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ORIGINAL INVESTIGATION / ÖZGÜN ARAŞTIRMA

Factors That Affect Auto-Continuous Positive Airway Pressure Level Designated During Titration Night in Patients with Obstructive Sleep Apnoea

Obstrüktif Uyku Apne Sendromlu Hastalarda Titrasyon Gecesinde Oto-CPAP Basınç Düzeyini Etkileyen Faktörler

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Abstract

OBJECTIVE: There is no designated pressure level for continuous positive airway pressure (CPAP) and there are many factors that affect pressure level. In our study, we aimed to assess factors that affect CPAP pressure level on titration night.

MATERIAL AND METHODS: Patients who were diagnosed with obstructive sleep apnoea syndrome (OSAS) and who were recommended to use CPAP between January 2005 and June 2011 were included in the study. The files of the patients were investigated retrospectively. All the patients were diagnosed with OSAS by polysomnography (PSG) conducted on the first night and their auto-CPAP titrations made on a second night by full-night PSG. The patients whose CPAP and BIPAP titrations made manually were excluded. The CPAP pressure level for each patient was set at the minimum pressure needed to abolish all respiratory events in the supine position and at the rapid eye movement (REM) stage.

RESULTS: Five hundred and twenty-five patients were included in the study. Three hundred and seventy (70.5%) were men and 155 (29.5%) were women. Mean age was 50.4±9.8 years, body mass index (BMI) was 32.2±5.7, Epworth Sleepiness Scale (ESS) score was 10.6±6, and CPAP pressure level was 10.5±2.1. In the first-night PSG, mean apnoea hypopnoea index (AHI) was 50.1±23.7, oxygen desaturation index (ODI) was 42.7±24.8, minimum oxygen saturation (min SpO_2) was 75.6±10.9%, and periodic leg movement index (PLMI) was 19.6±21.3. No correlation was found between CPAP pressure and age or gender. A positive correlation was found with BMI and ESS score. In the first-night PSG, a positive correlation was found with AHI, AI, ODI, and PLMI, and a negative correlation with min SpO_2%. In the last-night PSG, a positive correlation was found with sleep latency, full-face mask usage, and PLMI, and a negative correlation with sleep efficiency and nasal mask usage. In multivariate analysis, longer sleep latency and higher PLMI were found to be independent effective factors.

CONCLUSION: Although age and gender do not affect CPAP pressure level, higher BMI and ESS and severe OSAS require higher levels of CPAP pressure. Longer sleep latency, lower sleep efficiency, shorter REM latency, and higher PLMI and full-face mask usage on the last night also lead to higher levels of CPAP pressure.
KEY WORDS: Obstructive sleep apnoea, nasal continuous positive airway pressure, bad sleep quality

Özet

AMAÇ: Obstrüktif uyku apne sendromu (OUAS) için altın standart olarak kabul edilen sürekli pozitif havayolu basıncı (CPAP) için belirlenmiş standart bir basınç olmayıp basınç düzeyini etkileyen pek çok faktör mevcuttur. Çalışmamızda titrasyon gecesinde belirlenen CPAP basınç seviyesini etkileyen faktörleri araştırmayı amaçladık.

GEREÇ VE YÖNTEMLER: Ocak 2005-Haziran 2011 tarihleri arasında OUAS tanısı almış olan ve CPAP tedavisi önerilen 525 hastanın dosyası retrospektif olarak incelendi. Tüm hastalara ilk gece polisomnografi (PSG) yapılarak OUAS tanısı konduktan sonra ikinci gece tüm gece PSG ile birlikte oto-CPAP titrasyonu uygulandı. Her hasta için sırtüstü pozisyonda ve REM evresinde tüm solunumsal olayları baskılayacak minimum CPAP basıncı tespit edildi.

BULGULAR: CPAP titrasyonu yapılan toplam 525 olgunun 370'i (%70,5) erkek, 155'i (%29,5) kadın olup, ortalama yaş 50,48±9,87, body mass index (BMI); 32,29±5,71, epworth seleepiness scale (ESS); 10,68±6,06, CPAP basınç düzeyi; 10,52±2,18 bulundu. İlk PSG'de ortalama apne hipopne indeksi (AHİ); 50,15±23,73, apne indeksi (Aİ); 28,95±24,95, oksijen desatürasyon indeksi (ODİ); 42,72±24,83, minimum oksijen satürasyonu (SO_2) %; 75,63±10,96, periodic leg movement indeksi (PLMİ); 19,64±21,30 bulundu. CPAP basınç düzeyi ile yaş ve cinsiyet arasında korelasyon bulunamazken, BMİ, ESS, AHİ, Aİ, ODİ, PLMİ ile pozitif korelasyon; min SpO_2 ile negatif korelasyon bulundu. Titrasyon gecesindeki PSG'de tespit edilen uyku etkinliği ve nazal maske kullanımı ile negatif; PLMİ, REM latansı ve uyku latansı, oronazal maske kullanımı ile pozitif korelasyon tespit edildi. Geçirmiş olduğu KBB operasyonları ise CPAP basınç düzeyi ile ilişkili bulunmadı. Uzamış uyku latansı ve yüksek PLMİ bağımsız etkili faktörler olarak bulundu.

SONUÇ: Titrasyon gecesinde tespit edilen CPAP basınç düzeyini yaş ve cinsiyet etkilemezken, yüksek BMİ ve ESS, şiddetli hastalık, kötü uyku kalitesi, oro-nazal maske kullanımı daha yüksek basınç gerektirmektedir.

ANAHTAR SÖZCÜKLER: Obstrüktif uyku apne sendromu, sürekli pozitif havayolu basınç düzeyi, kötü uyku kalitesi

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INTRODUCTION

Continuous positive airway pressure (CPAP), which was first introduced by Sullivan et al. [1], is the most widely used and most effective treatment for obstructive sleep apnoea syndrome (OSAS). Traditionally, the effective pressure is titrated in the sleep laboratory by means of polysomnography (PSG), and is defined as the pressure level able to eliminate most apnoeas, hypopnoeas, and snoring in all sleep stages and body positions. However, this effective pressure can vary in the same patient from

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night to night and even during the same night, depending on body position, fatigue level, sleep stage, nasal patency, upper airway oedema, ingestion of alcohol, and sedative agents. Furthermore, regular maintenance of CPAP therapy itself and weight loss may alter the effective pressure in long-term usage [2-4]. Titration of the effective CPAP level is classically performed during a full polysomnographic study with the constant attendance of a technician throughout the night [5]. There has been considerable interest in recent years in auto-CPAP (APAP) devices capable of continuously adjusting the pressure to the effective level. The effectiveness of APAP devices in the treatment of sleep-disordered breathing has been demonstrated in many studies [3, 4, 6-10]. Some studies have been published comparing APAP vs. conventional constant CPAP as home therapy in patients with OSAS. Most of them have reported that patients slept on APAP at a mean pressure lower than on constant CPAP [11-16], but compliance was better on APAP in only one study [14]. Pressures automatically delivered throughout the night are taken into consideration to identify a fixed pressure level that may be appropriate for home treatment by means of traditional fixed-level CPAP machines. For that purpose, there is not yet a universally accepted criterion [15]; one of the most commonly used methods is to consider the 95th percentile APAP pressure determined through a seven-night APAP trial as the effective CPAP pressure [6-10,14]. In our study, we aimed to retrospectively assess factors that affected CPAP pressure level in patients with the diagnosis of OSAS who were recommended APAP titrations in our laboratory.

MATERIAL AND METHODS

Patients

Nine hundred and three patients who were diagnosed with OSAS underwent positive airway pressure titration between January 2005 and June 2011 in our sleep laboratory. Of these, 525 patients who underwent APAP titration were included in the study. Patients who applied to our sleep clinic with symptoms of OSAS were questioned about previous ear, nose, and throat (ENT) surgery and were assessed with the Epworth Sleepiness Scale (ESS) [17] for daytime sleepiness. They were given an appointment and admitted to the sleep laboratory for initial PSG. Patients who were diagnosed as OSAS were admitted to a second PSG evaluation for PAP titration. CPAP titration was not successfully accepted in the patients who had a sleep efficiency below 65%, who did not a REM stage, and in whom the respiratory events continued to occur in spite of higher CPAP pressure. Eighty-three of 903 patients were excluded from the study because their CPAP titration was found to be insufficient. Two hundred and ninety-five patients, whose CPAP and bi-level positive airway pressure (BPAP) titrations were made manually, were excluded also.

Polysomnography

Informed consent of all patients was obtained before first-night PSG and CPAP titration were conducted. Standard overnight PSG included recordings of EEG, electrooculogram, submental and bilateral leg electromyograms, and ECG. Air flow was measured by a nasal pressure transducer and respiratory effort by thoracoabdominal piezoelectric belts and respiratory inductance pletismography. Measurement of arterial haemoglobin oxygen saturation was performed by a finger pulse oximeter. All signals were collected (Viasys Sleep Screen, Germany; Viasys CephaloPro, Germany; Comet, USA) and digitalised (Matrix Sleep; SomnoStar; Grass) on a computerised PSG system operated by experienced technicians. Sleep stages were scored in 30-second epochs using Rechtachaffen-Kales [18] and American Academy of Sleep Medicine (AASM) 2007 [19] scoring systems. Each epoch was analysed for the number of apnoeas and hypopnoeas. Apnoea was defined a cessation of airflow for >10 seconds, and hypopnoea as a reduction of airflow ≥50% for >10 seconds plus an oxygen desaturation of >3% or an arousal [19,20]. Scoring was made by certificated specialists who were experienced in sleep medicine. Disease classification was made according to the AASM 2005 Guide [21]. Cases were graded according to AASM 1999 [20] criteria as follows: Apnoea hypopnoea index (AHI) ≥5 and ≤15 as mild; AHI >15 and ≤30 as moderate; and AHI >30 as severe. All the cases who had AHI >30, the cases who had AHI=5-30 with risk factors (hypertension, ischaemic heart disease, stroke, etc.), and the cases who had AHI=5-30 with daytime sleepiness were recommended CPAP titration. CPAP titration was performed automatically with the AutoSet auto-titrating device (ResMed, Australia) with full-night PSG, according to suggestions by AASM guidelines [3,22]. The CPAP pressure level for each patient was set at the minimum pressure needed to abolish snoring, obstructive respiratory events, and arousal frequency and to improve oxygenation in the supine position and at the REM stage. During the procedures, nasal and full-face masks were used. Patients with previously known COPD and heart failure were excluded from the study, as were patients with detected central apnoea and nocturnal hypoventilation syndrome on the first PSG, because we performed manual CPAP or BPAP titration on these patients.

Statistical Analysis

Files of the patients who underwent auto-CPAP titrations were examined retrospectively. Demographical characteristics, ESS scores, PSG findings, and CPAP pressure level of the patients were entered into Statistical Package for the Social Sciences (SPSS) 9.0 for Windows and analysed for frequency distributions. Spearman correlation analysis was conducted. A multivariate logistic regression analysis was conducted to evaluate the independent variables.

RESULTS

Three hundred and seventy (70.5%) of the 525 cases were men and 155 (29.5%) were women. Mean age was 50.4±9.8 years, body mass index (BMI) was 32.2±5.7, ESS score was 10.6±6.1, and CPAP pressure level was 10.5±2.1 (Table 1). In the first-night PSG, mean AHI was 50.1±23.7, apnoea index (AI) was 28.9±24.9, oxygen desaturation index (ODI) was 42.7±24.8, minimum oxygen saturation (min SpO_2) was 75.6±10.9%, and periodic leg movement index (PLMI) was 19.6±21.3 (Table 1). On the CPAP titration night PSG, mean sleep efficiency was 77.1±12.3%, sleep latency was 22.6±19.2 minutes, REM latency was 127.2±83.5 minutes, AHI was 5.1±4.1, AI was 1.9±2.2, ODI was 3.2±3.6, min SPO_2 was 88.8±4.5%, and PLMI was 10.9±15.1 (Table 1).

In terms of correlation with CPAP pressure level, the following results were achieved: no correlation was found with age or gender. A positive correlation was found with BMI and ESS score. In the first-night PSG, a positive correlation was found with AHI, AI, ODI, and PLMI, and a negative correlation with min SpO_2%. On the last night, nasal masks were used in 360 (68.6%) of 525 patients and 165 (31.4%) used a full-face mask. A positive correlation was found with sleep latency, full-face mask usage, and PLMI, and a negative correlation with sleep efficiency, REM latency, and nasal mask usage. Ninety-one patients (17.3%) had previous ENT surgery, including nasal septoplasty (50 cases), nasal polypectomy (16 cases), radiofrequency ablation (2 cases), uvulopalatopharyngoplasty (10

Table 1. Correlation between CPAP pressure level and all parameters

	Mean±SD	Correlation coefficient	
		r value	p value
CPAP Pressure cmH_20	10.5±2.1		
Age (years)	50.4±9.8	0.019	0.669
Gender		0.005	0.908
Female n/%	155 (29.5%)		
Male n/%	370 (70.5%)		
BMI kg/m^2	32.2±5.7	0.149	0.013
Epworth	10.6±6.1	0.189	0<001
First PSG AHI	50.1±23.7	0.219	0<001
First PSG AI	28.9±24.9	0.268	0<001
First PSG ODI	42.7±24.8	0.252	0<001
First PSG min SpO_2%	75.6±10.9	-0.177	0<001
First PSG PLMI	19.6±21.3	0.195	0<001
CPAP PSG AHI	5.1±4.1	0.027	0.531
CPAP PSG AI	1.9±2.2	0.109	0.015
CPAP PSG ODI	3.2±3.6	0.127	0.004
CPAP PSG min SpO_2%	88.8±4.5	-0.153	0.001
CPAP PSG PLMI	10.9±15.1	0.192	0<001
CPAP PSG sleep efficiency %	77.1±12.3	-0.099	0.016
CPAP PSG sleep latency min	22.6±19.2	0.173	0<001
CPAP PSG REM latency min	127.2±83.5	-0.140	0.005
Nasal mask n/%	360 (68.6%)	-0.104	0.008
Full-face mask n/%	165 (31.4%)	0.194	0<001
ENT surgery n/%	91 (17.3%)	-0.041	0.303

CPAP: Continue positive airway pressure, BMI: Body mass index, PSG: Polysomnography, AHI: Apnoea hypopnoea index, AI: Apnoea index, ODI: Oxygen desaturation index, SpO_2: Oxygen saturation with pulse oximeter, PLMI: Periodic leg movement index, REM: Rapid eye movement, ENT: Ear, nose, and throat, SD: standard deviation

cases), and tonsillectomy (13 cases). The presence of previous ENT surgery was not found to be correlated with CPAP pressure level (Table 1). In the multivariate analysis, longer sleep latency and higher PLMI in the last-night PSG were found to affect CPAP pressure level independently from the other factors (p=0.022 and p=0.025, respectively).

DISCUSSION

In our study, it was found that age and gender did not have an effect on the CPAP pressure level designated on the night of CPAP titration. Higher pressure levels were required for the following groups of patients: those with higher BMI and ESS scores; those with higher AHI, ODI, and PLMI and lower min SpO_2 assessed in the first-night PSG; those with higher PLMI, shorter REM latency, and bad sleep quality (longer sleep latency and lower sleep efficiency) assessed in the titration-night PSG. Also, usage of a full-face mask on the titration night led to higher pressure levels. The presence of previous ENT surgery did not have an effect on CPAP pressure levels.

There is not a designated pressure level for CPAP treatment that is accepted globally as the gold standard for treatment of OSAS. Ideal pressure is defined as the lowest possible pressure level that can improve the patient's sleep quality and alleviate respiratory events [6-10, 14, 15]. There are numerous studies conducted to designate patients' CPAP pressure levels beforehand to avoid second-night stays and reduce long waiting times. In most of these studies, BMI and AHI were reported to be the most important factors that affected CPAP pressure level and it was reported that optimal CPAP pressure level could be designated beforehand with formulas designed according to these values, enabling initiation of CPAP treatment with these pressure levels [23-25]. In these studies, the aim was to designate CPAP pressure level beforehand, according to the respiratory distress index (RDI), oxygen saturation (SaO_2), ESS, and BMI. Loredo et al. [26] also found that CPAP pressure level could not be designated according to ESS but the CPAP pressure level was correlated with RDI, SaO_2, and BMI. In Oksenberg's study [27], the relationship of pressure level with age, gender, BMI, ESS, and disease severity was assessed and it was found that as disease severity increased, the pressure level also increased but other parameters did not increase pressure level. Similarly, in Pavernagie's study, AHI and CPAP pressure level were found to be correlated [28]. In our study, it was observed that age, gender, and the presence of previous ENT surgery did not affect CPAP pressure level but in accordance with other studies, high BMI, ESS, and disease severity increased the pressure level required.

There are other factors that can affect CPAP pressure level. In the study of Yu et al. [29], a significant difference was found between CPAP pressure levels calculated according to formulas designed to take into account neck circumference, BMI, AHI values, and CPAP pressure levels designated on titration night. It was also reported that mouth leakages during automatic titration resulted in an increase in pressure level. Low sleep efficiency observed in PSG on titration night can also result in an increase in the pressure level [30]. It was reported in Jokic's study [31] that higher pressure levels were required during the first titration night but when the titrations were repeated 2 and 4 weeks later, CPAP pressure requirements were found to be lower. This finding was thought to be caused by an increase in compliance as days passed and an alleviation of upper respiratory inflammation by CPAP treatment. It was also concluded that repeated titrations were not always necessary; pressures could be lowered for patients who had discomfort without recurrent titration. In our study, all the CPAP titrations were made with full-night PSG and automatic CPAP, which is considered as standard. It was found that higher pressure levels were required for patients with longer sleep latency, lower sleep efficiency, shorter REM latency, and higher PLMI. Longer sleep latency and higher PLMI were found to be independent effective factors. Usage of full-face masks also led to higher pressure levels. It was thought that bad sleep quality and higher PLMI disturbed compliance by causing frequent arousals and usage of a full-face mask led to mask leakages, both resulting in higher pressure levels. Increased pressure levels in patients with a shorter REM latency is thought to occur because breathing events occur much frequently during REM sleep and cause higher pressure levels at the beginning.

The limitation of our study is that it was a retrospective study. However, with the great number of patients all of whom were APAP-titrated and with our results being consistent with previous studies, we think that this study makes a contribution to current literature.

In conclusion, higher BMI, increased disease severity, bad sleep quality (longer sleep latency and lower sleep efficiency), shorter

REM latency, higher PLMI, and usage of a full-face mask on the last night were found to be effective factors for increased CPAP pressure in this study. The multivariate analysis revealed that longer sleep latency and higher PLMI on the last night were independent effective factors. Finally, it was concluded that CPAP pressure level, which is affected by numerous factors, should surely be designated by an experienced technician in close observation with full-night PSG in laboratory conditions.

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