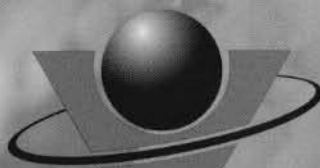


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THE EFFECTS OF MYOFUNCTIONAL APPLIANCE TREATMENT ON THE PERIORAL AND MASTICATORY MUSCLES IN CLASS II, DIVISION 1 PATIENTS

Aim: To evaluate the effect of a myofunctional appliance—the pre-orthodontic trainer (POT)—on the perioral and masticatory muscles by electromyography (EMG) in individuals with an Angle Class II, Division 1 malocclusion. **Methods:** Twenty children were treated with a POT appliance, which had to be worn every day for 1 hour and overnight. The EMG recordings were made at the beginning and end of POT therapy during maximal clenching, swallowing, and sucking. For statistical evaluation, the Wilcoxon nonparametric test was used at the $P < .05$ level. **Results:** During POT treatment, the EMG value for clenching of the anterior temporal muscle decreased significantly ($P < .001$). Also, for the mentalis muscle, the EMG value during clenching decreased significantly; for the orbicularis oris muscle, this was true for sucking ($P < .05$) and clenching ($P < .01$). For the masseter muscle, all EMG values were decreased during treatment but significantly only for clenching. **Conclusion:** During the 6 months of POT treatment, the perioral and masticatory muscles of Class II, Division 1 patients improved significantly. World J Orthod 2010;11:117–122.

Key words: preorthodontic trainer, EMG, myofunctional appliances, perioral muscles, masticatory muscles

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The effects of abnormal lip and tongue functions and habits on craniofacial development have been reported in the literature since the 19th century. Various appliances^{1–5} and protocols^{6,7} have been presented to treat this problem. The main intent of the advocated appliances is to eliminate oral dysfunctions, establish muscular balance, and correct or diminish maxillary incisor protrusion.⁸

Recent studies have shown that malocclusions might be caused by a child's habit or the way he swallows and breathes. Bass⁹ indicated that the most frequent skeletal problem in Class II preadolescents is mandibular retrognathia. This suggests that an appliance with the documented ability to significantly stimulate mandibular growth should be an important part of a clinician's armamentarium.

Animal studies have shown that appliances that position the mandible anteriorly can considerably stimulate mandibular growth, primarily by enhanced remodeling of the condyle.^{10–12}

Cheney^{13,14} introduced a myofunctional appliance called the oral shield. This appliance was designed to activate the lips and other facial muscles. As a result of using this appliance, the maxillary incisors uprighted and lip closure was improved. Myofunctional appliances are simple and economical, but require a careful selection of indication.¹⁵

Early treatment of deleterious habits is easier than correction after years of habit practice.¹⁶ Moreover, young patients are considered to be more cooperative than adolescents.¹⁶ The preorthodontic trainer (POT), a functional device

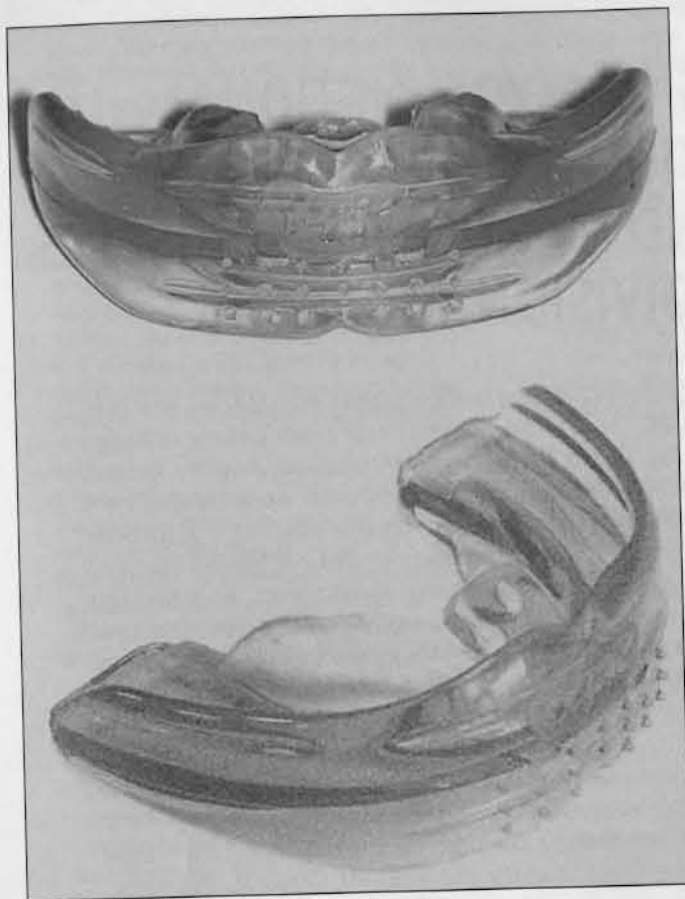


Fig 1 Frontal and oblique views of the preorthodontic trainer, which is commonly made of silicone or polyurethane.

most advantageously used in children from 4 to 10 years of age (Fig 1), is ideal for treating this population.

The trainer allegedly has the orthopedic effect of a functional appliance, as well as the capacity to align teeth and train muscles. It repositions the mandible and decreases mouth breathing, tongue thrusting, and thumb sucking. By distancing the lower lips from the dental arch, the trainer can prevent the patient from positioning the tongue against the lower lip during swallowing.¹⁵ It can further prevent acquired crowding and jaw discrepancies that are not frequently genetically induced.^{12,17}

Usumez et al¹⁵ investigated the treatment effects brought about by POT appliances and demonstrated that they stimulated dentoalveolar changes that result in a significant reduction of the overjet. Thus, they could be used well with appropriate patient selection.

Electromyography (EMG) signals indicate electrical potentials generated by the cells of skeletal muscles.¹⁸ Grossman et al¹⁹ suggested the use of EMGs for orthodontic diagnosis and treatment planning. Ahlgren²⁰ used it to evaluate mastication in children with special reference to occlusion, and Möller²¹ investigated the action of the masticatory muscles with facial morphology.

Surface and needle electrodes can be used for EMG. Surface electrodes have been widely employed because they are noninvasive, easy to adhere to the skin, and able to detect the total activity of any muscle. However, separation of single motor unit action potential is not easy with such electrodes.²²

The purpose of this study was to evaluate the effect of the POT appliance on the anterior temporal, mental, orbicularis oris, and masseter muscles during various activities in children.

MATERIALS AND METHODS

Subjects

The sample consisted of 20 Caucasian patients (10 boys and 10 girls) with an Angle Class II, Division 1 relationship treated between 2006 and 2007. The ANB angle of all patients was > 4.0 degrees and their overjet > 4.5 mm (mean ANB 5.5 ± 1.4 degrees, mean overjet 6.0 ± 1.2 mm). Ages ranged from 7.8 to 11.5 years (mean 10.1 ± 3.1 years). None had a thumb-sucking habit, and all were treated exclusively with the POT appliance (T4K, Myofunctional Research). Each patient was instructed to use the POT every day for 1 hour and all night for 6 months.

Positioning of the electrodes

Before each recording session, the procedure was explained in detail to all patients and their parents to allay anxiety. All participants were asked to wash their face with soap and water. Next, the skin over the muscles was cleaned with alcohol and thoroughly dried. Then, bipolar EL 254S shielded Biopac Silver-silver chloride (Ag-AgCl) disk surface electrodes (4.0-mm diameter) were covered with electrode gel and fixated with adhesive washers. The common ground electrode was adhered to the forehead, whereas the active electrodes were placed over the respective muscles.

For the right anterior temporal muscle and the right superficial masseter muscle, the electrodes were placed 1.0 cm to 1.5 cm distal of their anterior border. The site at the right anterior temporal muscle was located by palpation during clenching.^{23,24} The vertical site over the superficial masseter was defined as the middle of a line connecting the inferior border of the zygomatic arch at the zygomaticotemporal suture with the gonial angle. The electrodes for the upper orbicularis oris muscles were placed above the vermilion border of the lips. The positions of the electrodes at the first session were marked on each patient's chart and used as a guide at each subsequent recording.

Additionally, photographs were taken at the first session as a reference for future electrode placement.

EMG recording

The EMG signals were recorded at the start of the treatment and at the end of the sixth month. The recordings were made of maximal clenching in centric occlusion (four clenches), swallowing of saliva (two swallows), and sucking on a straw (six suckings).⁸ These actions were practiced beforehand by copying the observer. All participants were instructed to avoid protruding their jaw or tongue during a recording. For all recordings, the patients were seated upright in a dental chair with their head in natural balance.

The swallowing recordings were taken when a patient indicated that a sufficient amount of saliva had accumulated. For the sucking recordings, the patient sucked on a plastic straw placed in front of the anterior teeth and closing the open end of the straw with a finger.

The EMG signals were acquired by a Biopac-MP150 unit (BIOPAC Systems). The EMG-100C Biopac was used as an amplifier with a 2,000 gain. Its high-pass filter was set to 1.0 Hz and its low-pass filter to 500.0 Hz. The serial output of the EMG recorder was sampled at 5,000 samples per second and then sent to a computer via an Ethernet card.

Statistical method

All statistical analyses were performed using the Statistical Package for Social Sciences 13.0 (SPSS). Arithmetic means and standard deviations (SD) were calculated for each measurement. The Wilcoxon test was used to test the significance of the mean differences of the EMG variables between the two observations.

Table 1 Mean EMG (in decibel/Hertz) and SD values of the various muscles and functions at pre- and posttreatment, difference between the two time points, and statistical evaluation

Muscle/Functions	Pretreatment (T1)		Posttreatment (T2)		Difference (T2-T1)	Wilcoxon test
	Mean	SD	Mean	SD		
Anterior temporalis						
Swallowing	0.155	0.387	0.038	0.065	-0.117	NS
Sucking	0.040	0.091	0.003	0.003	-0.037	NS
Clenching	0.610	0.645	0.201	0.444	-0.409	***
Mentalis						
Swallowing	0.104	0.188	0.074	0.076	-0.030	NS
Sucking	0.249	0.296	0.297	0.393	0.047	NS
Clenching	0.958	0.232	0.538	0.593	-0.420	**
Orbicularis oris						
Swallowing	0.048	0.053	0.093	0.135	0.045	NS
Sucking	0.288	0.456	0.407	0.463	0.119	**
Clenching	0.016	0.215	0.144	0.060	0.128	*
Masseter						
Swallowing	0.044	0.103	0.006	0.014	-0.038	NS
Sucking	0.124	0.360	0.015	0.057	-0.109	NS
Clenching	0.781	0.863	0.185	0.353	-0.596	*

SD = standard deviation, NS = not significant, * $P < .01$, ** $P < .05$, *** $P < .001$.

RESULTS

The EMG values of the sample at pre- and posttreatment are shown in Table 1.

For the anterior temporal muscle, only the EMG activity during clenching at the beginning of treatment was significantly ($P < .001$) higher than that at posttreatment. In regard to the mentalis muscle, again, only the EMG activity during clenching at the beginning of treatment was significantly ($P < .05$) higher than that at posttreatment. The EMG activities during sucking ($P < .05$) and clenching ($P < .01$) at the beginning of treatment were significantly lower than that at posttreatment for the orbicularis oris muscle. For the masseter muscle, all EMG values were decreased during treatment but significantly ($P < .01$) for only clenching.

DISCUSSION

The POT is a flexible, passive appliance that assists in retraining the musculature and changing the mode of breathing and swallowing. Because there are no studies about this device, the present study was designed especially to evaluate the EMG

activity brought about by its use. There have been no reports that the POT appliance has any harmful effects.

Angle²⁵ wrote that according to his observation, almost every malocclusion has some soft tissue involvement. Another study showed that early treatment with an orthopedic appliance is successful in 80% of malocclusions; the remaining 20% require fixed appliances.²⁶ Muscle function and particularly tongue position and function have a great impact on the dentition and can lead to a deterioration of an orthodontic correction or even a recurrence of the original problem if not alleviated.²⁷

The POT is made from nonthermoplastic silicone or polyurethane, which gives the appliance its flexibility and inherent memory. Schendel et al²⁸ showed no mutagenic, toxic, or irritating properties in their biocompatibility tests on synthetic materials; Skomro²⁹ came to a similar conclusion.

The front part of the POT appliance incorporates a sort of oral screen that encourages nasal breathing. Graber³⁰ stated that oral screens are indicated in mild Class II occlusions and that the construction bite for these patients should

not be as protrusive as for activators. The use of myofunctional appliances such as the oral/vestibular screens in the primary and mixed dentitions are mentioned frequently in the literature,^{8,15} but only two studies have been published about the EMG changes these appliances induce.^{8,31}

In the present study, during maximal clenching, the anterior temporal muscle activity decreased significantly after 6 months of POT use. Tallgren et al⁸ reported similar changes.

Also, the activity of the mentalis muscle in individuals with incompetent lips under various functions was examined in some previous studies.³²⁻³⁵ Further, Stavridi and Ahlgren³⁶ studied the masseter, buccinator, and mentalis muscles with EMG and found a significant decrease in mentalis muscle activity during swallowing. In the current study, POT treatment decreased the mentalis activity only during clenching.

Similarly, Takada et al^{37,38} looked into the EMG activity of the inferior orbicularis oris muscles, Schieppati et al³⁹ researched that of the perioral muscles during mastication, and Schievano et al³¹ examined that of the orbicularis oris muscle before and after myofunctional therapy to find that it increased significantly. All thought that myofunctional therapy influences the perioral muscles because lip closure is established after therapy. Finally, Tallgren et al⁸ found that the sucking activity of the lips decreased significantly after 6 months and after 1 year of myofunctional appliance treatment. In contrast, the present research revealed that POT treatment increased the orbicularis oris activity during sucking.

CONCLUSION

During the 6 months of POT treatment, the masticatory and perioral muscles of Class II, Division 1 patients improved significantly.

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