

## Association Between Titration Method and Outcomes of First Night Satisfaction and CPAP Compliance

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### ABSTRACT

**Introduction:** The gold standard therapy for obstructive sleep apnoea syndrome (OSAS) is continuous positive airway pressure (CPAP). Our study evaluated the relationship between first night satisfaction and CPAP compliance, and the effect of using the titration method in this relationship.

**Methods:** Between January 2012 and December 2012, 40 patients with the diagnosis of OSAS and without comorbidities, who had undergone CPAP titration, were included. Of these, 20 patients had undergone manual titration (MT) with polysomnography, whereas 20 patients had undergone auto-adjusted CPAP (APAP) titration. Questionnaires were administered during the morning of the titration night. The first-year adherence to treatment and patient compliance were evaluated.

**Results:** Forty patients were randomised in two groups; 35 patients

who could procure the CPAP and were available at the end of the first year completed the study. From the 35 patients, 20 (6 males; 40%) were in the MT group while 15 (6 males; 30%) were in the APAP group. No significant difference was detected between the mean titration pressure levels obtained with the MT or APAP group. There was no difference in terms of responses to the questions on the questionnaire between the two groups. At the first-year evaluation, no significant difference was detected between the groups.

**Conclusions:** The titration method used to detect CPAP pressure, MT, or APAP does not affect patient satisfaction on the day following the titration night, and does not affect first-year compliance.

**Keywords:** CPAP compliance, manual titration, APAP

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### INTRODUCTION

The gold standard therapy for obstructive sleep apnea syndrome (OSAS) is continuous positive airway pressure (CPAP). However, one of the major problems of CPAP treatment is the low adherence and compliance. Many patients have difficulty initiating therapy because of discomfort with CPAP. Intolerance may establish poor compliance patterns. The rate of adherence to CPAP among OSAS patients ranges between 28% and 83% (1). However, the correct and reasonable length of time to use CPAP is essential to control the disease. The positive effects of CPAP therapy on OSAS patients are well known; when the patient is adherent to the treatment, CPAP provides significant improvement in the quality of life, reduces daytime sleepiness and other symptoms, and considerably decreases risk factors (2-4). However, these positive effects become irrelevant when the patient does not adhere to its use.

Adherence to CPAP is determined by many factors, including characteristics of the patients and disease, titration with the equipment, device characteristics and technology, psychosocial and economic factors, and physician support (5). Moreover, CPAP treatment should ideally involve a multidisciplinary team with physicians, nurses, and physical therapists, among others (6). The lack of adherence to the main treatment

of OSAS is an important problem. Because CPAP nonadherence is multifactorial, many studies have been conducted to identify the factors of CPAP adherence and effective strategies to promote adherence.

Compliance patterns may be established very early in the course of treatment, and initial exposure to CPAP, therefore, may have a tremendous impact on subsequent use. Previous studies have found that short-term compliance is influenced by the quality of the CPAP titration study and also long-term adherence to therapy can be predicted within the first few days of CPAP use (7).

It is known that manual titration is an expensive method compared with automatic CPAP titration. Benefit of using one method over another is not thoroughly investigated. We want to compare these two titration methods in patients without comorbidities and find out effect of titration method on compliance

Our study evaluated the relationship between first night satisfaction and CPAP compliance, and the effect of the titration method on this relationship, as well as variables that might be correlated with poor adherence to suggest strategies to promote CPAP use.

## METHODS

Between January 2012 and December 2012, 40 patients with the diagnosis of OSAS and without comorbidities, who had undergone CPAP titration, were included. Informed consent from the patients was received, and information concerning the study was distributed. All of the participants' rights were protected, and informed consent was obtained according to the Helsinki Declaration. Due to their admission order, odd number of patients were admitted to group 1, even number of patients were involved in group 2 as a randomisation method. The study protocol was approved by the local ethics committee.

### Patients

Patients with hypertension, diabetes mellitus, ischemic heart disease (IHD), chronic obstructive lung disease, depression, and sedative/hypnotic agent usage were excluded. Hypertension was defined as blood pressure >140/90 mmHg or those under medical treatment for hypertension; diabetes mellitus was defined as a fasting blood glucose level >126 mg/dL or those under antidiabetic treatment. Coronary artery disease was defined as ischemic changes on electrocardiography, angina, or taking medicine for IHD; depression was defined as a previous diagnosis of depression during the past 1 year or having symptoms in line with depressive mood changes.

### Polysomnography

For the diagnosis of OSAS, a full-night polysomnographic evaluation was performed at the laboratory for all patients (Embla N7000; Embla Systems, Middleton, WI, USA). During the polysomnographical recording, the parameters of electrocardiogram, electroencephalogram, electromyogram, electrooculogram, arterial oxygen saturation using pulse oximetry, nasal airflow, chest wall and abdomen movement, body position, and snoring via microphone were used, all in accordance with the 2007 American Academy of Sleep Medicine (AASM) guidelines. Apnea was defined as a drop in nasal airflow  $\geq 90\%$  of the baseline for  $\geq 10$  s. Hypopnea was defined as a reduction in the nasal pressure signal  $\geq 30\%$  of the baseline lasting  $\geq 10$  s, resulting in a  $\geq 3\%$  decrease in oxygen saturation from the pre-event baseline or an arousal. Desaturation was defined as a reduction in oxygen saturation by 3% from baseline. The mean oxygen saturation (SaO<sub>2</sub>) was defined as average SaO<sub>2</sub> during the night. The lowest SaO<sub>2</sub> was defined as the lowest value of SaO<sub>2</sub> during the night. The apnea-hypopnea index (AHI) was defined as the average number of apnea and hypopnea events per sleep hour. From the evaluation of the patients with an AHI >30, those fulfilling the inclusion criteria were included in the study. Polysomnographic recordings of the patients were evaluated by one certified physician.

### Titration Study

From the evaluation of patients with an AHI >30, those fulfilling the inclusion criteria had undergone another night of sleep tests with full polysomnography (Embla N7000; Embla Systems) for titration. Patients with the inclusion criteria were included in the study, and were randomised into two groups accordingly. An odd number of patients comprised the manual titration (MT) group, while an even number of patients comprised the automatic CPAP (APAP) group for titration. Forty patients were randomised to the MT and APAP groups with full-night polysomnography at our sleep laboratory. Of these, 20 patients had undergone MT with polysomnography, whereas 20 patients had undergone APAP. Routine information concerning the use of the CPAP device for 45 min was provided for each group before titration by the same technician. After selecting an adequate nasal mask, the patients underwent full-night manual CPAP titration using a remote control and a CPAP device (OmniLab Advanced; Resironics, Murrysville, PA, USA). The initial pressure was 4 cmH<sub>2</sub>O, and the pressure was increased by 1 cmH<sub>2</sub>O every 5 min until apnea completely disappeared. Thereafter, the pressure increased by 1 cmH<sub>2</sub>O every 10 min until hypopnea, flow limitation, and snoring disappeared in the rapid eye movement (REM) stage and supine position. This final pressure was considered to be the

optimal pressure. APAP titration was performed using another CPAP device (REMstar C-Flex; Resironics) and the same masks in the APAP mode. The lower and upper pressure limits were adjusted to 4 cmH<sub>2</sub>O and 15 cmH<sub>2</sub>O, respectively, for all patients. This device has the ability to adjust the pressure level according to the type of respiratory event and flow limitation. During the APAP night, after a 20-minute adaptation period, the device maintains its algorithm for pressure changes.

Routine information concerning the use of the CPAP device for 45 min was provided for each group before titration by the same technician. For online titration, adequate CPAP pressure was determined manually by a technician, and the pressure was increased until obstructive respiratory events such as apnea, hypopnea, arousals, and snoring were eliminated, or the recommended maximum CPAP (20 cm H<sub>2</sub>O) was reached. For automatic CPAP titration, a full-night recording was taken at the sleep laboratory without intervention of the technician. All of the patients were prescribed a fixed pressure CPAP, and none of them used APAP.

### Questionnaire

Patient satisfaction and desire to use the device were evaluated by the visual analogue scale with a short questionnaire administered during the morning after the titration study. All of the patients were advised to use nasal CPAP treatment without humidification.

### Follow-up

All the patients sent home with a CPAP prescription after an appropriate titration level had been determined by either CPAP or APAP. All of the patients were evaluated at the first, third, and twelfth months. Patients were evaluated at the first year after starting treatment. During the visit, compliance was objectively measured from the recording card of the device: 4 h/night on 70% of nights was accepted as CPAP tolerance. In addition, any problems with the device and mask were evaluated. Demographic, polysomnographic, and titration night survey responses were compared between the CPAP-tolerant and CPAP-intolerant patients.

## RESULTS

Although 40 patients were randomised into two groups, 35 patients who could procure the CPAP and were available at the end of the first year completed the study. From the APAP group, five of the patients were lost during the follow-up: two of them could not buy the CPAP device, two of them were lost after they came to their first-month and third-month control evaluation, and one of them died in a traffic accident. From the 35 patients, 20 (6 males; 40%) were in the MT group, and 15 (6 males; 30%) were in the APAP group. No significant difference was found between the two groups in terms of age, body mass index, and AHI values (Table 1). The only difference was in the oxygen desaturation index in terms

**Table 1.** Demographic and polysomnographic characteristics of the two groups

	MT	APAP	p
Age (years)	50.45±9.05	51.60±7.2	0.923
Sex (male/female)	6/14	6/9	0.543
Weight (kg)	89.70±14.55	90.13±16.97	0.881
Height (cm)	170.45±8.71	166.60±9.41	0.242
BMI (kg/m <sup>2</sup> )	31.00±5.33	32.51±5.74	0.629
AHI	52.35±14.8	44.81±12.97	0.179
ODI	48.12±16.41	38.15±13.94	0.040
Min SaO <sub>2</sub>	78.2±9.73	80.93±5.58	0.713
Mean SaO <sub>2</sub>	92.23±3.68	92.55±1.48	0.509
CPAP prescript pressure	8.5±1.6	8.66±1.79	0.786

MT: manual titration group; APAP: automatic positive airway pressure group; BMI: body mass index; AHI: apnea hypopnea index; ODI: oxygen desaturation index; Min SaO<sub>2</sub>: minimum oxygen saturation measured; Mean SaO<sub>2</sub>: mean oxygen saturation measured

**Table 2.** Questions asked in the survey to the technicians and summarised responses

	MT	APAP	P
ESS	11.45±3.44	10.80±3.46	0.861
How much complaint with his/her disease	7.45±2.45	7.40±2.29	0.865
Is the titration enough?	8.95±2.42	9.46±1.06	0.914
Is the patient pleased with the treatment?	8.2±2.58	8.86±1.80	0.477

ESS: Epworth sleepiness scale MT: manuel titration group; APAP:automatic positive airway pressure group

**Table 3.** Questions asked in the survey to the patients and summarised responses

	MT	APAP	p
Are you pleased with he treatment applied?	8.25±2.02	7.86±2.19	0.578
Would you like to sleep like this night now and then?	8.35±2.01	8.2±2.01	0.789
How did you sleep compared to your sleep at home?	7.90±2.1	8.13±1.76	0.891
Are you sleepy now?	7.85±2.60	8.80±1.86	0.170
Did you have good rest?	8.1±1.71	9.00±1.36	0.103
Would you like to use CPAP afterwards?	7.7±2.63	6.53±3.27	0.334
Compliance at 1 st year	9/11 (%55)	7/8 (%53)	0.923

MT: manuel titration group; APAP:automatic positive airway pressure group

**Table 4.** Parameters of the compliant and noncompliant cases at the end of 12 months

	Compliant (n=16)	Noncompliant (n=19)	p
Age (years)	49.81±7.49	51.89±9.06	0.389
Sex	6 male(62.5%)	6 male(%31.6)	0.717
BMI (kg/m <sup>2</sup> )	32.45±4.00	30.97±6.51	0.260
AHI	47.73±12.20	50.27±16.26	0.619
ODI	43.48±13.89	44.15±17.94	0.881
Min SaO <sub>2</sub>	79.00±9.20	79.68±7.55	0.947
ESS	11.62±4.09	10.79±2.78	0.324
CPAP pressure	8.75±1.69	8.42±1.68	0.458
MT/APAP titration	9/7 (56.2%)	11/8 (%57.9)	0.923

BMI:body mass index; AHI:apnea hypopnea index; ODI: oxygen desaturation index; Min SaO<sub>2</sub>: minimum oxygen saturation measured; ESS: epworth sleepness scale; MT/APAP titration: ratio of manuel titration group to automatic positive airway pressure group

of polysomnographic criteria ( $P=0.04$ ). No significant difference was detected between mean titration pressure levels obtained in the MT or APAP groups. No difference was noted in scores on the Epworth Sleepiness Scale between the two groups (Tables 2 and 3). At the first-year evaluation, no significant difference was detected between groups (Table 4).

## DISCUSSION

In our study, we found that the titration method used to detect CPAP pressure, MT, or APAP did not affect patient satisfaction on the day after the titration night, as well as first-year compliance. This is an important finding because MT is an expensive method, and authors recommend APAP titration and home night titration. If APAP or MT does not affect patient compliance, which is the most important problem in the long term in larger studies, a more expensive method would not be needed.

There are different variables independent of the CPAP mode that can influence CPAP adherence. Age, use of lipid-lowering medications, use of sedative/hypnotic agents on CPAP titration, a higher AHI, mask type, comorbid diseases, and greater daytime sleepiness were all factors shown to increase CPAP adherence (7–12). In contrast, a lower BMI ( $\leq 30$  kg/m<sup>2</sup>) and psychosocial factors such as living alone have been shown to be associated with poor CPAP adherence (13, 14). In our study, no relationship was found between age, sex, AHI, and BMI and compliance. In addition, we excluded all comorbid conditions as well as the use of sedative/hypnotic agents.

All of these parameters are detected in patients using fixed pressures as decided by APAP titrations. In our study, we investigated patient compliance without comorbid diseases after intensive assessment between the MT or APAP titration groups.

Although patients commonly express concerns about mask comfort and mask-related side effects, the studies do not suggest that the CPAP mask interface influences CPAP adherence (15–18). To rule out the effects of mask type and humidification, all of our patients used nasal mask, and no humidification was used in any participant. All of the patients had insurance from the government that does not cover the cost of a humidifier; thus, we did not order a humidifier for any of the patients. In addition, all of the patients had the same psychosocial factors; they were all married and had graduated from at least high school.

The effect of age on CPAP adherence is controversial. In some reports, reduced CPAP use with increasing age was documented, whereas others have noted higher rates of CPAP adherence with age (19–22). However, in a recently published paper, the effect of age on CPAP adherence was shown to be largely mediated by other factors using a multivariate model (23). Age was not statistically significant between our groups, and we did not find any effect of age on compliance in our study.

The effect of laboratory-based titration was evaluated in a retrospective chart review of 98 patients, and the patients' sleep laboratory experience with CPAP and support and education provided by the sleep technologists were important factors in facilitating CPAP compliance (24). In our study, the same level of support and education were provided by the technician, so all of the study patients received the same education on CPAP treatment.

Disease-related factors such as AHI (25–28), oxygen desaturation index (26, 29), and self-rated subjective sleepiness (25–28) are the most extensively examined factors, but their relationships were found to be weak. In most studies, the AHI values in the first night of polysomnography were significantly higher in subjects who had been using PAP, and it was interpreted that CPAP adherence was closely related to disease severity. There are also studies that showed conflicting results (26–29). In our study, no difference was found between the adherent and non-adherent subjects regarding polysomnographic findings or level of daytime sleepiness.

The limitations of our study were that our patients received their devices from a socialised insurance company (so that all of them received CPAP after titration night), and some patients were lost during follow-up (five of the patients from the APAP group). Because we had a small sample size, it would be more meaningful if the device recordings of these patients were available. In addition, in earlier studies, compliance was shown to be higher in the group who attended the follow-up. Thus, this would be a limitation because we lost five patients. One other limitations of our study is we only included patients without comorbidities. Although patients with comorbidities represents the majority of patients with sleep apnea who seek treatment, these patients could also need BIPAP treatment. Also comorbidities could also effect the first night satisfaction and CPAP compliance. Due to these reasons we excluded patients with comorbidities.

In conclusion, the titration method does not affect device acceptance in OSAS patients without comorbidities and matched for other co-variants. In addition, no compliance difference was noted in terms of MT compared to

APAP titration in these patients. Although MT is a very expensive method, further studies with larger patient populations are needed to show the requirement of MT; if no difference exists, MT is not needed.

**Ethics Committee Approval:** The study protocol was approved by the local ethics committee.

**Informed Consent:** All of the participants' rights were protected, and informed consent was obtained according to the Helsinki Declaration.

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

**Author Contributions:** Concept - SNS; Design - SNS, ŞA; Supervision - SNS, Eİ, LD; Resource - SNS, ŞA; Materials - SNS, Eİ, LD; Data Collection and/ or Processing - SNS, ŞA; Analysis and/or Interpretation - SNS, ŞA, Eİ, LD; Literature Search - SNS, ŞA; Writing - SNS, ŞA; Critical Reviews - Eİ, LD.

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