Advances in Open Neurovascular Surgery 2007

Bradley A. Gross, MD; Bernard R. Bendok, MD; Ziad A. Hage, MD; Issam A. Awad, MD; H. Hunt Batjer, MD

We have read with great interest the Advances in Stroke 2007 subsection in February’s issue of Stroke and congratulate Dr Fisher for nicely amalgamating articles addressing some of the most pressing advances and shortcomings in stroke management over the past year.1 Although advances in interventional approaches to stroke and neurovascular disease were nicely outlined,1,2 we noticed little emphasis on open neurosurgical approaches. Of particular interest to our cerebrovascular team, reviewing the success of hemispherectomy for malignant middle cerebral artery infarction1,3 served to support the evidence that we have observed at our institution for this successful intervention for an oftentimes devastating disease. We would, however, like to further highlight more of the exciting advances in open cerebrovascular neurosurgery that have emerged over the past year for stroke and neurovascular diseases.

Aneurysms

As already acknowledged in your Advances in Stroke 2007 subsection,2 the results of the International Study of Unruptured Intracranial Aneurysms (ISUIA) continued to meet with considerable scrutiny over the past year. Promisingly, advances in both endovascular and neurosurgical approaches to aneurysm treatment continued in 2007. Kassam et al reported the first endoscopic endonasal clipping of a superior hypophyseal aneurysm.4 Kim et al presented a novel approach to the management of fusiform aneurysms, circumferentially cinching a Gore-Tex sling against an already clipped reconstructed parent vessel by clipping the free ends of the sling immediately adjacent to the vessel.5 Krisht et al presented their impressive experience with 50 complex basilar aneurysms managed through a pretemporal, transzygomatic transcavernous approach.6 These aneurysms, unamenable to endovascular coiling, were successfully clipped in 98% of cases with no procedure-related mortality and 6-month follow-up Rankin scores of 0 to 2 in 92% of patients. Given that half of the patients in this series presented with subarachnoid hemorrhage, this is a truly remarkable contrast to the 30.9% death or dependence rate at 1 year reported by ISAT for clipping of ruptured, predominantly small anterior circulation aneurysms.7 In a series by Krayenbuhl et al, this same group describes a novel technique to minimize cavernous sinus bleeding during surgery in or through the cavernous sinus. The technique involves injecting fibrin glue into different cavernous sinus compartments, thus achieving hemostasis.8 Initially used by Hernesniemi and colleagues for venous hemostasis in the tentorium,9 the authors have applied the technique to the cavernous sinus using it successfully in 217 surgical cases. No significant clinical side effects were reported. Re-establishment of flow within the cavernous sinus was noted as early as 2 months postoperatively on follow-up angiography.

Using superficial temporal artery–posterior cerebral artery (STA-PCA) bypass, Takahashi et al reported complete thrombosis and dramatic shrinkage of a giant, partially thrombosed basilar tip aneurysm that could not be otherwise obliterated after clipping the unilateral posterior cerebral artery and posterior communicating artery, forming a “blind alley.”10 Sanchez-Mejia and Lawton reported the successful trapping of 3 distal dolichoectatic aneurysms of basilar perforating and circumferential arteries, exceedingly rare yet challenging lesions that are not amenable to endovascular therapy.11

Exciting advances in intraoperative vascular imaging continued in 2007 with Suzuki et al describing the use of intravenous fluorescein sodium in 23 patients undergoing aneurysm clipping.12 Twelve posterior communicating arteries, 12 anterior choroidal arteries, 4 lenticulostriate arteries, 3 recurrent arteries of Heubner, 3 hypothalamic arteries, one ophthalmic artery, one perforator from the vertebral artery, and one posterior thalamoperforator were visualized, and all 23 patients had no postoperative events from perforator artery occlusion. de Oliveira et al added to the burgeoning collection of literature on intraoperative indocyanine green videoangiography, describing its use in 60 patients and citing the correction of a clip application in one of 11 cases in which the aneurysm was close to a visible perforator (occluded P1 adjacent to a basilar apex aneurysm).13 The cultivation of these methods strikes a blow to a formerly relatively common cause of morbidity in open aneurysm surgery, namely, infarction secondary to inadvertent branch occlusion. Quantitative frequency-domain near-infrared spectroscopy, used by Calderon-Arunlphi et al in 25 neurovascular procedures to allow for continuous intraoperative measuring of tissue oxygen saturation, is yet another new approach presented in 2007 to measure intraoperative ischemia.14

Received March 7, 2008; final revision received April 30, 2008; accepted May 7, 2008.

From the Department of Neurological Surgery, Northwestern University Feinberg School of Medicine, Chicago, Ill.

Correspondence to Bernard R. Bendok, Northwestern University, Suite 2210 676 N St Clair, Chicago, IL 60611. E-mail bbendok@nmff.org


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Stroke is available at http://stroke.ahajournals.org

DOI: 10.1161/STROKEAHA.108.519629

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Vascular Malformations
Several intraoperative imaging advances particularly pertinent to the neurosurgical management of arteriovenous malformations and arteriovenous fistulae were reported. Intraoperative angiographic roadmapping, allowing for smaller craniotomies, more facile approaches, and the ability to localize small fistulae that were not visible on MRI or CT angiography, was reported by Ayad et al.13 Both Mathiesen et al16 and Unsgaard et al17 used stereoscopic navigation-controlled display of preoperative three-dimensional MR angiography and intraoperative 3-dimensional ultrasound angiography in the extirpation of 9 arteriovenous malformations. These imaging techniques allowed for identification and clipping of arterial feeders early on in the dissection, identification of perinodal dissection planes, intraoperative mapping of the size of the nidus, detection of residual nidus, and detection of possible brain shift.

There have been continuing reports defining arteriovenous malformation obliteration rates and complications after radiosurgery treatment,18–20 including a large series of pediatric arteriovenous malformation cases treated with similar outcome as adults.19 Other reports have added significant information to expected results of arteriovenous malformation or cavernous malformation treatments with various modalities.21–28

The application of intraoperative diffusion tensor imaging and white matter tractography continues to redefine operability for a plethora of vascular lesions. Chen et al reported their experience with this imaging technique in 10 patients with brainstem lesions, including 7 cavernomas.23 In all cases, no worsening of motor or sensory deficits was reported. In fact, all 7 patients undergoing excision of their brainstem cavernomas had improvement of motor and sensory deficits postoperatively.

Bypass
In the ever-advancing field of extracranial–intracranial and intracranial–intracranial bypass, Bremmer and colleagues introduced the novel sutureless excimer laser-assisted nonocclusive anastomosis technique in combination with an expanded polytetrafluoroethylene graft.29 Expanding on the already remarkable ELANA technique that has allowed for such feats as successful transylvian external carotid to posterior cerebral bypass,30 this easier to use approach allowed for shortened procedure times while maintaining commendable patency rates (89%) when tested in rabbits. Alternatively, Ferroli et al demonstrated the usefulness of self-closing nitinol U-clips (Medtronic, Inc, Minneapolis, Minn) for the construction of a high-flow external carotid artery–M2 bypass before trapping a giant serpentine middle cerebral artery aneurysm.31 This approach obviated the need for suture management and knot tying, decreasing procedure time. These exciting advances emerge at a time of increased demand for bypass, because more giant or complex aneurysms are being treated and as the role of bypass for patients with symptomatic severe arterial stenosis or occlusion may become redefined by studies such as the Carotid Occlusion Surgery Study (COSS).32

Noninvasive assessment of extracranial–intracranial bypass using quantitative MR angiography (qMRA) and the integrated Noninvasive Optimal Vessel Analysis software is yet another advancing modality showing promising results. Hanjani and colleagues reported their results on the evaluation of extracranial–intracranial bypass function and flow postoperatively using qMRA. The authors compared qMRA findings with postoperative angiography and intraoperative measurements taken with the Charbel Micro-Flowprobe. They found excellent correlation between qMRA and angiography and good correlation when comparing qMRA and intraoperative flow readings, concluding that qMRA may constitute a promising substitute to angiography for follow-up of bypass grafts.33 In another important work, Hanjani and Charbel re-emphasize the usefulness of the flow-assisted surgical technique in aneurysm and extracranial–intracranial bypass surgery.34 Flow-assisted surgical technique entails the use of the Charbel Micro-Flowprobe during aneurysm surgery, thus allowing for timely and judicious clip repositioning consequently preventing vessel compromise. Flow-assisted surgical technique also involves determining the cut flow index during extracranial–intracranial bypass surgery and permits instantaneous corroboration of bypass patency as well as sensitive prediction of postoperative bypass patency.

Ongoing Clinical Trials and Looking Forward
Neurovascular surgeons have embraced large clinical trials in each of the major pathologies, and many of these have made significant progress in the past year. Meta-analyses and new trials have compiled further information comparing carotid endarterectomy and carotid angioplasty and stenting, mostly in favor of open surgery.35,36 Results from the largest trial on the role of surgery for intracerebral hemorrhage37 were presented38 with further equipoise on the role of surgery, especially in cases of lobar hematoma. Minimally invasive thrombolytic evacuation is being addressed in ongoing Phase II trials of intraventricular (CLEAR Trial) and intracerebral (MISTIE Trial) hemorrhage,39,40 and the role of prothrombotic treatment with recombinant activated Factor VII is being increasingly examined in coagulopathic patients requiring urgent neurosurgical interventions.41 The year 2007 was rich in progress for cerebrovascular neurosurgeons with significant advances in intraoperative imaging and operative techniques and their results, some of which we felt compelled to enumerate. The range of “operability” will thus continue to be refined and outcomes are likely to improve.

Disclosures
None.

References

**Key Words:** advances ■ aneurysms ■ arteriovenous malformations ■ AVM ■ cerebrovascular accident ■ cerebrovascular disease ■ stroke management ■ subarachnoid hemorrhage
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Stroke. 2009;40:324-326; originally published online November 13, 2008;
doi: 10.1161/STROKEAHA.108.519629
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
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