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Correlation between duration of noise exposure and severity of hearing loss

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Abstract

Background and Objective: Noise pollution is one of the commonest occupational and environmental health hazard. The extent of damage to hair cells is determined by the intensity of noise to which a person is exposed, and the duration of noise exposure^[1]. Prolonged exposure to high intensity noise >85dB(A) or more, for eight hours can lead to permanent hearing loss. This exposure can be reduced significantly by using simple ear protection devices. NIHL can be easily prevented through the use of simple and economical tools, but are not used by people due to different reasons.³Our study aimed at determining the relation between the duration of exposure to loud noise on the severity of noise-induced hearing loss. The subjects of our study were train drivers working in an extremely noisy environment for long hours, without using any ear protection tool.

Materials and Method: This study involved 60 subjects, who were all train drivers. They were working in an extremely noisy environment for more than eight hours a day for more than ten years. The responses to brainstem evoked response audiometry were recorded and evaluated for severity of hearing loss.

Result: 60% subjects reported positive for sensorineural deafness. 18.3% of the subjects were having mild degree of hearing loss, 23.3% were having moderate degree of hearing loss and 18.3% were having severe degree of hearing loss.

Conclusion: It was found that the duration of exposure to noise has a positive correlation with the degree of severity of hearing loss ($p < 0.001$), the intensity of noise being the same.

Keywords: Intensity, duration of exposure, ear protection devices, brainstem evoked response audiometry

Introduction

Noise pollution is one of the commonest and preventable occupational health hazard that can be prevented through the use of simple and economical devices. Prolonged exposure to high intensity noise >85dB (A) or more, for eight hours or more can lead to permanent hearing loss. The potential for damage to hair cells is determined by the intensity (loudness) as well as the duration of noise exposure^[1]. When the ear is exposed to excessive sound levels for a long period of time, the overstimulation of hair cells leads to heavy production of reactive oxygen species, resulting in oxidative damage. This causes structural changes and degeneration of hair cells^[2]. Intensity of noise being the same, it is the duration of exposure that influences the severity of hearing loss. Also resistance to damage of hair cells from noise varies from person to person. NIHL is a preventable occupational health hazard. Regular use of ear protection devices have shown to offer good protection against damage to hair cells. Earplugs and earmuffs provide at least 5 to 10dB SPL of attenuation and this provides great protection^[3]. According to the US Department of Labors' Occupational Safety and Health Administration (OSHA), an employer must provide hearing conservation programs for all its employees working at a noise level of 85dB (A) or above for an average 8 hour time period^[4]. Unfortunately, not many institutions provide hearing conservation devices to its employees. Moreover people avoid the use of ear protection devices due to different reasons like lack of comfort, reduced sound quality and embarrassment. Management programs for people with NIHL include counseling and the use of hearing aids^[3]. The prognosis is excellent with the recent advancements in digital hearing aid technology, such as directional microphones and open-fit hearing aids. Our study was done to evaluate the severity of hearing loss among train drivers on the basis of duration of their service years and the use of ear protection device, if any.

Materials and Method

Our study group comprised of 60 train drivers (all males) who were exposed to high intensity noise for more than 8 hours a day over a period of 10 years and more of service. Age group included was 40-50 years. Personal and family history regarding any ear infection and injury, neurological disorder, use of ototoxic drugs etc. was ruled out. The subjects were also enquired about use of any ear protection devices by them. Informed consent was taken. The subjects' hearing capability was assessed using brainstem evoked response audiometry. Recordings were obtained and the data was subjected for statistical analysis. The peak latencies and inter-peak latencies were the important parameters analyzed. Statistical analysis was done using the Student t test and two-tailed Fisher exact test or chi-square (χ^2) test. All means are expressed as mean \pm standard deviation. The critical levels of significance of the results were considered at 0.05 and 0.001 levels i.e. $p < 0.05$ and $p < 0.001$ were considered significant.

Table 2: shows the recordings of BERA in right and left ears

	Mean Absolute Latencies(ms)			Mean Intrapeak Latencies (ms)		
	I	II	III	I-III	III-V	I-V
Right ear	1.761 \pm 0.368	3.733 \pm 0.404	5.770 \pm 0.475	1.972 \pm 0.307	2.036 \pm 0.221	4.008 \pm 0.304
Left ear	1.752 \pm 0.370	3.738 \pm 0.369	5.775 \pm 0.477	1.985 \pm 0.299	2.037 \pm 0.232	4.023 \pm 0.313

Both the peak latencies and the inter-peak latencies of right and left ears were found to be prolonged suggesting prolongation of the conduction time all through the pathway [5, 6, 7].

Table 3: Shows distribution of cases according to severity of hearing loss

Hearing loss	Case
Mild	11(18.3%)
Moderate	14(23.3%)
Severe	11(18.3%)
Normal	24(40.0%)
Total	60

Among the 60 subjects 11 (18.3%) had mild, 14 (23.3%) had moderate and 11 (18.3%) had severe degree of hearing loss [2].

Table 4: Shows the distribution of severity of hearing loss with relation to duration of noise exposure

SNHL (No. of cases)	Service (years)			Total
	11-15	16-20	>20	
Mild	6(22.2%)	4(14.3%)	1(20.0%)	11(18.3%)
Moderate	6(22.2%)	8(28.6%)	0	14(23.3%)
Severe	1(3.7%)	6(21.4%)	4(80.0%)	11(18.3%)
Normal	14(51.9%)	10(35.7%)	0	24(40.0%)
Total	27	28	5	60

The degree of hearing loss was more profound in subjects serving for very long duration. 80% (4/5) of the subjects who were exposed to loud noise for more than 20 years had severe degree of SNHL, while only 3.7% (1/27) of them working for 11-15 years duration had severe degree of hearing loss.

Result

36/60(60.0%) of the subjects were found to be having sensorineural hearing loss. They were further classified as mild, moderate and severe cases on the basis of recordings of BERA [2].

Table 1: Shows the distribution of cases according to duration of service years

Service(yrs)	Case
<10	0
11-15	27 (45.0%)
16-20	28 (46.7%)
>20	5 (8.3%)
Total	60

27/60(45.0%) of the subjects had service duration of 11-15 years. 28/60(46.7%) of them had service duration of 16-20 years, and 5/60(8.3%) worked for more than 20 years.

Table 5: Shows the duration of mean exposure and severity of hearing loss

SNHL	N	Service years	
		Mean	SD
Mild	11	16.09	3.419
Moderate	14	16.86	2.627
Severe	11	*19.09	3.145
Normal	24	14.96	2.562
Total	60	16.37	3.162

* $p < 0.001$; N=no. of cases

As the duration of exposure to loud noise increased the degree of severity of hearing loss also increased ($p < 0.001$).

Discussion

Noise induced hearing loss is a preventable occupational hazard. The use of ear protection devices and hearing conservation programs can greatly reduce the incidence of noise induced hearing loss. It has been proved that earplugs and earmuffs can provide protection of at least 5 to 10 dB, but use of these devices is not routinely practiced. The BERA recording showed prolongation of peak latencies and inter-peak latencies. 36/60(60.0%) of the subjects were reported to be having sensorineural hearing loss. These subjects were further classified as groups having mild, moderate and severe degree of hearing loss.² 11(18.3%) of the subjects were having mild degree of hearing loss, 14(23.3%) were having moderate degree of hearing loss and 11 (18.3%) were having severe degree of hearing loss. But 24 (40.0%) of the subjects were reported to have normal hearing. This may be possible because these 24 subjects had lesser duration of exposure, mean 14.96(\pm 2.562) yrs. The capability of hearing and resistance to damage from noise varies from person to person.

But the duration of exposure was found to have a great impact on the severity of hearing loss, intensity of noise being the same. We found a significant correlation between duration of exposure to loud noise and severity of hearing loss ($p < 0.0001$). As the duration of exposure to loud noise increased the degree of severity increased ($p < 0.001$). The longer the subjects were exposed to loud noise greater the severity of the hearing loss which was reflected by prolongation of absolute latencies and inter-peak latencies. This is due to the fact that continuous exposure to high intensity noise for long duration causes profound damage to inner hair cells, leading to changes in the BERA recordings [8, 9].

We also found that none of the subjects were using any kind of ear protection devices. When asked many of them were not even aware of such devices. Those who were aware of the devices were not using them for different reasons like embarrassment and discomfort. It has been found that although the response rate for their use is 78%, only 4% of the exposed individuals agree to use personal protection devices [10].

Therefore it is highly recommended that the use of such personal protection devices should be encouraged and made obligatory. In fact these should be provided positively by the institution itself. In addition, the institution should encourage and arrange for regular audiological evaluations using BERA technique. With these simple steps early detection of hearing loss and early intervention to halt its progression can be done.

Conclusion

The duration of exposure to continuous heavy noise has been found to be directly associated with the degree of severity of hearing loss. Therefore regular audiological evaluations using BERA should be encouraged by the institution. It is also proven that the use of earplugs and earmuffs reduces the damage caused to the hair cells. Therefore use of these devices should be encouraged their use should be made obligatory.

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