

# Microsurgical Treatment of Unruptured Intracranial Aneurysms

*A Consecutive Surgical Experience of  
450 Cases in the Endovascular Era*

THE NATIONAL  
**BRAIN**  
ANEURYSM  
CENTER



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## Abstract

### Objective

We report the management and outcomes of 55 patients with 60 intracranial aneurysms (IAs) arising distal to the major branch points of the Circle of Willis and vertebrobasilar system.

### Methods

From July, 1997 to December, 2006, our neurovascular service treated more than 2,000 IAs in 1,850 patients. We reviewed our database retrospectively to identify peripherally located IAs. Mycotic aneurysms and IAs associated with an arteriovenous malformation or an atrial myxoma were excluded.

### Results

We encountered 60 peripheral IAs in 55 patients. Forty-one (68%) were unruptured; 19 (32%) had bled. There were 42 small, seven large, and 11 giant lesions. The majority of aneurysms were wide-necked or fusiform making open surgical repair the preferred treatment in most cases. Fifty-three were treated surgically—direct clip reconstruction (26), trapping/proximal occlusion with distal revascularization (21), excision with end-to-end anastomosis (3), or circumferential wrap/clip reconstruction (3). Six aneurysms were coiled directly, and one patient underwent endovascular parent artery occlusion across the aneurysm neck. Overall, 49 patients had good outcomes, four were left with new neurological deficits, and two died.

### Conclusions

Peripherally situated aneurysms are rare. A disproportionate percentage of large and giant aneurysms were encountered in this group. Management often required open surgical treatment including revascularization to protect the distal cerebral territory. Parent artery preservation was possible in the majority of cases, and most patients enjoyed a good outcome.

## Introduction

Intracranial aneurysms (IAs) arising distal to the major branch points of the Circle of Willis and vertebrobasilar system are uncommon (2,4). These lesions are often fusiform, may not be associated with an arterial branch point, and reach large or giant size in a significant percentage of cases. As a result, many of these aneurysms are not amenable to traditional surgical neck clipping or simple endovascular coil embolization. We present an unusual series of patients with peripherally located IAs. Management strategies for these uncommon lesions are described, and the literature is reviewed.

## Patients and Materials

We retrospectively reviewed the records of all patients with intracranial aneurysms managed by our neurovascular service from July, 1997 to December, 2006. Of 1,850 patients with more than 2,000 intracranial aneurysms treated during this period, we identified 60 (2.9%) “peripherally” located IAs. We defined an aneurysm as “peripheral” if it arose distal to the middle cerebral artery (MCA) bifurcation or to the origins of the pericallosal artery, posterior cerebral artery (PCA), superior cerebellar artery (SCA), anterior inferior cerebellar artery (AICA), or posterior inferior cerebellar artery (PICA). Two patients with peripherally located frontopolar artery aneurysms were included as well. Mycotic lesions and IAs associated with an arteriovenous malformation or an atrial myxoma were excluded. Follow-up review ranged from three months to eight years (average 3.2 years), and no patient was lost to follow-up review.

## Results

We encountered 60 peripheral IAs in 55 patients. Locations included MCA (26), PICA (17), PCA (9), ACA (6), SCA (1), AICA (1). Ages ranged from 5 to 84 years. Forty-one (68%) were unruptured; 19 (32%) had bled. There were 42 (70%) small (maximal diameter < 1.0 cm), seven (12%) large (maximal diameter 1.0-2.5 cm), and 11 (18%) giant (maximal diameter >2.5 cm) lesions. The majority of aneurysms (83%) were wide-necked or fusiform and were not associated with an arterial branch point. Eight patients had additional aneurysms, and five of these had multiple peripheral IAs.

Seven aneurysms (12%) were treated endovascularly. Of these, six aneurysms were amenable to direct coil embolization. One patient underwent endovascular parent artery occlusion across the aneurysm neck. Fifty-three aneurysms (88%) were treated surgically. The techniques utilized included direct clip occlusion (26), trapping/proximal occlusion with distal revascularization (21), excision with end-to-end anastomosis (3), and circumferential wrap/clip reconstruction (3).

Outcomes were generally determined by neurological condition at the time of presentation. Overall, 49 patients had good outcomes, four developed new neurological deficits, and two died. The four new deficits included three strokes (one major, two mild) and one patient who developed focal seizures requiring long-term anticonvulsant therapy. During the follow-up period, no patient rebled from a previously ruptured aneurysm and no patient bled from a previously unruptured aneurysm. One patient developed lower extremity deep venous thrombosis requiring anticoagulation therapy. Eight patients required temporary external ventricular drainage for acute hydrocephalus after SAH. Of these, three patients required placement of a ventriculoperitoneal shunt.

## Discussion

The majority of IAs are saccular lesions that arise at arterial branch points on the Circle of Willis, the proximal aspect or bifurcation of the MCA, or at the

origins of the major vessels of the vertebrobasilar system. With the exception of distal anterior cerebral artery aneurysms arising at the origin of the pericallosal artery, true peripheral IAs are uncommon (2-4,6-8). In agreement with previous reports, we encountered a significant percentage of fusiform or wide-necked lesions and a disproportionately high percentage of large and giant aneurysms in our series (2,4). These factors substantially complicate treatment because many of these lesions cannot be managed by direct surgical neck clipping or simple coil embolization of the aneurysm sac.

Because of their relative rarity, the management of peripheral IAs remains controversial (1,2,4,5,7). Surgical options include direct clip reconstruction, vascular occlusion with or without distal revascularization, excision with end-to-end anastomosis, or some form of wrapping (1,4,7,9). Endovascular options include coil embolization of those lesions that have a relatively narrow-neck, stent-supported coiling, or parent artery occlusion (2,5). Traditionally, the majority of peripheral IAs managed endovascularly have been treated with parent artery occlusion (5). Although various forms of balloon test occlusion and amytal testing have been described in this setting, the results have been notoriously unreliable, and there is no test that can assess definitively the adequacy of collateral circulation (2,5).

In our series, the aneurysm could be reconstructed with surgical clips in 26 cases (43%). Often, it was difficult to predict in advance which aneurysms would be amenable to clip reconstruction, and several cases of large or giant, thrombotic lesions were unexpectedly found to be readily "clippable". In these cases, intraoperative angiography was invaluable in assessing the reconstructed vessel and often resulted in clip repositioning or placement of additional clips. Overall, the parent artery could be preserved in 35 (58%) of all aneurysms treated in our experience. Given this, we would question the appropriateness of an approach that calls for "universal" endovascular parent artery occlusion without revascularization, as has been advocated by some in the past (2,5).

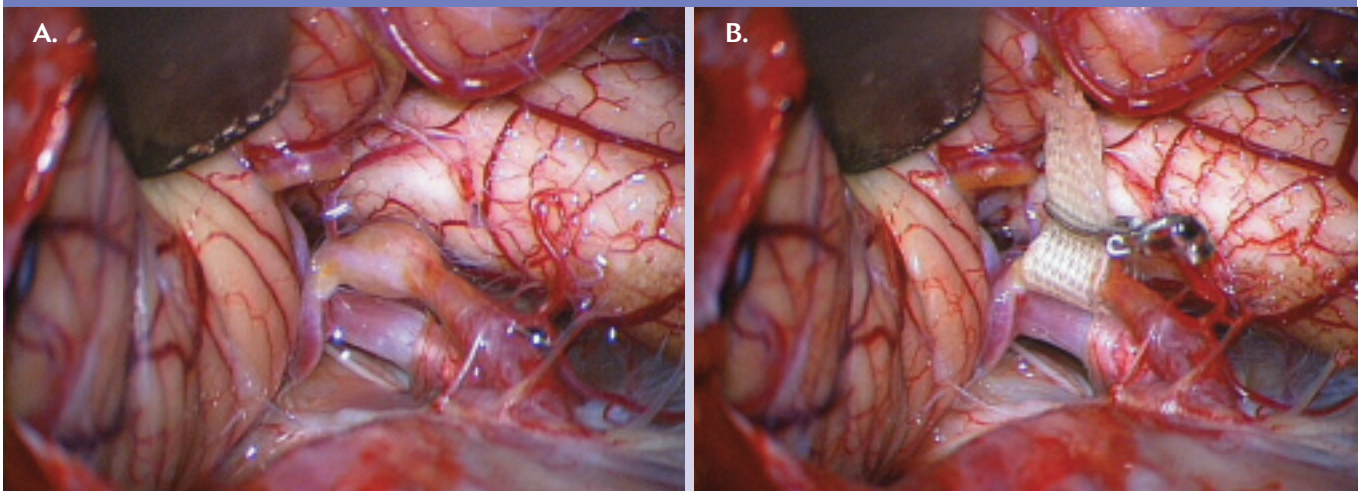
## Conclusions

Peripheral IAs are uncommon lesions that differ from typical saccular IAs and have unique management considerations. We describe an unusual series of 60 peripheral IAs highlighting the management of these lesions. In general, microsurgical exploration was favored over endovascular parent artery occlusion because of the potential for direct clip reconstruction with parent artery preservation or distal revascularization when vascular sacrifice was necessary.

The following points are underscored. Peripherally situated aneurysms are rare, but represent an important part of a subspecialized neurovascular

practice. A disproportionate percentage of large and giant aneurysms are encountered in this group. The involved parent artery was often of larger caliber than would have been expected given its peripheral location. Combining surgical and endovascular techniques, parent artery preservation was possible in more than 50% of our cases. When parent artery sacrifice was necessary, the use of distal revascularization was safe and highly effective in preventing distal ischemic injury. Using a thoughtful, individualized approach, a successful outcome was achieved in the majority of patients in our series.

**Figure 1.**



Intraoperative photographs demonstrate a fusiform aneurysm with atheromatous changes involving the PICA distal to its origin from the vertebral artery before (A) and after (B) wrap/clip reconstruction sparing critical brainstem perforators.

## References

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