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of the American Academy of Dental Sleep
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A Little Knowledge Is a Dangerous Thing

Leslie C. Dort, DDS, Diplomate, ABDSM, Editor-in-Chief *Journal of Dental Sleep Medicine*

Calgary, Alberta, Canada

The new guidelines for the use of oral appliances in the treatment of obstructive sleep apnea discuss for the first time the minimum required to be considered a “qualified dentist.”¹

The “qualified dentist” designation is intended to be a minimum standard. The “qualified dentist” definition also limits the type of institution/educator that is considered eligible to provide “qualified dentist” continuing education credits. The expectation is that the education will adhere to the guidelines in the critical areas of diagnosis, treatment and outcome assessment.

Recently, a patient whose management highlighted the need for “qualified dentists” presented to a clinic.

His cardiologist referred him for “assessment of existing oral appliance.” The patient was a 70 year old male, BMI = 36, neck circumference = 45 cm, currently treated for hypertension and GERD and undergoing investigation for ischemic cardiac disease. He had reportedly gained 15 lbs in the past two years. He had a cleft palate repair as a child but had no present limitations to eating, drinking or speaking due to the repair.

The patient had been diagnosed with severe obstructive sleep apnea (OSA) several years previously. His chief complaint had been snoring without daytime symptoms. He had been tolerant of CPAP. He had been using a chin strap with his CPAP. He developed tenderness in his TMJ’s and sought advice from his family dentist. His dentist reportedly pronounced the CPAP and chin strap responsible for the TMJ soreness and without consulting the sleep physician recommended discontinuation of CPAP and fabricated a custom-made, monobloc oral appliance (OA). The OA controlled snoring. The patient’s wife was satisfied and no further evaluation was conducted.

The cardiologist now investigating the patient’s cardiac concerns ordered a home sleep test (HST) to assess treatment effectiveness. The patient’s only concern was an increase in disruptive snoring. His Epworth Sleepiness Scale (ESS) was 5/24 and his Calgary Sleep Apnea Quality of Life (SAQLI) was 5.40. An HST was conducted while wearing the monobloc OA. The respiratory disturbance index (RDI) was 34 events/hour (patient slept primarily in the lateral position). The mean oxygen saturation was 86%. The lowest oxygen saturation recorded was 76%. The patient spent 92% of the recording time below an oxygen saturation of 90% and 12% of the time below 85% oxygen saturation.

This patient has not been given quality treatment. He has been using an oral appliance that likely has only masked his

only severe OSA symptom-snoring. He may have sustained irreversible end-organ damage as a result of years of inadequate treatment. There is a failure of the dentist to understand the need for treatment outcome assessment and the lack of correlation between snoring control and apnea control. There is a failure to communicate with the physicians. This failure is very possibly due to poor education. The dentist who made the monobloc very likely didn’t understand the negative consequences of replacing CPAP with an inadequate OA. The “qualified dentist” designation evolved with the goal of providing basic training in clinical care paths, physician-dentist communications system well as OA fabrication.

There are other gaps here as well. Where was the follow up of the CPAP provider, of the sleep physician and the primary care physician?

A qualified dentist providing OA therapy according to the recent guidelines is a leading example of state-of-the-art care. Let us hope for the benefit of patients that all health care providers involved in OSA therapy continue to improve basic standards of care.

CITATION

Dort LC. A little knowledge is a dangerous thing. *Journal of Dental Sleep Medicine* 2016;3(3):79.

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DISCLOSURE STATEMENT

Dr. Dort is Editor-in-Chief of *Journal of Dental Sleep Medicine*.

Differences in Volume and Area of the Upper Airways in Children with OSA Compared to a Healthy Group

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STUDY OBJECTIVES: The cause of obstructive sleep apnea in children is not fully known. The many risks and predisposing associated factors challenge its diagnosis and treatment. The objective of this research was to verify the differences in the volume and areas of the upper airways between children submitted to adenotonsillectomy for the treatment of OSA, but with persistent/recurrent postoperative OSA complaints, and a sex-age matched healthy control group, assisted by cone beam computed tomographic images.

METHODS: The study included a group of 20 children of both sexes, with mean age of 9.5 years, diagnosed with OSA and primary snoring (PS) by polysomnographic exam (AHI \geq 3), angle class II, and retruded mandible, and a control group of 20 healthy children of both sexes, mean age of 7.4 years, with the same characteristics, but without respiratory complaints. Both groups were submitted to otolaryngological and orthodontic clinical examinations, and to cone beam computed tomography exam (CBCT). Areas and volumes of the nasopharynx and oropharynx and lower axial area were measured. Mean, standard deviation, confidence interval, and Student t-test with a 5% significance between these groups were analyzed.

RESULTS: The results showed a significant difference ($p < 0.05$) in the volume and area of the nasopharynx of patients with OSAS compared to the same parameters in healthy patients. Children with OSA (SG) showed a significant narrowing in the nasopharynx and in the lower area of the upper airway (UA) compared to the control group (CG).

CONCLUSIONS: Children with persistent OSA symptoms after adenotonsillectomy present with narrowing of the nasopharynx, and CBCT is a useful complementary test for orthodontic diagnostic and treatment planning of these patients.

KEYWORDS: apnea and hypopnea syndrome, habitual snoring, nasopharynx and oropharynx size, CBCT

CITATION: Rossi RC, Rossi NJ, Filho EI, Rossi NJ, Chilvarquer I, Fujita RR, Pignatari SS. Differences in volume and area of the upper airways in children with OSA compared to a healthy group. *Journal of Dental Sleep Medicine* 2016;3(3):81–87.

INTRODUCTION

Obstructive sleep apnea (OSA) is a respiratory sleep disorder (RSD) characterized by partial or complete upper airway (UA) obstruction that can affect children in their very early phase of development.^{1–6} Children between 2 and 6 years old are the most affected group for the occurrence of upper airway lymphoid tissue hypertrophy, usually presenting with the most severe aspects of OSA. Diagnostic delays of this condition may generate a negative influence on their adult life quality.^{3–8} The polysomnographic (PSG) evaluation is considered the gold standard method for the diagnosis of OSA,^{1–6,14–16} and surgical removal of lymphoid tissue has been the standard treatment in these cases.^{9–13}

Recurrence of OSA can occur after adenotonsillectomy, and (among other causes) is believed to happen due to concomitant craniofacial disorders. Any condition that causes obstruction of the upper airway (UA) or reduces the pharyngeal muscles tonus can provide risk for OSA development.^{3,5–7} Some of these conditions may be recognized and treated by the orthodontist.

Orthodontic planning and diagnosis include panoramic radiograph, lateral X-ray, and a X-ray series of the entire

mouth, but these 2D tests fail to accurately assess the UA. Recent studies recommend 3D images as diagnostic tools to help identify obstructions in the UA, such as magnetic resonance imaging (MRI) and cone-beam computed tomography (CBCT).^{16,17}

MRI is typically used for evaluating soft tissues, and there is a lack of standardized parameters for hard tissue evaluation.¹⁶ CBCT exposes the child to less ionizing radiation when compared to multiple detector-row spiral CT, but even so, radiation will still be higher than a 2D exam. The individual dose emitted by a single 2D test is low, but the collective dose of all exams that is usually recommended, is equal to or slightly higher than the dose emitted by a single 3D examination.^{18–24,26} Furthermore, the 3D image is more reliable than 2D to assess all the head and neck structures as well as the upper airways, and it can be useful to and serve a large multi-professional group.^{27–31}

The objective of this research was to verify the differences in the volume and areas of the UA among children with OSA who have had adenotonsillectomy but continue to have persistent OSA, and a control group of healthy children, in order to plan the best orthodontic treatment.

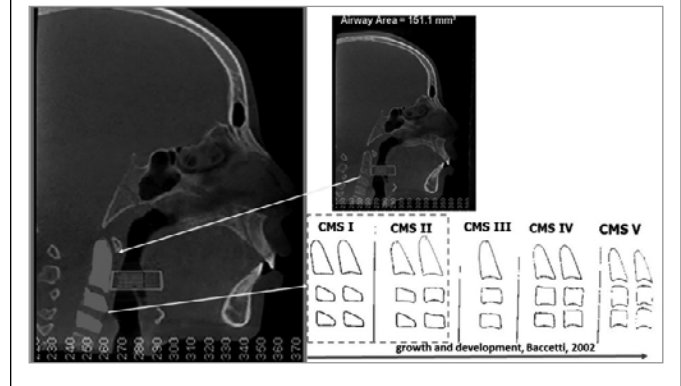
Table 1—PSG parameters.

Abbreviation	Term	Unit
A	Arousals	n
AI	Awakenings index	n/h
PMIM	Periodic movement of the lower limbs	n/h
PMA	PMIM associated with awakenings	n/h
ER	Respiratory events	n
AO	Obstructive apnea	n
H	Hypopnea	n
MA	Mixed apnea	n
AHI	Apnea and hipoapnea index	n/h
CA	Central apnea	n
RERA	Respiratory events related to apnea	n
OSAI	Obstructive sleep apnea index	n/h
RDI	Respiratory disorder Index	n/h
SpO ₂	Oxyhemoglobin saturation	%
Mean O ₂	SpO ₂ average	%
NADIR	Minimum SpO ₂	%
DRI	Desaturation index REM	n/h
DnRI	Desaturation index NREM	n/h
RDI	Respiratory disturbance index	n/h
ISL	Initial sleep latency	min
LRS	Latency to REM sleep	min
TST	Total sleep time	min
SE	Sleep efficiency	%
N1	NREM stage 1	%
N2	NREM stage 2	%
N3	NREM stage 3	%
RYM	Rapid eye movement	%
TAAS	Time awake after sleep	min
SO ₂ < 90%	SO ₂ less than 90%	n/h

METHODS

This observational case-control study was approved by the Ethics Committee of the Federal University Sao Paulo – UNIFESP under the number: 1739/11 02/12/2011, by the Ethics Committee of FOU SP-Dentistry College State University of Sao Paulo under the number 170/2010. Financed by the Research Foundation-FAPESP under the Protocol 2012/15715-2 November 2, 2012.

To accomplish this case-control study, a multidisciplinary team was enrolled. ENT examination was performed by an experienced otolaryngologist. Children suspected to have PS and OSA underwent a polysomnographic test to confirm the

Figure 1—Bone maturation rating.

diagnosis, and the report was certified by a professional expert in sleep medicine. Orthodontic evaluations were carried out by 3 orthodontists in 2 different clinics. All selected patients underwent orthodontic planning examination with CBCT, and these images were evaluated by 2 imaging studies experts.

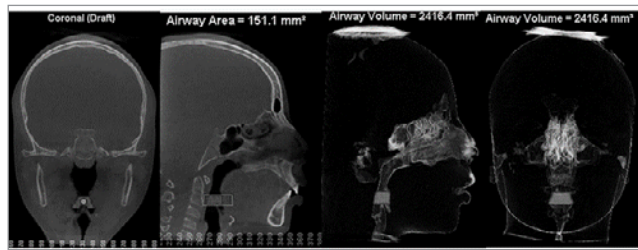
A total of 397 patients, ages ranging between 7–14 years, presenting with PS and OSA complaints were evaluated at the Oral breathing clinic at the Otorhinolaryngology Pediatric Division, Federal University of Sao Paulo (UNIFESP) from 2013 to 2014. All the patients had undergone adenotonsillectomy or had been excluded of having hypertrophic tonsils; but they all had OSA symptoms. After otorhinolaryngological and nasofibrosopic examinations, patients suspected of having OSA were referred for PSG. Patients with syndromes or obesity were excluded.

PSG was performed at the Sleep Apnea Institute-UNIFESP/SP. Patients stayed overnight and were evaluated with an electroencephalogram (EEG), electrooculogram (EOG), electromyogram (EMG) mental and/or submental muscle, electrocardiogram (ECG), airflow (nasal and oral), respiratory effort (thoracic and abdominal), other body movements (tibial EMG), oxygen saturation, and carbon dioxide concentration (precision oximeter). The parameters evaluated in PSG are described in **Table 1**

Twenty patients were selected for the study group (SG)—13 girls and 7 boys, with an average age of 9.5 years. The average apnea-hypopnea index of the patients included was 3.1, Angle Class II, short and retruded mandible and CMS I or II (**Figure 1**).¹⁴ Sexual dimorphism analysis in the PSG data was performed by Student t test, with 95% reliability.

The control group (CG) consisted of 12 girls and 8 boys, mean age of 7.4 years old, CVMS I or II,¹⁴ without respiratory complaints, Class II malocclusion, and retruded mandible, who sought orthodontic treatment at the Dentistry College, State University of Sao Paulo-FOUSP, SP for other reasons. Children of both study and control groups were referred to orthodontic planning studies (cephalometric and study models) and CBCT examinations. The selected patients and legal guardians signed the consent form.

For the CBCT, the participants were placed in the tomography room in a sitting position with their head parallel to the Frankfurt plane (FP), and the CBCT sensor was positioned

Figure 2—Orientation of cranial positioning.**Figure 3**—Orientation of the cranial positioning by Frankfurt plane and cephalometrics points (N, ANS, N. Or).

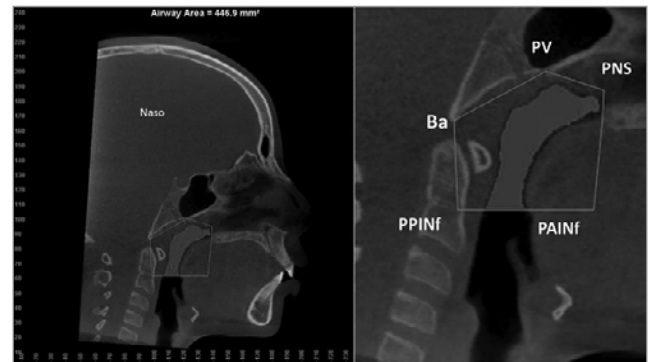
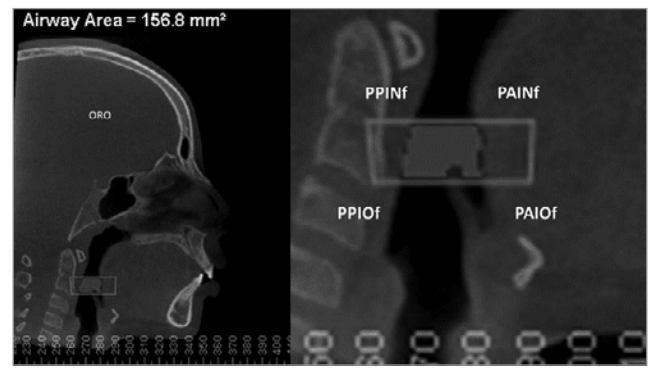
in order to cover the entire head. Patients were instructed to remain still, with relaxed lips, avoiding swallowing, and keeping a smooth breathing pattern during image acquisition.³¹

The equipment used for CBCT was the i-Cat (Cone beam 3-D Dental Imaging System, Imaging Sciences International, Hatfield, PA). After capturing the X-rays, the tomography sensors attenuated and digitalized the images through algorithm reconstruction, converting the data in medicine digital image for communication (DICOM).³⁰ After an accurate reconstructed digital image was obtained, participants were released.

The reconstruction of the primary image was performed at the workstation. The Dolphin 3D software (Imaging Dolphin/Patterson Dental, Chatsworth, CA, USA) was used for the proposed measurements. Before measuring the volume, area and lower area of the upper axial way, the pictures were standardized according to the orientation of the cranial positioning (**Figure 2**).²⁶

For the orientation of the cranial positioning, the axial plane coincides with the orbital points (Or); in the lateral, the coronal plane coincides with the porion (Po) on the left and right sides, and an axial plane is superimposed on the FP; the median sagittal plane joins the nasion (N) and the anterior nasal spine (ANS) (**Figure 3**).^{27,31}

For evaluating the nasopharynx (NP) area and volume, the points were placed at the posterior nasal spine (PNS), posterior vomer (PV), point of horizontal and vertical extent of PV, point of PNS extension, basion (Ba), PPINf (located 15 mm after the lower limit of the uvula), and PAINf (marked 15 mm above the lower limit to the uvula) (**Figure 4**).³¹

Figure 4—Demarcation of the area in the nasopharynx through the cephalometric points, to get the volume.**Figure 5**—Demarcation of the area in the oropharynx through the cephalometric points, to get the volume.

For the evaluation of the oropharynx (OP), the upper limit of the epiglottis was seen in the coronal plane, cut at its greatest length, and its highest portion was landmarked. In the image in sagittal view, this area was limited by the union of PPINf and PAINf, and the points were created in PAIOF and PPIOF located 15 mm front and rear, respectively, of the uvula point. Sensitivity was determined using the same criteria that was used for the NP (**Figures 5, 6**).³¹ In **Figure 7**, regions of oropharynx are highlighted by software tools.

Data from all measurements, the areas of the nasopharynx and oropharynx, the volumes of the oropharynx and nasopharynx, and lower axial area of the SG and CG, were measured with CBCT tools, and registered in a 2007 Excel table. The means, standard deviations, confidence intervals, and Student t-test with a 95% confidence level were calculated for all the obtained values.

RESULTS

No significant differences of the major values obtained in the PSG examination were observed between genders. A significant difference ($p = 0.04$) was only found for the hypopnea parameter (H): girls had a higher number of events than boys. The remaining parameters did not show significant differences between genders (**Table 2**).

Figure 6—Measurements of the lower axial area of the SG and CG.



Figure 7—Nasopharynx and oropharynx volumes.

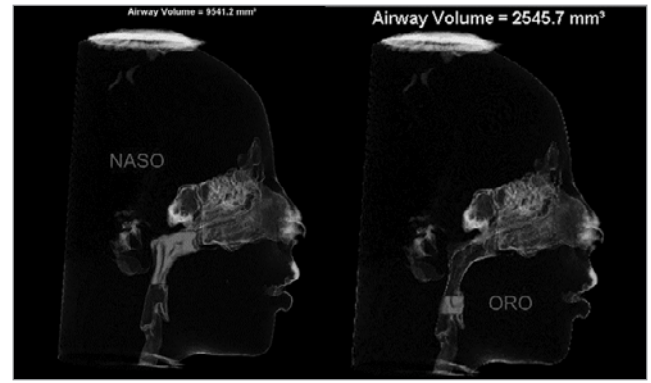


Table 2—Difference between genders (SG).

Gender	n		Age	Weight (KG)	Height (m)	Start	End
M	12	mean	9.56	33.33	1.35	21:48:33	(06:06:13)
F	15	mean	9.50	32.71	1.35	20:58:04	(06:14:56)
Total	27	test t	0.95	0.88	0.60		

Gender	n		ISL	LSS	TST	SE (%)	N1 (%)	N2(%)
M	12	mean	13.14	146.89	453.79	90.01	5.99	47.13
F	15	mean	18.18	161.11	397.76	87.38	7.22	44.83
Total	27	test t	0.43	0.63	0.12	0.88	0.83	0.92

Gender	n		N3(%)	RYM (%)	TAAS	A	AI	PMIM
M	12	mean	29.14	17.76	27.96	47.00	6.63	6.51
F	15	mean	30.20	17.69	38.81	44.07	6.89	4.15
Total	27	test t	0.86	0.89	0.72	0.58	0.79	0.68

Gender	n		PMA	RE	AO	H	MA	AHI
M	12	mean	0.08	21.11	2.34	3.94	0.00	3.10
F	15	mean	0.19	19.79	3.31	7.53	0.43	3.09
Total	27	test t	0.24	0.83	0.57	0.04*	0.25	0.98

Gender	n		RERA	SAI	AO	CA	RDI	SO ₂
M	12	mean	0.67	4.23	2.77	7.11	3.10	96.34
F	15	mean	0.07	1.47	2.33	4.43	3.29	84.06
Total	27	test t	0.28	0.41	0.76	0.35	0.87	0.32

Gender	n		Mean SO ₂	Nadir	DRI	DnRI	SO ₂ < 90%
M	12	mean	95.78	87.44	3.20	1.87	0.08
F	15	mean	96.56	91.84	10.06	1.44	0.17
Total	27	test t	0.55	0.08	0.43	0.76	0.53

*p < 0.05.

Regarding the CBCT measurements, the NP volume (4,949.85 mm³) and NP area (284.79 mm²) were significantly lower in the SG than in the CG (p = 0.001 and p = 0.002)

(8,100.93 mm³ and 417.87 mm²), respectively. The OP volume and area of the SG (1,645.43 mm³ and 112.88 mm²) and CG (1,410.81 mm³ and 100.18 mm²) did not show significant

Table 3—Mean, standard deviation, confidence interval, and student test-t between control group and study group.

Mean	Age	AHI	NP Area mm ²	NP Vol mm ³	OP Area mm ²	OP Vol mm ³	Axial Area mm ²
CG	7.4	0	417.87	8,100.93	100.18	1,410.81	74.48
SG	9.5	3	284.79	4,949.85	112.88	1,645.43	44.03
p value			0.002	0.001	0.5	0.6	0.01

differences. Clinical measures of OP were slightly higher in the SG (Table 2).

The CTCB cross-sectional areas of the nasopharynx, oropharynx, and hypopharynx in apneic patients were significantly reduced ($p < 0.05$) compared with those in the CG. The lower axial area of the NP was significantly lower ($p = 0.01$) in SG (74.48 mm²) than CG (44.03 mm²). The mean, standard deviation, confidence interval, and Student t-test with a 95% significance between these groups can be seen in Table 3.

There was a significant difference between the volume and area of the NP of patients with OSA in comparison to the same parameters of healthy patients, but for OP no significant differences were found. The results can be observed in Figure 8.

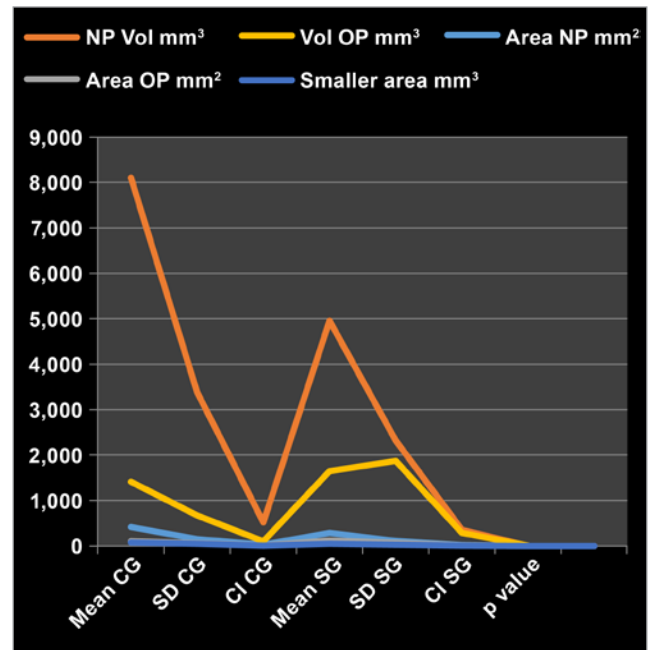
DISCUSSION

Sleep apnea is a relatively well understood disorder in adults, but in children it remains controversial, particularly due to the multifactorial nature of the disease in addition to the differences in response to each child growth phase. Our results may have implications to children from 7 to 14 years of age, who had already received some treatment for OSA such as tonsillectomy in early childhood but still present with OSA complaints, as demonstrated by other authors in previous studies.^{3–14} Our goal was to understand which sites the upper airways could be involved with the persistence of the disease, in order to develop an effective orthodontic treatment.

The results of our study showed that the upper airway was significantly smaller in SG when compared to healthy subjects mainly at the nasopharynx.^{13,14} Regarding the oropharynx, we observed that healthy patients (CG) had a smaller area and volume than the OSA patients; the differences however, were not statistically significant. The axial lower area of the OSA patients was significantly lower than the CG, as already observed by many others.^{18–25}

Reports in the literature showed that severe OSA is associated with younger ages (pre-adolescence) due to the increased lymphoid tissues, causing a narrowed pharynx.^{1–6,16} In the present study, the OSA patients were slightly older (average age of 9.5 years old), having already undergone a surgical treatment when younger, and mostly had no tonsils at all; even so, they presented with reduced NP volume. This observation demonstrated that other factors, such as craniofacial abnormalities, could play a role in the installation of OSA, in agreement with other studies.^{7–12} The CG patients did not have respiratory complaints and had no hypertrophic tonsils, despite their young age.

In addition, chronological age may not represent the real growth phase that can be best evaluated by bone age measurements.¹⁴ In our study, both groups were at the same stage of

Figure 8—Differences of means between CG and SG.

pubertal maturation (CVM I and II), and in the same age group (5–12 years old).²⁷ Maybe OSA studies in children assessing also the real phase of growth and children development, determined by bone ossification age, could minimize the chance of erroneous conclusions.

In this study, no differences in AHI were found between males and females of the study group, and the patients were not divided by gender (Table 1).

In general, male patients have shown to have an increased risk for OSA; the mechanisms underlying this predisposition are unclear.¹³ At least one previous study demonstrated a difference, and proposed that to be due to the usual more enlarged UA sizes in adult males than in females, this anatomical feature could let the male UA more likely to collapse.¹³

Recent studies of CBCT, have demonstrated that patients with retruded mandible and class II tend to have the OP volume reduced when compared to patients Class I and III malocclusion, with advanced or standard mandible. According to the authors, the mandibular position may have influence on the volume of the OP. Regarding the NP, significant differences have been shown only in patients presenting with Class I and Class II malocclusion; the volume is usually lower in Class II patients.^{17,22,25} We included Class II patients with retruded mandible in both CG and the SG groups, and our results showed a greater and significantly reduced area and volume of

the NP in patients with OSA and PS. The nasopharynx is not a region of the airway particularly related to mandible retrusion, but it could be associated with class II malocclusion, oral breathing, or allergic diseases.^{8,19,27} The SG patients were all oral breathers, which may have caused the narrowing of NP, even after they had been submitted to a surgical ENT treatment. This agrees with some authors who have shown the influence of the breathing mode on the anatomy of the upper airways.^{8,19,27}

The causes of the OSA disorder has not been totally established, particularly in the pediatric population, in which the growth and developmental events, and external factors, such as allergic diseases and habits, can influence the development of the sleep disorders, confusing the correct diagnosis. Due to such a complexity of OSA in children, the treatment should be planned in conjunction with various professionals simultaneously.³⁻¹⁴ The PSG diagnosis may not be enough for understanding the cause of disease, in order to achieve the best treatment. We should have tools to evaluate the anatomical obstructive site of the patient to plan for the possible treatment.^{1-7,15,16}

The MRI¹⁷ and CBCT exams¹⁸⁻²⁴ have shown to be of good assistance for the OSA understanding. Recent studies recommend considering the cone-beam computed tomographic (CBCT) to identify obstructions in the airways,¹⁸ due to the many advantages, including that as the 3D image is more reliable than 2D.¹⁸⁻²² CBCT exams^{3,15,16} are safely used for diagnosis in orthodontics because they can replace all routinely requested tests in the diagnosis and orthodontic planning, with the same or even lower ionizing radiation than tests routinely ordered.^{17,23,24}

Our goal was to understand and build parameters that could help the diagnosis and treatment of the recurrent PS and OSAS. Our sample was just large enough for statistical analysis, but not enough for definitive conclusions. The multifactorial aspects of the disorder and aspects related to childhood growth are a great obstacle in standardizing population samples. The observation of the sites where there is a decrease of size in the upper airways gives us an opportunity to offer the most appropriate orthodontic treatment. Studies involving patients with all patterns of malocclusion such as class I and III angle malocclusion should also be conducted for a comparison with our results.

CONCLUSIONS

Children diagnosed with primary snoring and persistent obstructive sleep apnea after tonsillectomy showed a significant and important narrowing of the upper airway, especially at the nasopharynx region. The sagittal lower area of the upper airway also showed significant reduction. CBCT proved to be a complementary test for diagnostic and treatment planning purposes, and it is available to health professionals of many areas, avoiding the need for potentially harmful orthodontic exams.

ABBREVIATIONS

AHI, apnea-hypopnea index
ANS, anterior nasion spine
AT, adenotonsillectomy

Ba, basion
CBCT, cone beam tomography
CG, control group
DICOM, digital image for communication
FAPESP, Research Foundation of Sao Paolo State
FOUSP, Dentistry College, State University of Sao Paolo
FP, Frankfurt plane
i-Cat, cone beam 3-D dental imaging system
N, nasion
NP, nasopharynx
OP, oropharynx
OSA, obstructive sleep apnea
PAINF, pharynx anterior inferior (15 mm after the lower limit of the uvula)
PAIOF, pharynx anterior (15 mm front of the uvula point)
PNS, posterior nasion spine
PPINF, pharynx posterior inferior (15 mm after the lower limit of the uvula)
PPIOF, pharynx posterior (15 mm rear of the uvula point)
Po, porion
PS, primary snoring
PSG, polysomnography
PV, posterior vomer
RSD, respiratory sleep disorder
SG, study group
UA, upper airway
UARS, upper airway syndrome
UNIFESP, Federal University Sao Paulo

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Correction of Severe Obstructive Sleep Apnea Syndrome with Interdisciplinary Medical and Dental Treatment Planning

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Private Practice

This article describes a comprehensive and interdisciplinary medical and dental treatment planning that was able to successfully address the patient's health issues including severe OSAS, high blood pressure, developing diabetes, and prostate cancer.

KEYWORDS: obstructive sleep apnea syndrome, interdisciplinary medical and dental treatment, PharyngOroFacial, surgically assisted mandibular expansion, telegnathic surgery

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INTRODUCTION

Obstructive sleep apnea syndrome (OSAS) is one of the more severe forms of sleep-disordered breathing (SDB). It can be a debilitating, even life-threatening, condition. Health issues associated with OSA include tooth grinding, temporomandibular disorders, facial deformities, ADHD, gastroesophageal reflux disease, premature aging, depression, hypertension, sexual impotence, Alzheimer disease, metabolic syndrome, diabetes, obesity, cancer, heart disease, and stroke.¹⁻³

OSAS is a multifactorial disease. Constriction of the upper airway is recognized as one of the most important culprits in the development of OSAS. Variables that affect the upper airway luminal size include the relative sizes of the jaw and tongue.

The case presented in this paper demonstrates the effective participation of the dental practitioner as a member of an interdisciplinary dental/medical team collaborating in the treatment of OSAS.

REPORT OF CASE

A 58-year-old male patient visited a new general dentist to improve his non-aesthetic smile.

The patient reported a history of severe OSAS (an apnea-hypopnea index [AHI] of 53 and Epworth Sleepiness Scale [ESS] was 19/24). His initial clinical symptoms included high blood pressure (150/90), excessive daytime sleepiness [EDS] affecting his job performance, and falling asleep during driving. For treatment of his OSAS he was using continuous positive airway pressure device (CPAP) with H₂O pressure of 18 cm. His CPAP compliance effort was good, but it was ineffective in reducing his symptoms including EDS due to air leakage around the facial mask. It was recommended by his sleep physician to take Provigil for improving his EDS with no other medications.

A clinical examination showed that the patient had a Class III skeletal and dental relationship with a moderate retrognathic position of the maxilla and retrusive position of the dentition in mandible (**Figure 1**). There was no presence of decay or

gingival inflammation, but he had generalized type one periodontitis, with horizontal bone loss and gingival recession.

He was missing teeth 1, 2, 16, 23, and 32; teeth 3, 30, and 31 had been replaced with implant-supported restorations. Tooth #23 was extracted in childhood.

The anterior crossbite as patient's main aesthetic dissatisfaction with his smile never had been addressed properly.

Treatment began with a combination of orthodontic and telegnathic surgery (when orthognathic surgery is used to treat OSA, it is referred to as telegnathic surgery) for correction of the maxillary/mandibular vertical, sagittal, and transverse deficiencies. An 8-mm surgically assisted mandibular expansion (SAME) as outpatient technique was performed to create a recipient site for future replacement of missing tooth #23 by an implant-supported restoration.

During this stage of treatment, patient reported a recent diagnosis of elevated blood sugar (fasting blood sugar FBS level of 106 mg/dL) and prostate cancer (diagnosed with rapidly elevating prostate specific antigen PSA of 1.8 ng/mL and confirmed with biopsy). The interdisciplinary medical/dental team recommended postponing treatment of prostate cancer by implanted radioactive seed until after the second stage surgery for treatment of his OSA, given the severity of his OSA and his intolerance of CPAP.

The second stage of telegnathic surgery included a 10-mm maxillary advancement, a 6-mm maxillary expansion, and a 5-mm mandibular advancement combined with counterclockwise rotation of the maxillomandibular complex. The patient proceeded with the surgery and treatment protocol for his prostate cancer three months later with complete remission. The postsurgical orthodontic treatment was completed within 15 months. The implant for the future replacement of missing tooth #23 was installed. The patient received partial connective tissue grafting to restore the excessive gingival recession.

A well balanced PharyngOroFacial relationship was attained. The general dentist provided a comprehensive equilibration followed by the restoration of the implant replacing missing tooth #23. A balanced facial profile with improved chin protrusion was obtained (**Figure 2**) but, most importantly, the

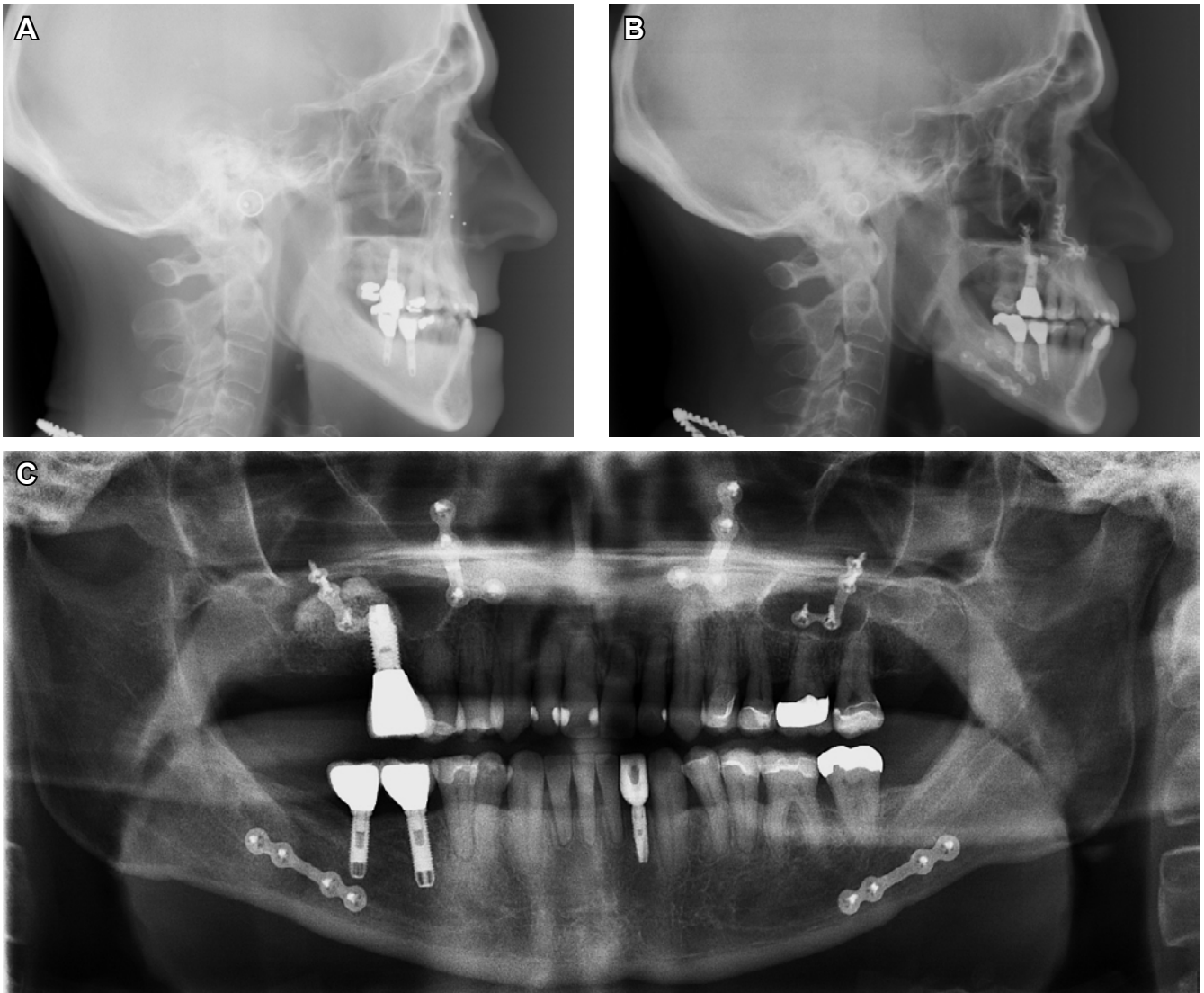
Figure 1—Pretreatment extraoral and intraoral photographs.



Figure 2—Posttreatment extraoral and intraoral photographs.



Figure 3



(A) Pretreatment cephalometric radiograph. **(B,C)** Posttreatment cephalometric and panoramic radiographs.

patient reported a significant improvement in the night sleep and daytime level of alertness. Later tests demonstrated that his high blood pressure (posttreatment systolic and diastolic blood pressure of 110/70 [120/80 is normal]), PSA level (posttreatment level of 0.01 ng/mL [< 2.5 is normal for men over 50]) and high blood sugar (posttreatment FBS level of 92 mg/dL [level < 100 mg/dL is normal]) normalized. His spouse reported no disturbances during sleep, and the postsurgical polysomnography performed at the sleep lab by his sleep specialist showed an AHI of 2.1 (< 5 is normal) and ESS of 3 (< 10 is normal). An increase in the retropalatal, retroglossal, and hypoglossal airway spaces concomitant with maxillary and mandibular advancement was evident on the cephalometric radiograph (Figure 3A–3C).

DISCUSSION

A few articles discuss the role of increased transverse dimension by means of SAME in resolving dentoalveolar crowding in treatment of OSA patients.⁴ However, none describes the important role of SAME in the development of implant site for replacement of missing teeth and its subsequent effectiveness in the treatment of OSA.

Maxillomandibular counterclockwise rotation and advancement surgery by expansion of the posterior nasopharyngeal openings also augment the nasal cavity. A nasal cavity volume increase should reduce the resistance to nasal airflow.⁵ If the airway is considered a simple tube, as the radius of the tube increases, the resistance to flow decreases exponentially to the fourth power (resistance = $8L\eta/\pi r^4$).⁶ Therefore, even small increases in the diameter of the tube (the nasal cavity) can dramatically decrease the resistance to nasal air flow.⁶

Surgically assisted mandibular expansion (SAME) as an orthodontic procedure and an outpatient protocol produced a proper recipient site for the installation of an implant to replace tooth #23.⁷ Also combined with the subsequent bimaxillary

advancement surgery provided adequate oral volume to accommodate the tongue thus opening the oropharynx.⁸

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POSTER #001

Longevity Of Fusion Custom Mask for Combination Therapy Treatment for OSA: Nine Year Follow-Up

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Introduction: The purpose of this study was to investigate the longevity of the Fusion Custom Mask (FCM) used in combination therapy to treat OSA in patients who presented to a dental sleep center. Being a new therapeutic option, it is unknown how long a FCM will last and if it is cost effective.

Methods: The FCM is a custom CPAP face mask that is fabricated from an impression of the face. This FCM is then connected to the post attached to an oral appliance. This strapless CPAP face mask features a CPAP interface with mandibular stabilization. A retrospective chart review of 75 FCM patients on combination therapy from 2006-2012 was conducted in 2015 to determine the current therapeutic disposition. All 75 patients were contacted by phone and interviewed.

Results: Current status as of 75 patients in 2015 is as follows: Unable to contact (#19 which left 56 remaining); Still wearing Custom mask #44 (78% of contacted patients); Went back to stock CPAP #5 (10%); Lost weight/ OSA resolved #3 (4%); Surgery/OSA resolved #2 (4%); Bad CPAP side effect #1 (2%); Deceased #1 (2%). Cost of 1.CPAP Mask vs 2.FCM is as follows: 1) Stock CPAP mask (\$150 AirFit™ F10 Full Face Mask); Annual cost \$800 (mask/tubing); 5 year cost \$4150. 2) FCM (\$3600); Annual cost \$80.00 (tubing); 5 year cost \$3650. Many of these patients with FCM were given their masks in 2006 and some every year since. That makes some of these custom masks over 9 years old. Longevity is clearly established in this survey. A few of these patients had to have their mask relined as they lost significant weight that caused leakage. But all 44 patients still wearing the mask were satisfied and in treatment. The actual life span of these masks have yet to be determined since they are still functioning after 9 years in some of these patients. The longevity of this device also makes the initial cost of the device comparable to stock CPAP mask when considered how long this mask lasts. The hose replacement is the only annual cost to the CM. Then the consideration that many of these patients remain in therapy saving lives and improving the health of these patients is a savings yet to be determined.

Conclusions: Not only is a CM effective in the long term in combination therapy, especially those on the severe end of the spectrum, but is also cost effective. The CM should be considered when other therapeutic methods of treating OSA have

failed or when CPAP pressures or the CPAP mask are intolerable to the patient.

POSTER #002

About 45 Cases of Application of SOMNOSNORE Mandibular Advancement Devices in Snoring Treatment

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Introduction: The mandibular advancement appliances used today in France represent devices with an adjustment system which adapts the mandibular propulsion to the patient's symptoms, but this system has the disadvantage of taking up space in the mouth. My experience of over 500 mandibular advancement devices (MAD) used in SAS or snoring treatment showed that snoring disappears since the first titration. The purpose of this study was to find out whether, in snoring, the good initial titration could prevent us from using titratable mandibular advancement splints mm/mm, which would simplify and ease their usage and thereby improve patient's comfort.

Methods: A single-center prospective study of 45 patients, from November 2014 to June 2015, has been carried out. Demographics: 25 men and 20 women. Average age: 43 years [24-72]. MAD Type: The SOMNOSNORE MAD, manufactured by Somnosed laboratory, was used for this study. It is identical to the Somnodent MAD but has no control cylinder. Contrariwise, this MAD is supplied with a top gutter and two bottom gutters: the first one with the desired titration and the second one with a supplementary protrusion of 2 mm. Titration: The initial titration was of 70% of the maximum active propulsion (MAP). Measuring of the titration was carried out with a George Gauge. This easy to use tool allows the most precise measurement of the progress to be made, and moreover, the protrusion is done exactly in the position requested by the recording range.

Conclusions: In total, among 44 patients, which completed the study, 43 subjects stopped snoring. The use of the SOMNOSNORE MAD allowed to achieve the full result in snoring treatment. This MAD is easy to produce, and, if the initial titration is well performed, the result is immediate and the follow-up is simplified. In future, the oral appliances with integrated control system could probably be replaced by less bulky devices with preset and easily interchangeable gutters to fit the patient's symptomatology.

POSTER #003

Effects of Sedation on Breathing in Patients Undergoing Dental Operation

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Introduction: Sedation for dental treatments is often applied to patients with strong anxiety and vomiting reflex, and undergoing major dental surgeries. Severe cardio-respiratory complications including deaths were reported under dental sedations. Under sedation which depresses the upper airway functions such as airway maintenance and airway protective reflexes, use of water during the treatment may block oral breathing and wider mouth opening may impair nasal airway patency. Furthermore, the water may be aspirated and induce the upper airway reflexes. We therefore tested a hypothesis that adverse respiratory events occur during dental sedation even in healthy adults.

Methods: Six adult patients scheduled for dental extraction under dental sedation were enrolled in this study (2 males and 4 females). In addition to a routine cardiorespiratory monitor, a type3 portable sleep apnea monitor was used to measure breathing through the nose, respiratory efforts, and oxygen saturation before and during the sedation. Conscious sedation was targeted by bolus intravenous injection of midazolam (1mg), bolus (10 mg) and continuous infusions of propofol (1-3mg/kg/hour). We analyzed the measured tracings during sedation to identify respiratory adverse events such as apnea, hypopnea, desaturation, sigh and cough reflex.

Results: Participants were middle-aged (47 ± 12 yrs) and non-obese (24 ± 4 kg/m²) except one with BMI 31 kg/m². Dental extraction was successfully accomplished in all participants without apparent adverse complications (57 ± 24 minutes). Desaturations occurred in association with apnea or hypopnea (12 ± 14 episodes/hour), and were more common in patients without oxygen administration ($n = 2$) than those receiving 3 liter/min oxygen ($n = 4$). Apnea and hypopnea occurred more frequently than the desaturation episodes (14 ± 12 episodes/hour, 23 ± 20 episodes/hour, respectively). Recovery from apnea and hypopnea often occurred in association with a coughing (20 ± 25 episodes/hour) or sigh (11 ± 5 episodes/hour) event. Interestingly, there is a positive correlation between the apnea/hypopnea index and frequency of cough reflex ($r = 0.89$, $P = 0.017$).

Conclusions: The results support the hypothesis and there were many abnormal respiratory events during dental sedation for healthy adults.

Support: This study was supported by Japanese grant-in-aid (4390363) from the Ministry of Education, Culture, Sports, Science and Technology, Tokyo, Japan.

POSTER #004

No Increase in Sleep Bruxism or Sustained Orofacial Muscle Activity during Sleep in Mild Traumatic Brain Injury Patients: A Controlled Study

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Introduction: Traumatic brain injury (TBI) is an acute condition caused by mechanical energy transfer to the head by an external physical force, resulting from sports, vehicle accidents, assaults, falls, etc. About 15% of mild TBI (mTBI) cases lead to headache, widespread pain, or various sleep disorders (e.g., insomnia, apnea). However, although bruxism and dystonia are occasionally reported after TBI, it is unknown whether mTBI also leads to sleep bruxism (SB). The aim of this study was to assess the frequency and severity of orofacial muscle activity in mTBI patients compared to control subjects at one month post-trauma.

Methods: Polysomnography (PSG) recordings (EEG, EOG, ECG, EMG) were conducted on the chin/suprahoid, right masseter, and leg/anterior tibialis of subjects for two consecutive nights. Nineteen mTBI patients were recruited at our trauma center at one month post-trauma and compared to 16 controls without sleep bruxism or pain. The first night was for habituation and the second was for data analysis of: 1) rhythmic masticatory muscle activity (RMMA), a biomarker of SB, detected in the masseter EMG and scored according to International Classification of Sleep Disorders (ICSD-3, 2014) criteria; and 2) muscle tone of the chin, masseter, and anterior leg/tibialis, calculated as the root mean square amplitude of 20 stable epochs without movement or arousal per sleep stage. Group differences were compared using Student's t-test.

Results: PSG analysis revealed that mTBI patients slept significantly less than controls (6.7 vs 7.5hrs) and had lower sleep efficiency (89.8 vs. 94.8%) and longer sleep latency (22.0 vs. 9.3min), although differences were within normal clinical range ($P < 0.05$ for all comparisons). 1) For SB analysis, the sample included 19 mTBI patients (M:10, F:9; mean age: 37yrs) and 16 controls (M:6, F:10; 28yrs). No significant between-group differences were found in the frequency of RMMA SB-related outcome measures (e.g., RMMA index of 1.0 and 0.8 for mTBI and controls, respectively; NS; $P = 0.55$). 2) For the sustained muscle tone analysis, the sample included 16 mTBI patients (M:7, F:9; 38yrs) and the same 16 controls. Although chin and masseter muscle tone did not differ between groups, mild TBI patients showed higher anterior tibialis muscle tone for each non-REM sleep stage ($P < 0.05$), and slightly higher in wake time before sleep and REM sleep ($P = 0.06$).

Conclusions: Patients with mTBI showed no evidence of SB or increased orofacial muscle tone. However, increased leg muscle tone in the non-REM sleep of TBI patients may reflect [a hyper-arousal state] (Khoury S, J Neurotrauma 2013).

Support: Study supported by the FRQS Pain Res Network and Canada Research Chair (GL).

POSTER #005

Is It Possible to Predict the Sleep Apnea Severity and Anatomical Pathophysiology by the Maxillofacial CT in Japan?Arisaka T¹, Chiba S¹, Yagi T¹, Chiba S^{1,2}, Tonogi M³, Ota F¹¹Ota Memorial Sleep Center, Sleep Surgery Center, Kanagawa, Japan, ²Department of Otorhinolaryngology, Jikei University School of Medicine, Tokyo, Japan, ³Department of Oral and Maxillofacial Surgery, Nihon University School of Dentistry, Tokyo, Japan

Introduction: Obstructive sleep apnea (OSA) is known as a social problem in Japan. It develops a cardiovascular disease, a traffic accident by daytime sleepiness and more by sleep breathing disorders. It is necessary to Polysomnography (PSG) testing in the diagnosis of OSA. However all facility can't be PSG testing. On the other hand, Japan has CT scanners by the highest number per capita. And It is conceivable that the frequency of the CT imaging is large number. Therefore the CT imaging has been investigated whether it is possible predict the OSA severity and is it useful to understand anatomical pathophysiology of OSA.

Methods: We enrolled consecutive 451 OSA patients who diagnosed by PSG and got consent to CT imaging, from April 2014 to March 2015 in Ota memorial sleep center (Kanagawa, Japan). We measured detail of maxillofacial structure from three-dimensional construction by DICOM data of CT. Each measurement, clinical findings and patient background was evaluated using multiple regression analysis.

Results: In the group of male were 371 cases. Independent predictors were the hyoid position, BMI, mandibular body length, angle of mandible, size of tonsil, facial axis, soft palate length and thickness, anteroposterior length of cranium and Lateral length of maxilla ($R^2 = 0.448$). In the group of female were 80 cases. Selected independent predictors were the BMI, hyoid position, size of tonsil, age and anteroposterior length of cranium ($R^2 = 0.523$). Prediction equation that was created from the cephalometric analysis of the same group of male were less accuracy ($R^2 = 0.356$).

Conclusions: By using a prediction equation created from the data of the maxillofacial CT, it was possible to predict the OSA severity with high accuracy. And also, we can understand anatomical pathophysiology of each case in Japanese male. In the future, we have the propose of standardization of CT analysis in Japan from these data.

POSTER #006

The Prevalence of General Dentists who Screen for Obstructive Sleep Apnea

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VCU School of Dentistry

Introduction: Obstructive sleep apnea (OSA) is a common condition involving up to 17% of adult males and 9% of adult females, many of which go undiagnosed for prolonged amounts of time. This fact is likely due to the lack of screening methods or overall minimal screening considerations by

health care professionals. The adult population visits a general dentist up to 25% more often than a primary care physician. In order to provide greater awareness and improved outcomes of sleep apnea, a knowledge of general dentist involvement of OSA detection is imperative in aiding diagnosis and subsequent treatment.

Methods: A brief, 12-item questionnaire was electronically sent to one-thousand General Dentists across the United States. The questionnaire consisted of a short demographic section followed by a series of questions regarding screening methods and preferences for OSA.

Results: Seventy-five dentists responded to the questionnaire. According to the results, approximately 70% of general dentists report participation in some type of screening for OSA. Only 40% of those who do screen report routine screening for at least 8 out of 10 patients. There are three main modalities to screen for OSA: patient interview, written questionnaire, and identification of anatomical parameters. The patient interview modality has the most frequent utilization at 70% of responders with most all identifying snoring and daytime fatigue. Next, is the identification of anatomical parameters at 53% of responders, in which most all examine tonsils/adenoids and neck circumference. Last, is the written questionnaire at only 38% of responders, with the most popular being the Epworth questionnaire. Nearly half of those who routinely screen for OSA utilize the patient interview as their preferred screening modality. On a scale from 1 – 5 (1 = uncomfortable, 5 = confident), dentists were asked to rate their confidence in screening for OSA. The majority (53%) of responders rated themselves 3 or less. The results demonstrate a well-rounded sample of the General Dentist population including representation of 28 states with at least one responder and 33 unique dental school training representation. The city size the dentists practice in is also represented very evenly, ranging from less than 20,000 to more than 500,000. Dentists who responded represented a broad range of dental experience (5-30+ years), while nearly half (48%) of responders reported over 30 years practicing dentistry. Roughly all responders (98%) reported practicing general dentistry in a private practice. 88% of those who suspect patients with OSA refer to physicians for evaluation.

Conclusions: The results show that 28% of dentists screen for OSA in at least 8 out of 10 patients. The patient interview is the widely preferred screening modality, followed by a written questionnaire and identification of anatomical parameters. The majority of general dentists report some level of discomfort in confidently screening for OSA. This data demonstrates the need for general dentists to become more aware and better trained to help accurately and confidently screen for OSA.

POSTER #007

The Prevalence of Pediatric Dentists who Screen for Obstructive Sleep Apnea

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Introduction: Obstructive Sleep Apnea (OSA) is a sleep disorder characterized by repeated episodes of upper airway obstruction for more than 10 seconds while sleeping. This results in pauses or apneas in breathing, which leads to interruptions in sleep. OSA affects 1-10% of children, and has significant sequelae when left untreated. It is estimated that children visit their dentist four times more often than their primary care physician, which provides a greater opportunity for pediatric dentists to screen for OSA. While there is ample research available on treatments and screening methods, there is limited research available on the prevalence of screening among pediatric dentists.

Methods: A brief questionnaire was electronically sent to approximately 5,500 Pediatric Dentists who are members of the American Academy of Pediatric Dentistry using REDcap.

Results: 448 pediatric dentists responded to the questionnaire. According to the results, 63% of pediatric dentists report participation in some type of screening for OSA but only 29% of those who do screen report routine screening 100% of their patients. There are three main modalities to screen for OSA: patient interview, written questionnaire, and identification of anatomical parameters. The patient interview modality has the most frequent utilization at 55% of pediatric dentists with most identifying snoring, daytime fatigue, and mouth breathing. Next, is the identification of anatomical parameters at 53%, in which most all examine tonsils/adenoids size. Last, is the written questionnaire at only 5%. Nearly half of those who routinely screen for OSA utilize the patient interview as their preferred screening modality. Only 7% of pediatric dentists provide treatment for their patients with OSA. Of the 7%, 76% focus on providing treatment for both the maxilla and mandible with the most common appliance being the rapid palatal expander. On a scale from 1 – 5 (1 = uncomfortable, 5 = confident), dentists were asked to rate their confidence in screening for OSA. The majority, 71% of pediatric dentists, rated themselves 3 or less. The results demonstrate a well-rounded sample of the pediatric dentist population including representation of 48 states and 57 dental schools. The city size the dentists practice in is also represented very evenly, ranging from less than 20,000 to more than 500,000. Dentists who responded represented a broad range of dental experience (5-30+ years). Approximately 90% of those who suspect patients with OSA refer to physicians for further evaluation.

Conclusions: The results show that more than one third of pediatric dentists do not screen their patients for OSA, which is significant portion of the pediatric population. Furthermore, the majority of dentists report some level of discomfort in confidently screening for OSA and 93% do not provide treatment for OSA. This data demonstrates the need for pediatric

dentists to become more aware and better trained to help accurately and confidently screen for OSA.

POSTER #008

The Influence of the Amount of Degree of Vertical Opening in the Design of Mandibular Advancement Device MAD for Obstructive Sleep Apnea Patients

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Introduction: Opening of the bite occurs during MAD treatment as all appliances have a given thickness causing vertical jaw displacement. Increased vertical mouth opening has an adverse effect on upper airway patency in the majority of OSA patients. The purposes of this study were to estimate the effect of vertical opening in the mandibular advancement and to evaluate the influence of the amount of vertical opening in the efficacy of MAD for obstructive sleep apnea (OSA) patients.

Methods: From the patients who were diagnosed as OSA by polysomnographic study at Instituto del Sueño de Madrid from January 2009 to February 2013, 225 patients who chose MAD as treatment option were included in this study. All the patients' data including clinical records and polysomnographic studies (both pre- and post-treatment) were reviewed and analyzed. Two degrees of vertical opening 2 and 5 mm were studied. Maximum protrusion and maximum retrusion was measured in each patient with George Gauge. The statistical analysis was made with the Wilcoxon signed-rank test for paired data.

Results: Mandibular total advance was 1.42 mm longer with 2mm compared with 5mm vertical opening (2mm 12,92 vs 5mm 11,5). 66% of maximum protrusion was 0,945mm longer for 2mm vertical opening (2mm 8,604 vs 5mm 7,659).

Conclusions: Total advance allowed 1,5mm more advance and 66% of maximum protrusion allowed 1mm with 2mm vs 5mm vertical opening. Amount of bite opening should be minimized to improve patient tolerance and increase the beneficial effect on upper airway dimensions. MAD was effective treatment option for the OSA patients regardless of severity. For the prevention of potential dental complications, the amount of vertical opening should be considered at the time of MAD treatment.

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POSTER #009

Mandibular Advancement Splint as a Comparable Treatment to Nasal Continuous Positive Airway Pressure in Patients with Positional Obstructive Sleep ApneaTakaesu Y¹, Tsuiki S^{2,3,4}, Kobayashi M^{2,3,4}, Komada Y^{2,3,4}, Inoue Y^{2,3,4}¹Department of Psychiatry, Tokyo Medical University, Tokyo, Japan;²Japan Somnology Center, Institute of Neuropsychiatry, Tokyo,Japan; ³Department of Somnology, Tokyo Medical University, Tokyo,⁴Foundation of Sleep and Health Sciences, Tokyo, Japan

Introduction: In clinical settings, many patients with obstructive sleep apnea (OSA) experience more severe OSA while asleep in the supine position than in the lateral position. Oksenberg *et al.* (2014) reported that these individuals called positional OSA is present in approximately 50%-60% of OSA patients who undergo polysomnography. Chung *et al.* (2010) interestingly suggested that positional OSA patients responded better to a mandibular advancement splint (MAS) than patients with non-positional OSA. Since positional OSA is likely to be a common OSA phenotype that can be detected by diagnostic polysomnography, MAS treatment for positional OSA patients may result in increased treatment efficacy and offer a patient-tailored approach to OSA. Accordingly, we hypothesized that the efficacy of an MAS is comparable to that of nasal continuous positive airway pressure (nCPAP) when used in patients with positional OSA.

Methods: The study protocol was approved by the ethics committee of the Foundation of Sleep and Health Sciences. Amongst patients diagnosed with OSA at a single sleep center from January 2008 to May 2014, male subjects with moderate OSA were recruited and stringently categorized as having positional OSA when the ratio of their lateral apnea-hypopnea index (AHI) to supine AHI was 0.5 or less, their lateral sleep time was longer than 60 minutes, and their lateral rapid eye movement sleep time was longer than 10 minutes. Treatment efficacy in terms of AHI was compared between positional OSA subjects with an MAS (N = 34) and those with nCPAP (N = 34) by the unpaired *t*-test after matching for age, body-mass index, and baseline AHI. A *p*-value of less than 0.05 was considered to indicate a statistically significant difference between groups.

Results: There were no significant differences in age ($p = 0.81$) or in body-mass index ($p = 0.07$) between the 2 treatment groups. Also there were no significant differences in baseline AHI (MAS : nCPAP = $20.6 \pm 3.9/\text{hr}$: $21.3 \pm 1.7/\text{hr}$, $p = 0.35$) or in follow-up AHI (MAS : nCPAP = $4.7 \pm 3.5/\text{hr}$: $3.4 \pm 3.7/\text{hr}$, $p = 0.12$) between the groups. Hence the AHI was lowered with MAS to the same extent as nCPAP.

Conclusions: This is the first demonstration that an MAS is as efficacious as nCPAP for positional OSA patients. We conclude that MAS treatment for this specific phenotype, positional OSA, may be a promising patient-tailored and first-line approach to OSA. The information on positional dependency should also be useful for determining the type of treatment to use immediately after OSA diagnosis.

POSTER #010

Long Term Evaluation of Occlusal Changes during Treatment with Mandibular Advance Device for Obstructive Sleep Apnea: Preliminary Report

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Introduction: The purpose of this study was to evaluate the magnitude and progression of dental changes associated with long-term mandibular advancement device (MAD) treatment of obstructive sleep apnea (OSA).

Methods: Prospective study of adults treated for primary snoring or mild to severe OSA with MAS for 6 months, 2, 4 and 8 years. The series of dental casts of patients were analyzed with a 3Shape 3D Orthodontic analysis for changes in overbite, overjet, dental arch crowding and width, and inter-arch relationships. The progression of these changes will be determined and initial patient and dental characteristics will be evaluated as predictors of the observed dental side effects of treatment. From the patients who were diagnosed as OSA by polysomnographic study at Instituto del Sueño de Madrid from January 2015 to June 2015, 245 patients who chose MAD as treatment option were included in this study. All the patients' data including clinical records and polysomnographic studies (both pre- and post-treatment) were reviewed and analyzed. A total of 245 patients (average age at start of treatment: 45.4 ± 9.8 years, 175 males) were included in this study. The average treatment length was 6.1 ± 1.4 months.

Results: In the preliminary 6 months interval evaluated there was a minimal reduction in the overbite (0.1 ± 0.05 mm), overjet (0.2 ± 0.6 mm). A corresponding increase of mandibular intercanine (0.1 ± 0.4 mm) and intermolar (0.1 ± 0.3 mm) width.

Conclusions: After an average preliminary observation period of 6 months, no clinically significant changes in occlusion were observed. The monoblock MAD used had no dental side effects. Further evaluation in time will be made 2, 4 and 8 years treatment follow-up. MAD was effective treatment option for the OSA patients regardless of severity. For the prevention of potential dental complications, a stable occlusion in advance given by the device should be considered at the time of MAD treatment.

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POSTER #011

Effects of a Novel Mandibular Advancement Device on AHI and Snoring in Patients with Obstructive Sleep Apnea: A Pilot StudyHart C¹, Lavery D², Czyniewski S³, Beer F³¹Breathing Assist Solutions, ²National Dental Care, ³Mobius Medical

Introduction: This prospective, single-arm, single-centre pilot trial was performed to establish the safety and efficacy of the Oventus device in treating obstructive sleep apnea (OSA) and snoring. The device is designed to provide mandibular advancement, and provide a passage from the front to rear of the mouth within the device for breathing. The method of bypassing any obstructions of the soft palate and nasal cavity, could provide an alternative treatment option for all patients, especially those with nasal congestion.

Methods: The trial consisted of 30 participants with OSA, diagnosed by baseline ambulatory polysomnography (PSG). All PSGs in the trial were scored independently by one RPSGT. Nasal congestion was measured at baseline. Additionally, subjective sleep questionnaires were completed pre and post treatment. The protocol design included a baseline PSG and dental requirements, fabrication and delivery of the appliance. Following 3-5 weeks of acclimatisation, a PSG was performed with the device in-situ. As per the protocol, the device could be manipulated increasing the mandibular protrusion (max 85%) two more times. Hence three follow-up PSGs with the device in-situ were permitted. Participants with a $\geq 50\%$ reduction in AHI were classed as responders.

Results: Of the 30 participants, 29 completed at least one follow-up PSG to assess the level of titration. One participant withdrew prior to completing any follow-up PSGs. On average the AHI decrease by 62.5% from baseline ($m = 41.0$, $sd = 26.4$) to the final PSG ($m = 16.2$, $sd = 15.4$). The mean difference was 25.7 ($sd = 16.8$, $p < 0.001$). Overall 22 (75.9%, 95%CI 59%-92%) participants were responders, which is statistically significant. Subgroup analysis was performed by nasal congestion (NC; $n = 17$) vs. no congestion (NNC; $n = 12$). The median percentage difference in AHI was 69.6% vs. 63.2% respectively for NC and NNC. Similarly, the proportion of responders was 76.5% vs. 75.0%. Although the study wasn't powered to detect a statistical difference - it appears those with nasal congestion can expect similar decreases in AHI and response rates. At baseline, the median percentage of time $< 90\%SpO_2$ was 6.2% for responders vs. 2.1% for non-responders. After the final PSG with the device, the time $< 90\%SpO_2$ was reduced $< 1\%$ of total sleep time for all participants. This decrease, following treatment, appears independent of changes in AHI or nasal congestion. On treatment all participants spend $< 1\%$ of time below 90% oxygen saturation.

Conclusions: In summary, this device is statistically significant in treating OSA. Additionally participants with nasal congestion responded in a similar way to those without nasal congestion, which supports a hypothesis that this device could be successfully used in patients with nasal congestion, which will be further analysed in future trials. An unexpected finding was that there was a reduction in the amount of time spent

below 90% oxygen saturation irrespective of nasal congestion or AHI response.

POSTER #012

Effects of Biomimetic Oral Appliance Therapy on Epworth Scores in Adults with Obstructive Sleep ApneaLiao F¹, Singh GD²¹Whole Health Dental Center, Falls Church, VA, ²BioModeling Solutions, Inc., Beaverton, OR

Introduction: Biomimetic oral appliance therapy (BOAT) differs from conventional mandibular advancement devices (MADs) that are currently deployed for the management of mild and moderate cases of obstructive sleep apnea (OSA) in adults, as it attempts to avoid unwanted tooth movements, temporo-mandibular joint issues and undesired facial profile changes that may be associated with long-term MAD use. Indeed, BOAT aims to correct the upper airway through midfacial redevelopment followed by mandibular correction, which may resolve OSA in adults. In this investigation, we test the hypothesis that perceived daytime sleepiness in adults with mild to moderate OSA can be addressed without primary mandibular advancement using BOAT.

Methods: In this preliminary study, we included 13 consecutive adults aged > 21 yrs. that had been diagnosed with mild to moderate OSA, following an overnight sleep study that had been interpreted by a board certified sleep physician. Prior to treatment each subject that participated in this pilot study completed an Epworth sleepiness scale (ESS) questionnaire. Each subject was treated by a dentist with advanced training in dental sleep medicine. At each monthly follow-up visit, examination for progress and adjustments of the devices were performed to optimize their efficacy. Post-treatment, each subject completed a follow-up ESS questionnaire. The mean ESS scores of the study sample was calculated prior to and after BOAT. The findings were subjected to statistical analysis, using paired t-tests.

Results: There were 7 females and 6 males that were included in this preliminary study. The mean age of the sample was 50 yrs. ± 12 . Prior to treatment the mean ESS score of the study subjects was 8.2 ± 6 . A further follow ESS questionnaire was done at a mean of 29.3 mos. ± 21.5 after BOAT. At this time, the mean ESS score decreased significantly ($p < 0.05$) to a value of 4.2 ± 3.6 after BOAT, which represents a fall in the mean ESS score by 51.4% for the study sample.

Conclusions: BOAT may be a useful method of managing adults with OSA who are seeking an alternative to long-term CPAP and MAD use. Although ESS is a discriminating test of daytime sleepiness, further data on specificity and sensitivity on these initial findings will be obtained using a larger sample size in long-term future studies.

POSTER #013

Prevalence of Subjective and Objective Residual Excessive Sleepiness During Successful Mandibular Advancement Device Therapy for Obstructive Sleep Apnea

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Introduction: A mandibular advancement device (OAm) effectively reduces the apnea-hypopnea index (AHI) in patients with obstructive sleep apnea (OSA). Some patients, however, show little or no improvement in their daytime sleepiness with OAm, despite a significant reduction in AHI. Little is known about the prevalence of such residual excessive sleepiness (RES) despite effective OAm treatment. We aimed to determine the prevalence of subjective and objective RES in patients treated with a titratable custom-made duobloc OAm in a fixed protrusion of 75% of the maximal mandibular protrusion.

Methods: A prospective prevalence study was performed collecting data from 70 OSA-patients (men/women ratio 59/11; age 48 ± 10 years; body mass index 28 ± 3 kg/m², baseline Epworth Sleepiness Score (ESS) 9 ± 5 and baseline AHI 19 ± 12 /h) undergoing OAm treatment. All patients underwent full-night polysomnography (PSG) with ESS scoring before starting and after 3 months of treatment, each time followed by multiple sleep latency tests (MSLT). Subjective and objective daytime sleepiness were assessed using the ESS and MSLT, respectively. Subjective RES is defined as a score on the ESS of $\geq 11/24$, mild objective RES as a mean MSLT score < 10 minutes and pathological objective RES as a mean MSLT score < 5 minutes.

Results: Out of 70 patients, 33 patients showed success with OAm as compared to baseline PSG, defined as a “decrease in AHI $\geq 50\%$ or AHI $< 5/h$ ”. Despite this success, 6 out of 33 patients (18%) showed subjective RES, based on an ESS $\geq 11/24$. Eleven out of 33 patients (33%) demonstrated mild objective RES (mean MSLT score < 10 minutes) whereas 2 out of 33 patients (6%) had pathological objective RES with mean MSLT scores < 5 minutes. A combination of subjective and mild objective RES was found in 4 out of 33 patients (12%) whereas 2 (6%) out of 33 patients showed a combination of subjective and pathological objective RES. Twenty out of 33 patients (61%) showed no subjective or objective RES when successfully treated.

Conclusions: Based on subjective and objective data, RES under OAm therapy showed a prevalence ranging from 6 to 33%, depending on the used definition.

Support: The study was funded by a 3 year grant of the Flemish government agency for Innovation by Science and Technology (IWT-090864).

POSTER #014

A New Oral Appliance Titration Protocol using the MicrO2 Sleep Device and Mandibular Positioning Home Sleep Test

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Introduction: A new oral appliance and titration protocol was evaluated for treatment of obstructive sleep apnea based on efficacy, titration efficiency and patient preference. The goal of this study was to show that with a well-qualified target position for efficacious treatment, patients can be treated quickly, with few titration steps, and tolerate 1mm advancements using a comfortable, lingual-less sleep device. The MicrO2 Sleep Device by Microdental Laboratories (Dublin, CA) is the first CAD/CAM manufactured appliance with sets of upper and lower trays milled from control cured grade PMMA. Combinations of the sets of trays provide for a titration protocol that protrudes the mandible to a treated position.

Methods: A mandibular positioning home sleep test (mpHST) developed by Zephyr Sleep Technologies (Calgary, AB) was used to automatically advance the patient’s mandible in response automatically detected respiratory events during a home sleep study to select patients that would be successful with oral appliance therapy and to provide a predicted efficacious mandibular position (target position, or PEMP). All participants ($n = 50$; AHI > 10 hr⁻¹; BMI < 45 kg/m²) received the mpHST in the home for a 2-3 night study and a binary prediction of outcome. With a target provided by the mpHST and range of motion (ROM) measured by the dentist, a specific MicrO2 series were made for all participants. The design was based on a goal of 1mm increments from the target to maximum. The patient was set immediately to the target position (or less than target at the discretion of the dentist). If treatment was unsuccessful as determined by HST (Remmers recorder, Sagatech), the position was advanced in 1-2 mm increments toward the maximum. Patients were classified a therapeutic success if they reached less than 10 events per hour and a 50% reduction from their baseline.

Results: Preliminary data included 31 males and 5 females, with a mean age of 48 years and BMI of 33 kg/m². Overall, 71% were treated by the MicrO2. By the mpHST test, 58% of patients were predicted to be successfully treated with OA therapy (predicted responders) and all of these were successfully treated by the MicrO2 (PPV = 100%). Of the predicted responders, 81% were treated at target and did not require further protrusion. The remaining 4 subjects were successfully treated within 1-4 titration steps using 1mm advancements. All participants with targets less than 90% of ROM accepted their target immediately, targets $> 90\%$ were advanced in 1 mm increments to their target within an average of 33 days. Continued titration resulted in 48% of predicted responders achieving an AHI < 5 . Further, 24% of predicted responders had severe OSA (AHI > 30) and 40% of these patients were treated to an AHI < 5 by the MicrO2.

Conclusions: The mpHST test enabled immediately effective treatment for the majority of patients with the MicroO2 and the remaining patients achieved treatment in 1 mm adjustments.

POSTER #015

A Mandibular Positioning Home Sleep Test Prospectively Predicts Outcome of Oral Appliance Therapy for OSA Using Retrospectively Derived Decision Criteria

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Introduction: Because of the inconsistent efficacy of oral appliance therapy (OAT) in treating OSA, efficient use of this therapy requires for patient selection for the therapy. We have previously evaluated the accuracy of a mandibular positioning home sleep test (mpHST) in making such selection. The present study evaluates possible improvement in selection accuracy made possible by using new decision criteria derived from our experience in the previous study.

Methods: We have carried out two clinical trials using a 2-3 night mpHST in which a computer positions the mandible in response to observed respiratory events. All participants (ODI > 10 hr⁻¹; BMI < 40kg/m²) received the mpHST and a custom, mandibular protruding oral appliance. Decision criteria applied to the mpHST results yielded a binary prediction of therapeutic outcome. The first trial (n = 122; SomnoMed G2 appliance) used decision algorithms derived from a pilot study. The second trial (n = 28; MicroDental Laboratories, MicroO2 appliance) prospectively used new algorithms derived from machine learning analysis of the results of the first study. Each mpHST supplied a predicted efficacious mandibular position (PEMP). Analysis was completed using both apnea-hypopnea index (AHI_{4%}) and oxyhemoglobin desaturation index (ODI_{4%}), and < 10 events per hour was taken to indicate successful therapy with the custom OA.

Results: Predictive accuracy of the mpHST using either outcome measure was as follows: From trial #1 to trial #2, AHI_{4%} sensitivity increased from 0.78 to 0.88, specificity increased from 0.62 to 0.83, positive predictive value increased from 0.83 to 0.88, negative predictive value increased from 0.55 to 0.83, error rate decreased from 0.27 to 0.14, and success rate decreased from 0.70 to 0.57. From trial #1 to trial #2, ODI_{4%} sensitivity increased from 0.78 to 0.80, specificity increased from 0.81 to 1.00, positive predictive value increased from 0.94 to 1.00, negative predictive value increased from 0.50 to 0.67, error rate decreased from 0.21 to 0.14, and success rate decreased from 0.79 to 0.71. Predictive accuracy for PEMP decreased from 91% to 81% from trial #1 to trial #2.

Conclusions: Each index of predictive accuracy, except PEMP, improved in trial #2 compared to trial #1, and the overall error rate decreased from 27% (AHI_{4%}) or 21% (ODI_{4%}) to 14%. The mpHST provides a robust prediction of OAT success.

POSTER #016

A Retrospective Study of Dental Records of Patients Treated of Obstructive Sleep Apnea who Preferred Oral Appliance Instead of Continuous Positive Air Pressure

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Introduction: Obstructive sleep apnea (OSA) is a chronic disorder and effective long-term treatment is necessary to prevent associated health risks. OSA is associated with higher levels of excessive daytime sleepiness (EDS), attributed to several factors such as increased arousal index (AI) and apnea hypopnea index (AHI) which can increase cardiovascular risk and affect the quality of sleep. The two most common therapies used to treat OSA are 1) continuous positive air pressure (CPAP), standard treatment which is highly efficacy, but has limitations, with suboptimal patient acceptance and adherence rates, which in turn obviates the desired health benefits. 2) The oral appliance (OA), alternative treatment where the mandibular advancement splint is the most commonly used. Patients often report preferring OA to CPAP therapy. Such therapies contribute to improving the patient's health.

Methods: A retrospective study of dental records of 14 patients with OSA, middle-aged and body mass index (BMI) 29.67 (5.17). Three polysomnography tests are used to compare before (baseline) and after (CPAP and OA) therapy. The OA used in this study is DIORS[®] - Dispositivo Intra Oral Restaurador do Sono. It modifies the upper airway, changing both the jaw and tongue posture. Its constructive is grounded in Functional Jaw Orthopedics concepts. Variance analysis for repeated measurements are applied to compare the results with 5% significance level. The IAH 31.57 (32.00) is evaluated by the American Academy of Sleep Medicine criteria (AHI < 5); the snore, by snoring score 3.5 (0.65); EDS, by Epworth Sleepiness Scale (ESS) 10:43 (5.87); and the quality of sleep, by sleep efficiency (ES) 80.86 (11.41) and AI 27.18 (26.36); cardiovascular health, cardiac beat major (CB_{major}) 89.26 (27.60).

Results: The study provides evidence of improvement in snoring (p-value 0.0038). BMI variations may have important role in OSA and were evaluated before other parameters (p-value 0.0065). There is an increase in mean BMI 30.37 (4.67), suggesting not be reasonable to assume that improvements have been caused by the reduction in body mass, and so it is assessed three parameters associated with sleep quality. Despite the significant increase in BMI, ESS (p-value 0.047) and ES (p-value 0.040) and AI (p-value 0.042) showed significant improvements of patients' health. Noteworthy is the successful treatment for patients distribution according to the classification of AHI < 5, 10 patients for CPAP and 12 for the OA (p-value 0.23). A highly significant finding is observed in the OA CB_{major} 76.90 (13.50) compared to CPAP CB_{major} 108.00 (59.5) with p-value 0.0029.

Conclusions: Among patients with OSA, despite the increase in BMI, both the CPAP and OA therapy suggest improvement in patient's health, but due to preference for AO, this appeared

more efficiency and effectiveness. It is recommended further studies to evaluate these results with the OA used.

POSTER #017

Knowledge and Concern About OSA in Adherent and Non-Adherent OSA Patients

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Introduction: Sleep-disordered breathing is associated with significant morbidity and mortality. A major problem with those who are diagnosed and begin treatment is a low rate of adherence to treatment. One approach to increasing adherence to treatment has been to educate patients about obstructive sleep apnea, its causes, treatments and consequences if not treated. The aim of this research was to survey patients who had been given an oral appliance for obstructive sleep apnea for their perceived level of knowledge of, and concern about OSA.

Methods: The Ohio State University Institutional Review Board approved this study. All patients who had received an oral appliance between October 2008 and March 2015 in one university associated private practice were contacted by phone and asked to respond to a series of questions regarding their appliance.

Results: Of the 242 eligible patients, 80 responded to the phone call invitation. Fifty-eight reported that they were adherent with their oral appliance therapy and 22 reported that they were

no longer using an oral appliance. The mean age, and initial BMI were 58.1 years, BMI 30, and 59.3 years and BMI 28.7 for the adherent and non-adherent groups respectively. Females were 36% in the adherent group and 45% in the non-adherent group. In the non-adherent group, 12 of the 22 reported that they were currently using CPAP. The mean knowledge on a scale of 0 (No knowledge) to 10 (Knowledgeable) was 7.7 in the adherent group and 8.1 in the non-adherent group. The mean concern on a scale of 0 (Unconcerned) to 10 (Concerned) about the consequences of untreated sleep apnea, was 8.4 for the adherent group and 7.1 for the non-adherent group. Within the 22 patients who were no longer wearing their oral appliances, 12 were using CPAP and 10 were not using any treatment. The scores for the CPAP and No-treatment patients were 8.1 and 8.3 for knowledge and 8.0 and 5.5 for concern, respectively. The two groups were similar in age and BMI. There was no large difference in their professed knowledge about OSA, but there was a larger difference in their reported concern about the consequences of untreated OSA. This disparity in concern about the consequences of untreated OSA was even greater when patients who were not treating their obstructive sleep apnea were compared with those who were undertaking some treatment. This could be a reason why the non-adherent group did not continue treatment, or it could be a justification for why they were non-adherent.

Conclusions: It does appear that one factor that could lead to increased adherence to oral appliance therapy for sleep apnea is patient education focused on the consequences of untreated OSA.

AADSM News and Updates

Reported by Leila Chahine, DMD; Don Farquhar, DDS; James Hogg, DDS; Sheri Katz, DDS; Katherine Phillips, DDS; Kevin Postol, DDS; Thomas Schell, DDS; Rose Sheats, DMD; AADSM Staff

AADSM 25TH ANNIVERSARY MEETING JUNE 9–11, 2016

Selected Summary Notes

The AADSM annual meeting is an opportunity for members to obtain continuing education experience in a wide variety of topics. The following selected summaries are intended to provide a “taste” of the meeting offerings.

Educational Courses:

Introduction to Dental Sleep Medicine

Obstructive Sleep Apnea: Pathophysiology, Diagnosis and Co-Morbidities

Don Farquhar, DDS

Pathophysiology of obstructive sleep apnea was presented including classification of abnormal sleep, airway anatomy and physiology. The signs and symptoms of OSA were reviewed, with an emphasis on recognition of these in the dental practice. Cardiovascular, cognitive and hormonal co-morbidities and epidemiology were discussed. Polysomnography, home sleep testing, diagnosis and treatment options for OSA were reviewed.

Oral Appliance History, Types and Mechanism of Action

Katherine Phillips, DDS

This lecture reviewed the basic of oral appliances in order to allow the practitioner to feel more comfortable selecting an appropriate appliance for their patient. Topics reviewed included the history of oral appliances, Medicare’s coverage of oral appliances, the importance of adherence to therapy and how appliance selection may impact this, the recently developed Definition of an Oral Appliance, and the pros and cons of the various appliance styles that are currently on the market. Specific patient situations were discussed in order for the practitioner to understand how thoroughly each patient must be evaluated in order to select an appliance that addresses their dental needs, while taking into consideration relevant medical history.

The New Patient: Examination, Determination of Candidacy, Impressions and Bite Registrations

Kevin Postol, DDS

Risk factors and signs of OSA were reviewed. Discussed how to determine which patients are good candidates for an oral appliance and what are the indications and contraindications of using an oral appliance. Then reviewed the new patient exam process and the treatment sequence including taking

various different impressions and bite relationships and how to develop a relationship with your local physician through proper communication process

After Delivery: Titration, Follow-Up and Sequellae

Jim Hogg, DDS

The purpose of this introductory to DSM course was to enable the participant to work within the 2015 AAASM/AADSM Guidelines to properly manage their patients over a approximate 3 month period to manage their Sleep Disordered Breathing. After the clinician is confident that the subjective and objective (HST) goals have been reached that their patient would be sent back for a follow up OATS and then followed up on a 6 month and then yearly basis.

The course participants were introduced to possible complications of OAT therapy such as TMD pain and bite changes. they also were introduced to the various calibration techniques that could be utilized in their offices to access when to send their patient back to the sleep physician for objective testing of the MAD efficacy.

Educational Courses:

Advanced Dental Sleep Medicine

Cognitive-Behavioral Therapy—Treatment for Insomnia

Anne Bartolucci, PhD

Dr. Bartolucci described various forms of CBT, and how specifically it can be useful in the large population who suffering from Insomnia. She discussed the various presentations of insomnia and approaches to management. She gave thoughtful instruction of both new and classic approaches toward the treatment of insomnia. She helped to debunk some myths and old ideas that impede a better understanding and treatment of this important condition. Her talk was full of practical advice with many practical clinical pointers for dental sleep medicine providers.

Beyond the AHI-Outcomes that Matter to Patients—Quality of Life in Clinical Practice

Leslie Dort, DDS

Dr. Dort discussed quality of life statistics, questionnaires and their usefulness across the broad range of circumstances that affect providers, patients and even 3rd party payers in field of sleep apnea. She familiarized the audience with these measures for better understanding of their clinical and practical importance. This presentation helped to clarify a practical understanding of what we do and why we do it—effectively raising the bar for a broader perspective on outcomes of therapy.

Mean Disease Alleviation

Marc Braem, DDS

Dr. Braem described the differences in expectation and results as it applies among various populations in the treatment of OSA—caregivers, population at large, patients, government and 3rd party payers. He described how adherence may affect the measure of success working in combination with treatment effectiveness. This very important topic validates the use of OAT vs CPAP. Dr. Braem also discussed combinations of additional helpful therapies such as sleep position training (SPT) and surgery as means of achieving additional alleviation of disease. These concepts help to reinforce the use and reliability of these therapies in a broader population of potential successes.

Otolaryngology Advances in the Treatment of OSA

Ryan Soose, MD

Dr Soose discussed the challenges and new perspectives on surgical correction of crowded upper airways. He presented the latest ideas and techniques in both diagnosis and treatment of the surgical candidate. He provided both broad and specific suggestions for individualistic approaches toward surgical correction of this disease as opposed to the traditional ‘cookie cutter’ approach that has been applied over the last 35 years. The latest topics in this field included the use of drug induced sleep endoscopy (DISE), which provides a very useful approach to help individualize surgical technique, hypoglossal nerve stimulation, transpalatal advancement and expansion sphincter pharyngoplasty (ESP) which is a surgical technique based on phenotyping the patient as to their muscular and skeletal anatomy. Initial studies are showing an improvement over UPPP surgery.

General Sessions

Insights into the Pathogenesis and Management of OSA Utilizing Upper Airway Imaging

KEYNOTE SPEAKER: **Richard Schwab, MD**

Dr. Schwab elaborated on upper airway imaging studies demonstrating that the increased volume of upper airway soft tissue structures is an important risk factor for sleep apnea.

His take home messages included:

- The combination of increased upper airway soft tissue structures and reduced craniofacial skeleton increases OSA risk
- Tongue fat may explain the relationship between obesity and sleep apnea
- The metabolic activity of the tongue is reduced in apneics
- Upper airway anatomy in adolescents is more similar to young children than adults “ therefore the initial therapy for adolescents with OSA would be adenotonsilectomy.
- His findings show that “weight loss decreases tongue fat and fat pad size,” and
- CPAP increases the upper airway primarily in the lateral dimension by decreasing the lateral walls

- Examining the centroids of the soft palate and tongue will help to understand the mechanism of action of oral appliances
- We need to better understand the changes in upper airway anatomy that occur with upper airway surgery including hypoglossal nerve stimulation

A Look Back at 25 Years of Dental Sleep Medicine

Robert Rogers, DMD

Rob Rogers, while having assumed every imaginable role for the AADSM in the past, was an invited lecturer and gave us a fabulous and important recount of the development of dental sleep medicine. He reminded us of the pioneers in the field, namely Peter George, Charlie Samelson, Rosaline Cartwright, Alan Lowe, Wolfgang Schmidt-Nowara, and Tom Meade as our early researchers. Rob Rogers, Mary Beth Rogers, Michael Alvarez, Arthur Strauss, and Alan Lowe began the AADSM’s predecessor as a study club. He reviewed the difficult, but successful path taken from having no research, no available training for dentists and skeptical medical colleagues, to the achievement of research worldwide, developing clinical protocol, the development educational programs, and the professional acceptance by medical colleagues.

Measuring Quality in the Treatment of OSA/Oral Appliances

Timothy Morgenthaler, MD

Dr. Morgenthaler asked the audience “Do you think you do a good job and how do you prove it?” The fact that dental care expenditures are declining will increasingly lead to an intensifying of competition and demands of legislation and patients to provide quality care. The Dental Quality Alliance report published by the ADA in 2012 raised the issue of quality care.

Quality care is safe, effective, patient-centered, timely, efficient and equitable. Challenges for quality measurement in dentistry include limited evidence-based guidelines—although dental sleep medicine is a leader in this area. There is limited knowledge of outcomes, limited diagnostic data collection to establish oral health benchmarks, limited information systems and limited information to claims data.

Measuring quality in healthcare involves structures, leadership, policies and governance. There will need to be some agreement upon processes of care and outcomes. He gave an example of how to measure quality using a continuous process of design, measure, analyze, improve, control and back to design.

Titration: Where to Start?

Ghizlane, Aarab, DDS, PhD

Dr. Aarab began with the premise that the efficacy of OAT is based on retention and adjustability of the appliance. With over 100 appliances that have FDA acceptance, including monoblocs and adjustable appliances, there are challenges to determining the optimal treatment position. Single night reporting presents challenges such as severity of OSA, nasal congestions, alcohol and medication that present night to night variability regarding resolution of AHI.

Titration can start at 50% to strike a balance between side effects and efficacy. Side-effects tend to be more frequent

with increased advancement. Dental changes are progressive in nature and the influence of design is not yet clear although increased vertical opening seems to have an adverse effect on outcome.

Recent studies suggest that contrary to popular thinking those with supine and REM dependent OSA are poor responders to OAT. Technologies using at home, over night remote titration will help to determine effective target titration. Phenotyping and pathogenesis of OSA are complex and require multiple approaches to result in the most effective outcomes over a diverse patient population.

Telemedicine

Steve Van Hout

Telemedicine is a rapidly growing modality to improve access to care for patients at a lower cost that can potentially improve patient outcomes. Telemedicine involves communication between the provider and patient either electronically via email, smartphones and other telecommunications technology, rather than in person. Providers can provide advice remotely and monitor their patients remotely as well, allowing for evaluation of adherence to treatment advice and medication use. There is a role for both the sleep physician and dentist in providing care to sleep patients via telemedicine. The AASM produced a position paper in 2015 specifically addressing this. Use of these technologies can improve communication with sleep physicians, allow dentists to screen and refer patients more easily and conduct thorough follow up with sleep patients utilizing oral appliance therapy.

Complementary and Alternative Therapies for Insomnia Disorder

Jennifer Martin, PhD

Dr. Martin discussed the issue that the public pays large amounts for products to help with insomnia that have no evidence and are not regulated. Not only are many alternative therapies for insomnia unregulated many herbal/natural products have safety concerns.

There are potential risks with Jamaican dogwood, kava kava, tryptophan and alcohol as treatments for insomnia. It is not known whether marijuana is better or safer than hypnotics. There is some evidence regarding the effectiveness of Tai chi, yoga and acupuncture.

Particularly positive results have been found using yoga for insomnia with post-menopausal women. Yoga has been found to help with insomnia more than omega 3's and a program of passive stretching. One of the limitations of yoga for insomnia is that it takes 12–16 weeks of yoga to produce a noticeable difference. Some studies show acupuncture in ear helps more than other areas. Difficult to evaluate acupuncture as the literature is too variable. Tai chi may be superior to some control interventions but not to CBT-I.

Midface Hypoplasia and Pediatric OSA: Causes, Correlations, and Orthodontic Interventions

Soleil Roberts, DMD, MSD

A brief overview of pediatric sleep disordered breathing was presented to summarize its pathophysiology, diagnosis, clinical

features, and consequences. Clinical presentation of pediatric obstructive sleep apnea was classified into three types with a description of each. Type I = Adenoid Facies, Type II = Pickwickian phenotype, and Type III = Syndromic/Craniofacial.

Maxillary hypoplasia was described in all three planes of space: transverse, vertical, and anteroposterior. With the aid of clinical photographs and lateral cephalograms, specific findings were demonstrated in hard and soft tissues.

Normal growth and development of the craniofacial complex was described from birth to young adulthood. Etiologic factors that impede normal maxillary growth were discussed.

Several treatment options to manage pediatric sleep disordered breathing were presented with particular emphasis on orthodontic interceptive treatment to include rapid palatal expansion and maxillary protraction. Maxillary protraction included both non-surgical (facemask) and surgical (distraction osteogenesis).

Early collaboration among dental professionals, physicians, and other health care providers was encouraged to identify children at risk for OSA, to intervene in a timely manner, and to monitor the impact of treatment on maxillary growth and development.

Phenotyping and Oral Appliances: Towards Individualized Strategies to Optimize Treatment Success According to Underlying Mechanisms

Danny Eckert, PhD

Dr. Eckert described 4 key pathophysiological traits that contribute to the development of OSA: impaired anatomy, ineffective upper airway muscles during sleep, low arousal threshold and ventilator control instability (high loop gain).

Each of these traits can be a therapeutic target. Anatomical problems are present in 70% of those with OSA and can be addressed through CPAP, OAT, genioglossus muscle stimulation and surgery. Weight loss and positional therapy may also be helpful. Medications, such as ones that increase cholinergic effects may be helpful for ineffective airway muscle activity. Sedative medications may be developed to help with a low arousal threshold and control of loop gain may be possible through management of oxygen and carbon dioxide levels.

Dr. Eckert described the use of ultrasound tool to help determine muscle characteristics. Simplified phenotyping tools need to be developed to provide individualized treatment plans. Most treatment plans will likely involve more than one treatment for maximum effectiveness. A single intervention may treat 25% of patients and two will treat 50% of patients successfully.

Modified Oral Appliance and Combination Therapy

James Hogg, DDS and Katherine Phillips, DDS

Many patients are incompletely treated using a mandibular advancement device as the sole form of therapy. Options are needed to augment efficacy. Some of these options include utilizing the CPAP in conjunction with the oral appliance, modifying the oral appliance to become the interface for the CPAP, surgical treatment combined with the MAD, positional therapy combined with the MAD, weight loss combined with the MAD and potentially medicaments used in conjunction

with the MAD. All of these options have their pros and cons, and thorough patient evaluation is required to determine which adjunctive therapy would be most appropriate for your patient, and your clinical skill level. Modifying the oral appliance requires knowledge of modification techniques, as well as knowledge of CPAP therapy. It is important to maintain close communication with the treating physician, and understand that the factors that influence your patients' compliance with their therapy, combination or not, is the subjective improvement they feel while utilizing therapy.

Sleep Deprivation

David Dinges, PhD

Sleep debt is the cumulative hours of sleep loss with respect to a subject-specific daily need for sleep. Difficulties in determining the appropriate amount needed for adults was improved by an evidence-based Consensus Statement produced by the AASM and Sleep Research Society. Chronic sleep restriction can have significant health risks. Sleep deprivation can cause cognitive impairments, sustained attention problems, drowsy driving, cardiovascular and weight management issues. Appropriate sleep time should be incorporated into an individual's healthy lifestyle in order to reduce adverse health effects.

Is Insomnia History? The Modernization of Sleep

Roger Ekirch, PhD

Dr. Ekirch is an historian who has researched the history of sleep. He theorizes that middle of the night insomnia may, for many, be the emergence of the person's circadian rhythm ("an older, more normal pattern"). He gives many examples of evidence that people, in the absence of artificial light and the constructs of modern society, sleep by intervals. The causes of sleep consolidation are:

- Later Bedtimes
- Shifting Popular Attitudes
- Artificial Lighting
- The New Normalcy

He cites many references to "first" and/or "second sleep":

"Even at night after their first sleep, they get up to eat and then they return to sleep."

—André Thevet, *The Peculiarities of French Antarctica...*
(Paris, 1878)

"If no disease or accident intervene, they [children] will need no further repose than that obtained in their first sleep, which custom will have caused to terminate of itself, just at the usual hour. And then, if they turn upon the other ear to take a second nap, they will be taught to look upon it as an intemperance, not at all redounding to their credit."

—"Time for Sleep," *Journal of Health*, I, no. 5 (Nov. 11, 1829), 75

AADSM 2016 EDUCATIONAL CALENDAR OF EVENTS

August 9–November 1

Fall Study Club Program
live, web-based seminars

September 17–18

Essentials of Dental Sleep Medicine Course
San Antonio, TX

October 22

Practical Demonstration Course
Darien, IL – AADSM National Office

Dental Sleep Medicine Staff Course
Lombard, IL

November 5–6

Advances in Dental Sleep Medicine Course
Nashville, TN

Essentials of Dental Sleep Medicine Course
Nashville, TN

December 3

Practical Demonstration Course
Darien, IL – AADSM National Office