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Original Article

Lateral Attic Wall Reconstruction with Glass Ionomer Bone Cement in the Management of Primary Acquired Attic Cholesteatoma in Children: A Preliminary Experience

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OBJECTIVE: To assess the effectiveness of glass ionomer bone cement (GIBC) in lateral attic wall reconstruction after primary acquired attic cholesteatoma surgery.

MATERIALS and METHODS: This prospective study was conducted on twenty children collected from the ENT outpatient clinics of a secondary and tertiary hospital. All patients presented with chronic suppurative otitis media with cholesteatoma of the primary acquired attic type. All patients underwent intact canal wall mastoidectomy (ICWM) with a transcanal atticotomy to address primary cholesteatoma involving the attic and the supratubal recess. Removal of the incus with or without decapitation of the malleus depended on the extension of the pathology. GIBC was used to build up the lateral attic wall in all cases. Ossiculoplasty and tympanoplasty were performed according to the extent of disease.

RESULTS: All patients had integrated skin covering the reconstructed attic wall with no signs of granulation tissue formation, canal wall edema, glass ionomer extrusion, or foreign body reaction on the 6th month, 1st year and 2nd year follow-up visits. Also, no persistent otorrhea was noted. The postoperative air-bone gap was significantly improved (p=0.007).

CONCLUSION: GIBC could be considered as a reliable artificial material for reconstruction of the lateral attic wall after transmeatal atticotomy in ICWM, making it feasible to avoid cavity problems of canal wall down mastoidectomy, especially in children.

KEYWORDS: Attic wall reconstruction, glass ionomer bone cement, chronic suppurative otitis media, cholesteatoma

INTRODUCTION

Cholesteatoma is a unique pathological condition of the temporal bone characterized by migration of hyperproliferative keratinized squamous epithelium into the middle ear and mastoid cavity [1].

Despite its multiple pathogenic theories, cholesteatoma in the epitympanum develops in two basically different forms: retraction pocket cholesteatoma following absorption of air from Prussak's space and papillary ingrowth from the Shrapnell's membrane [2]. Acquired cholesteatoma in children is an aggressive disease due to its rapid growth and high recurrence rate. Thus, the main goal of cholesteatoma surgery is local control to eradicate the disease process without leaving residual remnants, as well as preventing its recurrence [3, 4]. The most frequent locations of residual cholesteatoma are the sinus tympani and supratubal recess [4]. Therefore, a surgical technique that provides a good visualization of these locations is expected to be a good technique for preventing recurrence of cholesteatoma. The choice of resection technique, either canal wall-down mastoidectomy (CWDM) or intact canal wall mastoidectomy (ICWM), is still a subject of debate and must be determined for each individual case, especially according to the extent of the cholesteatoma and the surgeon's experience. When it is not definite that the pathology is completely removed, as in cases of extensive cholesteatoma, a CWDM technique should be considered [5].

Glass ionomer bone cement (GIBC) was invented by Wilson and Kent [6] and has been used in dentistry. The mixture of fluoro-aluminium silicate glass powder and solvent results in a whitish, paste-like material that adheres well to bone and hardens within a few minutes. In recent years, the potential use of GIBC in otorhinolaryngology has been explored and preliminary experience in otology has been described [7, 8].

We used GIBC to assess its effectiveness and safety in lateral attic wall reconstruction after primary acquired attic cholesteatoma surgical removal in children.

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MATERIALS and METHODS

This prospective study was conducted on twenty children presenting at the Otorhinolaryngology Outpatient Clinics of a secondary and tertiary referral hospital over a 2-year period, from April 2012 to April 2014, with primary acquired attic cholesteatoma of variable extensions to the middle ear and mastoid cavity. These patients were selected from a total of 180 chronic suppurative otitis media (CSOM) patients presenting in this period of time.

Ethical Considerations

The Ethical Committee of the School of Medicine approved the protocol of the study before it began; all patient parents provided written consent before participating in the study.

Surgical Technique

The patients were subjected to preoperative evaluation, including preoperative oto-endoscopic examination, preoperative pure tone audiometry (PTA), radiological assessment, and explanation of the surgery to patient guardians.

The procedure was carried out under general anesthesia in the form of ICWM through a post-auricular approach. A transcanal atticotomy was performed in all cases to ensure complete access to the anterior attic and supratubal recess area. Removal of the incus and excision of the malleus head were performed according to the extent of disease. Total clearance of cholesteatoma and granulations from the attic, antrum, and middle ear, including the sinus tympani area and supratubal recess were followed. The lateral attic wall was reconstructed with GIBC. Reconstruction of the ossicular chain depended on the degree of its involvement in the form of either incus interposition or incudostapedial joint fixation with GIBC. Deep temporalis fascia was used to reconstruct the tympanic membrane and to totally cover the reconstructed attic wall, thus avoiding direct contact of the external auditory canal wall skin with the GIBC.

Attic Reconstruction

Attic reconstruction was started after lateral atticotomy and complete removal of any middle ear pathology. A medium-sized cutting burr was used for atticotomy, extending from the anterior buttress of the Rivinus notch to the incus buttress posteriorly above the exit of the chorda tympani nerve. The lateral process of malleus and the chorda tympani nerve were preserved and were considered to be the lower edge of the reconstruction (Figure 1). A straight dental malleable metal strip (Figure 2) was fashioned and inserted medial to the remaining lateral attic wall over the head of the malleus and the chorda tympani (Figure 3). This strip was used as a cast for the GIBC and to guard against soiling the middle ear cavity and oval window niche structures with bone cement during reconstruction (Figure 4). The strip was removed after 10 minutes, leaving a dry reconstructed attic wall (Figure 5).

GIBC Preparation and Application

First, the bone cement (Medicem; Promedica Dental Material, Neumünster, Germany) was prepared by mixing the powder with the provided solvent in the recommended ratio (1:1). This mixture has high biocompatibility, high fluoride release, low acidity, and low solubility; it undergoes no temperature increase during setting time and shows no evidence of any ototoxic effects. During the cement mixing process, it reached its optimal sticky consistency after 3 to 4 minutes. Next, a

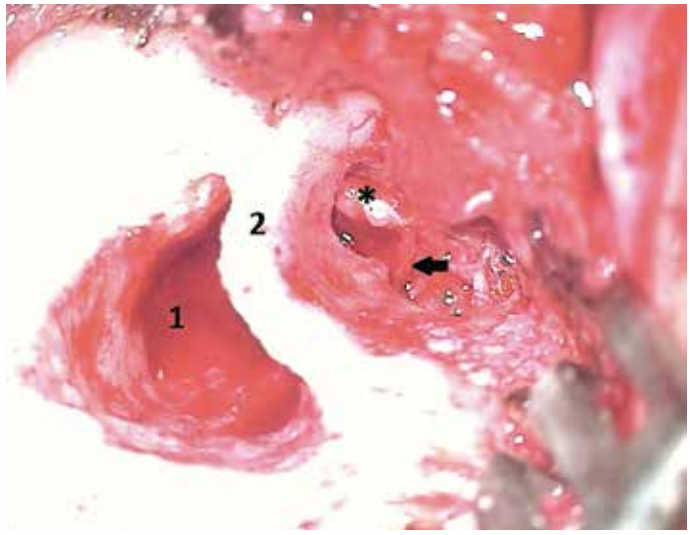

Figure 1. Right ICWM with a transmeatal atticotomy, showing: 1. mastoid cavity, 2. posterior canal wall. Black arrow: chorda tympani nerve; *: malleus head with its lateral malleolar process.

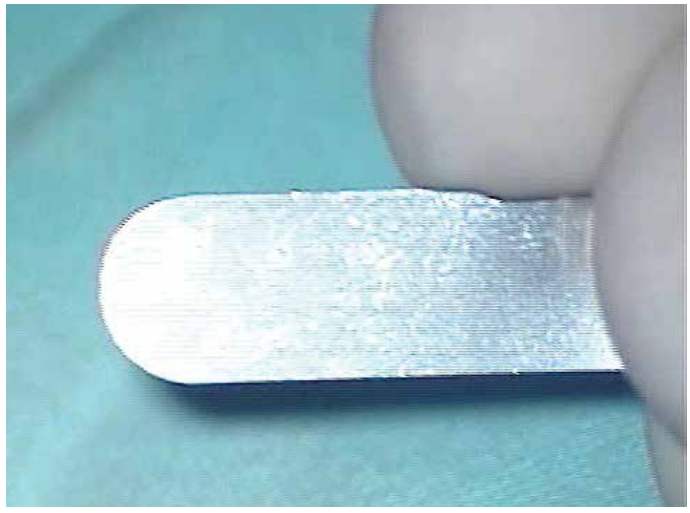

Figure 2. The straight dental malleable metal strip used.

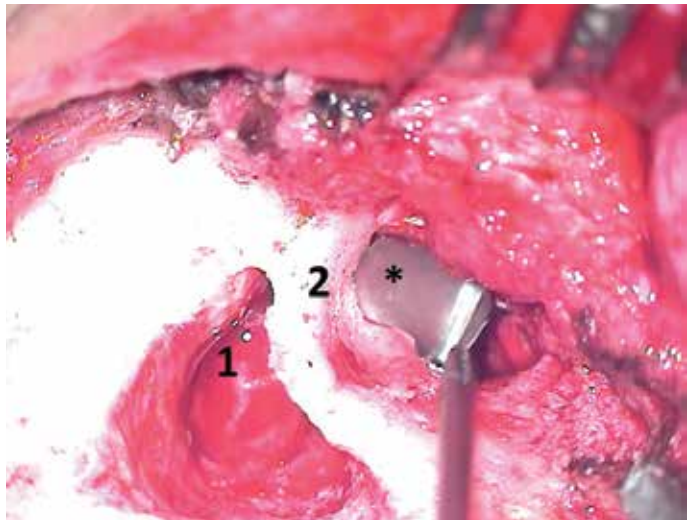

Figure 3. The metal strip, after bending *, was inserted under the remaining lateral attic wall lateral to the chorda tympani nerve and malleus head. 1. mastoid cavity, 2. posterior canal wall.

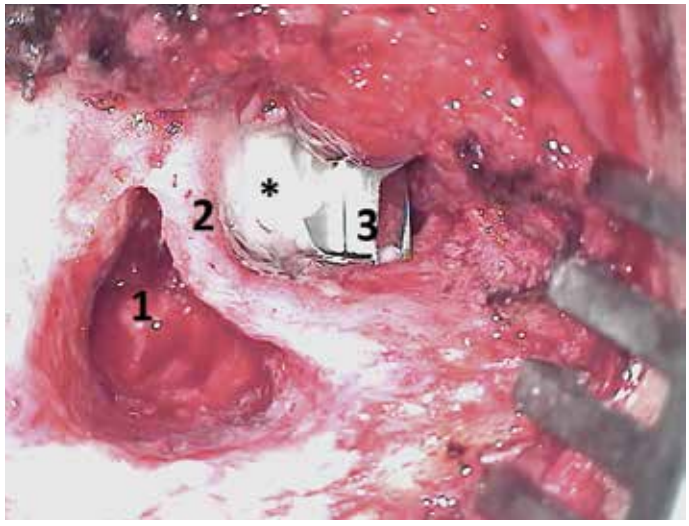

Figure 4. The reconstructed attic using GIBC *. 1. mastoid cavity, 2. posterior canal wall, 3. bended metal strip.

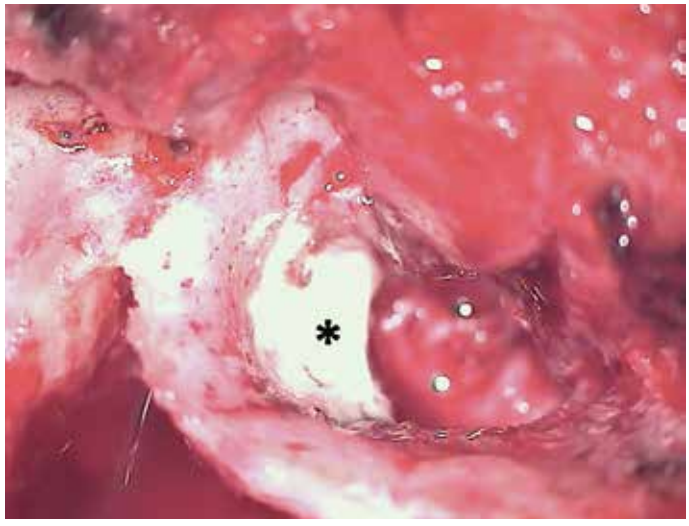

Figure 5. Reconstructed lateral attic wall *.

Figure 6. Rigid 0° endoscopic view of the right ear on the 6th month post-operative visit showing a GIBC reconstructed lateral attic wall covered with healthy fully integrated epithelium *. 1. posterior canal wall, 2. handle of malleus.

small droplet of GIBC was taken up by a curved needle and applied to reconstruct the attic wall defect. Reconstruction started at the apex of the deficient lateral attic wall and proceeded downward toward the lower limit of the defect, following an imaginary line between anterior and posterior bony canal buttress above the chorda tympani and the lateral process of malleus. Any excess amount of mixed cement was removed using a bone curette or diamond burr to obtain a smooth reconstructed external bony canal (Figure 5).

Postoperative Follow-up

Postoperative outpatient visits were scheduled on a weekly basis until the first month, then on the 6th week, 3rd month, 6th month, and twice annually for 2 years. During each visit, the external auditory canal was examined for persistent discharge, canal skin edema, granulation tissue formation, or foreign body reaction. An audiogram was performed at the 6th month and by the end of the follow-up period.

Statistical Analysis

The statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) software package (version 17.0, SPSS Inc.; Chicago, USA) The air–bone gap in the study was compared pre and post-operatively using the Wilcoxon matched pairs signed rank test for paired data. The exact McNemar's test was used to evaluate persistent otorrhea. Statistical significance was defined as $p<0.05$ for the analysis.

RESULTS

The current study was conducted on 20 children presenting with attic cholesteatoma of an age range between 7 and 17 years (mean, 12.0±3.1). All patients had conductive hearing loss on preoperative audiograms with an air bone gap ranging from 15 to 50 dB with a mean of 26.5±12.0 and a median of 23.0. Preoperatively, 16 patients presented with persistent otorrhea and 4 patients had intermittent otorrhea. All had significant improvement with complete healing with no evidence of granulation tissue in the post-operative period (Figure 6), except one patient who had post-operative ear discharge and achieved complete healing by the 3rd month visit ($p=0.008$). Eight patients had minimal external auditory canal edema by the 3rd week visit that totally resolved by the end of the 6th week. No patient developed a foreign body reaction or extrusion of the reconstruction material (Table 1). None of the patients developed otitis media with effusion or retraction pockets during the follow-up period.

Table 1. Clinical postoperative results of the 20 patients included in the study

Postoperative data	No	%
Otorrhea		
No	19	95
Yes	1	5
Healing time		
Normal (3 to 6 weeks)	19	95
Delayed (>6 weeks)	1	5
Granulation tissue formation		
No	20	100
Canal edema		
No	12	60
Minimal	8	40

Table 2. Pre- and postoperative air-bone gap statistics and tests of significance of the 20 patients included in the study

PTA air-bone gap (dB HL)	Range	Mean	SD	Median
Preoperative	15-50	26.5	12.0	22.5
Postoperative	10-20	13.5	3.4	15.0
Median change (range)	7.5 (0-35)			
z (p)	2.7 (0.007)*			

dB: decibel; HL: hearing loss; SD: standard deviation; z: wilcoxin; p: significant if <0.05

Postoperative PTA was performed for all patients on the 6th month visit and revealed a range of conductive hearing loss of 10 to 20 dB with a mean of 13.5±3.4 (Table 2). This improvement was found to be statistically significant (p=0.007). There was no change in the results of the hearing tests that were performed by the end of the second year.

DISCUSSION

Primary acquired cholesteatoma of the attic and anterior epitympanic space is a challenging pathology facing otologic surgeons. This problem can be solved if radical or modified radical mastoidectomy is planned, but cavity problems that are preferably avoided in children persist. On the other hand, classical ICWM does not provide good access to this space unless extensive transmastoid epitympanotomy is performed. In this approach, the working area is narrow to totally clear the pathology from the supratubal recess, with a high risk of middle fossa dura injury.

Modified ICWM techniques with transmeatal atticotomy provide an excellent route to the supratubal recess and anterior attic space, especially if combined with decapitation of the malleus head and removal of the incus. This approach is also considered to provide good access to the posterior epitympanic space and oval window niche area [9, 10]. Thus, the possibility of residual cholesteatoma decrease substantially, and the need for a second look procedure becomes minimal. However, the main disadvantage of this technique is a higher incidence of recurrent cholesteatoma unless the attic is adequately reconstructed [11]. Various reconstructive materials have been used; the ideal material should be non-resorbable, non-reactive, and retraction resistant, allowing naturally integrated skin to creep and cover the reconstructed lateral attic wall [12-14]. There is debate in the literature concerning the optimal materials for this purpose. Some surgeons prefer natural autografts such as cartilage, cortical bone, bone pate, or fascia [14-17]. Others use synthetic materials, such as titanium mesh or hydroxyapatite [18, 19].

A composite conchal graft used by Adkins [15] showed a minimal cholesteatoma recurrence rate (3%) with a mean of 3.5 years follow-up. Sakai et al. [14] used mastoid cortical bone plate and reported a reconstruction failure rate of 14% for 79 combined-approach tympanoplasty procedures (including attic retractions, perforations, and recurrent cholesteatoma) over 1 to 2 years of follow-up. Bone pate for scutumplasty was advocated by Pfleiderer et al. [16] in 29 cases, with a failure rate of 20% through one-year follow-up; this was superior to tragal cartilage graft, which showed a 57% failure rate for attic reconstruction in 14 cases over the same period of time. Pfleiderer [16] attributed this failure to inadequate cartilage blood supply, leading to its reabsorption and attic retraction. Fascia alone as a reconstructive material showed a failure rate of 48% in the form of retraction and cholesteatoma recurrence [17].

Zini et al. [18] used titanium mesh in 9 patients and had no failure rate for cholesteatoma recurrence or synthetic prosthesis rejection over 1 year of follow-up. Grote [19] used hydroxyapatite cement to fashion 120 canal wall prostheses and found that it was possible to reconstruct a radical mastoidectomy cavity with a new ear canal. He found no extrusion over an average of 5 years of follow-up.

In our study, we performed ICWM with a transmeatal atticotomy, preserving both the non-overstretched chorda tympani nerve and the lateral process of malleus as a landmark for the lower limit of attic reconstruction. We used GIBC as a reconstructive material for the scutum defect. The mixture and consistency of the bone cement was prepared as recommended by Saunders [20]. Among the advantages of this material is that it can be re-shaped using a bone curette or a diamond drill to obtain a smooth surfaced circumferential external auditory canal; also, it can be used simultaneously in middle ear ossicular reconstruction. The reconstructed material should be covered with an intact piece of grafting material to avoid direct contact with skin of the external auditory canal. Regarding the inflammatory reaction caused by GIBC, this study showed the absence of any inflammatory response in the form of persistent post-operative otorrhea, delayed healing time, foreign body reaction, or granulation tissue formation in almost all cases over the follow-up period.

Our study concludes and recommends the use of GIBC as a reconstructive material of the lateral attic wall in treating chronic otitis media with primary acquired cholesteatoma in children. Compared with alloplastic graft materials, GIBC is simple to apply, easily fashioned, and less expensive; unlike natural autografts, it carries no risk of disease transmission. Although the follow-up period of the current work was not very long, this material proved to be reliable, with minimal postoperative complications. However, it is difficult to accurately compare the outcomes of different reconstructive materials due to the varied definitions of failure rates in published studies.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Alexandria University School of Medicine.

Informed Consent: Written informed consent was obtained from patients' parents who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - A.O., F.A.; Design - A.O., F.A.; Supervision - A.O., F.A.; Resources - A.O., F.A.; Materials - A.O., F.A., A.A.; Data Collection and/or Processing - A.O., A.A.; Analysis and/or Interpretation - A.A.; Literature Search - A.A.; Writing Manuscript - A.O., A.A.; Critical Review - A.O.

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Conflict of Interest: No conflict of interest was declared by the authors.

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