

Effect of Mandibular Repositioning Appliance on Nasal Resistance of A Sample of Obstructive Sleep Apnoea Hypopnoea Syndrome Patients



Medical Science

KEYWORDS: obstructive sleep apnoea (OSA), Mandibular repositioning appliance (MRA), Rhinomanometer.

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ABSTRACT

Obstructive Sleep Apnoea / Hypopnoea Syndrome (OSAHS) is associated with obstruction of the upper airway and occurs as a result of repeated closure of the upper airway during sleep, either by anatomical or patho-physiological factors. The aim of this study is to clinically investigate the changes in nasal resistance of right and left nostrils when a mandibular repositioning appliance (MRA) was used for the treatment of OSAHS and to suggest possible improvement in research technology when using the MRA. A 23 OSAHS white Caucasian male patients aged 26-76 years were randomly selected and evaluated against 23 non-apnoeic subjects aged 26-60 years matched for race and sex from Fife region, Scotland. Anthropometric comparison is done for the body mass index (BMI) and the percentage of predicted neck circumference (PPNC). Rhinomanometer tests were used for the OSAHS patients and control before wearing the appliance and for the OSAHS group before and after wearing the MRA. Significant improvements in reduction of nasal resistance of the right and left nostrils after wearing the MRA.

INTRODUCTION

Sleep Apnoea is described as a potentially life-threatening breathing disorder in which periods of cessation of breathing (apnoeas) occurs in the presence of inspiratory effort [1-5]. Apnoea is a ten second breathing pause. Hypopnoea is a ten second event where there is continued breathing but ventilation is reduced by at least 50% from the previous baseline during sleep [6, 7]. The most serious disorder in terms of morbidity and mortality is claimed to be obstructive sleep apnoea [8].

Obstructive sleep apnoea / hypopnoea syndrome (OSAHS) is highly prevalent diseases [9] characterised by recurrent episodes of partial or complete obstruction of the upper airways during sleep [10]. A 4% of middle-aged men (30-60 years) and 2% of middle-aged women have OSAHS [10].

The prevalence of OSAHS is reported to be around 2% in the general population [11]. Numbers of researchers have reported that 70% of adults with (OSAHS) snored during childhood [1, 12-15] and 20% to 60% have been reported snoring in the elderly population [16]. The prevalence of the condition in children suggested to be between 7-12% [17-18]. Children who snore are reportedly mouth breathers [19, 20] or restless sleepers, have excessive daytime sleepiness, are hyperactive, [19-20], have poor hearing [20] or present with bilateral dental maxillary cross-bite [19].

Nasal continuous positive airway pressure (CPAP) is the primary treatment of OSAHS, but many patients are unable or unwilling to comply with this treatment. Of OSAHS patients in whom CPAP is recommended, 5-50% reject this treatment and 12-25% of the remaining patients can be expected to discontinue CPAP, especially if they have mild OSAHS and/or if they are not "subjectively sleepy" [22, 23].

The treatment of OSAHS may involve non-surgical and surgical techniques. *The non-surgical techniques include:* elimination of the aggravating factors, weight reduction, training, pharmacological therapy, electrical stimulation of the upper airway, ENT assessment plus any necessary treatment, CPAP, mandibular advancement appliances and nasal-valve dilators, while the Surgical techniques include: tracheostomy, nasal surgery, pharyngeal surgery (uvulo-palato-pharyngoplasty), maxillofacial surgery, tonsillectomy, adenoidectomy, tongue reduction and bariatric

surgery.

Several intra-oral appliances are developed for the treatment of upper airway obstruction. Oral appliances are devices used in purpose to re-position the mandible forward, thus modifying the position of the structures responsible of obstructing the upper airway for relieving snoring and obstructive sleep apnoea. The use of mandibular repositioning appliance is inexpensive when used for the treatment of mild to moderate cases of OSAHS compared to CPAP, which is the gold standard.

The aim of this research was to clinically assessing the nasal resistance when mandibular repositioning appliances (MRA) are used for the treatment of OSAHS.

MATERIALS AND METHODS

A case control study of 23 white Caucasians diagnosed with OSAHS and 23 subjects free from OSAHS selected randomly from patient attending the Orthodontic Clinic at Victoria Hospital, Kirkcaldy, Fife, Scotland. The main criteria of the subjects were not restricted by malocclusion and it was decided that due to the nature of the dental device, they would all be dentate. This was to maintain one standard design of the MRA, although the amount of bite opening and forward posture was individualized for each patient. The standard was to maintain minimal opening with maximal comfortable protrusion.

The inclusion criteria were as follows:

A. *The anomaly* group selection was based on the following:

- All subjects were previously diagnosed with OSAHS by polysomnographic diagnostic sleep studies (Edinburgh Sleep Laboratory) before presenting to the orthodontic clinic.
- The group consisted of 23 male, white Caucasian patients. The age ranged between 26-76 years.
- Subjects did not suffer from any chronic airway conditions or other chronic illnesses that would preclude them from using the appliance such as cancer patients who have had radiotherapy; the appliance may predispose them to oral cancer.
- Subjects had not undergone any surgery for the treatment of OSAHS.

B. The **control** group was based on the following:

- All subjects were in good medical health and did not suffer from any airway disease.
- The age group of the 23 adult males white Caucasian ranged between 26-60 years.
- All subjects were non-snorers

C. Anthropomorphic Measurements

Weight (kg) was recorded using TANITA–Body Fat Moni-

$$\text{Body Mass Index (BMI)} = \frac{\text{Weight (Kg)}}{\text{Height (m}^2\text{)}}$$

$$\text{Percentage of predicted neck circumference (PPNC)} = \frac{100 \times \text{neck circumference (mm)}}{[0.55 \times \text{height (cm)} + 310]}$$

D. The Rhinomanometer and Rhinometer Test

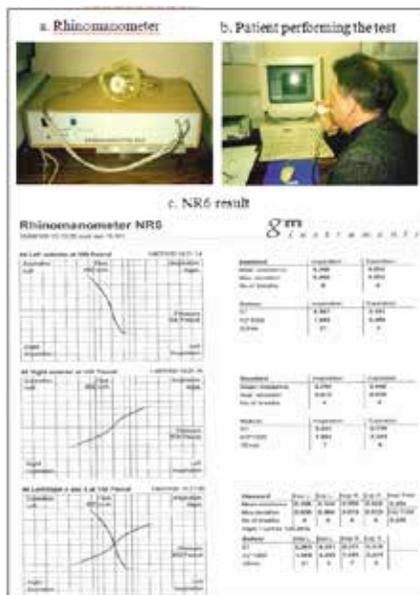
The NR6 (Clinical / Research Rhinomanometer (Fig. 1 a), supplied by (gm Instruments Ltd, 6 Ashgrove Rd, Kilwinning KA13 6PU, United Kingdom) measures nasal flow and the pressure producing the flow, using active anterior or posterior rhinomanometry, with either the Broms or standard technique as approved by the International Standardisation Committee. In addition it calculates and displays the Rohrer coefficients relating to the resultant curve.

Specification: (Range +/- 800 cc/sec, +/- 800 pa. Accuracy +/- 2%, Size / Weight: 27x8x30 cm/2kg). Easy to use, windows based program, graphical and numerical result presentation, be integrated into a nasal examination system comprising rhinometer, rhinomanometer, and database. Therhinomanometer tests were conducted for the 23 patients before and after wearing the appliance, and for the controls.

All patients and controls were sat down in the same position. They were shown how to place the tube in the anterior part of the nose, hold the mask tightly against the face, and breath normally while the lips were closed (Fig. 1b).

The test was recorded for four breaths for each nostril starting with the left one. The tests were then repeated to minimize the error, starting in the same order left first and then right (Fig. 1c).

Figure 1 (a. Rhinomanometer, b. Patient performing the test, c. NR6 result)

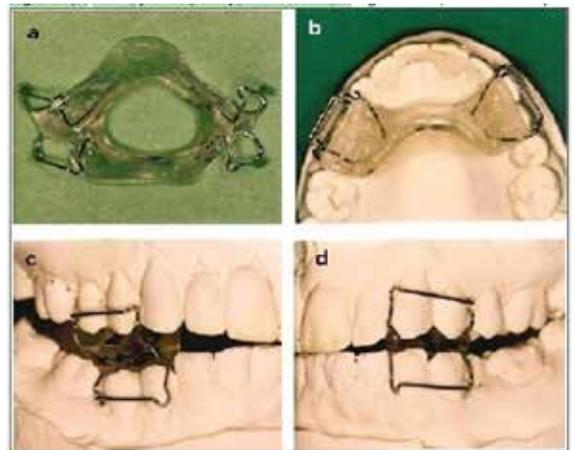


E. Mandibular Repositioning Appliance

The appliances were constructed at Victoria Hospital, Kirkcaldy. Impressions of the upper and lower arches were taken, together with a jaw registration with the mandible in a forward position. The objective was to record a position, which was 50% to 75% of the maximum protrusion as it has been reported that this amount of protrusion is required to maintain airway patency [23]. Experience has shown that this is best achieved by asking the patient to protrude his or her mandible as far as possible while making the registration, as inevitably the mandible tends to drift back a little while the registration is taken. The amount of opening was just sufficient to provide a breathing space and depended largely on the extent of the patient’s overbite. The mean amount of opening from the inter-cuspal position for the 23 patients was 6mm (range 3-9mm) and protrusion of 3-5mm. The impressions were poured in dental stone. Two sets of casts were used, one on which the upper and lower pieces were constructed and the other set mounted on an articulator using the jaw registration. The appliance is constructed from acrylic resin and Adams Clasps on upper and lower 1st and 2nd premolars and in their absence molar teeth to enable adequate retention. The two retainers are joined by acrylic with opening maintained for breathing (Fig. 2, a, b, c and d). The patients were warned of common complaints such as dry mouth during wear, so they were advised to use Vaseline and have a cup of water by the bed where they sleep.

A non-parametric paired *t* – test is used to compare the differences, with a *p* value less than 0.05 considered as significant.

Figure 2 (a. The appliance, b. Upper occlusion, c. Right lateral, d. Left lateral)



RESULTS

Twenty three male patients and 23 healthy controls were selected for this study. The mean age for the OSAHS was 51 years (range, 26-76 years), while that for the control was 38.04 years (range, 26-60).

Comparison between the OSAHS group and the controls

Body Mass Index (BMI): The median BMI for the OSAHS group was 26.9 (range, 23.8-44.1), and for the controls the median was 23.9 (range, 21.7-26.9), which is highly significance (*p*=0.001). This shows that Obstructive Sleep Apnoea/Hypopnoea Syndrome is significantly related to obesity (increase in the BMI). Fig 3a and table 1.

Percentage of Predicted Neck Circumference (PPNC): The median PPNC for the OSAHS was 101% (range, 83.54 - 121.43), while for the controls the median was 97.84% (range, 83.06-110.16), and a *p* value of 0.014, which shows a significance result. The accumulation of fat around the neck in the OSAHS group is significantly

higher than the controls; the fat tends to compress the airway thus reducing its size. Fig 3b and table 1.

Figure 3. Anthropometric Measurement between the OSAHS and the Control

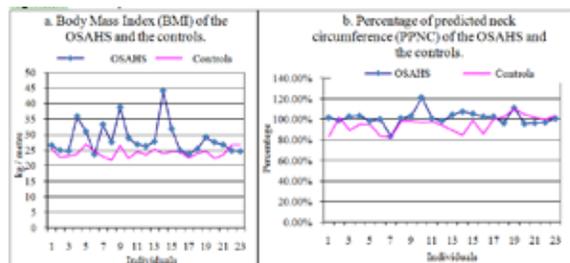


Table 1. Anthropometric Measurements

Variables	Control Median (Range)	OSAHS Median (Range)	Sig.
BMI	23.9 (21.7-26.9)	26.9 (23.8-44.1)	0.001
PPNC	97.84 (83.06-110.16)	101 (83.54-121.43)	0.014

Figure 3. Comparison of Nasal Resistance between the OSAHS and the Control

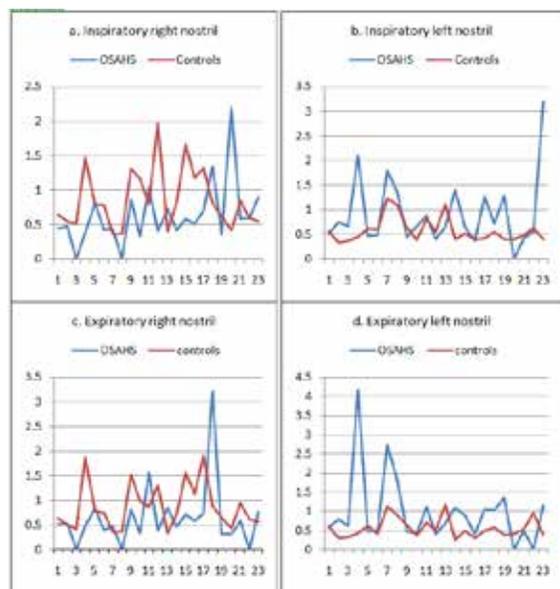
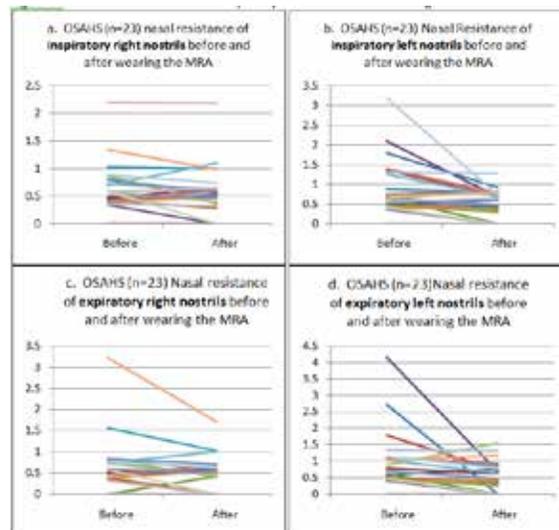


Table 2. Two tailed t - test

Variables		Before Median (min-max)	After Median (Range)	Sig.
	right	0.508 (0 - 2.2)	0.516 (0 - 2.19)	0.217
	left	0.661 (0 - 3.2)	0.636 (0 - 1.28)	0.003
Expiratory	right	0.514 (0 - 3.21)	0.538 (0 - 1.71)	0.042
	left	0.688 (0 - 4.16)	0.492 (0 - 1.56)	0.004

Figure 5. Nasal Resistance of OSAHS (n=23) before and after wearing the MRA



DISCUSSION

The Mandibular Repositioning Appliance (MRA) is one of several intra-oral appliances used for the treatment of OSAHS. The device requires relatively little clinical time, is easily made using inexpensive materials and is well tolerated. The 23 patients who took part in this trial were confirmed OSAHS patients with no previous treatment or surgery. Patients who were edentulous were excluded from the trial to keep one appliance design. Patients in this trial found that the appliance was comfortable to wear, with only minor adjustment being necessary. Reported problems with the device were few but occasional problems were encountered such as jaw muscles spasm and excessive salivation, particularly in the first two weeks. I have chosen this design because of its simplicity and good retention when compared to the semi - flexible devices.

This present study showed that the design used was successful in reducing the nasal resistance thus improving inspiratory and expiratory total air. The efficacy of MRA in snoring and OSAHS quoted in previous reports is variable [23]. It is likely that this is related to differences in appliance design as well as patient selection.

Comparison of the OSAHS and the control groups before wearing the MRA

BMI, is found to be increased in the OSAHS group than the control with high significance (P=0.001).

PPNC also found to be increased in the OSAHS group than the control with a significance (P= 0.014). This explains the increase of weight and fat accumulation around the neck resulting in narrowing of the airway and thus increasing the nasal resistance.

The efficacy of the MRA in reducing the amount of snoring by increasing the overall inspiratory and expiratory total by reducing the nasal resistance, thus improving the quality of sleep and life.

Comparison of the OSAHS group before and after wearing the MRA

(IRB – IRA) 60.86% of patients (14/23) and partners reported improvements in their quality of sleep hence increase in their total inspiratory air which explains the decrease of their nasal resistance and, reduction in level of snoring with less daytime

sleepiness. (30.43%) patients (7/23) have shown increase in nasal resistance after the use of the MRA with 8.70% patients (2/23) shown no change. ($P=0.217$).

(ILB – ILA) 73.91% of patients (17/23) and partners reported improvements in their quality of sleep, reduction in level of snoring with less daytime sleepiness. (21.74%) patients (5/23) have shown increase in nasal resistance after the use of the MRA with 4.35% patients (1/23) shown no change. ($P=0.003$).

(ERB – ERA) 60.86% of patients (14/23) and partners reported decrease in their nasal resistance and improvements in their quality of sleep, reduction in level of snoring with less daytime sleepiness. (30.43%) patients (7/23) have shown increase in nasal resistance after the use of the MRA with 8.70% patients (2/23) shown no change. ($P=0.042$).

(ELB – ELA) 69.57% of patients (16/23) and partners reported improvements in their quality of sleep, reduction in level of snoring with less daytime sleepiness. (21.74%) patients (5/23) have shown increase in nasal resistance after the use of the MRA with 8.70% patients (2/23) shown no change. ($P=0.004$).

The patients who have shown increase or no change in their nasal resistance explain local causes as nasal polyp or deviated nasal septum. This indicates that the treatment of these patients is beyond the effect of MRA, and most probably they require CPAP or surgery.

For the few patients who have reduced resistance after wearing the MRA, this is because of **increase upper airway size. Although the device decrease the upper airway volume by advancing the mandible and tongue, cephalometric analysis has shown that in some patients the downward rotation of the mandible can actually lead to an increase in upper airway size (24).**

The efficacy of MRA in snoring and OSA quoted in previous reports is variable (25). It is likely that this is related to differences in appliance design as well as patient selection. This present study showed that the design used was successful in decreasing the nasal resistance of inspiratory and expiratory right and left after wearing the appliance.

Others have reported a study of mandibular advancement splints in patients with snoring and OSA. Another study suggested that splints are efficacious in selected patients,

studied for half a night with and without the splint (26). The later method was employed to provide controls for inter-night variability, but this is not ideal since the two halves of the night are different in terms of sleep physiology.

This present research indicates that MRA is effective in the treatment of mild to moderate obstructive sleep apnoea evidenced by reduction of the nasal resistance and increase in the inspiratory and expiratory total air of the patients after wearing the MRA, symptomatic improvement in snoring, together with an improved social situation and objective improvement in snoring frequency and intensity, these results contrast with findings of other studies used MRA device [27].

For the few patients who have not benefitted from the MRA, this is because of increase upper airway size [27]. Although the device decrease the upper airway volume by advancing the mandible and tongue, cephalometric analysis has shown that in some patients the downward rotation of the mandible can actually lead to an increase in upper airway size [28].

CONCLUSION

Since snoring is a significant symptom of OSAHS syndrome, it is important that patients are diagnosed by physicians, using tests if appropriate, and that dentists do not offer anti-snoring appliances without this diagnosis and without follow-up to determine the effect on sleep study data.

This study confirms that MRA reduces the nasal resistance of left and right nostrils after wearing the appliance thus allowing more air intake which confirms the findings of others that the MRA may be useful alternative or adjunct to the use of the CPAP device in selected patients with snoring and mild to moderate OSAHS.

This pilot study has shown, however, that the MRA is effective in the control of mild to moderate OSAHS, although long-term results are required to determine if it may become an integral part of sleep clinic treatment strategy.

Further work is needed to evaluate long-term efficacy and patients need to be studied with the device in place and long term effect of the MRAs.

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