Operative Techniques in Otolaryngology 30 (2019) 212–216

ELSEVIER

Operative Techniques in
Otolaryngology

Vestibular nerve section via retrolabyrinthine craniotomy

Zachary R. Barnard, MD[a,b], Gregory P. Lekovic, MD, PhD[b], Eric P. Wilkinson, MD[b], Kevin A. Peng, MD[b]

From the [a]Cedars-Sinai Neurosurgery, Los Angeles, California
[b]House Ear Institute, Los Angeles, California

KEYWORDS
Retrolabyrinthine;
Vestibular;
Neurectomy;
Vertigo;
Meniere's disease

Meniere's disease can cause debilitating dizziness and vertigo despite maximal medical management. In select patients, treatment with vestibular nerve section provides optimal outcomes for symptom control and hearing preservation. Vestibular nerve section is also indicated in other vestibular disorders, including refractory uncompensated vestibular neuritis. Surgical approaches for vestibular nerve section include the retrolabyrinthine, retrosigmoid, middle fossa, and translabyrinthine craniotomies. The advantages of the retrolabyrinthine approach include rapid access, excellent visualization of the facial and cochlear nerves, and the possibility of hearing preservation in conjunction with consistent outcomes for vestibular symptoms. In this chapter, we discuss the retrolabyrinthine approach for vestibular nerve section, providing the reader with an overview of when, why, and how to employ the technique.

Introduction

Vestibular nerve section has been applied for multiple etiologies of uncontrolled dizziness and vertigo, most commonly Meniere's disease. Success rates have ranged from 85%-95% after failure of medical management.[1] Vestibular nerve section was first described in the early 1900s by Frazier.[2] Since that time, many others have described different indications for vestibular nerve section. Walter Dandy, a prominent neurosurgeon, described in 1941 a series of over 600 patients who underwent vestibular nerve section for Meniere's disease.[3] At the time, the procedures were all performed through a suboccipital approach. In 1978, Derald Brackmann and William Hitselberger described the use of a retrolabyrinthine craniotomy for vestibular and trigeminal nerve section to treat a patient with trigeminal neuralgia and Meniere's disease.[4] Herbert Silverstein and Horace Norrell followed this report with a series that focused on the retrolabyrinthine approach exclusively for vestibular nerve section in 1980, establishing its use in patients with refractory Meniere's disease.[5] After its introduction, the retrolabyrinthine approach was quickly adopted for its advantages in minimizing brain retraction, facial nerve injury, and hearing loss. The retrolabyrinthine approach also has the additional advantage of providing a wide view of the vestibulocochlear nerve from the brainstem to the porus acusticus. In this chapter, we describe and discuss the preoperative evaluation, surgical anatomy, surgical technique, postoperative care, and complications of the retrolabyrinthine approach for vestibular nerve section.

Address reprint requests and correspondence: Kevin Peng, MD, House Clinic, 2100 West Third Street, Suite 111, Los Angeles, CA 90057.
E-mail address: kpeng@houseclinic.com

http://doi.org/10.1016/j.otot.2019.07.005
1043-1810/

Indications for surgery and preoperative evaluation

Meniere's disease refractory to medical management is the most common indication for vestibular nerve section. Medical management for Meniere's may include corticosteroid therapy, diuretics, betahistine, tympanostomy tube with or without the use of middle ear pressure devices, and intratympanic therapy, to name only a few. Vestibular nerve section is often considered only after an endolymphatic mastoid shunt or an endolymphatic sac decompression has failed to provide benefit. The retrolabyrinthine approach depends on a neurotologist with experience performing retrolabyrinthine craniectomies to avoid iatrogenic damage to the labyrinth. The surgical corridor may be small, depending upon the size of the mastoid, the height of the jugular bulb, and the position of the cerebellar flocculus. Advantages of the retrolabyrinthine approach include a more direct, lateral approach to the vestibulocochlear nerve. It obviates the need for cerebellar retraction, such as that required by the retrosigmoid approach, as well as temporal lobe retraction, required by the middle fossa approach. Finally, in contrast to the translabyrinthine craniotomy, the retrolabyrinthine craniotomy allows for preservation of any residual hearing.

Preoperative workup involves full neurologic and otologic examinations prior to surgery. This includes MRI of the brain with and without contrast, videonystagmography with a full vestibular battery, and audiometric testing. These help elucidate the principal diagnosis and rule out neoplastic etiologies. When considering a retrolabyrinthine approach for vestibular nerve section, certain anatomical features should be evaluated. A patient who has a small mastoid or a laterally positioned flocculus may complicate exposure of the proximal portion of the vestibulocochlear nerve. In these instances, either endoscopic assistance with the retrolabyrinthine approach or simply a retrosigmoid craniotomy may be considered. Symptoms relief rates are often quoted at 85%-95%.[1]

Surgical anatomy

The retrolabyrinthine craniotomy begins similarly to a translabyrinthine craniectomy. A complete mastoidectomy is first performed with a high-speed drill, identifying the external auditory canal, the middle fossa plate, and the posterior fossa plate. The lateral semicircular canal is seen, and the vertical segment of the facial nerve may be identified, if desired. The sinodural angle is widely exposed, and the middle fossa, posterior fossa, sigmoid sinus, and sinodural angle are decompressed via full removal of all bony coverings. One centimeter of dura posterior to the sigmoid sinus is also decompressed, taking care to ligate the mastoid emissary vein safely.

The lateral semicircular canal is again identified, and the spiculated bone lateral and adjacent to the posterior semicircular canal is removed. The labyrinthine bone typically harbors a more yellowish hue than the surrounding bone. Inferiorly, below the level of the posterior semicircular canal, the vestibular aqueduct is encountered as a fold or redundancy of dura passing medially toward the labyrinth. Dissection is also carried superiorly and medially until the superior semicircular canal is seen superior and medial to the lateral semicircular canal (Figure 1). Additional removal of adherent pieces of bone allow for full decompression of the sigmoid sinus and posterior fossa dura.

The dura is then opened along the posterior fossa anterior to the sigmoid sinus. Once the dura has been opened, a layer of arachnoid covering the cerebellum, brainstem, and underlying neurovascular structures is seen. The arachnoid is then incised, and cerebrospinal fluid (CSF) is released, revealing the cerebellum and additional neurovascular structures. Superiorly in the field, the superior petrosal vein and the trigeminal nerve are seen. Inferior to this, the abducens nerve is seen traveling superiorly and entering Dorello's canal. Lateral and inferior to the abducens nerve are the facial and vestibulocochlear nerves. The basilar artery is seen medially, between the trigeminal and facial (VII) and vestibulocochlear (VIII) nerve complex. The proximal portion of the vestibulocochlear nerve may be covered by the flocculus of the cerebellum. Inferior to the vestibulocochlear nerve are the glossopharyngeal and vagus nerves (Figure 2).

The retrolabyrinthine craniotomy, unlike the translabyrinthine craniotomy, does not include removal of the semicircular canals, and thus the lateral extent of the cranial nerves is not well seen. This does not pose a problem since the proximal portion of the vestibulocochlear nerve is the area of interest for vestibular nerve section.

Surgical technique

The surgical steps for the retrolabyrinthine approach for vestibular nerve section are outlined below.[6,7] The procedure is initiated with the patient in the supine position and the airway secured under general endotracheal anesthesia. Mannitol 1 g/kg is administered to aid with brain relaxation. Facial nerve and auditory brainstem responses are monitored by placing appropriate leads and earpieces. Anesthesia monitoring notably includes continuous arterial pressure transduction via an arterial line, typically placed in the radial artery. A urinary catheter is placed. We then rotate the table 180 degrees away from the anesthesiologist to provide maximum maneuverability around the surgical site.

The head is placed on a gel cushion or in 3-point pin fixation and turned away from the affected side. The abdomen is prepared for abdominal fat graft harvest for later use in packing the craniotomy site and mastoid to prevent CSF leak postoperatively. Hair is removed both superior and posterior to the ear. Plastic drapes are used to isolate the surgical site; these help minimize spillage of irrigation fluid outside the sterile draping. After full draping,

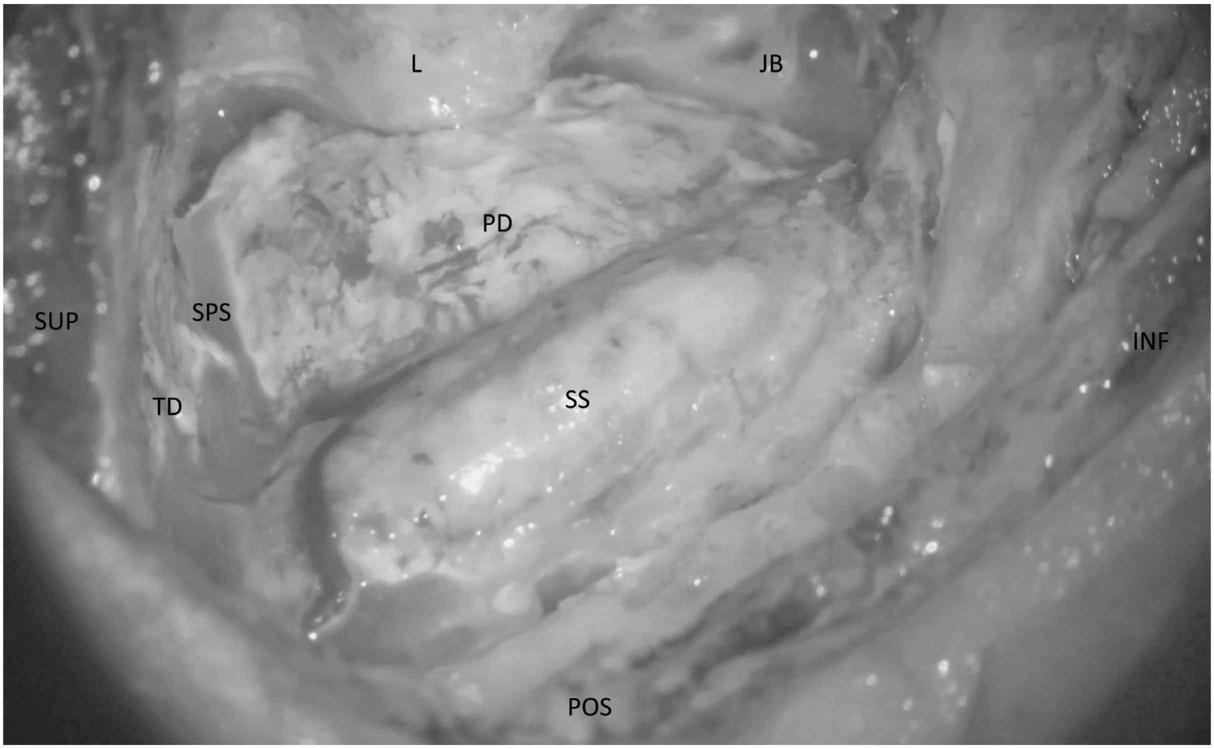

Figure 1 Retrolabyrinthine craniotomy. Demonstrated are the structures after completion of the retrolabyrinthine craniotomy and prior to opening the posterior fossa dura. SUP, superior; POS, posterior; INF, inferior; SS, sigmoid sinus; JB, jugular bulb; L, labyrinth; PD, posterior fossa dura; SPS, superior petrosal sinus; TD, temporal dura.

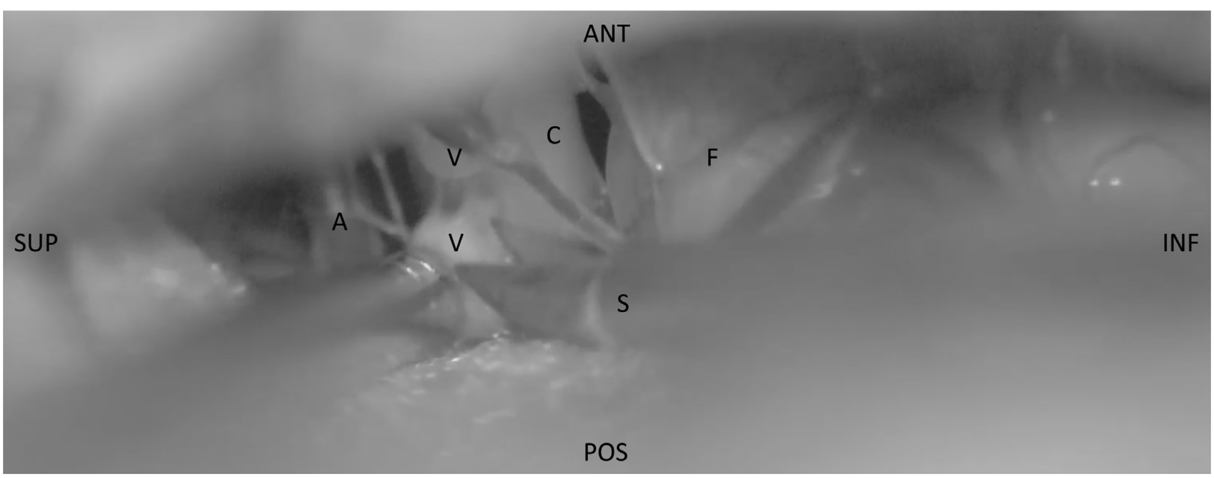

Figure 2 Neurovascular anatomy of the cerebellopontine angle through a retrolabyrinthine craniotomy. SUP, superior; POS, posterior; INF, inferior; ANT, anterior; A, anterior inferior cerebellar artery; V, cut vestibular segments of the vestibulocochlear nerve; C, cochlear segment of the vestibulocochlear nerve; F, flocculus; S, scissors.

administration of prophylactic antibiotics, and infiltration of local anesthetic and vasoconstrictor, a curved incision is made roughly 2-3 cm posterior to the postauricular sulcus. This incision begins 1 cm above the pinna and extends posterior and inferior to the mastoid tip (Figure 3). The scalp and underlying muscle are dissected in separate flaps. The muscle flap, including the temporalis muscle, the mastoid periosteum, and the cervical musculature, may be exposed using a C-shaped or a T-shaped incision (Figure 3).

With the assistance of the operating microscope, the craniotomy begins with a complete mastoidectomy using a high-speed drill and a large cutting burr, moving to a diamond burr as appropriate. As described above, exposure includes decompressing the middle fossa plate, the posterior fossa plate, the sigmoid sinus, and the sinodural angle. The labyrinth is preserved and all adjacent air cells and bony spicules are removed. Bony removal over and behind the sigmoid sinus must project about 1 cm posterior to the sinus to allow for adequate posterior retraction of the sinus and posterior dural flap. The jugular bulb is typically identified, but full decompression is generally not necessary. Moving medially, the mastoid air cells medial and posterior to the posterior semicircular canal are removed, and the endolymphatic duct is seen.

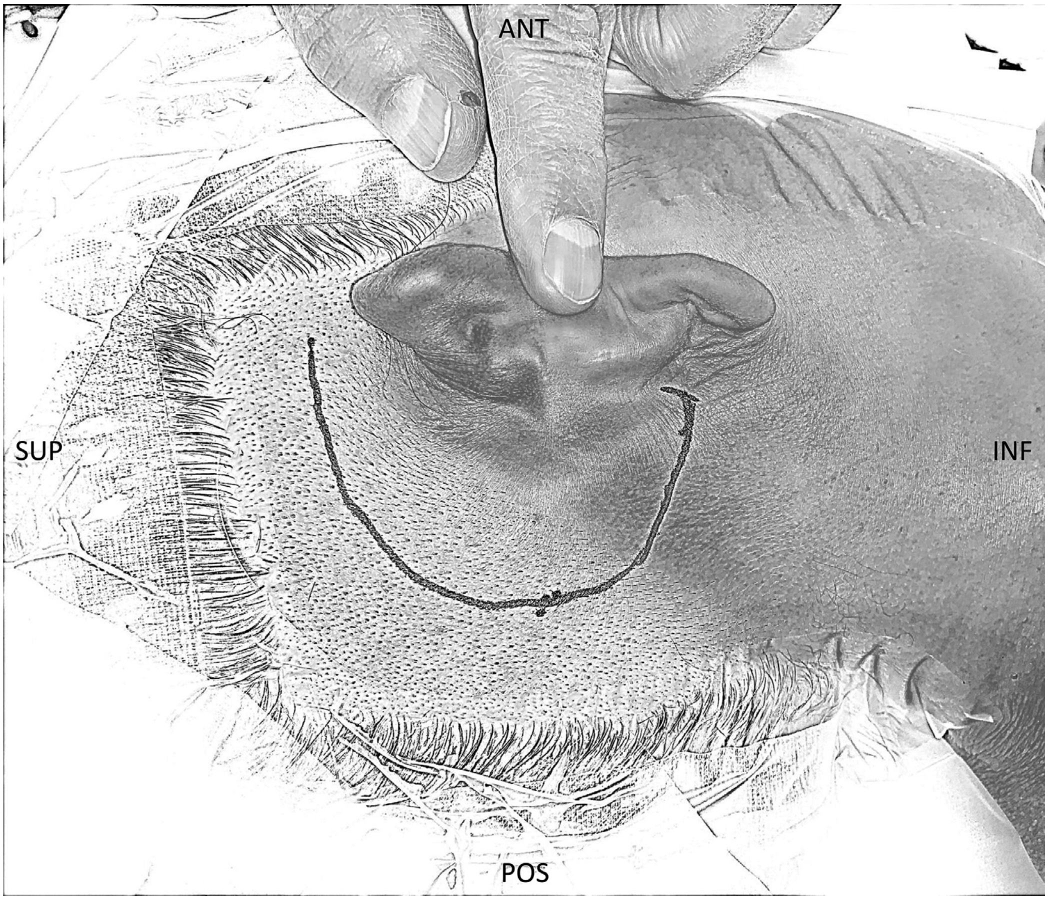

Figure 3 Incision for retrolabyrinthine approach. A curved incision, with the superior extent approximately 1 cm superior to the pinna, is fashioned. The inferior extent is at or just below the mastoid tip. The incision lies approximately 2-3 cm posterior to the postauricular sulcus and approximately 4-5 cm posterior to the external auditory canal. SUP, superior; POS, posterior; INF, inferior; ANT, anterior.

The dura is then opened, typically parallel to the superior petrosal sinus and sigmoid sinus, and sometimes traversing the endolymphatic sac. This dural flap is then reflected anteriorly and held in place with sutures. Multiple long narrow cottonoids are placed along the cerebellum for protection against manipulation. The arachnoid attachments covering the middle and lower cranial nerves are opened to allow for visualization of the VII/VIII complex and egress of CSF, allowing further brain relaxation. If desired, stimulation of the neural structures can confirm the location of the facial nerve. In the surgical position, the facial nerve may even appear inferior to the vestibulocochlear nerve at the root entry zone. Attention is then focused on the vestibulocochlear nerve approximately 5 mm distal to the brainstem, where dissection begins.

The superior and inferior vestibular nerves are typically indistinct from one another in the proximal cisternal segment of VIII, but this vestibular nerve bundle can often be distinguished from the more inferiorly lying cochlear nerve by a raphe or septum and a small vessel running in parallel. In addition, the cochlear nerve may demonstrate a slightly white coloration of the compared to the clear coloration of the vestibular nerve, deemed likely secondary to differences in myelin content. It should be noted that histologic studies by Silverstein et al showed that only 75% of patients have a cleavage plane, while others have vestibular fibers running with the cochlear fibers.[8] The plane between the vestibular and cochlear nerves can be developed using a fenestrated suction irrigator and a Rosen needle.

Care must be taken not to pull excessively on the cochlear nerve, as this may increase the likelihood of avulsion of the cochlear nerve endings on the cribriform area at the distal portion of the IAC. The facial nerve remains a concern due to its anteromedial location relative to the vestibulocochlear nerve. Intermittent stimulation of the facial nerve may be useful to confirm its exact location. Once a plane has been developed between the vestibular and cochlear nerves, a McElveen dissector can be used to approach the nerve from the inferior cleft. With gentle rotation, a complete plane can be dissected between the 2 nerves. Following this, microscissors are utilized to section the vestibular nerve. Adequate dissection along a length of the vestibular and cochlear nerves will ensure retraction of the cut ends, leaving an intended gap in the vestibular nerve.

The endoscope may be utilized at any point during dissection for improved visualization. While it is not necessary in most cases, it virtually obviates the need for cerebellar retraction. Single-handed dissection may prove more cumbersome than double-handed dissection, but if necessary, an assistant may hold the endoscope.

After the nerve has been sectioned, closure begins. Abdominal fat is harvested from the subcutaneous tissues in the left lower quadrant of the abdomen. The dura may be apposed with sutures or packed closed with fat. The middle ear is typically isolated at the aditus ad antrum from the craniotomy site with the use of bone wax, a piece of temporalis fascia, or simply with abdominal fat. The fat is cut into strips and gently weaved in the craniotomy site, including within the dural flaps if necessary. The mastoid is filled with abdominal fat, and a mesh cranioplasty is performed to maintain adequate pressure on the fat graft. The muscle flaps, deep dermal layer, and overlying skin flaps are closed with absorbable and nonabsorbable sutures. A mastoid pressure dressing is placed.

Complications

Complications associated with the retrolabyrinthine approach for vestibular nerve section are rare. CSF leak is possible, and care must be taken when laying the strips of fat in the dural defect to prevent postoperative CSF rhinorrhea or CSF egress from the incision. Adequate isolation of the middle ear at the aditus ad antrum—once again, with bone wax, temporalis fascia, abdominal fat, or a combination—in addition to bone wax occlusion of inferior mastoid air cells helps to minimize the incidence of CSF rhinorrhea. Superficial infection or meningitis can happen and should be recognized and treated acutely; lumbar puncture is necessary to confirm meningitis and speciate the offending microbe. Postoperative hematoma, while rare, can cause significant morbidity and mortality, particularly within the posterior fossa. Immaculate hemostasis prior to closure minimizes this risk. When near critical structures such as the cochlear or facial nerves, bipolar is not used; instead, gelatin sponge with thrombin is preferred.

Postoperative care

The patient is monitored in the intensive care unit for 12-24 hours following surgery, and routine postoperative imaging in the form of computed tomography of the head allows for detection of any significant hemorrhage in the surgical site. Patients will typically spend 1 night in the intensive care unit and 1-3 days in the hospital. Perioperative antibiotic prophylaxis is utilized. Systemic corticosteroids are not prescribed unless injury to the facial nerve is suspected intraoperatively or postoperatively. Physical therapy, including balance therapy and assistance with ambulation, begins as early as postoperative day 1.

Conclusion

Treatment of medical refractory vertigo, particularly in patients with Meniere's disease, includes vestibular nerve section. In particular, the retrolabyrinthine craniotomy offers the possibility of hearing preservation while still having the distinct advantage of reduced retraction on the cerebellum, a more direct trajectory to the brainstem, and an excellent view of the vestibulocochlear and facial nerves. Symptom relief rate is generally excellent.

Disclosures

The authors report no commercial or proprietary interest in any products or concepts discussed in this article.

References

1. Leveque M, Seidermann L, Tran H, et al: Vestibular function outcomes after vestibular neurectomy in Meniere disease: Can vestibular neurectomy provide complete vestibular deafferentation? Auris Nasus Larynx 37(3):308–313, 2010.
2. House JW, Hitselberger WE, Mcelveen J, et al: Retrolabyrinthine section of the vestibular nerve. Otolaryngol Head Neck Surg 92(2):212–215, 1984.
3. Dandy WE: Surgical treatment of Meniere's disease. Surg Gynecol Obser 72:421–425, 1941.
4. Brackmann DE, Hitselberger WE: Retrolabyrinthine approach: Technique and newer indications. Laryngoscope 88(2):286–297, 1978.
5. Silverstein H, Norrell H: Retrolabyrinthine surgery: A direct approach to the cerebellopontine angle. Otolaryngol Head Neck Surg 88(4):462–469, 1980.
6. Chen BS, Roberts DS, Lekovic GP: Vestibular neurectomy for intractable vertigo: Case series and evaluation of role of endoscopic assistance in retrolabyrinthine craniotomy. J Neurol Surg Part B: Skull Base 80(4):357–363, 2019.
7. House JW, Hitselberger WE, Mcelveen J: Retrolabyrinthine section of the vestibular nerve. Otolaryngol Neck Surg 2–5, 1984.
8. Silverstein H, Norell H, Haberkamp T, et al: The unrecognized rotation of the vestibular and cochlear nerves from the labyrinth to the brain stem: Its implications to surgery of the eighth cranial nerve. Otolaryngol Neck Surg 95:543–549, 1986.