Triple Coaxial Catheter Technique for Transfacial Superior Ophthalmic Vein Approach for Embolization of Dural Carotid-Cavernous Fistula*

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Key words: carotid-cavernous fistula, transvenous embolization, coaxial catheter

Summary

We report a triple coaxial catheter technique to facilitate the venous access to the superior ophthalmic vein during transvenous embolization of dural carotid-cavernous fistula (DCCF) via the transfacial venous route. Two patients with transvenous embolization of DCCFs by coils were treated with transfacial superior ophthalmic vein (SOV) approach by the triple coaxial catheter technique. The triple coaxial catheter system consisted of a 6F guiding catheter as the outer catheter and a 4F guiding catheter as the middle catheter and a microcatheter as the inner catheter to help navigation and manipulation.

The DCCFs were completely obliterated in both cases. There were no complications associated with the procedure. The ophthalmic symptoms of the patients had totally resolved at two-month follow-up.

The triple coaxial catheter technique can be used with the transfacial SOV approach in embolization of DCCF. This technique has two advantages over the double coaxial catheter technique because it offers additional length and support for the distal navigation of microcatheter into the SOV.

Introduction

Endovascular treatment is currently the treatment of choice for dural carotid-cavernous fistula (DCCF). Both transvenous¹⁻³ & transarterial^{4,5} approaches have been reported.

The transvenous approach is preferred due to higher clinical and anatomical cure rate⁵⁻¹⁰. There are various transvenous routes in embolization of DCCF¹¹.

Among the transvenous approaches, the inferior petrosal sinus (IPS) route is the shortest and most direct.

This approach may not be feasible when the IPS is obliterated.

The transfacial superior ophthalmic vein (SOV) approach is another alternative, but the navigation path is longer.

A double coaxial catheter technique is commonly used.

But this technique encounters certain technical difficulties such as inadequate length of the catheters and lack of support at the distal end during catheter manipulation.

We describe two cases of DCCF with the use of the triple coaxial catheter technique to tackle the above technical problems.

* The study was presented at Proceedings of the 8th Meeting of the Asian – Austrian Federation of Interventional and Therapeutic Neuroradiology (AAFITN 2008).

Figure 1 Patient 1. A) Right common carotid angiogram, anteroposterior (AP) view showing a right DCCF (arrow) with venous drainage through the right SOV and blockage of the right IPS. B) Non subtracted films, AP view, showing the 6F Modified Cerebral catheter (single arrow) placed through the right EJV with the 4F Vertebral catheter (double arrows) and the Excelsior SL 1018 microcatheter (arrow head). C) Post-embolization right common carotid angiogram, AP view, showing complete obliteration of the DCCF with coils (arrow).

Method and Illustrative Cases

From 1997 to 2007, 113 patients with DCCFs were treated with transvenous embolization with coils. The transvenous approaches were performed in all patients by femoral vein access. Of these, 14 patients were treated with transfacial SOV approach. Among those treated with transfacial SOV approach, 12 patients were treated with traditional double coaxial catheter technique. A 5F guiding catheter was placed in the internal or external jugular vein and a microcatheter with microguidewire system was then

used to catheterize the medial or lateral facial venous system into the SOV. Of the remaining two patients treated with transfacial SOV approach, we used a triple coaxial catheter technique to overcome the technical difficulties encountered in traditional double catheter technique. The triple coaxial catheter system consisted of a 6F guiding catheter as the outer catheter and a 4F guiding catheter as the middle catheter and a microcatheter as the inner catheter. The disadvantages of the traditional double coaxial catheter system were that the guiding catheter may not provide enough length for catheterizing

Figure 2 Patient 2. A) Left common carotid angiogram, AP view, showing a left DCCF (arrow) with venous drainage through the left SOV and blockage of the left IPS. B) Non subtracted films, AP view, showing the 6F Modified Cerebral catheter (arrow), the 4F Vertebral catheter (double arrows) and the Excelsior SL 1018 microcatheter (arrow head). C) Post-embolization left common carotid angiogram, AP view, showing complete obliteration of the DCCF with coils (arrow).

the SOV and it may not provide enough support to the microcatheter such that distal navigation via the facial venous system into the SOV may be difficult. The triple coaxial catheter system solved these problems because the middle 4F guiding catheter helped to track the 6F guiding catheter into the facial vein and the 4F middle catheter could be passed to the orbital rim to provide good support to the microcatheter. It also provides extra length for navigation due to two reasons, namely adding the length of the extra middle 4F guiding catheter and better straightening of vessels within the system.

Patient 1

A 64-year-old man presented with chemosis with ptosis of his right eye. Visual acuity (VA) of his right eye was 20/70. Magnetic resonance angiogram suggested the presence of an indirect DCCF. Digital subtraction angiogram (DSA) showed a right DCCF with venous drainage through right SOV. The right IPS was blocked (Figure 1A).

The right femoral vein was cannulated with Seldinger technique. A 6F guiding catheter was positioned in the internal jugular vein

(IJV). Both the right and left IPS approach were attempted but failed.

The right external jugular vein (EJV) with transfacial SOV approach was adopted. The usual double coaxial catheter technique was attempted but failed due to the long tortuous course. The triple coaxial catheter technique was introduced. A 4F Vertebral catheter was inserted into the proximal part of the right facial vein through a coaxial 6F modified cerebral catheter positioned in the right EJV of the patient. An Excelsior SL 1018 microcatheter was used over Transend-14 floppy microguidewire and Terumo GT-12 microguidewire to catheterize right SOV through his right facial vein (Figure 1B).

The right cavernous sinus and the outflow tract of SOV were packed with Guglielmi detachable coils. The post-coiling angiogram showed complete occlusion of the right DCCF (Figure 1C).

Patient 2

A 40-year-old man presented with chemosis and blurring of vision of his left eye for two months. His left eye VA was 20/100. CT scan showed features suggestive of a left DCCF. DSA showed the left DCCF with venous drainage to the left SOV. The left IPS was blocked in this patient (Figure 2A). The standard IPS approach was impossible in this case. A standard double coaxial approach was attempted but the procedure failed due to insufficient length of the catheters. The triple coaxial catheter technique was used.

A 4F vertebral catheter was inserted into his left facial vein through a coaxial 6F guiding catheter positioned in his left IJV. With the aid of 0.035" Terumo guidewire, the coaxial system was navigated up to the angular vein. An Excelsior SL 1018 microcatheter was used over Transend-14 floppy microguidewire to selectively catheterize the left SOV and the left cavernous sinus via the left angular vein (Figure 2B). The left cavernous sinus was packed with nine Guglielmi detachable coils. The post coiling angiogram showed complete occlusion of left DCCF (Figure 2C).

Results

The DCCFs in both patients were successfully obliterated. Their ophthalmic symptoms were totally resolved during their follow-up at

two months post treatment. There were no recurrences in either patient after follow-up for two years.

Discussion

Patients with DCCF usually present with ophthalmic symptoms including chemosis, proptosis, diplopia and visual impairment. Occasionally patients present with cerebral dysfunction. Possible physical signs include eye bruit, pulsatile exophthalmos, cranial nerve palsy, impaired visual acuity and other neurological signs^{12,13}.

In the old days, DCCF was treated with open surgery¹⁴. Some also report the use of radiosurgery for the treatment of DCCF¹⁵. With the advancement of endovascular treatment, endovascular embolization has become the treatment of choice. Both transarterial^{4,5} and transvenous¹⁻³ approaches have been adopted. The transvenous approach has been shown by several studies to have a better clinical outcome and anatomical cure rate⁵⁻¹⁰. Among the transvenous approaches, IPS and facial vein through SOV² are the two most widely described routes of choice. Both approaches commonly employ the traditional double coaxial catheter technique to achieve a cure.

The IPS was blocked in both of our cases. The IPS approach was thus not successful in either case. The transfacial route was chosen in both cases. The transfacial approach is a safe and effective approach^{16,17}. Facial vein normally drains into the IJV but there are normal variants which drain into the EJV. Post-mortem Gupta et al.¹⁸ found 9% of normal Indo-Asians had their facial vein draining into the EJV. This is important when using transfacial route for embolization of DCCF.

However, using the transfacial route may raise two problems which lead to failure of embolization. The transfacial route involves passage of catheter through the IJV or EJV in some patients, then the facial vein and SOV to reach the DCCF. This route varies in different patients and it can be so long and tortuous that the traditional double coaxial catheter system is not long enough to reach the SOV. Even if it is long enough to reach the SOV, the distal end of the catheter may be difficult to manipulate due to lack of support at the distal end. These problems were encountered in both of our patients. Introduction of the triple coaxial catheter

ter technique can solve the above two problems. It provides extra length to overcome the long tortuous pathway and better support to the distal end of microcatheter as the 4F guiding catheter in the middle can provide additional length, better straightening of the vessels and better support to distal end of microcatheter. This technique makes manipulation of the distal end of microcatheter easier, thus increasing the successful rate of embolization.

Conclusion

The triple coaxial catheter technique can provide interventionists with advantages in tackling difficult cases of DCCF over the traditional double coaxial catheter technique via the transfacial approach.

This technique also has its potential to be applied in endovascular treatment of other neuroendovascular diseases.

References

- 1 Agid R, Willinsky RA, Haw C, et al. Targeted endovascular coiling of cavernous dural arteriovenous fistulas using transfemoral medial and lateral facial vein approaches. *Neuroradiology*. 2004; 46 (2): 156-160.
- 2 Baldauf J, Spuler A, Hoch HH, et al. Embolization of indirect carotid-cavernous sinus fistulas using the superior ophthalmic vein approach. *Acta Neurol Scand*. 2004; 110 (3): 200-204.
- 3 He HW, Jiang CH, Wu ZX, et al. Transvenous embolization of cavernous dural arteriovenous fistula: report of 28 cases. *Chin Med J*. 2007; 120 (24): 2229-2232.
- 4 Culafić S, Juszkat R, Rusović S, et al. Endovascular treatment of carotid-cavernous fistula type A with platinum coils. *Vojnosanit Pregl*. 2008; 65 (12): 923-926.
- 5 Won KY, Young WK, Seong RK, et al. Transarterial coil embolization of a carotid - cavernous fistula which occurred during stent angioplasty. *Acta Neurochir*. 2009; 151: 849-854.
- 6 Cheng KM, Chan CM, Cheung YL, et al. Transvenous embolisation of spontaneous carotid-cavernous fistulas by sequential occlusion of the cavernous sinus. *Interventional Neuroradiology* 1999; 5: 225-234.
- 7 Gemmete JJ, Ansari SA, Gandhi DM. Endovascular technique for treatment of carotid-cavernous fistula. *J Neuro-Ophthalmol*. 2009; 29 (1): 62-71.
- 8 Miller NR, Monsein LH, Debrun GM, et al. Treatment of carotid-cavernous sinus fistulas using a superior ophthalmic vein approach. *J Neurosurg*. 1995; 83: 838-842.
- 9 Quinones D, Duckwiler G, Gobin PY, et al. Embolization of dural cavernous fistulas via superior ophthalmic approach. *Am J Neuroradiol*. 1997; 18: 921-928.
- 10 Yamashita K, Taki W, Nishi S, et al. Transvenous embolization of dural carotidocavernous fistulae: technical considerations. *Neuroradiology*. 1993; 35: 475-479.
- 11 Cheng KM, Chan CM, Cheung YL. Transvenous embolisation of dural carotid-cavernous fistulas by multiple venous routes: a series of 27 cases. *Acta Neurochir*. 2003; 145: 17-29.
- 12 Cheng KM. Neuro-endovascular therapy of carotid-cavernous fistula. *Hong Kong Med Diary*. 2006; 11 (12): 13-14.
- 13 Shownkeen H, Bova D, Origitano TC, et al. Carotid-cavernous fistulas: pathogenesis and routes of approach to endovascular treatment. *Skull Base*. 2001; 11 (3): 207-218.
- 14 Dolenc VV, Lipovsek M, Slokan S. Traumatic aneurysm and carotid-cavernous fistula following transsphenoidal approach to a pituitary adenoma: treatment by transcranial operation. *Br J Neurosurg*. 1999; 13 (2): 185-188.
- 15 Pollock BE, Nichols DA, Garrity JA, et al. Stereotactic radiosurgery and particulate embolisation for cavernous sinus dural arteriovenous fistulae. *Neurosurgery*. 1999; 45:459-467.
- 16 Cheng KM, Yu SCH, Wong GKC, et al. Transvenous embolization of dural carotid-cavernous fistulas with transfacial catheterization through the superior ophthalmic vein. 8th Congress of World Federation of Interventional and Therapeutic Neuroradiology, Venice, Italy, 19th - 22th October 2005.
- 17 Yu SCH, Cheng KM, Wong GKC, et al. Transvenous embolization of dural carotid-cavernous fistula with trans-facial catheterization through the superior ophthalmic vein. *Neurosurgery*. 2007; 60(6): 1032-1037.
- 18 Gupta V, Tuli A, Choudhry R, et al. Facial vein draining into external jugular vein in humans: its variations, phylogenetic retention and clinical relevance. *Surg Radiol Anat*. 2003; 25: 36-41.

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