Selective transvenous embolization of dural carotid–cavernous sinus fistulas with preservation of sylvian venous outflow

Report of three cases

MITSUGU NAKAMURA, M.D., NORHIKO TAMAKI, M.D., TETSURO KAWAGUCHI, M.D., AND SHIGEKIYO FUJITA, M.D.

Department of Neurosurgery, Kobe University School of Medicine, Kobe, Japan; and Department of Neurosurgery, Hyogo Brain and Heart Center at Himeji, Himeji, Japan

A transvenous embolization technique in which normal cerebral venous drainage can be spared is described. Of 26 dural carotid–cavernous fistulas treated by the authors, the affected cavernous sinus received not only the shunted flow but also the sylvian venous drainage in three cases. Two patients presented with an abducent nerve palsy, and one with an oculomotor nerve palsy. Selective transvenous embolization of the fistulous portions of the affected cavernous sinus was achieved, with preservation of the sylvian venous outflow. Postembolization angiograms revealed complete occlusion of the fistula in one patient and only a small amount of residual shunt in the other two. One of these two underwent subsequent transarterial embolization, and the other was followed without additional treatment. The patients’ symptoms resolved between 1 and 2 months posttreatment. Follow-up angiograms revealed that the remnant shunt had disappeared and the sylvian venous pathway had been preserved. The authors conclude that selective transvenous embolization of fistulous compartments in an affected sinus can be used to treat dural arteriovenous fistulas involving a cavernous sinus that also receives the sylvian venous outflow.

KEY WORDS • dural arteriovenous fistula • cavernous sinus • transvenous embolization • endovascular therapy • sylvian vein

In the treatment of dural arteriovenous fistulas (AVFs) involving the cavernous sinus, transvenous occlusion of the affected sinus has been found to effect a better cure than other treatment options.3,7,8,10,12,13 Because transvenous embolization ordinarily results in complete occlusion of the cavernous sinus, problems arise when occluded portions of the sinus receive normal venous drainage from parts of the brain. Three cases of dural AVFs involving the cavernous sinus are presented. Although the sylvian vein entered the affected cavernous sinus at the anterolateral part, selective transvenous embolization of the fistulous parts of the cavernous sinus was achieved along with preservation of the sylvian vein outflow pathway.

Clinical Material and Methods

Since 1992, the authors have treated 26 patients with dural carotid–cavernous sinus fistulas, in three of whom the affected cavernous sinus received not only the arteriovenous shunting flow but also the normal sylvian venous outflow. The three patients were all women who ranged in age from 57 to 59 years. Two patients presented with an abducent nerve palsy and one with an oculomotor nerve palsy. On digital subtraction angiograms it was seen that the fistulas drained into the superior and medial parts of the sinus and that the sylvian venous outflow entered the ipsilateral sinus at the anterolateral portion.

Selective transvenous embolization of the fistulous parts of the affected cavernous sinus and preservation of the sylvian venous outflow was attempted in all three cases. After placement of No. 5 French sheaths in the right femoral vein and left femoral artery, No. 5 French catheters were introduced into the common carotid artery (CCA) and the right inferior petrosal sinus, and a Fast-Tracker 18 microcatheter (Target Therapeutics Corp., Fremont, CA) was introduced into the affected cavernous sinus. After we conducted a detailed examination of the arteriograms and venograms, the fistulous portions of the affected cavernous sinus were occluded with interlocking detachable coils ([IDCs; Target Therapeutics] in two cases, and Guglielmi detachable coils ([GDCs]; Target Therapeutics) in one. Follow-up angiograms were obtained 6 and 12 months after embolization.
Case Reports

Case 1

This 59-year-old woman presented with horizontal diplopia. On admission, her neurological examination revealed a right-sided abducent nerve palsy. Right external carotid artery and internal carotid artery (ICA) angiograms demonstrated a dural AVF involving the right cavernous sinus (Fig. 1 upper left). The fistulous flow drained into the right inferior petrosal sinus and contralateral cavernous sinuses, whereas the normal superficial sylvian vein drainage entered the affected cavernous sinus and then flowed into the pterygoid plexus (Fig. 1 upper right). The microcatheter easily passed through the medial and superior parts of the affected sinus into its anterolateral portion. Venograms obtained through the microcatheter with its tip placed at the anterolateral portion of the cavernous sinus demonstrated flow of contrast material both to the inferior petrosal sinus, into which the arteriovenous shunt (AVS) drained, and to the pterygoid plexus, where the normal venous drainage entered (Fig. 1 center left). We placed an initial IDC just posterior to the superficial sylvian vein pathway and confirmed its patency by angiography before detachment of an initial coil (arrow). Center Right: Right ICA angiogram showing preservation of the sylvian venous pathway before detachment of an initial coil (arrow). Lower Left and Right: Postembolization right CCA angiograms showing occlusion of the fistulas and preservation of the sylvian vein outflow.

Fig. 1. Case 1. Upper Left and Right: Preembolization right external and ICA angiograms demonstrating a dural carotid–cavernous fistula draining into the ipsilateral inferior petrosal sinus and the superficial sylvian venous outflow draining into the affected cavernous sinus, with the flow continuing to the pterygoid plexus. Center Left: Intraoperative venogram obtained through a microcatheter demonstrating the contrast material draining into the inferior petrosal sinus as well as the pterygoid plexus. Arrow indicates the tip of the microcatheter. Center Right: Right ICA angiogram showing preservation of the sylvian venous pathway before detachment of an initial coil (arrow). Lower Left and Right: Postembolization right CCA angiograms showing occlusion of the fistulas and preservation of the sylvian vein outflow.
Case 2

This 57-year-old woman presented with a right-sided abducent nerve palsy. Admission angiograms demonstrated a dural carotid–cavernous fistula draining into the right inferior petrosal sinus, and the superficial sylvian venous outflow draining into the affected cavernous sinus (Fig. 2 upper left). The normal superficial and deep sylvian veins entered the affected sinus and then drained into the pterygoid plexus (Fig. 2 upper right). As in Case 1, the microcatheter easily passed through the fistulous part of the cavernous sinus into the normal sylvian venous pathway. We placed an initial IDC just posterior to the deep sylvian vein pathway, but its drainage path changed to the superficial sylvian vein during the embolization procedure (Fig. 2 center left). Selective embolization of the fistulous parts of the cavernous sinus was accomplished with placement of a total of 30 IDCs. It was extremely difficult to occlude the fistulous parts of the sinus completely while preserving the part receiving the sylvian venous outflow. However, a postembolization angiogram demonstrated preservation of the superficial sylvian vein pathway and a residual AVS draining into the contralateral cavernous sinus (Fig. 2 center right). The remnant shunt had resolved on angiograms obtained at 12 months postembolization (Fig. 2 lower), and the sylvian venous outflow was preserved. The patient’s right abducent nerve palsy had resolved by 2 month postembolization.

Case 3

This 57-year-old woman presented with a right-sided oculomotor nerve palsy. Admission angiograms demonstrated a dural carotid–cavernous sinus fistula draining into the right inferior petrosal sinus and contralateral cavernous sinuses (Fig. 3 upper left). The normal superficial sylvian vein drainage entered the affected cavernous sinus and then flowed, together with the fistulous drainage, into the contralateral cavernous sinus (Fig. 3 upper right). Unlike the other two cases, the pterygoid plexus had not developed sufficiently in this patient. Because the GDC placed in the superior intercavernous sinus did not prevent the anticipated normal venous outflow via the inferior intercavernous sinus, it was detached. However, the GDC transiently occluding the inferior intercavernous sinus was retrieved because it significantly retarded washout of the contrast material in the superficial sylvian vein and cavernous sinus. Occlusion of the superior and medial parts of the sinus with placement of a total of 20 GDCs was followed by transarterial embolization with platinum coils via the ipsilateral middle meningeal artery and the maxil-
lary artery for treatment of a remnant shunt. Postembo-
bolization angiograms demonstrated closure of the fistula
and preservation of the superficial sylvian vein pathway
draining into the contralateral cavernous sinus (Fig. 3
lower left and right). The patient’s right-sided oculomotor
nerve palsy had resolved by 1 month after embolization,
and follow-up angiograms at 6 months showed no fistu-
losus lesions.

Discussion

Endovascular Treatment of Dural Carotid–Cavernous
Fistulas

Several treatment options, including compression ther-
apy, transarterial embolization of feeding arteries, trans-
venous occlusion of the involved sinus, conventional radia-
tion therapy, and stereotactic radiosurgery have been used for dural AVFs in the cavernous sinus. Transvenous embolization of the affected sinus has frequently been the first choice. Introduction of thrombo-
genic material directly into the involved dural sinus was first described by Mullan. Hosobuchi described surgical placement of copper wire into the affected cavernous sinus, followed by electrocoagulation to occlude it. Vascular access to the cavernous sinus has been reported, including surgical exposure of the angular or superior ophthalmic vein, the transtethmoidal transphenoidal surgical approach, and the transfemoral approach via the ipsilateral inferior petrosal sinus, the angular vein, and the contralateral cavernous sinus. Copper wires, silk sutures, platinum microcoils, IDCs, and N-butyl cyanoacrylate have been used as embolic materials.

Transvenous occlusion of the affected cavernous sinus usually can include the entire sinus without risk, because in most cases the affected cavernous sinus does not contribute to normal venous drainage. However, in rare cases dural AVFs involve a cavernous sinus that participates in normal venous drainage. In our clinical experience, this occurred in 12% of patients with dural carotid–cavernous fistulas. In such cases complete occlusion of the cavernous sinus might result in venous infarction when out-
flow is obstructed. Watanabe, et al., reported on a patient with a dural carotid–cavernous fistula in whom the cavernous sinus received the normal cortical drainage from the insular vein. Postembolization magnetic resonance imaging demonstrated cerebral infarction in their patient that was caused by congestion in the area of the posterior insular vein because the anticipated drainage of the insu-
lar via the uncal vein after embolization had not occurred.

Modified Transvenous Embolization Technique for Dural AVFs

The authors have reported elsewhere that, for superior sagittal and transverse fistulas, embolization of the venous compartment of a fistula located within the sinus wall in front of the sinus lumen could preserve or restore the impaired sinus function. This technique, however, could not be used for dural carotid–cavernous fistulas because the mural venous compartments of the fistula did not dilate enough for a microcatheter to be advanced. The cavernous sinus has unique structural features that are diff-

Fig. 3. Case 3. Upper Left and Right: Preembolization right ICA angiograms demonstrating a dural carotid–cavernous fistula and the sylvian venous outflow, both of which drained into the contralateral cavernous sinus. Lower Left and Right: Right ICA angiograms showing occlusion of the fistula and preservation of the normal sylvian pathway, which drains into the inferior intercavernous sinus. Coils were placed in the cavernous sinus and feeding arteries via the middle meningeal and maxillary arteries.
Carotid–cavernous fistula embolization
different from the other venous sinuses and can be divided into several anatomical parts by the ICA running inside it. The postero-medial part of the cavernous sinus connects the superior and the inferior petrosal sinus. The antero-lateral part connects the superficial and deep sylvian vein, the superior and inferior ophthalmic vein, and the pterygoid plexus. Although there are interindividual differences in terms of the connections and the collateral pathways between these sinuses and veins, detailed angiographic examination of the fistulas and normal venous outflow makes it possible for practitioners to embolize the fistulous portions selectively and simultaneously preserve the normal venous outflow.

In our three patients the AVSs entered the superior and medial portions of the cavernous sinus, whereas flow from the sylvian vein entered its antero-lateral portion. We could not determine from preembolization angiographic studies whether the fistulous portions and the sylvian vein outflow communicated functionally within the cavernous sinus. During the embolization procedure, a microcatheter could easily be passed through the fistulous portion into the normal venous pathway inside the sinus. Venograms obtained via the microcatheter demonstrated flow of contrast material into both the fistulous drainage and the normal venous outflow pathways. Accordingly, we postulated that there was not a complete structural separation of the two compartments, but that trabeculae, partial sinus thrombosis, or other factors appeared to separate the two compartments hemodynamically within the affected cavernous sinus.

Great care was taken with the initial coil positioning, including detailed examination of angiograms before detachment of the first coil. Anteroposterior views provided particularly important information for initial coil placement. After detachment of the initial coil, the affected portions of the cavernous sinus were packed as densely as possible. After we placed the last coil in the inferior portion of the cavernous sinus, we used angiographic studies to reconfirm patency of the sylvian vein pathway. Yoshimura, et al.13 and Terada, et al.,14 also used IDCs and described the use of varied coil lengths and detachment and retrieval mechanisms in embolization of dural AVFs. We believe that retrievable coils such as IDCs and GDCs15 are suitable for difficult embolization procedures. As was shown in Case 3, these coils can be used for a transient occlusion test of a normal venous pathway. On the other hand, this modified transvenous technique for dural carotid–cavernous fistulas has one disadvantage: complete occlusion of the fistulous compartments of the cavernous sinus while preserving the normal venous outflow pathway is quite difficult. When a residual AVS is present, careful observation of the patient’s symptoms and follow-up angiograms are necessary, or the procedure should be combined with transarterial embolization. Although the spared venous pathway maintained patency on follow-up angiograms in the reported cases, late thrombosis of the venous outlet might result from platinum coils placed beside the normal venous pathway.

Conclusions

Transvenous embolization can be used to treat dural AVFs involving a cavernous sinus that also receives the normal cerebral venous outflow. This technique requires careful planning based on preoperative angiography and intraoperative venography and involves the use of retrievable coils.

References


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Address reprint requests to: Mitsugu Nakamura, M.D., Department of Neurosurgery, Kobe University School of Medicine, 7-5-1 Kusunoki-cho, Chuo-ku, Kobe 650-0017, Japan.

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