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HEARING ASSESSMENT FOLLOWING DIFFERENT TYPES OF TYMPANOPLASTY IN A TERTIARY CARE HOSPITAL OF THE GARHWAL REGION: A RETROSPECTIVE STUDY

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Abstract

Background: Chronic otitis media (COM) is a common cause of conductive hearing loss in developing countries. Tympanoplasty aims to eradicate middle ear disease and restore hearing; however, hearing outcomes vary depending on the type of tympanoplasty performed.

Objectives: To evaluate and compare hearing outcomes following different types of tympanoplasty in patients with chronic otitis media using air-bone gap closure on pure tone audiometry.

Materials and Methods: This retrospective observational study included 100 patients with chronic otitis media who underwent tympanoplasty at a tertiary care hospital in the Garhwal region between June 2023 and June 2024. Preoperative and postoperative pure tone audiometry was used to assess air-bone gap at 500, 1000, and 2000 Hz. Patients underwent Type I, II, III, or IV tympanoplasty based on intraoperative ossicular status. Hearing outcomes were evaluated at 3 and 6 months postoperatively. Statistical analysis was performed using SPSS version 20.0.

Results: Type I tympanoplasty was performed in 50% of patients, followed by Type II (30%), Type III (14%) and Type IV (6%). Statistically significant improvement in mean air-bone gap was observed postoperatively across all types of tympanoplasty ($p < 0.05$). The greatest hearing gain was observed in patients undergoing Type I tympanoplasty.

Conclusion: Tympanoplasty results in significant hearing improvement in patients with chronic otitis media. Hearing outcomes vary according to the type of tympanoplasty performed, with Type I tympanoplasty demonstrating superior postoperative hearing gain.

Keywords

Chronic otitis media; Tympanoplasty; Hearing gain; Pure tone audiometry

Introduction

Chronic otitis media (COM) is a persistent inflammatory disease of the middle ear cleft characterized by permanent pathological changes in the tympanic membrane, including perforation, retraction, or cholesteatoma. It commonly results from recurrent acute otitis media,

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prolonged Eustachian tube dysfunction, negative middle ear pressure, or unresolved otitis media with effusion. COM remains a significant public health problem in developing countries like India and is a leading cause of preventable conductive hearing loss, resulting in substantial social and functional disability[1-3]. Higher incidence is observed in developing country because of overcrowding, inadequate healthcare, poor hygiene, recurrent upper respiratory tract infections and poor nutrition. Prevalence surveys, show that the global burden of illness from COM involves 65–330 million individuals with draining ears, 60% of whom (39–200 million) suffer from significant hearing impairment[4]. COM in general causes a wide range of middle ear pathologies including irreversible mucosal damages, granulation tissue formation, cholesteatoma, ossicular destruction, tympanosclerosis and are classified accordingly into inactive mucosal, inactive squamous, active mucosal and active squamous type of chronic otitis media [5].

The primary objectives of surgical management in COM are eradication of middle ear disease and restoration of hearing. Tympanoplasty is the standard surgical procedure performed to restore sound pressure transformation at the oval window by coupling an intact tympanic membrane with a mobile stapes footplate via an intact or reconstructed ossicular chain and to provide sound protection for the round window membrane by a closed air containing and mucosa lined middle ear [6]. An intact ossicular chain is one of the most desirable attributes of a Tympanoplasty procedure and represents the most favourable hearing outcome . The surgical approach is individualised depending on disease extent, tympanic membrane status, ossicular chain integrity and middle ear mucosal condition. This procedure can be combined with either an intact canal wall (ICW) or a canal-wall-down (CWD) mastoidectomy to eradicate disease from the mastoid area. Temporalis fascia remains the most commonly used graft material for tympanic membrane reconstruction due to its ease of harvest, favorable acoustic properties, high graft uptake rate and excellent immunological compatibility[7]. Zöllner and Wullstein classified tympanoplasty based on ossicular chain status and the most lateral intact sound conducting structure on which the conductive mechanism will be constructed. Type I indicates all three ossicles to be present and mobile. Type II grafts the tympanic membrane to an intact incus and stapes. Type III exists when an intact mobile stapes suprastructure is present and tympanic membrane or graft remains directly on the stapes suprastructure. Type IV describes an absent or eroded suprastructure with graft or tympanic membrane overlying a mobile stapes footplate.Hearing outcomes vary among different types of tympanoplasty. Pure tone audiometry, particularly air-bone gap closure, is a reliable method for assessing postoperative hearing outcomes.

Aim

To evaluate and compare hearing outcomes following different types of tympanoplasty in patients with chronic otitis media using air-bone gap closure on pure tone audiometry.

Materials and Methods

This retrospective observational study was conducted in the Department of Otorhinolaryngology at HNB Base Hospital, Srikot, Srinagar, Uttarakhand, from June 2023 to June 2024. A total of 100 patients aged 12–53 years diagnosed with chronic otitis media were included.

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Inclusion criteria comprised patients with conductive hearing loss, good cochlear reserve and adequate Eustachian tube function. Patients with sensorineural hearing loss, mixed hearing loss, unfit for surgery, or unwilling to provide consent were excluded.

All the patients were thoroughly assessed preoperatively by detailed clinical history, local ENT examination including otoscopic examination, tuning fork tests using 256, 512 and 1024 Hz frequency tuning forks, pure tone audiometry and EUM (Examination under Microscope), eustachian tube patency (Valsalva manuevre and tympanometry). Radiological test (X Ray mastoid Schuller's view, HRCT Bilateral ear temporal bone) was done. Routine lab investigations – Complete Blood Count, Renal and Liver Function tests were conducted.

Informed and written consent was taken from all the patients undergoing tympanoplasty. Each patient had to undergo preoperative and postoperative pure tone audiometry to assess degree of hearing loss as per WHO classification and to calculate average AB(AIR BONE) gap at 500, 1000 and 2000 Hz done at 3rd month & 6th month follow up. PTA was done in acoustically treated room with HARP Diagnostic Audiometer.

Patients underwent different types of tympanoplasties depending on the disease status and ossicular status intra-operatively. The surgeries were performed either under local or general anaesthesia using a microscope by same surgeon. Post-operatively, all patients were given intravenous antibiotic, analgesics and antihistamines for 7 days. Sutures were removed on 7th day. All the cases were followed up on an outpatient basis after 2 weeks,4 weeks, later on at 3rd and 6th month. Otoendoscopy was done to assess graft status and presence of any discharge at every follow up. PTA was done at 3month and 6 months follow up and compared with pre-operative PTA.

Statistical analysis

The recorded data was compiled and entered in a spread-sheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Continuous variables were expressed as Mean±SD and categorical variables were summarized as percentages. A repeated measure ANOVA was employed for comparing. Further student's independent t-test, Chi-square test and ANOVA were applied for comparing various parameters. P value of less than 0.05 was considered statistically significant.

Results

In our study, majority of patients were between 21 to 30 years (as shown in table 1). Females-60 were more compared to male-40 with male: female ratio of 2:3. 82 patients in our study were from rural areas while 18 were from urban area.

Table 1 Age and Gender distribution of study patients

AGE GROUP (10-60 YEARS)	10-20	21-30	31-40	41-50	51-60
MALE (42)	8	16	14	4	0
FEMALE (58)	10	24	12	8	4

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All the patients (100%) had impaired hearing and history of ear discharge at the time of presentation. Ear discharge was profuse in 70 patients; moderate ear discharge was present in 14 patients and scanty discharge was present in 16 patients.

On otoscopic examination, findings were as shown in table 2; 72 patients had central perforation, 10 patients had subtotal perforation, 2 patients were having total perforation, 12 patients had retraction and 4 patients had cholesteatoma in our study.

Table 2 Otoscopic Findings in study ears (n=100)

CENTRAL PERFORATION	72
SUBTOTAL PERFORATION	10
TOTAL PERFORATION	2
RETRACTION	12
CHOLESTEATOMA	4

Table 3 Age distribution in different types of Tympanoplasties

AGE				
TYPE(TYMPANOPLASTY)			Frequency	Percent
I	Valid	<= 20	10	20.0
		21 – 30	22	44.0
		31 – 40	12	24.0
		41 – 50	6	12.0
		Total	50	100.0
II	Valid	<= 20	4	13.3
		21 – 30	12	40.0
		31 – 40	8	26.7
		41 – 50	4	13.3
		51+	2	6.7
		Total	30	100.0
III	Valid	<= 20	4	28.6
		21 – 30	2	14.3
		31 – 40	4	28.6

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		41 – 50	2	14.3
		51+	2	14.3
		Total	14	100.0
IV	Valid	21 – 30	4	66.7
		31 – 40	2	33.3
		Total	6	100.0

Pre-operative conductive hearing loss (mean AB gap) based on tuning fork test results (Rinne's test) in ears to be operated in study subjects using tuning fork of 256Hz, 512Hz and 1024Hz was done.12 patients had 0-20 dB hearing loss.48 patients had 20-30 dB hearing loss and 40 patients had 30 -45 dB hearing loss. PTA showed 26 patients had mild hearing loss. 46 patients had moderate hearing loss.12 patients had moderately severe hearing loss and minimal hearing loss was seen in 16 patients.

Type I tympanoplasty was performed in 50 (50%) patients, Type-II tympanoplasty was the type of surgery in 30 patients. Type III was performed in 14 patients and Type IV tympanoplasty was performed in 6 patients. Postoperatively, Rinne's test in operated ears in study subjects showed 60 patients had 0-20 dB hearing loss, 30 patients had 20-30 dB hearing loss and 10 patients had 30-45 dB hearing loss.

In type 1 tympanoplasty, the mean preoperative AB gap was 38 dB while as it was 18.92 dB and 13.8 dB at 3 months and 6 months postoperatively. In type II tympanoplasty, the mean preoperative AB gap was 30.67 dB while as it was 24.67 dB and 24 dB at 3 months and 6 months postoperatively. In type III Tympanoplasty, mean preoperative AB gap was 29.7 dB while as postoperatively it was 20.14 dB and 19.40 dB at 3 months and 6 months. In type 4 tympanoplasty, mean preoperative AB gap was 34 dB while as it was 30.33 dB at 3 months and 29 dB at 6 months postoperatively.

Table 4: PTA before and after type-I tympanoplasty in study ears (n=50)

PTA	Mean AB gap	SD	RANGE	COMPARISON	P VALUE
Preop	38	7.28	26-50 dB	-	-
3 month	18.92	6.02	11-31 dB	Preop vs 3 months	.000
6month	13.8	4.085	7-25 db	Preop vs 6 months	<.000

Table 5: PTA before and after type-II tympanoplasty in study ears (n=30)

PTA	Mean AB gap	SD	RANGE	COMPARISON	P VALUE
Preop	30.67	6.455	20-44 dB	-	-

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3month	24.67	7.112	15-42 dB	Preop vs 3 months	.01
6month	24	8.1	12-40 dB	Preop vs 6 months	.01

Table 6: PTA before and after type-III tympanoplasty in study ears (n=14)

PTA	Mean AB gap	SD	RANGE	COMPARISON	P VALUE
Preop	29.71	8.8	11-38 dB	-	-
3month	20.14	6.45	11-32 dB	Preop vs 3 months	.03
6month	19.43	7.4	8-32 dB	Preop vs 6 months	.03

Table 7: PTA before and after type-IV tympanoplasty in study ears (n=6)

PTA	Mean AB gap	SD	RANGE	COMPARISON	P VALUE
Preop	34	1.5	32-35 dB	-	-
3month	30.33	2.251	28-33 dB	Preop vs 3 months	.01
6month	29	1.54	28-31 dB	Preop vs 6 months	.00

DISCUSSION

In our study, majority of patients were in the age group of 21-30 years, with mean age being 29.88 years, indicating chronic otitis media to be more common in younger decade of life. In the study done by Somashekara et al minimum age was 17 years and maximum age was 49 years with mean age of 31.68±9.19 years[8.]In our study, out of 100 patients, 60 were females and 40 were males, indicating more predilection of CSOM in female population.82 patients in our study were from rural areas while 18 were from urban area. Studies by Mudhol et al and Islam et al had reported a higher preponderance of chronic suppurative otitis media in patients from rural areas than urban area[9-10.] History of profuse ear discharge was present in 70% of our subjects, moderate ear discharge was present in 14% subjects while as scanty discharge was observed in 16% subjects. Similar pattern of ear discharge has been reported in a study by Mondal et al[11].Type I tympanoplasty was performed in 50 patients, Type-II tympanoplasty was the type of surgery in 30 patients. Type III was performed in 14 and Type IV tympanoplasties was performed in 6 patients. Perforations cause a loss that depends on frequency, perforation size and middle-ear air space volume.5,6 Perforation size is an important determinant of the loss; larger perforations result in larger hearing losses. The volume of the middle-ear air space (combined tympanic cavity and mastoid air volume) is also an important parameter that determines the amount of hearing loss caused by a perforation. Other things being equal, for a given sound pressure in the ear canal and a given perforation, the resulting sound pressure within the middle-ear cavity will vary inversely with middle-ear volume. Hence, the transtympanic membrane sound-pressure difference will be smaller (and the conductive loss correspondingly greater) with smaller middle-ear volumes[12-13.]

When preoperative mean AB gap on PTA was compared with 3 month and 6 month follow up in type 1 tympanoplasty, the mean preoperative AB gap was 38dB (SD 7.2) while as it was 18.92dB (SD 6.02) and 13.8dB (SD 4.08) at3months and 6 months postoperatively with a p

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value of <0.001 at 3 months and 6 months, which is statistically significant. The mean postoperative gain in AB gap was 24.2dB in type 1 tympanoplasty (Table 4).Similarly in type II tympanoplasty, the mean preoperative AB gap was 30.67 dB (SD 6.3) while as it was 24.67dB (SD 7.112) and 24 dB (SD 8.1) at 3 months and 6 months postoperatively with a p value of <0.001 at 3 months and <0.001 at 6 months follow up which is statistically significant. The mean postoperative gain in AB gap was 6.67dB in type II tympanoplasty (Table 4).In type III Tympanoplasty, mean preoperative AB gap was 29.7 dB (SD 8.8) while as postoperatively it was 20.14 dB (SD 6.45) and 19.40 dB (SD 7.4) at 3 months and 6 months follow up with a p value of 0.003 at 3 months and 0.003 at 6 months. The difference is statistically significant. The mean postoperative gain in AB gap was 10.3 dB in type III tympanoplasty (Table 6). In type 4 tympanoplasty, mean preoperative AB gap was 34dB (SD 1.5) while as it was 30.33dB (SD 2.251) at 3 months and 29dB (SD 1.54) at 6 months postoperatively. The mean postoperative gain in AB gap was 5dB in type IV tympanoplasty. Intraoperative assessment revealed an intact and mobile ossicular chain, Erosion of the malleus, necrosis of the incus , Dislocation of the incudostapedial (IS) joint, Concurrent necrosis of both the malleus and incus and in some cases only the stapes footplate remained intact. These intraoperative findings correlated with the preoperative audiometric patterns observed in the study cohort. Tympanic membrane perforations are known to produce conductive hearing loss ranging from minimal impairment to approximately 50 dB. In chronic otitis media, the severity of hearing loss is predominantly determined by the extent of ossicular chain involvement. A relatively small perforation associated with a disproportionately large air–bone gap on audiometry is suggestive of ossicular discontinuity and typically necessitates surgical correction depending on the degree of functional deficit. In the absence of cholesteatoma, a conductive hearing loss of 20 dB or less generally indicates preservation of ossicular chain integrity. Conversely, ossicular discontinuity or fixation usually results in a conductive deficit of 30 dB or greater. Notably, normal or near-normal hearing thresholds may occasionally be encountered in cases of attic perforation with associated cholesteatoma, potentially reflecting an intact ossicular chain. Alternatively, sound transmission may occur through a cholesteatomatous mass replacing the ossicular framework, a phenomenon described as the “cholesteatoma hearer” or “silent cholesteatoma.” Progressive hearing deterioration in the absence of active middle ear disease raises suspicion of ossicular fixation. Such fixation may result from tympanosclerosis or otosclerosis and warrants appropriate diagnostic evaluation and management[14-16].

Conclusion

Tympanoplasty is an operation to eradicate disease in the middle ear and to reconstruct hearing mechanism. It can be concluded from our study that there is a gain in hearing threshold of patients with chronic otitis media, which is different for different type of tympanoplasty. Hearing gain is better in type I tympanoplasty than in type II , type III and type IV tympanoplasty.

Compliance with Ethical Standards

Conflict of interest The authors of this article declare that he/she has no conflict of interest.

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Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee.
Informed Consent Informed consent was obtained from all individual participants included in the study.

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