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Original Article / Çalışma - Araştırma

Evaluation of phonophobia with audiological tests in vestibular migraine patients

Vestibüler migren hastalarında fonofobinin odyolojik testler ile değerlendirilmesi

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ABSTRACT

Objectives: This study aims to review the diagnostic value of loudness discomfort level (LDL) and short increment sensitivity index (SISI) measurements in patients with vestibular migraine.

Patients and Methods: The study included 20 vestibular migraine patients (group 1; 5 males, 15 females; mean age 42.1 years; range 16 to 60 years) and 20 healthy controls (group 2; 6 males, 14 females; mean age 20.3 years; range 18 to 30 years). Pure tone audiometry, SISI, tympanometry, and LDL test were performed.

Results: Median LDL scores in groups 1 and 2 were 99.50 dB (interquartile range: 19.5) and 105 dB (interquartile range: 6), respectively. LDL scores were significantly lower in group 1 ($p<0.05$). According to the receiver operating characteristic analysis of LDL measurements, the area under curve was 0.76 ($p<0.05$) when vestibular migraine was the selection criterion. When 103.5 dB was taken as the cut-off point, the sensitivity of LDL test was 75% and specificity was 82%. There was no significant relationship between the SISI scores and phonophobia ($p>0.05$).

Conclusion: To our knowledge, this is the first study to show the potential diagnostic value of LDL as an audiological test in vestibular migraine. Further studies are warranted to elucidate the diagnostic value of LDL in the differential diagnosis of episodic vertigo.

Keywords: Loudness discomfort level; phonophobia; short increment sensitivity index; vestibular migraine.

ÖZ

Amaç: Bu çalışmada vestibüler migren hastalarında rahatsız edici ses düzeyi (LDL) ve short increment sensitivity index (SISI) ölçümlerinin tanısal değeri incelendi.

Hastalar ve Yöntemler: Çalışmaya 20 vestibüler migren hastası (grup 1; 5 erkek, 15 kadın; ort. yaş 42.1 yıl; dağılım 16-60 yıl) ve 20 sağlıklı kontrol (grup 2; 6 erkek, 14 kadın; ort. yaş 20.3 yıl; dağılım 18-30 yıl) alındı. Saf ses odyometrisi, SISI, timpanometri ve LDL testi uygulandı.

Bulgular: Grup 1 ve 2'de medyan LDL skorları sırasıyla 99.50 dB (çeyrekler açıklığı: 19.5) ve 105 dB (çeyrekler açıklığı: 6) idi. LDL skorları grup 1'de anlamlı olarak daha düşük idi ($p<0.05$). Vestibüler migren seçim ölçütü olduğunda, LDL ölçümlerinin alıcı işletim karakteristiği analizine göre eğri altında kalan alan 0.76 ($p<0.05$) idi. Eşik noktası olarak 103.5 dB belirlendiğinde, LDL testinin duyarlılığı %75, özgüllüğü ise %82 idi. SISI skorları ve fonofobi arasında anlamlı ilişki yoktu ($p>0.05$).

Sonuç: Bildiğimiz kadarıyla, LDL'nin vestibüler migrende bir odyolojik test olarak potansiyel tanısal değerini gösteren ilk çalışma budur. LDL'nin epizodik vertigonun ayırıcı tanısındaki tanısal değerinin aydınlatılması için ileri çalışmalara gereksinim vardır.

Anahtar Sözcükler: Rahatsız edici ses düzeyi; fonofobi; short increment sensitivity index; vestibüler migren.

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According to the International Headache Society (IHS) headache classification published in 2004, migraine is defined as a primary headache and 90% of patients suffering from headache have primary headache.[1,2] Vestibular migraine (VM) is defined as vertigo attacks directly caused by migraine.[2] Vestibular migraine can also be named "migraine-related dizziness" and "benign recurrent vertigo." The lifetime prevalence of VM has a reported frequency of 1% in the general population.[3] The diagnosis of VM relies on a detailed history and is established by internationally accepted criteria. There must be at least five episodes with vestibular symptoms of moderate or severe intensity lasting between five minutes and 72 hours, a current or past history of migraine without aura or migraine with aura, and at least 50% of the episodes have to be associated with migrainous features such as characteristic migraine headache, photophobia, phonophobia or visual aura.[4] Less than 10% of patients with VM meet these criteria.[3-7] Because there is no specific symptom to diagnose VM, its diagnosis is based on patient history. According to the classification by IHS and Neuhauser, phonophobia and photophobia during headache are both probable and definite diagnostic criteria.[1,2] Phonophobia and photophobia have a reported frequency of 23% and 53% respectively in VM patients.[8]

The aim of this study was to assess loudness discomfort level (LDL) and short increment sensitivity index (SISI) in patients with vestibular migraine and evaluate the diagnostic role of these tests.

PATIENTS AND METHODS

With Institutional Review Board approval, this study was conducted at an otolaryngology department of a tertiary academic center between September 2014 and March 2015. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Twenty vestibular migraine patients (group 1; 5 males, 15 females; mean age 42.1 years; range, 16 to 60 years) diagnosed according to the IHS criteria were included in the study. The control group (group 2; 6 males, 14 females; mean age 20.3 years; range, 18 to 30 years) consisted of 20 healthy subjects. All patients had a complete head and neck examination and were evaluated by the vertigo board (composed of otolaryngologists, neurologists and physical medicine specialists) of the academic center. Patients with retrocochlear disease or active middle ear disease were excluded.

Pure tone audiometry, SISI, tympanometry and LDL were performed with the Interacoustic AC-40 (Interacoustics A/S, Middelfart, Denmark) clinical audiometer. Audiometric evaluation was done during the interictal period. Patients had neither vestibular symptoms nor photophobia during the tests. Visual analog scale (VAS) scores were obtained from patients in order to assess overall disease status. Patients were also questioned for phonophobia and photophobia. Tympanometry was performed with the AT235 (Interacoustics A/S, Middelfart, Denmark) clinical tympanometer.

Statistical analysis

Statistical analysis was made using IBM SPSS version 22.0 (IBM Corp., Armonk, NY, USA) software. Chi-square (χ^2) exact tests were used for comparison of categorical data. Independent and paired sample t-tests were used for analysis of parametric variables while Wilcoxon and Mann-Whitney U tests were used for analysis of non-parametric variables based on the distribution pattern of the data. The Shapiro-Wilk test was used for determining the distribution pattern of the data. The distribution of the groups were non-parametric. Correlation analysis was performed via Pearson or Spearman correlation analysis based on the distribution pattern of the data. Data were expressed as "median, interquartile range (IQR)". Receiver operating characteristic (ROC) analysis was performed. A p value less than 0.05 was considered statistically significant.

RESULTS

Mean air conduction (500-4000 Hz) pure tone audiometry (PTA) thresholds for right and left ears in group 1 were 19.28 dB and 11.78 dB respectively. Mean air conduction (500-4000 Hz) PTA thresholds for right and left ears in group 2

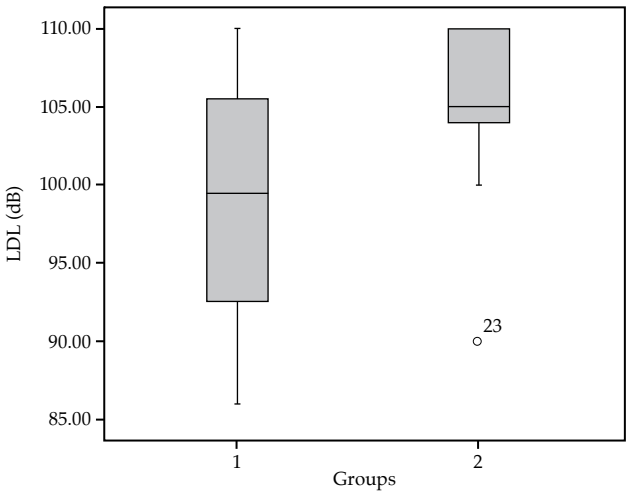

Figure 1. *Box and whisker plots of loudness discomfort level (LDL) scores of groups 1 and 2. (Group 1 median: 99.50 dB [IQR=19.50], group 2 median: 105 dB [IQR=6]).*

were 13.25 dB and 12.56 dB respectively. Mean air conduction PTA thresholds in group 1 and 2 did not differ significantly between both ears (p>0.05). Tympanometric measurements yielded type A configurations in all subjects. Eighty percent (n=16) of the patients had phonophobia while 45% (n=9) had photophobia. Mean LDL scores were 99.18 dB and 105.37 dB for group 1 and 2 respectively. Moreover, the median LDL scores of group 1 and 2 were 99.50 dB (IQR: 19.5) and 105 dB (IQR: 6) respectively (Figure 1). Median LDL scores were significantly lower in group 1 (p<0.05). The mean VAS score of group 1 was 28.5 mm.

Receiver operating characteristic analysis of LDL scores revealed that the area under curve (AUC) was 0.76 (p<0.05) when vestibular migraine was chosen as the selection criterion. When 103.5 dB was taken as the cut-off point, the sensitivity of the LDL test was 75% and specificity was 82% (Figure 2).

Median LDL was 98 dB and 105 dB in the phonophobia positive and negative subjects (including the control group) respectively (p<0.05) (Figure 3). In contrast, the difference of LDL was not statistically significant between phonophobia positive and negative patients (p>0.05). The SISI scores of group 1 were 6.32 for right ears and 1.95 for left ears compared to 1.56 for right ears and 1.32 for left ears in group 2. When SISI scores were analyzed, median SISI scores were 5% in phonophobia positive patients, 5% in phonophobia negative patients and 3% in the control group. No statistically significant difference was found between SISI scores of phonophobia positivite patients, phonophobia negative patients and the control group (p>0.05).

The median VAS scores of phonophobia positive patients were 30 mm and the median VAS scores of phonophobia negative patients were 20 mm. No significant correlation existed

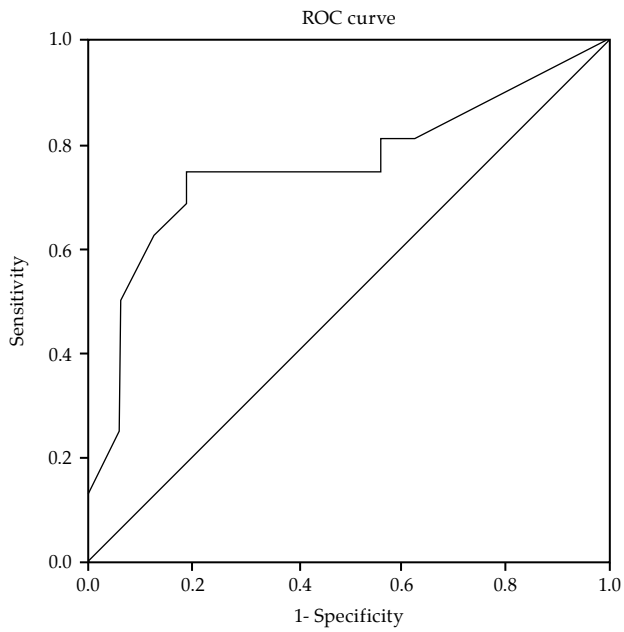

Figure 2. *Receiver operating characteristic (ROC) analysis for loudness discomfort level (LDL) scores. When vestibular migraine was chosen as the selection criterion, the area under curve (AUC) was 0.76.*

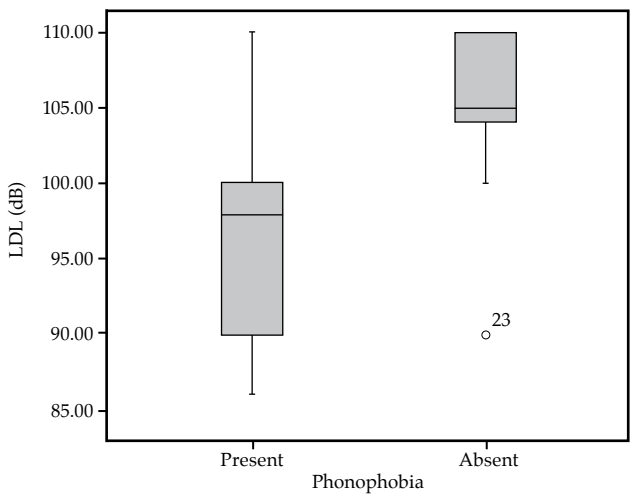

Figure 3. *Box and whisker plots of loudness discomfort level (LDL) values of phonophobia positive and negative subjects. Median LDL levels are 98 dB and 105 dB respectively.*

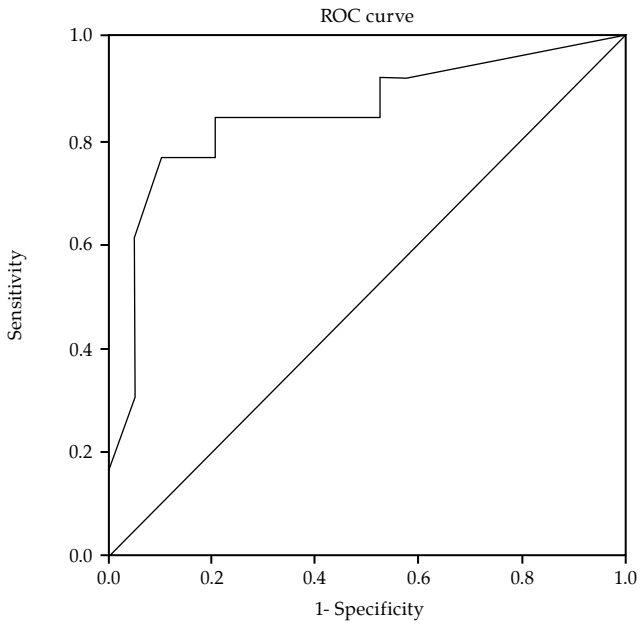

Figure 4. *Receiver operating characteristic (ROC) analysis for loudness discomfort level (LDL). When phonophobia was chosen as the selection criterion, the area under curve (AUC) was 0.85.*

between VAS and LDL scores ($p>0.05$).

Receiver operating characteristic analysis for LDL revealed that the area under curve (AUC) was 0.85 ($p<0.05$) when phonophobia was chosen as the selection criterion (Figure 4). When 103.50 dB was taken as the cut-off point, the sensitivity of the LDL test was 85% and specificity was 79%.

DISCUSSION

According to the IHS International Classification of Headache Disorders, 3rd edition published in 2013, photophobia and phonophobia are the two VM diagnostic criteria and phonophobia is defined as sound-induced discomfort.[1] Phonophobia is a transient and bilateral phenomenon that must be differentiated from recruitment, which is often unilateral, persistent and associated with cochlear hearing loss. Recruitment leads to an enhanced perception and often distortion of loud sounds in an ear with decreased hearing.[9,10] Short increment sensitivity index is one of the most significant tests to evaluate recruitment presence. The diagnosis of vestibular migraine is mainly based on the patient history and there are no established useful audiological parameters or biomarkers to support the diagnosis.

Although the exact pathophysiologic mechanism of VM remains unclear, there are various proposed mechanisms.[11] Magnetic resonance imaging studies report possible pathoanatomic connections between the pain and vestibular systems in migraine.[12] Another functional imaging study reported increased metabolism of the temporo-parietal-insular areas and bilateral thalami in two VM patients.[13] Other than central mechanisms, there are also proposed peripheral mechanisms. The relation between trigeminovascular system and inner ear was proposed because of common innervation.[14,15] Murdin et al.[16] reported that vestibular migraine was significantly associated with abnormal otoacoustic emissions. Zaleski et al.[17] reported that the rate of bilaterally absent ocular VEMP were significantly higher (28%, $p<0.01$) in the VM group compared with the control group.

Loudness discomfort level was found to be significantly lower in phonophobia positive patients in this study. Additionally LDL was significantly lower in VM patients compared to controls. According to the ROC curves, if 103.5 dB was taken as cut-off point, sensitivity and specificity would be significantly higher. Therefore, LDL indicates a significant difference between VM patients and controls. Also at this point, LDL may discriminate phonophobia positive and negative patients. According to the results of this study LDL levels could be used as an audiologic parameter to discriminate phonophobia.

When the SISI scores were analyzed median SISI scores were 5% in phonophobia positive patients, 5% in phonophobia negative patients and it was 3% in the control group. No statistically significant difference was found regarding the SISI scores of phonophobia positivite patients, phonophobia negative patients and controls. It can be elucidated that SISI might evaluate recruitment but recruitment and phonophobia are two different phenomena. Although LDL levels might support phonophobia (which is one of the diagnostic criteria of VM), the same does not apply for SISI scores.

Phonophobia is one of the most important symptoms of vestibular migraine. According to the results of this study the LDL test could be effective for the objective audiologic documentation of phonophobia. Loudness discomfort levels less than 103.5 dB could be

useful for the discrimination of vestibular migraine patients with a sensitivity of 75% and a specificity of 82%. To the best of our knowledge, this is the first study to show the potential diagnostic role of LDL levels as an audiologic tool in vestibular migraine. Given the high prevalence of phonophobia in VM patients of this study measuring LDL levels has a promising diagnostic value. However the small number of patients is a limitation of this study. Further studies with larger patient groups are warranted to assess the diagnostic value of LDL in the differential diagnosis of episodic vertigo.

Declaration of conflicting interests

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