Original Research

Evaluation of Factors Affecting Continuous Positive Airway Pressure Device Adherence in Patients with Obstructive Sleep Apnea Syndrome

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Abstract

Background and Objective: Many patients reject continuous positive airway pressure (CPAP) treatment, cannot tolerate it, do not use the machine correctly, or do not fully comply with CPAP use. We aimed to evaluate the factors contributing to the non-adherence of patients with obstructive sleep apnea syndrome (OSAS).

Materials and Methods: The study was conducted as face-to-face interviews with 183 patients diagnosed with OSAS and 79 partners. The patients were classified as those who stopped treatment (Group 1, n = 38), those with insufficient treatment (Group 2, n = 33), and those who continued treatment (Group 3, n = 112).

Results: The total 183 patients comprised 132 (71.1%) men. A negative correlation was between continuation of treatment and the thought that there was no benefit from the treatment (r = -0.457, P = 0.001). A positive correlation was between partner support and treatment adherence (r = 0.371, P < 0.001). In the multivariate model, the most significant patient-related reasons for terminating positive airway pressure (PAP) were determined as insufficient partner support and the thought that there was no benefit from the device. The partners of patients with good treatment adherence reported that during the treatment period, there was an increase in their own daily performance and mental energy and a marked improvement in daytime sleepiness (P < 0.001 for all).

Conclusion: PAP device adherence is affected by many factors. It was shown in this study that the spousal factor is just as important as the patient in the treatment process as a whole, and to achieve adherence, the partner must be included in the process.

Keywords: Sleep apnea; Continuous positive airway pressure; Treatment adherence

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Introduction

Obstructive sleep apnea syndrome (OSAS), which affects 2% of adult females and 4% of adult males, is known to cause an increase in morbidity and mortality related to various systems and diseases such as cardiovascular system diseases, obesity and dyslipidemia, and type 2 diabetes (1, 2). Continuous positive airway pressure (CPAP) is the first-stage treatment for OSAS. Previous studies have shown that the respiratory problems that can develop in association with OSAS and daytime sleepiness, can be reduced with CPAP treatment, and sleep quality and quality of life (QOL) can be improved (3). However, the critical point to be able to obtain the optimal therapeutic benefit from CPAP treatment is the adherence of the patient to the treatment (4, 5).

Many patients reject CPAP treatment, cannot tolerate it, do not use the machine correctly, or do not fully comply with CPAP use by only using the machine for part of the night or only on some nights. This is affected by factors such as the personality of the patient, severity of the disease,

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not being excessively sleepy during the day, and not having symptomatic benefit from the treatment, in addition to the lack of support and participation in the treatment process of the partner (6-8). Although the above-mentioned factors have been separately evaluated in literature, there is no study that has evaluated all of these factors together.

The aim of this study was to evaluate the factors contributing to non-adherence to the treatment. Four factors were examined: 1. clinical [age, Apnea-Hypopnea Index (AHI), daytime sleepiness] and pre-treatment demographic factors, 2. problems occurring during use of the machine in the treatment process (mask leakage, difficulty during exhalation, discomfort caused by the machine noise), 3. contribution of the partner to adherence to CPAP treatment (sleeping separately, support or lack of support of the partner in the treatment process, interruptions to intimacy), 4. change in variables related to the QOL of the patient and partner associated with the treatment (marital satisfaction, mental energy, less daytime fatigue and sleepiness, sexual performance after treatment, disturbance by the machine noise, disturbance by the appearance of the mask).

Materials and Methods

Study design and participants: Approval for the study was granted by the Local Ethics Committee. The study included 183 patients diagnosed with OSAS between 01-01-2014 and 31-12-2018, who aged ≥ 21 years, were classified as moderate (AHI: 15-30) or severe (AHI > 30) according to AHI values, and were married or living with a partner at the time of starting CPAP treatment. Face-to-face interviews were conducted with 183 patients and 79 partners who agreed to participate in the study. The study sample comprised individuals who were together with their partner before the treatment, stayed together during the treatment, and who still continued to be together. The diagnosis was made for all the patients from full-night polysomnography (PSG) in the sleep laboratory of a tertiary level training hospital. Adequate CPAP was determined after the second night PSG records. CPAP titration was applied manually, then pressure was increased until there were no obstructive respiratory events such as apnea, hypopnea, arousal, or snoring, or when maximum CPAP (20 cm H2O) was reached.

Informed consent was obtained from all the study participants. All study procedures were applied in accordance with the 1975 Declaration of Helsinki.

***Study plan, data collection, and data analysis*:** Patients who had started CPAP treatment in our clinic between the dates specified for the study were contacted by telephone. They were informed about the study and asked if they would participate together with their partner. Patients and partners who agreed to participate in the study were invited to attend face-to-face interviews. Pre-treatment data of patient body mass index (BMI), Epworth Sleepiness Scale (ESS), AHI (events/hour), and arousal index (AI) (events/hour) were recorded from the patient files. The interviews with the patients and partners were conducted by a trained moderator, who was not one of the researchers of this study. The interview procedure was conducted first with the patients. Approval for the study was granted by the Local Ethics Committee (decision no.: 2019-11/128).

Demographic characteristics were recorded, then the patients were questioned about a feeling of suffocation when using the machine, difficulty when exhaling, a feeling of tightness in the chest, air leakage, headache, nasal dryness, nasal bleeding, discomfort from the noise of the machine, redness in the eyes, swallowing air, redness and irritation of the skin, a feeling of fullness in the ears, embarrassment, difficulty in re-attaching the machine after getting up during the night, and thoughts that there was no benefit from the treatment. The patients were instructed to select factors causing termination of treatment, and when there was more than one reason, these reasons were ranked from most important to least important to a total of 10 points.

Interviews were then conducted with the parner and the questions related to the treatment process were asked and scored from 1 to 4 (1 = worse, 2 = no change, 3 = better, 4 = significantly better). Some questions were asked only of patients, such as “whether or not the partner was supportive in the treatment process and equipment-related problems”, and other questions were asked of patients and partners, such as “improved sleep quality after treatment, bed sharing, increased sexual performance after treatment, marital satisfaction, and mental energy, and less daytime sleepiness and fatigue, discomfort from the machine noise, disturbance from the mask appearance, and interruptions to intimacy”.

The patients were classified according to CPAP use. Group 1 (n = 38) comprised patients who had terminated treatment. Group 2 (n = 33) was defined as the insufficient treatment group, as those who used the machine for less than 4 hours per day or only on certain days of the week. Group 3 (n = 112) comprised patients who continued treatment, using the CPAP machine for ≥ 4.1 hours every day of the week.

The adherence of the patient to CPAP treatment was recorded on the measurement device of the machine and this period was divided by the number of days from baseline to that day; 4.1 hours per day or more was accepted as effective use. To determine the factors affecting adherence to CPAP treatment, the data of adherent and non-adherent patients were compared.

Statistical analysis: SPSS software (version 17.0, SPSS Inc., Chicago, IL, USA) was used for statistical evaluation of data. While Kolmogorov-Smirnov test was used to evaluate the conformity of continuous data to normal distribution, quantitative data were expressed as mean ± standard deviation (SD) and median range (minimum-maximum) values. Categorical data were shown in the tables as number and percentage. Multiple groups were compared by analysis of variance (ANOVA) [Tukey's honestly significant difference (HSD) test]. The primary end point of the study was the continuous use of positive airway pressure (PAP). Pearson and Spearman correlation analyses were used to evaluate the factors associated with PAP use. Patient-related variables (age, embarrassment, increased sexual performance, the thought that there was no benefit), pre-treatment PSG-related factors [baseline ESS score, baseline AHI, baseline oxygen desaturation index (ODI) values], variables associated with the procedure, and partner-related factors (partner support, increased mental performance, interruptions to intimacy) were determined as potential predictors affecting the patient continuing with PAP, and these were evaluated with a multivariate Cox proportional hazard regression model. The statistically significant results are shown in tables.

Results

A total of 183 patients comprised 132 (71.1%) men and 51 (28.9%) women, with a mean age of 52.53 ± 9.36 years. The mean follow-up period of the patients was 21.32 ± 12.39 months. Non-adherence to treatment was started in the first month by 81.6% of the patients who terminated treatment, and by 44% of the patients in the insufficient treatment group. When the patients were evaluated in respect of general PAP adherence, at the end of a 48-month follow-up period, treatment adherence was determined in 61.2% of patients and 18.1% showed insufficient adherence to treatment with daily use of < 4 hours (2.08 ± 0.61) or use only on certain days of the week. The demographic data of the patients are shown in table 1.

Table 1. Demographic characteristics and pre-treatment polysomnographic (PSG) findings of the patients with obstructive sleep apnea syndrome (OSAS) (n = 183)

Variables	Value
Age (year)	52.53 ± 9.36
Gender (male)	132 (72.1)
BMI at baseline (kg/m^2)	29.41 ± 6.26
ESS score at baseline	13.86 ± 3.16
TIB (minute)	369.93 ± 103.36
TST (minute)	324.02 ± 117.00
Sleep efficiency (TST/TIB) (%)	83.69 ± 1.95
REM sleep (minute)	44.13 ± 12.07
AHI (events/hour)	37.67 ± 24.96
AI (events/hour)	51.20 ± 28.37
SpO_2 (%)	91.85 ± 4.36
ODI (events/hour)	25.18 ± 15.11
Time of SpO_2 < 90% (%)	22.30 ± 21.62

Data are presented as mean ± standard deviation (SD), median and interquartile range (IQR), or number and percentage.
AHI: Apnea-Hypopnea Index; BMI: Body mass index; ESS: Epworth Sleepiness Scale; ODI: Oxygen desaturation index; REM: Rapid eye movement; SpO_2: Oxygen saturation; TIB: Time in bed; TST: Total sleep time; AI: Arousal index

When the patients were grouped as those showing non-adherence to treatment (n = 38), poor adherence (n = 33), and good adherence (n = 112), a statistically significant difference was found between the groups in terms of AHI and ODI values (P = 0.001, P = 0.019, respectively) (Table 2).

General continuation of treatment is shown in figure 1 and the relationships between the baseline ODI and AHI scores and CPAP treatment according to the Kaplan-Meier method are shown in figure 2.

Predictors of PAP adherence: Before the evaluation of potential predictors of CPAP adherence, factors associated with PAP adherence were evaluated with correlation analysis.

Table 2. Comparisons of the variables of demographic characteristics, polysomnographic (PSG) findings, and device-related factors of the patients before continuous positive airway pressure (CPAP) treatment according to the treatment groups

Variables	PAP use/night			P-value
	Non-adherence	Adherence		
		Poor adherence	Good adherence	
Patients (n = 183)	38	33	112	
Demographic variables				
Age (year)	52.94 ± 9.35	52.36 ± 9.51	50.18 ± 9.70	0.225
Gender (male)	25 (13.7)	26 (14.2)	81 (44.7)	0.074
PSG-related factors				
ESS score at baseline	13.97 ± 3.20	13.52 ± 3.03	14.10 ± 3.26	0.575
AHI (events/hour TST)	21.17 ± 9.16	31.89 ± 20.58	43.52 ± 30.84	0.001
AI (events/hour TST)	34.81 ± 15.39	47.30 ± 25.89	60.58 ± 32.15	0.001
SpO_2 (%)	94.28 ± 3.21	92.56 ± 4.19	90.98 ± 4.86	0.479
ODI (events/hour)	20.26 ± 14.54	23.36 ± 18.08	27.07 ± 19.72	0.019
Device-related factors				
Mean duration of PAP use (month)	7.13 ± 4.81	13.14 ± 3.97	31.31 ± 7.88	< 0.001
Mean duration of PAP use per night (hour)	1.60 ± 0.67	2.08 ± 0.60	5.04 ± 1.07	< 0.001

Data are presented as mean ± standard deviation (SD), median and interquartile range (IQR), or number and percentage
AHI: Apnea-Hypopnea Index; AI: Arousal index; ESS: Epworth Sleepiness Scale; ODI: Oxygen desaturation index; PAP: Positive airway pressure; SpO_2: Oxygen saturation; TST: Total sleep time; PSG: Polysomnography

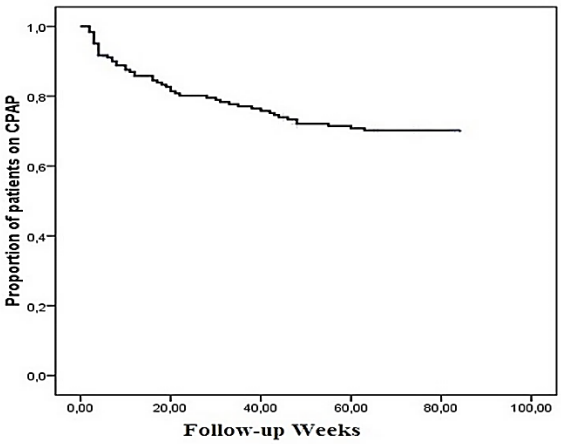

Figure 1. Kaplan-Meier Curve showing the proportion of patients on continuous positive airway pressure (CPAP) therapy versus time

Of the patient-related factors, a negative correlation was determined between continuation of treatment and feeling embarrassed by being seen with the machine by family members (r = -0.259, P = 0.004) and the thought that there was no benefit (r = -0.457, P = 0.001). Adherence to treatment in the first month was seen to affect overall treatment adherence at a significant level (r = 0.274, P = 0.001). Increased mental performance (r = 0.256, P = 0.007) and sexual performance (r = 0.283, P = 0.001) after treatment were determined to have a positive effect on continuation of treatment. A positive correlation was determined between partner support and treatment adherence (r = 0.371, P < 0.001). Factors related to PAP adherence are shown in table 3.

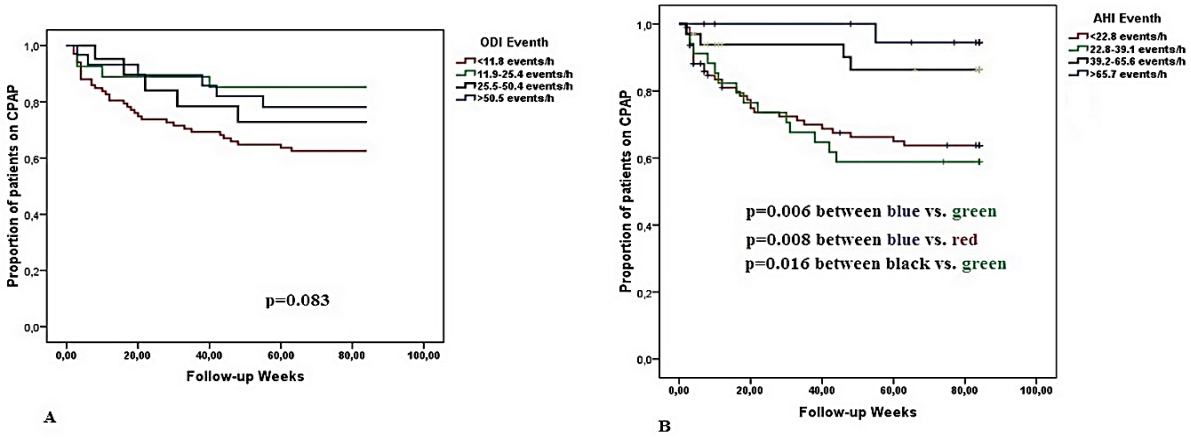

Figure 2. Correlations between the oxygen desaturation index (ODI) (A) and Apnea-Hypopnea Index (AHI) (B) scores in the baseline polysomnography (PSG) examination of the patients with obstructive sleep apnea syndrome (OSAS) and continuous positive airway pressure (CPAP) treatment; it was observed that patients with higher AHI values had good treatment compliance.

Table 3. Polysomnographic (PSG) findings and patient- and partner-related factors affecting treatment adherence

Variables	r	P-value
Baseline PSG factors		
AHI (events/hour TST)	0.163*	0.028
AI (events/hour TST)	0.141	0.052
ODI (events/hour)	0.158*	0.034
Patient-related factors		
First month treatment non-adherence	-0.274**	0.001
The thought that there is no benefit	-0.457**	< 0.001
Embarrassment	-0.259**	0.004
Increased sexual performance	0.283**	0.001
Marital satisfaction	0.153*	0.039
Interruptions to intimacy	-0.222**	0.011
Increased mental performance	0.246**	0.007
Partner-related factors		
Partner support	0.371**	< 0.001

AHI: Apnea-Hypopnea Index; AI: Arousal index; ODI: Oxygen desaturation index; PSG: Polysomnography; TST: Total sleep time
* Correlation is significant at the 0.05 level.
** Correlation is significant at the 0.01 level.

In the multivariate model, the relative hazard risk was determined for variables related to PSG and patient- and partner-related factors predicting the possibility of PAP adherence. The most significant patient-related reasons for terminating PAP were determined as insufficient partner support [hazard ratio (HR) = 6.880, 95% confidence interval (CI) = 4.542-17.361] and the thought that there was no benefit from the device (HR = 7.019, 95% CI = 3.636-13.549). The feeling of embarrassment and interruptions to intimacy were not seen to have a significant effect on terminating PAP. Regular use of the machine within the first month was determined to affect patient adherence to the device 3.9-fold (HR = 3.921, 95% CI = 2.017-7.622) and was an independent predictor (Table 4).

Table 4. Predictors of adherence to positive airway pressure (PAP) treatment of the patients with obstructive sleep apnea syndrome (OSAS)

Variables	Total	Non-adherence	Poor adherence	Good adherence	Adjusted HR	95% CI (lower-higher)	P-value*
Patients	183	38	33	112			
Demographic variables							
Age (year)							
< 46.4	56	9	9	38	0.286	0.165-1.701	0.134
46.5-54.3	46	9	9	28	0.750	0.229-2.459	0.286
54.4-61.7	50	13	10	27	1.130	0.364-3.513	0.635
> 61.8	31	7	5	19			0.832
PSG-related factors							
ODI (events/hour)	97	28	21	48	0.257	0.700-0.943	0.041
< 11.8 11.9-25.4	28	3	3	22	0.900	0.161-5.038	0.030
25.5-50.4	26	4	5	17	0.337	0.062-1.831	0.039
> 50.5	32	3	4	25			
AHI (events/hour)							
< 22.8	85	25	10	50	0.986	0.340-2.943	0.058
22.8-39.1	38	11	4	23	0.526	0.125-2.210	0.381
39.2-65.6	36	2	13	21	4.545	1.137-15.077	0.013
> 65.7	24	0	6	18			
First-month treatment adherence							
Adherent (ref)	94	11	17	66	3.921	2.017-7.622	0.001
Non-adherent	89	27	16	46	1.000		
The thought that there is no benefit							
Present	78	33	15	30	7.019	3.636-13.549	0.001
Absent (ref)	104	5	18	82	1.000		
Embarrassment							
Present	85	22	22	41	1.714	0.948-3.099	0.074
Absent (ref)	98	16	11	71	1.000		
Increased sexual performance							
Present (ref)	98	5	12	81	3.060	1.096-5.355	0.038
Absent	85	33	21	31	1.000		
Partner support							
Present	105	8	12	85	6.880	4.542-17.361	< 0.001
Absent (ref)	78	30	21	27	1.000		
Interruptions to intimacy							
Present (ref)	88	20	17	51	1.318	0.620-1.935	0.091
Absent	95	18	16	61			

*Wald test
Evaluated as HRs and 95% CI for Cox quartile risk regression; italicized and bold figures show P-values ≤ 0.05
AHI: Apnea-Hypopnea Index; ODI: Oxygen desaturation index; PSG: Polysomnography; HR: Hazard ratio; CI: Confidence interval

Table 5. Decisions of the partner about treatment according to the groups

Variables	PAP use/night			P-value
	Non-adherence	Adherence		
		Poor adherence	Good adherence	
Partner (n = 79)	21	16	42	
Interruptions to intimacy				
Significantly worse	16 (20.2)	11 (13.9)	32 (40.6)	0.318
No change	5 (6.3)	5 (6.3)	10 (12.7)	
Increased mental energy				
Significantly worse	4 (5.1)	0 (0)	0 (0)	< 0.001
No change	14 (17.7)	6 (7.6)	3 (3.8)	
Better	3 (3.8)	5 (6.3)	14 (17.7)	
Significantly better	0 (0)	5 (6.3)	25 (31.7)	
Daytime sleepiness status				
Significantly worse	4 (5.1)	0 (0)	0 (0)	< 0.001
No change	13 (16.5)	2 (2.5)	11 (13.9)	
Better	4 (5.1)	8 (10.1)	17 (21.5)	
Significantly better	0 (0)	6 (7.6)	14 (17.7)	

Data are presented as number and percentage; italicized and bold figures show P-values ≤ 0.05. This table includes the patients who answered the questions together with partners.
PAP: Positive airway pressure

Of the total 183 patients, partners of 79 patients agreed to participate in the study. In the interviews conducted with the partners, the complaint of interruptions to intimacy was reported in all the groups (P = 0.318). The partners of patients with good treatment adherence reported that during the treatment period, there was an increase in their own daily performance in mental energy and a marked improvement in daytime sleepiness (P < 0.001 for all). The significant variables in the responses of the partners related to the treatment are shown in table 5.

Discussion

In a brief evaluation of the study results, general treatment adherence was 61.2% at the end of 48 hours of follow-up, and 18.1% of the patients showed insufficient adherence to treatment with use of < 4 hours per day (2.08 ± 0.61 hours) or only on certain days of the week. When the factors affecting treatment adherence were examined, the most important patient-related reasons for terminating PAP were seen to be insufficient partner support and the thought that there was no benefit from the device.

Although there is consensus that the continuation of CPAP treatment by patients with OSAS plays a key role in obtaining maximum benefit from the treatment process, there are different opinions about the factors affecting adherence and there are many studies related to this subject (3-5). Due to the length and dynamic structure of the process, treatment adherence is affected by many factors such as the device, baseline PSG variables, and patient- and partner-related factors (4-8).

As stated above, although factors affecting CPAP adherence have been evaluated in many studies of OSAS patient cohorts in literature, these studies have generally evaluated the adherence process and a single aspect of treatment adherence; whereas, the current study is the first to have evaluated almost all aspects of the process.

In the current study, continuation of treatment was observed in 79.2% of the patients in the first 9-15 months and in 61.2%, in the follow-up period of 31.31 ± 7.88 months (mean: 5.04 ± 1.07 hours). Galetke et al. reported that 76% of patients adhered to treatment in a 9-15-month follow-up period, and this rate fell to 63% in the long term, and the mean CPAP use was 4.7 ± 2.3 hours per night in the patient group with treatment adherence (9). In another study, 68% of patients were reported to use the device for mean of 5.7 hours in a long-term follow-up (10). The results of the current study were similar to those of long-term follow-up studies in literature.

It has been reported in literature that the first 6-month period is important in treatment adherence, and patients who adhere to the treatment in that period have higher overall treatment adherence (4, 9). Similarly, Budhiraja et al. reported that the early period was an effective indicator of treatment adherence and emphasized that interventions should focus on the first weeks of treatment to reduce the rates of terminating treatment (11). Consistent with the previous findings in literature, it was observed in the current study that patients who did not adhere to

treatment in the first months terminated the treatment in subsequent months. In the correlation analyses applied, it was seen to be a significant relationship between non-adherence to treatment in the first month and terminating treatment ($r = 0.274$, $P = 0.001$). Regular use of the device in the first month was determined to be a significant independent indicator of patient adherence to the device.

In the current study, a weak correlation was seen between treatment adherence and the baseline PSG values of AHI and ODI, whereas no relationships were determined with age, gender, BMI, and ESS. These findings are similar to those of previous studies explaining the positive effect of OSAS severity on treatment adherence (9, 12).

Treatment side-effects and problems related to the interface or the device have been reported among the most common reasons for rejecting CPAP treatment (13). Despite high AHI values, 20.8% of the current study patients completely terminated the treatment. There could be many reasons for this, but the most frequently-reported reason in this study was that the patient did not think he/she was benefitting from the treatment and this was one of the independent markers of treatment adherence in both the correlation analyses and the logistic regression analyses. In addition, lack of partner support in the treatment process was also seen to have a negative effect on the treatment process and contributed to the patient terminating the treatment; moreover, it was determined to be an independent predictor of continuation of CPAP treatment. As has been reported in some previous studies (9, 13), this supports the hypothesis that psychosocial factors rather than biomedical factors have a more important role in acceptance of the long-term treatment with a CPAP machine.

Finally, in this study, the effects of CPAP treatment were evaluated on the daily function of the partner. Although several studies in literature have dealt in detail with the effects of CPAP treatment on the daily function of the patient (14-16), an important point that has been overlooked is that OSAS not only affects the daily function of the patient, but the daily function of the partner is also impaired (7, 8, 17). When the current study results were evaluated in respect of the partner, it was observed that treatment adherence of the patients increased the mental energy and daily performance of the partner and reduced the daytime sleepiness.

In a recent study by Ye et al., CPAP treatment and the importance of the partner in the treatment were evaluated. The importance of support from the partner in treatment was shown and it was emphasised that when the partner focussed on "we" rather than "I" in the treatment process, continuation of treatment increased. Similar to the findings of the current study, interruptions to intimacy and embarrassment of the patient about the condition and use of the mask were reported as the most important obstacles in the use of the treatment (7).

In another recent study, it was emphasised that the process should be evaluated as a whole and not just in respect of the patient, and participation of the partner in the treatment prevented early termination of the treatment. Furthermore, an increase in sleep quality of the partners of patients who continued treatment was reported to have a positive effect on both daily performance and sexual performance (8). When evaluated in this respect, the current study results were consistent with literature. In the evaluation of the results of the current study in respect of predictors of adherence to CPAP treatment, it can be concluded that the use of various behavioural approaches is important to increase adherence.

The most important limitation of this study was that the data related to the baseline PSG of the patients were obtained from the patient files and computer records and were, therefore, dependent on documentation quality. However, as our clinic is newly established (approximately 5 years), patient records are kept in great detail on the computer, and data loss can be considered to be at a minimal level. Another point which could be criticised is that the period of sufficient adherence was accepted as ≥ 4.1 hours. Although many studies have reported that a minimum of 4.1 hours per night of CPAP treatment is sufficient for the positive effects to occur (6, 9, 18), studies that have evaluated the positive effect on cardiovascular problems have reported that a longer period of use is necessary (9, 19). However, this should not be considered as a limitation, as the main aim of this study was to evaluate the factors affecting adherence to and continuation of the treatment, not the effects of CPAP treatment. Finally, as there is no validated questionnaire on this subject, the questions asked of the patients and partners were modified

versions of the questions used in various previous studies. It can be considered that there is a need for questionnaire studies on this subject.

Conclusion

The basis of CPAP treatment is patient compliance and adherence to the treatment. In the current study, it was determined that the use of PAP was abandoned particularly at the beginning of the treatment process. Partner support is one of the main factors affecting treatment adherence. In addition, throughout the treatment process, indirect benefits were observed from the positive effects of the treatment such as an increase in daily performance of the partner, an increase in mental energy, and a significant decrease in daytime sleepiness. In brief, it was shown in this study that the partner factor was just as important as the patient in the treatment process as a whole, and to achieve adherence, the partner must be included in the process.

Conflict of Interests

Authors have no conflict of interests.

Acknowledgments

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