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Operative Techniques in

Neurosurgery

Giant Vertebral Artery Aneurysms

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Giant vertebral aneurysms remain some of the most challenging lesions encountered by cerebrovascular surgeons today. Advances in surgical skull base and bypass techniques, combined with new endovascular techniques, have decreased the morbidity and mortality rate associated with treating these lesions. This article outlines the indications, planning, and surgical and endovascular techniques that we use to treat these aneurysms.
Oper Tech Neurosurg 8:98-103

KEYWORDS aneurysm, giant, vertebral, endovascular, stent

Giant aneurysms of the posterior circulation account for about one-third of all giant aneurysms, and most occur at the basilar trunk or basilar apex.[1] Giant aneurysms of the posterior inferior cerebellar artery (PICA) also occur as do lesions of the distal vertebral artery and its confluence. Because these aneurysms are in difficult locations and are associated with a high rate of surgical morbidity, endovascular options feature more prominently in their treatment than in aneurysms of the anterior circulation.

This article presents surgical approaches to proximal posterior circulation aneurysms and some endovascular options for obliterating or trapping these lesions. Dolichoectatic or giant serpentine aneurysms are included in the discussion. These lesions are fusiform and can involve the entire circumference of the afflicted vessel. They often become symptomatic with mass effect on the brain stem. Their treatment can require parent vessel sacrifice with or without bypass or other creative solutions. Basilar trunk and apex lesions are discussed elsewhere.

Preoperative Evaluation

All patients undergo comprehensive evaluation with conventional laboratory studies, electrocardiography, computed tomography (CT), magnetic resonance imaging (MRI), and angiography with rotational views, if possible. During surgery involving these lesions, the lower cranial nerves are often manipulated with attendant speech and swallowing difficulties.[2] Because this risk is so high with giant aneurysms, the possibility of tracheotomy and placing a feeding tube preoperatively must be considered. Vessel sacrifice is also common in the treatment of these lesions. If sacrifice of a dominant vertebral artery is anticipated, balloon trial occlusion (BTO) of the vertebral artery should be performed.

Hydrocephalus

This symptom is associated with giant aneurysms of the posterior fossa and is caused by obstruction of the ventricular system. It is tempting to target hydrocephalus for therapy, particularly in patients deemed too old or too infirm to undergo definitive surgery. However, the results of shunting such patients is often poor. Soon after the shunt is placed, mass effect frequently worsens and the aneurysm can even rupture.[3,4]

Surgical Technique

Most aneurysms of the proximal vertebral artery, PICA, the distal vertebral artery, and the vertebral confluence can be treated by some variation of a far-lateral, suboccipital exposure. Lesions at the confluence or fusiform lesions involving the basilar trunk may benefit from increasing surgical exposure by addition of a presigmoid or transpetrosal approach. A superficial temporal artery or vein bypass into the posterior communicating artery can be performed via a pterional exposure as described elsewhere in this issue.

Head Position

The patient is placed either supine with a shoulder roll under the ipsilateral shoulder to reduce the degree of neck rotation or in the lateral park-bench position with the down arm slung from beneath the operating table in the space created by the Mayfield head holder. The patient's head is placed in three-point skull fixation with the nose horizontal with the floor. Tipping the vertex of the head slightly toward the floor allows the space between the mastoid and the shoulder to open and facilitates an inferior to superior view. Forward displacement of the shoulder also increases access to the operative corridor.

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1092-440X/05/$-see front matter
doi:10.1053/j.otns.2005.09.009

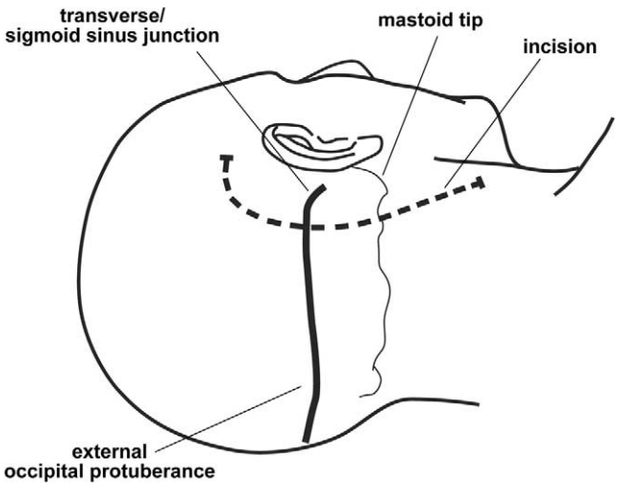

Figure 1 "C" incision for suboccipital craniotomy.

Incision and Craniotomy

A curvilinear or large "C"-shaped incision begins about 1 cm above the helix and is extended posteriorly and inferiorly about 5 cm below the mastoid tip (Fig. 1). A curvilinear incision with the lateral limb extending to the mastoid tip and the medial incision beginning at the midline and extending to the level of the midcervical spine is an excellent alternative. The initial scalp flap is begun at the superior extent of the incision and is elevated in a subgaleal fashion. Elevation of the flap continues into the cervical portion of the exposure, and a large subcutaneous skin flap is elevated without initial elevation of the cervical musculature (Fig. 2). The scalp flap is elevated directly behind the external auditory canal. Because the skin and subcutaneous tissues often become very thin there, "button-holing" of the skin can occur easily. A sponge roll is placed beneath the flap and fishhook retractors are used.

Attention is then directed to the cervical musculature. The sternocleidomastoid muscle is visualized. A cleft between the sternal and clavicular bellies of this muscle is identified by a small amount of adipose tissue. The belly of this muscle is split in the direction of the fibers with monopolar electrocautery. The posterior portion of the muscle is reflected with the splenius capitus posteriorly away from the suboccipital region. A cuff is left on the subocciput for later use to re-attach the muscle (Fig. 3).

The deep musculature of the suboccipital triangle is encountered, and knowledge of the anatomy is mandatory for safe exposure of the vertebral artery. The obliquus muscles are removed from the C1 transverse process and reflected medially, exposing the perivertebral venous plexus and vertebral artery. The bleeding sometimes encountered from the perivertebral plexus can be controlled with bipolar electrocautery or topical hemostatic agents (Fig. 4).

The bony resection is performed with a high-speed drill. Typically, a craniectomy rather than a craniotomy is performed and later reconstructed with acrylic. The bony opening can be as high as the transverse-sigmoid junction and should include the foramen magnum. Removal of the ring of C1 can help provide an inferior-to-superior view. The drilling of the foramen magnum should continue to the atlanto-occipital joint. Although the occipital condyle can be partially resected, it is seldom necessary to do so. The dura is then opened in a curved fashion with the base of the incision on the sigmoid sinus (Fig. 5).

Intracranial Dissection

The initial intracranial dissection with the use of the operative microscope entails a sharp opening of the cisterna magna to allow the evacuation of cerebrospinal fluid. This opening permits relaxation of the cerebellum and allows the proximal vertebral artery to be identified deep to the spinal root of cranial nerve XI. Sharp dissection of the arachnoid around the IX, X, and XI cranial nerve complex minimizes inadvertent traction on the nerves. The proximal vertebral artery is followed distally, and the cerebellar tonsil is gently elevated to expose lower cranial nerves and the distal PICA (Fig. 6). A large aneurysm mass may obscure the relationship of PICA to the vertebral artery. The vertebral artery makes a sharp medial bend at the origin of PICA. The distal vertebral artery is below and medial to the aneurysm. Occasionally, it is identified by dissecting above cranial nerves VII and VIII and looking medially.

Treatment Options

For a lesion involving the origin of PICA, clip reconstruction is often possible.[5] A long straight clip placed parallel to the axis of the vertebral artery provides good visualization; however, a single clip often lacks the closing force to obliterate the aneurysm. The use of a fenestrated clip in tandem to the straight clip can provide additional force at the distal neck. If the origin of PICA is from the actual neck of the aneurysm or if PICA is densely adherent to the aneurysm, a fenestrated clip or series of clips with the PICA placed in the fenestration can be helpful.

As with other giant aneurysms, complete trapping with temporary clips on the proximal and distal vertebral artery as well as on the distal PICA allows the aneurysm to be opened and deflated, which facilitates clip reconstruction. The PICA often emerges from the aneurysmal neck and must be preserved. In larger or irregular lesions an anatomical reconstruction may not be possible. Fashioning the vertebral artery

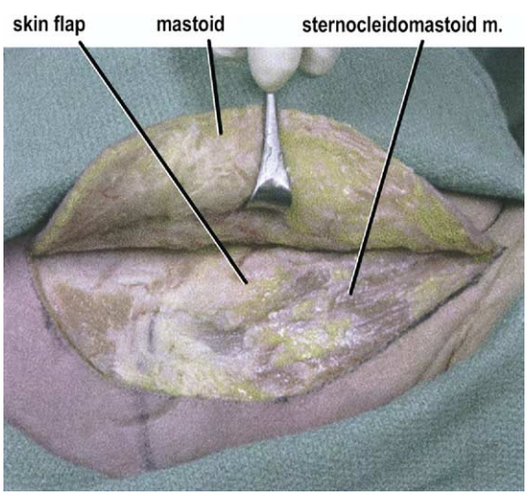

Figure 2 A subcutaneous flap is elevated.