

Original Research Article

A prospective study of the hearing gain achieved in relation to the site and size of tympanic membrane perforation after type 1 tympanoplasty with temporalis fascia graft

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ABSTRACT

Background: Chronic otitis media (COM) mucosal type is characterised by recurrent ear discharge and hearing loss secondary to tympanic membrane perforation. Type 1 tympanoplasty is the surgical option for its closure. The objective of this study is to record the site and size of tympanic membrane perforation, quantify the hearing loss with pure tone audiogram and to assess the hearing gain achieved following type 1 tympanoplasty with temporalis fascia graft.

Methods: This prospective study comprises 120 patients of the age group of 15 to 60 years with COM who attended the otorhinolaryngology department, from June 2015 to May 2018. Site and size of perforation were assessed by the number of quadrants involved. Hearing loss was quantified by pure tone audiometry (PTA) pre-op and 3, 6 and 12 months post-op. The pure tone average with the air-bone gap (ABG) at 12 months is used for the assessment.

Results: In this study, mean pure tone average pre-operatively for small, medium, large and subtotal perforations were 26 dB, 32 dB, 35 dB, 42 dB respectively and 14.37 dB, 23 dB, 23.66 dB, and 32.5 dB post operatively after one year. On statistical analysis by ANOVA test, postoperative hearing gain was statistically significant.

Conclusions: The study shows that hearing loss was proportional to the size of perforation. Air-bone closure following type 1 tympanoplasty was more for subtotal perforation and for perforations involving both anterior and posterior quadrants.

Keywords: Air-bone gap, Chronic otitis media, Conductive hearing loss, Pure tone audiogram, Type 1 tympanoplasty, Temporalis fascia graft

INTRODUCTION

Tympanic membrane perforation leads to recurrent ear infections and hearing loss. The target of middle ear surgery is to render the ear safe with good hearing. Mucosal type of chronic otitis media (COM) is characterised by a perforation in the pars tensa. The surface area of the tympanic membrane plays an

important role in transmitting the sound energy to inner ear. It also serves as a protective function to middle ear infections and also shields the round window. This shielding is necessary to create a phase difference, so that the sound waves do not impact on both oval and round windows simultaneously. A perforation on the tympanic membrane results in reduced surface area for sound pressure transmission and loss of shielding effect on the

round window.¹ There were studies which stated that hearing loss will be more if the perforations are present in the posteroinferior quadrant and it will be less in anteroinferior quadrant.² Hearing loss will be less in perforation away from the manubrium than those touching the manubrium.³ The present study is an effort to test the validity of the above concept. In a study by Kumar et al, it was found there was a relation between area of perforation and amount of hearing loss at 250 and 500 HZ but not at higher frequencies.⁴ Gudepu et al had shown that the hearing loss associated with perforation was more at lower frequencies than at higher frequencies and it increases with the size of perforation.⁵ Our study aims to evaluate the hearing improvement following type 1 tympanoplasty with temporalis fascia graft in relation to site and size of perforation.

METHODS

The present study is a prospective study of 120 patients between the age group of 15 to 60 years with mucosal type of COM who attended outpatient department of ENT in Pushpagiri Institute of Medical sciences and Research centre, Tiruvalla, Kerala, India from June 2015 to June 2018. Patients were grouped depending on the site and size of tympanic membrane perforation and pure tone audiogram (PTA) of each patient was recorded. All the patients underwent type 1 tympanoplasty with temporalis fascia graft by underlay technique. All the patients were followed up for one year and hearing assessment done at 3 month, 6 months and 1 year. The PTA at the end of one year is taken for the assessment. The data obtained were analysed using ANOVA test.

Inclusion criteria

All patients between the age group of 15 to 60 years chronic otitis media mucosal type with perforations which remained dry for minimum three months duration and underwent type 1 tympanoplasty using temporalis fascia graft were selected; both sexes were included.

Exclusion criteria

Exclusion criteria were patients below 15 years and above 60 years; patients with wet ears; immunocompromised patients; patients with sensorineural hearing loss; patients with recurrent and residual perforation; patients in whom ossiculoplasty were done; those patients whose graft did not take up after 1 year follow up.

After taking written informed consent and ethical clearance, a detailed history was taken and otological examination was done under the microscope. Tympanic membrane perforations were classified into small, medium, large and subtotal based on the number of quadrants involved. Location of the central perforation was also denoted by its relationship to the handle of malleus as anterior, posterior, or inferior. Audiological

assessment were done by PTA. PTA average was calculated by taking average of air conduction threshold at 500 Hz, 1 KHz, 2 KHz and 4 KHz. Air bone gap (ABG) was also assessed similarly. In all cases, surgical closure of the perforation was done by type 1 tympanoplasty using temporalis fascia graft by underlay technique. Follow up of the patients were done at 3, 6 and 12 months postop by assessing the graft intake and serial PTA. The results were tabulated and statistically analysed by ANOVA test.

RESULTS

Gender distribution

Out of 120 patients 54 were males (45%) and 66 were females (55%) (Figure 1).

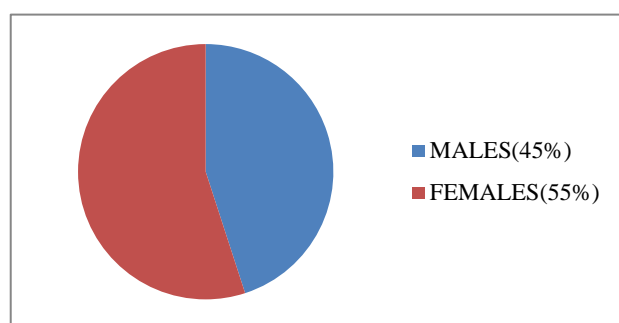


Figure 1: Gender distribution.

Age distribution

The age of the patients ranged from 15 to 60 years with mean age group of 32. The maximum number of patients presented in the age group <30 years (47.5%), followed by patients in the age group of 31 to 50 (42.5%) followed by patients in age group of 51 to 60 (10%) (Figure 2).

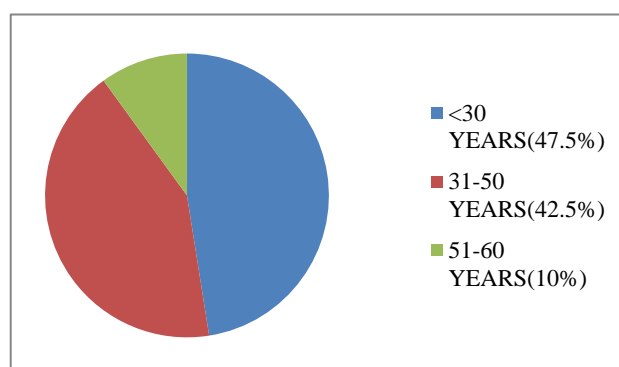


Figure 2: Age distribution.

Side distribution

69 patients underwent type 1 tympanoplasty on right side and 51 patients underwent surgery on the left side (Figure 3).

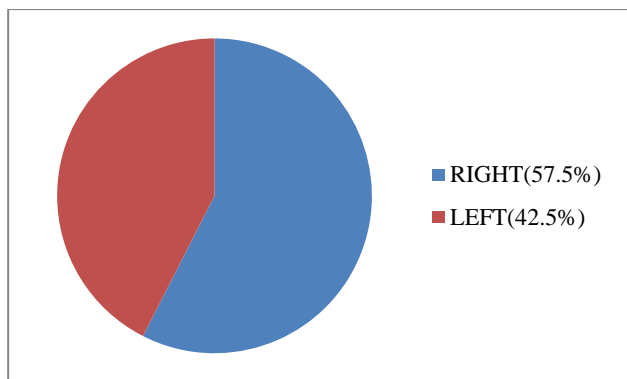


Figure 3: Side distribution.

Site of perforation

63 cases (52.5%) had anterior perforation that is perforation anterior to the handle of malleus. 27 cases (22.5%) had posterior perforation that is perforation posterior to the handle of malleus and 30 cases (25%) had perforation on either sides of handle of malleus (Table 1).

Table 1: Perforation with respect to site.

Site	No. of patients	Percentage (%)
Anterior	63	52.5
Posterior	27	22.5
Both	30	25

Table 3: Mean PTA and air bone gap in relation to site of perforation.

Site	N	Pre-op PTA in dB	Post-op PTA in dB	Pre-op ABG in dB	Post-op ABG in dB
Total	120	32.65	22.75	22.45	13.05
Anterior	63	29.95	20.19	20.04	11.76
Posterior	27	33	23	22.4	14.1
Both	30	38	27.9	27.5	14.8

Table 4: Mean PTA and air bone gap relation to size of perforation.

Size	N	Pre-op PTA in dB	Post-op PTA in dB	Pre-op ABG in dB	Post-op ABG in dB
Small	24	26	14.37	10	8.37
Medium	66	32.63	23.45	24.68	13.95
Large	18	35	23.66	24.83	13
Subtotal	12	42.5	32.5	33.25	17.5

Air bone closure following type 1 tympanoplasty with temporalis fascia was more in perforation involving both anterior and posterior quadrant.

Preoperative PTA average for small, medium, large and subtotal perforations were 26, 32.63, 35, 42.5 decibels respectively and post op average were 14.37, 23.45, 23.66 and 32.5 decibels respectively.

Size of perforation

Out of 120 cases of COM with perforations, 24 cases (20%) had small perforation, in which perforation involved only one quadrant of pars tensa, 66 cases (55%) had medium sized perforation with involvement of two quadrants, 18 cases (15%) had large perforation involving three quadrants and 12 cases (10%) had subtotal perforation involving all the quadrants (Table 2).

Table 2: Perforation with respect to size.

Size	No. of patients	Percentage (%)
Small	24	20
Medium	66	55
Large	18	15
Subtotal	12	10

Preoperative PTA average for patients with anterior, posterior and both anterior & posterior perforations were 29.95, 33, 38 decibels respectively. Postoperative PTA average was 20.19, 23, 27.9 decibels respectively.

Preoperative mean air-bone gap for patients with anterior, posterior perforation and perforation involving both anterior and posterior quadrants were 20.04 dB, 22.4 dB and 14.8 dB respectively. The hearing gain achieved were an ABG of 11.76 dB, 14.1 dB and 14.8 dB for anterior, posterior and both anterior and posterior perforations respectively (Table 3).

Pre-operative mean air-bone gap of patients with small, medium, large and subtotal perforations were 10 dB, 24.68 dB, 24.83 dB, 33.25 dB respectively. The postop ABGs were 8.37 dB, 13.95 dB, 13 dB, 17.5 dB for small, medium, large, subtotal perforations respectively (Table 4).

Air bone closure was more achieved in subtotal perforation followed by large perforations.

Table 5: Statistical analysis by ANOVA test.

Source of variation	SS	df	MS	F*	P value	F crit
Between group	226.804762	2	113.402381	15.5565162	1.0213E-06	3.0737629
Within group	852.895238	117	7.28970289			
Total	1079.7	119				

*F value significant.

Results were analysed statistically with ANOVA test. The F value was found to be significantly higher than Fcrit (Table 5).

DISCUSSION

The middle ear acts as an effective transformer to conduct acoustic energy from the tympanic membrane to the stapes foot plate at the oval window. This is achieved by an intact tympanic membrane, ear ossicles and an air-filled middle ear to shield the round window from the acoustic stimuli to maintain the phase difference between the two windows. The impedance difference between the middle and inner ear is mainly matched by the ratio of the surface area of the tympanic membrane to the stapes footplate and by the lever action of the ossicles and tympanic membrane. In tympanic membrane perforation, the lever action is compromised. In perforation with an intact rim of tympanic membrane, hearing is better preserved than when margins are affected as energy transfer from canal to membrane is via the rim. The degree of loss is proportional to the size of perforation and greater loss in lower frequencies.⁶

COM mucosal type is one of the important cause for hearing loss and recurrent ear infections in developing countries like India. Type 1 tympanoplasty is the surgical choice for this condition. This is a prospective study on the clinical profile of 120 patients with COM mucosal type in a tertiary care centre in South India. The study quantifies the hearing loss in relation to size and site of perforation and the air bone closure achieved following type 1 tympanoplasty with temporalis fascia. In our study, like other studies of Wasson et al, we observed that larger the perforation of the tympanic membrane greater the decibel loss in sound perception which can be attributed to the "Round Window Baffle" effect. Unlike this, a study by Voss et al and Oluwole et al did not observe any significant differences in hearing loss in anterior versus posterior quadrant perforations.^{7,8}

In the present study, patients below 15 and above 60 years excluded. Maximum number of patients was in the age group of below 30 years. Children are considered to be poor candidates for type 1 tympanoplasty as they are more prone to recurrent respiratory infections due to immaturity of immune system and Eustachian tube related problems. Out of 120 cases 54 cases were males and 66 cases were females.

Out of 120 cases, 24 patients had small sized perforation, 66 had medium perforation, 18 patients had large perforation and 12 had subtotal perforation. In a similar

study conducted by Voss, to determine the hearing loss in perforations of tympanic membrane in 62 cases, 48% had small perforations, 40% had medium sized perforations and 12% had subtotal perforations.⁷ Voss stated that the dominant mechanism for hearing loss is the reduction in sound pressure difference across the tympanic membrane. The study stated that reduction in the areal ratio between the tympanic membrane and stapes makes little contribution to the total loss, and direct stimulation of the oval and round windows may limit the loss, but only for perforations greater than 1 to 2 quadrants of tympanic membrane.

Titus et al, in his study on correlation of the site of tympanic membrane perforation with degree of hearing loss using video-otoscopy concluded that in acute tympanic membrane perforations, the site of the perforation and the magnitude of hearing loss was insignificant ($p=0.244$) versus that in chronic perforations ($p=0.047$).⁹ Titus concluded that the posterior perforations were most common in chronic perforations and speculated that there was greater hearing loss due to superimposition of diseases to the middle ear like cholesteatoma.⁹

In the present study, regarding the site of perforation, hearing loss preoperatively was more in perforations involving both anterior and posterior part of tympanic membrane than each site occurring singly. The ABG preoperatively was also more in this group. This was similar to the study by Pannu et al, Nahata et al which also showed that posterior quadrant perforations caused more hearing loss due to loss of round window baffle effect.^{10,11}

Comparing the size of perforation, hearing loss and ABG were more in subtotal perforations followed by large perforations. Nayak et al also observed a similar result in their study.¹²

The gain in hearing and air bone closure were more in patients who had subtotal perforations and in patients with perforation involving both anterior and posterior quadrants. This was followed by large perforations and perforation involving only posterior quadrant. These results were statistically significant by analysis of variance test (ANOVA) with a high f value.

CONCLUSION

Chronic otitis media- mucosal type is more common in young and middle aged population. Unilateral involvement is more common. There is significant

relationship between the site and size of perforation with hearing loss. The difference in mean PTA average and mean ABG between different sizes of perforation were statistically significant. Hearing loss increases with size of perforation. Larger the perforation greater the hearing improvement after the surgery. In relation to the site of perforation, hearing improvement was more with perforations involving both anterior and posterior quadrants.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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