Impact of Noise on Hearing of Individuals Working in the Temples

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ABSTRACT

Introduction: One of the most mystifying problems faced by individuals who are exposed to high levels of noise (either occupational or recreational) is the slow deterioration of hearing that takes place. Evidence from the literature also indicates that noise exposure causes a significant sensory neural hearing loss. Hence we planned to compare the hearing of priests and workers of temples using Pure tone Audiometry and the fine spectral DPOAEs.

Method: Twenty three male participants between the ages of 20 to 65 years were included in the study. Group 1 participants worked in the temple premises for more than 5 years and all the individuals had reported to have been exposed to noise during work. Group 2 was not exposed to noise.

Results: The temple workers had poor thresholds and significantly reduced SNRs compared to the control group.

Conclusions: Temple noise has impact on individuals working in the temple premises presence of NIHL.

Keywords: - NIHL, Temple Noise, hearing Loss

INTRODUCTION

Slow deterioration of hearing that takes place in individuals who are exposed to high levels of noise (either occupational or recreational) is one of the most mystifying problems. Noise-induced hearing loss (NIHL) is the second most common form of sensorineural hearing loss, after presbycusis. The damage caused by the noise is imperceptible, painless, and enormously slow, that the individual is unaware of his loss of hearing for a long time, and hence it is the most pervasive of all the occupational health hazards. Noise exposure is perhaps the most common etiology of preventable hearing loss. Generally, this prolonged exposure to sounds as high as 85 dBA is hazardous even though the most important factor is the amount of sound exposure. Both the levels as well as the length of exposure are important and are interrelated [1-2].

The pathophysiology of the ear damage due to the noise exposure has been widely studied in humans and the mechanism whereby excessive sound exposure damages the ear is very well understood. Lesser levels of damaging sound exposure results in a temporary threshold shift (TTS). If this TTS occurs regularly, there is a poor recovery resulting in a permanent threshold shift (PTS). This PTS occurs as a consequence of persistent exposure to such sounds resulting in some hair cells not able to recover from damage. The outer hair cells in the basilar part of the cochlea which is the area that responds to 4 kHz and also the adjacent areas

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of 3 and 6 kHz, are the first to fail permanently. This area of the ear is identified to be most sensitive, because of the harmonic amplification by the ear canal and also because of the absolute sensitivity. Once these hair cells start degenerating they are less likely to recover and a permanent hearing loss is expected. Characteristically thus, following a long duration of noise exposure, hearing loss is presented as an audiometric notch, which is usually greatest at 4 kHz but can also be anywhere between 3 kHz and 6 kHz. With higher noise exposure for prolonged duration, the loss starts extending to the neighbouring frequencies. Moreover, if the sound is intense, it produces a more severe pattern of TTS which may result in a PTS more rapidly.

Outer hair cells are more susceptible to noise exposure than inner hair cells. Noise exposure causing TTS is anatomically correlated with decreased stiffness of the stereocilia of outer hair cells. The stereocilia become disarrayed and floppy. Presumably, in such a state they respond poorly. These are associated with fusion of adjacent stereocilia and loss of stereocilia. With more severe exposure resulting in PTS, injury can proceed from a loss of adjacent supporting cells to complete disruption of the organ of Corti. Histopathologically, the primary site of injury appears to be the rootlets that connect the stereocilia to the top of the hair cell. With loss of stereocilia, hair cells die. Death of the sensory cells can progressively result in Wallerian degeneration and further loss of the primary auditory nerve fibres. Hence, it becomes important to study the effect noise exposure in individuals working in different areas as they are exposed to different types of noises, with similar pattern of cochlear loss.

NIHL has been studied extensively in various occupational groups and using various testing procedure. Silva and Cabral studied the Noise Exposure Levels of Priests and Worshippers in Churches and found that the exposure level varied between 95.4 to 99.5 dBA which also poses risk to the worshipper, so they reported that hearing conservation programs with adequate acoustical sanitisation measures must be implemented. Nevertheless, the impact of noise in temples has not been studied, even though pujas (worships) in temples are usually associated with lot of noise. This includes sounds of drums, bells, people shouting prayers, the sounds from various instruments like Saxophone, Nadhaswaras, Thaal, Dholki, Drums, etc. The temple workers and worshippers are thus exposed to sounds of high intensities (as high as 100 dB) and of a wide range of frequencies. Hence, these individuals could be prone to have hearing loss due to this kind of noise exposure. This makes it important for us audiologists to evaluate the level of hearing so that a good Hearing Conservation Program can be implemented.

Pure-tone audiometry has been a gold standard in evaluating the hearing status since decades based on which the Boyler’s notch has been the most commonly reported pattern in NIHL. However OAEs are also gaining popularity due to the type of information it gives regarding outer hair cells (OHC) functioning, which is essential for a healthy hearing, but are most vulnerable part of the ear in response to noise. It is also commonly agreed that the onset and gradual development of NIHL is mainly a consequence of OHC loss. The spectral changes in DPOAEs were employed in this study as DPOAEs identify the slightest changes in the cochlear function, and DPOAEs were reported to be more reliable than PTA, ideal for monitoring the cochlear functioning in those exposed to noise. Hence, it was decided to carry out this present study using fine spectral changes in DPOAE in addition to the PTA and immittance measures.

Need: NIHL is a more prevalent disorder among hearing disorders. Evidence from the literature also reports that noise exposure causes a significant sensory hearing loss. We hypothesised that noise exposure (due to exposure to sounds of drums, bells and other sounds) would have a negative impact on hearing health of individuals working in the temple premises throughout the day. Pharmacological line of management is not an effective choice in bringing the hearing back to normal level in individuals with NIHL. Hence, it is important to assess the hearing in this group, so that appropriate preventive measures may be advised either by using globalised hearing conservation programme or by other means like shifting of the work area away from noise.

Aim: To evaluate the hearing of priests and workers of temples using Pure tone Audiometry and the fine spectral changes in DPOAEs.

Subjects and Method

Participants: Twenty three male participants (Group 1: 9 workers from the temple and group 2:14 controls) between the ages of 20 to 65 years (mean age of group 1 and group 2 was 40.11 and 41.11 respectively) were included in the study. All the individuals in group 1
worked in the temple premises for more than 5 years and all the individuals had reported to have been exposed to noise during work. All participants did not have history of.presence of neurological problems, middle ear pathology or vestibular problems. In figure 1 hearing threshold of all the participants from each group across the octave frequencies are shown.

![Frequency vs Hearing threshold](image)

**Figure 1:** Shows PTA mean thresholds across the frequencies for all the participants.

**Procedure:** The participants were first seated in a sound treated audiological laboratory. A brief case history was taken followed by an otoscopic evaluation. Immitance audiometry was conducted to rule out middle ear pathology because the transmission properties of the middle ear directly influence OAE characteristics. Then, pure tone audiometry using the instrument GSI 61 clinical audiometer was performed and audiometric thresholds were obtained at 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz and 8 kHz for both ears. The pure tone average (average of thresholds obtained at 500 Hz, 1 kHz, 2 kHz & 4 kHz) for each participant was calculated for both ears. The participants were then evaluated using pure spectral changes in DPOAEs using a computer-based DPOAE analyser (GSI AUDERA). DPOAEs were recorded for a total 49 pairs of frequencies with a resolution of 12 points per octave between 1 kHz to 8 kHz. With f2:f1 ratio of 1.20 in all occasions and Intensities of f1 and f2 kept at 65/55 dB SPL. In this study, data was represented with reference to f2 with rejection criterion set at 30 dB SPL or if L1 and L2 differed by > 2 dB from the target values beyond which a frame was rejected.

**RESULTS**

The frequency specific thresholds revealed that the temple workers had poor hearing thresholds indicating the presence of hearing loss. The DPOAE values showed that the SNRs were poorer in the temple workers compared to the control group. The mean and standard deviations as shown in Table 1 were higher in the control group compared to the temple workers.
Table 1: Showing the mean and standard deviation of the DPOAE amplitude and SNRs at the four octaves.

<table>
<thead>
<tr>
<th>Frequency in octaves</th>
<th>Temple Workers (dB)</th>
<th>Mean &amp; SD</th>
<th>Control Controls (dB)</th>
<th>Mean &amp; SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 Hz – 1kHz signal amplitude</td>
<td>2.40 ± 3.33</td>
<td></td>
<td>2.72 ± 4.52</td>
<td></td>
</tr>
<tr>
<td>500 Hz – 1kHz SNR</td>
<td>8.92 ± 3.49</td>
<td></td>
<td>12.10 ± 6.37</td>
<td></td>
</tr>
<tr>
<td>1kHz – 2kHz signal amplitude</td>
<td>4.76 ± 5.60</td>
<td></td>
<td>7.19 ± 5.65</td>
<td></td>
</tr>
<tr>
<td>1kHz – 2kHz SNR</td>
<td>17.31 ± 5.94</td>
<td></td>
<td>23.51 ± 6.59</td>
<td></td>
</tr>
<tr>
<td>2kHz – 4kHz signal amplitude</td>
<td>-2.64 ± 7.61</td>
<td></td>
<td>3.02 ± 5.72</td>
<td></td>
</tr>
<tr>
<td>2kHz – 4kHz SNR</td>
<td>18.41 ± 7.92</td>
<td></td>
<td>26.52 ± 5.25</td>
<td></td>
</tr>
<tr>
<td>4kHz – 8kHz signal amplitude</td>
<td>-13.29 ± 6.30</td>
<td></td>
<td>-10.90 ± 6.34</td>
<td></td>
</tr>
<tr>
<td>4kHz – 8kHz SNR</td>
<td>7.98 ± 6.33</td>
<td></td>
<td>12.09 ± 5.81</td>
<td></td>
</tr>
</tbody>
</table>

On applying Mann Whitney U test for the values, a statistically significant difference was observed between the two groups which was specific to the octaves 1 kHz to 2 kHz, 2 kHz to 4 kHz and 4 kHz to 8 kHz at p < 0.05.

Pearson’s product moment correlation was employed to observe the degree of correlation between the age, PTA and DPOAEs. The results revealed a good degree of positive correlation between Age and the PTA at p = 0.004, r = 0.64 which suggests that the PTA increased as age increased. It was also observed that there was a good degree of negative correlation between the age and the DPOAE values specific to the octaves 2kHz – 4kHz at p = 0.00, r = -0.771 and 4kHz – 8kHz at p = 0.01, r = -0.712 which indicates that as age increased the DPOAE SNRs at the higher octaves reduced. In addition, a good degree of negative correlation was observed between the PTA and the DPOAE SNRs between 2 kHz – 4 kHz octave at p = 0.00, r = -0.771.

DISCUSSION

This study aimed at investigating the hearing sensitivity among temple workers using PTA and DPOAE. The results showed that most of the Temple workers had pure tone thresholds higher than the normal limit with majority showing a notch at high frequencies between 3 - 6 kHz. This particular pattern is typical of the Boyler’s notch observed in individuals with NIHL [8] which is attributed to the OHCs dysfunction which takes place maximally in this frequency region as a result of the harmonic amplification by the external ear and absolute hearing sensitivity, secondary to noise exposure [13].

The results also showed that the temple workers had lower DPOAE signals and SNRs at all the three octaves in comparison to the controls. This can be attributed to the impact of the temple noise on the hearing sensitivity of the individuals working in the temple leading to outer hair cell dysfunction indicative of Sensory-neural Hearing loss.

A significant positive correlation between age and PTA was observed which suggested that older individuals working in the temple premises had higher thresholds which could be due to the longer years of exposure to the damaging noise leading to higher degree of hearing loss and also permanent threshold shifts. The age also showed a negative correlation with the DPOAEs at higher octaves indicative of the DPOAEs (at high frequencies 2 kHz to 4 kHz & 4 kHz to 8 kHz) reducing as the age advances. These particular findings could be attributed to an interaction of the noise NIHL and age related loss. The noise NIHL owing to years of exposure to loud noise which impacts the higher frequencies specifically, as well as age related loss of hearing sensitivity as a result of the deterioration in the structural aspects and functional metabolism of the inner ear. An influence of presbycusis on noise induced hearing loss has been suggested [13]. The effect of noise is hence equivocal. The interactions between NIHL and age related hearing loss are complicated, difficult to determine, and poorly understood [13]. Hence poorer pure tone thresholds and reduced DPOAE SNRs were
obtained as age advanced.

The PTA also significantly correlated with the DPOAE SNRs specific to 2 kHz to 4 kHz which indicates more loss in those frequencies which is associated with the Boyler’s notch, a typical characteristic of NIHL. This specific finding lessens the chances of age related hearing loss while supporting the presence of NIHL in this population. This in accordance with the findings that the outer hair cells (OHCs) in the most basilar part of the Cochlea are the first to get damaged permanently, the area that responds for sound frequencies between 3 and 6 kHz. This has been attributed to the absolute sensitivity as well as the harmonic amplification by the ear canal in response to the noise. Hence, after a long period of noise exposure, sensory neural hearing loss is presented as an audiometric notch, which is usually maximal at 4 kHz but may also range anywhere from 3 kHz to 6 kHz at par with the observations in these temple workers. All these findings increase the possibility of NIHL in the individuals working in the temple premises, in line with the reports by the other researchers on the various populations. The findings of this present study are also in coherence with the findings of the study done on individuals working in the churches who are reported to have hearing loss due to noise exposure. This present study provides valuable insight about the effect of the damaging noise on the hearing in the individuals working in the temple premises. This may be helpful in understanding the impact of noise on the hearing of these individuals. The present findings stress the need to implement good preventable measures for individuals working in the temple premises.

CONCLUSION

These results could be attributed to the impact of the temple noise on the hearing sensitivity of the individuals working in the temple leading to a hearing loss, demonstrating the presence of NIHL among the individuals working in the temple premises. However study needs to be replicated using a larger sample for generalisation of finding.

Source of Funding- Self

Conflict of Interest - Nil

Ethical Clearance- Taken from Institutional Ethical Committee.

REFERENCES