

# Evaluation of the effect of CPAP treatment on voice in obstructive sleep apnea with objective and subjective voice analyzes

A. ALTINTOP GEÇKİL<sup>1</sup>, S. YASLIKAYA<sup>2</sup>, Z. BİRİŞİK AYCAN<sup>3</sup>

<sup>1</sup>Department of Pulmonary Medicine, Faculty of Medicine, Malatya Turgut Ozal University, Malatya, Turkey

<sup>2</sup>Department of Otolaryngology, Adiyaman University Training and Research Hospital, Adiyaman, Turkey

<sup>3</sup>Department of Voice and Speech Therapy, Malatya Turgut Özal University Training and Research Hospital, Malatya, Turkey

**Abstract. – OBJECTIVE:** Obstructive sleep apnea (OSA) is a multifactorial disease that is the most common among sleep-related respiratory disorders. In our study, we aimed to compare the objective and subjective voice analysis results of the patients with CPAP treatment indication after polysomnography performed in the sleep disorders center before the start of CPAP treatment, the 1<sup>st</sup> month, and the 3<sup>rd</sup> month after the treatment.

**PATIENTS AND METHODS:** Patients were asked to say the vowels /a:/ for 5 seconds, respectively for voice recording. MPT and S/Z ratios were also recorded. Using the Praat voice analysis program Jitter%, Shimmer%, HNR, f0 values were obtained. VHI-10 questionnaire was applied. The voice analysis results of the patients before and after the treatment were compared.

**RESULTS:** 26 patients were included in the study. Since 8 of these patients did not come to the 3<sup>rd</sup> month evaluation, the study was completed with the data of 18 patients. In our study, at the end of the 3<sup>rd</sup> month, no difference was found in terms of the fundamental frequency, Shimmer%, HNR, and S/Z values. There was a statistically significant decrease in Jitter% at the 1<sup>st</sup> month after treatment and 3<sup>rd</sup> month after treatment compared to pre-treatment ( $p=0.05$ ,  $p=0.018$ ). There was a statistically significant decrease in MPT at the 1<sup>st</sup> month after treatment and 3<sup>rd</sup> month after treatment compared to pre-treatment ( $p<0.001$ ,  $p<0.001$ ). There was a statistically significant decrease in VHI-10 at the 1<sup>st</sup> month and 3<sup>rd</sup> month after treatment compared to pre-treatment. Furthermore, there was statistically significant difference between 3<sup>rd</sup> month after treatment compared to 1<sup>st</sup> month after treatment. ( $p=0.043$ ,  $p=0.030$ ,  $p=0.029$ ).

**CONCLUSIONS:** Our study showed that CPAP treatment had both objective and subjective positive effects on voice recovery in the OSA patient group.

*Key Words:*

Acoustic, CPAP, VHI-10, Phonation, Polysomnography, Obstructive sleep apnea.

## Introduction

Obstructive sleep apnea (OSA) is a multifactorial disease that is the most common among sleep-related respiratory disorders and causes various clinical pathologies accompanied by predisposing factors such as age, gender, and obesity<sup>1</sup>. Other than snoring, clinically nocturnal symptoms such as apnea, nocturia, night sweats, dry mouth, frequent awakening, and daytime symptoms such as headache, excessive daytime sleepiness, concentration impairment, and cognitive and mood changes are observed<sup>2</sup>. When patients with OSA are not treated, complications ranging from cardiovascular, pulmonary, metabolic, endocrine, neuro-psychiatric, nephrological, gastrointestinal, and hematological problems to death can be seen in patients due to recurrent episodes of hypoxia<sup>3</sup>.

Studies<sup>4,5</sup> conducted with OSA patients have emphasized that potential upper respiratory tract problems, including long-standing voice problems, chronic refractory cough, and diurnal dyspnea, are common, especially in women. Pathologies in the tissues lining the upper respiratory tract affect voice analysis results by changing the resonance and articulation<sup>6</sup>. Atan et al<sup>7</sup> found that OSA patients had worse voice analysis and voice handicap index values than the control group. Dryness in the upper respiratory tract due to snoring and sleeping with the mouth open may

affect the vocal cords and cause phonation disorders. Although the origin of such problems in OSA is probably multifactorial, the leading underlying cause is upper respiratory inflammation and/or possible pharyngeal and laryngeal hypersensitivity. The pathophysiological mechanisms may affect the upper respiratory tract, and OSA also affects the voice<sup>8</sup>. Obesity can cause OSA by changing the upper respiratory configuration; studies conducted on obese patients have shown that the prevalence of voice problems is higher<sup>9,10</sup>. Lundeborg et al<sup>11</sup> reported that adenotonsillar hypertrophy affects the voice quality perceptually and acoustically.

CPAP devices are used as the gold standard treatment method in OSA. Since the upper respiratory tract of the users of the device is constantly exposed to positive air pressure, various changes and modifications can be seen in the nose, pharynx, and larynx<sup>7</sup>. After CPAP treatment, edema in the upper respiratory tract in OSA may decrease. Nasal and oral dryness, nose bleeding, nose-throat irritation, and pathologies related to air pressure in the tear ducts and middle ear can be seen due to CPAP use<sup>12</sup>. OSA-induced pathologies and the changes the device may cause are intertwined, and it can be predicted that these changes will affect voice formation. In this context, besides the publications in the literature reporting that CPAP use in patients diagnosed with OSA may have positive effects on the voice, some state that it does not affect the voice and that the voice is adversely affected<sup>7,13,14</sup>.

Voice is the primary communication tool in daily life, and any pathology affecting the voice can reduce the quality of life. The lower respiratory tract (lung capacity) and the upper respiratory tract (laryngeal, supralaryngeal vocal tract) contribute to the formation of voice. The supralaryngeal vocal tract acts as a resonator for the voice produced in the larynx by the force of the airflow from the lungs. Changes in any part of the voice production process result in differences in voice properties. Today, some methods (objective, subjective, perceptual) are used to evaluate the human voice, and acoustic and aerodynamic voice analyses are used in the objective evaluation. Various computer-based voice analysis programs are used for acoustic voice analysis, and the Praat voice analysis program (version 6.1.03, Boersma & Weenink) gives reliable results<sup>15</sup>. For aerodynamic voice analysis, maximum phonation time (MPT) and S/Z ratio measurements can be done quickly without needing additional devices and

programs. In the subjective voice assessment, the voice handicap index (VHI-10), which is easy to use and consists of 10 questions, can be used<sup>16</sup>. Few studies have been conducted on the effects of OSA on the voice, and this study aimed to evaluate the effects of CPAP treatment on voice quality acoustically, aerodynamically, and subjectively.

## Patients and Methods

### *Study Design*

Patients aged 18-60 who applied to Malatya Turgut Özal University Training and Research Hospital Sleep Disorders Center and received CPAP indication with an OSA diagnosis were included in the study. We aimed to compare the objective and subjective voice analysis results of the patients with CPAP treatment indication after polysomnography performed in the sleep disorders center before the start of CPAP treatment, the 1<sup>st</sup> month, and the 3<sup>rd</sup> month after the treatment. Patients with normal endoscopic and stroboscopic ear, nose, and throat examinations and normal evaluation with a pulmonary function tester (Jaeger Vyntus Spiro, USA) were included in the study. Patients who smoke, use alcohol, use drugs, have chronic respiratory diseases such as COPD, asthma, and allergic rhinitis, patients with systemic diseases (cardiac, neurological, endocrine, metabolic) that may affect voice quality, who work in jobs exposed to chemical vapors, who had undergone surgery due to any pathology in the respiratory tract and patients who received voice therapy, were not included in the study.

### *Polysomnographic Evaluation*

All-night polysomnography recording was performed on the patients with a 55-channel (Alice 6® Sleepware, Philips Respironics, PA, USA) computerized system. Evaluation of sleep stages and respiratory events observed during sleep was performed according to the "American Academy of Sleep Medicine (AASM)" criteria<sup>17</sup>. Apnea was defined as cessation of oro-nasal airflow for at least 10 seconds. Hypopnea was defined as a 3% decrease in oxygen saturation with at least a 50% decrease in oro-nasal airflow or concomitant arousal monitoring. The total number of apneas and hypopneas per hour of sleep was defined as the apnea-hypopnea index (AHI). All-night CPAP titration was planned for patients with moderate and severe OSA with AHI >15 and patients with mild OSA with AHI= 5-15 with concomitant

symptoms and cardiovascular or cerebrovascular risk factors. These patients were hospitalized for one more night, and CPAP titration was performed using an automatic CPAP device (Philips Respironics, PA, USA). Following the titration result, a CPAP device with a moisturizing property was prescribed to the patients, and device training was given. As recommended in the literature, patients were recommended to use a CPAP device at least 6 days a week and not less than 4 hours in treatment compliance<sup>18</sup>.

### **Voice Evaluation**

The patients' voices were recorded in a voice proof environment with the help of a microphone (SAMSON C01UPRO; Samson Technologies, Hauppauge, NY, USA) using the audio recording program Audacity (version 2.1.2, Dominic Mazzoni). For the voice recording, the volunteers were asked to make the vowel voice "a" for 5 seconds in the voice-isolated audiometry cabinet. Voice analyzes of the five-second recordings obtained with the Audacity program were performed using the Praat (version 6.1.03) voice analysis program. With the Praat voice analysis program, the voice's fundamental frequency, the perturbation parameters Jitter%, Shimmer%, and the harmonics-to-noise ratio (HNR) were obtained from the spectral parameters. The fundamental frequency ( $f_0$ ) is the number of opening and closing cycles (vibrations) of the vocal folds per second, and it reports the thickness and thinness of the voice. Jitter% indicates irregularity of vocal cords; normally, it should be  $<1$ ; as the jitter value increases, the voice becomes coarser, and the voice quality decreases. The shimmer% shows the relative changes between the amplitudes of the voice wave at short intervals; normally, it should be  $<3$ . Fundamental frequency, Jitter%, Shimmer%, and HNR results were recorded with voice analyses before and after CPAP treatment in the 1<sup>st</sup> and 3<sup>rd</sup> months.

MPT and S/Z ratios were also recorded. For MPT measurement, the patients were asked to make the vowel voice /a:/ for the longest time after a deep inspiration, and the time was kept and recorded. For the S/Z ratio, the patients were asked to make the sounds /s/ and /z/ for the longest they could sing separately after a deep inspiration, and their durations were recorded.

The VHI-10 is a 30-item questionnaire that measures voice disorders effects on a five-point scale of 0 to 4. The total score ranges from 0 to 120, with higher scores indicating an increase in the severity of voice problems. VHI-10 question-

naires were performed before and after the treatment in the 1<sup>st</sup> and 3<sup>rd</sup> months.

### **Ethics Approval and Consent to Participate**

Before the study, approval was obtained from the Malatya İnönü University Clinical Research Ethics Committee (No:2018/9; 27.06.2018). Informed consent was obtained from all patients included in the study.

### **Statistical Analysis**

The voice analysis results of the patients before and after the treatment in the 1<sup>st</sup> and 3<sup>rd</sup> months were compared using the SPSS (IBM SPSS Statistics 25, Armonk, NY, USA) statistical program. *t*-test was used for homogeneously distributed data, and the Mann-Whitney U test was used for heterogeneously distributed data for differences between independent groups. The difference between the groups was evaluated with the "Paired Sample *t*-test",  $p < 0.05$  was considered significant. In the Power G (version 1.3) analysis, the power of the study was calculated as 95.3%.

## **Results**

A total of 26 patients, 13 female, and 13 males, were included in the study. The mean age of the patients was 54.45 (33-60), and the mean BMI was 34.48 (24.8-46.1) kg/m<sup>2</sup>. The mean AHI of 26 patients was 49.6 (110.4-24.4). The mean CPAP pressure of the patients was 7.4 mmHg (5-11). In the first 3 months of the treatment, the compliance rate of the patients with CPAP treatment (considering the use of the device for at least 4 hours 6 days a week) was over 70%, and all patients were using devices with moisturizing properties. All patients were evaluated before and after the treatment in the 1<sup>st</sup> month, but since 8 did not come for the 3<sup>rd</sup> month follow-up, the remaining 18 patients were evaluated in the 3<sup>rd</sup> month after the treatment.

The fundamental frequency values of 26 patients participating in the study were 132 (76-320) and 109 (76-275), respectively, before and in the 1<sup>st</sup> month after the treatment. The decrease in fundamental frequency values was not statistically significant ( $p=0.192$ ). Jitter% values were 2.5 (0.18-9.85), 1.03 (0.13-6.23), respectively. This decrease in Jitter% values was statistically significant ( $p=0.016$ ). Shimmer% values were 17.68 (2.48-24.11) and 15.11 (2.02-24.70), respectively.

**Table I.** Comparison of a total of 26 patients who participated in the study at the beginning of the study and 1st month after treatment (f0: Frequency, HNR: Harmonics-to-noise ratio, MPT: Maximum phonation time, VHI-10: Voice handicap index).

	Pre-treatment	Post-treatment 1 <sup>st</sup> month	<i>p</i>
f0 (Hz)	132 (76-320)	109 (76-275)	0.192
Jitter %	2.5 (0.18-9.85)	1.03 (0.13-6.23)	<b>0.016</b>
Shimmer %	17.68 (2.48-24.11)	15.11 (2.02-24.70)	0.097
HNR (dB)	7.36 (0.10-26.62)	9.52 (1.18-28.34)	0.277
MPT	6.57 (0-27)	16.92 (7-29)	<b>&lt;0.001</b>
S/Z Ratio	0.99 (0.46-2.20)	0.94 (0.50-1.50)	0.385
VHI-10	1.81 (0-16)	1.19 (0-10)	<b>0.033</b>

The decrease in Shimmer<sup>0</sup>% values was not statistically significant ( $p=0.097$ ). HNR (dB) values were 7.36 (0.10-26.62), 9.52 (1.18-28.34), respectively. No statistical difference was found in terms of HNR values ( $p=0.277$ ). MPT values were 6.57 (0-27), 16.92 (7-29), respectively. This increase in MPT values was significant ( $p<0.001$ ). S/Z values were 0.99 (0.46-2.20), 0.94 (0.50-1.50), respectively. There was no statistical difference in terms of S/Z values ( $p=0.385$ ). VHI-10 values were 1.81 (0-16), 1.19 (0-10), respectively. This decrease in VHI-10 values was statistically significant ( $p=0.033$ ).

In the voice analysis of 26 patients who started the study, there was no difference in the base frequency, Shimmer<sup>0</sup>%, HNR and S/Z values at the end of the first month compared to the pre-treatment. However, there was a statistically significant difference in pre-treatment Jitter<sup>0</sup>%, MPT, and VHI-10 values compared to pre-treatment (Table I).

The fundamental frequency values of 18 patients who completed the study before the treatment, in the 1<sup>st</sup> month after the treatment, and in the 3<sup>rd</sup> month after the treatment were 125 (82-316), 107 (80-209), 96 (80-145), respectively; this decrease in fundamental frequency values was not statistically significant ( $p>0.05$ ). Jitter<sup>0</sup>% values were 2.93 (0.20-9.85), 1.39 (0.14-6.23), 0.82 (0.09-6.27), respectively. Jitter<sup>0</sup>% values were statistically significantly lower in the 1<sup>st</sup> month after the treatment and the 3<sup>rd</sup> month after the treatment than in pre-treatment ( $p=0.05$ ,  $p=0.018$ , respectively). Shimmer<sup>0</sup>% values were 17.03 (2.48-24.06), 16.93 (2.85-23.36), 16.70 (6.22-24.70), respectively. The decrease in shimmer<sup>0</sup>% values was not statistically significant ( $p>0.05$ ). The HNR (dB) values were 8.0 (0.22-26.62), 8.3 (1.18-13.99), 7.56 (0.11-23.73), respectively, and no statistical difference was found in terms of HNR values ( $p>0.05$ ). MPT values were 3.33 (0-16), 14.6 (6-27), 16 (7-29), respectively. This increase in MPT values was statistically

significant in the 1<sup>st</sup> month after treatment and 3<sup>rd</sup> month after treatment compared to pre-treatment ( $p<0.001$ ,  $p<0.001$ , respectively). S/Z values were 1.06 (0.46-2.20), 1.00 (0.50-1.50), 1.01 (0.75-1.60), respectively; in terms of S/Z values no statistical difference was found ( $p>0.05$ ). VHI-10 values were 2.44 (0-16), 1.61 (0-10), 1.28 (0-8), respectively. This decrease in VHI-10 values was statistically significant in the 1<sup>st</sup> month and 3<sup>rd</sup> month after treatment compared to pre-treatment and was statistically significant at 3<sup>rd</sup> month after treatment compared to the 1<sup>st</sup> month after treatment ( $p=0.043$ ,  $p=0.030$ ,  $p=0.029$ , respectively).

In the voice analyzes of the 18 patients who completed the study, there was no difference in terms of baseline frequency, Shimmer<sup>0</sup>%, HNR and S/Z values at the end of the 3<sup>rd</sup> month compared to the pre-treatment. However, there was a statistically significant difference in Jitter<sup>0</sup>%, MPT, and VHI-10 values at the 1<sup>st</sup> month after treatment and 3<sup>rd</sup> month after treatment compared to pre-treatment (Table II).

## Discussion

Our study completed the acoustic voice analysis using the Praat voice analysis program in OSA patients who started CPAP treatment. Compared to pre-treatment, we found a significant improvement in Jitter<sup>0</sup>%, MPT, and VHI-10 values in the 1<sup>st</sup> and 3<sup>rd</sup> months after CPAP treatment. These results showed us that CPAP treatment improves voice in OSA patients whose voice is negatively affected. As a result of the significant changes brought about by CPAP treatment, it can be expected that it may affect voice performance. In the current literature, there are different opinions, positive or negative, about the effects of CPAP treatment on voice.

Perturbation parameters (fundamental frequency, Jitter<sup>0</sup>%, Shimmer<sup>0</sup>%, HNR) obtained by

**Table II.** Comparison of voice analysis results of 18 patients who completed the study (f0: Frequency, HNR: Harmonics-to-noise ratio, MPT: Maximum phonation time, VHI-10: Voice handicap index).

	Pre-treatment	Post-treatment 1 <sup>st</sup> month	Post-treatment 3 <sup>rd</sup> month	$p^*$	$p^{**}$	$p^{***}$
f0 (Hz)	125 (82-316)	107 (80-209)	96 (80-145)	0.279	0.405	0.079
Jitter %	2.93 (0.20-9.85)	1.39 (0.14-6.23)	0.82 (0.09-6.27)	<b>0.05</b>	<b>0.018</b>	0.191
Shimmer %	17.03 (2.48- 24.06)	16.93 (2.85-23.36)	16.70 (6.22-24.70)	0.795	0.950	0.851
HNR (dB)	8 (0.22- 26.62)	8.3 (1.18- 13.99)	7.56 (0.11-23.73)	0.850	0.854	0.519
MPT	3.33 (0-16)	14.6 (6-27)	16 (7-29)	<b>&lt;0.001</b>	<b>&lt;0.001</b>	0.239
S/Z Ratio	1.06 (0.46-2.20)	1.00 (0.50-1.50)	1.28 (0-8)	0.409	0.518	0.986
VHI-10	2.44 (0-16)	1.61 (0-10)	1.28 (0-8)	<b>0.043</b>	<b>0.030</b>	<b>0.029</b>

\* Comparison of pre-treatment and post-treatment 1<sup>st</sup> month.

\*\* Comparison of pre-treatment and post-treatment 3<sup>rd</sup> months.

\*\*\* Comparison of 1<sup>st</sup> month post-treatment and 3<sup>rd</sup> month post-treatment.

acoustic analysis are important parameters used in evaluating voice quality at the glottic level. An increase in HNR indicates that the signal-to-noise ratio is reduced, and the voice is of better quality. An increase in Jitter% and Shimmer% values or a decrease in HNR indicates a decrease in voice quality<sup>19</sup>. In the study of Atan et al<sup>7</sup>, a significant decrease in Jitter% and Shimmer% values and a significant increase in fundamental frequency values were detected after one month of regular use of CPAP with a humidifier. In addition, VHI scores decreased significantly compared to pre-treatment. In the study of Saylam et al<sup>13</sup>, while there was no change in the 1<sup>st</sup> month after CPAP treatment in the objective acoustic voice analysis of the patients, a significant increase was found in the Jitter%, Shimmer% and HNR values at the 6<sup>th</sup> month compared to the pre-treatment, indicating that the voice was negatively affected. However, no change was found in the fundamental frequency and MPT. In the study of Hamdan et al<sup>20</sup>, the increase in all of the perturbation parameters of the patients using CPAP devices without a humidifier compared to the control group who did not use the device was significant for Shimmer% values. The data obtained in these studies suggested that CPAP devices without humidification property may cause dryness in the upper respiratory tract and cause a decrease in voice quality. In the study of Karakurt et al<sup>21</sup>, moderate/severe OSA patients who were started on CPAP treatment were divided into two groups low pressure ( $\leq 9$  cm H<sub>2</sub>O) and high pressure ( $\geq 10$  cm H<sub>2</sub>O), according to the CPAP titration results. Jitter%, Shimmer% values, and HNR decreased significantly after treatment in the high-pressure group, but these findings showing an increase in voice quality were not seen in the low-pressure group. This study showed that

patients with high-pressure needs might improve their voice more effectively after treatment.

MPT and S/Z ratio are the parameters used for aerodynamic voice analysis; MPT is the phonation time of the patient at the appropriate pitch and voice intensity. The S/Z ratio helps evaluate the degree of glottic closure and pulmonary functions. In cases where glottic closure is not complete, and resonance is impaired, it is expected that the S/Z ratio will increase due to a decrease in MPT and a shorter Z time<sup>22</sup>. Saylam et al<sup>13</sup> found no difference in MPT values after 6 months of CPAP treatment in patients using CPAP devices without moisturizing properties. In our study, we found a significant increase in MPT values in the 1<sup>st</sup> and 3<sup>rd</sup> months after the treatment compared to the pre-treatment, which showed us that the glottic voice formation could be improved with the treatment of OSA. Our study found that the S/Z ratio did not change after CPAP treatment compared to pre-treatment.

VHI-10 is a questionnaire used to evaluate the effect of voice disorders on quality of life<sup>16</sup>. Hsiung et al<sup>23</sup> found that VHI-10 had a weak correlation with the acoustic voice parameters Jitter%, Shimmer%, HNR, and MPT. Another study found a significant correlation between the fundamental frequency, Jitter%, and Shimmer% values and VHI scores<sup>24</sup>. In their study, Hartke et al<sup>14</sup> found a decrease in gastroesophageal reflux symptoms in patients who regularly used CPAP devices with moisturizing and warming properties for 6 months and predicted that this would positively affect voice formation. However, no change was observed in the voice handicap indexes of the patients. In the study of Atan et al<sup>7</sup>, a statistically significant improvement was found in the mean VHI-10 values after CPAP treatment compared

to before CPAP treatment. In the study of Saylam et al<sup>13</sup>, the 1<sup>st</sup> and 6<sup>th</sup> month voice handicap index values of the patients who used the CPAP device without moisturizing feature increased significantly compared to pre-treatment; that is, the subjective voice evaluations were found to be worse. In our study, we found that VHI-10 values changed positively with treatment. The reason for these different results in studies is that VHI-10 is a subjective test that is affected by many factors.

In patients with OSA, symptoms similar to perfusion disorders may occur in the body due to hypoxia during sleep. Free radicals due to hypoxemia may occur and trigger local inflammation<sup>25</sup>. Foresi et al<sup>26</sup> showed that respiratory inflammation occurs in OSA patients and the presence of inflammation markers such as pentane and nitric oxide in expiratory air. Upper respiratory tract inflammation may negatively affect voice formation<sup>20</sup>. Publications reported that CPAP treatment reduces inflammation and upper respiratory tract edema. Fortuna et al<sup>27</sup> showed that upper respiratory inflammation improved after CPAP treatment and detected decreased nitric oxide levels in respiratory air. Their study reported that the regular use of CPAP for 3 months reduced the oxidative stress in the systemic and upper respiratory tract in patients with moderate and severe OSA and reduced inflammation in the upper respiratory tract<sup>28</sup>. In the study of Ryan et al<sup>29</sup> on moderate and severe OSA patients, they compared the MRIs of the patients before and 4-6 weeks after CPAP treatment and found the decrease in upper airway edema and increase in pharyngeal airway volume to be significant.

Our study showed that the significant improvements we detected in Jitter%, MPT, and VHI-10 values in the 1<sup>st</sup> and especially in the 3<sup>rd</sup> month after CPAP treatment might be due to the positive effects of CPAP use on the upper respiratory tract in OSA patients. The reasons for the failure of CPAP treatment are patient non-compliance, pathologies obstructing the upper respiratory tract, mask problems, and congestion in the nasal mucosa<sup>30</sup>. Therefore, it is very important to start the treatment with the appropriate device, comply with the treatment, and treat the upper respiratory tract pathologies. In our study, the upper respiratory tract endoscopy of all our patients was normal, all patients were using a CPAP device with a moisturizing feature, and the treatment compliance rate was high. These factors were also factors that had a positive effect on the voice. In our study, the decrease in fundamental frequency

and Shimmer% values and the increase in HNR values were insignificant in the evaluation made with CPAP treatment for 3 months. It needs to be supported by prospective studies that will be evaluated with longer-term CPAP treatment with more patients.

## Conclusions

Our study showed that CPAP treatment had both objective and subjective positive effects on voice recovery in the OSA patient group where the voice was negatively affected. Knowing these positive effects, especially by patients who use their voice professionally, will positively affect the treatment compliance of the patients.

## Conflict of Interest

The Authors declare that they have no conflict of interests.

## Acknowledgements

We want to thank the participants who volunteered to participate.

## Funding

All authors declare no financial support.

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