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Dural arteriovenous fistula between the inferolateral trunk and cavernous sinus draining to the ophthalmic vein: a case report

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Running title: Dural arteriovenous fistula between the inferolateral trunk and cavernous sinus draining to the ophthalmic vein

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Abstract

BACKGROUND: The formation of a dural arteriovenous fistula (DAVF) between inferolateral trunk (ILT) and cavernous sinus (CS) is very rare.

CASE DESCRIPTION: This study presents a case of ILT-CS DAVF. A 64-year-old male patient had exophthalmos of the left eye with redness and swelling. Digital subtraction angiography (DSA) revealed a connection between the ILT and the CS that formed a high-flow DAVF that was drained only to the ophthalmic vein and no other parts of the CS. The ILT was chosen as the transarterial path for treatment because it was enlarged. The microcatheter was navigated into the ILT, and two coils were then used to occlude the ILT. After occlusion of the ILT, no image of the DAVF indicated that the ILT-CS DAVF was completely cured. The patient’s symptoms improved gradually after surgery. At the 6-month follow-up visit, DSA showed no sign of ILT-CS DAVF, and the patient’s eye symptoms had disappeared.

CONCLUSIONS: Although ILT-CS DAVF is rare, it still can be seen in clinical practice, and coiling the ILT via a transarterial approach is a good option for treatment.

Keywords: inferolateral trunk, cavernous sinus, dural arteriovenous fistula, coiling
Introduction

Dural arteriovenous fistula (DAVF) of cavernous sinus (CS) is not rare, in which both the external carotid artery (ECA) and the internal carotid artery (ICA) can participate in the arterial supply for a CS DAVF. However, it is very rare that the inferolateral trunk (ILT), as a supplying artery for a CS DAVF, forms a high-flow ILT-CS DAVF. This study reports just such a case. Either a transarterial or a transvenous approach can be chosen as the treatment for CS DAVF, the transvenous approach is the major approach currently used. In this case, the ILT was already enlarged and was the only supplying artery for the high-flow ILT-CS DAVF; therefore, a trans-ILT approach in which the ILT was occluded by coils was used successfully.

Case report

A 64-year-old male patient had intermittent redness and swelling of the left eye for 2 months, and because his symptoms gradually worsened, especially with exophthalmos for 20 days, he was hospitalized in the Department of Neurosurgery at the First Hospital of Jilin University. The patient was healthy and had no history of head injuries, hypertension, diabetes, or other related disorders. Physical examination showed exophthalmos, conjunctival congestions, and swelling of his left eyeball, along with the patient’s inability to close his left eyelids (Figure 1A). The lateral movement of his left eye was restricted, and diplopia was present.
His left visual acuity was 0.5, and his left pupil was normal in size and sensitive to light stimulation. The fundus examination showed congestive veins and edema in his left eye. Auscultation showed no bruit in his eye or eye orbit.

After hospitalization, computed tomography (CT) examination revealed normal bone around his eye orbit, no mass effect lesion behind his eyeball, no thrombosis of the cavernous sinus, and no signs of hemorrhage, edema, or hydrocephalus besides an old lacunar infarction above the left caudate nucleus in the intracranial tissue (Figure 1B-D). Digital subtraction angiography (DSA) was performed, and the angiography of his left ICA showed the ILT from the CS segment of the ICA was connected with the CS and formed a high-flow DAVF. The DAVF drained to the ophthalmic vein (OV) and did not affect the rest of the CS (Figure 2A). No abnormalities were noted in the angiography of his left ECA, right common carotid artery (CCA), and vertebral artery (VA) (Figure 2B-D). According to the DSA, the diagnosis of a DAVF that was supplied by the left ILT and that drained to the left OV was confirmed, and embolization of the DAVF via the ILT was chosen.

The transarterial approach was used, and the ILT-CS DAVF was carefully evaluated by the 2D-DSA taken with the best angle of projection and the 3D-DSA during surgery. It was noted that the ILT originated from the CS segment of the ICA and then connected with the CS at its lateral and
bottom sides to form the DAVF, which was drained to the OV; moreover, the OV was dilated (Figure 3). During surgery, an Echelon 10 microcatheter was able to navigate into the ILT over a Syncro 14 microwire, but not into the CS. Microcatheter angiography was performed via the ILT and clearly showed the DAVF, and the ILT was then occluded by Target helix soft coils (Coil size: 2 mm×3 cm and 1.5 mm ×3 cm). After the ILT was occluded, DSA was repeated and showed no evidence of ILT-CS DAVF (Figure 4).

After surgery, the patient’s eye symptoms were significantly reduced, and a thin-slice scan of the skull base was performed the next day. The reconstructed skull base image showed that the coils were located on the lateral side of the left CS, near the foramen ovale; the axial, sagittal and coronal views of the head CT showed that the coils were on the top of the sphenoid sinus hanging wall (Figure 5). Six months after surgery, the redness and swelling of the left eye and exophthalmos had disappeared, and his vision had returned to normal; meanwhile, DSA showed no recurrence of ILT-CS DAVF (Figure 6).

**Discussion**

CS arteriovenous fistula (AVF) is an abnormal communication either directly between the ICA lumen and the CS or indirectly between branches of the ICA and/or ECA and the CS.\(^6\,7\) The classification of CS AVF may vary.\(^4\) Barrow et al. (1985) developed a detailed classification
for CS AVF, and until recently, this classification was the standard. They defined Type A AVF as direct fistulas between the ICA and the CS, Type B AVF as solely supplied by ICA-branches, Type C fistulas as supplied only by the dural branches of the ECA, and Type D AVF as supplied by both territories.  

Barrow classification describes at least two separate disease entities: Type A CS AVFs are lesions resulting from ruptured aneurysms, spontaneous dissection, or traumatic carotid rupture and are high-flow; Types B-D are CS DAVFs and are often low-flow. In terms of CS DAVF following the Barrow classification, the most frequent type is the Type D fistula (90%), which is often supplied by numerous branches from both the ICA and ECA territories, sometimes bilaterally.

The ILT-CS DAVF reported in this study was a Type B DAVF that was supplied only by the ILT in the ICA. The ILT is a branch that arises inferiorly from the C4 segment of the cavernous ICA and anastomoses to meningeal branches of the internal maxillary artery, providing collateral circulation between the ECA and the ICA systems. In this case, the ILT was on the lateral side of the CS and connected with the CS on its lateral and bottom sides, forming a high-flow DAVF. Moreover, the venous drainage of the DAVF does not involve other parts of the CS but only the OV, causing the symptoms around the eye, which is very rare. In this study, the ILT-CS DAVF was determined to be high-flow by DSA,
similar to a traumatic ILT-CS AVF, but no history of trauma was noted for the patient. During endovascular treatment, no direct fistula point between the ILT and the CS was noted, and both the microwire and the coils were not able to navigate into the CS; therefore, ILT-CS DAVF was considered in this case. The ILT-CS DAVF in this case may have originated from recanalization after thrombosis in the neighboring vein structures of the ILT.

In most cases, CS DAVFs must be treated, and the treatments can be applied via the transvenous or transarterial approach. In treatments via the transarterial approach for the Types B-D DAVF, Type C DAVFs are usually easy to treat because catheterization of ECA feeders is technically less difficult, and injecting liquid embolic agents is clinically less risky; Types B and D DAVFs are more challenging because embolization of the ICA branches can be dangerous, and these DAVFs are slow-flow and have multiple feeding arteries. To date, most Types B and D DAVFs are treated via the transvenous approach; therefore, it is very important that the venous drainage pattern be clarified. The Barrow DAVF classification is only based on the different sources of the supplying arteries but ignores the venous drainage pattern of CS DAVFs, which is a drawback in the Barrow classification. The most comprehensive description of venous drainage of CS DAVFs was proposed by Wenderoth et al. in 2017. The classification includes the
presence of unilateral or bilateral arteriovenous shunting; ipsilateral, contralateral, or bilateral venous drainage; the patency or otherwise of the relevant inferior petrosal sinus; and the presence or absence of retrograde leptomeningeal venous drainage.\(^9\)

In this study, the type B ILT-CS DAVF was only drained via the OV and not the CS, which is type 3a in the Wenderoth classification, representing a unilateral DAVF with ipsilateral inferior petrosal sinus occlusion and no contralateral vein-to-vein shunting. Since there are no other drainage veins, the OV becomes the only choice if the intravenous approach is chosen.\(^9\) In this case, the only supplying artery of this Barrow Type B ILT-CS DAVF was from the ILT. Anatomically, although the ILT is exhibited on angiography in only 4 to 7\% of cases, when the ILT is the only supplying artery of the DAVF, it enlarges due to the elevated blood flow pressure, which allows transarterial embolization.\(^2, 15\) Similarly, Horie et al. (2012) presented a case with a DAVF between the ILT and the OV; the ILT was coiled, and the DAVF was cured.\(^12\)

Several materials are available for ILT-CS DAVF embolization, including Onyx liquid embolic agents, coils, or a combination. For this case, Onyx agent was not suitable because first, the ILT was short, meaning that the Onyx could be easily refluxed into the ICA; second, in a high-flow situation, the Onyx can be flushed into the distal OV. In this case, since the ILT-CS DAVF was supplied only by the ILT, the coils were the best
choice. Due to the enlargement of the ILT, 2 coils were used during embolization. In summary, although Barrow Type 2 DAVF is rare, ILT-CS DAVF can still be seen in clinical practice. The coiling the ILT via a transarterial approach is a good choice for the treatment of ILT-CS DAVF.

Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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Consent

Written informed consent was obtained from the patient for publication of this manuscript and any accompanying images. Copy of the written consent is available for review by the Editor of this journal.

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None

References


Figure legends

Figure 1. Ocular appearance and preoperative head CT. A: Photograph showing protrusion of the left eyeball and conjunctival congestion and swelling. B: The bone window of orbital CT showed normal bone around the eye and no mass effect lesion behind the eyeball. C-D: Brain CT showed no thrombosis of the cavernous sinus, no signs of hemorrhage, edema, or hydrocephalus and normal brain tissue besides low-intense infarcts on the top of the left caudate nucleus.

Abbreviation:

CT: Computed Tomography

Figure 2. Preoperative DSA. A: Angiography of the left ICA showed that the ILT from the CS segment of ICA was in communication with the CS and formed the DAVF. The DAVF was drained to the OV. B: Angiography of the left ECA showed that no branches of the ECA participated in the blood supply of the DAVF. C: Angiography of the right common carotid artery was normal; D: Angiography of the VA was normal.

Abbreviation:

DSA: digital subtraction angiography
ICA: internal carotid artery
ILT: inferolateral trunk
CS: cavernous sinus
DAVF: dural arteriovenous fistula
OV: ophthalmic vein
ECA: external carotid artery
VA: vertebral artery

Figure 3. Intraoperative DSA of the DAVF. A-B: The best angle of projection of the 2D-DSA from the early arterial phase and the arterial phase showed that the ILT originated from the CS segment of the ICA and then connected with the CS at its lateral side to form the DAVF. The DAVF was drained to the OV, which was dilated. C-D: Different angles of projection of 3D-DSA more clearly showed that the ILT originated from the CS segment of the ICA then connected with the CS at its lateral side to form the DAVF.

Abbreviation:

DSA: digital subtraction angiography
DAVF: dural arteriovenous fistula
ILT: inferolateral trunk
CS: cavernous sinus
ICA: internal carotid artery
OV: ophthalmic vein
**Figure 4. DAVF embolization procedure.** A: DSA showed that the Echelon 10 microcatheter was navigated into the ILT, and microcatheter angiography clearly showed the DAVF. B: The ILT was occluded with Target helix soft coils. C: Microcatheter angiography after ILT occlusion showed no evidence of DAVF and contrast agent refluxed into the ICA. D: Silhouette imaging of DSA showing the coils in the ILT and contrast agent remaining in the CS. E-F: ICA angiography showed no evidence of DAVF.

**Abbreviation:**

DAVF: dural arteriovenous fistula  
DSA: digital subtraction angiography  
ILT: inferolateral trunk  
ICA: internal carotid artery  
CS: cavernous sinus

**Figure 5. Postoperative CT reconstruction and CT images.** A: The reconstructed CT skull base image showed that the coils were located on the lateral side of the left CS, near the foramen ovale. B-D: Axial, sagittal and coronal views of the thin cut source CT images showed the location of the coil mass.

**Abbreviation:**

CT: computed tomography
CS: cavernous sinus

**Figure 6. Follow-up photograph of the eye and DSA images.**

A: Photograph of the eye showing normal ocular appearance after recovery.

B-D: DSA of the common carotid artery showing complete embolization of the DAVF and no signs of recurrence.

**Abbreviation:**

DSA: digital subtraction angiography
1. cavernous sinus (CS) arteriovenous fistula (AVF) is an abnormal communication between the internal carotid artery and the CS.

2. The formation of a dural arteriovenous fistula (DAVF) between inferolateral trunk (ILT) CS is very rare.

3. Coiling the ILT via a transarterial approach is a good option for treatment of ILT-CS DAVF.