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Evaluation of Subjective Eustachian Tube Function and Hearing Perception of Patients with Acute and Chronic Rhinosinusitis

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ABSTRACT

Objective: Rhinological or otological diseases can negatively affect eustachian tube functions and cause eustachian tube dysfunction. Hearing loss can be seen in patients with eustachian tube dysfunction. The aim of this study is to evaluate the effects of acute or chronic rhinosinusitis on eustachian tube dysfunction with the Eustachian Tube Dysfunction Questionnaire (ETDQ-7) and perception of hearing impairment and disability with the Amsterdam Inventory for Auditory Disability and Handicap (AIADH).
Material and Methods: This study was carried out with 33 acute rhinosinusitis, 32 chronic rhinosinusitis (study groups), and 32 undiagnosed (control group) participants who applied to the ENT outpatient clinic. All participants filled out the ETDQ-7 and AIADH.
Results: It was determined that the participants in the control group had lower ETDQ-7 and AIADH scale scores than the scale scores of the participants in the acute rhinosinusitis and chronic rhinosinusitis groups ($p<0.05$). There was no significant difference between the ETDQ-7 and AIADH scale scores between the acute and chronic rhinosinusitis groups ($p>0.05$).
Conclusions: Rhinosinusitis can cause eustachian tube dysfunction and problems in hearing perception by negatively affecting eustachian tube functions and hearing perception.
Keywords: Acute rhinosinusitis, chronic rhinosinusitis, eustachian tube dysfunction, hearing perception

INTRODUCTION

Rhinosinusitis is a disease caused by inflammation of the paranasal sinuses and nasal mucosa (1). Acute rhinosinusitis is defined as acute inflammation with sudden onset of symptoms and reversible inflammation. The most common symptoms associated with acute rhinosinusitis (ARS) have been reported as runny nose and congestion, pain and pressure in the facial region, and decreased sense of smell (2). Chronic rhinosinusitis (CRS) is defined as the presence of multiple sinonasal symptoms with inflammation for more than 12 weeks. It has been reported that most of the patients diagnosed with chronic rhinosinusitis have otological symptoms such as ear fullness/occlusion, cracking/popping sound in the ear, dizziness, and otalgia (3).

The Eustachian tube is part of the system of adjacent organs, including the nose, palate, nasopharynx, and middle ear cleft. The function of the eustachian tube is to protect the middle ear against inflammation and infection from viruses, bacteria, and gastroesophageal reflux, and patients with any dysfunction may have mild to moderate conductive hearing loss (4). Eustachian tube obstruction caused by inflammation of the nasopharynx; may cause allergic rhinitis, chronic rhinosinusitis, and reflux with eustachian tube dysfunction (ETD) (5).

Studies related to the effect of rhinosinusitis on eustachian tube dysfunction and hearing perception is very few in number. Lin et al. reported a significant correlation between chronic rhinosinusitis, outer hair cell destruction, and sensorineural hearing loss (6). In a study conducted in a tertiary rhinology clinic, it was reported that the increase in

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sinonasal symptoms was also a precursor to the increase in ETD symptoms (7).

The aim of our study is to evaluate the effects of acute or chronic rhinosinusitis on eustachian tube dysfunction with the Eustachian Tube Dysfunction Questionnaire (ETDQ-7) and perception of hearing impairment and disability with the Amsterdam Inventory for Auditory Disability and Handicap (AIADH).

MATERIAL AND METHODS

This study was approved by the Medical Research Ethics Committee of the Ege University, Faculty of Medicine (Date: 18.11.2021, No: 21-11.1T/16). The study was performed following the ethical principles of the Helsinki Declaration. The study consisted of two study groups of volunteers, 33 of whom were diagnosed with acute rhinosinusitis and 32 of whom were diagnosed with chronic rhinosinusitis by ENT physicians, who applied to the Department of Ear Nose and Throat, Ege University Faculty of Medicine Hospital and 32 undiagnosed healthy volunteers formed the control group between November 2021 and February 2022. A total of 97 participants were involved in the study. Participants between the ages of 18-65 who were diagnosed with acute or chronic rhinosinusitis by clinical examination, endoscopy, and radiological examinations, and who had not been diagnosed/have experienced hearing loss before the diagnosis of acute or chronic rhinosinusitis were included in this study. After these participants were informed about the study, an informed consent form was obtained, and the case report form was filled out.

The Eustachian Tube Dysfunction Questionnaire (ETDQ-7) was applied for the evaluation of the eustachian tube functions of the participants. The Turkish validity and reliability study of this scale was carried out by Erdoğan Özgür et al. in 2016 and it was recommended to be used in the detection of eustachian tube dysfunction and the evaluation of the severity of the disease. The total scale score was specified as 14.5 as the threshold value. A total scale score above this value indicates eustachian tube dysfunction (8).

For the evaluation of hearing perception, the Amsterdam Inventory for Auditory Disability and Handicap (AIADH) was used. The Turkish validity and reliability study of this questionnaire was conducted by Müjdeci et al (9). The total score of the questionnaire is between 0 and 90, and the higher the score, the more the hearing problem is reported (9).

Statistical analysis

SPSS (Statistical Package for the Social Sciences) 23.0 package program was used for statistical analysis of the data. Categorical measurements were summarized as numbers and percentages, and continuous measurements as mean and standard deviation (median and minimum-maximum where necessary). The Shapiro-Wilk test was used to determine whether the parameters in the study showed a normal distribution. The Mann Whitney u test was used for binary variables and Kruskal Wallis tests were used for more than two groups for parameters that did not show normal distribution. Tamhane's T2 tests, one of the Post Hoc tests, were used to determine the source of the difference between the groups. The statistical significance level was taken as 0.05 in all tests.

RESULTS

A total of 97 volunteer participants, 33 of whom were diagnosed with acute rhinosinusitis, 32 with chronic rhinosinusitis, and 32 without diagnosis, were included in the study.

Among the study groups included in the study, 63.6% of the patients diagnosed with acute rhinosinusitis were female and 71.9% of the patients diagnosed with chronic rhinosinusitis were female. Among the study groups, the mean age of patients diagnosed with acute rhinosinusitis was 31.2±13.6, and the mean age of patients diagnosed with chronic rhinosinusitis was 35.8±13.2 (Table 1).

It was determined that the average duration of diagnosis of patients with acute rhinosinusitis was 50.06 days, and the average duration of diagnosis of patients with chronic rhinosinusitis was 3528.125 days.

Symptoms were found in 64 (98.5%) of the patients. Fatigue in 47 (72.3%); Painful sensitive teeth in 25 (38.5%); cough in 20 (30.8%); ear pain in 41 (63.1%); ear fullness in 50 (76.9%) cases; 51 (78.5%) had headache, 27 (41.5%) had a feeling of pressure and swelling in the head and nose; Limited nasal breathing in 29 (44.6%), sore throat in 19 (29.2%); Fullness in the facial region in 7 (10.8%) of the patients; It was determined that 46 (70.8%) of them had tinnitus symptoms. Hearing loss after rhinosinusitis was detected in 21 (32.3%) of the patients (Table 2).

The frequency of fullness in the face area of the chronic rhinosinusitis group (p=0.004) was higher than the acute rhinosinusitis group (p<0.05). No significant difference was

Table 1: The age of the participants

	Acute rhinosinusitis	Chronic rhinosinusitis	Undiagnosed (control) group
	Mean±SD Med (Min-Max)	Mean±SD Med (Min-Max)	Mean±SD Med (Min-Max)
Age	31.2±13.6 25 (18-64)	35.8±13.2 31.5 (21-62)	32±10.1 28 (22-64)

SD: Standard deviation

Table 2: The symptoms observed in the study groups

	Frequency (n)	Percent (%)
Symptom		
No	1	1.5
Yes	64	98.5
Weakness		
No	18	27.7
Yes	47	72.3
Painful sensitive teeth		
No	40	61.5
Yes	25	38.5
Cough		
No	45	69.2
Yes	20	30.8
Earache		
No	24	36.9
Yes	41	63.1
Ear Fullness		
No	15	23.1
Yes	50	76.9
Headache		
No	14	21.5
Yes	51	78.5
Pressure sensation and swelling in the head and nose		
No	38	58.5
Yes	27	41.5
Limited nasal breathing		
No	36	55.4
Yes	29	44.6
Throat Ache		
No	46	70.8
Yes	19	29.2
Fullness in the face area		
No	58	89.2
Yes	7	10.8
Tinnitus		
No	19	29.2
Yes	46	70.8
Hearing loss sensation		
No	44	67.7
Yes	21	32.3

found in terms of other symptoms in the acute rhinosinusitis and chronic rhinosinusitis groups (p>0.05).

No significant difference was obtained between acute and chronic rhinosinusitis groups regarding AIADH and ETDQ-7 scores.

It was determined that there were differences between all groups (p<0.05) according to ETDQ-7 (p<0.001), AIADH (p=0.001), localization of sounds, which are the sub-parameters of AIADH (p=0.011) and speech intelligibility in a noisy environment (p=0.007).

When Tamhane's T2 test, one of the Post Hoc tests, was applied to determine the differences between the groups, those in the undiagnosed (control) group;

- Since the ETDQ-7 scale scores were lower than the scale scores of the patients in the acute rhinosinusitis (p<0.001) and chronic rhinosinusitis (p<0.001) groups,
- Since the T-AIADH scale scores were lower than the scale scores of the patients in the acute rhinosinusitis (p=0.002) and chronic rhinosinusitis (p=0.019) groups,
- Since the sub-parameter scores of the localization of voices were lower than the scale scores of the patients in the acute rhinosinusitis (p=0.003) and chronic rhinosinusitis (p=0.014) groups,
- It was determined that the speech intelligibility parameter scores in a noisy environment were lower than the scale scores of the patients in the acute rhinosinusitis (p<0.001) and chronic rhinosinusitis (p=0.002) groups (p<0.05) (Table 3).

DISCUSSION

As a result of the literature, the lack of sufficient research evaluating the subjective eustachian tube dysfunction and perception of hearing impairment in patients with rhinosinusitis is one of the reasons for this study.

There is a consensus in the literature that the incidence of rhinosinusitis is higher in women than in men. The prevalence and incidence of rhinosinusitis were reported to be higher in women than in men (10, 11). In our study, the fact that 63.6% of the participants diagnosed with acute rhinosinusitis were women and 71.9% of the participants diagnosed with chronic rhinosinusitis were women, supports the literature.

There is no consensus in the literature about the relationship of rhinosinusitis with age. The highest reported prevalence of chronic rhinosinusitis in both genders in the Canadian population was found to be in persons aged 30 to 60 years. This trend is similar to that reported by the National Center for Health Statistics, with the prevalence appearing to be highest in individuals aged 45 to 60 years, at 17.4% (10). Studies show that the incidence of acute rhinosinusitis is highest in people aged 25 to 44 years (12). Albu et al. reported that CRS is one of the most common chronic medical conditions worldwide, affecting all age groups (13). In our study, the mean age of the participants diagnosed with acute rhinosinusitis was 31.2, and the mean age of the participants diagnosed with chronic rhinosinusitis was 35.8.

Table 3: The differences between the groups regarding the scale scores

	Acute rhinosinusitis (a) (n=33)	Chronic rhinosinusitis (b) (n=32)	Undiagnosed (control) (c) (n=32)	p	Post Hoc p significance
	Mean±ss Med (Min-Max)	Mean±ss Med (Min-Max)	Mean±ss Med (Min-Max)		
ETDQ-7	25.3±8.3 26 (8-37)	22.8±6.6 22.5 (10-37)	12.9±8.1 9 (7-41)	**<0.001**, d**	a-c; p<0.001 b-c; p<0.001
T-AIADH	17.2±11.7 18 (6-37)	15.5±11.3 9.5 (6-39)	8.9±6.4 6 (2-30)	**0.001**, d**	a-c; p=0.002 b-c; p=0.019
Discrimination / identification of sounds	1.8±2.5 0 (0-8)	1.7±2.6 0 (0-7)	0.9±1.9 0 (0-8)	0.361**d**	No difference
Localization of sounds	2.6±2.8 2 (0-10)	2.0±2.3 1 (0-6)	0.6±1.3 0 (0-5)	**0.011**, d**	a-c; p=0.003 b-c; p=0.014
Speech intelligibility in a noisy environment	4.2±4.1 4 (0-10)	3.7±3.9 2 (0-10)	0.97±1.6 0 (0-5)	**0.007**, d**	a-c; p<0.001 b-c; p=0.002

* P<0.05, **p<0.001, d: Kruskal wallis test, Post hoc p= Post hoc Tamhane's T2 test

The most commonly reported symptoms of chronic rhinosinusitis are fatigue, headache, facial pressure, ear pain, and ear fullness (14). Symptoms for acute rhinosinusitis are usually runny nose, nasal congestion and facial pain or pressure, fever, headache, cough, earache or pressure (15). In our study, most of the symptoms in the literature were present in 98.5% of all patients.

The prevalence of otological symptoms in patients with rhinosinusitis is significant and ranges from 15% to 42% in the literature. Eustachian tube dysfunction (ETD) is stated to be one of the most common otological manifestations of CRS. It is assumed that mucosal edema and sinonasal secretions may cause pressure, fullness, and pain in the ear by impairing the dilatation and pressure equalization functions of the eustachian tube. Communication difficulties can be counted among the long-term effects of ETD. Auditory fullness is the most common symptom among ETD patients, while other shared symptoms include tinnitus and hearing loss (16). Tangbumruntham et al. found that the 3rd and 4th questions representing auditory fullness and ear problems with cold or sinusitis had the highest scores among the individual questions in patients with CRS who were administered ETDQ-7 (17). Maniakas et al. evaluated patients with rhinosinusitis using the Sinonasal Outcome Test (SNOT-22) quality of life tool. SNOT-22 includes two questions that screen for ear pain and ear fullness, which are symptoms of eustachian tube dysfunction (18). It was reported that eustachian tube dysfunction is high in patients with a diagnosis of rhinosinusitis. In our study, 70.8% of patients had tinnitus and 32.3% had symptoms of hearing loss. Lin et al. reported a significant relationship between chronic rhinosinusitis (CRS) and auditory impairment. It has been determined that CRS may impair cochlear functions by damaging inner hair cells and/or outer hair cells, and consequently change the activity of the entire auditory pathway from the VCN to the inferior colliculus. Therefore, attention should be paid to the patient's hearing, such as tinnitus and other symptoms in the early stages of CRS (19). Likewise, eustachian tube dysfunction can cause otitis media, and research has shown that sensorineural hearing loss is one of the sequelae of otitis media. Noxious substances in the middle ear can penetrate the perilymph through the round window, causing damage to the blood-maze barrier in the spiral ligament region (20). In our study, it was determined that the patient group diagnosed with rhinosinusitis had lower ETDQ-7 and AIADH scores than the undiagnosed (control) group.

Ananthakrishnan et al. reported that patients with sensorineural hearing loss experience greater speech perception problems compared to those with normal hearing, and this may be due to cochlear damage altering the neural representation of speech transmitted to higher centers along the auditory neurax, in addition to raising the audiometric thresholds (21). Picou et al. reported that patients with sensorineural hearing loss have difficulty in perceiving daily speech, especially in noisy and resounding environments (22). In our study, it was determined that the patient group diagnosed with rhinosinusitis had a lower speech intelligibility parameter score in a noisy environment, which is a sub-parameter of the AIADH than the undiagnosed (control) group. This supports that rhinosinusitis can negatively affect speech intelligibility in noisy environments.

Patients with sensorineural hearing loss often have difficulty understanding speech among other sounds. Findings show that hearing loss hinders the ability to filter sound sources by location and causes communication difficulties in social situations. They also have difficulty understanding speech sounds coming from different directions (23). Meuret et al. reported that patients with sensorineural hearing loss also had a decrease in the localization of sound compared to those with normal hearing (24). Sensorineural hearing loss may involve dysfunction of both inner hair cells and outer hair cells. In most etiologies, outer hair cell damage is more prominent. In this case, the spectral resolution and cochlear gain of the auditory system decreases and naturally affects the sound localization performance negatively (25). Speech information processing capacity is impaired due to reduced audibility. Impairment of speech capacity is due to physiological defects somewhere

along the auditory pathway, resulting in reduced localization (26). In our study, it was determined that the patient group diagnosed with rhinosinusitis had lower localization of sound scores, which is a sub-parameter of the AIADH than the undiagnosed (control) group. This supports that rhinosinusitis can negatively affect sound localization.

CONCLUSION

In our study, we aimed to evaluate the eustachian tube dysfunctions and perception of hearing impairment in patients diagnosed with rhinosinusitis simply and inexpensively in outpatient clinics with the ETDQ-7 and T-AIADH and to evaluate the relationship between eustachian tube dysfunctions and perception of hearing disability. The results of our study show that rhinosinusitis negatively affects eustachian tube functions, speech intelligibility, sound localization, and perception of hearing impairment and increases tinnitus perception.

With this study, we think that the use of ETDQ-7 and T-AIADH in routine outpatient services may be beneficial in evaluating the perception of eustachian tube dysfunction and hearing disability accompanying rhinosinusitis patients, and their response to follow-up and treatment. In cases with suspected eustachian tube dysfunction and hearing loss, the ETDQ-7 and the T-AIADH can be used to determine the severity of the disease, as well as for treatment and follow-up.

One of the limitations of our study is the relatively small number of patients and the fact that the evaluation was not supported by objective methods. In order to reach more precise results, it is thought that it will be important to increase the number of patients in future studies, to add objective tests, and to compare them with subjective test results.

Ethics Committee Approval: This study was approved by the Medical Research Ethics Committee of the Ege University, Faculty of Medicine (Date: 18.11.2021, No: 21-11.1T/16)

Informed Consent: Written informed consent was obtained.

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