Retrolabyrinthine transsigmoid approach to basilar trunk and vertebrobasilar artery junction aneurysms

Technical note

STEVEN L. GIANNOTTA, M.D., AND DENNIS R. MACERI, M.D.
Departments of Neurological Surgery and Otolaryngology, Los Angeles County–University of Southern California Medical Center, Los Angeles, California

A retrolabyrinthine transsigmoid approach was employed successfully in three patients with vertebrobasilar aneurysms. The major benefits of this technique include a relatively shallow depth of exposure, lack of brain stem retraction, and simplicity as compared to traditional and some recently proposed methods. All three patients have returned to their previous activities.

KEY WORDS • aneurysm • subarachnoid hemorrhage • basilar artery • vertebral artery • operative approach

THE surgical management of aneurysms of the basilar trunk and vertebrobasilar artery junction poses a formidable challenge even to the most accomplished practitioner. Access to this area is hampered by the overlying brain stem, the web of intervening cranial nerves (few of which exhibit much resistance to manipulative trauma), and the depth of the "valley" formed by the petrous pyramids and the clivus relative to traditional entry portals. A number of tactics have been employed in approaching basilar trunk aneurysms. Most share certain disadvantages, including a relatively confined access pathway and the necessity to retract either the brain stem, the temporal lobe, or both. A retrolabyrinthine transsigmoid craniectomy was utilized in three patients with aneurysms arising on or near the lower basilar artery segment in an effort to obviate some of these problems. The technique used and a summary of the clinical course in these patients are presented.

Operative Technique

The side on which the aneurysm is to be approached is predicated on the specific anatomical orientation of the neck and/or the relative size of the sigmoid sinuses. Following placement of a lumbar drain, the patient is positioned supine with the head angled 45° away from the side of entry. This enables the ipsilateral cerebellar hemisphere and brain stem to be dependent with respect to the petrous bone and clivus. With cerebrospinal fluid (CSF) evacuation and osmotic diuresis, the retroclival space opens widely. Pin headrest fixation is optional. Since the headrest frequently serves as the base for self-retaining retractor systems, it was used in our cases in the event that retraction became necessary. A slightly curved scalp incision is made 3 cm behind the ear, extending from the asterion to just below the rim of the foramen magnum. Retractors are placed and a modified mastoidectomy is performed using a suitable high-speed drill. Air cells are removed from an area bordered superiorly by the floor of the middle fossa and the superior petrosal sinus, inferiorly by the jugular bulb, and anteriorly by the posterior semicircular canal.

Bone is then removed over the sigmoid and for about 4 cm posterior to it (Fig. 1). This exposes the posterior fossa dura anterior and posterior to the sigmoid sinus. Rotating the table facilitates bone removal. The dura is opened on both sides of the sigmoid sinus at the superior and inferior extent of its exposure, and the sinus is ligated and divided. The entire dural flap is then completed and reflected anteriorly, ultimately covering the intact labyrinth. Immediately after the dura is opened, the flocculus and cochlear-facial nerve complex are in view. Superiorly, the fifth cranial nerve is evident and inferiorly the ninth, 10th, and 11th nerves are readily identified.

With the relaxation afforded by CSF drainage, os-
Fig. 1. Diagram showing partial mastoidectomy and retrosigmoid craniectomy prior to dural opening. The intact semicircular canals, the mastoid segment of the facial nerve, and the sigmoid sinus are visualized.

motric diuretics, and the dependent position of the cerebellum and brain stem, a No. 5 French suction resting on a Cottonoid patty on the flocculus is all the retraction needed to begin dissection of the aneurysm. When the arachnoid of the prepontine and cerebellopontine angle cisterns is opened, the basilar artery comes into view. With further dissection this vessel can be exposed from immediately adjacent to the vertebral artery junction up to the point where the superior cerebellar artery takes off (Fig. 2). Depending on the size of intervening spaces, it may be expedient to work simultaneously on both sides of the cochlear-facial nerve complex. This exposure allows adequate room for placement of temporary clips on the proximal vertebral vessels if necessary. Following satisfactory clip ligation of the aneurysm, a tight dural closure and waxing of all open air cells should obviate potential CSF otorhinorrhea.

Case Reports

Case 1

This 28-year-old woman awoke one morning with the acute onset of nausea, vomiting, and vertigo. On admission to a local hospital, a computerized tomography (CT) scan revealed a contrast-enhancing lesion consistent with an aneurysm adjacent to the basilar artery trunk. There was no evidence of subarachnoid blood. A lumbar puncture was not performed. Cerebral angiography revealed a wide-based aneurysm originating from the left side of the basilar artery trunk near the origin of the anterior inferior cerebellar artery (AICA). The lesion was originally believed to be inoperable and the patient was discharged. Six weeks later the patient was referred to our institution, at which time her neurological examination was normal.

On June 4, 1986, a left retro labyrinthine transsigmoid craniectomy was performed through which the aneurysm was easily approached. The aneurysm exhibited a very wide base, and the presence of organized clot at the apex of the dome confirmed the previous hemorrhage. In order to obliterate as much of the neck as possible a large Sugita clip was applied. Prior attempts to treat the aneurysm with smaller clips had proved unsuccessful due to the tendency of the clips to slide off with each pulsation. The patient awoke with only the slightest facial asymmetry, which cleared by the 2nd postoperative day. On June 9, angiography confirmed the successful obliteration of the aneurysm with a small portion of the neck still visible (Fig. 3). On June 11, she was discharged and has since resumed her activities as a seamstress.

Case 2

This 44-year-old woman developed the acute onset of fulminant pulmonary edema and subsequent coma. An admission CT scan demonstrated diffuse subarachnoid blood. Within 1 week her pulmonary condition had stabilized and she had regained consciousness. Cerebral angiography demonstrated a bilobed aneurysm at the verteobasilar artery junction. On May 29, 1986, the patient was referred to the Huntington Memorial Hospital. Her neurological examination was completely normal with the exception of an unusual affect manifested by an inappropriate enthusiasm. A CT scan showed moderate hydrocephalus.

On June 5, through a retro labyrinthine transfegral approach, the aneurysm was identified. Each lobe of the aneurysm was secured with separate clips, because complete obliteration of the neck was impossible without compromising one or both vertebral arteries. Upon
Basilar and vertebrobasilar artery junction aneurysms

awakening, the patient's only deficit was a hoarse voice. She was allowed to leave the intensive care unit on the 2nd postoperative day but had to be returned suddenly on the 4th postoperative day because of falling blood pressure and spiking fevers.

Otolaryngological examination and chest x-ray films demonstrated a paralyzed vocal cord with chronic aspiration and subsequent pneumonia. A tracheostomy was performed and, with appropriate antibiotic therapy, her fever abated. A new onset of lethargy prompted a repeat CT scan which showed an increase in ventricular size since the previous scan. Placement of a lumbo-peritoneal shunt caused marked improvement in her level of consciousness. Cerebral angiography confirmed the successful obliteration of the aneurysm (Fig. 4). On July 1, the patient was discharged from the hospital, and on January 6, 1987, her tracheostomy tube was removed. Her voice and vocal cord function have returned to normal, and she has resumed her previous activities in the health insurance industry.

Case 3

This 38-year-old man suffered a subarachnoid hemorrhage during coitus on May 10, 1987. Cerebral angiography demonstrated an aneurysm arising from the left AICA at its junction with the basilar artery. The AICA went on to feed an arteriovenous malformation (AVM) of the left cerebellar hemisphere, vermis, and tonsil. On May 16, he was referred to Huntington Memorial Hospital. His neurological examination was normal with the exception of a mild stiff neck.

On May 18, the aneurysm was exposed through a retrolabyrinthine transsigmoid approach. It was clear that the aneurysm was the source of the hemorrhage and it was easily ligated with clips. He suffered no neurological deficit and was discharged on May 23, when angiography demonstrated successful obliteration of the aneurysm. On July 3, he was readmitted for elective removal of the AVM via a modification of the existing craniectomy into a more traditional lateral suboccipital approach (Fig. 5).

Discussion

Drake and Peerless have enjoyed success with either of two approaches for basilar artery aneurysms. Depending on the aneurysm's rostrocaudal location along the clivus, they used either a suboccipital or a subtemporal-transtentorial approach. The suboccipital approach (and its modifications) has the benefit of being familiar to most surgeons; however, because the rostral extent of the craniectomy is limited by the sigmoid sinus, the line of sight to the lesion is along a caudal to rostral diagonal that significantly lengthens the distance. The necessity to retract both the cerebel-
lum and the brain stem adds to potential morbidity. This risk can be lessened by a more radical removal of the ring of the foramen magnum and arch of C-1 laterally, but some medullary retraction may still be necessary.8

The subtemporal-transtentorial approach has been used effectively for basilar artery trunk aneurysms, but shares some of the drawbacks of the posterior approach.2-14'15'17'18 The line of sight is along a rostral to caudal diagonal, lengthening the distance to the lesion, and entails retraction of both the temporal lobe and the pons. Retraction damage to the temporal lobe and injury to the vein of Labbé may be lessened by adopting the extradural transpetrosal technique proposed by Kawase, et al.12 This approach suffers from a relatively constricted corridor (2 \times 1 \text{ cm}) between the trigeminal nerve and the cochlea as well as a heightened potential for hearing loss and CSF rhinorrhea. For either the suboccipital or the supratentorial approach requiring a diagonal trajectory, the ability to gain proximal or distal control of the parent vessel (especially with large aneurysms) may be compromised.

Combinations of supra- and infratentorial access have been proposed.13 Kasdon and Stein11 combined a suboccipital craniectomy with a temporal craniotomy and sectioning of the tentorium to obtain a panoramic view of the brain stem and basilar artery. Retraction was still necessary to “rotate the temporal lobe, cerebellum, and pons . . . .” They were successful in obliterating two low-lying basilar aneurysms with this technique.

Obviously, as the entry point into the posterior fossa comes closer to the clivus, retraction is minimized and the depth of dissection is lessened. Thus, the transoral or transclival approach seemed ideal for basilar trunk aneurysms.5'7'16'19 Unfortunately, the narrowness of the clivus and the long traverse through the oropharynx severely constricts this approach. These drawbacks, combined with the unacceptable potential for CSF leak and infection, more than offset the benefits of avoiding retraction damage.

Archer, et al.,1 proposed a Le Fort I maxillary osteotomy rather than splitting the palate to accomplish the transoral transclival approach for low-lying posterior circulation aneurysms. Their technique reportedly widens the exposure to the clivus and facilitates closure of the mucoperiosteal defect. However, the need for lumbar CSF drainage and nasogastric feedings in the postoperative period as well as the very real potential for CSF infection remain disadvantages.

In an effort to develop a “shallower” posterior approach to lesions in and around the clivus, Sekhar and Estomillo12 combined and modified the transcochlear and infratemporal approaches formerly used for petrous

FIG. 4. Case 2. Preoperative (left) and postoperative (right) angiograms demonstrating a vertebrobasilar junction aneurysm and subsequent clip ligation.
Basilar and vertebrobasilar artery junction aneurysms

FIG. 5. Case 3. Preoperative (left) and postoperative (right) angiograms demonstrating clip ligation of the anterior inferior cerebellar artery aneurysm (thick arrow) and subsequent removal of an associated arteriovenous malformation (thin arrows).

and skull base tumors. They reported their experience in treating two patients, one with a basilar trunk aneurysm and the other with a posterior inferior cerebellar artery aneurysm. Although this very extensive "trans-temporal" exposure virtually eliminates cerebellum and brain-stem retraction, it is much more elaborate than necessary for basilar artery aneurysms, probably having its greatest benefit for neoplastic lesions of the skull base. Furthermore, the practice of transposing the facial nerve from its mastoid course, a key maneuver in the transcocchlear approach, virtually ensures at least a temporary facial nerve palsy.

Our goal in employing the retrolabyrinthine transsigmoid approach to aneurysms near the clivus was to address some of the perceived drawbacks of existing exposure strategies. It was our feeling that retraction of the brain stem and temporal lobe, inherent in most of the traditional posterior and combined supra- and infratentorial approaches, was responsible for a large portion of the morbidity associated with surgery for basilar trunk aneurysms. Secondly, the most successful approaches were hampered by relatively deep access along constricted corridors. Two benefits are derived from entering the posterior fossa through the mastoid and dividing the sigmoid sinus. First, a shallow approach is executed bringing the entry point closer to the plane of the clivus. Second, the direction of entry is along the shortest possible trajectory to the middle and lower thirds of the clivus, and, consequently, the midbasilar artery and vertebrobasilar junction. In addition, the dependent position of the cerebellum, in conjunction with spinal drainage and osmotic agents, minimizes cerebellar retraction and eliminates brain stem retraction. The brain stem in effect falls away from the clivus. This is of particular benefit for aneurysms that point back into the basilar sulcus. If there is a preexisting hearing loss on the side of the approach, removal of the labyrinth will widen the exposure toward the clivus even further, shortening the distance and enhancing access to the preptontine cistern. By ligating the sigmoid at its junctions with the transverse sinus and jugular bulb, a sizable exterior portal is made, exposing the basilar artery from the point where the superior cerebellar artery takes off to just proximal to the vertebro-basilar junction. Thus, proximal and distal control for basilar trunk aneurysms is easily achieved. In fact, this approach affords exposure of the basilar artery similar to the combined supra- and infratentorial procedures or the transtemporal approach without extensive bone removal. Familiarity with mastoid anatomy and neurootological surgical techniques, or the assistance of an otologist in making the approach, virtually ensures at least a temporary facial nerve palsy.

The side on which the approach is made is governed by the specific geometry of the aneurysm and the relative sizes of the sigmoid sinuses as assessed by cerebral angiography or enhanced CT scan. If the origin of the neck is strongly lateralized to one side of the basilar artery, the approach should be made ipsilateral to that side. For aneurysms directed superiorly or inferiorly, the approach is made on the side of the smallest lateral and sigmoid sinus. In the event that the aneurysm must be exposed on the side of a strongly dominant sinus, several options may be available. First, the retrolabyrinthine retrosigmoid technique may be utilized, skeletonizing the sigmoid, and working alternately in front of and behind it (GG Ferguson, personal communication, 1987). Second, the approach can be abandoned in favor of one of the more conventional techniques. Third, a translabyrinthine or transcocchlear approach can be used, the drawback being the loss of auditory function. We have not as yet attempted the latter.

With the exception of the transclival procedure, none of the available techniques (including the currently proposed one) obviates the need to work in close proximity to the cranial nerves. Our Case 2 underscores the
morbidity associated with injury to the lower cranial nerves in the vicinity of vertebrobasilar and basilar trunk aneurysms. Experience in working in this area and delicate technique may be as important as selection of the approach in minimizing complications.

References


Manuscript received August 26, 1987. Accepted in final form February 2, 1988. Address reprint requests to: Steven L. Giannotta, M.D., Department of Neurological Surgery, University of Southern California Medical Center, 1200 North State Street, Suite 5046, Los Angeles, California 90033-1084.