CASE REPORT

Neurol Med Chir (Tokyo) 53, 195～198, 2013

Dural Arteriovenous Fistula at the Anterior Clinoid Process Draining Directly Into the Superficial Middle Cerebral Vein

—Case Report—

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Abstract

A 76-year-old man presented with subarachnoid hemorrhage. Selective angiography revealed a dural arteriovenous fistula (DAVF) at the right anterior clinoid process, draining into the superficial middle cerebral vein in a retrograde fashion. Two internal carotid artery aneurysms were also demonstrated at the origin of the posterior communicating artery and the anterior choroidal artery on the same side. The patient underwent craniotomy, and all lesions were treated simultaneously. Rupture of the anterior choroidal artery aneurysm was confirmed. DAVF draining directly into the superficial middle cerebral vein is extremely rare. The precise location of the shunt, the anatomical features, and venous drainage must be evaluated to consider treatment.

Key words: dural arteriovenous fistula, superficial middle cerebral vein, anterior clinoid process

Introduction

Dural arteriovenous fistula (DAVF) can be divided into the sinus type and non-sinus type based on the venous drainage route and the affected sinus.[2,3,6,15] The most common locations of the non-sinus type DAVF are tentorial, ethmoidal, and spinal. We report a rare case of non-sinus type DAVF at the anterior clinoid process with retrograde venous drainage into the superficial middle cerebral vein (SMCV).

Received March 7, 2012; Accepted April 2, 2012

Case Report

A 76-year-old man with a history of lung carcinoma suffered sudden onset of altered consciousness and was admitted to our neurosurgical department. On admission, his consciousness level was E1V1M2 on the Glasgow Coma Scale. Computed tomography (CT) showed Fisher 3 subarachnoid hemorrhage. Three-dimensional CT angiography showed two aneurysms on the right internal carotid artery and the dilated right SMCV, connecting with the dura mater at the anterior clinoid process (Fig. 1). Selective angiography revealed a DAVF located at the

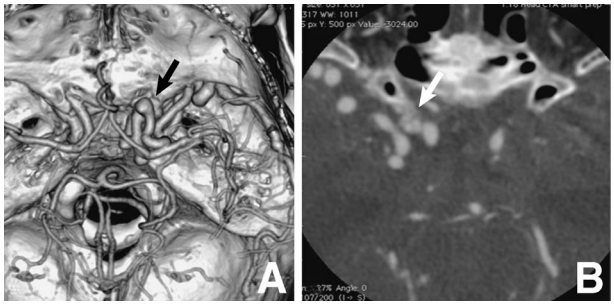

Fig. 1 Three-dimensional computed tomography angiography shaded surface rendering image (A) and source image (B) on admission showing the dilated superficial middle cerebral vein, connecting with the dura mater at the anterior clinoid process (*arrow*), and two internal carotid artery aneurysms at the origin of the posterior communicating artery and the anterior choroidal artery.

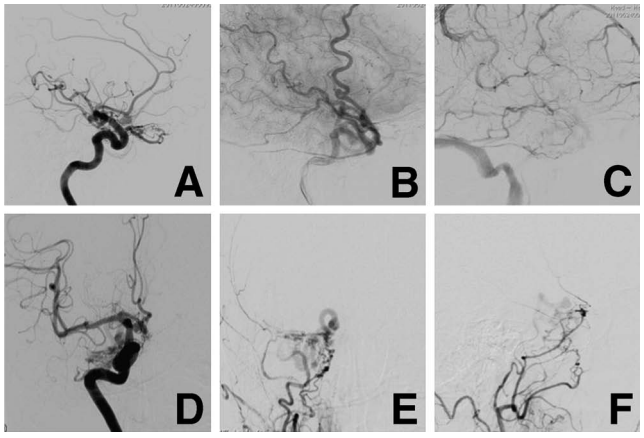

Fig. 2 A–D: Right internal carotid angiograms, lateral views (A: early arterial phase, B: late arterial phase, C: venous phase) and anteroposterior view (D: arterial phase), showing a dural arteriovenous fistula at the anterior clinoid process, fed by the recurrent meningeal artery of the ophthalmic artery and the inferolateral trunk of the internal carotid artery, draining directly into the superficial middle cerebral vein in a retrograde fashion. The cavernous sinus is not opacified (C). E, F: Right external carotid angiograms, anteroposterior view (E) and lateral view (F), showing the feeding arteries coming from the foramen rotundum artery, accessory meningeal artery, and middle meningeal artery.

right anterior clinoid process. The feeding pedicles came predominantly from the recurrent meningeal artery of the ophthalmic artery and the inferolateral trunk of the internal carotid artery, but also from the foramen rotundum artery, accessory meningeal artery, and middle meningeal artery. The shunted blood flow drained into the SMCV in a retrograde fashion. Varicose dilatation of the SMCV was noted. The right cavernous sinus was not opacified by bilateral internal and external carotid angiography. Two internal carotid artery aneurysms were also demonstrated at the origin of the posterior communicating artery and

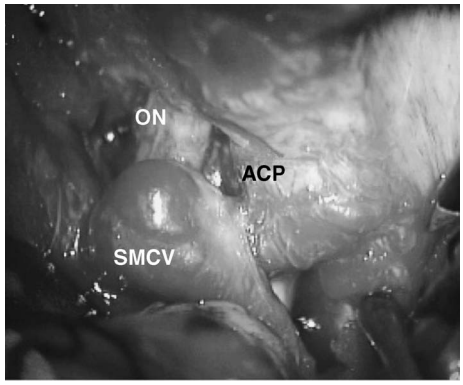

Fig. 3 Intraoperative photograph showing the dilated superficial middle cerebral vein (SMCV) entering the dura mater at the right anterior clinoid process (ACP). ON: optic nerve.

Fig. 4 Postoperative right external (A) and internal (B) carotid angiograms, lateral views, showing complete disappearance of the dural arteriovenous fistula.

the anterior choroidal artery on the right (Fig. 2).

The patient underwent right frontotemporal craniotomy. The sylvian fissure was dissected microsurgically, and the right internal carotid artery and surrounding structures were exposed. The dilated SMCV entered the dura mater at the right anterior clinoid process (Fig. 3). The SMCV was clipped and cut as close to the dura as possible. Next, both internal carotid artery aneurysms were clipped, and rupture of the anterior choroidal artery aneurysm was confirmed.

Postoperative neurological examination revealed no neurological deterioration, and the patient's consciousness showed gradual improvement. Angiography on postoperative Day 7 demonstrated complete obliteration of the DAVF (Fig. 4). A ventriculoperitoneal shunt was placed for management of normal pressure hydrocephalus. Two months later, the patient was discharged to a rehabilitation center. His clinical condition was assessed as modified Rankin scale grade 3.

Discussion

The SMCV normally runs along the lesser sphenoid wing and flows into the sphenoparietal sinus (SPS) or directly into the cavernous sinus. However, anatomical variations

are not uncommon, and studies using three-dimensional CT angiography or magnetic resonance imaging have analyzed and classified such variations, especially from the standpoint of the embryologic development.[12,13] Two embryologic sinuses participate in the development of the cavernous sinus: the primitive tentorial sinus and prootic sinus. The prootic sinus participates in forming the cavernous venous plexus, the SPS, and the foramen ovale venous plexus draining into the pterygoid plexus, and receives blood flow from the superior ophthalmic vein. The cortical and pial veins, which develop into the SMCV, drain through the primitive tentorial sinus into the transverse sinus during the early embryonic stage. With development of the cerebral hemisphere, the primitive tentorial sinus elongates anteromedially and anastomoses with the cavernous sinus or paracavernous venous plexus. Several variations in the drainage pattern of the SMCV can be formed in this course of developmental anastomosis. If the tentorial sinus is located more medially, the SMCV may drain into the cavernous sinus directly or through the connection with the SPS. If the tentorial sinus is located more laterally, anastomosis between the cavernous sinus and the tentorial sinus is less likely to occur, and the SMCV may drain into the pterygoid plexus through the sphenoidal emissary veins around the foramen ovale, or into the transverse sinus or superior petrosal sinus via the persistent tentorial sinus.[7,10,12,13]

Recent histopathological studies of DAVF have suggested that the essential lesion of DAVF is direct communication between the dural arteries and dural veins within the dura, and that the venous outflow may drain into the adjacent sinus or cortical veins.[8,9] Further, occlusive change of the draining system may occur in the DAVF and contribute to the aggressive clinical course due to the development of venous hypertension.[4,11] In the present patient, the DAVF was located around the anterior clinoid process and all the shunted blood flow drained into the SMCV in a retrograde fashion. The ipsilateral cavernous sinus was not opacified by bilateral internal and external carotid angiography. Cognard type III or IV non-sinus type DAVF in this location is extremely rare, with only two reported cases.[10,14] In this case, the original drainage routes of the blood flow from the SMCV were unknown. However, taking the most medial course of the SMCV into consideration, the drainage was likely to enter the cavernous sinus directly or via the connection with the SPS based on embryologic development.[7,10,12,13] We speculate that the DAVF draining into the SMCV occurred first, and occlusive change of the cavernous sinus resulted in the development of this Cognard type IV non-sinus type DAVF.

Surgical interruption of the draining vein has been established as curative treatment for Cognard type III or IV non-sinus type DAVF.[6,15] In this patient, two saccular aneurysms were present, and the lesion responsible for the subarachnoid hemorrhage could not be determined preoperatively. Therefore, we decided to perform surgical treatment of all lesions simultaneously, and complete obliteration of all these lesions was achieved without difficulty or neurological deterioration. Transarterial embolization with liquid embolic materials may be curative for Cognard type III or IV fistula. The aim of injection is to penetrate the shunt and reach the origin of the draining vein.[3,15] In Japan, n-butyl cyanoacrylate (NBCA) is used as an embolic material. However, due to the chemical and physical properties, the injection of NBCA requires extensive experience and the cure rate is not sufficiently high. Recently, promising results of treatment for DAVF with cortical venous drainage have been achieved using Onyx.[1,5] However, there are some potential risks of complications such as the cranial nerve palsies and migration of the Onyx through the dangerous anastomosis, and the indication for endovascular treatment for this type of DAVF should be determined carefully.

In the present patient with DAVF of the SMCV, the cavernous sinus was occluded and the shunt flow drained into the SMCV in a retrograde fashion. However, if the cavernous sinus is patent and ''antegrade'' venous drainage flows into the cavernous sinus, the condition may be misdiagnosed as cavernous sinus DAVF with ''retrograde'' drainage into the SMCV.[15] Inappropriate coil embolization of the cavernous sinus may lead to serious complications due to worsening venous hypertension. Therefore, evaluation of the precise location of the shunt (sinus or cortical vein) and the direction of the shunted blood flow (from the cavernous sinus to the cortical vein or from the cortical vein to the cavernous sinus) is very important.

The present rare case of non-sinus type DAVF at the anterior clinoid process with retrograde venous drainage into the SMCV shows the precise location of the shunt, the anatomical features, and venous drainage must be evaluated to consider the treatment.

Conflicts of Interest Disclosure

The authors have no personal financial or institutional interest in any of the drugs, materials, or devices in the article. All authors who are members of The Japan Neurosurgical Society (JNS) have registered online Self-reported COI Disclosure Statement Forms through the website for JNS members.

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