ORIGINAL INVESTIGATION

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

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OBJECTIVES: 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 were 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 SpO₂) 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 SpO₂%. 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

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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 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 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, electrocugram, 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 plethysmography. 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 Rechtshaffen-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 as 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 certified 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 hypventilation 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 SpO2) 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 SpO2 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 SpO2. 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 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 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 (SaO₂), 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, SaO₂, 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 designated 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 efficien-
Because of our study is retrospective, the ethical committee approval was not obtained.

**Informed Consent:** Written informed consent was obtained from patients who participated in this study.

**Peer-review:** Externally peer-reviewed.

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**REFERENCES**

27. Oksenberg A, Arons E, Froom P. Does the severity of obstructive sleep apnea predict patients requiring high continuous positive airway pressure? Laryngoscope 2006;116:951-5. [CrossRef]