Microsurgical Approach to Giant Intracranial Aneurysms

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Although rare among intracranial lesions, giant intracranial aneurysms pose a unique degree of complexity and technical difficulty. The nature of their presentation includes haemorrhage, mass effect, thromboembolism, or all three. Their prognosis has typically been poor. Precise perisurgical planning and particularly mastery of the surgical techniques are crucial for a potentially improved outcome. This article therefore focus on microsurgical approaches to giant intracranial aneurysms.

Preoperative Management and Diagnostic Evaluation

Understanding the lesion and its relation to its surrounding structures is imperative before any surgical intervention is undertaken. Computed tomography (CT), CT angiography, magnetic resonance imaging (MRI), digital subtraction angiography, and MR angiography are key studies that can provide information about the anatomy and morphology of the aneurysm as well as the location of branched vessels⁶.

CT may demonstrate a calcified lesion with eggshell borders. MRI can demonstrate a signal void. Four-vessel cerebral angiography can demonstrate the anatomy, location, adjacent branched vessels, collateral circulation, and distal cerebral perfusion. Cerebral angiography must be interpreted cautiously because the ac-

tual size of the aneurysm may not be shown accurately because of intra-aneurysmal thrombus. CT angiography can provide a three-dimensional reconstruction of the lesion and surrounding vessels.

Surgical Approach to Giant Aneurysms of the Anterior Circulation

There are multiple ways of surgically managing giant intracerebral aneurysms. Although the surgeon's experience plays an important role, the specific surgical modality used depends on the location, size, and shape of the aneurysm as well as on the patient's medical condition. The goal should be to maximize exposure of the aneurysm to obtain adequate visualization of the anatomy and to insure effective clip placement with minimum retraction of the parenchyma.

For treatment of aneurysms of the anterior circulation, the pterional transsylvian approach has been widely practiced by most neurosurgeons. For this procedure a frontotemporal craniotomy is performed. The squamosal portion of the temporal bone is often removed inferiorly, and preferably the lesser wing of the sphenoid bone is drilled to the anterior clinoid process. Various modifications of the pterional transsylvian approach have been proposed to avoid retraction of vital brain structures. One

modification involves the orbitozygomatic-pterional approach, which requires the en bloc removal of the superior and lateral orbital margins, orbital roof, and anterior zygoma¹⁻⁶.

This additional bony removal improves access to the internal carotid artery (ICA), anterior circulation involving the frontal lobe, temporal lobe, and sylvian fissure. It also provides access to the circle of Willis and to superior basilar artery aneurysms including those involving the posterior cerebral artery, superior cerebellar artery, and basilar bifurcation³⁻⁶. The exposure gained by this procedure provides the extra room necessary for a bypass procedure. Depending on the location of the aneurysm, in rare instances a complex giant aneurysm may not be readily accessed through this approach. Hence, an interhemispheric approach may be warranted.

Surgical Approaches to Giant Aneurysms of the Posterior Circulation

Four approaches are proposed for the treatment of giant aneurysms of the posterior circulation²⁻⁶. The exact approach is determined by the location of the lesion and its relation to the basilar artery, which is divided into the upper basilar zone, midbasilar zone, and lower vertebrbasilar zone. The extended orbitozygomatic approach is routinely used for upper basilar zone aneurysms. Removal of the anterior and posterior clinoid processes as well as a portion of the clivus is also warranted for the upper basilar zone.

The transpetrosal approach is used for the midbasilar zone. The transpetrosal approach is further divided into the retrolabyrinthine, translabyrinthine, and transcochlear approaches. The retrolabyrinthine approach requires removal of the mastoid process of the temporal bone. The superior and posterior semicircular canals are skeletonized. Hearing is preserved because the cochlea and semicircular canals are spared. In contrast, the translabyrinthine approach requires removal of the semicircular canals and skeletonization of the posterior half of the internal auditory canal. Hence, hearing is sacrificed. The transcochlear approach requires resection of the petrous bone, semicircular canals, internal auditory canal, cochlea, and tympanic portion. It is used when manipulation of the brain stem at the clivus is necessary.

The far-lateral approach is reserved for exposure of the vertebrobasilar zone. This approach requires resection of the posterior two thirds of the occipital condyle, the inferior rim of the foramen magnum, and the posterolateral arch of C1 to the level of the sulcus arteriosus of the vertebral artery. It provides excellent access to the vertebral artery, vertebrobasilar junction, and posterior inferior cerebellar artery.

When a lesion involves multiple zones, a combined approach is implemented. For example, a far-lateral approach can be combined with a transpetrosal or a combined supratentorial-infratentorial approach to provide more exposure of the clivus to attain access to giant aneurysms involving the mid- and lower basilar artery. Similar exposure can be achieved using a presigmoid transpetrosal approach combined with a supratentorial-infratentorial craniotomy.

Direct Clipping of Giant Intracranial Aneurysms

The structure of giant aneurysms is complex, and they can require long or multiple short clips. The neck is friable. Therefore clips must be placed meticulously with minimum manipulation of the aneurysm. Clips must be placed so that the patency of the parent and perforating arteries is preserved. Initially, both proximal and distal vascular control must be obtained. Proximal control may require removal of the anterior clinoid process.

Aneurysms located at the level of the clinoid, ophthalmic artery, or both may require a different approach to obtain proximal control. One method involves cervical dissection to expose and isolate the cervical ICA. Other options involve endovascular balloon occlusion of the cavernous segment of the ICA and exposure of the petrous ICA through Glasscock's triangle²⁻⁶.

Posterior circulation aneurysms pose a different level of difficulty. A temporary clip may be placed directly inferior to the superior cerebellar artery. Vertebrobasilar junction aneurysms pose an even more difficult situation: A temporary clip may be placed only on a parent vertebral artery. Placement of temporary aneurysm clips for vascular control helps reduce the mass of an aneurysm, thereby improving visualization of the vascular anatomy.

Through improved visualization, securing the aneurysm neck may require less manipulation of the aneurysm. It also helps avoid clipping of parent and perforating vessels. When thrombus or calcification is present, however, obtaining proper vascular control may be challenging. To do so may necessitate incision and drainage of the thrombus through sharp dissection or use of ultrasonic surgical aspiration.

Select patients with a posterior giant aneurysm may require hypothermic cardiac standstill to allow clipping³⁻⁶. In our experience with 98 patients, acceptable results can be obtained with unclippable aneurysms when this adjunct is used.

All patients are evaluated with intraoperative or postoperative angiography to confirm clip placement and patency of parent and perforating vessels and bypass grafts. Residual aneurysms are treated with direct surgical or endovascular techniques.

Alternate Approach to Giant Intracranial Aneurysms

Aneurysms that are unamenable to clipping may be treated through different routes: proximal vessel occlusion, trapping, aneurysmorrhaphy, and/or excision of the aneurysm followed by primary reanastomosis²⁻⁶.

In aneurysm trapping the clips are applied as close to the aneurysm as possible to avoid accidental occlusion of the parent or perforating vessels. In unforeseen circumstances, proximal occlusion may be the only safe choice when perforating branches arise adjacent to the aneurysm. Dolichoectatic aneurysms may be treated with proximal or distal parent vessel

occlusion. This treatment creates enough turbulence within the aneurysm to result in thrombosis. In aneurysmorrhaphy the vessels are reconstructed primarily if possible. The parent vessels may require mobilization to achieve primary closure.

Cerebral Revascularization

Unclippable giant aneurysms that require trapping, proximal vessel occlusion, or aneurysmorrhaphy may require revascularization to avoid ischemic insult due to decreased cerebral blood flow¹⁻⁶. Clinical and angiographic evidence provides adequate information that may indicate the need for revascularization. If a vessel appears incompetent, revascularization is warranted. Poor collateral circulation and decreased distal flow on preoperative angiography revascularization are also indications for revascularization. Xenon CT, cerebral blood flow studies, positron emission tomography, and balloon test occlusion may provide additional information indicating the need for revascularization.

Conclusions

The surgical management of giant intracranial aneurysms can be complex. Thorough understanding of the anatomy and morphology of the aneurysm is imperative to achieve a successful outcome. A number of direct and indirect methods are available. The most suitable approach is based on the size, shape, and location of the lesion. Revascularization may be warranted for specific situations when ischemic insult is anticipated.

References

- 1 Lawton MT, Spetzler RF: Management strategies for giant intracranial aneurysms. *Contemp Neurosurg* 16: 1-6, 1994.
- 2 Lawton MT, Spetzler RF: Surgical management of giant intracranial aneurysms: experience with 171 patients. *Clin Neurosurg* 42: 245-266, 1995.
- 3 Lawton MT, Spetzler RF: Surgical strategies for giant intracranial aneurysms. *Neurosurg Clin N Am* 9: 725-742, 1998.
- 4 Lawton MT, Spetzler RF: Surgical strategies for giant intracranial aneurysms. *Acta Neurochir Suppl (Wien)* 72: 141-156, 1999.
- 5 Spetzler RF, Riina HA et Al: Giant aneurysms. *Neurosurgery* 49: 902-908, 2001.
- 6 Thompson BG Jr KG, Hamilton MG et Al: Special techniques for managing giant intracranial aneurysms, in Tindall GT CP, Barrow DL (eds): *The Practice of Neurosurgery*. Baltimore: Williams and Wilkins 1: 2105-2125, 1996.

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