

Using bone cement in re-bridging incudostapedial joint

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Abstract

Objective: to evaluate the hearing outcomes of using ionomeric bone cement in re-bridging incudostapedial joint discontinuity.

Methods: This study included 50 patients who had ossiculoplasty using ionomeric bone cement for re-bridging of incudostapedial joint. There pre and post-operative audiologic outcomes were evaluated and reviewed by using pure tone audiometry averages and the air bone gap values with a follow up period of one year.

Results: 42 patients (84%) had a post-operative air bone gap less than 20 dB following one year of surgery. The pre and post-operative mean of pure tone averages were 50.04 ± 7.28 and 32.74 ± 7.07 respectively (P value < 0.01). The pre and post-operative mean of air bone gap were 36.56 ± 6.41 and 17.60 ± 5.77 respectively which was statistically significant (P value < 0.01).

Conclusion: using of ionomeric bone cement is a good grafting material in incudostapedial re-bridging ossiculoplasty being cost effective, easy applicable and biocompatible and give a satisfactory hearing outcome in selected patients.

Keywords: Bone cement; Incudostapedial; Ionomeric; Ossiculoplasty; Re-bridging

1. Introduction

Ossiculoplasty main goal is to restore hearing by reconstructing the sound transformer mechanism when hearing loss is due to problem in the ossicular chain which leads to conductive hearing loss.[1] A wide variety of techniques and materials are being used in ossiculoplasty in order to reconstruct the ossicular chain and the ideal material that is being used must be stable, safe, biocompatible and easily applied.[2]

Incudostapedial joint erosion is the most common finding in chronic middle ear disease and to reconstruct this defect several techniques and materials are being used. The use of bone cement is getting attention and increasingly being used to re-bridge incudostapedial joint discontinuity.[3]

Bone cements are materials that have been implicated in dental field for long time as materials for luting and filling. The powder is being mixed with dissolving liquid and the resulted mixture hardens in a few minutes by means of exothermic reaction. The glass ionomer bone cement (Master-Dent, product by Dentonics, USA) that is used in this study is a glass ionomer composed of two parts, the first is powder and the second is liquid. After the two parts are being quickly mixed the resulted material hardens to be like bone in consistency. The bone cement has the ability of being shaped before hardening, and it directly bonds to the bone without any reaction to the surrounding fluid. Having such features makes it a useful material that can be used in ossiculoplasty.[4]

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Using of bone cement as a re-bridging material in ossiculoplasty had shown a good result regarding hearing outcomes and labeled as reliable method in several studies done on it.[5] In our study we aim to evaluate hearing outcomes results of 50 patients who ossiculoplasty surgery in order to re-bridge incudostapedial joint using ionomeric bone cement.

2. Material and method

This study is a retrospective review of 50 patients who had incudostapedial re-bridging ossiculoplasty surgery for conductive hearing loss in our hospital between January 2021 and January 2023 in order to evaluate the hearing outcomes. Approval was taken from our institution ethical committee.

Our inclusion criteria were for adult patients aged between 18-60, disease free middle ear and mastoid or cleansed middle ear cleft, no presence cholesteatoma, and ossicular chain that is intact except of having discontinuity between the stapes head and the long process of incus and an intact tympanic membrane following the surgery and a follow up period of one year was provided. Ionomeric bone cement being the material of choice for re-bridging the incudostapedial joint and all patients was operated by the same main surgeon and the same anesthetic conditions. Patients who had a revision surgery or graft failure were excluded.

A pre-operation hearing evaluation using pure tone audiometry (PTA) and a one year follow up PTA post-operatively should be present for all the candidates.

We calculated the pure tone averages from the thresholds at 0.5 kHz, 1 kHz, 2 kHz, and 3 kHz that is obtained from the PTA pre and post-operatively for all the patients. Also, the air bone gap (ABG) was calculated for each patient test, and closure of the ABG to within 20 dB was considered successful according to the American Academy of Otolaryngology-Head and Neck Surgery guidelines.[6]

We compared the obtained results pre and post-operatively and analyzed the data using Statistical Package for the Social Sciences for Windows.; ver 24. (Armok. NY: IBM Corp) software for statistical analysis.

2.1. Techniques

The middle ear cavity was exposed using endaural, transmeatal or postauricular approach. Mastoidectomy was performed when needed with removal of granulation tissue. Re-bridging of the incudostapedial joint was done when discontinuity was present between the long process of the incus and the head of stapes.

Bone cement was prepared by mixing the powder and the dissolving liquid on a metal plate, the mixture is muddy in nature before getting hardened in few minutes.

Using a micro needle, the bone cement was taken in pieces and the gap was reconstructed between the incus and stapes. At this stage the new bridge hardens and become stable, after that the mobility of the ossicular chain was tested for the success of reconstruction. After completing the surgery, the ear was closed in the standard techniques.

3. Results

There were 28 female and 22 male patients with age range from 18 to 60 years (mean 42.38 ± 9.33). The indication for surgery was chronic otitis media with perforated tympanic membrane in 34 patients and conductive hearing loss with retraction pocket in tympanic membrane in 16 patients.

The post-operative ABG was less than 20 dB was successfully achieved in 42 patients (84%). The pre-operative PTA mean was 50.04 ± 7.28 , while the post-operative PTA mean was 32.74 ± 7.07 (P value less than 0.01) **Figure 1**. The pre-operative ABG mean was 36.56 ± 6.41 , while the post-operative ABG mean was 17.60 ± 5.77 (P value less than 0.01) **Figure 2**. The results are shown in **Table 1**.

The mean change in PTA pre and post-operatively was 17.30 ± 10.28 with 95% confidence interval ($t=11.90$, $df=49$) and the mean change in ABG pre and post-operatively was 18.96 ± 9.28 with 95% confidence interval ($t=14.44$, $df=49$).

In the 50 patients, 16 patients (32%) had exploratory tympanotomy, 21 patients (42%) had tympanoplasty and 13 patients (26%) had tympanoplasty with mastoidectomy. There were no significant statistical results on the hearing regarding the different types of operations (P value >0.01).

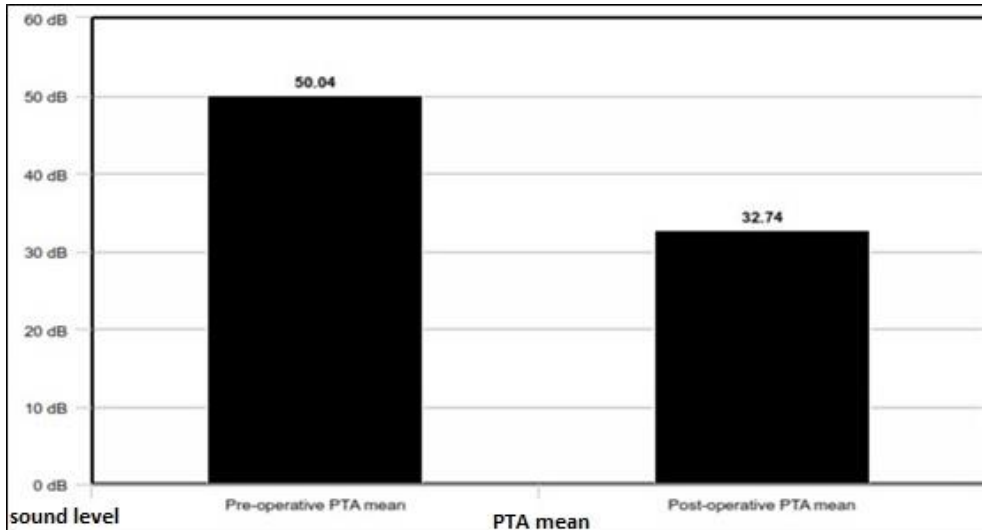


Figure 1 Pre-operative VS post-operative PTA means

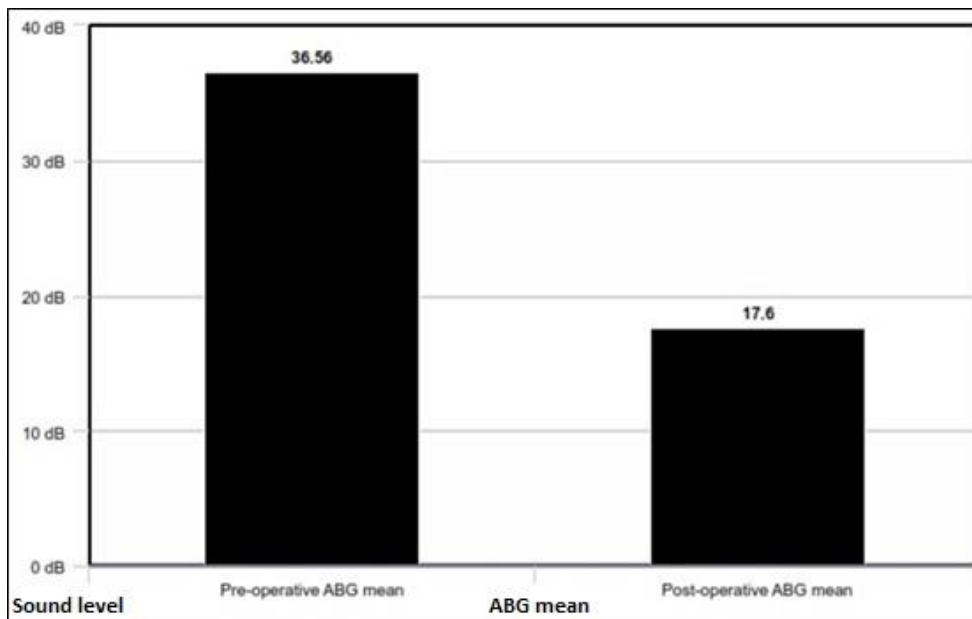


Figure 2 Pre-operative VS post-operative ABG means

Table 1 Pre-operative and post-operative PTA average and ABG

	PTA average (mean ± SD)	ABG (mean ± SD)
Pre-operative	50.04 ± 7.28	36.56 ± 6.41
Post-operative	32.74 ± 7.07	17.60 ± 5.77

PTA Pure tone Audiometry, ABG Air Bone Gap, SD Standard Deviation

4. Discussion

Our study results showed a significant hearing improvement after re-bridging the incudostapedial joint with bone cement. A variety of techniques are being used when the ossicular chain defect is between the long process of incus and stapes such as; partial ossicular replacement prosthesis (PORP), total ossicular replacement prosthesis (TORP),

autologous cartilage graft.[7] However, the main problem remain the high rate of extrusion or dislocation which in turn will lead again to conductive hearing loss.[8] Using the bone cement got the advantages of giving good hearing results, easy to be used and applied and being cost effective since bone cement are cheaper when compared to any material that is used in ossiculoplasty.[9]

Even though bone cement application is easy, there are major points not to be missed while its being applied. The mixture should be used within few minutes before it gets hard, and to be careful that there is no hemorrhage before the application process since it interferes with its hardening. Also, to keep in mind that the bone cement only adheres to bone, so any mucosa that covers the ossicles should be removed.[10] Ionomeric bone cement is potentially neurotoxic so it should not be in contact with perilymph, dura or any neural structures, if any contamination happens the cement should be aspirated immediately and do multiple irrigations in order to remove it. To prevent such incidence gelfoam is placed over the stapes footplate and the facial nerve during the process of application.[11,12]

Another advantage of bone cement that it got no interference regarding graft take rate.[13] in our cases we used gelfoam as supporting material when tympanic membrane grafting is done, this gives protection against contact between the tympanic membrane and the bone cement. One of the main advantages of using bone cement that the problem of high rate material extrusion faced with the other materials that is used in ossiculoplasty is not present, since there is no contact between the cement and the tympanic membrane.[14] We had no recorded cases of extrusion in using bone cement for re-bridging the incudostapedial joint defect.

One of the important factors to obtain a good hearing outcome post-operatively and to avoid complications when using bone cement ossiculoplasty is the proper selection of patient, since such re-bridging technique is not suitable in atelectatic ears, canal wall down mastoid surgery or in the presence of cholesteatoma.[15] Another important factor in patient selection is the distance that present between the remained incus and head of the stapes, since the ideal cases for using bone cement in incudostapedial re-bridging are when such distance is less than one third of the incus long process. When the gap is larger than two thirds of the long process of incus another technique must be used. However, for cases when the gap distance is between the previously mentioned cut points, the bone cement could give successful results by being repeatedly applied until the whole gap is bridged.[16]

Bone cement ossiculoplasty is most commonly indicated for re-bridging of the incudostapedial joint, but still bone cement can be of use in other cases such as, to secure prostheses like PORP or TORP, or when incus subluxation is present.[17]

5. Conclusion

The use of ionomeric bone cement is considered a good grafting material in ossiculoplasty specially when the defect is present between the long process of incus and the head of stapes, having the advantages of being cost effective, easy applicable, biocompatible and with good hearing outcomes post-operatively. Good patient selection is an integral part in this technique in order to give the optimum results.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

The present research work does not contain any studies performed on animals/human subjects by any of the authors.

Statement of informed consent

Due to the retrospective nature of this study, Informed consent from patients was waived.

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