Analysis of a Functional Appliance

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Editor's Note:

The Passivator appliance, as employed in the practice of Allen J. Moses, has reportedly shown significant promise for correction of such varied and diverse complaints as headaches, neck aches, earaches, backaches, facial pain, neuralgia, ringing in the ears, cervical whiplash, snoring and sleep apnea." In an effort to further understand and explain the biomechanical effect, Moses has attempted to quantify the biophysical alteration of the intraoral and perioral milieu. Moses is aware that his use of the electromyograph in part of his study may be subject to critical review, particularly in light of the lack of muscle fiber selectivity of the electrodes. He feels, however, that the use of the instrument in this study constitutes a search for scientific knowledge as opposed to an effort to "propagate new dogma."

Moses received his DDS degree from the University of Illinois College of Dentistry in 1968. He served in the United States Air Force as a captain from 1968-79. He is a member, fellow and regent of the International College of Craniomandibular Orthopedics. This group is dedicated to scientific measurement of jaw behavior. He also is a member of the Chicago Dental Society, Moses has authored several clinical papers and has appeared on scientific programs both nationally and internationally on the subject of jaw-related (TM) disorders. He has been a clinical instructor at the University of Illinois College of Dentistry and is on the staff of the Michael Reese Hospital. Moses currently conducts a private practice in Chicago, with heavy emphasis on temporomandibular joint problems and the effect on the rest of the body.

For several years, I have used an intraoral appliance referred to as a Passivator (Fig.1) for elimination and control of bruxism and treatment of acute closed lock.[1] Subjective patient feedback indicates that it helps eliminate chronic pain symptoms and snoring as well.

Fig. 1 Passivator

The criteria held for any appliance prescribed for intraoral use, besides being clinically effective, are that it be comfortable, neither decrease volume of space for the tongue nor adversely affect breathing and swallowing, and that is to do no damage to the teeth, muscles and periodontia.

The conventional appliance treatment of acute closed lock (Fig.2) causes dysphagia as measured by computerized mandibular scanning.[2] The introduction of deleterious neuromuscular forces, in my opinion, contraindicates this appliance if a better alternative is available.

Fig. 2 Farrar type appliance

The Passivator is an inter-arch acrylic appliance constructed in an edge-to-edge trajectory and separates the arches by 1.5 mm with acrylic. The existing dental literature seems to support a bite such as this as being appropriate and comfortable for long-term bionator use without deleterious consequences.[3,4] The appliance captures the disc in place and prevents superior and distal condylar displacement and keeps the disc from popping forward on the condyle, allowing the distal disc ligament to heal. As measured by computerized mandibular scanner the Passivator prevents dysphagia when it is in place. Even patients with dysphagia pre-existing the acute close lock, swallow correctly with the appliance in place.

The restraining effect on bruxism appears to be from the lingual and palatal flanges which prevent significant lateral movement of the mandible. Movement of the mandible is limited to opening and closing in an anterior trajectory.

Snoring is defined as obstructive sleep breathing. It originates in the collapsible part of the airway from the epiglottis to the cranium. This area has no rigid support - only the muscles keep it open.[5] During sleep, some of these muscles become flaccid, and this in combination with obstructions such as relaxed tongue, enlarged tonsils and adenoids can cause airway occlusion. Apnea is collapse of the upper airway resulting in periodic total obstruction of breathing. A significant number of snorers experience sleep apnea.

This clinical experiment was designed to measure certain factors to see if the data would help substantiate any hypothesis as to how and why the appliance works in any of the situations in which it is used. Basically, two clinical parameters were measured:

• space for the tongue in the natural dentition as compared to space for the tongue with the appliance in place;

• and electromyographic activity in both anterior temporalis and masseter in maximal intercuspal clench on both the natural dentition and maximal interdental clench in the Passivator.

Eighteen patients for whom the Passivator was indicated to control bruxism were selected for the study. Some of these patients had other jaw-related symptoms.

Volumetric analysis

For the first clinical test, stone models were constructed. The models were luted together with sticky wax in centric occlusion and alginate was vibrated into the tongue space between the arches. When the impression material set, the models were separated and the alginate mold was placed in a 500-milliter beaker calibrated in 10-milliter increments. The volume of water displaced by the alginate was measured and defined as "tongue space in centric occlusion (Fig. 3A, 3B)."

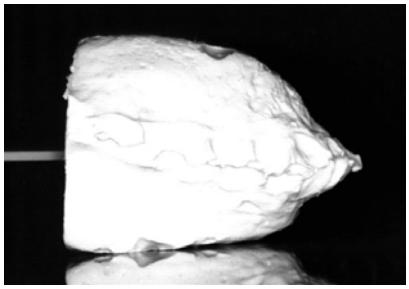

Fig. 3 A Alginate of tongue space in central occlusion.

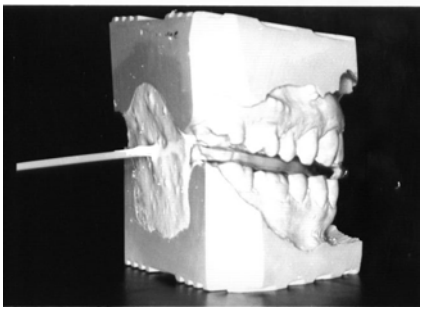

Fig. 3 B Alginate of tongue space with appliance in place.

The Passivator was then placed into position between the same stone models and again luted in place with sticky wax. Alginate was again vibrated in the space

between the models. When the alginate set, the models were separated and the passivator plus the attached alginate was measured volumetrically in the graduated beaker. The appliance was then separated and the volume of the appliance measured separately. Because the appliance occupies space in the oral cavity which the tongue cannot occupy at the same time, the volume of the Passivator was subtracted from the total and the remaining volume defined as "tongue space available with Passivator."

Fig. 4 Measurement of tongue space by volumetric displacement.

Chart A shows the measurements obtained from the 18 patients studied. The average space available for the tongue in centric occlusion was 42.44 milliters. The tongue space in the Passivator adjusted jaw position averaged 46.17 milliters. The average increase in space available for the tongue with the appliance was 3.72 milliter. This is an average increase of nine percent.

In the second part of this study, silver chloride skin electrodes were placed bilaterally over the anterior temporalis and medical masseter muscles. The same 18 patients were used as in the first part. A Myontronics electromyograph model EM26 was used to measure electrical activity in these muscles in maximal clench in both centric occlusion and in the corrected jaw position with the Passivator in place on each patient. The patients were seated in a secretarial chair with head erect, eyes looking straight ahead and feet flat on the floor. All patients were very cooperative. The instructions to the patient are "bite as hard as you can on your back teeth" and then "bite as hard as you can where your teeth fit into the appliance."

Chart B shows the results of this part of the experiment. The average electrical activity in a maximal clench in the existing dentition in temporalis anterior muscle was 80.36 microvolts and in medical masseter muscle was 49.20 microvolts. In the Passivator corrected jaw position, the average electrical activity "biting hard" in temporalis anterior was 28.81 microvolts and in medical masseter was 29.84 microvolts. In both muscles, the average electrical activity significantly decreased in maximal clench in the Passivator. The average decrease in medical masseter was 39 percent but the average decrease in temporalis anterior was an even more dramatic 64 percent.

Discussion

In the first part of the experiment, of the 18 patients measured, two showed small net decreases in space available for the tongue with the passivator in place while 16 patients showed net increase in space available for the tongue with the appliance in place. A paired t-test showed the results of this part to be, in fact, statistically significant ($t=2.94$, $p<.01$).[6]

In the second part of this experiment, the final reading for each muscle tested is the average of eight separate readings. Eighteen patients had the muscles tested bilaterally for both temporalis anterior and medical masseter. The 36 averages were used to get the final average from each muscle. For the medical masseter, eight of the 36 averages showed in creases in activity and 28 showed decreases in activity from biting hard in centric occlusion to biting hard with the appliance in place. In the case of the temporalis anterior, in three instances the average increased and 33 times the activity decreased. Statistically, there was no significant difference between either the right or the left side for both muscles. The decrease in average electrical activity was significant in both cases (t [medical masseter] $)=2.86$, $p< .05$ and (t[temporalis anterior] $)=4.96$, $p<.001$).

Conclusions

The importance of the volumetric measurement part of the experiment is its simplicity. If done routinely before appliance delivery, in those cases where a net decrease in space for the tongue with the appliance in place is found, the appliance can then be further reduced in size.

The advent of biomedical instrumentation in dentistry gives clinicians the means for evaluation of intraoral appliances not heretofore available. In those instances where the EMG demonstrated increase in muscle activity clenching on the Passivator, either the appliance may be contraindicated or the jaw position can be altered to one where the muscle activity would be reduced in maximal clench on the Passivator. Electronic diagnostic aids cannot only measure results, but direct treatment with a scientific accuracy not previously attainable. Several questions debated in the literature might perhaps now be answered by clinical studies done by any conscientious dentist with the biomedical instrumentation currently available.[7,8]

The controversy as to whether an intraoral appliance can cause intrusion of the posterior teeth can now be studied in the dental office. The study presented here may indicate that because muscle activity is greatly reduced in a bite more protrusive than centric occlusion, intrusion of teeth is unlikely to occur with the Passivator.

The physiology of muscle activity has been well documented in the literature. The efficiency of aerobic activity is 24 times that of anaerobic metabolism. The

breakdown products of the Citric Acid Cycle, using ATP as the currency of energy, are H_2O and CO_2 compared to the Embden Meyerhoff pathway, whose nociceptive metabolic end-product is lactic acid.[9] When muscles (such as braced jaw muscles) are in a constant state of chronic contraction, they can go from aerobic to anaerobic metabolism and the lactic and pyruvic acids that build up as trigger points in these muscles as a result of this metabolic switch cause chronic pain.

The results of this experiment seem to indicate that the activity of muscles can be reduced by use of an appliance. If the metabolism can be maintained at aerobic levels, the

mechanism by which the pain level might be reduced would be eliminated of anaerobic metabolism involving activity of the Embden Meyerhoff pathway and the lactic and pyruvic acid buildup. The prime importance of this experiment, however, maybe in directing jaw placement in intraoral sleep apnea/snoring appliances. Bernard Jankelson defined the myocentric occlusal position as the one occurring in a true relaxed muscular trajectory where the mandible relative to the cranial base is vertically stopped in a position of neuromuscular balance and function.[10] For each person there is one optimal myocentric position. From rest position to myocentric bite, the mandible should travel from 1 to 1.5 mm vertically, have the appropriate anterior component of movement and no lateral deviation.

Numerous appliance designs have been reported as successful in treating sleep apnea.[11-15] Most increase inter-arch distance beyond freeway space. Some have patent protection[16, 17] and it is mandated for at least one that it be constructed in a "neuromuscular bite" in the relaxed or myocentric trajectory.[17] There is not sufficient clinical data which indicate that an intraoral appliance constructed in a relaxed neuromuscular trajectory which deliberately opens the bite three to four millimeters beyond normal freeway space, is beneficial. The data presented in this study seem to indicate a possible physiologic basis and rationale for an alternative jaw position to the myocentric trajectory in sleep apnea/snoring appliances.

There is no longer reason for blindly accepting dental dogma when the means to test them are available. Dentists now have the biomedical instrumentation to independently make determinations such as this within their offices. It is important that such studies be done to elicit more effective protocols for scientifically treating patients.

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