American Journal of Otolaryngology and Head and Neck Surgery

Research Article
Published: 24 Jun, 2021

Traumatic Incudostapedial Disarticulation: Anatomical Reconstruction Using Ionomeric Bone Cement

Mohamed R Ghonim, Mohamed A Salem, Bassem Ashraf, Yousef K Shabana and Ahamed Hemdan*

Department of Otolaryngology, Mansoura University, Egypt

Abstract

Objective: To outline a surgical strategy, for anatomical reconstruction of traumatic Incudostapedial Joint Disarticulation (ISD) with intact Tympanic Membrane (TM), using ionomeric bone cement aiming for improving the stability and the functional outcomes of the procedure.

Materials and Methods: A prospective clinical study conducted on 37 ears (37 patients) operated upon for conductive hearing loss due to isolated ISD with intact TM following head trauma from 2011 to 2018. Air and bone conduction thresholds at frequencies 500 Hz to 4000 Hz, were determined pre- and postoperatively, with a minimal follow-up period of 12 months. Anatomical reconstruction of ISD using ionomeric bone was performed.

Results: The overall postoperative results were statistically significant, regarding the pure-tone average and the mean air bone gap (P value <0.001). The Air Bone Gap (ABG) closure within 10 dB was found in 31 ears (83.8%) and to within 20 dB in 33 ears (89.2%) and above 20 dB (mean 22 dB) in 4 ears 10.8%). No complications were noticed and no patient had an air-bone gape more than 30 dB. The cochlear function remained stable postoperatively, reflecting the safety and feasibility of this line of management.

Conclusion: The anatomical reconstruction of traumatic ISD using ionomeric bone cement is considered as satisfactory, safe and cost-effective technique.

Keywords: Ossiculoplasty-Traumatic Conductive Hearing Loss- Incudo-Stapedial Disarticulation (ISD); Bone Cement

OPEN ACCESS

Correspondence:
Mohamed R Ghonim, Department of Otolaryngology, Mansoura University, Egypt,
E-mail: ghonimmr@icloud.com

Received Date: *05 Jun 2021*
Accepted Date: *21 Jun 2021*
Published Date: *24 Jun 2021*

Citation:
Ghonim MR, Salem MA, Ashraf B, Shabana YK, Hemdan A. Traumatic Incudostapedial Disarticulation: Anatomical Reconstruction Using Ionomeric Bone Cement. Am J Otolaryngol Head Neck Surg. 2021; 4(5): 1137.

Introduction

An ossicular lesion that follows head trauma is usually suspected in patients with non-resolving conductive hearing loss (for more than 6 months) with a persistent Air-Bone Gap (ABG) of more than 30 dB and an intact tympanic membrane [1].

Different ossicular injuries can occur after head trauma. The most common injuries include incudostapedial joint Disarticulation (ISD), incus dislocation and stapes lesions. Other injuries as isolated malleus and incus fractures are uncommon. It is generally known that the most frequent site to be injured is the Incudostapedial Joint (ISJ). This might be explained by the loose suspension of the incus between both firmly attached malleus and stapes [2,3].

Several treatment modalities can be used for reconstruction of ISD. One of these modalities is the replacement of the ISJ or the incus completely using either Partial Ossicular Replacement Prosthesis (PORP) or incus interposition. Unfortunately, complications may occur after using these modalities as extrusion of the prosthesis or migration of the graft, respectively. Alternatively, using prosthesis (Teflon prosthesis) between intact incus and the footplate or between intact incus and the vestibule to bypass ISD and the stapes in cases with isolated ISD and or stapes lesions or both may solve this problems with a satisfactory hearing outcomes [4,5].

Tissue adhesive, cartilage and bone were alternative modalities utilized to manage ISD while maintaining the normal anatomy. Furthermore, the use of bone cements in ISD has increased which was introduced as an excellent alternative to currently accepted methods [6-10]. Cement plug technique was performed in revision stapedectomy with necrosis of long process of the incus where the prosthesis was reinserted first to the remaining long process of the incus and then fixed using the cement plug [11]. In addition, bone cement was utilized for anatomical incus repositioning between malleus and stapes in incus dislocation or during trans-mastoid supralabyrinthine facial

decompression after temporal bone fractures [12].

This study was conducted to outline a surgical strategy, using ionomeric bone cement for anatomical reconstruction of post-traumatic isolated ISD with intact TM aiming to improve the stability and the functional outcome of ossiculoplasty.

Patients and Methods

This prospective study was conducted on 37 cases between July 2011 and July 2018. All cases had posttraumatic conductive hearing loss due to isolated ISD (diagnosed intraoperatively) with intact tympanic membrane and facial nerve. All surgeries were performed at least 6 months after trauma. Anatomical reconstruction of ISD using ionomeric bone was performed.

Institutional ethics committee approval was obtained prior to conduction of the study (MD.18.03.14). All the patients signed a written informed consent prior to surgery.

All cases were operated on by senior surgeon (first author) *via* trans-canal approach. The diagnosis of ossicular lesion depended mainly on the intraoperative finding. The middle ear and the ossicular chain status and mobility were examined microscopically and, in some cases, 0- and 30-degree endoscopes were additionally used to exclude other ossicular lesions (Figure 1, 2).

Reconstruction of ISD in 37 ears using ionomeric bone cement (Harvard Ionoglass Cem, Harvard Dental International GmbH) was done. After preparation of the cement, it was applied by a needle to bridge the gap and restore the integrity of ISJ anatomically (Figure 3). During cement application, pieces of Gelfoam were applied to protect the facial nerve and the stapes footplate and then removed after the cement got hardened (Figure 4).

The tympanic membrane was returned to its position followed by packing of the external ear canal with Gelfoam soaked with an antibiotic ear drops.

Audiological assessment was carried out according to AAOHNS guidelines. Both Air Conduction (AC) and Bone Conduction (BC) thresholds were recorded preoperatively and 6 months postoperatively for the frequencies 0.5, 1, 2, and 3 kHz. The Air Bone Gap (ABG) was measured as the difference between AC and BC thresholds. Successful postoperative hearing was defined as ABG of ≤ 20 dB [13].

Statistical analysis was performed using a statistical software (SPSS, ver. 20, IBM, Chicago, IL USA). A paired Student's t-test was used to compare the means of the pre- and postoperative hearing results. One-way ANOVA was used to compare means and standard deviations. Closure of air-bone gap within 20 dB was considered a successful result. Chi-square test was used to test the association between categorical variables while Fischer exact test was used when expected cell count less than 5. With P<0.05 was considered significant.

Results

Thirty-seven cases (31 left ears and 6 right ears) were included in the study. The mean age was 21.13 ± 10.5 years (range, 12 to 45 years). Thirty-five patients (94.6%) were males while 2 patients (5.4%) were females. Road traffic accident was the cause in 30 patients (81.1%) while blunt head trauma and fall from height was the cause in 7 patients (18.9%). The mean duration between trauma and surgical intervention was 4.9 ± 5.2 years (range 8 months to 16.3 years). Seven

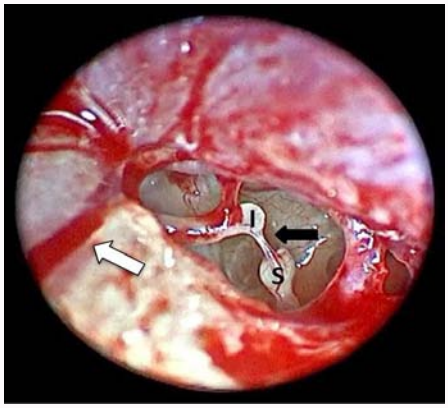

Figure 1: It shows endoscopic view of the right middle ear with incudostapedial dislocation (black arrow), incus (I), stapes head (S) and fracture line (white arrow).

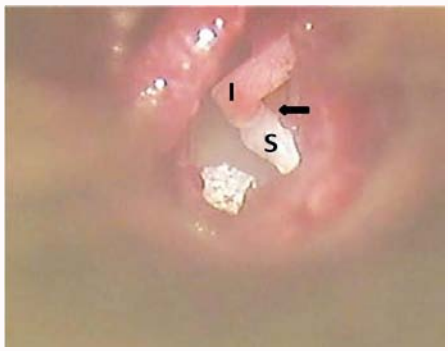

Figure 2: It shows microscopic view of the left middle ear with incudostapedial dislocation (black arrow), incus (I) and stapes head (S).

Figure 3A and 3B: It shows application of the cement by a needle to bridge the gap and restore the integrity of IS joint anatomically.

ears (18.9%) had fracture line of posterior and post-superior metal wall (Figure 1). Local anesthesia was used in 34 (91.9%) ears.

The mean preoperative and postoperative AC thresholds were 44.2 ± 12.8 dB and 14.7 ± 11.4 dB respectively with statistically significant difference (P value was <0.001) (Table 1). The mean preoperative and postoperative BC thresholds were 11.6 ± 6.5 dB and 11.3 ± 6.8 respectively with statistically non-significant difference (P value was 0.422) (Table 1). The mean ABG improved significantly from 32.4 dB preoperatively to 3.3 dB postoperatively (P value was <0.001). The ABG closure within 10 dB was found in 31 ears (83.8%) and to within 20 dB in 33 ears (89.2%) and above 20 dB (mean 22 dB) in 4 ears (10.8%).

In 27 cases, surgical intervention was done early (within 2

Figure 4: It shows restored incudostapedial joint.

Table 1: Hearing results.

Cases = 37	Preoperative	Postoperative	Significance
Air Conduction (dB)	44 ± 12.8	14.7 ± 11.4	P<0.001
Bone Conduction (dB)	11.6 ± 6.5	11.3 ± 6.8	P=0.422
Air–Bone Gap (dB)	32.5 ± 8.8	3.3 ± 7.8	P<0.001

years from trauma) and ABG closure within 20 dB was achieved in all of the 27 cases (100%). In 10 cases, on the other hand, surgical intervention was done after more than 2 years from trauma and ABG closure within 20 dB was achieved in 6 out of the 10 cases (60%). Such difference in ABG closure within 20 dB between early and delayed surgical intervention was statistically significant (P value <0.001).

In 33 patients in whom ABG closure within 20 dB was achieved, the mean duration from onset of trauma to surgical intervention was 3.9 ± 4.2 years. While in 4 patients who achieved more than 20 dB ABG closure, the duration from onset of trauma to surgical intervention was 16 ± 0.4 years.

There were no complications reported in any of the patients in relation to the application of ionomeric cement as perforation of the tympanic membrane, otorrhea or granulations.

Discussion

This study was conducted to assess the effectiveness of anatomical reconstruction of traumatic ISD using ionomeric bone cement. In this study, the main cause of ISD was head trauma due to traffic accident which was in agreement with previously published studies [3,4,14]. In these cases, reconstruction of ISD using ionomeric bone cement represented an option.

In this study the postoperative mean AC threshold, mean ABG and ABG closure were statistically significant when compared to the preoperative results indicating improvement in postoperative hearing outcome. The BC threshold, indicating cochlear function, remained stable postoperatively, reflecting the safety and feasibility of this line of management in experienced hands. No complications were noticed and none of the patients had an air-bone gap of more than 30 dB, a finding that can be used in counseling and assuring the potential future patients undergoing an exploratory tympanotomy for persistent post-traumatic CHL.

The ABG closure showed a statistically significant improvement when surgical intervention was done early after trauma. A possible explanation can be that delayed surgical intervention might lead to some sort of stapes fixation. This finding was consistent with previous studies which found that early surgical intervention may improve hearing outcome [3,15].

Since earlier trials of Incudostapedial rebridging ossiculoplasty by reconstructing the missing part of the long process of the incus or ISD with liquid ionomeric bone cement, it had the advantages of precise hearing results, cost effectiveness, and ease of application. In our study, ABG closure to within 20 dB was found in 33 ears (89.2%). Ozer et al. [10], found that of 15 patients, 9 (60%) had successful postoperative hearing (an ABG to within 20 dB) [16]. Gungor et al. [16] found that in 30 patients where rebridging ossiculoplasty from incus to stapes using bone cement was done, post-operative ABG closure to less than 20 dB and 10 dB were 79% and 43% [17]. In a study, by Baglam et al. [17], on 136 patients with ISD in different otological diseases, the postoperative ABG of <20 dB was achieved in 81.6% of patients. There were significant improvement of the mean postoperative pure tone average and ABG. The authors noted that the defect between the long process of the incus and the stapes head is important to consider when selecting patients; cases with defects less than one third of the incus long arm are ideal candidates for reconstruction using bone cement [17]. However, it seems impractical to compare the outcomes of ossicular reconstruction due to traumatic lesions with other causes as chronic otitis media and cholesteatoma.

Reconstruction of the ISD may be accomplished by several means such as insertion of tragal cartilage or cortical bone, incus interposition or using prosthesis [18]. Basson, and Lierop, used the cartilage interposition technique in managing ISD and attained an average postoperative ABG of 11 dB [19]. Delrue et al. performed incus interposition for ISD and reported that the mean ABG was 32.2 ± 12.0 dB preoperatively and 14.8 ± 9.8 dB postoperatively. The postoperative ABG closure to within 20 and 10 dB was 76.7% and 30%, respectively [20]. In a study done by Goldenberg and Driver, in patients undergoing ossiculoplasty, the long-term results of 233 patients who underwent ossicular reconstruction with Goldenberg hydroxyapatite prostheses (incus replacement, incus-stapes replacement, partial and total ossicular replacement prosthesis [PORP and TORP]) revealed an ABG of 21.1 dB in 56.8% of cases with an extrusion rate 5.29%. With the consideration of postoperative ABG as 20 dB or less, the overall success rate was 64.8% for all the prostheses used. The best results were with incus replacement prosthesis (76%) followed by the incus-stapes prosthesis (85.7%), then with a noticeably lower success rates for PORP (44.4%) and TORP (61.9%). Successful hearing result was reported in 50.6% patients. This study showed lower success rates of PORP and TORP [21]. Ghonim et al. [4] used Teflon piston in management of ISD in 24 cases and attained a postoperative ABG of 1.04 dB and postoperative ABG closure with in 20 and 10 dB in 100% and 91.6% respectively [4]. Another similar study by Shabana et al. [5] on using Teflon piston in ISD in 18 cases, a postoperative ABG of 9 and 10 dB in short and long term follow-up period was attained with ABG closure within 20 and 10 dB in 89% and 83% of cases respectively [5].

Thus, this study showed the effectiveness and safety of anatomical reconstruction of traumatic ISD using ionomeric bone cement when compared to studies that used conventional techniques such as tragal cartilage or cortical bone, incus interposition or using prosthesis.

Conclusion

A few months after head trauma, ossicular lesion is suspected in cases with non-resolving ABG gap of more than 30 dB with an intact TM. Traffic accidents are the commonest cause of ossicular lesions. When ISJ is dislocated, the anatomical reconstruction using ionomeric bone cement represents a satisfactory cost-effective

technique.

References

1. Grant JR, Arganbright J, Friedland DR. Outcomes for conservative management of traumatic conductive hearing loss. Otol Neurotol 2008;29(3):344-9.
2. Ayache D, Williams MT. Malleus handle fracture. Otol Neurotol. 2003;24(3):519-20.
3. Yetiser S, Hidir Y, Birkent H, Satar B, Durmaz A. Traumatic ossicular dislocation: Etiology and management. Am J Otolaryngol. 2008;29(1):31-6.
4. Ghonim MR, Shabana YK, Ashraf B, Salem MB. Traumatic ossicular disruption with intact tympanic membrane: Treatment modalities in 42 cases. Our experience in 42 patients. Clin Otolaryngol. 2015;41:176-9.
5. Shabana YK, Abu-Samra M, Ghonim MR. Stapes surgery for post-traumatic conductive hearing loss: How we do it. Clin Otolaryngol. 2008;34(1):64-75.
6. Babu S, Seidman MD. Ossicular reconstruction using bone cement. Otol Neurotol. 2004;25(2):98-101.
7. Baglam T, Karatas E, Durucu C, Kilic A, Ozer E, Mumbuc S, et al. Incudostapedial rebridging ossiculoplasty with bone cement. Otolaryngol Head Neck Surg. 2009;141(2):243-6.
8. Gungor V, Atay G, Bajin MD, Yarali M, Sarac S, Sennaroglu L. Comparison of various bone cement ossiculoplasty techniques and functional results. Acta Otolaryngol. 2016;136(9):883-7.
9. Hoffmann KK, Kuhn JJ, Strasnick B. Bone cements as adjuvant techniques for ossicular chain reconstruction. Otol Neurotol. 2003;24(1):24-8.
10. Ozer E, Bayazit YA, Kanlikama M, Mumbuz S, Ozen Z. Incudostapedial rebridging ossiculoplasty with bone cement. Otol Neurotol. 2002;23(5):643-6.
11. Ghonim M, Shabana Y, Ashraf B, Salem M. Revision stapedectomy with necrosis of the long process of the incus: Does the degree of necrosis matter? A retrospective clinical study. J Int Adv Otol. 2017;13(1):28.
12. Ghonim MR, Shabana YK, Ashraf B, Salem MB. Anatomical reposition of incus after transmastoid facial nerve decompression using bone cement: Preliminary results in 17 patients. Clin Otolaryngol. 2016;41(1):95-9.
13. Gurgel RK, Jackler RK, Dobie RA, Popelka GR. A new standardized format for reporting hearing outcome in clinical trials. Otolaryngol Head Neck Surg. 2012;147(5):803-7.
14. Jakse K, Jakse R. Diagnosis and therapy of stapes fractures and luxations. Laryngorhinootologie. 2002;81(2):87-92.
15. Yan X, Liu P, Ji C, Zhang M, Zhang X, Zhu F, et al. Outcomes of ossicular disruption in traumatic facial paralysis: A case series. Acta Otolaryngol. 2020:141(3):222-5.
16. Gungor V, Atay G, Bajin MD, Yarali M, Sarac S, Sennaroglu L. Comparison of various bone cement ossiculoplasty techniques and functional results. Acta Otolaryngol. 2016;136(9):883-7.
17. Baglam T, Karatas E, Durucu C, Kilic A, Ozer E, Mumbuc S, et al. Incudostapedial rebridging ossiculoplasty with bone cement. Otolaryngol Head Neck Surg. 2009;141(2):243-6.
18. Celik H, Felek SA, Islam A, Demirci M, Samim E, Oztuna D. The impact of fixated glass ionomer cement and springy cortical bone incudostapedial joint reconstruction on hearing results. Acta Otolaryngol. 2009;129(12):1368-73.
19. Basson OJ, Van Lierop AC. Conductive hearing loss after head trauma: Review of ossicular pathology, management and outcomes. J Laryngol Otol. 2009;123(2):177-81.
20. Delrue S, Verhaert N, van Dinther J, Zarowski A, Somers T, Desloovere C, et al. Surgical management and hearing outcome of traumatic ossicular injuries. J Int Adv Otol. 2016;12(3):231-6.
21. Goldenberg RA, Driver M. Long-term results with hydroxylapatite middle ear implants. Otolaryngol Head Neck Surg. 2000;122(5):635-42.