

Indirect Carotid-Cavernous Sinus Fistulas Treated by Transvenous Approach Through the Superior Ophthalmic Vein: A Case Report and Technical Note

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ABSTRACT

Objective: To present the results of our alternative treatment of indirect carotid-cavernous sinus fistulas.

Methods: A 50-year-old woman, whom the standard underwent surgical exposure of the superior ophthalmic vein (SOV), retrograde venous catheterization, and coil embolization of the cavernous sinus.

Results: Complete fistulas obliteration was accompanied by recovery of the clinical symptoms.

Conclusion: The surgical SOV approach might be sufficient when standard endovascular intervention does not succeed. The technique is safe and effective when performed by an interdisciplinary team.

Keywords: Embolization; indirect carotid-cavernous sinus fistulas; superior ophthalmic vein

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Carotid-cavernous sinus fistulas (CCFs) are spontaneous or acquired connections between the carotid artery and the cavernous sinus. Barrow et al¹ classified CCFs as direct (Type A) or indirect (dural; Types B-D). Direct CCFs are high-flow fistulas caused by a traumatic or aneurysmal rupture of the cavernous carotid artery into the cavernous sinus. Indirect or dural CCFs are low-flow states caused by anomalous connections between the cavernous sinus and smaller-caliber branches of the internal carotid artery, external carotid artery, or both. The clinical presentation of symptoms depends on the pathologic anatomy of the CCF. It is related to their size, duration, location, adequacy and route of venous drainage. Patients may present with pulsatile proptosis, bruit, diplopia, chemosis, pain, and/or increased intraocular pressure (IOP).

In indirect CCFs, endovascular management should be the primary treatment because of a low rate of morbidity and favorable outcomes in patients.² For Barrow types B-D indirect CCFs, transarterial embolization can markedly decrease a large area of shunt, but is not likely to result in

angiographic elimination and cure of an arteriovenous shunt except in rare instances of limited fistulas with the safety of an accessible blood supply.¹¹

Transfemoral venous embolization with coils has been widely accepted as the treatment of choice.³ The venous route goes usually through the internal jugular vein and the inferior petrosal sinus (IPS) up to the pathologic shunts of the cavernous sinus. In some cases where IPS is not opacified, some authors have proposed navigation through the obstructed IPS by assisted guidewire penetration.^{4,5,11} This technique is not always feasible and severe complications of transvenous approaches via the IPS have been reported.^{5,11} The other approaches are either from the transfacial to superior ophthalmic vein (SOV) by a transfemoral approach or combined surgical and endovascular intervention via the SOV directly to the cavernous sinus. The authors report a case of indirect dural CCFs where the standard endovascular access via the transfemoral IPS route and transfacial SOV approach were not feasible, then the combination of surgical and endovascular intervention via the SOV became necessary. To our knowledge, a surgical approach through a SOV has not previously been published in Thailand.

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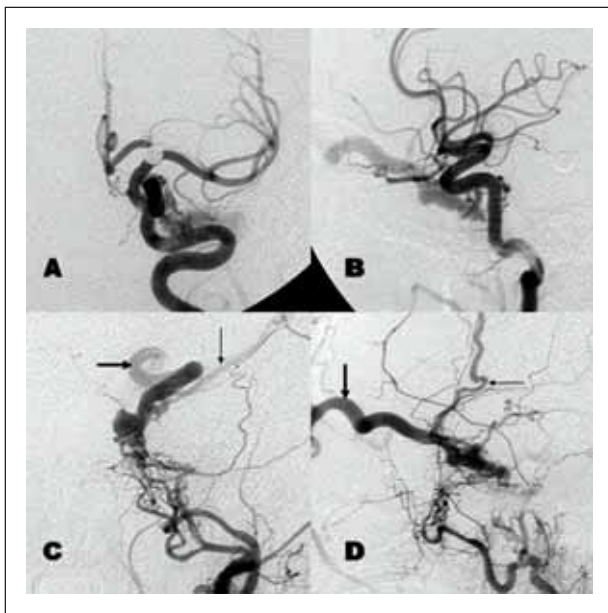


Fig 1. Initial angiogram shows indirect CCF, receiving arterial supplies from multiple meningeal branches of left internal carotid artery (A frontal and B lateral views) and left external carotid artery (C frontal and D lateral views), draining into left frontal cortical vein (small arrow) and left superior ophthalmic vein (large arrow).

CASE REPORT

Seven months before admission, a 50-year-old woman developed proptosis on the left side, left orbital bruit, and left conjunctival injection. The intraocular pressure of the affected eye rose to 28 mmHg. Initial cerebral angiography revealed a Barrow type D CCF on the left side fed by multiple meningeal branches of the left external carotid artery, and by the internal carotid artery on the same side (Fig 1). The CCF drained from the cavernous sinus into the left SOV and via a left frontal cortical vein into the superior sagittal sinus. Both inferior petrosal sinuses could not be detected on initial angiogram. We attempted to



Fig 2. Position of the guiding catheter after cannulating superior ophthalmic vein.

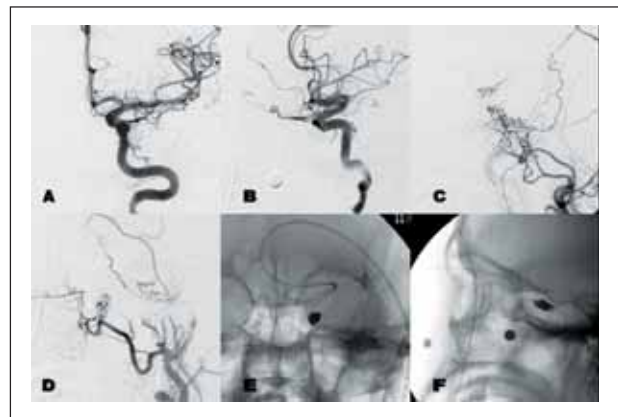


Fig 3. Postembolization internal (A frontal and B lateral views) and external (C frontal and D lateral views) carotid angiogram demonstrates complete obliteration of the fistulas. Note the absence of venous reflux via left SOV and left frontal cortical vein. E Frontal and F lateral views of scout films show position of the guiding catheter and coils in left cavernous sinus

gain access to the left cavernous sinus through a 0.038'' guidewire (Terumo Corporation Tokyo, Japan) penetration of a thrombosed inferior petrosal sinus. The first part of the transfemoral venous access led to a failed approach to the exact site of the fistula on the left cavernous sinus because we reached only the posterior compartment of the cavernous sinus but we were not able to reach the anterior compartment in which the CCF shunts was located. In this session, we decided to use an alternative approach via left facial vein and left angular vein. The second attempt also failed because the guiding catheter could not be placed far enough into the left external jugular vein due to difficult vascular anatomy of acute angles between the left subclavian vein and left external jugular vein which did not allow advancement of a microcatheter to the fistula site. Therefore the decision for the operative exposure of the SOV and retrograde catheterization of this vein was made in the following session.

The procedure was performed in the operating room under fluoroscopic guidance. An operating microscope was used. After induction of general anesthesia the incision site for access to the SOV was prepared. An incision in the skin of the superior sulcus of the upper nasal eyelid was made. The orbicularis oculi muscle was divided to identify the arterialized supratrochlear vein. The orbital septum was opened in the area of the supratrochlear vein, and orbital fat was exposed. Carefully reviewing the previous angiogram assisted in localizing the supratrochlear vein, which could then be followed to the SOV. Two 2-0 silk ligatures were passed underneath the SOV with a right-angle clamp and separated by approximately 10 mm. With the ligatures in place, the 18-gauge Terumo® intravenous needle (Terumo Corporation Tokyo, Japan) was used to cannulate the SOV. To use the 5-F Cobra catheter (Terumo Corporation Tokyo, Japan) as a guiding catheter, under fluoroscopic guidance, it was inserted through the SOV to the cavernous sinus and was held in place with the proximal ligature after changing (Fig 2).

The patient was then transferred to the angiographic suite. Fiber coils (Boston Scientific, Fremont, CA) were delivered to the cavernous sinus through a 2.5-F Fastracker microcatheter. Once the carotid-cavernous fistula was closed, the SOV was ligated both proximally and distally. Vicryl 4-0 sutures were used to reapproximate the orbicularis



Fig 4. One week after embolization, the symptoms of periorbital edema, ecchymosis and chemosis were gradually improved.

oculi muscle. Finally the skin incision was closed. The day of the operation the patient had puffy eye lids, increasing chemosis and periorbital ecchymosis. During the following week those symptoms gradually disappeared and the intraocular pressure normalized.

DISCUSSION

Both Borden classification⁶ and Cognard classification⁷ can be used to categorize dural arteriovenous fistulas into benign or aggressive based on the presence of cortical venous reflux. According to the study of van Dijk et al⁸, the persistence of cortical venous reflux yields an annual mortality rate of 10.4%. In addition, disregarding aggressive events at presentation, the annual risk of intracranial hemorrhage or nonhemorrhagic neurological deficit is 8.1% and 6.9%, respectively, adding up to a 15.0% annual event rate. These numbers mandate prompt diagnosis and treatment of these aggressive lesions.

The treatment of the benign type of dural CCFs begins with observation as the first step because of the high probability of spontaneous occlusion.⁹ For patients with diminished visual acuity, progressively increasing intraocular pressure, intracerebral hemorrhage, cranial nerve palsy and cortical venous drainage, urgent treatment is required. Endovascular intervention is now the first choice of therapy.² Different techniques of embolization have been established. Transarterial or transvenous routes can be used, depending on the vascular anatomy. Transvenous approaches have proved to be safer and often more effective than transarterial access.³ Venous drainage of dural cavernous carotid fistulas is usually to the ipsilateral cavernous sinus. Depending on the site of the fistulous connection, subsequent drainage may be anterior (either to the SOV or the inferior ophthalmic vein) or posterior (to the inferior petrosal sinus, pterygoid,



Fig 5. One month after embolization, only residual resolving ecchymosis at lower eyelid was left.

or clival plexus). If the drainage is anterior, to the orbital veins, some authors prefer using the transfemoral SOV approach via the facial vein,¹³ but catheterization to the fistulous site is not always feasible. When the drainage is to the inferior petrosal sinus, a transfemoral IPS embolization is the most successful option. In cases of difficulties due to the category of venous drainage other approaches have already been used.

There are reports on the transfemoral transcortical venous access to the cavernous sinus,¹² transfemoral SOV approach via the superficial temporal vein,¹⁴ direct puncture of the SOV,^{14,15} cannulation of a frontal vein¹⁶ or superficial temporal vein¹⁷ as well as the surgical exposure of the SOV and its retrograde catheterization.¹⁸ Despite the risk of the approach itself, the main complication associated with transvenous embolization is over-packing of the cavernous sinus resulting in cranial nerve palsies, dural dissections, or penetrations.¹¹

The management of CCFs by the surgical SOV approach combined with endovascular intervention is still a rare event and to our knowledge there is no report of this technique in Thailand. It has become clear that this procedure is very useful if standard embolization via the transfemoral artery or venous access are not feasible.

In this report, we describe the treatment of a type D CCFs, focusing on the combined microsurgical and endovascular treatment via a SOV approach. The potential surgical complications of the SOV approach are blepharoptosis, forehead dysesthesia,¹¹ hemorrhage from the surgical cutdown, the venous puncture, or rupture of the SOV; damage to the trochlea or other orbital structures, and infections.¹⁰ Therefore, the less risky transfemoral transvenous approach was preferred initially.

Our patient presented with typical symptoms of CCFs. She suffered from proptosis, chemosis, and secondary glaucoma. Diagnosis was made with cerebral angiography. The fistulas were of spontaneous origin and defined as dural shunts due to the supply of the cavernous sinus by dural branches of the ICA and ECA. The CCFs revealed a type D category referring to Barrow et al.¹ In the presented patient, we tried to start with the conventional method of the transfemoral venous coil embolization, but we were unable to get a proper position of the guiding catheter. The combined surgical exposure and retrograde catheterization of the SOV was then indicated. We used the operative technique as described above to get through the SOV with a skin incision in the superior sulcus of the nasal upper eyelid. Successful procedures resulted in complete elimination of CCFs. The clinical symptoms resolved slowly and were absent after 1 month follow up. In addition, the cosmetic results were exceptional with no visible scar. We did not experience major complications other than acute proptosis and periorbital ecchymosis, which gradually resolved. Although there is a potential risk of vision loss -- neovascular glaucoma^{19,20}, the surgical SOV approach is a direct and efficient way to access and occlude the cavernous sinus. If the SOV is not dilated or if it is located deep in the orbit, transorbital venous access may not be possible.

CONCLUSION

Most indirect carotid-cavernous fistulas can be treated either through the transarterial or transvenous route. When the standard endovascular routes for access to the fistulas cannot be used, direct cannulation of the SOV is an option. We find that retrograde catheterization of an enlarged

SOV is a safe, direct, and efficient way to access the cavernous sinus, allowing endovascular coil occlusion of dural cavernous sinus fistulas with excellent angiographic and clinical results. Collaboration between neurosurgeons and endovascular interventionists optimizes a patient's outcome.

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