LETTER TO THE EDITOR

Electromyographic evaluation during orthodontic therapy: comparison of two elastodontic devices

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To the Editor,

Neuromuscular orthodontics is assuming increasingly significant clinical and scientific roles in dentistry. Numerous studies have shown that the use of surface electromyography (sEMG) and kinesiography can be of fundamental help in all orthodontic cases (1). Initially employed for the treatment of temporomandibular disorders (TMDs), these modalities have proven to aid the planning, control of the therapy, and remote control of orthodontic treatments (2-5). Correct occlusion, as well as being aesthetically appreciable, must be able to interact perfectly with the neuromuscular balance of the stomatognathic system. The evaluation of muscle activity can support the determination of the mandibular and cranial growth vectors in the treatment of TMDs and in follow-up management to reduce the risk of recurrence after orthodontic therapy. Stomatognathic and extra-stomatognathic tension at the level of the trigeminal system should be eliminated before the start of treatment, to enable the procedure to be performed correctly also from a medicolegal point of view. Therefore, electromyographic (EMG) examination is used in standard practice to verify the resolution of neuromuscular tension (with physiotherapeutic support in some cases) before the initiation of orthodontic treatment (6). Nowadays, orthodontic therapies with elastodontic appliances are spreading a lot. There is a complete array of activators for every type of mouth, according to the skull conformation, body features, and dental arch shape. Proper employment of this activator in association with physical exercises will allow patients to obtain benefits in the entire neuromyofascial system. This device improves the chewing function, aligns the teeth, re-educates the tongue due to stimulation toward the retroincisal papilla spot, and modulates the muscular tone in occlusal-postural syndrome; moreover, it is ideal for treating obstructive sleep apnea syndrome. Activators balance the skeletal bases through two double matched planes, upper and lower, where teeth are positioned with effects of propulsion, retropulsion, and expansion. After employing the positioners, the orthodontist will require minor tooth movement after functional treatment because of the elastomeric material (7). The aim of this study was to verify the clinical validity of assessments performed with two of these devices (EQ OSA; Eptamed and Occlus-o-Guide; Sweden & Martina) by comparing EMG activity before treatment and 6 months after treatment. The hypothesis was that soft appliances should be more comfortable for the patient.

MATERIALS AND METHODS

Study sample

This study was carried out in accordance with the fundamental principles of the Declaration of Helsinki,

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and was approved prior to commencement by the Ethics Committee of the University of L'Aquila (no. 16137/2016). Eighty-two patients aged 7–11 years were clinically examined at the Dental Clinic of the University of L'Aquila, Italy. The same clinician performed all examinations, which included the acquisition of dental panoramic radiographs, extraoral and intraoral photographs, and alginate impressions of both dental arches. Based on these data, the orthodontist created a treatment plan specific to each patient according to the index of orthodontic treatment needs described by Brook and Shaw (8). The following exclusion criteria were applied: presence of epilepsy, systemic disease, TMD, or periodontal disease; and lack of written informed consent from a parent or legal guardian. The inclusion criteria were skeletal and dental class II malocclusion (divisions 1 and 2) and deep bite. Ultimately, 66 patients aged 7–11 years were enrolled in the study and divided into the test and control groups. The test group comprised 36 patients (18 male, 18 female; mean age, 9.19±1.43 years) treated with the EQ OSA device. The control group comprised 30 patients (15 male, 15 female; mean age, 9.16±1.41 years) treated with the Occlus-o-Guide. The two groups exhibited the same orthodontic features. All patients underwent sEMG analysis, with muscle tone evaluated with the eyes closed, at baseline (T0; prior to the initiation of orthodontic therapy) and 6 months after treatment initiation (T1). Registration of Scan 9, which shows the activity of the muscles (masseters, anterior digastrics, sternocleidomastoid, and anterior temporalis) in the resting position, was performed at both timepoints (1).

Protocol

Each patient in the test group received a soft, white, natural rubber EQ OSA device suitable for his or her dentition phase (7). This device, which has a shape similar to a mouthguard, embraces both dental arches, reaching distally to cover the last molars present in the arch. There are several measures, based on the distance between the palatal cusps of the first premolars. The patient fits the upper and lower splints over his/her teeth. The device is activated by biting, through soft elastic forces led by muscle energy. The activator is worn overnight. The EQ O.S.A. is a type of orthodontic appliance that stimulates growth and, through the input of muscle movements, elicits tissue development toward a suitable chewing function. Biting this elastomeric device balances tension up to the sphenobasilar synchondrosis, according to osteopathic medicine and philosophy (7).

Each patient in the control group received a G-type (for mixed dentition) Occlus-o-Guide device, according to his or her dentition phase. Constructed from an elastomeric material, these preformed activators are ideal for use in the early through late mixed dentition. There are also different sizes of this appliance, the most appropriate is chosen by measuring the distance between the distal wall of the upper left lateral incisor and the distal wall of the upper right lateral incisor. It is also possible to measure through the lower lateral incisors. Everything is measured through a special ruler provided by the manufacturer. Along with their activator properties, ideal for correction of class II malocclusion, being based on tooth size, these appliances [aptly coined EGAs (Eruptive Guidance Appliances)] also function as a positioner along with correcting overbite and mild-to-moderate crowding. The appliance provides depressive forces to the front teeth and simultaneously encourages the posterior elements to erupt in their optimal vertical position. It is necessary, however, to intervene when they are erupting, before the periodontal fibers stabilize the definitive vertical level of the posterior elements. It is also a myofunctional regulator that tends to properly rebalance muscle forces, rehabilitates the posture of the tongue, re-educates atypical swallowing and stimulates correct breathing. The patients were instructed to use the device overnight (2, 9). The orthodontist checked patients every 30 days to evaluate eventual modifications to carry out on the device. The EQ OSA device and the Occlus-o-Guide device are shown in Fig.1.

EMG assessment

EMG activity was recorded using an eight-channel Myotronics K7 Evaluation System (Myotronics Inc., Seattle, WA, USA) equipped with bipolar electrodes, with an inter-electrode distance of 20 mm. The patient's skin was cleaned thoroughly with alcohol, and electrodes were positioned on the left and right masseter and anterior temporal muscles, as described by Castroflorio et al. (10, 11). Electrodes were also placed on the left and right anterior digastric muscles (12) and on the left and right sternocleidomastoid muscles, parallel to the muscle fibers and over the lower portion of the muscle to avoid the innervation point, as described by Falla et al. (13). Electrical

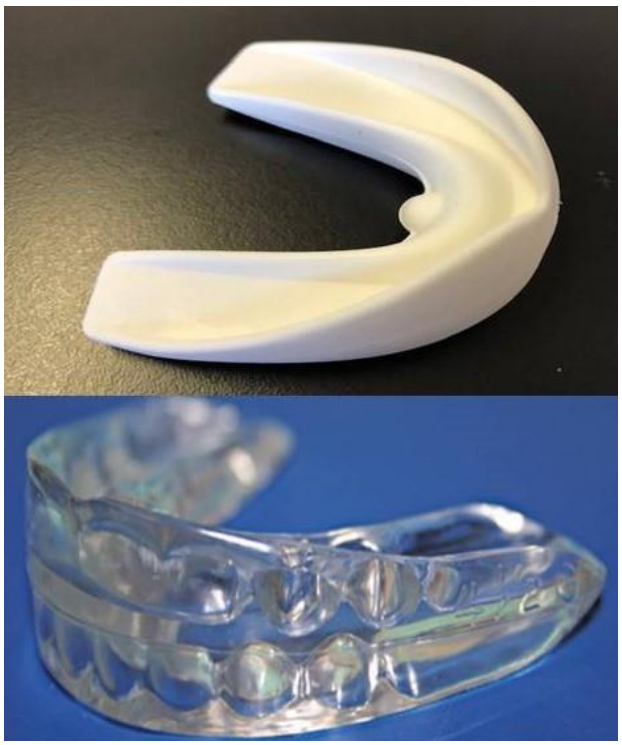

Fig. 1. *EQ OSA device and Occlus-o-Guide device.*

signals were amplified, recorded, and digitized with the K7 clinical software package (Myotronics Inc.). Root mean square values (in microvolts) were used as indices of signal amplitudes (1). This study involved the evaluation of scan 9, performed with the eyes closed and open, to assess muscle tone in the resting position. Scan 9 shows sEMG muscolar activity at basal condition in resting position. The resting position is the correct relationship between the jaw and the upper dental arch in resting condition, when the teeth are not in contact.

RESULTS

The unpaired *t*-test was used for within-group comparisons. Statistical significance was set at $p < 0.05$. The results are shown in Table I. Data are presented as mean (standard deviation). Eptamed *vs* Occlus-o-Guide, unpaired *t*-test. Although values for the right and left sides showed improvement in patients treated with the EQ OSA relative to those treated with the Occlus-o-Guide, no difference was significant at T0 or T1. From T0 to T1, the sum of sEMG values changed from 15.1 to 14.9 μV in the test group and from 15.2 to 15.5 in the control group; these differences were not significant. The mean sEMG value improved in the test group (changing from 1.9 at T0 to 1.7 at T1) relative to the control group (changing from 1.8 to 2.1), but this difference was not significant, as shown in Table I and in Fig. 2.

DISCUSSION

Many studies have examined muscle changes during orthodontic therapy. The achievement of lower levels of resting activity for the mandibular and postural muscles is a desirable outcome of orthodontic treatment. The sum of resting electrical activities of the eight mandibular and postural muscles serves as a primary marker of orthodontic treatment efficacy. Conventional orthodontic treatment aims to achieve morphological and aesthetic norms based on static assessments, however, the functioning of the cranial-mandibular muscles and joints involved in occlusion occurs through interactions with the nervous system. Farronato et al. (2) reported that EMG values obtained with two devices for the advancement of the jaw (the Occlus-o-Guide and Andresen devices) *in situ* were comparable. Another recent study demonstrated that neuromuscular orthodontic treatment resulted in greater relaxation of the masticatory muscles and better function than with traditional orthodontic treatment. In the present study, EMG values of patients treated with EQ OSA and Occlus-o-Guide devices did not differ significantly, but patients who wore the EQ OSA device showed greater muscle relaxation. In fact, with the devices *in situ*, electromyographic values were similar in the two groups (no significative differences), but in the test group the muscles were more relaxed. The use of the activator, in association with exercises and techniques for muscular balance, allows the patient to gain benefits throughout the neuromyofascial system – with fewer concerns for the orthodontist. In fact, this device can help the patient to educate the tongue posture, educate the nasal breathing, align the teeth and to advance the jaw. Biting these elastomeric devices balances tension up to the sphenobasilar synchondrosis, according to osteopathic medicine and philosophy. The teeth's positions are determined by this new skull harmony

Table I. *Electromyographic values (microvolts) obtained before treatment initiation (T0) and 6 months thereafter (T1).*

	T0			T1		
	Eptamed n=36	Occlusoguide n=30	p-value	Eptamed n=36	Occlusoguide n=30	p-value
RTA	2.2 (1.2)	2 (1.0)	0.4703	2.3 (1.2)	2.2 (1.3)	0.7466
LTA	2.2 (1.1)	2.3 (1.2)	0.7254	2.0 (1.0)	2.5 (1.2)	0.0694
RMM	1.9 (0.9)	1.7 (0.8)	0.3482	1.7 (0.8)	1.9 (0.9)	0.3430
LMM	1.8 (1.0)	2 (1.1)	0.4423	1.8 (0.9)	2.0 (0.8)	0.3482
RDA	1.4 (0.9)	1.5 (0.6)	0.6051	1.5 (1.1)	1.9 (0.9)	0.1156
LDA	1.3 (0.8)	1.6 (1.1)	0.2050	1.6 (1.2)	2.0 (1.2)	0.1823
RTP	1.9 (1.1)	2.0 (1.5)	0.7561	1.8 (1.4)	2.3 (1.4)	0.1534
LTP	1.9 (1.2)	1.8 (0.9)	0.7078	2 (1.4)	2.1 (1.1)	0.7517
Sum sEMG	15.1 (7.2)	15.2(7.6)	0.9565	14.9(6.9)	15.5(7.1)	0.7296
Mean sEMG	1.9 (0.8)	1.8(1.0)	0.6532	1.7(0.5)	2.1 (1.3)	0.0934

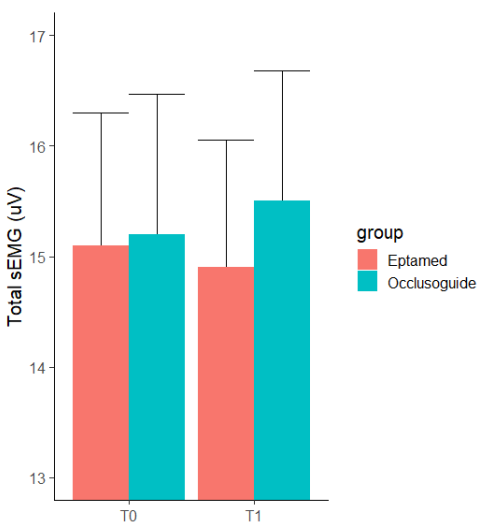

Fig. 2. *Bar graph of total sEMG values stratified by timing according to group "Eptamed" and "Occlusoguide". No statistical differences between groups were shown.*

through an osteopathic effect; benefits are also in the cervical posture (6).

The limitations of this study include the small sample and relatively short (6-month) orthodontic evaluation period. In the future, it would be highly desirable to repeat this study with a larger, and possibly more homogeneous, cohort. The results of this study indicate that the use of these types of elastodontic devices, that must be worn only during the night, is effective in aligning the teeth, advancing the jaw, nasal re-education and tongue posture, as well as having cervical benefits. Therefore, wearing a device for less hours a day than traditional ones, having a more relaxed muscle activity detected by EMG, and having greater functional and neuromuscular results and in less time can be the future of interceptive orthodontics.

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