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Review Article

Surgical Procedure For Ossiculoplasty

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ABSTRACT

Background: Ossiculoplasty, also known as ossicular chain restoration, is frequently done to restore hearing after middle ear disorders such cholesteatoma or tympanosclerosis have been removed. Reconstruction can be done all at once during the initial procedure, or it can be done in two steps, such as in cases with extensive cholesteatomas and damaged tympanic mucosa. The materials used to replace or reconstruct the continuity of the ossicles can be artificial prostheses made of Plastipore, ceramics, titanium, and hydroxyapatite or homologous grafts like remodeled incus or tragal cartilage. Hearing after tympanoplasty and tympanomastoid surgery for chronic otitis media has been markedly improved using ossicular graft material in ossicular chain rebuilding. Today, otologists have a wide array of tools from which to choose but they may find it difficult to know which middle ear implant works best. This study aimed to determine the hearing outcome of using tragal cartilage in performing ossiculoplasty.

Conclusions: Using tragal cartilage in performing ossiculoplasty improves the hearing outcome.

Keywords: Ossiculoplasty**,** TORP, PORP.

INTRODUCTION

A long-term middle ear cleft infection is known as chronic suppurative otitis media (CSOM). There are two varieties: attico-antral and tubo-tympanic. It is linked to hearing loss and purulent ear discharge. The degree of the conductive type hearing loss caused by CSOM varies with the disease's progression. The middle ear's sound transmitting machinery, which includes the ossicular chain, is harmed by the chronic infection, resulting in hearing loss [1, 2].

The middle ear hearing mechanism can be surgically rebuilt to restore the lost hearing. The middle ear's ossicular chain is rebuilt with ossiculoplasty. Restoring the ossicular chain's continuity will enable it to transmit sound waves from the tympanic membrane to the oval window, which is the goal of ossiculoplasty. Different techniques for reconstructing the middle ear sound conducting system have developed over time. Few of them are still in use today. Numerous attempts to repair the breach in the tympanic membrane have been performed since the seventeenth century [3, 4].

Various graft materials have been used for osseoplasties. Materials such as ceramic and hydroxyapatite PORP, polyethylene TORP, titanium prosthesis, or autologous cartilage (tragal or conchal) have been employed, as well as allografts (homografts) of the same tissue. However, the latter synthetic materials have high extrusion rates and are costly. Numerous ossiculoplasty methods and prosthetic devices have been investigated and documented in scholarly works. Regretfully, the abundance of

reconstruction techniques confirms that none of the approaches that are now in use are perfect. Certain investigations use autografts of conchal and tragal cartilage [5, 6].

There have been reports of ossicular reconstruction by employing two materials in place of ossicle or cartilage alone. Malhotra revealed a "bone-cartilage composite graft" for total or partial ossicular replacement prosthesis (PORP) and an "umbrella" graft for total ossicular replacement prosthesis (TORP). According to both groups, ossiculoplasty using these composite materials had low complication rates and satisfactory hearing results [7, 8].

According to the pathological defect of the ossicles

1-Erosion of incudostapedial joint (IS)

The most frequent ossicular defect in children and adults is erosion of the incudostapedial joint with an intact, movable malleus. These kinds of defects can be rebuilt in a few different ways [9].

Rebuilding the joint itself comes first. The Applebaum incudostapedial joint prosthesis (Gyrus ENT, Bartlett, Tenn.), which is composed of hydroxylapatite, is one of the most widely used prostheses for joint replacement. As seen in the illustration below, this prosthesis is an elongated cube with a trough on one face to take the remaining incus long process and a hole on the other face for the stapes neck and capitulum (Figure 1).

A Kurz angular prosthesis (Plester) (Kurz Medical, Inc., Norcross, Ga) is the second alternative for joint replacement. It is composed of a gold shaft, gold cup, and titanium clips (Figure 2).

Initially, the stapes head is where the gold cup is positioned. The clips are then crimped to the lengthy incus procedure. One benefit of the device is that the shaft is available in varying lengths to accept residues of various sizes from the lengthy incus procedure [9].

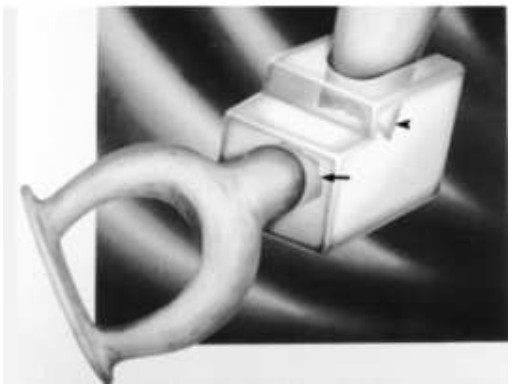

Figure (1): Applebaum incudostapedial joint prosthesis **[9].**

Figure (2): Kurz angular prosthesis “Gold and Titanium” **[9].**

2-Malleus present, stapes present (M+S+)

Three possibilities are available for rebuilding in this case. Reconstruction with an incus replacement prosthesis is the first choice (Figure 3a). When the incus is gone but the malleus and stapes are extant, a second option for rebuilding is to exclude the malleus (Figure 3b). This may be carried out with the use of prosthetic partial ossicular reconstruction (PORP).

Reconstructive using a whole ossicular reconstructive prosthesis is a third alternative. Positioned between the stapes superstructure and the fallopian canal on the footplate is the basis of the whole ossicular reconstructive prosthesis (Figure 3c) [9].

The Applebaum incus replacement prosthesis and the Wehrs single or double notched incus prosthesis (seen in the figure below) are two potential choices for incus replacement prostheses. (Figure 4), or the short Black Spanner Strut [9].

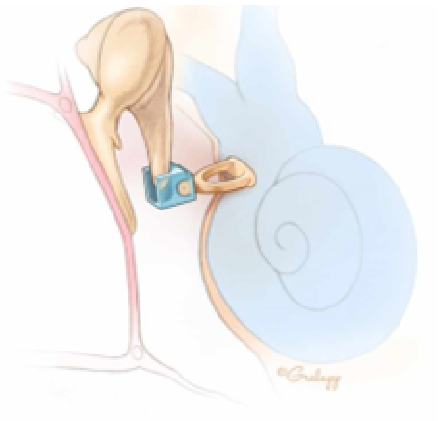

Figure (3): (a) Applebaum ceramic prosthesis spanning a distal long process defect. (b) Ceramic crutch and cup type prosthesis connecting the malleus long process (manubrium) with the capitulum of the stapes.

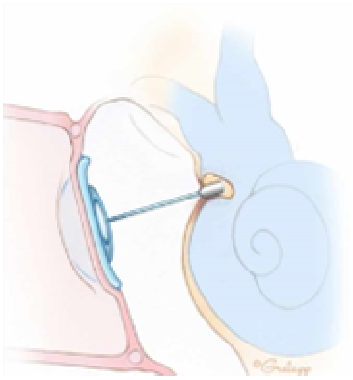

Figure (3c): Total ossicular replacement prosthesis (TORP). To discourage extrusion, autologous cartilage is interposed between the prosthesis and the tympanic membrane.

Figure (4): Wehrs single-notched incus replacement prosthesis [9].

3-Malleus present, stapes footplate present (M+Sf+)

There are two possible reconstruction possibilities when the malleus is present, and the stapes footplate is the only thing left:

- Using an incus-stapes prosthesis as the initial choice (Figure 5a).
- The alternative two is to employ a complete ossicular reconstruction prosthesis (TORP) in place of the malleus as (Figure 5b).

4-Malleus and Incus absent, Stapes present (M-S+)

When the stapes is intact and the malleus and incus are gone, the best option for ossicular reconstruction is a PORP. There are lots of PORPs out there. The Goldenberg HAPEX (Gyrus ENT, Bartlett, Tenn.) is one example (see the image below) (Figure 6) and the Kurz titanium PORPs (seen in the image below; manufactured by Kurz Medical, Inc., Norcross, Georgia) [9].

Autologous cartilage is positioned between the prosthesis and tympanic membrane in titanium partial ossicular replacement prosthesis (PORP) in order to prevent extrusion.

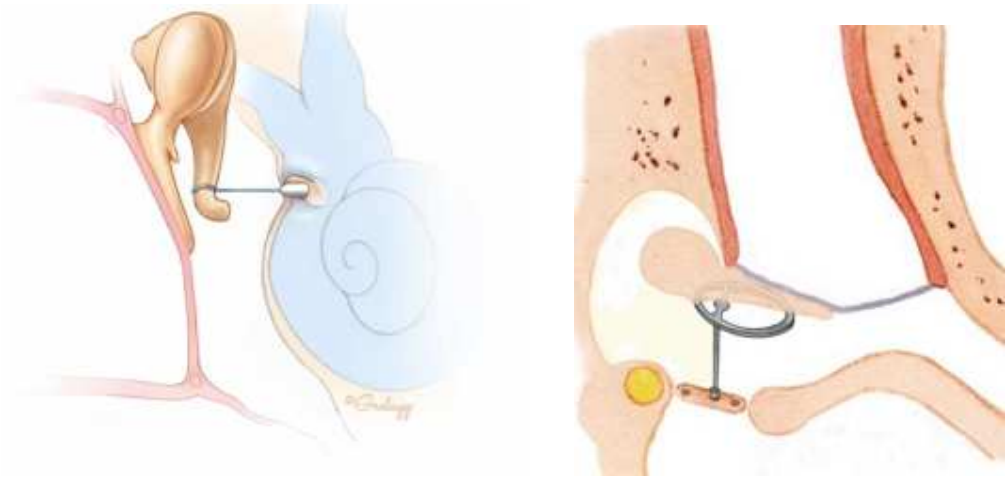

Figure (5): (a) A piston stapes prosthesis crimped onto the long process of the incus and is anchored in surgically created footplate fenestra (stapedotomy). (b) malleus and use (TORP).

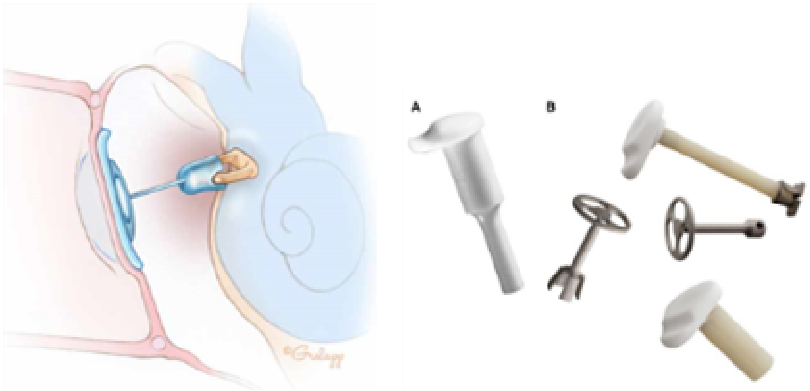

Figure (6): Goldenberg HAPEX partial ossicular reconstruction prosthesis (PORP). (A) and Dusseldorf-type BELL partial ossicular reconstruction prosthesis and Dusseldorf-type titanium AERIAL total ossicular reconstruction prosthesis (B) [9].

5-Ossicular Reconstruction with Bone Cement:

Chemicals called bone cement are created when an acid and base react. This indicates that a liquid is combined with a powder that has been prepared to create a mixture that solidifies through a reaction. Cements can be categorized using the following methods based on their chemical composition: glass ionomer cement (glass powder and polyacrylic liquid), silicate cement (glass powder and phosphoric acid liquid), and carboxylate cement (Zinc Oxide "ZnO" powder and polyacrylic acid liquid) are four types of cement [10].

The majority of the incus long process defect is the area where bone cement is employed. The most common pathology for which bone cement is utilized is incus long process defect, which is used for incudostapedial rebridging between the incus and stapes. Using this provides a natural method of sound transfer (Figure 7). To prevent the interposed incus from dislocating, bone cement can also be utilized [11]. If the interposed incus is beneficial, it can be fastened to the malleus using bone cement if it is used in between the stapes suprastructure and malleus or the stapes footplate and malleus.

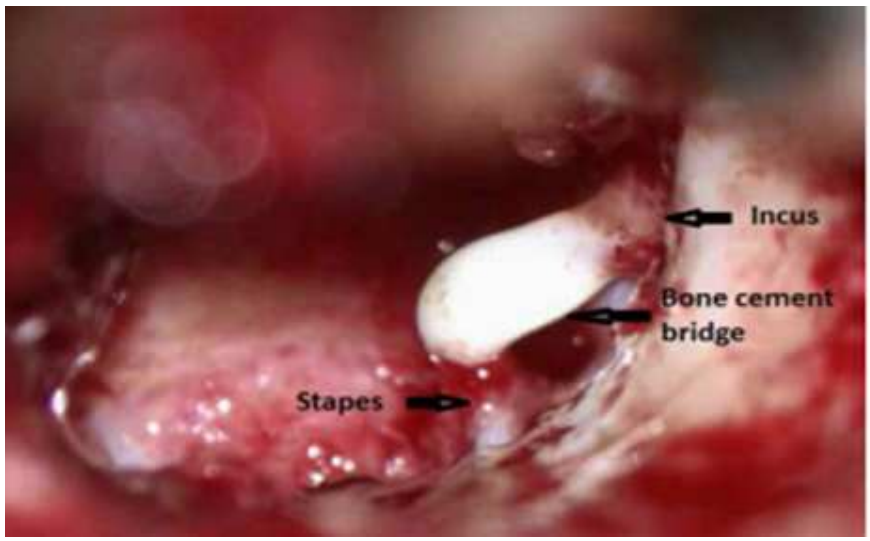

Figure (7): Incudostapedial re-bridge with bone cement [11].

6-Cartilage Ossiculoplasty:

The hearing result of ossiculoplasty has significantly improved in recent years due to the development of innovative surgical procedures and advancements in the tool arsenal available to otologists. Ossiculoplasty success is mostly dependent on case selection and technical proficiency **[17]**.

One of the initial materials for OCR was autologous cartilage graft in 1971 [18]. The Benefits include low cost, low extrusion rate, biocompatibility, and easy availability. It is possible to employ rib cartilage, septal cartilage, conchal cartilage, and tragal cartilage [19].

Prognostic Factors in ossiculoplasty

Numerous papers have addressed the prognostic factors and hearing outcomes following ear surgery.

Extrinsic factors, which are under the surgeon's control, and intrinsic factors, such as disease severity, residual ossicular chain status, and eustachian tube function, were separated out by Kartush in 1994. A few examples of extrinsic influences were the prosthesis and graft composition, design, staging, and surgical technique. These characteristics are stratified into prognostic categories using the middle ear risk index (MERI).

In 2001, Becvarovski and Kartush updated the MERI, adding smoking as a middle ear danger and awarding two risk

points for it. Significant effusions or granulation tissue increased two danger points. Additionally, the risk value for cholesteatoma had been raised to two danger points (table 1). The Ossicular Outcomes Parameters Staging (OOPS) index scores were proposed by Dornhoffer in 2001 (table 2) [12].

Failure of Ossicular Reconstruction

Failed ossicular reconstruction surgery can be caused by displacement of the prosthesis. High-resolution temporal bone CT provides a clear view of prosthesis displacement. (Fig. 8). Correlation with clinical results may be required when stapes prosthesis and TORPs appear to extend into the vestibule but are actually in the proper location **[15]**.

Complications of ossiculoplasty

Stapes superstructure fracture, dislocation, annular ligament tear with perilymphatic fistula, severe or complete sensorineural hearing loss (SNHL) with incus prosthesis, and stapedial footplate fracture with incus-stapes prosthesis are among the intraoperative complications of ossiculoplasty [16].

Vertigo, erosion, and prosthesis extrusion are possible further problems. The only absolute contraindication is an active ear infection; relative contraindications include middle ear mucosal illness that persists over time and the recurring failure to achieve desired results with the same or comparable prostheses [16].

CONCLUSIONS

We can conclude that using tragal cartilage in performing ossiculoplasty improves the hearing outcome.

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REFERENCES

1. **Kong JS, Jeong CY, Shim MJ, Kim WJ, Yeo SW, Park SN**. Comparative study of new autologous material, bone‐cartilage composite graft, for ossiculoplasty with Polycel® and Titanium. Clin Otolaryngol. 2018; 43(2): 434-9.
2. **Polanik MD, Trakimas DR, Castillo‐Bustamante M, Cheng JT, Kozin ED, Remenschneider AK**. Do high‐frequency air‐bone gaps persist after ossiculoplasty? LIO. 2020; 5(4): 734-42.
3. **Seok Moon I, Hyun Song M, Kim HN, Chung MH, Lee WS, Lee HK**. Hearing results after ossiculoplasty using Polycel® prosthesis. Acta Otolaryngol. 2007; 127(1): 20-4.
4. **Nagamani YS.** A Study To Evaluate And Compare The Outcome Of Ossiculoplasty Using Autograft (Ossicle) Versus Synthetic Graft (Teflon). Doctoral dissertation, RGUHS. 2012; (India).
5. **Khanam SF, Malik BA, Qazi SM, Dar NH, Altaf S, Khan MI et al.** A study of outcome of ossiculoplasty using autologous cartilage, refashioned incus, and polytetrafluoro-ethylene (Teflon) prosthesis in patients of chronic suppurative otitis media. EJO. 2023; 39(1): 78.
6. **Mahanty S, Maiti AB, Naskar S, Das SK, Mandal S, Karmakar M.** A comparative study of outcome of ossiculoplasty using cartilage graft, bone and different alloplasts in chronic otitis media. Indian J. Otol. 2015; 21(2): 144-8.
7. **Kim KM, Kang JM, Song JN, Kim HB, Seo JH.** Comparison of Surgical Outcomes Between Ossicle-Cartilage Composite Graft and Synthetic Ossicular Prosthesis for Ossicular Reconstruction. Ear Nose Throat J. 2022;01455613221088727.
8. **Malhotra M.** 'Umbrella'graft tympanoplasty. J Laryngol Otol., 2010; 124(4): 377-81
9. **Battista R, Talavera F, Roland P, Meyers A, Shahet J.** Ossiculoplasty. 2016.
10. **Bayazit YA, Ozer E, Kanlikama M, Durmaz T, Yilmaz M.** Bone Cement Ossiculoplasty: Incus to Stapes Versus Malleus to Stapes Cement Bridge. Otol. Neurotol. 2005; 26(3): 364-7.
11. **Kalcioglu MT, Tan M, Fleerakkers J.** The use of Bone-cement for ossicular chain defects. Eur Arch Otorhinolaryngol, 2013; 270: 2849-55.
12. **Almazrou K, Alqahtani M, Alshehabi M**. Middle ear risk index as a prognostic factor in pediatric ossicular reconstruction. Indian J. Otol. 2013; 19 (1): 23.
13. **Becvarovski Z, Kartush JM**. Smoking and tympanoplasty: implications for prognosis and the Middle Ear Risk Index (MERI). Laryngoscope. 2001; 111(10): 1806-11.
14. **Dornhoffer JL, Gardner E**. Prognostic factors in ossiculoplasty: a statistical staging system. Otol Neurotol. 2001; 22: 299-304.
15. **Noujaim D, Juliano A, Moonis G**. Lesions of the Middle Ear Ossicles: Acquired, Traumatic, Congenital, and Postsurgical Pathology. Neurographics.2014; 4(4): 176-82.
16. **Mudhol RS, Naragund AI, Shruthi VS**. Ossiculoplasty: revisited. Indian J Otolaryngol. Head Neck Surg. 2013; 65(3): 451–54.
17. **Chavan SS, Jain PV, Vedi JN, Kumar Rai D, Kadri H.** Ossiculoplasty: A Prospective Study of 80 Cases. Iran. J. Otorhinolaryngol. 2014; 26(76): 143.

18. **Young M, Vowler SL.** Long-term hearing results after ossicu-loplasty: an analysis of prognostic factors. Otol Neurotol. 2006; 27: 874-81.

19. **Dornhoffer JL.** Cartilage tympanoplasty. Otolaryngol Clin North Am. 2006; 39(6):1161–76.

Table (1): Middle ear risk index (meri) scores. M malleus; i incus; s stapes; +present; - abscent [13].

Risk factor	Risk value
Otorrhea	
I: Dry	0
II: Occasionally wet	1
III: Persistently wet	2
IV: Wet, cleft palate	3
Perforation	
Absent	0
Present	1
Cholesteatoma	
O:M+I+S+	0
A:M+S+	1
B:M+S-	2
C:M- S+	3
D:M- S-	4
E:Ossicle head fixation	2
F:Stapes fixation	3
Middle ear: granulations or effusion	
No	0
Yes	1
Previous surgery	
None	0
Staged	1
Revision	2

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