

Endovascular Treatment of Intracranial Aneurysms

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The article by Cekirge et al in this issue of the *AJNR* (1) is another chapter in the growing use and recognition of coils as an endovascular method to treat cerebral aneurysms. In this paper, the authors report their experience with the use of the interlocking detachable coil (IDC) as an alternative to the recognized and increasingly used Guglielmi detachable coil (GDC). Having used the IDC successfully in five cases, they report their results and discuss the IDC in comparison with other detachable coils.

The question we raise is, why should we be looking for an alternative coil device, since we have gathered (in multicenter studies of over 6000 patients) good experience using the GDC? If a new device is needed, will “just another coil” be the answer? We think, with many others, that the GDC is the most appropriate actual and available coil to treat a great variety of cerebral aneurysms safely through an endovascular approach. Switching to a new device, or even testing an alternative device, should not be done if its safety is not comparable to or a significant improvement over the GDC. If less favorable results are produced, such a trial could discredit endovascular treatment of aneurysms, which has greatly improved since the introduction of the GDC in 1991 (2).

The reasons to look for an alternative coil device may be variable; the following comment does not claim to be exhaustive. The different factors are not treated in the order of importance, but in the order of the problems currently faced in the use of coils by neuroradiologists.

Indication.—The average berry aneurysm is treatable with commercially available GDC devices; only if the endovascular access is difficult (eg, very tortuous) or the site of aneurysm implantation difficult to reconstruct (eg, large overall neck size in relation to the size of the

parent artery, vessels originating from the aneurysm pouch, fusiform involvement of a whole arterial segment) are there insurmountable obstacles to successful treatment with the GDC (3). Most of these situations will require not only an improved coil design but a completely different way of treatment, perhaps involving additional devices, such as stents (4, 5) or liquid polymers (6). GDC devices can be used for other, less delicate situations, such as venous occlusions for the treatment of dural arteriovenous fistulas (7), where many coils might be required to obtain occlusive packing of a dural sinus. In addition to the need to fill a potentially larger space than an aneurysmal cavity, because of the presence of an arteriovenous shunt, the fast venous flow might require stronger or more complex coils to withhold the imposed pressure and flow conditions. However, coil systems constructed to treat such conditions still have to be flexible enough to negotiate the path to intracranial compartments.

Availability and Price.—GDC devices have not been available worldwide to all clinicians hoping to deal with cerebral aneurysms. This certainly has been a good reason to look for an alternative device and this was the case also with many Japanese colleagues using the IDC (mechanically detachable or interlocking detachable coil). Another, potentially more important, reason to look for alternative devices may be price. This varies from country to country and, considering an average need of 3.6 to 4.5 GDCs for complete endovascular treatment of an aneurysm, may cause the procedure to exceed the price of a competitive surgical procedure.

Choice of Material and Implant Characteristics.—Platinum was chosen as the material for GDC and IDC, and tungsten for mechanical de-

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tachable spirals, because these materials are biocompatible, soft, and pliable, withstand corrosion, and accept the required device design (8, 9). Thrombogenicity also was considered a favorable characteristic. However, it is also a significant risk factor to this treatment exposing the distal vascular bed to a temporary risk of thromboembolism (10). Filling of an aneurysmal cavity by coils may appear radiographically dense. However, we know from histologic studies that a significant part of the aneurysmal cavity becomes occluded by induced thrombus formation. This clot has no permanency and exposes the initially excluded aneurysmal cavity to the risk of recurrent cavity formation or coil compaction. The concept of thrombogenicity might require some rethinking to improve the risk factors of thromboembolism and aneurysm recurrence (11).

Choice of Dimensions and Coil Design.—The advantage of the device design relates primarily to malleability, a physical property allowing the coils to be delivered to distal tortuous vessels and, once delivered, to assume a given shape and dimension. Although a large choice of variable dimensions is available, the operator has to choose a predefined coil dimension, which might prove inadequate. There is also a maximal length to each coil design which, allowed to travel through a microcatheter of too long or too tightly curved coils, may exhibit critical limitations of introduction because of increased friction characteristics.

Introduction.—The introduction of a coil device requires in general a regular and round microcatheter lumen to avoid undue friction during deployment. Lumen irregularities may also lead to precocious detachment of mechanically detachable coils, since the actual available models detach as soon as the protection by the regular lumen of the catheter ceases to prevent coil release. The irregular, mostly stiffer area of junction between the coil and the introducing wire may lead to greater friction during introduction of IDC or mechanical detachable spirals than the GDC.

Release.—The release of mechanically detachable coils has been studied by Marks et al (12), who considered the interlocking system (eccentric junction design) to be the best of those studied, including a “clamped ball” and a “looped ribbon” concentric design. Release of

the IDC has been reported as smooth in uncomplicated vascular anatomy (12, 13). However, the Japanese experience with the IDC has shown difficulties with a snapping movement during detachment (M. Ezura, A. Takahashi, Y. Fujii, T. Yoshimoto, “Long-term Follow-up of Cerebral Aneurysms Treated by Intravascular Neurosurgery,” presented at the annual meeting of the Japanese Society for Intravascular Neurosurgery, Niigata, November 1994). One of the problems of all available detachable systems is the fact that, for release of the coil, the junction of the deployment wire has to be introduced and reach distal to the microcatheter tip, exposing the stiff junction area and giving rise to a risk of “grabbing” or “grasping” (12) an already implanted coil or puncturing (GDC) vasculature structures. In addition to the available coil release, two systems have been proposed: the immediately electrically detachable coil (14) and the Jackson coil design. Both systems are not yet fully evaluated or developed for the dimensions of cerebral aneurysms. Nevertheless, these designs appear interesting, because detachment may occur with the junction area remaining in the tip of the catheter during coil detachment, avoiding potential problems of coil release related to exposure of the introducing wire.

Withdrawal.—Withdrawal must be accomplished safely with a detachable coil device. The IDC has been demonstrated to exhibit the highest release force (mean, 228 g) of mechanically detachable systems (12), and to unravel before a junction rupture occurs. We have rarely encountered the formation of a coil knot during withdrawal attempt of an already deployed but inadequate coil (GDC). A more frequent problem involves the possibility of a coil's becoming unraveled with too much traction. This can happen where tortuous routes lead to increased friction. The problems of withdrawal may lead to system alterations that make further manipulation difficult; design improvement potentially would lead to safer devices.

We have listed a personal view of some remaining problems related to the actual coil devices available for endovascular treatment of cerebral aneurysms, and therefore we encourage further improvement of the coil design. Concerning the proposed alternative of using IDC for cerebral aneurysmal cavity filling, we would like to express our personal preference

for the GDC, considering our experience with alternative coil devices.

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