Endovascular Flow Splitting

TO THE EDITOR: In the March issue of the *Journal of Neurosurgery*, Takahashi et al. (Takahashi JC, Murao K, Iihara K, et al: Successful “blind-alley” formation with bypass surgery for a partially thrombosed giant basilar artery tip aneurysm refractory to upper basilar artery obliteration. *J Neurosurg* 106:484–487, March 2007) reported the successful treatment of a giant, partially thrombosed aneurysm of the basilar artery (BA) tip region by direct clipping of the BA tip, left posterior communicating artery (PCoA), and P₂ segment.

**Abstract**

Partially thrombosed giant aneurysms that are located at the basilar artery (BA) bifurcation and are not amenable to clip application are among the most challenging lesions for neurosurgeons. They compress vital structures such as the brainstem and the thalamus, and the prognosis is extremely poor when they are left untreated. Although obliteration of the upper BA is a promising approach for these aneurysms, some lesions are refractory to this treatment, and effective additional strategies have not been clearly established. The authors report a case treated by placement of clips in the unilateral posterior cerebral artery (PCA) and posterior communicating artery as well as by superficial temporal artery–PCA bypass after unsuccessful upper BA obliteration. Complete thrombosis and dramatic shrinkage of the aneurysm were obtained.

Vessel occlusion transformed the aneurysm in the dead end of a vascular “alley.” A distal bypass furnished the left PCA, which was occluded at the P₂ segment. Such a risky operation was performed in 2 steps, first by direct clipping of the BA tip, which was ineffective in reducing lesion growth, and second by clipping the PCoA and P₂ segment combined with bypass surgery on the distal PCA. Direct coiling of the patent portion of the aneurysm was judged infeasible or feasible but ineffective on the thrombosed portion of the aneurysm. The happy end of the story—that is, complete anatomical and clinical cure of the patient—compels us to congratulate the authors.

On the other hand, at least 2 different endovascular treatments, less invasive than direct surgery, would have been possible. First, simultaneous coil obliteration of the patent portion of the aneurysm and the P₁-P₂-PCoA junction would have produced the same anatomical result on flow splitting, with the added benefit of obliteration of the aneurysm. Obliteration of the parent vessel guarantees anatomical cure of the lesion, regardless of the presence of a thrombosed portion. As clearly shown in their Figs. 1B and 3A and C, the aneurysm neck does not exactly involve the BA tip, but rather the left P₁-P₂-PCoA junction. We and others have applied similar treatments in similar cases of aneurysms, with subsequent complete anatomical and clinical cure (Fig. 1). Second, coiling of the aneurysm and contemporaneous positioning of a stent on the P₁-P₂ segment might allow long-term anatomical reconstitution of the neck. Note, however, that the concept that stents allow better long-term results in large aneurysms by improving neck healing, a common theory in the European neuroradiological community, has not been proven and thus remains an opinion.

As regards perfusion of distal PCA territories, distal bypass is a possible solution. In our experience, endovascular occlusion of the P₂ segment in 8 consecutive patients did not cause any clinically evident distal infarctions because

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**Fig. 1.** Angiograms obtained in a 47-year-old woman who experienced the sudden onset of left cranial nerve III palsy. A: Left vertebral artery angiogram obtained in the arterial phase, oblique view, showing a large aneurysm of the P₁-P₂-PCoA junction. Arrows indicate the left PCA arising from the aneurysm wall. B: Platinum coil occlusion of the aneurysm and the P₁-P₂-PCoA junction. C: Left internal carotid artery angiogram obtained in the late arterial phase, lateral view, demonstrating retrograde filling of the peripheral PCA (arrows) through leptomeningeal collateral vessels. The patient had no clinical deficits or ischemic lesions on postoperative magnetic resonance imaging.
of the rich collateral circulation; other authors have reported similar results.1

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Reference

RESPONSE: We thank Drs. Bergui and Bradac for their comments. First, we must say that our paper focused on ways of dealing with the partially thrombosed BA tip giant aneurysm when the classic obliteration technique involving occlusion of the upper BA results in failure. Although BA obliteration has long been performed with a measure of success in cases of unclippable giant aneurysms at the BA tip, this strategy is ineffective in some cases, and no detailed technical reports on the additional surgery are available. We intended to show that another option exists even in cases previously considered hopeless. Needless to say, the treatment in our case was not an intentional 2-stage operation.

As to the general management of BA tip giant aneurysms, Drs. Bergui and Bradac have proposed 2 promising strategies. One is coil embolization of the aneurysm lumen with simultaneous occlusion of the PCA. Indeed, they have shown a successfully treated case of a large aneurysm arising from the left P1-P2 junction. However, our case differs anatomically. We do not agree with their comment that “the aneurysm neck does not exactly involve the BA tip.” Although it is true that the patent portion of the aneurysm lumen leans leftward and involves the left P1-P2-PCoA junction, 3D computed tomography angiography clearly demonstrates that the BA tip is also affected (Fig. 2B in our paper). Furthermore, in the operative field we observed involvement of the BA tip in the extremely wide neck. If the parent artery was occluded with coils, the vital perforating vessels that arise from the BA tip area could have been sacrificed and serious complications would have occurred.

Another strategy proposed by Drs. Bergui and Bradac is the use of an intracranial vascular stent. Although this approach appears promising, these devices are, unfortunately, not yet available in our country. We hope such new technologies and devices will help us to treat complicated giant aneurysms that cannot be cured at present.

We simultaneously performed a superficial temporal artery–PCA bypass and obliteration. As Drs. Bergui and Bradac have commented, collateral networks between the PCA and other arteries are developed to a considerable extent in many cases. However, we selected a reliable method to prevent infarction in the occipital lobe because our patient had left ptosis at the time of surgery and would have been extremely distressed if homonymous hemianopia were to occur as a result of occipital infarction. (DOI: 10.3171/JNS/2008/108/6/1255)

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Biostatistics With Neurosurgical Importance


Generally speaking, there have been 2 commonly used methods in medical statistics for describing the relationship between 2 (sets of) variables (clinical factors): 1) correlation study; and 2) regression analysis. Although both can be used for prediction,14,28 regression analysis is certainly the more preferred and more definitive test. There are differences between these 2 methods. Correlation is a measure of the association between 2 variables; however, no causal relationship is implied. With regard to determining correlation, the Pearson correlation coefficient has been used to indicate the extent to which 2 variables change with one another in a linear fashion. Conversely, the Spearman rank correlation test, such as that used in the study by Yamamoto et al.,29 is a nonparametric measure of the correlation between 2 variables with no assumptions about the frequency distribution of the variables. Regression analysis is used to determine whether there is any significant statistical relationship between 2 independent variables. It has been noted that there are different types of regressions, such as logistic regression (supposedly used in the study by Tyler-Kabara et al.,28 but with marked violation of the statistical definition), multilinear regression, and Cox regression.5,8,10,19,25,30

Statistical methods require the assumption of the null hypothesis as true. All such assumptions must be strictly followed. Nevertheless, some authors have violated the statistical assumptions of a study.1,7,9,11,12,14–26,29 The clinical researcher must consider the hypothesis of the statistical model used. For instance, in a Cox regression model, which is most commonly used for survival analysis,1 the statistical assumption is a reduction in the proportional hazard. Furthermore, such an assumption is carried across time, regardless of the first 48 hours after cerebral aneurysm bleed-