

Research Article

Long-Term Oral Appliances for Moderate to Severe Sleep Apnea Syndrome Tended to Lose Efficacy

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Keywords

• Obstructive sleep apnea; Oral appliance; Apnea hypopnea index

Abstract

Objectives: Oral appliances are a treatment for obstructive sleep apnea hypopnea syndrome. The main objective of this study was to determine if Apnea Hypopnea Index was stabilized under long-term oral appliance treatment. The secondary objectives were to verify the long-term stability of success and to measure failure rates of oral appliances.

Methods: Efficacy results of the oral appliances based on the apnea-hypopnea index reduction and success and failures rates were retrospectively collected from 95 patients treated by a retention oral appliance with at least one renewal, for a moderate to severe obstructive sleep apnea hypopnea syndrome. The entire procedure was performed by otolaryngologists. The primary goal was the evolution of apnea hypopnea index at the time of oral appliance renewals. The secondary goal was the complete response, the partial response and failure rates of oral appliances tolerance at each renewal.

Results: Eighty-one patients had two OAs (85.3%), 13 patients had three OAs (13.7%) and 1 patient had five OAs (1.1%). Even though oral appliances allowed a significant apnea-hypopnea index reduction and a high success rate, our study showed a significant loss of efficacy (+0.7/h per year of use, $p < 10^{-4}$) whereas weight and mandibular advancement did not differ significantly. Furthermore, success and failure rates decreased and increased respectively, especially between the first and the second oral appliance. Rates remained constant stable between the second and the third appliances.

Conclusion: Practitioners must be aware of this loss of efficacy and should maintain control of the apnea hypopnea index even after many oral appliance renewals.

ABBREVIATIONS

AHI: Apnea Hypopnea Index; CPAP: Continuous Positive Airway Pressure; OA: Oral Appliance; OSAHS: Obstructive Sleep Apnea-Hypopnea Syndrome

INTRODUCTION

Oral Appliances (OAs) are one of possible treatments of Obstructive Sleep Apnea-Hypopnea Syndrome (OSAHS) [1-13]. Their efficiency is ensured by increasing the caliber of the upper airways (anteroposterior expansion of space behind the tongue base, lateral expansion of the pharyngeal walls and at the level of the soft palate by changing the configuration of the uvula and the tongue) [6,14-16] and thanks to an action on the stretching receptors of the genioglossus muscle [6,14,15], probably by decreasing its hyperactivity [14]. In France, OAs are reimbursed as a second-line treatment for severe OSAHS (Apnea Hypopnea Index (AHI) ≥ 30 events/h) and for moderate OSAHS ($15 < \text{AHI} < 30$ /h) with cardiovascular morbidity after refusal or discontinuation of Continuous Positive Airway Pressure (CPAP), and as a first-line treatment for moderate OSAHS ($15 < \text{AHI} < 30$ /h) with clinical signs and without cardiovascular morbidity [17]. Since 2018, an OA renewal can be prescribed and reimbursed every three years (every two years before 2018) if the previous one was effective (clinically and after a sleep exam) [17]. Our

otolaryngologist unit completely manages the procedure: dental printing, issuing, adjusting and renewal.

However very few long-term reports of OA efficacy have been reported [18-20] on little samples with opposite results. This begs the question: Do OAs remain efficient as time goes on?

In our unit the first patients were recruited for OAs in 2008 for the ORCADES study [21] and were followed-up since then with OA renewal every two to five years according to the OA statement. The main objective of the study was to determine if AHI remained stable under long-term OA treatment in severe OSAHS after refusal or intolerance to CPAP, and in moderate OSAHS.

MATERIALS AND METHODS

Population

Every patient who received two or more OAs in our unit between 06/01/2008 and 01/01/2020 was retrospectively included. During the follow-up patients were recommended for OA renewal every two to five years according to the OA statement.

Ninety-five patients were included. Population characteristics are reported in Table 1. Eighty-one patients had two OAs (85.3%), 13 patients had three OAs (13.7%) and 1 patient had five OAs (1.1%).

OA type, follow-up and efficacy control

The only OA design used in our unit was the CAD/CAM Narval® titratable twin-block retention OA (figure 1) manufactured by Resmed laboratory (Saint-Genis-Laval, France). It was chosen because of its design: a minimal, horizontal force is applied on the temporomandibular joint [22] and it relies on pluradicular roots of mandibular molars to limit dental mobilization. Our ORL team manages the entire procedure:

A dental print by alginate was performed at the ENT consultation and sent to the production site of the OA (you can see the technique on our Youtube channel: <https://www.youtube.com/watch?v=d09mc7L6-HA&t=37s>)

Issuing: explanations on the set up and removal of the OA (you can see the technique on our Youtube channel: <https://www.youtube.com/watch?v=PCDdNp6tstQ&t=0s>), the side effects and their management and the maintenance of the OA were explained

Adjusting (you can see the technique on our Youtube channel: <https://www.youtube.com/watch?v=AA-0qAwi76k>) renewal

At each OA delivery, the previous advancement was applied on the new OA. A titration of advancement was then performed if necessary, according to the patient's clinical signs. Finally, the patient performed the same sleep exam (polygraphy or polysomnography) in the same place and with the same sleep specialist than the first exam. Sleep exams were interpreted according to the American Association of Sleep Medicine criteria, available at the time of the interpretation.

Primary and secondary objectives of the study

The main objective of this study was to determine if AHI remained stable under long-term oral appliance (after iterative renewals).

The secondary objectives were to determine the evolution of long term OA success/failure rates evolution.

Primary and secondary outcomes

The main outcome metric was AHI at different points in time.



Figure 1 CAD/CAM Narval® titratable twin-block retention oral appliance (with the kindly authorization of Resmed laboratory).

The secondary outcomes metrics were the success or failure rates at different time points. Several success definitions of success or failure exist in the literature [7,10,21,23-26]. The most frequently used criteria (which were used in this study) were:

- Success: AHI reduction > 50% and, the opposite, failure: <50% AHI reduction

- Complete response: residual AHI ≤ 5/h

Statistical studies

AHI modeling according to time was performed using a univariate linear regression on repeated data.

Mean comparisons of AHI, mandibular advancement, success and failure rates (paired data) were performed with Student tests.

Statistical tests and modeling were performed with R software (lm function).

Ethical consideration

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

For this type of study, formal consent of patients is not required in France.

RESULTS

Modelization of long-term AHI evolution

Modeling results are presented in Table 1.

AHI significantly increased according to the time: +0.7 event/h per year of use, $p < 10^{-4}$.

Neither BMI neither mean nor mean mandibular advancement significantly differed according to the time.

Success and failure rates of OA

The mean AHI reduction with the first OA was 17.6 events/h ($p < 10^{-5}$). The failure rate, defined as a <50% AHI reduction, was 20.7%.

The other success and failure rates according to the time are shown in Table 2. We can see a tendency toward decrease in efficacy rates (complete and partial responses) and a tendency toward increase of failure rates according to time, especially between the first and the second OA, although all those differences were not significant.

Compliance and adherence to the OA

Tolerance difficulties were reported by six patients (6.4%): too much retention for three patients (3.2%) leading to a milling, not enough retention for three patients (3.2%) leading to a heating to tighten the OA. Only one patient discontinued the use of OA (1.1%) because of 41 dental extrusions and the patient was given a CPAP.

Table 1: population characteristics.

Males / Females n (%)	64 (64.4) / 31 (35.6)
Mean age $\pm$ SE [min ; max] (yr)	58.6 $\pm$ 10.5 [28.2 ; 80.3]
Body mass index $\pm$ SE [min ; max] (kg/m ²)	26.8 $\pm$ 4.11 [18.1 ; 38.1]
Severe OSAHS with CPAP abandonment n (%)	32 (36.8)
Severe OSAHS with CPAP refusal n (%)	5 (5.7)
Mean weight variation $\pm$ SE [min; max] (kg)	+0.15 $\pm$ 5.05 [-16 ; +28]
Mean AHI before oral appliance $\pm$ SE [min; max] (/h)	26.4 $\pm$ 10.5 [15 ; 55.4]
Mean absolute advancement $\pm$ SE [min; max] (mm)	7.2 $\pm$ 1.8 [3 ; 12]
Mean relative advancement $\pm$ SE [min; max] (%)	83.3 $\pm$ 33.8 [38.4 ; 175]
Relative advancement = advancement at the last consultation (mm) / maximal advancement (mm)	
Abbreviations: SE: Standard-Error; AHI: Apnea-Hypopnea Index; OSAHS: Obstructive Sleep Apnea Hypopnea Syndrome	

Table 2: comparisons of means before/after oral appliance (OA) renewal.

	First OA at 3 months vs first OA at 2 years	First OA vs second OA	Second OA vs third OA
AHI (/h) $\pm$ SD			
Before	8.3 $\pm$ 7.1	10.4 $\pm$ 9.2	10.8 $\pm$ 9.1
After	10.4 $\pm$ 9.2	10.8 $\pm$ 9.1	6.2 $\pm$ 4.4
p	0.03448	0.1079	0.707
Advancement (mm) $\pm$ SD			
Before	7.19 $\pm$ 1.53	7.62 $\pm$ 1.74	8.38 $\pm$ 1.77
After	7.62 $\pm$ 1.74	8.38 $\pm$ 1.77	7.29 $\pm$ 1.7
p	0.7473	0.9228	0.4226
Complete response rate (%)			
Before	45.1 $\pm$ 50.1	32.8 $\pm$ 47.3	11.8 $\pm$ 32.7
After	32.8 $\pm$ 47.3	11.8 $\pm$ 32.7	9.1 $\pm$ 29.4
p	0.05871	0.01156	0.3287
Failure rate (%)			
Before	20.7 $\pm$ 40.8	27.3 $\pm$ 44.9	35 $\pm$ 48.9
After	27.3 $\pm$ 44.9	35 $\pm$ 48.9	17.7 $\pm$ 40.8
p	0.05697	0.01156	0.3632
Complete response: AHI after last OA <5/h. Failure: <50% AHI reduction (compared to initial AHI) after last OA			
Abbreviations: AHI = Apnea Hypopnea Index; SD = Standard Data			

DISCUSSION

Our study is the second after Marklund et al., and their nine patients [19] to report a significant long-term decrease in OA efficacy, and the first study with a large number of patients.

All the results of our study suggest a time sensitive loss of efficacy in OA on AHI:

- AHI significantly increased, estimated at +0.7 event/h per year of use, i.e. +7events/h per 10 years of use, despite a

close follow-up, a stable weight and a stable mandibular advancement.

- Efficacy rates tended to decrease and failure rates tended to increase.

Our study has also globally shown a very low failure rate of the first OA (20.7%) that was not comparable to the princeps study with retention bibloc OA [21]. This can be easily explained: a person whose OA was efficient wants an OA renewal.

Only three studies reported the long-term results of OAs. Two are published from the same team, with very few patients and opposite results. In the first one [19], the monobloc OA was ineffective after 15 years of use. In the second one, focusing on the five-year-efficacy with a non-titrable bibloc OA on 19 patients [18], the mean initial AHI was 22/h, the short-term (3 months) mean AHI was 5/h and the long-term (five years) mean AHI was 4.9. In this cohort the mean AHI remained stable. Those opposite results can be explained by the design of the OA. OA are often considered as a whole homogeneous group, but efficacy and tolerance differ according to the design [27]. Indeed the design is very important in improving or maintaining tolerance and efficacy [28-31]. Uniken Venema et al. [20] reported their long-term experience in treatments of OSAHS with PPC and OAs. In 14 patients, OA was still efficient at ten years (mean initial AHI 31.7 $\pm$ 20.6 events/h whereas mean 10-year follow-up AHI 9.9 $\pm$ 10.3 events/h) without studying AHI evolution according to the time.

Our study may be criticized because it is retrospective. Indeed, a prospective study is needed but it would take years to confirm those available results. Another critic would be the large Standard Error as time went on because less and less patients were presents in the cohort (only 14.7% of patients had 3 OAs or more).

CONCLUSION

Even though OA led to a significant AHI reduction and a high success rate in moderate to severe OSAHS patients, our study showed a significant loss in efficacy, whereas weight and mandibular advancement did not differ significantly. Practitioners must be aware of this loss of efficacy and maintain control of the AHI even after many OA renewals.

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