

Articles of the Month – March 2021

New technologies

IEEE Trans Biomed Circuits Syst. 2021 Mar 12;PP.

doi: 10.1109/TBCAS.2021.3065824. Online ahead of print.

Link: <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9376900>

Smart Mandibular Advancement Device for Intraoral Monitoring of Cardiorespiratory Parameters and Sleeping Postures

Syedfakhreddin Nabavi, Sharmistha Bhadra

Abstract

Obstructive sleep apnea (OSA), as a highly prevalent sleep disorder, causes several serious health complaints. It has been proved that using intraoral mandibular advancement devices (MADs) during sleep is an efficient treatment for OSA. However, due to limited number of sleep study laboratories, effectiveness of MAD therapy is not regularly monitored. This paper proposes a smart MAD with the capability of continuously monitoring of cardiorespiratory parameters as well as sleeping postures and breathing routes. In this regard, a flexible hybrid wireless sensing platform based on the intraoral photoplethysmography (PPG), temperature and accelerometry monitoring is developed. It is qualitatively and quantitatively discussed that the intraorally captured PPG signals by the smart MAD have similar features as the ones received from the conventional anatomical position, i.e., the left index fingertip. Extensive experimental measurements indicate that the proposed smart MAD can estimate heart-rate (HR), respiration rate (RR), respiration pattern (RP), and blood oxygen saturation (SpO₂) with an overall accuracy of 90% in comparison to the reference measurements, while such a capability is not dependent on subject's positions and breathing route. It is also shown that the smart MAD can readily identify different sleeping postures, namely, supine, left, right, and prone and breathing routes. The accuracy, reliability, repeatability, and stability of the proposed smart MAD's measurements are proved by examining a group of subjects. The proposed smart MAD has potential to monitor the effectiveness of MAD treatment and eliminate untreated OSA without the requirement of attaching an extra monitoring platform to the patient's body.

EADSM comment:

The technology is advancing for MAD, approaching PAP, in terms of continuous monitoring of their efficacy.

Sleep Breath. 2021 Mar 26.

doi: 10.1007/s11325-021-02355-7. Online ahead of print.

Link: <https://link.springer.com/article/10.1007%2Fs11325-021-02355-7>

A novel intraoral neuromuscular stimulation device for treating sleep-disordered breathing

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Abstract

Purpose: To ascertain the usefulness of a novel intraoral neuromuscular stimulation device in treating patients with primary snoring and mild obstructive sleep apnoea (OSA). This device uses daytime awake neuromuscular electrical stimulation (NMES) as an application to induce toning of the tongue muscles.

Methods: A prospective cohort study of 70 patients with sleep-disordered breathing was conducted. Objective snoring and respiratory parameters were recorded with 2 consecutive night WatchPat sleep studies before and after treatment. The device was used for 20 min once daily for a 6-week period. Secondary outcome measures using visual analogue scale reporting of snoring by patient and Epworth Sleepiness Score (ESS) were recorded. Quality of life parameters were also noted.

Results: Objective reduction of snoring was noted on the sleep studies in 95% of participants, with an average snoring time reduction of 48%. Subjectively, the visual analogue scale reported by partners' similarly demonstrated reduction in 95% of the patients with an average reduction of 40%. In a subset of 38 patients with mild OSA, AHI reduced from 9.8 to 4.7/h (52% reduction), ODI 7.8 to 4.3/h (45% reduction), and ESS from 9.0 to 5.1. Adverse effects encountered were minimal.

Conclusion: This prospective cohort study demonstrates a notable improvement in both objective and subjective parameters of snoring and mild OSA in both simple snorers and patients with mild OSA. This device offers a safe and novel approach to reduce snoring and mild OSA by utilising intraoral neuromuscular electrical stimulation. This could be a preferred option for patients as it alleviates the need of using an oral device during sleep.

EADSM comment: New type of intraoral appliance based on muscle stimulation without mandibular advancement. Although, more evaluation is needed.

OA therapy

Sleep. 2021 Mar 12;44(3):zsaa196.

doi: 10.1093/sleep/zsaa196.

Link: <https://academic.oup.com/sleep/article/44/3/zsaa196/5909314?login=true>

Influence of mandibular advancement on tongue dilatory movement during wakefulness and how this is related to oral appliance therapy outcome for obstructive sleep apnea

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Abstract

Study objectives: To characterize how mandibular advancement splint (MAS) alters inspiratory tongue movement in people with obstructive sleep apnea (OSA) during wakefulness and whether this is associated with MAS treatment outcome.

Methods: A total of 87 untreated OSA participants (20 women, apnea-hypopnea index (AHI) 7-102 events/h, aged 19-76 years) underwent a 3T MRI with a MAS in situ. Mid-sagittal tagged images quantified inspiratory tongue movement with the mandible in a neutral position and advanced to 70% of the maximum. Movement was quantified with harmonic phase methods. Treatment outcome was determined after at least 9 weeks of therapy.

Results: A total of 72 participants completed the study: 34 were responders (AHI < 5 or AHI ≤ 10 events/h with >50% reduction in AHI), 9 were partial responders (>50% reduction in AHI but AHI > 10 events/h), and 29 nonresponders (change in AHI <50% and AHI ≥ 10 events/h). About 62% (45/72) of participants had minimal inspiratory tongue movement (<1 mm) in the neutral position, and this increased to 72% (52/72) after advancing the mandible. Mandibular advancement altered inspiratory tongue movement pattern for 40% (29/72) of participants. When tongue dilatory patterns altered with advancement, 80% (4/5) of those who changed to a counterproductive movement pattern (posterior movement >1 mm) were nonresponders and 71% (5/7) of those who changed to beneficial (anterior movement >1 mm) were partial or complete responders.

Conclusions: The mandibular advancement action on upper airway dilator muscles differs between individuals. When mandibular advancement alters inspiratory tongue movement, therapeutic response to MAS therapy was more common among those who convert to a beneficial movement pattern.

EADSM comment: This study shows a strong relationship between inspiratory tongue response and treatment success with OA and puts further light on the mechanism of action of these appliances.

Evaluation of Respiratory Resistance as a Predictor for Oral Appliance Treatment Response in Obstructive Sleep Apnea: A Pilot Study

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Abstract

The aim of this study was to determine the utility of respiratory resistance as a predictor of oral appliance (OA) response in obstructive sleep apnea (OSA). Twenty-seven patients with OSA (mean respiratory event index (REI): 17.5 ± 6.5 events/h) were recruited. At baseline, the respiratory resistance (R20) was measured by impulse oscillometry (IOS) with a fitted nasal mask in the supine position, and cephalometric radiographs were obtained to analyze the pharyngeal airway space (SPAS: superior posterior airway space, MAS: middle airway space, IAS: inferior airway space). The R20 and radiographs after the OA treatment were evaluated, and the changes from the baseline were analyzed. A sleep test with OA was carried out using a portable device. The subjects were divided into Responders and Non-responders based on an REI improvement $\geq 50\%$ from the baseline, or REI < 5 after treatment, and the R20 reduction rate between the two groups were compared. The subjects comprised 20 responders and 7 non-responders. The R20 reduction rate with OA in responders was significantly greater than it was in non-responders ($14.4 \pm 7.9\%$ versus $2.4 \pm 9.8\%$, $p < 0.05$). In responders, SPAS, MAS, and IAS were significantly widened and R20 was significantly decreased with OA ($p < 0.05$). There was no significant difference in non-responders ($p > 0.05$). A logistic multiple regression analysis showed that the R20 reduction rate was predictive for OA treatment responses (2% incremental odds ratio (OR), 24.5; 95% CI, 21.5-28.0; $p = 0.018$). This pilot study confirmed that respiratory resistance may have significant clinical utility in predicting OA treatment responses.

EADSM comment: In the same area as the above article, this study tries to predict response to oral appliance therapy based on the reduction in respiratory resistance among responders, but not in non-responders.

New classification of OSA

ERJ Open Res. 2021 Mar 1;7(1):00928-2020.

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Link: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7917384/>

Evaluation of a multicomponent grading system for obstructive sleep apnoea: the Baveno classification

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Abstract

New findings on pathophysiology, epidemiology, and outcome have raised concerns on the relevance of the apnoea-hypopnoea index (AHI) in the classification of obstructive sleep apnoea (OSA) severity. Recently, a multicomponent grading system decision integrating symptomatology and comorbidities (Baveno classification), was proposed to characterise OSA and to guide therapeutic decisions. We evaluated whether this system reflects the OSA population, whether it translates into differences in outcomes, and whether the addition of AHI improves the scheme. A total of 14 499 OSA patients from the European Sleep Apnoea Database cohort were analysed. The groups were homogeneously distributed and were found to clearly stratify the population with respect to baseline parameters. Differences in sleepiness and blood pressure between the groups were analysed in a subgroup of patients after 24-36 months of treatment. Group A (minor symptoms and comorbidities) did not demonstrate any effect of treatment on outcome. However, groups B (severe symptoms, minor comorbidities), C (minor symptoms, severe comorbidities) and D (severe symptoms and comorbidities) were associated with improvement in either or both parameters with treatment. The AHI is an essential prerequisite of the diagnosis; however, adding the AHI did not improve the classification. Rather, it was inferior with respect to guiding the treatment decision. Thus, the Baveno classification allows a better stratification of the OSA population and may provide a better guidance for therapeutic decisions in OSA.

EADSM comment: New classification of sleep apnea, beyond AHI, will probably influence the indications for oral appliance therapy.