Effects of Hyperlipidemia on Noise Induced Hearing Loss (NIHL)

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Abstract Likelihood of developing noise induced hearing loss (NIHL) is affected by some factors such as genes, nutrition and healthy hearing habits. We investigated this study to determine the effect of hyperlipidemia on NIHL. In a case–control study, 144 workers who exposed to continuous noise more than 85 dBA (88–89 dBA) from a textile factory in Tehran were examined. Serum Blood test results as index for dyslipidemi, were collected and audiometry tests were carried out to analyze the association of hyperlipidemia and NIHL. The mean $\pm$ SD of Cholesterol level for NIHL and control were 188.19 (28.46) and 159.00 (26.66) mg/dL respectively. Also the mean $\pm$ SD of Triglyceride level for NIHL and control were 203.75 (53.92) and 105.00 (30.50) mg/dL consecutively. After adjusting odds ratio (OR) for NIHL, only hypertriglyceridemia had association with NIHL. (aOR = 1.07; 95 % CI 1.04–1.10), and there wasn't any relation between hypercholesterolemia and NIHL (aOR = 1.02; 95 % CI 0.99–1.05). Workers with hypertriglyceridemia are at increased risk for NIHL. In factories with elevated noise levels, besides hearing conservation programs, attention to blood serum level of workers and healthy diet are proposed to help in preserving hearing threshold.

Keywords Hyperlipidemia · Noise induced hearing loss (NIHL) · Hypercholesterolemia · Hypertriglyceridemia · Textile workers

Introduction

Noise induced hearing loss (NIHL) is the most common occupational diseases which is preventable [1].

Some factors like age, gender, race, family history of ear diseases and metabolic disorders such as hypertriglycerides and diabetes affect developing it [2].

Although some studies pointed to hyperlipidemia role in NIHL [3], pathogenic mechanism is unknown. It seems that dyslipidemia causes microcirculation disorders in inner ear [2]. Hyperlipidemia, hyperviscosity and atherosclerosis bring about perfusion in cochlea and hearing impairment [4].

Nowadays, as there isn't any definite treatment for NIHL, identify diverse factors in developing NIHL in preventing of incidence of it, is essential. Also, based on widespearing of dyslipidemia [5] and preventability of NIHL [1], also exploring more evidence about correlation of this disorder with NIHL, demographic data, audiometric tests and hearing examination of workers who exposed to 88–89 dBA were analyzed.

Material and Methods

Study Group

Data were collected from 144 textile workers who exposed to continuous noise more than 85 dBA (88–89 dBA) for 8 h. All the participants in the study were male. A case–control study was carried out in workers under 50 years old, without any

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pathological ear disease or surgery, no ototoxic drugs consumption or ear trauma for 3 months. They didn't wear any hearing protection devices (HPD). Before the study, all the participants signed the informed consent.

Otoscopy, tympanometry and audiometry tests (pure tone audiometry, PTA) was done by an audiologist who was blinded to the subjects. Tympanometry device applied was Madsen GN otometrics. PTA was carried out by clinical audiometer (PC-based Interacoustic, Equinox AC 440, Denmark by TDH39) in an acoustic room in the factory. It was recorded at six frequencies (0.5, 1, 2, 3, 4 and 8 kHz). As the first sign of hearing loss from noise espousing is a notch of the audiogram at 3, 4 or 6 kHz, with recovery at 8 kHz [6], we used 3 and 4 kHz for detecting NIHL. Sound was measured via sound level meter (SLM) (Larson Davis Model 824, Provo, Utah, USA).

After that, Participants based on hearing loss were allocated into two groups: normal hearing (≤ 25 dB) and NIHL group (> 25 dB).

Besides, according to US National Institutes of Health (NIH), Adult Treatment Panel III of National cholesterol Education program, workers were subdivided concerning serum cholesterol and triglyceride level: a normal cholesterol group < 200 mg/dL or hypercholesterolemic group ≥ 200 mg/dL, and also a normal triglyceride group < 150 mg/dL or hypertriglyceridemic group ≥ 150 mg/dL.

Statistical Analysis

The Logistic regression model was used to estimate the odds of a NIHL as a function of the Cholesterol and Triglyceride levels. We looked specifically for interaction between two covariates (Cholesterol $\times$ Triglyceride), and we excluded this nonsignificant term. The results are presented as ORs and their 95 percent CIs. All analyses were carried out by using SPSS software Package, version 16.

Results

Our data included 144 men aged 25–50 years with a mean age of 36.9(95 % CI 34.90–37.28) and 36.53(95 % CI 35.31–37.75) years for NIHL ($n = 68$) and control ($n = 76$) groups, respectively. The mean Cholesterol level for NIHL was 188.19 (28.46) and for control group was 159.00 (26.66). Also the mean Triglyceride level was 203.75 (53.92) mg/dL for NIHL and 105.00 (30.50) mg/dL for control group (Table 1).

We planned to start with fitting a preliminary Logistic model to observe the influence of the independent variables on NIHL. Our test of interaction (Cholesterol $\times$ Triglyceride) showed that the association between the Triglyceride level and NIHL was not different among Cholesterol levels ($P = 0.29$). In Logistic model controlling for Cholesterol level, the odds of NIHL increased with increasing

Table 1 Characteristics of the analytical sample by groups

Variables	NIHL		Control		P value*
	Mean	SD	Mean	SD	
Age (year)	35.75	5.24	36.53	5.34	0.38
Cholesterol level (mg/dL)	188.19	28.46	159.00	26.66	< 0.001
Triglyceride level (mg/dL)	203.75	53.92	105.00	30.50	< 0.001

* Student's t test

Table 2 Adjusted^a odds ratios for NIHL

Independent variables	Odds ratio	95 % confidence interval
Cholesterol level (mg/dL)	1.02	0.99–1.05
Triglyceride level (mg/dL)	1.07	1.04–1.10

Triglyceride level: obesity odds ratio was 1.07(95 % CI 1.04–1.10) (Table 2). We infer that a 1-mg/dL increase in Triglyceride has 7 % increases in the odds of NIHL.

An association was observed between Cholesterol level and NIHL (but nonsignificant). NIHL odds ratio was 1.02 (95 % CI 0.99–1.05) for Cholesterol level (Table 2).

Discussion

Our findings of this study showed that in workers with elevated triglyceride (hypertriglyceridemia), risk of NIHL was greater than ones with normal triglyceride levels. But elevated cholesterolemia didn't have significant relation with NIHL.

Sensorineural hearing loss (SNHL) is more prominent in high levels of cholesterol, triglyceride, low LDL and HDL concentration patients [7, 8] and in NIHL participants [3].

In animal research, structural changes like vacuolar degeneration, paranchymal protuberance of the stria vascularis and the surface of organ of corti, isolation of the labiates structure of the myelin sheath of the cochlear nerve, clearance of the intermediate cells cytoplasm in the stria vascularis, high pinocytotic vesicles in the endothelium of cochlear vascular supplies, elevated vacuoles in the outer hair cells (OHCs) had observed [9–11].

Also, the other proposed mechanism is increased blood viscosity and atherosclerosis of the cochlear vessels due to dyslipidemia which lead to blood perfusion of the cochlea and propagate hearing impairment [12–14]. Moreover, as OHC function is sensitive to dyslipidemia [7, 15, 16] and in NIHL, OHCs are the most susceptible sensory cells of the cochlea to noise overexposure [17]. So it is not illogical to expect that dyslipidemia lead to more NIHL.

Besides animal studies, some human researches have done to evaluate the relationship between hyperlipidemia and NIHL. Chang et al. [3] assessed the influence of

hyperlipidemia in NIHL workers and found the relationship between hypertriglyceridemia and NIHL.

Another study has conducted by Arlien-soborg et al. [18] to analyse the association between noise exposure and serum lipid level. Although levels of total cholesterol, LDL-cholesterol, triglycerides and cholesterol/HDL ratio increased by occupational noise exposure, but after adjusting the effect, it was not significant. There are some differences between this research and ours: (a) They didn't consider the use of HPD in workers (workers should have the same circumstances) (b) Also in theirs, the noise exposure level was different (between 57 and 114 dBA) but it was limited and determined in our study (88–89 dBA).

New strategies applied for preventing NIHL like antioxidants are effective [19, 20], nevertheless recognizing different factors accompanied increasing risk of NIHL like dietary regimens are essential. Food low in saturated fats and management of dyslipidemic workers (like take them to less noise sites or decrease work hours) are recommended.

Our study had some strength: noise level was determined (limited to 88–89 dBA). Also all workers were similar about not wearing HPD.

Limitation and scope for future studies included: Measure the other blood serum levels factors such as LDL, HDL and blood pressure. Apply the other instruments such as extended high frequency audiometry, otoacoustic emissions and auditory brainstem response, evaluate women workers and the others who expose to nonoccupational noise and acoustic trauma.

Conclusion

Taken together, as there isn't any definite treatment for NIHL, identify diverse factors in developing NIHL in preventing of incidence of it, is essential. In factories with elevated noise levels, besides hearing conservation programs, attention to blood serum level of workers and healthy diet are proposed to help in preserving hearing threshold. To have the best results in this aspect, larger studies are needed to be performed.

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