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Embolization of Dural Arteriovenous Fistulas with Interlocking Detachable Coils

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Summary: Our clinical experience with interlocking detachable coils for the embolization of high-flow dural arteriovenous fistulas is reported. Interlocking detachable coils are useful for transarterial and transvenous embolizations of dural arteriovenous fistulas because (*a*) immediate coil detachment is possible, (*b*) the coils can be replaced easily, (*c*) detached coils rarely migrate, and (*d*) fewer interlocking detachable coils than conventional fiber coils are required for successful embolization.

Index terms: Arteriovenous malformations, embolization; Fistula, arteriovenous; Interventional instruments, coils

Dural arteriovenous fistulas (AVFs) usually occur in the cavernous sinus or in the posterior fossa, accounting for 10% to 15% of intracranial arteriovenous malformations (1). They are considered to be acquired and may develop spontaneously or after trauma (2, 3). The treatment of dural AVFs may include open surgery and/or endovascular surgery (4–8). Interlocking detachable coils (IDCs) (Target Therapeutics, Fremont, Calif) have been developed; we report their successful use in the treatment of dural AVFs.

Methods

Each procedure was performed via the percutaneous transfemoral approach under systemic heparin anticoagulation (5000 U). A 5- or 6-F guiding catheter (Cathex, Tokyo) was placed from the femoral vein or artery, and a Tracker-18 catheter (Target Therapeutics) with a Terumo-16 guide wire (Terumo, Tokyo) was then passed coaxially. Digital subtraction angiography was performed with 4 mL of Iopamilon 300 injected by hand over 2 seconds. The affected sinuses or the feeders of a dural AVF were embolized using IDCs with or without conventional platinum fiber coils. In addition, in cases 2 and 3, the dura mater and tentorium were coagulated and cut extensively to isolate the sinuses under right occipital and suboccipital craniotomies.

Results

A summary of the patients treated with IDCs is presented in the Table. All lesions were embolized with 2-mm × 4-cm or 3-mm × 6-cm IDCs. In Case 1, the fistula was occluded using only three IDCs. In Cases 2 and 3, feeders from the vertebral artery were embolized safely with IDCs. When the guiding catheter migrated to vessels other than feeding arteries, errant IDCs were easily pulled out without detachment. After confirmation of appropriate positioning, the coils were detached instantaneously. There was no unexpected movement of the end of the coil at the time of detachment.

Case 1

A 76-year-old woman presented with an exophthalmus, chemosis, and oculomotor palsy of her left eye. The initial cerebral angiogram showed a dural AVF involving the cavernous sinuses on both sides, supplied by bilateral external and internal carotid arteries. She was treated with transarterial embolization at another clinic. Branches of the external carotid arteries on both sides had been embolized with platinum helical coils. She was transferred to our clinic because her symptoms did not improve. Angiograms obtained at our clinic demonstrated that the left side of the cavernous sinus was still opacified mainly through the right internal carotid artery (Fig 1A). A 6-F guiding catheter was passed into the right inferior petrosal sinus via the femoral vein. A Tracker-18 microcatheter was introduced into the right cavernous sinus, and three IDCs (2 mm × 4 cm) were inserted and released. The shunt flow was remarkably reduced on angiograms after embo-

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Summary of three patients treated with IDCs

Case	Age, y/ Sex	Clinical Manifestations	Location	Embolized Sinus or Feeders	No./Size of IDCs	Results
1	76/F	Exophthalmus oculomotor palsy	Cavernous sinus	Cavernous sinus	3/2 mm × 4 cm	Excellent
2	54/F	Tinnitus	Transverse sinus	Feeders of VA	4/2 mm × 4 cm 1/3 mm × 6 cm	Excellent
				Feeders of ECA	12/3 mm × 6 cm	
3	59/F	Subarachnoid hemorrage	Straight sinus	Feeders of VA	8/2 mm × 4 cm	Excellent
				Feeders of ECA	10/3 mm × 6 cm	

Note.—ECA indicates external carotid artery; and VA, vertebral artery.

lization (Fig 1B). Heparin was not administered after the embolization. Within the next few days, her exophthalmus and chemosis decreased almost completely.

Discussion

IDCs and Guglielmi detachable coils (GDCs) have been developed as vascular occlusion systems for the treatment of cerebral vascular diseases such as intracranial aneurysms and arteriovenous malformations. With these systems, a variety of cerebrovascular lesions can be treated effectively and safely.

IDCs and GDCs differ in the mechanism of detachment. GDCs use an electrocurrent for detachment (9–11). The advantage of GDCs is that no mechanical force is necessary to detach the coil; thus the coil does not move at the time of detachment. Another advantage is that thrombosis can be promoted by the electrical current. This is especially useful in the treatment of cerebral aneurysms. The disadvantage of GDCs is that detachment is not instantaneous, and it usually takes 5 to 10 minutes to detach a coil. In these AVFs, target vessels or sinuses were successfully embolized without electrothrombosis.

In the present series of dural AVFs, we used IDCs because they could be detached instantaneously. A coil is detached by pushing it over the marker on the coil pusher (Fig 2). This causes a slight movement of the coil at the site of detachment. In our experience, there was no trouble by this slight movement of the coil.

We found that IDCs were useful in the treatment of dural AVFs because: (*a*) immediate coil detachment is possible; (*b*) when a coil does enter unexpected sites, it can be withdrawn easily before detachment; and (*c*) fewer IDCs than conventional fiber coils are required for successful embolization, thus less time is needed

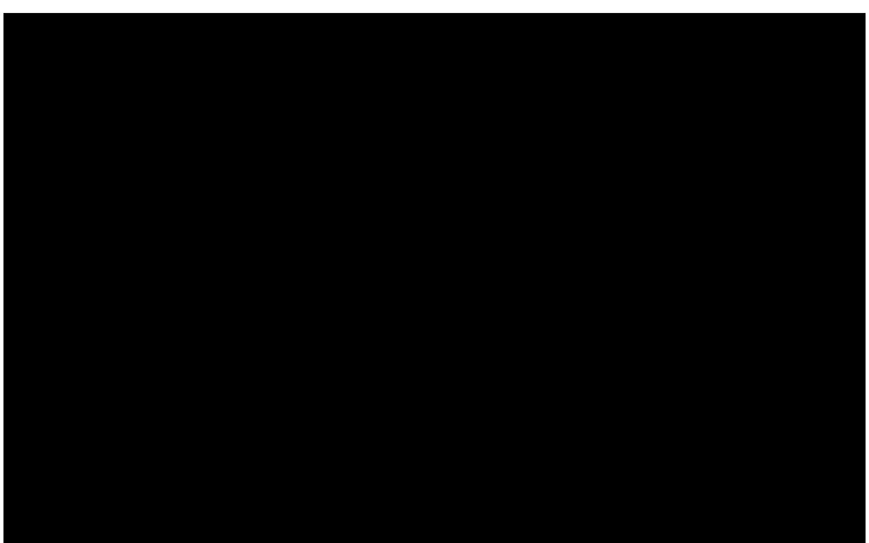

Fig 1. Case 1.

A, Right internal carotid angiogram obtained before embolization shows that the affected cavernous sinus was fed mainly by the right internal carotid artery.

B, Right internal carotid angiogram obtained after embolization shows reduction of the arteriovenous shunt (IDC; *arrows*).

Fig 2. Configuration of the IDC system shows an 0.016-inch (0.40 mm)-diameter coil pusher with an attachment mechanism and 0.015-inch-diameter nonfibered platinum microcoils coupled to the pusher.

for the procedure. Our experience showed that detached IDCs rarely migrate.

Disadvantages of the IDC system are: (*a*) it is difficult to insert a long coil (over 8 cm) into tortuous vessels (available coils varied from 4 cm to 20 cm in length); and (*b*) IDCs move slightly at the time of detachment because they need to be pushed over the marker. The former disadvantage may be corrected by the development of smaller coils for Tracker-10 catheters; currently IDCs are available only for Tracker-18. The latter disadvantage may be eliminated by careful manipulation at the time of detachment.

With proper selection among various coils, cerebrovascular lesions may be treated more safely and effectively.

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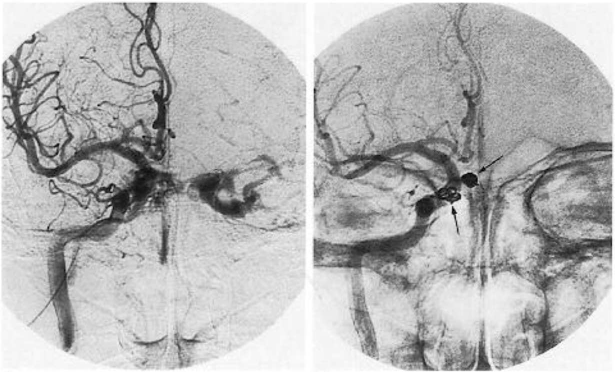
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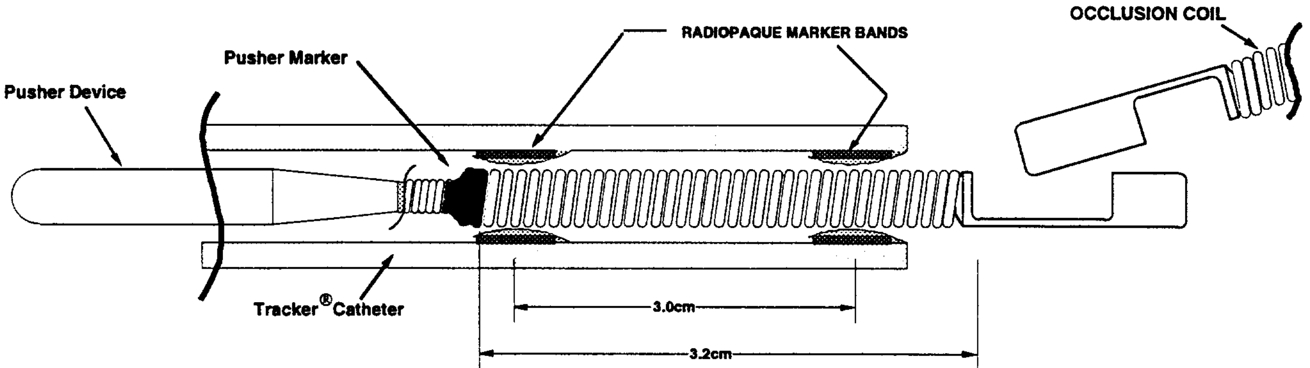

OCCLUSION COIL
RADIOPAQUE MARKER BANDS
Pusher Marker
Pusher Device
Tracker® Catheter
3.0cm
3.2cm