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Case Report

Visual Field Defect after Transfrontal Sinus Approach of Ethmoidal Dural Arteriovenous Fistulas (eDAVFs) : Experience and Complication of Transfrontal Sinus Approach

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The approach to ethmoidal dural arteriovenous fistulas (eDAVFs) is usually via a pterional or a frontal craniotomy. However, the transfrontal sinus is a more direct route to the fistula. The aim of this report is to describe our experience and associated complications occurring as a result of flow diversion in the transfrontal sinus approach for eDAVFs. In this report, we discuss visual field defects occurring after a transfrontal sinus operation. This approach is most direct for surgical treatment of an eDAVF, enabling preservation of neural structures with minimal to no negative effects on the brain. Although the surgery was uneventful, the patient presented with a left side visual field defect. An ophthalmologic exam detected an arterial filling delay in the choroidal membrane and ischemic optic neuropathy was highly suspected. The patient is currently recovering under close observation with no special treatment. The transfrontal sinus approach provides the most direct and shortest route for eDAVFs, while minimizing intraoperative bleeding. However, complications, such as visual field defects may result from a sudden flow diversion or eyeball compression due to scalp traction.

Keywords Intracranial arteriovenous malformations, Frontal sinus, Surgical procedures, operative, Complications

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INTRODUCTION

Anterior cranial fossa DAVFs are rare (5.8%),[1)13)] with a high incidence of sudden intracranial hemorrhage (62-91%).[4)19)21)22)] Many approaches to accessing such fistulas, including pterional, orbitozygomatic, or subfrontal craniotomies have been reported.[1)10-12)] A transfrontal sinus approach, however, provides the most direct route to the site of a lesion, thereby minimizing brain manipulation. Herein, we have described the complications associated with ethmoidal dural arteriovenous fistulas (eDAVFs), including vision defects, which are avoided using the transfrontal sinus approach.

CASE REPORT

A 45-year-old male reported with seizure. The patient's neurologic examination was normal. However, brain magnetic resonance imaging (MRI) showed findings suggestive of eDAVF, with a large nidus located near the left gyrus rectus (Fig. 1). Digital sub-

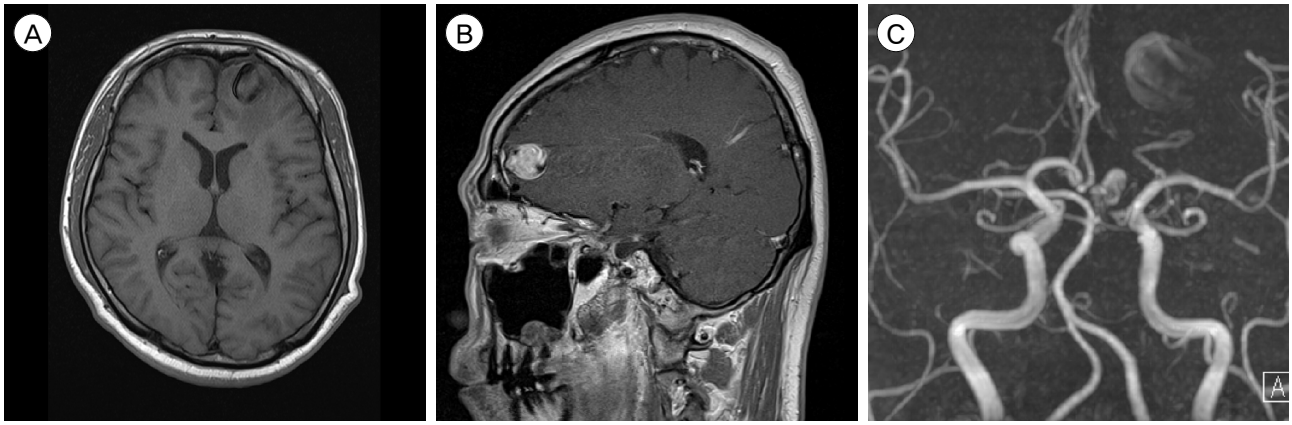

Fig. 1. (A) Axial T1-weighted magnetic resonance imaging showing an enlarged vein at the left frontal lobe; (B) ecstatic left frontal cortical vein (19 mm x 15 mm) compressed brain; (C) magnetic resonance angiography showing vascular malformation, such as arteriovenous malformation on the left frontal lobe.

traction angiography showed a DAVF, arterialized by the left anterior and posterior ethmoidal arteries, by anastomosis of the right ophthalmic artery, and by both the left and right external carotid arteries. The DAVF was drained by a large vein originating from the cribriform plate, which drained into the cortical draining veins and then into the superior sagittal sinus (Fig. 2). MRI also showed that the large, ectatic left frontal cortical vein (19 mm × 15 mm) was being compressed, thus causing brain edema of the corresponding area (Fig. 1). Surgical management was chosen instead of an endovascular approach. The patient was placed in a supine position with a lumbar drain and the head was laid straight but slightly elevated. A bicoronal incision was made, revealing the periosteum. The skin flap was wrapped with gauze and then retracted as much as possible in order to reveal the supraorbital notch. A neuronavigation system was used to confirm and outline the location of the frontal sinus, and a 3.6 cm × 2.7 cm craniotomy was then performed over the marked frontal sinus (Fig. 3).

Opening of the dura, after removal of the frontal sinus, revealed a small feeding artery flowing from both ophthalmic arteries. The main arterialized vein was connected to the dura near the cribriform plate of the ethmoid bone. This portion of the dura was cauterized along with all of the main arterialized veins, as revealed in the surgical field.

Brain retraction was restricted in order to avoid frontal lobe injury. The craniotomy was closed with

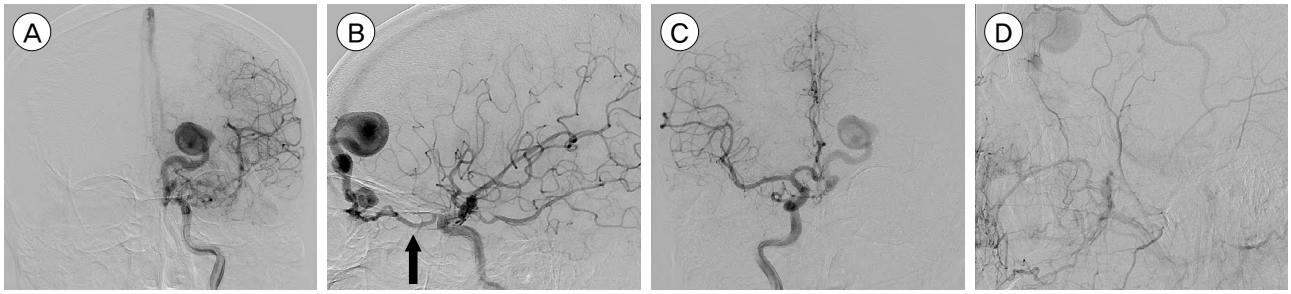

Fig. 2. Digital subtraction angiography. (A) Anteroposterior view of the left internal carotid artery (ICA) and (B) Lateral view of the left ICA: dural arteriovenous fistulas vascularized by the left anterior and posterior ethmoidal arteries originating from the left ophthalmic artery. Diameter of the left ophthalmic artery was 2.13 mm (arrow); (C) Anteroposterior view of the right ICA showing anastomosis arising from the right ophthalmic artery; (D) Lateral view of the right ECA showing anastomosis. The venous drainage through a large vein, which drains into frontal cortical veins, which then drain into the superior sagittal sinus.

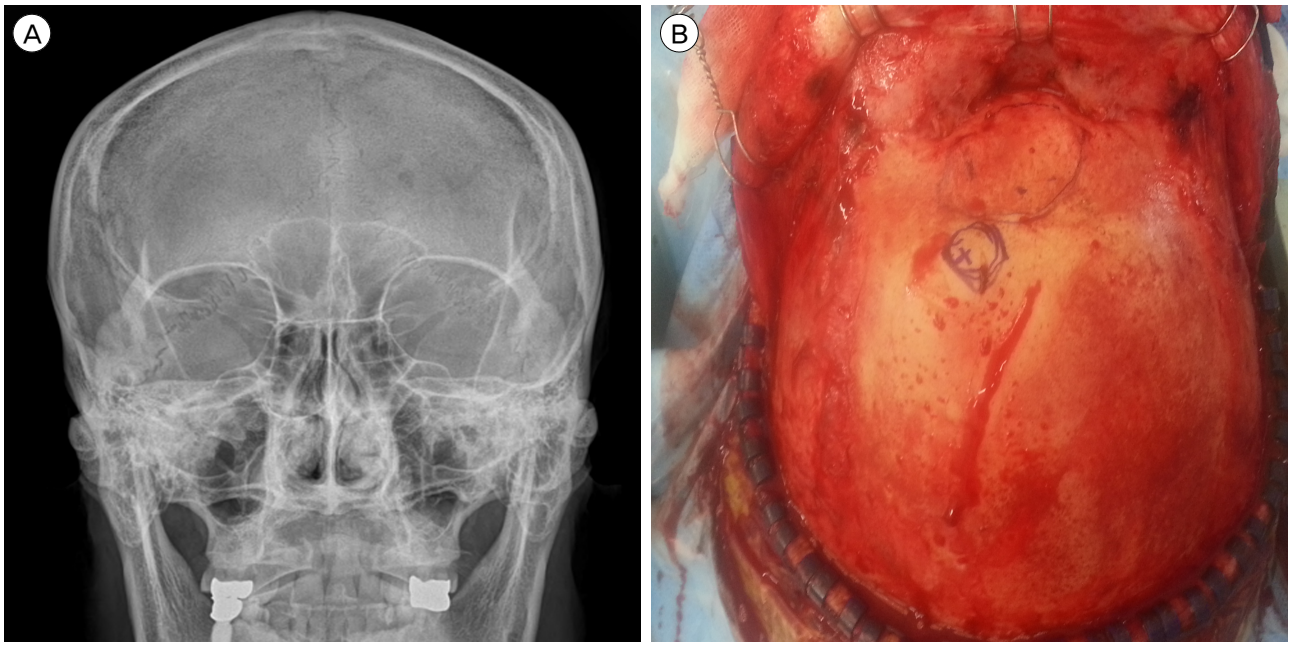

Fig. 3. (A) Anteroposterior plain film. Size of the frontal sinus is approximately 3.6 cm x 2.7 cm; (B) Perioperative image. Margin of the frontal sinus and large vein is marked using a neuronavigator.

the patient's original sinus wall and Poly-bone cement. Post-operative CT scan showed no abnormalities, and the postoperative angiography showed clearance of the fistula (Fig. 4).

Immediately after the operation, severe visual disturbances were detected in both eyes, with a central blind spot in the left visual field. Fluorescein angiography showed a slight filling delay in the choroidal

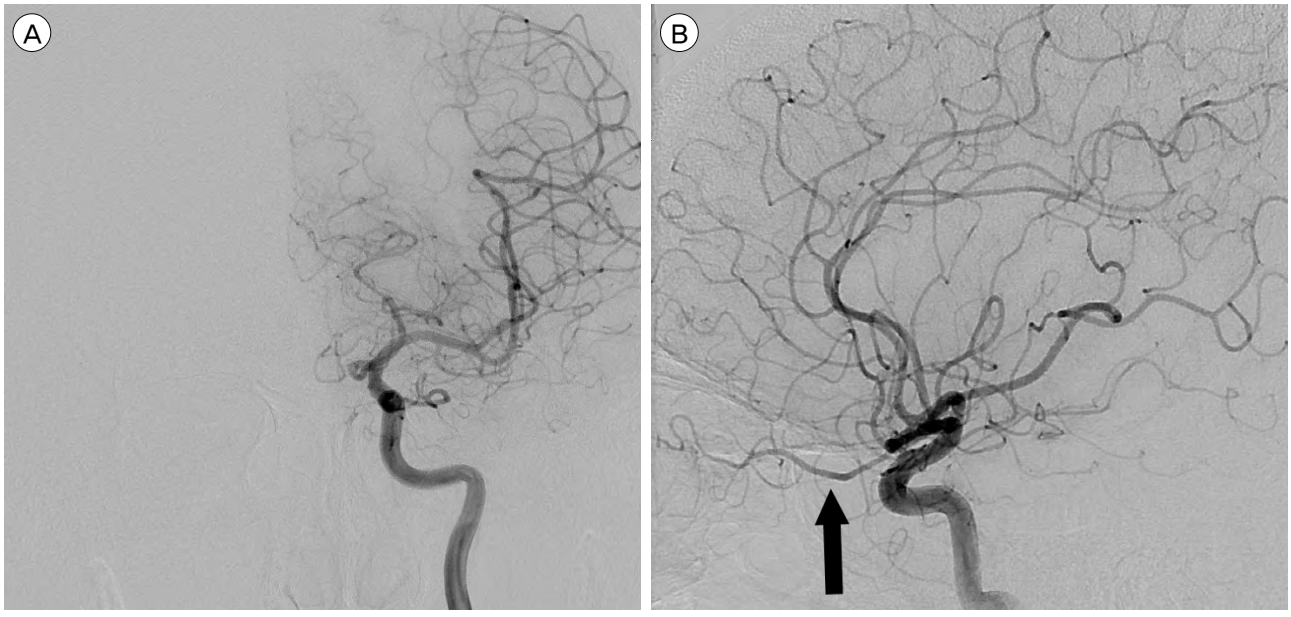

Fig. 4. Digital subtraction angiography. (A) Anteroposterior view of the left internal carotid artery (ICA) and (B) Lateral view of the left ICA. Drainage into the large vein is no longer observed and the dural artertiovenous fistula is not present. Diameter of the left ophthalmic artery decreased to 1.10 mm (arrow) as compared to 2.13 mm pre-operation.

arteries without apparent vascular occlusions or ischemic disease. The patient's vision in the right eye was completely restored to preoperative status but a thick central scotoma remained in the left eye.

DISCUSSION

Although the pathogenesis of anterior cranial fossa DAVF remains unclear, DAVF secondary to head trauma has been reported.[5] eDAVFs are rare lesions, occurring at the cribriform plate in the anterior cranial fossa, with a high incidence of hemorrhage (62-91%).[21] They are usually supplied by the ethmoidal branches of the ophthalmic artery and occasionally by the middle meningeal artery of the external carotid artery. DAVFs are then drained by the frontal cortical veins into the superior sagittal sinus.[2)3)22)] DAVFs are treated in the presence of cortical venous drainage, and both surgical and endovascular approaches have been described.[1)7)9)14)15)24)]

In the case of the eDAVF, which are supplied by both ethmoidal arteries and the left meningeal artery, an endovascular treatment would require selective catheterization of the ethmoidal arteries. We decided to proceed with a surgical approach, because catheterization, as with the endovascular approach, would not only be difficult but may lead to far greater complications.[6)8)14)15)23)]

The reported success rate for surgical treatment is higher than that for endovascular treatment. Bifrontal, low subfrontal, pterional, unilateral modified orbitozygomatic, and transfrontal sinus approaches have been described.[1)11)14)] We decided on a purely transfrontal sinus approach, in order to minimize brain traction, prevent olfactory bulb injury, and minimize bleeding into the superior sagittal sinus. The transfrontal sinus approach also offers the shortest and most direct route to the DAVF.[16)20)] The transfrontal sinus approach is therefore well known for its use in anterior skull base tumors. Postoperative ocular fluorescein angiography showed a slight choroidal filling delay, with focal central anopia in the left eye. A previous study reported bilateral orbital infarction due to ophthalmic artery occlusion, resulting from severe retraction of the skin flap, without wrapping with gauze during cranioplasty of the frontal skull base.[17)] The orbicularis oculi orbital muscle was retracted to the fullest in order to fully expose the frontal sinus (Fig. 3B). Direct compression of the eyes, due to retraction of the skin flap, may have caused ischemia resulting in visual disturbance and central scotoma.

Flow diversion may also be a possible explanation for the visual disturbance described above. Postoperatively, the diameter of the ophthalmic artery decreased from 2.13 mm to 1.10 mm (51.6%) (Fig. 2B, 4B). Micro damage resulting from such changes in blood flow may have caused injury of the retina.[18)]

Our patient showed marked improvement and recovery of vision 24 hours after onset of the initial visual disturbances and focal central anopia. Considering the recovery time and decrease in the extent of central anopia, direct compression of the eye due to skin flap retraction seems much more likely to be causative of visual disturbance.

CONCLUSION

The transfrontal sinus approach provides a short and direct route which enables performance of a small craniotomy. However, as seen in the case reported above, extensive traction in patients with a small sinus may lead to complications, as described above. When performing surgeries using a bicoronal incision, care should be taken to avoid compression of the eyes.

Disclosure

The author declares that they have no vested interest that could be reason for inaccurately reporting the facts of this study.

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