Effectiveness of non-operative treatment of obstructive sleep apnea. Review of the scientific literature

Andrius Mykolas Verenis[1], Aušra Baltrušaitytė[2], Eglė Ivanauskienė[3]

[1] Faculty of Odontology, Lithuanian University of Health Sciences, Kaunas, Lithuania

[2] Associate Professor, PhD, Department of Prosthodontics, Lithuanian University of Health Sciences, Kaunas, Lithuania

[3] Department of Prosthodontics, Lithuanian University of Health Sciences, Kaunas, Lithuania

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Corresponding address:
Andrius Mykolas Verenis, Lithuanian University of Health Sciences, Kaunas, Lithuania. E-mail: amverenis@gmail.com. Correspondence address: Ašigalio g. 5, 45, Lithuania

Abstract

Objectives: To asses the effectivnes of Continuous positive airway pressure (CPAP) and Mandibular andvancement devices as treatment for obstructive sleep apnea by using Apnea-hypopnea index (AHI).
Material and methods: PubMed, Cochrane Library, Wiley Online Library and Science Direct scientific literature databases were reviewed. The quality of the studies was assessed using the Cochrane Rob 2 tool. Change in OSA was assessed by the Apnea-Hypopnoea Index (AHI). Qualitative statistical comparison of data was performed, $p < 0,05$.
Results: 5 publications were selected for the systematic literature review, 367 patients were included, the study period was from 6 weeks to 10 years. Reduction in AHI: from baseline after CPAP treatment (n=3), from baseline after MAD treatment (n=3).
Conclusions: MAD and CPAP both reduce AHI, but CPAP treatment proves to be more effective.

Key words:

Obstructive sleep apnea, Mandibular advancement device, Continuous positive airway pressure

Introduction

Obstructive sleep apnea (OSA) is a prevalent condition characterized by repeated narrowing or blockage of the throat during sleep, which can cause either complete cessation of breathing (apnea) or partial obstruction (hypopnea). This leads to disruptions in the exchange of gases, resulting in a decrease in oxygen levels, an increase in carbon dioxide levels, and interruptions in sleep patterns. These factors contribute to the various consequences of obstructive sleep apnea, such as effects on cardiovascular health, metabolism, and cognitive function [1]. The aim of OSA treatment is to restore adequate respiratory function and oxygen saturation during sleep. Treatment options depend on the severity of the OMA and fall into four categories: (1) lifestyle modification; (2) the use of a continuous positive airway pressure (CPAP) machine; (3) the use of a mandibular advancement device (MAD); and (4) surgical procedures [2].

Based on the data primarily collected from Europe and North America, the general adult population has a prevalence rate of OSA ranging from 9% to 38%. Men have a prevalence rate ranging from 13% to 33%, while women have a prevalence rate ranging from 6% to 19%. However, the prevalence rate is much higher among the elderly population [3]. The aim this current study is to assess the effectivnes of OSA treatment with CPAP and MAD according to current scientific literature.

Objectives

1. To assess the efficacy of CPAP in the treatment of OMA based on the Apnea-Hypopnea Index
2. To assess the efficacy of MAD in the treatment of OMA based on the Apnea-Hypopnea Index
3. Compare CPAP and MAD as a treatment for OSA

Material and methods

1. Search protocol

This systematic review of the literature was conducted and documented in accordance with the Preferred Reporting Items for Systematic Reviews (PRISMA) guidelines [4]. The searches were performed on 1 March 2023 in the scientific literature databases PubMed, Cochrane Library, Wiley Online Library and Science Direct. Information on the success of OSA treatment with CPAP and MAD was sought.
The focus question was formulated by using the PICO (population (P), intervention (I), control (C), and outcome (O)) study design protocol: In adults diagnosed with obstructive sleep apnea, how does the effectiveness of Continuous Positive Airway Pressure (CPAP) compare to Mandibular Advancement Devices (MAD) in terms of reducing apnea-hypopnea index (AHI)? The PICO question components and information are displayed in table 1.

2. Selection of studies

The articles were investigated independently by 2 authors. Researchers discussed and compared their selections and matched all the differences through discussion. The screening of all of the articles was done during the final stage. The exclusion of the articles was done after investigation of titles and abstracts.

Table 1.
PICO question

Component	Information
Population	Adults diagnosed with obstructive sleep apnea
Intervention	Continuous Positive Airway Pressure (CPAP)
Comparison	Mandibular Advancement Devices (MAD)
Outcome	Reduction in apnea-hypopnea index (AHI)

The decision, whether to include the publication or not, was done after the analysis of the full text, according to the inclusion and exclusion criteria.

3. Eligibility criteria

This systematic review of the scientific literature included studies, study participants, treatments and outcomes that met the specified criteria.

Criteria for inclusion of articles:

- Scientific studies describing the effectiveness of OSA treatment using CPAP and MAD.
- Human studies.
- Patients over 18 years of age.
- Studies in English.
- Studies with a sample size of 10 or more patients.
- Follow-up period of one month or more.

Criteria for exclusion of articles:

- Animal studies.
- Article published more than 5 years ago.
- Articles discussing the treatment of OMA with only one of the machines, i.e. CPAP or MAD.
- Sample size less than 10 patients.
- Pilot studies.
- Studies in languages other than English.
- Meta-analyses, systematic literature reviews, books.

4. Search method

PubMed, Cochrane Library, Wiley Online Library and Science Direct scientific literature databases were searched using keywords: Obstructive sleep apnea, Mandibular advancement device, Continuous positive airway pressure. The first stage involved a process of identifying overlapping articles. Based on the titles of the articles, publications that were not relevant to the topic of this systematic literature review were then excluded. The abstracts of the remaining publications were then read and articles whose abstracts did not meet the objectives of this systematic review were excluded. All remaining articles were assessed according to the established inclusion and exclusion criteria. Articles that did not meet these inclusion criteria, as well as articles for which full access could not be obtained, were excluded. The full search strategy is illustrated graphically in Fig. 1 PRISMA Flow diagram.

5. Methodology for data collection

Information was collected from all articles that met the inclusion criteria:

- Publication details – authors and year of publication.
- Study characteristics – duration, phases and patient sample size.
- Efficacy results of MAD and CPAP treatment, described in quantitative and qualitative values with confidence intervals (standard deviation).
- Risk of bias in individual studies.

6. Risk of bias

The risk of bias in studies is related to missing or incomplete information that does not meet the objectives of the systematic review. It is also possible that the information is presented in an unstructured way, which may be due to bias on the part of the authors, which may have influenced the results of the studies analysed. The risk of bias for each study was assessed individually using the Cochrane appraisal tool [5]. Using the results obtained, Fig. 2 was constructed.

7. Overview of studies

This systematic review included 5 publications [6-10]. All included studies described treatment of OMA with CPAP and MAD. Study samples ranged from 30 to 103 subjects. A total of 367 patients were studied to evaluate OSA treatment. All five publications included prospective studies [6-10] and two publications included crossover studies [9-10].

Lai et al. [6] enrolled 105 patients aged 18 years or older with a baseline AHI of ≥30 after their first polysomnography. The study investigated the treatment of OSA in the presence and absence of mandibular retrognathia. In this literature review, it was chosen to only include the data of subjects who did not have mandibular retrognathia in the review of outcomes, in order to make the comparison of patients as similar as possible. Silva et al. [7] included 79 patients. Patients with an AHI of ≥ 5 and < 15 sleep events per hour were included, irrespective of existing symptoms. Venema et al. [8] included 103 patients.

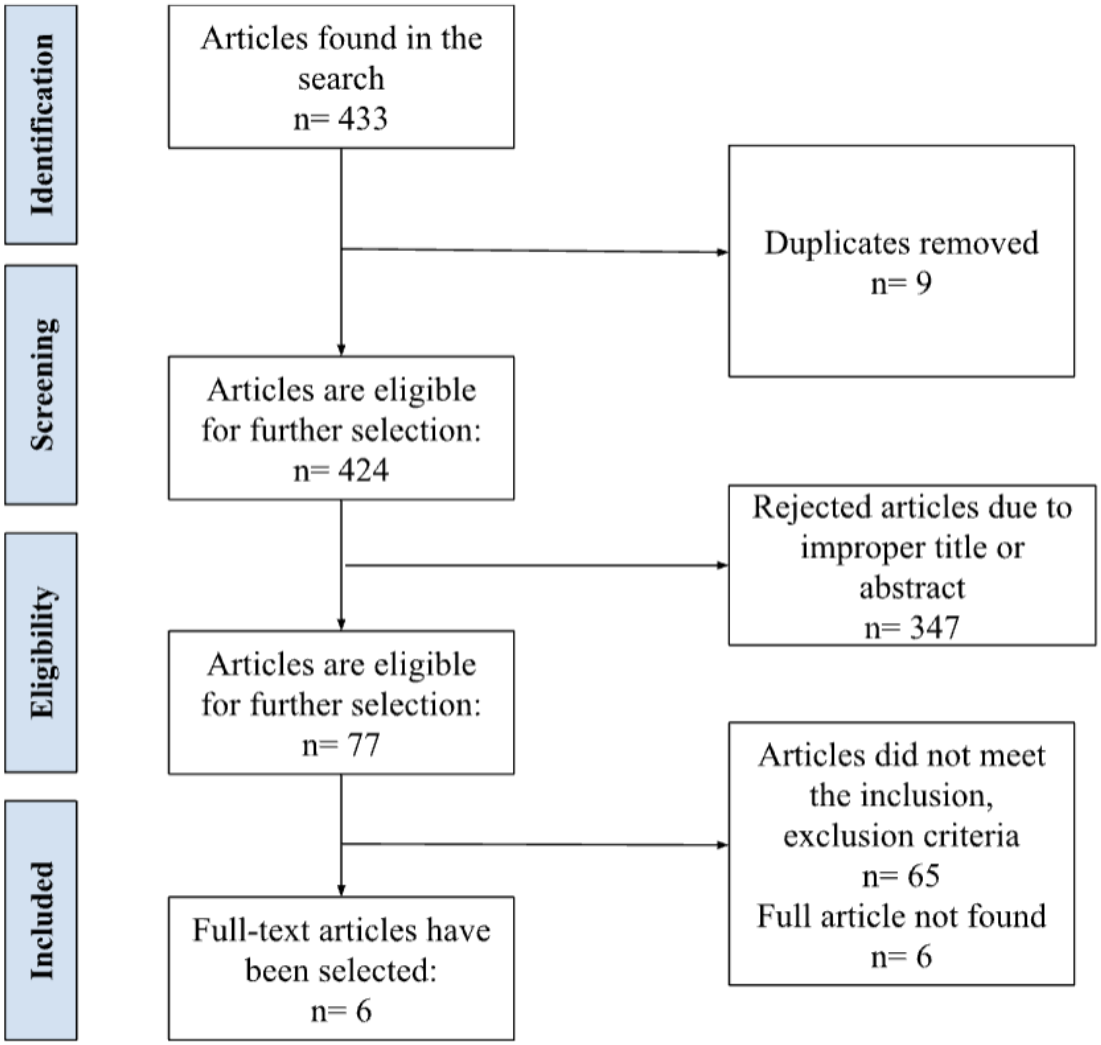

Fig. 1.
PRISMA Flow diagram

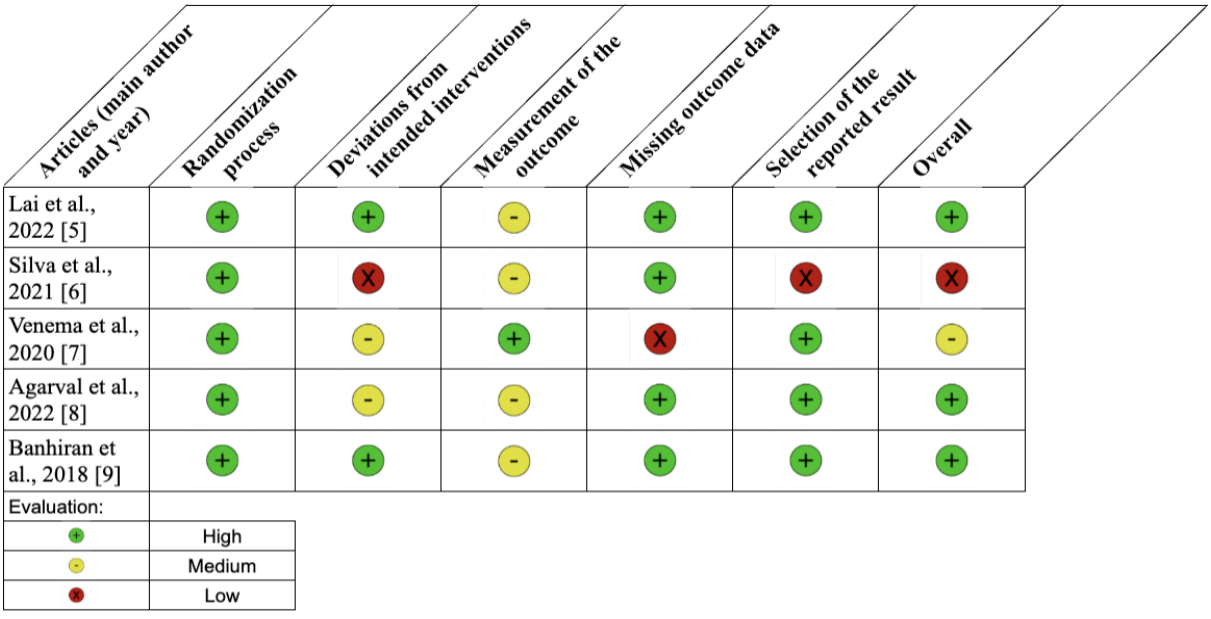

Fig. 2.
Risk of bias

At baseline, patients were randomised to treatment with MAD or CPAP. This study is a longitudinal observational study with patients initially enrolled in another randomised controlled clinical trial. This 10-year follow-up study focused on assessing only those patients who are still using the originally prescribed treatment. Agarwal et al. [9] enrolled 30 patients in the study. Patients were divided into three groups of 10 patients based on baseline AHI values, as follows: Group I: mild OSA (AHI= 5- 14.9); Group II: moderate OSA (AHI= 15- 29.9); Group III: severe OSA (AHI >30). The study by Banhiran et al. [10] included 50 patients with AHI ≥5 events per hour. This information is depicted in Table 2 baseline data.

The Apnea-Hypopnoea Index (AHI) is the total number of apnoeas and hypopnoeas recorded in a night-time sleep study divided by the total sleep time [11]. The AHI indicates the severity of obstructive sleep apnoea: Mild OMA (AHI 5- 14.9 per hour), moderate OMA (AHI 15- 29.9 per hour) and severe OMA (AHI ≥ 30 per hour) [12].

A statistically significant difference between the MAD and CPAP group was found by Lai et al. [6] ($p < 0.05$), Agarwal et al. [9] ($p < 0.05$) and Banhiran et al. [10] ($p < 0.001$). Statistically significant changes between baseline and post-treatment measurements in the MAD group were found by Lai et al. [6] ($p < 0.05$), Silva et al. [7] ($p < 0.05$), Venema et al. [8] ($p < 0.05$) . Statistically significant changes between baseline and post-treatment measurements in the CPAP group were found by Lai et al. [6] ($p < 0.05$), Silva et al. [7] ($p < 0.05$), Venema et al. [8] ($p < 0.05$). A statistically significant change between the control group and the applied treatment (CPAP or MAD) was found by Silva et al. [7] ($p < 0.05$). This information is depicted in table 3 AHI results.

Table 2.
Baseline data

	Author, year	Type of study	Sample size	Inspection times	Groups (n)	AHI before treatment Mean ± SD
1	Lai et al., 2022 [5]	Prospective	n= 105	6 months 12 months	Group A- CPAP MR (33) Group B- MAD MR (32) Group C- CPAP MR- (20) Group D- MAD MR- (20) (with mandibular retrognathia (MR) and without mandibular retrognathia (MR-))	CPAP= 39.14 ± 3.54 MAD= 37.81 ± 6.01
2	Silva et al., 2021 [6]	Prospective	n= 79	6 months 12 months	CPAP (31) MAD (25) Control (23)	CPAP= 10.0 ± 4.6 MAD= 9.3 ± 5.2
3	Venema et al., 2020 [7]	Prospective	n=103	3 months 1 year 2 years 10 years	CPAP (52) MAD (51)	CPAP= 49.2 ± 26.1 MAD= 31.7 ± 20.6
4	Agarval et al., 2022 [8]	Prospective crossover	n=30	2 months	Group 1- mild OMA (10) Group 2- moderate OMA (10) Group 3- severe OMA(10) In each group, 5 patients received MAD and 5 patients CPAP. Crossover study	Group 1= 13.84 ± 0.97 Group 2= 26.41 ± 2.63 Group 3= 36.80 ± 2.13
5	Banhiran et al., 2018 [9]	Prospective crossover	n= 50	12 weeks (6 weeks MAD, 6 weeks CPAP)	Group A- CPAP -> MAD (25) Group B- MAD -> CPAP (25) Crossover study	Group A= 39.0 ± 27.7 Group B= 39.3 ± 23.4

Table 3
AHI results

	Author, year	AHI after treatment Mean ± SD		P
		MAD	CPAP	
1	Lai et al., 2022 [5]	6 months:13.44 ± 2.82 A (n=18) 12 months: 12.73 ± 3.03 A (n=18)	6 months: 3.27 ± 2.60 *A (n=18) 12 months: 2.81 ± 1.93 *A (n=18)	<.05
2	Silva et al., 2021 [6]	6 months: 4.2 ± 9.1 AB (n=20) 12 months: 3.8 ± 12.6 AB (n=19)	6 months: 1.2 ± 9.9 AB (n=16) 12 months: 1.7 ± 14.2 AB (n=15)	<.01
3	Venema et al., 2020 [7]	3 months: 2.2 ± 3.6 A (n=14) 1 year: 1.3 ± 1.9 A (n=14) 2 years: 2.7 ± 3.2 A (n=14) 10 years: 9.9 ± 10.3 A (n=14)	3months: 1.7 ± 2.9 A (n=17) 1 years: 1.7 ± 3.4 A (n=17) 2 years: 0.47 ± 1.1 A (n=17) 10 years: 3.4 ± 5.4 A (n=17)	<.05
4	Agarval et al., 2022 [8]	Group 1= 3.36 ± 0.90 (n=10) Group 2= 5.44 ± 1.88 (n=10) Group 3= 6.15 ± 2.43 (n=10)	Group 1= 0.84 ± 0.27 * (n=10) Group 2= 3.35 ± 0.95 * (n=10) Group 3= 2.86 ± 1.19 * (n=10)	<.05
5	Banhiran et al., 2018 [9]	12.92 ± 2.05 (n=43)	2.56 ± 0.49 * (n=43)	<.001
*Statistically significant difference between MAD ir CPAP treatment				
A Statistically significant difference between initial testing and after treatment				
B Statistically significant difference between chosen treatment method and control group				

Discussion

This study compared the effectiveness of CPAP and MAD treatment in patients with OSA based on research publications. The results show that both MAD and CPAP treatments are effective, with an improvement in the AHI compared to baseline [7, 8]. However, when comparing MAD and CPAP with each other for the treatment of OSA, a higher efficacy of CPAP was observed with respect to the AHI index [6, 9, 10].

The most common side-effects of CPAP were dry throat and discomfort with the device, while MAD-related side-effects were jaw pain and increased salivation. Other side effects associated with CPAP were nasal congestion/irritation, nasal discharge, facial pain (on contact with the mask), irritated eye (air leakage), facial skin damage, embarrassment (poor self-esteem), and burden due to cleaning the device. Other side effects associated with MADs included: malocclusion, halitosis, dry mouth or pharynx, gum pain, toothache [9, 10].

Although CPAP was superior to MAD in reducing current and past respiratory problems detected by polysomnography, it is also important to realise that the success of any treatment depends on more than just the objective response. Getting used to the machine and its long-term use is also important in treatment, as it determines the success of the treatment and the patient's use and acceptance of the machine. CPAP was more effective than MAD in reducing AHI, but MAD was more acceptable and more frequently used [6].

Pattipati et al. in her recent meta-analysis revealed that there was a significant and greater decrease in AHI among patients who received treatment with CPAP compared to those who used MAD. The analysis suggests that CPAP is a more effective treatment option for OSA as compared to MAD. However, MAD may be a suitable alternative therapy for certain patients, especially for those who have difficulty adhering to CPAP due to its side effects [13].

As per the analysis, CPAP is found to be more effective than MAD for the treatment of OSA. However, it is important to note that the evidence supporting this conclusion is limited to a few studies. More studies are needed to determine the long-term efficacy and adherence of oral appliances like MAD in the treatment of OSA.

Conclusions

1. CPAP as treatment for OSA proves to be useful, by reducing AHI.
2. MAD as treatment for OSA proves to be useful, by reducing AHI.
3. When comparing MAD with CPAP, CPAP shows to be more effective then MAD.

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