of the plotted SL$_{OSLER}$ or SL$_{EEG}$ measurements converged within a range of mean $\pm$ 1.96 SD.

Conclusions: Our findings thus demonstrated that SL$_{OSLER}$ is consistent with SL$_{EEG}$ in Japanese patients with OSA.

Basic Research

DIFFERENTIAL EFFECTS OF INTERMITTENT HYPOXIA ON PHENOTYPIC AND METABOLIC FEATURES OF AIRWAY MUSCLES IN WEANING- AND ADOLESCENT-AGED RATS

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Introduction: Repetitive episodes of hypoxia during sleep is a pathology of obstructive sleep apnea (OSA). Comparative studies between humans (children & adolescents), and rodents (rats) have suggested differential hypoxic responses to metabolic morbidities due to functionally immature neurotransmitters. In adolescents, intermittent hypoxia (IH) systemically and locally induces pro-inflammatory cytokines, which leads to progressive atrophic alterations in skeletal muscles. However, there are no comparative studies to verify the metabolic changes in airway muscles exposed to IH at different growth periods. Thus, the aim of this study was to clarify the effects of IH on phenotypic and metabolic features of the geniohyoid (GH) and diaphragm (DIA) muscles in weaning- and adolescent-aged rats.

Materials and methods: The three-week old (weaning-aged), and seven-week old (adolescent-aged) male Sprague-Dawley rats used in this study, were categorized into 2 groups based on their growth periods and the intervention. The experimental group was exposed to IH at the rate of 20 cycles/h (nadir of 4% O_2 to peak of 21% O_2 with 0% CO_2), while the control group received normal room air breathing alone for 8 h/d. After 3-weeks, all the rats were sacrificed and samples of their GH and DIA muscles were collected. Real-time PCR and western blot analysis were performed to evaluate the gene and protein expressions for pro-inflammatory and muscular metabolic factors in the respiratory muscles. Statistical analysis of the normoxic and IH groups was performed using unpaired t-test ($p < 0.05$).

Results: Western blot analysis for muscular phenotypic and metabolic features showed that in the adolescent-aged rats, IH exposure significantly increased the protein levels of the fast-twitch isoform, sarcoplasmic reticulum Ca(2+)-ATPase (SERCA1) in the DIA muscle (1.77-fold change vs. control), as well as decreased the protein levels of the slow-twitch isoform, (SERCA2a) in the GH muscle (0.50-fold change vs. control) . In the weaning-aged rats exposed to IH, SERCA1 significantly decreased (GH: 0.48-fold change vs. control; DIA: 0.48-fold change vs. control), while SERCA2a was comparable in both muscles. PCG-1α protein was significantly decreased in the GH and DIA muscles of the adolescent-aged rats exposed to IH. qPCR showed that exposure to IH significantly elevated mRNA levels of pro-inflammatory cytokines; (IL-1β: 3.3-fold change vs. control), and TNF-α (1.9-fold change vs. control) in the GH muscle of the adolescent-aged rats, whereas they were significantly decreased in the weaning-aged rats (IL-1β: 0.62-fold change vs. control; TNF-α: 0.65-fold change vs. control). The mRNA levels of iNOS significantly increased in the GH muscle of the adolescent-aged rats (2.5-fold change vs. control) compared to those of the weaning-aged rats.

Conclusions: IH increased pro-inflammatory gene levels with change in muscular isoforms from the fast- to the slow-twitch types in the GH muscle of the adolescent-aged rats, whereas IH decreased SERCA1 with a downregulation of pro-inflammatory genes in the weaning-aged rats. However, these findings suggest that phenotypic and metabolic alterations and/or features of airway muscles, depend on the developmental stages of the rats exposed to IH.

Other

THE SURGICAL TREATMENT OF OBSTRUCTIVE SLEEP APNEA SYNDROME: IS ISOLATED VALUE OF AHI A SUFFICIENT CRITERION OF SUCCESS?

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Introduction: Uvulopalatopharyngoplasty (UPPP) and its combination with bipolar radiofrequency surgery of the tongue base (UPPP + RFBT) are the most common surgical treatment modalities of obstructive sleep apnea syndrome (OSAS). These procedures should improve the results of polygraphy, decrease the daytime sleepiness and influence also the incidence of cardiovascular disorders and snoring. In this project, we concentrate on the comparison of apnea – hypopnea index (AHI) change with subjective results and satisfaction of patients.

Materials and methods: In our hospital 106 patients underwent surgical treatment of OSAS during a period from 2014 to 2016. The set of patients was divided into several groups according to anatomical conditions and results of a polygraphy. The first group underwent UPPP and second one underwent UPPP+RFBT. Both of these groups were divided according to the grade of sleep apnea. We assessed apnea – hypopnea index (AHI) by polygraphy. The polygraphy was performed before surgery and 6 months after surgery. We compared subjective results after surgery to change in AHI and Sher's criteria.

Results: Despite of being invited only one half of all the patients turned up to control monitoring after surgery. In the end, we had 53 patients with postoperative monitoring, 28 of them underwent UPPP and 25 underwent UPPP+RFBT.

We noticed an improvement of presurgical AHI in 77% of the patients. This portion correlates with the results of subjective satisfaction of patients. The patients reported complete elimination of symptoms (snoring and daytime sleepiness) in 81%, 19% of the patients felt partial improvement. Nobody quoted subjective worsening after surgery, although we registered in 23% worsening of AHI. The results based on proportional decrease of AHI didn't correlate with the subjective satisfaction of the patients.

Regarding the severity of OSAS the improvement of AHI was noted in 47% in a mild OSAS cases treated by both surgical modalities. The efficiency in moderate OSAS was 56%. Only the group with severe OSAS (treated by UPPP + RFBT) was improved in 80% of cases. The Sher's criteria of success were met in 40% of all patients after surgery.

Conclusions: The surgical treatment of OSAS is an important method in cases where non surgical treatment fails or is refused. The results of this project show a poor correlation between AHI change and subjective feelings after surgery. We find out unsatisfying results based on simple changes of AHI values, but a majority of the patients were satisfied with subjective improvement after the surgery. Isolated AHI change is probably not a good criterion of surgery success. We suggest to add also the subjective parameters (e.g. ESS) to the evaluation.

Basic Research

THE NEUROPHYSIOLOGICAL BASIS OF SLEEP PERCEPTION DURING SLEEP ONSET PERIOD

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Introduction: Sleep is a reversible state of consciousness associated with reduction of awareness, response to external stimuli, and appearance of

behavioral and physiological changes. The perception of sleep, by definition, is measured by subjective report. Previous study has shown that perception of sleep is associated of loss of thinking process, as well as decreased experience of sensation and perception (Yang, Han, Yang, Su, & Lane, 2010). However, the neurophysiological mechanism underlying sleep perception remains uncertain. The aim of this study is to use EEG and fMRI to compare the difference in brain activities before awakenings with and without perception of sleep.

Materials and methods: Forty-eight healthy adults (20-35 years old, 31 females and 17 males) were recruited to participate in the study. Simultaneous EEG and fMRI recordings were conducted while they were lying in fMRI scanner and trying to fall asleep. They were awakened at N1 or N2 stages of sleep. They were then interviewed concerning the status of their subjective experience immediately prior to the awakening. The content of the interview included perceptual experiences, thought content and processes, emotional experiences, engagement with reality, and orientation toward time and place. Their metabolism and functional connectivity within prefrontal cortex and the thalamo-cortical system were analyzed.

Results: Forty-one interviews were included in the analyses, twenty of them were awakened from stage N2 sleep, five were awakened from stage N1 sleep, and sixteen were from waking state. EEG results showed that absolute delta activities were higher in awakenings with sleep perception than those without sleep perception at F4, P3, P4 and PZ. Absolutes alpha activities were also found be lower in awakenings with sleep perception than those without sleep perception at F7, Cz, P3, P4, T7, P7, P8, Pz, Oz and CP1. fMRI data showed higher functional connectivites between dACC and left precuneus in awakenings with perception of sleep, comparing to those without sleep perception.

Conclusions: The study provided EEG-based evidence that perception of sleep is associated with decreased activation in frontoparietal network. Besides, fMRI showed association between sleep perception and stronger connectivity between regions that have been shown to be related to self-referential processing. The finding suggests that an increase of internal focus instead of attending to external stimuli might play a key role in the perception of sleep.

Sleep Breathing Disorders
APPLYING COMPUTATIONAL FLUID DYNAMICS TO OPTIMIZE ADJUSTMENTS ON ORAL APPLIANCE USED FOR THE TREATMENT OF SNORING AND OBSTRUCTIVE SLEEP APNEA

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Introduction: Computational fluid dynamics (CFD) is often used in studies to understand the correlation between mandibular protrusion and widening of the airway lumen. The result can be applied to calculate for the amount of protrusion required in order for patient to have a treatment effect with oral appliance. This study uses CFD to evaluate upper airway flow field characteristics of obstructive sleep apnea (OSA) patients treating with oral appliance and to validate the aforementioned calculated mandibular protrusion requirement (optimum adjustment distance for the oral appliance). This helps doctors on the adjustments of the oral appliance which reduces number of revisits required by the patient.

Materials and methods: This study included twenty adult OSA patients with apnea-hypopnea index (AHI) between 15 and 30. Two scans of patients′ upper airway region were taken using cone beam computed tomography (CBCT) scanner; first scan is with a natural occlusion position followed by a second scan which a bite fork was used to protrude patient′s mandible. CFD was used to simulate airway flow field characteristics and a database along with calculation algorithm from the previous study were used to calculate for the optimum adjustment distance. CFD calculation uses finite volume method to get required information on Navier-Stokes equation. After patient fitted with optimally adjusted oral appliance, comparison was made between simulated and polysomnography (PSG) results for validation. Finally, each airway flow field characteristics and the

reliability of the method used to calculate for optimum adjustment distance were evaluated.

Results: This study combines medical images and bite fork to get models on the airway and related muscles and structures before and after mandibular protrusion. CFD is used to analyze each model for airway flow field characteristics and to calculate for the optimum adjustment distance of the oral appliance. After patient fitted with optimally adjusted oral appliance, the result shows the protrusion of the mandible widened the airway lumen with reduction of stenosis; airway flow field characteristics also changed with reduction in air pressure difference and in airflow rate which is consistent with reduction of stenosis. When comparing simulated results and PSG results on patient fitted with optimally adjusted oral appliance, the results are consistent with each other where patients′ AHI reduced significantly (7 or lower). This result further shows the reliability and validity of the calculation.

Conclusions: This study shows by combining medical images, CFD and database analytics, it is possible to calculate for the optimum adjustment distance of oral appliance used for the treatment of snoring or OSA. It also provide valuable information to doctors on the adjustments of oral appliance and ultimately reduces number of revisits required by the patient.

Sleep Breathing Disorders
VIRTUAL SURGERY AND SIMULATION ANALYSES ON UPPER AIRWAY OF OBSTRUCTIVE SLEEP APNEA PATIENTS

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Introduction: Maxillomandibular advancement (MMA) is one of the treatment methods used for treating patients diagnosed with obstructive sleep apnea (OSA). Many studies are done to evaluate the effectiveness of the MMA and among the methods used, computational fluid dynamics (CFD) is one of the most common and effective method. This study uses CFD and solid mechanics techniques to simulate MMA on OSA patients and compare the simulated upper airway conditions with actual post-surgical upper airway conditions. The purpose of this study is to provide patient's pre-surgical and virtual post-surgical upper airway conditions to surgeon before actual surgery.

Materials and methods: Sixteen adult OSA patients with average BMI of 22.7, and average apnea-hypopnea index (AHI) of 40.8 were included in this study. Using pre- and post-surgical images of the patient from computed tomography (CT) scanner to reconstruct patient's head and neck and structures including maxilla, mandible, airway, neck muscles, soft tissues and their appearances; and use optimal material analysis method to match the post-surgical appearance and find anisotropic material properties of the muscles. Use the obtained muscle material properties and mandibular advancement distance, solid mechanics technique was used for solid part (maxilla, mandible, muscles) of virtual surgery simulation. Solid mechanics calculation uses finite element method: advancement of mandible moves muscle and related structure and hence changed the morphology of the airway, especially the pharyngeal area. To run simulation with fluid dynamics technique, apply average normal inspiration volume of 500 ml/sec to the pre-surgical, virtual post-surgical, and actual post-surgical upper airway models of the patient. Finite volume method was used in fluid dynamics to get required information on Navier-Stokes equation. Finally, use computational fluid dynamics to simulate and observe three aforementioned upper airway flow field characteristics and to evaluate the reliability of virtual surgery simulation.

Results: This study combines medical images, CFD and solid mechanics to obtain pre-surgical, virtual and actual post-surgical morphologies of the airway and related structures; using calculation to obtain neck muscle material properties and apply the information using solid mechanics technique for virtual surgery which simulated the morphologies of the airway and related structures. Computational fluid dynamics analyzes the models for flow field characteristics of the airway, the result shows the difference in virtual and actual post-surgical morphologies is 3% and the difference in