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ORIGINAL ARTICLE

Clinical impact of adaptive servoventilation compared to other ventilatory modes in patients with treatment-emergent sleep apnea, central sleep apnea and Cheyne–Stokes respiration

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Abstract
Introduction: Adaptive servoventilation is a recent ventilatory mode initially designed to treat Cheyne–Stokes respiration (CSR). Recently, the efficacy of ASV has been discussed for the treatment of central sleep apnea (CSA) and treatment-emergent central sleep apnea (treatment-emergent CSA) where other forms of traditional positive airway pressure (PAP) may be insufficient.
Objectives: To compare the clinical impact of ASV with other forms of PAP in treating patients with treatment-emergent CSA, CSA and CSR.
Methods: Medical data of all the patients who underwent polysomnography (PSG) with ASV titration were evaluated. The patients were divided into two groups according to the mode of ventilation reimbursed: ASV and PAP (AutoCPAP/CPAP/BIPAP). All patients had a minimal follow-up of 6 months. Both groups were compared in terms of symptoms, apnea hypopnea index, compliance, cardiac function and cardiovascular events.
Results: ASV titration was performed in 33 patients (30M/3F) with a mean age of 69 ± 8 years. The majority (58%) present a treatment-emergent SA and 42% a CSA and or CSR. The median initial diagnostic AHI was 46 ± 22 events/h.

After the initial diagnosis, 28 patients were treated with PAP and 5 with servoventilation. All of the patients treated with PAP were posteriorly submitted to PSG and ASV titration because of suboptimal response to PAP. Despite a clear indication for ASV, due to differences in reimbursement, 15 patients continued treatment with PAP (12 with AutoCPAP, 1 with BIPAP and 2 with CPAP) and 16 changed to ASV. Two patients were lost in follow-up.

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In both groups, most of patients present a treatment-emergent SA (53% in ASV group vs. 67% in PAP group) or a CSA/CSR (29.4% in ASV group vs. 20% in PAP). After ASV titration, the mean follow-up was 25 ± 14 months. Both groups (ASV vs. PAP) were similar in terms of compliance (77 ± 23% vs.88 ± 14%) and in terms of Epworth sleepiness scale score (6 ± 5 vs. 7 ± 5). There was a statistical difference in terms of residual AHI: mean AHI was 4 ± 3 in ASV group and 9 ± 3 in PAP group ($P = 0.005$). We found no differences in terms of left ventricular fractional shortening (ASV 33 ± 10% vs. PAP 32 ± 10%). Although no difference was observed between the 2 groups in terms of non-fatal cardiovascular events (3 events in each group), 2 fatal cardiovascular events occurred in the PAP group (sudden death).

Conclusions: These data confirm that ASV is an efficient treatment in patients with treatment-emergent CSA, CSA/CSR significantly decreasing residual AHI. In both groups, compliance rate was high and sleepiness improved. It is relevant that the 2 patients who died of sudden death were treated with PAP.

Introduction

Central sleep apnea is characterized by a lack of drive during sleep resulting in insufficient or absent ventilation and compromised gas exchange. The lack of respiratory efforts during cessation of airflow may lead to frequent nighttime awakenings, with consequent excessive daytime sleepiness and increased risk of adverse cardiovascular outcomes.[1]

Cheyne–Stokes respiration (CSR) is a disorder characterized by recurrent central apneas during sleep alternating with a crescendo-decrescendo pattern of tidal volume. It is observed in patients with congestive heart failure, usually during stages 1 and 2 non-REM sleep when ventilation is under chemical-metabolic control.[2,3]

In recent years, sleep physicians have recognized that some patients with obstructive sleep apnea develop central apneas or CSR after initial treatment with positive airway therapy. That sleep disorder is called treatment-emergent central sleep apnea. The significance and the prevalence of treatment-emergent SA is not clear; it ranges from 2.5% to 20%.[4–10] There is some controversy around the optimal treatment of CSA syndrome and treatment-emergent central sleep apnea.

Adaptive servoventilation is a recent ventilatory mode, able to provide a dynamic adjustment of inspiratory pressure support. ASV continuously calculates a target minute ventilation, breath-by-breath, increasing or decreasing the pressure support in order to avoid transient episodes of central hypopnea/apnea after hyperventilation and associated hypocapnia.

The first commercial ASV devices became available in 2006. The device used for PSG in this study is AutoSet CS®. The device provides a fixed end-expiratory pressure adjusted to treat obstructive events and a respiratory frequency back-up rate. The inspiratory pressure is adjusted by the device in order to obtain a calculated target ventilation (90% of the patient's recent average ventilation) of a running 3 min reference period.

The present study is a retrospective case-series comparison of the efficacy of traditional non-invasive positive pressure ventilation (PAP) and ASV in patients with diagnosis of treatment-emergent central sleep apnea, central sleep apnea and or Cheyne–Stokes respiration.

Methods

Patients

We identified all the patients referred to ASV titration at our Sleep Medicine Center. Most of the patients had previously undergone an unsuccessful PAP trial.

Definitions

The ASV titration was done by split-night PSG (SomnoStar® Sleep System). Sleep stage scoring was performed according to standard criteria of the *American Association Sleep Medicine (2007)*. An apnea was defined as ≥90% airflow reduction for ≥10 s, and a hypopnea was defined as ≥30% reduction in airflow for ≥10 s accompanied by ≥3% desaturation from baseline. An arousal was defined as ≥3-s increase in EEG frequency following ≥10 s of stable sleep, accompanied by an increase in submentalis EMG activity for ≥1 s during REM sleep. The AHI was calculated as the number of apneas and hypopneas per hour of sleep. The arousal index was calculated as the number of arousals per hour of sleep. Obstructive sleep apnea syndrome was diagnosed if RDI was ≥5 events and the patient was symptomatic (daytime sleepiness, nocturnal gasping or choking, loud snoring with description of breathing interruptions) or if RDI was >15 even if patient was asymptomatic. CSA was diagnosed if the number of central apnea per hour was ≥5 and at least 50% of the total AHI was central in origin. Treatment-emergent SA was diagnosed if CPAP titration eliminated obstructive events but the residual central apnea index (CAI) was ≥5 or the CSR pattern became predominant.

Study design

After the baseline sleep study, patients diagnosed with treatment-emergent CSA, CSA or CSR were submitted