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Original Research Article

A study of occurrence of postoperative sensorineural hearing loss after middle ear surgeries

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ABSTRACT

Background: Chronic otitis media is the most common middle ear disease that is encountered in our hospital. There are various surgical procedures that are performed in cases of COM and other similar conditions of the middle ear. Any type of otosurgical procedure involves the risk of inner ear damage. As middle ear surgery is also performed for functional reasons this risk should be taken into consideration. There have been some studies mentioning many insults to the cochlea during middle ear surgeries. Some studies claim that sensorineural hearing loss post-surgery is not significant at all. In view of these contradictory studies, further study is essential on this subject.
Methods: All patients undergoing middle ear surgeries are subjected to pure tone audiometry pre-operatively and tenth day, one month and three months postoperatively. Hearing assessment done with pure tone audiometer. The hearing threshold for pure tone audiometer was determined in a sound treated room at frequencies ranging from 125-8000 Hz for air conduction and 250-4000 Hz for bone conduction.
Results: Sensorineural hearing loss was not found in any of the patients postoperatively on 10th day 1st month and 3rd month.
Conclusions: There was no significant variation between preoperative and postoperative bone conduction levels. Therefore middle ear surgeries have not resulted in any SNHL. Duration of ear discharge, duration of surgery, type of surgery had no bearing on postoperative sensory neural hearing levels.

Keywords: Sensorineural hearing loss, Bone conduction, Middle ear surgeries, Audiometry

INTRODUCTION

Surgery of the ear is a fascinating, yet challenging field in otorhinolaryngology. Chronic otitis media is the most common middle ear disease that is encountered in our hospital. There are various surgical procedures that are performed in cases of COM and other similar conditions of the middle ear.

A thorough knowledge of the post-operative complications and pitfalls is indispensable for the surgeon, not only to provide the best possible care to his patients, but also to further improve his surgical outcomes.

Any type of otosurgical procedure involves the risk of inner ear damage. As middle ear surgery is also performed for functional reasons this risk should be taken into consideration.

The purpose of this study is for the assessment of sensorineural hearing loss after middle ear surgeries like tympanoplasty, mastoidectomy and tympanoplasty with mastoidectomy. There have been some studies mentioning many insults to the cochlea during middle ear

surgeries.[1] Some studies claim that sensorineural hearing loss post-surgery is not significant at all. In view of these contradictory studies, further study is essential on this subject.

METHODS

All patients undergoing middle ear surgeries in Navodaya Medical College**,** Raichur who comply with inclusion and exclusion criteria, during the period of November 2014 to August 2016.

Inclusion criteria were patients with age more than 11 years and less than 50 years and all middle ear surgery patients operated in the Department of ENT Navodaya Medical College Hospital And Research Centre, Raichur.

Exclusion criteria were patients younger than age 11 to eliminate the possibility of inaccuracies of audiological testing in children, patients older than 50 years of age were excluded because of the increased incidence of presbyacusis in this age group. Patients with history of familial hearing loss, prolonged exposure to noise, head trauma and patients with otosclerosis.

A total of 100 patients who presented to department of ENT, Navodaya Medical College Hospital and Research Centre were subjected to the study.

A thorough clinical history was taken for duration of otorrhoea, frequency of otorrhoea, hearing loss, duration and nature of previous treatment.

All cases were subjected to detailed examination which included general physical examination, careful examination of ear, nose and throat. Otoscopic, otomicroscopic examination and tuning fork tests were performed.

All patients undergoing middle ear surgeries are subjected to pure tone audiometry pre-operatively and tenth day, one month and three months post-operatively. Hearing assessment done with Arphi pure tone audiometer.

The hearing threshold for pure tone audiometer was determined in a sound treated room at frequencies ranging from 125-8000 Hz for air conduction and 250-4000 Hz for bone conduction.

Data was analysed using SPSS software.

RESULTS

All patients are divided age wise into four groups. Children between the age group of 11 -20 years is 32% and in the age group of 21-30 years 37% which is the highest in all age groups, 31-40 years is 11% and 40-50 years is 20% (Figure 1).

Patients between the age group of 11-30 years comprise almost 70% of the patients. Thus showing the maximum prevalence percentage of 37% from 21-30 years of age. Followed by 11-20 years with 32%.

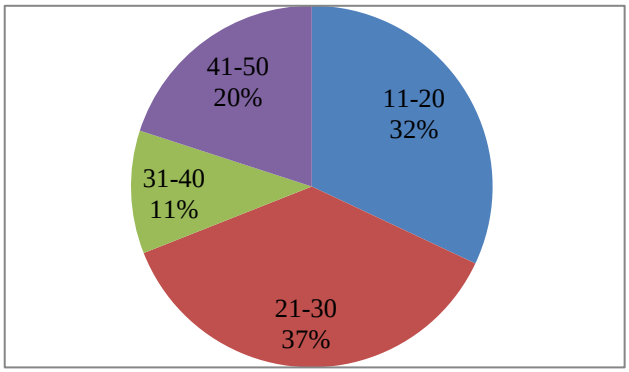

Figure 1: Age group distribution.

Patients are divided into two groups based on gender distribution. Patients are more in the female group (66%) than in the male group (34%) (Figure 2).

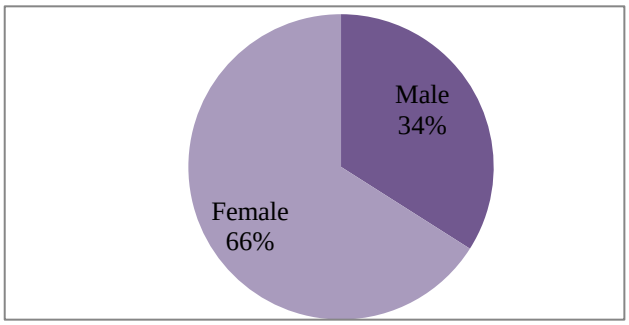

Figure 2: Gender distribution.

Based on duration of symptoms at the time of presentation patients are divided into three groups. Those presenting 0-2 years 30%, 2-5 years 23%, and >5 years 47% (Figure 3).

Majority of our patients had ear discharge more than 5 years. No significant difference was noted in post operative SNHL pertaining to duration of ear discharge.

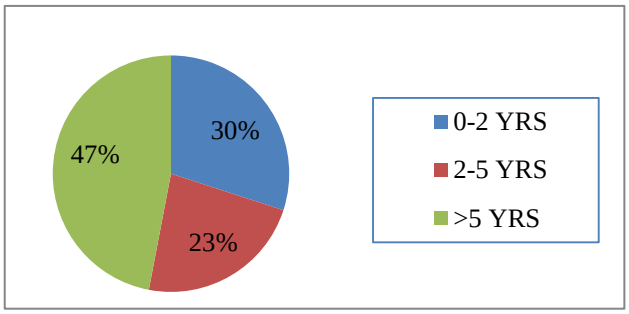

Figure 3: Distribution of study subjects according to duration of symptoms.

Based on duration of time of surgery patients are divided into 5 groups, patients whose surgery was done in 1 hour were 18%, 1.5 hours were 28%, 2 hours were 33% 2.5 hours were 18%, and 3 hours were 3%. Majority of the cases were done in 1.5- 2 hours (Figure 4).

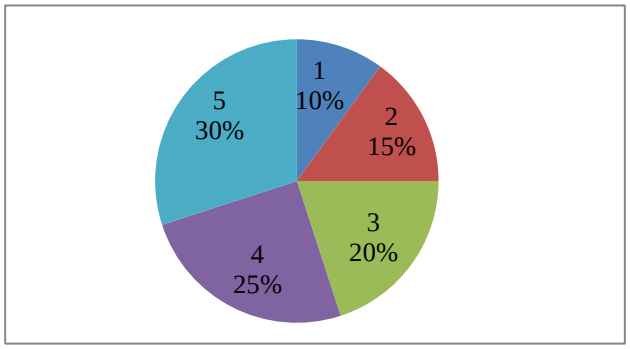

Figure 4: Distribution of study subjects according to duration of surgery.

Most of our patients underwent endoscopic and microscopic tympanoplasty 78%.

17% of the patients underwent modified radical mastoidectomy (MRM) and 5% of the patients underwent cortical mastoidectomy (Figure 5).

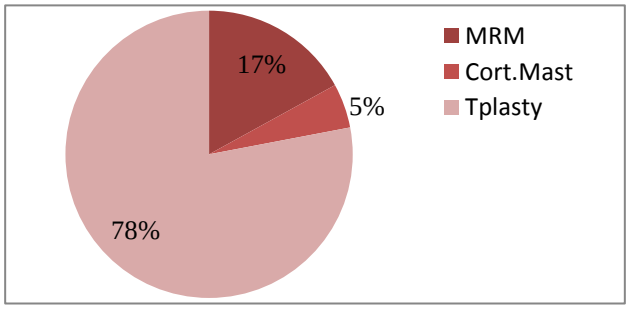

Figure 5: Distribution of study subjects according to type of surgical procedure.

The present study was conducted on 100 patients.17 cases of MRM, 5 cases of cortical mastoidectomy, and 78 cases of tympanoplasty were included in the study.

The paired-samples T test procedure is used to test the hypothesis of no difference between two variables. The data may consist of two measurements taken on the same subject or one measurement taken on a matched pair of subjects. In this study paired-samples T test procedure is used to test the significant difference between the pre-operative and postoperative bone conduction audiometry values taken on the same patient. Here p value is the probability of t- statistics. The basic idea is simple. If the treatment had no effect, the average difference between the measurements is equal to 0 and the null hypothesis holds good. On the other hand, if the treatment did have an effect (intended or unintended!), the average difference is not 0 and the null hypothesis is rejected.

Mean of bone conduction audiometry at 10 days postoperatively is slightly higher than that of the preoperative values at 0.5 kHz, 1 kHz, 2 kHz and 4 kHz.

Mean bone conduction audiometry results at 1 month post operatively are also slightly higher than the pre-operative values at 0.5 kHz, 1 kHz, 2 kHz and 4 kHz.

Mean bone conduction values at 3 months post operatively is equal to preoperative values at 0.25 kHz and slightly higher at 0.5 kHz and 2 kHz and slightly lower at 1 kHz and 4 kHz. Since the p value between the mean of preoperative and postoperative values is more than 0.05, all the changes seen in the postoperative period are not statistically significant.

Sensorineural hearing loss was not found in any of the patients postoperatively on 10th day 1st month and 3rd month (Table 1).

Table 1: Statistical analysis.

	Preoperative PTA		Postoperative at 10th day				Postoperative at 1st month				Postoperative PTA at 3rd month			
	Mean	SD	Mean	SD	T value	P value	Mean	SD	T value	P value	Mean	SD	T value	P value
0.25	13.35	6.67	13.2	8.18	0.25	0.8	13.32	8.18	0.28	0.77	13.6	8.53	0.43	0.66
0.5	14.7	8.61	14.8	8.57	1.74	0.08	14.9	8.85	1.64	0.1	14.95	8.98	1.68	0.09
1	14.35	8.55	14.6	8.67	1.91	0.06	14.4	8.6	0.57	0.56	14.2	8.52	1	0.31
2	14.3	9.02	14.6	9.01	1.34	0.18	14.4	9.03	1	0.31	14.7	9.29	2.6	0.01
4	13.55	8.83	14.2	8.25	1.09	0.27	14.45	8.1	1.59	0.11	13.2	8.12	0.57	0.56

DISCUSSION

In a study by Hagewald et al, patients undergoing mastoidectomy were tested for SNHL within 48hrs and at 30hrs post–operatively.[5]

All our patients were in the age group 11-50 years. Similar age group was selected by Yadav et al.[6] In this age group there is less chance of false results in subjective audiometry and presbyacusis.

Prevalence of CSOM in children in south India is 28 % according to Biswas et al.[2] Our study is also having almost same prevalence in 11-20 yrs. Group.

Urquhart et al, studied 40 patients of mastoid surgeries and postoperative ear surgeries and found relation between duration of ear discharge and post op sensorineural hearing loss.[2] no such correlation was observed in our study.

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

Tos et al, reported that in 50 patients of acoustic neuroma who underwent translabyrinthine tumour removal, no sensorineural hearing loss was noted. The patients underwent audiometric tests pre-operatively and at 30 postoperative day.[8] Our patients underwent three types of surgeries i.e., modified radical mastoidectomy, cortical mastoidectomy and endoscopic tympanoplasty and no sensorineural hearing loss was noted.

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.[9] Our study did not show any statistically significant correlation between preoperative and postoperative bone conduction thresholds, factors such as duration of surgery did not appear to influence the final outcome.

Schick et al, conducted a retrospective analysis of temporary sensory hearing deficits after ear surgery. 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 concluded that slight 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.[10] Our study did not show any temporary or permanent shift.

Biswas et al, concluded that sensory neural hearing loss after mastoid surgery is not due to noise generated by the drill. In the event of any hearing loss during this period, other causes should be sought.[2]

Holmquist et al, presented a simple technique for measuring sound intensities during surgery. They stressed that drill-generated noise must be regarded as a risk to the cochlea during ear surgery.[11] They suggested that real sound levels in the air close to the drill were not appreciably higher than the equivalent noise levels reaching the cochlea through the skull by bone conduction.

Spencer et al, conducted a study on 5 patients who underwent mastoidectomy. Postoperative pure tone audiometry was carried out on each patient 48 hours after surgery. No evidence of a bone conduction threshold shift was detected in any of the patients in either the operated or the contralateral ear.[12] In our study also there was no significant hearing loss postoperatively.

Exposure to high levels of noise is known to be harmful to the ear. Cochlear injury may be sustained acutely from sudden-impact noise or may develop gradually over time if noise is prolonged over time.

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 and a diamond burr.[6] He was able to show that this set the footplate moving at a speed corresponding to a noise of at least 130 dB. It was assumed that burr trauma to the ossicular chain was a high risk to the inner ear.

Paparella, in an experiment on cats showed that placing a 4mm cutting burr against the body of incus resulted in injury to the organ of Corti, whereas 0.5 mm cutting burr directly on the long process of incus failed to produce cochlear injury.[13]

Sensorineural hearing loss following middle ear surgery has been shown to occur in 1.2% to 4.5% of patients. It is not known how many of these losses were due to noise trauma to the cochlea. Schuknecht and Tonndorf assumed that the acoustic intensities generated by the burr were at safe levels.[14]

Kylen et al, stated that drill induced noise during ear surgery may result in postoperative high-tone sensory neural hearing loss.[15] They supported the view that manipulation of the ossicular chain may result in a predominantly lower-frequency threshold shift.

Domanech et al, conducted a study to demonstrate sensorineural high frequency hearing loss after drill generated acoustic trauma in tympanoplasty.[16] 24 patients with normal bone conduction audiometric thresholds scheduled for tympanoplasty were assessed with an electro-stimulation, bone conduction high-frequency audiometer which can measure hearing frequencies up to 20 kHz before and after surgery. It was concluded that drilling of the temporal bone could impair the hearing level in the high frequencies in a significant number of patients.[16]

It was suggested in these studies that drill generated noise transmitted via the bone, and not via the ossicles, in some cases might be responsible for the high-tone loss, especially since the frequency of 4000 Hz was involved in all cases. Experimental studies in guinea pigs have shown that drilling noise causes a severe loss of sensory cells in the cochlea.[17]

Kylen et al, measured a noise level of 100 dB in the ipsilateral cochlea and of 90-95 dB on the contralateral

side; the authors concluded that bone conducted noise trauma might in some cases be responsible for the high-tone loss.[18] Direct drilling on the middle ear ossicles results in sensorineural hearing loss. Helms demonstrated experimentally that drilling on the ossicles sets the footplate moving at a speed corresponding to a damaging noise of at least 130 dB.[7] Whether or not drill-generated noise in mastoidectomy may result in a high-tone loss in the ipsilateral ear is still a controversial issue. In large clinical series, sensorineural hearing loss following middle ear surgery has been demonstrated in 1.2% to 4. 5% of patients.[9,17,18] The noise level was highest using large burrs and it was higher with cutting than with diamond burrs. The noise level was lowest, about 70-80 dB, using a 2 mm diamond burr. Variations in rotation speed and site of drilling did not appear to influence the noise level.

Singh et al, studied the inherent risk of inner ear damage with middle ear surgeries in 60 patients. Bone conduction thresholds in different frequencies were recorded by a pure-tone audiometer both pre-operatively and post-operatively. The over-all results showed one case (1.67%) with significant or severe SNHL of more than 25 dB and ten cases (16.66%) with mild to moderate SNHL including three cases of temporary threshold shift. In majority of the cases (11.67%) 2000 and 4000 frequencies were involved.[19]

Paksoy et al, in their study state that drill induced sensorineural hearing loss is one of the causes of hearing loss.[20]

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 haircells.[21]

Vallter et al, conducted a study on inner ear depression after middle ear interventions. A total of 3989 middle ear cases operated on between 1991 and February 1999 at the Department of Otorhinolaryngology, Head and Neck Surgery, University of Warzburg, Germany were studied retrospectively. The pre- and postoperative audiograms in the frequency range between 500 and 8000Hz were analysed and correlated to the different intra operative findings. They concluded that the risk for sensorineural hearing loss caused by middle ear surgery is low.[22] None of the analysed factors seemed to be a relevant prognostic risk factor for postoperative inner ear depression.

Huttenbrink conducted a prospective study to study the reaction of the cochlea after the trauma of middle ear surgery.[1] For this purpose the bone conduction of fifty patients was tested every day, beginning on the first post-operative day. To collect the information on possible damaging mechanisms, three surgical techniques were studied: Stapes surgery with the opening of inner ear; mastoidectomy with drill-generated noise; tympanoplasty with manipulation at the stapes. He concluded that excessive drilling may result in a temporary threshold shift, which has already resolved at the time of unpacking the ear and no signs of hydraulic damage after manipulation of the stapes could be discovered.

Migrov et al, conducted a study to determine possible changes in the outer hair cell (OHC) function related to drill noise exposure.[23] 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. Five fresh cadaveric temporal bones were used. Stapes displacement was measured using laser doppler vibrometry during short drilling episodes. Diamond and cutting burrs of different diameters were used. The effect of the drilling on stapes footplate displacement was compared with that generated by an acoustic signal. The equivalent noise level (dB sound pressure level equivalent [SPL eq]) was thus calculated. This study suggests that drilling on the ossicular chain can produce vibratory force that is analogous with noise levels known to produce acoustic trauma.[23] 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.

Measurements on temporal bones performed by Schuknecht and Tondorff showed noise levels of 50-60 dB and it was concluded that bone-conducted noise is of no importance for the development of high-tone loss in patients, whereas air-conducted noise may be dangerous for the surgeon! Performing drilling experiments on temporal bones in intact skulls.[14]

Tos et al, conducted a study on 50 patients for undergoing translabyrinthine acoustic surgery for acoustic neuroma. No case of sensory neural hearing impairment could be demonstrated postoperatively.[25] The distance to the contralateral cochlea is considerably larger than to the ipsilateral cochlea and the large cutting burrs are used for only a short period for resection of cortical bone at the start of the mastoidectomy, but the total effective drilling time of 1.5 hours is considerably longer than for a conservative radical operation. After all, there is a limit to how long even an inexperienced surgeon can use a large cutting burr at a conservative radical operation.

Spencer et al, conducted a study on 5 patients who underwent mastoidectomy. Postoperative pure tone audiometry was carried out on each patient 48 hours after surgery. No evidence of a bone conduction threshold shift was detected in any of the patients in either the operated or the contralateral ear. So they concluded that a noise induced hearing-loss following mastoid surgery is an

unlikely event especially if the burrs employed are sharp and the drill performance satisfactory.[12]

The pre and postoperative bone conduction thresholds for the frequencies 0.25 through 16 kHz were compared in 46 ears in which a high-speed ear drill was used. In 15 of these, thresholds were also obtained in the contralateral ear. There was no statistically significant postoperative threshold change at any single frequency in either the operated or the contralateral ear.[27]

Sixty two patients who had undergone different mastoid operations served as the basis for this study. 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 is suggested that there is no damage exclusively due to the drill noise during mastoid surgery.[28]

Twenty two patients requiring mastoid surgery in their diseased ears, having contralateral normal ear were included. Pure tone audiometry and otoacoustic emissions (OAEs) were utilized for baseline evaluation. OAEs were repeated during the immediate postoperative period and daily up to the 6th postoperative day. The amplitudes of the OAEs of contralateral normal ears were found affected immediately after surgery and progressive improvement was detected with full recovery at 72–96 hours. None of the patients had permanent deterioration in OAE amplitudes. The burs used during mastoid surgery can cause temporary hearing threshold changes in the contralateral ears. This adverse effect recovers spontaneously within 72–96 hours postoperatively.[29]

Smyth et al, set criteria as 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.[3] In our study, one of our patients had postoperative BCA variations more than 10 dB.[4]

Spencer investigated a group of twenty-four ears and the noise levels generated by the suction tube are measured at operation by means of a probe microphone lowered into the external auditory meatus The conclusions reached are that, although the sound levels attained are at times quite high, they are not of sufficient amplitude, nor are they present for a sufficient length of time, to produce a sensorineural hearing loss.[12]

Desai et al, state that the incidence of mild sensory hearing OSS after middle ear surgery in immediate post-operative period is quite high and may go undetected and has tendency to recover spontaneously.[29] The cause of hearing loss can be attributed to trauma due to noise and vibration produced by drills and suction irrigation.

Parkin et al, studied variables including diamond burrs, cutting burrs, two different air drills (Hall and Stryker), an electric drill (Emesco), and drilling with and without suction irrigation. The results show that the single factor contributing the highest noise level is suction irrigation.[30] In our patients suction is used in all surgeries and drill is used in MRM and cortical mastoidectomy, but no significant SNHL is observed.

Jang et al, stated that even though the peak intensity of the suctioning noise may reach a level of more than 90 dB, it is not likely that the suctioning noise during the ventilation tube placement procedure causes noise-induced sensorineural hearing loss.[31] In our study we have used suction in all cases but no SNHL was observed.

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