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Original Article

Outcomes of Canal Wall Down Mastoidectomy following Type III Tympanoplasty

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Abstract:

Objectives: *To see the hearing outcomes following Type III tympanoplasty with stapes columella grafting after canal wall down mastoidectomy and find out the recurrence rates in patients undergoing this procedure.*

Methods: *This prospective observational study includes 120 cases undergoing Type III tympanoplasty with stapes columella grafting following canal wall down mastoidectomy for cholesteatoma at a tertiary care center from 2018 to 2020. Patient charts were reviewed for demographic data, diagnosis, and operative details. Patients were included in statistical analysis if they were found to have undergone the aforementioned procedure. Evaluation of hearing improvement was made by comparing preoperative air-bone gap (ABG) and ABG at follow-up at 6 months and 1 year postoperatively.*

Results: *One hundred and twenty patients were included for this study. Erosion of the otic capsule, posterior fossa plate, or tegmen was noted in 20% of cases, highlighting disease severity. One hundred and two (85%) had undergone prior otologic surgery. Mean time to short-term follow-up was 6 ± 3 months. The average short-term ABG was 25 ± 12 dB HL; 36% achieved an ABG <20 dB and thirteen had follow-up at least 1 year postoperatively (mean = 33 ± 16 months). At longer-term follow-up, mean ABG was 24 ± 11 dB HL. Hearing remained stable over time (*P *= .26).*

Conclusion: *In some patients undergoing canal wall down mastoidectomy for advanced or recurrent cholesteatoma, Type III tympanoplasty with stapes columella grafting yields marginal hearing benefit.*

Keywords: *outcomes, hearing loss, tympanoplasty, mastoidectomy*

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Introduction:

Treatment of chronic otitis media and cholesteatoma comprises clearance of disease and reproducing an adequate ventilation pathway to prevent recurrence of tympanic membrane (TM) retraction or cholesteatoma formation. Surgical management of chronic otitis media is aimed to eradicate the disease, where hearing restoration is considered as secondary importance[1]. Traditionally, canal wall up (CWU) mastoidectomy has been associated with a higher risk of disease recurrence or need for reoperation than is seen with modified radical or canal wall down (CWD)mastoidectomy[2-7]. Though, CWU tympanomastoidectomy may preserve more native anatomy, and can lead to improved hearing outcomes and is often considered as an primary surgical approach[8,9]. Where disease burden is more or revisions are required , CWD is often performed in those cases. CWD mastoidectomy allows greater access to the middle ear for more adequate disease clearance, in many cases obviating the need for a second-look procedure prior to ossicular reconstrution[10].

But this removal of the canal wall reduces the volume of the middle ear cavity may cause more exposure to the middle ear via CWD procedures which can be difficult for ossicular reconstruction as. Sometimes partial or total ossicular chain reconstruction (PORP or TORP) can be attempted depending on individual case status, but due to be minimal space between the stapes and the neo-tympanic membrane in ears with a CWD cavity these options are often not feasible[11]. However, If standard prosthetics can be used to reconstruct the ossicular chain good results are often acheived[12]. There is an alternative to prosthetic ossicular chain reconstruction which is Type III tympanoplasty with stapes columella grafting. In this technique, cartilage or other tissue used to fashion a neo-tympanic membrane is placed directly onto the capitulum of a mobile stapes[13]. This paper aims to describe the experience with Type III tympanoplasty with stapes columella grafting in patients undergoing CWD mastoidectomy at a single institution.

Materials and Methods:

It is a prospective observational study of two years from 2018 to 2020 at a tertiary care specialized hospital in Bangladesh. Prior to the study Ethical Review Board approval is obtained from the instituition. In this study we have taken all cases of Type III tympanoplasty with stapes columella grafting in CWD mastoidectomy performed over a 2 year period.

To find out whether the patient undergone ossicular reconstruction in any capacity, CPT codes are routinely done. All information are kept in an excel sheet and updating and clearance was done for all patients who had undergone Type III tympanoplasty with stapes collumella grafting following CWD. Information was collected on demographic and clinical variables including the age of the patient at surgery, gender, and various characteristics regarding the disease burden of the individual patients and operative findings. We also collected data regarding the presence or absence of drainage and/or cholesteatoma at the time of surgery, presence or absence of the ossicles, and whether this was an initial or revision surgery. Using the above factors, an Ossiculoplasty Outcomes Parameters Staging (OOPS) index score was calculated for each patient. This index attempts to predict likelihood of success in ossiculoplasty based on middle ear status and includes items such as presence or absence of drainage, middle ear mucosal status, type of mastoidectomy performed, presence or absence of the malleus, and whether the surgery is a revision.

Operative technique involved CWD mastoidectomy. In this technique, the canal wall is removed medially to the level of the facial ridge and typically to the level of the facial nerve itself. In the study place the surgeon removes ossicles, apart from the stapes, if still present. Cartilage, typically harvested from the tragus, is placed over the capitulum of the stapes, and fascia is placed over the cartilage to complete the tympanoplasty. Cartilage is used routinely in all instances of stapes major columella grafting as opposed to fascia only grafting.

For analysis both pre and post postoperative audiometric data are collected. The audiometric data collected included air and bone conduction thresholds recorded at 0.5 kHz, 1 kHz, 2 kHz, and 3 kHz as is in accordance with the guidelines set forth by the American Academy of Otolaryngology-Head and Neck Surgery[15]. This allowed for determination in changes of ABG and assessment of hearing improvement postoperatively. Statistical analysis was conducted using SPSS, version 23. (IMB, Armonk, New York, USA) to see the significant change between pre- and postoperative ABG.

Results:

Between the years of 2018 and 2020, 168 consecutive ossiculoplasty have been performed at the study place. Out of 120 cases (<0.01%) were Type III tympanoplasty with stapes columella grafting. The mean age at the time of surgery was 43 ± 14.2 years; 65% (n = 13) of patients were male. Baseline disease-specific and operative characteristics are summarized in Table 1. The mean preoperative air conduction pure tone average (AC PTA) and ABG were 49.20 dB HL and 28 ± 13 dB HL, respectively. Eighteen patients had moderate to severe sensorineural hearing loss preoperatively (median = 62 dB HL; range, 55-65 dB HL) with poor word recognition (median = 35%; range, 29%-41%) and were excluded from further analyses assessing improvement in conductive loss.

In regards to middle ear status, the OOPS index was calculated for each patient to determine the likelihood of success with OCR based on middle ear status. All patients had scores of 4 or greater. Sixty six patients (55%) had an absent malleus secondary to middle ear disease, and the remaining fifty four (45%) had their malleus removed due to either partial erosion or lack of continuity

Table I :
Clinical and Post-operative findings of cases (n=120)

Patient Characteristics	No. (%)
Diagnosis	
COM with cholesteatoma	120(100)
COM without cholesteatoma	00(00)
Ossicles	
Normal	00(00)
Abnormal, malleus present	120(100)
Abnormal, malleus absent	00(00)
Status of mastoid preoperatively	
Intact canal wall mastoidectomy	24(20)
Canal wall down mastoidectomy	116(80)
Revision surgery	
Yes	102(85)
No	18(15)
Labyrinthine fistula	
Yes	18(15)
No	102(85)
Tegmen erosion	
Yes	12(10)
No	108(90)

With the remainder of the ossicular chain. Finally, 42 patients (35%) were found to have chronic drainage, and 102 patients (85%) were undergoing revision surgery. It is noted

that all patients were found to have good aeration of the neotympanum in follow-up, indicated by mobility of the membrane on pneumatic otoscopy.

The mean time to short-term follow-up was 6 ± 3 months. The average short-term ABG was 25 ± 12 dB HL, yielding a mean ABG improvement of 6 ± 11 dB HL. The improvement in preoperative to postoperative ABG at short-term follow-up was not statistically significant (*P*=.06). Thirty six percent of patients achieved an ABG d”20 dB. The mean postoperative AC PTA was 47 ± 15 dB HL.

Seventy eight patients had followed up at least 1 year post operatively (mean = 29 ± 17 months). At longer duration follow up, the mean ABG was 24 ± 11 dB HL, with an improvement of 8 ± 12 dB on average. The improvement in preoperative to postoperative ABG was not significant (*P*= .26). Forty two percent of patients achieved an ABG d”20 dB beyond 1-year postoperatively. The mean long-term AC PTA was 49 ± 19 dB HL.

Discussion:

Type III tympanoplasty with stapes columella grafting is a technique for ossicular reconstruction in which cartilage or other graft material for the neo-tympanic membrane is placed directly on the stapes capitulum. This requires a mobile stapes to allow for any chance at meaningful hearing postoperatively. At our institution, this type of reconstruction is performed most commonly in patients undergoing CWD mastoidectomy. Even in these patients, other methods of reconstruction (PORP or TORP) are sometimes feasible. We perform stapes columella grafting tympanoplasty when there is contracted neo-tympanum secondary to either disease or the mastoidectomy, thus limiting the available space for placement of a prosthesis.

In the current study it is found that there is hearing improvement post operatively with stapes columella grafting but no significance analysis was performed. Despite lack of significance, some patients did have marginal hearing benefit with this type of reconstruction. In this patient population, disease clearance is the more important factor given that nearly all of these patients were undergoing revision surgery. In fact, 102 patients (85%) had previously had CWD procedures. Patients requiring CWD mastoidectomy may have severe disease at baseline as CWD procedures frequently are reserved only for patients in whom cholesteatoma cannot be safely removed with a canal wall sparing approach. In this series as we have attempt reconstruction, hearing outcome is better. Most importantly, patients undergoing revision procedures clearly have had difficulty with disease control previously. The low revision rate following surgery with this technique highlights its usefulness as a potential means for reconstruction following CWD procedures.

Few other studies exist regarding this type of procedure in this patient population. Parveen[16] reported on 30 patients who had OCR with Type III tympanoplasty following modified radical mastoidectomy in 2013. In this study, 43.3% of the patients had AGB closure of 20 dB or less, and 6.7% had ABG closure of 30 dB or less, similar to the results found in this study. In that particular study, 102 patients underwent Type III tympanoplasty without augmentation, indicating that a fascia-only graft was utilized. Only 30 patients had cartilaginous grafts, which was performed routinely in our study. Shresha et al[17] showed a reduction in the mean AB 37.8 dB to 29.8 dB, which did show statistical significance, though the authors note that there was wide variation in hearing outcomes between patients. Although our results did not show statistically significant improvement between pre-and postoperative levels, the

mean ABG of 25±12 dB at 1 year postoperatively is lower than the mean ABG in the Shreshaet al[17] study.

Merchant et al[18,19] previously published results on Type III tympanoplasty with stapes columella grafting. In 1 study,[18] the authors describe 34 cases of stapes columella grafting with an aerated middle ear using fascia only and just 9 instances of fascia-cartilage grafting (similar to the procedure described in this article). They determined that fascia-cartilage grafting led to improved hearing results and middle ear aeration additionally led to better hearing outcomes[18]. In this initial report by Merchant et al[18], there is no discussion of length of follow-up or rates of disease control. The importance of tympanic membrane mobility and its middle ear aeration is highlighted by this study as patients with poor middle ear aeration postoperatively were noted to have significantly worse hearing outcomes. Middle ear aeration allows for increased conduction of sound to the oval window even when there is no ossicular reconstruction.[13] In our cohort, all patients were found have good aeration postoperatively despite a contracted neo-tympanic space. It is likely that there would have been poorer outcomes had there been poor middle ear aeration following tympanoplasty.

In further review of their patients, Merchant et al[19] commented on an additional 8 patients, bringing the total cohort to 17 patients. They again described a significant improvement in cartilage grafting over fascia only grafting[19]. They stated that disease-free ears should be achievable in 90% or more of the patients undergoing this procedure.[19] Similarly, in our institution, we routinely use cartilage grafting. While some of the patients in the present cohort did not experience as robust improvement in their hearing compared to those in Merchant et al's[19] study, the majority of patients in this cohort did have serviceable hearing following surgery. Of note, in these studies, Merchant et al[18,19] compared different subsets of patients and the procedures that were performed rather than comparing hearing results from pre and postop-erative levels. As such, it is unclear how much patients improved in these studies from their preoperative state.

In all cases described in this series, the malleus was either absent (n = 12) or removed (n = 7) at the time of surgery. By Merchant et al.[19] Presence of the malleus has been shown in previous studies to be an important prognostic indicator for outcomes following tympanoplasty[14,20,21], though its relevance specifically in CWD mastoidectomy is less clear. In some instances, the malleus is of primary importance because it is used during placement of prostheses. In cases of CWD mastoidectomy with a contracted neotympanum, the malleus could potentially be an impediment to ossicular reconstruction of tympanoplasty. Although this series does not definitively show a benefit in removing the malleus in these patients, stapes columella grafting in CWD mastoidectomy is ultimately made easier by its removal.

As noted previously, patients undergoing CWD mastoidectomy are more likely to have disease that is more difficult to control. In other instances, these patients typically have undergone 1 or more canal wall–sparing procedures in an effort to preserve hearing through more conservative surgery. It is prudent that control of disease takes priority in order to prevent more serious complications in the future, such as labyrinthine fistula or encephalocele. Some of the patients in our present study were noted to have already suffered these complications at time of surgery. Our results indicate that even in patients with complex disease, CWD with stapes columella tympanoplasty is a safe

procedure with excellent disease control rates, even for patients who have had disease that has proven to be difficult to control previously. Moreover, in some patients, there is a reasonable chance for improvement in hearing without placement of prosthetic that may prove to be quite difficult in a contracted neotympanum.

The present study does have limitations. First, despite the large number of patients treated for chronic ear disease at our institution, only 120 cases met the criteria for this study. The number of patients that had follow-up extending beyond a year was even less. As such, the ability to draw statistically significant conclusions is somewhat limited. Additionally, given the low numbers in this study, we considered longer-term follow-up to be a year or more. Ideally, assessment of hearing outcomes would involve following patients for at least 2 years or more as complications or hearing deficit can develop greater than 2 years out from surgery with other types of ossicular reconstruction[22]. Finally, patients with better hearing outcomes may be less likely to follow up long-term, and as such there is potential for selection bias wherein only the patients with worse hear-ing outcomes achieved long-term follow-up in this study.

Conclusions:

Type III tympanoplasty with stapes columella grafting leads to varying rates of hearing improvement following canal wall down mastoidectomy. Though the improvement vary with patient but recurrence rates of cholesteatoma is less. and as such, this should be considered a safe means of ossicular reconstruction for patients undergoing canal wall down mastoidectomy.

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