

Oral Appliance Design : More than just Plastic with Screws

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There are approximately 100 intraoral appliances that have FDA clearance for the treatment of obstructive sleep apnea and snoring in the US. Simply put, an intraoral appliance for the treatment of snoring and OSA is merely a piece of plastic with screws for adjustment. Clinical success is ultimately determined by the skill of the dentist, but there are at least six design principles to be considered when selecting the appropriate appliance:

1. The more space created for the tongue, the less likely it is to collapse on the airway during sleep. Therefore does the appliance create maximal volume for the tongue or is the tongue space full of acrylic and/or the adjustment mechanism?
2. Oral airway dilation is the primary goal. There is more to an oral appliance than just mandibular advancement. Can the tongue advance to the lips or is there anterior tongue restraint?¹
3. Stimulation of protrusive tongue reflexes is a desirable effect of an oral sleep appliance. There are four protrusive tongue reflexes- Jaw-Hypoglossal Reflex; Lingual-Hypoglossal Reflex; Glossopharyngeal- Hypoglossal Reflex; and Tongue-Tongue Reflex; plus one non-retrusive reflex- Masseter-Hypoglossal Reflex. Does the oral appliance facilitate stimulation of these reflexes?²
4. Facilitation of nasal breathing, with the lips together during sleep, is preferred to oral breathing with the mouth open. Does the oral appliance take up valuable space with acrylic in the roof of the mouth or is the palate uncovered and available for correct placement of the tongue?
5. Comfort of the appliance is really an important determiner of compliance. Can the patient comfortably close their lips with the appliance in place? Can the patient talk, or take a drink of water with the appliance in place? Does the appliance gag the patient?
6. Strength is also a desirable feature of the appliance. Breakage means the patient may have to be without the device while it is being repaired. The more vertical and the more protrusive the maxillmandibular position, the less the absolute biting power in maximal clench and bruxism; so clinical expertise, as well as design, play a role in reducing appliance breakage.

Enough cannot be said about the

importance of the maxillo-mandibular relationships in determining oral appliance efficacy. The appliance can facilitate airway maintenance once the correct position has been established. Deciding the maxillo-mandibular position for optimal airway stenting is a major clinical decision. The literature is sorely lacking in principles of scientific clinical guidance on this subject of MMR.

Common sense principles for registering the maxillo-mandibular relationship are-

1. The maximum vertical that still permits the lips to be comfortably closed during sleep, so the patient is nose breathing; and
2. The maximum comfortable protrusive position, presumably with the proper combination of vertical and protrusive to stent the airway open.

How to find that position: Manual Muscle Testing (MMT)

MMT is a system of functional neurological assessment that guides clinicians to therapeutic measurements that restore optimal neurological respiratory and postural functioning. MMT measures a muscle's isometric response to changing pressure over a three second period. MMT is conducted according to the American Medical Association standards of consistency, in muscle testing, as utilized in physical medicine for disability evaluation.

MMT is a "make or break" isometric test in which a patient actively holds a body part in a prescribed position in which the clinician attempts to "break" the press using muscle counterforce, exerted over a 3-second period.³

Based on the response to MMT, a muscle status is said to be inhibited or facilitated. Inhibited, or "weak" is the inability to resist pressure over the 3-second test period. Conditionally facilitated, or "strong" means the patient is able to maintain the test position against gradually increasing pressure over a three second period.

MMT is not a measure of strength. Inhibited ("weak") in one maxillo-mandibular position and facilitated ("strong") in another is not a measure of fatigue, dis-ease or pathology. Instead it is viewed as a functional neurologic change reflecting neuroplasticity elsewhere in the nervous system. MMT is a method of assessing changes in muscle function regulated in the Central Integrative State (CIS).

The regulation of muscle function is

basically accomplished at a subconscious level. Information provided within the muscle spindle cells and golgi tendons generate the signal output. Function and movement are generated by the premotor and motor cortex and sent into the reticular activating system, hypothalamus and limbic system. The CIS is defined as the summation of all excitatory and inhibitory inputs at a neuron. MMT is a measurement of the status of the Central Integrative System (CIS) both baseline and as an effect of the MMT or challenge. "Weak" Manual Muscle Test (MMT) is a result of an inhibitory CIS summation of the muscle's converging pathways associated with the alpha motoneuron pool. This inhibition cannot be associated with fatigue of the muscle. The pathways to the CIS are either ascending, segmental (somatic, visceral or chemo-receptor) or descending, suprasedgmental (conscious-cortical or reflexogenic- brain-stem cerebellum, postural). This increase in isometric strength with a functional realignment of the maxilla and mandible could have huge implications relative to total body health and muscle function.

Impact on neurological function may arise from-

- Biochemical status
 - Nutritional
 - Vitamins
 - Allergies
- Changes in neuronal membrane potential
- Altered neurotransmitter levels
- Hypothalamic monitoring of blood
- Neuronal activity of cortical origin
 - Cognitive
 - Emotional
 - Depressive

Four separate studies⁴⁻⁷ have validated that MMT provides objective neurophysiologic measurement of functional status. It has also been demonstrated that improved isometric muscle strength can be obtained in an altered maxillo-mandibular relationship by the Tufts/Mehta group, in six published research studies.⁸⁻¹³ In a "bite registration" with a vertical maxillo-mandibular position beyond freeway and a protrusive position beyond edge-to-edge at maximal isometric strength of deltoid muscle, the elevator muscles do not exhibit maximal EMG activity. In that jaw position, the elevator muscles are longer than in rest position. Muscle physiology has shown that muscles attain maximal EMG activity at



their shortest, most contracted position.

Maximum EMG activity in muscles is demonstrated in centric occlusion

Daytime neural control of airway size is largely under involuntary control. Head posture is affected by airway patency. Head posture may become habituated to airway patency. Mouth breathers have a more forward head posture than nose breathers. Forward head posture is more stressful than good head posture. The oral airway is smaller in a mouth breather than in a nose breather. Apnoeic patients have smaller airways during the day than non-apnoea patients.

MMT is a system of functional neurological assessment that guides clinicians to therapeutic measures that restore optimal neurological, respiratory and postural functioning. By placing a limb in a particular prescribed position, it is possible to effectively isolate an individual muscle and test its response to isometric pressure. MMT must adhere to rigorous principles and follow strict standardized protocols that:

- a. specify patient and examiner position;
- b. the precise alignment of the muscle being tested;
- c. proper timing of the MMT;
- d. direction of the resisting force to the patient; and
- e. verbal and visual demonstrations.

MMTs are designed to replicate the primary vector of motion of a muscle, while minimizing the contribution of secondary mover muscles. MMTs are not a strength competition between examiner and patient. Any healthy muscle that can be isolated to restrict the vector of movement can be used for testing. It is recommended that treatment positions be evaluated using three muscles to establish consistency and clinical validity. The

direction of force should be the same each time the muscle is tested. The tester should apply the same force to the same contact point with the same timing on each test.

To record the maxillo-mandibular relationship for an oral sleep appliance, an MMT is done on a healthy muscle preferably with the patient standing in good posture on flat shoes or barefoot. The base-line MMT is done in good posture with the lips together, teeth slightly apart at rest position and the tongue placed against the roof of the mouth to establish the facilitated test muscle and experience the "strength of the lock". In most cases, for both convenience and consistency, the MMT is done on the deltoid. As a basis for comparison to the facilitated muscle, an MMT is also done in good, balanced posture with the patient's lips together, tongue in the roof of the mouth and teeth touching in centric occlusion. The maxillo-mandibular position of centric occlusion almost always demonstrates inhibition (or a "weak" test). To establish the treatment maxillo-mandibular position, the bite shims pictured in Figure 1 are placed between the anterior teeth. The object is repeated with a series of MMTs with different numbers of shims to establish the "strongest" isometric condition. First the vertical height is determined and then protrusive, followed by midline. When the "strongest" isometric position relative to vertical, protrusive and midline are identified, polyvinyl siloxane registration material is extruded between the teeth. This is extruded in the posterior segments of the maxilla and mandible and overlapped and locked into the bite shims.

Recording a "bite" for an oral sleep appliance is a "dentocentric" notion. Establishing the maxillo-mandibular treatment position for an oral appliance

utilizing MMT demonstrates that the central nervous system, at a subcon-scious level, not only reacts to incoming information, but defines how this information is represented to itself. This in turn leads to internal processing of the information and subsequent signaling to control other parts of the body. An oral appliance, successful at treating obstructive sleep apnea and/or snoring, has achieved oral airway dilation and stenting.

About the authors

Dr. Allen J. Moses is in private practice in Chicago, USA. His primary endeavour is the delivery of high quality, comprehensive general dentistry. He has a special interest, expertise and board certification in the diagnosis and treatment of craniofacial pain, temporomandibular disorders and oral appliances for controlling snoring and sleep apnea. He holds a faculty appointment as an assistant professor at Rush University Medical School in the Department of Sleep Disorders, where he teaches, does research and designs appliances for sleep apnea and snoring. He can be contacted at ajmosesdds@sbcglobal.com

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References

References are available on request at editor@healtalkt.com

Legends

- Fig. 1. Maxillo-mandibular registration for oral sleep appliance and anterior bite shims.
- Fig. 2. Correct position for Manual Muscle Testing of deltoid muscle.¹⁴
- Fig. 3. The left image shows oral airway, no appliance, lips together, teeth apart, tongue in the roof of the mouth. The image on the right of the same patient demonstrates airway dilation, oral appliance in place, lips together, teeth apart and tongue in roof of the mouth.

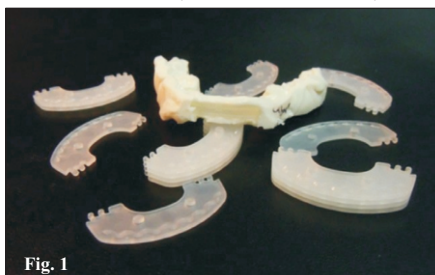


Fig. 1



Fig. 2

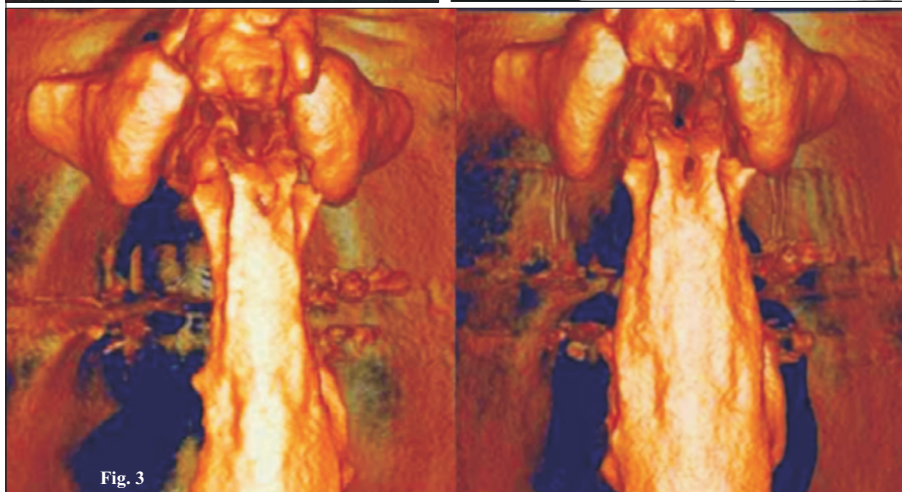


Fig. 3

