A more effective Bite Registration technique for Dental Sleep Appliances; the inclusion of increased vertical dimension (3D) over the traditional 2D techniques

Author Information

Dr. David E. Rawson, DDS

Dr. David E. Rawson is a 1974 graduate of Dentistry from The University of Western Ontario in London, Ontario. He spent his first five years as a Dental Officer in the Canadian Armed Forces.

After his military career, he opened a General Family Practice in London, ON in 1979 and has maintained a keen interest in the dynamics of the face and dentition.

Since 1998, Dr. Rawson has traveled extensively throughout North America studying with leaders in chronic head and neck pain, Temporomandibular Joint Dysfunction (TMD), Orthodontics and Sleep Disordered Breathing, including snoring and sleep apnea.

In 2003, Dr. Rawson limited his practice to the diagnosis and treatment of these conditions, incorporating a holistic approach to patient needs using a multi-disciplinary team approach to enhance treatments. These therapies include osteopathy, craniosacral therapy, massage therapy, nutritional and lifestyle counselling, and referral to the appropriate allied healthcare practitioners for maximum benefit to the patient. Effectively using modern technology and new treatment concepts, treatments avoid needles, surgery and drugs.

He is a past Instructor at his alma mater Dental School and has lectured to medical and dental audiences across Canada and the United States.

He has given much of his time to leadership in his profession having served as Co-Founder and President of the Canadian Academy of Craniofacial Pain, Founder and existing President of The Canadian Academy of Clinical Sleep Disorders Disciplines (CACSDD), Board Member of the AACP and The International Association for Orthodontics (IAO).

Dr. Rawson enjoys teaching his colleagues the newer concepts in TMJ and Sleep Apnea and regularly hosts them in his office in the treatment of his many patients.

Dr. David E. Rawson, DDS

Diplomate, American Board of Craniofacial Pain (ABCP).

Diplomate, Academy of Clinical Sleep Disorders Disciplines (ACSDD).

Fellow, American Academy of Craniofacial Pain, (AACP)

Fellow, International College of Dentists (ICD).

Founder and President of Canadian Academy of Clinical Sleep Disciplines, Disorders (CACSDD).

Co-Founder and Past President, Canadian Chapter, (ACPP).

Correspondence:
derawson@cacsdd.org

Cell: 519-630-1832

Abstract

Aim: Evaluate the effect on Apnea Hypopnea Index (AHI) by adding vertical opening of Mandibular Advancement Devices (MAD). A technique for establishing the proper amount of vertical opening is also discussed.

Materials and methods: Traditional MADs bite registrations were modified to increase vertical opening. Pre-and-post Polysomnogram (PSG) and Home Sleep Studies (HST) studies to compare any potential improvement. 34 patients were included. Criteria for the study was any Obstructive Sleep Apnea (OSA) diagnosed patient presenting as failed or refused CPAP, or who specifically requested Oral Appliance Therapy (OAT) for treating their condition. Age range was from 21 to 66 years of age and no selection for sex was used. Exclusion criteria included the usual concerns for inadequate dentition (too few teeth) or periodontal conditions which might negatively affect their long term dental prognosis. All categories of AHI scores were accepted. However 26 of the 34 subjects (76.5%) had a pre-treatment AHI score in the Severe category (AHI >30) with a range from 33.2 to 113.1.

The Phonetic Bite (PB) Technique was used to obtain all bite registrations for this study and the materials used are commonly found in all dental offices. No special tools or instruments were needed.

Results: Statistically significant improvement was reported for all patients in the study (mild, moderate and severe OSA).

Conclusion: This study reveals a reduction in AHI of ~ 75%

Introduction

The effectiveness of Oral Appliance Therapy for treating sleep apnea is well supported in the literature. This 3D technique increases the efficacy of OAT and now demonstrates that it can be safely used for all categories of diagnosed cases of OSA, not just Mild (AHI = 5-15) and Moderate (AHI = 15-30) as is the commonly held belief.

This approach focuses on a 3D bite registration (the Phonetic Bite Technique[1]) which includes more Vertical opening and less Advancement as typically implemented in the traditional (2D) Anterior-Posterior measurement techniques. The 2D technique is solely based on forward jaw movement with a predetermined vertical opening, usually 2 - 4 mm in thickness and measured with a George Gage (Great Lakes Orthodontics, www.greatlakesortho.com).

This report demonstrates a significant reduction of AHI scores (~75%) in ALL categories of OSA over the traditional 2D techniques while minimizing any Temporomandibular Joint (TMJ) issues.

By incorporating increased vertical, the Condyle is kept inside the Glenoid Fossa (Figure 3) thereby reducing the potential for TMJ strain, morning stiffness and patient discomfort leading to an increased risk of lack of compliance of the OAT. AHI scores are reduced on average ~ 75% with minimal TMJ issues and\or significant bite changes.

Authors dental practice is focused on TMJ Disorders and Sleep Disorders. We treat patients daily with limited opening, joint clicking, jaw dislocations and all the associated chronic head and neck pains due to improper and timely diagnosis and treatment of their jaw joints

This paper describes the protocol for establishing a PB and the results of the post treatment sleep studies.

Materials and methods

26 patients were selected who met the inclusion requirements (Table 2):

- Clinical diagnosis of Sleep Apnea
- Untreated severe AHI =30+

6 patients were selected who met the inclusion requirements (Table 1):

- Clinical diagnosis of Sleep Apnea
- Untreated Moderate AHI =15-30

Critical Elements for design of an effective Oral Appliances

- Minimum bulk: Patient comfort and compliance is improved when the Oral Appliance is as small as possible and provides maximum tongue space.
- Strong: The device must be durable and resist breaking or fracturing
- Support for bruxers: Device needs to be able to withstand bruxing without damage
- Lateral movement: To minimize undesired stresses on the TMJ the MAD must allow some lateral movement

The Temporomandibular Joint (TMJ)

A detailed discussion of the TMJ and its relationship to designing the ideal Oral Appliance for OSA is beyond the scope of this paper. However, it is critical to have a working knowledge of a healthy jaw joint in order to minimize any joint or bite issues as a result of fitting an Oral Appliance.

Patients should be able to demonstrate a Vertical Range of Motion (ROM) of at least 40 mm with ease and no deviation or deflection from the vertical plane down the middle of the face. The patient should also be able to move the mandible to the right and left side and protrude in the 8-10 mm range, also with no obvious pain or clicking. If any of these conditions exist, with or without a history of chronic pain in the jaw joint, face or head, this should be a caution to the clinician considering an Oral Appliance for OSA. It is recommended that these patients first be screened and appropriately treated as required by a competent TMJ clinician prior to the fabrication of OAT to minimize any TMJ issues following the provision of OAT.

Establishing and recording the Phonetic Bite

Figure 1 is a tomogram of a normal, healthy TMJ with the ideal condylar position while the patient is in full occlusion[2]. The centre of the condyle is centered in the Glenoid Fossa, anterior to the auditory meatus (ear canal, red arrow) by 4-5 mm and displays sufficient room (2-3mm) for the Articular Disk (yellow arrows).

Compare this to another patient (Figure 2), also showing the condylar position in full occlusion. Notice the narrowing of the area for the articular disk (yellow arrows) and the proximity of the condyle to the auditory meatus (red arrow). Typically, this could indicate the presence of TMJ signs and symptoms as described above. However, the patient in Figure 2 presented with no TMJ discomfort upon full opening,

no clicking or popping and is typical of older patients whose disc may have worn thinner over time allowing the condyle to seat more fully in the Fossa.

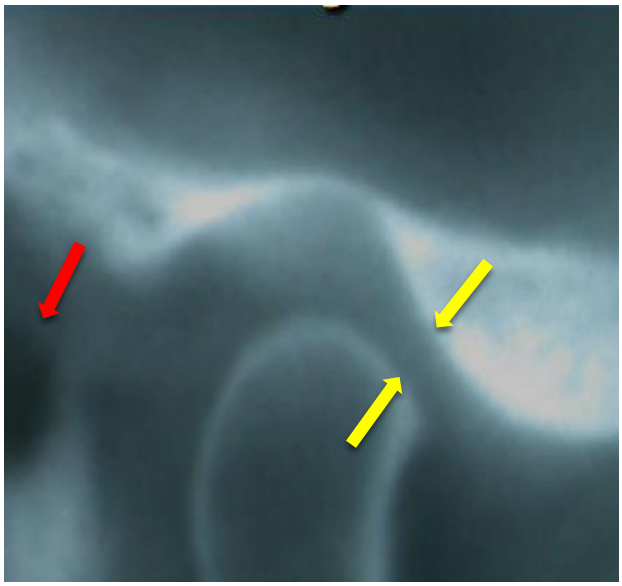

Figure 1 - Ideal condylar position in full occlusion. Red arrow = auditory meatus, yellow arrows = articular disk space.

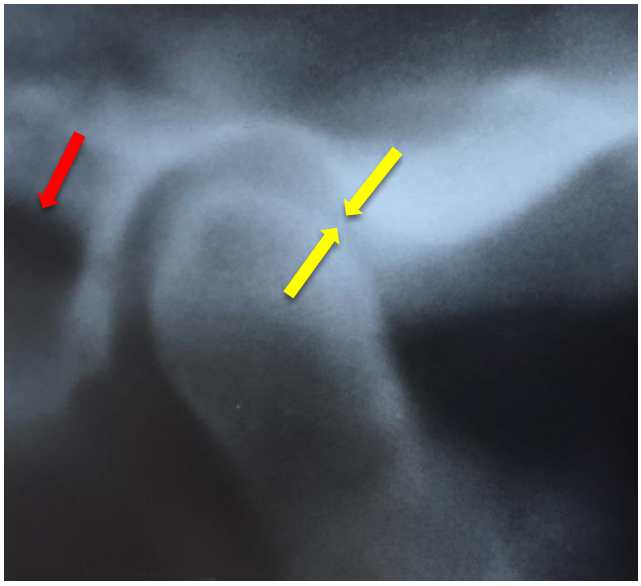

Figure 2 - Maximum Occlusion. Notice decreased articular disc area (yellow arrows). Red arrow = auditory meatus.

In a healthy TMJ, with a normal ROM of 50 mm, the first 25 mm of opening is “rotation” within the fossa where no apparent change in the position could be shown radiographically. The second half of the normal opening (25 -50 mm) produces a “translation” of the condyle (i.e. actual movement in downward and forward direction). Upon widest opening (35+mm) the joint complex (Condyle AND Articular Disc) actually “dislocates” out of the socket and returns back into the socket upon normal closing.

A healthy TMJ complex “brings the disc along with it” thereby providing the lubrication and painless ease of motion. This is unique to the human body and is it also important to remember that BOTH left and right joints need to travel in the same direction with ease and no deflection or disc slipping off the joint.

The goal of the PB Technique is to understand and respect the normal function of the bilateral

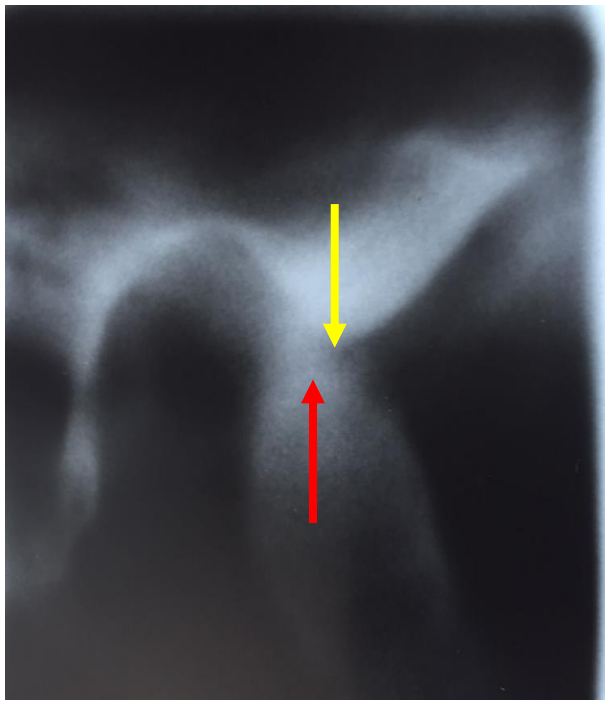

Figure 3 - Phonetic Bite. Yellow arrow indicates the ‘peak’ of the Articular Eminence, and the red arrow indicates the position of the condyle in the PB Technique.

TMJs and design an appliance which “houses” the condyle inside the fossa rather than stretching it past a healthy range and holding it semi rigidly for a full night of sleep.

Establishing the Phonetic Bite

The Goal of the PB Technique is to allow the patient’s own neurology to guide us to a three dimensionally (3D) balanced mandibular position as it relates to the maxilla while repeating a series of “S” sounds by counting from “66” to “75”. This technique brings the upper and lower incisal edges into a vertical plane (edge to edge) to create the whistle aspect of the “S” sound.

STEP 1

Begin by seating the patient upright in the dental chair and observe their Overbite (OJ) and Overjet (OB) in maximum occlusion. Since most patients present with a Class I Occlusion, there should be an OJ of 3+ mm and OB of 2-3mm. Class II occlusions and those with deeper bites will of course have increased measurements for both OJ and OB. These increased OJs and OBs are significant in determining the ideal mandibular position for an OAT.

To begin the PB technique, have the patient **recite with you**, in a normal relaxed cadence, the numbers upwards starting at “66”. If there are no TMJ issues, and the patient has a normal OJ and OB, you will note that in creating the “S “sound the patient actually brings their upper and lower incisal edges into close approximation. Also note that the maxillary and mandibular dental midlines generally line up. This contrasts the midlines in full occlusion if there is a malocclusion or crossbite. In this case, the mandible has to settle into whatever position gives the maximum tooth intercuspation[3].

In the case of normal OJs and OBs there should be an interincisal gap of 3 -5 mm with incisal edges lined up in a straight vertical plane. If the patient has a malocclusion or crossbite, their full occlusion bite may present with non-coincident dental midlines.

If the patient has an OJ and\or OB greater that 5 mm the incisal edges may not line up in the vertical plane but all other findings described for “normal” occlusions should be present.

STEP 2

Once you have determined the edge to edge position of the mandible and the interincisal gap in mm, have the patient repeat “75” while “holding the Five” note for 2-3 seconds (Figure 4). You will notice an increased interincisal gap which often adds 3-5 mm to the first distance. This is the position of the mandible that you need to record as your “target starting” position for the OA

STEP 3

Select a **round** “bite stick” whose diameter closely matches the “75” interincisal measurement. A round object allows the patient to “sit” lightly on a 2 point contact on the upper and lower incisors. Round suction tubes are very easy to use. Do not use a flat bite stick such as a tongue depressor other hard flat objects.

While the Dental Assistant gently holds the end of the suction tube (Figure 5) sticking out of the patient's mouth, the dentist quickly injects a fast setting bite registration of choice (Figure 6). The author uses a Polyvinyl Silicone (PVS) with a setting time of 30 -45 seconds.

It is vitally important for the Assistant to observe the patient's mandible during the injection of the PVS bite registration material to ensure it does not move. Movement can occur with a swallow or if the patient bites too hard on the plastic suction tube (if you use a collapsible "bite stick").

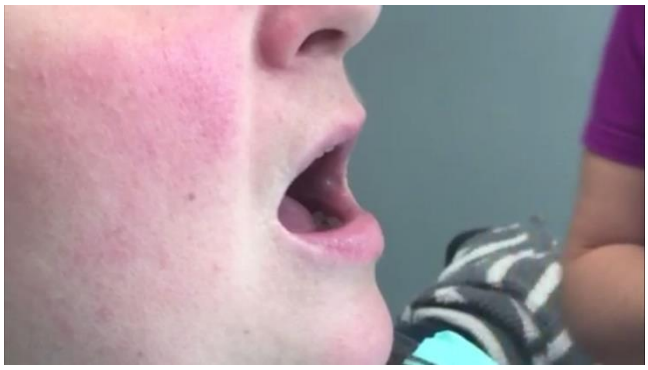

Figure 4 - Opening while saying the elongated "five"

Figure 5 - Patient bites on round tube to duplicate the opening

STEP 4

Once the PVS is fully set on both sides of the arch, gently slide the tube out and then guide the patient to wiggle the mandible around to loosen the full arch PVS and have them use their fingers and thumbs to unlock the seated Bite Registrations.

This is a good time to warn about missing teeth, severe undercuts of bridge & implants and malposed teeth. This may make the removal of the PVS somewhat challenging and alarming for the patient. Prudent dental examination to identify these potential areas of difficulty and minimal use of the PVS in problematic areas will make this process easier for patient and dental team alike.

Figure 6 – Use fast-setting silicone bite registration between upper and lower teeth to record the resulting space and capture the occlusal surfaces.

Figure 7 – Phonetic Bite registration

Case Presentation

ME, a 48 year old male presented for evaluation of possible OAT following an unsuccessful attempt at CPAP. TMJ evaluation was within normal limits and with a full complement of healthy teeth, it was determined that he was a suitable candidate for OAT. Figure 8 demonstrates condylar position in Maximum Occlusion, the PB technique joint position (Figure 10) and the condylar position upon delivery of the Panthera D-SAD 3D printed nylon Sleep Apnea Device (Figure 11). Figure 9 shows the actual vertical spacing of the mandible and maxilla mounted with PB technique.

In my office, the PB technique is just the “target starting” position for OAT. The dental models are mounted with the PB using the Acculiner Articulator[A] which incorporates the 3D dimensions of this technique. Once this is accomplished, I adjust for any inadvertent mandibular shifts (swallows etc. as described above) by correcting midline shifts etc.

The **essential component** of this technique that provides the significant reduction in AHI is the ADDED VERTICAL[3] in addition to that recorded using the PB technique described above. As a general rule, I increase the vertical dimension in the bicuspid region to 10 mm between arches. As a TMJ clinician I have learned to respect the adaptive capacity of the human body when you work within its physiological limits. Vertical positioning of the condyle heals TMJ disorders better than advancement. As it turns out, this added vertical component also opens the airway better that the 2D approach and also reduces sleep bruxism.

One of the issues with the new 3D printed nylon appliances such as the Panthera D-SAD, presented here, is that it is not possible to add vertical to the appliances in the clinic or lab such as we often do with the commonly used dental acrylic bases or other dental laboratory materials.

Occasionally a patient may be unable to tolerate the vertical incorporated with the PB technique either due to a small mouth, deep bite or borderline TMJ status. It is easy to reduce some of the vertical component on the Panthera D-SAD base.

[A] The Accu-Liner Articulator is no longer available, however a very similar device (The Aligner System) is available from www.thealigner.com.

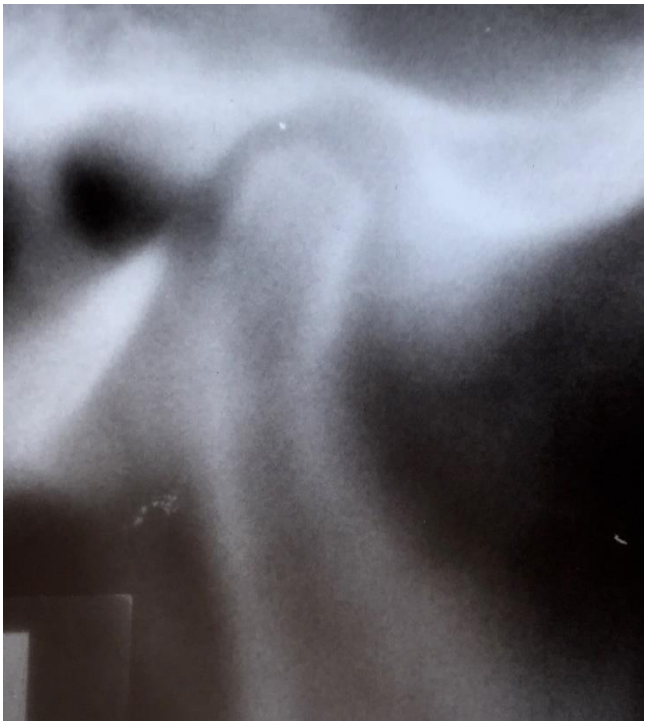

Figure 8 - Tomogram of maximum occlusion

Figure 9 - Phonetic Bite registration

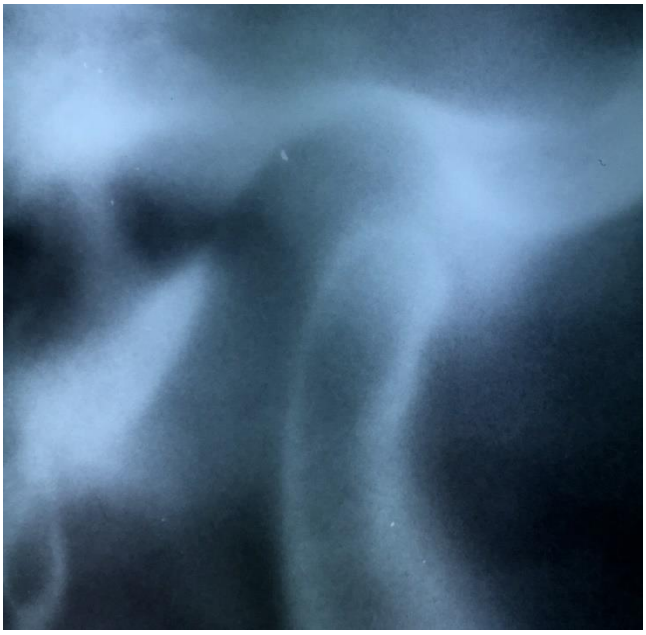

Figure 10 - Tomogram of Phonetic Bite

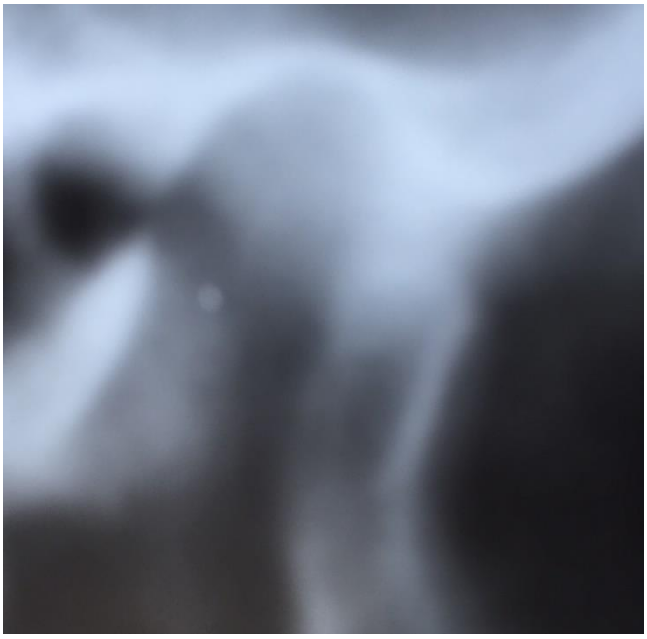

Figure 11 - Tomogram with Panthera Sleep Apnea Device

Panthera Digital Sleep Apnea Device (D-SAD)

The Panthera D-SAD Sleep Apnea Device (Panthera Dental, Quebec, Canada) was designed to duplicate the vertical opening (Figure 9) and reproduce the condylar position (Figure 11).

Figure 12

Figure 13

Figures 12 and 13 show the initial placement of the Panthera D-SAD. Note the 10 mm vertical component is divided approx. 30% on the maxillary member and 70% on the mandibular member. This intermaxillary space is actually very well tolerated by patient with OSA. In this case I adjusted the nylon pads on the distal aspect to create two flat platforms.

Results

This PB approach was followed for two groups of patients, moderate AHI (Table 1) and severe AHI (Table 2).

For the Moderate AHI Group (n=6, Table 1), there was an average improvement in AHI of 74.8%, ranging from a low of 63.3% to a high of 83.0%

NAME	Pre Tx AHI	Post Tx AHI	% Reduction
BH	27.9	6.3	77.4%
CJ	29.1	6.2	78.7%
DE	28.8	4.9	83.0%
EW	14.9	3.5	76.5%
MH	25.7	9.7	62.3%
RL	27.6	8.1	70.7%
Averages	25.7	6.5	74.8%

Table 1 – Preop AHI = Moderate

For the severe AHI group (n=26, Table 2) there was an average improvement in AHI of 76.9%, ranging from a low of 51.2% to a high of 96.5%.

NAME	Pre Tx AHI	Post Tx AHI	% Reduction
BB	33.2	5.9	82.2%
BH	52.9	10.6	80.0%
CB	53.9	9.8	81.8%
CS	73.1	3.9	94.7%
DB	61.1	7.2	88.2%
DS	88.3	34.2	61.3%
DT	82.6	24.3	70.6%
EM	45.3	22.1	51.2%
GY	71.2	19.7	72.3%
HB	47.5	8.2	82.7%
IH	58.6	12.7	78.3%
JV	33.3	17.7	46.8%
JW	32.2	5.6	82.6%
KR	67.6	7.7	88.6%
LF	80.0	9.5	88.1%
MB	48.2	14.1	70.7%
ME	37.2	9.1	75.5%
MP	59.9	2.1	96.5%
PC	64.0	15.2	76.3%
RB	30.3	5.5	81.8%
RB	50.7	13.4	73.6%
RB	28.3	4.4	84.5%
RH	113.1	13.1	88.4%
SG	39.8	12.8	67.8%
SM	64.7	28.5	56.0%
WC	37.4	7.6	79.7%
Averages	55.9	12.5	76.9%

Table 2 – Preop AHI = Severe

Discussion

Conventional wisdom and generally accepted guidelines have previously delegated Oral Appliances to treatment of OSA to only Mild and Moderate AHI categories or cases where the patient rejects CPAP[4]. This paper presents a paradigm shift in the ability of Oral appliances implementing this 3D approach to be considered a valid treatment for ALL categories of OSA. Our research demonstrated an overall average reduction in AHI of approx. 75% in 32 cases, of which 81.3 % were in the severe category with pre-treatment AHI scores ranging from 33.2 to 113.1.

Given the low compliance to CPAP therapy, OAT for OSA using the PB technique described in this article elevates Dental Sleep Appliances to a widely accepted and proven treatment choice for ALL cases of OSA.

Conclusions

Patient acceptance and compliance for this approach is high and patients reported positive feedback in terms of comfort, compliance and bed partner observations.

Devices like the Panthera D-SAD meet the demanding patient and clinical criteria and the CAD/CAM design and manufacture make it easy to accommodate the necessary vertical opening.

This study reveals an approximate AHI Reduction of ~ 75 % using this design. It is relevant to note that 82.4% of the cases were in the severe category!

I would propose that with the high level of compliance, comfort and positive results, this 3D approach for oral appliances should be considered as a treatment of choice for ALL categories of OSA.

Definitions

AHI	Apnea–Hypopnea Index
CAD/CAM	Computer-Aided Design/Computer-Aided Manufacture
D-SAD	Digital Sleep Apnea Device (Panthera Sleep, Quebec, Canada)
HST	Home Sleep Studies
MAD	Mandibular Advancement Device
OAT	Oral Appliance Therapy
OSA	Obstructive Sleep Apnea
PB	Phonetic Bite
PSG	Polysomnogram (Sleep Study)
ROM	Range of Movement
SAD	Sleep Apnea Device
TMD	Temporomandibular Disorder
TMJ	Temporomandibular Joint
3D technique	Adding vertical opening (Phonetic Bite)

Acknowledgements

The author would like to thank Richard A. Bonato, Ph.D. for his assistance in proofreading and editing this paper.

The author has no relevant financial or nonfinancial relationships to disclose.

References

1. Singh, Prof. G. Dave & Olmos, Steven. (2008). Use of a sibilant phoneme registration protocol to prevent upper airway collapse in patients with TMD. Sleep & Breathing. 11: 209-16.
2. This is referred to as the “Gelb 4\7” position named by Dr. Harold Gelb, New York, USA, a leader in TMJ Therapy. See www.abc4de.org/ABC4DE-020218-Lecture-Handout-airway_centric_journal.pdf
3. Abduo, Jaafar. (2012). Safety of increasing vertical dimension of occlusion: A systematic review. Quintessence International. 43: 369-80.
4. *Clinical Practice Guideline for the Treatment of Obstructive Sleep Apnea and Snoring with Oral Appliance Therapy: An Update for 2015 An American Academy of Sleep Medicine and American Academy of Dental Sleep Medicine Clinical Practice Guideline.* https://aasm.org/resources/clinicalguidelines/oral_appliance-osa.pdf

Additional Reading

Christiansen E L: The Temporomandibular Joint, Structure, Function and Dysfunction. *Foundation for Oral Rehabilitation,* www.for.org/en/learn/elibrary/temporomandibular-joint

Dellavia C, Musto P, Toma M, Guenza G, Rosati R. A Multidisciplinary Approach For Temporomandibular Disorders Management. . *Foundation for Oral Rehabilitation,* www.for.org/en/learn/elibrary/multidisciplinary-approach-temporo-mandibular-disorders-management