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ARAŞTIRMA / RESEARCH

Comparison of objective and subjective voice change parameters after medical treatments in allergic rhinitis

Allerjik rinitin tıbbi tedavileri sonrası objektif ve subjektif ses değişikliklerinin karşılaştırılması

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Abstract

Purpose: In the present study, we aimed to investigate the efficacy of different treatments on voice quality in allergic rhinitis. Thus we compared the objective and subjective voice parameters of patients with allergic rhinitis before and after treatment groups.

Materials and Methods: Patiens treated with intranasal steroid sprey is the 1. group, intranasal steroid spray+oral antihistamine is the 2. group. The objective (fundamental frequency(F0) ,shimmer%, jitter%, noise to harmonics ratio (NHR) and subjective (total nasal symptom score(TNSS), voice-handicap index(VHI)) voice analysis were compared .

Results: All voice parameters were improved after treatment in both groups except F0 in group 1. F0 values after treatment in the 2. group was significantly higher than before treatment; F0 values in the 1. group was higher but it was insignificant. There was no significant difference between the subjective parameters and objective parameters including F0, jitter%, shimmer% and NHR values between group 1 and group 2.

Conclusion: We found that voice quality improved with intranasal steroid sprey treatment, and also with the addition of oral antihistamine to intranasal steroid in allergic rhinitis. However, no significant difference was detected in voice analysis with this combined treatment in the subjective and objective evaluation .

Keywords: Allergic rhinitis, voice analysis, voice quality

Öz

Amaç: Bu çalışmada allerjik rinittte farklı tedavilerin ses kalitesine olan etkisini araştırılması amaçlanmıştır. Bu nedenle allerjik rinit hastalarında farklı tedavilerinde, tedavi öncesi ve tedavi sonrası objektif ve sübjektif ses parametrelerini karşılaştırılmıştır.

Gereç ve Yöntem: 1.grupta intranasal steroid sprey, 2.grupta intranasal steroid sprey+oral antihistaminik tedavisi verdik. Objektif analizde Praat analiz sisteminde temel frekans(F0), shimmer%, jitter%, ses-harmoni oranı(NHR) ortalama değerlerini ; sübjektif ses analizinde total nasal semptom skoru(TNSS) ve ses handikap indeksi(VHI) skorlarını karşılaştırılmıştır. .

Bulgular: Grup 1'de F0 hariç her iki grupta da tedavi sonrası tüm ses parametreleri gelişti. 2. grupta tedaviden sonra F0 değerleri tedaviden öncekilerden anlamlı derecede yüksekti; 1. gruptaki F0 değerleri daha yüksekti ancak anlamlı değildi. Subjektif parametreler ile F0,% jitter,% shimmer ve NHR değerleri dahil objektif parametreler arasında grup 1 ve grup 2 arasında anlamlı fark yoktu.

Sonuç: Allerjik rinit tedavisinde hem intranasal steroid sprey hem de intranasal steroid sprey+oral antihistaminik kullanımı ile ses kalitesi artmaktadır. Ancak kombine tedavi ile objektif ve sübjektif ses analizlerinde anlamlı farklılık saptanmamıştır.

Anahtar kelimeler: Allerjik rinit, ses analizi, ses kalitesi

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INTRODUCTION

Allergic rhinitis (AR) is a global disease with increased prevalence, particularly in large cities worldwide and becoming an emergency problem affecting 10-15% of the population and manifests with symptoms such as rhinorrhea, itching, sneezing, a need to clear the throat, cough and affected voice function[1]. AR is not fatal; however, it may affect morbidity by on daily activities and social life. It may be seasonal or perennial[2].

A therapeutic ladder is suggested: allergen avoidance, medical therapies and immunotherapy are used in treatment. The choice of treatment will mostly depend on patients' preferences, cost and local availability. Therefore, in the first place, intranasal steroid spreys are followed by antihistamines, and combined treatments are used if sneezing or itching is obvious or unresponsive to monotherapy[1] .

The voice is an essential way of communicating and talking. Voice problems often negatively affect individuals' lives. The nose and the supraglottic area affects voice quality, and quality changes may be detected in physical examinations without any edema or erythema[3] . In addition, thick and viscous mucus from allergies restricts vocal fold vibration. Coughing and clearing the throat are also observed in these patients with AR[4] . Postnasal drainage to the oropharynx and larynx occurs due to the increased secretion from glands in the nose, resulting in throat clearing, irritation, coughing, and dysphonia[5] . As a result, vocal quality deteriorates because of edema and inflammation as a consequence of irritation and trauma in the folds and mucus. In addition, the resonance changes due to the hyponasality caused by the nasal mucosal edema, which causes subjective and objective voice change. The symptoms are relieved, and voice disorders may recover with medication. Few studies have reported the effects of allergies on the voice in contrast to a vast number of studies that have reported on frequently observed nasal symptoms and allergies.

Using the skin prick test, Simberg et al. detected that symptoms of throat clearing, wheezing, fatigue, hesitations in voice, and pain were more frequently detected in college students who had allergies. These problems decreased with immunotherapy[6]. In a similar study, Ohlson et al. found the ratio of AR at 22 percent in 1,250 students with voice disorders[7]. Millqvest et al. found that individuals with pollen allergies experienced voice problems each day. The functional, emotional, and total voice handicap index (VHI) increased, and voice quality deteriorated in the pollen season as well[8] .

A simple technique, acoustic voice analysis, which objectively evaluates acoustic signal characteristics created with voice vibrations, has frequently been used in studies[9] . Doğan et al. performed objective and subjective evaluations in patients with asthma and found that VHI were higher than normal values in 40 percent of the patients. As well, the maximum phonation period was shortened, jitter and shimmer were prolonged in women[10] . Niedzielski performed an objective evaluation of nasality and its effect on voice in patients with AR and found jitter and shimmer was higher; however, it was statistically insignificant. Mean pitch (F0), mean harmonics-to-noise ratio (HNR), and signal noise ratio (SNR) was significantly higher[11] .

The number of studies performed using both objective and subjective evaluations has started to increase in recent years. Therefore, this study examined objective and subjective voice parameters in AR patients and compared the pre- and post-treatment values in patients with different treatments. In the present study, we compared this effects of different treatments in voice quality which haven't previously studied. The total nasal symptom score(TNSS) and VHI were used for subjective evaluation; F0, jitter%, shimmer% and NHR (mean noise-to-harmonics ratio) for objective evaluation.

MATERIALS AND METHODS

This prospective clinical study was conducted in the Adana City Training and Research Hospital , Department of Otolaryngology. Local ethics board approval of the hospital (2017/80) was granted. In 2001, the World Health Organization proposed a new Allergic Rhinitis and its Impact on Asthma (ARIA) classification, which classifies AR according to severity and symptom duration and than it was validated in 2016 and is currently widely used worldwide.

All physicians primarily used the ARIA guidelines for their diagnoses and treatments. We also used this classification system. ARIA distinguished intermittent AR, defined by symptoms occurring for <4 days/week for <4 consecutive weeks, from persistent AR, defined by symptoms occurring for >4 days/week for >4 consecutive weeks. Moreover, a

severity scale of mild to moderate-severe symptoms (based on the AR impact on activities and quality of life) was proposed. Patients who presented symptoms of nasal congestion, nasal discharge, itching, and sneezing between August and September 2018, in otorhinolaryngology outpatient clinic of our hospital were evaluated and who have mild , persistant symptoms according to ARİA (The Allergic Rhinitis and its Impact on Asthma) classification were included in the study .

The patients' ages ranged between 18 and 58 years. Informed consent was provided by the patients. The skin prick test was performed by a physician of allergy and imunology on the patients who had pale nasal mucosa, serous nasal discharge, as noticed in the physical examination, by otolaryngologists. To qualify for enrolment, patients with AR needed to have a positive skin prick test result. Allergic complaints and physical examination supported by positive skin prick test constituted the principal of our study. We diagnosed many of the patients in the routine daily outpatient clinic in our hospital. But we excluded some for what we think may affect the voice. Exclusion criteria for the study were as follows: advanced septal deviation, nasal polyps, vocal nodules, reflux, asthma, the use of anticoagulant and acetylsalicylic acid, history of upper respiratory tract infections within one month of the study, postnasal drainage, intubation within three months of the study, smokers, teachers and singers.

The patients were instantly diagnosed, have complaints about a few years and house dust mite allergens were detected in the skin prick test. In August and September people spend their time outside and don't expose to house dusts. This period was a poor severity of complaints so the initial treatment was applied. There was no antiallergic medication theraphy used in the last 6 months.

The patients were divided into two groups per the treatment. Intranasal mometasone furoate (once daily, 50 micrograms 2 sprays to each nostril) was initiated to patients in the group 1. Intranasal mometasone furoate (once daily, 50 micrograms 2 sprays to each nostril) + oral antihistamine(OAH) (desloratadine 5 mg/day) were initiated in group 2 . Groups were designed according to ARİA (The Allergic Rhinitis and its Impact on Asthma) classification inorder to use the proper treatment [12] .

Twenty participants were planned for participation in each of the groups. Objective and subjective voice analysis were performed on the patients who completed each step before treatment by otolaryngologists. The patients were evaluated two months after the treatment they received, and the same analyses were repeated again.

Subjective voice analysis

1-The total nasal symptom score (TNSS) consists of four allergic symptoms: nasal congestion, itching, rhinorrhea, and sneezing. The scores vary between 0 and 3, with 0 meaning no symptoms and 3 meaning the most severe symptoms. Patients with TNSS scores above 6 were included in the study [13] .

2-The Turkish version of the voice handicap index (VHI-10), which consists of 10 questions about voice in daily life, was completed for the patients [14] . The scores vary between 0 and 4, with 0 meaning no symptoms and 4 meaning chronic symptoms [15] . The total score was between 0 and 40 and was evaluated in each group.

Objective voice analysis

The Praat (Paul Boersma and David Weenink) voice analysis system is one of the leading voice analysis programs and was used for this study. All participants were seated in a quiet room , 20 cm from a high-quality , dynamic, cardioid microphone (*Audio Technica at 2020*), which was focused on one sound source, simultaneously reducing pick-up from the sides and rear and connected to a laptop computer.

Voice samples were elicited by asking each participant to produce sustained phonations of the /a/ sound at their habitual levels of pitch and loudness. The investigator ensured that each participant was comfortable and competent in producing sustained phonations at their habitual levels. The patients were educated three times before recording .Three sustained phonations , with each phonation lasting 5 seconds , were then recorded. The means were used for data analysis.

To rule out the effects of onset and offset of voicing, we analyzed the 3-s portion in the middle of the vowel production. The selected segments were later digitized with a sampling frequency of 44,100 Hz and a resolution of 16 bits per sample and analyzed using the Praat voice analysis system (University of Amsterdam,The Netherlands) . Four of the Praat acoustic parameters of the voice was chosen for this study. The other Praat parameters were excluded as

irrelevant for the experiment's purposes. F0 (Hz), jitter (%), shimmer (%) and NHR were measured on acoustic voice analyses.

The voice analyses were compared in the groups before and after treatment. The differences between groups were analyzed in order to show the effect of different treatment modalities on voice quality.

Statistical analysis

The data were analyzed using the IBM Statistical Package for the Social Sciences (SPSS) Version 20.0 package program..The Wilcoxon signed-rank test was used to investigate the difference between two dependent variables because the variables showed non-normal distribution. The Mann-Whitney U test was used to investigate the differences between the groups because the variables had a non-normal distribution. The significance value of 0.05 was used to interpret the results; $p<0.05$ was considered as statistical significance.

RESULTS

A total of 40 patients between the ages of 18 and 58 years completed the study. Patients were divided into two groups with 20 participants in each group. The 1. group encompassed 13 women and 7 men with a mean age of 30.1 years and an age range of 18-58 years; the 2. group comprised 11 women and 9 men with a mean age of 32.2 years and an age range of 18-55 years. The age and gender distribution between groups was substantially close-ranged.

Subjective evaluation

The TNSS and VHI significantly decreased after the treatment in both groups ($p<0.05$)(Table 1-2).

Table 1. The difference between the time in considering the subjective and objective values

Parameters	1.group(n:20)	Mean	Median	Min	Max	Sd	P value
TNSS	Pre-treatment	6.95	7	6	8	0.76	
	Post-treatment	5.4	5	4	7	0.75	0.001
VHI	Pre-treatment	7	5	0	20	6.02	
	Post-treatment	5.15	4	0	17	5.21	0.001
F0	Pre-treatment	213.45	218.07	102.22	317.65	5.,6	
	Post-treatment	214.08	212.04	109.23	323.62	59.54	0.94
JİTTER %	Pre-treatment	0.53	0.32	0.14	2.92	0.61	
	Post-treatment	0.48	0.29	0.17	2.85	0.6	0.002
SHİMMER%	Pre-treatment	5.06	4.23	1.87	20.69	4.08	
	Post-treatment	3.9	2.68	0.17	20.37	4.14	0.001
NHR	Pre-treatment	0.05	0.02	0	0.29	0.07	
	Post-treatment	0.04	0.01	0	0.29	0.07	0.021

TNSS:Total nasal symptom score , VHI:Voice handicap index , F0:Fundamental frequency , NHR:Noise to harmonic ratio

Table 2. The difference between the time in considering the subjective and objective values in group 2

	Group 2(n:20)	Mean	Median	Min	Max	Sd	P value
TNSS	Pre-treatment	8.55	9	7	10	1	
	Post-treatment	6.6	6	5	9	1.05	0.001
VHI	Pre-treatment	6.25	1	0	26	8.53	
	Post-treatment	4.65	0,5	0	22	6.64	0.002
F0	Pre-treatment	185.49	199.22	114.14	253.56	46.51	
	Post-treatment	200.72	206.96	119.66	283.09	46.68	0.048
JİTTER%	Pre-treatment	0.46	0.35	0.16	2.22	0.44	
	Post-treatment	0.34	0.28	0.11	1.2	0.24	0.008
SHİMMER%	Pre-treatment	6	4.99	2.2	13.86	3.03	
	Post-treatment	4.65	3.56	1.9	9.25	2.28	0.001
NHR	Pre-treatment	0.07	0.03	0	0.53	0.12	
	Post-treatment	0.04	0.03	0	0.11	0.03	0.038

TNSS:Total nasal symptom score, VHI:Voice handicap index, F0:Fundamental frequency, NHR:Noise to harmonic ratio)

Although no statistically significant difference was detected between the change in values before and after treatment considering groups , a greater decrease was detected in TNSS and VHI values in the 2. group (p>0.05)(Table 3) .

Objective evaluation

There was no statistically significant difference regarding F0 values in the 1. group before and after treatment(P>0.05) (Table 1). The F0 value before treatment in the 2. group was significantly lower than after treatment (p<0.05) (Table 2).

The jitter , shimmer percentage and NHR values after treatment in both groups 1 and 2 were significantly lower compared with the value before treatment (p<0.05)(Table 1-2).There was no significant difference in improvement of the voice quality regarding the whole objective voice analysis between 1. and 2. groups (p>0.05) (Table 3) .

Table 3.The Mann-Whitney U Test results regarding the difference between the groups considering the subjective and objective change values

		Groups						
		n	Mean	Median	Min	Max	Sd	P value
TNSS difference	Group 1	20	-1.55	-1.5	-3	-1	0.6	0.193
	Group 2	20	-1.95	-2	-4	-1	0.94	
	Total	40	-1.75	-2	-4	-1	0.81	
VHI difference	Group 1	20	-1.85	-2	-5	0	1.57	0.336
	Group 2	20	-1.6	-1	-9	0	2.26	
	Total	40	-1.73	-1	-9	0	1.92	
F0 difference	Group 1	20	0.63	-0.76	-15.53	32.16	10.62	0.062
	Group 2	20	15.23	6	-37.47	96.92	30.19	
	Total	40	7.93	1.7	-37.47	96.92	23.53	
Jitter% difference	Group 1	20	-0.06	-0.04	-0.35	0.64	0.19	0.534
	Group 2	20	-0.12	-0.06	-1.02	0.22	0.25	
	Total	40	-0.09	-0.06	-1.02	0.64	0.22	
Shimmer % difference	Group 1	20	-1.16	-0.46	-5.41	1.19	1.67	0.552
	Group 2	20	-1.35	-1.08	-5.89	0.22	1.58	
	Total	40	-1.26	-0.83	-5.89	1.19	1.61	
NHR difference	Group 1	20	0.01	0	-0.03	0.1	0.03	0.552
	Group 2	20	0.03	0	-0.08	0.48	0.11	
	Total	40	0.02	0	-0.08	0.48	0.08	

(TNSS:Total nasal symptom score, VHI:Voice handicap index, F0:Fundemental frequency, NHR:Noise to harmonic ratio)

DISCUSSION

In the present study, we evaluated the acoustic voice analysis results and subjective voice parameters before and after treatment in two different treatment groups. AR patients in these groups received intranasal steroids alone and intranasal steroid + oral antihistamine . We detected no significant difference between the two treatment groups regarding the nasal symptom score and VHI. No significant difference was detected between the objective criteria such as F0, jitter, shimmer and NHR values.

AR is a common and chronic inflammatory condition with an increasing prevalence, causing sociological and an economic burden worldwide [16] . Nasal congestion, rhinorrhea, and itching symptoms are observed in upper respiratory tract irritation as a consequence of Immunglobuline E-dependent chronic inflammatory conditions in AR. Intranasal steroids (INS) are strongly recommended for the treatment of AR because of their superior efficacy in controlling nasal congestion and other symptoms of this inflammatory condition. The continuous use of INS is recommended and more efficacious than intermittent use [17] . Physicians should recommend oral second-generation/less-sedating antihistamines for patients with AR and primary symptoms of

sneezing and itching[18]. ARIA guideline panel acknowledged that the choice of treatment would depend mostly on patient preferences and local availability and cost of treatment. We administered an intranasal spray for patients who mainly described having congestion and administered intranasal steroid + oral antihistamine treatment for patients who reported accompanying itching, sneezing and ocular symptoms. The investigation of whether there was a significant difference between two groups and whether the additional oral combination treatment to intranasal steroid use provided any additional benefit for voice quality constituted the basis for our study.

The lungs provide airflow in the development of the voice, and the vocal folds function as an oscillator by converting the airflow to a wave motion, and the nasal cavity, sinuses, pharynx, supraglottic area, oral cavity, and head enable the resonance and amplification[19]. Hyponasal or hypernasal speaking may develop due to diseases that affect the nasal cavity because the nasal cavity is an important voice resonator [20,21]. The need for frequent throat clearing and coughing develop because of the postnasal drainage, and the effect on the larynx of this mucoid drainage due to allergic inflammation. These effects and nasal resonance changes cause voice alterations [22]. Therefore, the voice is affected by the nasal cavity and the larynx. Cecil et al. also found these results in their study [23]. We also suggest that phonatory and resonatory influences were detected in our patients. According to Williams, the mechanism of allergic laryngitis is primarily edema formation of the entire larynx or in specific portions of it, such as the arytenoids or the vocal folds. The edema on the contact surface of the true vocal folds produces a hoarseness, which is a quality of the voice that sounds harsh, discordant, and of low pitch[24].

Nasal symptom scores mean the symptoms of AR have been shown to have a significant effect on quality of life, and therefore any improvements in quality of life should help to reduce the disease burden[25,26]. The nasal symptom scores in our study showed that quality of life was significantly decreased in AR; increased with both of the treatments, however, no significant difference was detected between two treatment groups.

The VHI-10 is a patient-reported outcome instrument that measures a patient's self-perception of voice handicap[27]. Higher scores are indicative that a voice problem has a more severe handicapping effect on the individual's life than a lower score. Although the mean values before treatment in groups 1 and 2 were 7 and 6.25, respectively, in this study, the mean values after treatment decreased to 5.15 and 4.65, which indicates that the symptoms were alleviated after treatment, and thus the resonance and phonation improved.

The frequency of opening and closing of the vocal cords determines the frequency of the sound waves, which means the pitch of the voice (F0). F0 is expected to increase when the nasal cavity is treated in many studies. Jackson-Manaldi detected lower F0 levels in both in male and female allergic patients in their study[3]. Acar et al. detected increased postoperative F0 values in patients with nasal polyps in their study[28]. Despite these studies, post-treatment F0 values decreased with INS+OAH in AR[29]. F0 values increased in both groups after treatment; significance was only found in INS+OAH group in our study. Furthermore we didn't consider the influence of gender on voice analysis and compared mixed group with reference to the many recent studies. As well the number of females and males in groups are not that far.

Both jitter and shimmer have been described as objective measures of the biomechanical vibratory properties of the vocal folds, which are considered central to the determination of vocal quality[30,31]. Although insignificant, the jitter and shimmer values decreased in stage I-II nasal polyposis; however, increased in stage III patients with full nasal cavity, postoperatively [28]. The jitter and shimmer values in both treatment groups decreased significantly one by one, no significance was detected between groups in our study. Jitter and shimmer values decreased significantly with INS+OAH in the AR study of Develioglu et al[29].

Acar et al. used NHR in their study and postoperative changes were not significant with endoscopic sinus surgery in nasal polyposis[28]. The NHR values significantly decreased in both groups in our study, but the difference between the groups was insignificant.

Objective evaluation provides the numeric values of voice acoustics, and we found that F0 values increased, and jitter, shimmer and NHR values decreased. However, no significant difference was detected between the groups. The most important feature of our study was the joint evaluation of both the subjective and objective criteria. We were able to compare the changes in both parameters and found

them correlated. We observed that the clinical improvement reflected the objective evaluation.

We lacked the use of a stroboscope and were unable to evaluate the vocal folds in numerological terms. This study only addressed AR's effect on voice which is kind of indirect. To examine how AR effect the resonators system of speech should be more eligible.

In conclusion, Intranasal steroids and oral antihistamines have frequently been used as medical treatments in AR. AR may cause symptoms such as voice change in addition to many symptoms. Medical treatment improves nasal symptoms and voice disorders. In our study, we found that voice quality improved with intranasal steroid treatment alone and with the addition of oral antihistamines; on the other hand available evidence suggested that there is no additional benefit on voice from a combination therapy compared with INCS alone.

Yazar Katkıları: Çalışma konsepti/Tasarımı: SOE, BT, TÖ, ZAE, KT, GÖ, ÖAŞ; Veri toplama:; SOE, BT, KT, TÖ Veri analizi ve yorumlama: ZAE, SOE; Yazı taslağı: SOE; İçeriğin eleştirel incelenmesi: ÖAŞ; Son onay ve sorumluluk: GÖ; SOE, BT, TÖ, ZAE, KT, GÖ, ÖAŞ; Teknik ve malzeme desteği: TÖ; Süpervizyon: SOE, BT, TÖ, ZAE, KT, GÖ, ÖAŞ; Fon sağlama (mevcut ise): yok.
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