

## Original Research Article

# Extended high frequency hearing sensitivity in normal contralateral ears exposed to mastoid drill noise in patients undergoing mastoid surgery

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### ABSTRACT

**Background:** This study aimed at evaluation of extended high frequency hearing in non operated normal ear in patients undergoing mastoid surgery using otological micro drill.

**Methods:** A hospital based prospective observational study was carried out. Patients up to 40 years of age with unilateral ear disease were recruited and divided into two groups- mastoidectomy group comprising 30 patients who underwent mastoid surgery using high speed microdrill and tympanoplasty group who underwent surgery without using microdrill. Pure tone audiometry (conventional and extended high frequency) was performed preoperatively, on 3rd and 10th postoperative day.

**Results:** In mastoidectomy group, Air conduction thresholds in extended high frequency showed significant changes on 3rd postoperative day and showed recovery by 10th postoperative day. Recovery started by 3rd postoperative day and in majority of cases there was a complete recovery by 10th postoperative day.

**Conclusions:** Otological drilling has a significant effect on the extended high frequency hearing of normal contralateral ear. Extended high frequency audiometry till 16000 Hz is a sensitive modality for evaluation to monitor these cases on post-operative follow up.

**Keywords:** Extended high frequency hearing, Sensorineural hearing loss, Mastoidectomy, Microdrill

### INTRODUCTION

Exposure of ear to noise is a known factor leading to hearing loss. Incidence of noise induced damage and related sensorineural hearing loss is estimated to be between 1.2-4.5%.<sup>1</sup> Microdrill is used routinely in all mastoid surgeries. Drilling in mastoidectomy may involve exposing the ear to a noise of about 100 dB and the contralateral cochlea to levels 5-10 dB lower.<sup>2,3</sup> Prolonged noise insult to the contralateral ear can certainly have potential risk of temporary hearing loss.<sup>4</sup>

The expected hearing loss may be missed if only conventional pure tone audiometry is utilized.<sup>6,7</sup> One of the other proposed methods for diagnosis of this hearing loss is high frequency audiometry which evaluates the hearing threshold at frequencies higher than 8000 Hz that is 10000 Hz, 14000 Hz, 16000 Hz as it is believed that these frequencies are affected earlier than conventional frequencies due to exposure to noise.<sup>8-10</sup>

Despite the fact that noise generated by drilling could easily be transmitted to the contralateral cochlea via bone, postoperative hearing status of the contralateral ear has received less interest among researchers. Further there is a

paucity of literature concerning this topic published in Indian context. This study aimed at assessing the extended high frequency hearing thresholds in the non-operated normal ear in patients undergoing mastoid surgery using otological microdrill. This prospective study will give an insight into the role of extended high frequency audiometry in evaluating acoustic damage to the contralateral ear in postoperative period.

**METHODS**

An approval was taken from the ethics committee of the institute for conducting the study. A hospital based prospective observational study was carried out during the time period of November 2016 to March 2018. Patients up to 40 years of age with unilateral chronic otitis media having otoscopically and audiological normal contralateral ear who underwent otological surgery were included in the study and were divided into two groups- mastoidectomy group and tympanoplasty group. 30 patients were included in each of the two groups. Patients above the age of 40 years, with bilateral ear disease and bilateral hearing loss, previously operated ear and patients with congenital ear anomaly (which precludes audiological assessment) were excluded from the study. An informed consent was taken from all patients included in the study. All patients underwent clinical and audiological examination and assessment. Audiological assessment included pure tone audiometry including extended high frequency audiometry. Pure tone audiometry included conventional and extended high

frequency audiometry using Modified Hughson-Westlake procedure in a sound treated audiometry room. A two channel audiometer MAICO MA 43 was used. Air conduction testing was done using SENNHEISER HDA 300 headphones and frequencies tested included 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 3000 Hz, 4000 Hz, 6000 Hz, 8000 Hz, 9000 Hz, 10000 Hz, 11200 Hz, 12500 Hz, 14000 Hz, 16000 Hz. Bone conduction was measured using Radio Ear B71 at frequencies including 250 Hz, 500 Hz, 1000 Hz, 2000Hz, 4000 Hz. Pure tone audiometry was performed preoperatively, on 3rd and 10th postoperative day. The hearing thresholds obtained were recorded in a proforma.

The speed of otological microdrill (MEDTRONIC) was between 20,000 to 60,000 rpm. The burr diameter (cutting and diamond) were between 2-6 mm. Duration of drilling in individual cases was recorded. Data was collected and recorded on a pre- designed proforma.

**RESULTS**

Mastoidectomy group- out of 30 patients included in this group, 22 (73.33%) were males and 8 (26.67%) were females. The mean age was 23.3±9.49 years. 15 patients (50%) had disease in the right ear and 15 (50%) had disease in the left ear. Tympanoplasty group- out of 30 patients, 23 (76.67%) were males and 7 (23.33%) were females. The mean age was 24.2±7.9 years. 20 patients (66.67%) had disease in the right ear and 10 (33.33%) had disease in the left ear.

**Table 1: Mean of thresholds.**

PTA	Mastoidectomy			Tympanoplasty		
	Conventional PTA	Extended high frequency PTA	Bone conduction PTA	Conventional PTA	Extended high frequency PTA	Bone conduction PTA
<b>Pre-operative</b>	20.6±6.5 dB	37.26±16.51 dB	5.67±4.27 dB	17.08± 6.15 dB	29.88±16.11 dB	6.19±8.41dB
<b>Third day post-operative</b>	23.56±6.98 dB	45.11±15.12 dB	6.09±4.87 dB	17.38±5.91dB	27.05±16.62dB	4.75±4.03dB
<b>Tenth day post-operative</b>	20.85±8.75 dB	37.32±15.65 dB	6.14±3.88 dB	17.69±6.2dB	26.67±15.51dB	5.70±7.41 dB

**Table 2: Comparison of mean of thresholds (p value).**

Group	PTA modality	Preoperative and 3 <sup>rd</sup> postoperative day	Preoperative and 10 <sup>th</sup> postoperative day
<b>Mastoidectomy</b>	Conventional PTA	0.648	0.567
	Extended high frequency PTA	0.001*	0.538
	Bone conduction PTA	0.758	0.147
<b>Tympanoplasty</b>	Conventional PTA	0.415	0.657
	Extended high frequency PTA	0.566	0.538
	Bone conduction PTA	0.797	0.826

\*p<0.05 significant

Air conduction thresholds at conventional frequencies were evaluated as mean of thresholds at 250, 500, 1000, 2000, 3000, 4000, 6000 and 8000 Hz. Air conduction threshold at extended high frequencies was calculated as mean of thresholds at 9000, 10000, 11200, 12500, 14000 and 16000 Hz. Bone conduction threshold was calculated as mean of thresholds at 250, 500, 1000, 2000 and 4000 Hz (Table 1).

Air conduction thresholds in extended high frequencies in mastoidectomy group is significantly affected on third postoperative day ( $p=0.001$ ) when compared to preoperative thresholds while no such difference noted on 10th postoperative day. Air conduction thresholds in conventional frequencies and bone conduction thresholds in both mastoidectomy and tympanoplasty groups are not significantly affected on both 3rd and 10th postoperative day (Table 2).

## DISCUSSION

In the mastoidectomy group where otologic drill was used, we observed an increase in hearing threshold in extended high frequency audiometry (9000-16000 Hz) on third postoperative day ( $p=0.001$ ) when compared to preoperative thresholds. However, in the tympanoplasty group there was no significant change ( $p=0.06$ ) in pre and post-operative hearing thresholds. Hearing assessment done on 10th postoperative day revealed normal hearing threshold in the mastoidectomy group suggesting that temporary threshold shift which occurred after drilling returned back to normal on follow up in the normal contralateral ear. There was no significant threshold shift observed in air conduction and bone conduction in conventional frequencies (250-8000 Hz) and (250-4000 Hz) respectively in both the groups. Similar observations were reported by Hegewald et al on 48 hours postoperative assessment where temporary threshold changes were observed at 2000 Hz-11000 Hz in mastoidectomy patients.<sup>11</sup> Goyal et al and Baradranfar et al also reported significant change in post operative air conduction threshold at high frequency (4000-8000 Hz) on serial assessment over three days post operatively.<sup>12,13</sup> None of the authors however did an extended high frequency audiometry in 9000-16000 Hz range. On the contrary, Tos et al reported no change in hearing threshold in PTA on post-operative assessment.<sup>1</sup>

## CONCLUSION

This study demonstrates a significant effect of otologic drilling on the hearing of contralateral ear due to the noise and vibration produced by the drill which gets conducted transcranially. However, recovery started by 3rd postoperative day and in majority of cases there has been a complete recovery by the 10th postoperative day. Extended high frequency audiometry (9000-16000 Hz) in the post-operative period is a sensitive modality for evaluation to monitor these cases on postoperative follow up. Hence extended high frequency audiometry may be

included as part of pre and post operative audiological assessments. However, a larger sample size will provide a better understanding of noise induced hearing changes while using microdrill in mastoid surgeries.

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## REFERENCES

1. Tos M, Lau T, Plate S. Sensorineural hearing loss following chronic ear surgery. *Ann Otol Rhinol Laryngol.* 1984;93:403-9.
2. Soujadin ER, Bleeker JD, Hoeksema PE, Molenaar I, Van Rooyen JP, Ritsma RI. Scanning electron microscopic study of the organ of corti in normal and sound damaged guinea pigs. *Ann Otol Rhinol Laryngol.* 1976;85:1-58.
3. Philips JI, Heyns PS, Nelson G. Rock drills used in South African mines: A comparative study of noise and vibration levels. *Ann Occup Hyg.* 2007;51:305-10.
4. Karatas E, Mimam MC, Ozturan O, Erdem T, Kalcioğlu MT. Contralateral normal ear after mastoid surgery: evaluation by otoacoustic emissions (mastoid drilling and hearing loss). *ORL J Otorhinolaryngol Relat Spec.* 2007;69:18-24.
5. Zou J, Bretlau P, Pyykko I, Starck J, Topilla E. Sensorineural hearing loss after vibration: an animal model for evaluating prevention and treatment of inner ear hearing loss. *Acta Otolaryngol.* 2001;121:143-48.
6. Urguhart AC, Mc Intosh WA, Boinstein NP. Drill generated sensorineural hearing loss following mastoid surgery. *Laryngoscope.* 1992;102:689-92.
7. Man A, Winerman I. Does drill noise during mastoid surgery affect the contralateral ear? *Am J Otolaryngol.* 1985;6:334-35.
8. Lopes AC, Otubo KA, Basso TC, Marinelli EJJ, Lauris JRP. Occupational hearing loss: Tonal audiometry X high frequencies audiometry. *Int Arch Otolaryngol.* 2009;3:293-302.
9. Singh R, Saxena RK, Varshney S. Early detection of noise induced hearing loss by using ultra high frequency audiometry. *Int J Otorhinolaryngol.* 2009;10(2):1-5.
10. Wang Y, Yang B, Li Y, Hou L, Hu Y, Han Y. Application of extended high frequency audiometry in the early diagnosis of noise induced hearing loss. *Zhonghua Er Bi Yan Hou Ke Za Zhi.* 2000;35(1):26-8.
11. Hegewald M, Heitman R, Weiderhold ML. High frequency electrostimulation hearing after mastoidectomy. *Otolaryngol Head Neck Surg.* 1989;100:49-56.
12. Goyal A, Singh PP, Vashishth A. Effect of mastoid drilling on hearing of the contralateral ear. *J Laryngol Otol.* 2013;127:952-6.

13. Baradaranfar MH, Shahbazian H, Behniafard N, Atighechi S, Dadgarnia MH, Mirvakili A, et al. The effect of drill generated noise in the contralateral healthy ear following mastoid surgery: The emphasis on hearing threshold recovery time. *Noise Health*. 2015;7:209-15.

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