Articles of the Month – May 2021

MAD

Dimensional analysis of the upper airway in obstructive sleep apnea syndrome patients treated with mandibular advancement device: a bi and three-dimensional evaluation

Rocío Marco-Pitarch [1], Marina Selva-García [1], Andrés Plaza-Espín [1], Javier Puertas-Cuesta [2], Rubén Agustín-Panadero [1], Enrique Fernández-Julián [3], Jaime Marco-Algarra [4], Antonio Fons-Font [1]

Background: The efficiency of the mandibular advancement device (MAD) in patients with obstructive sleep apnea syndrome (OSAS) has been demonstrated. Nevertheless, the behavior of the upper airway once MAD is placed and titrated, and its correlation with the apnea hipopnea index (AHI) is still under discussion.

Objectives: analyze the morphological changes of the upper airway through a bi and three-dimensional study and correlate it with the polysomnographic variable, AHI.

Methods: Patients were recruited from two different hospitals for the treatment of OSAS with a custom-made MAD. A cone beam computer tomography and a polysomnography were performed at baseline and once the MAD was titrated.

Results: 41 patients completed the study. Treatment with MAD reduced the AHI from 22.5 ± 16.8 to 9.2 ± 11.6 (p ≤ 0.05). There was a significant increase of the total airway volume with MAD from 21.83 ± 7.05 cm^3 to 24.19 ± 8.19 cm^3 , at the expense of the oropharynx. Moreover, the correlation between the improvement of the AHI and the augmentation of the volume of the upper airway was not statistically significant.

Conclusions: the oral device used in this prospective study increased the mean upper pharyngeal airway volume and significantly reduced the AHI. Future studies that measure the muscular tone are needed to completely understand the association between the AHI and the physiological and anatomical response of the upper airway.

Keywords: OSA; OSAS; intraoral device; mandibular advancement; obstructive; polysomnography; sleep apnea; tridimensional analysis; volume.

EADSM comment: In accordance with previous studies, these results show a widening of the airway from MAD. The authors did not detect any correlation between this increase in airway volume and the reduction in AHI. This is understandable, because many factors might influence this relationship. For instance, non-anatomical pathophysiological factors might influence the mechanism of the device.

Reasons for failure of mandibular advancement splint therapy in the treatment of obstructive sleep apnea

Tuula Palotie [1], Anni Peltomaa [2], Adel Bachour [3], Patrick Bachour [4], Antti Mäkitie [5], Miikka Peltomaa [6], Pekka Vallittu [7]

Abstract

Objective: To investigate the reasons for poor adaptation to mandibular advancement splint (MAS) treatment.**Methods:** The study consisted of 44 patients with obstructive sleep apnea who had unsuccessful MAS treatment. Data were collected on age, body mass index, gender, general and mental diseases, continuous positive airway pressure (CPAP) tryout, usage of occlusal splint, dental overjet, temporomandibular disorders, shortened dental arch, sleep apnea severity, and Apnea-Hypopnea Index. Sixty patients who underwent successful MAS treatment were controls.**Results:** Patients with missing molars failed significantly more often in MAS therapy than the controls (*p = 0.020*). Patients with CPAP tryout prior to MAS treatment had a tendency to fail MAS treatment. MAS treatment was more likely to be successful in patients with prior occlusal splint experience (*p = 0.050*).**Conclusion:** The study could not identify a single reason for MAS failure.

Keywords: Obstructive sleep apnea; mandibular advancement splint; missing molars; shortened dental arch; sleeping disorder.

EADSM comment: Adherence is ultimately important for life-long diseases. In accordance with previous literature, it is difficult to predict adherence prior to treatment. After testing treatment with a mandibular advancement device, less side effects and sufficiently improved snoring have been found to relate to a higher adherence.

Force Distribution of a Novel Core-Reinforced Multilayered Mandibular Advancement Device

Hyo-Won Ahn [1], Soo-Yeon Lee [2], Hobeen Yu [2], Jin-Young Park [2], Kyung-A Kim [1], Su-Jung Kim [1]

Abstract

A mandibular advancement device (MAD) is a commonly used treatment modality for patients with mild-to-moderate obstructive sleep apnea. Although MADs have excellent therapeutic efficacy, dental side effects were observed with long-term use of MADs. The aim of this study was to analyze the force distribution on the entire dentition according to the materials and design of the MADs. Three types of MADs were applied: model 1 (single layer of polyethylene terephthalate glycol (PETG)), model 2 (double layer of PETG + thermoplastic polyurethane (TPU)), and model 3 (core-reinforced multilayer). In the maxilla, regardless of the model, the incisors showed the lowest force distribution. In most tooth positions, the force distribution was lower in models 2 and 3 than in model 1. In the mandible, the mandibular second molar showed a significantly lower force in all models. The mandibular incisors, canines, and molars showed the highest force values in model 1 and the lowest values in model 3. Depending on the material and design of the device, the biomechanical effect on the dentition varies, and the core-reinforced multilayered MAD can reduce the force delivered to the dentition more effectively than the conventional single- or double-layer devices.

Keywords: core-reinforced; dental side effects; force distribution; mandibular advancement devices; multilayer.

EADSM comment: Interesting article evaluating the influence of various device composition on the force distribution of MADs and consequently, possible risks for tooth movements.

Long-term periodontal changes associated with oral appliance treatment of obstructive sleep apnea

Piyush Heda [1], Bassam Alalola [2][3], Fernanda R Almeida [4], Hugh Kim [4], Bernardo U Peres [5], Benjamin T Pliska [4]

Abstract

Study objectives: To characterize the mandibular anterior teeth crown height as a marker of periodontal changes and bone loss as a side effect of an oral appliance (OA) worn for a minimum of 4.5 years.

Methods: This retrospective study conducted on patients with healthy baseline periodontium recruited participants from consecutive sleep apnea patients treated with an OA between 2004 to 2014. Eligible participants were recalled for a follow-up visit where a periodontal exam was performed, a lateral cephalogram and dental impressions were obtained. Clinical crown height for mandibular anterior teeth and cephalometric variables were measured and compared before and after treatment. A full periodontal evaluation was performed at the follow-up visit.

Results: 21 patients enrolled with a mean treatment length of 7.9±3.3 years. For the mandibular anterior teeth, clinical crown height did not change over the evaluated period. At follow-up, all the periodontal assessed variables were within normal limits, with the mean probing depth of 1.4±0.5 mm, recession 0.6±1.1 mm and Clinical Attachment Loss (CAL) 0.8±1.0 mm. Compared to baseline, there was a significant proclination of mandibular incisors (mean increase of 5.1°) with the continued use of OA. Gingival levels were maintained with clinically insignificant changes during the observation period.

Conclusions: Inclination of the mandibular incisors increases significantly with the use of an OA in patients with obstructive sleep apnea (OSA). Positional changes in these teeth were not associated with any measured evidence of increase in clinical crown height or gingival recession.

Keywords: obstructive sleep apnea; oral appliances; periodontal changes.

==EADSM== comment: I pleasant result that the authors found no periodontal side effects from long-term MAD therapy.

Predicting Polysomnography Parameters from Anthropometric Features and Breathing Sounds Recorded during Wakefulness

Ahmed Elwali[1], Zahra Moussavi[1][2]

Abstract

Background: The apnea/hypopnea index (AHI) is the primary outcome of a polysomnography assessment (PSG) for determining obstructive sleep apnea (OSA) severity. However, other OSA severity parameters (i.e., total arousal index, mean oxygen saturation (SpO2%), etc.) are crucial for a full diagnosis of OSA and deciding on a treatment option. PSG assessments and home sleep tests measure these parameters, but there is no screening tool to estimate or predict the OSA severity parameters other than the AHI. In this study, we investigated whether a combination of breathing sounds recorded during wakefulness and anthropometric features could be predictive of PSG parameters.

Methods: Anthropometric information and five tracheal breathing sound cycles were recorded during wakefulness from 145 individuals referred to an overnight PSG study. The dataset was divided into training, validation, and blind testing datasets. Spectral and bispectral features of the sounds were evaluated to run correlation and classification analyses with the PSG parameters collected from the PSG sleep reports.

Results: Many sound and anthropometric features had significant correlations (up to 0.56) with PSG parameters. Using combinations of sound and anthropometric features in a bilinear model for each PSG parameter resulted in correlation coefficients up to 0.84. Using the evaluated models for classification with a two-class random-forest classifier resulted in a blind testing classification accuracy up to 88.8% for predicting the key PSG parameters such as arousal index.

Conclusions: These results add new value to the current OSA screening tools and provide a new promising possibility for predicting PSG parameters using only a few seconds of breathing sounds recorded during wakefulness without conducting an overnight PSG study.

Keywords: correlation; machine learning; obstructive sleep apnea; screening; sleep report; trachea.

==EADSM== comment: Very convenient, if OSA can be detected from just breathing features during wakefulness, in the future.

Period-to-Period Variability of Moderate/Severe Obstructive Sleep Apnoea

Charlotte A Wigston [1 2], John R Stradling [2 3], Chris D Turnbull [4 5]

Abstract

Introduction: The severity of obstructive sleep apnoea (OSA) is highly variable on a night-to-night basis. Patients are commonly categorised based on the severity of their OSA, and this is then used to influence management and reimbursement, including continuous positive airway pressure (CPAP). We aimed to establish to what extent the OSA severity category changes during two periods of OSA, based on mean and maximum oxygen desaturation index (ODI).

Methods: Patients with a diagnosis of moderate to severe OSA who had been on CPAP for greater than 1 year were included in this study. Subjects underwent two periods of CPAP withdrawal for four nights each.

Results: Twenty-five patients completed the study. Based on the mean ODI of the four nights, 14 (56%) patients changed OSA severity categorisation, with three (12%) changing category to mild. Based on the maximum ODI of the four nights, nine (36%) patients changed OSA severity categorisation, with one (4%) changing category to mild. One third to a half of patients' OSA severity category changed between the two periods of four night's CPAP withdrawal.

Conclusions: OSA is highly variable on a period-to-period basis as well as on a night-to-night basis. We believe the concept of patients having a definable and 'real' level of OSA severity is therefore flawed. OSA severity should be based mainly on symptoms, as these are the dominant reasons for treatment, and the sleep study should be used qualitatively to ascertain whether respiratory events are the likely cause of the symptoms.

Trial registration: ISRCTN17987510.

Keywords: Continuous positive airway pressure; Obstructive; Polysomnography; Sleep apnoea.

==EADSM== **comment**: To be remembered, that a diagnosis of OSA might be uncertain.

Pathophysiology

Experimental study on the influence of model variations on the airway occlusion of an obstructive sleep apnea patient

M Arnold [1], S Burgmann [2], L Bonitz [3], A Pugachev [4], U Janoske [2]

Abstract

This study deals with the analysis of model parameters to mimic the airway collapse of an obstructive sleep apnea patient during nasal breathing. Different material properties and geometry variations of a patient-specific airway model are analyzed in detail. The patient-specific airway geometry is obtained from MRI data. A completely rigid model is compared to two partly elastic variations with different elasticities. Furthermore, the influence of the nasal cavities and the treatment effect of a mandibular protrusion are studied. Rigid model parts are 3D-printed and elastic parts cast from silicone. The models are analyzed under the impact of a transient airflow which is realized through a computer controlled piston pump. The results suggest, that, for moderate deformations, the elasticity of the soft tissue replicate influences rather the level of the pressure drop inside the airway than the shape of the pressure curve. The same suggestion can be made for the influence of the nasal cavities. Often, the spatial location of the minimum pressure is taken as the collapse site of the airway geometry. This study demonstrates, that the spatial locations of the minimum pressure and the maximum deformation do not match. This reveals the importance of a coupled approach of soft tissue and airflow analysis in the search of the collapse site and therefore the best treatment option. A treatment effect of the mandibular protrusion can be anticipated with an accurate patient-specific airway model.

Keywords: Collapsible airway; Experimental study; Obstructive sleep apnea; Silicone models; Soft tissue elasticity.

EADSM comment: Study that highlights that measurements do not always match, such as the spatial locations of the minimum pressure and the maximum deformation, which might influence results from studies.

Age-specific associations between habitual snoring and cardiovascular diseases in China: a 10-year cohort study

Yuxia Wei [1], Jun Lv [2], Yu Guo [3], Zheng Bian [3], Junning Fan [1], Huaidong Du [4], Ling Yang [4], Yiping Chen [4], Yulu Qin [5], Ping Wang [5], Junshi Chen [6], Zhengming Chen [7], Canqing Yu [8], Liming Li [9], China Kadoorie Biobank Collaborative Group

Background: There is limited convincing evidence of the relationship between habitual snoring and cardiovascular diseases (CVDs).

Research question: Is habitual snoring associated with total CVD and CVD subtypes in different age groups of Chinese adults?

Study design and methods: The China Kadoorie Biobank study enrolled over 0.5 million adults aged 30 to 79 years from 10 regions in China. Snoring status and other baseline characteristics were collected from 2004 to 2008 using an interviewer-administered laptop-based questionnaire. The present analysis included 489,583 participants without stroke or coronary heart disease at baseline. Cox proportional hazards models were used to calculate the adjusted hazard ratios (HRs) and 95% confidence intervals (CIs) of CVDs for habitual snoring versus nonhabitual snoring.

Results: During a median follow-up of 9.6 years, 130,935 participants developed CVDs. Associations between habitual snoring and CVDs varied with age. Among participants aged <50 years at baseline, habitual snoring was associated with an increased risk of total CVD (HR: 1.11, 95% CI: 1.07-1.14) after adjustment for known CVD risk factors including systolic blood pressure. The corresponding HRs (95% CIs) for ischemic heart disease, ischemic stroke, and hemorrhagic stroke were 1.18 (1.12-1.24), 1.12 (1.05-1.19), and 1.05 (0.92-1.19), respectively. However, such associations in adults aged 50~64 years were much weaker, and no statistically significant association was observed among individuals aged ≥65 years. Age-specific risk estimates were generally similar across sex and obesity subgroups.

Interpretation: Habitual snoring was associated with increased risks of total CVD, ischemic heart disease, ischemic stroke, but not hemorrhagic stroke in Chinese and these associations were mainly limited to those aged<50 years. Clinicians in China are suggested to identify snoring, particularly in younger adults.

==EADSM== **comment**: Impressive study showing that early habitual snoring is related to CVD-risk, although it cannot be ruled out that OSA causes this relationship. The results indicate that it is beneficial to start treatment <50 years of age. In this age group, probably MADs are indicated for many patients.