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Research Paper

Evaluation of Drill Generated Acoustic Trauma on the Non-Operated Ear Following Mastoid Surgery

Medical Science

KEYWORDS : Hearing loss,Noise-induced; Mastoid/surgery; Otolaryngology/instrumentation

Dr. B.V.Chandre Gowda — Dean and Principal, Professor in the Department of ENT, Kempegowda Institute of Medical Sciences, K.R.Road, V.V.Puram, Bangalore-560004. Karnataka

Dr. Amrita Suzanne Mathew — Post Graduate, Department of ENT, Kempegowda Institute of Medical Sciences, K.R.Road, V.V.Puram, Bangalore-560004. Karnataka.

ABSTRACT

Objectives:To evaluate the effect of mastoid drilling on hearing in the contralateral normal ear and to determine the nature and duration of hearing loss.

Materials and methods:60 consenting adults,aged 18-50years,with unilateral squamosal chronic otitis media with contralateral normal hearing preoperatively,undergoing modified radical mastoidectomy(MRM),were included in a prospective observational study.Clinical evaluation,pure tone audiometry(PTA)and relevant investigations were done.Postoperatively,patients underwent PTA on days 1,3,5,7 and 1,3,6months.

Results:Mean age was 31.47±3.38 years.Preoperative mean bone conduction(BC) threshold was 8.5±1.9 dB.Mean drilling time was 44.53±10.02 minutes.Postoperatively,high frequency sensorineural hearing loss(SNHL) was noted in the nonoperated ear in 79%,23%,9% and 2% of patients on days 1(p<0.001),3,5 and 7 respectively,with mean BC thresholds of 35.58±17.83 dB,17.46±11.13 dB,13.61±9.02 dB and 9.01±4.17dB respectively.100% of patients had normal hearing at 1,3 and 6 months.

Conclusion: Drill induced noise during mastoidectomy causes temporary high frequency SNHL in the nonoperated ear due to transcranial conduction of vibration

INTRODUCTION

The exposure of the ear to noise is a well known factor which can lead to sensorineural hearing loss (SNHL). In otology, a wide variety of devices are used that have significant noise outputs. Noise levels range from 120-122 dB during drilling of cortical bone, and from 117-121 dB while drilling the mastoid cavity[1]. Exposure to loud noise during ear surgery can thus result in acoustic trauma[2].

Drill generated noise has been incriminated as a cause of SNHL in the operated ear[3]. The introduction of increasing high speed drills for mastoid surgery has heightened the concern that cochlea damage may occur in both the operated and non operated ear[4]. When a drill is used during mastoid surgery, the ipsilateral cochlea is exposed to noise levels of about 100 dB and the contralateral cochlea to levels of 5-10 dB lower[5].

Drill induced noise is transmitted to the non operated ear in 2 ways: through the skull and around the ear[6], with minimal interaural attenuation[7]. The drill is not only a source of noise, but also a strong vibration generator, transmitting oscillations into both the cochleae thereby amplifying its damage[6]. Noise exposure results in dysfunction of the outer hair cells, which may produce a temporary hearing loss on surgery applied or opposite ear[6,8].

Drill generated noise levels and the exposure time interval determines the hearing loss levels related to the type of surgery. In mastoid surgery, higher levels of noise induced hearing losses are expected due to longer time of exposure to drilling[9].

The manner in which variables such as rotation speed, type of burr, burr size and site of drilling influence bone conducted, drill generated noise levels in ear surgery has been investigated[10].

As in the case of the diseased ear, the normal hearing status of the contralateral ear is of great importance, and the influence of this noise should thus be analysed.

This study was therefore undertaken with the aims of evaluating the effect of mastoid drilling on hearing in the contralateral normal ear and to determine the nature and duration of hearing loss if present.

MATERIALS AND METHODS

A prospective observational study was conducted in the Department of ENT, Kempegowda Institute of Medical Sciences, Bangalore, from June 2013 to March 2015.

60 consenting adults of both sexes aged 18 to 50 years, presenting with unilateral squamosal chronic otitis media with contralateral normal hearing and undergoing modified radical mastoidectomy on the diseased ear were included in the study. Patients with bilateral ear disease/hearing loss, history of smoking, ototoxic drug intake, noise exposure, systemic disease such as diabetes, hypothyroidism, renal disease etc, family history of hearing loss and attrition to follow up were excluded from the study.

A detailed history was taken, followed by general and ENT examination, including otoscopic and microscopic ear examination. Investigations conducted were PTA (pure tone audiometry), tympanometry and relevant imaging such as X-ray of both mastoids or high resolution computerised tomography of the temporal bones.

Routine preoperative workup up was carried out. All patients underwent modified radical mastoidectomy under general anaesthesia (not comprising nitrous oxide), using cutting and diamond burrs of varying sizes as required. Post operative care included routine antibiotic, analgesic and antihistamine therapy.

Patients were followed up on days 1,3,5 and 7 and at 1, 3 and 6 months for audiometric (PTA) assessment of hearing.

RESULTS

32 males and 28 females (male : female ratio of 1:1) met the inclusion criteria. The mean age of the study group was 31.47±3.38 years.

Preoperatively, nonoperated ears were found to have mean air and bone conduction thresholds of 9.6 ± 2.9 dB (range = 2-20 dB) and 8.5 ± 1.9 dB (range = 2-10 dB) respectively on PTA.

Mean drilling time was 44.53 ± 10.02 minutes (range = 30-58 minutes). No intraoperative or postoperative complications were observed.

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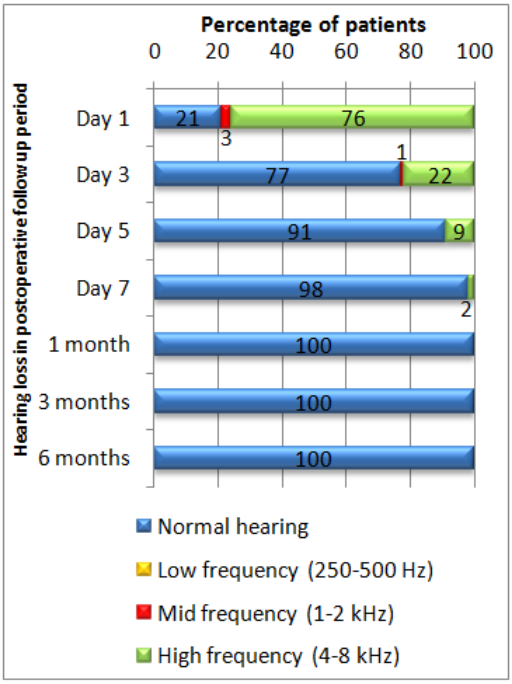
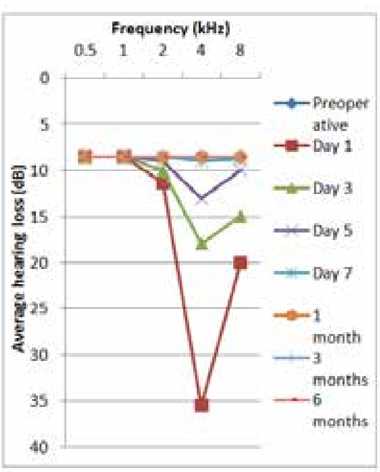
During the follow up period, sensorineural hearing loss was noted in the nonoperated ear in 79% of patients on day 1. On days 3, 5 and 7, 23%, 9% and 2% of patients respectively continued to have hearing loss, while in the remaining patients, bone conduction threshold returned to normal preoperative levels.(Graph 1).

The mean bone conduction threshold was 35.58 ± 17.83 dB, 17.46 ± 11.13 dB, 13.61 ± 9.02 dB and 9.01 ± 4.17dB on the 1st, 3rd, 5th and 7th postoperative days respectively. (Graph 2 and Graph 3). At 1, 3 and 6 months of follow up, 100% of patients had normal hearing (preoperative levels) in the nonoperated ear.

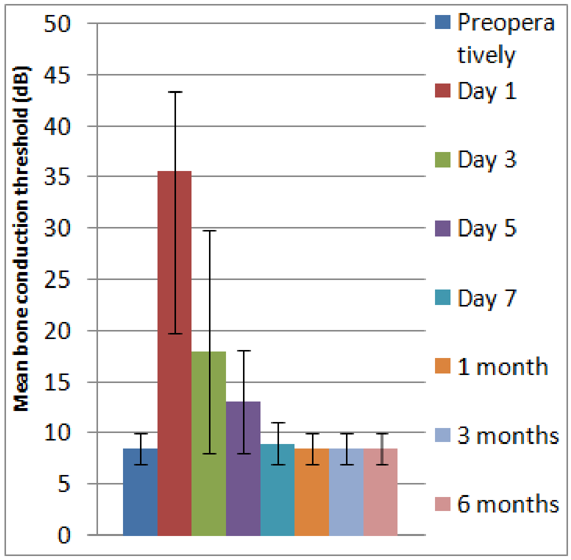
A statistically significant shift in bone conduction threshold is observed at higher frequencies (4-8 kHz) on postoperative day 1 ($p<0.001$), thereby making the association between mastoid drilling and hearing loss positive . However, the shift in high and mid frequency bone conduction threshold on days 3 to 7 were not statistically significant. No gender differences were noted.



Graph 1 – Analysis of postoperative hearing loss in the non-operated ear



Graph 2 – Analysis of bone conduction threshold in non-operated ear



Graph 3 – Mean bone conduction threshold in non-operated ear pre and postoperatively

DISCUSSION

Drilling is the major part of tympanomastoid surgery. Since the interaural attenuation of the skull is minimal, noise generated by the drill may be transmitted to both cochleae via bone vibration, causing sensorineural hearing loss in the contralateral nonoperated ear[7]. Noise induced damage and related sensorineural hearing loss during mastoid drilling has practical implications for both the patient and the surgeon[8].

The possible effect of nitrous oxide in general anaesthesia on hearing, has been documented[11] and thus nitrous oxide was not used during surgery in our study.

Older subjects and those with systemic diseases have been found to be more vulnerable to vibration and noise[10] and were therefore excluded from our study.

Studies have shown that mastoid drill burrs cause noise levels constantly exceeding 100 dB in the operated ear and 5-10 dB lower in the contralateral ear[5]. Parkin et.al. found that sound levels above 115 dB can cause sensorineural hearing loss if sustained for over 15 minutes[12].

Kylen et.al[5] and Goyal et.al[13] showed that large cutting burrs produced more noise and vibration than fine small cutting burrs and this was further reduced with the use of equivalent sized diamond burrs.

In our study, results are in response to a mean drilling time of 45 minutes similar to those in studies by Karatas et.al[14] and Man et.al[3], with the selection of various sizes and kinds of burrs as required.

In our study, a significant association was seen between mastoid drilling and noise induced hearing loss in the contralateral ear upto the 3rd postoperative day, with complete recovery by 1 month. Similar results were found in a study by Karatas et.al who concluded that mastoid drilling causes transient hearing loss in the contralateral normal hearing ear, which recovers spontaneously within 72-96 hours postoperatively[14]. However Migirov et.al[15] and Karimi et.al[16] demonstrated that this loss, though reversible, may last for >1 month.

Kylen et.al found a statistically significant shift in threshold at 4 and 8 kHz following noise exposure[5], as was seen in our study.

Similar results concurring with those seen in our study were also documented by Da Cruz et.al[6], Hegewald et.al[17] and Schick et.al[18] who demonstrated a temporary threshold shift at high frequencies in the nonoperated ear in the early postoperative period following mastoid drilling. Howerever, in contrast, studies by Man et.al[3], Urquhartet.al[8], Hilmi et.al[4] and Tos et.al[7] failed to show any statistically significant hearing loss in the nonoperated ear, associated with mastoid drilling.

CONCLUSION

Drill induced noise during mastoidectomy can cause temporary high frequency sensorineural hearing loss in the nonoperated ear due to transcranial conduction of noise and vibration. Despite its reversible influence, drill generated noise induced hearing loss should be given due consideration, especially in patients with only one hearing ear. It can be minimised by proper surgical technique including selection of burrs and reducing the operating time and thereby the duration of exposure of the cochlear structures to noise.

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