Surgical Treatment of Anterior Cranial Fossa Dural Arteriovenous Fistula — Report of Two Cases

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ABSTRACT

Anterior cranial fossa dural arteriovenous fistula (DAVF) is uncommon. In this report, we present two patients with anterior cranial fossa DAVF. The first patient was a 46-year-old man who had had two episodes of generalized tonic-clonic seizure. Magnetic resonance imaging revealed abnormal vasculature in the right anterior frontal area and bilateral carotid angiogram demonstrated a DAVF in the right anterior cranial fossa. The feeding arteries were from the bilateral anterior ethmoid arteries, middle meningeal arteries, and superficial temporal arteries. The venous drainage was through the cortical veins of the right frontal lobe and then the superior sagittal sinus. Venous ectasia was also noted. During surgery, the feeding arteries from the external carotid artery were divided and the leptomeningeal draining veins were interrupted without excision of the nidus. Angiography one year after surgery revealed no residual DAVF. The patient was doing well after five years of follow-up except for one episode of seizure. The other patient was a 62-year-old man who suffered sudden onset of severe headache with vomiting and consciousness disturbance. Brain computed tomography (CT) scanning revealed intracerebral hemorrhage in the right frontal lobe. A CT angiogram showed abnormal vasculature and a carotid angiogram demonstrated an anterior cranial fossa DAVF with a feeding artery from the right anterior ethmoid artery. The venous drainage was through a cortical draining vein in the right frontal lobe and finally the superior sagittal sinus. Venous ectasia was also noted. The patient underwent surgery to remove the intracerebral hematoma and excise the DAVF. Post-operative angiography showed no residual DAVF. The patient was in good condition after one and one half years of follow-up.

Key words: anterior cranial fossa, dural arteriovenous fistula, surgery

INTRODUCTION

Cranial dural arteriovenous fistulae (DAVFs) account for 10% to 15% of intracranial arteriovenous malformations [1]. Only 4% to 10% of DAVFs are located at the anterior cranial fossa and about 50 cases have been reported [2-5]. The anterior cranial fossa DAVF mainly involves the dura in the region of the cribriform plate and the anterior falx [6]. The age at occurrence ranges from 40 to 70 years [4,6,7]. It is male predominant, which is different from DAVFs at other locations [4,6,7]. Patients with cranial DAVFs, including those at the anterior cranial fossa, often undergo surgical excision and/or endovascular embolization to eliminate the DAVF [2,4]. However, increasing evidence suggest that a subgroup of patients with DAVFs drained only by leptomeningeal venous drainage could be treated by interruption of the leptomeningeal venous drainage without excision of the nidus [6,8-11]. In this report, we present two cases of anterior cranial fossa DAVFs. One patient was treated by division of the feeding arteries from the external carotid arteries and interruption of the leptomeningeal venous drainage without excision of the nidus and the other was treated with total excision of the DAVF. Our experience in the management of these two
patients, together with a literature review and surgical options for anterior cranial fossa DAVF, will be discussed.

CASE REPORTS

Case 1

This 46-year-old man had a traffic accident with injury to his frontal area four months prior to admission. Then two episodes of generalized tonic-clonic seizure occurred two weeks prior to admission. On admission, he had a clear consciousness and neurological examination revealed no abnormalities. An electroencephalogram showed mildly scattered slow waves without any epileptiform activity. Valproic acid 500 mg bid was given and it eliminated seizure activity. Magnetic resonance imaging revealed abnormal vasculature in the right anterior cranial fossa, mainly in the medial inferior frontal area. Bilateral carotid angiography demonstrated a DAVF in the right anterior cranial fossa (Fig. 1). The DAVF was classified as type III according to Borden's classification [12] and type IV according to Cognard’s classification [13] because it drained into the cortical veins with venous ectasia. During surgery, the dilated superficial temporal arteries were ligated and divided first. Then a bifrontal craniotomy was done. Many

![Fig. 1. Preoperative and postoperative common carotid angiograms of Case 1. A & B. Anteroposterior projections of preoperative right common carotid angiogram (A) and lateral projection of preoperative left common carotid angiogram (B), showing a dural arteriovenous fistula (DAVF) in the right anterior cranial fossa. The DAVF is fed by the bilateral anterior ethmoid arteries, middle meningeal arteries, and superficial temporal arteries. The venous drainage is through the cortical veins of the right frontal lobe, and finally the superior sagittal sinus. Venous ectasia is also noted. C&D. Lateral projection of the postoperative (one year after surgery) right common carotid angiogram (C), and lateral projection of the postoperative left common carotid angiogram (D), showing no residual or recurrent DAVF.](image-url)
Anterior cranial fossa dural AVF

transcalvarial vessels were noted and bleeding was stopped by bone wax. The dilated middle meningeal arteries were coagulated and divided. Then the dura was opened. The tortuous, engorged, dilated cortical veins over the surface of the right frontal lobe were found to contain arterialized blood. The venous connections between the right frontal lobe and the falx cerebri, and between the right frontal lobe and the dura of the cranial base were coagulated and divided one by one. When these vessels were disconnected completely, the color of the cortical veins became dark red, and the venous engorgement was gone. The post-operative course was complicated by repeated seizure. Computed tomography revealed a bifrontal epidural hematoma, which was evacuated immediately. After the second operation, the patient recovered without seizures again. Angiograms done 10 days and one year after surgery revealed no residual or recurrent DAVF (Fig. 1 C, D). The patient was doing well after five years of follow-up except for one episode of seizure.

Case 2

This 62-year-old man had no history of head injury. He experienced a sudden onset of severe headache with vomiting and consciousness disturbance. On admission, he was drowsy and had no sensorimotor deficits. Brain computed tomography (CT) scanning showed an intracerebral hematoma in the right anterior medial frontal area (Fig. 2A). Carotid angiography showed an anterior cranial fossa DAVF (Fig. 2B), with feeding artery from the right anterior ethmoid artery. The venous drainage was through a cortical vein to the superior sagittal sinus with venous ectasia. The DAVF was classified as type III according to Borden's classification [12] and type IV according to Cognard's classification [13] because it drained into the cortical veins with venous ectasia. The

![Fig 2. Preoperative and postoperative common carotid angiograms in Case 2. (A) Brain computed tomographic scan shows an intracerebral hematoma with perifocal edema in the right anterior frontal lobe. (B) Lateral projection of preoperative common carotid angiogram reveals an anterior cranial fossa dural arteriovenous fistula (DAVF) fed by the right anterior ethmoid artery and drained through the cortical vein of the right frontal lobe, and then the superior sagittal sinus. Venous ectasia is also noted. (C) Lateral projection of postoperative common carotid angiogram (7 days after surgery) reveals no residual DAVF.](https://example.com/fig2)
patient underwent surgery to remove the hematoma, and the tortuous vein was excised after interrupting the feeding artery and the draining vein. Post-operative angiography revealed no residual DAVF (Fig. 2C). The patient was in good condition after one and one half years of follow-up.

DISCUSSION

The dural arteriovenous fistulae in these two presented patients were classified as Borden's classification type III and Cognard's classification type IV because these DAVFs drained directly into the cortical veins and eventually into the superior sagittal sinus, and were accompanied by venous ectasia [12,13]. With this type of anterior cranial fossa DAVF, patients may have aggressive neurological presentations, and manifest with increased intracranial pressure due to venous hypertension, progressive focal neurological deficits because of a mass effect secondary to varix dilatation, and intracranial hemorrhage resulting from rupture of a venous aneurysm [2-4,6,10,13,14]. All these events may cause severe neurological deficits. Therefore, aggressive treatment is mandatory [6,7].

To properly manage patients with anterior cranial fossa DAVF, it is important to understand the vascular anatomy of the DAVF. The anterior cranial fossa DAVF mainly involves the dura in the region of the cribriform plate and the anterior falx [6]. The arterial supply of this type of DAVF is mainly from the ipsilateral anterior ethmoid artery [6], as seen in Case 2. Sometimes, additional feeders may come from the contralateral anterior ethmoid artery, distal branches of the internal maxillary arteries or middle meningeal arteries, or from the superficial temporal artery branches through transcalvarial anastomoses [6], as seen in Case 1. The venous drainage of an anterior cranial fossa DAVF, as seen in both of our patients, is primarily into the cortical veins of the anterior frontal lobe from which they drain into the superior sagittal sinus or cavernous sinus [7]. The optimal management of DAVFs is still controversial [10]. Although endovascular and radiosurgical techniques have been advocated for the treatment, the obliteration rates of these two procedures are lower than that of surgery. In addition, these two procedures may cause complications, such as occlusion of the ophthalmic artery, resulting in visual loss or radiation injury to healthy brain tissue, although they are less invasive than surgery and have minimal perioperative risks. Therefore, surgical treatment is more favored for the management of anterior cranial fossa DAVFs [4,6,7,10]. Earlier reports suggest surgical resection is necessary to obliterate the DAVFs [4,15-18]. In Case 2, surgical resection was adopted as the treatment strategy since excision of this type of DAVF was considered simple. However, another treatment method, obliteration of the pial venous drainage without excision of the nidus of the DAVF, was used in Case 1. Since most anterior cranial fossa DAVFs have simple fistula between the dura and the cortical veins without a significant dural nidus, an anterior cranial fossa DAVF is similar to a spinal DAVF [10]. Spinal DAVFs are effectively treated simply by interruption of the arterialized medullary vein that drains the fistula into the subarachnoid space [19]. Recently, this treatment method has been applied to the anterior cranial fossa DAVF. This simple surgical procedure results in little blood loss, a relatively short operation time, and most importantly, minimal surgical risk. In contrast, a nidal excision can cause significant perioperative morbidity, and even mortality, especially when the nidus is large [10]. Furthermore, in patients with mild or minimal neurological deficits, such as as Case 1 who only had seizures, excision of the dura or the variceal or aneurysmal venous dilatation is not considered necessary [6,7]. Thus, the anterior cranial fossa DAVF in Case 1 was treated with obliteration of the pial venous drainage without excision of the nidus. Angiography demonstrated successful obliteration. Several reports have confirmed high obliteration rates with low complication rates using surgical interruption of the drainage veins close to the nidus of anterior cranial fossa DAVFs [7,9-11].

In conclusion, surgical excision can be used as the treatment strategy, especially when the nidus is small with few feeding arteries and draining veins, as in Case 2. However, leptomeningeal venous disruption without nidus excision might also be considered a safe and effective surgical procedure, as in case 1.

REFERENCES

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前顱窩硬腦膜動靜脈瘻管之外科治療—二病例報告

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摘要

前顱窩硬腦膜動靜脈瘻管是少見的疾病，在本研究報告中，我們提出以外科手術治療二位病人的經驗。第一位病人是一位46歲的男性，他發生二次全身性癲癇發作，腦部磁振攝影檢查顯示病人右側額部有異常的血管，二側顳動脈血管攝影發現在前顱窩有一硬腦膜動靜脈瘻管，其灌流動脈來自二側顳前動脈、顳中動脈及顳後動脈，靜脈引流則是經由右側顳葉的皮質靜脈，然後進入上矢狀窦，而且這些皮質靜脈有擴大現象。病人接受手術將灌流動脈及引流靜脈切斷，但並未切除病灶。手術後一年的血管攝影檢查顯示無殘餘或再發的硬腦膜動靜脈瘻管，經五年的追蹤，這位病患除了曾發生一次癲癇外其他情況良好。另一位病人是一位62歲的男性，他突然發生頭痛、嘔吐、及意識不清現象，腦部電腦斷層攝影發現其右側顳部有脳內出血，電腦斷層血管攝影發現有不正常血管，顳動脈血管攝影顯示前顱窩有一硬腦膜動靜脈瘻管，其灌流動脈來自右側顳動脈，靜脈引流則是經由右側顳葉的皮質靜脈，然後進入上矢狀窦，而且這些靜脈有擴大現象。病人接受手術清除血塊，並將病灶切除，手術後血管攝影檢查顯示無殘餘的硬腦膜動靜脈瘻管，經一年半的追蹤，這位病患情況良好。根據治療這二位病人的經驗及文獻上資料，我們將探討前顱窩硬腦膜動靜脈瘻管的手術治療方式的選擇。(慈濟醫學 2003; 15:199-204)

關鍵語：前顱窩，硬腦膜動靜脈瘻管，外科治療