Flow diversion for intracranial aneurysms

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The introduction of flow diversion for the treatment of intracranial aneurysms could potentially herald the beginning of a “new endovascular era.” Flow diverters are endovascular devices with a high metal ratio, and, unlike traditional microcatheter-delivered stents for intracranial use, are characterized by a very low porosity. Because of these characteristics, after a flow diverter is deployed across the neck of an aneurysm, flow is “redirected” away from the aneurysm into the parent vessel. This flow disruption encourages intra-aneurysmal thrombosis and progressive angiographic obliteration. Animal and clinical studies have also shown that, as the clot organizes and eventually retracts, angiographic aneurysm obliteration is accompanied by shrinkage of the aneurysm sac.

Additional theoretical advantages of flow diverters include avoidance of any intraaneurysmal manipulation (since the device is deployed across the aneurysm neck), provision of a scaffold for neointimal layer formation across the neck of the aneurysm, and “reinforcement” of the segment from which the aneurysm originates by providing structural strength. In the past few years, flow diverters have been available for clinical use. Early clinical series have reported high percentages of technical success and very high rates of complete aneurysm occlusion. As experience has accumulated, extension of the concept of flow diversion to territories other than the proximal intracranial internal carotid artery (ICA) has been explored. However, with increasing experience and widespread use, several problems have been recognized. These are mostly related to the issue of delayed aneurysm rupture while intraluminal thrombosis takes place and the little-understood phenomenon of distal intraparenchymal hemorrhages.

More than 5 years after the introduction of flow diverters into clinical practice, what is the current place of this technology in the treatment of patients with intracranial aneurysms? Piano and coworkers2 detail their experience with flow diversion in the treatment of 104 aneurysms in 101 patients. Of note, this is an all-inclusive series from an experienced group. Forty-seven of the 104 aneurysms were treated with the Silk device (Balt Extrusion), and 57 were treated with the Pipeline embolization device (Covidien/ev3). The authors confirm that flow diversion is very effective in the treatment of aneurysms involving the ICA proximal to the origin of the posterior communicating artery with a very high degree of complete angiographic obliteration at 6 months and a low complication rate. Aneurysms involving the proximal intracranial ICA have a “sidewall” morphology ideal for the concept of flow diversion and do not involve critical perforators, hence the high obliteration rate and safety of flow diversion in this segment. Flow diverters are not equally effective or safe when locations other than the proximal intracranial ICA are considered and this series suggests a lower rate of complete obliteration in these other locations.

One of the most feared complications of this technology is the risk of delayed (usually within the first 3 weeks after treatment) aneurysm rupture. The exact incidence of this complication is not known, but it is probably very low, and the complication is usually confined to very large and giant symptomatic aneurysms. In the series reported by Piano et al.,2 delayed rupture occurred in 1 patient. In order to prevent delayed rupture, many operators (including our group) have used intraluminal coils to “temper” the effects of intraaneurysmal thrombosis. It is yet unknown whether or not this strategy indeed reduces the incidence of delayed aneurysm rupture. I am interested in the authors’ opinion about this issue.

Another unresolved issue that has emerged is the risk of distal intraparenchymal hemorrhages. These seem to occur within the first few days after treatment. In the series under discussion this occurred in 1 patient, while in 3 other cases, asymptomatic hemorrhages were observed on the routine postoperative CT and attributed by the au-
thors to wire perforations. The etiopathogenesis of distal intraparenchymal hemorrhage is poorly understood. It cannot be attributed to dual antiplatelet therapy, which all of these patients are treated with. Intraparenchymal hemorrhages are not observed with the same frequency in patients undergoing other endovascular procedures for which the same dual antiplatelet regimen is utilized. In a recent Canadian series, this complication was reported to occur in up to 8.5% of patients. In the experience of Piano and coworkers, it appears that a distant intraparenchymal bleed, not related to wire perforations, was noted only in 1 patient. This is in line with our own experience (1 distal intraparenchymal hematoma in 85 consecutive flow diversion procedures).

There is ongoing discussion and controversy regarding the ideal duration and intensity of antiplatelet therapy in patients undergoing flow diversion and the need for routinely tested sensitivity to antiplatelet therapy. These discussions and different recommendations are often based on anecdotal experience and not necessarily supported by sound scientific data. We do not routinely test for platelet responsiveness. Although not specifically mentioned in this paper, it appears that Piano and coworkers share the same practice and yet report a very low incidence of peri-procedural ischemic complications. It would be interesting if the authors could elaborate a little more on this issue. It also appears that Piano and collaborators have a “minimalistic” approach to postoperative antiplatelet therapy, as patients were maintained on dual antiplatelet therapy for 1 month only. After 1 month, ticlopidine was discontinued and patients were treated with aspirin alone for an additional 3 months, after which even the aspirin was discontinued. Despite this “minimalistic” antiplatelet regimen, in this series the incidence of postprocedural ischemic complications was very low and definitely not higher than other reported series. In line with the authors’ philosophy of “keeping it simple,” “bixial” access was used in the vast majority of procedures.

Overall, this series confirms the important role of flow diversion in the treatment of complex aneurysms involving the proximal intracranial ICA. It is my opinion that if widespread application of this technology confirms the results of early series, flow diversion will become the treatment of choice for the majority of proximal ICA aneurysms not amenable to “simple” coiling. More data and careful analysis of effectiveness and complications are required before flow diversion can be extended to other vascular territories. The incidence of ischemic complications is relatively low and does not justify overly aggressive pharmacological regimens (more than the one utilized by these authors). Like many other procedures in neurosurgery, the key is to “keep it simple” and avoid dogmatic statements regarding pharmacological and technical aspects of the procedure, as any added degree of complexity may result in higher complication rates without significant benefits.

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References

Response
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We thank Dr. Lanzino for his thoughtful and overall positive comments about our series. In his editorial, he raises important points. Is coiling effective and necessary in larger aneurysms treated with flow diverters to prevent delayed rupture? We do not know the answer to this question, although, as specified in our paper, we have been placing coils in addition to flow diverters in larger and symptomatic aneurysms. This practice started after we were faced with our first delayed rupture, which occurred approximately after 30 patients had been treated with flow diverters without additional coils. Incidentally, this delayed rupture occurred while there was an ongoing and heated debate at meetings about this issue, its causes, and the need for adjunctive coiling. Thus, we decided that adding coils was indicated in larger aneurysms, with the rationale that coils could “fragment” a large volume of clot (and its possible dire consequences) into smaller “less dangerous” segments. We certainly would prefer a simpler procedure (just implantation of a flow diverter) and many centers keep doing just that. We do not believe that a more aggressive flow disruption inside the aneurysm (superimposing more flow diverters) would alter the process leading to delayed ruptures; instead it may just accelerate it. The aneurysm that ruptured in a delayed fashion in our series was a very large (> 20 mm) round midbasilar artery aneurysm—probably a dissecting aneurysm—and a high-speed inflow jet was very well visible. We have not yet had any additional delayed ruptures, but this does not prove that coils are effective in preventing delayed ruptures. Hopefully, more experience and better understanding of the in vivo process responsible for these (fortunately rare) events will provide us with better answers in the future.

Antiplatelet treatment in neuroendovascular procedures is another important and even bigger issue, full of contradictions and irrational beliefs. Most of the literature on this topic is extrapolated from the cardiology experience on coronary atherosclerotic lesions, and the findings cannot be immediately transferred to a completely different field, such as neuroendovascular procedures for intracranial aneurysms. We think that flow diverters, notwithstanding a higher metal density, entail a lower risk of platelet aggregation compared to the “previous” intra-
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cranial self-expanding stents mainly because they are (or should be) apposed completely to the walls of the artery, leaving no extra-stent space where a clot could form and having no struts in the lumen of the artery, the latter being a common occurrence with other intracranial stents. Despite the widespread utilization of tests to study platelet response after antiplatelet treatment, there are several studies suggesting it is very difficult to check for drug responsiveness in a reliable way (see, as one example of many, the 2011 article by Marco Cattaneo.1). In our series there were very few thromboembolic complications. This could be related to random chance, to our use of ticlopidine (available free of charge to the patient in our country) in place of clopidogrel (even though there should not be any pharmacological differences between the two), or could be related to the very low thrombogenicity of these devices. Moreover, thromboembolic events were rare in our experience even when flow diverters were used in small arteries or in emergency situations, supporting the view that a well-placed device carries little risk.

We cannot agree more with Dr. Lanzino on the issue of “keeping things simple,” a concept on which we have based our practice for the past 30 years. We also share Dr. Lanzino’s view that we have entered a “new endovascular era” that will benefit a large population of patients with challenging aneurysms.

Reference


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