Mechanically Detachable Coil Embolization of a Traumatic Carotid-Cavernous Fistula — Case Report —

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ABSTRACT. A 33-year-old man presented with a traumatic carotid-cavernous fistula (CCF) successfully treated with mechanically detachable coils (MDC's). The fistula was treated with 14 MDC's via an endovascular transarterial approach and with 5 MDC's via an endovascular transvenous approach. The CCF completely disappeared, and the patient has recovered. The advantages of using MDC's include retrievability and reduction of working hours because of the mechanically detachable system.

Key words: endovascular therapy — mechanically detachable coil — traumatic carotid-cavernous fistula

Traumatic carotid-cavernous fistula is generally treated with detachable balloons, but that method has not been successful in all cases. We report the first case of successful treatment of a traumatic carotid-cavernous fistula with mechanically detachable platinum coils, and discuss the advantages of these coils.

CASE

A 33-year-old man developed a large left carotid-cavernous fistula (CCF) following a motor vehicle accident. One month later, he was admitted to our hospital because of left-sided conjunctival injection, mild exophthalmos, blepharoptosis, incomplete external ophthalmoplegia and pulsatile tinnitus.

Selective left internal carotid angiography demonstrated a direct CCF of the C5 segment of the internal carotid artery (Fig 1). The draining vessels were anteriorly the superior ophthalmic vein, inferiorly the pterygoid plexus, and posteriorly the superior and inferior petrosal sinuses and the basal vein of Rosenthal.

On March 8, 1994, endovascular treatment via a transarterial approach was performed with mechanically detachable coils (MDC's) (Target Therapeutics, Fremont, CA). A 6 French catheter was guided into the left internal carotid artery through a 7 French introducer inserted into the femoral artery. Then a special version of the Tracker-18 microcatheter (Target Therapeutics, Fremont, CA) was introduced through this guiding 6 French catheter and directed into the anterior compartment of the cavernous sinus via the orifice of the internal

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Fig 1. Left internal carotid angiogram showing a traumatic carotid-cavernous fistula mainly draining through the superior ophthalmic vein, the basal plexus, the superior and inferior petrosal sinuses, and the basal vein of Rosenthal

Fig 2. Left internal carotid angiogram just after the transarterial embolization with coils The coils are positioned in the anterior part of the cavernous sinus and the shunt flow is slightly decreased.

carotid artery under direct fluoroscopic visualization and road mapping. One 8×20 MDC, three 6×20 MDC's, and two 5×15 MDC's were positioned in the anterior compartment of the cavernous sinus (the first number is the diameter of the circular memory in mm and the second is the length of the coil in cm when straightened), and 26 braided occlusion devices (BOD's) (Target Therapeutics, Fremont, CA) were placed among the MDC's. When we attempted to insert more MDC's into the cavernous sinus, a part of one MDC began to migrate into the internal carotid artery from the orifice of the CCF. So the migrating MDC was retrieved and this operation using the endovascular transarterial approach was stopped (Fig 2).

One week later, endovascular treatment via a transvenous approach was performed with MDC's. A 7 French introducer was inserted into the femoral vein, and a 6 French catheter was guided into the left internal jugular vein through this introducer. The Tracker-18 microcatheter was then introduced

Fig 3. Left internal carotid angiogram after the transvenous embolization with coils showing markedly decreased flow of the carotid-cavernous fistula

through the guiding 6 French catheter, guided through the inferior petrosal sinus and directed into the posterior compartment of the cavernous sinus. Five 5×15 MDC's were used to occlude the CCF, and 22 BOD's and 5 fibered platinum coils (FPC's) (Target Therapeutics, Fremont, CA) were used to fill the spaces between the MDC's. Postoperative angiography demonstrated markedly decreased flow of the CCF (Fig 3). The pulsatile tinnitus immediately decreased and gradually disappeared. The conjunctival injection and mild exophthalmos gradually disappeared, and the blepharoptosis and incomplete external ophthalmoplegia slowly improved.

Two months later, he noticed the same pulsatile tinnitus, and a left carotid angiogram revealed dilatation of the residual part of the cavernous sinus (Fig 4). On June 16, endovascular treatment via a transarterial approach was performed using the same method. A 8×20 MDC, a 7×20 MDC, four 6×20 MDC's and two 5×15 MDC's were used to occlude the CCF. This time, no

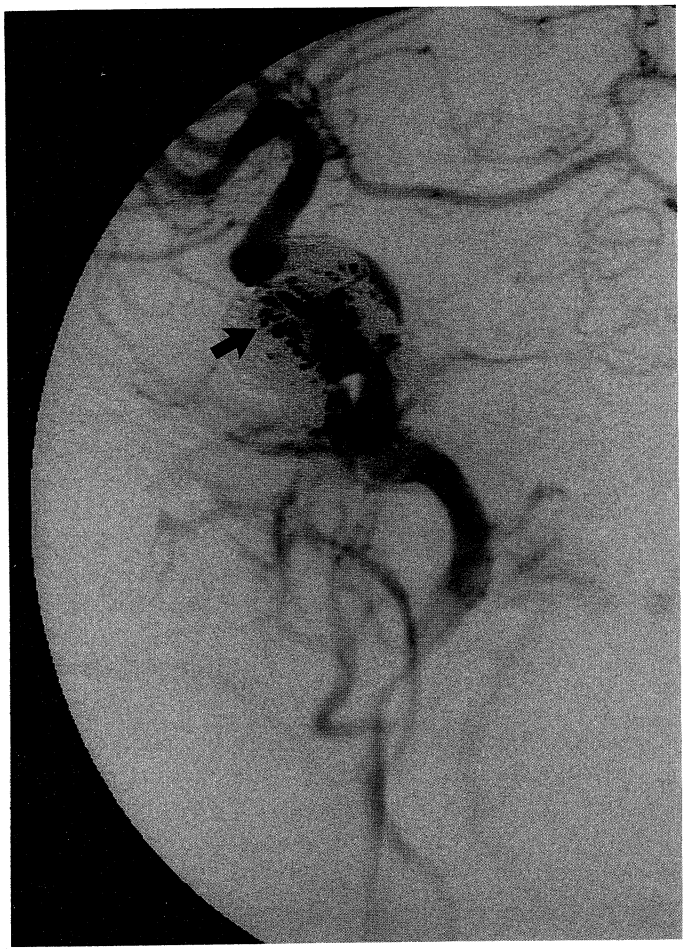

Fig 4. Left internal carotid angiogram two months after the embolizations showing dilatation of the residual part of the cavernous sinus (arrow)

part of any of the MDC migrated into the internal carotid artery. Neither BOD's nor FPC's were used, because they might have migrated into the internal carotid artery, the orifice of which was near this residual part of the cavernous sinus. Postoperative angiography demonstrated complete disappearance of the CCF (Fig 5). Just after the embolization, the pulsatile tinnitus completely disappeared, and neurological signs and symptoms gradually improved. One month later, his neurological examination was free of any signs or symptoms, and a left carotid angiogram revealed no recurrence of the CCF.

DISCUSSION

Although traumatic CCF's are generally treated by transarterial detachable balloon embolization therapy, in more recent years, newer microembolic steel and platinum coils, silk suture, and normo-butyl-cyanoacrylate have become the preferred materials for treatment.[1] Transarterial detachable balloon

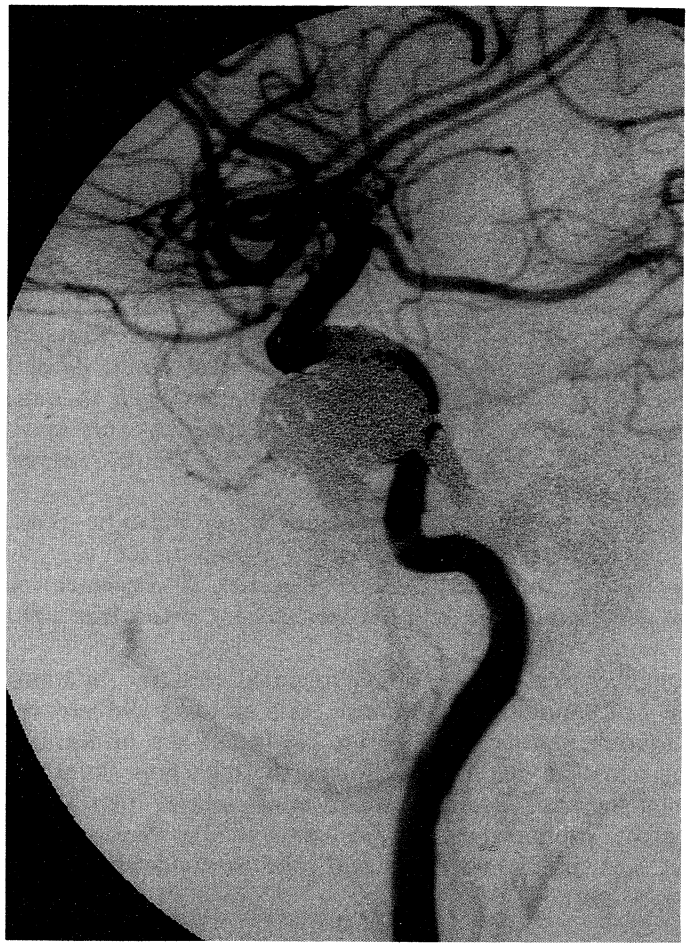

Fig 5. Left internal carotid angiogram showing complete disappearance of the carotid-cavernous fistula after the last transarterial embolization

embolization is occasionally unsuccessful due to a small fistula orifice, partitions of the cavernous sinus, and sharp objects (bone fracture fragments, foreign objects).[2,3] Halbach *et al*[3] who carried out transarterial platinum coil embolization of direct CCF's, pointed out the risk of migration of the coils. Therefore, they expressed the hope for development of shorter, more thrombogenic, detachable or retrievable coils [Guglielmi G, *et al*[4]]. Guglielmi *et al*[5] reported a case of direct CCF caused by a ruptured intracavernous aneurysm which was successfully treated with two electrolytically detachable platinum coils. We reported the first case of successful treatment of direct (traumatic) CCF with mechanically detachable coils.

The mechanically detachable coil (MDC) which we used is designed to be mechanically detached with an interlocking system, whereas the Guglielmi detachable coil (GDC) is electrolytically detached and the detachment of the coil occurs within 4 to 12 minutes.[4] The interlocking design of the MDC we used allows the coil to be advanced and retracted before final placement in the CCF, and to be delivered safely. Because the MDC is immediately detached when the interlocking portion slips out of the tip of Tracker-18 microcatheter, the working time is shortened and the X-ray exposure dose to the patient under fluoroscopic visualization may be reduced.

A transvenous approach may be effective when the orifice of the CCF is smaller than the uninflated diameter of the balloon or proximal carotid occlusion has occurred.[6] However, Debrun *et al*[2] noted that the percentage of success is low because partitions within the cavernous sinus preclude placement of the balloon near the fistula orifice. The transvenous approach with the MDC's was used in the second operation. The insertion of the MDC's was easy because of their small diameter and the flexibility of the coil. Debrun *et al* also reported that oculomoter nerve palsy, which was caused by compression of the nerve by the balloon inside the cavernous sinus, developed in 20% of their cases.[2] The incomplete external ophthalmoplegia in our case gradually improved within a few months after the treatment. This may have occurred because the MDC's were inserted among the cranial nerves or partitions without expansion of the nerves.

In cases where the internal carotid artery must be preserved, a MDC controlled by retrieval and repositioning proves to be very useful. With a detachable balloon, however, there is some risk of permanent occlusion of the internal carotid artery due to early detachment before the balloon enters the cavernous sinus.

Although a part of one MDC migrated into the internal carotid artery during the first transarterial approach, this accident did not occur during the last transarterial approach despite the closure of the orifice. The orifice may have become smaller due to reduction of the high flow shunt after the previous endovascular therapy. It is difficult to treat cases of high flow direct shunt, as in our patient, completely by doing endovascular therapy only once. When using MDC's, it may be necessary and safer to divide the endovascular therapy into a few stages.

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