Sleep disorders

The impact of a multidisciplinary approach on response rate of mandibular advancing device therapy in patients with obstructive sleep apnoea syndrome

Impatto di un approccio multidisciplinare sulla risposta alla terapia con device di avanzamento mandibolare nei pazienti affetti da sindrome delle apnee ostruttive durante il sonno

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SUMMARY

The aim of the present study was to evaluate the importance of a multidisciplinary approach on increasing the response ratio expectation to mandibular advancing device (MAD) therapy in patients with obstructive sleep apnoea syndrome, especially in severe cases. Forty-two mild-to-severe OSAS patients were selected, after comprehensive evaluation by neurologists, otorhinolaryngologists and orthodontists, and treated with a Somnodent® device. Six months later, a polysomnographic exam with the MAD in situ was performed. The paired t-test evaluated the effectiveness of therapy and the results were compared with data from systematic reviews. The average treatment response was statistically significant for the apnoea/hypopnea index (AHI) and oxygen desaturation index and was higher than the outcomes presented in literature. An optimum therapy response (AHI < 5) was observed in 53% of patients (40% in severe OSAS) and a good response (AHI < 10) in 73% of patients (50% in severe OSAS). The Somnodent® device was effective and the multidisciplinary patient selection improved the response ratio compared to that reported by previous systematic reviews.

KEY WORDS: Multidisciplinary approach • Sleep apnoea • Mandibular advancing device • Response rate • Efficacy

RIASSUNTO

Lo scopo dello studio è quello di valutare l'impatto dell'approccio multidisciplinare nel determinare la percentuale di risposta alla terapia con dispositivi ad avanzamento mandibolare nei pazienti affetti da OSAS, anche di severa entità. Dopo una valutazione che ha compreso una visita neurologica, otorinolaringoiatrica ed ortodontica, 42 pazienti sono stati selezionati e sono stati trattati con un dispositivo ad avanzamento mandibolare (MAD) a tipo Somnodent®. A 6 mesi dalla consegna del MAD, i pazienti sono stati sottoposti ad un esame polisonnografico con il dispositivo in situ. Un paired t-test è stato utilizzato per valutare l'efficacia alla terapia e le percentuali di risposta ottima (AHI < 5) e buona (AHI < 10) ottenute sono state confrontate con quelle riportate dalle revisioni sistematiche presenti in letteratura. Sono state raggiunte una risposta ottima nel 53% dei pazienti (40% nei pazienti gravi) e una risposta buona nel 73% dei pazienti (50% nei pazienti gravi). I risultati ottenuti confermano l'efficacia del Somnodent® e dimostrano come la selezione multidisciplinare del paziente possa determinare un'incremento della percentuale di risposta alla terapia odontoiatrica, rispetto a quella riferita dalla revisione sistematica della letteratura.

PAROLE CHIAVE: *Approccio multidisciplinare • Apnea, dispositivo ad avanzamento mandibolare • Percentuale di risposta • Efficacia*

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Obstructive sleep apnoea syndrome (OSAS) is a common sleep breathing disorder characterized by snoring and repetitive complete (apnoea) or partial (hypopnoea) cessations of airflow during sleep, resulting in oxygen desaturation and sleep fragmentation [1]. It affects approximately 2 to 4% of the middle-aged population, and is considered a serious public health problem that can lead to an impaired quality of life for its signs and symptoms (excessive daytime sleepiness and impaired cognitive ability). It is also associated with an increased morbidity and mortality because of its potential pathophysiological consequences (increased risk of cardiovascular,

cerebrovascular, metabolic diseases and motor vehicle accidents) [1-5]. While continuous positive airway pressure (CPAP) is considered the gold standard treatment for this disorder, mandibular advancing devices (MADs) are recommended as an effective alternative therapy for patients affected by mild to moderate OSAS [3-6], and also represent a treatment option in severe OSAS patients, who cannot tolerate or refuse CPAP or are poor candidates for surgery [3-9]. Randomized trials have documented significant decreases in the apnoea/hypopnoea index (AHI) and in excessive daytime sleepiness with MAD therapy, confirming their effectiveness in inducing anatomical changes in the oropharynx and in stabilizing upper airway caliber [10 11]. Low nasal resistances, shorter soft palatal length, supine-dependent OSAS, increased retropalatal airway space and a prevailing retrolingual collapse are all associated with good response to MAD treatment [12-15]. The objective of the present study was to evaluate the importance of a multidisciplinary approach in the diagnosis and in patient selection to increase the response ratio expectation to MAD therapy, especially in severe cases of OSAS.

Materials and methods

Study design

Forty-two adult patients (38 males and 4 females) with a mean age of 53.2 ± 11.1 years, recruited by neurologists and otolaryngologists of the Neurology and Ear, Nose and Throat (ENT) Departments of "S. Orsola-Malpighi" University Hospital of Bologna (Italy) and by a private practitioner orthodontist between March 2011 and May 2012, were selected for the study. The inclusion criteria were mild to moderate OSAS (patients who presented a number of apnoeas and/or hypopnoeas per hour of sleep less than or equal to 30) or severe OSAS (patients who presented a number of apnoeas and/or hypopnoeas per hour of sleep greater than 30), when CPAP or surgical procedures were refused and in case of CPAP intolerance [3 8], retrolingual collapse ≥ 50% and retropalatal collapse ≤ 50% during Müller manoeuvre, tonsillar grade < 3 [16], low nasal resistance (no important nocturnal nasal obstruction complained by the patient, no important inferior turbinate hypertrophy or septal deviation) [13 17], sufficient tooth anchorage (at least 6 teeth in the lower arch), no substantial tooth mobility or untreated periodontal disease, no temporomandibular joint (TMJ) pain and ability to protrude the mandible > 6 mm [18]. Inclusion criteria are shown in Table I. At baseline (T0), all patients underwent comprehensive medical history collection, body mass index (BMI) recording, nighttime polysomnography (PSG) recording pulse oximetry, thoracic respiratory movements, nasal and oral airflow measurements and body position and an otorhinolaryngologic assessment including fibre-optic nasopharyngoscopy with the Müller manoeuvre. The dentist carried out an objective exam (dental, periodontal and functional examination), radiological (lateral teleradiography and relative cephalometric tracing, panoramic radiography) and a dental cast analysis. The examinations performed at T0 are summarized in Table II. Nine patients underwent oral pretreatment for the presence of caries and/or periodontal disease before inclusion in the study. All patients received an oral device and were instructed about its management. One week, one month and three months after delivery, patients and their bed partners were interviewed on subjective improvement in OSAS symptoms and quality of sleep, and the short-term side effects were evaluated. Six months later (T1), a PSG exam with the same conditions of the exam at T0 was performed with the MAD in situ and all patients were interviewed on improvements, adherence and adverse effects. The BMI of all patients at T1 was recorded to exclude the hypothesis that weight variations influenced PSG values.

Table I. Inclusion criteria.

Inclusion criteria
Mild to moderate OSAS or severe OSAS when CPAP or surgical procedures were refused and in case of CPAP intolerance
Retrolingual collapse ≥ 50% and retropalatal collapse ≤ 50% during Müller Manoeuvre
Tonsillar grade < 3
Low nasal resistance
At least 6 teeth in the lower arch
No substantial tooth mobility or untreated periodontal disease
No temporomandibular joint (TMJ) pain
Ability to protrude the mandible more of 6 mm

Table II. Multidisciplinary examination performed at T0.

Neurologist	ENT	Orthodontist
Medical history collection	Anatomical upper airway evaluation	Clinical extraoral examination
Sleep evaluation	Mallampati scoring	Clinical dental and periodontal examination
PSG evaluation	Tonsillar grading	TMJ examination
BMI recording	Nasal resistance evaluation	Orthopantomography evaluation
	Nasopharingoscopy with Müller manoeuvre	Lateral teleradiography evaluation
		Cephalometric tracing
		Dental cast examination

Fig. 1. Somnodent® MAS: frontal view.

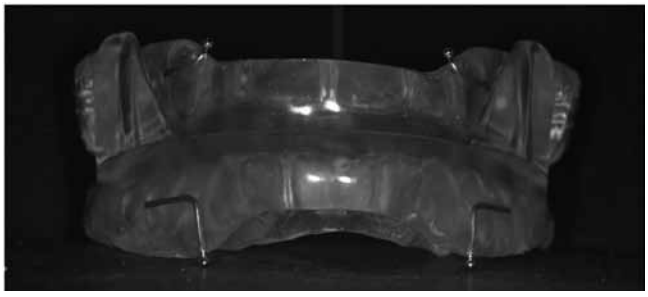

Fig. 2. Somnodent® MAS: lateral view.

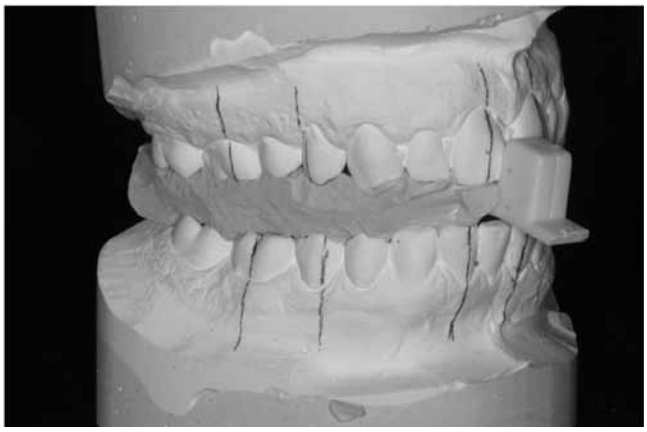

Fig. 3. The 5 mm George Gauge bite fork.

Oral device

Patients were treated with a Somnodent® mandibular advancement splints (MAS) appliance (Somnomed® Ltd, Australia), a custom-made two-piece device with vertical extensions to induce mandibular protrusion with an adjustable screw mechanism on the upper splint to achieve a gradual advancement [19] (Figs 1, 2). Its design allows a high degree of freedom for lateral and vertical movements, and its construction material (Bflex) also allows obtaining adequate anchorage if the patient is completely edentulous in the upper arch, provided that six teeth are present in the lower arch. The initial therapeutic position was individuated with a George Gauge bite fork with a 5 mm vertical interincisal opening [20]; this amount of anterior bite opening was not altered during the study (Fig. 3). An advancement of the 50-60% of maximal protrusive range was performed, depending on patient tolerance and OSAS severity [20]. The protrusion was gradually increased after four weeks of adaptation, in patients who reported no sufficient improvement of symptoms [22]. All appliances were delivered with the instruction to use vertical elastics to prevent mandibular collapse [23].

Statistical analysis

Data are presented as mean ± standard deviation. A paired t-test was used to evaluate the effectiveness of MAD therapy. The analyzed variables with and without the appliance were: BMI; AHI (calculated as the average number of respiratory events per hour of sleep); AHI in supine (AHIsup) and in non-supine position (AHInsup); oxygen desaturation index (ODI) (calculated as the average number of > 4% drop in oxygen saturation per hour of sleep [24]); minimum arterial oxygen saturation level ($MinO_2Sat$); the p values < 0.05 were considered statistically significant (Table II). The percentage of patients who obtained an optimum response (AHI at T1 < 5 events per hour) and a good response (AHI at T1 < 10 events per hour) with MAD treatment were compared with systematic reviews available in the literature.

Table III. Effect of Somnodent MAS on BMI and polysomnographic parameters.

Variable	T0 Mean ± SD	T1 Mean ± SD	Significance
BMI	29.05 ± 4.12	29.10 ± 4.30	NS
AHI	26.7 ± 15.7	7.53 ± 7.78	†
AHIsup	42 ± 21.8	15.9 ± 19.7	†
AHI nsup	13.1 ± 13.6	4 ± 6.28	†
ODI	23.8 ± 15.3	7.22 ± 7.41	†
CT < 90%	4.9 ± 5.68	0.8 ± 0.9	†

*T student paired t-test: [SD Standard Deviation; * p < 0.05; † p < 0.01; NS: not significant]; BMI: body mass index; AHI: apneoa/hypopnoea index; AHIsup: apnoea/hypopnoea index in supine position; AHInsup: not in supine position; ODI: Oxygen Desaturation Index*

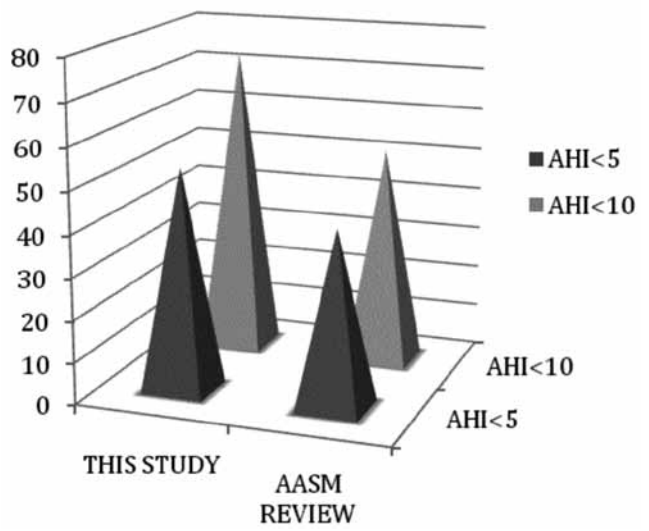

Fig. 4. Graph representing the difference in optimum and good response ratio between this study and AASM review data.

Results

All patients (100%) and their bed partners were satisfied by the treatment and in the reduction in snoring. Some patients experienced side effects only during the first months of treatment: TMJ discomfort occurred in 15 patients, difficultly chewing in the morning in 7 patients and tooth discomfort in only 1 patient. These side effects did not preclude, in any case, the use of the device. No patient discontinued treatment after six months because of short-term side effects. No significant differences in BMI values from T0 to T1 were noted, and therefore variation in patient weight did not influence the results of this study. The average response to treatment was statistically significant for both AHI and ODI ($p < 0.01$) (Table III). In this study, a significant mean AHI at T1 reduction of 19.2 events per hour was obtained, with a significant mean reduction of AHIsup of 26.1 events per hour, a significant mean reduction of AHInsup of 9.1 events per hour, a significant average ODI reduction of 16.6 events per hour and significant mean increase of $MinO_2Sat$ of 3.9%. An optimum response was seen in 53% of patients, compared to 35-38% in randomized, crossover, placebo-controlled studies included in the Hoffstein systematic review [1 11 25 26], and a good response in 73% of patients compared to 50-55% reported by the Metha and Naismith studies [1 11 26] included in the Hoffstein review. The AASM review reported a mean percentage of good response in 52% of patients and an average rate of optimum response in 42% of subjects; evaluating success on severe OSA, in this study 40% of patients obtained an optimum response and 50% a good response to MAD, compared to an average success of 34% referred by the AASM review [10] (Fig. 4). The comparison between our study and above studies considering inclusion criteria are shown in Table IV.

Table IV. Comparison of inclusion criteria between the present study and studies included in mentioned reviews.

Our study	Studies included in mentioned reviews
OSAS severity	OSAS severity
Dental Criteria	Dental Criteria
Obstruction site	
Nasal resistance	

Discussion

The efficacy of Somnodent® in MAS was demonstrated in the present study. The subjective evaluation of severity and frequency of snoring showed that both patients and their bed partners were satisfied. The design of the appliance allowed an excellent degree of freedom in execution of lateral and vertical movements, and the gradual protrusion enabled finding the therapeutic final advancement, reducing patient discomfort. Vanderveken et al. in 2012 [23] demonstrated the tendency of airway patency to decrease when vertical dimension increase from 4 to 20 mm, suggesting that vertical elastics (Fig. 5), by preventing mouth opening, can improve MAD treatment in many subjects. An optimal treatment response was achieved in 53% of patients and a good response was attained in 73% of cases. Comparing the response rates to those reported in literature by Hoffstein [11] and in the AASM review [10], it can be supposed that the higher percentage of success in this study can be attributed to patient selection and to the fact that a multidisciplinary approach in diagnosis of OSA can improve the results of MAD treatment in subjects affected by severe OSAS [26]. In fact, the selection criteria for the majority of the studies included in the reviews listed above were polysomnographic values and dental, functional and periodontal controindication. In this study, an obstruction site evaluation was performed and only patients with a low tonsillar grade, low nasal resistance and prevalent

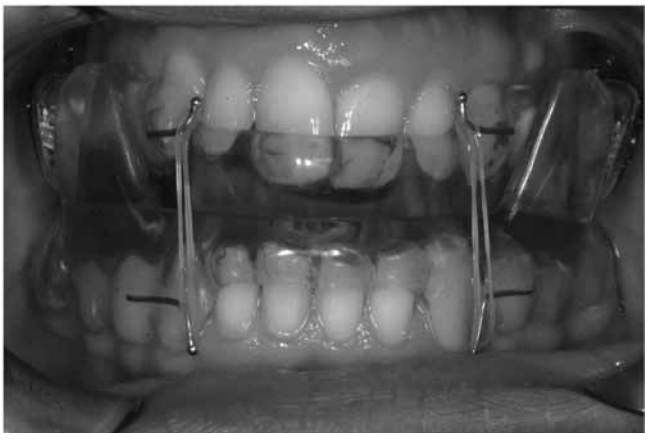

Fig. 5. Intraoral vertical elastics.

retrolingual obstruction were included. Tonsillar hypertrophy represents a recommendation for their surgical removal [9] and nasal congestion may reduce patient tolerance to the oral appliance treatment; in 2006, Marie Marklund demonstrated that patients with nasal congestion experienced a lower rate of occlusal modifications, which may be related with a lower adherence to oral device treatment [17]. Two years later, Cistulli et al. estimated the impact of high nasal resistance, demonstrating its negative influence on MAD treatment outcome [12]. Regarding the significance of a preventive obstruction site assessment, in 2006 Ng et al. evaluated upper airway pressure during natural sleep and demonstrated that retrolingual collapse was associated with a higher grade of response [16]. In a review on oral devices published in 2007, Cistulli et al. included primary retrolingual collapse during sleep and larger retropalatal airway space as predictors of a favourable response to MAD treatment [15]. The potential limitation of this study was that nasendoscopy with the Muller manoeuvre determined obstruction sites and the pattern of collapse during obstructive events, although the effect of sleep on pharyngeal size is significant [28]. An improvement on outcome of MAD therapy can be offered by sleep endoscopy with advancement simulation. In the study of Johal on sleependoscopy performed with a MAD simulator to improve patient selection, treatment success, as defined by a follow-up AHI < 10 events per hour, was achieved in 79% of patients [29]. In 2011, Vanderveken and Braem described a technique to obtain an individual protrusion simulator with a metal bitefork to perform, during sleep endoscopy, an advancement as similar as possible to that reproducible by the oral device [30].

Conclusions

It can be concluded that:

1. Somnomed MAS® is effective in reducing the subjective perception of snoring in all patients and in decreasing respiratory events.
2. The device is well accepted by patients and only transient poor short-term adverse effects occurred.
3. The success ratio was improved by multidisciplinary diagnosis and patient selection.

References

[1] Metha A, Qian J, Petocz P, et al. *A randomized, controlled study of a mandibular advancement splint for obstructive sleep apnea*. Am J Respir Crit Care Med 2001;163:1457-61.

[2] Young T, Peppard PE, Gottlieb DJ. *Epidemiology of obstructive sleep apnea: a population health perspective*. Am J Respir Crit Care Med 2002;165:1217-39.

[3] Kushida CA, Morgenthaler TI, Littner MR, et al. *American Academy of Sleep Medicine. Practice parameters for the treatment of snoring and obstructive sleep apnea with oral appliance: An update for 2005*. Sleep 2006;29:240-3.

[4] Epstein LJ, Kristo D, Strollo PJ Jr, et al. *Adult Obstructive Sleep Apnea Task Force of the American Academy of Sleep Medicine. Clinical Guidelines for the evaluation, management and Long-term care of obstructive sleep apnea in adults*. J Clin Sleep Med 2009;5:263-76.

[5] Fusetti M, Fioretti AB, Valenti M, et al. *Cardiovascular and metabolic comorbidities in patients with obstructive sleep apnoea syndrome*. Acta Otorhinolaryngol Ital 2012;32:320-5.

[6] McDaid C, Durée KH, Griffin SC, et al. *A systematic review of continuous positive airway pressure for obstructive sleep apnoea-hypopnoea syndrome*. Sleep Med Rev Dec 2009;13:427-36.

[7] Lim J, Lasserson TJ, Fleetham J, et al. *Oral appliances for obstructive sleep apnoea* (Review). Cochrane Database of Systematic Reviews 2009;(3):CD004435.

[8] Schwarting S, Huebers U, Heise M, et al. *Position paper on the use of mandibular advancement devices in adults with sleep-related breathing disorders. A position paper of the German Society of Dental Sleep Medicine (Deutsche Gesellschaft Zahnaerztliche Schlafmedizin, DGZS)*. Sleep Breath 2007;11:125-6.

[9] Randerath WJ, Verbraecken J, Andreas S, et al. *European Respiratory Society task force on non-CPAP therapies in sleep apnoea. Non-CPAP therapies in obstructive sleep apnoea*. Eur Respir J 2011;37:1000-28.

[10] Ferguson KA, Cartwright R, Rogers R, et al. *Oral Appliances for snoring and obstructive sleep apnea: a review*. Sleep 2006;29:244-62.

[11] Hoffstein V. *Review of oral appliances for treatment for sleep-disordered breathing*. Sleep Breath 2007;11:1-22.

[12] Henke KG, Frantz DE, Kuna ST. *An oral elastic mandibular advancement device for obstructive sleep apnea*. Am J Respir Crit Care Med 2000;161:420-5.

[13] Zeng B, Ng AT, Qian J, et al. *Influence of nasal resistance on oral appliance treatment outcome in obstructive sleep apnea*. Sleep 2008;31:543-7.

[14] Ferguson KA. *The role of oral appliance therapy in the treatment of obstructive sleep apnea*. Clin Chest Med 2003;24:355-64.

[15] Chan AS, Lee RW, Cistulli PA. *Dental appliance treatment for obstructive sleep apnea*. Chest 2007;132:693-9.

[16] Ng AT, Qian J, Cistulli PA. *Oropharyngeal collapse predicts treatment response with oral appliance therapy in obstructive sleep apnea*. Sleep 2006;29:666-71.

[17] Marklund M. *Predictors of long-term orthodontic side effects from mandibular advancement devices in patients with snoring and obstructive sleep apnea*. Am J Orthod Dentofacial Orthop 2006;129:214-21.

[18] Petit FX, Pépin JL, Bettega G, et al. *Mandibular advancement devices: rate of contraindications in 100 consecutive obstructive sleep apnea patients*. Am J Respir Crit Care Med 2002;166:274-8.

[19] Deane SA, Cistulli PA, Ng AT, et al. *Comparison of mandibular advancement splint and tongue stabilizing device in obstructive sleep apnea: a randomized controlled trial*. Sleep 2009;32:648-53.

[20] Pitsis AJ, Darendeliler MA, Gotsopoulos H, et al. *Effect of vertical dimension on efficacy of oral appliance therapy in obstructive sleep apnea*. Am J Respir Crit Care Med 2002;166:860-4.

[21] Walker-Engström ML, Ringqvist I, Vestling O, et al. *A prospective randomized study comparing two different degrees of mandibular advancement with a dental appliance in treatment of severe obstructive sleep apnea*. Sleep Breath 2003;7:119-30.

[22] Almeida FR, Lowe AA. *Principles of oral appliance therapy for the management of snoring and sleep disordered breathing*. Oral Maxillofac Surg Clin North Am 2009;21:413-20.

[23] Vroegop AV, Vanderveken OM, Van de Heyning PH, et al. *Effects of vertical opening on pharyngeal dimensions in patients with obstructive sleep apnoea*. Sleep Med 2012;13:314-6.

[24] Silber MH, Ancoli-Israel S, Bonnet MH, et al. *The visual scoring of sleep in adults*. J Clin Sleep Med 2007;3:121-31.

[25] Gotsopoulos H, Chen C, Qian J, et al. *Oral appliance therapy improves symptoms in obstructive sleep apnea: a randomized, controlled trial*. Am J Respir Crit Care Med 2002;166:743-8.

[26] Passali D, Caruso G, Arigliano LC, et al. *Database application for patients with obstructive sleep apnoea syndrome*. Acta Otorhinolaryngol Ital 2012;32:252-5.

[27] Naismith SL, Winter VR, Hickie IB, et al. *Effect of oral appliance therapy on neurobehavioral functioning in obstructive sleep apnea: a randomized controlled trial*. J Clin Sleep Med 2005;1:374-80.

[28] Faria AC, Garcia LV, Santos AC, et al. *Comparison of the area of pharynx during wakefulness and induced sleep in patients with obstructive sleep apnea (OSA)*. Braz J Otorhinolaryngol 2012;78:103-8.

[29] Johal A, Battagel JM, Kotecha BT. *Sleep nasendoscopy: a diagnostic tool for predicting treatment success with mandib- ular advancement splints in obstructive sleep apnoea*. Eur J Orthod 2005;27:607-14.

[30] Vanderveken OM, Vroegop AV, Van De Heyning PH, et al. *Drug-induced sleep endoscopy completed with a simulation bite approach for the prediction of the outcome of treatment of obstructive sleep apnea with mandibular repositioning appliances*. Operative Techniques in Otolaryngology 2011;22:175-82.

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