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The Correlation Between Sleep Efficiency During Continuous Positive Airway Pressure Titration Polysomnography and Epworth Sleepiness Scale Score in Patients with Obstructive Sleep Apnea

ABSTRACT

Background: Continuous positive airway pressure is the standard treatment for obstructive sleep apnea. However, nonadherence to continuous positive airway pressure use remains a significant limitation that prevents satisfactory results from being achieved. Epworth Sleepiness Scale score and sleep efficiency values may predict adherence. This study aims to assess the relationship between the Epworth Sleepiness Scale score and sleep efficiency measured during continuous positive airway pressure titration polysomnography.

Methods: A retrospective analysis of the medical records of patients with obstructive sleep apnea/hypopnea who had undergone polysomnography for continuous positive airway pressure titration in an ear, nose, and throat center between January 2014 and August 2017.

Results: Assessment of 170 individuals based on the Epworth Sleepiness Scale score and sleep efficiency during polysomnography with continuous positive airway pressure showed that patients with excessive daytime sleepiness had higher sleep efficiency (mean = 82.0%) than patients with normal daytime sleepiness (mean = 78.1%) ($P = .043$).

Conclusion: Patients with excessive daytime sleepiness as measured on the Epworth Sleepiness Scale have higher sleep efficiency during continuous positive airway pressure titration polysomnography.

Keywords: CPAP, obstructive sleep apnea, sleep apnea, upper airway resistance syndrome

INTRODUCTION

Obstructive sleep apnea (OSA) is a chronic disorder characterized by total or partial obstruction of the airways during sleep that leads to reduced airflow.[1-4] The condition is estimated to affect 2% to 4% of adults and is more common in men.[5]

Polysomnography (PSG) is currently the gold standard for the diagnosis of OSA and can monitor cardiac, respiratory, and neurophysiological parameters.[3] The procedure provides a range of data that can be used to determine the severity of the disease, including the apnea-hypopnea index (AHI), which is defined as the number of times an obstructive event occurs per hour of sleep.[3,4]

Another parameter that can be analyzed with PSG is sleep efficiency (SE), which reflects the ratio between actual sleep time and time spent in bed.[6-8] As the equation used to calculate this index takes into account several sleep variables, there is a direct relationship between SE and consolidated sleep.[9] According to the literature, there is also an association between SE and academic success, mental health, physical health, and cognitive function.[10,11]

The Epworth Sleepiness Scale (ESS) was introduced in 1991 as a means of diagnosing sleep disorders and is the most widely used questionnaire for assessing excessive daytime

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sleepiness.[12,13] It is used extensively to assess the severity of OSA as around 87% of patients with sleep disorders report feeling sleepy during the day.[14]

The main treatment for OSA is the administration of continuous positive airway pressure (CPAP). Continuous positive airway pressure can prevent apneas and hypoxia in many patients as well as reduce symptoms of daytime sleepiness. One of the problems of treatment with CPAP, however, is patient intolerance, which is reflected in adherence levels that vary between 30% and 60%.[15] Patients with less severe OSA have been reported in the literature to be more likely to abandon treatment.[16] Approximately 15% of patients refuse CPAP treatment after a single night of use, mainly because of repeated complaints of discomfort caused by the mask as well as nasal congestion and claustrophobia.[13,15]

Patients who reported greater willingness to use CPAP were those with the best SEs during titration of the equipment according to Somiah et al. The authors also note that a patient's initial experience with CPAP and changes in SE are significant predictive factors for long-term use of this treatment.[17]

The aim of this study was to investigate the relationship between patients' daytime sleepiness measured on the ESS and SE measured during CPAP titration PSG.

METHODS

The study consisted of a retrospective analysis of the records of patients who underwent PSG in an ear, nose, and throat center, between January 2014 and August 2017. The study was approved by the Ethics Committee of Sociedade Evangelica Beneficente de Curitiba on September 26, 2017, under reference no. 2.298.223. Informed consent was waived by the Ethics Committee due to the design of the study.

Inclusion criteria were being 18 years or older and having undergone PSG following a clinical recommendation and for CPAP titration. Patients who were selected had completed the ESS prior to the examination and filled out a sleep performance questionnaire after the PSG. Cases for which data were incomplete and patients who only underwent 1 PSG session were excluded.

The following information was taken from each patient's record: sex, age, body mass index (BMI), ESS score, data from the diagnostic PSG (AHI and SE), data from the PSG with CPAP titration (AHI, SE, REM, rapid eye movement sleep latency and titration), and the results of the sleep performance questionnaire based on the patient's complaints and opinions regarding the examination. The questionnaire included closed questions (Were you tired or not when you woke up?) and questions about symptoms and sources of discomfort during and after the PSG, such as difficulty breathing, headache, sore legs, generalized pain, nervousness, and tiredness.

Each patient's ESS score was compared with his/her SE during CPAP titration PSG. The score for the sleep performance questionnaire applied after the exam and the AHI were analyzed to determine whether there was a relationship between them.

The following classification was used for AHI values: AHI $\leq$ 5 – normal; 5 < AHI $\leq$ 15 – mild OSA; 15 < AHI $\leq$ 30 – moderate OSA; and AHI > 30 – severe OSA.[3] An SE of 85% or more was considered normal.[8] Body mass index was classified as follows: BMI < 18.5 – underweight; 18.5 $\leq$ BMI < 25 – normal weight; 25 $\leq$ BMI < 30 – overweight; and BMI $\geq$ 30 – obese.[18] Epworth Sleepiness Scale scores from 0 to 10 were considered normal, while scores from 11 to 24 were considered to indicate excessive daytime sleepiness.[12]

The information collected was tabulated and presented in the form of tables. Qualitative variables are expressed as frequencies and percentages, and quantitative variables as the mean, median, minimum, maximum, and standard deviation (SD). The non-parametric Mann–Whitney *U* test was used to compare 2 classifications for a qualitative variable with a quantitative variable, and the chi-squared test was used to test for an association between qualitative variables. The Jarque-Bera test was used to determine whether the data had a normal distribution, and a significance level of .05 was used (Statistica 10.0. Statsoft®).

RESULTS

Of 242 patients with OSA who underwent PSG between 2014 and 2017, a total of 70 were excluded because of incomplete data and 2 because they decided not to undergo a second CPAP titration PSG. In all, 170 patients were therefore included in the population sample.

The sample consisted predominantly of men (69.4%), and the mean age was 55 years (SD = 13.6). The mean BMI was 29.41 (SD = 4.38), and 85.3% of the patients were classified as overweight or obese. According to the answers to the ESS questionnaire, 30.6% experienced excessive daytime sleepiness (Table 1).

In the first PSG, the mean AHI was 44.5, and 72.9% of the patients were classified as having severe OSA (Table 2). Sleep efficiency at the first examination had a mean value of 84.4% and was considered normal in 60.6% of the participants.

The descriptive data for CPAP titration PSG are shown in Table 3. Mean AHI was 3.0 (SD = 3.5). According to the OSA classification, the AHI became normal for 83.5% of the patients when they used CPAP. Sleep efficiency had a mean value of 79.4% (SD = 15) and was considered reduced in 57.1% of the participants.

Table 1. Results on the ESS

ESS	n	%
Normal	118	69.4
Excessive daytime sleepiness	52	30.6
Total	170	100.0

ESS, Epworth Sleepiness Scale.

Table 2. AHI at first PSG

AHI Classification	n	%
Normal	0	0.0
Mild OSA	8	4.7
Moderate OSA	38	22.4
Severe OSA	124	72.9
Total	170	100.0

AHI, apnea/hypopnea index; PSG, polysomnography; n, number of individuals; OSA, obstructive sleep apnea.

Table 3. Descriptive Data for PSG with CPAP Titration

Variable	n	Mean	Median	Minimum	Maximum	SD
AHI	170	3.0	2.0	0.0	21.3	3.5
SE with CPAP (%)	170	79.4	83.0	17.0	98.9	15.0
REM sleep latency (minutes)	165	121.4	95.0	8.0	354.0	75.0
CPAP (cm of H_2O)	170	8.7	8.0	5.0	18.0	2.4

n, number of individuals; SD, standard deviation; AHI, apnea/hypopnea index; SE, sleep efficiency; PSG, polysomnography; CPAP, continuous positive airway pressure; REM, rapid eye movement.

In the sleep performance questionnaire answered by patients after CPAP, 69.4% stated that they felt rested when they woke up. The discomfort experienced when using the CPAP mask was the main complaint reported (69.4% of the sample). When asked to compare a night's sleep in the clinic with a night's sleep at home, 13% considered the former less satisfying, 46.2% reported no difference, and 40.8% considered a night's sleep in the clinic better. More than half of the patients (58.8%) denied they experienced any of the symptoms of discomfort considered more common during PSG (difficulty breathing, headache, sore legs, generalized pain, nervousness, and tiredness).

When the different categories for the ESS score were compared with SE CPAP titration PSG (Table 4), we found that SE was greater (mean = 82.0%) in patients with excessive daytime sleepiness than in those with a normal ESS score (mean = 78.1) ($P = .043$).

As shown in Table 5, comparison of SE during CPAP titration with the number of complaints mentioned by patients (difficulty breathing, headache, sore legs, generalized pain, nervousness, and tiredness) revealed that the number of complaints during PSG was greater among patients with reduced sleep efficiency ($P = .001$).

No statistically significant relationship was observed when ESS score classifications were compared with the initial value of SE, that is, SE without CPAP ($P = .327$), with the classifications for initial SE ($P = .287$), or with REM sleep latency ($P = .539$). Furthermore, no statistically significant correlation was found between SE classification during CPAP titration PSG and the source of discomfort reported by the patient during the examination ($P = .555$).

Similarly, no statistically significant correlation was found between initial AHI and the numerical value of SE during CPAP titration PSG ($P = .540$) or the SE classification during the same study ($P = .825$).

DISCUSSION

Our results show that SE was greater in patients who received CPAP and who complained of daytime sleepiness on the ESS. There was no statistically significant correlation between AHI and SE.

Complaints related to the mask during CPAP titration were common among our patients. This finding agrees with the literature, which suggests that around half of patients who undergo CPAP treatment make similar complaints.[19] Wolkove et al[20] reported that discomfort caused by the mask, claustrophobia, anxiety, and inconvenience are factors that can lead to patients failing to comply with treatment.

Daytime sleepiness has been associated with greater compliance with CPAP while the severity of OSA as measured by the AHI is a weak predictive factor for adherence to CPAP.[15,21] Similarly, Janson et al[16] found that patients who had more complaints of snoring and daytime sleepiness were more likely to adhere to CPAP. However, some authors found only a weak relationship between severity of OSA or ESS score and tolerance of CPAP.[22-24]

Table 4. Association Between ESS Classification and SE During PSG with CPAP

		SE					
Epworth Classification	n	Mean	Median	Minimum	Maximum	Standard deviation	*P**
Normal	118	78.2	81.7	17.0	98.9	15.4	.043
Excessive daytime sleepiness	52	82.0	85.2	43.0	96.8	13.8	

*Non-parametric Mann–Whitney *U* test; $P < .05$.
SE, Sleep efficiency; PSG, polysomnography; ESS, Epworth Sleepiness Scale.

Table 5. Association Between SE with CPAP and Number of Complaints Reported

		Number of Complaints Reported During PSG					
SE with CPAP	n	Mean	Median	Minimum	Maximum	Standard deviation	*P**
Normal	73	0.4	0	0	3	0.8	.001
Reduced	97	1.0	1	0	5	1.2	

*Non-parametric Mann–Whitney *U* test; $P < .05$.
PSG, polysomnography; SE, sleep efficiency; n, number of complaints; CPAP, continuous positive airway pressure.

Patients' tolerance of CPAP equipment the first time they use it may be influenced by the fact that PSG is performed in a clinic rather than in the place where the patient usually sleeps. A study by Bruyneel et al[25] (2011) showed that patients who underwent PSG at home had better SE and lower latency and slept for longer than individuals who underwent PSG in a hospital setting.

Many studies have analyzed characteristics that might predict tolerance of CPAP by patients with OSA. According to the literature, an improvement in SE and the consequent reduction in daytime sleepiness are associated with adherence to CPAP.[26-28] Greater compliance with CPAP has been observed in patients who had had a better night's sleep (i.e., higher SE) during titration even after controlling for disease severity. For this reason, it has been suggested that a patient's first contact with CPAP has a significant influence on treatment adherence.[26]

A study by Sawyer et al[23] found that AHI and ESS were weakly correlated with treatment compliance and listed other parameters for which the correlation was more significant: volume and area of the patient's nasal cavity, nasal resistance, and improvements in spouse's sleep quality.[23] Kohler et al[24] in turn observed that higher CPAP pressure, younger age, and a higher oxygen desaturation index were associated with a greater chance of long-term use of CPAP.

Very few studies in the literature use the relationship between complaints of sleepiness on the ESS and SE. If it is assumed that patients who have a better SE on the night when the equipment is titrated are more inclined to use CPAP, then it follows that the ESS score could also have predictive value for CPAP compliance.[17] A previous publication demonstrated the association between ESS score and the adherence to CPAP but in a nonlinear correlation.[29] Epworth Sleepiness Scale score could therefore be used as a simple way of predicting patient adherence to CPAP therapy. Another possibility is that compliance with CPAP may be associated more with the patient's perception of problems associated with daytime sleepiness than with the disorder itself or the severity of the disorder.

The findings of this study indicate that patients with excessive daytime sleepiness as measured on the ESS have higher SE during CPAP titration polysomnography. However, further studies of long-term adherence to CPAP are required before it can be concluded that a high ESS score is a predictive factor for CPAP compliance.

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