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Original Research Paper

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A STUDY OF DRILL INDUCED HEARING LOSS IN THE CONTRALATERAL EAR FOLLOWING MASTOID SURGERY.

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ABSTRACT

Background: Mastoidectomy is the mainstay of COM treatment . Usage of the micro motor drill has an effect on the contralateral ear due to the noise induced by the drill and the sound-conducting characteristic of the intact skull.

Aims And Objectives:

1. To identify the drill induced hearing loss in the contralateral ear, by transient evoked otoacoustic emissions following mastoidectomy.
2. To identify the relation between the type of burr tip used and the amount of hearing loss.

Methodology: This study consisted of 63 patients that underwent mastoidectomy. A pre-operative PTA and TEOAE was done. PTA was repeated on POD-1 and POD-7. TEOAE was done on POD-1,3 and 7. Intraoperatively, the type of burr tip used and the individual drilling time for each type of drill bit was recorded.

Results: 37 patients developed transient SNHL by POD-3. All patients recovered by POD-30. Higher frequencies of 3000 Hz and 4000 Hz were commonly affected. No change was detected on PTA.

Conclusion: The drill is not only a source of noise but is also a strong vibration generator. These strong oscillations are transmitted into the cochlea. Thus surgeons should select appropriate burrs and drills to minimize the temporal bone vibrations.

KEYWORDS : Transient evoked otoacoustic emissions, Drill induced hearing loss, PTA, Burr tip.

INTRODUCTION

Mastoidectomy is the mainstay of the treatment and may be either an intact canal wall mastoidectomy or a canal wall down mastoidectomy. Drilling the bone during mastoidectomy can lead to sensorineural hearing loss (SNHL) in the healthy contralateral ear as well as in the operated ear because of undesired acoustic trauma.[1] Acoustic trauma to the contralateral cochlea, is due to minimal transcranial attenuation of the bone conducted sound. While drilling, the ipsilateral cochlea is subjected to a sound of 100 dB, whereas the opposite cochlea to levels which are 5 to 10 dB lower.[2] This in turn can lead to dysfunction of the outer hair cells (OHC), thus causing temporary or permanent hearing loss.[3] It has been suggested that an audiometry test is insufficient for the early detection of noise-induced cochlear damage. This can be effectively assessed by otoacoustic emissions (OAE).[4]

Variables such as rotation speed of the burr, type of burr and burr size, play an important role in drill induced hearing loss.[5] The noise produced by diamond burrs differs from that of cutting burrs. The mean noise levels of the diamond burrs are 5–11 dB lower than those of the cutting type.[6]

Studies using pure tone audiometry (PTA) and OAE for analysis, revealed a number of variations in their findings. Hence the present study was done at our tertiary care centre to identify the drill induced hearing loss in the contralateral ear, by transient evoked otoacoustic emission (TEOAE), after mastoidectomy and assess the relation between the type of burr tip used, duration of drilling and the amount of hearing loss.

AIMS AND OBJECTIVES

1) To identify the drill induced hearing loss in the contralateral ear, by transient evoked otoacoustic emissions following mastoidectomy.
2) To identify the relation between the type of burr tip used and the amount of hearing loss.

MATERIALS AND METHODS

It is a hospital-based prospective study, consisting of 63 patients, between 8 to 50 years of age, that underwent mastoidectomy from November 2018 to April 2020, was conducted in the department of Otorhinolaryngology, BLDE's (Deemed to be university) Shri B.M. Patil medical college, hospital and research centre, Vijayapura, after ethical clearance. Patients with pre-existing SNHL, history of prior ear surgeries and those on ototoxic drugs were excluded from this study.

After a well informed and written consent, each patient was subjected to a thorough otological examination and a detailed clinical history with emphasis on a normal contralateral ear. A bilateral X-ray mastoid (Schuller's view) was done for each patient. For every patient a pre-operative PTA and TEOAE (Echo lab OAE, ECL, model number-14028) were done. Post-operatively, PTA was repeated on day 1 and 7, whereas TEOAE was performed on day 1,3 and 7. If any changes in OAE readings were detected, the patient was subjected to a repeat OAE until normal values were obtained. If required, the repeat OAE was done on day 15, 30, 60 and 90 post-operatively. TEOAE was measured at 1000 Hz, 2000 Hz, 3000 Hz and 4000 Hz.

Cutting and diamond burr tips of various sizes (1-6mm) were used for each patient. Intraoperatively, the type of burr tip used and the individual drilling time for each type of burr was recorded using a stopwatch.

RESULTS

Cortical mastoidectomy was done for 35 cases (53%), while modified radical mastoidectomy (MRM) was preferred for the remaining 28 patients (44%). The mean drilling time varied from 47 to 66 minutes, depending on the type of surgery. In MRM, the average time of drilling with a cutting burr was 53.4 minutes and with a diamond burr was 15.6 minutes. During cortical mastoidectomy, the cutting burr was used for mean duration of 36.7 minutes, while the diamond burr was used for 11 minutes.

Twenty-six patients (41.3%) did not develop hearing loss following mastoidectomy. However, 37 patients (58.7%) had abnormal TEOAE readings and suffered from temporary drill

induced hearing loss in the contralateral ear. There were significant worsening in values of TEOAE at higher frequencies of 3000 and 4000Hz, in comparison to lower frequencies (1000 to 2000 Hz). Among the 37 patients that developed transient hearing loss, 30 (81.09%) cases suffered from decreased hearing by POD-1, whereas 7 (18.91%) cases developed a transient SNHL by POD-7.

Out of the 37 cases that developed a transient hearing loss, 4 (10.8%) recovered by POD-3, 19 (51.4%) patients were normal by POD-7, 10 (27.0%) showed no abnormality by POD-15 and the remaining 4 patients (10.8%) recovered by POD-30. Thus, no patient suffered from drill induced hearing loss beyond POD-30. On PTA, no changes were observed on post-operative day 1 and 7.

Table 1: Distribution Of Cases With Hearing Loss.

HEARING LOSS IN TOTAL	N	%
NORMAL	26	41.3
HEARING LOSS	37	58.7
TOTAL	63	100

In this study, it was observed that drilling with different sizes of cutting burr for a mean duration of 45.4 minutes resulted in drill induced hearing loss, whereas when used for an average of 37.5 minutes, normal TEOAE readings were achieved. Using the ROC curve, we established that drilling with a cutting burr for more than 40.2 minutes, had a sensitivity of 70% and a specificity of 69%, in causing drill induced hearing loss. It was also detected that drilling with a diamond burr for an average of 13.8 minutes resulted in hearing loss in the contralateral ear. However, no hearing impairment was noted when drilling was done for a mean time duration of 10.8 minutes. We detected that the usage of a diamond burr for over 12.5 minutes, had a sensitivity of 68% and specificity of 65%, in causing hearing loss.

Table 2: Sensitivity And Specificity Of Cutting And Diamond Burr.

PARAMETERS	CUT-OFF VALUE	SENSITIVITY	SPECIFICITY
Cutting Burr	40.2	70%	69%
Diamond Burr	12.5	68%	65%

DISCUSSION

Mastoid surgery is associated with a risk of SNHL, which is transient and in most cases reversible. The micro motor drill used during mastoidectomy acts as a source of noise as well as vibrations, which are transferred to both cochleae via bone conduction.[7] The sound intensity produced by drilling is estimated to be >100dB. Since interaural attenuation by bone conduction is minimal (0-5dB) and drill induced noise can cause hearing loss to the contralateral ear.[8] Parkin *et al* found that sound levels above 115dB could cause SNHL if sustained for more than 15 minutes.[9]

Cortical mastoidectomy was the treatment of choice for 35 cases (53%), while MRM was preferred for the remaining 28 patients (44%). This is concordant to the studies of Patil A *et al* [3] and Jerath V *et* al.[6]

The average time of drilling using a cutting burr and diamond burr in the case of MRM was 53.4 minutes and 15.6 minutes respectively. On the other hand, in cortical mastoidectomy, the cutting burr was used for an average of 36.7 minutes, while drilling with a diamond burr was done for 11.0 minutes. The mean drilling time varied from 47 to 66 minutes. This is consistent with the studies of Goyal A *et al* [9] and Baradaranfar MH *et al*.[10] Baradaranfar MH *et al* [10] established that the mean time of drilling was 56.48 ± 12.70 min (median 55 min, range 40-90 min). Goyal A *et al* [9] reported the mean drilling time as 53.93 min, while the average drilling duration using the cutting burr and diamond burr were 28.63 min (SD 13.687) and 24.63 min (SD 15.897) respectively.

It was observed that, 26 patients (41.3%) did not develop hearing loss following mastoidectomy. However, it was noted that 37 patients (58.7%) had abnormal TEOAE readings and suffered from temporary drill induced SNHL in the contralateral ear. On PTA, no changes were observed on post-operative day 1 and 7. This is in concordance to the studies of Goyal A *et al*, [9] Paksoy M *et al* [11] and Sliwinska-Kowalska N *et al*. [12]

Paksoy M *et al* [11] concluded that 67% of patients showed hearing impairment following mastoidectomy. Sliwinska-Kowalska N *et al* [12] established that there was no change in the PTA but a constant and gradual decrease in TEOAE was noted. Goyal A *et al* [9] detected that there was a substantial decrease in TEOAE and DPOAE readings in the opposite ear, following mastoidectomy. However, no changes were noted on PTA.

Out of the 37 patients that developed hearing loss, 30 (81.09%) cases developed impaired hearing by POD-1, whereas 7 (18.91%) cases suffered from a transient SNHL by POD-7. This is in concordant to the studies of Abtahi SH *et al* [7] and Jerath V *et al*.[8] On POD-1, Abtahi SH *et al* [7] observed that majority of the patients developed abnormal OAE values. Jerath V *et al* [6] found a significant drop in TEOAE values on POD-1.

Our study concluded that there was significant worsening in TEOAE readings at higher frequencies of 3000 and 4000Hz, than in lower frequencies of 1000 and 2000 Hz. Baradaranfar MH *et al* [10] also established that drill induced hearing loss was more at frequencies higher than 2000Hz. On the contrary, Abtahi SH *et al* [7] observed a significant difference in DPOAE and TEOAE values, at low frequencies of 500 to 2000Hz as well as at higher frequencies of 4000 and 8000 Hz.

In the current study, out of the 37 cases that developed transient hearing loss, 4 (10.8%) recovered by POD-3, 19 (51.4%) patients were normal by post-operative day 7, 10 (27.0%) cases showed no abnormality by post-operative day 15 and the remaining 4 patients (10.8%) recovered by POD-30. All patients recovered by POD-30. These finding was consistent with the studies of Migirov L *et al* [5] and Abtahi SH *et al*.[7]

Migirov L *et al*,[5] established that deterioration of DPOAE amplitudes were noted immediately after surgery, with progressive improvement within 72 to 96 hours. However complete recovery was observed by 4 weeks. Abtahi SH *et al* [7] concluded that most of the patients developed hearing loss, had normal TEOAE and DPOAE readings by POD-7.

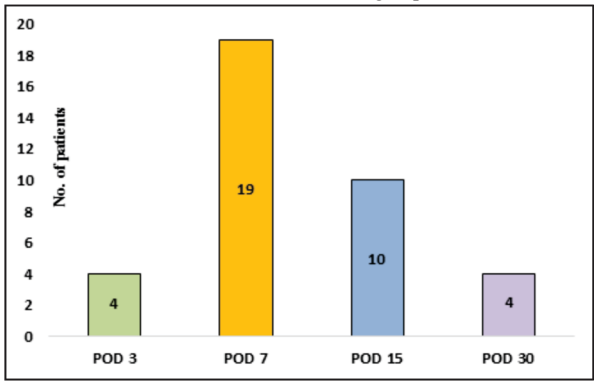

Figure 1: Distribution Of Cases According To Day Of Recovery.

Kylén P *et al* [2] study tested three different types of cutting burrs. The 6 mm cutting burrs developed a noise level of 88 to 108 dB. The use of a 4 mm burr resulted in a reduction of 1 to 6 dB, while

drilling with a 2 mm burr caused a decrease of 5 to 16 dB, thus concluding that burr size and type can affect the acoustic trauma levels.

It was suggested that all drills emitted noise exceeding 85 dB. The pneumatic drill can reach a noise level of 114 dB, while the shielded self-propelled drill almost complied with a noise level of 85 dB. By isolating the operator from the self-propelled drill, many believe that complications arising from both vibration as well as noise exposure can be solved.[13]

CONCLUSION

Following mastoidectomy, drill induced hearing loss, especially at frequencies higher than 2000 Hz may occur. This transient and reversible type of SNHL recovers within 7 days in majority of the patients. However, in a handful of cases, the hearing loss may be prolonged (1 month post operatively).

The clinical impact of the drill induced hearing loss varies. Some patients with small amount of hearing changes are completely asymptomatic, while others complain of tangible effects.

The drill is not only a source of noise but is also a strong vibration generator, and a strong oscillation is transmitted into the cochlea. Thus surgeons should pay more attention to the vibrations and lessen the intensity of drill induced hearing loss by an appropriate selection of burrs and drills, thus minimizing the vibrations of the temporal bone.

Declarations:
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Conflict of Interest: Not applicable

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