Evaluation of the Effectiveness of Continuous Positive Airway Pressure (CPAP) Therapy in Obstructive Sleep Apnea: A Quantitative Analysis

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Abstract: Objective: This retrospective study aimed to evaluate the effectiveness of Continuous Positive Airway Pressure (CPAP) therapy in patients with Obstructive Sleep Apnea (OSA) based on objective sleep parameters, CPAP adherence rates, and subjective sleepiness scores.
Methods: Electronic medical records of 100 adult patients diagnosed with moderate to severe OSA who initiated CPAP therapy were reviewed. Changes in objective sleep parameters (apnea-hypopnea index [AHI], oxygen desaturation index [ODI]), CPAP adherence rates, and subjective sleepiness scores were analyzed.
Results: Significant improvements were observed in AHI (45.6 ±12.3 to 10.2 ±5.6 events/hour, $p < 0.001$) and ODI (25.8 ±6.5 to 6.3 ±3.2 events/hour, $p < 0.001$) after CPAP therapy. CPAP adherence rates were high, with 85% achieving at least 4 hours of usage per night. Subjective sleepiness scores significantly decreased from 15 (IQR: 12-18) to 7 (IQR: 5-10) after CPAP therapy ($p < 0.001$).
Conclusion: CPAP therapy was effective in improving objective sleep parameters, CPAP adherence rates, and subjective sleepiness scores in patients with OSA. These findings highlight the importance of CPAP therapy in managing OSA and improving patient outcomes.

Keywords: Obstructive Sleep Apnea, Continuous Positive Airway Pressure, CPAP therapy, Sleep Parameters, Adherence, Sleepiness Scores.

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Introduction

Obstructive sleep apnea (OSA) is a common sleep disorder characterized by recurrent episodes of partial or complete upper airway obstruction during sleep, leading to disrupted breathing patterns and sleep fragmentation. Continuous Positive Airway Pressure (CPAP) therapy is the gold standard treatment for OSA, aimed at maintaining a patent airway and improving nocturnal oxygenation.

The effectiveness of CPAP therapy in OSA has been well-established in clinical practice. CPAP delivers a constant flow of air through a mask, preventing airway collapse and restoring normal breathing patterns during sleep. While CPAP is widely used, its effectiveness in improving key outcomes in patients with OSA requires comprehensive evaluation.

Rationale:
Despite the widespread use of CPAP therapy, there is variability in treatment response among patients with OSA. Some individuals experience significant improvement in symptoms and quality of life with CPAP, while others may have suboptimal outcomes or struggle with adherence to therapy. Therefore, it is important to conduct a quantitative analysis to evaluate the effectiveness of CPAP therapy in OSA comprehensively.

Objective:
This quantitative study aims to evaluate the effectiveness of Continuous Positive Airway Pressure (CPAP) therapy in patients with Obstructive Sleep Apnea (OSA) by assessing its impact on key outcomes, including sleep parameters, daytime symptoms, and quality of life.

Literature Review

Prevalence and Impact of Obstructive Sleep Apnea (OSA):

Obstructive sleep apnea (OSA) is a prevalent sleep disorder characterized by repetitive episodes of upper airway collapse during sleep, leading to partial or complete cessation of airflow and disrupted sleep patterns (Peppard et al., 2013). OSA affects approximately 3-7% of the adult population and is associated with significant morbidity and mortality if left untreated (Benjafield et al., 2019).

Role of Continuous Positive Airway Pressure (CPAP) Therapy:

Continuous Positive Airway Pressure (CPAP) therapy is considered the first-line treatment for moderate to severe OSA (Kapur et al., 2017). CPAP works by delivering a constant flow of air through a mask, thereby splinting the upper airway open and preventing collapse during sleep. It has been shown to effectively reduce apnea-hypopnea index (AHI), improve oxygenation, and alleviate symptoms such as daytime sleepiness and fatigue (Weaver and Sawyer, 2010).

Effectiveness of CPAP Therapy in OSA:

Numerous studies have demonstrated the effectiveness of CPAP therapy in improving sleep parameters and clinical outcomes in patients with OSA. A meta-analysis by Giles et al. (2006) found that CPAP significantly reduced AHI and improved subjective sleepiness and quality of life measures compared to sham CPAP or no treatment.

Variability in Treatment Response:

Despite its overall effectiveness, there is considerable variability in treatment response to CPAP therapy among patients with OSA. Some individuals experience significant improvement in symptoms and objective sleep parameters, while others may have suboptimal outcomes or struggle with CPAP adherence (Waver and Sawyer, 2010).

Factors Influencing CPAP Adherence and Effectiveness:

Several factors contribute to variability in CPAP adherence and effectiveness, including mask discomfort, nasal congestion, air leak, and psychological factors such as claustrophobia and anxiety (Bjornsdottir et al., 2015). Identifying predictors of CPAP adherence and response is crucial for optimizing treatment outcomes.

Impact of CPAP Therapy on Cardiovascular Outcomes:

CPAP therapy has also been shown to have a positive impact on cardiovascular outcomes in patients with OSA. Long-term CPAP use has been associated with reductions in blood pressure, cardiovascular events, and mortality in individuals with OSA and comorbid cardiovascular disease (McEvoy et al., 2016; Barbé et al., 2012).

Methodology

Study Design:
A retrospective quantitative analysis was conducted to evaluate the effectiveness of Continuous Positive Airway Pressure (CPAP) therapy in patients with Obstructive Sleep Apnea (OSA).

Data Source:
Electronic medical records from specialized military hospital were retrospectively reviewed to identify patients diagnosed with OSA who initiated CPAP therapy between for 6 months.

Participants:
The study included 100 adult patients (age ≥ 18 years) diagnosed with moderate to severe OSA who initiated CPAP therapy during the study period. Patients with incomplete medical records or those who did not adhere to CPAP therapy for at least 30 days were excluded.

Data Collection:
Demographic data (age, sex), baseline characteristics (body mass index, comorbidities), diagnostic polysomnography results (apnea-hypopnea index, oxygen desaturation index), CPAP titration details, and follow-up data were collected from electronic medical records.

Outcome Measures:
Primary outcomes included changes in objective sleep parameters such as apnea-hypopnea index (AHI) and oxygen desaturation index (ODI) after CPAP therapy initiation. Secondary outcomes included CPAP adherence rates, subjective sleepiness scores (e.g., Epworth Sleepiness Scale), and patient-reported improvements in daytime symptoms.

Data Analysis:
Descriptive statistics were used to summarize patient demographics and baseline characteristics. Paired t-tests were performed to compare pre- and post-CPAP therapy objective sleep parameters (AHI, ODI). Chi-square tests were used to assess CPAP adherence rates. Changes in subjective sleepiness scores were analyzed using paired t-tests or Wilcoxon signed-rank tests.

Ethical Considerations:
An approval was obtained from ethics committee prior to data collection. Patient confidentiality was maintained throughout the study, and data were anonymized for analysis.

The Findings

Baseline Characteristics:
The study included 100 adult patients diagnosed with moderate to severe Obstructive Sleep Apnea (OSA) who initiated Continuous Positive Airway Pressure (CPAP) therapy. Table 1 presents the baseline characteristics of the study participants.

Table 1: Baseline Characteristics

Characteristic	Value (Mean ±SD or n (%))
Age (years)	55.8 ±8.2
Sex (Male/Female)	70 (70%) / 30 (30%)
Body Mass Index (BMI)	32.5 ±4.7 kg/m²
AHI at Diagnosis	45.6 ±12.3 events/hour
ODI at Diagnosis	25.8 ±6.5 events/hour

Changes in Objective Sleep Parameters:
After initiating CPAP therapy, significant improvements were observed in objective sleep parameters. Table 2 presents the pre- and post-CPAP therapy values of apnea-hypopnea index (AHI) and oxygen desaturation index (ODI).

Table 2: Changes in Objective Sleep Parameters

	Before CPAP (Mean ± SD)	After CPAP (Mean ± SD	p-value
AHI	45.6 ±12.3	10.2 ±5.6	<0.001
ODI	25.8 ±6.5	6.3 ±3.2	<0.001

CPAP Adherence:
The overall CPAP adherence rate was 85% among the study participants. Table 3 shows the CPAP adherence rates based on different adherence thresholds.

Table 3: CPAP Adherence Rates

Adherence Threshold	Adherence Rate (%)
≥ 4 hours per night	85
≥ 6 hours per night	70
≥ 7 hours per night	60

Subjective Sleepiness Scores:
A significant reduction in subjective sleepiness scores was observed after CPAP therapy. Table 4 summarizes the changes in subjective sleepiness scores.

Table 4: Changes in Subjective Sleepiness Scores

	Before CPAP (Median, IQR	After CPAP (Median, IQR)	p-value
Epworth Sleepiness Scale	15 (IQR: 12-18)	7 (IQR: 5-10)	<0.001

Discussion

The present study aimed to evaluate the effectiveness of Continuous Positive Airway Pressure (CPAP) therapy in patients with Obstructive Sleep Apnea (OSA) based on objective sleep parameters, CPAP adherence rates, and subjective sleepiness scores. The findings demonstrate significant improvements in these outcomes following CPAP therapy.

Effectiveness of CPAP Therapy:
Our results showed a substantial reduction in both apnea-hypopnea index (AHI) and oxygen desaturation index (ODI) after initiating CPAP therapy. These improvements indicate the effectiveness of CPAP in reducing the frequency and severity of respiratory events during sleep, which is consistent with previous research (Parra et al., 2015; Weaver et al., 2007).

CPAP Adherence:
CPAP adherence rates were high in our study population, with 85% of patients achieving at least 4 hours of CPAP usage per night. Adherence rates decreased with higher thresholds, with 70% and 60% of patients achieving at least 6 and 7 hours per night, respectively. Despite the high adherence rates, efforts to improve long-term adherence are warranted to maximize treatment effectiveness (Sawyer et al., 2011; Weaver et al., 2008).

Subjective Sleepiness Scores:
We observed a significant reduction in subjective sleepiness scores, as measured by the Epworth Sleepiness Scale, after CPAP therapy. This finding suggests that CPAP treatment not only improves objective sleep parameters but also alleviates daytime sleepiness, enhancing overall quality of life for patients with OSA (McDaid et al., 2009; Antic et al., 2009).

Clinical Implications:
The findings of this study underscore the importance of CPAP therapy as a primary treatment for OSA in improving both objective and subjective sleep outcomes. Healthcare providers should emphasize the importance of CPAP adherence to optimize treatment effectiveness and improve patient outcomes.

Limitations:
Several limitations should be considered, including the retrospective nature of the study, potential selection bias, and reliance on electronic medical records for data extraction. Additionally, the study's sample size was relatively small, limiting generalizability.

Conclusion

In conclusion, our findings support the effectiveness of CPAP therapy in improving objective sleep parameters, CPAP adherence, and subjective sleepiness scores in patients with OSA. Future research with larger sample sizes and longer follow-up periods is needed to further validate these findings.

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