Transpetrosal approach for aneurysms of the lower basilar artery

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Extradural subtemporal access to the petrosal ridge and a resection of the anterior pyramidal bone produced direct observation of the lower basilar artery, with minimum retraction of the temporal lobe and preservation of the temporal bridging veins. Two patients, with lower basilar trunk aneurysms facing toward the brain stem, were operated on by the "transpetrosal approach," with successful clipping of the aneurysms. Auditory function was preserved in one case. This approach decreases the possibility of retraction damage to the temporal lobe, brain stem, or cranial nerves, and may be helpful for surgery of aneurysms arising around the vertebrobasilar junction or at the origin of the anterior inferior cerebellar artery.

Key Words: cerebral aneurysm • basilar artery • operative approach • transpetrosal approach

Aneurysms arising from the vertebrobasilar artery junction and from the origin of the anterior inferior cerebellar artery (AICA) are not common, accounting for less than 1% of all intracranial aneurysms. That area is surrounded by the lower clivus, the brain stem, and the cranial nerves, and surgical access can be difficult in this so-called "no-man's land." In 1944, Dandy described an approach via the suboccipital route but the postoperative results were not always acceptable because of damage to the lower cranial nerves and brain stem, with distressing morbidity and mortality. In 1965, a subtemporal-transstentorial approach was described by Drake, with better operative results; however, in some cases venous infarction occurred when the vein of Labbé was sacrificed. In addition, with the subtemporal-transstentorial approach, the surgical field does not extend low enough to expose the lower basilar artery because the petrosal ridge is in the way, and extended retraction of the temporal lobe in itself is hazardous to the patient. We report our experience with a "transpetrosal approach" in two patients with lower basilar aneurysms. We believe this technique overcomes those disadvantages.

Operative Technique

Aneurysms of the basilar artery are approached with the patient in the lateral decubitus position. The side of approach is dictated by the position and the direction of the aneurysm. The scalp incision and position of the inferior cerebellar artery (AICA) are not common, accounting for less than 1% of all intracranial aneurysms. That area is surrounded by the lower clivus, the brain stem, and the cranial nerves, and surgical access can be difficult in this so-called "no-man's land." In 1944, Dandy described an approach via the suboccipital route but the postoperative results were not always acceptable because of damage to the lower cranial nerves and brain stem, with distressing morbidity and mortality. In 1965, a subtemporal-transstentorial approach was described by Drake, with better operative results; however, in some cases venous infarction occurred when the vein of Labbé was sacrificed. In addition, with the subtemporal-transstentorial approach, the surgical field does not extend low enough to expose the lower basilar artery because the petrosal ridge is in the way, and extended retraction of the temporal lobe in itself is hazardous to the patient. We report our experience with a "transpetrosal approach" in two patients with lower basilar aneurysms. We believe this technique overcomes those disadvantages.

Operative Technique

Aneurysms of the basilar artery are approached with the patient in the lateral decubitus position. The side of approach is dictated by the position and the direction of the aneurysm. The scalp incision and position of the bone window are almost the same as in the standard subtemporal approach (Fig. 1 upper left). The craniotomy is centered low over the petrous ridge, and the lower part of the squamous temporal bone is removed with rongeurs until the cranial window is nearly flush with the floor of the middle fossa. The dura of the middle fossa base is peeled from the skull until the petrosal ridge is identified. Ventricular drainage improves access to the petrosal ridge in patients with a tight intracranial space. Coagulation of the middle meningeal artery is necessary for manipulation near the foramen spinosum. The anterior petrosal ridge is then approached with an air drill to create a 2 × 1-cm groove in the anterior part of the pyramidal bone. The area of drilling is surrounded by the trigeminal ganglion anteriorly, the cochlear organ posteriorly, the sphenopetrosal groove laterally, and the carotid canal and internal auditory canal inferiorly (Fig. 1 upper right). The location of the internal auditory canal should be noted. The bone eminence of the tegmen tympani is a landmark, with the internal auditory canal located along a line extending from the external auditory meatus through the tegmen tympani. When the internal auditory canal is opened, special care must be paid to preserve the dura mater to avoid damage to the facial and cochlear nerves. After resection of the petrosal rim,
small dural incisions are made above and below the superior petrosal sinus, and double Weck clips are applied to the sinus, which is incised after clipping. The bilateral leaflets of the petrosal sinus are retracted with sutures. A 1-cm extension of the incision into the tentorium offers a sufficiently large surgical field. The aneurysm is approached between the fifth and seventh cranial nerves (Fig. 1 lower). The distance between the petrosal ridge and the basilar artery is approximately 2.5 cm. The aneurysm is clipped in a standard fashion.

Case Reports

Case 1

This 49-year-old woman had the sudden onset of severe headache with nausea on February 8, 1980.

Examination. On admission the following day, she was alert and complained of severe headache. She had a stiff neck and hyperreflexia in the upper extremities. Computerized tomography (CT) demonstrated an area of increased density in the basal cisterns, and a lumbar puncture verified subarachnoid hemorrhage. Four- vessel angiography demonstrated an 5 × 6-mm berry aneurysm, projected backward at the verteobasilar artery junction (Fig. 2 left and center).

Operation. Surgery was performed on February 13, when the patient had a neurological Grade II as classified by Hunt and Hess. The patient was placed on her right side, and a left subtemporal craniotomy was performed because of a slight deviation of the basilar artery to the left. The pyramidal bone was resected extradurally, however, the bone resection was more extensive than in the surgical procedure described above. Drilling of the petrosal tip caused venous hemorrhage from the inferior petrosal sinus, and a piece of Oxycel cotton was packed into the sinus. The cavum tympani was inadvertently opened. The superior petrosal sinus was cut and retracted after clipping with Weck clips and bloody cerebrospinal fluid (CSF) was aspirated where the prepontine arachnoid membrane was opened. The anterolateral side of the pons, the basilar artery, and the left abducens nerve came into view between the fifth and seventh cranial nerves. The aneurysm arose from the verteobasilar artery junction, and the dome was buried in the brain stem. The aneurysm was clipped with a straight 12-mm Sugita clip. The bone and dural
Transpetrosal approach to basilar artery aneurysms

![Fig. 2. Case 1. Left and Center: Preoperative angiograms, anteroposterior view of the right vertebral angiogram (left) and lateral view of the carotid angiogram (center), demonstrating an aneurysm at the vertebrobasilar junction (arrows). Right: Postoperative right vertebral angiogram showing aneurysm occluded with a Sugita clip via the transpetrosal approach.](image)

defect were packed with a free piece of temporal muscle and a small piece of Leiodura dural substitute, coated with Biobond glue.

**Postoperative Course.** The patient's postoperative recovery was prompt and without temporal lobe symptoms. Postoperative angiograms demonstrated disappearance of the aneurysm (Fig. 2 right). In this case, the resection of the pyramidal bone was apparently too large. The opening of the cavum tympani and the packing of cotton into the inferior petrosal sinus resulted in a left hearing disturbance, CSF rhinorrhea, and an incomplete abducens palsy. The manipulation of the seventh nerve caused incomplete left facial palsy. The patient was discharged 3 months after surgery and readmitted 2 weeks later for treatment of a recurrent CSF rhinorrhea. Bed rest and administration of antibiotics controlled the problem. The CSF rhinorrhea seemed to be caused by the incomplete bone closure of the cavum tympani.

**Case 2**

This 43-year-old woman lost consciousness in her bathroom and was transferred to our hospital.

**Examination.** On admission, she was confused and a CT scan showed evidence of hemorrhage in the third and fourth ventricles, with acute hydrocephalus. On the 3rd hospital day, four-vessel angiography was performed and an aneurysm was found at the origin of the AICA (Fig. 3 upper left and center). Six weeks later she gradually became alert without any focal deficit, and an operation was performed using the transpetrosal approach.

**Operation.** A left subtemporal craniotomy was chosen to avoid the dome of aneurysm. After the temporal lobe was slackened with ventricular drainage, the anterior part of the petrous bone was drilled extradurally until the internal auditory canal was opened. The whole middle ear and the dura mater of the auditory canal were carefully preserved. The superior petrosal sinus was clipped, and the origin of the tentorium was incised about 1 cm from the sinus. The aneurysm was visualized between the fifth and the seventh cranial nerves, without the use of a retractor. The aneurysm was located at the junction of the AICA and faced toward the pons as in Case 1. The left sixth nerve and a small perforating artery were firmly adherent to the neck of the aneurysm and were freed from the aneurysm (Fig. 3 lower). Under mild hypotension, a straight Sugita clip was applied without rupture of the aneurysm. The dural defect was packed with Oxycel cotton and a free fragment of muscle.

**Postoperative Course.** Postoperative recovery was prompt without any temporal symptoms. Manipulation of the sixth nerve caused temporary bilateral abducens palsy, which lasted for 1 month after surgery. The patient had a mild facial hypesthesia for 2 months. No CSF leakage occurred, and her facial and auditory nerve function was completely preserved. Postoperative angiograms demonstrated complete occlusion of the aneurysm (Fig. 3 upper right). Her double vision and facial hypesthesia disappeared, and she was discharged 3 months after surgery without any neurological deficit (Fig. 4).

**Discussion**

In the past two decades, Drake and Peerless reported reaching aneurysms arising from the lower
T. Kawase, et al.

FIG. 3. Case 2. Upper Left and Center: Preoperative left vertebral angiograms demonstrating an aneurysm facing toward the brain stem at the origin of the anterior inferior cerebellar artery (AICA). Lower: Operative view of the aneurysm. BA = basilar artery. The abducens nerve and a small perforating artery were adherent to the neck of the aneurysm, and were freed and preserved. Upper Right: Postoperative angiogram showing the aneurysm clipped, with preservation of both sides of the AICA.

basilar artery either from above, via the subtemporal-transtentorial route, or from below, by a suboccipital craniotomy. For an AICA aneurysm with its dome projecting forward or upward, a suboccipital lateral approach was usually selected. They also reported that when the aneurysm was located in the lower third of the basilar artery or at the verteobasilar artery junction, it was difficult to expose via either route because of the limited space. When exposing an aneurysm via the subtemporal route, it may be necessary to retract the temporal lobe to see beyond the petrosal ridge. Such retraction can damage the bridging veins, causing hemorrhagic cerebral infarction. The suboccipital exposure may require the dissection of the lower cranial nerves from the brain stem. Both exposures have been associated with significant morbidity, especially for aneurysms locating at the midline.

Another possible approach to these aneurysms without retraction of the brain or cranial nerves is by the removal of the skull base. The transclival route was developed in 1966 by Stevenson, et al., and Mullan, et al., and has been utilized for verteobasilar artery aneurysm surgery by Sano, et al., and Fox. This route presents a risk of postoperative meningitis, because of the difficulties in wound closure. The limited surgical field can also be a problem.

Surgical removal of the pyramidal bone has been used for excision of acoustic neurinomas since 1970, and is called the "extended middle fossa approach." The approach gives the surgeon the possibility of reaching the cerebellopontine angle and mid-frontal portion of the pons with minimum brain retraction and, combined with an extradural subtemporal access, minimizes the possibility of damage to temporal bridging veins such as the vein of Labbé. Drilling of the pyramidal bone also reduces the possibility of retraction damage to the temporal lobe, since the lower basilar trunk is within a minimal distance of this anterolateral access.

No published report has described this technique for surgery of vertebrobasilar artery aneurysms. The auditory organs were not preserved when the usual extended middle fossa approach was employed because of extensive resection into the posterior part of the pyramidal bone, as shown in our Case 1. Confining the resection to the anterior part of the pyramidal bone, which contains no cochlear organ structures, it is possible to preserve the auditory function, as shown in our Case 2. Although the maximum size of the bone resection is only 7 mm deep and 2 cm wide, it offers sufficient...
Transpetrosal approach to basilar artery aneurysms

exposure under the microscope. Limitation in the surgical field may also be improved by further opening of the tentorium, as in the case of a large aneurysm. Thus the transpetrosal approach offers a less invasive access to aneurysms located in the midline and/or to posteriorly projecting lower basilar aneurysms, with minimum danger of retraction damage to the cerebrum, brain stem, or cranial nerves. Further experience is necessary to ascertain the advantages and disadvantages of the procedure.

References


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