ENT Updates

ORIGINAL ARTICLE

ENT UPDATES 11(2):110-114
DOI: 10.5152/entupdates.2021.21229

Assessment of Noise Sensitivity in Migraine Patients

ABSTRACT

Background: Noise and light sensitivities are typical symptoms for migraine attack type headaches. Sometimes, these sensitivities can be observed without these attacks as well. The purpose of this study was to analyze sensitivity to noise in migraine patients.

Method: In the study, 30 patients with no hearing loss who were being followed-up for their migraine illness, and 30 patients with similar demographic characteristics who did not have migraine, were included. The patients were given a hearing test and their hearing thresholds were determined. All of the patients were administered the Weinstein Noise Sensitivity Scale. The demographic data and noise sensitivity levels of the 2 groups were compared.

Result: The mean score on the Weinstein Noise Sensitivity Scale was observed as 89.47 ± 14.66 in the group without migraine, and as 93.34 ± 12.61 in the group with migraine. Although there was no statistically significant difference between the mean scale scores of 2 groups, the mean result of migraine group was found higher in migraine group. When 2 groups were compared with respect to the noise sensitivity subgroup, which has 99 and higher scores, the migraine group was found to be statistically different from control group.

Conclusion: It was observed in this study that migraine patients experience noise sensitivity even without acute attacks. It is considered that preliminary information can be obtained about how the auditory and sensory pathways are affected in migraine patients, by using scales, similar to the noise sensitivity scale.

Keywords: Migraine, noise sensitivity, questionnaire survey

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Cite this article as: Gökdoğan O, Gökdoğan Ç, Kemal Kemaloğlu Y, Cengiz B. Assessment of noise sensitivity in migraine patients. *ENT Updates.* 2021; 11(2): 110-114.

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Received: *April 30, 2021*
Accepted: *July 8, 2021*

INTRODUCTION

Noise is defined as unwanted sound. Sounds which have the same acoustic properties can be perceived as "nice" by some people and as 'noise' by others. Due to genetic and/or familial reasons, some individuals develop a noise adaptation disorder, and sensitivity develops as a consequence. This is defined as subjective noise sensitivity. Although it has been shown that subjective noise sensitivity has nothing to do with an individuals' hearing, a relationship has been found between individuals' behavioral differences, their tendency toward certain psychological states, and their negative perception of their health.[1,2]

Different studies have shown that getting annoyed due to loud sounds is an indication of noise sensitivity. It has been reported that patients who have had head trauma, migraine headaches, facial paralysis, otologic infections, and surgical interventions such as stapedectomy also have loud-noise sensitivity (hyperacusis).[2-4]

The relationship between noise sensitivity, hyperacusis, and phonophobia has still not been clearly shown. However, there is a relationship between noise sensitivity and some behavioral characteristics, psychiatric illnesses, weak perception of health, and social differences. It has been shown that patients who have noise sensitivity are more sensitive to environmental stimulants as well.[4] It has been shown in various studies that these patients are more susceptible to neurosis, depressive symptoms, and psychological problems.[2,4]

It has been shown that noise sensitivity has an inverse relationship with the quality of life scores. In addition, it has been shown that the noise sensitivity level is related to mental and physical health.[2,5] Therefore, the level of noise sensitivity can be accepted as a marker for

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individuals' perception of health and their tendency to psychological problems, in addition to being an identifying marker for the problem caused by sound.

Migraine is a condition which is marked by headache attacks, and is accompanied by nausea, vomiting, photophobia, and phonophobia. The prevalence of migraine in the general population varies between 6% and 16%. It is observed 2.5 times more in women compared to men.[6]

In migraine patients, the most studied and known subject in terms of audio vestibular involvement is the effects on the vestibular system. In particular, as the awareness of vestibular migraine increases, the accumulation of knowledge on vestibular migraine increases as well. However, effects on the auditory system should not be ignored despite the vestibular system's more frequent involvement in migraine patients. During attacks, phonophobia is known to be the most frequent auditory symptom. As a result of the auditory path getting affected in migraine patients, symptoms such as hearing loss, tinnitus, sudden hearing loss, and difficulty in discriminating sound can be observed as well. As a consequence of these effects, it is reported that auditory brain stem responses are impaired.[7] In clinical practice, the intolerance to noise is considered to be among the most frequently experienced problems that migraine patients face in daily life.[3]

Migraine is generally related to symptoms of depression and anxiety, and the intensity of this relationship is in direct proportion to the frequency of headaches. In addition, the anxiety and/or depression which may develop in migraine patients exacerbate the condition's effects on the individual. Depression is also accepted as a risk factor in terms of chronic migraine progression.[8,9]

The noise sensitivity scale developed by Weinstein has been used widely to assess individuals' sensitivity to noise. This scale has been translated to Turkish by Yildiz et al.,[10] and it has been tested for validity and reliability.

The purpose of this study is to assess noise sensitivity, which is one of the predictive factors of the auditory path being affected in migraine patients, during the periods between attacks. Weinstein's Noise Sensitivity Scale was used for this assessment.

METHODS

The ethical board's approval for the assessment of noise sensitivity in migraine patients was obtained from the Mugla Sitki Kocman University Clinical Research Ethical Board, dated December 27, 2018, and numbered 22/IX. According to the guidelines of the ethics committee, we accepted and complied with the Declaration of Helsinki. The study was carried out between January, 2020 and January, 2021. Consent forms were obtained from all the patients.

Thirty patients diagnosed with migraine (with aura or without aura) by the department of neurology, whose follow-up continues, were included in group 1. For group 2, 30 healthy volunteers with similar demographic characteristics were included. Since migraine is seen more in women, and the previous studies did not report gender differences in subjective noise sensitivity, only female patients and volunteers were included.

All of the patients and volunteers were questioned about hearing loss prior to being included in the study. All patients underwent an otologic examination by a senior otorhinolaryngologist. The hearing thresholds of all patients were evaluated through pure-tone audiometric analysis (Interacoustics AC-40 clinical audiometer, Assens, Denmark) by a senior audiologist. Both air and bone conduction thresholds were determined. A senior neurologist diagnosed the migraine, and also guided the treatment and follow-up for all the patients.

Those with a history of hearing loss, and those who were determined as having hearing loss in the audiometric analysis were excluded. Moreover, patients who had a history of otologic or neurological surgery were excluded from the study. Patients who used medications for any chronic disease other than to treat acute migraine attacks, were also excluded for potential effects.

The participants in the study and control groups were administered the Weinstein Noise Sensitivity Scale. The demographic data and the noise sensitivity levels of both groups were compared. The Weinstein Noise Sensitivity Scale consists of 21 questions to assess the effect of noise on an individual. Depending on the agreement or disagreement with each question, the participant is asked to give scores from 1 to 6. After the evaluation of each question, the scores are added together and a total score between 21 and 126 is achieved. In this study, the subjects' scores of 99 and above were compared, as 99 was determined as the noise sensitivity threshold between the 2 study groups, both in group differences and in the Turkish adaptation study.

The statistical evaluation of the data was done with Statistical Package for the Social Sciences (SPSS) version 25.0 (IBM SPSS Corp.; Armonk, NY, USA). The data showed normal distribution. The Kolmogorov–Smirnov test was used to assess the distribution. Descriptive statistics were used for average age, audiological pure-tone average, and scale-score average. Numerical variables that followed parametric assumptions were compared using the independent-samples *t*-test, and categorical variables were compared using the chi-square test. The significance level was accepted as $P < .05$ in all statistical analyses.

RESULTS

While the age average of group 1 was determined as 39.04 ± 8.05, the age average of the group 2 was determined as 34.6 ± 8.62. A statistical difference between the groups was not observed in terms of age ($P = .07$).

MAIN POINTS

- The higher sensitivity to noise in migraine patients may be an important indicator of the impact of migraine on their quality of life.The decrease in the quality of life of migraine patients may trigger or increase psychological problems, including anxiety and depression.
- Increased sensitivity to noise in patients with migraine may be a warning symptom of auditory pathway involvement.

The bone conduction thresholds of group 2 were 5.86 ± 1.93 dB in the right ear, and 5.65 ± 1.72 dB in the left ear. The pure-tone average of air conduction thresholds in group 2 was determined as 9.13 ± 2.88 dB in the right ear and as 8.69 ± 2.24 dB in the left ear. In group 1 bone conduction thresholds of right ear was 7.21 ± 3.21 dB and left ear was 6.08 ± 2.10 dB. In group 1, the air conduction pure-tone average was determined as 10.78 ± 3.30 dB in the right ear and as 10.65 ± 3.12 dB in the left ear. A statistical difference was not observed between the groups in terms of pure-tone threshold. (air conduction thresholds: right ear, $P = .14$; left ear, $P = .059$; bone conduction thresholds: right ear, $P = .058$; left ear, $P = .71$)

As a result of Weinstein Noise Sensitivity Scale scores, while the score of group 2 was determined as 89.47 ± 14.66, the score of group 1 was determined as 93.34 ± 12.61. It was observed that the difference between the groups was not statistically significant ($P > .19$).

The results of the scale were evaluated in the form of questions (Figure 1). The results of the scale, when applied to the migraine patients, revealed that while an average of 5 points and above were achieved in 7 questions, between 4 and 5 points were achieved for 12 questions, between 3 and 4 points was achieved for 1 question, and less than 3 points was achieved for 1 question, out of the total of 21 questions. When the scale was applied to the healthy participants, the scores achieved were an average of 5 points and above for 2 questions, between 4 and 5 points for 10 questions, and between 3 and 4 points for 7 questions.

While the number of subjects with a threshold of 99, which was determined as the noise sensitivity threshold in the Turkish adaptation study, and over 99 was determined as 52.17% in group 1, it was determined as 21.73% in group 2. A statistically significant difference was found between the 2 groups ($P = .033$)

DISCUSSION

Migraine has different sub-types, depending on the accompanying symptoms and involvement areas. Menstrual migraine, hemiplegic migraine, vestibular migraine, and abdominal migraine can be listed among these types. According to the latest ICDH-3 (The International Classification of Headache Disorders) classification, temporary neurological symptoms related to brain stem involvement were classified as a separate aura type. In the past, these symptoms were defined as basilar migraine, and it was considered that the symptoms were related to basilar artery involvement. With the new classification, among the symptoms related to brain stem involvement and defined as aura are: dysarthria, vertigo, tinnitus, hearing loss, diplopia, ataxia, and decrease in level of consciousness.[11] When the frequency of symptoms related to brain stem involvement were evaluated, it was determined that there were differences at the rate of 70% for vertigo, 46.9% for diplopia, 42.1% for tinnitus, 36.8% for dysarthria, 32.9% for ataxia, 25.4% for consciousness level, and 23.7% for impairment in hearing.[12]

As it is known, audio vestibular symptoms can sometimes be observed during the attacks and sometimes between the attacks, in migraine patients. Hamed et al.[13] have determined phonophobia complaints in about 21% of the 58 subjects who had migraine with aura and without aura, and tinnitus complaints in 14%, and achieved normal pure-tone audiogram and immittance findings in the basic audiological evaluation compared to the control group. However, anomalies were found in the electrophysiological auditory tests of about two-thirds of the subjects with migraine in this study. When compared with the control group, apparent differences were found between the otoacoustic emission amplitudes in subjects that had migraine with aura and the auditory brainstem response (ABR) latencies of subjects that had migraine without aura.[13] Similar findings were published by Bolay et al.[14] as well. In Bolay et al.'s[14] study, differences were also found in the contralateral suppression, which shows the control of upper centers on the cochlea, and it was suggested that this might be the reason for phonophobia in migraine. The researchers in these 2 studies have suggested that the anomalies determined in the otoacoustic emissions (OAE) and ABR variables might either be an indication of auditory dysfunction in migraine or an impairment in the central processing mechanisms

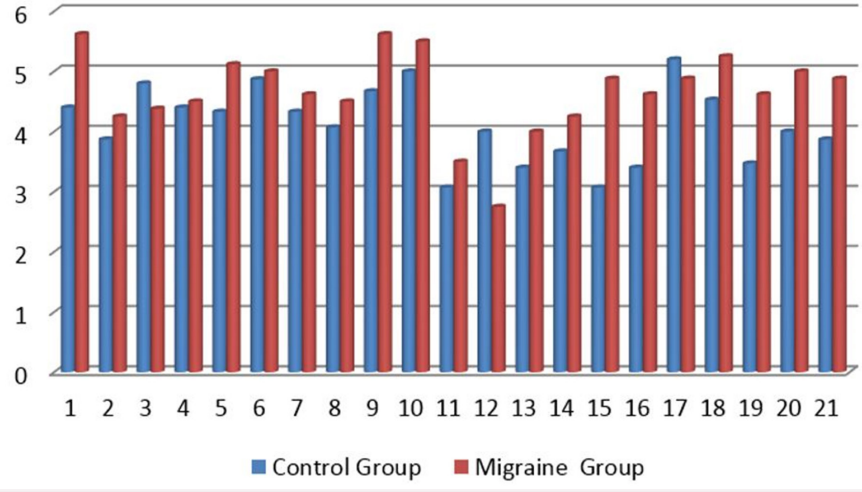

Figure 1. The average values of the Weinstein Noise Sensitivity Scale questions for migraine patients with normal hearing, and healthy volunteers (X axis: question number, Y axis: the average value of the question).

in migraine.[13,14] In this study, the apparent high rate in terms of the number of subjects, both, in the difference in group averages according to the control group, and in the upper group noise sensitivity threshold between subjects with migraine (it was determined as 99 for Turkey),[10] supports this result.

Phonophobia in migraine patients, in particular during an attack, is an observed symptom and it generally creates a discomfort in proportion to the intensity of the headache. The affected pathophysiological region of sound sensitivity observed in migraine patients has not clearly been shown yet. As a result of repeating migraine attacks, increased activity in the brain stem and trigeminal pathway is one of the suggested hypotheses.[15] However, there are also hypotheses which suggest that the sensitivity is cortical in origin, and a decrease in phonophobia in 64% of the patients together with a decrease in migraine attacks as a result of transcranial magnetic stimulation of the cortical areas support this hypothesis.[16]

Hyperacusis is in particular observed in chronic pain syndromes where sensorial processing is impaired. Some similarities have been suggested between sound sensitivity and the development of pain.[17] It is known that all sensory input, with the exception of the sense of smell, passes from the thalamus before spreading to the cortex. The importance of sensorial processing impairment in migraine has been shown in previous studies. The impairment of the cortical inhibitor effect, which is effective on the auditory pathway, as a result of the impairment of thalamus–cortex interaction in migraine patients, can also affect the sensorial processing period.[18]

However, the connections between the thalamus and the amygdala are important in terms of hyperacusis development in migraine patients, and the discomfort that results. The projections of the amygdala on the hippocampus can have an effect on sound sensitivity and on the avoidance behavior which develops as a result of this. The amygdala, which is stimulated by sensorial signals not processed by the subcortical or higher cortical structures, can cause excessive negative emotional reactions induced by sound, just like in cases of anxiety and agitation.[19]

Although mechanisms of sound sensitivity in migraine patients cannot clearly be presented, the amygdala and hippocampus can be counted among the areas in which psychological stress develops during this process. The amygdala is warned about dangers under normal conditions and is effective on the physiological changes in this process. Basically, hippocampus is effective during the processing of memory, stress, and emotions. Therefore, in order to reduce exposure to stressful and noisy environments, it facilitates learning avoidance behaviors.[20]

Another area which can be effective in the pathophysiological mechanism is the locus coeruleus. This is an important area located in the brain stem and is also the noradrenalin center in the central nervous system. The noradrenergic projections resulting from this area are important for the auditory pathway. Noradrenergic stimulation shown both in the cochlea and the brain stem modulate the auditory pathway, and the increased noradrenergic stimulation arising from this area can cause sound sensitivity and discomfort. However, connections between the locus coeruleus and the amygdala can cause depressive and emotional effects to develop in this process.[17,21]

Although phonophobia is observed during attacks in migraine patients, we evaluated the subjective noise sensitivity which is regarded as a personal characteristic in subjects with migraines with aura and without aura, between attacks, and found it to be significantly higher compared to the control group. According to our knowledge, this study is the first in the literature to analyze the relationship between migraine and subjective noise sensitivity in normal hearing patients. Although the number of subjects in this study was small, a clear finding emerges that subjective noise sensitivity in patients with migraine is higher. In the literature, the relationship between phonophobia or hyperacusis and subjective noise sensitivity has not been shown yet. In a single study carried out on people who had been subjected to long-term small doze of chemical exposure, while a relationship was not found in the control group, a significant relationship was found in the exposed individuals.[22] In the past studies, no significant auditory difference was found in individuals with subjective noise sensitivity. If future studies support the findings of this study, the subjective noise sensitivity scale will allow us to evaluate and follow-up migraine subjects independent of hearing loss and other cochlear symptoms. In this study, the detailed electrophysiological evaluation and long-term follow-up of patients diagnosed with noise sensitivity were the negative aspects. These need to be prioritized in future studies. More advanced studies have been planned to fulfill this need. Another reason why electrophysiological evaluations were not performed is the pandemic conditions. Since evaluation through these tests required a long time in closed environments, such evaluations could not be done under pandemic conditions.

The Weinstein Noise Sensitivity Scale was analyzed for each question in both groups. In particular, when 7 questions which received 5 points and above in the migraine group were analyzed, it was observed that the psychosocial consequences caused by migraine greatly influence the individual's daily life. In the scale used to evaluate the migraine patients, the participants expressed the following about what caused them the most discomfort "If my apartment is good, I would not mind living on a noisy street," "Noise easily wakes me up," "If the apartment you are thinking about renting is across the fire station, would that bother you?" "Sometimes noise irritates me and causes discomfort," and "People who make noise when I'm about to sleep or while I'm working drive me crazy." In this context, the question which received a maximum of 2 points was related to the kind of an environment in which the individuals wished to live, and the how decisions made in accordance with this can affect the individual's life as well. However, according to the noise sensitivity scale applied to the migraine patients, it was observed that music and sounds other than speaking in daily life do not negatively affect them too much.

When the scale results of the healthy volunteers who were included in the study were analyzed, it was observed that the subjects were annoyed with intense/loud noise (such as motorcycle noise). It was observed in this group as well that listening to favorite music while trying to concentrate on work does not bother them. This finding, observed in both groups, shows us that the perception of speech and the perception of music can

be effective on different pathways. More advanced studies are needed on this topic.

Just like the rest of the world, our country has been living under pandemic conditions since March 2020. Our daily life and educational processes have been affected, besides giving way to certain arrangements to be done in the area of health. While health-related processes such as telerehabilitation, and remote consultancy services became more popular, it is attempted to have shorter contact durations for both the patients and the institutions providing health services. In this regard, stimulating tests gain importance in terms of simple, easily applicable and required advanced studies used for migraine patients with vestibular symptoms or without these symptoms. If there is noise sensitivity in patients who are diagnosed with migraine at the end of a study and if they are in their proper treatment and follow-up periods, then future studies should prioritize determining whether there are clinical differences, in particular cochlear symptoms which may occur in the beginning stage.

CONCLUSION

In the study, it was determined that the noise sensitivity level in migraine patients who do not have hearing loss differs significantly in comparison to healthy individuals. Although this finding is related to migraine patients having a negative health perception about themselves, being more sensitive to the environment, being more susceptible to depression and anxiety and the existence of some social behavioral disorders, it may also be related to the effects on the sensorial pathway. Even if migraine patients who have noise sensitivity do not have any hearing loss, it is important that they are followed-up in terms of cochlear symptoms and the evaluation of different variables of clinical migraine. There is a need for further studies in this area to support individuals with this condition.

Ethics Committee Approval: Ethical committee approval was received from the Mugla Sitki Kocman University Clinical Research Ethical Board, dated December 27, 2018 and numbered:22/IX.

Informed Consent: Written informed consent was obtained from all participants who participated in this study.

Peer review: Externally peer-reviewed.

Author Contributions: Concept – O.G., C.G., Y.K.K., B.C.; Design - O.G., C.G., Y.K.K., B.C.; Supervision - O.G., C.G., Y.K.K., B.C.; Resource - O.G., C.G., Y.K.K., B.C.; Materials - O.G., C.G., Y.K.K., B.C.; Data Collection and/or Processing - O.G., C.G., Y.K.K.; Analysis and/or Interpretation - O.G., C.G., Y.K.K., B.C.; Literature Search - O.G., C.G., Y.K.K., B.C.; Writing - O.G., C.G., Y.K.K., B.C.; Critical Reviews - O.G., C.G., Y.K.K., B.C.

Disclosure: This manuscript was presented in the Turkish National Otorhinolaryngology Head and Neck Surgery Congress 2020, as an oral presentation.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

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