

Effect of Middle Ear Surgery on Sensorineural Hearing: A Prospective Study of 150 Cases

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ABSTRACT

Introduction: Chronic otitis media (COM) is one of the most common middle ear diseases for which a patient visits an otolaryngologist. Depending on the type and extent of the disease, various surgical procedures are performed in cases of COM. There is a wide spectrum of postoperative complications that are known to happen after middle-ear surgery, sensorineural hearing loss (SNHL) being one of them. SNHL following middle-ear surgery is an important yet underreported complication and may be caused by acoustic trauma due to drilling and suction or due to manipulation of ossicles. Many contradictory studies have been published to date. With the help of this study, we tried to evaluate SNHL as a complication of middle ear surgeries in our set-up.

Materials and methods: A prospective study including 150 patients was conducted for 2 years. Three types of middle ear surgeries were included in the study: tympanoplasty, cortical mastoidectomy, and modified radical mastoidectomy. Pure tone audiometry (PTA) was performed on each patient preoperatively and seventh day and at 3 months postoperatively. The values obtained underwent statistical analysis to obtain *p*-value. *p*-value < 0.05 was considered statistically significant.

Result: No postoperative SNHL was found and the difference between the preoperative bone conduction threshold values and postoperative values were not found to be statistically significant.

Conclusion: From the above study we conclude that though the drilling and suction produce a significant level of noise, there is no statistically significant shift in the bone conduction threshold values.

Keywords: Middle ear surgeries, Pure tone audiometry, Sensorineural hearing loss.

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INTRODUCTION

Chronic otitis media (COM) is one of the most common middle ear diseases for which a patient visits an otolaryngologist. The diagnosis of COM implies a permanent abnormality of the pars tensa or pars flaccida, most likely a result of earlier acute otitis media, negative middle ear pressure, or otitis media with effusion. Depending on the type and extent of the disease, various surgical procedures are performed in cases of COM. These procedures include tympanoplasty, cortical mastoidectomy, and modified radical mastoidectomy.

There is a wide spectrum of postoperative complications that are known to happen after a middle-ear surgery. Thorough knowledge of the postoperative complications is indispensable for an ENT surgeon, not only to provide the best possible care to his patients but also to further improve his surgical outcomes. Sensorineural hearing loss (SNHL) following middle-ear surgery is an important yet under-reported complication.

Exposure to a high noise level is a well-known factor causing a reduction in auditory acuity and this shift of hearing threshold may be temporary or permanent. Both bone drilling and suction are very essential in ear surgery to achieve adequate exposure, but they produce a significant level of noise. During drilling the exposed cochlea is subjected to noise levels of more than 90 dB, while the contralateral cochlea to ≥ 80 –85 dB.^{1–3} Variables, such as rotation speed of burr, type of burr, size of burr, and site of drilling have been investigated in isolated temporal bones, cadavers, and animal models and their effects have also been studied on postoperative SNHL. Other than the acoustic trauma caused by drills and suction, SNHL can also occur due to the manipulation of ossicles.

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Several studies have mentioned that many insults to the cochlea during middle ear surgeries can produce a postoperative SNHL⁴ whereas some claim that SNHL following surgery is not at all significant. Given these contradictory studies, we conducted the present study to determine the incidence of SNHL following middle-ear surgery in our set-up.

MATERIALS AND METHODS

A prospective study including 150 patients was conducted for 2 years from May 2017 to May 2019 at our tertiary health care center.

Inclusion criteria were patients undergoing middle ear surgery for COM with ages more than 10 years and less than 50 years.

Children younger than 10 years of age were excluded to reduce inaccurate audiological results. Patients older than 55 years of age were excluded as presbycusis has been accounted to affect the population sixth decade onwards. Patients with a history of

familial hearing loss, prolonged exposure to noise, head trauma, otosclerosis, and those who had undergone middle ear surgery previously were also excluded.

A detailed clinical history was taken to determine the duration and frequency of otorrhea and hearing loss. A thorough general, as well as otorhinolaryngological examination, was carried out. The affected ear was examined using an otoscope, followed by an examination under a microscope. All the patients underwent pure tone audiometry preoperatively.

Three surgical procedures were included in the study; tympanoplasty, cortical mastoidectomy, and modified radical mastoidectomy. Most of the cases were operated by residents and a few by consultants. All cases were performed under a Zeiss microscope. A postaural approach was used in all the cases. Mastoidectomies were performed using Marathon lab Micromotor drill machine (Collateral Medical Pvt Ltd, Inc., Mumbai, India) with cutting and diamond burs of varying sizes. Duration of surgeries was considered. Audiometry was performed postoperatively after 7 days and 3 months.

The data so collected were analyzed statistically to examine any significant shift of bone thresholds postoperatively.

RESULTS

A total of 150 cases were enrolled in this prospective study. Agewise, the patients were divided into three groups: Maximum (65) patients belonged to the age group 10–25 (43%). Of them, 34 were females and 31 males. Forty-six (31: males: 25: females) patients were aged between 26 years and 40 years. Only 39 (26% patients belonged to the age group 41–55 years. The last group had 23 females and 15 males (Fig. 1).

The most common clinical presentation was ear discharge which was present in 132 patients. The next common presentation was hearing loss that was reported by 123 out of 150 patients. Tinnitus was present only in 43 patients. Only nine patients complained of associated vertigo (Fig. 2).

Taking into account the duration of symptoms, three categories were created. A 26% of patients had the disease for less than 1 year. Patients having a duration of symptoms between 1 year and 5 years were 22%. Most of the patients (52%) had the disease for more than 5 years (Fig. 3).

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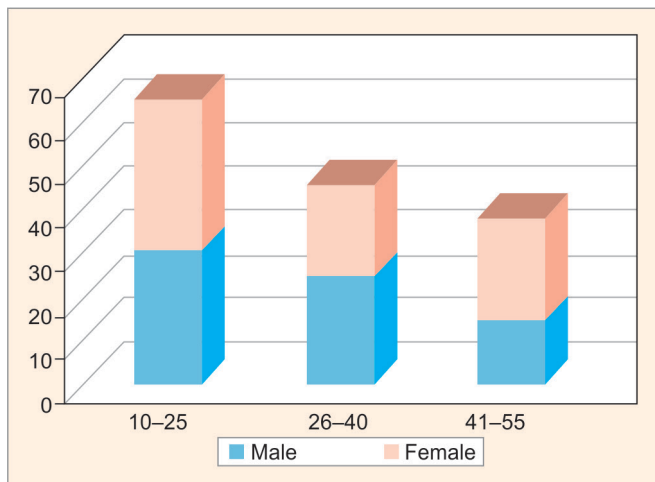


Fig. 1: Age and sex distribution

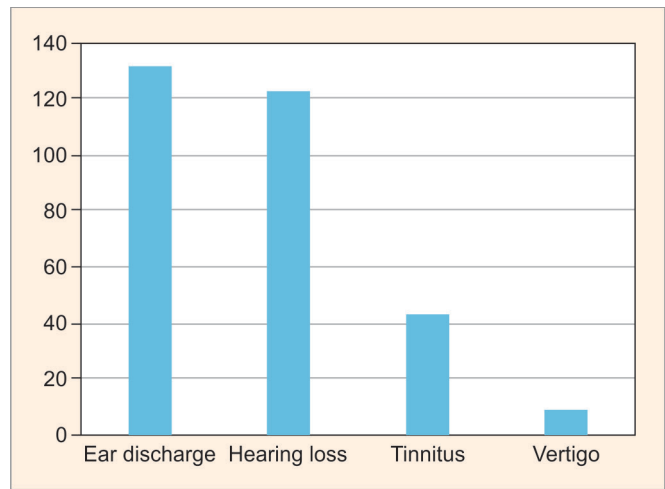


Fig. 2: Clinical presentations

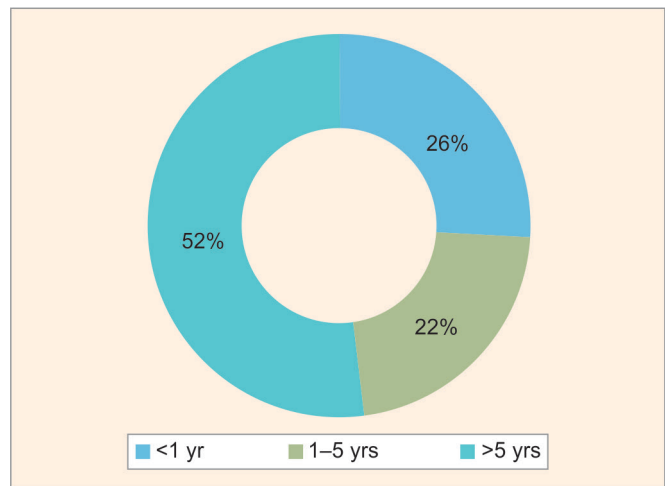


Fig. 3: Distribution according to the duration of symptoms

Table 1: Groups according to the type of procedure performed

Type of procedure	No. of cases
Tympanoplasty	64
Cortical mastoidectomy	35
Modified radical mastoidectomy	51

Table 2: Groups according to the duration of surgery

Duration of surgery (hr)	No. of cases
<1	55
1-2	48
2-3	33
>3	14

43% of the enrolled patients underwent tympanoplasty. Cortical mastoidectomy was done in 23% of cases and modified radical mastoidectomy in 34% (Table 1).

According to the duration of surgery, cases were divided into four categories. A 37% of surgeries took less than 1 hour. A 32% of the cases were completed within 1–2 hours and 22% of the cases within 2–3 hours. Only 9% of operations took longer than 3 hours (Table 2).

Table 3: Statistical analysis

Frequency (kHz)	Preoperative bone conduction audiogram (dB)		Postoperative bone conduction audiogram—7th day (dB)			Postoperative bone conduction audiogram—after 3 months (dB)		
	Mean	SD	Mean	SD	p-value	Mean	SD	p-value
0.25	15.45	8.64	16.4	8.12	0.37	15.3	8.35	0.88
0.5	18.31	8.51	18.52	8.37	0.83	18.14	8.29	0.86
1	23.47	7.94	23.2	8.53	0.78	23.73	8.1	0.78
2	26.82	8.27	27.41	8.24	0.54	26.8	7.93	0.98
4	20.53	7.32	21.71	9.03	0.21	20.29	6.87	0.77

The data concerning the bone conduction thresholds were collected from pure tone audiometry performed preoperatively on the 7th day, and after 3 months. Unpaired t-test was used to compare these data and find any significant difference, if present, between the preoperative and postoperative bone conduction thresholds taken on the operated ear of the same patient. The *p*-value less than 0.05 was considered statistically significant (Table 3).

The mean of bone conduction threshold values showed a slight rise at 0.25, 0.5, 2, and 4 kHz frequencies on the 7th postoperative day.

The mean of bone conduction thresholds after 3 months was almost equal to preoperative values at 0.25 and 2 kHz, lower at 0.5 and 4 kHz, and higher at 1 kHz frequency.

The *p*-value was never observed <0.5. Thus, the difference between the preoperative bone conduction threshold values and postoperative values was not found to be statistically significant.

DISCUSSION

Chronic suppurative otitis media (CSOM) is a very common ailment in a developing country like India where 29.5% of the total population, that is 363 million Indians, are living below the poverty line. And almost all of these patients require middle ear surgeries either to alleviate the symptoms decreasing the quality of life or to avoid complications associated with them. But surgeries themselves are not free of complications. During middle-ear surgery, many complications can arise like bleeding, injury to the facial nerve, damage to the sinus plate, and damage to the dural plate. SNHL can also occur following middle ear surgeries but remains underreported. The SNHL following a middle ear surgery can be attributed to acoustic or surgical trauma due to the use of drills and suction. Good exposure is the key to achieve a successful middle ear surgery without which there is a great chance of damaging important structures or leaving behind the residual disease. Bone drilling and suction are essential components of any middle ear surgery to establish a proper exposure. Even in tympanoplasty cases with narrow external auditory canals, the use of a drill to perform canaloplasty becomes indispensable. Other than drills and suction, trauma to an intact ossicular chain from middle ear dissection can also lead to an increase in the bone conduction thresholds.

Several studies have shown noise levels of 84–128 dB generated during the use of drills. During drilling the exposed cochlea is subjected to noise levels of more than 90 dB, while the contralateral cochlea to ≥ 80 –85dB.¹⁻³

In a study conducted by Kylen et al.,² the relationship between variables related to burr and noise levels generated was studied. According to it, a 6 mm burr produced a sound level of 88–108 dB,

a 4 mm burr resulted in a reduction of 1–6 dB, and the use of 2 mm one burr led to a reduction of 5–16 dB. The mean noise level produced by diamond burrs were found to be 5–11 dB less than the mean levels produced by cutting ones. Variations in the speed of rotation had little effect on the noise level generated. They concluded that noise trauma to the inner ear can only be avoided by reducing the duration of noise exposure, that is, by reducing the duration of the surgery.

According to Huttenbrink et al.,⁴ excessive drilling may result in a temporary threshold shift, which already resolves by the time of unpacking the ear.

A study conducted by Hegewald et al.⁵ assessed postoperative SNHL in patients who had undergone mastoidectomy. The audiometry was performed after 30 and 48 hours postoperatively. This study reported no significant postoperative hearing loss.

In a study conducted by Tos et al.,⁶ postoperative sensorineural hearing loss was recorded in 50 patients of acoustic neuroma undergoing translabyrinthine tumor excision. Audiometry was performed preoperatively and on the 30th day following surgery. No postoperative SNHL was found.

According to Biswas et al.,⁷ drill-generated noise does not produce a hearing loss in mastoid surgeries. So, if there is hearing loss postoperatively, we should look for other causes.

Studies by Smyth and Parkin^{3,8} report postoperative SNHL following middle ear surgeries.

According to Parkin et al.,³ if sound levels greater than 115 dB are endured for more than 15 minutes, they can result in sensorineural hearing loss. They also reported that suction alone can produce noise levels of 10–31 dB.

Khurana et al.⁹ conducted a study to analyze the risk of inner ear damage following middle ear surgeries. Out of 60 cases included in the study, mild SNHL was found in 10 and significant SNHL in one case.

In our study, no such postoperative SNHL was found and the difference between the preoperative bone conduction threshold values and postoperative values was not found to be statistically significant.

Urquhart et al.,¹⁰ reported a relation between duration of ear discharge and postoperative SNHL.

Palva and Sorri¹¹ reported postoperative SNHL to be directly related to the duration of surgery. No such statistical correlation was found in our study.

The lack of statistically significant shift in bone conduction thresholds may be because even though the sound produced by suction and drill may exceed the safe level, the exposure is intermittent. This may provide enough time for the sensory cells to recover without causing much structural damage and result in only temporary threshold shifts, as has been observed in our study.

CONCLUSION

From the above study we conclude that though the drilling and suction produce a significant level of noise, there is no statistically significant shift in the bone conduction threshold values. If any temporary threshold shift occurs, it usually recovers within 3 months. Moreover, the implementation of correct technique and instruments during the surgery also aid in avoiding postoperative sensorineural hearing loss.

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