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A PROSPECTIVE STUDY OF SENSORINEURAL HEARING LOSS FOLLOWING MIDDLE EAR SURGERIES.

ENT

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ABSTRACT

Introduction: Middle ear surgeries are done mainly to correct the conductive hearing loss, however, some of these surgeries may end up with sensorineural hearing loss which is undesirable. Hence, this study was undertaken to determine the incidence and prognosis for sensorineural hearing loss in patients following middle ear surgeries.

Materials and Methods: 153 patients who underwent middle ear surgeries were selected for the study after excluding patients who were undergoing middle ear surgeries for intracranial complications of middle ear disease and conditions which could cause progressive sensorineural hearing loss. The patients were assessed with pre and post operative pure tone audiometry up to 2 months.

Results: We found that out of 153 ears, 143(93.465%) had no post operative sensorineural hearing loss while 10 (6.535%) had suffered hearing loss at the end of 2 months for the high frequency (4KHz). Majority of the patients who suffered hearing loss were of cortical mastoidectomy with tympanoplasty (70%), tympanoplasty (20%) and modified radical mastoidectomy (10%) respectively.

Conclusion: In this study, it was found that incidence of development of sensorineural hearing loss after middle ear surgeries in the immediate post operative period is high, but has tendency to recover spontaneously.

KEYWORDS

sensorineural hearing loss, middle ear surgeries, bone conduction, audiometry.

INTRODUCTION:

Mild sensorineural hearing loss following middle ear surgery has been an important complication in relation to middle ear surgery. Despite of the better treatment options, advances in surgical technique, operative instruments, monitoring devices, mild sensorineural hearing loss still persists[1]. Lack of proper knowledge about this problem is because of the less reporting of exact magnitude of hearing loss on account of difficulty in measuring hearing threshold of patients in immediate postoperative periods. Various studies have shown sensorineural hearing loss as a consequence of middle ear surgical procedures[2,3,4,5].

The incidence of sensorineural hearing loss was found highest in patients with congenital malformations of middle ear, granulating otitis media, cholesteatoma, mastoidectomies especially canal wall down procedure. In view of the hearing loss, certain precautions were advocated such as disarticulation of incudo stapedial joint before clearing the attic, malleus should be handled along the direction of its handle and careful removal of granulations around the stapes footplate[2].

Hence, this study was done to assess the incidence, prognosis, possible causes and preventive measures of sensorineural hearing loss following middle ear surgeries. There are studies which mention various insults to cochlea during middle ear surgeries[6]. Whereas other studies mentioned that sensorineural hearing loss post-surgery is not significant at all. In view of these contradictions, further study was required on this subject.

MATERIALS AND METHODS:

All patients who underwent middle ear surgeries in the department of otorhinolaryngology were selected for the study. A total of 153 patients were selected for participation in the study. Exclusion criteria included patients who were undergoing middle ear surgeries for intracranial complications of the middle ear disease and any condition which could causes progressive sensorineural hearing loss such as Age – 50 years and above, Meniere's disease, Professionals working in noisy environment, Hypothyroidism, Diabetes, Multiple sclerosis, Hypertension, Leukemia, polycythemia and other hyper viscosity conditions, Acoustic neuroma and patients on ototoxic drugs.

The patients were assessed with pre and post operative pure tone audiometry up to 2 months. Data obtained were analysed using mean , standard deviation, chi square test for comparing more than two proportions.

RESULTS:

In the present study, 7 ears (5%) were in the age group range of 0 to 10 years, 52 ears (34%) were in 11 to 20 years, 57 ears (37%) were in 21 to 30years, 20 ears (13%) were in 31 to 40 years and 17 ears (11%) were in age group of 41 to 50 years respectively. 70 ears (46%) were of males and 83 (54%) were of females. The demographic data has been represented in Figure 1.

In our study, there were 50 tympanoplasty procedures (33%), 78 cortical mastoidectomy with tympanoplasty procedures (51%) and 25 modified radical mastoidectomy procedures (16%) as shown in figure 2. All patients were evaluated by pure tone audiometry both pre-operatively and post-operatively at post operative day 2, day 7, 1 month and 2 months respectively. We considered increase in bone conduction threshold post operatively of more than 10 dB from the pre operative value as a significant hearing loss. On post operative evaluation, we found that there was no considerable change in bone conduction threshold in lower frequencies (500, 1 KHz , 2 Khz).

For Higher Frequency (4 KHz and above) In **tympanoplasty,** out of 50 ears; on post operative day 2 there were 9(18%) with sensorineural hearing loss which showed an improvement to 5(10%), 2(4%) and 2(4%) over day 7,1 month and 2 month respectively. Thus, at 2 months only 2 out of 50 operated patients for tympanoplasty had persistent hearing loss(figure 3). Thus, using chi square test for comparing more than two proportions it was found that there is no significant changes in bone conduction threshold changes for tympanoplasty over follow up days.

In **cortical mastoidectomy with tympanoplasty** out of 78 ears; at post operative day 2 there were 48(62%) with sensorineural hearing loss which showed an improvement to 42(54%),12(15%) and 7(9%) over the day 7,1 month and 2 month respectively. Thus, 7 ears out of 78 operated ears of cortical mastoidectomy with tympanoplasty had a persistent hearing loss. Thus, using chi square test for comparing more than two proportions it was found that there is significant bone conduction threshold change for the cortical mastoidectomy with tympanoplasty procedure over the post operative period.

In **modified radical mastoidectomy** out of 25 ears; there were 19(76%) with sensorineural hearing loss which showed an improvement to 12(48%), 2 (8%) and 1 (4%) over day 7, 1 month and 2 month respectively. Thus, at 2 months only 1 ear out of 25 operated ears of modified radical mastoidectomy had a persistent hearing loss. Thus, using chi square test for comparing more than two proportions it was found that there is significant bone conduction threshold change for the modified radical mastoidectomy procedure over the post operative period.

By using chi square test, we found that there is no significant difference in the bone conduction threshold change caused by various surgical procedures by 2 months period (Figure 4)

Bone conduction threshold changes and their relation to middle ear surgical procedures

In this study, we have observed hearing loss in decibels for lower frequency, ie, 500Hz,1KHz, 2KHz taken together and compared with pre operative and post operative values. Similar observation was also noted for high frequency, i.e. 4 KHz and comparison was done between pre operative and post operative values. The observations are as shown in Figures 5,6,7. The data shows that, the change in bone conduction threshold at lower frequencies became insignificant by post operative day 7 (P value >0.01) whereas in the higher frequency the bone conduction threshold change became insignificant by post operative day 7 in tympanoplasty procedures and by 2 months in modified radical mastoidectomy procedures. However, in cortical mastoidectomy with tympanoplasty the change in bone conduction threshold remained significant even at 2 months post operative follow up (P value < .00001).

In our study, relationship between hearing loss and different surgical procedures was studied and results were compared to each other and are shown in figure 8. On comparison, we found that there was no significant hearing loss after 2 months of post operative surgery, irrespective of, type of middle ear surgical procedure.

DISCUSSION:

The study was conducted over 153 patients, who were divided into 3 groups based on surgical procedure underwent i.e. tympanoplasty, cortical mastoidectomy, modified radical mastoidectomy. Out of 153 ears, 50 underwent tympanoplasty, 78 underwent cortical mastoidectomy with tympanoplasty and 25 underwent modified cortical mastoidectomy.

We found that out of 153 ears, 143(93.465%) had no post operative sensorineural hearing loss while 10 (6.535%) had suffered hearing loss at the end of 2 months for the high frequency (4KHz). Majority of the patients who suffered hearing loss were of cortical mastoidectomy with tympanoplasty (70%), tympanoplasty(20%) and modified radical mastoidectomy (10%) respectively.

A study done in Royal Victoria Hospital, Belfast, Northern Ireland ,a series of 3000 consecutive operations of tympanoplasty were reviewed in regard to the occurrence of sensorineural hearing loss .Worsening of bone conduction thresholds by 10 dB through the frequencies 500 to 4000 cps, or a 10% reduction in speech discrimination scores were considered significant. In trans canal tympanoplasty, the incidence of cochlear damage was greater in ears when initially the ossicular chain was incomplete, by contrast in combined approach tympanoplasty the risk was greater when the chain was intact initially. It was concluded that cochlear trauma was usually due to 1) the hydraulic effect of excessive stapes manipulation during the removal of disease, and 2) the development of a perilymph fistula[2].In our study, we too considered a change of 10dB or more in bone conduction threshold as significant. Our study supported the above study results.

Another study done in University of Oulu, Finland, a series of 1,680 chronic ear operations high-tone hearing losses occurred in 75 cases (4.5%). The majority of losses (57%) were limited to the frequency range of 4,000 to 8,000 Hz, and only six (0.3%) involved the most important area of speech frequencies. Some recovery occurred in all ears during the first three postoperative months. Certain surgical precautions were advocated, such as disarticulation of the incus before cleaning of the attic, dissection of the malleus in the direction of its handle, and conservative removal of granulations around the stapes[3]. Our study also showed bone conduction hearing loss in the higher frequency.

A study done in Hillel Jaffe Memorial Hospital, Hadera, Israel, the bone conduction threshold changes of 97 patients (100 ears) who underwent mastoid surgery were determined. Three types of mastoid surgery were evaluated: Radical mastoidectomy, modified radical mastoidectomy, and intact wall atticomastoidectomy. The difference between the average three speech frequency preoperative bone conduction thresholds of the radical mastoidectomy group differed significantly when compared to the modified radical mastoidectomy or intact wall atticomastoidectomy group.[4]

Another study done in Gentofte University Hospital in Hellerup, Denmark. Sensorineural hearing loss occurred in a total of 1.2% of cases: 0.5% became totally deaf, and 0.7% acquired a high tone loss, most often at 4 kHz only. The incidence was highest in congenital malformations, granulating otitis and cholesteatoma, mastoidectomy, especially canal-down. The most common causes of anacusis were removal of cholesteatoma from the semicircular canal and removal of the fistula membrane. Different types of severe high tone loss were described and, in addition, 19 patients with mild high tone loss were discussed.[5.]

A study done in Baroda medical college, Baroda 80 patients who had undergone middle ear surgery were analysed for postoperative sensorineural hearing loss. 36 patients had no postoperative sensorineural hearing loss (45%), while 44 patients (55%) had suffered mild sensorineural hearing loss which was quite significant. Majority of the patients who suffered from hearing loss were those undergoing mastoidectomy (72%) compared to those undergoing plain tympanoplasty (38%).[1] Our study supported the above findings.

Helms stated that inner ear hearing loss caused by middle surgery is a rare post-operative finding.[7]

Palva and Sorri, reported that they found SNHL on the contralateral side during first week post-operatively and concluded that it increased with increased duration of surgery.[8] Our study did not show any change in postoperative bone conduction thresholds on the contralateral side.

Schick et al, conducted a retrospective analysis of temporary sensory hearing deficits after ear surgeries. In this study, thresholds at 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz were analysed in 393 patients before, the first 4 days and 3 weeks after ear surgery to evaluate possible temporary threshold shifts. They came to the conclusion that temporary threshold shifts could be observed at 2000 Hz and 4000 Hz after ear surgery. Use of the drill and manipulation at the ossicular chain usually results in no significant sensory hearing deficit.[9]Our study also showed bone conduction threshold shifts in higher frequencies.

Spencer et al, conducted a study on postoperative pure tone audiometry after 48 hours, on patients who underwent mastoid surgeries. No evidence of a bone conduction threshold shift was detected in any of the patients.[10] In contrast our study, there was sensorineural hearing loss postoperatively.

The short process of incus is most susceptible to trauma from burr. Helms measured the amplitude of the stapes footplate movement when the ossicular chain was drilled with a cutting or a diamond burr[11]. On contact with the burr the footplate was found moving at a speed corresponding to a noise atleast of 130 dB. It was concluded that burr trauma to the ossicular chain was a high risk to the inner ear.

Experimental studies in guinea pigs via scanning electron microscopic study have shown that drilling noise causes a severe loss of sensory cells in the cochlea.[12]

Paksoy et al, in their study state that drill induced sensorineural hearing loss is one of the causes of hearing loss.[13]

Alharbi et al, in their study state that one should avoid touching ossicular chain during ear surgery as a high focused acoustic energy is transmitted to inner ear causing damage in structure and deterioration of function. Spontaneous recovery could occur after acoustic trauma but may be incomplete with permanent scar formation in outer haircells14. Our study supported the above findings.

Vallter et al, conducted a study on inner ear depression after middle ear interventions. They concluded that the risk for sensorineural hearing loss caused by middle ear surgery is low15. Our study results are in contradiction with the above study.

Migrov et al, conducted a study to determine possible changes in the outer hair cell (OHC) function related to drill noise exposure[16]. Drill-induced noise during mastoidectomy can cause reversible changes in DPOAE in the non-operated ear. OHC function may be diminished during the period after mastoid surgery and last >1 month. Their study suggested that drilling on the ossicular chain can produce vibratory force that is analogous with noise levels known to produce acoustic trauma. For the same type of burr, the larger the diameter, the greater the vibratory force, and for the same size of burr, the cutting burr creates more vibratory force than the diamond burr. The cutting burr

produces greater high frequency than lower-frequency vibratory energy[16].

The pre and postoperative bone conduction thresholds for the frequencies 0.25 through 16 kHz were compared in 46 ear, high-speed ear drill was used. There was no statistically significant postoperative threshold change found at any single frequency in either the operated or the contralateral ear.[17]

Sixty two patients who had undergone different mastoid operations , the average drilling time during surgery was 45 minutes. Sound pressure levels did not exceed 84 dB in the operated ear and 82 dB in the contralateral ear. Though some sensorineural hearing loss was found in the operated ear in fourteen patients, no changes in hearing were found in the contralateral ear. It was suggested that there is no damage exclusively due to the drill noise during mastoid surgery.[18]

Desai et al, state that the incidence of mild sensory hearing loss after middle ear surgery in immediate postoperative period is quite high and may go undetected and has tendency to recover spontaneously.[19]The cause of hearing loss can be attributed to trauma due to noise and vibration produced by drills and suction irrigation. Our study supports the above observation.

Figure1: Showing age and gender demographics of the patients.

Age group	Number of patients	Percentage	Sex	No. of patients	Percentage
0 to 10	7	4.575	Female	83	54
11 to 20	52	33.986	Male	70	46
21 to 30	57	37.255			
31 to 40	20	13.072			
41 to 50	17	11.112			
	153	100			

Figure 2: Showing types of middle ear surgeries studied.

Type of surgery	Number of ears	Percentage
Tympanoplasty	50	33
Cortical Mastoidectomy	78	51
Modified Radical Mastoidectomy	25	16

Figure 3: Showing number of patients having hearing loss post-operatively.

Surgery	Total Patients	Persistent Hearing Loss till POD 2	Persistent Hearing Loss till POD 7	Persistent Hearing Loss till 1 month	Persistent Hearing Loss till 2 month
Tympanoplasty	50	24	16	9	2
Cortical Mastoidectomy	78	64	57	38	7
Modified radical Mastoidectomy	25	22	18	12	1

Figure 4: Statistical analysis using chi square test for hearing loss at end of 2 months.

Surgery	Not recovered	Recovered	Chi Square test
Tympanoplasty	2	48	X^2 =1.549 P value=0.461
Cortical mastoidectomy	7	71	
Modified radical mastoidectomy	1	24	

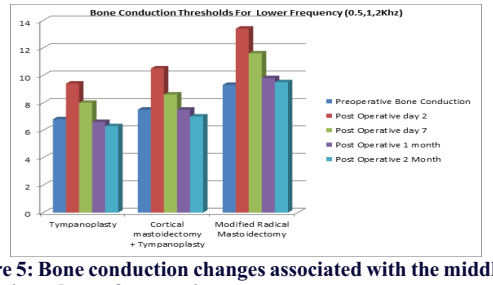


Figure 5: Bone conduction changes associated with the middle ear surgeries at lower frequencies.

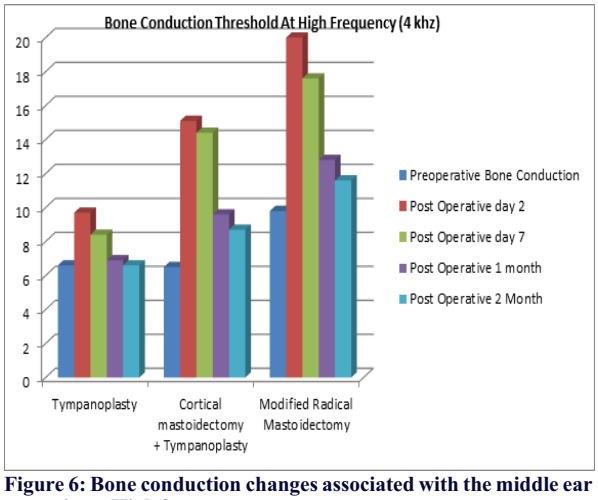


Figure 6: Bone conduction changes associated with the middle ear surgeries at High frequency.

Figure 7: Data showing results of hearing loss at different frequencies and post operative days with statistical significance.

Time Duration	Surgical procedure Frequency	Tympanoplasty			Cortical Mastoidectomy With Tympanoplasty			Modified Radical Mastoidectomy		
		Mean (dB)	SD	P Value	Mean (dB)	SD	P Value	Mean (dB)	SD	P Value
Pre Operative	Low Frequency	6.8	5.4	-	7.5	5.5	-	9.3	5.1	-
	High Frequency	6.6	6.8	-	6.5	6.3	-	9.8	6.2	-
Post operative day - 2	Low Frequency	9.4	6.6	< .00001	10.5	6.6	< .00001	13.4	6.6	< .00001
	High Frequency	9.7	8.0	0.0001	15.1	8.3	< .00001	20.0	8.4	< .00001
Post operative Day - 7	Low Frequency	8.0	6.3	0.0008	8.6	5.7	< .00001	11.6	5.8	0.0001
	High Frequency	8.4	8.4	0.0165	14.4	8.9	< .00001	17.6	9.1	0.00001
Post Operative Day - 1 Month	Low Frequency	6.6	5.6	0.445	7.5	5.5	0.363	9.8	4.8	0.672
	High Frequency	6.9	7.0	0.582	9.6	7.6	< .00001	12.8	8.0	< .002
Post operative Day - 2 month	Low Frequency	6.3	5/5	0.028	7.0	5.5	0.141	9.5	4.8	0.203
	High Frequency	6.6	7.1	1	8.7	7.5	< .00001	11.6	8.1	<0.03

Figure 8: Statistical analysis comparing the different types of middle ear surgeries.

Surgical procedure	No of patients			**Statistical result(Fischer exact test) P value**
	Recovered	Not recovered	Total	
Tympanoplasty	48	2	50	**0.4809**
Cortical mastoidectomy	71	7	78	
Surgical procedure	No of patients			**Statistical result(Fischer exact test) P value**
	Recovered	Not recovered	Total	
Tympanoplasty	48	2	50	**1**
Modified Radical Mastoidectomy	24	1	25	

Surgical procedure	No of patients			Statistical result(Fischer exact test) P value
	Recovered	Not recovered	Total	
Cortical Mastoidectomy	71	7	78	**0.6759**
Modified Radical mastoidectomy	24	1	25	

CONCLUSION:

- The incidence of development of sensorineural hearing loss after middle ear surgery in the immediate post operative period was found to be high, but had the tendency to recover spontaneously.
- The development of sensorineural hearing loss is seen more for mastoidectomy procedures (cortical mastoidectomy and modified radical mastoidectomy) than tympanoplasty, the cause being attributable to noise trauma due to the drilling.
- The sensorineural hearing loss was found for the higher frequency, 4 Khz.
- Contrary to the opinion that the presence of a radical cavity leads to a deterioration in the bone conduction threshold, our results indicated that, on an average no significant changes in bone conduction thresholds were found following mastoid surgery with cortical mastoidectomy or modified radical mastoidectomy.
- Studies have shown recoveries from noise induced hearing loss following middle ear surgeries, up to one year post operative period. Hence, we recommend longer follow up period for better assessment.

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