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Research Article

Hearing Outcomes in Canal Wall up Versus Canal Wall down Mastoidectomy

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ABSTRACT
Introduction: Chronic active otitis media - squamous variety is a disease characterized by chronic inflammation of middle ear and mastoid air cells. Advantage of CWDM [Canal Wall Down Mastoidectomy] are complete removal of the disease. This study will focus on this advancement of gain in audiological function following canal wall down mastoidectomy with appropriate tympanoplasty and ossicular reconstruction.
Materials and Methods: It is an Institutional based descriptive observational study with the subjects having Chronic Otitis Media in the age group of 12 to 65 years, who have been planned to undergo single stage reconstruction after CWDM. The results of pure tone audiometry done were analysed by SPSS (version 27.0)
Results: The most common age distribution of patients with chronic otitis media in 30-42 years (52.5%). The most common sex affected male (55%). In the pre-operative Air Bone Gap, number of patients in d" 25 decibel, 26-40 decibel and 41-60 decibel were 5, 33, 2 respectively whereas in post-operative it was 25, 15, 0 respectively. There was a gain of 6.899 decibel between preoperative mean air bone gap & post-operative mean air bone gap.
Conclusion: CWDM is a safe and effective surgical procedure and is a preferred procedure in current otological practice. There was a gain in pre-operative and post-operative air bone gap. A modest closure of air bone gap can be expected helping the patient to achieve social hearing levels.

Keywords: Tympanoplasty; Audiometry, Pure-Tone; Mastoidectomy; Hearing loss; Otitis media: Cholesteatoma; Malleus; Incus; Prostheses; Cartilage.

INTRODUCTION

Hearing is one of the five senses. The ear is the one which functions not only as the hearing organ but also as a balancing organ. Proper hearing leads to an active and robust form of communication which may be hampered by various factors impending the hearing process.

One such pathology is Chronic active otitis media squamous variety a disease characterized by chronic inflammation of middle ear and mastoid air cells with Cholesteatomas/ granulation causing erosion of the ossicular chain and middle ear cleft. Patients usually present with chronic or recurrent ear discharge which may be foul smelling and progressive hearing loss, which can eventually lead to thickening of the middle-ear mucosa and mucosal polyps consistent with the study by Meyerhoff et al on pathology of chronic otitis media.[1] Chronic Otitis Media results from persistent atelectasis or tympanic perforation, recurrent infection, and chronic effusion. Granulation tissue may be soft or fibrous, contain cholesterol or haemorrhage, and may coexist with Cholesteatomas. Cholesteatomas are stratified squamous epithelial masses with exfoliated keratin. There are four major theories that help explain the aetiology of this disease. The first is the squamous metaplasia theory, which suggests that inflammation causes the mucosal lining of the middle ear to become hyperproliferative. The second major theory postulates that squamous epithelium from the outer layer of the tympanic membrane migrates through a perforation through the drum and into the middle ear. Basal hyperplasia theory is the third theory, which assumes that basal cells of the tympanic membrane proliferate and move medially through the basement membrane into the middle ear. The fourth and final theory is the retraction pocket theory, So much so, in fact,

that cholesteatoma resulting from a retraction pocket is named primary acquired cholesteatoma.[2,3] A secondary acquired cholesteatoma is formed by infection, trauma, or surgical manipulation causing implantation of skin into the middle ear through a defect in the eardrum. Yorgancilar et al[4] published about complications are related to bony erosion or deformity that may involve the Scutum, ossicles, mastoid, tegmen tympani, sigmoid sinusn plate, facial nerve canal, or lateral semi-circular canal (e.g., labyrinthine fistula) rare intracranial complications include meningitis, abscess formation, venous sinus thrombosis, and cerebrospinal fluid rhinorrhoea. Other causes of conductive hearing loss in chronic otitis media (without Cholesteatoma) include ossicular erosion (e.g., incus, stapes), ossicular fixation and tympanosclerosis. High resolution computed tomography is a useful imaging modality for cholesteatomas. It depicts the bony and soft tissue involvement of the mastoid–middle ear complex, associated ossicular/facial canal erosions and integrity of the tegmen tympani. However, it cannot differentiate between granulation/scar tissue and cholesteatomatous tissue.[5,6] Magnetic Resonance Imaging with Diffusion Weighted Imaging can prevent unnecessary revision surgery in patients who are suspected of having recurrent or residual disease.[7] Restricted diffusion assists in distinguishing Cholesteatomas from other inflammatory masses (e.g., granulation) The purpose of our study is to analyse the improvement in hearing or the functional outcome of tympanoplasty in canal wall down mastoidectomy in chronic otitis media using the available database of pure tone audiometry results.

MATERIALS AND METHODS

An Institutional based descriptive observational study undertaken in a tertiary care teaching hospital over a period of eighteen months (January 2023 – June 2023). After obtaining due permission from the Institutional Ethics Committee and the hospital authority, the source of data was the hospital records. Inclusion criteria: All patients with Chronic Otitis Media (squamous variety) in age group > 12years and <65years, who have been planned to undergo single stage reconstruction after Canal Wall Down Mastoidectomy. Exclusion criteria: Chronic Otitis Media mucosal type, Chronic Otitis Media with intra cranial complications, History of previous surgery or revision surgery, malignancy of external and middle ear, patients age <12years or > 65years, sensorineural or mixed hearing loss. Patient selection was done among those attending the Otorhinolaryngology outdoor or getting admitted in the Indoor department with diagnosis of Chronic Otitis Media (Squamous disease) willing to undergo Tympanoplasty with canal wall down mastoidectomy and all the patients during the study period fulfilling the inclusion and exclusion criteria were included in the study. Thus, a total of 40 patients were in the study. Statistical analysis plan. The data from pure tone audiometry were entered into a Microsoft excel spreadsheet and then analysed by SPSS (version 27.0; SPSS Inc., Chicago, USA). Descriptive statistics were performed to find frequency, percentage and mean. The data were collected using predesigned schedule. The study variables were the age, gender, results of pure tone audiometry, air-bone gap. Disease load of hearing loss estimated by World Health Organisation (2023).[8] Over 5% of the world's population – or 430 million people – require rehabilitation to address their disabling hearing loss (including 34 million children). It is estimated that by 2050 over 700 million people – or 1 in every 10 people – will have disabling hearing loss. Disabling hearing loss refers to hearing loss greater than 35 decibels in the better hearing ear. Nearly 80% of people with disabling hearing loss live in low- and middle income countries. The prevalence of hearing loss increases with age, among those older than 60 years, over 25% are affected by disabling hearing loss.

Table I: Pre-Operative Pure Tone Audiometry with groups

Pre-Operative Pure Tone Audiometry Less Than or Equal To 25 = 1, 26 - 40 = 2, 41 - 60 = 3, Greater Than or Equal To 60 = 4

	·25	26-40	41-60	>60	TOTAL
CWDM with type III tympanoplasty with Partial Ossicular Replacement Prosthesis (PORP) (Group A)	0 (0%)	5 (38.4%)	7 (53.8%)	1 (7.8%)	13 (100%)

CWDM with type III tympanoplasty with Partial Ossicular Replacement Prosthesis (PORP) (Group A)	0 (0%)	7 (38.9%)	10 (55.6%)	1 (5.5%)	18(100%)
CWDM with type IV tympanoplasty with Total Ossicular Replacement Prosthesis(TORP) (Group C)	0 (0%)	3 (33.3%)	4 (44.4%)	2 (22.3%)	9 (100%)
Total	0 (0%)	15 (37.5%)	21 (52.5%)	4 (10%)	40 (100%)

Table II: Pre-Operative Air Bone Gap

PRE-OPERATIVE AIR BONE GAP				
	·25	**26-40**	**41-60**	**TOTAL**
Canal Wall Down Mastoidectomy with type III tympanoplasty with Partial Ossicular Reconstruction Prosthesis (Group A)	1 (7.7%)	11 (84.6%)	1 (7.7%)	13 (100%)
Canal Wall Down Mastoidectomy with type III tympanoplasty with cartilage (Group B)	3 (16.7%)	15 (83.3%)	0 (0%)	18 (100%)
Canal Wall Down Mastoidectomy with type IV tympanoplasty with Total Ossicular Reconstruction Prosthesis (Group C)	1 (11.1%)	7 (77.8%)	1 (11,1%)	99 (100%)
Total	5 (12.5%)	33 (82.5%)	2 (5%)	40 (100%)

Table III: Post-Operative Pure Tone Audiometry

POST OPERATIVE PURE TONE AUDIOMETRY					
	≤25	26-40	41-60	>60	TOTAL
Canal Wall Down Mastoidectomy with type III tympanoplasty with Partial Ossicular Reconstruction	4 (30.8%)	6 (46.1%)	3 (23.1%)	0 (0%)	13 (100%)
Prosthesis (Group A) Canal Wall Down Mastoidectomy with type III tympanoplasty with cartilage (Group B)	2 (11.1%)	13 (72.2%)	3 (16.7%)	0 (0%)	18 (100%)
Canal Wall Down Mastoidectomy with type IV tympanoplasty with Total Ossicular Reconstruction Prosthesis (Group C)	2 (22.2%)	4 (44.4%)	2 (22.2%)	1 (11.1%)	9 (100%)
Total	8 (20%)	23 (57.5%)	8 (20%)	1 (2.5%)	40 (100%)

Table IV: Post-Operative Air Bone Gap

POST-OPERATIVE AIR BONE GAP			
	≤25	**26-40**	**TOTAL**
Canal Wall Down Mastoidectomy with type III tympanoplasty with Partial Ossicular Reconstruction Prosthesis (Group A)	9 (69.2%)	4 (30.1%)	13 (100%)
Canal Wall Down Mastoidectomy with type III tympanoplasty with cartilage (Group B)	10 (55.6%)	8 (44.4%)	18 (100%)

Canal Wall Down Mastoidectomy with type IV tympanoplasty with Total Ossicular Reconstruction Prosthesis (Group C)	6 (66.7%)	3 (33.3%)	9 (100%)
Total	25 (62.5%)	15 (37.5%)	40 (100%)

DISCUSSION

Canal Wall Down Mastoidectomy is a safe and effective surgical procedure commonly performed for Chronic Otitis Media squamosal type of ear disease and is preferred procedure in current otological practice Berenholz et al9 retrospectively studied both partial and total ossiculoplasty in Canal Wall Down cases, Closure of the air-bone gap, complications with focus on hearing results in Canal Wall Down ossiculoplasty. The study

revealed that the mean patient age at time of surgery was 38.6 years, with 22 (55%) male and 18 (45%) female patients. Preoperative audiometric revealed an airconduction Pure Tone Audiometry of 51.4 decibel, a Boneconduction Pure Tone Audiometry of 22.0 decibel. Postoperative testing at 6 months revealed an Air conduction Pure Tone Audiometry of 39.1 decibel, Bone Conduction Pure Tone Audiometry of 21.9. In our study, the mean age with Standard Deviation was 35.875 ± 10.028. the age distribution of patients with chronic otitis media in the group 17-29 years was 14 (35%), 30- 42 years were 21 (52.5%) and 43-59 years were 5 (12.5%). There was a gain of 6.899 decibel between pre-operative mean air bone gap & post - operative mean air bone gap. Most commonly used technique of ossiculoplasty involves interposition of reshaped body of incus between stapes superstructure and malleus in cases with necrosis of incus. In our study we found out that the most common ossicular defects in order of frequency are necrosis of long process of incus, loss of incus with stapes superstructure and loss of all ossicles except stapes foot

plate which bears resemblance to the outcome of the study conducted by Sanna et al.10 In our study, stapes superstructure and isolated stapes foot plate were present in 31 and 9 patients respectively. To achieve optimum results, augmentation ossiculoplasty with Canal Wall Down Mastoidectomy is performed in single stage which involves increasing the height of superstructure stapes or stapes foot plate to the level of fallopian canal or above the canal. This technique is performed with the help of reshaped head of malleus or body of incus placed over stapes superstructure. In cases with absence of above bones either Partial Ossicular Reconstruction Prosthesis or piece of conceal cartilage with attached perichondrium may be used for augmentation. A similar study involving single stage canal wall down tympanoplasty by Lucas Oscar11 showed that a singlestage canal wall-down tympanoplasty is an appropriate treatment for acquired tympanomastoid cholesteatoma. We used Teflon Partial Ossicular Reconstruction Prosthesis (n = 13) and conceal cartilage with attached perichondrium in our study. In cases with absent stapes superstructure, we used Teflon Total Ossicular Reconstruction Prosthesis (n = 9) placed on stapes foot plate and conceal cartilage sandwiched between Total Ossicular Reconstruction Prosthesis medially and temporal fascia laterally. Another study conducted by Stupp et al12 on experience with titanium implants in the middle ear in place of Teflon as used in our study Canal Wall Down Mastoidectomy with type III tympanoplasty with Partial Ossicular Reconstruction Prosthesis (Group A), Canal Wall Down Mastoidectomy with type III tympanoplasty with Cartilage (Group B) & also in Canal Wall Down Mastoidectomy with type IV tympanoplasty with Total Ossicular Reconstruction Prosthesis (Group C) showed that the titanium prostheses used proved to be excellent in terms of the material properties as well as in terms of operative handling, the postoperative healing of the implants and, last but not least, the functional hearing results.

In addition to an optimal prosthesis, for hearing success good surgical technique is necessary, which, in addition to safe rehabilitation and reconstruction, also takes into account the functional aspects. Similar study conducted by Kos et al13 concluded that Canal Wall Down mastoidectomy an adequate solution for the treatment of chronic otitis with cholesteatoma or chronic otomastoiditis that is resistant to conservative treatments. The anatomic and functional results are satisfactory, and the rate of complications is acceptably low. A tympanoplasty can be performed simultaneously. Thus, for the large majority of patients, only a single intervention is required. Another study conducted by Sheikh et al15 showed that Ossicular Chain

Discontinuity is a common complication. In small/central perforations, the chance of Ossicular Chain Discontinuity is 23%, while in large/ subtotal perforations the chance nearly doubles (49.6%). High Air Bone Gap at 1,000 Hertz (>27.5 decibel) and 2,000 Hertz (>17.5 decibel) are the most reliable variables associated with Ossicular Chain Discontinuity. The number of ears with Air Bone Gap between 0 – 20 decibel
is improved after surgery in all groups. The number of ears with Air Bone Gap located within 25-40 decibel hearing loss is improved after surgery in Group A. However, there were considerable limitations while undertaking the present study. There are various factors that have been taken into consideration like age, gender and ear effected does not depict disease prevalence and incidence in the general population as it only showcases the portion of the people attending the Otorhinolaryngology Outdoor Patient Department and even fewer of them undergoing the necessary treatment. The actual disease prevalence might be much more than anticipated.

CONCLUSION

Canal wall down mastoidectomy with tympanoplasty is a good surgical procedure for chronic otitis media with Cholesteatoma. A modest closure of the air bone gap can be expected helping the patient to achieve acceptable social hearing levels. These results suggest that the tendency of the postoperative mastoid aeration is dependent on the preoperative middle ear disease.

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