A raised bar for aneurysm surgery in the endovascular era

M. Yashar S. Kalani, MD, PhD, John E. Wanebo, MD, Nikolay L. Martirosyan, MD, PhD, Peter Nakaji, MD, Joseph M. Zabramski, MD, and Robert F. Spetzler, MD

Department of Neurosurgery, Barrow Neurological Institute, St. Joseph’s Hospital and Medical Center, Phoenix, Arizona

While microsurgical treatment of cerebral aneurysms has a rich and documented history of success, the impressive progression of endovascular technology, techniques, and skill has permanently altered the paradigm for treating intracranial aneurysms. The results of the International Subarachnoid Aneurysm Trial (ISAT) and the Barrow Ruptured Aneurysm Trial (BRAT) and its follow-up studies, even with the noted flaws in selection bias and crossover, have threatened to make open surgical treatment of cerebral aneurysms a relic. However, despite the successes of endovascular therapy, not all aneurysms are amenable to endovascular treatment, if for no other reason than simply because of safety concerns. Now the pendulum has swung back toward the middle with the publication of long-term evaluations of the durability of endovascular treatment showing evidence of delayed hemorrhages or growth of coiled aneurysms in endovascularly treated patients. Nonetheless, endovascular techniques provide a less invasive alternative to cerebrovascular surgery for aneurysms, and neurosurgeons now have a new standard of care to meet—that provided by endovascular management of cerebral aneurysms.

The rapid introduction of endovascular tools and techniques has revolutionized treatment for patients with a diverse array of vascular pathologies. From the Stentriever (Stryker Corp.) and thrombectomy tools for stroke to the introduction of liquid embolic agents (Onyx; Codivien, LP) for embolization of vascular malformations and cancers and flow-diverting stents for complex cerebrovascular aneurysms, endovascular tools have impressively revolutionized the treatment of these pathologies over the past decade. These neurointerventional techniques have indeed raised the bar for open aneurysm surgery and have prompted cerebrovascular surgeons to innovate and push for refinement, minimization of morbidity, and continued durability of treatment associated with aneurysm surgery. Thus, during the same period, surgical advances have continued to make microsurgery—the most durable technique for treating aneurysms—safer, more cosmetically appealing, and less invasive.

Despite rapid advances in endovascular techniques, there remain patients with aneurysms who are not ideal candidates for endovascular treatment, although they are still treated with these techniques, often because of a lack of availability of a surgeon who is well versed in and comfortable with open surgery. In an era when most of the trainees in North American neurosurgery residency programs complete their training for surgical treatment of aneurysms after having treated fewer than 50 aneurysms, maintaining excellence while continuing to teach microsurgical treatment of aneurysms remains both a necessity and a priority. Herein, we review advances in surgical treatment of aneurysms and highlight the importance of continued training in microsurgical techniques.

Minimally Invasive Tailored Craniotomies

The field of skull base and cerebrovascular surgery has witnessed a transition from large craniotomies that provided extensive views of the anatomy at the skull base to more tailored approaches that minimize brain exposure while continuing to provide adequate visualization without marginalizing safety. The trend toward miniaturization of craniotomies stems from patient demand for better cosmesis. Improvements in microscopes and surgical instrumentation and the incorporation of neuro-navigation into surgical treatment paradigms for aneurysms have allowed surgeons to expose vascular lesions safely while minimizing morbidity to the adjacent brain. Although to date, no randomized trial has documented decreased use of pain medications or improved cosmetic outcomes with smaller openings, and there are unlikely to be any such trials, experience has demonstrated shorter

ABBREVIATIONS BRAT = Barrow Ruptured Aneurysm Trial; ICG = indocyanine green; ISAT = International Subarachnoid Aneurysm Trial.

INCLUDE WHEN CITING Published online February 24, 2017; DOI: 10.3171/2016.9.JNS161914.
lengths of stay and improved subjective patient satisfaction with the use of tailored craniotomies compared with the use of larger skull base approaches.30

Tailored craniotomies are particularly appropriate for cerebral aneurysm surgery, given that most of these lesions reside at a depth from the skull opening, which renders them particularly attractive for such an approach (Fig. 1).

Tailored, minimally invasive craniotomies do not violate the basic tenets of aneurysm surgery. With a tailored approach, the surgeon can readily obtain proximal and distal control, perform dissection of perforators and the aneurysm neck, and close and obliterate the aneurysm without risk to the patient. When a tailored or “keyhole” craniotomy is used, patient positioning is of paramount impor-

FIG. 1. The “keyhole” concept and tailored minimally invasive skull base approaches. The keyhole concept is based on the premise that minimizing trauma to structures in the operative path of the surgeon facilitates performance of a safe and effective operation. However, the association of the keyhole concept with small craniotomies is a misconception. A: Artist’s illustration showing examples of keyhole approaches. A keyhole craniotomy for a cortical lesion should be the size of the lesion (I and II) and, by necessity, may be large (II). For deep-seated lesions (III), the superficial opening can be minimized because more cortical exposure gains the surgeon little at the operative depth. Minimally invasive skull base approaches create a less traumatic exposure without sacrificing the working angles and surgical degrees of freedom necessary to safely approach and treat lesions. B and C: Preoperative MR angiogram (B) and intraoperative photograph (C) of an unruptured anterior communicating artery aneurysm treated using an orbitozygomatic approach. D and E: Preoperative CT angiogram (D) and intraoperative photograph (E) of a similar aneurysm treated using a keyhole supraorbital craniotomy. Instruments in photographs provide perspective. For simple, unruptured aneurysms, the addition of the larger skull base craniotomy adds little for exposure and treatment of the aneurysm. With ruptured aneurysms, brain edema may necessitate a larger opening. Panels A, C, and E are used with permission from Barrow Neurological Institute. Figure is available in color online only.