

Adherence of Mandibular Advancement Device for Obstructive Sleep Apnea in a Veteran Population

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Study Objectives: To determine the adherence rate of a custom-fit mandibular advancement device (MAD), and the factors that may affect this adherence within a veteran population with obstructive sleep apnea (OSA).

Methods: This is a retrospective chart review on veteran patient adherence for the treatment for OSA. Adherence was defined as wearing the MAD for at least 4 hours per night and for at least 70% of that time. Patients ranged from having mild to severe OSA and many were not compliant with continuous positive airway pressure (CPAP) usage. A DentiTrac® microrecorder (Braebon, <https://www.braebon.com/products/dentitrac/>, Ontario, Canada) was embedded within each MAD to record patient compliance. Compliance data were recorded at days 14, 30, and 90. Patient demographic and clinical characteristics were reviewed to identify additional factors affecting adherence.

Results: The 57 subjects had an average age of 54.6 years, body mass index 30.7 kg/m², and average apnea-hypopnea index (AHI) before treatment of 15.3 events per hour. Adherence was at 72% after 14 days (95% confidence interval = 64% to 80%), 67% at 30 days (95% confidence interval = 59% to 77%) and 63% at 90 days (55% to 72%). A repeated-measures mixed model indicated that pretreatment AHI was negatively related to the 14-day, 30-day, and 90-day adherence percentages ($P = 0.025$).

Conclusions: The MAD should be considered a valuable first-line treatment option for mild or moderate OSA in the veteran population, although maintaining adherence across time seems to be a challenge. It appears that MAD adherence may be superior to CPAP adherence in this population.

Keywords: adherence; apnea-hypopnea index; compliance; mandibular advancement device; microrecorder; obstructive sleep apnea; veterans; oral appliance therapy

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INTRODUCTION

Obstructive sleep apnea (OSA) is a repetitive collapse of the upper airway during sleep. This disorder is described as ranging from obstructive apneas, hypopneas, and/or respiratory effort-related arousals.¹ OSA is the most common sleep-related breathing disorder.¹ It is estimated that one billion people worldwide have OSA in some form. Of that total, treatment is needed for 454 million people who have moderate to severe OSA.² If left untreated, OSA can result in increased risk of excessive daytime sleepiness, decrease in cognitive function, hypertension, cardiovascular disease, and in severe cases, death.^{3,4} Treatments range from behavioral, nonsurgical, surgical, and or a combination of these. The first-line nonsurgical treatment is fixed continuous positive airway pressure (CPAP) and its effectiveness is well established.^{5,6} However, adherence is believed to be on average less than 50%, with different studies reporting adherence ranging from 17% to 71%. Adherence has been established as the usage of the CPAP machine for a minimum of 4 hours in a

24-hour period for 70% of use.^{7,8} Adherence for a mandibular advancement device (MAD) is defined in the same way. In the veteran population, when good adherence was defined as use of CPAP on 3 or more nights per week, only 39% to 53% of patients with mild to severe OSA maintained good adherence.⁹ Randomized controlled trials have shown that oral appliances are a good alternative because of their low cost, relative comfort, and ease of use, which results in greater patient adherence.⁹⁻¹¹ Traditionally, adherence for oral appliances is self-reported by the patient but more objective measurements can now be reported with radiofrequency identification, tooth microphones, or different microsensors.

The primary aim of the study was to determine the adherence rate of a custom-fit MAD within a veteran population with OSA and, secondarily, to describe factors that may affect adherence.

METHODS

This is a retrospective chart review on patients of the

Table 1. Patient population characteristics.

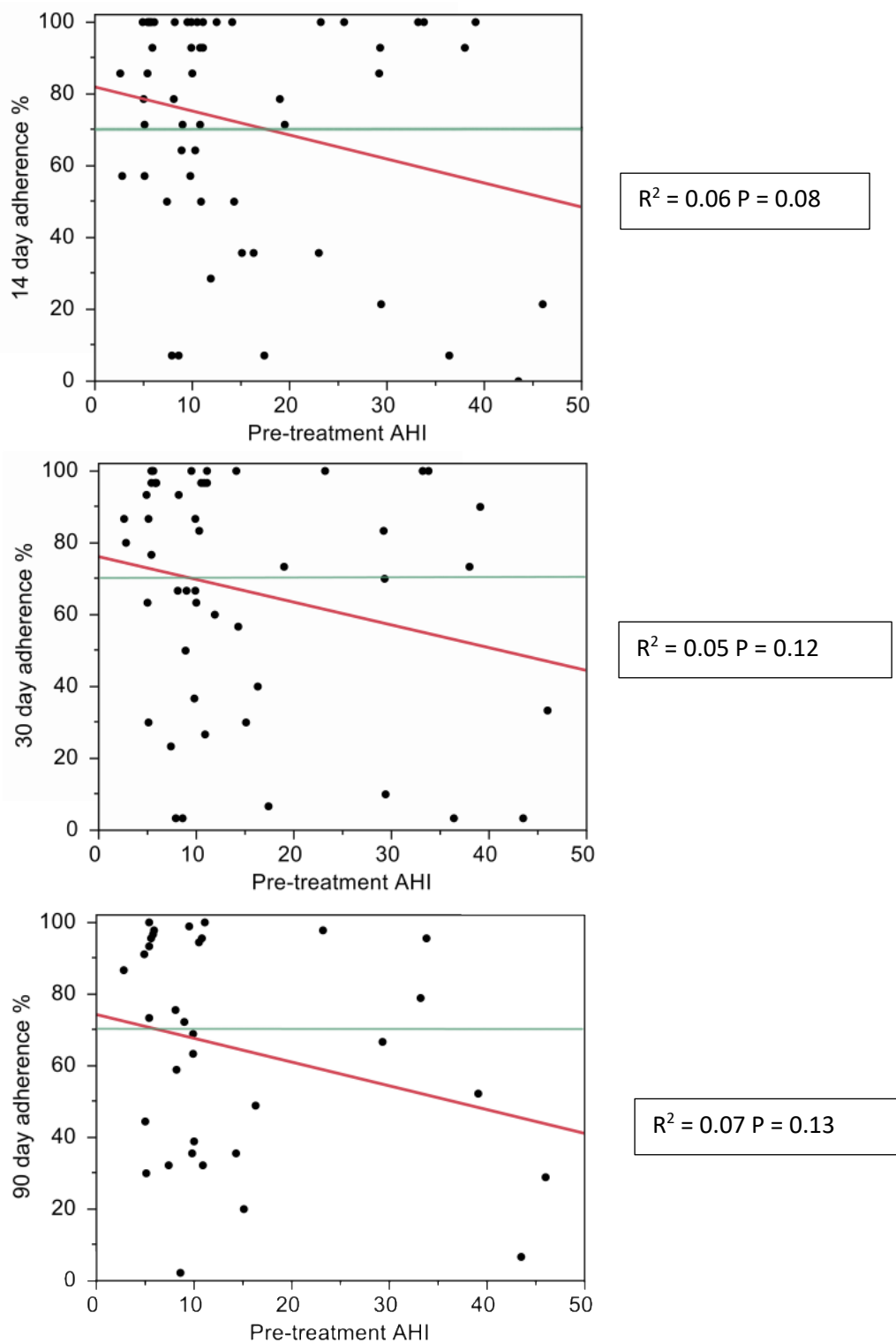
Characteristic	N	Percentage	14-Day Adherence %		30-Day Adherence %		90-Day Adherence %	
			Mean	<i>P</i> ^a	Mean	Mean	Mean	
Sex				0.277				
F	11	19%	80		71		70	
M	46	81%	70		66		64	
Race				0.704				
African American	27	47%	76		69		67	
Caucasian	28	49%	68		65		65	
Other	2	4%	71		63		51	
Diagnoses								
TBI				0.885				
N	55	96%	72		67		66	
Y	2	4%	75		50		48	
PTSD				0.798				
N	35	61%	71		70		66	
Y	22	39%	73		61		62	
Non-PTSD				0.836				
N	30	53%	73		71		75	
Y	27	47%	71		61		53	
HTN				0.207				
N	30	53%	67		59		59	
Y	27	47%	78		75		69	
COPD/asthma				0.275				
N	55	96%	71		66		65	
Y	2	4%	93		80		68	
CHF/CAD				0.584				
N	51	89%	73		67		67	
Y	6	11%	63		61		55	
Stroke/TIA				0.617				
N	52	91%	71		65		65	
Y	5	9%	79		77		60	
^b Switch PAP to OAT				0.254				
dual	1	2%	100		97		94	
N	18	32%	80		74		67	
Y	38	67%	67		62		62	

BMI, body mass index; CHF/CAD, chronic heart failure/coronary artery disease; COPD, chronic obstructive pulmonary disease; HTN, hypertension; Non-PTSD, depression/anxiety/bipolar/ADHD/adjustment disorder; OAT, oral appliance therapy; PAP, positive airway pressure; PTSD, posttraumatic stress disorder; TBI, traumatic brain injury; TIA, transient ischemic attack.

^aValues of *P* calculated from *t*-test/analysis of variance or correlation.

^b Of the 57 veterans who received a mandibular advancement device for their obstructive sleep apnea, 38 were unsuccessful with PAP and switched to OAT, 18 had no previous PAP therapy, and 1 used a PAP in conjunction with their OAT.

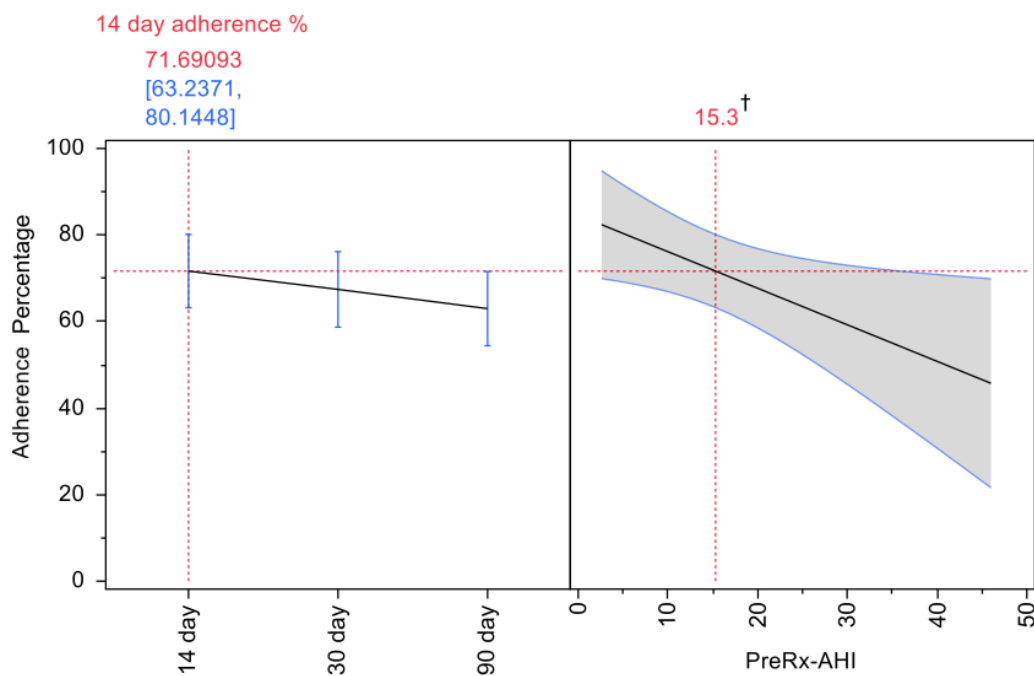
Figure 1. Daily Adherence Percentage at 14-, 30- and 90- days by Pre-treatment AHI



Green Line: Denotes 70% adherence cut-off
 Red Line: Trend Line

McGuire Veterans Affairs Medical Center: Integrated Sleep Disorders Center receiving a custom-fit MAD for the treatment for OSA from November 2016 to September 2017. Patients were eligible for use of the MAD according

to the Veteran Affairs criteria: mild to moderate OSA, or moderate to severe OSA after failed CPAP, or in conjunction with other modalities. Each MAD appliance had a DentiTrac® microrecorder embedded within the

Figure 2. Adherence Percentage, Estimates from (repeated-measures) Mixed-Model

Mixed marginal model profiler for adherence percentage by pre-treatment AHI for days 14, 30 and 90, including 95% confidence intervals.

† Average PreRx-AHI

device. Compliance data were uploaded from the DentiTrac® base station. Daily adherence was defined as the percentage of days wearing the MAD for at least 4 hours. Patient adherence was defined as daily adherence of at least 70% (yes or no). Adherence was calculated at day 14, day 30, and day 90 of wearing the MAD. The fit of the MAD was assessed after 14 days as well as adherence data from the microrecorder. Patient demographic and clinical characteristics were reviewed to determine factors affecting adherence. Fifty-seven patients received a custom-made MAD and were thus eligible for the study. Statistical analysis used a modified intent-to-treat protocol. The modification was that all patients with data at each of the follow-up occasions were analyzed. That is, 54 patients had data at 14 days, 48 at 30 days, and 35 at 90 days.

RESULTS

The 57 subjects (Table 1) had an average age of 54.6 years, body mass index 30.7 kg/m², and an average before-treatment apnea-hypopnea index (AHI) of 15.3 events per hour. After 14 days 65% of the patients were adherent, and at 30 days 56% were adherent, and at 90 days 50% were adherent.

Each of the predictors in Table 1 were screened along with age, body mass index, and pretreatment AHI to determine which may be related to the 14-day adherence percentage. None passed a screening significance level of $\alpha = 0.20$ except pretreatment AHI. Figure 1 shows scatterplots for the trend at each time point.

A repeated-measures mixed model indicated two things: (1) Pre-treatment AHI was negatively related to the 14-day, 30-day, and 90-day adherence percentages ($P = 0.025$). That is, the higher the AHI the lower the adherence. (2) Adherence percentage showed a nominal decline across the three time periods ($P = 0.17$). At the 14-day recall, the adherence percentage was 72% (95% confidence interval 63% to 80%), and by the 90-day recall adherence was 63% (95% confidence interval = 54% to 72%) Figure 2 and Table 2.

DISCUSSION

Self-reporting was the main way that patient adherence was recorded for oral appliances. Technology has allowed for the placement of adherence tracking devices into an oral device. The inclusion of objective tracking of these devices can now provide a true adherence percentage. Oral appliance therapy with the MAD should be considered a valuable first-line treatment option for mild to moderate OSA in the veteran population, and with objective adherence reporting, OSA care for veterans can be better understood for providers. The efficacy of CPAP has been endorsed across many studies, when used properly and with good adherence.^{1-6, 12-23} Unfortunately, the adherence rates of CPAP are generally considered to be at approximately 50%.¹⁹ Because of the increased adherence, decreased cost, ease of use, and portability custom fit MADs should be considered a first-line treatment for OSA.

Table 2. Adherence percentage and estimates from a repeated-measures mixed model.

Characteristic	Mean	SD	14-Day Adherence %		30-Day	90-Day
			Correlation	P	Adherence %	Adherence %
Age	30.7	4.1	-0.05	0.710	0.03	0.08
BMI	54.6	12.4	0.00	0.976	-0.01	-0.12
Pre-treatment AHI	15.3	11.4	0.83	<.0001	-0.23	-0.26

AHI, apnea-hypopnea index; BMI, body mass index; SD, standard deviation.

Even with the ultimate need for a CPAP, a custom MAD would allow the patient to have an additional treatment option for OSA when CPAP adherence is not possible. A similar study with a veteran population reported adherence with custom MADs at 66.8% and 58.3% for the 2-week and 6-month recalls, respectively.²⁴ These results were on par with the findings of this study. Socioeconomic challenges and lack of a support system increase the lack of adherence within the veteran population.²⁴ These challenges could be a reason for the slight decrease in adherence between veteran and general population studies.

Previous studies have indicated that AHI was a strong predictor of long-term CPAP adherence.²⁵⁻²⁷ Patients with a higher AHI were more likely to adhere to long-term CPAP usage compared with patients with lower AHI.²⁵⁻²⁷ Studies using oral appliances did not find a link between adherence and severity of OSA.²⁸ However, a statistical association was seen between increased baseline AHI and lower adherence percentages. The higher the baseline AHI, the lower the adherence rates ($P=0.025$). The current study did not find any significant association of adherence to PTSD or other comorbidities within the veteran population. This contradicts some theories linking the two.²⁶

The use of CPAP is seen to be more effective than MADs in controlling OSA. However, 10% to 50% of the patients who are prescribed a CPAP find it intolerable to use and therefore use an alternative treatment option. The remaining patients that do use CPAP have an adherence rate of approximately 50%.^{19,20} When patients were able to use both oral appliance therapy and CPAP, most patients preferred the oral device over the CPAP.^{11,21} The increase in adherence with MADs over CPAP allows for the overall effectiveness of MADs to be the same, if not better, in controlling OSA.²³ Oral devices have been seen to decrease nighttime diastolic blood pressure. A significant decrease was observed when the oral device was compared to CPAP ($P<0.05$), placebo ($P<0.05$), and baseline ($P<0.01$).²⁹ Patients with positional apnea would also benefit from a MAD because on average the supine position is more susceptible to OSA.²²

There are limitations to the current study. Although every attempt was made to measure adherence at every

time point, the missing patient follow-up data could result in overstating adherence.

Custom MADs should be considered a valuable first-line treatment option for mild or moderate OSA in the veteran population. Long-term maintenance of adherence is still a challenge that needs to be improved. However, adherence using MAD may be superior to that of CPAP in this population.

ABBREVIATIONS

AHI: apnea-hypopnea index
 BMI: body mass index
 CHF/CAD: chronic heart failure/coronary artery disease
 COPD: chronic obstructive pulmonary disease
 CPAP: continuous positive airway pressure
 HTN: hypertension
 MAD: mandibular advancement device
 Non-PTSD: depression / anxiety / bipolar / ADHD / adjustment disorder
 OAT: oral appliance therapy
 OSA: obstructive sleep apnea
 PAP: positive airway pressure
 PTSD: posttraumatic stress disorder
 TBI: traumatic brain injury
 TIA: transient ischemic attack.

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DISCLOSURE STATEMENT

The authors have no conflicts of interest to disclose.