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Short Communication

Do Sleep Parameters or Cognitive Level Predict CPAP Adherence in Obstructive Sleep Apnea Syndrome?

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Abstract

Objectives

To clarify if sleep parameters and general cognitive level predict long-term continuous positive airway pressure (CPAP) adherence in patients with obstructive sleep apnea syndrome (OSAS).

Methods

45 OSAS patients were studied with a polysomnography and a psychological assessment before CPAP onset. CPAP adherence was followed for a period of 6 months and patients were divided into adherent and non-adherent groups based on the CPAP use at least 4 h/night on at least 70% of nights. Logistic regression analysis was used to determine which variables predicted CPAP adherence.

Results

Patients were working-aged men with moderate to severe OSAS. Longer total sleep time and decreased amount of slow wave sleep predicted CPAP adherence after 6 months. Also older age predicted adherence in univariate analysis. Education, body mass index, severity of OSAS, subjective sleepiness, depressive symptoms or general cognitive level were not associated with adherence.

Conclusion

Despite of the longer total sleep time, OSAS patients with less slow wave sleep may be more motivated to CPAP use.

Keywords: Adherence; Cognitive Level; Continuous Positive Airway Pressure; Obstructive Sleep Apnea Syndrome; Sleep Quality

Abbreviations:

AHI: Apnea-Hypopnea Index, Number/Hour;
BDI-II: Beck Depression Inventory II;
BMI: Body Mass Index ;
CPAP: Continuous Positive Airway Pressure;
EEG: Electroencephalography;
ESS: Epworth Sleepiness Scale;
IQ: Intelligence Quotient;
N1%-N3%: Amount of Sleep Stages N1-N3 of the Total Sleep Time
ODI4%: Oxygen Desaturation Index, Number/Hour
OSAS: Obstructive Sleep Apnea Syndrome
PSG: Polysomnography
REM%: Amount of Rapid-Eye Movement Sleep of the Total Sleep Time
SEI%: Sleep Efficiency as a Percentage of the Total Sleep Time
SWS: Slow Wave Sleep
TST: Total Sleep Time

Introduction

Obstructive sleep apnea syndrome is characterized by repetitive episodes of upper airway obstruction during sleep and results in oxygen desaturation and arousals from sleep. Continuous positive airway pressure (CPAP) treatment is a first-line treatment in OSAS. It provides a constant positive airway pressure to the upper airway preventing collapses and stimulating normal breathing. CPAP normalizes oxyhemoglobin saturation, reduces number of apnea and hypopnea (apnea-hypopnea index, AHI) and sleep fragmentation [1], and has a positive effect on daytime symptoms such as sleepiness, cognitive changes and mood disorders [2]. Treatment of OSAS prevents co-morbid disorders e.g. hypertension, metabolic syndrome and cardiovascular diseases [3, 4]. However, CPAP treatment problems diminish the amount of adherent patients to 30-60% [5]. Use of CPAP on 4 hours per night on 70% of nights is a clinical and empirical benchmark of CPAP adherence, but more use may result in even better outcomes [6]. Association has been reported between CPAP adherence and patient characteristics (e.g. age, severity of OSAS), psychological and social factors (e.g. self-efficacy, spouse support), treatment titration procedure and other technological CPAP device factors [6, 7]. Interventions (e.g. support and educational interventions) on CPAP adherence have been developed based on the research findings [5, 6].

OSAS patients with improved subjective sleep quality and reduced daytime sleepiness show better CPAP adherence because they notice the effect of the treatment [5-7]. However, the association between CPAP adherence and objectively measured sleep quality has gained only limited attention. At least polysomnographic variables at the initial exposure to CPAP are related to adherence. Rapid-eye-movement (REM) sleep rebound, but not slow wave sleep (SWS) rebound, on the first CPAP night is found to be related to better compliance [8]. Also better sleep quality on CPAP titration night based on lower amount of sleep stage 2 (S2%) and greater amount of REM sleep (REM%) are found to be related to better adherence [9]. Slight sedation to promote CPAP adaptation on the titration night is associated with longer total sleep time (TST) and higher sleep efficiency (SEI%), and is found to be a significant predictor for better CPAP adherence [10, 11]. The relation between polysomnographic findings and adherence before the onset of CPAP are only tentative. Sleep architecture may predict the variance in CPAP adherence [9] even though any association between polysomnographic sleep variables and CPAP adherence has not been found [9, 12].

The impact of general cognitive level on CPAP adherence is an open question even though cognitive skills may have a significant effect on patient's health behaviour. In older OSAS patients, vigilance tasks are associated with CPAP compliance after 3 months suggesting that those patients who are least vigilant at baseline are more likely to comply the treatment [13]. In patients with Alzheimer's disease, cognitive level does not predict CPAP adherence while depressive symptoms are more related to poor CPAP adherence [14]. Instead in acute stroke patients, cognitive problems and worsening cognitive dysfunction is found to be associated with poor CPAP adherence [15]. The aim of the present study is to clarify if polysomnographic sleep parameters at the diagnostic night or general cognitive level predict long-term CPAP adherence.

Materials and Methods

Consecutive male patients referred to sleep laboratory due to the suspicion of OSAS were interviewed to make sure they met the initial eligibility criteria: working-aged, right-handedness, no other sleep disorders or clinically significant medical disorder, no medication affecting the central nervous system, no substance or alcohol abuse and no self-reported primary perception disorder. The diagnosis was confirmed with an interview (a clinical picture and subjective complaints of OSAS) and a diagnostic full-night polysomnography (PSG).

In the PSG, 6 EEG derivations, 2 electro-oculography channels, submental muscle tonus, electrocardiogram, airflow by nasal pressure transducer and thermistor, thoracoabdominal respiratory movements, blood oxygen saturation, leg movements and body position were recorded. The recordings were classified into the sleep stages by America Academy of Sleep Medicine (AASM) rules [16] by 2 independent scorers with an interscorer agreement of 86.0% (Kappa 0.76). A consensus sleep staging was used in the analyses. The AHI was calculated as the number of apneas and hypopneas per hour of sleep [16]. Microarousals were scored according to the criteria of the American Sleep Disorders Association [17].

Included OSAS patients had AHI > 10 and their first treatment choice was CPAP. 45 patients met the eligibility criteria and underwent a second night PSG and a psychological assessment on the following morning. The recordings of the second night were used in the analyses. After the onset of CPAP, the patients met a nurse 2-3 times and adherence to CPAP was followed by down-loadings from the devices. The inclusion criteria for the CPAP adherence was at least 4 h/night at least 70 % of the nights over a period of 6 months. On this basis, the patients were divided into adherent and non-adherent groups. The study was approved by the Ethical Committee of the Hospital District and the patients gave their written informed consent.

Subjective sleepiness was assessed with the Epworth Sleepiness Scale (ESS) [18] and depressive symptoms with the Beck Depression Inventory II (BDI-II) [19]. General cognitive level was based on the intelligence quotient (IQ) assessed with a short form of the Wechsler Adult Intelligence Scale -Revised [20].

Statistical Analyses

Since all variables were not normally distributed, nonparametric Mann-Whitney U test was used to compare the groups. The significance was set at 0.05 for all analyses. Binary logistic regression analysis was carried out to determine which variables were statistically significantly associated with CPAP adherence.

The predictors were divided into 3 groups: 1) patient characteristics and severity of OSAS: age, education in years, body mass index (BMI), AHI and oxygen desaturation index (ODI4), 2) sleep architecture at the diagnostic night: TST, SEI%, amount of sleep stages (N1%, N2%, N3%, REM%), 3) daytime functioning and symptoms before CPAP onset: ESS, BDI-II and IQ. Firstly, the predictive significance of each variable was determined separately in univariate logistic regression analyses. Then, the best combination of predictors in above mentioned 3 variable groups was computed using backward stepwise model (probability to entry 0.05 and to removal 0.1). The predictors for multivariable analysis were selected on the basis of the univariate analysis; variables with the P-value 0.1 or lower in the univariate analyses were used. In the final model, the best combination of predictors across all variables was computed.

Results

After 6 months of CPAP treatment, 23 patients (51%) were classified as adherent (CPAP using hours 6.0 ± 1.1) and 22 patients as non-adherent with inadequate use of the CPAP. Adherent patients were slightly older, had more N2 and less N3 and had a higher IQ than non-adherent patients (Table 1). Adherent patients' AHI, ODI4 and ESS score tended to be higher, but the variables did not differ statistically.

Table 1. Characteristics and comparison of adherent and non-adherent patients, and binary logistic regression analysis for CPAP adherence with each variable separately (univariate analysis), the best set of predictors in 3 variable groups (multivariable analyses in 3 models) and the final best combination of the predictors.

	Adherent patients N = 23	Non-adherent patients N = 22	p-value[1]	Univariate			Multivariable[2] 3 models			Multivariable[2] final model		
	mean±SD	mean±SD		OR	95 % CI	p-value	OR	95 % CI	p-value	OR	95 % CI	p-value
Age	49.7±1.4	43.9±1.5	.014	1.14	1.03-1.27	.014	1.14	1.03-1.27	.014	removed		
Education, y	12.6±1.4	12.3±0.5	.598	1.04	0.84-1.28	.730	not entered					
BMI	31.2±0.9	29.4±0.9	.128	1.10	0.96-1.26	.187	not entered					
AHI, n/h	46.4±4.8	35.4±4.4	.088	1.02	1.00-1.05	.107	not entered					
ODI4%, n/h	32.1±4.8	20.6±4.1	.086	1.03	1.00-1.06	.082	removed					
ARI, n/h	34.7±4.5	31.8±3.5	.838	1.01	0.98-1.04	.601	not entered					
TST	436.5±10.9	409.0±9.5	.146	1.01	1.00-1.03	.073	1.02	1.00-1.03	.031	1.02	1.00-1.03	.031
SEI,%	90.4±1.2	90.3±1.3	.699	1.00	0.91-1.11	.972	not entered					
N1%	5.3±0.6	6.9±1.0	.184	0.88	0.73-1.06	.176	not entered					
N2%	71.8±1.6	63.4±2.0	.007	1.12	1.03-1.21	.006	removed					
N3%	5.4±1.3	11.6±1.5	.003	0.87	0.78-0.96	.008	0.85	0.76-0.95	.004	0.85	0.76-0.95	.004
REM%	17.6±1.0	18.1±1.1	.666	0.98	0.87-1.10	.711	not entered					
ESS	12.4±0.8	10.5±0.8	.098	1.15	0.97-1.36	.101	removed					
BDI-II	8.3±1.6	6.7±1.0	.829	1.04	0.94-1.15	.412	not entered					
IQ	113.2±1.7	108.1±2.3	.043	1.06	0.99-1.13	.082	removed					

[1]Mann-Whitney U, adherent vs. non-adherent patients

[2]Backward stepwise method

Abbreviations: SD = standard deviation, BMI = body mass index; AHI = apnea-hypopnea index; ODI4% = oxygen saturation index; ARI = arousal index; TST = total sleep time; SEI = sleep efficiency of TST; S1% = sleep stage 1 percentage of TST; S2% = sleep stage 2 percentage of TST; SWS% = slow wave sleep percentage of TST; REM% = rapid eye movement sleep percentage of TST; ESS = Epworth Sleepiness Scale; BDI-II = Beck Depression Inventory, IQ = intelligence quotient.

Older age, increased N2% and decreased N3% emerged as statistically significant single predictors for CPAP adherence (Table 1).

When the best predictors of the 3 different variable groups were computed, older age, longer TST and decreased N3% predicted CPAP adherence. Finally, when the best combination of all variables was computed, longer TST and decreased N3% continued to predict CPAP adherence.

Discussion

In this study, longer TST but decreased N3% before CPAP onset predicted CPAP adherence after 6 months. Also older age predicted adherence in univariate analysis. Education, BMI, severity of OSAS, subjective sleepiness, depressive symptoms or IQ did not predict adherence, which is in line with the conflicting predictive value of these variables in recent reviews [5-7].

Our result contrasts the findings of Somiah et al. [9] and Spokova et al. [12] who did not find any relationship between polysomnographic sleep variables and CPAP adherence. Compared to the study findings stating that longer TST, greater REM% and REM rebound are predictive to CPAP adherence at CPAP titration night [8-11], the results of the present study indicate that before CPAP onset also the lack of slow wave sleep may be a significant predictor for CPAP adherence.

Older age did not remain as a significant predictor in the final multivariate logistic regression analysis. Amount of deep sleep declines in normal aging at least scored by Rechtschaffen and Kales rules but it is not yet well documented how age affects on N3% by AASM rules [21]. According to one study it is possible that scoring by AASM rules shows more deep sleep in aged patients than Rechtschaffen and Kales scoring [21]. Our data suggest that it is possible that OSAS patients show also more decline of N3 due to their illness, not just due to normal aging. A limitation of this study is, that subjective sleep quality was not assessed and it could not be clarified if the patients with decreased N3% also felt unrefreshing sleep. Another limitation is that this study group consisted only of men and the results cannot be generalized to female OSAS patients. Women with OSAS show atypical subjective symptoms compared to men including difficulty falling asleep, frequent awakenings and insomnia [22] and it is possible that also objectively measured sleep quality of female OSAS patients differ from that of male patients. The results of the present study should also be confirmed with a larger study sample.

Aloia and co-workers [13] suggested that attention and memory deficits may be related to future compliance because patients easily notice the improvement in these skills during CPAP treatment. In our study, adherent patients had slightly higher IQ than non-adherent patients, but general cognitive level did not predict CPAP adherence. This may be explained by the fact that all patients had normal cognitive level compared to normative data, and it is probable that only more severe cognitive decline is associated with CPAP adherence. A limitation of the present study is that the impact of different cognitive skills on CPAP adherence was not assessed.

Based on our data, the lack of slow wave sleep is one aspect that may be used to predict which OSAS patients will be adherent to CPAP.

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