A stepwise illustration of the translabyrinthine approach to a large cystic vestibular schwannoma

Christopher M. Nickele, M.D.,¹ Erinc Akture, M.D.,¹ Samuel P. Gubbels, M.D.,² and Mustafa K. Başkaya, M.D.¹

Departments of ¹Neurological Surgery and ²Otolaryngology, University of Wisconsin, Madison, Wisconsin

Of the presigmoid approaches, the translabyrinthine approach is often used when a large exposure is needed to gain access to the cerebellopontine angle but when hearing preservation is not a concern. At the authors’ institution, this approach is done with the aid of ENT/otolaryngology for temporal bone drilling and exposure.

In the present article and video, the authors demonstrate the use of the translabyrinthine approach for resection of a large cystic vestibular schwannoma, delineating the steps of positioning, opening, temporal bone drilling, tumor resection, and closure. Gross-total resection was achieved in the featured case. The patient’s postoperative facial function was House-Brackmann Grade II on the side ipsilateral to the tumor, although function improved with time.

The translabyrinthine route to the cerebellopontine angle is an excellent approach for masses that extend toward the midline or anterior to the pons. Although hearing is sacrificed, facial nerve function is generally spared.

Key Words • translabyrinthine approach • vestibular schwannoma • surgical technique • video

Although the translabyrinthine approach was described by Panse in 1904 and first used to resect a cerebellopontine angle tumor by Quix in 1912, it was not until House reported on 47 resections with no deaths in 1964 that the approach was truly popularized.¹ Since that time it has been well described in the literature as a useful approach for resecting vestibular schwannomas in cases in which hearing preservation is not a concern. Additionally, a modified use of this approach has been described in combination with a transtentorial component for the resection of vestibular schwannomas and other lesions of the cerebellopontine angle and proximate anatomy.⁴

Surgical series of translabyrinthine resections often include meningiomas of the cerebellopontine angle and the internal acoustic meatus, schwannomas of the facial and trigeminal nerves, and cholesteatomas, neurinomas, and chordomas, illustrating the multiple uses of this approach.⁴ In the present report, the translabyrinthine approach for resection of a large cystic vestibular schwannoma (Fig. 1) is described in a stepwise manner using text, a narrated video (Video 1), and still images obtained in a single patient.

Video 1. Narrated video describing the steps of the translabyrinthine approach for vestibular schwannomas from positioning and opening through closure. In this example, the tumor was left-sided, large, and cystic. Click here to view with Media Player. Click here to view with Quicktime.

Surgical Indications

Although case series exist describing hearing preservation in the setting of partial labyrinthectomy, the main indication for the approach remains resection of vestibular schwannomas in patients in whom preoperative hearing is absent or nonserviceable.² When hearing preservation is a goal of surgery, or when a smaller lesion is being resected, a retrosigmoid craniotomy may be appropriate. In the case of the largest of vestibular schwannomas, a combined translabyrinthine-transtentorial approach may be indicated.⁴

Abbreviation used in this paper: IAC = internal auditory canal.
Positioning and Incision

The patient is positioned supine with the head turned contralateral to the side of the lesion. This must be done to the point that the zygomatic arch is almost parallel to the floor. If the patient’s neck is inflexible, a shoulder roll may be required for positioning. The chin must also be assessed, and should be 2 fingerbreadths away from the sternum; flexion should not be severe enough to compromise venous return from the head. Distance should be kept between the planned incision and the patient’s ipsilateral shoulder, which will otherwise limit the surgeon’s range of motion later in the procedure.

The head is placed in pins in the Mayfield skull clamp to which the navigational frame is anchored. The neuronavigation system is registered and used for incision planning and, later, to aid in tumor resection. Facial electromyography needles are placed for seventh cranial nerve monitoring to be performed later in the procedure. At our institution, the otolaryngology team prefers to position the patient facing away from the anesthesiologist, with the surgeon sitting between the patient and the anesthesiologist.

A C-shaped incision is planned behind the ear, as needed, to expose the mastoid tip, sigmoid sinus, and transverse-sigmoid junction, and to be as high as the floor of the middle cranial fossa (Fig. 2). The floor of the middle fossa is marked by the level of the zygomatic arch, but neuronavigation can assist in determining the position as well as the location of the junction of the transverse and sigmoid sinuses. As a final check before prepping and draping, the table should be air-planed toward and away from the anesthesiologist. This ensures that the patient will be stable later in the procedure when the table will need to be manipulated to facilitate dissection distally along the seventh cranial nerve and in the internal acoustic meatus. When prepping, one must keep in mind that an abdominal field and potentially a lateral thigh field should be prepared for fat graft harvest and potential fascial harvest.

Opening and Approach

The skin is divided sharply and electrocautery is used to divide the muscle, leaving the peristomal intact for the time being. The peristomal layer will be used as an additional layer and protection against CSF leakage at the time of closure. Skin edges are undermined anteriorly and posteriorly, both to benefit exposure and to enable the surgeon to harvest a fascial graft from the temporalis muscle. In the event that this is not possible, a fascial graft can be harvested either from the rectus muscle when the abdominal fat graft is taken or from the tensor fascia lata.

The peristomal is then elevated. As emissary veins are encountered, the peristomal around them should be cleared completely from the bone, and the veins waxed. As the peristomal is elevated, the limits of the exposure are as follows: the mastoid tip inferiorly, 1–2 cm behind the sigmoid sinus posteriorly, and the spine of Henle anteriorly. Once this is accomplished, mastoid drilling may begin.

At our institution, drilling starts with a large cutting bur, as well as the suction irrigator. A standard mastoidectomy begins with skeletonization of the tegmen, sigmoid sinus, and posterior border of the external auditory canal. The drill is then used to enter the mastoid antrum and identify the incus and the lateral semicircular canal. A diamond bit can then be used to remove the remainder...
of bone off of the sigmoid sinus and 1–2 cm of the posterior fossa dura. The tegmen is removed to expose middle fossa dura, and the presigmoid dura is also exposed by finishing the bony removal there (the endolymphatic duct will likely be transected during this process). This boney removal is accomplished using a small rongeur once the drill has sufficiently thinned the bone. The rongeur will also be used at this point to remove the petrous ridge over the superior petrosal sinus heading medially (Fig. 3).

At this time, further drilling with the diamond bit allows the surgeon to identify the vertical segment of the facial nerve in the proximal mastoid. This is followed toward the stylomastoid foramen, leaving a thin shell of bone over the nerve in the fallopian canal. The labyrinthectomy is begun by entering the lumen of the lateral semicircular canal and then the posterior semicircular canal. The vestibule is exposed and the lateral semicircular canal is removed. The subarcuate artery will often be encountered at this point in the foramen of the superior semicircular canal.

The sigmoid sinus can now be traced toward the jugular bulb, which is defined with the drill. Variations in this anatomy may limit exposure in the presence of a high-riding jugular bulb, which can be directly inferior to the IAC in some patients. This limits the trough that will later be drilled below the IAC because the inferior limit of this trough is the jugular bulb. Once the jugular bulb is identified, drilling can commence to uncover the dura of the IAC. The troughs are then drilled superior and inferior to the IAC with the goal being to expose the IAC 270° around its circumference. The superior trough is delimited by the superior edge of the IAC and the middle fossa dura. At this stage, the only bone on the IAC dura should be along its anterior aspect (Fig. 4).

To identify the superior vestibular nerve, which sits superior to the falciform crest, the falciform crest should now be located. This is the nerve from which most vestibular schwannomas arise, and it can be transected while causing little morbidity. Most frequently its transection results in transient vertiginous symptoms. Frequently the falcine crest is removed, proceeding medially, and a plane can be developed between the tumor and the facial nerve. The dura is opened further laterally and then inferiorly and superiorly along the presigmoid posterior fossa dura.

This is best done using a microsurgical blade followed by scissors.

**Tumor Removal**

While the first portion of the tumor in the IAC may be dissected partially off of the facial nerve, the majority of this portion of the dissection is left for the end of the resection. It is the cisternal portion of the tumor that actually is resected first. Once enough general dissection has been achieved to visualize the tumor, the lesion is debulked internally to improve its mobility. This process allows the surgeon to dissect the mass partially away from the brainstem and begin attempting to identify cranial nerves. The goal is ultimately to achieve circumferential dissection around the tumor. To debulk the tumor internally, its surface is coagulated and cut with scissors. This allows the surgeon access to the center of the tumor, which can be resected with pituitary rongeurs or an ultrasonic aspirator. If the course of the facial nerve has not already been established, the surface of the tumor must be stimulated to determine that the facial nerve does not have twigs running through the area that is about to be coagulated and cut. The facial nerve most commonly runs along the anterior surface of the tumor and is also commonly found along the anterosuperior or anteroinferior surface. Although the surface of the tumor is coagulated with the bipolar electrocautery, care is taken not to use electrocautery near the brainstem or any cranial nerves.

In the standard translabyrinthine approach, in which hearing is sacrificed, the eighth cranial nerve can be identified at the brainstem, coagulated, and transected (Fig. 5). The nerve is first stimulated to verify that it is not the facial nerve. In cases in which the facial nerve has been damaged by the tumor, the surgeon must establish a threshold for stimulation of the facial nerve before concluding that a nerve does not stimulate, and therefore must not be, the facial nerve. One should note that the cochlear nerve in the IAC is not removed at this time. Instead it is left for the end of the resection, so that the facial nerve is given some stability to handle the dissection of the adherent tumor. Thus, the cochlear nerve in the IAC is taken only as the last portions of the tumor are resected (Fig. 6).
Transection of the eighth cranial nerve allows for further dissection of the mass off of the brainstem and therefore further debulking of the mass. As this back-and-forth process of debulking and dissection continues, the tumor will eventually be a husk that has been separated from the brainstem. At this time, the shell of the tumor is resected with curved microscissors, leaving only the outer portion of the tumor, which is adherent to the facial nerve. This last fragment is dissected from the facial nerve using sharp dissection techniques and the diamond and arachnoid knives.

In large masses, the anatomy is quite distorted and a systematic approach to identification of landmarks is needed. A helpful strategy in this case is first to identify the inferior pole of the tumor. From this point, cranial nerves can be identified as the tumor is rolled from inferior to superior, starting with cranial nerves IX, X, and XI. From here, the flocculus is identified along with choroid plexus in the foramen of Luschka. The surgeon should find the eighth and seventh cranial nerves just ventral to it. The anterior inferior cerebellar artery should have a loop between these 2 nerves at the brainstem. Whatever strategy the surgeon takes, the arteries and veins of the posterior fossa should be respected, and every effort should be made not to take the superior petrosal veins.

**Closure**

Once the tumor resection is completed and hemostasis has been achieved, the wound is packed closed. The dura that has been opened cannot be closed primarily, and a fat graft harvested from the abdomen is placed. One large piece of fat may be harvested, but strips will be cut and inserted into the surgical cavity to the level of the dura. It is important not to allow these fat strips to advance past the level of the dura into the cerebellopontine angle or to pack them too aggressively because cranial nerve deficits may result. A fascial graft, as mentioned, may be obtained from the temporalis muscle during the opening.

Alternatively, it may be harvested from the rectus muscle via the fat incision or from the tensor fascia lata of the thigh. This fascial graft is simply draped over the mastoid antrum, mastoid and tympanic facial nerve, and all air cells of the facial recess and zygomatic groove. At this point in the procedure, synthetic fibrin glue or other suitable epoxy can be interspersed among the fat strips and fascial graft to guard against CSF leakage.

The periosteum, muscle, and skin are closed in layers. The skin is often closed with a running locked stitch; in redo cases or those in which poor wound healing is a concern due to radiation or other causes, interrupted vertical mattress sutures are used. A mastoid dressing is then applied and is left in place for several days.

**Postoperative Management**

If there is evidence of hydrocephalus or if there is some other reason to be concerned about wound healing, a lumbar drain is placed at the outset of surgery, although this is uncommon. The patient is admitted to the neurosurgical ICU, and drainage is undertaken hourly. At the authors’ institution, drainage is typically begun at a rate of 5 ml/hour and increased as long as the patient does not suffer intolerable headaches and nausea. It is often increased to a rate of 15 ml/hour, and occasionally higher. The duration of drainage depends on the surgeon’s level of concern for CSF leak. Usually the lumbar drain can be clamped for 24 hours at the conclusion of the healing process to ensure that no CSF leak is present, and drainage is then discontinued.

In the majority of cases, however, no such CSF drainage is required. The patients spend their first postoperative night in the ICU and undergo MRI on postoperative Day 1 (Fig. 7). After this, and barring any specific concerns, the patient can be transferred to the floor. Although particular attention is paid to the posterior fossa on the MRI, these patients will often have a small filling defect in the sigmoid sinus, representing a clot. The clot is generally treated by keeping the patient well hydrated; specific anticoagulation therapy is not performed. As long as
there is no significant edema, the patient can be weaned quickly from Decadron. Other postoperative care is not specific to this procedure.

Disclosure
The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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Supplemental online information:

Address correspondence to: Mustafa K. Başkaya, M.D., University of Wisconsin Hospital and Clinics, 600 Highland Avenue, CSC K4/828, Madison, Wisconsin 53792. email: m.baskaya@neurosurgery.wisc.edu.