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Comparison Of Hydroxyapatite Cement And Conchal Cartilage In Reconstruction Of Incus Long Process Defect: Our Experience

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Abstract
Background: *Chronic Suppurative Otitis Media (CSOM) often leads to erosion of the incus long process, resulting in conductive hearing loss. Various materials have been employed to reconstruct this defect, including autografts and synthetic alternatives.*
Material and Methods: *A retrospective study was conducted on 20 patients with incus long process defects. Group A (n=10) underwent reconstruction with HA cement, while Group B (n=10) received conchal cartilage grafts. Preoperative and postoperative hearing outcomes were evaluated using pure tone audiometry.*
Results*: Both groups demonstrated significant improvement in air-bone gap closure (p < 0.001). Both cartilage interposition and GIC ossiculoplasty are effective in reconstruction of long process of incus bone defect and they are not superior to each other, although no significant complications were observed in either group.*
Conclusion*: In conclusion both cartilage interposition and GIC ossiculoplasty are effective in reconstruction of long process of incus bone defect and they are not superior to each other*
Keywords: *Chronic Suppurative Otitis Media (CSOM), Ossiculoplasty, Conchal cartilage, Hydroxyapatite cement*

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I. Introduction:

Chronic Suppurative Otitis Media (CSOM) is a persistent middle ear infection characterized by intermittent or continuous ear discharge through a perforated tympanic membrane[1,3]. It remains a leading cause of preventable hearing impairment worldwide, particularly in regions where early medical intervention is often delayed. Among the ossicular structures, the long process of the incus is most frequently affected by erosion, largely due to its vulnerable blood supply via mucosal vessels traversing small foramina[2.] Damage to this region often leads to disruption of the incudo-stapedial joint, impairing the ossicular chain's ability to efficiently transmit sound vibrations to the inner ear, thereby resulting in conductive hearing loss[2].

Reconstructing the ossicular chain, known as ossiculoplasty, aims to restore hearing by re-establishing the continuity between the tympanic membrane and the oval window. Various techniques have been developed for this purpose, utilizing materials such as autografts (e.g., incus interposition), homografts, or synthetic prostheses like titanium and hydroxyapatite. However, concerns regarding cost, availability, and long-term outcomes continue to influence the choice of reconstructive material[2,6].

In recent years, Glass Ionomer Cement (GIC) has emerged as an alternative material for ossicular reconstruction due to its favourable handling properties, biocompatibility, rapid setting, and affordability. Similarly, hydroxyapatite cement, initially used in cranial surgeries, has found increasing applications in otology, including ossicular repair, mastoid obliteration, and canal wall reconstruction[1,7].

This study aims to compare the clinical outcomes of ossicular reconstruction using hydroxyapatite cement versus conchal cartilage interposition in patients presenting with long process defects of the incus, and we call this technique incudo-stapedial re-bridging ossicular reconstruction.

II. Material And Method

This retrospective clinical research study was carried out on Department of otorhinolaryngology at GMERS Medical college, Gandhinagar, Gujarat from June 2024 to December 2024. A total of 20 adult patients (both male and female) were for in this study

Study design: Retrospective clinical research study

Study location: This is a tertiary care teaching hospital based study done in Department of otorhinolaryngology at GMERS Medical college, Gandhinagar, Gujarat

Study Duration: from June 2024 to December 2024

Sample Size: 20 patients

Subjects & selection method: The study population was drawn from GMERS Medical college and hospital, Gandhinagar having incus long process defect. Patient Selection and Preoperative Evaluation of total of 20 patients were selected after thorough clinical, otoscopic, and audiological evaluation.

Preoperative assessment included:
1. Detailed history: Duration of symptoms, hearing loss, ear discharge, previous treatments.
2. Otoscopy and microscopy: Assessment of perforation, middle ear status, and mobility of ossicles.
3. Pure Tone Audiometry (PTA): To assess hearing loss and measure preoperative air-bone gap.
4. Impedance audiometry: To evaluate middle ear function and tympanic membrane compliance.

Patients are divided into 2 groups. Each group has 10 patients. The Surgical procedure of group A and group B were performed by same surgeon and were randomly selected.
Group A(N=10 patients)- Performed with GIC application to incus long process defect
Group B(N=10 patients)- Conchal cartilage interposition was performed in incus long process defect

Inclusion Criteria:
1. Age between 18 and 55 years
2. case of CSOM (mucosal type) with dry ear for at least 4 weeks.
3. Intraoperative finding of partial ossicular erosion (mainly the long process of the incus).
4. No evidence of cholesteatoma or granulation tissue at the time of surgery.
5. Willingness to participate in the study and attend regular follow-ups.

Exclustion Criteria:
1. Presence of cholesteatoma or unsafe CSOM
2. Total ossicular chain discontinuity requiring total ossicular replacement prosthesis.
3. Sensorineural hearing loss (air-bone gap <10 dB)
4. History of prior ossiculoplasty or mastoidectomy
5. Active infection or wet ear at time of surgery.

Surgical Procedure for Group A patients:

The middle ear was exposed through a post auricular incision Temporalis fascia was harvested and used for tympanic membrane reconstruction, mastoidectomy performed when necessary. Elevation of tympanomeatal flap and exposure of the middle ear. Inspection of the ossicular chain, identification of erosion of incus long process). Removal of necrotic/infected ossicle portions if required. Preparation of ossicular ends: roughening or flattening with a diamond burr to improve cement adhesion.

Application of Glass Ionomer Cement, The GIC used was HY-BOND GLASSINOMER CX-Smart. The material was prepared in a sterile field according to manufacturer instructions (powder-liquid mix). GIC was applied with a microspatula or applicator to bridge the defect between Incus and stapes[1]. Care was taken to avoid contact with soft tissue or middle ear mucosa to prevent granuloma formation[1]. The cement was allowed to harden in situ for 5–8 minutes without movement[1,2,4]. Graft Placement and Closure, Temporalis fascia graft was placed over the tympanic membrane perforation using the underlay technique. Ossicular chain integrity was rechecked before repositioning the tympanomeatal flap. It is important that the glass ionomers not come into contact with nerves or neural tissue because of their adverse effects on these tissues (10). Care should be taken not to drop bone cement on the facial or Jacobson nerves during the performance of ISRO(incudo-stapedial re-bridging ossiculoplasty)[7] in the middle ear.

Surgical procedure for Group B patients

The middle ear was exposed through a post auricular incision, incudomalleolar joint was separated by means of an angled pick after the defect in incus long process was observed , When the long process of incus was found to be eroded, a small rectangular piece of cartilage was excised from the posterior aspect of the concha using sharp dissection. The conchal cartilage was refashioned according to the size of the defect and was used to bridge the gap between the eroded long process and stapes head. The middle ear was packed with Gel

foam and temporalis fascia graft was used to repair the tympanic membrane perforation in all cases. Ossicular chain integrity was rechecked before repositioning the tympanomeatal flap[3].

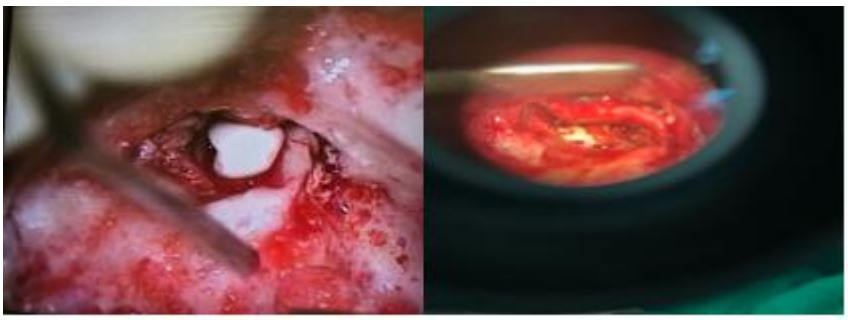

Image 1 : Showing GIC in between part of incus and stapes

Image 2: Showing Conchal Cartilage in between part of incus and stapes

Outcome measures:

Air conduction (AC) and bone conduction (BC) pure-tone thresholds (frequencies: 500, 1,000, 2,000 and 3,000 Hz) were measured as recommended by the guidelines of the Committee on Hearing and Equilibrium. Preoperative and postoperative (3 and 6 months after surgery) pure-tone averages (PTA) were calculated for the frequencies 500, 1,000, 2,000 and 3,000 Hz, as well as the preoperative and postoperative air–bone gap (ABG) and postoperative AC gain.

Statistical Analysis:

Data were recorded and analysed using Microsoft Excel and SPSS software. Paired t-tests were used to compare preoperative and postoperative hearing levels. A p-value of <0.05 was considered statistically significant.

III. Results And Observation

A total of 20 patients were included in the study, comprising 12 males (60%) and 8 females (40%). The age of patients ranged from 18 to 55 years, with a mean age of 34.6 ± 9.8 years. The majority of patients (70%) were in the age group of 20–40 years.

Hearing Outcomes:

Postoperative pure tone audiometry was conducted at 3 months and 6 months. Results are summarized below: Mean Preoperative ABG: 34.5 ± 5.2 dB

Mean Postoperative ABG (6 months): 17.2 ± 4.6 dB. Average ABG Closure: 17.3 dB Statistical significance: $p < 0.001$. Thus, 85% of patients achieved successful hearing improvement (defined as ABG ≤ 20 dB).

Table 1: Comparison of Hearing Outcomes Between Hydroxyapatite Cement and Conchal Cartilage Groups

Parameter	HA Cement Group (n=10)	Conchal Cartilage Group (n=10)	Total (n=20)
Mean Preoperative ABG (dB)	34.2 ± 5.0	34.8 ± 5.4	34.5 ± 5.2
Mean Postoperative ABG at 6 months (dB)	15.8 ± 4.2	18.6 ± 4.9	17.2 ± 4.6
Mean ABG Improvement (dB)	18.4	16.2	17.3
Patients with ABG < 20 dB at 6 months	9/10	8/10	17/20
Complications	0	0	0

Note: ABG = Air-Bone Gap; Values expressed as mean ± SD where applicable.

Table 2: Demographic and Surgical Characteristics of the Study Population

Parameter	HA Cement Group (n=10)	Conchal Cartilage Group (n=10)	Total (n=20)
Mean Age (years)	32.4 ± 9.1	33.6 ± 8.7	33.0 ± 8.9
Gender (M/F)	6 / 4	5 / 5	11 / 9
Side of Surgery (R/L)	5 / 5	6 / 4	11 / 9
Diagnosis	Chronic Otitis Media (10)	Chronic Otitis Media (10)	20
Type of Tympanoplasty	Type III	Type III	-

Parameter	HA Cement Group (n=10)	Conchal Cartilage Group (n=10)	Total (n=20)
Follow-up Duration	6 months	6 months	6 months

Note: R = Right ear; L = Left ear; Type III refer to Wullstein classification of tympanoplasty.

Patient Satisfaction:

At 6 months, 17 patients (85%) reported subjective improvement in hearing and satisfaction with the surgical outcome. The remaining 3 patients either had no noticeable change or were unsure about improvement but did not report worsening.

IV. Discussion

The ossicular chain plays a critical role in transmitting sound from the tympanic membrane to the cochlea. Among the ossicles, the long process of the incus is particularly prone to erosion, primarily due to its anatomical vulnerability and limited blood supply[2]. Discontinuity at this site often results in significant conductive hearing loss, which necessitates surgical reconstruction to restore auditory function[2].

Ossiculoplasty is a well-established technique for repairing ossicular defects in patients with Chronic Suppurative Otitis Media (CSOM). Various materials have been used historically, broadly classified into autografts (such as cartilage or ossicles), homografts (from cadaveric donors), and synthetic allografts (such as hydroxyapatite or titanium)[2,6]. Each material presents unique advantages and limitations regarding availability, biocompatibility, cost, and long-term stability.

In the present study, we compared two commonly used materials for reconstructing defects in the incus long process: hydroxyapatite (HA) cement and conchal cartilage. Both materials demonstrated satisfactory hearing outcomes.

Hydroxyapatite cement offers several advantages. It is easily moldable, adheres chemically to bone, and allows for precise bridging of small defects. Its rapid setting time and strong fixation provide a stable connection between the incus and stapes, optimizing sound transmission. In our experience Both cartilage interposition and GIC ossiculoplasty are effective in reconstruction of long process of incus bone defect and they are not superior to each other

Conchal cartilage remains a reliable autograft material, especially in resource-limited settings. It is biocompatible, readily available, and poses no risk of disease transmission. However, cartilage grafts are subject to potential issues such as resorption, warping, or slight changes in shape over time[6], which may affect long-term results. Despite these concerns, our short-term follow-up (six months) revealed no significant complications or decline in hearing outcomes in the cartilage group[3,6].

The absence of postoperative complications such as infection, extrusion, or ossicular dislocation in either group highlights the safety and feasibility of both techniques when performed meticulously. Importantly, none of the patients in our series experienced neurotoxic effects or middle ear adhesions associated with GIC usage, an issue reported occasionally in experimental studies.

Overall, the findings of our study are consistent with previous reports suggesting that both HA cement and cartilage interposition are effective options for ossicular reconstruction. HA and cartilage both are excellent alternative when cost, availability, or surgeon preference dictates its use.

V. Conclusion

Both cartilage interposition and GIC ossiculoplasty are effective in reconstruction of long process of incus bone defect and they are not superior to each other

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