ORIGINAL RESEARCH

Impact of size and the site of the tympanic membrane perforation on hearing loss

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Received: 12March, 2023 Accepted: 18April, 2023

ABSTRACT
Even though the incidence as well as prevalence of CSOM has decreased in recent times it is still a national health problem. Chronic otitis media with perforation is often accompanied by varying degrees of hearing loss which causes significant physical and psychosocial problems. Tubotympanic type of chronic suppurative otitis media is characterized by a perforation of the pars tensa. Tympanic membrane perforations were classified into small, medium, subtotal and total perforations based on the number of quadrants involved, perforations limited to one quadrant were classified as small perforations, involving two quadrants as medium, three quadrants as subtotal and all the four quadrants with intact annulus as total perforations. We were able to find strong relation between duration of ear discharge and degree of hearing loss. The relation between the two was statistically significant also. The longer the duration larger the perforation and more the hearing loss.

Key words: Size and the site, tympanic membrane perforation, hearing loss

INTRODUCTION

Chronic otitis media is a long-standing inflammation of a part or whole of the mucoperiosteal lining of the middle ear cleft which poses serious health issues worldwide especially in developing countries. Even though the incidence as well as prevalence of CSOM has decreased in recent times it is still a national health problem [1]. Chronic otitis media with perforation is often accompanied by varying degrees of hearing loss which causes significant physical and psychosocial problems [2]. Tubotympanic type of chronic suppurative otitis media is characterized by a perforation of the pars tensa. The surface area of an intact tympanic membrane plays an important role in transmitting sound energy to middle ear. It also serves a protection function to the middle ear cleft and shields the round window. This shielding is necessary to create a phase differential so that the sound waves does not impact on both the windows simultaneously. A perforation on the tympanic membrane results in reduced surface area for sound pressure transmission and allows sound to pass directly into the middle ear.

It is a general view that size of tympanic membrane perforation is proportionate to degree of hearing loss [3], larger the perforation, greater the hearing loss. It is also acknowledged fact that the site of perforation and the duration of ear discharge have significant effect on the magnitude of hearing loss. Posterior quadrant perforations are believed to be worse than the anterior ones because of direct exposure of the round window to sound waves. However another group believed that there is no significant effect associated with location of the perforation [4].

METHODOLOGY

The study included 51 patients between 10-60 years of age with Chronic Otitis Media with tympanic membrane perforation who attended the Department of ENT.

STUDY SETTING: It was a hospital based study.

STUDY DESIGN: Cross-sectional prospective study.

SAMPLING TECHNIQUE: Patients with Chronic Otitis Media were selected by random sampling. A sample of 51 cases was selected.

INCLUSION CRITERIA

- Patients above 10 years and below 60 years

irrespective of gender Patients with safe type of CSOM.
- Patients with intact ossicular chain.
- Patients with only conductive hearing loss.

EXCLUSION CRITERIA

1. Age below 10 years and above 60 years of age.
2. Patients not willing for surgery.
3. Patients having sensorineural or mixed hearing loss.
4. Patients with atticoantral disease.
5. Patients with tympanosclerosis.
6. Patients with ossicular chain pathology.
7. Patients with history of long-term intake of systemic ototoxic drugs.

METHOD OF COLLECTION OF DATA

Patients who satisfied the above-mentioned criteria for selection were taken as subjects for the study after taking an informed and written consent. A detailed history of presenting illness, past history and personal history was taken

1. Clinical examination including general physical examination, systemic examination, otological examination, tuning fork tests and examination under the microscope was done.
2. Tympanic membrane perforations were classified into small, medium, subtotal and total perforations based on the number of quadrants involved, perforations limited to one quadrant were classified as small perforations, involving two quadrants as medium, three quadrants as subtotal and all the four quadrants with intact annulus as total perforations.
3. Location of the central perforation was denoted by their relationship to the handle of malleus as anterior, posterior and inferior.
4. Audiological assessment was done by Pure Tone Audiometry. Pure tone average was calculated by taking average of air conduction thresholds at 500Hz, 1kHz, 2kHz and 4kHz.
5. Air bone gap was assessed similarly.
6. Relevant radiological investigations was done.
7. Management by type 1 tympanoplasty (under lay technique) with cortical mastoidectomy was done
8. Follow up of patients was done 3 months post operatively to determine graft uptake and hearing improvement.

RESULTS

Table 1: Mean PTA with respect to side of perforation

Descriptive Statistics				
	L_R	**Mean**	**Std.**	**N**
PTA_Pre			Deviation	
	R	34.2727	8.39037	22
	L	31.6293	10.28145	29
	Total	32.7696	9.51379	51
PTA_Po	R	25.7977	6.63864	22
	L	23.2241	7.16556	29
	Total	24.3343	6.99432	51

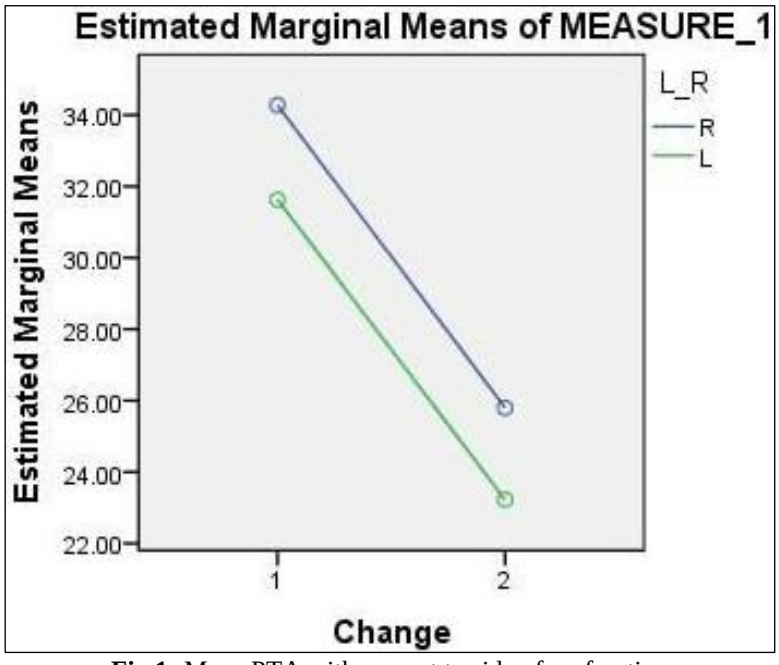

Fig 1: Mean PTA with respect to side of perforation

Table 2: Mean ABG with respect to side of perforation

Descriptive Statistics				
	L_R	**Mean**	**Std. Deviation**	**N**
ABG_Pre	R	25.1932	8.58013	22
	L	22.8448	11.25445	29
	Total	23.8578	10.16025	51
ABG_Po	R	13.8318	6.13554	22
	L	13.2328	6.93977	29
	Total	13.4912	6.54755	51

Table 3: Tests of Within-Subjects Effects

Measure: Measure_1					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Change	2751.437	1	2751.437	77.362	.000
Change * L_R	19.140	1	19.140	.538	.467
Error(Change)	1742.714	49	35.566		

PROFILE PLOTS

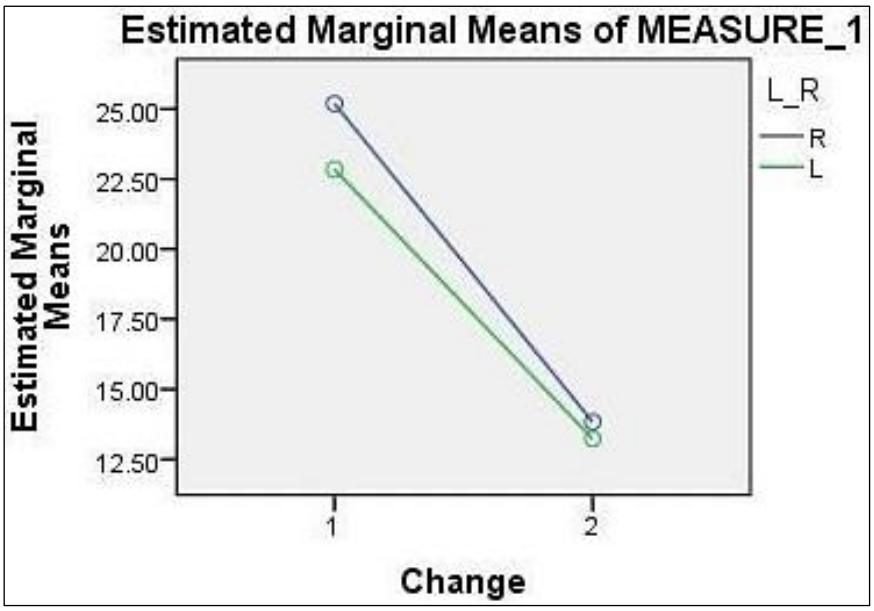

Fig 2: Mean ABG with respect to side of perforation

Table 4: Gender wise comparison with respect to side of perforation L_R * Sex

Crosstab					
			Sex		**Total**
			M	**F**	
L_R	R	Count	11	11	22
		%	34.4%	57.9%	43.1%
	L	Count	21	8	29
		%	65.6%	42.1%	56.9%
Total		Count	32	19	51
		%	100.0%	100.0%	100.0%

Table 5: Comparison of pre and post-operative PTA with site of perforation General Linear Model

Descriptive Statistics				
	Site	**Mean**	**Std. Deviation**	**N**
PTA_Pre	A	29.0714	6.58662	28
	P	27.0833	8.24432	9
	Both	43.8214	5.72816	14
	Total	32.7696	9.51379	51

PTA_Po	A	22.5464	4.94415	28
	P	17.7778	4.62575	9
	Both	32.1250	4.71266	14
	Total	24.3343	6.99432	51

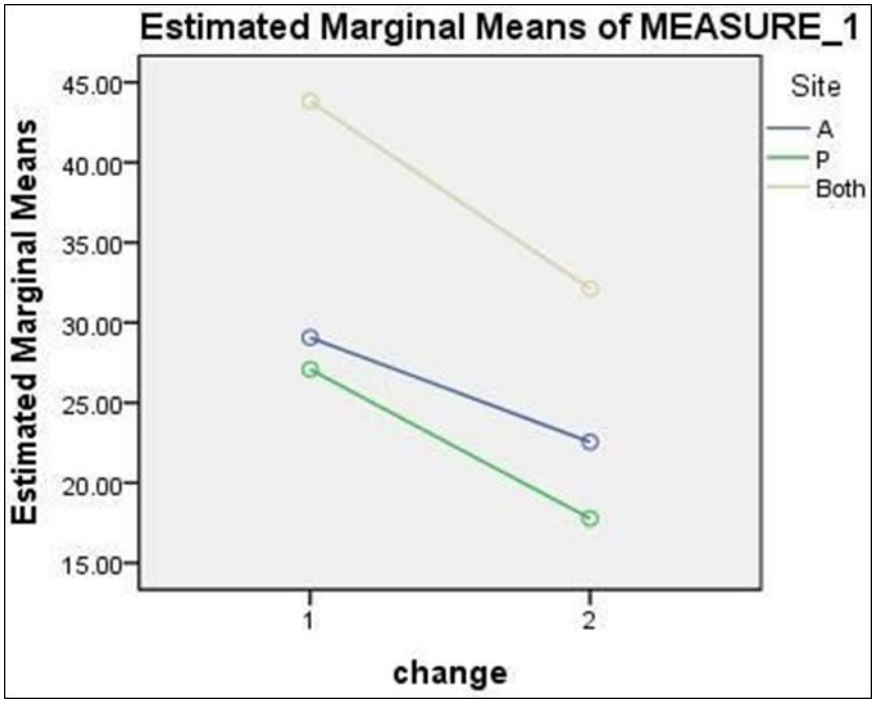

Fig 3: Comparison of preoperative and postoperative PTA with respect to site of perforation

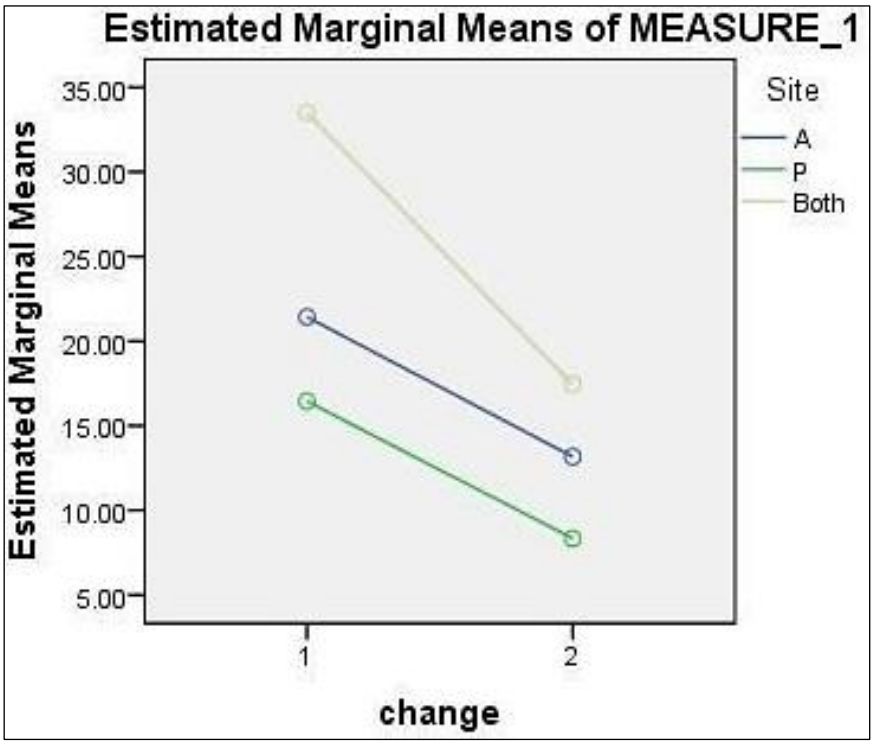

Fig 4: Comparison of preoperative and postoperative ABG with respect to site of perforation

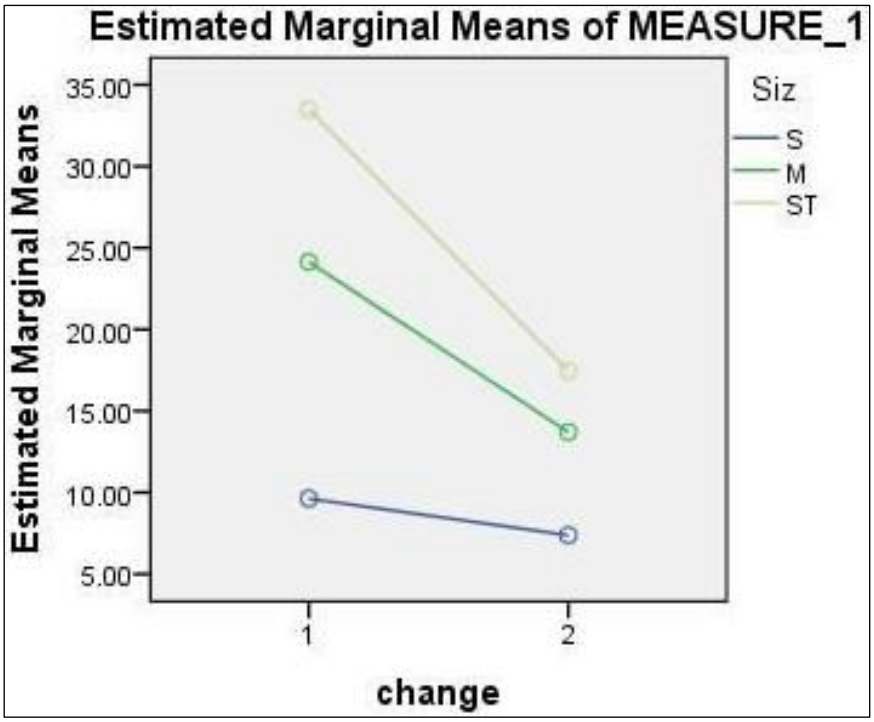

Fig 5: Comparison of preoperative and postoperative ABG with respect to size of perforation

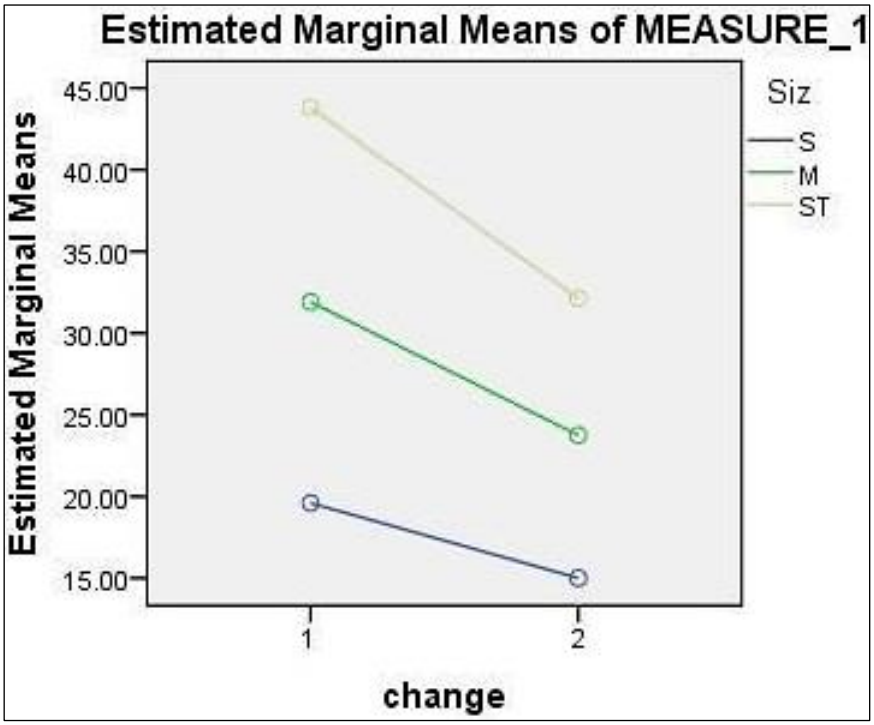

Fig 6: Comparison of preoperative and postoperative PTA with respect to size of perforation

Table 6: Multiple comparison of size of perforation vs. hearing loss

	Hearing loss					
Duration of ear discharge	**Mild**	**Moderate**	**Moderately severe**	**Severe**	**Total**	**P value**
Less than 10 years	14%	20%	3%	2%	38%	
More than 10 years	12%	32%	16%	1%	62%	
Total	26%	52%	19%	3%	100%	0.023

We were able to find strong relation between duration of ear discharge and degree of hearing loss. The relation between the two was statistically significant also.

The longer the duration larger the perforation and more the hearing loss.

DISCUSSION

Out of 51 cases 27 patients had medium sized perforations, 10 had small perforations and 14 had subtotal and total perforations. In a similar study conducted by Mehta RP to determine the hearing loss in perforation of tympanic membrane in 62 cases, 48.3% had small perforations, 40% had medium sized perforations and 11.29% had subtotal perforations. Voss stated that the dominant loss mechanism is the reduction in sound pressure difference across the tympanic membrane. The study stated that reduction in the area ratio between the TM and the 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 the TM. Voss S further carried out studies on non-ossicular signal transmission in the human ear. Direct acoustic stimulation of the cochlea by sound pressure difference between the oval and round windows (called the acoustic route) has been thought to contribute to hearing loss [5, 6]. This has been cited by many authors as an explanation for the greater hearing loss seen in posterior quadrant involvement. Voss study aim was to determine the efficacy of this acoustic route in tympanic membrane perforations. Results of this cadaveric study showed that sound pressure from ear canal to the middle ear depends on the perforation size but not on the location Titus S. in his study on correlation of the site of tympanic membrane perforation with the 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).Titus concluded that the posterior superior 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 cholestaetoma[7, 8].

In our study, patients with small perforation had shown average hearing loss of 19.6dB. In the study 1 (by Kumar *et al*.), 1-14 mm2 size perforation had shown average hearing loss of 28.23 dB [5]. In our study, medium sized perforations had shown average hearing loss of 31.9 dB. In the study 1 (by Kumar *et al*.), 15-27 mm2 perforations had shown average hearing loss of 32.42 dB. In our study, subtotal and total perforations had shown average hearing loss of 53.27 dB and 52.3dB respectively.

In the study 1 (by Kumar *et al*.), 28-41 mm2 size perforations had shown average hearing loss of 36.26 dB.. The study 2 (by Nepal *et al*.) has not measured the size of perforation microscopically, so its results could not be compared with our study [2].

All patients underwent relevant blood and radiological investigations. All patients underwent cortical mastoidectomy with type 1 tympanoplasty underlay technique under general anaesthesia. Patients were followed up for a duration of 3 months.

Repeating a Pure tone Audiometry at the end of 3 months assessed hearing improvement.

In our study pure tone average preoperatively for small, medium, subtotal and total perforations was 19.6, 31.9, 53.27 and 52.3 respectively. Mean air bone gap preoperatively for small, medium, subtotal and total perforations was 9.625, 24.13, 31.56 and 45 respectively. The difference in hearing loss between different sizes of perforation was statistically significant. The mean pure tone average post operatively was 15, 23.75, 31.54 and 35.62 for small, medium, subtotal and total perforations respectively. Mean air bone gap post operatively was 7.38, 13.70, 17.9 and 14.37 for small, medium, subtotal and total perforations respectively. While calculating the mean PTA threshold preoperatively and postoperatively we were able to find that the hearing improvement after surgery was statistically significant. In relation with size, average hearing improvement was found more with larger perforations, after the surgical treatment as preoperative average hearing loss was also more in those cases. This was in accordance to Mawson 9who stated that the impairment of auditory function will also depend upon the position of perforation. Similarly study by Walter *et al*. and Thorburn10 showed that the hearing loss is more when the perforation is in the vicinity of postero inferior quadrant. This was due to the loss of sound protection of the round window.

In relation with site of perforation average hearing improvement was found more with posterior perforations as preoperative average hearing loss was also more in those cases. Out of the 51 patients only one patient had excellent hearing outcome with 0-10dB postoperatively while 11 patients had good hearing results with 10-20dB improvement. Majority of the patients (25) had fair hearing improvement 20-30dBand the rest of them had poor outcome with more than 30dB postoperatively.

Duration of the ear discharge was also taken into account. Patients were divided into two groups, those who had symptoms for less than ten years and those who had for more than 10 years. The relation between duration of ear discharge and degree of hearing loss was found to be significant similar to studies by Sakagami*et al*. [11]. The longer the duration larger the perforation and more the hearing loss. Out of 51 patients 35 had symptoms more than 10 years.

The conductive hearing loss resulting from tympanic membrane perforation is frequency dependent with the largest losses occurring at lower frequencies. Similar results were observed in studies carried out by Voss SE *et al*. [12] and Ahmed SW *et al*. [4].

CONCLUSION

- In our study we observed that there is significant relationship between size and site of tympanic membrane perforation with hearing loss, greater

the size more was the average hearing loss and found same relation with site i.e. perforation involving all four quadrants were having more average hearing loss. In our study mean pure tone average for small, medium, subtotal and total perforations was 19.6dB, 31.9dB, 53.27dB and 52.37dB.

- Out of the 51 patients only one patient had excellent hearing out ome with 0-10dB postoperatively while 11 patients had good hearing results with 10-20dB improvement. Majority of the patients (25) had fair hearing improvement 20-30dB, and the rest of them had poor outcome with more than 30dB postoperatively.
- Small perforations have better hearing outcome followed by medium and then by subtotal and total perforations.

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