

Adequacy of prescribing nasal continuous positive airway pressure therapy for the sleep apnoea/hypopnoea syndrome on the basis of night time respiratory recording variables

J M Montserrat, A Alarcón, P Lloberes, E Ballester, C Fornas, R Rodriguez-Roisin

Abstract

Background - The increased demand of full polysomnographic studies, not only for diagnostic purposes but also for continuous positive airway pressure (CPAP) titration, has produced long waiting lists. Simpler methods are therefore needed to avoid having to refer all patients for full polysomnography. The hypothesis that CPAP therapy for the sleep apnoea/hypopnoea syndrome (SAHS) can be performed exclusively on the basis of recording night time respiratory variables was tested.

Methods - The level of CPAP in a group of 41 patients (three women) of mean (SD) age 52 (10) years, body mass index 31.5 (4.4) kg/m², and apnoea/hypopnoea index (AHI) 53(16) events/hour was measured. During a two week period CPAP titration was performed in a random order in two settings: (1) in the sleep laboratory using full polysomnography; and (2) in the respiratory ward using equipment which continuously recorded and displayed pulse oximetry, airflow, chest and abdominal motion, and body position. The level of CPAP was increased progressively until apnoea, hypopnoea, snoring, and thoracoabdominal paradox disappeared.

Results - No differences in CPAP levels (9.34(2.2) versus 9.68 (2.1) cm H₂O) were found between full polysomnography and night time respiratory recordings. The accuracy of the measurement of both procedures showed good agreement. Only one patient showed a significant difference in CPAP level requirements between the two methods.

Conclusions - Night time respiratory recording is sufficient to permit a reasonable choice of CPAP levels to abolish all the respiratory disturbances in most of the patients studied.

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Keywords: obstructive sleep apnoea, CPAP, treatment.

Continuous positive airway pressure (CPAP) has become the treatment of choice for the sleep apnoea/hypopnoea syndrome (SAHS).¹⁻⁶ The demand for polysomnography, not just for diagnostic purposes but also for titrating CPAP to obtain optimal pressures, has produced long

waiting lists. Easier procedures of evaluating CPAP may allow patients to initiate CPAP treatment without full polysomnography. Conventionally, full polysomnography is the only satisfactory method for determining the optimal level of CPAP for the treatment of SAHS as higher pressures are generally required during rapid eye movement (REM) sleep, and this sleep phase needs to be reached and tested during the night.⁶⁻⁸ We hypothesised that the increased amount of both delta and REM sleep during the first night of CPAP therapy should allow us to titrate the level needed to abolish adverse respiratory events during the night without needing to monitor the neurological variables. Our goal was therefore to use only respiratory variables to determine whether the level of CPAP required was appropriate to abolish apnoea, hypopnoea, snoring, and thoracoabdominal paradox.

Methods

SUBJECTS

Forty one subjects (three women) with polysomnographically documented moderate to severe obstructive sleep apnoea (OSA) were recruited from the sleep clinic of the Hospital Clinic at Barcelona. Patients were eligible if they had received no prior treatment for OSA, has no other active medical problems, and had no pulmonary dysfunction on routine pulmonary function testing. This study was approved by the ethics committee of the hospital.

STUDY DESIGN

During a two week period CPAP titration (see below) was performed in two settings in random order to all the patients: (1) in the sleep laboratory using full polysomnography; and (2) at the respiratory ward using night time respiratory recordings only.

Polysomnography

Full polysomnography was performed in the usual manner including continuous monitoring of the electro-oculogram (EOG), electroencephalogram (EEG), and chin EMG for sleep staging according to standard criteria.⁹ Arterial oxygen saturation (SaO₂) was measured continuously with a finger probe using a pulse oximeter (504 Critical Care System Inc, Waukesha, WI, USA). Ribcage and abdominal

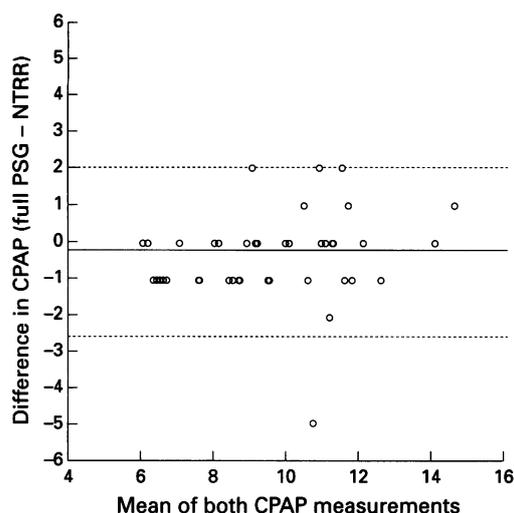
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Comparison of CPAP level measured by the two methods. The solid line represents the mean bias ($-0.34 \text{ cm H}_2\text{O}$) of the individual differences and the dotted lines are the limits of agreement (mean bias ± 2 standard deviations of the differences: $+2.0$ to -2.68). PSG = polysomnography; NTRR = night time respiratory recordings.



motion were monitored by piezoelectric bands placed over the thorax and abdomen (RespEZ, Tm Bionic, Midlothian, Virginia, USA). Airflow was assessed using a thermistor. All signals were recorded continuously on a polygraph (Nicolet 1A98, Madison, Wisconsin, USA). After one hour of basal recordings CPAP titration was started until respiratory events disappeared. Supine position and at least two REM sleep periods were registered.

Night time respiratory recording

Night time respiratory recording without polysomnography was carried out with a DENSA Pneumograph (Densa Ltd, Flint, UK) to measure airflow by a thermistor, and chest and abdominal motion by magnetometry. SaO_2 was measured using the same pulse oximeter as for polysomnography. All the signals were continuously displayed on a computer screen throughout the night. After one hour of basal recordings CPAP titration was started until respiratory events disappeared. At least one prolong period of supine sleep was registered.

CPAP treatment

Subjects were first instructed about CPAP treatment by the physician. On the day in which CPAP titration was performed they were admitted to hospital and received further education with the CPAP machine and its mask. They were even allowed to use the mask during a short nap (20 minutes). During both nights of titration the nasal CPAP level (Sleep Easy III, Respironics) was increased progressively from $4 \text{ cm H}_2\text{O}$, by steps of $1 \text{ cm H}_2\text{O}$, until apnoea, hypopnoea, snoring, thoracoabdominal paradox, and arousals (full polysomnography) had disappeared. After the nasal CPAP pressure required to stabilise the upper airway was achieved, it was reduced by $1 \text{ cm H}_2\text{O}$ steps until the respiratory events or snoring resumed. The CPAP level chosen was at end-expiration, immediately before the reappearance of abnormal respiratory events. The reason for using this procedure for CPAP titration is the upper airway hysteresis, as demonstrated by Condos *et al.*¹⁰

STATISTICAL ANALYSIS

Data are expressed as mean (SD). Paired *t* testing was used to analyse differences in CPAP levels between the two procedures (full polysomnography versus night time respiratory recording). Agreement between the two measurements was assessed by the method of Bland and Altman.¹¹ The mean value of both measurements was plotted on the abscissa, and the difference between the two values was plotted on the ordinate. The bias was estimated by the mean difference. The limits of agreement between the two methods were calculated as the mean bias ± 2 times the standard deviation of the individual differences. Whether the mean bias was significantly different from zero was determined by calculating the 95% confidence interval of the bias. Significance was accepted at $p < 0.05$.

Results

PATIENTS

The anthropometric data, pulmonary function data, and polysomnographic characteristics of the subjects are given in the table. The mild pulmonary dysfunction found in some subjects was attributable to obesity and/or airways limitation. At baseline all patients had a moderate to severe AHI on diagnostic polysomnography ($52.9(16)$ events/hour).

CPAP REQUIREMENTS

The mean value of CPAP required to abolish respiratory events during sleep was $9.34 (2.2) \text{ cm H}_2\text{O}$ using polysomnography and $9.68 (2.1) \text{ cm H}_2\text{O}$ using night time respiratory recording. The mean of the individual differences between the CPAP pressure level achieved with both methods was $-0.34 (1.17) \text{ cm H}_2\text{O}$ with a 95% confidence interval of $0.37 \text{ cm H}_2\text{O}$. The mean value of both measurements and the difference between each CPAP value is shown in the figure. The difference between the CPAP values was not significant and, in most of the patients, differences were not greater than $1-2 \text{ cm H}_2\text{O}$. Only one patient had a significant difference in the CPAP level requirement.

Discussion

The purpose of this study was to investigate the adequacy of prescribing nasal CPAP on the

Characteristics of subjects ($n = 41$)

	Mean	SD
Age (years)	52.2	10.8
Height (m)	1.67	0.10
Weight (kg)	88.5	17.6
Body mass index (kg/m^2)	31.5	4.4
Neck circumference (cm)	42.5	4.7
FEV ₁ (% pred)	83.4	17
FVC (% pred)	85.4	15
AHI (events/hour)	52.9	16
CPAP ($\text{cm H}_2\text{O}$)		
Polysomnography	9.34	2.2
Night time respiratory recording	9.68	2.1

FEV₁ = forced expiratory volume in one second; FVC = forced vital capacity; AHI = apnoea/hypopnoea index; CPAP = continuous positive airway pressure

sole basis of night time respiratory recording in the ward compared with polysomnography in the sleep laboratory. We found that night time respiratory recording allowed a reasonable choice of CPAP level to abolish all the night time respiratory disturbances.

Nasal CPAP is a highly effective treatment of SAHS and it has become the major non-surgical long term treatment.²⁻⁶ Sullivan *et al* described its use in 1981¹ but it was not until 1985 that it began to be recognised as the most practical form of long term therapy.⁸ Nasal CPAP acts predominantly by providing a physical pressure splint to the upper airway.¹² It is imperative to ensure that the pressure used is sufficient to prevent apnoea, hypopnoea, thoracoabdominal paradox, and snoring in all sleep stages and in all postures of sleep. The supine position and REM sleep usually require higher pressure levels than a lateral position or non-REM sleep.⁷ This means that full polysomnography is the only satisfactory procedure for prescribing the optimal level of CPAP for treatment of the SAHS.^{13,14} Over the last years several approaches have been developed to determine the adequate CPAP level for SAHS by easier methods – for example, CPAP titration during a nap,¹³ a partial night study,¹⁵ or even on the basis of a prediction equation using the apnoea/hypopnoea index, body mass index, and neck circumference.¹⁶ All these had the same objective, namely to prescribe an adequate CPAP level until it was possible to perform full polysomnography. Sanders *et al*¹⁵ assessed whether or not a prescription for CPAP for SAHS could be achieved on the same night as the diagnostic polysomnography. They studied 50 consecutive patients and found that, although most patients with SAHS could obtain a satisfactory prescription for CPAP, most required alterations of that prescription. Miljeteig and Hoffstein¹⁶ examined the factors that accounted for the variability in CPAP levels required to abolish SAHS and also investigated the feasibility of predicating the lowest effective pressure from simple anthropometric and polysomnographic variables. They found that variability in pressures required to abolish night time respiratory events were related primarily to obesity and severity of SAHS, and that it was possible to predict the initial CPAP level required with sufficient accuracy to simplify the empirical determination of the best CPAP level in the sleep laboratory. In all but one patient the levels of CPAP pressure were very close for the two procedures. Only one patient showed a marked difference (8 cm H₂O during full polysomnography versus 13 cm H₂O during night time respiratory recording) for which we do not have a convincing explanation. During both procedures the patient was supine, although spending less time in this position during full polysomnography. Neither alcohol ingestion, sedative drug consumption, nor sleep deprivation were found to be the cause of this discrepancy.¹⁷⁻¹⁹ Finally, we cannot be certain that the differences in CPAP level between full polysomnography and night time respiratory

recording were due to natural variability of upper airways obstruction¹⁹⁻²² rather than an inadequate assessment of requirement during night time respiratory recording, even if no significant night time variability in the severity of untreated sleep disorders has been observed in patients with severe SAHS such as ours.²⁰⁻²² In our population there were no differences in body mass index, alcohol consumption, type of nasal device and CPAP machine used, or duration of the trial between either of the titration procedures.

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