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The Relationship Between Noise-Induced Occupational Sensorineural Hearing Loss and Platelet Panel: A Retrospective Study

Gürültüye Bağlı Mesleki Sensorinöral İşitme Kaybı ve Trombosit Paneli Arasında İlişki: Retrospektif Bir Çalışma

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Abstract

Objectives: There are various risk factors such as age, genetics, smoking, hypertension, diabetes mellitus, and vascular diseases that affect noise-induced Occupational Sensorineural Hearing Loss (OSNHL). In addition to nerve damage, pathology may occur in the vascular and hematological structure of the cochlear system in sensorineural hearing loss. For this reason, we wanted to evaluate the relationship between platelet panel parameters and hearing loss.

Materials and Methods: Socio-demographic characteristics, audiometry results, platelet parameters, physical examination and admission complaints were collected in the data package by retrospectively scanning patient files. The patients were evaluated for the presence of OSNHL. Subgroup analysis was performed. Since all patients work in similar industrial environments, it was assumed that there would be a risk of noise in all of them.

Results: The mean age of the patients was 40.0±8.3 (302 patients). Patients with OSNHL were older than those without hearing loss (43.5±8.0; 36.2±6.9 p<0.001). The ratio of male and female patients with OSNHL was 146/11, and 139/6 in those without hearing loss. Platelet count and plateletcrit values of patients with OSNHL were found to be higher and statistically significant (275.7±62.4, 245.1±42.0 p<0.001, 0.28±0.06; 0.25±0.04 p<0.001, respectively). There was no difference between mean platelet volume (MPV) values (10.4±0.8; 10.3±0.8 p=0.654). There was no significant correlation between age, smoking and platelet panel in patients with and without hearing loss (Pearson's correlation analysis). Receiver operating characteristic analysis of thrombocyte counts, plateletcrit and MPV values of patients with hearing loss was performed [respectively; area under the curve (AUC)=0.64 (0.57-0.70 p<0.001), AUC=0.65 (0.58-0.71 p<0.001), AUC=0.52 (0.45-0.58 p=0.522)].

Conclusion: Platelet count and plateletcrit values are higher in patients with OSNHL than those without hearing loss, regardless of age and smoking.

Key Words: Noise, Platelet, Plateletcrit, Occupational, Sensorineural Hearing Loss

Öz

Amaç: Gürültüye bağlı Mesleki Sensorinöral İşitme Kaybı'nı (MSNİK) etkileyen yaş, genetik, sigara, hipertansiyon, diabetes mellitus, vasküler hastalıklar gibi çeşitli risk faktörleri mevcuttur. Sensorinöral işitme kaybında sinir hasarının yanı sıra koklear sistemin vasküler yapısında da patoloji oluşabilir. Bu sebepten trombosit paneli parametrelerinin işitme kaybı ile ilişkisini değerlendirmek istedik.

Gereç ve Yöntem: Hasta dosyaları geriye dönük taranarak sosyo-demografik özellikleri, odyometri sonuçları, trombosit parametreleri, fizik muayene ve başvuru yakınmaları veri paketinde toplandı. MSNİK tanısı almış ve almamış hastalar iki alt gruba ayrıldı. Tüm hastalar aynı ortamlarda çalıştığı için hepsinde gürültü riski olacağı varsayıldı.

Bulgular: Hastaların ortalama yaşı 40,0±8,3 idi (toplam 302 hasta). MSNİK tanılı hastalar, işitme kaybı olmayanlara göre daha yaşlıydı (43,5±8,0; 36,2±6,9 p<0,001). MSNİK tanılı erkek ve kadın hasta oranı 146/11, işitme kaybı olmayanlarda ise 139/6 idi. MSNİK'li hastaların trombosit sayısı ve plateletkrit değerleri daha yüksek ve istatistiksel olarak anlamlı saptandı (sırasıyla, 275,7±62,4; 245,1±42,0 p<0,001, 0,28±0,06; 0,25±0,04

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Öz

p<0,001). MPV değerleri arasında bir fark yoktu (10,4±0,8; 10,3±0,8 p=0,654). İşitme kaybı olan ve olmayan hastaların yaş/sigara ve trombosit paneli arasında yapılan Pearson korelasyon analizi anlamlı değildi. İşitme kaybı olan hastaların trombosit sayıları, plateletkrit ve MPV değerlerinin alıcı işlem karakteristikleri analizi yapıldı [sırasıyla; eğri altında kalan alan (AUC)=0,64 (0,57-0,70 p<0,001), AUC=0,65 (0,58-0,71 p<0,001), AUC=0,52 (0,45-0,58 p=0,522)].

Sonuç: MSNİK'li hastalarda trombosit sayımı ve plateletkrit değerleri yaş ve sigaradan bağımsız olarak işitme kaybı olmayanlara göre daha yüksek seyrediyor.

Anahtar Kelimeler: Gürültü, Trombosit, Plateletkrit, Mesleksel, Sensorinöral İşitme Kaybı

Introduction

Hearing loss is grouped as conductive, sensorineural, or mixed type. Conductive hearing loss develops due to pathologies of the outer ear (eardrum) and middle ear. There is an obstacle in the transmission of sound and its conversion into mechanical vibrations. Sensorineural hearing loss is due to damage to the inner ear (cochlea) or auditory nerve, there is a problem in the conversion of mechanical sound into neuroelectric signals in the inner ear. Mixed hearing loss is a combination of conductive and sensorineural hearing loss (1). The main causes of sensorineural hearing loss are aging, genetic mutations, exposure to noise, exposure to ototoxic drugs, and degenerative processes associated with chronic conditions (2). Vasculitic diseases such as polyarteritis nodosa, giant cell arteritis, granulomatous polyangiitis affecting the vessels of the vestibulecochlear system cause sensorineural hearing loss (3). Strong associations between sensorineural hearing loss and other risk factors such as smoking, adiposity, diabetes mellitus and cardiovascular disease are supported by epidemiological studies, but causality remains unclear. In a study involving people aged 43–84 years, smoking, central obesity, and poorly controlled diabetes mellitus were associated with hearing loss later in life, suggesting that vascular changes contribute to age-related hearing loss (4).

Noise-induced hearing loss in the workplace is an important health problem with economic consequences. Occupational noise exposure causes 7-21% hearing loss among workers; this rate is lowest in industrialized countries where the incidence has decreased and highest in developing countries (5). Occupational Sensorineural Hearing Loss (OSNHL), unlike acoustic trauma, develops over time because of continuous or intermittent exposure to noise. The main features are that it is bilateral, always sensorineural, cochlear hair cells are affected in the inner ear, and the first sign is "notching" (occurs at 3000, 4000, 6000 Hz, and heals at 8000 Hz). OSNHL risk increases with prolonged noise exposures above 80 dB and increases significantly as exposures rise above 85 dB (6).

Platelets are small, non-nucleated cells derived from megakaryocytes in the hematopoietic system. The platelet production from megakaryocytes is a systematic and regulated process thought to occur in the bone marrow and, as recently shown, in the lung (7). Platelet count (PC), mean platelet volume (MPV), and plateletcrit (PCT) are some of the most important platelet panel parameters in the hemogram. Platelets are the most important cells of the peripheral blood, involved in hemostasis and thrombosis formation in blood vessels. Mediators and substances released from platelets (such as P-selectin) play an important role in the progression of coagulation, inflammation, thrombosis and atherosclerosis. Since the cochlear artery is a terminal branch of the anterior-inferior cerebellar artery with poor collateral circulation, any pathology affecting collateral blood flow at this location can damage the cochlea and can cause hearing loss (8).

In this study, we wanted to review the relationship between the platelet panel of patients with a diagnosis of noise-induced OSNHL.

Materials and Methods

Data Source and Study Population

The study was conducted on the data obtained from the polyclinic records of the patients who applied to the Ege University Faculty of Medicine Hospital Occupational Diseases polyclinic between November, 2015-October, 2021. Patients who had been exposed to noise for at least two years and had hemogram and audiometry results were evaluated. Additionally, sociodemographic characteristics of the patients, working conditions, physical examination, complaints at admission, smoking, body mass index (BMI) information were retrospectively obtained from the polyclinic records. Patients with chronic diseases thought to affect the platelet panel (such as anemia, cancer, rheumatological diseases) and patients with abnormal blood infection markers (such as sedimentation, C-reactive protein) were excluded from the study. Patients with a history of ototoxic drug use, sudden hearing loss and acute trauma were excluded from the study. The study complied with the Declaration of Helsinki, and approved by the Ethics Committee and the Institutional Review Board of Ege University Faculty of Medicine (approval no: 21-10.1T/1; date: 27.10.2021).

Statistical Analysis

IBM SPSS Statistics 24 program was used in the analysis of the data. Categorical variables were expressed in cross-tables and numerical variables in the mean, median, standard deviation, minimum and maximum. In the comparison of independent categorical variables, chi-square test was used. The existence of a statistically significant difference was examined with Student's t-test for the parametric among the groups in terms of continuous variables, and the Mann-Whitney U test for nonparametric variables. Pearson's correlation analysis was also performed. P-values of <0.05 were considered statistically significant. Receiver operating characteristic (ROC) analysis was performed between the variables.

Results

The mean age of all patients included in the study was 40.0±8.3 (302 patients) (Table 1). Of all patients, 94.4% (285 patients) were males and 5.6% (17 patients) were female. The ratio of male and female patients with OSNHL was 146/11, and 139/6 in those without hearing loss (Table 2). Patients with OSNHL were older than those without hearing loss (43.5±8.0; 36.2±6.9 p<0.001). Working time, BMI and smoking status of the patients were higher and statistically significant than those without the disease (respectively, 22.6±9.4; 14.7±7.7 p<0.001, 27.1±4.3; 26.1±3.8 p=0.039, 10.6±9.9; 7.7±7.6 p=0.005) (Table 3).

The mean PC, PCT and MPV of all patients are shown in Table 1. PC and PCT values of patients with occupational hearing loss were higher and statistically significant in the study (respectively, 275.7±62.4; 245.1±42.0 p<0.001, 0.28±0.06; 0.25±0.04 p<0.001). There was no difference between MPV values (10.4±0.8; 10.3±0.8 p=0.654) (Table 3). ROC analysis of thrombocyte counts, PCT and MPV values of patients with hearing loss was performed [respectively; area under the curve (AUC)=0.64 (0.57-0.70 p<0.001), AUC=0.65 (0.58-0.71 p<0.001), AUC=0.52 (0.45–0.58 p=0.522)] (Figure 1).

Of the patients with occupational hearing loss, 79.6% (125 patients) did not have any hearing complaints at the time of diagnosis. Hearing difficulty was the most common active complaint [(14.7%+3.2%)/28 patients]. While the most common accompanying occupational diseases were musculoskeletal diseases [31.2% (49 patients)] and pneumoconiosis [19.1% (30 patients)], 41.4% (65 patients) of the patients did not have any concomitant occupational disease. Hearing loss was bilateral in 94.3% of the patients (148 patients) (Table 4).

When the audiograms of patients with OSNHL were examined, the mean hearing threshold was found to be 46.6±17.5 dB on the right and 46.8±16.2 dB on the left at high frequencies (Table 4).

Pearson's correlation analysis was performed for the relationship between age smoking and platelet panel in patients with and without hearing loss. No significant correlation was found (Tables 5 and 6).

Discussion

Because of the study, we observed that our patients with a diagnosis of hearing loss were older, had a higher BMI, had

Table 1: Demographic characteristics and laboratory of all patients

Variables	n	Mean±SD	Min.	Max.
Age (year)	302	40.0±8.3	23	63
Working time (year)	302	18.8±9.5	1	48
Smoking (packyear)	290	9.2±9.0	0	36
BMI (kg/m^2)	297	26.7±4.1	17	48
Thrombocyte (10^3/µL)	286	261.0±55.6	142	544
Plateletcrit (%)	286	0.27±0.05	0.15	0.50
MPV (fL)	286	10.4±0.9	8.5	13.4
Hemoglobin (g/dL)	286	15.3±1.1	13.0	18.1

n: Number of patients, SD: Standard deviation, Min.: Minimum, Max.: Maximum, BMI: Body mass index, MPV: Mean platelet volume

Table 2: Gender table of all patients included in the study

		OSNHL	
		Yes	No
Gender	Women	11 (7.0%)	6 (4.1%)
	Men	146 (93.0%)	139 (95.9%)
Total		157 (100%)	145 (100%)

OSNHL: Occupational Sensorineural Hearing Loss

a longer working time and smoked more than those without. These are information supported by the literature. Interestingly, patients with occupational hearing loss had higher PCs and PCT than those without. Age and smoking did not affect this condition. The ROC curve for platelets and PCT was interpreted in the weak range (0.6-0.7). Noise did not be a reason, because all patients were selected from the same working environment.

Sensorineural hearing loss is the result of damage to the organ of Corti (the region of the cochlea that contains hair cells) and/or stria vascularis damage, which provides metabolic support to the organ of Corti and provides an electrochemical potential, which is the driving force in the transmission of sound by sensory hair cells (2). Prolonged exposure to loud noise can cause permanent hearing loss because of the death of many hair cells that detect sound. Besides noise, there are many modifiable and non-modifiable risk factors that can cause the progression of noise-induced hearing loss. Modifiable risk factors are smoking, obesity, diabetes mellitus, and insufficient exercise, while non-modifiable risk factors are age, race, and genetics. These factors overlap with noise and accelerate the occurrence of noise-induced hearing loss (9).

In many studies, hearing loss has been associated with cochlear microcirculation. Hairy cells are extremely sensitive to oxygen deficiency. Exposure to noise causes cochlear blood vessels to contract. Ischemia-reperfusion damage, which becomes permanent because of long-term exposure, releases free oxygen radicals in the endothelium (9). This information prompts considerations about whether platelets affect noise-induced cochlear vascular damage.

If we look at the relationship between platelets and the vestibulocochlear system, in a study conducted on 43 patients with primary thrombocythemia, peripheral vestibular system involvement was found in 20.9% (9 patients) of the patients and it was associated with microcirculation disorder due to platelet dysfunction (10). In Cogan syndrome, which is a rare autoimmune disease, there is a coexistence of platelet elevation and sensorineural hearing loss (11).

Thromboxanes are potent vasoconstrictors released by activated platelets and cause platelet aggregation. The risk of occlusive vascular events is high in patients whose thromboxane levels are not adequately suppressed. In the study conducted in patients with tinnitus, it was found that the thromboxane level was higher than the control group, in other words, platelets were more active in patients with tinnitus (12).

Ex vivo, whole blood, flow studies have shown that fibrillary collagens (types I and type III) found in the vascular intima and media, as well as in atherosclerotic plaques, are among the most potent platelet-activating agents (13). Proteins such as secretogranin III, cyclophile A and calumenin have been identified that have been confirmed to be localized in the platelet structure of atherosclerotic human vessels and released upon activation. The presence of these proteins is thought to contribute to atherosclerosis and thrombosis in the vessel walls (14). In a meta-analysis, low platelet glycoprotein IIIa receptor

Table 3: The relationship between Occupational Sensorineural Hearing Loss and different variables

Variables	OSNHL	n	Mean±SD	p-value
Age (year)	Yes	157	43.5±8.0	<0.001
	No	145	36.2±6.9	
Working time (year)	Yes	157	22.6±9.4	<0.001
	No	145	14.7±7.7	
Smoking (packyear)	Yes	150	10.6±9.9	0.005
	No	140	7.7±7.6	
BMI (kg/m^2)	Yes	156	27.1±4.3	0.039
	No	141	26.1±3.8	
Hemoglobin (g/dL)	Yes	149	15.3±1.1	0.328
	No	137	15.4±1.0	
Thrombocyte (10^3/µL)	Yes	149	275.7±62.4	<0.001
	No	137	245.1±42.0	
Plateletcrit (%)	Yes	149	0.28±0.06	<0.001
	No	137	0.25±0.04	
MPV (fL)	Yes	149	10.4±0.8	0.654
	No	137	10.3±0.8	

Student's t-test, p-value <0.05 is significant
OSNHL: Occupational Sensorineural Hearing Loss, n: number of patients, SD: Standard deviation, BMI: Body mass index, MPV: Mean platelet volume

level was associated with a good prognosis in patients with sudden sensorineural hearing loss (p=0.037) (15).

In a retrospective study on diabetic sensorineural sudden hearing loss, the PC and PCT value were found to be higher than the control group, and even the PCT value was found to be statistically significant (278±82, 268±74 p>0.05, 0.31±0.08, 0.28±0.04 p<0.05, respectively) (16).

Vascular disorders and high plasma viscosity can cause sensorineural hearing loss due to cochlear damage. In an environment where the PC is relatively high, it is much more common for the vascular structures feeding the cochlear system to be damaged by continuous vasoconstriction due to noise. In the study by Sagit et al. (17), the PC and PCT value of the patients with sudden idiopathic hearing loss were found to be higher than the control group (respectively 258.03±58.28, 249.06±61.96 p>0.05; 0.23±0.06, 0.20±0.04 p<0.05). In another study by Durmuş et al. (18), the PCof patients with sudden sensorineural hearing loss was found to be significantly higher than the control group (258.59±50.63, 228.33±65.21 p<0.05).

Study Limitations

It is quite difficult to evaluate the disorder in the vascular system of the cochlea according to the PC. It would be better to evaluate the disruption of microcirculation relative to the activation of platelets. For example, measuring the level of thrombaxane. However, it is a fact that patients with hearing loss have higher PC and PCT values. We hope that this study will lead to better quality studies in the future.

Conclusion

Noise-induced occupational hearing loss is an important health problem in working life. It is important to remember

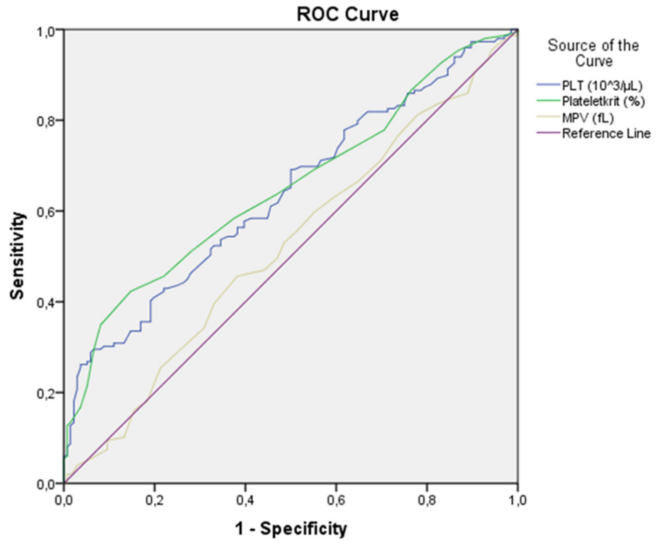

Figure 1: ROC curve between OSNHL and platelet panel

ROC: Receiver operating characteristic, OSNHL: Occupational Sensorineural Hearing Loss, MPV: Mean platelet volume

Table 4: Complaints, hearing threshold, localization and concomitant occupational disease in patients with OSNHL

	N=157 (%100)			
Concomitant Occupational Disease	**No** 65 (41.4%)	**Musculoskeletal** 49 (31.2%)	**Pneumoconiosis** 30 (19.1%)	**Others** 13 (8.3%)
Hearing complaints	**No** 125 (79.6%)	**Hearing difficulty** 23 (14.7%)	**Tinnitus** 4 (2.5%)	**Hearing difficulty+Tinnitus** 5 (3.2%)
Localization	**Bilateral** 148 (94.3%)	**Unilateral** 9 (5.7%)	-	-
Hearing threshold (dB)*	**Right** (46.6±17.5)	**Left** (46.8±16.2)	-	-

N: number of patients, dB: Decibel
*V notching usually at 4000 Hz
OSNHL: Occupational Sensorineural Hearing Loss

Table 5: Pearson's correlation analysis between smoking and platelet panel

OSNHL	Smoking	PLT	r	p	PCT	r	p
Yes (n=149)	10.6±9.9	275.7±62.4	0.040	0.630	0.28±0.06	0.025	0.768
No (n=137)	7.7±7.6	245.1±42.0	-0.043	0.622	0.25±0.04	-0.067	0.440

r: Pearson's correlation coefficient, p<0.05 is significant
OSNHL: Occupational sensorineural hearing loss, n: Numbers of patients, PLT: Platelet, PCT: Plateletcrit

Table 6: Pearson's correlation analysis between age and platelet panel

OSNHL	Smoking	PLT	r	p	PCT	r	p
Yes (n=149)	43.5±8.0	275.7±62.4	0.103	0.213	0.28±0.06	0.110	0.182
No (n=137)	36.2±6.9	245.1±42.0	-0.142	0.098	0.25±0.04	-0.036	0.675

r: Pearson's correlation coefficient, p<0.05 is significant
OSNHL: Occupational sensorineural hearing loss, n: Numbers of patients, PLT: Platelet, PCT: Plateletcrit

that besides the main effect of noise, there are facilitating risk factors such as age, genetics, central obesity, high blood sugar, smoking and hypertension. In our study, we tried addressing the relationship between hearing loss and platelet parameters of workers working in the same physical environment. Unfortunately, we did not find many publications specific to the subject in the literature. We can talk about a meaningful relationship. However, much more studies are needed to say that higher PC and PCT are a risk factor for noise-induced sensorineural hearing loss.

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Ethics

Ethics Committee Approval: The study complied with the Declaration of Helsinki, and approved by the Ethics Committee and the Institutional Review Board of Ege University Faculty of Medicine (approval no: 21-10.1T/1; date: 27.10.2021).

Informed Consent: A retrospective study.

Peer-reviewed: Externally peer-reviewed.

Authorship Contributions

Concept: Y.S.H., M.T., Design: Y.S.H., M.T., Data Collection and Processing: Y.S.H., M.T., Analysis or Interpretation: Y.S.H., M.T., Literature Search: Y.S.H., M.T., Writing: Y.S.H., M.T.

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