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Commentary

Endovascular Therapy of Intracranial Aneurysms

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The use of endovascular techniques, mostly detachable balloons, for treatment of intracranial aneurysms has progressed since balloons were first used in neuroendovascular therapy [1]. Although the use of detachable balloons for treating intracranial fistulas while preserving the parent artery quickly became the treatment of choice, especially for traumatic carotid-cavernous fistulas, balloon therapy of intracranial aneurysms has lagged behind. In our own early experience, about 10 years ago, in using detachable balloons to treat aneurysms while preserving the parent arteries, we encountered various problems [2], and therefore for many years we reserved balloon treatment for occlusion of parent arteries, which is a simple and safe although less elegant technique for treating unclippable aneurysms [2, 3]. At the same time, Victor Shcheglov in Kiev has exercised great technical skill, ingenuity, and remarkable clinical judgment in using detachable balloons for the primary treatment of all patients with intracranial aneurysms who are referred to the Ukrainian Neurosurgical Research Institute [4]. Among Western neurovascular therapists, the group of neuroradiologists in San Francisco have been the prime innovators for some years in using balloons to treat intracranial aneurysms with preservation of the parent arteries [5–7]. They have been joined recently by others, most notably Jacques Moret in Paris.

Higashida et al. [7] provide a remarkable summary of their series of patients with intracranial aneurysms treated by detachable balloon while preserving the parent arteries. They have restricted their cases to patients who were not candidates for aneurysmal clipping by the neurosurgeons with whom they work. They have, therefore, used balloons in a rather difficult group, selected from patients with a high-risk disease. They must be commended for their innovation, the quality of their work, and their persistence in difficult situations. They also must be encouraged to continue to study these cases to the maximum and to provide the results to a wide audience in a detailed and credible way.

Of the 15 deaths (17.9%) in the whole series that occurred on short- and long-term follow-up, 10 were due to aneurysm rupture in 19 patients in whom the aneurysms were subtotally occluded by the balloons. This is a 53% mortality in this subgroup, identified presumably from the obvious filling of parts of the aneurysms and/or necks of the aneurysms at the end of treatment. Higashida et al. did attempt repeat balloon embolization to obliterate the aneurysm in 10 patients in this series. Presumably, the 19 cases with subtotal occlusion were the patients who remained after all treatments were tried.

This subgroup of patients with aneurysms that were not occluded is therefore an extremely high-risk group. Higashida et al. have not indicated the locations of the aneurysms in the 19 cases. Did most or all of the nine patients who lived not have cavernous aneurysms, a situation in which regrowth likely would not lead to devastating hemorrhage? Otherwise, the statistics would indicate that subtotal occlusion of aneurysms located in the subarachnoid space is associated with an even higher risk of aneurysmal rerupture than the 53% reported by Higashida et al. Another conclusion of this work, not drawn by the authors, is that other treatment should be considered for patients in this high-risk category. In addition to clipping of aneurysms and placement of balloons within aneurysms, proximal placement of balloons, Selverstone clamps, surgical clipping, or Drake tourniquet (with bypass, if necessary) [8, 9] can be used to occlude or narrow parent vessels. Such Hunterian therapy addresses the theory of growth and maintenance of aneurysms on the basis of the biophysical dynamics of flow directions and stresses [10].

This article is an invited commentary on the preceding article by Higashida et al.

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Use of such methods to redirect the flow patterns might result in much better outcomes [8] than the 53% mortality reported by Higashida et al. [7].

We are extremely impressed with the 65 patients (77.4%) in the current series [7] in whom radiologic follow-up showed apparent occlusion of the aneurysm. It is amazing that the entire neck of the aneurysm was obliterated in so many cases, since the balloons have convex edges and the arterial walls must present a concave edge to the flowing lumen for the arteries to be considered normal and intact. If a remnant of the neck remains between the balloon and the lumen of the parent artery, the aneurysm would still be subject to the same biophysical forces and stresses that led to its development and growth in the first place [10], considering that the necks of aneurysms lack the elastic layers of normal arteries. We wonder, therefore, how many of the 65 cases with occlusion of the aneurysm actually had a small remnant of the neck that might be a quite subtle finding on angiography [11]. An example of a neck remnant is illustrated in Figure 4E in the paper [7] by Higashida et al. It is described in the text as a large basilar artery aneurysm with "occlusion of the aneurysm," although the legend points out the neck renmant. We also think that the remnant can be seen easily in Figures 4C and 4D. We similarly interpret Figures 3C–3E as showing a neck remnant (pointed to by arrows in Fig. 3C), although Higashida et al. have interpreted this figure as one that shows obliteration of the aneurysm.

Our experience in treating more than 3000 aneurysms has taught us that a remnant of the neck, recognized angiographically, frequently is present. A remnant was seen in 6–7% of aneurysms clipped during a recent extended period (unpublished data). At least 1% of our patients whose aneurysms were clipped had recurrence of clinical signs and symptoms on long-term follow-up that were due to regrowth of the neck remnant [12]. We also have learned that it is difficult to recognize tiny neck remnants of aneurysms on angiograms obtained after treatment [5, 11, 12] because of overlapping vessel origins, subtraction artifacts (from metallic clips or opaque balloons), and the angiographic views taken. Many of our original interpretations of postoperative angiograms read "complete aneurysm obliteration," but after the experiences leading to our report [12] on the regrowth of aneurysms from residual neck remnants we became aware of more of the subtleties and pitfalls in the interpretation of angiograms obtained after the treatment of aneurysms. We therefore suspect that some of the 65 patients in the series of Higashida et al. [7] who had apparent complete occlusion of the aneurysm had remnants of the aneurysmal neck. In our series [12], we found a mean of 8 years between clipping and clinical manifestation of serious problems from regrowth of aneurysms. We think, therefore, that the follow-up program of only 12 months reported by Higashida et al. [7] is insufficient. Concern about aneurysmal regrowth exists for all cases, not just those with the most obvious continued aneurysmal filling. The findings on angiography are subtle, and this technique may be inadequate to show the smallest neck remnants.

It is a common neurosurgical practice after treatment of an aneurysm to tell the patient that he or she is safe, especially if no obvious neck remnant is seen on postoperative angiography. However, the literature [12, 13] on regrowth of symptomatic aneurysms from neck remnants suggests that a cure can be claimed only after a long time has passed. One neurosurgeon (Robert Spetzler, personal communication) actually tells his patients that they will need to have follow-up studies with angiography 3–5 years after clipping. Perhaps the implication is that interventional neuroradiologists should follow higher standards of practice than neurosurgeons for the follow-up of treatment of aneurysms. This may be true if the prevalence of neck remnants is higher after balloon treatment. However, even though long-term follow-up imaging is not common neurosurgical practice, it does not mean that neuroradiologists should do the same, at least until the long-term results are known.

The work of Higashida et al. [7] is an extraordinary series in the forefront of treatment in this field. By restricting themselves to the most difficult unclippable aneurysms or aneurysms in patients who are not candidates for surgery, they are weighting the statistics against themselves somewhat. It is possible that endovascular therapy will become the equal of, or even better than, surgery, even for clippable aneurysms. Shcheglov's Kiev series [4] and Moret's Paris series both included many patients with clippable aneurysms. Because of medicolegal and ethical concerns, and because of competition among specialties, any change in North America from surgical to endovascular therapy of aneurysms probably will lag behind the change in other parts of the world. It may be that new endovascular techniques, in development or to be developed, will be even more successful and safer than balloons. While we are waiting for this to take place, it is important that series such as that of Higashida et al. [7] continue to be self-critical. In view of what is now known about the regrowth of aneurysm necks [13], even the 65 patients with "complete aneurysm occlusion" should have long-term follow-up to find and treat those who will have regrown aneurysms from unseen neck remnants. This prevails, of course, for incomplete surgical treatment as well.

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