26th Annual Meeting of the American Academy of Dental Sleep Medicine: Boston, MA, June 2–4, 2017

POSTER #001

LONG-TERM SIDE EFFECTS OF SLEEP APNEA TREATMENT WITH ORAL APPLIANCES

Hamoda MM, Almeida FR, Pliska BT

Department of Oral Health Sciences, Faculty of Dentistry, University of British Columbia, Vancouver, BC, Canada

Introduction: Oral appliances for the treatment of obstructive sleep apnea (OSA) reduce upper airway collapse by advancing the mandible (OA_m) and decreasing the collapsibility of the upper airway. OA_m are well tolerated, still these appliances have known side effects, with the most serious being dental movement. Previous studies have shown that the amounts of dentoalveolar changes are not related to appliance design but to the duration of therapy. It is not yet clear whether there are also irreversible skeletal changes related to OA use.

As oral appliance treatment for OSA is a life-long therapy, careful and extended follow-up of patients is required to evaluate possible side effects with prolonged durations of oral appliance use. The objective of this study is to evaluate both the magnitude and progression of the dental and skeletal changes associated with long-term OA_m treatment.

Methods: Retrospective study of lateral cephalograms of adults treated for primary snoring or mild to severe OSA with an OA_m for a minimum of 8 years. All patients were treated with a custom made titratable oral appliance; the number of lateral cephalograms obtained for each patient ranged between 2 to 9 and the baseline cephalogram for each patient was obtained prior to the initiation of treatment. The cephalograms were analyzed for skeletal, dental and soft tissue facial changes. The progression of these changes over time was determined and initial patient and dental characteristics were evaluated as possible predictors of the observed dental side effects of treatment. Approval for the study was obtained from the UBC Clinical Research Ethics Board H11-01661.

Results: A total of 62 patients (average age at start of treatment: 49 ± 8.6 years) were included in this study and average treatment length was 12.6 years (range: 8-21 years). Over the total treatment interval evaluated there was a significant ($P < .001$) reduction in overjet (3.5 ± 2.5 mm) and overbite (2.2 ± 2.3 mm), as well as maxillary incisor retroclination and mandibular incisor proclination. All changes seemed to continuously progress except for overbite reduction which levelled off with time. Although some statistically significant ($P < .001$) skeletal changes were noted in the SNB and mandibular plane angles, measured differences were less than a 1° and were deemed not clinically significant.

Conclusions: This study represents the longest OA_m side effects follow up duration conducted to date. It confirms that there are significant and progressive dental changes with prolonged OA_m use and no clinically significant skeletal changes.

POSTER #002

IS SNORING DURING PEDIATRIC DENTAL PROCEDURES INDICATIVE OF OBSTRUCTIVE SLEEP APNEA?: A PILOT STUDY

Chiang HK[1], Best AM[1], Leszczyszyn DJ[2]

[1]School of Dentistry, Virginia Commonwealth University, Richmond, Virginia; [2]School of Medicine, Virginia Commonwealth University, Richmond, Virginia

Introduction: The American Academy of Pediatric Dentistry estimated over 300,000 children are sedated annually during pediatric dental care. Pharmacologic and physiologic effects of sedation and anesthesia simulate the effects of sleep and can uncover the propensity for snoring. Snoring duration and loudness are associated with obstructive sleep apnea (OSA) severity. Therefore, sedation for dental procedures presents a unique opportunity to use snoring to identify children at higher risk for OSA. The purpose of this pilot was to determine whether pediatric snoring could be used as a screening tool for OSA.

Methods: The case-control study was approved by the VCU-IRB (HM 15315). All participants were pediatric dental patients requiring moderate sedation. Snoring cases were identified by significant snoring (audible, turbulent sounds lasting longer than 2 breaths) during dental care. Non-snoring (control) participants were selected from those without significant snoring. OSA was diagnosed using a portable home sleep monitoring device. Parents filled out two questionnaires: Pediatric Sleep Questionnaire (PSQ) and the Pediatric Symptom Checklist (PSC). Groups were compared using a *t*-test.

Results: In the 19 children screened for eligibility, there were 10 snoring cases (59%) and 7 controls recruited and completed the home monitoring portion of the study. The 9 males and 8 females had an average age of 5.5 years (range = 4 to 8) and had an average BMI percentile of 59.3 (range = 2nd to 99th percentile). Fifty-seven percent of the children were black and 29% were white. The snorers and non-snorers did not differ on demographics. The primary outcome variable was the respiratory disturbance index (RDI) indicator of OSA. Although the children who snored during pediatric dental surgery had a nominally higher RDI than the control children who did not snore (mean = 5.3 vs. 4.3), this difference was not statistically significant ($P > .7$). Using a cut-off of RDI > 5 to indicate significant OSA, there were 5 of 8 in the snorer group and 2 of 4 in the non-snorer group who met this criteria. Similar results were obtained using the snore index (SI), and type 1&2 snoring percentages; specifically that the snorers had nominally higher

but statistically non-significant averages. On the other hand, one non-snoring participant had a maximum relative loudness of 27dB and this resulted in the group mean being nominally higher than the snoring group's average. The results from the questionnaires were more hopeful. Both the PSQ and PSC average was 5 points higher in the snoring group than the average of the non-snorers but the difference was not statistically significant (PSQ $P = .056$, PSC $P > .4$).

Conclusions: Snoring during pediatric dental procedures does not appear to be indicative of obstructive sleep apnea on its own. Future studies could explore whether this clinical finding would add to the screening capability of existing questionnaires such as the PSQ.

Support: This study was funded by Virginia Commonwealth University Clinical Research fund.

POSTER #003

MANAGEMENT OF COMPLEX SLEEP APNEA WITH MANDIBULAR ADVANCEMENT DEVICE: A CASE REPORT

Li S, Correa L, Mehta NR

Tufts University School of Dental Sleep Medicine, Boston, Massachusetts

Introduction: Complex sleep apnea may be defined as the presence of both obstructive and repetitive central sleep apnea occurring in the same individual during the same night (R.J. Castriotta, R. Majid, 2013). During REM sleep, the behavioral system is dominant, with impaired ventilator response to hypercapnia, especially during phasic REM sleep (E.A. Phillipson, 1977). During non-REM sleep, in contrast, the metabolic control of breathing is dominant, with minimal to absent behavioral control (B.R. Fink, 1961). For this reason, in adults, significant central apnea is more frequently and sometimes exclusively seen during non-REM sleep, whereas obstructive apnea is more frequently seen in REM sleep (E. Lugaresi et al., 1972). Some authors state that the number of central apnea events may increase with initiation of positive airway pressure (PAP) therapy due to increased alveolar ventilation with a decrease of CO_2 lower than the apneic threshold (D. Neu et al., 2015). However, there is a lack of data on the influence of oral appliance therapy (OAT) on central component of complex sleep apnea. The purpose of this case report is to show result of management of complex sleep apnea with OAT.

Methods: A 59-year-old male with long-term symptoms of sleep disturbance was referred by his sleep physician to explore the option mandibular advancement device (MAD) due to intolerance to PAP therapy. The patient underwent home sleep study with type 3 home sleep test device. He was diagnosed with Complex Sleep Apnea (AHI = 31.4 events/h) with large amount of central apnea (CA) events (CA index = 20.2 events/h). The overall respiratory events index (REI) was 38.2 events/h with the majority of the events happening in supine position. Baseline oxygen saturation was 97.4% with lowest O_2 saturation of 84.2%. A custom, adjustable MAD was fabricated and fitted with 80% jaw protrusion; titration of the MAD

was reached at 90% during follow up appointment. Morning jaw repositioning device (MRD) was provided to minimize potential development of occlusal side effects. After achieving subjective success, the patient was referred back to the sleep physician to objectively assess the efficacy of the MAD.

Results: Follow-up polysomnography demonstrated reduction of obstructive and central sleep apnea with the use of the MAD with residual apnea in the supine position (AHI = 8.8, CA index = 2), mean O_2 saturation = 94%, with lowest O_2 saturation = 90%. Subjective improvement included feeling more refreshed at the morning and improved quality of sleep. Epworth Sleepiness Scale score was reduced from 13/24 to 4/24. Patient was satisfied with the MAD and reported minor bite symptoms at the morning after removal of the MAD, which were eliminated by using the MRD for 15-20 minutes.

Conclusions: This case report demonstrated improvement of obstructive and central apnea components with the MAD. A possible mechanism of reduction of central apnea events could be associated with stabilization of the ventilator control system and improving the sleep architecture.

POSTER #004

CESSATION OF SNORING WITH AN INCREASED APNEA HYPOPNEA INDEX DURING MANDIBULAR ADVANCEMENT DEVICE THERAPY: A CASE REPORT

Ebato A[1], Tsuiki S[2-4], Almeida F[4], Kohzuka Y[4], Suzuki H[1], Inoue Y[2]

[1]Department of Oral Function and Rehabilitation, Nihon University School of Dentistry at Matsudo, Japan; [2]Japan Somnology Center, Institute of Neuropsychiatry, Japan; [3]Aging and Geriatric Dentistry, Faculty of Dentistry, Tohoku University, Japan; [4]Department of Oral Health Sciences, Faculty of Dentistry, The University of British Columbia, Canada

Introduction: Snoring is a typical chief complaint in patients with mild obstructive sleep apnea (OSA) who initiate oral appliance therapy. The cessation of snoring after a prescription of a mandibular advancement device (MAD) can often be assumed to reflect a patent upper airway following mandibular advancement, which would simultaneously support the effectiveness of MAD. However, we recently experienced a case of mild OSA in which snoring disappeared with the use of an MAD, but the apnea-hypopnea index (AHI) increased. This case highlights the importance of objective follow-up evaluation of MAD treatment.

Methods: A 41-year-old male (body mass index [BMI] = 22.2 kg/m^2) was diagnosed with mild OSA with an AHI of 8.5 events/h and was referred to the Sleep Apnea Dental Clinic, Yoyogi Sleep Disorder Center, Tokyo, for treatment with MAD. The patient complained of mild insomnia and light sleep and his wife reported loud snoring with episodes of apnea. The score on the Japanese version of the Epworth Sleepiness Scale at his first visit was 7. The patient did not complain of dozing-off during work. A custom-made monobloc MAD was fabricated at 50% of the maximum mandibular protrusion. After 3 months of MAD treatment with additional advancement

of the mandible as necessary, he used his MAD 6-7 nights a week and his wife no longer reported his snoring, although he did not feel any subjective improvement of his sleep. He went through follow-up polysomnography with the MAD.

Results: Follow-up polysomnography with the MAD in place revealed that his snoring had indeed improved from 14.8% to 0.4% of the total sleep time. However, the AHI had increased from 8.5 events/h to 11.6 events/h and the nadir $SlpO_2$ fell from 93% to 87%. Notably, the AHI during rapid eye movement sleep increased from 8.8 events/h to 33.4 events/h.

Conclusions: While an MAD has been reported to predominantly enlarge the velopharynx, which is where snoring originates, it is interesting to find a patient in whom OSA worsened despite the presence of a typical sign of improved upper airway patency (ie, cessation of snoring). Although the reason for the increased AHI in this case is unknown, we speculate that a slight increase in BMI may have resulted in an increase in the collapsibility of the oropharynx and/or hypopharynx. To avoid adverse health outcomes such as hypoxemia even after treatment, we emphasize the need for the objective follow-up evaluation of MAD treatment using polysomnography.

POSTER #005

THE ROLE OF A NOVEL ORAL APPLIANCE THERAPY DEVICE ON PHARYNGEAL PRESSURE SWINGS AND CPAP REQUIREMENTS DURING SLEEP IN OBSTRUCTIVE SLEEP APNEA: A PILOT STUDY

Amatoury J[1,2], Tong B[1], Nguyen C[1], Szollosi I[3], Eckert DJ[1,2]

[1]*Neuroscience Research Australia (NeuRA), Sydney, Australia;* [2]*School of Medical Sciences, University of New South Wales, Sydney, Australia;* [3]*Oventus Medical Ltd, Brisbane, Australia*

Introduction: Oral appliance (OA) therapy is often an effective alternative to continuous positive airway pressure (CPAP) for the treatment of obstructive sleep apnea (OSA). However, OA treatment efficacy varies and is often poorly tolerated in people with high nasal resistance. A new OA therapy device that incorporates an opening to the oral cavity (Oventus, O_2Vent T) allows breathing through the device airway, which may reduce the high inspiratory pressures required to drive air through the pharynx in people with nasal obstruction. The goals of the current study were to: (1) assess pharyngeal pressure swings during sleep with and without the OA therapy device and (2) determine the effect of the device on the CPAP requirements to minimize pharyngeal pressure swings and abolish residual events.

Methods: Four individuals were studied overnight in the sleep physiology laboratory (3 male; age: 43-62 years, BMI: 28-33 kg/m^{2}). In addition to standard polysomnography, subjects were fitted with a nasal CPAP mask and pneumotachograph to quantify airflow. Choanal pressure (Pcho) and epiglottic pressure (Pepi) were measured using pressure transducer-tipped catheters. Nasal resistance was quantified during quiet nasal breathing awake (Pcho/flow@200ml/s). Nasal CPAP was carefully titrated during NREM sleep to determine "therapeutic

CPAP" level. Participants were studied under the following conditions during supine NREM sleep: (1) no OA and no CPAP (baseline), (2) OA only, (3) CPAP only, and (4) OA and CPAP combination therapy. The degree of mandibular advancement with the OA therapy device was sub-optimal to allow expression of residual events that required combination OA and CPAP therapy. The apnea-hypopnea index (AHI) and nadir Pepi swings were determined during each condition. CPAP levels with OA therapy to achieve nadir Pepi values equivalent with therapeutic CPAP without the OA was also determined.

Results: Awake nasal resistance ranged between 2.8 and 20.6 cmH_2O/mL/s (12.3 ± 8.2 cmH_2O/mL/s, mean ± SD). 3/4 participants had high nasal resistance (> 3 cmH_2O/mL/s). Baseline AHI was 37 ± 35 events/h, which decreased with OA therapy to 8 ± 10 events/h. Average nadir Pepi swings during baseline NREM sleep were -8.5 ± 2.5 cmH_2O, falling to -4.1 ± 1.6 cmH_2O with OA therapy. The therapeutic CPAP level required to abolish respiratory events during NREM sleep without OA therapy was 6.8 ± 2.4 cmH_2O with corresponding nadir Pepi swings of -4.0 ± 2.6 cmH_2O. With OA and CPAP combination therapy, a CPAP level of 2.3 ± 0.9 cmH_2O abolished respiratory events and resulted in further reduction of the nadir Pepi swings to -2.7 ± 1.1 cmH_2O.

Conclusions: The oral appliance device with built in airway reduces pharyngeal pressure swings and the CPAP requirements necessary to achieve stable breathing during sleep. These options may be viable alternatives for the treatment of OSA in people with high nasal resistance.

POSTER #006

WHEN TO PERFORM FOLLOW-UP POLYSOMNOGRAPHIC EVALUATION OF ORAL APPLIANCE THERAPY FOR OBSTRUCTIVE SLEEP APNEA

Eno Y[1,2], Tsuiki S[3,4], Fukuda T[3], Taga H[1,5], Inoue Y[3]

[1]*JR Tokyo General Hospital, Japan;* [2]*School of Dentistry, Meikai University, Japan;* [3]*Japan Somnology Center, Institute of Neuropsychiatry, Japan;* [4]*Aging and Geriatric Dentistry, Faculty of Dentistry, Tohoku University, Japan;* [5]*Department of Anesthesiology, Fujigaoka Hospital, Showa University, Japan*

Introduction: There is no concise tool for deciding when to perform follow-up polysomnography in oral appliance therapy for obstructive sleep apnea (OSA). However, the timing of this evaluation is clinically important because frequent polysomnographic studies are impractical with regard to both the patient's inconvenience and cost. The STOP questionnaire consists of 4 yes/no questions (ie, snoring, tiredness during daytime, observed apnea, high blood pressure), and is used to identify subjects who may be at risk of OSA if they answer yes to 2 or more questions (Chung et al. Anesthesiology 2008). We hypothesized that a reduction in the STOP score (ie, fewer yes responses), in patients undergoing oral appliance treatment could be an indicator of the best timing for follow-up polysomnography.

Methods: The study protocol was approved by the ethics committee of the Institute of Neuropsychiatry. Among patients who were diagnosed with OSA at a single sleep center from June 2011 to December 2015, OSA patients who were to be prescribed a monobloc were consecutively targeted and prospectively recruited into this study (ie, STOP group). Subjects who lived alone were excluded. The STOP score was recorded at every patient visit, while the upper and lower parts of the appliance were separated and later reattached as necessary. We considered that the appropriate timing for follow-up polysomnography was when the STOP score stopped changing. A historical control group was also established from consecutive patients without a STOP score for whom we had both baseline and follow-up polysomnographic studies (n = 228, June 2005 to May 2011).

Results: The median (interquartile range) STOP scores significantly decreased with oral appliance treatment from 3 (2-3) to 0 (0-1) in the STOP group (n = 69) ($P < .05$, Wilcoxon signed-rank test). The duration from appliance prescription to follow-up polysomnography in the STOP group was longer than that in the control group (147 [115-215] vs 113 [70-198] days, $P < .05$, Mann-Whitney U test). The apnea-hypopnea index (AHI) was improved in both the STOP group (16 [10-22] to 3 [2-7] events/h, $P < .05$) and the control group (18 [13-26] to 6 [3-11] events/h, $P < .05$). However, a greater percentage of subjects achieved a follow-up AHI of < 5 events/h with a > 50% reduction in baseline AHI in the STOP group (44 of 69 patients, 64%) than in the control group (94 of 228 subjects, 41%) ($P < .05$, chi square test).

Conclusions: These findings suggest that recording of the STOP score is helpful for determining the timing of follow-up polysomnography in oral appliance treatment: this may reflect satisfactory adherence to and successful adjustment of oral appliances. We conclude that this simple, quick, and inexpensive evaluation facilitates proper and necessary follow-up diagnosis in oral appliance therapy.

POSTER #007

PEDIATRIC SLEEP-DISORDERED BREATHING: THE DENTAL MIRACLE

White JR[1], Boota A[2], Alexander N[3], Hooks K[4]

[1]*Dental Sleep Medicine-SC, Greenville, South Carolina;* [2]*Palmetto Pulmonary and Critical Care, PA, St. Francis Hospital, Greenville, South Carolina;* [3]*Greenville ENT, Greenville Hospital System, Greenville, South Carolina;* [4]*Medbridge Healthcare, Greenville, South Carolina*

Introduction: Oral respiration, abnormal cranio-facial growth and pediatric obstructive sleep apnea are truly a medical/dental highball with a twist of myofunctional therapy. The constant interaction between oral-facial muscles and oral-facial structural growth starts early in development and continue thru childhood. Chronic open mouth posture and breathing, as Guilleminault tell us, is an important clinical marker of oral-facial dysfunction which over time will alter normal naso-maxillary development. Oral respiration, deficient maxilla and malocclusion are not historical characteristics of the human genotype and suggest that environmental factors have

a significant role and may alter the phenotype. To correct deficient maxilla and malocclusion the dental profession has used rapid maxillary expansion (RME) first introduced by Angell in 1860 and brought back into favor by Haas in 1961. RME consist of application of orthopedic forces to the midpalatal suture with the forces dissipating across the cranial and circum-maxillary sutures. This results in a larger maxillary arch which will accommodate the teeth in a pleasing arrangement but also significantly increase the nasal volume. This increase in nasal volume will decrease airway resistance which among variables causing soft tissue collapse trumps.

Methods: Data were available for two female 9 year old twins. Excessively loud snoring, enlarged tonsils, and excessive daytime sleepiness. Pediatrician disregarded Mother's concerns, and ENT denied adenotonsillectony. Mother presented video of girls snoring, gasping with apneas to a dental sleep professional. Upon examination the dental professional found the girls to be retrognathic and maxillary deficient using a visual clinical assessment; White/Hooks survey. Patients underwent HST with a 4 channel device (effort, flow, pulse, and saturation were monitored), at the request of the dental professional to asses sleep. Increase in heart rate, frequent arousals, and a high number of respiratory events were noted (AHI 83&35). A trial of CPAP at 7 cmH$_2$O was conducted to provide a baseline for treatment results. Patients improved cognition and temperament improved overnight and maintained with continued use of CPAP. RME was performed by the dental professional with continued CPAP use during the expansion. Patient's adenoids and tonsils were removed by pediatric ENT post expansion. Post expansion, adenotonsillectony positive subjective results mimicked those during CPAP trial.

Results: HST was conducted on both girls during treatment. Diagnostically (83&35); With CPAP (0&0); Post RME without CPAP (11&7); Post T&A and RME (5&3).

Conclusions: These positive results should bring appreciation to the complex interplay between normal respiration, craniofacial growth and development and its contribution to pediatric obstructive sleep apnea.

POSTER #008

PREDICTORS OF SUCCESS FOR ORAL APPLIANCE (OA) THERAPY IN OBSTRUCTIVE SLEEP APNEA (OSA) PATIENTS BASED ON INITIAL CRANIOFACIAL CHARACTERISTICS

Khojah M, Correa LP, Finkelman M, Trotman CA, Kanavakis G

Tufts University School of Dental Medicine, Boston, Massachusetts

Introduction: The aim of this investigation was to explore hard and soft tissue cephalometric predictors for the success of oral appliance therapy, in patients with varying severity of OSA.

Methods: A review of 108 consecutively treated patients with OSA was performed at the Dental Sleep Medicine Clinic at Tufts University School of Dental Medicine. Fifty-two subjects, all treated with OA therapy were included. Our predictive factors included BMI, age, gender, mandibular plane angle (MP), vertical distance between MP and the most superior

point of the hyoid bone (MP-H), ANB angle (ANB), soft tissue ANB angle (S.T. ANB), anterior-posterior upper lip position (UL-VL), anterior-posterior lower lip position (LL-VL), and anterior-posterior soft tissue chin position (C-VL). Treatment success was defined in three ways: (1) At least 50% reduction in initial AHI, (2) Residual AHI $\leq$ 10 after treatment, and (3) Residual AHI $\leq$ 5. A multiple regression model was developed to study the effect of various variables on success. The level of statistical significance was set at .05.

Results: No statistically significant differences were found between subjects with mild, moderate and severe OSA ($P > .05$). BMI (median = 28.3, IQR = 5.9) was weakly correlated to AHI ($rs = 0.28$, $P = .045$). OA therapy resulted in 51.9%, 55.7% and 30.7% successful outcomes, using the first, second and third methods of defining success, respectively. MP and C-VL were positively associated with treatment success ($AUC_{MP} = 0.67$ and $AUC_{C-VL} = 0.71$).

Conclusions: A weak positive correlation was found between BMI and OSA severity. The MP and C-VL were significantly correlated to the outcome of OA therapy, but showed a weak to moderate predictability for the success of OA therapy. The results should be interpreted with caution and their clinical significance should be investigated in future studies.

reprinted with permission from the SRS

POSTER #009

THE EFFECT OF THE CUSTOM FACE MASK ON THERAPEUTIC CPAP PRESSURE

Prehn RS[1,2,3], Simmons JH[3,4]

[1]*Director Restore TMJ & Sleep Therapy, PA, The Woodlands, Texas;* [2]*Adjunct Professor, University of Texas School of Dentistry, Houston, Texas;* [3]*Sleep Education Consortium, Houston, Texas;* [4]*Comprehensive Sleep Medicine Associates, Houston, Texas*

Introduction: The purpose of this study was to investigate the effect of therapeutic CPAP pressures needed to resolve OSA when patients fabricated a custom face mask (CFM), which is used in combination therapy to treat OSA in patients who presented to a dental sleep center. The CFM is a custom CPAP face mask that is fabricated from an impression of the face. This CFM is then connected to the post attached to an oral appliance. This strapless CPAP face mask features a CPAP interface with mandibular stabilization.

Methods: A retrospective chart review of 35 CFM patients on combination therapy from 2006-2012 was conducted in 2015 to determine changes in therapeutic CPAP pressures caused by utilizing the CFM in combination therapy.

Results: Average CPAP pressures before CFM: 14 cmH$_2$O ($\pm$ 4). Average CPAP pressures after CFM: 13 cmH$_2$O ($\pm$ 3). Average reduction in CPAP pressures for those that had reduction (n = 15): 4.3 cmH$_2$O. Average increase in CPAP pressures for those that had increase (n = 12): 1.6 cmH$_2$O. No change in CPAP pressures (n = 8)

Most patients (n = 15) in this follow-up survey that had reduction of CPAP pressures after the fabrication of the CFM, had

significant reduction of pressures (average 4.3 cmH$_2$O). The patients (n = 12) that had increased CPAP pressures after the fabrication of the CFM had only minor increases of CPAP pressure settings (1.6 cmH$_2$O).

The reason the 12 patients had an increase in CPAP pressures (and the 8 patients who had no change) after the fabrication of the CFM, is most likely that the OSA disorder may have actually become worse (nothing to do with the CFM) and the CFM is helping to keep these patients in effective therapy with the higher pressures. These patients were also on the higher end of BMI compared to the ones who had reduction in CPAP pressures. The other possibility is that these patients were under-titrated to begin with (intolerance of high pressures) and now they are able to tolerate these higher pressures with the CFM.

A unique aspect of the CFM is that leakage around the mask is significantly reduced by providing an improved seal of the mask against the face. The design of the mask, by virtue of the way it is fabricated from an accurate impression of the face specifically in line with facial and nasal contours, enables the pressure of the PAP to expand the facial skin outwards towards the mask. This creates a more reliable seal. In the majority of patients in the study, the result was a significant reduction of CPAP pressures allowing a more comfortable experience improving satisfaction and compliance.

Conclusions: The CFM should be considered for patients that require high therapeutic CPAP pressures in order to resolve OSA. The CFM is not only able to handle high pressures, but is also able to provide a secure CPAP interface by its direct attachment to an oral appliance, providing mandibular stabilization and advancement. This will increase effectiveness of combination therapy along with increased patient satisfaction and compliance.

POSTER #010

AERODYNAMIC CHARACTERISTICS OF THE UPPER AIRWAY: OBSTRUCTIVE SLEEP APNEA PATIENTS VERSUS CONTROL SUBJECTS

Chen H, Li Y, Aarab G, Reiber JHC, de Lange J, Lobbezoo F, Tu S, van der Stelt P

Academic Centre for Dentistry Amsterdam (ACTA)

Introduction: To determine the difference in aerodynamic characteristics of the upper airway between obstructive sleep apnea (OSA) patients and their controls.

Methods: We prospectively selected thirteen OSA patients (age = 43.1 $\pm$ 9.9, apnea-hypopnea index (AHI) = 14.9 $\pm$ 7.1 events/h) and ten control subjects (age = 44.7 $\pm$ 15.3). The diagnosis of OSA patients was based on an overnight polysomnographic recording. To exclude the presence of OSA, the control subjects filled out the validated Philips questionnaire. NewTom5G cone beam computed tomography (CBCT) scans were obtained from OSA patients and control subjects. Computational models of the upper airway of OSA patients and their controls were reconstructed on basis of their CBCT images. Using computational fluid dynamics (CFD) analysis with these models, we characterized the aerodynamic features within the

upper airway (ie, velocity, wall shear stress, wall static stress, and airway resistance).

Results: There was no significant difference in age, gender and body mass index between the OSA patients and controls. In OSA patients, the airway resistance during inspiration (R_{in}) and expiration (R_{ex}) was significantly higher than that in the controls (Z_{in} = -2.2, P_{in} = .03; Z_{ex} = -2.4, P_{ex} = .02).

Conclusions: During respiration, the airway resistance (R) of OSA patients was higher than that in controls. The repetitive collapse of the upper airway in OSA patients can be explained by the higher airway resistance (R) in their upper airway.

POSTER #011

THE VALIDITY OF USING A PHARYNGOMETER FOR AIRWAY MEASUREMENT COMPARED TO CBCT MEASUREMENTS

Ananthan S, Patel S, Kanti V, Kabaria A, Creanga A

Rutgers School of Dental Medicine, Newark, New Jersey

Introduction: An acoustic pharyngometer is a simple device that offers a cost effective, quick and noninvasive method of measuring the upper airway. It is commonly used in a dental sleep clinic to determine the risks of obstructive sleep apnea (OSA). The pharyngometer works on the following principle: an audible sound signal is generated at the bottom of a tubular probe and is transmitted into the cavity via an anatomically fitted coupler. The acoustic pulse is partially reflected when it encounters an area change. The amplitude and temporal changes in the reflected pulse compared with the incident pulse are used to calculate the changes in airway cross sectional area. A computer performs the calculation. Although the pharyngometer is used extensively in airway studies, its use has previously not been validated. The aim of the present study is to establish the validity of the use of a pharyngometer as compared to Cone Beam Computed Tomography (CBCT) measurements.

Methods: Patients who were referred to the Division of Oral Radiology at the Rutgers School of Dental Medicine, Newark, New Jersey for full volume (whole head) CBCT imaging for various reasons were recruited for the study. The iCAT 17-19 (Imaging Science International, Hatfield, Pennsylvania) was used for CBCT imaging. The Eccovision pharyngometer (Sleep Group Solutions, Hollywood, Florida) was used to measure the volume of oropharyngeal space. The volumetric readings from the pharyngometer were compared to the volumetric readings of CBCT oropharyngeal space analysis obtained from InVivo dental imaging software version 5.4.4 (Anatomage, San Jose, California). SPSS version 24 (IBM, Armonk, New York) was used for the data analysis. A Pearson's correlation test was performed.

Results: 25 subjects were recruited for the study. 21 subjects were included in the final analysis. The ages of the subjects ranged from 16-74 years. 16 subjects were female and 5 were male. The Pearson correlation coefficient was r = 0.978.

Conclusions: The correlation between the two modalities of measuring the airway volume is strong. The pharyngometer may be a suitable device for readings in the same patient, between treatment visits, in settings such as sleep clinics (before and after the delivery of a mandibular advancement device), orthodontic settings (before and after palatal expansion), and some instances when airway analysis is desired without radiation exposure. The pharyngometer is a valid tool to use for airway measurement when compared to CBCT readings.

POSTER #012

ASSESSMENT OF THE STOP-BANG SCREENING QUESTIONNAIRES IN DETECTING SLEEP-DISORDERED BREATHING AMONG DENTAL PATIENTS IN A COMMUNITY PRACTICE SETTING

Dillow KD, Sanders AE, Essick GK

University of North Carolina School of Dentistry, Chapel Hill, North Carolina

Introduction: Obstructive sleep apnea (OSA) is widely under-diagnosed, despite simple-to-administer screening questionnaires. One questionnaire that is often recommended is the STOP-BANG. In studies of non-dental patient populations, the STOP-BANG—designed to screen patients for OSA prior to surgery—was found to exhibit high sensitivity but low specificity. We sought to determine if the STOP-BANG is suitable to screen dental patients for sleep-disordered breathing (SDB) by comparing its outcomes with those from nocturnal pulse oximetry.

Methods: Flyers were used to recruit a convenience sample of adults at a community-based dental practice in Raleigh, North Carolina. A dental hygienist administered the STOP-BANG screening questionnaires and issued instructions for over-night pulse oximetry. High-risk for SDB was defined by ≥ 3 of the following eight items: loud snoring; daytime tiredness; witnessed apnea; hypertension; BMI > 35; age > 50; neck circumference > 40 cm; male gender (original 2008 scoring criteria). Based on a recent recommendation to improve the specificity of the STOP-BANG, high-risk was alternatively defined as the presence of ≥ 5 of the eight items, or ≥ 3 items that included at least one of "BMI > 35," "neck > 40 cm," or "male" (2016 scoring criteria). Overnight pulse oximetry classified dental patients according to SDB severity defined by oxygen desaturation index (ODI) at cut-points of ≥ 5, ≥ 15 and ≥ 30 events/h in which oxyhemoglobin saturation decreased ≥ 3% from baseline. The sensitivity, specificity, and diagnostic accuracy (area under the ROC curve) of the STOP-BANG were calculated for each of the three levels of ODI severity using each of the two sets of scoring criteria.

Results: Among 119 dental patients studied (mean age = 51 years), 47.9% were male and 24.4% were obese. Over half screened high-risk using the 2008 criteria (67.2%) or the 2016 criteria (56.3%). The percentage of patients with SDB decreased ten-fold with increased ODI severity from 66.4% (ODI ≥ 5) to 26.9% (ODI ≥ 15) to 6.7% (ODI ≥ 30). Across the three levels of SDB severity, the sensitivity of the STOP-BANG in detecting SDB averaged 80.7% (2008 criteria) and

74.2% (2016 criteria); the specificity averaged 39.1% and 51%; and the diagnostic accuracy averaged 0.60 and 0.63, respectively. The accuracy was similar for the different cut-points of ODI severity, whereas the sensitivity and specificity covaried in magnitude.

Conclusions: An unexpectedly high percentage of patients (more than half) in a general dental practice screened high-risk for SDB based on the STOP-BANG questionnaire. ROC curve analysis produced areas under the curve in the range of 0.6 to 0.7, indicating fair diagnostic accuracy when using pulse oximetry as the gold standard. Use of the 2016 scoring criteria resulted in a higher specificity, and thus can be used to minimize the number of dental patients without SDB who are referred for follow-up evaluation by a sleep physician.

POSTER #013

INVESTIGATING THE CORRELATION BETWEEN CHANGES IN THE SEVERITY OF OBSTRUCTIVE SLEEP APNEA AND CHANGES IN PATIENT'S QUALITY OF LIFE USING SAQLI QUESTIONNAIRE

Lamia A, Baflah LA, Correa LP, Mehta NR, Kulich R, Alghanem T, Maloney GE

Tufts University, Boston, Massachusetts

Introduction: The purpose of this study was to investigate whether reduction in apnea-hypopnea index (AHI) would result in an improved self-reported of quality of life for patients using mandibular advancement devices (MAD) for the management of obstructive sleep apnea (OSA).

Methods: Thirty-two (32) subjects were recruited from the Dental Sleep Medicine Clinic, Tufts University Dental School. Data were collected at baseline and at a posttreatment visit following a minimum of 4 weeks of intervention. Data for the SAQLI questionnaire were collected using an Audio Computer-Assisted Self Interviewing survey system and via in-person interviews. Pre- and post-mean AHI scores and Sleep Apnea Quality of Life Index (SAQLI) scores were compared using a paired-sample *t*-test. The association between the change in SAQLI scores and in AHI between pretreatment and posttreatment were determined using Pearson correlation analysis, as the data were distributed normally. A *P* value < .05 was considered statistically significant.

Results: A total of 32 subjects were recruited for the study, 18 females and 14 males, with an average age of 53.88 (SD = 12.36) years. Twenty-five subjects, 13 females and 12 males, completed the SAQLI questionnaire and were included in the analysis. A paired *t*-test was conducted and showed statistical significant results in reduction of AHI values (P = .02), AHI pretreatment 18.41 (15.95) and posttreatment 10.24 (9.74). SAQLI scores were not statistical significant (P = .14). Some patients' quality of life improved to a certain degree, social interaction and symptoms domains were largely improved.

Conclusions: AHI values after intervention showed significant changes; however, the change in severity of AHI was not correlated with the change in severity of SAQLI scores. Results are

discussed with respect the impact of other variables such as depression and anxiety.

POSTER #014

COMBINATION OF MANDIBULAR ADVANCEMENT DEVICE AND POSITIONAL THERAPY IN THE MANAGEMENT OF SEVERE OSA: A CASE REPORT

Karimi N, Correa L, Mehta NR

Tufts University School of Dental Medicine, Boston, Massachusetts

Introduction: The purpose of this study was to present the results of positional therapy (PT) as adjunct option for management of residual OSA in a patient utilizing mandibular advancement device (MAD).

Methods: A 78-year-old male referred by a sleep physician to the Dental Sleep Clinic at Tufts Dental School for the use of MAD due to BIPAP therapy intolerance. Diagnostic sleep study (Type I) revealed severe obstructive sleep apnea (AHI = 59.72, Nadir O_2 = 84%). REM sleep 23.3%. BIPAP titration (18/7 cm) with persistent obstructive events and emergence of central apneas. Examination of masticatory muscles and TMJ within normal findings with a baseline discomfort Visual Analog Scale (VAS) of 0/10. A MAD was fabricated and fitted with 80% maximum jaw protrusion, reaching 90% at the last visit with discomfort VAS scale 0/10 at the end of therapy.

Results: Type III sleep test (WP-200) read and interpreted by sleep physician showed a reduction of OSA severity (AHI = 21.2) and increased Nadir O_2 = 89%, REM sleep 23% with MAD. Combination of MAD and positional therapy revealed additional reduction to normal values (AHI = 3.9) Nadir O_2 = 92%, REM sleep = 23%. Patient was scheduled to follow up his sleep physician and at the dental sleep clinic for long-term follow-ups as standard clinical guidelines.

Conclusions: This case report showed the benefit of body position as an adjunct therapy for residual OSA in patients with mandibular advancement devices. Evidence of positional therapy efficacy is emerging and in combination with MAD could be an important armamentarium in the management of OSA patients in dental practice.

POSTER #015

WEARABLE NON-INVASIVE VIBROACOUSTIC STIMULATION IMPROVES CRANIAL CIRCULATION, QUALITY OF SLEEP AND MINIMIZES NEGATIVE EFFECTS OF APNEIC EVENTS

Aharon NJ[1], Uryash A[2]

[1]Aharon and Associates, Pittsburgh, Pennsylvania; [2]Parallel Biotech, Miami Beach, Florida

Introduction: Obstructive sleep apnea (OSA) affects 10% of adults and remains an important cause of morbidity leading to progressing functional decline of patients and high healthcare expenditures. OSA is a condition characterized by symptoms of brain dysfunction such as extreme daytime sleepiness, depression, anxiety and memory problems. Recent studies suggest that one of the major causes of brain dysfunction of

sleep apnea sufferers is due to weaker cranial blood flow. Wearable devices that address chronic medical conditions will have a positive impact on disease management and cost.

Vibroacoustic stimulation (VAS) is the noninvasive delivery of sonic stimulation to regional arteries via speaker embedded in a wearable neck applicator. VAS induces pulsatile shear stress on the vascular endothelium via penetrating rhythmic sound waves. This leads to upregulation of a transcriptionally regulated cellular mechanotransduction system and endothelial nitric oxide synthase (eNOS). This in turn increases availability of nitric oxide (NO) and vasodilation.

We hypothesize that physical acoustic forces from VAS may induce increase of cranial blood flow, decrease desaturation, improve quality of sleep and contribute to improvement in brain function in OSA patients.

Methods: We investigated the effects of VAS System (Parallel Biotech, Miami, Florida) on cranial circulation, brain function and quality of sleep in OSA volunteer patients, in compliance with IRB requirements. OSA patients were randomized to receive daily 10 minutes VAS before falling asleep and during REM phase (OSA-VAS) (n = 5) or control (OSA-C) (n = 5) for 2 weeks. Blood flow/oxygenation relationships were analyzed using an infrared-doppler, plethysmography and pulse-oximetry. Sleep phases and quality were analyzed by digital monitoring.

Results: VAS decreased desaturation during REM and NREM sleep, significantly increased distal blood flow and improved quality of sleep. Patients also reported better mood and alertness during wakefulness. VAS increased peripheral cranial perfusion in OSA patients by 15% ($P < .01$). Oxygenation levels were 8% higher in OSA-VAS group ($P < .01$). Data: * $P < .01$ (OSA-C vs. OSA-VAS).

Conclusions: In OSA patients, a wearable non-invasive neck vibroacoustic stimulator (VAS) markedly improved cranial blood flow, quality of sleep and reduced desaturation, possibly via modulation of vertebral and carotid arterial circulation. These findings have implications for prevention and treatment of OSA using non-surgical, cost-effective and sleep-friendly solution.

POSTER #016

COMBINATION THERAPY FOR SEVERE OSA AND RELIEF OF TMD UMBRELLA SYMPTOMS: A CASE REPORT

Mansouri N, Correa L, Mehta NR

Tufts University School of Dental Medicine, Boston, Massachusetts

Introduction: The purpose of this case report is to present the effects of mandibular advancement device (MAD) on a patient with severe obstructive sleep apnea (OSA) and chronic history of TMJ pain, headaches and neck pain and the effects of a combination therapy of continuous positive airway pressure (CPAP) and MAD on OSA patients.

Methods: A 45 year-old male referred by a sleep physician to the Dental Sleep Clinic at Tufts Dental School for the use of

MAD due to PAP therapy intolerance. Diagnostic split night sleep study (Type I) revealed severe obstructive sleep apnea (AHI = 71.6, central apneas = 3, lowest SpO_2: 89%, REM = 0%) in the first half of the night and moderate obstructive sleep apnea and emergent central apneas when using the CPAP in the second half (AHI = 25.4, central apneas = 15, lowest SpO_2 = 86%, REM = 1.1%) . Epworth Sleepiness Scale (ESS) 6/24, PAP therapy was prescribed but he experienced air leakage and developed neck pain when using it. He also reported frequent transmeridian travels for work and having difficulty carrying the PAP machine. Clinical history intake and examination revealed chronic symptoms of TMJ pain, headaches, ear pain, and neck pain with a Visual Analogue Scale (VAS) score of 6/10. A MAD was fabricated and fitted with 80% maximum jaw protrusion

Results: Patient reported improvement in the overall quality of sleep and a significant reduction in TMJ pain (VAS 0/10), ear pain (0/10), headaches (2/10) and neck pain (VAS 2/10) with ESS reduction 2/24. Follow-up split night sleep study (Type 1) interpreted by a board certified sleep physician with the MAD in place for the first half of the night showed a > 60% reduction of OSA severity (AHI = 28.46, central apneas = 2, lowest SpO_2 = 89%, REM = 13.4%) while the second half of the night showed (AHI = 11.57, central apneas = 5, lowest SpO_2 = 92%, REM = 8.4%) while using the MAD and PAP therapy. Combination therapy of MAD and PAP was recommended, long-term follow-ups were scheduled at 6 months and 1-year as standard clinical guidelines.

Conclusions: This case report showed a reduction of OSA from severe to mild, an improvement in REM sleep cycle and resolution of TMD symptoms and chronic headaches. Studies support the direct effect of anterior jaw repositioning and increase of VDO over neck, masticatory muscles, and unloading of TMJ area. The use of MAD for OSA may be beneficial on patients with pre-existing TMD symptoms, and PAP emergent central apneas, in severe OSA cases combination therapy may help to improve PAP compliance by assisting on reducing air pressure. Patient selection is a key factor when using MAD for severe OSA, as anatomical features and BMI are potential clinical predictors for oral appliance success.

POSTER #017

NORMAL RANGE OF MAXIMUM MANDIBULAR PROTRUSION: FIRST STEP IN THE DESIGN AND CONSTRUCTION OF A CUSTOMIZED MANDIBULAR ADVANCE DEVICE

Mayoral Sanz P, Martín JV, Romero MM, Reyes MG

¹*Alfonso X University of Madrid, Spain*

Introduction: One important aspect of the construction of a mandibular advance device (MAD) is the advancement of the mandible. Frequently, with higher level of advancement, better treatment effect can be obtained, although potential increase of side effects should be considered and balanced. The degree of advancement is usually expressed in % of maximum protrusive capacity or/and in millimeters (mm). Percentage of maximum protrusive capacity is used in reference to potential

side effects and percentage or millimeters to effectiveness in opening the upper airway. Among the studies that address the mandibular movements, just few of them have determined the normal range of this movement. Therefore, the aim of this study was to estimate the range of mandibular advance in a representative sample of adult population.

Methods: 100 students of dentistry 20–24-years-old were included in this study. Measurement of mandibular border paths of Posselt movement was carried out with the aid of a marker fixed to the mandible and recorded using a video camera and then processed by a computer program capable of detecting the marker on the images and reconstructing its trajectory graphically in the 2D space. Maximum protrusion, maximum retrusion and total mandibular advance **were** measured in each patient with 2 mm and 5 mm George Gauge. The statistical analysis was made with the Wilcoxon signed-rank test for paired data.

Results: Mandibular total advance was 13.62 mm with the 2 mm fork of a George Gauge and 12.51 with the 5 mm one 11.37 mm linear and 14.35 mm curved border path of Posselt. The full range of mandibular protrusion movement measured through the border paths of Posselt Diagram of a healthy subject starts with a mandibular downward movement guided by sliding of the mandible head through the posterior wall of the articular eminence and the incisor edge of lower incisors across the lingual surface of upper incisors till the border-to-border position with 2 mm upward and 3 mm forward mandibular displacement. Following this initial movement, there is a 3 mm upward and 9 mm forward mandibular displacement and, at the end of the movement, a small curve is observed.

Conclusions: The values of mandibular motion range for the population studied can serve as a reference parameter for its use in functional evaluation of the mandibular protrusion and in the customization of MAD for treatment of obstructive sleep apnea. The amount of bite opening should be minimized to improve patient tolerance and increase the beneficial effect on upper airway dimensions, since increase in bite opening reduces the range of mandibular advancement.

POSTER #018

CBCT IN THE STUDY OF DIFFERENT PHENOTYPES OF RESPONDERS AND NON-RESPONDERS OF MANDIBULAR ADVANCE DEVICE TREATMENT: A PRELIMINARY STUDY

Mayoral Sanz P[1], Contreras MM[2], Domínguez-Mompell R[3]

[1]*Alfonso X University of Madrid, Spain;* [2]*Rey Juan Carlos University of Madrid, Spain;* [3]*University of California Los Angeles (UCLA)*

Introduction: Mandibular advancement devices (MAD) are increasingly being used in the treatment of obstructive sleep apnea (OSA) as an effective alternative to continuous positive airway pressure (CPAP). MAD protrude the mandible with the aim of increasing upper airway calibre and thereby preventing collapse of the upper airway during sleep. However, the mechanisms by which MAD improve OSA are not well understood. Limited studies have identified an effect of mandibular

advancement on aspects of the structure and function of the upper airway. Therefore, the aim of this study was to study the changes on the airway structures and determine the different phenotype of responders and non-responders of MAD treatment.

Methods: 10 patients mild to moderate OSA treated with MAD, 7 responders and 3 non-responders, were included in this study. A custom-made two-piece MAS Orthoapnea was used. Home sleep monitoring was performed at baseline and 6 weeks after of treatment. Cone-beam computed tomography (CBCT) scans were obtained for all patients with and without MAD.

Results: Mean mandibular advancement was 8.2 ± 1.6 mm (mean ± standard deviation). This produced movement through a connection from the ramus of the mandible to the pharyngeal lateral walls in all subjects. In the sagittal plane, 2 patterns of posterior tongue deformation were seen with mandibular advancement—(A) bidirectional motion pattern in responders and (B) minimal anterior movement in non-responders. Baseline AHI (events/h) responders 19.7 ± 8.3 non-responders 20.6 ± 8.5 and AHI with MAS (events/h) responders 7.7 ± 4.3 and non-responders 22.0 ± 7.8

Conclusions: Mandibular advancement in responders has two mechanisms of action which increase airway size: forward movement of the tongue and lateral airway expansion. CBCT is useful in identifying upper airway form and size changes of MAD treatment.

POSTER #019

DIFFERENCE IN DENTAL ARCH SIZE BETWEEN JAPANESE AND CAUCASIAN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA: AN INTERNATIONAL COMPARISON STUDY

Kohzuka Y[1,2], Taga H[3], Almeida F[1,2], Tsuiki S[1,4]

[1]*Department of Orthodontics, Faculty of Dentistry, The University of British Columbia, Canada;* [2]*Frontier Clinical Research Centre, Canada;* [3]*JR Tokyo General Hospital, Japan;* [4]*Institute of Neuropsychiatry, Japan*

Introduction: Obesity is a major factor which increases the collapsibility of the upper airway in Caucasian patients with obstructive sleep apnea (OSA). In contrast, cranio- and dento-facial factors could be mainly involved in the development of OSA in Asian people who are less obese in comparison with Caucasians. However, clinically, not all Caucasian OSA patients are obese, similarly not all Japanese OSA patients have OSA due to craniofacial factors. We hypothesized that, when the severity of OSA in addition to obesity was matched between the two races, there would be lesser anatomic differences between Japanese and Caucasian OSA patients.

Methods: The study protocol was approved by the both ethics committee of the Institute of Neuropsychiatry, Tokyo and the University of British Columbia, Vancouver. Amongst OSA patients who visited each Sleep Apnea Dental Clinic, male OSA patients were recruited to the study. As per clinical protocol for each clinic, an upright lateral cephalogram was undertaken to

evaluate maxillomandibular dimensions while study models were fabricated for an analysis of dental arches. After matching age, body mass index (BMI), and apnea-hypopnea index (AHI), a total of 31 Japanese and 32 Caucasian OSA patients were selected for final analysis. The maxillomandibular dimensions as well as the dental arch width and length both in the upper and lower dentitions were compared between the two ethinic groups using unpaired t-tests.

Results: There were no statistically significant differences between Japanese patients and Caucasian patients with regard to age (48 ± 8 vs 48 ± 7 years, $P = .93$), BMI (28 ± 2 vs 29 ± 3 kg/m^2, $P = .10$), and AHI (25 ± 16 vs 25 ± 12 events/h, $P = .99$). No significant difference was also found with respect to SNA (81 ± 3 vs 82 ± 5 degrees, $P = .39$) and SNB (79 ± 3 vs 78 ± 7 degrees, $P = .63$), and sagittal tongue size (39 ± 3 vs 38 ± 4 cm^2, $P = .79$) between Japanese and Caucasians. In turn, upper intercanine width (27 ± 2 vs 25 ± 2 mm, $P < .01$), upper interfirst molar width (41 ± 6 vs 36 ± 3 mm, $P < .01$), and lower interfirst molar width (37 ± 3 vs 35 ± 3 mm, $P < .01$) were significant larger in Japanese patients than Caucasian patients. Upper (39 ± 5 vs 37 ± 3 mm, $P = .09$) and lower (33 ± 3 vs 32 ± 2 mm, $P = .63$) dental arch lengths were not different between Japanese OSA patients and Caucasian patients.

Conclusions: There is a lateral dilation in the dental arches, in Japanese patients with OSA. We conclude that, although minor, these dental changes in Japanese OSA patients may play an important role in the understanding of craniofacial differences and OSA incidence between Japanese and Caucasian, where Japanese arches are wider but more retropositioned.

POSTER #020

PHARYNGEAL AIRWAY DIMENSIONS WHILE AWAKE CORRELATE WEAKLY WITH OUTCOME OF ORAL APPLIANCE THERAPY FOR OSA

Remmers JE[1,2], Charkhandeh S[2], Zareian Jahromi SA[1,2]

[1]University of Calgary, Calgary, Canada; [2]Zephyr Sleep Technologies, Calgary, Canada

Introduction: While continuous positive airway pressure (CPAP) has been standard medical therapy for obstructive sleep apnea (OSA), this status has recently been called into question by evidence that the therapy does not reduce the incidence of cardiovascular events. Oral appliance therapy (OAT) has higher compliance and is preferred over CPAP by most patients. However, OAT resolves OSA in only 50% to 60% of patients. This highlights the need to prospectively identify therapeutic responders to mandibular protruding OAT.

Imaging the pharyngeal airway may provide a basis for selecting favorable candidates for OAT. Mandibular protrusion changes the mechanics of the collapsible regions of pharyngeal airway, but the protrusion-induced changes in the size of segments of the pharyngeal airway, measured while awake, have not been convincingly linked to patients' responses to OAT. The objective of this research is to assess the relation between such changes in airway geometry and OAT response.

Methods: Twenty-eight individuals with OSA underwent cone beam computed tomography (CBCT) of the upper airway and were treated with a mandibular protruding oral appliance (MicrO$_2$). Baseline oxyhemoglobin desaturation index (ODI) was measured as the mean value determined from two nights of home monitoring with a validated recorder. Therapeutic ODI was similarly measured as the mean value determined from two home sleep tests while wearing a custom-made OA adjusted to a final protrusive position. OAT outcome was calculated as the fractional reduction in ODI comparing baseline and therapeutic values.

A scan was performed while awake with the mandible at each of two positions: centric occlusion (CO) and mandibular advancement (MA). No appliance was in the mouth for CO scan. The MA scan was performed with a temporary oral appliance in place and set at 90% of full protrusion. The scans were taken while the participants were seated and relaxed. Five geometric measurements were obtained from each of the two pharyngeal segments, velopharynx and oropharynx, namely: volume (V), minimum cross-sectional area (MCA), anterior-posterior (A-P) and lateral-lateral (L-L) distances at MCA, and mid-sagittal area (MSA). The relative protrusion-induced change in each geometric variable was correlated with OAT outcome.

Results: Mandibular protrusion significantly increased V and L-L of the velopharynx and the oropharynx ($P < .05$). MCA, A-P, and MSA did not differ statistically between CO and MA scans for either segment. A linear regression analysis comparing OAT outcome with fractional change in each of the ten variables revealed no significant correlation. Weak, non-significant correlations were observed for OAT outcome versus velopharyngeal V ($r = -.33$; $P = .08$) and OAT outcome versus oropharyngeal MSA ($r = .32$; $P = .09$). A multi-variable regression illustrated a weak, but significant correlation between all features and OAT outcome ($r = .51$; $P = .006$).

Conclusions: We demonstrate in OSA individuals a significant, but weak, correlation between the protrusion-induced increase in pharyngeal dimensions while awake and OAT outcome.

POSTER #021

UTILIZING A FULLY DIGITAL CLINICAL WORKFLOW FOR ORAL APPLIANCE THERAPY WITH AN AUTO-TITRATING MANDIBULAR POSITIONER (AMP): A FEASIBILITY STUDY

Charkhandeh S[1], Vranjes N[2], Kuhns D[3], Mosca E[1], Bruehlmann S[1]

[1]Zephyr Sleep Technologies, Calgary, Canada; [2]The Snore Centre, Calgary, Canada; [3]ProSomnus Sleep Technologies, Dublin, California

Introduction: It is estimated that in the US alone, the number of patients on oral appliance therapy (OAT) will be over one million by 2023. To keep up with the rising demand, more efficient and precise workflow models are required to minimize inaccuracies and costs associated with delivery of care. The

purpose of this study is to evaluate the feasibility of a novel, fully digital workflow model, utilizing intra-oral digital scanning and CAD/CAM device manufacturing, in combination with an AMP for patient selection and effective target protrusion (ETP) prediction to minimize inefficiencies and improve quality of care.

Methods: In the first study group (Group A: n = 30), the workflow impact of placing participants prospectively determined to be successful with OAT directly at a pre-selected target was evaluated. A CAD/CAM MRD (MicrO$_2$ Sleep Device) was inserted at the pre-determined ETP or if required, at a lower protrusion with instructions to adjust in 1-2 mm increments to ETP at home. During the first year, additional follow-up appointments requested by the participants were recorded.

In the second study group (Group B: n = 5), we evaluated the feasibility of utilizing existing technologies to create a fully digital clinical workflow for manufacturing MRDs at a pre-selected target. Two CAD/CAM MRDs (MicrO$_2$) per patient were manufactured using a conventional method (PVS impressions and bite registration) and a digital method using an intraoral digital scanner (iTero) and a "digital open-bite registration". Each patient received both appliances and the dental fit, occlusal fit and patient preference were recorded.

Results: Group A: The median ETP was 63% (range: 36% to 100%). 67% of participants had their OA inserted directly at ETP, including 2 who had an ETP > 80%. All participants self-calibrated at home to achieve ETP, where 86% were a therapeutic success. 4 participants required in-office appointments for calibration of the OA to achieve success. Once therapeutic success had been achieved, 12 participants required 1-2 non-calibration follow-up appointments for reasons such as new dental restorations, polishing, repair, or discomfort. The remainder of participants did not require additional dental chair time.

Group B: In the conventional workflow, 2 appliances required minor dental adjustments & 3 appliances required occlusal adjustments. In the digital workflow, no dental or occlusal adjustments were required. All patients preferred the digital MRDs in terms of comfort.

Conclusions: Utilizing the existing tools and technologies, it may be possible to create new workflow models for OAT that are more accurate, require less follow-up and chair time, and improve patient satisfaction. In combination with an AMP test to select suitable patients for OAT and identify an ETP, these models may improve the quality and delivery of care. Further well-controlled studies are required to test the complete workflow.

POSTER #022

CLINICAL SIGNIFICANCE OF PATIENT PHENOTYPE IN OUTCOME PREDICTION FOR ORAL APPLIANCE THERAPY AND THERAPEUTIC PROTRUSIVE POSITION (TPP) BASED ON AN AUTO-TITRATING MANDIBULAR POSITIONER (AMP) TEST: A RETROSPECTIVE ANALYSIS

Charkhandeh S[1], Zareian Jahromi SA[1,2], Bruehlmann S[1], Mosca E[1]

[1]*Zephyr Sleep Technologies, Calgary, Canada;* [2]*University of Calgary, Calgary, Canada*

Introduction: Oral appliance therapy (OAT) remains an underutilized treatment, likely due to its inconsistent efficacy and the lack of a standard objective titration method to reach an effective therapeutic protrusive position (TPP). We have previously demonstrated the accuracy of an at-home auto-titrating mandibular positioner (AMP) in prospectively identifying OAT outcome in > 150 patients. The objective of this study was to retrospectively analyze the data set to evaluate the correlation between patients' physical characteristics (OSA severity, weight, and dental anatomy) and OAT outcome and TPP.

Methods: Participants (n = 48) with obstructive sleep apnea (OSA) participated in a study to evaluate the accuracy of the AMP device. Following the AMP test with a temporary dental appliance, each participant was treated with a custom oral appliance and advanced until therapeutic success was achieved as determined by outcome sleep tests. The final protrusion was determined the TPP. In this study, characteristics of baseline ODI, BMI, neck circumference (NC), age, dental overbite (OB) & overjet (OJ) were evaluated for correlation with OAT and TPP in the group that achieved therapeutic success (ODI < 10 events/h).

Results: The values for correlations between TPP and baseline characteristics for the group who achieved therapeutic success were: baseline ODI, $r = -.30$, $P = .09$; BMI, $r = .51$, $P = .01$; NC, $r = .65$, $P < .01$; OJ, $r = -.14$, $P = .44$; OB, $r = -.07$, $P = .70$; and age, $r = -.23$, $P = .20$. For the group who achieved therapeutic success, the values for correlation between TPP and ΔODI were $r = .25$, $P = .15$, and between TPP and final ODI were $r = .16$, $P = .36$.

There were no significant differences found between individuals who were successfully treated with OAT and those who were not for any of the following characteristics: BMI, $P = .42$; NC, $P = .27$; OB, $P = .62$; OJ, $P = .13$. A significant difference was found between groups for baseline ODI, with the group who experienced therapeutic success having a lower baseline ODI than the group who did not ($P < .001$).

Conclusions: There were no significant correlations between TPP and baseline ODI, OJ, OB, age, ΔODI, or final ODI for participants who achieved therapeutic success. Weak, yet significant correlations were found between TPP and BMI and NC among those known to be therapeutic successes; however, as there was no correlation with outcome with any measures the finding is not clinically relevant. For prediction of outcome, despite there being a significant difference between the therapeutic success and failure groups for baseline ODI, there was no correlation between therapeutic position and ODI for those who achieved therapeutic success. The results of the analysis show that none of the factors can individually be used as a reliable tool to predict outcome or the amount of protrusion required to achieve efficacious treatment with OAT.

POSTER #023

CUSHING'S DISEASE CUSHIONING THE PATIENT'S AIRWAY

Patel IY[1], Patel SI[2], Carr AB[1]

[1]Department of Dental Specialties, Mayo Clinic College of Medicine, Rochester, Minnesota; [2]Center for Sleep Medicine, Mayo Clinic College of Medicine, Rochester, Minnesota

Introduction: Cushing's disease occurs as results of hypersecretion of cortisol in the blood. Cushing's disease occurs in about 15 per million people with average age of diagnosis 20-50 years old. Obstructive sleep apnea is common in Cushing's disease. It is thought that fat accumulation in the parapharyngeal space is the cause of obstruction. The treatment of Cushing's disease impacts the severity of obstructive sleep apnea.

Methods: We reviewed a case of Cushing's disease with a large pituitary microadenoma that underwent transphenoidal resection and the impact of surgery on OSA.

Results: A 58-year-old with a past medical history of Cushing's disease, large pituitary microadenoma status post transphenoidal resection was referred for oral appliance therapy to treat the residual obstructive sleep apnea.

He reported increase in blood pressure over the last 3-5 years, weight gain, hypogonadism, and presence of obstructive sleep apnea for the last 14 years. The first polysomnography (PSG) revealed an apnea-hypopnea index (AHI) of 9 and respiratory disturbance index (RDI) of 32. After symptoms onset of Cushing's disease, PSG showed AHI 66 and RDI of 67.

Polysomnography performed four years after transphenoidal surgery, revealed AHI 8 and RDI 13. Pre-operative MRI was notable for pituitary microadenoma 7-8 mm. Post-operative MRI had no evidence of residual neoplasm.

His Epworth Sleepiness Scale score was 4/24. He was utilizing an over the counter oral appliance with residual symptoms of snoring.

Physical examination revealed Friedman's class III oropharynx, neck circumference 41 cm, maximum interincisal opening of 53 mm, right excursion of 12 mm and left excursion of 14 mm. No temporomandibular disorder.

A custom-fitted oral appliance was fabricated and dispensed. The mandible was advanced 60%. Snoring resolved. A follow-up sleep test is pending.

Conclusions: OSA in some patients with Cushing's disease secondary to a pituitary microadenoma may improve or resolve after surgery. As illustrated by this case, Cushing's disease patients with OSA preoperatively should be retested a few months after successful surgery to determine whether OSA is still present. Oral appliance can be an effective treatment modality depending on the severity of the disease.

POSTER #024

DENTAL SIDE-EFFECTS OF LONG-TERM OBSTRUCTIVE SLEEP APNEA THERAPY: A 10-YEAR FOLLOW-UP STUDY

Uniken Venema JAM[1,3], Hoekema A[2], Sokolova D[3], Doff M[3]

[1]Rijksuniversiteit Groningen, Groningen, Netherlands; [2]ACTA, Amsterdam, Netherlands; [3]Universitair Medisch Centrum Groningen, Groningen, Netherlands

Introduction: Obstructive sleep apnea (OSA) is a sleep-related breathing disorder. OSA is characterized by repetitive obstruction of the upper airway during sleep. Patients are usually treated with either continuous positive airway pressure (CPAP) or oral appliance therapy. The objective of this study is to evaluate changes in dental occlusion, which are associated with long-term oral-appliance and CPAP therapy.

Methods: 29 OSA patients using an anterior traction oral appliance and 34 patients using CPAP therapy, were evaluated. Data was analyzed at baseline, 2-year and 10-year follow-up. Changes in dental occlusion were manually analyzed from dental plaster casts using a digital sliding caliper.

Results: At 2-year follow-up, oral appliance therapy resulted in significant dental changes as compared to CPAP therapy. Overjet and overbite decreased on average with 1.5 mm (SD ± 1.5 mm) and 1.2 mm (SD ± 1.1 mm), respectively. The anterior-posterior change in occlusion was significantly larger in the oral appliance group (–1.3 ± 1.5 mm) as compared to the CPAP group (–0.1 ± 0.6 mm). Both groups showed a significant decrease in number of occlusal contact points in the (pre)molar region. At the 10-year follow-up, higher significant changes were seen in overjet and overbite, but also in anterior-posterior change and in the number of contact points in the (pre)molar region. Definitive analysis are currently being conducted and will follow.

Conclusions: This study confirms that oral appliance and CPAP therapy changes dental occlusion significantly. These changes appear more pronounced with an anterior traction oral appliance as compared to CPAP therapy.