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Original Article

Audiovestibular Dysfunction in Patients with Fibromyalgia Syndrome

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OBJECTIVES: Fibromyalgia syndrome is a disorder of widespread pain with unknown etiology. These patients frequently suffer from otologic complaints. This study aims to analyze the audiovestibular functions in patients with fibromyalgia syndrome.

METHODS: The study included 33 fibromyalgia patients and 33 healthy volunteers. All the study subjects underwent audiological assessment, multifrequency tympanometry, transient otoacoustic emission, and ocular and cervical vestibular-evoked myogenic potentials tests.

RESULTS: Pure-tone hearing thresholds of right and left ears were found to be decreased in fibromyalgia patients compared to controls ($P < 0.05$). Middle ear resonance frequency values were significantly decreased in patients with fibromyalgia syndrome compared to controls ($P < .05$). The values for signal-to-noise ratios were higher in controls than in the FMS patients. The difference was significant for 1000, 2000, and 4000 Hz ($P > .005$). Cervical vestibular-evoked myogenic potential waves were obtained in all controls, but could not be obtained in 5 right ears and 4 left ears of the fibromyalgia patients ($P < .05$). Also, ocular vestibular-evoked myogenic potentials were obtained in all controls, but could not be obtained in 7 right ears and 10 left ears of the patients with fibromyalgia syndrome ($P < .05$).

CONCLUSION: Our findings support the presence of audiovestibular dysfunction in patients with fibromyalgia. Further research that focuses on the pathogenesis of these dysfunctions is required.

KEYWORDS: Dizziness, fibromyalgia, hearing loss, tinnitus

INTRODUCTION

Fibromyalgia syndrome (FMS) is a non-inflammatory chronic disease, characterized by widespread musculoskeletal pain.[1] The etiology is still unknown and FMS is often misdiagnosed.[1] The estimated prevalence in the general population is between 2 and 11%.[2] Fibromyalgia affects females between the ages of 25 and 65, although it can be seen in all ages and in both sexes.[3,4] It is more common in females than in males.[5] The main symptoms of fibromyalgia include chronic tightness in the muscles, muscle pain, muscle spasms, insomnia, fatigue, tension, abdominal pain, facial tenderness, sensitivity to noise and bright lights, and central nervous system abnormalities. Various neurological symptoms such as tinnitus, ear fullness, vertigo, and dizziness may also be associated, regardless of the disease severity.[2] In the literature, the audiological findings of fibromyalgia patients are contradictory, and the tests used to evaluate the vestibular system are limited. The aim of this study is to perform detailed audiovestibular evaluations of FMS patients, with current test batteries.

METHODS

This study was approved by the Başkent University Institutional Review Board and Ethics Committee (*KA15/232)*. The study group included 33 female patients with age ranging from 20 to 60 years, who were diagnosed with fibromyalgia syndrome at the Department of Physical Therapy and Rehabilitation.[6] The control group consisted of 33 healthy age- and sex-matched volunteers. Informed consent was obtained from all participants included in the study.

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The inclusion criteria for the study and control groups were as follows:

FMS Patients

1. Being diagnosed with fibromyalgia syndrome at the Department of Physical Therapy and Rehabilitation.
2. Presence of Type A tympanogram, ipsilateral and contralateral reflexes in impedance meter screening.
3. Having no history of previous ear surgery.

Controls

1. Absence of any co-existing diseases including audiovestibular pathologies;
2. Presence of Type A tympanogram and presence of 500-4000Hz ipsilateral and contralateral reflexes in impedance meter screening;
3. Patients without any otorhinolaryngological pathologies that may prevent or complicate the audiovestibular tests.

Being over the age of 60, pregnancy, a history of head trauma, and accompanying co-morbidities (neurological, muscular, rheumatological, etc.) were the exclusion criteria.

Detailed anamnesis was taken from the patients, and otorhinolaryngological examinations were performed.

A questionnaire was given to all the study patients to determine the presence of audiovestibular symptoms (e.g., vertigo, hearing impairment, and tinnitus).

All the tests were performed by a senior audiologist, who was blinded to the study.

Audiological Evaluation

Pure-tone audiograms were performed using Clinical Audiometer AC-40 (Interacoustics A/S, Assens, Denmark) in silent cabins. Air and bone conduction hearing thresholds were measured using TDH 39 standard earphones between 0.125 and 8 kHz and Radioear B-71 bone vibrator between 500 and 4000 Hz, respectively. Pure-tone averages were calculated at 500, 1000, and 2000 frequencies.

Acoustic Impedancemetry

Immittance measurement of the subjects was performed using a GSI TympStar Version 2 (Grason 05 Stadler Inc., MN, USA) middle ear tympanometer. İpsilateral and contralateral reflexes were tested between 500, 1000, 2000, and 4000 Hz with an acoustic impedance meter.

Multifrequency Tympanometry

In this procedure, a probe was sealed in the ear canal, and the ear canal pressure was kept constant. Tympanograms were recorded with probe frequencies ranging from 250 to 2000 Hz at 50Hz intervals.

Transient Evoked Otoacoustic Emissions (TEOAEs)

TEOAEs were recorded by means of a GN OtometricsA/S (MADSEN Capella, Taastrup, Denmark) emission analyzer, using insert earphones in a sound-attenuated room. The stimulus level in the outer ear was set at 83±3 dB SPL.

Ocular Vestibular-Evoked Myogenic Potentials (oVEMP)

Grason-Stadler (GSI) Audera (Grason-Stadler Inc., MN, USA) equipment was used for myogenic activity recordings. The peak points N1 and P1, latency, and amplitudes were noted.

Cervical Vestibular-Evoked Myogenic Potentials (cVEMP)

The activity of the sternocleidomastoid muscle (SCM) was detected using Grason-Stadler (GSI) Audera (Grason-Stadler Inc., MN, USA) equipment. Short tone-bursts (95 dB nHL, 500 Hz, each with a 1 ms rise–fall time and a 5 ms plateau) were delivered. The first positive (p13) and the first negative (n23) myoelectrical peak of cVEMP were analyzed.

Statistical Analysis

Statistical analysis of the data was performed using the Statistical Package for the Social Sciences (SPSS) for Windows 18 program (IBM Corp.; Armonk, NY, USA). The Chi-square test and Student's *t*-test were used for comparisons. Values for $P < .05$ were considered as statistically significant.

RESULTS

The mean age was 45.48 + 9.15 and 43.03 + 7.3 years in fibromyalgia patients and controls, respectively. There was no significant difference between the age of the patients and controls ($P = 0.233$).

The mean duration of the pain was 4.71 ± 4.4 years (1-20 years). Based on the questionnaire, hearing loss was reported in only 1 of 33 patients, feeling of ear fullness in 16 patients, tinnitus in 15 patients, and vertigo in 14 patients.

Audiological Findings

A total of 66 ears of patients and 66 ears of healthy controls were audiologically tested. Pure-tone hearing thresholds of right and left ears in 2 groups at frequencies of 250, 500, 1000, 2000, 4000, 6000, and 8000 Hz are given in Table 1. The pure-tone hearing thresholds of fibromyalgia patients were found to be significantly higher than those of the controls ($P < .05$).

Resonance Frequency (RF) Findings

The resonance frequency comparisons between the 2 groups are listed in Table 2. Resonance frequencies of both ears were significantly decreased in FMS patients compared to the controls ($P < .05$).

TEOAEs Findings

Although reproducibility percentages were lower in the FMS patients than in the controls, the difference did not reach statistical significance ($P = .07$). The values for signal-to-noise ratio were higher in controls than in the FMS patients. The difference was significant for 1000, 2000, and 4000 Hz ($P > .005$) (Table 3).

Vestibular-Evoked Myogenic Potentials Findings

cVEMPs were obtained in all controls. cVEMPs could not be obtained in 5 right ears and 4 left ears of the patients. There was a statistically significant difference between the 2 groups ($P=0.03$). According to our questionnaire, 3 patients, whose cVEMPs were not detectable, complained of vertigo.

Similarly, oVEMPs were present in all controls. oVEMPs could not be detected in 7 right ears and 10 left ears of the patients, and the

Table 1. Pure-Tone Hearing Thresholds of Fibromyalgia Patients and Controls. Values are Given as Mean (dB) ± Standard Deviation

Right ear	**250 Hz**	**500 Hz**	**1000 Hz**	**2000 Hz**	**4000 Hz**	**6000 Hz**	**8000 Hz**
Fibromyalgia	11.06 ± 6.22	11.52 ± 7.12	14.39 ± 6.70	11.06 ± 7.98	13.03 ± 7.90	20.0 ± 8.29	19.09 ± 11.35
Controls	4.85 ± 5.07	5.45 ± 5.20	6.67 ± 5.10	5.00 ± 3.53	6.82 ± 3.91	8.64 ± 4.72	8.79 ± 4.68
P	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Left ear	**250 Hz**	**500 Hz**	**1000 Hz**	**2000 Hz**	**4000 Hz**	**6000 Hz**	**8000 Hz**
Fibromyalgia	11.36 ± 7.52	11.06 ± 6.81	13.64 ± 6.87	10.30 ± 8.09	16.06 ± 9.58	19.85 ± 8.79	18.48 ± 10.49
Control	3.64 ± 4.00	3.79 ± 4.15	5.30 ± 4.13	5.45 ± 3.82	6.97 ± 4.31	8.18 ± 4.29	8.33 ± 4.78
P	<.001	<.001	<.001	.003	<.001	<.001	<.001

Table 2. Resonance Frequency Values in Fibromyalgia Patients and Controls

	Right ear		**Left ear**	
	Fibromyalgia	**Control**	**Fibromyalgia**	**Control**
RF* (Hz)	653.03 ± 161.98	898.48 ± 84.30	745.45 ± 163.15	921.21 ± 101.57
P	<.001		<.001	

difference was statistically significant ($P < .001$). Based on our questionnaire, 6 patients, whose oVEMPs were absent, complained of vertigo.

Of 33 patients with fibromyalgia, both the oVEMPs and the cVEMPs of 4 patients were negative. Among them, 3 patients complained of vertigo.

DISCUSSION

The pathogenesis of the audiovestibular symptoms and signs of these patients is still undetermined. Since patients may experience alterations in perception and other sensory input, audiovestibular complaints are often attributed to central hypersensitivity and dysregulation of the nervous system.[7,8] As Rosenhall et al.[7] and Koca et al.[2] reported, vertigo/dizziness and sensorineural hearing loss are markedly high in patients with FMS. However, studies that have investigated the audiovestibular symptoms with thorough current audiovestibular tests are very limited in the literature. Hence, we aimed to evaluate the audiovestibular symptoms and signs with audio-tympanometry, resonance frequency analysis, TEOAEs and VEMPs. Accordingly, our results suggest an involvement of the audiovestibular system in patients with FMS.

Fibromyalgia is commonly associated with ear-related symptoms. Rosenhall et al.[7] reported sensorineural deafness and auditory brainstem response abnormalities in 15 and 30% of 168 fibromyalgia patients, respectively, suggesting that fibromyalgia may be associated with the inner ear or with central auditory impairment. Another study reported that ear-related symptoms of patients occurred significantly after the onset of fibromyalgia.[9] Wolfe et al.[6] reported that patients with fibromyalgia had significantly more frequent hearing difficulties than patients with rheumatoid arthritis or osteoarthritis. Bayazit et al.[10] reported ear-related symptom complaints in 50% of patients (tinnitus in 16.7%, subjective symptoms of deafness in 12.5%). However, some other studies reported no significant difference in the incidence of deafness between healthy subjects and fibromyalgia patients.[10-12] In our study, the patients with FMS had significantly increased hearing thresholds. It has not yet been clarified

Table 3. TEOAEs in Fibromyalgia Patients and Controls are Shown

	Fibromyalgia	**Control**	***P***
Reproducibility	85.3 ± 17.3	90.9 ± 179	.07
1000 Hz	11.2 ± 8	14.1 ± 5.6	**.021**
1414 Hz	13.8 ± 7.3	17.7 ± 17.5	.095
2000 Hz	13.3 ± 6.6	15.6 ± 4.5	**.02**
2828 Hz	13.2 ± 21.1	13.5 ± 5.2	.894
4000 Hz	9.9 ± 5.4	13.2 ± 5.1	**.001**

which pathophysiological mechanisms lead to hearing loss in almost all frequencies in this syndrome.

Interestingly, only one patient complained of hearing loss in the questionnaire, however nearly half the patients noted tinnitus and ear fullness. In such cases, like patients with ear fullness whose pure-tone audiometry tests and Eustachian tube functions were within normal limits, central nervous system desensitization should be considered.[13,14]

It was thought that ear symptoms of patients may also develop due to muscular involvement in addition to sensorineural pathway pathologies. Thus, both middle and inner ear functions should be assessed in FMS. It is suggested that ear fullness, ear ache, and tinnitus significantly increase following the onset of the disease.[6,13] However, Likuni et al.[13] observed that a type A tympanogram was common in patients with ear fullness, while the Eustachian tube function tests detected an increased number of obstructed, normal, and patulous Eustachian tubes in patients with ear fullness compared to patients without ear fullness.

To our knowledge, our study was the first to show that RF values of the patients were significantly lower than those of the healthy subjects. In a normalization study from our clinic, Sezin et al.[15] evaluated 60 volunteers (120 ears) and received an average of 999.6 Hz (1020.8 Hz in the right, 978.3 Hz in the left ear) RF values. In the present study, a statistically significant difference was found between the RFs of fibromyalgia patients and those of healthy individuals. The RF values of the control group are compatible with the normative data of our clinic.[15] The higher RF is observed in pathologies with high stiffness, and lower RF is observed in pathologies where mass effect is evident.[16] A decrease in the RF of the FMS patients suggests a dysfunction in the middle ear structures. Further studies are essential to highlight the pathogenetic pathway.

The TEOAE test is a type of otoacloustic emission (OAE) that evaluates cochlear pathology specific to frequency and detects minor changes in the condition of the cochlea. Gündüz et al.[11] found a significant reduction in emission amplitudes of patients with fibromyalgia compared to the control group, in the TEOAE test. In the TEOAE contralateral suppression responses, they found abnormal responses in the patient group compared to the control group. These findings support the presence of a dysfunction in the central afferent auditory pathways in fibromyalgia patients.

The TEOAE results in our study may indicate an isolated involvement of some frequencies in fibromyalgia patients. The results are not clear in the literature either. Besides, patients with FMS often use non-steroidal anti-inflammatory drugs(NSAIDs) because of their chronic pain. The TEOAEs findings we obtained may be due to the side effects of NSAIDs, which needs to be clarified with further studies. When pure sound averages, multifrequency tympanometry, and otoacoustic emission tests are evaluated together, it shows that hearing loss may occur in fibromyalgia cases. In support of these findings, 16 patients stated that they felt a fullness in their ears and 15 patients had tinnitus as subjective complaints. However, the detected auditory dysfunction is at a subclinical level, which suggests a dysfunction in the middle ear and central pathways rather than the inner ear.

Cervical VEMP gives information about the saccule, inferior vestibular nerve, central vestibular connections, and anatomical integrity and normal function of the spinal anterior horn cells. oVEMP is a new test battery that evaluates the arc consisting of the utricular and superior vestibular nerves, vestibular nucleus, midbrain, ocular motor nucleus, and extraocular muscles.[17,18] It is also used to diagnose and monitor central neurological problems affecting the brainstem.[19-21] Bayazit et al.[10] showed prolonged n23 latency interpeak latency in FMS patients. In our study, both VEMPs were recorded in the controls, while in FMS patients, 57/66 ears recorded cVEMPs, 49/66 ears recorded oVEMPs. In questioning the cases where VEMP waves were absent, we found that only some of the fibromyalgia cases had vertigo complaints. Spontaneous nystagmus was not observed in any case. The VEMP findings obtained support the probability of a dysfunction in the vestibular reflex pathways in fibromyalgia cases. However, it may not always provide clinical findings due to the effect of compensatory mechanisms.

We believe that with future studies, VEMP tests can provide important information in FMS patients and be a part of routine evaluation.

Tests (Auditory brainstem response (ABR), contralateral suppression, etc.) used in evaluating the central audiological system were not performed in this present study, which may be a limitation. As future goals, similar evaluations in male fibromyalgia patients may be performed to investigate whether the involvement of the audiovestibular system differs between females and males. Also, the audiovestibular findings in FMS patients of different age groups may be evaluated.

CONCLUSION

In previous studies, the audiological and vestibular systems were evaluated separately. The hearing and balance system function interchangeably and should be evaluated together in systemic diseases such as fibromyalgia. The results of this investigation showed that audiovestibular dysfunction is not rare in the FMS group. We noted impaired hearing thresholds, lower resonance frequency values, and abnormal cVEMP and oVEMP results, which indicate both auditory and vestibular system involvements in this syndrome. Otolaryngologists should be familiar with the neurotologic manifestations of FMS.

Ethics Committee Approval: This study was approved by the Başkent University Institutional Review Board and Ethics Committee (KA15/232).

Informed Consent: Informed consent was obtained from all participants included in the study.

Peer Review: Externally peer-reviewed.

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