Autologous Cartilage Ossiculoplasty

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KEYWORDS

• Autologous • Cartilage • Ossiculoplasty • Tympanoplasty • Myringostapediopexy • Myringoplatinopexy • Mastoidectomy • Tympanomastoidectomy

KEY POINTS

- Ossicular disruption is a common pathologic finding in chronic middle ear disease.
- The ideal ossiculoplasty material should be firm, easy to use, readily available, have low extrusion and resorption rates and give a perfect air-bone gap closure.
- Autologous cartilage tympanoplasty is cheap, biocompatible, easily accessible and easily sculptured to various ossicular defects.
- Audiological results from cartilage ossiculoplasty are comparable to other ossiculoplasty materials.

INTRODUCTION

Ossiculoplasty is defined as surgical reconstruction of the ossicular chain. It is synonymous with ossicular reconstruction. Ossiculoplasty is done to address the conductive component of hearing impairment in individuals who are unfortunate to suffer ossicular disorders. There are various materials used in ossiculoplasty. Autogenous materials such as cartilage, cortical bone, remnant ossicles and synthetic materials such as Teflon, titanium, hydroxyapatite, steel, platinum, gold, and alloys have been used with varying degrees of success. Synthetic ossicular prosthesis are normally fashioned as partial ossicular replacement prosthesis or total ossicular replacement prosthesis. Failure of ossiculoplasty has been attributed to a variety of factors, including, but not limited to prosthesis material, and the search for the best outcome in ossiculoplasty is very much alive.[1] Synthetic ossicular prosthesis is expensive and is particularly prone to extrusion despite attempts at modification of surgical techniques, including support with cartilage struts.[2,3]

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Abbreviations	
ABR	auditory brainstem evoked audiometry
HRCT	high-resolution computed tomographic scan

ETIOLOGY

The etiology of ossicular pathology varies from inflammatory disorders such as chronic suppurative otitis media,[4] with or without cholesteatoma being the most common cause. Ossicular chain discontinuity can also result from traumatic ossicular fractures and congenital ossicular anomalies.

The most common ossicle to be affected in chronic ear disease is the incus, followed by stapes and finally the malleus.[5] In congenital cholesteatoma, the senior author has identified the stapes as the first and most commonly affected ossicle.[6] Erosion or necrosis of the long process of incus is predominantly the initial stage of ossicular destruction by inflammatory disease. This has been attributed to the variability in its blood supply. The malleus has been noted to be the most resistant ossicle.[7]

PRESENTATION

Ossicular pathology commonly presents with ear discharge followed closely by hearing loss.[8] This is due to discontinuity in the sound transmission mechanism. Ear discharge, facial nerve palsy, blocked sensation, aural fullness are also possible presentations. Some patients may present with normal hearing, for example, where a cholesteatoma matrix bridges 2 disrupted ossicles and maintains the conduction ability.[9] In these patients, a high index of suspicion, coupled with a thorough physical examination and high-resolution computed tomographic scan (HRCT) temporal bone, the diagnosis can often be established preoperatively. Ossicular disruption may also be encountered intraoperatively and may also be iatrogenic, both accidental and nonaccidental for example, in facial nerve decompression procedures where the incus and malleus are removed to access the tympanic and labyrinthine segments of the nerve. In patients with a tympanic membrane perforation or retraction, erosion or absence of ossicles can frequently be identified.

CLINICAL EXAMINATION

All patients with suspected ossicular pathology should undergo a comprehensive general physical assessment, to rule out other possible causes of hearing impairment. Conventional otoscopy, coupled with either, or both, otoendocopy and otomicroscopy is vital to establish a proper diagnosis. Any secretions or discharge should be meticulously cleared to enable proper assessment. Use of photo documentation is now readily available, which helps in patient counseling.[10] Particular attention is given to any tympanic membrane perforations, retraction pockets, cholesteatoma, absence of any or part of an ossicle. A tuning fork examination is crucial in determining the presence and nature of hearing loss. A good tuning fork examination should be used for correlation and confirmation of audiometric testing.

AUDIOMETRY

Pure tone audiometry is used to objectively determine hearing thresholds and speech discrimination scores. Any discrepancy between pure tone average and speech discrimination scores should raise suspicion of a sensorineural component to the hearing loss. Documentation of the air–bone gap during the initial assessment is

important since it offers a baseline for comparison of hearing outcomes after ossiculoplasty. Patients with profound hearing impairment are not considered candidates for ossiculoplasty. The very young, and the mentally infirm, benefit from auditory brainstem evoked audiometry (ABR) to ascertain the presence and degree of hearing impairment. A bone conduction ABR is a good adjunct in determining bone conduction thresholds and the air–bone gap.[11] Other causes of a large air–bone gap include tympanosclerosis, otosclerosis, and ankylosis of the ossicular chain should be considered and ruled out.

TYMPANOMETRY

Various configurations on the tympanogram along with compliance and external auditory canal volume can assist in determining if the ossicles are fixed or if there is discontinuity. In ossicular discontinuity, a type Ad curve with a normal canal volume is present. In ossicular fixation, a type As with normal canal volume is a common finding. In cholesteatoma, type B curve with increased canal volume is a common finding due to the presence of a retraction pocket or a perforation.[12]

IMAGING

The initial imaging modality of choice is HRCT of the temporal bone. This is an excellent tool in assessing the ossicular chain for its presence, form, and continuity.[13] The HRCT also helps in ruling out the differential diagnoses considered above with a favorable degree of certainty. Newer software enabling 3 dimensional volumetric reconstructions has improved ability to pick up even subtle anomalies, erosion, and discontinuity of the ossicular chain.[14] MRI using the nonechoplanar diffusion-weighted sequence is important in confirming the diagnosis of a cholesteatoma since it restricts diffusion and thus appears as a hyperintense signal. It has been established to have a high positive predictive value for cholesteatoma detection.[15] Other MRI sequences are important in establishing the presence of complications, such as extradural of intradural involvement, labyrinthine fistula, and so forth. It is also important in assessing for inner ear anomalies, especially in patients with congenital ossicular anomalies who are at an increased risk of concurrent inner ear anomalies.

THE ROLE OF CARTILAGE IN OSSICULOPLASTY

The search for the best material for ossiculoplasty has been a long-standing debate among otologists. The ideal material should be firm, easy to use, readily available, have low extrusion and resorption rates, and give a perfect air–bone gap closure. These desired characteristics make it an ominous task identifying a good substitute to an eroded ossicular chain. In his practice, the senior author has perfected the art of autologous cartilage tympanoplasty and shares his experience in this article. We prefer the use of nasal septal floor cartilage as this has proven to be firm enough, resistant to bowing, easy to sculpture, easy to harvest with little to no morbidity.

HARVESTING OF CARTILAGE

Procedure is done under local anesthesia. Patient is positioned in supine position. Prominent nasal hair is trimmed. Nasal surgical field is prepared and draped in aseptic technique. Local anesthetic is prepared using 10 cc of 2% lignocaine, 10 cc normal saline, and 8 drops of adrenaline 1:1000 using a Fr gauge 21 needle. It is infiltrated using a Fr gauge 26 needle. Further infiltration with normal saline helps with hydrodissection. A Killian incision is made, the 10 mm caudal L strut is preserved. The

mucoperichondrium is elevated till the bony septum. Anterior and inferior incisions are made on the quadrangular cartilage. A rectangular piece of quadrangular cartilage is removed in one piece (this may be repositioned back afterward). The thick septal cartilage inferior attachment to the maxillary crest is harvested using a freer elevator. This cartilage is preferred because it is sturdy and has an almost cylindrical cross section, which can easily be shaped to fit various ossicular defects. The remnant quadrangular cartilage is repositioned, the mucoperichondrial flaps are sutured and apposed. The nasal cavity is packed with 10 cm Merocel packs bilaterally.

CARTILAGE HARVESTING

In chronic suppurative otitis media, the extent of damage to the middle ear structures, and occasionally the inner ear can be very varied. Ossicular destruction is a common finding, with multiple forms of pathology and ossicular remnants seen. Several authors have classified ossicular defects, with the most commonly used being the Austin classification as modified by Kartush (**Fig. 1**A–D).[5,16]

This wide pathology requires the operating surgeon to have a wide armamentarium of options and solutions to reconstruct the hearing mechanism after successful clearance of disease.

These challenges also extend to ossicular reconstruction in the setting of noninfective pathology of ossicular chain including discontinuity, trauma, and congenital malformations.

Advantages of autologous septal floor cartilage include it is free, easy to harvest, sturdy in nature, and hence offering good rigidity. It has the ability to be shaped into various shapes and forms to conform to the ossicular defect. It can be used in the setting of infective middle ear disease. It does not extrude and retains its form even in recurrent disease or the infective setting.

Cartilage remains intact and sturdy even in infected ear.

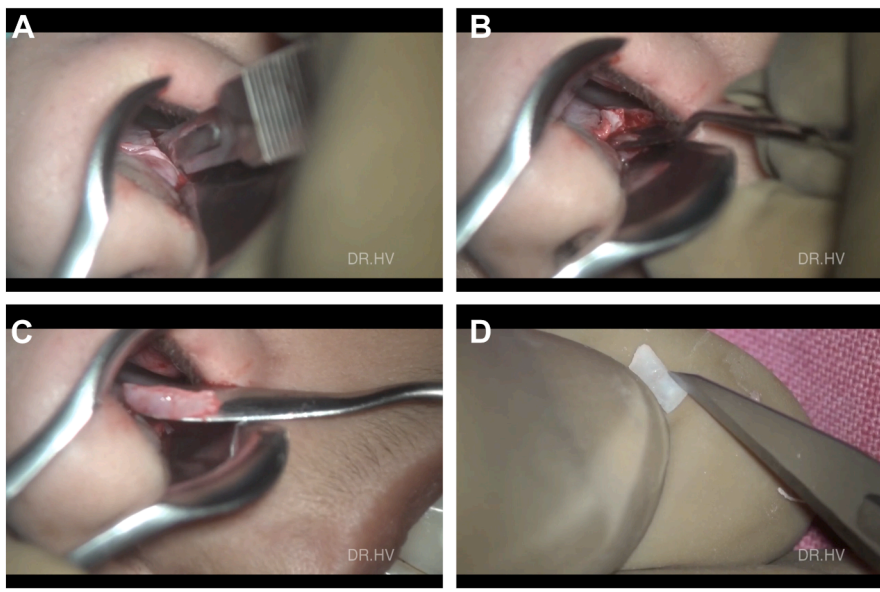

Fig. 1. (*A–D*) Cartilage harvesting.

FAILURE OF INTACT CANAL WALL MASTOIDECTOMY DONE 5 YEARS PRIOR AT OUR CENTER

Reconstruction of Ossicular Defects: Different Scenarios

The senior author considers the status of the stapes as the most important determinant of whether to do ossiculoplasty and which form of reconstruction to undertake. A mobile stapes or stapes remnant is a prerequisite for ossicular reconstruction. Once a determination of the need for ossiculoplasty is made, the cartilage is sculpted based on ossicular status. The length is determined by (1) mastoidectomy technique: Intact canal wall generally requires a longer cartilage strut then canal wall down procedures. The annular sulcus is taken as an approximate reference for height in case of intact canal wall procedures and the dome of the lateral semicircular canal is the reference for height of the cartilage in case of canal wall down mastoidectomy. (2) Individual middle ear cavity depth as determined intraoperatively. The cartilage strut is sculpted into a cylindrical block, rectangular prism, or pentagonal prism depending on the shape and easiest fit of the septal spur cartilage. The distal end of this strut is then modified depending on the ossicular status. We hereby present different scenarios and how we handle them at our center. The 2 most common types of ossiculoplasty that we perform are myringostapediopexy and myringoplatinopexy (Fig. 2A–D).

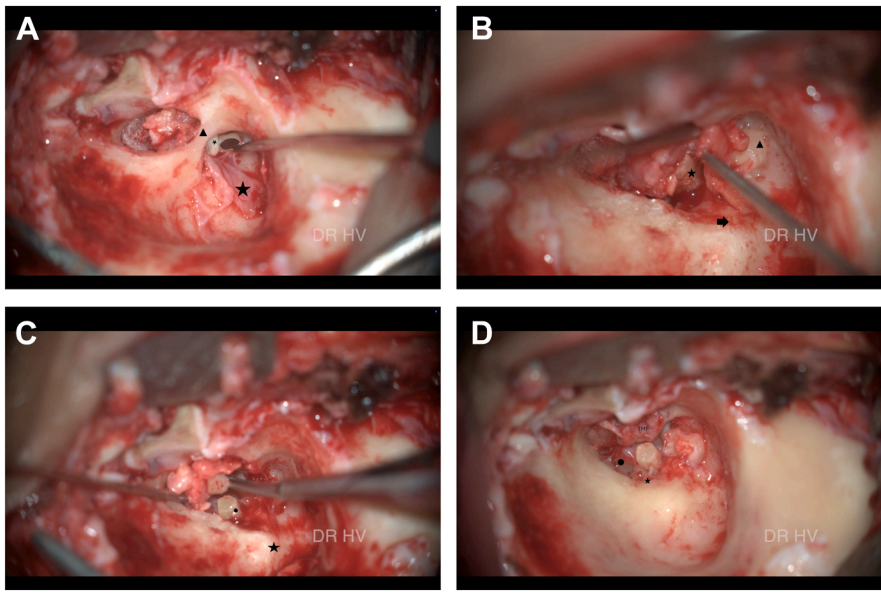

Fig. 2. Failure of intact canal wall mastoidectomy done 5 years prior at our center. (*A*) Failure of intact canal wall mastoidectomy done 5 years prior at our facility (*small asterisk*—remnant incus, large *asterisk*—cholesteatoma sac, *arrowhead*—bridge). (*B*) Disease cleared and canal wall down mastoidectomy done. The Cartilage placed during the previous surgery (Myringostapediopexy was done) is intact and normal and still locked in position on the head of stapes and stapedial tendon. (*Asterisk*—previous cartilage ossiculoplasty. *Arrow*—level of the lateral semicircular canal, *arrowhead*—head of malleus). (*C*) Since a canal wall down mastoidectomy was done, the height of the cartilage is being trimmed with iris scissors, without disturbing the cartilage from its previous position (*Black dot*—trimmed cartilage, *asterisk*—level of lateral semicircular canal). (*D*) Cartilage has been cut short to the level of lateral semicircular canal (TMF—tympanomeatal flap, *asterisk*—stapedial tendon still locked in situ. *Black dot*—round window).

Scenario 1: The whole of the stapes, including the superstructure is present, a myringostapediopexy is the preferred type of ossiculoplasty.

MYRINGOSTAPEDIOPEXY

A 0.5 mm diameter core is drilled out from the distal portion of the cartilage strut. This groove houses the capitulum of the stapes. A small groove which locks to the stapedial tendon is cut on one side of the strut, on the distal end, adjacent to the groove for the stapedial head. To ensure stability of the reconstruction, it is imperative to remove any remnant lenticular process before the ossiculoplasty.

Steps of Myringostapediopexy

Scenario 2: Both stapes crura present, with or without the neck, the ossiculoplasty of choice is myringocruropexy (Fig. 3A–G).

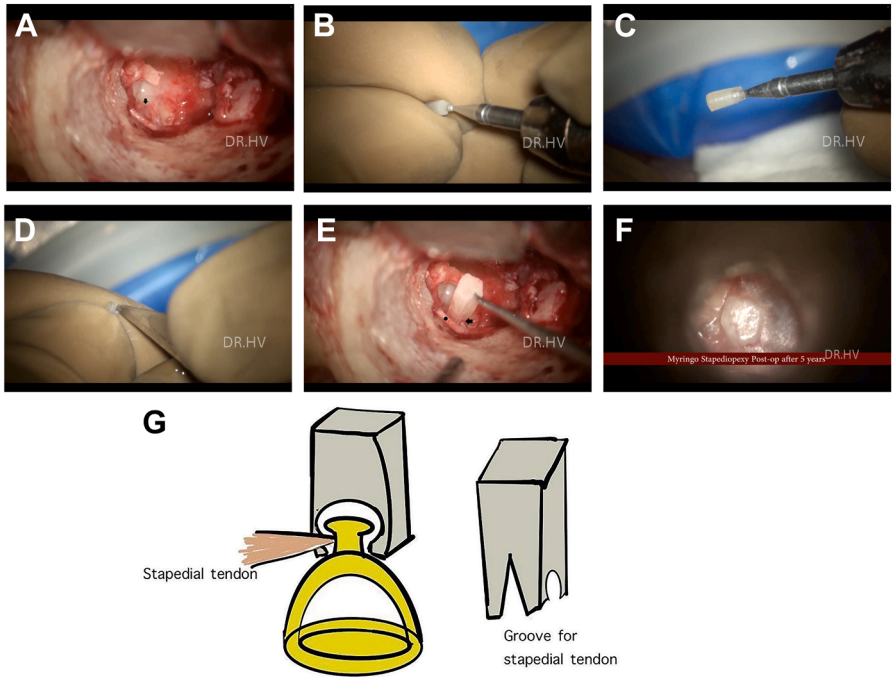

Fig. 3. (*A–G*) Steps of myringostapediopexy. (*A*) Scenario with absent incus and intact malleus and stapes superstructure (*arrow*—stapes superstructure). (*B*) Creating a groove for the head of the stapes. (*C*) The burr completely locked into the groove for the head of the stapes. This ensures adequate depth of the groove (*D*) Making a "slit" for the stapedial tendon to lock into. (*E*) Placing the cartilage strut onto the head of stapes and ensuring the slit corresponds to the stapedial tendon. After applying gentle pressure, the cartilage locks in place with the head of stapes lodged inside the groove and the stapedial tendon fixed inside the slit. (*Black dot*—chorda tympani, *Black arrow*—lower end of cartilage showing the stapedial tendon snugly fitting into the slit.) (*F*) Postop endoscopic image of the reconstruction seen after 5 years. (*G*) Myringostapediopexy, artistic impression.

MYRINGOCRUROPEXY

A curved core of cartilage is carved out of the distal end of the strut, this curvature follows the curvature of the crura and acts as an anchoring groove for the crura.

Steps of Myringocruropexy

Scenario 3: Both crura absent, footplate present and mobile, the ossiculoplasty of choice is myringoplatinopexy (Fig. 4A–E).

MYRINGOPLATINOPEXY

The distal end of the cartilage spur is curved into an ovoid, circular, or rectangular shape corresponding to the shape of the footplate. A fascia graft piece is then placed on the footplate, on top of which, the cartilage columella strut is placed. The fascia acts as an interpositioning material between the reconstruction and the footplate. This is then supported with gelfoam and the tympanic membrane reconstructed using temporalis fascia.

Scenario 4: Anterior crus remnant, intact, mobile footplate, the ossiculoplasty of choice is myringoanterocruroplatinopexy (Fig. 5A–H).

Myringoanterocruroplatinopexy: The distal end is tapered anteriorly, leaving a longer posterior segment that sits on the footplate and a shorter anterior segment into which a hole is drilled to accommodate the remnant anterior crus. This is adjusted depending on the length of the remnant crus.

Scenario 5: Posterior crus remnant, intact, mobile footplate, the ossiculoplasty of choice is myringoposterocruroplatinopexy.

Myringoposterocruroplatinopexy: The distal end is tapered posteriorly, leaving a longer anterior segment that sits on the footplate and a shorter posterior segment

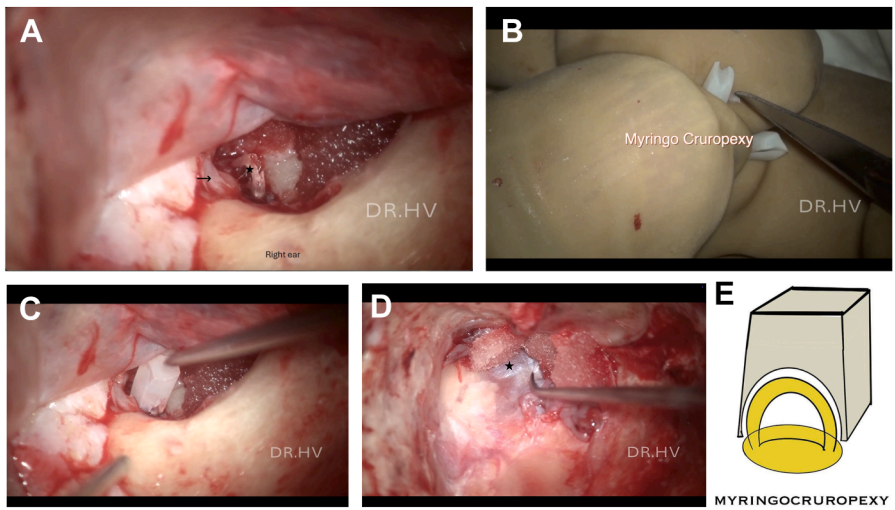

Fig. 4. (*A–E*) Steps of Myringocruropexy. (*A*) Scenario showing absent incus, eroded head and neck of stapes, remnant crura, facial nerve, second genu (*arrow*—dehiscent facial nerve at second genu, *asterisk*, remnant stapedial crura). (*B*) Inverted U-shaped slit made on the cartilage such that the cartilage fits onto the shoulders of the stapes. (*C*) Fixing the cartilage onto the remnant stapes. (*D*) After placing the temporalis fascia graft, the shadow of the cartilage strut (*asterisk*) is seen through the translucent graft, confirming that the cartilage is sandwiched between the remnant stapes and the temporalis fascia graft. (*E*) Myringocruropexy, artistic impression.

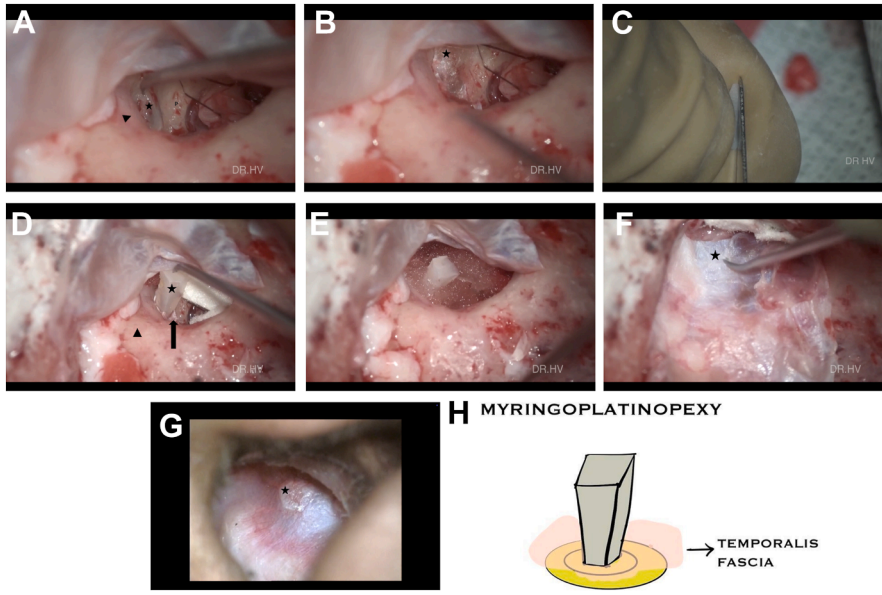

Fig. 5. Myringoplatinopexy. (*A*) Scenario showing absent malleus, incus, and stapes superstructure. Footplate was normal and mobile (P—promontory, *arrowhead*—facial nerve, *asterisk*—footplate). (*B*) A small rectangular piece of temporalis fascia cut and placed on the footplate. This ensures that the cartilage does not sit directly on the footplate (*asterisk*—fascia on footplate). (*C*) Cartilage being sculpted such that the distal end is square, narrower than the proximal end, and fits onto the footplate. The broader top end ensures that there is more surface contact with the neo-tympanum, thereby ensuring better sound conduction. (*D*) The cartilage strut being placed. The fascia, which was placed on the footplate folds inward, thereby holding the lower end of the cartilage in position (*asterisk*—cartilage strut, *arrow*—fascia on footplate folding over the cartilage, *arrowhead*—level of lateral semicircular canal). (*E*) Middle ear covered with gel foam soaked in steroid drops. (*F*) Placement of the temporalis fascia graft to cover the cavity, cartilage (*asterisk*) visible through the graft, confirming appropriate placement. (*G*) Postop image of the ear after 10 years, showing the neo-tympanum draping over the cartilage (*asterisk*). (*H*) Myringoplatinopexy, artistic impression.

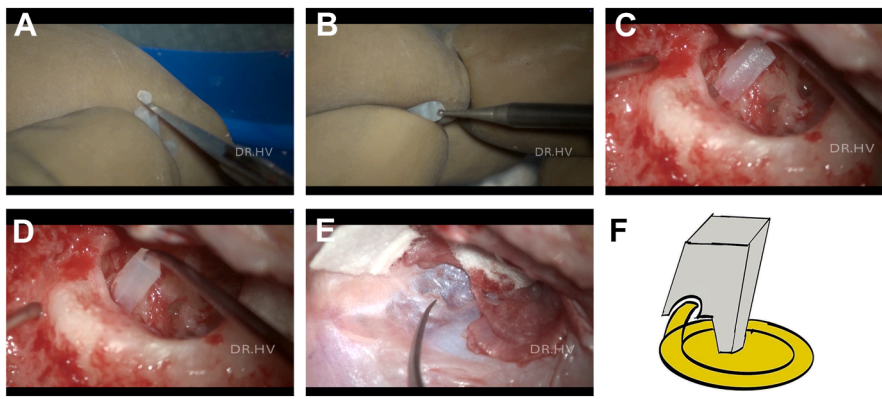

Fig. 6. Myringoanterocruropexy and myringoposterocruropexy. (*A*) A step-like cut made on the lower end of the cartilage. (*B*) A groove is being drilled for the remnant posterior or anterior crus, depending on situation. (*C*) The cartilage being placed, with the groove corresponding to the remnant posterior/anterior crus and the other half corresponding to the footplate. (*D*) The cartilage locked in place. (*E*) Shadow of the cartilage seen below the temporalis fascia graft. (*F*) Artistic impression of myringoanterocruropexy/myringoposterocruropexy.

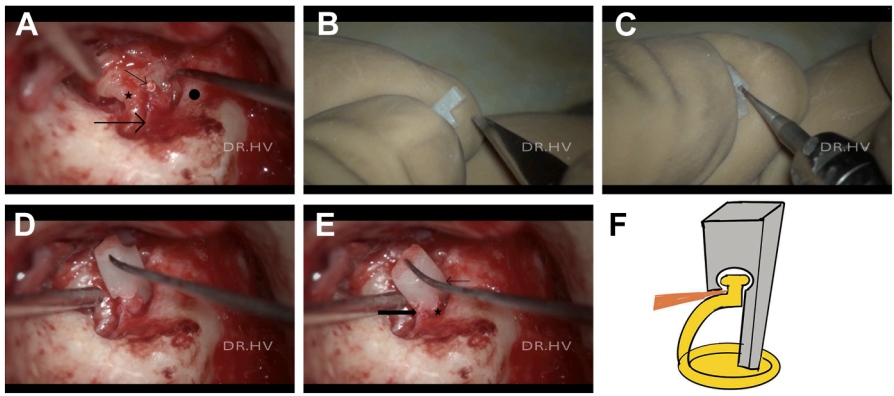

Fig. 7. Steps of Myringostapedioplatinopexy. (*A*) Scenario with absent incus, malleus and anterior stapes crus, stapes superstructure and posterior crus present, footplate mobile (*small arrow*—stapes head, *asterisk*—promontory, *big dot*—facial canal, *large arrow*, stapedial tendon). (*B*) A step-like cut made on the lower end of the cartilage. (*C*) Creating a groove for the head of the stapes, a slit for the stapedial tendon to lock into is also made. (*D*) Placing the cartilage strut onto the head of stapes and ensuring the slit corresponds to the stapedial tendon. (*E*) After applying gentle pressure, the cartilage locks in place with the head of stapes lodged inside the groove and the stapedial tendon fixed inside the slit and the anterior step sitting on the footplate (*bold arrow*—stapedial tendon locked in situ, *asterisk*—stapes head locked into the cartilage, *small arrow*—anterior step sitting on the footplate. (*F*) Artistic impression of myringostapedioplatinopexy.

into which a hole is drilled to accommodate the remnant posterior crus. This is adjusted depending on the length of the remnant crus. Care is particularly taken to ensure the reconstruction does not sit on the promontory as this may impede proper sound conduction.

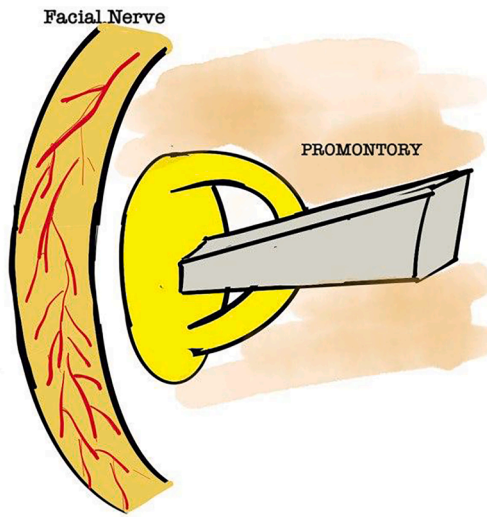

Fig. 8. Stapes bypass myringoplatinopexy, artistic impression.

MYRINGOANTEROCRURUPEXY AND MYRINGOPOSTEROCRURUPEXY

Scenario 6: Posterior crus, head and neck remnant, intact stapedial tendon, mobile footplate, the ossiculoplasty of choice is myringostapedioplatinopexy with a modification to accommodate the stapedial tendon as this improves stability of the reconstruction (**Fig. 6**A–F).

MYRINGOSTAPEDIOPLATINOPEXY

The distal end is tapered posteriorly, leaving a longer anterior segment that sits on the footplate and a shorter posterior segment into which a hole is drilled to accommodate the remnant posterior crus. This is adjusted depending on the length of the remnant crus. A small groove, which locks to the stapedial tendon, is cut on the side of the strut corresponding to the stapedial tendon, on the distal end, adjacent to the groove for the stapedial head.

Steps of Myringostapedioplatinopexy

Scenario 7: Whole of stapes present, but tilted toward the promontory, hence difficult doing myringostapediopexy, the ossiculoplasty of choice is a stapes bypass myringoplatinopexy (**Fig. 7**A–F).

STAPES BYPASS MYRINGOPLATINOPEXY

The distal end of the cartilage spur is curved into an ovoid, circular, or rectangular shape corresponding to the shape of the footplate. A fascia graft piece is then placed on the footplate, on top of which, the cartilage columella strut is placed. The strut goes through the intercrural space, bypassing the suprastructure (**Fig. 8**).

Disadvantages of autologous cartilage ossiculoplasty: prolongs operating time, additional site morbidity(nasal), may lose contact with footplate requiring revision. Steep learning curve to perfect the art of sculpting the cartilage.

CLINICS CARE POINTS

- Pearls: Autologous septal cartilage is free, Easy to harvest, Sturdy, Doesn't extrude.
- Pitfalls: An extra incision is taken; Steep learning curve for cartilage sculpturing; Need for a nasal pack.

REFERENCES

1. Yung M. Long-term results of ossiculoplasty: reasons for surgical failure. Otol Neurotol Off Publ Am Otol Soc Am Neurotol Soc Eur Acad Otol Neurotol 2006; 27(1):20–6.
2. Shinohara T, Gyo K, Saiki T, et al. Ossiculoplasty using hydroxyapatite prostheses: long-term results. Clin Otolaryngol Allied Sci 2000;25(4):287–92.
3. Zöllner C. Interposed cartilage as a precaution against extrusions of ceramic ossicular replacement implants. Ann Otol Rhinol Laryngol 1987;96(2 Pt 1):207–9.
4. Young A, Ng M. Ossiculoplasty. In: StatPearls. StatPearls Publishing; 2025. Available at: http://www.ncbi.nlm.nih.gov/books/NBK563162/. Accessed September 23, 2025.
5. Austin David FMD. Reporting results in tympanoplasty. Am J Otol 1985;6(1):85–8.

6. Honnurappa V, Mahajan N, Vijayendra VK, et al. A unified classification of middle ear and petrous bone congenital cholesteatomas. J Int Adv Otol 2022;18(4):315–9.
7. Hossain MD, Ahamed MNU, Kabir Sumon MMA, et al. Status of ossicles in cholesteatoma. Bangladesh J Otorhinolaryngol 2016;21(2):97–101.
8. Tawalbeh M, Khreesha L, Ali E, et al. Comparison between autologous and artificial graft ossiculoplasty in canal wall down tympanomastoidectomy: a 10 year's personal experience. Indian J Otol 2022;28(1):18–22.
9. Kuo CL, Shiao AS, Yung M, et al. Updates and knowledge gaps in cholesteatoma research. BioMed Res Int 2015;2015:1–17.
10. 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.
11. Cone-Wesson B. Bone-conduction ABR tests. Am J Audiol 1995;4(3):14–9.
12. Tympanometry - american family physician. Available at: https://www.aafp.org/pubs/afp/issues/2004/1101/p1713.pdf. Accessed September 23, 2025.
13. Thukral CL, Singh A, Singh S, et al. Role of high resolution computed tomography in evaluation of pathologies of temporal bone. J Clin Diagn Res 2015. https://doi.org/10.7860/JCDR/2015/12268.6508.
14. Fatterpekar GM, Doshi AH, Dugar M, et al. Role of 3D CT in the evaluation of the temporal bone. Radiographics 2006;26(suppl_1):S117–32.
15. Van Egmond SL, Stegeman I, Grolman W, et al. A systematic review of non-echo planar diffusion-weighted magnetic resonance imaging for detection of primary and postoperative cholesteatoma. Otolaryngol Neck Surg 2016;154(2):233–40.
16. Kartush JM. Ossicular chain reconstruction. Otolaryngol Clin North Am 1994;27(4):689–715.