Surgical Treatment of a Dural Arteriovenous Fistula in the Superior Petrosal Sinus of an Elderly Patient With Minimal Suboccipital Craniotomy
—Case Report—

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Abstract
An 85-year-old woman presented with a dural arteriovenous fistula of the superior petrosal sinus manifesting as venous infarction of the cerebellum. Magnetic resonance imaging and angiography revealed right cerebellar swelling, venous engorgement, and an arteriovenous fistula in the superior petrosal sinus. Our initial attempt to obliterate the lesion through a transvenous endovascular approach failed, so we successfully treated the fistula via surgical interruption of the superior petrosal vein through a small suboccipital craniotomy. Careful examination of the pattern of venous drainage is important to determine surgical indications. This case indicates that minimally invasive open surgery can be effective even in an elderly patient.

Key words: arteriovenous fistula, superior petrosal sinus, surgery, minimally invasive surgery, elderly

Introduction
Dural arteriovenous fistulas (AVFs) are relatively rare, with a prevalence of 0.16 per 100,000 people per year, according to the Scottish Vascular Malformation Study.1) Dural AVFs are thought to be caused by sinus thrombosis, venous hypertension, head injury, and hormonal influences. Dural AVFs which cause hemorrhage and progressive focal neurological deficits are called aggressive dural AVFs and require treatment. The purpose of treatment is to eliminate the blood flow from the dural AVF to the leptomeningeal vein. Intravascular sinus embolization is the treatment of choice because of its effectiveness and less invasiveness.10) Open surgery is used for frontal fossa lesions because of the difficult access to venous outflow by the endovascular route, absence of sinus to be embolized, and the relatively easy open-surgical access. Treatment for dural AVFs of other sinuses such as the transverse-sigmoid sinus or superior petrosal sinus (SPS) remains controversial.5) Dural AVFs of the SPS are also called tentorial dural AVFs, and account for 3.6% of all dural AVFs.2,4,6,8,11) The SPS lies between the cavernous sinus and transverse sigmoid sinus junction, and can drain into either the sinus or petrosal vein.7)

We successfully treated a case of dural AVF of the SPS in a woman in her ninth decade through open surgery after the failure of endovascular management.

Case Report
An 85-year-old woman presented with head heaviness, nausea, and vomiting persisting for 3 weeks. Neurological examination revealed right intention tremor and truncal ataxia. No nystagmus was observed. Magnetic resonance imaging showed a lesion in the right cerebellum appearing as low intensity on T1-weighted image and tortuous vessels among the cerebellar folia (Fig. 1A). Cerebral angiography showed a dural AVF with the right occipital, middle meningeal, and posterior auricular arteries draining into the right SPS (Fig. 1B). There was no drainage from this sinus into the sigmoid or cavernous sinus, so the blood drained into the anastomotic lateral mesencephalic vein only through the right petrosal vein.

Considering the patient’s age and the need to prevent long-term bed rest, we first chose an endovascular approach to the lesion. To occlude the shunting points, we attempted transvenous embolization. The guiding wire could reach the SPS via the inferior petrosal and cavernous sinuses, but the microcatheter could not enter the SPS due to stenosis of the entrance, so coil embolization was not possible. Transarterial embolization was performed in the occipital and middle meningeal arteries to reduce the arteriovenous shunt flow. The patient’s neurological symptoms did not improve, so we decided to pro-
ceed with open surgery to occlude the petrosal vein.

Surgery was performed with the patient in the lateral position after careful placement of lumbar drainage. A 5-cm incision was made around the right asterion and the transverse-sigmoid sinus was exposed through a 3-cm craniotomy (Fig. 2B). Arterialized bleeding from the mastoid emissary vein was managed with Gelfoam® (Pharmacia & Upjohn Co., Division of Pfizer, Inc., New York, N.Y., U.S.A.) soaked with fibrin glue (Beriplast; CSL Behring, King of Prussia, Pa., U.S.A.) and cerebrospinal fluid was drained. After the dural incision, petechial hemorrhage was observed over the cerebellar cortex and the red petrosal vein was easily identified. When this vein was coagulated, the vein of the cerebellopontine fissure turned blue (Fig. 3). Yasargil titanium clip FT740 clips (Vasari Titanium Aneurysm Clips; Aesculap AG & Co. KG, Tuttingen, Germany) were applied to the coagulated vein just in case coagulation was not sufficient and the blood flow recovered. The wound was closed in layers. The total operative time was 1 hour 58 minutes.

After surgery, the patient’s cerebellar symptoms diminished rapidly, and postoperative digital subtraction angiography revealed that no arteriovenous shunt was present (Fig. 2A). The patient was moved to another hospital for rehabilitation, and 4 months after surgery, she was ambulatory at home in modified Rankin scale score 2.

Discussion

In our case, the SPS was occluded on the transverse-sigmoid sinus junction side, and the conduit into the cavernous sinus was stenotic. Whether this was the cause or result of dural AVF in our patient is not clear, but posed technical difficulty for transvenous sinus embolization. During the endovascular procedure in our patient, the guiding wire could not pass through from the sigmoid sinus into the SPS. The guiding wire could reach the SPS via the cavernous sinus, but the microcatheter could not enter the SPS.

Transarterial embolization is sometimes difficult, resulting in incomplete obliteration, but is useful for reducing the arterial blood supply for open surgery. In our patient, the craniotomy was placed carefully but red arterialized bleeding was seen from the mastoid emissary vein. This bleeding was controlled easily with a piece of fibrinogen-soaked Gelfoam, perhaps because of the reduced arterial supply.

A patient with a dural AVF in which the fistula drains into the subarachnoid space only through the leptomeningeal vein is a good candidate for open surgery.3,4,9) Interrupting the leptomeningeal vein reduces venous pressure, and if the residual dural AVF has no outflow, thrombosis occurs inside the dura. Even if the affected sinus does not become thrombosed, by eliminating cortical reflux, the ag-

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gressive dural AVF becomes benign and adequate clinical results can be achieved.\textsuperscript{10} If the petrosal vein acts as a drain, the vessel is easily accessed through a small craniotomy similar to that used in microvascular decompression for trigeminal neuralgia. Adequate elevation of the upper body, moderate neck flexion assuring venous drainage, and careful lumbar drainage allow easy retraction of the cerebellum, which is edematous due to hemorrhage and venous congestion.

Angiographic findings must be interpreted carefully to ensure that there is no other leptomeningeal venous channel that might cause an abrupt increase in cortical venous pressure. We believe that open surgery can be an effective treatment for dural AVF of the SPS with or without transarterial endovascular embolization if the pathophysiological and anatomical evaluation supports the procedure.

We confirmed the closure of the shunt by observing the change in venous color and with Doppler ultrasonography. Intraoperative digital subtraction angiography, if available, can help confirm the absence of leptomeningeal venous drainage after temporary interruption of the draining vein. Endovascular measures are often chosen as initial treatments for symptomatic vascular pathology in elderly patients because they are less invasive. However, open surgery can be well tolerated if carefully planned.

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\textbf{References}


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