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Technical Corner

ORAL APPLIANCE DESIGN

By Allen J. Moses, DDS, D.ABDSM

There are approximately 100 intraoral appliances that have FDA clearance for the treatment of apnea and snoring. Simply put, an intraoral appliance for the treatment of snoring and obstructive sleep apnea 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 in the mouth, the less likely it is to collapse on the airway during sleep. Does the appliance create maximal volume for the tongue or is the tongue space full of acrylic 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?
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, Tongue-Tongue Reflex, and one non-retrusive reflex; Masseter-Hypoglossal Reflex. Does the oral appliance facilitate stimulation of these reflexes?
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 the lips? Can the patient talk or take a drink of water with the appliance in place? Does the appliance gag the patient?

6. Strength of the appliance is also a desirable design feature. Breakage means the patient may have to be without their device while it is being repaired. The more vertical and the more protrusive the maxillo-mandibular position, the less the absolute biting power in maximal clench and bruxism; so clinical expertise as well as design play a role in reducing breakage.

Enough cannot be said about the importance of the maxillo-mandibular relationships in determining oral appliance efficacy. The appliance can facilitate maintenance once the position is established. Deciding the maxillo-mandibular position for optimal airway stenting is a major clinical decision. The literature is sorely lacking principles of scientific clinical guidance on this subject.

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

1. The maximum vertical that the lips can be comfortably closed during sleep so the patient is nose breathing.
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 an approximately three second period. MMT is conducted according to American Medical Association (AMA) 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 by muscle counterforce exerted over a three second period.

Based on the response to MMT, a muscle status is said to be inhibited or facilitated. Inhibited or "weak" is inability to resist pressure over the three 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, disease or pathology of 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).



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The regulation of muscle function is basically accomplished at a subconscious level. Information provided within the muscle spindle cells and golgi tendons generate 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 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 chemoreceptor) or descending, suprasegmental (conscious-cortical or reflexogenic-brainstem cerebellum, postural). This increase in isometric strength with functional realignment of 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 studies have validated that MMT provides objective neurophysiologic measurement of functional status. That improved isometric muscle strength can be obtained in an altered maxillo-mandibular relationship has been shown by the Tufts/Mehta group in six published research studies. 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 and 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. Apneic patients have smaller airways during the day than nonapneic 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 specify patient and examiner position, the precise alignment of the muscle being tested, proper timing of the MMT, direction of the resisting force to the patient, 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 baseline 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 objective is a repeated 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 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 subconscious 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.

Figure 1.

Maxillo-mandibular registration for oral sleep appliance and anterior bite shims

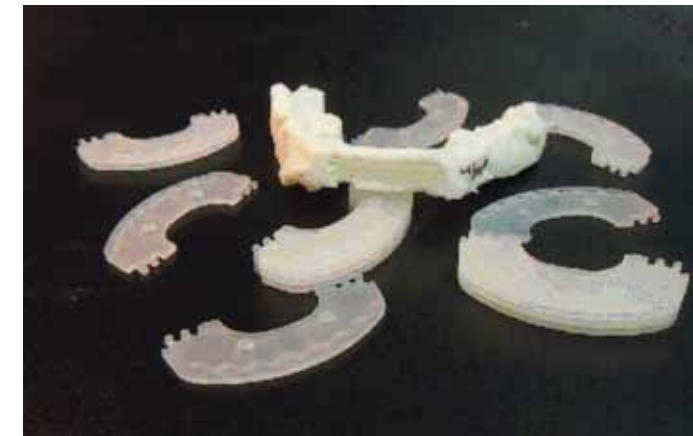


Figure 2.

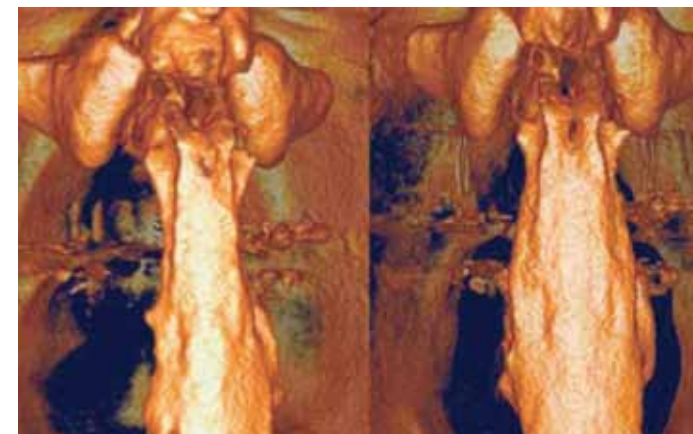
Correct position for Manual Muscle Testing of Deltoid Muscle



Figure 3.

Left shows oral airway, no appliance, lips together, teeth apart, tongue in the roof of the mouth

Right, same patient, demonstrates airway dilation, oral appliance in place, lips together, teeth apart, tongue in roof of the mouth



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