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Contralateral suppression of otoacoustic emissions in migraine patients without vestibular involvement

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Abstract

Objective: Our aim was to investigate contralateral suppression of otoacoustic emission for the evaluation of auditory reflex in patients with migraine which is a disease that may cause dysfunction of sensorial modulation.

Methods: Voluntary migraine patients without vestibular symptoms who consulted to Neurology Clinic, and diagnosed according to the IHS 2004 criteria, and healthy volunteers were included in the study. All volunteers underwent complete otorhinolaryngologic and pure-tone audiometric examinations. Thirty voluntary migraine patients with bilateral otoacoustic emission measurements, and 30 healthy volunteers matched in terms of age and sex were included in the study. Otoacoustic emission measurements were obtained with 65 dB SPL click stimulus with and without mask by masking with contralateral 50 dB SPL broad band noise. Responses were compared between two groups.

Results: Positive result was obtained in suppression tests in 40 of 60 (67%) ears of healthy volunteers and in 30 of 60 (50%) ears of migraine patients. However, there was no statistically significant difference between groups regarding positive suppression frequency and suppression values. Even though a statistically significant difference between migraine patients without vestibular involvement and control group was not seen, there was a decrease in contralateral suppression responses in the migraine group.

Conclusion: Although it is statistically insignificant, we have demonstrated that migraine patients without vestibular symptoms showed a decrease in the suppression values compared to the healthy volunteers. We believe that in new studies with larger series, contralateral otoacoustic emission suppression test can be used as an early tool to diagnose audiovestibular symptoms in migraine patients without any vestibular involvement.

Keywords: Contralateral suppression test, MOC reflex, non-vestibular migraine, otoacoustic emission.

Özet: Vestibüler şikayeti olmayan migren hastalarında kontralateral otoakustik emisyon süpresyonu

Amaç: Bu çalışmanın amacı duyusal modülasyon bozukluğuna yol açan migren hastalığı olan kişilerde işitme sistemi refleksi ölçümünde kullanılan bir test olan kontralateral otoakustik süpresyon testinin sonuçlarının değerlendirilmesidir.

Yöntem: Çalışmaya nöroloji polikliniğine başvuran, Uluslararası Başağrısı Derneği'nin 2004 yılı kriterlerine göre migren tanısı alan ve vestibüler şikayeti olmayan gönüllü migren hastaları ve sağlıklı gönüllüler dahil edildi. Bütün gönüllülere tam otolojik muayene, saf ses odyometri testi yapıldı. Bilateral otoakustik emisyon yanıtı alınan 30 gönüllü migren hastası ve karşılaştırma için yaş ve cinsiyet özellikleri gönüllü hasta grubuna benzeyen 30 sağlıklı gönüllü çalışmaya dahil edildi. Çalışmaya dahil edilen gönüllülere kontralateral 50 dB SPL geniş bant gürültü ile maske yapılarak 65 dB click uyaran ile maskeli ve maskesiz otoakustik emisyon ölçümleri yapıldı. Her iki gruptan elde edilen veriler karşılaştırıldı.

Bulgular: Sağlıklı gönüllülerin değerlendirilen 60 kulağının 40'ında (%67) süpresyon testi pozitif olarak tespit edilirken migren hastalarının değerlendirilen 60 kulağından 30'unda (%50) süpresyon testi pozitif olarak tespit edildi. Fakat süpresyon pozitifliği oranlarında ve süpresyon emisyon değerlerinde istatistiksel olarak anlamlı bir fark izlenmedi. İki grup arasında istatistiksel olarak anlamlı bir fark olmasa da migrenli grupta kontralateral supresyon cevaplarında azalma izlendi.

Sonuç: Vestibüler şikayeti olmayan migren hastalarında normal kişilerle karşılaştırıldığında istatistiksel olarak anlamlı olmasa da kontralateral süpresyon cevaplarında bir azalma izlenmektedir. Daha büyük seri içeren yeni çalışmalar ile kontralateral otoakustik emisyon testi vestibüler şikayeti olmayan migren hastalarında odyovestibüler şikayetlerin erken tanısında kullanabileceği kanaatindeyiz.

Anahtar sözcükler: Kontralateral süpresyon testi, MOC refleksi, non-vestibüler migren, otoakustik emisyon.

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Migraine is a common disorder whose readily recognized manifestation is headache. Although auditory symptoms are considered to be less common than vestibular symptoms in migraine patients, it may result in a low frequency, and sudden sensorinueral hearing loss.[1] Migraine is characterized by recurrent episodes of moderate to severe generally unilateral pulsating headache which lasts for 4 to 72 hours. Photophobia and/or phonophobia and nausea and /or vomiting can accompany. In migraine with aura, headache is preceded by some focal neurologic symptoms. Some audiovestibular symptoms may be present in patients during or between the attacks. Dizziness, motion intolerance, vertigo, nystagmus, tinnitus, fluctuating, and also sudden hearing loss may which may sometimes persist can occur. In the literature, abnormalities were reported in audiometry (pure-tone audiometry, PTA), auditory brainstem response (ABR), caloric testing and vestibular evoked myogenic potentials (VEMP).[2]

The incidence of sudden sensorineural hearing loss (SSNHL) of any cause is estimated to be 20 per 100,000 person-years. Fortunately, almost 50% of sufferers recover completely or partially. Up to now, lots of theories have been studied in order to determine the causes of SSNHL, and vascular etiology has gradually gained popularity. Because migraine has been demonstrated to be a risk factor for any cardiovascular event, in order to identify the risk for SSNHL and other auditory impairments in migraine patients, various studies have been performed.[3] Upon an attack, vasospasm may occur in labyrinthine artery which in turn results in inner ear hypoxia. Also a delayed endolymphatic hydrops emerges in long-standing sensorineural hearing loss.[1]

Sudden hearing loss has been described in patients with migraine. These patients typically have also some neurological phenomena that can be due to vasospasm: retinal migraine, hemiplegia, angina, and/or visual aura. Oscillopsia, which is the sensation of oscillation of the intensity of ambient sound is highly likely to be a migranous aura and suggestive of the vasospasm. Nevertheless a permanent hearing loss is most probably due to an infarct on auditory tract. Due to their antispasmodic properties, calcium channel blockers prevent the attacks of monocular blindness. Thus, in a patient with documented hearing fluctuation in association with migraine symptoms, calcium channel blockers may be the drug of choice, while triptans are contraindicated because they induce vasospasm.[4]

Medial olivocochlear (MOC) reflex pathway is the main efferent system that controls cochlea. Sound enters the cochlea through the middle ear and the frequency is analyzed along the length of the cochlea. Cochlear amplification is produced by outer hair cell (OHC) receptor currents causing audio frequency changes in the length of OHCs that amplify cochlear mechanical responses to sound.[5]

The inner hair cells (IHCs) sense cochlear motion and fire auditory nerve fibers that carry acoustic information to the cerebrum. The outer spiral bundle from type II auditory nerve fibers has been shown to be important in MOC reflex. Outer spiral bundle fibers form afferent synapses with OHC, which provides some local control over OHC activity. MOC fibers synapse directly with the cell bodies of the type II auditory nerve fibers and the outer spiral bundle axons under OHCs.[6] MOC fibers are thick and myelinated, which allow both recording and electrical stimulation of MOC fibers. When depolarized by an action potential, the MOC terminal releases ACh. Ach promotes Ca influx into the OHC that opens Ca-gated K channels which results in K influx and finally hyperpolarization which is also named as fast effect. Slow effect is thought to be mediated mainly by increased conductance and decreased stiffness of OHC. In this way, organism can inhibit cochlear amplification. Each MOC fiber terminates in a characteristic frequency region of the cochlea near the MOC fiber's characteristic frequency.[7] The click stimuli have wideband spectra but are punctuate in time. Therefore, basillary membrane oscillates in its own resonant frequencies while tonal stimuli force the membrane to follow the externally applied frequency.[8] Olivocochlear activity improves threshold detection and intensity discrimination of tones in background noise. As a result, responses of auditory nerve fibers to brief tones are reinforced in the presence of noise.[9] Because each MOC fiber innervates a relatively narrow region of the cochlea (from very punctate up to about an octave), the narrow tuning curves suggest that the MOC acoustic reflex is frequency-specific.[10]

Materials and Methods

Study Design

Voluntary migraine patients without vestibular symptoms who consulted to Neurology Clinic and healthy volunteers were included in the study. Diagnosis of migraine was made according to the International Headache Society (IHS) 2004 criteria. All volunteers underwent a whole otorhinolaryngologic, and pure-tone audiometric examinations. Thirty voluntary migraine patients with bilateral otoacoustic emissions and 30 healthy volunteers matched in terms of age and sex were included in the study. In total, 120 ears of 60 patients were evaluated. Responses were compared between two groups. Patients were not under medical treatment either for migraine (with triptans or calcium channel blockers) or any other illness.

Technique

Pure-tone audiometry was measured at 500, 1000, 2000, 4000 Hz frequencies and mean PTA value was calculated. Thresholds at 25dB nHL and less were considered as normal hearing. Bilateral transient otoacoustic emission test was applied to patients with normal hearing. Echoport ILO292 USB II (Otodynamics, Hatfield, England) was used for measurements. Otoacoustic emission measurements were obtained with 65 dB SPL click stimuli by masking with contralateral 50 dB SPL broad band noise. Both masked and unmasked emissions were recorded. A decrease in masked response in comparison to the unmasked response was considered as positive suppression. Equality of responses or increase in magnitude of masked responses was considered as absence of suppression.

Results

Thirty voluntary migraine patients with any vestibular symptoms who consulted to the Neurology Clinic, and diagnosed according to the IHS 2004 criteria and 30 healthy volunteers (totally120 ears) were included in the study. No statistically significant difference was observed between groups in terms of age, sex and PTA (Table 1).

Interaural differences between both groups were not significant, neither. Signal-to-noise ratios (SNR) of the groups were not statistically and significantly different. While contralateral otoacoustic suppression was present in 40 out of 60 (67%) ears of healthy controls, and signal-to-noise ratios were 30 in 60 (50%) ears in the migraine group. However comparison of both groups did not show any statistically significant difference (Table 2). Frequency-specific emission values of both groups are shown in Figs. 1, 2 and 3.

Table 1. General data of study and control groups.

	Migraine group	Control group
Age (mean)	32.1±9.6	31.8±7.7
Sex(female/male)	25/5	26/4
PTA (dB nHL)	10.4±3.5	10.3±3.3
Total SNR	13.4±5.1	12.3±5.1

Table 2. Contralateral suppression results of both groups.

	Migraine group	Control group
Contralateral suppression ratio (%)	50 (30/60)	67 (40/60)
Mean suppression level (dB)	0.3±2.3	0.6±2

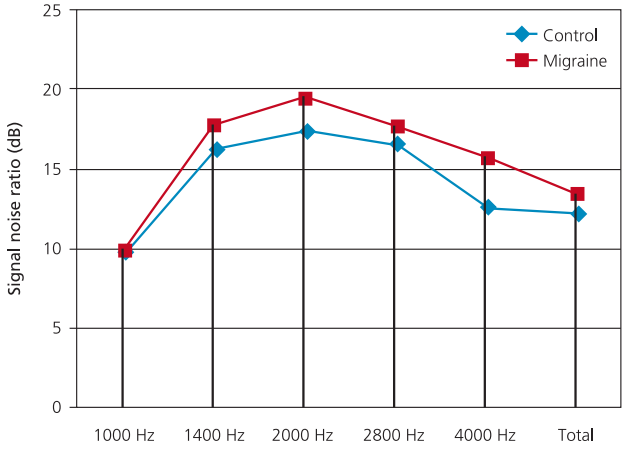

Fig. 1. TEOAE SNR findings of migraine and control groups.

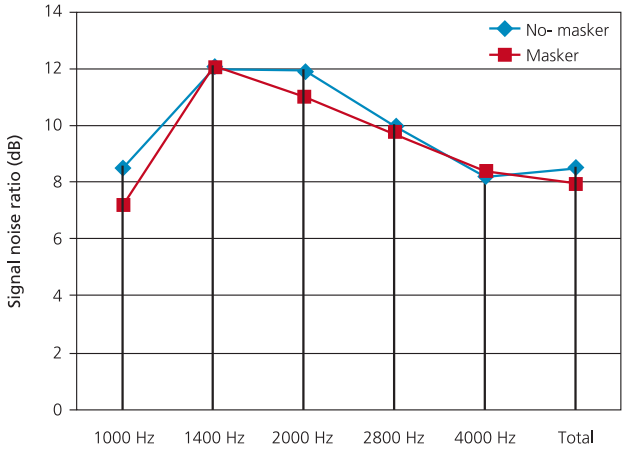

Fig. 2. Emission graphics of control group with and without suppression.

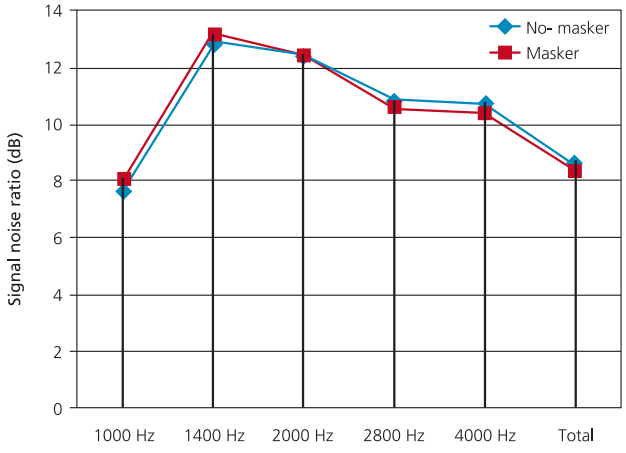

Fig. 3. Emission graphics of migraine group with and without suppression.

Discussion

The association of migraine with neurologic and neuro-otologic manifestations has been reported in the literature.[11–13] It has been theorized that patients with migraine have suffered from recurrent damage to the inner ear due to potential vasospasm. Auditory symptoms are considered to be less frequent than co-existing vestibular symptoms. Kayan and Hood had stated that phonophobia is the most common auditory symptom in migraine patients.[12,13] Electrocochleography (EcoG), vestibular evoked myogenic potentials (VEMP), auditory brainstem responses (ABR) and otoacoustic emissions are the main electrophysiologic tests that have been used. Bayazit et al. reported that while all of their patients had normal PTA and speech discrimination scores, approximately 1/3 of their patients had abnormal ABRs such as prolongated latency of wave I in 20%.[9,13] According to the study of Dash et al., it was demonstrated that patients with migraine accompanied with vertigo are more likely to have pure-tone abnormalities than patients without vertigo during attacks of headache. In that study it was stated that abnormal ABR findings such as prolongation of latencies and interpeak latencies can be the preceding symptoms of audiovestibular dysfunction in patients with migraine.[13,14]

Otoacoustic emissions are invariably associated with properly functioning OHCs. OAE can monitor any changes in cochlear integrity which can not be detected by other audiological methods. DPOAE scans whole cochlea in a frequency-specific manner and has superiority over other methods in examining higher frequency area.[9] DPOAE testing indicated a normal functioning cochlea at the frequency range of 1–4 kHz in migraine patients. It has been reported that thresholds for pure-tone hearing at high frequencies between 6 and 8 kHz had decreased in migraine patients; however, pure-tone hearing was not affected within 0.5–4 kHz range. Additionally decreased DPOAE amplitudes at the 5-kHz region support the involvement of basal parts of the cochlea in migraine. Van Der Feltz-Cornelis et al. hypothesized that a chronic migrainous process may enhance potentiation of the auditory cortex which may in some cases evokes acoustic auras with auditory hallucinations.[15] This hypothesis was also supported by the research with auditory evoked potentials (ABRs) that showed lack of habituation in the auditory cortex in migraineurs.[16]

In the present study, we used contralateral otoacoustic emission suppression test to evaluate the afferent and efferent pathways of auditory system. Therefore we could also manage to examine the centrifugal pathway from cortex to cochlea. It was formerly stated that vestibular migraine had deleterious effects on central control over cochlea.[9,17] We have shown that migraine patients without vestibular symptoms demonstrate a statistically insignificant decrease in the suppression values and ratio in the presence of suppression. In the study of Bolay et al. where migraine group was not divided into groups according to the presence of vestibular symptoms, it was stated that contralateral sound stimulus did not induce significant suppression of TEOAEs and TEOAE amplitudes in migraine patients, while TEOAEs and TEOAE amplitudes were significantly reduced in the control group upon exposure to contralateral sound stimulation, which is consistent with the literature.[9,17] Besides in vestibular migraine a decrease in contralateral otoacoustic emission suppression has been stated. In our study, newly diagnosed migraine patients without accompanying audiovestibular symptoms showed decreased suppression responses like vestibular migraine patients as reported previously.[18]

Conclusion

Although it is statistically insignificant, we have demonstrated that migraine patients without vestibular symptoms showed a decrease in the suppression values and ratio in the presence of suppression compared to the healthy volunteers. The main implication of these findings is to provide earliest examination of auditory dysfunction much faster than other methods. Also MOC reflex measurements do not need any patient cooperation. Upon detection of suppression deficit, clinician should keep in mind that a possible vasospasm has begun influencing inner ear. Prophylactic vasospasmolytic drugs may be added to therapy even in the absence of any other clinical feature. Besides, during an attack and sometimes following the attack, the patients may be more prone to the acoustic damage to the inner ear due to the loss of central control over OHC amplification. In further studies containing larger series, contralateral otoacoustic emission suppression test can be used as an early tool to diagnose audiovestibular symptoms in migraine patients even they do not have any vestibular involvement.

Conflict of Interest: No conflicts declared.

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