Surgical Approaches to the Ossicular Chain

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KEYWORDS

• Ossiculoplasty • Otologic surgery • Microsurgery • Endoscope • Microscope

KEY POINTS

- The surgical approach should address coexisting middle ear or mastoid disease while allowing full inspection of the ossicles to identify the cause of conductive hearing loss.
- Surgical corridors include the transcanal, endaural, transmeatal, postauricular, and transmastoid/transfacial recess approaches and visualization achievable using a microscope and/or endoscope.
- Endoscopic approaches may be desirable for their wide angle visualization and potential to reduce postoperative recovery time due to use of natural corridors.

INTRODUCTION

A conductive hearing loss is caused when sound vibrations are unable to reach the inner ear due to obstructions or pathology in the external ear canal or middle ear. The causes of conductive hearing loss include ear canal stenosis, atresia, or obstructions, tympanic membrane perforations, or pathologies affecting the ossicles (malleus, incus, and stapes).[1] Ossiculoplasty or ossicular chain reconstruction, is a common otologic procedure performed to restore hearing in patients with a conductive hearing loss resulting from the discontinuity or fixation of the middle ear ossicles, due to acquired or congenital causes.[2–5] Over the years, numerous surgical approaches have been developed and refined to access the ossicular chain, each with its own advantages, disadvantages, and specific indications. This article provides a comprehensive overview of the various surgical approaches employed in ossiculoplasty, discussing key considerations such as patient selection, perioperative setup, and the nuances of each technique. By understanding the spectrum of available approaches, surgeons can tailor their choice of technique to address a variety of pathologies (**Fig. 1**A–C) and disease severities in hopes of achieving the best possible hearing outcomes for their patients.

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Abbreviations	
CT	computed tomography
EER	ear environment risk

PATIENT SELECTION

Careful patient selection is paramount for successful ossiculoplasty outcomes. Ideal candidates for ossiculoplasty typically present with conductive hearing loss due to ossicular chain discontinuity, fixation, or damage, confirmed by audiometric testing and otoscopic examination. The etiology of the ossicular pathology (eg, congenital fixation, chronic otitis media, trauma, and congenital anomalies) can be assessed during history taking. Ideally, patients should have a healthy middle ear environment, free from active infection or significant inflammatory disease, as these conditions can compromise graft take and overall surgical success. The degree of conductive hearing loss is determined during the patient's audiometric evaluation. Those with an air-bone gap of less than 15 dB may be counseled against surgery since the likelihood of

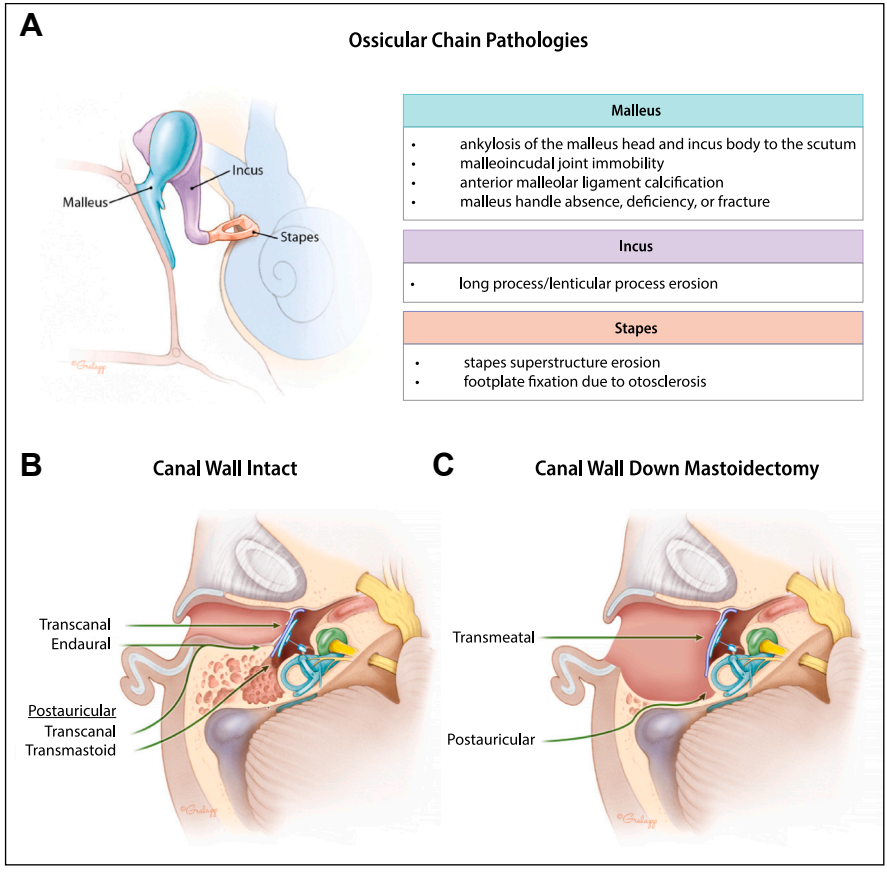

Fig. 1. Overview of common ossicular chain pathologies and approaches. (*A*) Ossicular chain pathologies by ossicle (*B*) Approaches to the middle ear and ossicular chain when the canal wall is left intact. (*C*) Approaches to the middle ear and ossicular chain when then canal wall has been removed. (*Image courtesy* Chris Gralapp.)

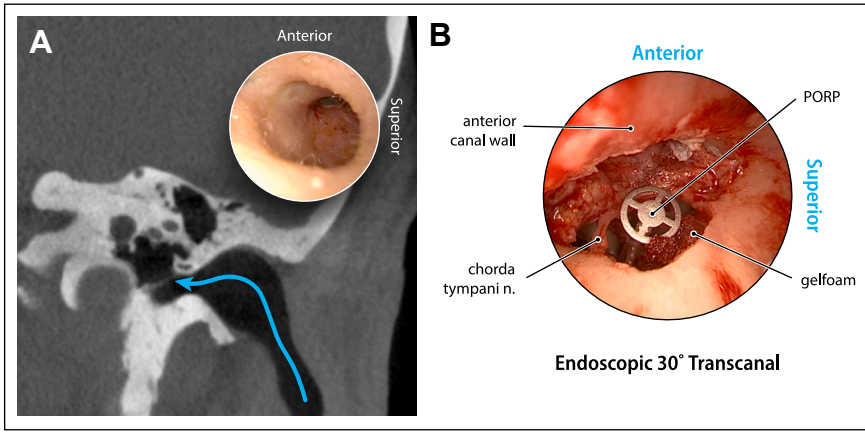

Fig. 2. Tortuous ear canals on CT. (*A*) Coronal CT temporal bone demonstrating the tortuous ear canal of a patient with Turner syndrome and the endoscopic 0° view of the ear canal as an inset. (*B*) Endoscopic 30° view of prosthesis placement via transcanal endoscopic approach.

achieving an improvement is decreased especially in cases of ossiculoplasty revision.[6] Patients with a mixed hearing loss may be candidates for ossiculoplasty as well since surgery could potentially improve their performance with hearing aids. Patients should also be informed of alternatives for hearing rehabilitation, such as hearing aids or bone conduction hearing devices, which are available from various manufacturers.[1,7,8]

Preoperative evaluation also includes assessing the patient's overall health, including any comorbidities that might increase surgical risk or impair healing. Other factors such as a history of recurrent ear infections, Eustachian tube dysfunction, or prior unsuccessful middle ear surgeries should be carefully considered, as they may influence the choice of surgical approach and the anticipated prognosis.[9–11] Patient expectations regarding hearing improvement and potential limitations of the procedure should be thoroughly discussed. Finally, imaging studies, such as fine-cut ($\leq$0.6 mm thickness) computed tomography (CT) scans of the temporal bone, may be used to evaluate for the potential sites of ossicular damage or disruption. Preoperative imaging may be helpful for choosing a technique or surgical approach based on the size and course of the ear canal (**Fig. 2**A, B) or if other middle ear/mastoid disease is present.[12,13] For example, a narrow or tortuous canal, like is in the case of patients with Down syndrome or Turner syndrome, could make an endoscopic approach more favorable than a microscopic approach. In these scenarios, a microscopic approach would require additional incisions (ie, postauricular or an endaural incision).[14,15]

ANESTHESIA CONSIDERATIONS

Anesthesia for ossiculoplasty requires careful planning to ensure patient safety and optimize surgical conditions. General anesthesia is typically preferred, as it allows for precise control of patient movement and airway management, crucial for delicate middle ear surgery. The choice of anesthetic agents should consider their potential impact on intraoperative neuromonitoring if facial nerve monitoring is used. Nitrous oxide anesthesia is typically avoided in middle ear surgery procedures, such as ossiculoplasty, because it increases middle ear pressure.[16]

Hemodynamic Stability

Maintaining stable blood pressure is important to minimize bleeding in the middle ear, which can obstruct the surgeon's view. Controlled hypotension may be considered in select cases to further reduce bleeding, but this must be balanced against the patient's comorbidities.

Neuromonitoring

If facial nerve monitoring is employed, short-acting muscle relaxants or no muscle relaxants should be used during the case to ensure accurate nerve stimulation responses. The anesthesiologist should be made aware of the surgeon's need for neuromonitoring.

Nausea and Vomiting Prophylaxis

Postoperative nausea and vomiting can be particularly distressing after ear surgery. Prophylactic antiemetics are highly recommended to prevent retching and discomfort, which could impact the healing of the surgical repair.

Pain Management

A multimodal approach to pain management, including local anesthetics infiltrated by the surgeon and systemic analgesics, is employed to ensure adequate postoperative pain control. The authors prefer to avoid the use of lidocaine for canal injections as there have been reports of transient facial paralysis.[17]

Positioning

The patient's head is typically turned to the side opposite to the operative ear, and the anesthesiologist must ensure that the patient's head is secured and any pressure points are padded to prevent pressure injury or alopecia.[18]

Communication

Clear communication between the surgical and anesthesia teams is paramount throughout the procedure to address any changes in patient status or surgical needs.

POSITIONING AND PERIOPERATIVE MEDICATIONS

Patients are placed in a supine position, with the occiput well-padded and the head rotated slightly away from the surgeon. The height of the table should be adjusted so that the surgeon achieves a comfortable ergonomic position with either a microscope or an endoscope. Preoperative prophylactic antibiotics such as Cefazolin are typically given for coverage of *Staphylococcus* and *Streptococcus spp*. Clindamycin would be an acceptable alternative for those with penicillin allergies.[19] Additionally, a dose of intravenous dexamethasone is given to reduce the risk of postoperative nausea and vomiting, as well as to provide anti-inflammatory benefit to the inner ear given the expected micromanipulations of the ossicular chain during the procedure. The patient's skin is then prepared for the surgical procedure by applying Betadine (10% povidone-iodine) antiseptic solution to the skin of the auricle and surrounding areas. A 3 mL syringe can be used to draw up some of the antiseptic solution to fill the ear canal before the placement of surgical drapes.

MICROSCOPIC TRANSCANAL APPROACH

Transcanal approaches to the middle ear provide direct access to the middle ear for ossicular chain evaluation and ossiculoplasty. This approach is suitable for cases

where the extent of middle ear disease is limited but can be combined with postauricular approaches as necessary. When the canal caliber is adequate, microscopic visualization through a speculum can be sufficient. However, in cases where there is a narrower canal lumen, an endoscope can be used instead or a canaloplasty via a postauricular transcanal or endaural approach could be used.

The primary benefits of using a binocular microscope for transcanal middle ear surgery is the ability to have depth perception and bimanual instrumentation, where a suction can be used along with microdissection instruments to clear debris, blood, or serve as another instrument to manipulate tissue flaps, grafts, or prostheses.[20] The typical tympanomeatal flap incision consists of radial cuts at the 12 o'clock and 6 o'clock positions and then is connected laterally about 2 round knife's widths (~4 mm) from the annulus. The middle ear is usually entered posteroinferiorly and the tympanic annulus is elevated out of the annular sulcus and the tympanic membrane is carefully microdissected off the chorda tympani nerve and carried superiorly. This flap elevation typically affords visualization of the long process of the incus, the stapes, the round window, and the undersurface of the malleus manubrium (**Fig. 3**A–F). Due to variability of the amount of scutal bone that may be present, removing the scutum may be necessary to visualize the malleus head and neck. Once the ossicles are evaluated and the pathology is determined, the type of ossiculoplasty can be determined. After the ossicular chain reconstruction is performed, a cartilage graft may need to be harvested when prosthesis is used. The cartilage graft can be sourced from either from the tragus or the conchal bowl and tailored to fit over the prosthesis before replacing the tympanomeatal flap. The edges of the flap are then carefully unfurled, and the ear canal is packed with an antibiotic-soaked gelfoam packing.

ENDOSCOPIC TRANSCANAL APPROACH

Endoscopes have some unique advantages in middle ear surgery including increased visual detail and a wide-angle field of view. The higher level of detail provided by endoscopes can be useful for evaluating and diagnosing ossicular chain pathologies (**Fig. 4**).[21–23] However, there are some drawbacks, which include the lack of depth perception and the inability for bimanual surgery for maintaining a clear surgical field and tissue manipulation.[24] To overcome these, a surgeon can use infer depth from motion parallax and maintain a clear filed, especially during tympanomeatal flap elevation with specialized endoscopic suction instruments, hemostatic agents with topical epinephrine solution, and controlled hypotension. The endoscope can often provide a complete view of the tympanic membrane and middle ear cavity and can be further enhanced with angled endoscopes.[25] This usually allows anterior portions of the tympanic membrane to be visualized more easily using an endoscope when compared to an operating microscope and speculum. This can add more flexibility in tailoring the tympanomeatal flap design to access different anatomic regions like the protympanum. There are ear endoscopes available with an integrated suction allowing for simultaneous suctioning and microdissection and reducing instrument exchanges.

Certain subtle pathologic changes to the ossicular chain can also be more clearly visualized using the endoscope and can be a great adjunctive tool for inspection even for surgeons who use the microscope primarily. There are a few important surgical pearls that may be helpful for performing ossiculoplasty with the endoscope, and they relate to the management of bleeding/hemostasis, maintaining exposure and surgical corridors with props, and using prostheses designed with increased support.

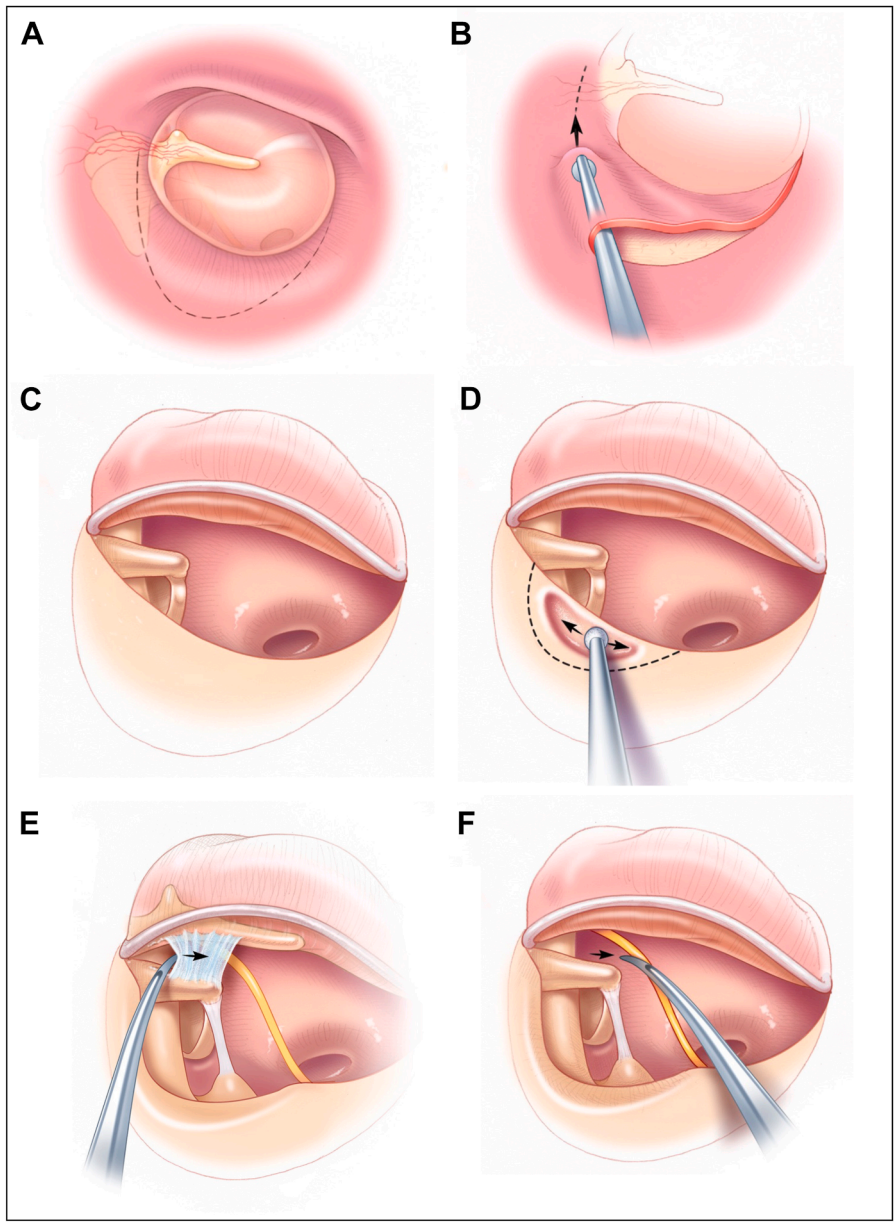

Fig. 3. A stepwise approach for accessing the middle ear and ossicles through the ear canal. (*A*) A tympanomeatal flap is designed to from the 12 to 6 o'clock in a right ear. (*B*) The tympanomeatal flap is elevated toward the annulus. (*C*) The middle ear is entered by elevating the annulus and revealing the middle ear space. (*D*) The scutum is removed with a drill or a curette to reveal more of the attic and ossicles. (*E*) Mucosal adhesions can be lysed between the ossicles and the chorda tympani nerve. (*F*) The chorda tympani nerve is mobilized and protected.

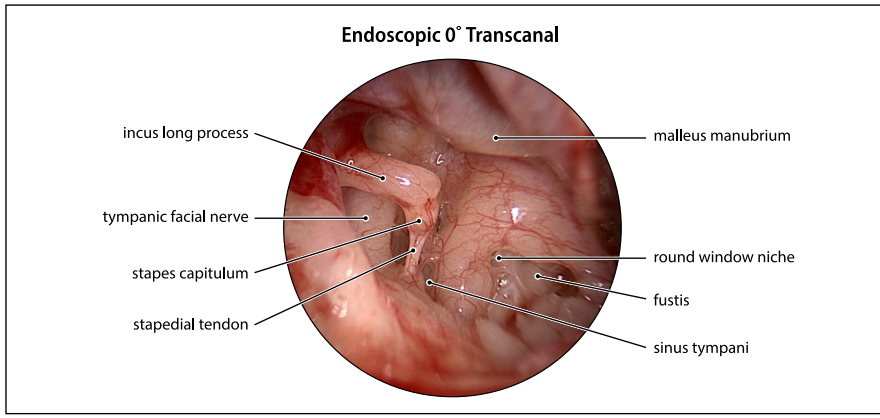

Fig. 4. Endoscopic view of the middle ear with annotated landmarks.

For endoscopic transcanal approaches, minimizing bleeding and limiting the need to clear the surgical field with suction is key and improves surgical efficiency by reducing the number of instrument changes. There are several commercially available endoscopic ear surgery instruments that have been designed with integrated suction ports and can be useful for tympanomeatal flap elevation. Additionally, an injection of a vasoconstricting agent (like 1:100,000 epinephrine) can be performed along the vascular strip at the bony-cartilaginous junction and an additional injection inferiorly along the bony external auditory canal. There are some surgeons who may use a more concentrated 1:10,000 epinephrine as a secondary injection to reduce injected volume that can lead to tissue edema and a narrowed ear canal aperture. During this process, close communication about when epinephrine is being injected with the anesthesiologist is key so that the patient's vital signs can be closely monitored. If the patient does not have significant comorbidities, permissible hypotension with systolic blood pressures as low as is safe and raising the head of the operating room table slightly, in a reverse Trendelenburg position can be helpful. Hemostatic adjuncts like Surgicel SNoW (Ethticon, Somerville, NJ) or cotton soaked in 1:1000 to 1:10,000 topical epinephrine can be used throughout the case, particularly during flap elevation, to provide topical vasoconstriction/hemostasis. Closed-loop communication with the surgical scrub technician and the circulating nurse is required to keep track of these cottonoids. The counts should be verified at the conclusion of the case in addition to visual inspection to confirm that all surgical cotton is removed.

When selecting prosthesis to be used during an endoscopic approach, it may be advantageous to use an *attachment* prosthesis, such as the Kurz CliP prosthesis or the Grace Medical NyteByte prothesis, which have prongs that attach to head of the stapes rather than just resting on the capitulum.[26] They are advantageous because their coupling is supported by a firm attachment to the stapes and can be easier to place into final position with a single-handed endoscopic technique. Additionally, very little to no gelfoam needs to be placed in the middle ear cavity to support the prosthesis and prevent it from displacement, allowing for faster postoperative healing and expedited final hearing outcomes. In an endoscopic transcanal technique, after prosthesis is placed a cartilage graft is usually harvested (from the tragus or conchal bowl) and fashioned to sit atop the platform of the prosthesis before replacing the tympanomeatal flap.[27] It is important to unfurl all the edges of the

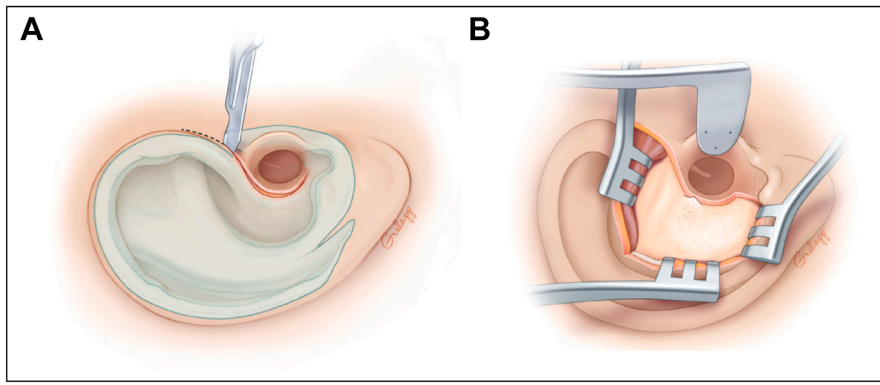

Fig. 5. The endaural approach begins with (*A*) an incision along the incisura along the helical root between the helical root cartilage and the tragus (*B*); this allows for exposure of the external auditory canal. (*Image courtesy* Chris Gralapp.)

tympanomeatal flap and then antibiotic-soaked gelfoam packing is be placed in the ear canal to keep the flap secure.

ENDAURAL APPROACH

The endaural approach can offer an excellent microscopic exposure of the middle ear without the need for a speculum. The disadvantage is the use of an external incision, but minimal visible scarring can be achieved with proper incision planning along the auricle's aesthetic subunits and meticulous closure. While the endaural approach provides excellent transcanal microscopic exposure and bimanual instrument access, a transcanal endoscopic approach can typically also achieve a similar or wider surgical exposure. The endaural approach begins with infiltration of local anesthetic with epinephrine along the planned incision line along the helical root, preauricular region, tragus, and ear canal. The superior and inferior canal incisions are made, and the superior incision is then extended superiorly just posterior to the tragus and along the anterior limb of the helix toward the superior root of the helix. Care is taken to place this incision between the subunits of the auricle to allow for the incision to eventually be camouflaged for a favorable cosmetic result. The soft tissue dissection is then carried along the subcutaneous plane to expose the cartilaginous external auditory canal, meatus, and periosteum. A Koerner's posterior ear canal flap can then be elevated in a subperiosteal plane and retracted posteriorly. A small self-retaining retractor can then be placed to increase the exposure of the medial external auditory canal and the tympanic membrane. The middle ear can then be entered in the typical fashion by elevating the tympanomeatal flap medially toward the annulus and elevating the annulus and the tympanic membrane from the 12 o'clock to 6 o'clock position (**Fig. 5**A, B). Once the middle ear is entered, the ossicles can then be inspected and the ossiculoplasty performed. Grafting material including temporalis fascia and tragal cartilage is accessible through the endaural incision as well.

For closure, the tympanomeatal flap is repositioned over the posterior canal wall, and the endaural incision is closed in anatomic layers with absorbable sutures for the subcutaneous tissues, and fine absorbable or nonabsorbable sutures for the skin. The Koerner's posterior ear canal flap is then replaced, and its edges should

be carefully unfurled and oppose the tympanomeatal flap incision. Antibiotic-soaked gelfoam packing can be placed in the ear canal as well as antibiotic-soaked otologic wicks.

POSTAURICULAR TRANSCANAL APPROACH

The postauricular transcanal approach can provide additional exposure to the anterior ear canal due to its shallower approach angle especially when combined with a canalplasty. It also provides exposure without the use of a speculum, and the mastoid can be exposed in case a mastoidectomy needs to be performed. Through the postauricular incision, additional grafting material can also be harvested through the existing incision including temporalis fascia and conchal cartilage (**Fig. 6**A–C). Also the incision is well-hidden behind the auricle, but it is important to appropriately suspend the ear in the proper position as it can lead to a prominent ear or an ear that is set higher or lower.[28,29] Other potential complications associated with the use of a postauricular incision include numbness and scarring.[30] Entry into the middle ear is nearly identical to the aforementioned approaches, but if there is a prominent anterior canal bulge or narrowing, a canalplasty can also be performed to increase the bony exposure.

TRANSMASTOID FACIAL RECESS (POSTERIOR TYMPANOTOMY) APPROACH

The transmastoid facial recess (or posterior tympanotomy) approach can be performed when an ossiculoplasty is performed in a staged manner. During the first stage, a canal wall up mastoidectomy is completed to remove disease cholesteatoma and the facial recess is opened widely. A tympanoplasty using a cartilage graft is performed and a silastic sheet is placed into the middle ear to maintain patency. Then when the second stage is performed, approximately 6 months later, the postauricular incision is opened and a *second-look* is performed to evaluate for any disease recurrence.[31,32] The silastic sheet can be removed and the middle ear, epitympanum, and other difficult to visualize areas can be examined with an endoscope to ensure that those areas are also free of disease. Then ossicular chain prosthesis can be selected and placed through the facial recess and attached to the stapes capitulum or the stapes footplate and placed beneath the preexisting cartilage graft. The fit should be snug against the tympanic membrane/cartilage graft construct and the stapes (**Fig. 7**A, B). The distinct advantage of this approach is that it can allow for prosthesis placement and immediate hearing improvement after the second stage since the tympanic membrane and cartilage graft are already well-healed and there should be no need for canal incisions, tympanomeatal flap elevation, middle ear packing, or dry ear precautions.[33]

TRANSMEATAL APPROACH IN A PRIOR CANAL WALL DOWN CAVITY

Whether it is being performed as a staged procedure or to revise a previously placed prosthesis, it may be necessary to perform an ossiculoplasty in a previous canal wall down cavity.[34] In these instances, we have found it important to take note of the height of the facial ridge or the bone that overlies facial nerve in the tympanic cavity, at the second genu and mastoid segment.[35] It is important to note whether the facial nerve is bare or dehiscent in these areas, and this can be assessed on preoperative CT imaging or may have been noted on previously written operative reports. An endoscope or a microscope (in cases with wide meatoplasties) can be used for visualization and a transmeatal approach may be preferred to a postauricular approach

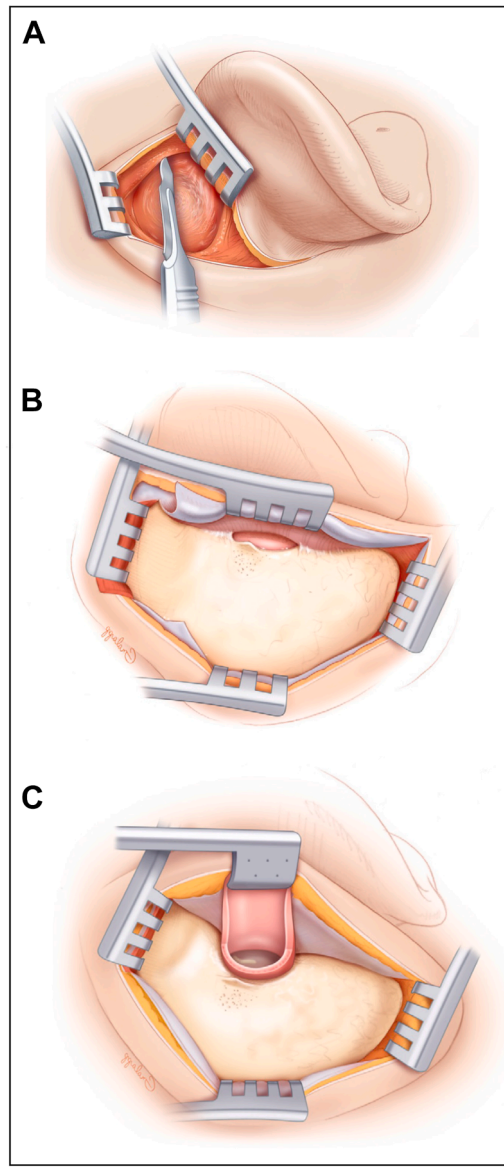

Fig. 6. The postauricular transcanal approach uses a curvilinear postauricular incision, then (*A*) the ear is elevated forward along the temporalis muscle facia and mastoid periosteum plane. (*B*) Mastoid periosteal incision is made, and the periosteum is then elevated forward until the spine of Henle, and the external auditory canal is seen. (*C*) The external auditory canal is then incised, and the tympanic membrane is revealed. (*Image courtesy* Chris Gralapp.)

since it can avoid disrupting a well-healed and epithelialized mastoid bowl. When elevating the tympanic membrane/tympanomeatal flap it is important to create the incision posterior to the facial ridge and then elevate toward the middle ear cavity and any previously placed cartilage grafts. Blunt dissection using a piece of cotton

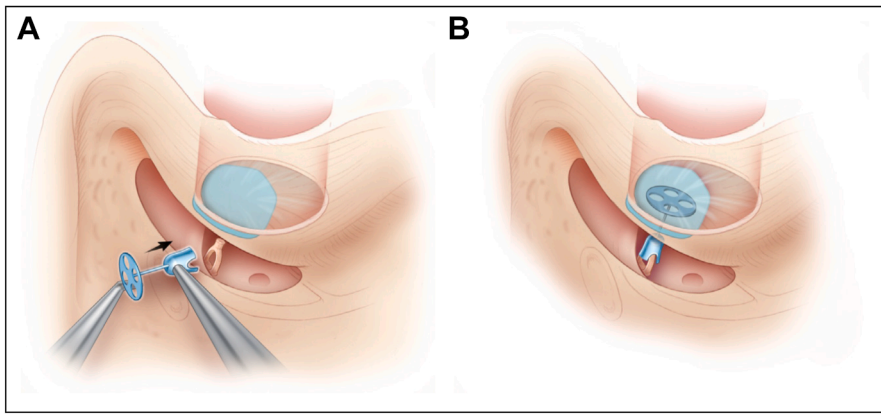

Fig. 7. In the setting of a prior canal wall up mastoidectomy, the middle ear ossicles can be reconstructed in a staged approach. Through a prior postauricular incision, mastoidectomy, and facial recess corridor (*A*) the ossicular chain reconstruction prosthesis can be placed and (*B*) it sits securely between the stapes and previously placed cartilage grafts.

or dissolvable Surgicel SNoW (Ethicon, Somerville, NJ) can aid in gently elevating the skin over the tympanic and vertical segments of the facial nerve. The goal is to expose the stapes, round window, and the facial nerve (**Fig. 8**A, B). Once adequate exposure is achieved, an ossiculoplasty prosthesis can be selected and placed along with a cartilage graft. The tympanic membrane flap can then be redraped over the facial ridge. If there is foreshortening of the flap, a temporalis fascia graft can be used to extend the coverage as an underlay graft. Once the flaps and/or grafts are placed, the middle ear and mastoid cavity can be packed with dissolvable antibiotic soaked gelfoam packing.

MIDDLE EAR EXPLORATION

Determining the cause of conductive hearing loss requires a detailed examination of the ossicular chain to determine the etiology. Once the etiology of the conductive hearing loss is identified, it can then be addressed. Exposure of the malleus neck and head may be required to evaluate for malleus related pathologies and the long process of the incus and the lenticular process, and the stapes superstructure. In some cases, the scutum may need to be removed to increase the exposure of the malleus head/neck. The scutum can be removed with either a curette or a microdrill. Great care should be taken to avoid transmitting forces to the ossicular chain; inadvertent drilling of the ossicular chain can result in sensorineural hearing loss.[36] The ossicles, stapes crurae, as well as the malleoincudal and incudostapedial joints should be inspected, any scar bands, mucosal adhesions, or tympanosclerotic plaques should be lysed or removed. The round window should also be visualized as a round window reflex can be helpful for assessing continuity of the ossicles or after reconstruction.

POSTOPERATIVE CARE AND PAIN MANAGEMENT

After surgery, pain control typically consists of non-steroidal anti-inflammatory medications (NSAIDs) or minimal narcotic pain medication, stool softeners, and ototopical antibiotics (Ofloxacin otic solution) to help dissolve the gelfoam packing material.

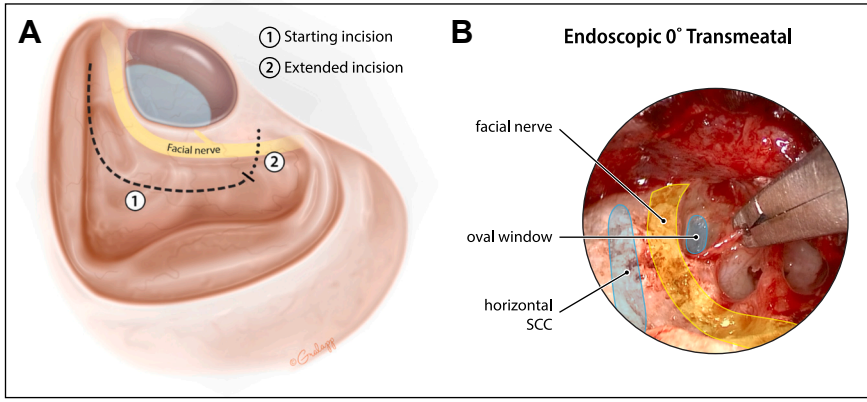

Fig. 8. In a prior canal wall down mastoidectomy cavity, a microscope or endoscope can be used to elevate the neotympanic membrane. (*A*) The tympanic remnant flap incision (1) is made behind the facial nerve and parallel to the facial ridge. Then the flap can be elevated off the facial ridge, and cottonoids can be used to gently and bluntly dissect the skin flap. The incision can be extended (2) to allow for greater exposure with care being taken when crossing the course of the facial nerve. (*B*) An intraoperative endoscopic view of the transmeatal approach with the facial nerve, oval window, and the horizontal semicircular canal in view. (*Image courtesy* Chris Gralapp.)

Postoperative pain after endoscopic and microscopic ear surgery have been compared in a recent meta-analysis and found that there was significantly less postoperative pain with endoscopic ear surgery compared to microscopic ear surgery.[37] The rates of postoperative infection are quite low. Oral antibiotics are not routinely prescribed unless an infection was noted intraoperatively.[19,38] Patients are also counseled to avoid strenuous physical activity, exercise, or straining for about 2 weeks after surgery. They will follow up for their first postoperative visit at around 2 weeks and a repeat audiogram in about 6 weeks.

OUTCOMES

Endoscopic Versus Microscopic Approaches

In a recent systematic review and meta-analysis, subjects from 4 studies were pooled and the audiometric outcomes were compared between those who underwent ossiculoplasty with an endoscopic versus a microscopic approach. They pooled 442 participants from studies performed in 2017 to 2022, 193 in the endoscopic group, and 249 in the microscopic group, and found there were comparable results without significant differences in their hearing outcomes: air bone gap, air bone gap closure, pure tone audiometry, or word recognition scores.[39] In the pediatric population, a study was published during the early adoption of exclusively endoscopic approach for ossiculoplasty at a single-institution, and compared their endoscopic and microscopic results. They found a trend that showed greater improvements in pure tone average (PTA) of about 10.7 dB in the endoscopic group compared to 5.9 dB in the nonendoscopic group but was not statistically significant.[40] However, a recent study found that when an endoscopic ossiculoplasty required an additional mastoidectomy, it was associated with poorer hearing outcomes.[41] Multiple systematic reviews and meta-analyses have also consistently

shown less postoperative pain and lower analgesic use with endoscopic ear surgery when compared to microscopic ear surgery. This is likely because it uses a natural corridor and involves less soft tissue dissection and has been demonstrated across various otologic procedures in both adult and pediatric patients.[37,42–45]

Middle Ear Health

The overall health of the ear and the middle ear environment can play a role in the hearing outcomes after ossiculoplasty. An Ear Environment Risk (EER) score was developed to assess the environmental factors affecting the middle ear and their correlation with audiometric outcomes after ossiculoplasty. Through multivariable regression analyses, they found that multiple revision status, presence of canal wall down mastoidectomy cavity, absent malleus, absent stapes superstructure, frequent otorrhea, pediatric age, and blunted/lateralized tympanic membrane were independently correlated with PTA-air-bone gap (ABG). The EER score outperformed existing grading scales with regards to correlating with audiometric outcomes.[9–11] These studies have allowed for certain risk factors to be assessed and accounted for when comparing hearing outcomes and also emphasize the importance of creating a stable, disease-free environment to improve hearing outcomes.

SUMMARY

A successful ossiculoplasty hinges on a thorough understanding of various surgical approaches, each offering distinct advantages and considerations. The choice of approach—whether transcanal, endaural, postauricular, transfacial recess, or transmeatal—is dictated by the extent of middle ear disease, the patient's anatomy, the specific ossicular pathology, and surgeon preference. While microscopic techniques offer depth perception and bimanual dexterity, endoscopic approaches enable enhanced wide field visualization and less invasive surgery, particularly for subtle pathologies and challenging anatomic areas. Careful patient selection, meticulous preoperative planning, and precise intraoperative technique are paramount to achieving optimal hearing outcomes and minimizing complications. Continuous refinement of these surgical techniques, coupled with advancements in instrumentation, continues to improve the prognosis for patients undergoing ossicular chain reconstruction.

CLINICS CARE POINTS

- Conductive hearing loss due to ossicular chain pathologies can be addressed via multiple surgical approaches, including transcanal and post-auricular soft-tissue approaches and via an intact external auditory canal or via a canal wall down mastoid cavity.
- Various forms of surgical magnification may be employed for ossicular chain recontstruction, primarily an endoscope or a microscope. The choice of instrumentation may be based on the extent of disease, the patient's anatomy, and surgeon preference.
- In some cases, endoscopic ossicular chain reconstruction approaches may enable a more minimally invasive approach and less post operative pain.

DISCLOSURE

The authors have no disclosures.

REFERENCES

1. Hill-Feltham PR, Johansson ML, Hodgetts WE, et al. Hearing outcome measures for conductive and mixed hearing loss treatment in adults: a scoping review. Int J Audiol 2021;60(4):239–45.
2. Luers JC, Huttenbrink KB. Surgical anatomy and pathology of the middle ear. J Anat 2016;228(2):338–53.
3. Mittal R, Lisi CV, Gerring R, et al. Current concepts in the pathogenesis and treatment of chronic suppurative otitis media. J Med Microbiol 2015;64(10):1103–16.
4. Olszewska E, Wagner M, Bernal-Sprekelsen M, et al. Etiopathogenesis of cholesteatoma. Eur Arch Otorhinolaryngol 2004;261(1):6–24.
5. Van Hoecke H, Calus L, Dhooge I. Middle ear damages. B-ENT 2016;Suppl 26(1):173–83.
6. Page JC, Cox MD, King D, et al. Long-term outcomes of ossiculoplasty with and without an intact malleus. Otol Neurotol 2019;40(1):73–8.
7. Ellsperman SE, Nairn EM, Stucken EZ. Review of bone conduction hearing devices. Audiol Res 2021;11(2):207–19.
8. Richards JP, Symms JT, Beasley K, et al. Bone conduction implants. Curr Opin Otolaryngol Head Neck Surg 2020;28(5):308–13.
9. Gluth MB, Judd RT, Gurgel RK, et al. A multi-center study of ossiculoplasty hearing outcomes and a grading scale of ear environment risk. Laryngoscope 2025; 135 Suppl 2(Suppl 2):S1–11.
10. Judd RT, Gluth MB, Gurgel RK, et al. Impact of modifiable surgical factors on ossiculoplasty outcomes after controlling for ear environment risk: a multi-institutional study. Otol Neurotol 2025. https://doi.org/10.1097/MAO.0000000000004611.
11. Judd RT, Imbery TE, Gluth MB. The utility of numeric grading scales of middle ear risk in predicting ossiculoplasty hearing outcomes. Otol Neurotol 2020;41(10): 1369–78.
12. Robson CD. Conductive hearing loss in children. Neuroimaging Clin N Am 2023; 33(4):543–62.
13. Vassallo E, Gatt AS, Grech R, et al. Imaging in sensorineural and conductive hearing loss-an educational review. Radiol Med 2025;130(1):46–62.
14. Hargunani CA, King E, Milczuk HA, et al. Endoscopic ear surgery in children with Down syndrome. Int J Pediatr Otorhinolaryngol 2020;131:109884.
15. Zanetti D, Di Lella F, Negri M, et al. Surgical management of middle ear cholesteatoma in children with Turner syndrome: a multicenter experience. Acta Biomed 2018;89(3):382–8.
16. Chinn K, Brown OE, Manning SC, et al. Middle ear pressure variation: effect of nitrous oxide. Laryngoscope 1997;107(3):357–63.
17. Kim H, Lee J, Jeon Y. Transient facial paralysis after myringotomy and ventilation tube insertion under sedation with sevoflurane inhalation and four-quadrant blocks with lidocaine: a case report. J Dent Anesth Pain Med 2020;20(3):161–3.
18. Davies KE, Yesudian P. Pressure alopecia. Int J Trichology 2012;4(2):64–8.
19. Antonelli PJ. Perioperative use of antibiotics in otologic procedures. Curr Opin Otolaryngol Head Neck Surg 2015;23(5):330–3.
20. Mudry A. The history of the microscope for use in ear surgery. Am J Otol 2000; 21(6):877–86.
21. Ridge SE, Shetty KR, Lee DJ. Current trends and applications in endoscopy for otology and neurotology. World J Otorhinolaryngol Head Neck Surg 2021;7(2): 101–8.

22. Tarabichi M. Endoscopic middle ear surgery. Ann Otol Rhinol Laryngol 1999; 108(1):39–46.
23. Thomassin JM, Duchon-Doris JM, Emram B, et al. [endoscopic ear surgery. Initial evaluation]. Ann Otolaryngol Chir Cervicofac 1990;107(8):564–70. Otochirurgie endoscopique. Premier bilan.
24. Hu Y, Teh BM, Hurtado G, et al. Can endoscopic ear surgery replace microscopic surgery in the treatment of acquired cholesteatoma? A contemporary review. Int J Pediatr Otorhinolaryngol 2020;131:109872.
25. Furukawa T, Watanabe T, Ito T, et al. Feasibility and advantages of transcanal endoscopic myringoplasty. Otol Neurotol 2014;35(4):e140–5.
26. Mantsopoulos K, Thimsen V, Taha L, et al. Comparative analysis of titanium clip prostheses for partial ossiculoplasty. Am J Otolaryngol 2021;42(5):103062.
27. Dornhoffer J. Cartilage tympanoplasty: indications, techniques, and outcomes in a 1,000-patient series. Laryngoscope 2003;113(11):1844–56.
28. Kim YH. A prospective study on changes in auricular protrusion after chronic otitis media surgery with the postauricular approach. J Int Adv Otol 2020;16(2): 253–8.
29. Mokhatrish M. Auricular protrusion after the postauricular approach: a review of the current literature. Cureus 2023;15(10):e46509.
30. Chern A, Sharma RK, Grewal MR, et al. Patient-reported postoperative pain and numbness: applications for endoscopic vs. microscopic ear surgery. J Pers Med 2022;12(10). https://doi.org/10.3390/jpm12101718.
31. Bu DD, Schwam ZG, Wanna GB, et al. Cost-effectiveness of diffusion-weighted magnetic resonance imaging versus second-look surgery in treating cholesteatoma: a modeling study. Otol Neurotol 2024;45(2):163–8.
32. Cohen MS, Basonbul RA, Kozin ED, et al. Residual cholesteatoma during second-look procedures following primary pediatric endoscopic ear surgery. Otolaryngol Head Neck Surg 2017;157(6):1034–40.
33. Blevins NH. Transfacial recess ossicular reconstruction: technique and early results. Otol Neurotol 2004;25(3):236–41.
34. Gjini EK, Kalmanson OA, Noonan K, et al. Techniques in management of cholesteatoma: radical and canal wall Down mastoidectomy. Otolaryngol Clin North Am 2025;58(1):123–32.
35. Capriotti V, Dal Cin E, Gatto A, et al. Facial ridge management in canal wall Down tympanoplasty for middle-ear cholesteatoma. J Laryngol Otol 2023;137(10): 1118–25.
36. Jiang D, Bibas A, Santuli C, et al. Equivalent noise level generated by drilling onto the ossicular chain as measured by laser Doppler vibrometry: a temporal bone study. Laryngoscope 2007;117(6):1040–5.
37. Toulouie S, Block-Wheeler NR, Rivero A. Postoperative pain after endoscopic vs microscopic otologic surgery: a systematic review and meta-analysis. Otolaryngol Head Neck Surg 2022;167(1):25–34.
38. Gupta S, Heman-Ackah SE, Lalwani AK. Are prophylactic antibiotics necessary for otologic surgery? Laryngoscope 2012;122(6):1183–4.
39. Lim CY, Yeo BSY, Goh X, et al. Outcomes of endoscopic versus microscopic ossicular chain Reconstruction-A systematic review and meta-analysis. Laryngoscope 2025;135(6):1899–907.
40. Cohen MS, Landegger LD, Kozin ED, et al. Pediatric endoscopic ear surgery in clinical practice: lessons learned and early outcomes. Laryngoscope 2016; 126(3):732–8.

41. Fink R, Molinari G, Burato A, et al. Endoscopic ossiculoplasty: audiological and surgical outcomes from a multicenter experience with 292 cases. Eur Arch Otorhinolaryngol 2025. https://doi.org/10.1007/s00405-025-09473-y.
42. Benchetrit L, Kwock M, Ronner EA, et al. Assessment of pain and analgesic use in children following otologic surgery. Otolaryngol Head Neck Surg 2021;165(1):206–14.
43. Kakehata S, Furukawa T, Ito T, et al. Comparison of postoperative pain in patients following transcanal endoscopic versus microscopic ear surgery. Otol Neurotol 2018;39(7):847–53.
44. Kwinter A, Purcell PL, Leonard CG, et al. Comparing transcanal endoscopic ear surgery to post-auricular microscope-guided surgery in pediatric ossiculoplasty: hearing outcomes and post-operative pain. Otol Neurotol 2021;42(10):e1648–51.
45. Manna S, Kaul VF, Gray ML, et al. Endoscopic versus microscopic middle ear surgery: a meta-analysis of outcomes following tympanoplasty and stapes surgery. Otol Neurotol 2019;40(8):983–93.