A randomized trial of auto-titrating CPAP and fixed CPAP in the treatment of obstructive sleep Apnea–Hypopnea

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Summary

Background: Continuous positive airway pressure (CPAP) remains the treatment of choice for obstructive sleep apnea–hypopnea (OSAH). Auto-titrating CPAP (APAP) devices automatically adjust pressure and may improve treatment compliance compared to fixed CPAP (F-CPAP).

Methods: Randomized, prospective, single-blind, crossover trial to compare efficacy, side effects, compliance, patient satisfaction and preference between APAP and F-CPAP therapy in patients with moderate to severe OSAH. There were two treatment periods of 4 weeks each (APAP and F-CPAP), separated by a 2-week washout period.

Results: Ten CPAP-naive OSAH patients (9 males) completed the study. They had mean ± SD age of 44.9 ± 9.7 years; body mass index of 35.9 ± 12.9 kg/m² and apnea/hypopnea index (AHI) of 47.2 ± 35.6. Both forms of therapy were equally effective in improving the symptoms and in reducing the AHI. Both forms of therapy were associated with frequent side effects and had similar patient compliance. At the end of the study, more patients (6–1) preferred F-CPAP to A-CPAP therapy.

Conclusion: A-PAP was as effective as F-CPAP in the treatment of OSAH but was not associated with fewer side effects, better compliance, better satisfaction or increased patient preference.

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Introduction

Nasal continuous positive airway pressure (CPAP) remains treatment of choice for obstructive sleep apnea–hypopnea (OSAH).1 Fixed CPAP (F-CPAP) machines deliver a constant pressure that may be excessive during times of the night. Auto-titrating CPAP (APAP) devices automatically adjust the level of positive pressure according to patient’s needs.2 Preliminary studies have shown that APAP is as effective as F-CPAP but the evidence that it increases compliance to CPAP therapy is controversial.3 The aim of this randomized trial was to compare the efficacy, side effects, patient compliance, satisfaction and preference between APAP and F-CPAP in treatment of OSAH.
Methods

Ten CPAP-naive patients (9 males) with symptomatic OSAH (apnea/hypopnea index (AHI) > 15/h) were recruited for this randomized prospective single-blinded crossover trial. An initial overnight, supervised polysomnogram was conducted and scored according to previously described method.4 A second night CPAP-titration study was performed to determine effective pressure. Patients were randomized to receive APAP and F-CPAP for 4 weeks each separated by a 2-week washout period. Patients were unaware of the treatment mode and referred to the two treatment periods as treatment A and treatment B. At the end of each treatment period and the washout period, questionnaire was administered and home sleep monitoring was performed. Questionnaire elicited information about symptoms, treatment efficacy, side effects, and patient satisfaction, and Epworth sleepiness scale. At the end of the study, each patient was asked whether they would prefer to use the first or the second form of CPAP therapy. Home sleep monitoring was performed with the Poly-G Portable Apnea Recorder and Sleep I/T-8 (CNS Inc, Chanhassen, Minnesota, USA).

CPAP therapy was undertaken with a Virtuoso smart CPAP system (Respironics Inc, Murrysville, Pennsylvania, USA). For each patient, the same machine was used either in F-CPAP (pressure equal to determined titration pressure) or in APAP (pressure range 3–20 cm H2O) mode. The APAP system utilized an algorithm that used a pressure transducer and microprocessor to monitor the airway for vibration patterns. When three airway instability events were detected within 1 min, the pressure increased by 2 cm H2O over a 1-min period. When no events indicating instability were detected, the pressure decreased by 1 cm H2O over a 5-min period. The built-in time meter within the CPAP system monitored total machine usage and cumulative patient compliance (time at pressure) and was used to evaluate treatment compliance.

Paired t-test was used to compare the results of two treatment periods (APAP and CPAP). Statistical significance of differences for repeated observations was tested with repeated measures analysis of variance (ANOVA). All P values < 0.05 were considered significant.

Results

Patients reported symptoms of snoring (100%), witnessed apnea (80%), unrefreshing sleep (80%) and excessive daytime sleepiness (70%). The mean age was 44.9 ± 9.7 years, body mass index (BMI) of 35.9 ± 12.9 kg/m2 and neck circumference 45.0 ± 4.0 cm. Table 1 summarizes Epworth sleepiness scale score and sleep study values at baseline and after each mode of therapy (APAP and F-CPAP). Both forms of therapy were highly effective in improving snoring, excessive daytime sleepiness, AHI, arousal index and desaturation index. During APAP therapy, patients required lower pressure (6.7 ± 4.1) than F-CPAP therapy (11.7 ± 1.7) cm of H2O ($P = 0.001$) but the minimum arterial oxygen saturation (SaO2) was lower during APAP therapy ($P = 0.03$).

Objective monitoring showed similar compliance with APAP (4.3 ± 1.9) and F-CPAP therapy (3.7 ± 2.6) h/night ($P = NS$). Patients reported similar compliance, satisfaction with therapy and difficulty in using the machine with both forms of

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Home sleep monitoring data and Epworth sleepiness scale score at baseline and after each mode of CPAP therapy.</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
</tr>
<tr>
<td>Apnea/hypopnea index</td>
<td>47.2 ± 35.6*</td>
</tr>
<tr>
<td>Arousal index</td>
<td>17.3 ± 17.7*</td>
</tr>
<tr>
<td>Desaturation index</td>
<td>53.0 ± 36.0*</td>
</tr>
<tr>
<td>Minimum O2 saturation</td>
<td>67.8 ± 12.5*</td>
</tr>
<tr>
<td>Basal O2 saturation</td>
<td>91.3 ± 4.5*</td>
</tr>
<tr>
<td>Total sleep time (min)</td>
<td>381 ± 92</td>
</tr>
<tr>
<td>Stage 1–2 sleep (%)</td>
<td>71 ± 27</td>
</tr>
<tr>
<td>Stage 3–4 sleep (%)</td>
<td>14 ± 25</td>
</tr>
<tr>
<td>REM sleep (%)</td>
<td>15 ± 7</td>
</tr>
<tr>
<td>Epworth score</td>
<td>11.1 ± 6.4*</td>
</tr>
</tbody>
</table>

Values expressed as mean ± sd.

*Denotes $P < 0.05$, between baseline and after either form of therapy.

**Denotes $P < 0.05$, between APAP and F-CPAP therapy.
therapy. Nearly half of the patients who had difficulty in using one mode of therapy were able to tolerate the other mode. At the end of the trial, more patients preferred F-CPAP than A-CPAP (60% vs. 10%; \( P = 0.06 \)), with 10% satisfied with either and 20% satisfied with neither of the two treatments.

**Discussion**

Our study confirmed that APAP was an effective therapy for treatment of OSAH and required significantly lower airway pressure than F-CPAP therapy. Both forms of therapy were associated with frequent minor side effects. Nearly half of the patients who had difficulty in using one CPAP mode were able to tolerate the other mode with minimal discomfort. APAP therapy did not lead to better treatment compliance. Our study was limited by small sample size and some of the differences observed between the two treatment groups, though clinically important, may not reach statistical significance.

There have been few randomized trials comparing APAP and F-CPAP therapy for a period of week or more. Two had shown an improved compliance with APAP therapy\(^3\,^5\) whereas four trials reported compliance similar to F-CPAP.\(^6\,^8\,^9\) In addition, there are safety concerns with the use of APAP therapy that need further study. Despite an adequate control of AHI, significant arterial oxygen desaturation can still occur. The minimum arterial SaO2 was lower with APAP therapy in our study. D’Ortho et al.\(^7\) found that patients on APAP spent 8.8 ± 20.5 min with SaO2 less than 90% compared to 3.6 ± 10.3 min on F-CPAP therapy. In a single night study of 20 patients using a Respironics prototype, Sharma et al. found that the minimum arterial SaO2 was significantly lower with APAP than F-CPAP.\(^10\) Scharf et al.\(^11\) using a DeVilbiss NCPAP 3 system (Horizon auto adjust) reported a slight increase in frequency of hypopnea events during use of APAP system. Central apnea may occur during APAP treatment. The American Academy of Sleep Medicine recommends that patients with congestive heart failure, chronic lung diseases, patients expected to have nocturnal desaturation for reasons other than OSAH (e.g. obesity hypoventilation syndrome) and patients who do not snore (either due to surgery or naturally) are not currently candidates for APAP titration or treatment.\(^12\)

A number of APAP devices are commercially available. They monitor different parameters to detect breathing events and utilize a variety of algorithms to adjust the pressure. There is no clear evidence that one APAP technology is superior to the other and results from study of one device cannot be generalized to all APAP devices. A recent bench study compared the responses of five commonly used APAP machines, including the one used in this trial, to well-defined breathing patterns.\(^13\) In response to a pattern of repetitive apneas two devices did not modify positive airway pressure, two increased the pressure to 10 cm and one to 16 cm H2O. Most of the devices failed to increase the pressure in response to various hypopnea patterns but all devices increased the pressure when snoring was included in the flow limitation pattern. The rates of automatic pressure reduction after normalizing the breathing pattern were also different among the five APAP devices.

In summary, CPAP is an effective therapy for symptomatic OSAH. F-CPAP has been used extensively and remains the machine of choice for long-term home therapy. The APAP machine is neither more effective nor more preferred by the patient. Further studies are needed to define patient subgroups in which APAP can be recommended as the initial mode of therapy.

**References**

9. Series F, Marc I. Efficacy of automatic continuous positive airway pressure therapy that uses an estimated required


