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Original article

ASSESSMENT OF THE CONSERVATIVE EFFECT OF SPORTS ON HEARING FUNCTION

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Abstract

Objectives: Hearing loss for the young age population is getting a more significant problem with the use of phones as music players. Today, exposure to noise above 70 dBA is considered as a risk factor for hearing loss. Especially increased sound levels, while listening to music in noisy environments (traffic, etc.) with insert phones are thought to have caused this problem. Free radicals and blood circulation disorders in the 4000 Hz region of the cochlea play a part in the mechanism of this hearing loss. The effect of physical exercise on both distortion product otoacoustic emissions (DPOAE), and on the temporary effects of noise on human cochlear function was examined. Early changes of the micromechanical role in the cochlea can be monitored by otoacoustic emissions (OAEs). OAEs have been shown to be physiologically vulnerable and to reflect the mechanical nonlinearity of the cochlea. Changes in DPOAEs were compared to changes in behavioural thresholds and the susceptibility to noise exposure was investigated. The objective of this study is to assess the conservative effect of sports in noise-induced hearing loss (especially on 4000 Hz). Sport is an effective way to improve circulation and reducing free radicals and also increasing body temperature. These factors are considered to be protective for hearing loss.

Methods: For this study, 20 athletes and 20 control group individuals who listen to music for at least two hours a day with headphones will be evaluated with audiometry (4000 Hz) and otoacoustic emission tests. After assessed with emission and audiometric examination, they will be made to listen to noise at 2000 Hz for 10 minutes and afterward will be evaluated once more.

Result & Conclusion: According to our study doing sport regulary was not significantly protective for temporary threshold shifts (TTS). However, the athletes was not professional and all participants were young. This study can be improved and research group should be enlarged with older people.

Keywords: sports, otoacoustic emissions, music, 4000 Hz.

Introduction

Hearing is the perception of the sounds in the brain. The perception process has three main steps: Conductive (Outer ear and middle ear), Sensory (Inner ear) and Neural pathway (VIII. CN). Cochlea works as a frequency detector with the help of inner and outer ear hair cells. Noise is generally defined as unwanted sound. It has been known that exposure to noise for a long time can be damaging for hearing sensitivity. (Melnick, 1991)

Exposure to noise causes the increase of reactive oxygen species (ROS) and free radicals in the cochlea, which due to overactivation of mitochondria, enzymatic reactions. These free radicals are changed to hydroxyl radicals in stria vascularis with high destructive effect. Reactive oxygen species cause damage to the hair cells of the cochlea.(Doosti et al., 2014)

Changes in hearing ability are usually caused by fatigue in nuclei of the central auditory pathways, reduced activity of the primary afferent neurons, decreased oxygen tension in the cochlear endolymph and local vasoconstriction, particularly of the stria vascularis. (Alessio & Hutchinson, 1992)

Noise can affect cochlea and/or auditory neural pathway. Since temporary or permanent threshold shift occurs.(Ryan, 2017)Temporary threshold shifts (TTS) when the temporary hearing loss occurred, hearing ability returned to normal in all subjects within 48 hours, following the short-term hearing loss. In the noise conditions, TTS occurred at 3000, 4000 and 6000 Hz. This TTS was expected since noise occasions maximum threshold shifts in octaves above the center frequency of the noise band. (Alessio & Hutchinson, 1992)

Hearing loss for the young age population is getting a more significant problem. Lately, as

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portable music players (MP3 players, and smartphones) become more common, especially among young people, the problem of the potential impact of reproduced music on the auditory system is receiving more interest. Today, exposure to noise above 70 dBA is considered as a risk factor for hearing loss (Katz et al.). Especially increased sound levels, while listening to music in noisy environments (traffic, etc.) with insert phones are thought to have caused this problem.

The cardiovascular system is believed to be a key regulator of hearing sensitivity. One widely held theory is that a reduction in blood flow through the inner ear causes temporary threshold shifts (TTS) and following short-term hearing loss. (Alessio & Hutchinson, 1992). Chronic cardiovascular adaptations to physical training might attenuate the level of hearing loss from noise exposure, hence protecting hearing sensitivity. (Cristell, Hutchinson, & Alessio, 1998)Increased body temperature and release of chemical substances, which cause the changes in metabolic activity, (Lindgren & Axelsson, 1988)possible inhibition of the stapedius reflex during exercise (Colletti et al., 1991)have been suggested as possible explanations.

The objective of this study is to assess the conservative effect of sports in noise-induced hearing loss (especially on 4000 Hz). Sport is an effective way to improve circulation and reducing free radicals and also increasing body temperature. These factors are considered to be protective for hearing loss.

Methods

We have included 40 people for this study. We tested the subjects in two groups. The first group is the control group and the second group is the group of athletes. The control group (mean=20,1 ± 0,9) and the athlete group's (mean =20,6 ± 1,9) ages are close to each other. Control group has 12 women and 8 men and the athlete group has 10 women and 10 men. The athlete group has 13 volleyball and 3 tennis players with 4 kickboxers.

Figure 1: Anechoic cabin where we do our measures.

To have a homogeneous outcome, both groups have selected from people who listen to music for at least 2 hours a day. Other acceptance criteria for all of them: being 18-25 years old, have normal hearing, being healthy, listen to music with earphone for at least 2 hours a day. Acceptance criteria for athletes: doing exercise at least 2 days a week and doing said sport for at least 3 years. We prepared a survey that includes 8 questions for the participants` personal information. These questions are about frequency and duration of exercise, gender, age, smoking, interested in sport, stress level, duration of listening music, medical history.

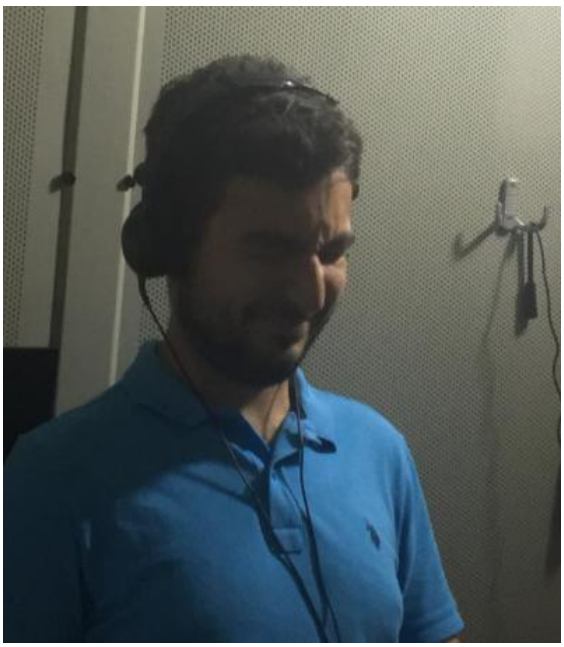

Figure 2: While participants were exposing to noise in anechoic cabin.

The cochlear hair cells are divided into two types: outer hair cells (OHCs) and inner hair cells (IHCs). OHCs are the most sensitive and susceptible sensory cells of the cochlea to overexposure to noise. OHCs' activities are evaluated by otoacoustic emissions (OAEs). Distortion product OAE (DPOAE) is a sensitive method for assessing the small changes in OHCs function. DPOAE is a test for measuring hearing thresholds at speech frequencies(Attias, Horovitz, El-Hatib, & Nageris, 2001). We recorded the outer hair cell responses on 250-8000 Hz frequencies with Distortion OtoAcoustic Emissions (DPOAE) by Otodynamics Echoport ILO292-II device, and we used 226 Hz UGD TE+DPOAE Probes. We recorded air conduction thresholds Interacoustics AC-40 device which has two channel and can measure high frequencies. We took the 4 kHz frequency thresholds into consideration. After assessed with emission and audiometric examination, we exposed them to noise for 10 minutes. Noise exposure was third-octave band noise of 102 dB SPL centered at 2 kHz by Interacoustics AC-40 device. Afterwards the participants` air conduction thresholds and OAEs were evaluated once more.

Figure 3: Inside of anechoic cabin where participants expose to noise.

Statistical Analysis

We used SPSS IBM 25.0 statistical program for evaluation and calculation of the data. Then summarized the data and evaluated the means and standard deviations. We used the paired sample T-test and unpaired T-test to explain the differences between athletes and non-athletes hearing function after noise exposure. Also, to explain the differences between measurements, repeated measurements analysis of variance was used according to the results of the test of normality. The significance level was taken as 0.05.

Results

We measured the participants' air conduction thresholds and DPOAE responses after noise exposure we measured again. For both air conduction thresholds and DPOAE responses, there was no significant difference between before and after the noise exposure results. ($p>0.05$) So, there is no notable conservative effect of sports on hearing function between athletes and the control. As shown in Table 1, the hearing function did not change with 10 minutes of noise exposure in athletes and the control group.

Table 1: Before and after assessment values

	Variables	N	Mean	Std. Deviation	Std. Error Mean	Sig. (2-tailed)
Difference	Left Ear Pure Tone Threshold İn Control Group	20	-,2500	4,12789	,92302	0,087
	Left Ear Pure Tone Threshold İn Athlete Group	20	-,5000	6,66886	1,49120	

	Right Ear Pure Tone Threshold İn Control Group	20	1,0000	4,75727	1,06376	0,264
	Right Ear Pure Tone Threshold İn Atlete Group	20	3,5000	8,59927	1,92285	
	Left Ear Signal Noise Ratio in Control Group	20	,9200	5,34540	1,19527	0,549
	Left Ear Signal Noise Ratio in Athlete Group	20	-,1950	6,29273	1,40710	
	Right Ear Signal Noise Ratio in Control Group	20	,0250	6,20457	1,38738	0,928
	Right Ear Signal Noise Ratio in Athlete Group	20	,2150	6,90456	1,54391	

Discussion

Sport and doing exercises routinely for the lifetime known as a protector of health. This protection mainly depends on the improvement of cardiovascular system functions. The noise-induced hearing loss seems to be related with free oxygen radicals and the vascular system of the cochlea.

At the beginning of the study, because of the known effects of sports that related to decreasing the free oxygen radicals and improving the body vessels, we thought that doing exercises as a lifestyle can help to protect the hearing. Also, sports helps to enhance the mood by increasing the serotonin and some other neuropeptides that has also modulator effects in cochlea. (Papesh et al., 2016) However, the results of our study show no significant effect on the hearing thresholds and outer hair cell functions.

According to Engdahl (2004), there was a positive correlation between the temporary effect of noise exposure. The other studies mostly were done while the participants were doing exercise (Colletti et al., 1991; Alessio & Hutchinson, 1992). Moreover, mostly they reveal that TTS is increasing while doing sports. They explain this situation: increasing of the free oxygen radicals at sport, increasing the body temperature that causes increased sensitivity for damage and decrease the activity of stapedius muscle which is one of the vital protectors of the cochlea.

In our study, we try to show the long-term effects of doing exercise for hearing protection. Our research shows no significant change for the control group and athletes. No significant difference at control group for our study. The reason for this result might be noise was not enough, individuals are young and listen to music routine 2 hours per a day, so they have adaptation to noise more than the others who do not listen.

Cristel et al. (1998), made people do aerobic for eight weeks then controlled the TTS. So they had control about participants sports duration and intervals. They have significantly improved results after participants did 8-week aerobic programme.

Other studies that include TTS and exercise used the same noise. (Alessio & Hutchinson, 1992; Cristell et al., 1998; Engdahl, 2004). So we choose the same noise. Both groups listen to music for the same duration, and we detected by a survey. Because the individuals were young, their blood structures have been affected less, and free oxygen radicals affected them less than older people. Thus both groups might have tolerance for noise. Due to the control group data did not change, we thought we could not measure the athletes. So, the research group should be enlarged and counted older people in the study.

Conclusion

The cardiovascular system is believed to be a key regulator of hearing sensitivity. Sport increases the blood flow through the inner ear that might be protective for TTS. In our study, we try to show the long-term effects of doing exercise for hearing protection. According to our research doing sport regularly was not significantly protective for temporary threshold shifts. However, the athletes were not professional, and all the participants were young. This study can be improved, and the research group should be enlarged with older people.

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