Dural Arteriovenous Fistula in the Anterior Cranial Fossa
—Four Case Reports—

Takafumi TANEI, Kazuhiro FUKUI*, Kenichi WAKABAYASHI*, Yuki MITSUI*, Norio INOUE*, and Masao WATANABE*

Department of Neurosurgery, Nagoya University School of Medicine, Nagoya, Aichi; *Department of Neurosurgery, Toyohashi Municipal Hospital, Toyohashi, Aichi

Abstract
Three of 4 cases of dural arteriovenous fistulas (DAVFs) in the anterior cranial fossa were detected incidentally by magnetic resonance (MR) imaging, and one case manifested as intracerebral hemorrhage. Cerebral angiography revealed fistulas located in the anterior cranial fossa. Three patients underwent surgery, and the fistulas were successfully obliterated. One patient with nonruptured DAVF requested conservative medical management. Incidental detection of asymptomatic or nonruptured DAVFs in the anterior cranial fossa has increased with the wider use of MR imaging. Increase in the size of a venous varix is the indicator for aggressive therapeutic intervention in a patient receiving conservative medical management for asymptomatic or nonruptured DAVFs in the anterior cranial fossa.

Key words: asymptomatic dural arteriovenous fistula, incidental dural arteriovenous fistula, anterior cranial fossa, magnetic resonance imaging

Introduction
Dural arteriovenous fistulas (DAVFs) in the anterior cranial fossa are rare, and tend to manifest as intracranial hemorrhage. The incidence of intracranial hemorrhage associated with DAVFs in the anterior cranial fossa is higher (79%) than that associated with DAVFs in other regions (15%). Incidental detections have been increased by the routine magnetic resonance (MR) imaging of many patients with minor neurological symptoms. The lesions appear as flow void signs of enlarged cortical veins in the frontal lobe. MR angiography shows venous dilations in the same area. Here we report four cases of DAVFs in the anterior cranial fossa treated at our institution from 1989 to 2006.

Case Reports
Case 1: A 75-year-old man presented with right arm weakness and was referred to our department under a diagnosis of small lacunar infarction. MR imaging revealed a lacunar infarction in the left corona radiata and flow void signs in the right frontal lobe (Fig. 1A). MR angiography revealed vascular abnormalities (Fig. 1B). Cerebral angiography revealed DAVFs in the right anterior cranial fossa fed by the bilateral ethmoidal arteries, and drained into the superior sagittal sinus (SSS) with a venous varix through the ascending cortical vein (Fig. 1C, D). Surgical obliteration was performed through a frontal craniotomy. Postoperative angiography confirmed obliteration of the fistulas (Fig. 1E, F). The postoperative course was uneventful.

Case 2: A 65-year-old man underwent a brain health check-up with MR imaging which detected flow void signs in the left frontal lobe. Neurological examination revealed no abnormalities. Cerebral angiography revealed DAVFs in the left anterior cranial fossa fed by the bilateral ethmoidal arteries, and drained into both the cavernous sinus and the SSS with a small venous varix through the subfrontal cortical vein (Fig. 2A, B). The fistulas were surgically obliterated via a low frontal craniotomy, and the venous varix was excised. Histological examination of the venous varix showed irregularities in the vascular wall and partial thinning of the media (Fig. 2C, D). The internal elastic lamina of almost the entire vascular wall was undetectable (Fig. 2E). Postoperative angiography showed obliteration of the fistulas. The postoperative course was uneventful.
Fig. 1 Case 1. A: Axial T₂-weighted magnetic resonance (MR) image showing flow voids in the right frontal lobe indicating venous varix and dilated vessels. B: Axial MR angiogram showing right frontal vascular abnormalities. C, D: Right internal carotid angiograms, anteroposterior (C) and lateral views (D), showing the fistula site (thick arrow) fed by the right anterior ethmoidal artery (arrowhead), and drained by a frontopolar route to the superior sagittal sinus (double arrows) with a venous varix (arrow). E, F: Postoperative right internal carotid angiograms, anteroposterior (E) and lateral views (F), showing occlusion of the dural arteriovenous fistulas.

Fig. 2 Case 2. A, B: Left internal carotid angiograms, lateral (A) and oblique views (B), showing the fistula site (thick arrow) fed by the left anterior ethmoidal arteries (arrowhead), and drained primarily into a subfrontal cortical vein (arrow) then via the ascending cortical vein (thick arrowhead) into the superior sagittal sinus with a small venous varix (double arrows), and via the olfactory vein (arrowheads) to the cavernous sinus. C–E: Photomicrographs showing the venous varix wall with normal anatomical structure containing areas of irregularity (C) and partial thinning of the media (D), but the internal elastic lamina of almost the entire wall is undetectable (E). C, D: hematoxylin and eosin stain, ×200; E: van Gieson’s elastic stain, ×200.

Case 3: A 63-year-old man complained of dizziness. MR imaging revealed flow void signs on the surface of the left frontal cortex (Fig. 3A). Cerebral angiography revealed DAVFs in the left anterior cranial fossa fed by the bilateral ethmoidal arteries, and drained into the SSS with a small venous varix through the subfrontal cortical vein (Fig. 3B, C). The patient requested conservative medical management. Angiography 3 years later revealed no remarkable change in the size of the venous varix (Fig. 3D).

Case 4: A 75-year-old man was admitted to our hospital following sudden loss of consciousness. On admission, he exhibited right hemiparesis, and his Glasgow Coma Scale score was 6 (E1V1M4). Com-
Fig. 3 Case 3. A: Axial T₂-weighted magnetic resonance image showing flow void signs on the surface of the left frontal lobe (arrow). B, C: Left carotid angiograms, lateral (B) and oblique views (C), showing the fistula site (thick arrow) fed by the left anterior ethmoidal arteries (arrowhead), and drained primarily into a subfrontal cortical vein (thick arrowhead), then via the ascending cortical vein (arrow) into the superior sagittal sinus (double arrows) with a small venous varix. D: Left carotid angiogram, lateral view, 3 years later revealing no remarkable change in the size of the venous varix (arrow).

computed tomography (CT) revealed a hematoma in the left frontal lobe (Fig. 4A). He underwent emergency craniotomy for evacuation of the hematoma, but cerebral angiography was not performed because of brain herniation. Left frontotemporal craniotomy revealed DAVFs located in the left side of the cribriform plate with balloon-shaped dilated vessels (Fig. 4B, C). The fistulas were occluded and the balloon-shaped vessels were excised (Fig. 4D). Postoperative angiography showed obliteration of the fistulas. The patient was discharged with mild disorientation and right hemiparesis.

Discussion

DAVFs in the anterior cranial fossa have a uniform drainage pattern primarily into the cortical veins of the subfrontal region and ultimately into the SSS (80.8%) or posteriorly into the basal vein of Rosen-thal or the cavernous sinus. Direct drainage into the subfrontal cortical veins causes intracranial venous hypertension associated with a high incidence of intracranial hemorrhage and other clinical symptoms such as headache, seizure, and visual loss. Evaluation of the intracranial venous hypertension is essential for deciding on the method of treatment for asymptomatic or nonruptured DAVF. Venous varix and parenchymal edema indicate venous hypertension. Venous varix is present in 72% of cases of DAVFs in the anterior cranial fossa. Reduced regional cerebral blood flow (rCBF) in response to acetazolamide administration observed by stable xenon CT is helpful in the identification of intracranial venous hypertension.

The natural history of DAVF progression in the anterior cranial fossa is unclear because only a few cases have been followed up for a long period of

Neurol Med Chir (Tokyo) 48, December, 2008
time without treatment. One case of nonruptured DAVF in the anterior cranial fossa followed up for 7 years confirmed an increase in the size of the venous varix that suggested increased hemodynamic stress arising from the draining venous channels.\(^7\) Histological degenerative changes such as destruction of the internal elastic lamina and irregularity of the vascular wall progressed with the increase in the size of the venous varix. The histological changes make the venous varix less tolerant to hemodynamic stress.\(^6\) Therefore, if a patient requests conservative medical management for asymptomatic or nonruptured DAVFs in the anterior cranial fossa, as in our Case 3, an increase in the size of the venous varix is the indicator for more aggressive therapeutic intervention.

Currently, surgical management is the treatment of choice for DAVFs in the anterior cranial fossa because of the high success rate of fistula obliteration with minimal morbidity.\(^{1,4,5,8,13-15}\) Transarterial embolization is possible but not common because of the difficulty in catheterizing small vessels and the high risk of visual compromise due to occlusion of the retinal branches.\(^{1,5,7,8,13}\) Transvenous embolization using coils has potential, as this technique supports the navigation of a microcatheter through the frontal bridging vein tortuositities, enabling the detection of the exact location of the fistula.\(^2\) Transvenous embolization for DAVFs in the anterior cranial fossa may be worth attempting if a patient refuses surgical treatment.

The indications for the surgical treatment of DAVFs in the anterior cranial fossa are intracranial hemorrhage, venous varix, symptomatic DAVF, and reduction in the response of rCBF to acetazolamide observed by stable-xenon CT. If a patient requests conservative medical management for asymptomatic or nonruptured DAVFs in the anterior cranial fossa, an increase in the size of a venous varix is the indicator for aggressive therapeutic intervention.

**References**

3) Deguchi J, Yamada M, Kobata H, Kuroiwa T: Regional cerebral blood flow after acetazolamide challenge in patients with dural arteriovenous fistula: simple way to evaluate intracranial venous hyper-
7) Im SH, Oh CW, Han DH: Surgical management of an unruptured dural arteriovenous fistula of the anterior cranial fossa: natural history for 7 years. Surg Neurol 62: 72–75, 2004

Address reprint requests to: Takafumi Tanei, M.D., Department of Neurosurgery, Nagoya University School of Medicine, 65 Tsurumai-cho, Showa-ku, Nagoya 466–8550, Japan.
e-mail: nsstukasyun@msn.com