Endovascular Treatment of a High-Flow Direct Traumatic Carotid Cavernous Fistula with a Two Year Follow-up

C. FANG

6th People Hospital, Jiao Tong University, Shanghai, China

Key words: complex carotid cavernous fistula, embolization, covered stent

Summary

Endovascular treatment of high-flow direct traumatic carotid cavernous fistula (CCF) carries many difficulties. One of them is that carotid dissection may be associated with pseudo-aneurysm formation even when the CCF can be successfully embolized by detachable balloons. This article details a unique technique of treating pseudo-aneurysm by obstructing the lumen with preservation of the parent artery.

The case presented here involves a 50-year-old man with a history of severe trauma. The angiography revealed that his bilateral high-flow carotid cavernous fistula was successfully embolized by detachable balloons and control digital subtraction angiography at the end of the procedure demonstrated the fistula closed and the internal carotid artery preserved. But two months later, a pseudo-aneurysm formed in the right internal carotid artery. Under endovascular treatment along with other techniques including coils, stent-assisted and covered stent, the pseudo-aneurysm was excluded with preserved ICA. Two years later, the fistula and pseudo-aneurysm both disappeared quietly without patent foreign body reaction in the parent arterial wall.

Introduction

Traumatic carotid cavernous fistula (CCF) is a direct arteriovenous shunt caused by trauma. Normally the intracavernous carotid artery and its branches will be torn, resulting in a failed

communication between the intracavernous carotid artery and the cavernous sinus. The clinical symptoms are closely related to the high pressure inside the cavernous sinus and the altered direction of the venous drainage. The therapeutic goal is to occlude the fistula, commonly using detachable balloons¹. However, some complicated traumatic carotid-cavernous fistulae with high flow and wide neck cases may require other embolic agents or a combined technique, such as coil and stent assisted embolization, etc.²⁻⁵.

Case Report

This 50-year-old man, with a history of trauma to the skull base, had clinical signs of pulsatile proptosis, chemosis, intracranial bruit, and decreased visual acuity. Digital subtraction angiography (DSA) confirmed a direct high flow CCF in the right and left cavernous sinus, filling from the cavernous part of the bilateral internal carotid artery (ICA). There was little opacification of the supraclinoid parts of the bilateral ICA and intracranial branches because all the blood was diverted to the cavernous sinus into the enlarged superior ophthalmic vein, the inferior petrosal sinus and jugular vein (Figure 1A,B).

Endovascular therapy

First therapy

After puncture of the right femoral artery, a diagnostic catheter was navigated into the right

and left ICA and angiography in standard projection was performed. The origin of the fistula was difficult to display despite multiple projection angiograms.

Through 8F Envoy guiding catheter, seven #3 detachable balloons (BALT) were floated through the right cervical ICA dissection and into the fistula site. Repeated attempts with balloon deflation and inflation were made to achieve a satisfactorily stable position for the balloon within the fistula. By the same procedure, two #3 detachable balloons were floated through the left cervical ICA dissection and into the fistula site. A control ICA injection after the procedure demonstrated complete obliteration of the bilateral fistula with the internal carotid artery preserved (Figure 1C,D). The

clinical symptoms improved and intracranial bruit disappeared.

Two-month follow-up

Internal carotid artery angiography was performed to show that the left and right cavernous sinus fistula had disappeared, but a pseudo-aneurysm had formed in the right CS (Figure 1E,F). So we performed second procedure for the pseudo-aneurysm.

Through a 6F guiding catheter, a micro-catheter was inserted into the lumen of pseudo-aneurysm, and coil embolization (GDC, Boston scientific/Target) was performed in the aneurysm lumen. To protect the ICA and to facilitate coil placement within the pseudo-aneurysm lumen, a stent (Neuroform, Boston scientific)

Figure 1 A,B) Right carotid artery angiography showing a direct high flow CCF in the right cavernous sinus, little opacification of the supraclinoid parts of the right ICA and intracranial branches, the blood was diverted to the cavernous sinus into the enlarged superior ophthalmic vein, the inferior petrosal sinus and jugular vein. C,D) After multi-balloon embolization in the sinus, right carotid artery angiography shows complete obliteration of the fistula with the internal carotid artery preserved. E,F) two month follow-up: the internal carotid artery angiography show the right cavernous sinus fistula has disappeared, but a pseudo-aneurysm has formed. G,H) A stent (Neuroform, Boston scientific) was planted into the parent artery (cervical ICA dissection) to assist coil embolization in the lumen. G) Postembolization angiogram showed the right pseudo-aneurysm was almost complete occluded with minimal residual filling of the lumen (H). I,J) 12 month follow-up: the internal carotid artery angiogram shows the right pseudo-aneurysm reopened with migration of the coil embolization. The stented parent artery shows good flow. A 0.014-inch microwire was advanced across the injured segment of the ICA stent. K) Over the microwire, a covered stent (4x10 mm) was advanced and deployed across the site of the pseudo-aneurysm. The angiogram shows the right pseudo-aneurysm was completely excluded with preserved ICA. L) two year follow-up: angiography shows complete occlusion of the fistula and pseudo-aneurysm of the right cavernous sinus with filling of both intracranial branches and expedite bloodstream of the focus segment of the right ICA with smooth blood vessel.

was planted in the parent artery (cervical ICA dissection).

Post-embolization angiogram showed the right pseudoaneurysm was almost completely occluded with minimal residual filling of the lumen (Figure 1G,H). The patient has been main-

tained on aspirin (100 mg/d) and clopidogrel (75 mg/d) since the stent procedure.

12-month follow-up

The internal carotid artery angiogram showed the right pseudo-aneurysm had re-

opened with the coil embolization compressed and displaced from cervix to lumen and patent ICA stent with good flow (Figure 1I).

The right oculomotor palsy progressed. We decided to do a third procedure. To protect the parent ICA and decrease the pressure of the cavernous sinus, we determined to plant a covered stent (Shanghai, MicroPort).

A 6F guiding catheter was inserted into the right internal carotid artery, and a 0.014-inch microwire was advanced across the injured segment of ICA where a Neuroform stent had been planted.

Then over the microwire, a covered stent (4x10 mm) was advanced and deployed across the site of the pseudoaneurysm (Figure 1J), using nominal pressures (6 atm) for deployment. After this procedure, the angiogram showed the right pseudo-aneurysm was completely excluded with preserved ICA (Figure 1K).

The patient has been maintained on aspirin (100 mg/d) and clopidogrel (75 mg/d) continuously.

Two-year follow-up

One year after the last endovascular treatment, the patient was admitted for clinical and angiographic follow-up examination. The clinical results of the therapy were good: clinical symptoms and signs had regressed. Control DSA was performed to check the results of the treatment. Angiography showed a completely occluded fistula, and a pseudo-aneurysm of the bilateral cavernous sinus with filling of both intracranial branches of the left and right ICA (Figure 1L). The expedite bloodstream of focus segment of the right ICA with blood vessel was smooth.

Discussion

According to Parkinson's classification, TCCFs are divided into Type I and Type II. Type I is a single tear in the intracavernous carotid artery itself forming a high flow arteriovenous fistula.

Type II is formed by the broken branches of the intracavernous carotid artery. Some dual branches of the ipsilateral external carotid artery and the contralateral internal carotid artery usually join the blood supply of the fistula via arterial anastomoses.

Detachable balloons are still commonly used in the treatment of TCCF. But with the avail-

ability of other devices, recently some doctors used detachable coils to occlude the carotid cavernous fistula with stent or balloon assisted embolization, aiming to protect the ICA. According to some series reports, a need for parent artery occlusions has been up to 20% of Type I carotid cavernous fistulas³⁻⁶. Especially in a high flow fistula, balloon occlusion is a more technically demanding procedure, requiring a lot of experience in performing navigation of the catheter with a detachable balloon into the CS (angiography cannot clearly show the fistula.) A systematic progression can be achieved by repeated inflation and deflation of the balloon. But the disadvantage of the method is the displacement or deflation of the balloon inside the CS with subsequent reopening of the fistula or pseudoaneurysm formation⁶⁻⁸.

In the case mentioned above, the fistula was closed by multiballoon embolization, but owing to the right fistula with high flow and wide neck, the balloons deflated one or two months following the procedure, and angiography showed pseudo-aneurysm formation.

With dense coil packing in the cavernous sinus, the possibility of a pseudo-aneurysm of the carotid artery with the coil technique should be low. But there may be a disadvantage of the migration of the coils to unwanted sites with the lumen reopened.

In the case above, ten months after coil embolization the pseudo-aneurysm reopened due to the migration of the coils. So it is difficult to fill a pseudo-aneurysm with no aneurysm wall. Additionally, other disadvantages of the technique are the comparatively higher cost of materials associated with the use of numerous coils in the site, and increased weight of materials in the surrounding sinus, causing corresponding symptoms by pressing on nerves or structure^{8,9}. Due to the consideration of these disadvantages, we did not use coil embolization for the reopened pseudo-aneurysm during the third procedure.

The favorable outcomes could be achieved by the use of a stent deployed across the pseudo-aneurysm neck or CCF in the parent artery for reconstructive endovascular treatment of pseudo-aneurysm and high flow CCF in combination with intralumen filler coils. However, there are several disadvantages in this method. In case mentioned above, we presented an advanced reconstructive technique: the covered

stent was deployed in the parent artery to exclude the aneurysms from the circulation. I believe that this technique offers not only a much more definitive reconstructive treatment than the endovascular treatment of stent assisted coil embolization, but also a solution to the tissue of mass effect of the materials in the lumen¹⁰.

There is a positive outcome in this case and no patent foreign body reaction occurred in the vascular wall after the covered stent had been planted for 12 months.

Conclusions

It is difficult to treat high flow direct traumatic CCF with detachable balloons, due to its easy reopening or pseudo-aneurysm formation. Dealing with those difficulties, the technique of stent assisted or covered stent coil embolization would be a very effective alternative treatment. However, with my limited experience in using a covered stent for pseudoaneurysm, more research on this type of technique is needed to certify the feasibility.

References

- 1 Phadke RV, Kumar S et Al: Traumatic carotid cavernous fistula: anatomical variations and their treatment by detachable balloons. *Australas Radiol* 42: 1-5, 1998.
- 2 Moron FE, Richard P et Al: Endovascular treatment of high-flow carotid cavernous fistulas by stent-assisted coil placement. *Am J Neuroradiol* 26: 1399-1404, 2005.
- 3 Lee CY, Yim MB et Al: Traumatic aneurysm of the supraclinoid internal carotid artery and an associated carotid-cavernous fistula: vascular reconstruction performed using intravascular implantation of stents and coils-case report. *J Neurosurg* 100: 115-119, 2004.
- 4 Redekop G, Marotta T, Weill A: Treatment of traumatic aneurysms and arteriovenous fistulas of the skull base by using endovascular stents. *J Neurosurg* 95: 412-419, 2001.
- 5 Jansen O, Dorfler A et Al: Endovascular therapy of arteriovenous fistulae with electrolytically detachable coils. *Neuroradiology* 41: 951-957, 1999.
- 6 Ruth L, Peter H et Al: Endoluminal stent placement and coil embolization for the management of carotid artery pseudoaneurysms. *J Endovasc Ther* 8: 53-61, 2001.
- 7 Phatouros CC, Sasaki TY et Al: Stent-supported coil embolization: the treatment of fusiform and wide-neck aneurysms and pseudoaneurysms. *Neurosurgery* 47: 107-113, 2000.
- 8 Coldwell DM, Novak Z et Al: Treatment of posttraumatic internal carotid arterial pseudoaneurysm with endovascular stents. *J Trauma* 48: 470-472, 2000.
- 9 Saito R, Ezura M et Al: Combined neuroendovascular stenting and coil embolization for cervical carotid artery dissection causing symptomatic mass effect. *Surg Neurol* 53: 318-322, 2005.
- 10 Ssil Saatci, Saruhan Cekirge et Al: Treatment of internal carotid artery aneurysms with a covered stent: experience in 24 patients with mid-term follow up results. *Am J Neuroradiol* 25: 1742-1749, 2004.

Chun Fang, M.D.
Radiology Dept.
6th People Hospital
600, Yi Shan Road
Shanghai, 200233, China