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# Investigation of Outer Hair Cell Function of the Cochlea in Psoriasis Patients

## Psöriazis Hastalarında Koklear Dış Tüy Hücre Fonksiyonunun Araştırılması

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**ÖZ**

**Amaç:** Psöriazis, T hücre aracılı sistemik bir hastalık olarak kabul edilmektedir ve sistemik inflamatur yanıt immun sistem aracılı işitme kaybına neden olabilir. Çalışmamızda, psoriazis hastalarında koklear fonksiyonunun göstergesi olan otoakustik emisyon (OAE) ölçümü ile hastalık süre ve şiddeti ile arasında bir ilişki olup olmadığını değerlendirmeyi amaçladık.

**Araçlar ve Yöntem:** Çalışmaya psoriasis tanılı 44 hasta dahil edildi. Kontrol grubu 35 sağlıklı gönüllüden oluşturuldu. Hastaların yaşı, cinsiyeti, hastalık başlangıç yaşı ve süresi, aile öyküsü ve ek hastalıkları sorgulandı ve psoriazis alan şiddet indeksi (PASI) hesaplandı. Odyolojik ve otolojik değerlendirmeler yapıldı. Distortion Product Otoakustik Emisyon (DPOAE) 500, 1000, 2000, 4000, 6000, 8000 ve 10000 Hz frekanslarında ölçüldü.

**Bulgular:** 500, 1000, 2000, 4000, 6000, 8000 ve 10000 Hz'deki DPOAE değerleri karşılaştırıldığında hasta grubu ile sağlıklı gönüllüler arasında anlamlı fark yoktu. PASI skoru ile 1000 Hz'deki SNR değeri arasında (p=0.031) ve hastalık süresi ile 4000 ve 6000 Hz'deki DPAOE değerleri arasında (sırasıyla p=0.033, p=0.038 anlamlı fark bulundu.

**Sonuç:** Psöriazisin uzun süreli, kronik sistemik bir hastalık olduğu göz önüne alındığında, hastaların erken dönemde işitme yakınmaları olmasa dahi yakından takip edilmesi önemlidir ve hastalığın süresi ve şiddeti arttıkça hastaların işitme duyusu etkilenebilir.

**Anahtar Kelimeler:** dış tüy hücreleri; otoakustik emisyon; koklea; psoriazis

**ABSTRACT**

**Purpose:** Psoriasis has been accepted as a T-cell mediated systemic disease and systemic inflammation may also cause immune-mediated hearing loss. We aimed to evaluate cochlear function with otoacoustic emission (OAE) measurement in psoriasis patients and to evaluate whether there is a relationship between duration and severity of the disease and OAEs.

**Materials and Methods:** Forty-four patients diagnosed with psoriasis were included in the study. The control group consisted of 35 healthy volunteers. The patients' age, gender, onset age, family history, disease duration, and additional diseases were questioned, and psoriasis area severity index (PASI) was calculated. Audiological and otological evaluations were performed. Distortion Product Oto-acoustic Emission (DPOAE) were measured at 500, 1000, 2,000, 4,000, 6000, 8000 and 10000 Hz frequencies.

**Results:** There was no significant difference in DPOAE values at 500, 1000, 2000, 4000, 6000, 8000, and 10000 Hz between healthy volunteers and psoriasis patients. There was a significant difference between PASI score and SNR value at 1000 Hz (p=0.031), disease duration, and DPAOE values at 4000 and 6000 Hz (p=0.033, p=0.038 respectively)

**Conclusion:** Considering that psoriasis is a long-term, chronic systemic disease, patients should be follow-up closely even if they do not have hearing complaints in the early period, and as the duration and severity of the disease increases, the hearing of the patients may be affected.

**Keywords:** cochlea; otoacoustic emission; outer hair cell; psoriasis

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## INTRODUCTION

Psoriasis, which can be seen at any age, is a life-long disease that affects the quality of life negatively by significantly impairing physical and psychosocial health.[1-3] In recent years, it has been recognized as a T-cell mediated systemic disease. T cells are responsible for the release of inflammatory cytokines, and this systemic inflammation may also cause immune-mediated hearing loss.[4]

Kemp has proven for the first time that the cochlea is not only an organ that receives sound but also produces acoustic energy.[5] These sounds obtained by a probe placed in the external auditory canal are called otoacoustic emissions (OAE). Outer hair cells in the cochlea are highly susceptible to damage due to exogenous factors. Otoacoustic emissions are an ideal, non-invasive and objective instrument that measures the function of outer hair cells.[6]

Inner ear involvement can be seen in all systemic autoimmune diseases. However, studies evaluating cochlear function and high-pitched frequency hearing loss in psoriasis are extremely rare.

Therefore, in our study, we aimed to evaluate cochlear function with otoacoustic emission measurement in psoriasis patients and to evaluate whether there is a relationship between the duration and severity of the disease and OAEs.

## MATERIALS AND METHODS

Forty-four patients who presented to the dermatology department and were diagnosed with psoriasis and 35 healthy controls between July 2020 and February 2021 were included in this prospective controlled study. Ethics committee approval was received from the ethics committee of Adıyaman University (23.06.2020-2020/6-46). After a detailed explanation of the study, informed consent was obtained from each patient.

The patients' age, gender, onset age, family history, disease duration, smoking habit and alcohol consumption, medical treatments, and additional diseases were questioned. Psoriasis area severity index (PASI) was calculated by a dermatologist. Patients with other autoimmune skin diseases were excluded.

Audiological and otological evaluations were performed by an otolaryngologist. Patients were examined otoscopically, and those with normal ear examinations were included in the study. Exclusion criteria were congenital ear anomaly, history of temporal bone fracture and cranial trauma, reported hearing loss, ototoxic drug usage, noise exposure, acute or chronic otitis media and otitis externa, previous ear surgery. Appropriate ear probes were placed in the external ear canal. A sensitive microphone and two different speakers were used for frequencies of f1 and f2. The results were presented at 500, 1000, 2,000, 4,000, 6000, 8000, and 10000 Hz frequencies and Distortion Product Otoacoustic Emission (DPOAE) and Signal Noise Ratio (SNR) were measured.

### Statistical Analysis

All of the data obtained were analyzed by Statistical Package for the Social Sciences, version 22.0 for Windows (SPSS, Chicago, IL). Number, percentage, median, maximum, minimum, mean, and standard deviation values were used in descriptive statistic methods. When investigating the normal distribution of variables, the Shapiro-Wilk test was used due to the number of units. While examining the differences between the groups, T-Test was used if the variables displayed a normal distribution, and Mann Whitney U-Test was utilized if the variables did not have a normal distribution. Chi-Square Test was used for qualitive variables. The Spearman Correlation Test was used for the relationship between PASI score and DPOAE test, psoriasis duration and DPOAE test. A p-value below 0.05 was considered statistically significant.

## RESULTS

The psoriasis group comprised 44 patients (17 male and 27 female). The mean age of the psoriasis group was 39,29 years (range 18-71years). The healthy control group comprised 13 males and 22 females. The mean age of the control group was 38.82 years (range 18-69 years). There was no statistically significant difference between the ages and genders of the groups (p=0.897, p=0.987 respectively) (Table 1).

Family history was present in 12 patients (27%), and the PASI score was 9.75±6.20. Disease duration was

8.70±5.73 years, and disease onset age was 31±11.53 years. Nine patients had arthritis (20.5%), and 21 patients had nail involvement (47.7%).

**Table 1.** Demographic characteristics of psoriasis patients and healthy controls

| Characteristics | Psoriasis Group | Control Group | P-value |
|---|---|---|---|
| Age (mean ± SD) years | 39.29 ±16.65 | 38.82 ± 15.12 | .897[a] |
| Sex (male/female) | 17/27 | 13/22 | .987[b] |

aT test, bChi-square test

Otoscopic examinations of all participants were normal, and all were questioned in terms of vestibular symptoms, but none had vestibular complaints. There was no significant difference between the DPOAE and SNR values at 500, 1000, 2000, 4000, 6000, 8000, and 10000 Hz with healthy controls (p>0.05) (Table 2). There was a significant difference between PASI score and SNR value at 1000 Hz (p=0.031), disease duration, and DPAOE values at 4000 and 6000 Hz (p=0.033, p=0.038 respectively) (Table 3).

**Table 2.** Comparison of DPAOE and SNR values in psoriasis patients and healthy controls

| | Right ear | | | Left ear | | |
|---|---|---|---|---|---|---|
| Frequency (Hz) | Psoriasis n = 44 | Control n = 35 | p-value | Psoriasis n = 44 | Control n = 35 | p-value |
| 500 SNR | 2.02 ± 5.92 | 1.56 ± 4.85 | 0.703[a] | 4.34±5.69 | 2.21±6.45 | 0.113[a] |
| 500 DP | 8.82 ± 8.14 | 8.36 ± 9.89 | 0.821[a] | 10.5 (0-29) | 8(−10-28) | 0.090[b] |
| 1000 SNR | 7.50 (-11-22) | 11 (-13-33) | 0.181[b] | 7.30±9.12 | 9.46±7.57 | 0.246[a] |
| 1000 DP | 8.00 (−20-19) | 9.0(-11-21) | 0.698[b] | 6.73 ± 9.04 | 8.10±7.68 | 0.461[a] |
| 2000 SNR | 12.55±8.05 | 12.38±8.89 | 0.931[a] | 12.27±9.96 | 13.03±8.81 | 0.718[a] |
| 2000 DP | 6.02±8.00 | 6.18±8.46 | 0.931[a] | 5.61±9.38 | 6.69±8.69 | 0.590[a] |
| 4000 SNR | 9.52 ± 7.08 | 9.38±7.47 | 0.931[a] | 10 (-17-25) | 11.0(-10-25) | 0.541[a] |
| 4000 DP | −4.50 ± 5.81 | −3.72 ±7.35 | 0.590[a] | - 4.66±8,67 | −4.85±6.37 | 0.912[a] |
| 6000 SNR | 5(-12-19) | 7.0(-19-27) | 0.866 | 4.57±7.49 | 4.82±6.73 | 0.873[a] |
| 6000 DP | 6.25±5.90 | 5.74±9.24 | 0.764[a] | -6.34±7.94 | 6.13±7.58 | 0.901[a] |
| 8000 SNR | 4.50 (-10-14) | 6 (-18-14) | 0.794[b] | 7.0(-7-14) | 6(-18-15) | 0.458[b] |
| 8000 DP | -6.5 (-21-6) | -7 (-24-7) | 0.602[b] | -4-(18-5) | -4 (-26-4) | 0.916[b] |
| 10000 SNR | 6.0 (-20-16) | 5 (-18-19) | 0.444[b] | 5.0 (-18-14) | 7 (-19-9) | 0.225[b] |
| 10000DP | -3 (-26-13) | -3 (-30-13) | 0.651[b] | -3(-39-8) | -2 (-20-12) | 0.568[b] |

Note: Mean ± SD is presented in cases where the data were distributed normally, and median (minimum-maximum) values in cases where the data were not normally distributed.
aT test.
bMann-Whitney U test.

**Table 3.** The relationship between hearing frequencies and disease severity and disease duration in psoriasis patients

| Frequency (Hz) | Psoriasis area severity index (PASI) | | Psoriasis Disease Duration (year) | |
|---|---|---|---|---|
| | Spearman's R | Pc | Spearman's R | Pc |
| 500 DP | -0.130 | 0.402 | 0.126 | 0.414 |
| 500SNR | -0.094 | 0.546 | -0.096 | 0.536 |
| 1000DP | -0.241 | 0.115 | -0.229 | 0.135 |
| 1000SNR | -0.325 | 0.031 | -0.226 | 0.140 |
| 2000DP | -0.201 | 0.190 | -0.122 | 0.432 |
| 2000SNR | -0.172 | 0.265 | -0.082 | 0.596 |
| 4000DP | -0.135 | 0.383 | -0.322 | 0.033 |
| 4000SNR | -0.194 | 0.206 | -0.004 | 0.979 |
| 6000DP | -0.030 | 0.845 | -0.314 | 0.038 |
| 6000SNR | -0.006 | 0.971 | -0.108 | 0.484 |
| 8000DP | -0.054 | 0.730 | -0.075 | 0.627 |
| 8000SNR | -0.073 | 0.638 | -0.151 | 0.328 |
| 10.000DP | -0.267 | 0.080 | -0.234 | 0.126 |
| 10.000SNR | -0.069 | 0.474 | -0.236 | 0.123 |

[C]Spearman correlation test

## DISCUSSION

The etiopathogenesis of psoriasis has not been fully elucidated. But in the etiology, an autoimmune mechanism characterized by T cell-mediated hyperproliferation of keratinocytes is involved.[7] Although psoriasis is defined as a skin disease, it has been reported to be associated with many other comorbidities and autoimmune diseases that may result from chronic inflammation in psoriasis. Diabetes mellitus, obesity, non-alcoholic fatty liver disease, atherosclerosis, hypertension, dyslipidemia, and psoriatic arthritis are reported.[8]

Lehnhardt points out that sensorineural hearing loss (SNHL) may first occur as a result of an autoimmune response against the inner ear. The autoimmune mechanism

in the etiology of psoriasis suggests that it may be associated with sensorineural hearing disorders.[7]

OAE is a non-invasive measurement method developed to understand the mechanism of SNHL and to shed light on the function of the cochlea.[9]

It can detect very early changes and even slight changes in the cochlear micromechanics that patients may not notice.

Psoriasis, which has been thought to be a completely cutaneous disease for a long time, is now accepted as a systemic inflammatory disease that shares pathogenic pathways with many chronic and progressive diseases.[10]

For this reason, dermatologists play an active role not only in relieving symptoms with dermatological treatment but also in preventing physical comorbidities and coordinating early diagnosis and treatment if they develop.[8]

The inner ear may be the target of an autoimmune attack, and SNHL may occur as a complication of a number of non-organ-specific autoimmune diseases, or it may be indirectly affected by immune complex deposition or other mechanisms.[11] Studies on hearing in autoimmune diseases such as rheumatoid arthritis, polyarteritis nodosa, ankylosing spondylitis, systemic lupus erythematosus, Behçet's disease, and Sjögren's syndrome have been published.[12-18]

Karabulut et al. examined the results of pure tone audiometry between 250-8000Hz and DPAOE between 1000-8000Hz in 42 patients with psoriasis and 60 healthy controls and found no significant difference in any frequency.[9]

However, Yen et al. found that patients with psoriasis had a significantly higher incidence of sensorineural hearing loss than the healthy group.[19]

Güneş et al. compared 24 patients with psoriatic arthritis and 38 healthy controls. In the evaluation of hearing frequencies between 4000 and 6000 Hz, a statistically significant difference was found. When DPOAE values were analyzed within the 1000–4000 Hz interval, they found a statistically significant difference at 3000 and 4000 Hz. However, DPOAE was not observed at higher frequencies.[20]

Vir et al. examined pure tone audiometry at frequencies of 250-16000 Hz in 29 psoriasis patients and 30 healthy controls, and a significant difference was found at high frequencies. They also stated that there is a significant difference in DPOAEs measured between 357-5694 Hz.[21]

DPOAE measurement is closely related to the physiological state of cochlea outer hair cells. Its main purpose of the use is to evaluate the effect of pathological conditions associated with SNHL on cochlear function. DPOAE, if normal, provides extremely strong evidence that cochlear function is normal regardless of audiometric data. It is tested in less time than pure tone audiometry and provides objective data specific to the frequency.

Dikici et al. performed a study on patients with rheumatoid arthritis. While there was no statistically significant difference in pure tone audiometry between the patient group and the control group, a statistically significant difference was found regarding the responses to transient evoked otoacoustic emission (TEOAE) at frequencies of 1, 1.5, 2 and 3 kHz. The authors suggested that SNHL that cannot be detected by pure tone audiometry in patients with rheumatoid arthritis can be detected earlier using TEOAE.[22]

Therefore, we use DPOAE and SNR values at 500, 1000, 2000, 4000, 6000, 8000 and 10000 Hz instead of other audiological evaluations such as pure tone audiometry and tympanometry, taking into account the loss of time and cost. There was no significant difference between the patient group and healthy controls. We found a negative correlation between both PASI score and disease duration and all DPOAE and SNR values but a significant difference was observed only between PASI score and SNR value at 1000 Hz and disease duration and DPAOE values at 4000 and 6000 Hz. As the severity and duration of the disease increased, DPOAE values of the patients decreased. This result shows that the long duration and increased severity of the disease may have a negative effect on cochlear function. However, further studies with a larger number of patients are needed.

Considering that psoriasis is a long-term, chronic systemic disease, it should be taken into consideration that patients should be closely monitored even if they do not have hearing complaints in the early period, and as the duration and

severity of the disease increases, the hearing of the patients may also be affected.

**Conflict of Interest**

The authors declare that there is not any conflict of interest regarding the publication of this manuscript.

**Authors' Contributions**

Concept/Design: OYA, EID. Data Collection and/or Processing: OYA, EID. Data analysis and interpretation: OYA, EID. Literature Search: OYA, EID. Drafting manuscript: OYA, EID. Critical revision of manuscript: OYA, EID. Supervision: OYA, EID.

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