Endovascular Treatment of Direct Carotid-Cavernous Fistulas Using Detachable Coils

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Key words: direct carotid-cavernous fistula, detachable coil, endovascular therapy

Summary

Five direct carotid-cavernous fistulas (direct CCFs) in four patients were treated by an endovascular technique using detachable coils. The embolizations were performed according to one of two strategies. 1) By embolizing the fistula, that is the compartment of the cavernous sinus adjacent to the fistula orifice, after embolization of the draining veins. 2) By embolizing the fistula only. The former strategy was used to treat first two cases and the latter to treat other three cases. In two of the cases in which only the fistula was embolized, a microcatheter was placed in the draining vein via a transvenous route beforehand, in the event that the embolization resulted in an incomplete closure and the draining veins became inaccessible. In four cases, a complete cure was achieved with preservation of the internal carotid artery and in one case, the internal carotid artery containing the fistula was occluded. The embolization of direct CCFs with detachable coils, which are suitable for both transarterial and transvenous approaches, has several advantages over balloon embolization. We believe this procedure will become an alternative treatment.

Introduction

To treat direct CCFs most effectively, the fistula needs to be obliterated while preserving the internal carotid artery (ICA). Direct CCFs are usually treated with detachable balloons by

a transarterial route, but the preservation of the ICA has been successful in only 60-88% of cases¹⁻³. Recently-developed detachable and retrievable coils offer several advantages over detachable balloons for the treatment of direct CCF^{2,4-8}. They are available for both a transarterial and a transvenous approach, easy to introduce into the fistula and fit the complicated structure of the cavernous sinus (CS). The methods and the efficacy of embolization with detachable coils will be discussed in this paper.

Material and Methods

Five fistulas in four patients, traumatic in three and idiopathic in two, were treated by an endovascular technique using either interlocking detachable coils (IDCs) or Guglielmi detachable coils (GDCs, Boston scientific Co.). The embolization was performed according to one of two strategies. 1) By embolizing the fistula, that is the compartment of the CS adjacent to the fistula orifice, after embolization of the draining veins such as the superior ophthalmic vein (SOV) or sylvian vein (SV). 2) By embolizing the fistula only via a transarterial route. First two cases were treated using the former strategy and other three cases using the latter. In two of the three cases treated according to the latter strategy, a microcatheter was placed in the draining vein via a transvenous route beforehand, because we were afraid that the embolization resulted in an incomplete

Figure 1 Case 2. A, B) Left internal carotid angiogram, anteroposterior and lateral views, showing the direct CCF draining into the left SV and IPS, and the right SOV and SV via the intercavernous sinus. C, D) A microcatheter was introduced into the intercavernous sinus via the left IPS, and another catheter was advanced into the left SV through the fistula in the C4 portion of the ICA. The intercavernous sinus and the left SV were embolized, respectively. E) Left internal carotid angiogram after embolization of the compartment of the CS close to the fistula, lateral view, showing the faint residual shunt draining into the IPS. F) A plain film of the skull indicates the coils placed in the intercavernous sinus, the left SV and the fistula.

closure and the draining veins became inaccessible. In one patient, the fistula was embolized by the transarterial approach only.

Results

The five fistulas in four patients are summarized in the table. In four cases, a complete cure was achieved with preservation of the ICA. In one case, the ICA containing the fistula was occluded because of the cervical ICA occlusion due to dissection of the wall by the guiding catheter. No neurological deficits were associated with the procedures and all patients experienced a full recovery.

Representative case

Case 2 (figure 1)

A 57-year-old woman was involved in a traffic accident, which resulted in contusion of the right temporal lobe. She developed left oculo-

motor palsy two weeks later, left abducent palsy three months later, and right exophthalmos and chemosis four months later. A left internal carotid angiogram revealed a direct CCF draining into the left SV and inferior petrosal sinus (IPS), and into the right SOV and SV via the intercavernous sinus. Transarterial and transvenous embolizations were performed.

A microcatheter was introduced into the intercavernous sinus via the left IPS, and the other microcatheter was advanced into the left SV through the fistula in the C4 portion of the ICA.

The intercavernous sinus was then occluded with IDCs and the drainage into the contralateral SOV and SV disappeared. Next, the left SV was occluded, and finally the compartment of the CS close to the fistula was embolized. The faint shunt flow draining into the IPS remained, but a follow-up angiogram performed one month later revealed a complete obliteration of the fistula.

Figure 2 Case 3 (this case is the same patient as a case 1). This patient was treated for a left direct CCF 32 months previously. A) Right internal carotid angiogram, lateral view, showing the right direct CCF draining into the right SOV, IOV, SPS and bilateral IPS. B) A microcatheter was advanced into the junction of the SOV and IOV by a transvenous route. C) Another catheter was introduced into the CS through the fistula by a transarterial route and only the fistula was embolized using GDCs. D, E) Right internal carotid angiogram after embolization, lateral and anteroposterior views, showing a complete closure of the fistula. Note that the right CCF was occluded using fewer coils than the left CCF, in which both the draining veins and the fistula were embolized.

Table Summary of the cases

case	age, sex	cause of fistula	site of fistula	draining veins	approach	site of embolization	preservation of ICA	angiographic result
1	21, M	unknown	left C5	left SOV	transarterial	drainer&fistula	(+)	complete occlusion
2	57, F	trauma	left C4	left SV, IPS right SOV	transarterial &transvenous	drainer&fistula	(+)	incomplete → complete occlusion
3	23, M	unknown	right C5	right SOV, IOV, SPS left IPS	transarterial &transvenous	fistula	(+)	complete occlusion
4	25, M	trauma	right C4-5	right SOV, SV, IPS	transarterial &transvenous	ICA containing fistula	(-)	complete occlusion
5	13, M	trauma	left C3	left SOV, SV, IPS right IPS	transarterial	fistula	(+)	complete occlusion

SOV = superior ophthalmic vein; IOV = inferior ophthalmic vein; SV = sylvian vein; IPS = inferior petrosal sinus; SPS = superior petrosal sinus; ICA = internal carotid artery. Case 3 is the same patient as case 1

*Case 3 (figure 2):
this is the same patient as in case 1*

A 21-year-old man with a 19-month history of left exophthalmos and chemosis was admitted to our institute. A left internal carotid angiogram revealed a direct CCF with drainage into the dilated SOV. After embolization of the SOV and inferior ophthalmic vein (IOV), the fistula was occluded using IDCs by a transarterial approach. The fistula was obliterated and the patient experienced a full recovery.

Thirty-two months later, however, he came back with exophthalmos and chemosis of the right eye. A right internal carotid angiogram revealed a direct CCF draining into the right SOV, IOV, superior petrosal sinus and bilateral IPS. A microcatheter was introduced into the CS through the fistula by a transarterial route and the other was advanced into the junction of the SOV and IOV by a transvenous route. The fistula was embolized using GDCs without embolization of the draining veins, and a complete cure was achieved.

Discussion

Transarterial embolization with detachable balloons is currently considered to be the treatment of choice for direct CCF^{1,3}. However, this procedure has limitations: for example, if the fistula is too small, it may be difficult to advance the balloon, while if it is large the balloon may extrude or migrate to the ICA resulting in stenosis or occlusion of the parent artery. Moreover, if the initial balloon embolization fails, the navigation of an additional balloon is difficult and the balloon can compress the surrounding structures causing cranial nerve palsy.

In 1991, Halbach et al² reported treating cases of direct CCFs with platinum coils by a transarterial route. However, there was a risk of the coil protruding or migrating to the ICA because the coils used were not retrievable. In 1992, Guglielmi et al⁷ reported a case of direct CCF caused by a ruptured intracavernous aneurysm successfully treated with electrically detachable coils which were retrievable and this procedure was followed by others^{4,8}.

Since April 1996, we have been using IDCs and GDCs for the embolizations of direct CCFs according to two strategies; one is to on-

ly embolize the fistula and the other is to embolize the fistula after embolization of the draining veins. The advantage of the former is that it does not alter the pattern of drainage and it requires fewer coils to close the fistula. However, the compartment of the CS adjacent to the fistula can be difficult to identify in case with a high flow shunt or with a markedly dilated CS. In case of the embolization using coils, unlike using balloons, it is not clear until the end of the procedure whether a complete occlusion is achieved. Also, if the transarterial embolization of the fistula results in an incomplete occlusion, the approach to the draining veins becomes difficult due to the presence of coils and the drainages can remain open. Some authors^{4,8} reported that a progression of thrombosis led to a complete occlusion as observed by a follow-up angiogram in case with a slight residual flow at the end of the procedure. However, this cannot be expected in all cases.

Therefore, in our first 2 cases, the draining veins responsible for the symptoms such as the SOV or SV were occluded before the embolization of the fistula. The advantage of this strategy is that the draining veins will be certainly interrupted and the fistula becomes easy to identify and obliterate due to the retention of flow. However, this has a risk of promoting extensive venous thrombosis or causing a hemodynamic change in the drainage pattern, which may result in the deterioration of ocular symptoms or intracranial hemorrhage⁸. Accordingly, we devised a new method of embolization which overcome these disadvantages.

A microcatheter was introduced into the CS close to the fistula via a transarterial route and the other microcatheter was advanced into the draining vein via a transvenous route. If a shunt remains patent after the embolization of the fistula, the draining vein can be occluded using this catheter.

This method is useful in achieving a complete occlusion of the fistula without interruption of the draining pathways.

Conclusions

The embolizations of direct CCFs with detachable coils, which are suitable for both transarterial and transvenous approaches, will become an alternative treatment.

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