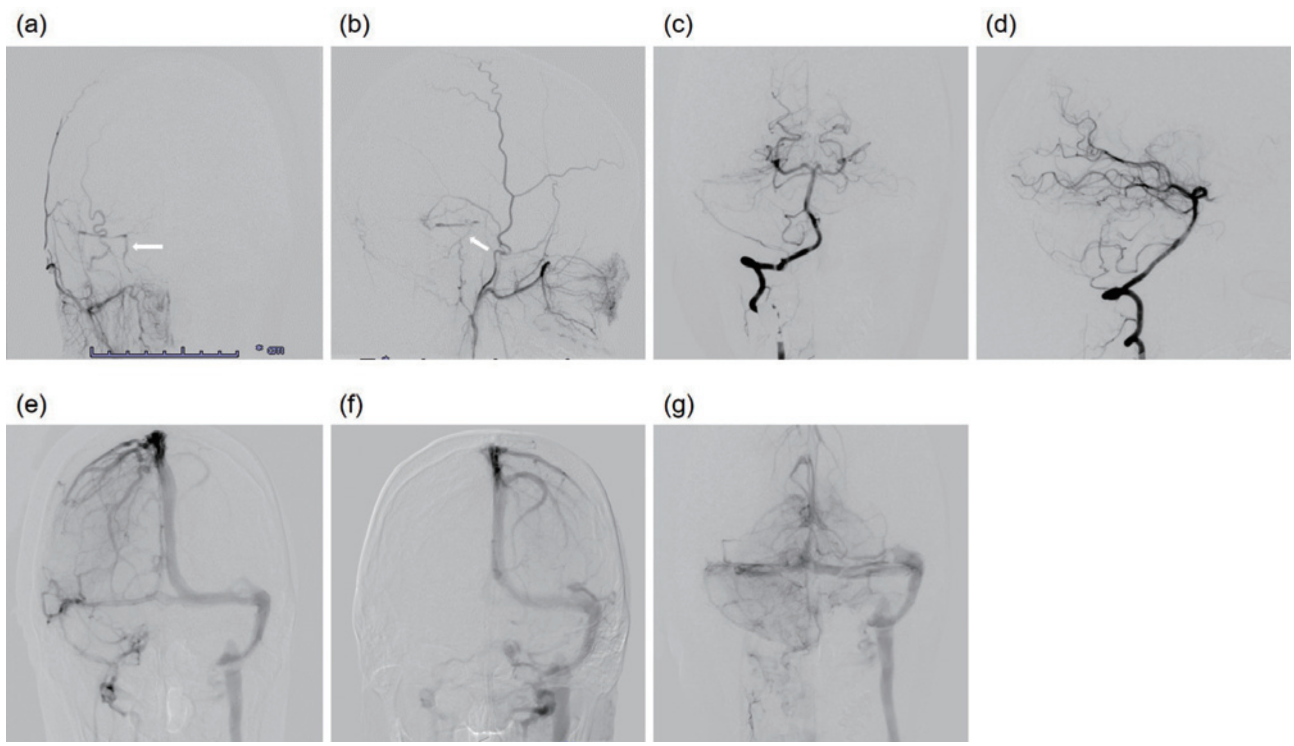

Fig. 2 Anteroposterior (a) and lateral (b) view of the right external carotid angiography showing that the right middle meningeal and occipital arteries feed the dural arteriovenous fistula. The shunt flow drained the petrosal vein only (arrow). The anterior and the posterior segments of the right superior petrosal sinus are unobservable. The anteroposterior (c) and lateral (d) views of the right vertebral angiography show that the right posterior meningeal artery feeds the dural arteriovenous fistula. The anteroposterior view of the right internal carotid (e), left internal carotid (f), and right vertebral (g) angiography shows a shrinkage in the right jugular vein and opened left jugular and inferior petrosal veins.

the right SPS were thrombosed. The anterior segment of the SPS, from CS to the petrosal vein, did not appear in DSA. As the shunt point was located posteriorly to the isolated SPS, the diagnosis was right isolated SPSdAVF, Borden classification type 3. Contrast-enhanced MRI (Fig. 3a), performed to intricately evaluate the anterior segment,

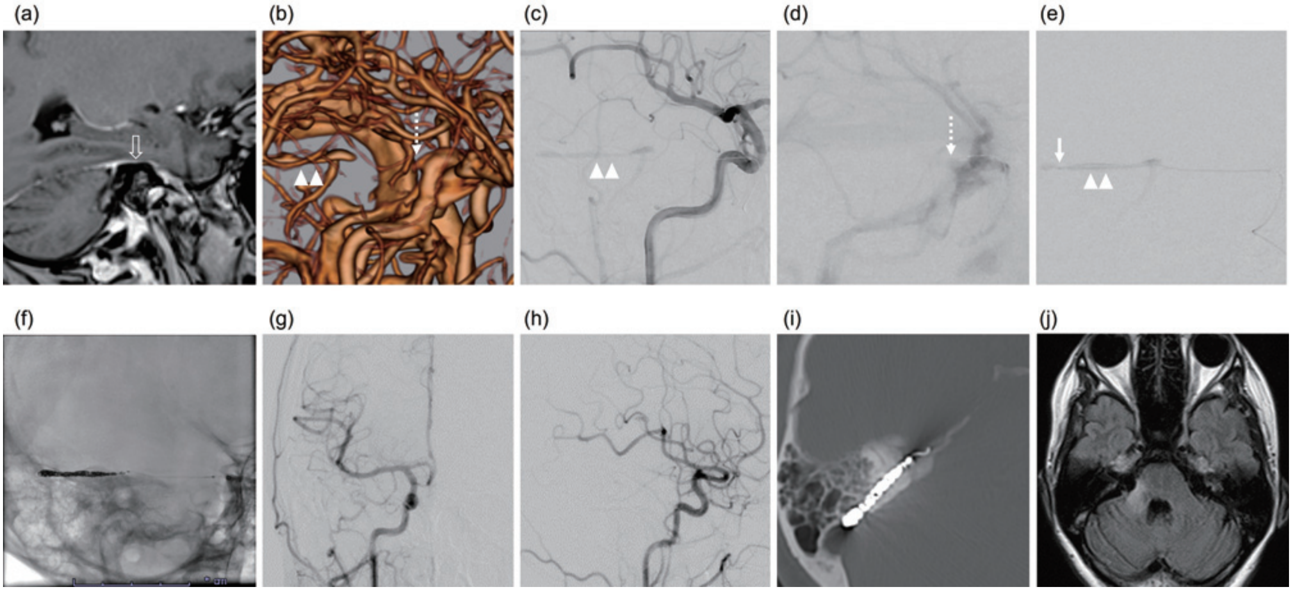

Fig. 3 Contrast-enhanced magnetic resonance image (a) showing the anterior segment of SPS was enhanced (open arrow). It meant that the vessel structure presented the anterior part of SPS. Contrast-enhanced computed tomography (b) and right common carotid angiography at arterial (c) and venous phase (d) showing the beak-filling pattern (dotted arrow) of cavernous sinus posterolaterally, and it would connect to the isolated superior petrosal sinus (arrowhead). Microcatheter angiography (e) showing the shunt flow. The arrow indicated the microcatheter tip. Craniogram (f) showing coils in the isolated superior petrosal sinus. Anteroposterior (g) and lateral (h) views after treatment demonstrating no arteriovenous shunt. Postembolization axial computed tomography (i) showing coils in the superior petrosal sinus. All views (b-f) are from the same angle. Magnetic resonance image after 6 months (j) showing an improved venous congestion.

showed an enhanced anterior segment of SPS. Since DSA did not show the flow in the anterior segment of SPS, contrast-enhanced MRI showed enhanced thrombosis in the anterior segment of SPS. Moreover, the anterior segment of SPS was expected to be obstructed by thrombosis. The venous phase of three-dimensional CT (Fig. 3b) showed the beak-filling pattern of CS posterolaterally. We expected that it would connect to the isolated SPS. The patient underwent surgery through TVE. Under general anesthesia, a 7-Fr guiding catheter (ENVOY) was inserted in the left internal jugular bulb. A 4.2-Fr ASAHI FUBUKI (Asahi Intecc, Nagoya, Japan) was inserted via the left inferior petrosal sinus into the left CS. Then, an Excelsior 1,018 microcatheter (Stryker, Kalamazoo, MI, USA) was introduced via the inter CS into the right CS. The DSA of the right common carotid angiography at the venous phase (Fig. 3d) revealed the entrance of the right SPS segment.

Using biplane DSA, a microcatheter with a 0.014-inch outer diameter micro guidewire (CHIKAI, Asahi Intecc, Nagoya, Japan) penetrated the isolated SPS through the anterior segment of the thrombosed SPS (Fig. 3c). A microangiography (Fig. 3e) showed the microcatheter in the isolated SPS. Coils were inserted into the isolated SPS from the posterior side to the SPS to the anterior side (Fig. 3f). After TVE, the DSA (Fig. 3g, h) showed a complete occlusion of the SPSdAVF, and CT (Fig. 3i) showed the coil mass in the right SPS, without associated complications. Follow-up MRI (Fig. 3j) 6 months postoperatively showed improved venous congestion, and DSA performed after 1 year showed no recurrent dAVF. Although the patient had right facial palsy and truncal ataxia, the symptoms of dizziness disappeared and she could walk while holding things.

Discussion

This report highlights two important clinical points. First, the anterior approach route, from CS to isolated SPS, helps treat isolated SPSdAVF. Second, the anatomical construction of the SPS before treatment must be evaluated to use this approach.

Treatment strategies and approach route to the isolated SPS

First, the anterior approach route helps treat the isolated SPSdAVF, for which TAE was preferred. However, injecting liquids, such as N-butyl cyanoacrylate and Onyx, via the artery surrounding the petrous bone is dangerous because of the risk of palsy of cranial nerves, such as VII and VIII. Despite the usefulness of the provocation test, false negatives might occur,[7] making evaluation under symptomatic conditions challenging. Another TAE risk is embolic agent transmission across extracranial-intracranial/vertebral artery anastomoses.[3] The transvenous approach is efficient and safe if approaching the isolated sinus via the adjacent sinus is possible.[3] Although surgeons can often penetrate the thrombosed IPS, penetrating the thrombosed SPS remains possible. In this case, we approached the isolated SPS from the CS site because the shunt point was posterior to the isolated SPS. To penetrate the thrombosed SPS, catheter support and biplane views were essential. A distal access catheter was necessary to provide distal support until the furthest possible point to the microcatheter and micro guidewire,[8] and it allowed us to penetrate the thrombosed sinus. We used contralateral IPS to access the isolated SPS. The IPS originates in the posteroinferior aspect of the C, whereas the SPS arises in the posterosuperior part of the CS. The angle of the ipsilateral IPS-CS-ipsilateral SPS was extremely steep. The angle of the contralateral IPS-interCS-ipsilateral SPS was less steep than that of ipsilateral IPS-CS-ipsilateral SPS. The angle is soft via the contralateral IPS, making transmitting straight force easy for the catheter to penetrate the thrombosed sinus. Other approach routes in TVE were the transverse sinus or the Rosenthal basal vein.[2] The posterior route via the transverse sinus was close to the isolated sinus. However, the anterior route via the CS was preferred over the posterior route to avoid shunt point embolization from the downstream-to-upstream dAVF venous flow. A previous study performed TVE through the transverse sinus, straight sinus, and basal vein into the lateral mesencephalic vein. However, the treatment may lead to venous perforation because of the thin walls of the venous varix.[5] Anatomical knowledge could help lead the catheter into the isolated SPS.

Although we may perform a craniotomy to ligate the petrosal vein, the dAVF outlet,[9] it was avoided because it was more invasive than our approach. Thus, surgeons might consider treating isolated SPSdAVF with TVE rather than TAE.

Evaluation of the anatomical construction of the SPS

Second, the anatomical construction of the SPS before treatment must be evaluated. Padget et al.[10] reported that SPS originates from the middle dural plexus. The posterior segment of SPS, from the petrosal vein to the transverse sinus, developed as a drainage route of the ventral metencephalic vein and the anterior segment, from CS to the petrosal vein, was developed by primitive tentorial sinus anastomosis, which can be plexiform or hypoplastic. A previous report showed regular hemodynamic features of the SPS on cerebral angiography,[11] but 34.5% of cases did not show the anterior segment of SPS. In contrast, another report showed that MRI, using T1 Volumetric Isotropic TSE Acquisiton Black Blood and 3D-T1 Fast Field Echo, could evaluate the occluded sinus.[12] In the present case, contrast-enhanced MRI revealed the vessel structure of the anterior segment of the SPS. Furthermore, the anterior segment of SPS was found to be occluded due to thrombosis. Therefore, we tried to reach the isolated SPS from the CS via the anterior segment of the thrombosed SPS. In addition, the venous phase of CT angiography and DSA showed the entrance of the thrombosed SPS. Our results show that the multimodal evaluation of vessel structures is important for safe catheter maneuvers in TVE.

Conclusion

This is the first report to describe the usefulness of the anterior transvenous approach from CS to reach the isolated SPS. This method could treat isolated SPSdAVF. Evaluating the anatomical structures with MRI is necessary before treatment using this approach route.

Acknowledgments

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Abbreviations

CS: Cavernous sinus
CT: Computed tomography
DSA: Digital subtraction angiography
MRI: Magnetic resonance imaging
SPSdAVF: Superior petrosal sinus dural arteriovenous fistula

Informed Consent

Informed consent was obtained from the patient.

Conflicts of Interest Disclosure

The authors declare no conflicts of interest.

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