Endovascular Treatment of Cavernous Sinus Dural Arteriovenous Fistulas by Direct Puncture of Facial Vein

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ABSTRACT

Transvenous embolization through the superior ophthalmic vein (SOV) is one of the most effective treatments for cavernous sinus dural arteriovenous fistulas (DAVF). We describe a simple application of intravenous catheterization to approach the SOV with direct percutaneous puncture of the facial vein without a surgical procedure. Contralateral digital subtracted roadmap and arteriogram in anterior-posterior projection are the best image references to place the surface markers precisely for the direct percutaneous puncture of the facial vein in such a circumstance.

CASE REPORT

A 56-year-old male suffered significant left eye proptosis as well as congestion of the conjunctiva for more than 3 months before his first visit. Physical examination revealed proptosis of left eye with marked congestion of the conjunctiva. Progressive worsening of his vision was also noted in the recent week. Magnetic resonance images (MRI) revealed a dilated signal-void SOV in his left orbit. Angiography disclosed dural or indirect type arteriovenous fistulas with the arterial feeders from bilateral cavernous segments of internal carotid arteries (ICA) and bilateral external carotid arteries (ECA) branches to the left cavernous sinus (Barrow Type D). Predominantly venous drainage was the engorged left SOV and to the left facial vein (Fig. 1). There was neither significant cortical venous reflux nor posterior-inferior drainage through the inferior petrosal sinus (IPS). Transarterial embolizations of bilateral ECA feeders were performed. The ocular symptoms were improved after the embolization and rapidly recurred in three weeks.

Second section of embolization with transvenous approach was then arranged. The IPS was angiographically blocked without obvious connection of the internal jugular vein and the cavernous sinus. Although the literature suggests that the IPS could be catheterized in such a circumstance [3], we still failed to catheterize the IPS. We
then tried an SOV approach by navigating the microcatheter from the external jugular vein through the facial vein. The microcatheter reached the facial vein but could not cannulate through it. The anterioposterior (AP) view of contralateral ICA and ECA angiograms clearly demonstrated the facial vein and its course which let us decide to try direct percutaneous puncture of the facial vein to approach the SOV (Fig. 2). However, the facial vein was not clearly identified from patient’s cheek. We put two small lead markers on the surface of the patient’s left cheek precisely along the straight segment of the facial vein by using contralateral carotid artery angiographic roadmap (Fig. 3). The facial vein was then carefully punctured with an 18 G intravenous catheter (IC) needle from the lower marker towards the upper marker. With only several trials, the IC soft needle was successfully cannulated into the facial vein. After insertion of a 0.035-inch hydrophilic guide wire, the IC soft needle was exchanged into a 4 french femoral sheath, which was inserted into the facial vein for about 3-4 cm in length and secured with surgical tapes on the patient’s cheek (Fig. 4). A microcatheter was then smoothly navigated through the facial vein, the SOV and into the left cavernous sinus without much difficulty. Another intra-arterial diagnostic catheter was inserted into the right common carotid artery for monitoring the fistulas during the embolization. Totally Eleven pushable platinum fibered microcoils (Vortex, Target Therapeutic/Boston Scientific, Fremont, CA) were used to pack in two regional compartments of the cavernous sinus.

**Figure 1.** Digital subtracted angiograms of bilateral internal and external carotid arteries (a. lateral view of left internal carotid artery. b. anterioposterior view of left external carotid artery. c. lateral view of right internal carotid artery. d. anterioposterior view of right external carotid artery) show the cavernous sinus dural arteriovenous fistulas with feeders contribute to the left cavernous sinus. The predominant drainage vein is the left superior ophthalmic vein (arrows). There is no obvious drainage through inferior petrosal sinus. The posterior inferior portion of the left cavernous sinus has a plexiform appearance or partial thrombosis (a, c, arrowheads).
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sinus (Fig. 5). Post-embolization angiography revealed complete obliteration of the DAVFs immediately (Fig. 6). Post-embolization course was uneventful and the patient recovered from his symptoms shortly. The puncture wound on the patient’s cheek was minimal and posed no cosmetic problem. The patient received angiographic follow-up study eighteen months later revealed complete cure of the cavernous sinus DAVF. The patient continues to be free of symptoms after more than 3 years of clinical follow-up.

DISCUSSION

Patients with indirect type, or dural type arteriovenous fistulas (DAVF) involving cavernous sinus can be conservative observation or be treated by radiosurgery or endovascular embolization depending on the severity of the clinical symptoms and risks of cortical vein reflux. Endovascular embolization of cavernous DAVF, including transarterial or/and transvenous approaches, by using various materials can
**Figure 4.** A 4 French femoral sheath is placed into the facial vein after cannulation of the facial vein by intravenous catheter needle. The surface guideline is seen. (The two lead markers have already been removed). No surgical exposure of the vein is required.

**Figure 5.** Post-embolization non-subtracted radiograms in lateral view a. and anteroposterior view b. show the fibrous platinum microcoils are packed in two different compartments of the left cavernous sinus (arrowheads). Two linear non-forming fibrous platinum microcoils (arrows) were put in the branches of the external carotid artery at the first transarterial embolization.
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obliterate the fistulas. Transvenous approaches have been proven safe and effective, and have become the treatment of choice [2-5]. Many transvenous routes have been reported in the treatment of cavernous sinus DAVF. The inferior petrosal sinus (IPS) is one of the most common approaches when using transfemoral catheterization because the IPS has a shorter and straighter course. However, the IPS may be difficult to access because of its plexiform nature, thrombosis, stenosis or even hypoplasia/aplasia. The SOV is another approach to the cavernous sinus. Access to the SOV has been recommended especially when the patient has predominantly anterior venous drainage though this vein [6]. Transfemoral approach to SOV usually poses difficulty because there is an abrupt angulation and tortuosity at the exit of the SOV. Surgical exposure of the SOV may have a favorable outcome [7]. However, it also carries the risk of damaging anterior orbital structures such as trochlea, levator palpebrae superiors, and supraorbital nerves. If injury to the SOV or acute thrombosis happened before complete closure of the fistulas, retro-orbital hemorrhage or acute deterioration of ocular symptoms may occur [8]. Direct percutaneous punctures through the superior orbital fissure to the affected cavernous sinus or deep orbital puncture to the SOV have also been reported [8, 9]. However, these methods used a very short distance of catheterization in the venous structure and also carry the risk of retro-orbital hematoma and other related injuries. These methods are relatively technical-dependent and usually reserved as the last choice of treatment.

From anatomic point of views, there are several tributary veins of the SOV that could be accessed [4, 10]. The use of these veins differs by cases and depends on the venous drainage of the cavernous sinus DAVF. Careful evaluation of angiographies to determine the accessible vein is very important. Cases of transfemoral catheterization through the retromandibular vein, the superficial temporal vein, and then the SOV has been reported [2, 11]. Frontal vein direct puncture and catheterization into the SOV has been

Figure 6. Post-embolization digital subtracted angiograms of the right common carotid A. and left common carotid arteries b. in anterioposterior views show complete obliteration of the left cavernous sinus dural arteriovenous fistulas.

6a

6b
reported and has a favorable result [10]. Surgical exposure of the facial vein at the base of the mandible bone has also been used to reach the cavernous sinus [12].

In our case, transarterial embolization and transfemoral transvenous approaches had failed. After analysis of the venous drainage of the fistulas, the left facial vein was the major drainage vein and was clearly demonstrated, especially in the AP projection of the contralateral carotid angiographies. Because this segment of facial vein is usually not easy to identify from the surface, we put two small lead markers on the patient’s cheek as our puncture guideline. Using simple venous access technique by an IC needle was successfully done without much difficulty. In addition, this method does not require surgical exposure of the SOV or the facial vein, as described in the previous reports [5, 12].

Direct percutaneous facial vein puncture for treatment of cavernous sinus DAVF has its advantages. First, shorter intravascular catheterization distance allows better control to manipulate the microcatheter, as compared to transfemoral approaches. The distance is also long enough to provide good support of the microcatheter as compared to the closer approaches such as direct puncture to deep SOV or cavernous sinus. Second, if an unexpected occlusion of the approach vein occurs before complete closure of the DAVF, collateral tributary veins including supraorbital or superficial temporal vein, retromandibular vein, frontal vein, and contralateral angular vein may prevent rapid deterioration of ocular symptoms [12].

In conclusion, direct percutaneous puncture of the facial vein by using surface markers as the guideline to approach the SOV can be an alternative method for transvenous embolization of cavernous sinus DAVF when other approaches have failed. This technique is relatively simple and safe which doesn’t required surgical exposure of the vein. Careful evaluation of angioarchitectures is mandatory to identify the accessible route for transvenous embolization. Contralateral digital subtracted arteriogram and roadmap in AP projection are the best image references for the direct percutaneous puncture of facial vein in such a circumstance.

REFERENCES