TECHNICAL CORNER: WHAT SLEEP TECHNOLOGISTS SHOULD KNOW ABOUT ORAL APPLIANCES

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Frequently, we encounter sleep technologists at meetings who will look at an oral appliance, point to it and ask, "Do those things really work?" The short answer is, "Yes, for most people - if they are made correctly." The long answer involves more details about what is new in oral appliances and how they work.

Sleep apnea is defined as a cessation of airflow during sleep for 10 seconds or longer with the most common subtype being obstructive sleep apnea (OSA). Continuous positive airway pressure (CPAP) is the treatment recommended by the American Academy of Sleep Medicine (AASM) for severe OSA, but their clinical practice parameters recognize that oral appliance therapy (OAT) may be used as a treatment of first choice for primary snoring, mild and moderate OSA.[1,2] Whereas CPAP acts as a pneumatic splint maintaining upper airway patency by blowing the tissue apart, OAT acts as a mechanical splint keeping the upper airway dilated by moving the mandible in a forward and open position, expanding the posterior airway and moving the tongue forward (see Figure 1).

Success has been observed in both obese and nonobese patients, and the increase in airway space when using OAT improves airflow, reduces snoring and shows overall improvement in sleep disordered breathing.[3,4,5,6] Oral appliance therapy has been shown to be effective when compared to either no treatment or placebo.[3,4] Our preferred term to describe OAT is oral airway dilation because it involves much more than simply mandibular advancement. To describe an oral appliance merely as a mandibular advancement device (MAD) ignores the necessary and important role of the tongue in creating a patent airway.

To understand OAT, one must understand the important role of the tongue. For its size, the tongue is the strongest muscle in the human body, capable of exerting 500 pounds of force against the teeth, almost 30 times the force exerted by orthodontics, and it occupies the most space in the airway. Indeed, the observation of scalloped lateral borders of the tongue during routine dental examination may be an indication of OSA. There are eight muscles in the human tongue: genioglossus, hyoglossus, styloglossus, palatoglossus - extrinsic muscles anchored to bone that change the position of the tongue; inferior longitudinal, superior longitudinal, transversis, and verticalis – intrinsic muscles not attached to bone that change the shape of the tongue. As we age there are changes in the strength of upper airway muscles that play a crucial role in sleep apnea. For example, genioglossus strength decreases with age, and research has found strengthening upper airway muscles significantly reduces OSA.[7,8] Likewise, modern oral appliance designs for the treatment of sleep apnea use tongue positioning techniques to optimize the airway.

Just as there are different CPAP interfaces with some patients preferring one type over another, there are many different oral appliance designs. There are approximately 90 appliances cleared by the FDA for treating snoring and OSA, but the vast majority of them are lacking in essential features such as titratibility and unobstructed anterior space permitting maximal lingual protrusion. Off-the-shelf thermoplastic (i.e., boil & bite) designs tend to be bulky and represent the bottom of the barrel in comfort, cost and effectiveness. In our opinion, they are generally not effective and may be largely responsible for the historical skepticism often associated with OAT within a sleep laboratory environment.

Traditionally, oral appliance designs were divided into tongue retaining devices (TRDs) and mandibular advancement devices (MADs), with the former advancing only the tongue and the latter advancing the mandible and the extrinsic muscles of the tongue. Other names have also been used to describe MADs, including mandibular advancement splints and mandibular repositioning appliances / devices. The problem with TRDs is that most people do not find them comfortable because the tongue is not normally advanced beyond the lips and held outside of the mouth overnight. The exception to this would be people with Down syndrome, who appear to tolerate TRDs better.

Older MAD designs were either one-piece or two-piece construction with adjustment mechanisms at the front of the mouth that actually prevented maximal tongue protrusion. It is illogical to advance the mandible yet at the same time limit forward tongue positioning needed for optimal airway expansion. More recent advances in OAT actually combine the benefits of TRDs and MADs and are considered oral airway dilators.[9] This is because the open anterior design permits the tongue to be forward and toward the roof of the mouth while at the same time placing the mandible in a protruded position during the night (see Figure 1).

The design of oral appliances, however, is but one key component in successful OAT. Another key element involves placing the maxillo-mandibular relationship into optimal positioning, which is often referred to as the bite registration. The appliance is, therefore, a customized medical device uniquely prepared for only this one individual in the entire world, unlike a CPAP mask that is mass produced in a factory. If the bite registration is properly achieved, the result is both comfortable and effective (see Figures 1, 2, & 3).

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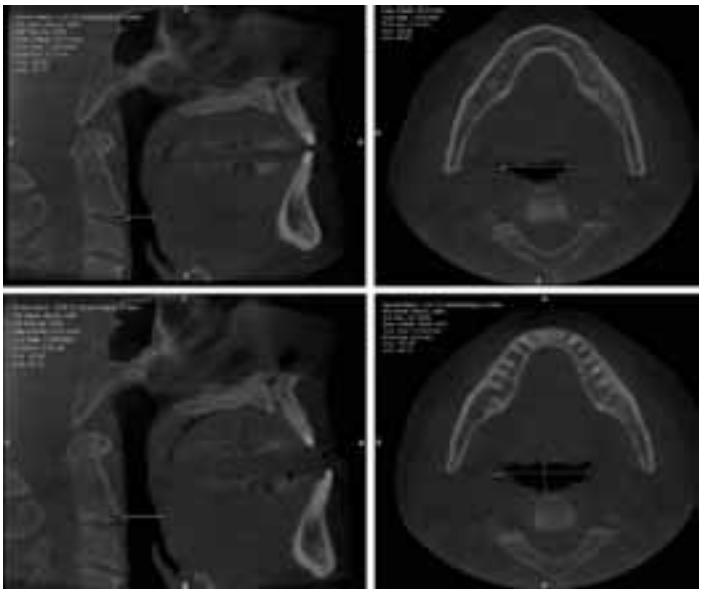

FIGURE 1. CONE BEAM TOMOGRAMS. TOP TWO IMAGES SHOW THE PATIENT AT REST POSITION, TONGUE IN ROOF OF MOUTH AND NO APPLIANCE. BOTTOM IMAGES ARE TAKEN WITH APPLIANCE IN PLACE, TONGUE IN ROOF OF MOUTH, LIPS SEALED. MARKED IMPROVEMENT IS DEMONSTRATED IN AIRWAY DIMENSIONS WITH APPLIANCE IN PLACE.

The proper position for registration of the bite is important for success of oral appliance therapy. The space between the upper and lower teeth should be at a vertical height such that the lips can comfortably stay closed to facilitate nose breathing. To achieve oral airway dilation, the axis of muscular support of the tongue is changed as well as the position of the hyoid bone relative to the skull. This does require some measure of skill and training. But sometimes OAT or CPAP therapy alone may not be enough, and in such cases combination therapy may produce success.

Patient compliance with CPAP therapy remains an important issue, and this is an area where OAT may be a valuable addition to the sleep laboratory armamentarium. The combination of CPAP and OAT may be beneficial for some patients, particularly those with high pressure. For example, we have observed success in high pressure CPAP patients with a pre-appliance baseline CPAP level of 16 cm H_2O, which dropped to 9 cm H_2O with the addition of OAT. This combination improved both patient comfort and compliance.

Regardless of OSA treatment modality, the additional combination of daily oropharyngeal exercises with either CPAP therapy or OAT should also improve patient outcomes. According to recent research, the use of upper airway exercises adopted from speech pathology successfully reduced the apnea/hypopnea index (AHI) by 40 percent when used alone in comparison to a control group.[8] Many dentists combine OAT with such exercises, and they also may be used effectively with traditional CPAP treatment.

Oral appliance therapy is not without possible side effects, but they can be minimized when a quality appliance is made by a properly educated dentist who continues to follow up and manage the patient. Frequent salivation is a relatively benign side effect that usually disappears within two weeks of OAT initiation. A more serious side effect involves temporomandibular joint (TMJ) discomfort, but this can be minimized with proper bite registration techniques and carefully titrating the appliance if necessary. When oral appliances for sleep apnea protrude the lower jaw and tongue, they also act as muscle deprogrammers. The forward treatment position on some patients is so physiologically comfortable that they choose to not bite on their back teeth. Subsequently, they sometimes perceive that a bite change has occurred. This may even happen with CPAP. All patients should be trained by their dentist to exercise back to their natural bite first thing in the morning to avoid permanent change.

In summary, a dentist educated in sleep medicine can play an important role in the treatment of your primary snorers, mild and moderate OSA patients, or CPAP intolerant patients. Practitioners of dental sleep medicine are experts in the upper airway and frequently use modern tools, such as 3-D cone beam tomogram and home sleep apnea recorders, to monitor the success of oral appliance therapy from baseline to follow-up to ensure successful long-term patient outcomes. The dentist can assist your sleep laboratory in a variety of patient cases and make a valuable contribution to the management of your patients.

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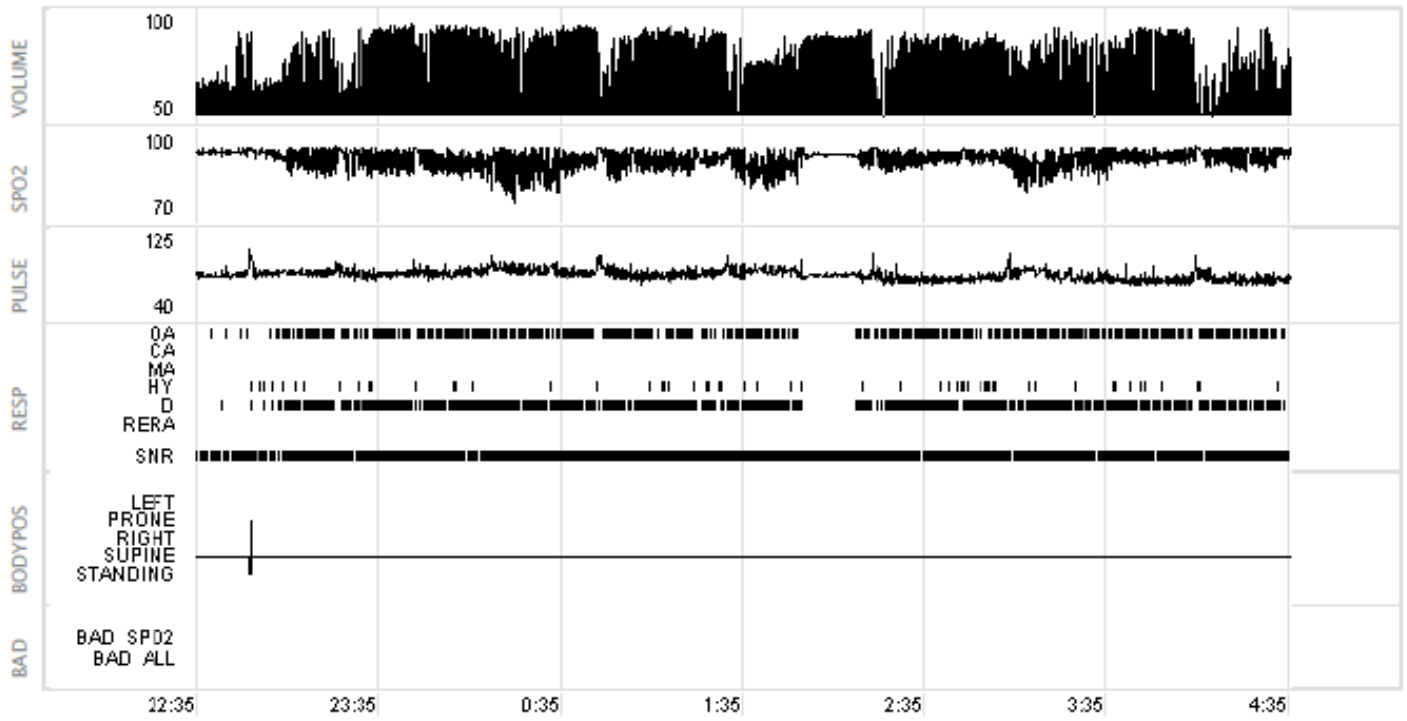


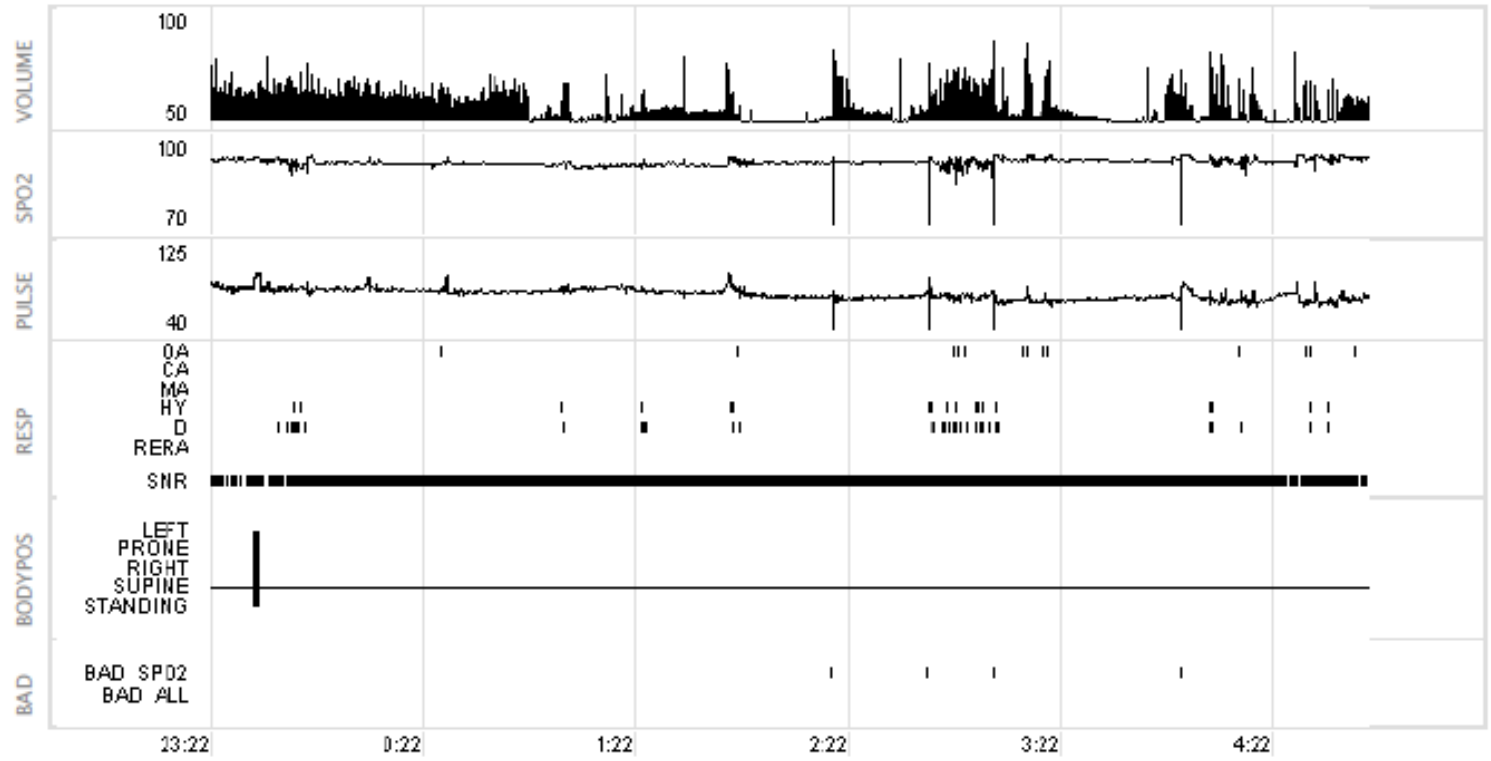
OXIMETRY

SpO_2 Range	%	Minutes
98–100 %	4.7%	16.9
96–98 %	18.0%	65.0
94–96%	25.0%	90.2
92–94 %	16.6%	60.0
90–92 %	12.6%	45.5
90–100 %	77.0%	277.6
80–89 %	21.8%	78.7
70–79 %	1.2%	4.2
60–69 %	0.0%	0.0
50–59 %	0.0%	0.0
< 50%	0.0%	0.0

	Total	Index
Desaturations ≥4%	496	82.6

	Mean	Min.	Max.
SpO_2(%)	92.3	71.0	99.0
Pulse (BPM)	80.5	65.0	116.0

FIGURE 2. A BASELINE HOME SLEEP APNEA TEST SHOWED SEVERE OSA WITH AN AHI OF 72. NOTE ALSO LOUD SNORING (DB) AND SPO2 DATA WITH 496 DESATURATIONS OF ≥4%.



OXIMETRY

SpO₂ Range	%	Minutes
98–100 %	1.8%	6.0
96–98 %	15.3%	50.0
94–96%	63.7%	207.3
92–94 %	17.2%	56.0
90–92 %	1.6%	5.1
90–100 %	99.6%	324.3
80–89 %	0.4%	1.2
70–79 %	0.0%	0.0
60–69 %	0.0%	0.0
50–59 %	0.0%	0.0
< 50%	0.0%	0.0

	Total	Index
Desaturations ≥4%	28	5.2

	Mean	Min.	Max.
SpO_2(%)	94.4	84.0	98.0
Pulse (BPM)	74.5	57.0	103.0

FIGURE 3. FOLLOW-UP HOME SLEEP APNEA TEST SHOWS SUCCESSFUL TREATMENT USING ORAL AIRWAY DILATOR (PATIENT WAS CPAP INTOLERANT). AHI WAS REDUCED TO 5.7 FROM THE BASELINE OF 72. NOTE ALSO SIGNIFICANT REDUCTION IN SNORING (DB) AND DRAMATIC IMPROVEMENT IN SPO2 DATA WITH 28 DESATURATIONS OF ≥4% FROM THE BASELINE OF 496. ❖