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Original Research Article

A study of the hearing status in the contralateral healthy ear of patients with chronic otitis media following mastoidectomy surgery in a tertiary care hospital, Kerala, India

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ABSTRACT

Background: Bone drilling and suction during surgeries, exposes cochleae to noise of markedly high levels, temporal bone vibrations to high speeds of drill bits. Variations in burr type and drilling duration can determine extent of noise generated. These may affect cochlea and hearing status of a patient. This study tries to identify hearing loss if any, in the apparently healthy contralateral ear and, the effect of various drill parameters on hearing status in patients with chronic otitis media following mastoidectomy surgery.
Methods: Study done using proforma, clinical examination data from operation theatre during surgery and audiology department. Pure Tone Audiometry of apparently healthy contralateral and diseased ears in patients done before surgery, within 24 hrs and 72 hrs after surgery.
Results: Out of 161 patients ,12 patients (7.45%) developed hearing loss post operatively. The mean duration of drilling with cutting burr in the 12 patients with hearing loss was 28 minutes 20 seconds (SD: 1.72) and for diamond burr was 25 minutes and 26 seconds (SD: 2.06). Among the patients with hearing loss, four had multiple frequencies affected (33.3%). There was a statistically significant relation in type of drills used in surgery and hearing loss ($p<0.001$). In 10 Out of 12 patients, the hearing loss post-surgery, (83.3%) reverted to normal within 72 hrs.
Conclusions: A positive correlation exists between, transient sensorineural hearing loss that develops post-surgery with the various type of drills used for surgery, which reverted to pre-operative hearing levels within 3 days.

Keywords: High frequency, Drill, Sensory-neural hearing loss, Mastoidectomy

INTRODUCTION

Sensorineural hearing loss (SNHL) results from lesions of either the cochlea, cranial nerve VIII or the central auditory pathways. It may be either congenital (present at the time of birth) or acquired (start later in life). Exposure to high levels of noise for variable time durations is a well-known factor for the development of sensorineural hearing loss in people.[1] One such scenario where the ear is exposed to noise levels of 90 to >100 decibels is at the time of drilling during mastoidectomy surgery; leading to hearing loss which results from temporal bone vibrations. Majority of the hearing loss which develops as a result of powered instruments is a temporary threshold shift.[2] Patients in whom the contralateral ear is the only hearing ear, the noise production during drilling, predisposing factors and vibration may influence the techniques and precautions to be adopted while treating the patient. Pure tone Audiometry is a subjective audiometry test which can be used for the measurement of hearing acuity by using pure tones (Single frequency sound) to estimate the air conduction and bone conduction thresholds for

various frequencies. This gives a rough estimate of the degree of hearing impairment an individual has. Mastoidectomy surgeries nowadays play a very important role in treatment of chronic otitis media. Drilling with various drill burrs forms an important aspect of these type of surgeries.

Objectives of the study

To strike an association between post-operative hearing loss in the apparently healthy contralateral ear with the type of burrs and duration of their use in drilling. To determine the nature of hearing loss by establishing whether it is temporary or permanent. To assess the threshold recovery time after surgery using pure tone audiograms.

METHODS

Thorough history was taken using proforma, clinical examination done and data was collected from operation theatre during the surgery and audiology department. Outcome measurement was done with Pure Tone Audiometry evaluation of apparently healthy contralateral and diseased ears in patients with chronic otitis media before surgery and within 24 hrs and 72 hrs after surgery. Data collected and then tabulated and analyzed.

Study design

The study design was prospective study.

Study duration

The study was conducted for 18 months (December 2018- June 2020).

Study setting

The study was conducted at ENT department, Audiology Department, Operation theatre, Amala Institute of Medical Sciences, Kerala, India.

Study population

A total of 161 in patients with chronic otitis media of the age group 10 -50 years who underwent mastoidectomy surgery attending ENT department, during the study period. Patients had an apparently healthy contralateral ear with near normal or minimal hearing loss.

Inclusion criteria

Patients with chronic otitis media. Age group: 10- 50 years. Contralateral healthy ear.

Exclusion criteria

An underlying ear disorder in the contralateral ear. Unwillingness to participate in the study. History of Meniere's disease. Patients of age below 10 years and above 50 years.

Sample size

$N = (Z1-\alpha/2)2pq/ d2$

$\alpha = 0.05$ (1.96)

p = incidence of hearing loss in the previous study (37.5% upto 72 hours after surgery in study by Domenech et al9).

$q = 1- p$

d = Relative precision (20 % of p)

Sample size found to be 160.

Sampling method

The sampling method was consecutive sampling.

Ethical consideration

The study was conducted according to the Helsinki declaration, 1975 as revised in 2000 procedure and was approved by Institutional Research Committee and Ethical Committee. Informed consent was taken from each subject. Detailed subject information was provided to the subjects to read before taking consent. There are no risks involved in the study. Confidentiality of the subjects were maintained.

RESULTS

From the study conducted in 161 patients, 62% were males and 38% females. (Figure 1). 12 out of 161 patients (7.45%) developed hearing loss post-operatively. (Table 1)

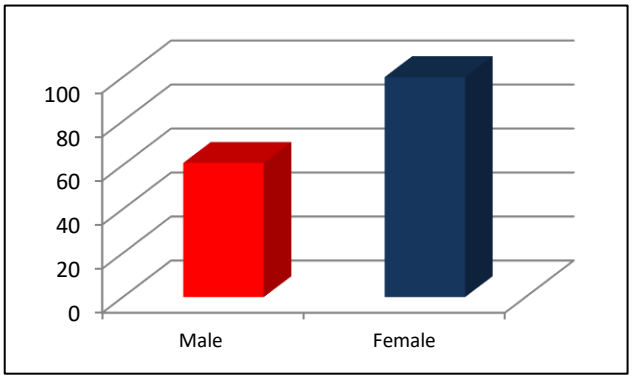

Figure 1: Gender distribution.

Mean age of the study population was 36.47 years.

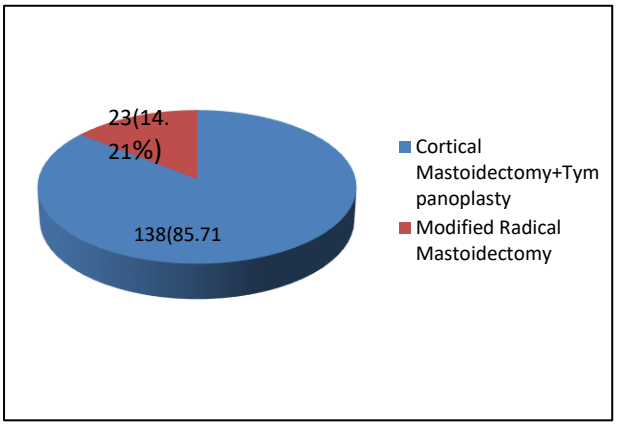

Figure 2: Number of surgical procedures.

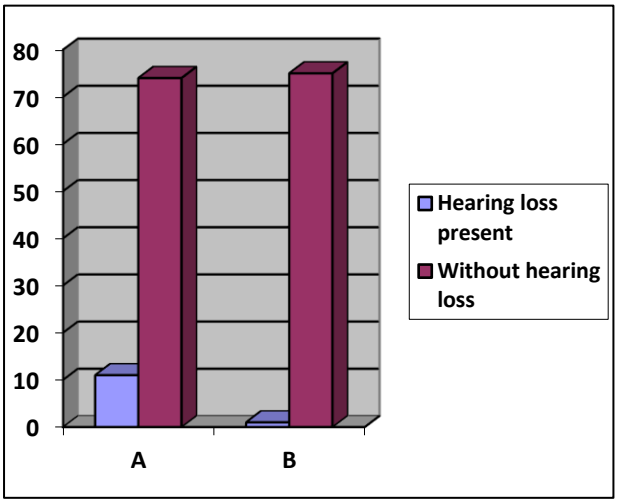

Figure 3: Number of patients and their hearing status for various durations of drilling.

Most commonly done surgery among the population was cortical mastoidectomy with tympanoplasty (138 out of 161 patients: 85.71%). (Figure 2).

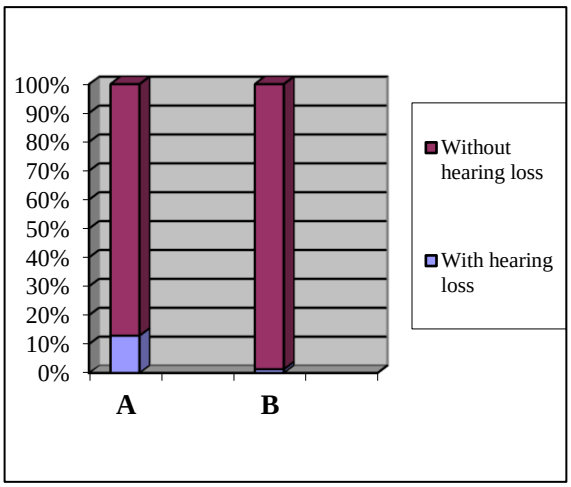

Figure 4: Percentage of patients and their hearing status for various durations of drilling.

The mean duration of drilling in 161 patients with cutting and diamond burr together was 44 minutes 16 seconds (SD:1.78).

The mean duration of drilling with cutting burr in the 12 patients who developed hearing loss was 28 minutes 20 seconds (SD:1.72) and in the remaining 149 patients who did not develop hearing loss, was 22 minutes and 49 seconds (SD: 2.80); while the mean duration of drilling with diamond burr in these 12 patients with hearing loss was 25 minutes 26 seconds (SD: 2.06) and in the remaining 149 patients, was 20 minutes and 31 seconds (SD: 2.96). (Table 1).

Table 1: Hearing status with different burrs.

Type of burr used	Hearing loss	N	Time		P value (Students t test)
			Mean	Std. Deviation	
Cutting burr	No	149	22.4978	2.80378	0.0001
	Yes	12	27.805	1.7200	
Diamond burr	No	149	19.9134	2.96558	0.0001
	Yes	12	25.2667	2.06307	

Table 2: Number of patients with hearing loss in various frequencies.

Frequencies affected	Hearing loss		Total	P value (Chi square test
	No	Yes		
0	149	0	149	
0.5 kHz	0	1	1	
0.5, 1 and 2 kHz	0	1	1	0.001
0.5 kHz and 8 kHz	0	1	1	
1 kHz	0	2	2	

Continued.

Frequencies affected	Hearing loss		Total	P value
2, 4 and 8 kHz	0	1	1	
4 kHz	0	1	1	
4 and 8 kHz	0	3	3	
8 kHz	0	2	2	
Total	149	12	161	

Table 3: Hearing status in various frequencies in the pre-op period and 24 hrs. post -surgery.

	Hearing loss	N	Mean	Std. Deviation	P value (students t test)
Pre-op 0.5 kHz	No	149	28.52	9.975	0.088
	Yes	12	33.75	12.271	
Pre-op 1 kHz	No	149	25.47	8.144	0.419
	Yes	12	27.50	10.766	
Pre-op 2 kHz	No	149	26.88	10.242	0.374
	Yes	12	24.17	8.747	
Pre-op 4 kHz	No	149	29.40	13.581	0.874
	Yes	12	28.75	12.636	
Pre-op 8 kHz	No	149	35.54	14.144	0.266
	Yes	12	30.83	12.762	
24 hrs 0.5 kHz (post-op)	No	149	28.52	10.093	0.039
	Yes	12	35.00	13.652	
24 hrs1 kHz	No	149	24.43	8.373	0.310
	Yes	12	27.08	12.147	
24 hrs 2 kHz	No	149	25.60	10.032	0.445
	Yes	12	23.33	7.785	
24 hrs 4 kHz	No	149	30.37	14.071	0.835
	Yes	12	31.25	14.001	
24 hrs 8 kHz	No	149	39.33	15.052	0.216
	Yes	12	33.75	13.672	

Table 4: Hearing status in various frequencies in 72 hrs. Post- surgery.

Post-op 72 hrs, 0.5 kHz	No	149	28.42	9.934	0.109
	Yes	12	33.33	12.673	
Post-op 72 hrs 1 kHz	No	149	24.33	8.213	0.450
	Yes	12	26.25	11.307	
Post-op 72 hrs 2 kHz	No	149	25.27	10.064	0.351
	Yes	12	22.50	6.571	
Post-op 72 hrs 4 kHz	No	149	28.79	13.652	0.911
	Yes	12	28.33	12.851	
Post-op 72 hrs 8 kHz	No	149	35.37	14.274	0.208
	Yes	12	30.00	12.247	

The number of cases which had duration of drilling more than the mean drilling duration time, was 85 (52.79%), of which 11 cases had developed hearing loss post-surgery (12.94%). In 74 cases (87.06%) with drilling time more than the mean drilling duration, there was no hearing loss post-surgery. The number of cases which had duration of drilling less than the mean drilling duration time was 76 (47.21%), of which only 1 case had hearing loss post-surgery (1.31%). There was no hearing loss in 75 cases (98.69%). (Figure 3).

It was noticed that hearing loss at higher frequencies (4 kHz and 8 kHz together) occurred in 4 patients and the duration of drilling with cutting burr in these patients were found to be 2 to 5 minutes more than that with diamond burr. There was one patient each with hearing loss for 0.5 kHz and 4 kHz alone involved. (8.3% each). Two patients had hearing loss with 1 kHz and 8 kHz alone involved. (16.66%). (Table 2).

In the study, out of 12 patients with hearing loss: 7 patients (58.33%) developed hearing loss in the higher frequency (4 kHz or 8 kHz) – supporting a noise-induced hearing loss pattern lasting upto 24 hours post-surgery.

It is seen that there is a statistically significant relation in the type and duration of drills used in surgery ($p<0.001$). (Table 3).

However no statistically significant hearing loss was present 72 hours following operation in the study population. (p values for 0.5 kHz, 1 kHz, 4 kHz and 8 kHz being: 0.109, 0.45, 0.35, 0.91 and 0.20 respectively). (Table 4)

Out of the 12 patients who developed hearing loss post-surgery, 10 patients (83.33%) had their hearing loss reverted back to normal within 72 hours itself.

DISCUSSION

Results of this study revealed that a positive correlation exists between the transient sensorineural hearing loss that develops post surgery with the various type of drills being used for the surgery which reverts back to pre-operative hearing levels usually within 3 days. The results of this study is consistent with that of study conducted by Baradaranfar et al, which was a prospective study in 28 consecutive patients with chronic otitis media who had undergone tympanomastoidectomy using PTA and DPOAE in all contralateral ears before and 6 hours, 24 hours, 48 hours, 72 hours and 96 hours after the surgery.[3] According to the PTA, mean hearing recovery times were 61.98±26.76 h (3000 Hz),62.73±26.50 h (4000 Hz),67.08±25.90 h (6000 Hz),70.70±24.13 h (8000 Hz).The study showed that following mastoid surgeries there was a hearing loss at high frequency which was transient and reversible within or after 72 hours. In another prospective study carried out by Goyal et al in 2008 on 30 patients with unilateral cholesteatoma and normal contralateral hearing ear, statistical association was higher for cutting burrs compared to diamond burrs in OAE.[4] In the prospective study by Souvik on 44 patients with unilateral chronic otitis media squamosal disease during 2013 using PTA and OAE, it was concluded that there was a post-operative sensorineural hearing loss due to noise and heat generation, drilling close to an intact ossicular chain and vibration of temporal bones.[5] Study by Tos et al in 2303 ear surgeries between 1965 to 1980 showed sensorineural hearing loss of 1.2 % in ipsilateral ear.[6] The incidence of hearing loss was found to be lower with better drill techniques developed in later periods of the study. In a prospective study by Migirov et al in 2008 in 13 mastoidectomy and 5 tympanoplasty patients comparing DPOAE recordings immediately after surgery at 2 and 4 kHz showed a significant decrease in DPOAE and the recovery process had begun within 24 hours and continued for 4 weeks.[7] Study by Flottorp in 228 patients during 1954 to 1961 showed that frequency level of 2000 Hz was sensitive for acoustic trauma which he attributed to poorly developed stria vascularis and poorer blood supply of Organ of Corti at the base.[8] In a study done by Domenech et al in 1988 on 24 patients with audiometer, it was found that there was a measurable hearing loss in the upper limits of audible higher frequencies.[9] Each patient had hearing loss involving multiple frequencies, but higher frequency involvement was seen in most patients. The study conducted by Cruz et al in 12 patients who underwent temporal bone surgery through intraoperative DPOAE recordings demonstrated a temporary OHC dysfunction in the non-operated ear.[10] In study done by Urquhart et al in 1991 in 40 patients who underwent cortical or modified radical mastoidectomy comparing pre- and post-operative bone conduction audiograms showed that there was no evidence of TTS after 24 hours of surgery at any frequencies and any sensorineural hearing loss can be attributed to other causes like labyrinthine or ossicular trauma rather than noise-induced.[11] In a study by Ho-Ki Lee et al in 10 mastoidectomy patients with a mean exposure time of 41 minutes, it was found that cutting burr produced louder sounds (73 to 83 dB) compared to the diamond burrs (69 to 76 dB) when used for the same duration.[12]

This has emphasized on use of better drill techniques for improving the outcomes and reducing hearing loss if any, which can occur in the opposite healthy ear. These can be achieved by the following measures: for drilling, water irrigation should be used, diamond burr to be used adequately rather than drilling with cutting burrs for long durations, appropriate size burr, adequate speed of drilling, sufficient care to be observed while drilling close to the oval window and ossicular chain, surgeon should attain sufficient expertise on cadaver dissection, adequate antibiotic coverage which can prevent bacterial toxins from inducing adverse effects and hearing impairments, PTA can be used to assess the hearing status of a patient post-operatively, thereby helping the surgeon assess and adopt better techniques for surgery with regard to drill duration and type of drill bits, use of Ultrasonic devices for powered transcanal endoscopic ear surgery.

Limitations of this study

This single centre study was conducted on limited number of patients during a short period. Therefore, a multicentre study on a large number of patents is warranted.

CONCLUSION

This study shows, a positive correlation does exist between the transient sensorineural hearing loss that develops post-surgery with the various type of drills used for surgery. Even type of drill and duration can influence the sensory neural component which were found to revert to pre-operative hearing levels usually within 3 days. But these shortcomings in drilling techniques can be overcome by observing measures as described. Thereby,

improving work experience, outcome of the surgery as well as gaining trust of the patients.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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