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Clinical and polysomnographic evaluation of morning headache in patients with obstructive sleep apnea syndrome

Obstrüktif uyku apne sendromu ve sabah baş ağrısı birlikteliğinde klinik ve polisomnografik değerlendirme

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Abstract

Background: The aim of the present study was to investigate the clinical and polysomnographic (PSG) characteristics in patients with PSG-verified obstructive sleep apnea syndrome (OSAS) with or without morning headache (MH) and to evaluate the response to nasal continuous positive airway pressure (n-CPAP) treatment.

Methods: Patients who were referred to the sleep laboratory due to suspected OSAS were prospectively evaluated and divided into two groups: with MH (group 1) and without MH (group 2). Age, sex, body mass index (BMI), Epworth Sleepiness Scale (ESS), Pittsburg Sleep Quality Index (PSQI), Hamilton Depression Scale (HDS), Hamilton Anxiety Scale (HAS), and PSG variables were compared. Patients in group 1 who received n-CPAP treatment were also evaluated for headache persistence.

Results: Seventy-eight patients with OSAS were included and 28 (35.9%) patients reported MH. Female gender and mean BMI were significantly higher in group 1 (43% vs. 20%, p=0.03; 33.1±4.9 vs. 30.6±4.8 kg/m^2, p=0.04, respectively). The ESS was higher in group 1 (10.8±4.4 vs. 8.4±4.1, p=0.02). PSQI score, HDS and HAS did not differ between the groups. Average SpO2 (90±3.64 vs. 92.4±2.88) and minimum SpO2 (78.1±10.7 vs. 83.2±6.8) were significantly lower in the MH group (p=0.02 and p=0.03). In addition, duration of SpO2 <90 was significantly higher in the MH group (17.98±17.67 vs. 11.07±12.37, p=0.04). Nineteen (86.4%) of the 22 patients who received n-CPAP treatment were headache free.

Conclusion: Minimum SpO2 levels and the duration of desaturation during sleep were associated with MH. The other risk factors were female gender and higher BMI. N-CPAP therapy is an effective treatment for patients with MH.

Keywords: Morning headache, sleep apnea headache, continuous positive airway pressure.

Öz

Amaç: Bu çalışmada polisomnografik olarak obstrüktif uyku apne sendromu (OUAS) tanısı konulan hastalarda sabah başağrısı (SBA) olan ve olmayan grupların klinik ve polisonmografi (PSG) sonuçları ile nazal pozitif basınçlı havayolu tedavisinin (n-CPAP) baş ağrısı üzerine etkileri araştırılmıştır.

Yöntemler: OUAS şüphesi ile uyku laboratuarına yönlendirilen hastalar prospektif olarak takip edilerek SBA olan (grup 1) ve SBA olmayan (grup 2) olmak üzere iki gruba ayrıldı. Yaş, cinsiyet, vücut kitle indeksi (VKI), Epworth uykululuk skalası (EUS), Pittsburg uyku kalitesi indeksi (PUKI), Hamilton depresyon skalası (HDS), Hamilton anksiyete skalası (HAS), and PSG sonuçları karşılaştırıldı. Grup 1'deki hastalardan n-CPAP tedavisi alanların son takipteki baş ağrıları değerlendirildi.

Bulgular: OUAS tanısı alan 78 hastanın dahil edildiği çalışmada hastaların 28'inde (%35,9) SBA vardı. Kadın cinsiyet ve ortalama VKI grup 1' de istatistiksel olarak fazla idi (sırasıyla %43 ve %20, p=0,03; 33,1±4,9 ve 30.6±4.8 kg/m^2, p=0.04). EUS sonuçları grup 1'de daha yüksek saptandı (10,8±4,4 vs. 8,4±4,1, p=0,02). PUKI, HDS and HAS iki grup arasında karşılaştırıldığında fark bulunmadı. Ortalama SpO_2 (90±3,64 ve 92,4±2,88) and minimum SpO_2 (78,1±10,7 ve 83,2±6,8) grup 1'de anlamlı düşük saptandı (p=0,02 ve p=0,03). Grup 1'de uyku süresi boyunca SpO_2 90'ın altında olduğu süre istatistiksel olarak daha yüksek idi (17,98±17,67 ve 11,07±12,37, p=0,04). n-CPAP tedavisi olan 22 hastanın 19'unda (86,4%) son takipte baş ağrısı saptanmadı.

Sonuç: Minimum SpO2 değerleri ve uyku sırasındaki desatürasyon süresi, kadın cinsiyet ve VKI SBA ile ilişkilidir. n-CPAP tedavisi SBA olan OUAS hastalarında etkili bir yöntemdir.

Anahtar Kelimeler: Sabah baş ağrısı, uyku apne sendromu, pozitif basınçlı havayolu tedavisi.

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Introduction

Obstructive sleep apnea syndrome (OSAS) is characterized by recurrent episodes of partial or complete obstruction of the upper airway during sleep, often resulting in oxygen desaturation [1]. Sleep disruption may cause unrefreshing sleep, daytime sleepiness, fatigue, lack of energy, and intellectual deficit, and other common symptoms are snoring, nocturia, reflux, and morning headache (MH) [2]. The estimated prevalence of at least mild OSAS is 17%–33% in women and 34%–59% in men, while the prevalence of moderate or severe OSAS is 6%–13% in women and 13%–30% in men [3, 4].

Headache prevalence is high among patients, as evaluated using polysomnography (PSG) [5]; 29%–67% of patients with headache had OSAS using PSG [6, 7] while 32%–55% of OSAS patients had headache [5, 8]. The mechanism of the relationship between sleep and headache remains unclear. Patients with sleep disorders often complain of MH, and some studies have reported that MH is a non-specific clinical finding in sleep disorders [9-11]. It can also be encountered in primary or secondary headache disorders [12, 13] and mental disorders [14]. MH was reported more frequently among patients who were referred with a presumptive diagnosis of OSAS, and it is considered to be a common clinical finding of OSAS [15-17]. The prevalence of MH was reported to be 12%–18% in OSAS patients and 5%–8% in the general population [14, 18].

In the International Classification of Headache Disorders (ICHD) 3rd edition, MH associated with OSAS was classified as "sleep apnea headache," under the topic of "Headache attributed to disorders of homoeostasis" [13]. Some studies showed a relationship between MH and OSAS severity [15, 17] or MH and oxygen desaturation [17, 19], while other studies denied this relationship [5, 18]. Previous studies reported that effective use of nasal continuous positive airway pressure (n-CPAP) or uvulopalatopharyngoplasty (UPPP) could improve MH [15, 17, 20], which supports the association between OSAS and MH.

It is unclear whether the mechanism of MH in patients with OSAS is related to hypoxia, hypercapnia, or disturbance in sleep, and this requires clarification. The aim of the present study was to investigate the clinical and PSG characteristics in patients with PSG-verified OSAS with or without MH and to evaluate the response to n-CPAP treatment.

Material and methods

Patients with various sleep complaints were referred for suspected OSAS to the sleep laboratory of Beykoz State Hospital from April to September 2021 and were prospectively evaluated. Eighty-nine patients were diagnosed with OSAS. Eleven patients were excluded from study for the following reasons: four patients had other comorbid primary sleep disorders; four patients had poor signal quality on the recorded channels; and three patients had less than 3 hours of total sleep time. All participants provided written informed consent to participate in the study, in accordance with the standards of the Declaration of Helsinki. The study was approved by the ethics and Research Committee at the Umraniye Training and Research Hospital (B.10.1.TKH.4.34.H.GP.0.01/142.)

All patients underwent an 8-hour PSG that was supervised by a qualified technician. A Compumedics E series 44-channel device (MFI medical, San Diego, CA, USA) was used, and the recordings were performed in accordance with the American Academy of Sleep Medicine (AASM) criteria.

PSG data were evaluated by an experienced sleep physician, and the recordings were scored according to the AASM criteria (AASM-2020). OSAS was diagnosed on the basis of clinical evaluation and according to the criteria of International Classification of Sleep Disorders third edition (AASM ICSD-2014). The apnea–hypopnea index (AHI) was calculated as the number of apneas and hypopneas per hour during sleep, and the cut-off point for OSAS was ≥5/h. OSAS severity was classified using the AHI as follows: mild (5 to <15), moderate (15 to <30), and severe (≥30). The other PSG parameters that were evaluated were total sleep time (TST), sleep efficiency index, sleep stage percentages of TST (nonrapid eye movement [NREM] 1, 2, 3 and rapid eye movement [REM]), average oxygen saturation (SpO2), minimum SpO2, and duration of desaturation (SpO2<90).

The assessment for MH was performed using a headache questionnaire. If MH was present, headache features such as localization, frequency, duration, severity (visual analog score), and quality were recorded by the first author in a face-to-face interview. Sleep apnea headache have been distinguished from other neurological diseases using the International Classification of Headache Disorders (ICHD-3). The first two criteria to be met are as follows: MH is present on awaking after sleep with OSAS (AHI≥5); and includes at least two of following three criteria: 1) temporal relationship between headache onset and OSAS; 2) headache worsening or improving in parallel with worsening or improving OSAS; and 3) at least one of the following: 3.1) recurring on ≥15 days/month; 3.2) a duration of less than 4 hours; and 3.3) bilateral, pressing quality that was not accompanied by nausea, photophobia, or phonophobia. According to the definition of sleep apnea headache in the ICDH-3, the headache resolves with successful treatment of OSAS. Because some patients did not undergo CPAP treatment, we used the term MH instead of sleep apnea headache. If the patients were treated with n-CPAP, the frequency and severity of headache was compared with pre- and post-n-CPAP treatment.

Excessive daytime sleepiness was evaluated using the Turkish version of the Epworth Sleepiness Scale (ESS) [21], and sleep quality was assessed using the Turkish version of the Pittsburg Sleep Quality Index (PSQI) [22]. Seven components including sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, sleeping medication use, and daytime dysfunctions were evaluated. The Hamilton Depression Scale (HDS) and Hamilton Anxiety Scale (HAS) were used to evaluate the presence of depression or anxiety that may cause MH.

Patients were divided into two groups: with MH (group 1) and without MH (group 2). Groups were compared according to age, sex, body mass index, comorbid disease (hypertension, diabetes mellitus, or cardiovascular disease), smoking, ESS, PSQI, HDS, HAS, and PSG variables. Additionally, headache persistence was evaluated for patients in group 1 who received n-CPAP treatment.

Statistical Analysis

Statistical analysis was performed using SPSS version 12 (SPSS Inc., Chicago, IL, USA). Categorical data were reported as the frequency while continuous data were reported as the mean and standard deviation. Normal distribution was investigated using the Shapiro–Wilk test, and variance homogeneity was assessed using the Levene test. To compare the groups, chi-square tests were used for categorical data, and independent sample t-tests were used for continuous data. If needed, the Mann–Whitney U test was used for continuous variables that had a non-normal distribution. A P-value of 0.05 was used as the cut-off for establishing statistical significance.

Results

Seventy-eight patients with OSAS were included in this study. Among the 78 consecutive OSAS patients, 28 (35.9%) reported MH. The mean frequency of headache was 14.3 ± 10.3/month, and 42.8% of the patients had 15 or more headaches in a month. (Table 1).

Table.1 The characteristics of morning headache in 28 patients (Group 1).

	n	%
Frequency		
1-8/month	6	21.5
8-15/ month	10	35.7
>15/month	12	42.8
Duration		
<1 h	4	14.2
1-4 h	19	68
>4 h	5	17.8
Character		
pressing	20	71.4
throbbing	6	21.4
stabbing	2	7.2
Severity (VAS)		
mild	6	21.4
moderate	18	64.3
severe	4	14.3
Localization		
bilateral	22	78.5
unilateral	6	21.5

Vas: visual analog scale.

Mean age did not differ between the groups (49.5±8.1 years vs. 50.1±10.8 years, respectively), while there were significantly more women in group 1 compared to group 2 (43% vs 20%, p=0.03). The mean body mass index (BMI) was higher in group 1 (33.1±4.9 kg/m^2 vs. 30.6±4.8 kg/m^2, p=0.04). Additionally, 71.4% of patients in group 1 had a comorbid disease, while 48% of patients had a comorbid disease in group 2 (p=0.04) The most common comorbid disease was hypertension, and it was present 50% of the patients in group 1 and 38% in group 2. (Table 2).

Table. 2 Demographic and clinical characteristics of patients with and without morning headache.

	Group 1 (n=28)	Group 2 (n=50)	P
Age (year) †	49.5± 8.1	50.1± 10.8	0.78*
Female ‡	12 (42.9)	10 (20)	0.03**
BMI (kg/m^2) †	33.1± 4.9	30.6± 4.8	0.04*
Comorbidity ‡	20 (71.4)	24 (48)	0.04**
Smoking ‡	12 (43)	21 (42)	0.94**

†: mean ± standard deviation, ‡: n (%), BMI: body mass index.

The ESS, which evaluated excessive daytime sleepiness, was higher in group 1 compared to group 2 (10.8±4.4 vs. 8.4±4.1, p=0.02). There was no significant difference between the PSQI score and subgroup scores for sleep quality between the groups (p>0.05). Similarly, HDS and HAS were not significantly different between the groups (p=0.55 and p=0.74, respectively). Eleven patients had a cut-off value of >8 for HDS (39.3%) in the MH group, while 17 (34%) had this cut-off in group 2. Moderate depression (HDS 14–18) was detected in four patients in both groups, while an HDS of >18 was not found in any of the patients (Table 3).

The mean AHI was higher in the MH group, but this difference was not statistically significant (38.9±19.5 vs. 34.3±21.7, p=0.35). The incidence of MH was 29.4% in mild OSAS, 36% in moderate OSAS, and 38.9% in severe OSAS. The average SpO_2 (90±3.64 vs. 92.4±2.88) and minimum SpO_2 (78.1±10.7 vs. 83.2 ±6.8) were significantly lower in the MH group (p=0.02 and p=0.03). Additionally, the duration of desaturation was significantly higher in the MH compared to the non-MH group (17.98±17.67 vs. 11.07±12.37, p=0.04).

Table 3. Epworth Sleepness Scale, Pittsburg Sleep Quality Index, Hamilton Depression Scale and Hamilton Anxiety Scale in groups.

	Group 1	Group 2	p*
Epworth Sleepness Scale †	10.8±4.4	8.4±4.1	0.02
Pittsburg Sleep Quality Index †	7.7±3.8	6.7±3.07	0.18
Sleep quality †	1.68±0.90	1.52±0.73	0.40
Sleep latency †	1.04±0.96	0.84±0.79	0.33
Sleep duration †	1.36±0.95	1.38±0.83	0.91
Habitual sleep efficiency †	1.04±1.36	0.96±1.12	0.77
Sleep disturbance †	1.39±0.62	1.12±0.71	0.09
Use of sleeping medication †	0.11±0.56	0.12±0.48	0.91
Daytime disfunction †	1.07±1.52	0.74±0.96	0.17
Hamilton Depression Scale †	8.43±3.91	7.92±3.46	0.55
Hamilton Anxiety Scale †	8.6±3.9	8.3±4.6	0.74

†: mean ± standard deviation, *Independent t test

Total sleep time, sleep efficiency index, and the percentages of NREM 1, 2, 3 and REM sleep did not differ between the groups (Table 4).

Table. 4 Polysomnographic parameters of patients in groups.

	Group 1	Group 2	P
TST (min) †	367.3±73.7	345.9±78.3	0.24*
SEI (%) †	75.3±14	74.4±15.3	0.80*
REM (%) †	14.1±6.6	14.7±8.4	0.75*
NREM1 (%) †	9.8±5.2	9.1±6.6	0.61*
NREM2 (%) †	61.7±8.3	62.6± 10.9	0.71*
NREM3 (%) †	14.2±7.3	13.6± 8.8	0.73*
AHI †	38.9±19.5	34.3±21.7	0.35**
Average O_2 †	90.92±2.58	92.40±2.88	0.02*
Min O_2 †	79.60±7.92	83.26±6.83	0.03*
Sleep time with O_2 <90% (%) †	17.98±17.67	11.07±12.37	0.04*

†: mean ± standard deviation.
TST: Total sleep time, SEI: Sleep efficacy index, REM: Rapid eye movement, NREM: non-rapid eye movement, AHI: Apnea- hypopnea index, O2: Oxygen level
*Independent t test
**Mann-Whitney U test

Fourteen (63.4%) of the 22 patients who received n-CPAP treatment day 1, 16 (72.7%) at week 1, and 19 (86.4%) at the month 1 follow-up were headache-free. In three patients whose headache persisted, the frequency of pain decreased by ≥50%.

Discussion

The main finding in the present study was that hypoxemia was prominent in OSAS patients with MH compared to the group of without MH. While the average SpO2 and minimum SpO2 levels were significantly lower in the MH group, duration of desaturation was significantly higher compared to the non-MH group. However, other studies showed different findings regarding the role of nocturnal hypoxia in the development of sleep apnea headache or MH in OSAS patients. Koç et al. [19] found the mean and minimum SpO2 to be lower and the desaturation index higher (both TST and REM) in OSAS patients with MH compared to those without MH [19]. Göksan et al. [17] found the mean SpO2, minimum REM, and NREM SpO_2 levels

to be low and the AHI to be high in the MH group, but none of these were a determining factor for MH in the logistic regression analysis. Additionally, in some studies, no significant difference was found between OSAS patients with and without MH for respiratory parameters using PSG [8, 18, 20, 23].

In the present study, no relationship was found between OSAS severity and MH or the mean AHI in both groups. While some studies showed that the prevalence of MH increases with OSAS severity [15, 16, 17], other studies did not support this relationship [5, 9, 18, 19, 23]. Alberti et al. [15] and Loh et al. [16] revealed this relationship when they increased OSAS severity by one degree in the presence of oxygen desaturation out of proportion to their AHI, but that association was not confirmed when they defined OSAS severity based on only AHI. Consistent with our study, the relationship between oxygen desaturation levels and the occurrence of MH was revealed in these other studies, and the notion that hypoxia plays a role in the development of MH was supported.

Sleep fragmentation and architectural distraction were reported to be a possible reason for MH development in OSAS [12]. In a study comparing patients who were diagnosed with OSAS with and without MH the day after the PSG examination, sleep duration, sleep efficiency, and NREM sleep percentage were found to be low in the MH group [11]. Eren et al. [24] determined that sleep disturbance was common in the patients with pulmonary disease. In other studies, no difference was found between patients with or without MH in terms of sleep duration, sleep efficiency, or NREM and REM sleep percentages, which is in agreement with our results [8, 17, 19].

MH is known to be a common symptom in OSAS [25, 26]. While the prevalence of MH in OSAS was reported to be 12%–18% in population-based studies [14, 18], this ratio increased to 20%–48% in patients with sleep problems, especially respiratory problems, who underwent PSC evaluation [15, 20, 23]. The prevalence of MH in our study was 35.9%, which is similar to that of the abovementioned studies.

Spalka et al. [23] found a relationship between MH and hypertension in OSAS, but this relationship was not present for BMI. Koç et al. [19] reported that comorbid diseases were higher in OSAS, but no difference was found between the MH and non-MH groups. Epidemiological studies have reported that comorbid diseases are detected with a higher incidence in women with OSAS than in men [4, 27]. In our study, BMI and comorbid disease association were higher in the MH group. These results may be related to the greater number of female patients in the MH group.

In a population-based study, MH was reported to be significantly higher in patients with, compared to those without, depression and anxiety (28.5% vs. 5.5%) [14]. In another study, depression was high in OSAS patients with headache, but there was no difference between patients with and without MH [8]. Another study did not include OSAS patients with MH who had HAD >8 because depression may be the major etiology of headache [17]. No difference was found in depression and HAD scores between patients with and without MH in the present study, and this finding suggested that depression was not a major factor in the etiology of MH in our patients.

While some studies reported no difference between ESS in OSAS patients with and without MH [8, 20, 28] there are also studies that found a significantly higher ESS in the MH group, which is similar to our results [19]. Additionally, consistent with the results of Suzuki et al., the PSQI total score and subgroup scores were not different between groups with and without MH in the present study [20].

The results of a study evaluating the n-CPAP treatment response in OSAS patients with chronic headache were found to be insufficient (24% of patients' headaches improved) [6], while another study reported that OSAS treatment may be effective for headaches in many patients [7]. However, effective oxygenation with n-CPAP therapy can achieve 80%–92% pain elimination in OSAS patients with MH [17, 20]. Similarly, our study showed that 86.4% of the patients who received n-CPAP treatment were headache-free at the end of the month 1, and the frequency of headaches in the remaining three patients decreased by ≥50%.

The mechanism by which the development of MH and sleep apnea headache occurs in OSAS has not yet been clarified. In the MH group, average and minimum SpO_2 were significantly lower, and duration of <90% SpO_2 was significantly higher. Considering our PSG results and n-CPAP treatment responses, nocturnal hypoxemia may play a role in the development of MH.

The present study also has some limitations. First, the number of the patients was relatively small. Second, we performed a regression analysis to evaluate the effectiveness of the n-CPAP therapy. Despite the limitations the study, this was a prospective study that contributes additional data about the relationship between MH and OSAS.

Mean and average SpO_2 levels and the duration of desaturation during sleep are the major risk factors for MH in women and OSAS patients with a higher BMI. N-CPAP therapy is an effective treatment for patients with MH.

References

1. Yeghiazarians Y, Jneid H, Tietjens JR, Redline S, Brown DL, El-Sherif N, et al. Obstructive Sleep Apnea and Cardiovascular Disease: A Scientific Statement From the American Heart Association. Circulation 2021;144:e56-e67.
2. Lee JJ, Sundar KM. Evaluation and Management of Adults with Obstructive Sleep Apnea Syndrome. Lung. 2021;199:87-101.
3. Peppard PE, Young T, Barnet JH, Palta M, Hagen EW, Hla KM. Increased prevalence of sleep-disordered breathing in adults. Am J Epidemiol. 2013;177:1006-14.
4. Fietze I, Laharnar N, Obst A, Ewert R, Felix SB, Garcia C, et al. Prevalence and association analysis of obstructive sleep apnea with gender and age differences - Results of SHIP-Trend. J Sleep Res. 2019;28:e12770.
5. Sand T, Hagen K, Schrader H. Sleep apnoea and chronic headache. Cephalalgia. 2003;23:90-5.
6. Mitsikostas DD, Vikelis M, Viskos A. Refractory chronic headache associated with obstructive sleep apnoea syndrome. Cephalalgia. 2008;28:139-43.
7. Johnson KG, Ziemba AM, Garb JL. Improvement in headaches with continuous positive airway pressure for obstructive sleep apnea: a retrospective analysis. Headache. 2013;53:333-43.
8. Neau JP, Paquereau J, Bailbe M, Meurice JC, Ingrand P, Gil R. Relationship between sleep apnoea syndrome, snoring and headaches. Cephalalgia. 2002;22:333-9.
9. Aldrich MS, Chauncey JB. Are morning headaches part of obstructive sleep apnea syndrome? Arch Intern Med. 1990;150:1265-7.
10. Poceta JS, Dalessio DJ. Identification and treatment of sleep apnea in patients with chronic headache. Headache. 1995;35:586-9.
11. Goder R, Friege L, Fritzer G, Strenge H, Aldenhoff JB, Hinze-Selch D. Morning headaches in patients with sleep disorders: a systematic polysomnographic study. Sleep Med. 2003;4:385-91.
12. Dodick DW, Eross EJ, Parish JM, Silber M. Clinical, anatomical, and physiologic relationship between sleep and headache. Headache. 2003;43:282-92.
13. Headache Classification Committee of the International Headache Society (IHS) The International Classification of Headache Disorders, 3rd edition. Cephalalgia. 2018;38:1-211.
14. Ohayon MM. Prevalence and risk factors of morning headaches in the general population. Arch Intern Med. 2004;164:97-102.
15. Loh NK, Dinner DS, Foldvary N, Skobieranda F, Yew WW. Do patients with obstructive sleep apnea wake up with headaches? Arch Intern Med. 1999;159:1765-8.
16. Alberti A, Mazzotta G, Gallinella E, Sarchielli P. Headache characteristics in obstructive sleep apnea syndrome and insomnia. Acta Neurol Scand. 2005;111:309-16.
17. Goksan B, Gunduz A, Karadeniz D, Agan K, Tascilar FN, Tan F, et al. Morning headache in sleep apnoea: clinical and polysomnographic

evaluation and response to nasal continuous positive airway pressure. Cephalalgia. 2009;29:635-41.
18. Kristiansen HA, Kvaerner KJ, Akre H, Overland B, Sandvik L, Russell MB. Sleep apnoea headache in the general population. Cephalalgia. 2012;32:451-8.
19. KoÇ G, MetİN KM, AkÇay BD, KaradaŞ Ö, Sayin R, YetkİN S. Relationship between Apnea-Hypopnea Index and Oxygen Desaturation in REM-Sleep Period and Morning Headache in Patients with Obstructive Sleep Apnea Syndrome. Noro Psikiyatr Ars. 2020;57:294-98.
20. Suzuki K, Miyamoto M, Miyamoto T, Numao A, Suzuki S, Sakuta H, et al. Sleep apnoea headache in obstructive sleep apnoea syndrome patients presenting with morning headache: comparison of the ICHD-2 and ICHD-3 beta criteria. J Headache Pain. 2015;16:56.
21. Izci B, Ardic S, Firat H, Sahin A, Altinors M, Karacan I. Reliability and validity studies of the Turkish version of the Epworth Sleepiness Scale. Sleep Breath. 2008;12:161-8.
22. Ağargün MY KH, Anlar Ö. The validity and reliability of the Pittsburgh Sleep Quality Index. Turk Psikiyatri Derg. 1996;7:107-15.
23. Spałka J, Kędzia K, Kuczyński W, Kudrycka A, Małolepsza A, Białasiewicz P, et al. Morning Headache as an Obstructive Sleep Apnea-Related Symptom among Sleep Clinic Patients-A Cross-Section Analysis. Brain Sci 2020;10:57.
24. Eren F, Baktik BO, Demir A. The assessment of headache and sleep quality in patients with chronic obstructive pulmonary disease.J Surg Med. 2022;6:488-93.
25. Kirsch DB. Obstructive Sleep Apnea. Continuum (Minneap Minn). 2020;26:908-28.
26. Park JW, Mehta S, Fastlicht S, Lowe AA, Almeida FR. Changes in headache characteristics with oral appliance treatment for obstructive sleep apnea. Sci Rep. 2021;11:2568.
27. Basoglu OK, Tasbakan MS. Gender differences in clinical and polysomnographic features of obstructive sleep apnea: a clinical study of 2827 patients. Sleep Breath. 2018;22:241-49.
28. Greenough GP, Nowell PD, Sateia MJ. Headache complaints in relation to nocturnal oxygen saturation among patients with sleep apnea syndrome. Sleep Med. 2002;3:361-4.