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Weight gain may affect mandibular advancement device therapy in patients with obstructive sleep apnea: a retrospective study

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Abstract

Purpose The aim was to analyze whether or not weight gain influences the treatment outcome of patients with obstructive sleep apnea (OSA) treated with mandibular advancement devices (MAD).

Methods As a part of a follow-up study among OSA patients treated with MAD in primary oral health care, a group of 28 patients reporting worsening of daytime or nighttime symptoms of OSA was given closer examination. Altogether, 21 subjects had a complete set of recordings and were enrolled into the study.

Results Only three subjects had lost weight during the study period. The mean weight gain of 3.6 kg ± 7.1 kg was significant ($p = 0.035$). According to linear regression, weight gain was independently significantly associated with lower mean peripheral oxygen saturation 92.4 (SD 1.8 (% per hour) ($p = 0.019$)) and lowest oxygen saturation 80.1 (SD 7.2 (%) ($p = 0.024$)) scores.

Conclusions Weight gain is detrimentally associated with MAD treatment in patients with OSA. These findings suggest that regular follow-up by an experienced dentist is advisable to assess for possible worsening of OSA. Patient support to encourage weight control may be an important adjunct to MAD treatment for OSA.

Keywords Obstructive sleep apnea · Mandibular advancement device · Overweight · Primary health care

Introduction

Obstructive sleep apnea (OSA) is a common breathing disorder characterized by upper airway collapse during sleep. When obstructions occur repeatedly, they may result in oxygen desaturation and arousals from sleep [1]. OSA is a growing global health problem [1, 2]. Its major risk factors are overweight or obesity, gender, age, and craniofacial anatomy. Its major symptoms are snoring with witnessed apneas and daytime tiredness [1]. Untreated OSA may lead to other severe conditions as myocardial infarction, congestive heart failure, stroke, and diabetes mellitus [1].

The gold standard for treating OSA is the continuous positive airway pressure device (CPAP) [3, 4]. However, mandibular advancement devices (MAD) have also been shown to be effective, especially in the treatment of mild to moderate OSA [5, 6]. In fact, some studies have reported comparable outcomes with MAD and CPAP [7, 8]. Also, follow-up studies have shown good compliance with MAD and that the treatment can improve patients' quality of life and sleep, reduce loud snoring, and decrease daytime tiredness [9, 10]. In a recent study by Gjerde et al. [11], MADs also showed promising outcomes in moderate and severe OSA patients who did not adapt to CPAP treatment.

Two out of three patients with OSA are reportedly overweight [12]. According to the World Health Organization (WHO), worldwide obesity has more than doubled since

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1980. In 2014, 39% of adults over 18 years were overweight (body mass index, BMI, equal to 25 or more) and 13% were obese (BMI equal to 30 or more) [13]. The growing problem of weight gain augments the number of patients with OSA worldwide, increasing the economic burden across societies.

Weight has a significant role not only in the development of OSA, but also in the progression of the disease. A study by Berger et al. [14] showed that the increase in apnea-hypopnea index (AHI) was mainly dependent on an increase in BMI. Peppard et al. [15] found in their longitudinal study that a 10% weight gain predicts a 32% increase in AHI. Tuomilehto et al. [16] and Kajaste et al. [17] underscored the importance of weight reduction in the treatment of mild OSA. A recent study by Kulkas et al. [18], in which they used a novel-adjusted AHI parameter (incorporating individual event severity, i.e., taking into account the morphology, duration, and depth of obstruction events), demonstrated that weight loss, in particular, affects more positively the individual respiratory events in non-supine than in supine position.

Oxygen saturation during sleep is important for assessing the severity of OSA. A study by Gries et al. [19] showed that the mean oxygen saturation level was significantly lower in OSA patients than in healthy subjects (93.5 ± 3.8 vs. 96.5 ± 1.5, $p < 0.0005$). A corresponding difference was also found in the lowest oxygen saturation level, respectively (65.9 ± 22.6 vs. 90.4 ± 3.1, $p < 0.0005$).

Good compliance was found in a long-term follow-up randomized controlled trial performed on patients with OSA treated with oral appliances [9], as well as in earlier studies [5]. However, in another study among general dental practitioners and specialist dentists working in community dental care, we found differences in their knowledge and attitudes of how to treat these patients [20]. Nevertheless, among those patients who continued visiting a dentist in the community dental care clinic, some complained of recurrent symptoms of OSA, despite regular use of the MAD. These patients were referred for more detailed examinations. In the present retrospective study using patient records, we aimed to evaluate whether or not changes in weight played a role in the worsening of OSA.

Material and methods

The clinical records of 28 patients with OSA (age range 39–75 years, 14 men) were retrospectively examined. Twenty-one patients had a complete set of recordings and were eligible for the study. All patients had been treated with a similar Herbst-type MAD, which was fabricated free of charge to them in community dental care in Helsinki, Finland. All MADs were fabricated at the same dental laboratory and adjusted by a specialist dentist. The patients included in the present study had complained of worsening recurrent symptoms despite the ongoing treatment with MAD and were seeking care on their own initiative. Both the diagnostic study prior to treatment and the control studies were performed at home using an ambulatory, level 3 polysomnographic (PSG) device (Nox T3, Resmed®). All subjects gave a written consent.

The following data were recorded during record review for the present study:

Descriptive data: gender, age, average follow-up time in years, weight at baseline and at follow-up PSG recordings, former treatment of OSA before MAD treatment, and ongoing medications.

Data from PSG recordings: apnea-hypopnea index (AHI) in respiratory events per hour, snoring, and mean and lowest peripheral oxygen saturation percentages.

Statistical methods

Paired sample *t* test was used to compare the mean outcomes between the two occasions. Linear regression models were fitted to analyze the associations of weight change and the variation of AHI, mean oxygen saturation score (mean % per hour), and lowest oxygen saturation score (%) during the follow-up sleep study. Independent variables entered in the models were age (years), gender (male = 0, female = 1), and weight change (kilograms). SPSS® statistical software (version 22) was used for the analyses.

Results

Altogether, 21 patients were included in the present study, 12 men (mean age 58.5; SD 9.5) and 9 women (mean age 64.0; SD 9.2, $p = 0.20$). The mean follow-up time was 5.5 years (SD 1.8).

Prior to MAD treatment, CPAP was unsuccessfully used by three patients. After the diagnostic PSG, treatment with CPAP was initiated for 17 patients. Regular medication for elevated blood pressure was used by 67% of patients, regular use of statins by 38%, and anticoagulants and thyroxine by 24%. One patient had no regular medication.

Table 1 Mean values of the studied items prior to treatment and at visit with MAD in use. Paired sample *t* test

	Prior to treatment		With MAD		
$n = 21$	Mean	SD	Mean	SD	*p* value
Weight (kg)	84.6	11.3	88.2	13.7	0.035
AHI	22.1	16.6	19.3	13.9	0.44
Oxygen saturation (%/hour)	93.5	1.8	92.4	1.8	0.001
Lowest oxygen saturation (%)	84.4	7.7	80.1	7.3	0.23

AHI apnea/hypopnea index, *SD* standard deviation

Table 2 Linear regression models for the associations of weight gain and mean AHI per hour, mean oxygen saturation %, and lowest oxygen saturation scores assessed by ambulatory polysomnography at follow-up. Adjusted by gender and age

	AHI			Mean oxygen saturation			Lowest oxygen saturation		
$n = 21$	β	S.E.	p	β	S.E.	p	β	S.E.	p
Gender (female)	− 5.634	6.288	0.383	− 0.032	0.724	0.965	− 0.318	2.915	0.914
Age	− 0.223	0.341	0.522	− 0.095	0.039	0.027	− 0.339	0.158	0.046
Weight gain	0.838	0.425	0.065	− 0.126	0.049	0.019	− 0.487	0.197	0.024
			$R^2 = 0.21$			$R^2 = 0.39$			$R^2 = 0.36$

AHI apnea-hypopnea index

β regression coefficient, *S.E.* standard error (both unstandardized), R^2 not adjusted

Only three subjects had lost weight during the study period. The mean weight gain was significant ($p = 0.035$) (Table 1). Also, the mean peripheral percentage oxygen saturation was significantly lower at follow-up with MAD in use than at baseline before treatment ($p = 0.001$) (Table 1).

According to linear regression, weight gain was independently significantly associated with the lower mean peripheral oxygen saturation (% per hour) ($p = 0.019$) and lowest oxygen saturation scores ($p = 0.024$) (Table 2). The age- and gender-adjusted regression models explained 39% of the variation of mean oxygen and 36% of the lowest oxygen saturations (Table 2).

Discussion

The main finding of our study is that in patients with OSA, weight gain may negatively influence the effectivity of MAD treatment. Additionally, continuing follow-up care may be critically important to assure patients of effective therapy with MAD.

The patient medical history of sleep-related symptoms along with the number of respiratory events per hour (apnea-hypopnea index or AHI) has long been the standard way to measure severity of sleep apnea. A single apnea or hypopnea is defined as an event of 10 s or longer. The convention used to classify OSA severity categorizes OSA as mild for 5–14 respiratory events per hour, moderate for 15–30 events per hour, and severe for 30 or more events per hour [4]. However, recent studies have introduced the importance of more accurate diagnostics to capture a more complete picture of OSA. It has been suggested that the degree of severity of OSA should not depend only on the number of respiratory events, but should also consider the duration of events and the effect on oxygen desaturations [21]. Our findings regarding oxygen saturation do lend support to the idea of seeking a more complete description of OSA severity.

Previous studies have shown that weight reduction positively influences sleep apnea patients [15, 16]. In 2000, Peppard et al. found that weight change was positively related to change in AHI [15]. They defined even more specifically that a one percentage change in weight was associated with approximately 3% change in AHI. Also, Tuomikoski et al. studied mild OSA patients and found an average of 10.6% weight loss also improved the mean oxygen saturation [16]. It is noteworthy that weight gain occurred in the majority of our patients. Furthermore, our results indicate that even a relatively slight increase in weight may be detrimental to MAD treatment outcome. Due to weight gain, 17 of our 21 patients required the initiation of CPAP treatment.

A limitation of the present study is the relatively small sample size. All conclusions must therefore be drawn cautiously. Furthermore the subjects in our study were a convenience sample of patients seeking care for their worsened symptoms of OSA, despite the ongoing MAD treatment. Only those who had a complete set of recordings were eligible for the study. These circumstances imply that our study population was highly selected decreasing our ability to generalize our findings to other populations. Another limitation of the present study is there was no control group enrolled. However, our retrospective clinical setting may contribute pragmatic data from real-life conditions [22].

Our results suggest the need for regular monitoring of patients with OSA who receive MAD therapy. Our findings further suggest that for patients with OSA, a more intensive focus on weight control is necessary.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval For this type of study, formal consent is not required.

Informed consent Informed consent was obtained from all individual participants included in the study.

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