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Commentary

Electrolytically Detachable Microcoils

Fernando Viñuela,[1] Gary Duckwiler,[1] and Guido Guglielmi[1]

Dr Sadato and colleagues have shown the utility of electrothrombosis in the treatment of a complex dural fistula (1). They are to be congratulated on their fine work. The treatment of dural fistula from the transvenous approach is often the only way to exclude the lesion completely. In their case, it was quite difficult to eradicate the fistula by using standard coils. Their postulate that the electrothrombosis induced by their experimental detachable coils was a primary factor in finally curing the fistula is reasonable.

We have used the Guglielmi detachable coil (GDC) for high-flow fistulae. In March 1990, after more than 1 year of laboratory work and several stages of technical refinements, the GDC microcoils became available for clinical use under a strict FDA-approved protocol (2, 3). Since then, we have had the opportunity to treat nine patients with fistulous lesions utilizing the GDC system: five patients had spontaneous dural-type carotid-cavernous fistulae treated by transvenous approach, three patients had high-flow carotid-cavernous fistulae (two traumatic and one due to a ruptured intracavernous aneurysm), and one patient had a posttraumatic vertebro-vertebral fistula. This technique has proved to be useful in cases in which it was necessary to cast the cavernous sinus, because these particular microcoils are very pliable and adapt to the morphology of the cavernous sinus without producing significant mass effect to the intracavernous cranial nerves (4).

The detachable microcoils are also useful because one is able to predict their behavior before detachment, important information in high-flow fistulae with recruitment of large cerebral cortical veins. The retrieveability of the coils allows for more flexibility in the choice of coil size, without the risk of inadvertent migration. Furthermore, the pliability of these coils can be an advantage in areas where access is difficult. A problem that can occur with standard coils is the "kickback" of the microcatheter while depositing the coil, especially when the coil is larger than the diameter of the vascular lumen. With the GDC, this is not a great problem, and a tighter packing can be obtained.

Finally, we agree with Sadato et al that electrothrombosis plays a significant role in the development of clot/occlusion of the fistula. However, we have found that electrothrombosis alone is insufficient to insure occlusion of either a fistula or an aneurysm, and that tight packing is essential.

On reviewing Dr Sadato's article, one notices that their coil appears to be similar to the GDC system, with two distinct differences. First, the material between the delivery wire and the platinum coil is copper. Copper can be toxic in high doses and this could be a consideration when embolizing with multiple coils. Second, the platinum coil itself appears to closely resemble the standard commercial microcoils, which are significantly stiffer than the GDC. We do not have information about the technical characteristics of their detachable microcoil (length and diameter of platinum coil and delivery wire, insulation of the delivery wire, physical characteristics of delivery microcatheter). Also, their guiding catheter system does not appear to have safety markers in the coil and in the microcatheter to indicate when the junction between the platinum coil and the stainless steel is beyond the tip of the microcatheter (Fig. 1). We have found that this technical refinement is indispensable for the embolization of small or acute aneurysms, because of the possibility of aneurysm perforation by the stiffer stainless steel portion of the detachable microcoil. Also, in cases in which multiple coils have been placed, it can be difficult to actually determine when the coil has left the catheter (Fig. 2).

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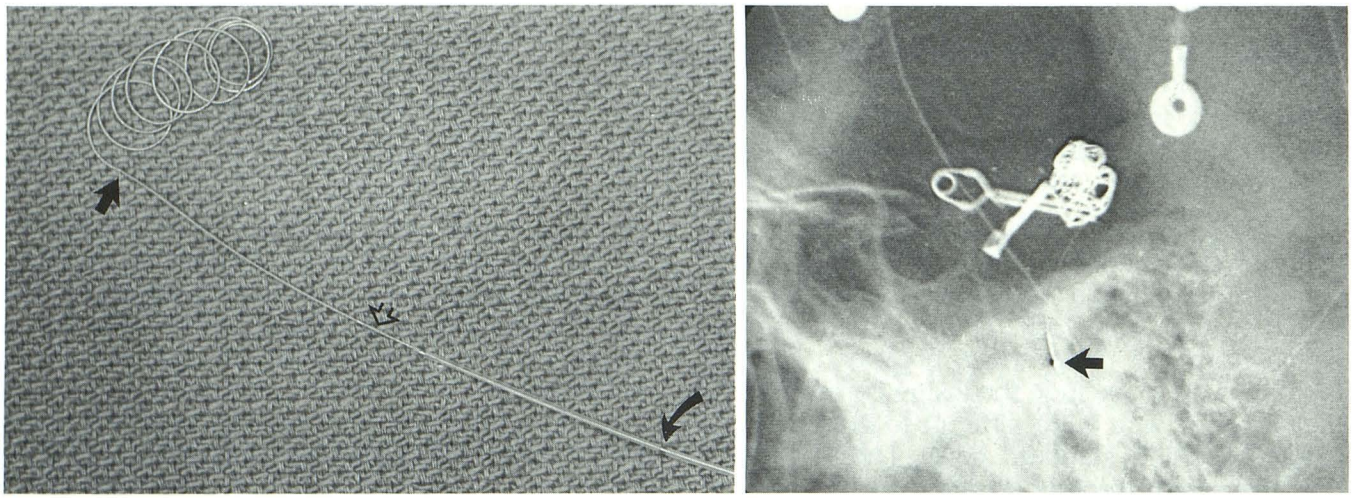

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Fig. 1. The GDC delivery system with the proximal safety markers. The *solid arrow* shows the junction between the platinum coil and the stainless steel delivery wire. It is this segment that will electrolyze. The *open arrow* identifies the proximal radiodense marker that is aligned during detachment with the proximal catheter marker (*curved arrow*). Alignment of these markers assures appropriate placement of the coil into the bloodstream without risking perforation of the vascular structure by the stiffer stainless steel delivery wire.

Fig. 2. Clinical case showing that the coil and the tip of the delivery catheter is hidden due to prior coil placement. In this instance it is necessary to rely upon the proximal safety markers for appropriate placement and detachment. The *arrow* identifies the proximal catheter marker aligned with the delivery wire proximal safety marker.

The authors use a detachment technique similar to that employed with the GDC system: the positive electric current applied to the platinum coil attracts the negatively charged blood elements which develop a fresh clot around it (electrothrombosis). The same current dissolves the susceptible metal (copper or stainless steel) at its junction with the platinum coil, thereby detaching the platinum coil in the vascular lumen. Most of the stainless steel delivery wire, in the case of the GDC, is protected and insulated by a teflon lamination.

It is difficult to comment on the safety of this detachable microcoil system for the treatment of aneurysms. The GDC system has been developed for the treatment of this type of vascular pathology and all technical efforts have been made to develop a system that allows safe deposition of the GDC microcoils in small and acute aneurysms (5). The development of a fresh clot is important to reduce the possibility of coil migration but the key to the success of the technique resides in its capacity to cast the aneurysm completely with the coil and not exert excessive lateral pressure in its wall. We do not know if the physical characteristics of Dr Sadato's platinum coil allow completely filling of an aneurysm without increasing the risk of aneurysmal rupture. It would be important for the authors to comment on this point.

We congratulate the authors for developing a detachable microcoil system that seems useful for treatment of slow flow, acquired carotid cavernous fistulae. They acknowledge that they have followed and learned from the GDC system, identifying the need for controllable delivery systems. The use of copper as the junctional metal raises the question of copper toxicity, a factor that is not present in the GDC system. The results of outcome studies depend on the physical and biologic characteristics of the materials being used. There is a danger that individuals and groups both within and outside the medical community will inadvertently lump together all "coil embolization" when analyzing issues of safety and efficacy. We should be rigorous in the description of our embolic techniques and materials when publishing or presenting our data.

We believe that the use of Dr Sadato's microcoil system should be intensively tested in the laboratory before being used in intracranial aneurysms. The elements to be investigated include: 1) pliability of the coil and capacity to adapt to the shape of the aneurysm without deforming it; 2) presence of safety markers to know when the stainless steel portion of the coil has reached the tip of the microcatheter; 3) availability of micro-

coils with different diameters and lengths to accommodate the morphologic variability of aneurysms; and 4) development of a standardized electric current for electrothrombosis and electrolysis. The standardization of the technique allows the use of it in more than one center, by more than one therapist, and facilitates a more rigorous assessment of its utility and safety.

The authors prove in their article that they are familiar with all the refined techniques used in embolization of vascular lesions in the cavernous sinus. They have performed treatment with a combination of transarterial and transvenous approaches with elegance, safety, and success. Necessity has prompted them to develop their own electrolytically detachable coil system because, the authors claim, the GDC system may not be available in Japan for several years. We fail to identify a logical explanation to this problem unless it is related to very strict regulations contained in the Japanese health system. It is hoped and expected that the GDC will become more widely available in the near future (pending FDA approval).

We wholeheartedly support ongoing investigations of new embolic materials, techniques, and systems. This is how patient care is advanced. However, diligent attention to preclinical evaluation of the physicochemical and biologic effects is essential for appropriate application of the new technology. Also, clear statements about the characteristics, and about the differences between existing technologies are important to ensure the proper evaluation of each technique.

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