Original Article

Effect of Pre-Orthodontic Trainer Treatment on the Masticatory and Perioral Muscles in Patients with Class II Subdivision 1 Malocclusion Evaluated by Surface EMG

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Abstract

Introduction: Myofunctional appliances have been shown to have a positive effect on the muscles in the facial area. Surface electromyography (sEMG) is one of the reliable methods used to investigate these effects.

Aim: The aim of this follow-up study is to evaluate the effect of a myofunctional appliance T4K on the perioral and masticatory muscles in patients with class II subdivision 1 malocclusion by sEMG.

Materials and methods: Sixteen children were treated with a Trainer appliance (T4K) for 9 months. The appliance should be worn every day for 1 hour and overnight. The EMG recordings were performed at the beginning and at the end of the Trainer therapy. The anterior temporal and masseter muscles were examined during maximal clenching. The orbicularis oris and mentalis muscles were examined during swallowing and sucking. Statistical analysis was performed using IBM SPSS Statistics version 23.0.

Results: The EMG values of the anterior temporal and masseter muscles during clenching increased significantly as a result of the treatment ($p<0.05$). At the end of the observation period, the EMG values of the mentalis muscle did not change during both sucking and swallowing ($p>0.05$), while the values of the orbicularis oris muscle increased significantly during sucking and swallowing ($p<0.05$).

Conclusions: As a result of the treatment with Trainer appliance, the EMG activity of the perioral and masticatory muscle significantly increased, while no change was observed in the electrical activity of the mentalis muscle.

Keywords

INTRODUCTION

Abnormal oral functions and their impact on craniofacial growth and morphology are widely studied. However, their effects on the growth of the mandible are still a subject of interest and controversy.[1]

Myofunctional appliances have been introduced into the dental practice to treat functional disorders and to reestab-

lish muscle balance. One of the main goals of the interceptive treatment is correction of the abnormal activity of the lips, the mentalis muscle and the tongue. The main reason for using myofunctional appliances is to achieve muscular balance, eliminate oral dysfunction, and to reduce or correct maxillary muscle hyper- and hypoactivity.[2] These appliances have been successfully used for many years due to their simplicity and ease of use, for carefully selected cases and by experienced operators.[3]

One of the widely used myofunctional appliances is T4K (Pre-Orthodontic Trainer, Myofunctional Research Co., Australia). It is a useful appliance for treating class II/1 malocclusions, which according to Class II/1 malocclusion is one of the most common malocclusions in clinical practice[4] and, according to the Index of Malocclusion Severity Assessment, is rated as severe and very severe malocclusion depending on the severity of the distal bite.[5]

AIM

The aim of this study was to examine electromyographically the response of the masseter, anterior temporal, orbicularis oris, and mentalis muscles to the treatment with the T4K Pre-Orthodontic Trainer.

MATERIALS AND METHODS

Sixteen patients (mean age, 10±1.4 years) were selected for treatment with the T4K Pre-Orthodontic Trainer First Phase (Myofunctional Research Co., Australia). The inclusion criterion was that the children should have class II/1 malocclusion. The main exclusion criteria were that the children had not previously received orthodontic treatment, did not have any temporomandibular disorders (TMD), and did not experience orofacial pain while clenching.

The children were instructed to wear the T4K Pre-Orthodontic Trainer First Phase, for one hour during the daytime and at night while sleeping (**Fig. 1**). The follow-up period lasted 9 months.

Surface EMG recordings were performed during three activities: maximal clenching, swallowing water taken in the mouth in advance, and sucking through a straw while the other end was closed with a finger. Each EMG recording lasted 3 seconds for every contraction except swallowing.

The surface EMG activity of the right and the left masseter and the anterior temporal muscle were recorded during maximal clenching for 3 seconds. The EMG recordings during swallowing and sucking through a straw were performed using bipolar electrodes positioned over the *musculus orbicularis oris* and *musculus mentalis*. The intervals between all muscle contractions were one minute. All activities were repeated three times. As these contractions are voluntary, we used the contraction with maximal value for the statistical analysis.

The patient sits in a dental chair with head unsupported and upright back. A two-channel electromyograph (Neuro-EMG-Micro-2) with Neuro-MEP-Ω software was used to perform the recordings. For each contraction, the appliance gives two values: maximal and mean value of the whole separate contraction. Before the recording, the skin above the examined muscles was cleaned with 70% alcohol and after drying up, silver/silver chloride bipolar electrodes were positioned. EMG recordings were performed at the beginning and at the end of the treatment (mean treatment period of 9.5±1.4 months).

The EMG recordings were made during maximal clench in centric occlusion, during swallowing water and during sucking through a straw. The patients made three attempts of every task. The activity of masseter and anterior temporalis muscles bilaterally were detected during maximal clench while the muscular activity of *m. orbicularis oris* and *m. mentalis* were tested during swallowing and sucking.

Figure 1. T4K First Phase.

Statistical analysis

The statistical analysis was performed using IBM SPSS Statistics version 23.0. The nonparametric test of Kolmogorov-Smirnov was used to check the normality of distribution. The statistical evaluation of EMG values between the groups was performed by Mann-Whitney U-test with 95% confidence interval ($p<0.05$).

RESULTS

The EMG values of the pre- and post-treatment muscle activity are shown in **Tables 1, 2**.

Both the maximal and mean values of the muscle activity of *m. temporalis* and *m. masseter* showed statistically significant increase during clenching at the end of the observation period compared with the pretreatment values ($p<0.05$, $p<0.02$, respectively).

Table 2 presents the EMG activity of *orbicularis oris* and *mentalis* muscles during swallowing and sucking.

The results showed that statistically significant differences during swallowing and sucking at the end of the treatment period were observed only in the *orbicularis oris* muscle. Both maximal and mean EMG values were increased ($p<0.05$). The EMG activity of the mental muscle did not change after Trainer application and the difference between the pre- and post-treatment values was insignificant.

DISCUSSION

The aim of the study was to investigate the activity of the masticatory and perioral muscles as a result of a Trainer treatment.

The soft tissues, the masticatory and other facial muscles influence not only the bone growth, but also have an impact on the treatment results and stability after orthodontic treatment. The basic method to evaluate the changes of the muscle activity/function is electromyography[6], hence appropriate application of non-invasive EMG provides objective information about the results and usefulness of the orthodontic appliances. The reliability of EMG studies on the activity of elevator and facial muscles has been evaluated in previous studies.[2,7] In this study, we examined the effects of myofunctional treatment on orofacial muscle activity registered using surface EMG during the oral functions of clenching, sucking, and swallowing.

In our study, we found that the activity of the anterior temporal and masseter muscles during voluntary maximal clenching significantly increased at the end of the observation period compared with the pre-treatment values. This is valid both for the maximal and mean values of the EMG activity. Early studies by Pancherz et al. reported that in patients with distal occlusion, the reduced activity of the masseter and temporal muscles after treatment with the activator and Herbst appliance gradually increased, approaching the values obtained with normal occlusion, which is compatible with the results of our study.[8] Our data also correlate with the results of a study by Satygo et al.[9] who reported an identical increase in the activity of these muscles at clench. The results obtained by Petrovic et al.[10] are similar: they found that the electrical activity of the masticatory muscles in Angle Class II/2 malocclusion significantly increased during the first year of treatment with the activator compared to the start of the therapy. In-

Table 1. EMG activity of masseter muscle and anterior temporalis muscle at maximal clenching. Maximal and mean values in μV before and after treatment

Muscle	Maximal values in μV			Mean values in μV		
	Before	After	*p*	Before	After	*p*
Masseter right	929.56±451.6	1089.25±452.7	<0.05	282.68±82.9	309.25±89.5	<0.05
Masseter left	1021.19±481.9	1303.75±570.6	<0.05	303.75±101.9	359.68±107.52	<0.05
Temporalis right	1080.5±414.9	1358.31±380.8	<0.05	314.06±72.56	362.0±62.5	<0.05
Temporalis left	1134.06±289.9	1415.56±325.30	<0.02	317.43±60.2	360.43±69.6	<0.02

Table 2. EMG activity of *orbicularis oris* (OOM) and *mentalis* muscles (MM) during swallowing and during sucking through a straw. Maximal and mean values in μV before and after treatment

Muscle	Maximal values in μV			Mean values in μV		
	Before	After	*p*	Before	After	*p*
OOM swallowing	714.93±335.9	965.31±525.3	<0.05	225.61±56.9	266.25±81.1	<0.05
OOM sucking	786.93±353.3	965.18±490.6	<0.05	262±62.5	294.18±80.4	<0.05
MM swallowing	739±224.9	883.9±363.7	NS	251.06±45.3	263.75±62.6	NS
MM sucking	748.5±306.5	861±374.4	NS	251.06±62.9	272.88±83.8	NS

NS: not significant

creasing potential action is approximately equal for both observed muscles. On the contrary, Uysal et al.[11] found that after an 8-month Pre-Orthodontic Trainer treatment, the activity of the anterior temporal, mental, and masseter muscles was decreased. Tallgren et al.[2] reported similar changes in the EMG activity of anterior temporal muscle at maximal clenching during myofunctional appliance treatment. Uner et al.[12] evaluated masticatory muscles in distal occlusion and found an increased activity in the masseter muscle in the physiologic rest position of the mandible at the beginning of treatment, and the reduction of the activity at the end of treatment with an activator.

During sucking through a straw with a closed opposite end, the results of the EMG recording showed a statistically significant increase in the muscular activity of the *orbicularis oris* muscle. During sucking, Uysal et al.[11] found increase in the activity of *orbicularis oris* muscle, while Yagci et al.[13] reported a statistically significant decrease. Our results support the findings of Uysal et al.[11] In our study, when the patients were instructed to swallow, the EMG activity of the *orbicularis oris* muscle significantly increased, while other authors reported no changes before and after treatment.[11]

We did not observe significant changes during sucking and swallowing in pre-and post-treatment values of the EMG activity of the mentalis muscle. Similar results reported Uysal et al.[11]

CONCLUSIONS

The results of the prospective study of T4K-treated patients showed significant changes of the muscle activity as detected via surface electromyography. No changes after treatment were observed in the mentalis muscle. The temporalis and masseter muscles, which keep the appliance in the mouth, and the orbicularis oris muscle, which is responsible for touching the lips together with the Trainer, increased their activity.

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Влияние преортодонтического лечения с помощью аппарата Trainer на жевательные и периоральные мышцы у пациентов с аномалией прикуса II класса, подраздел 1, оценённое с помощью поверхностной ЭМГ

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Резюме

Введение: Доказано положительное влияние миофункциональных аппаратов на мышцы лица. Поверхностная электромиография (sEMG Г) является одним из надёжных методов исследования этих эффектов.

Цель: Целью данного последующего исследования является оценка влияния миофункционального аппарата T4K на периоральные и жевательные мышцы у пациентов с аномалией прикуса II класса, подраздел 1, с помощью sEMG.

Материалы и методы: Шестнадцать детей получали лечение с помощью аппарата Trainer (T4K) в течение 9 месяцев. Прибор следует носить каждый день в течение 1 часа и на ночь. Записи ЭМГ проводились в начале и в конце терапии Trainer. Переднюю височную и жевательную мышцы исследовали при максимальном сжатии. При глотании и сосании исследовали круговую мышцу рта и подбородочную мышцу. Статистический анализ проводился с использованием IBM SPSS Statistics версии 23.0.

Результаты: В результате лечения значения ЭМГ передних височных и жевательных мышц при сжимании значительно увеличились ($p<0.05$). В конце периода наблюдения значения ЭМГ подбородочной мышцы не изменялись как при сосании, так и при глотании ($p>0.05$), тогда как значения круговой мышцы рта достоверно возрастали при сосании и глотании ($p<0.05$).

Заключение: В результате лечения аппаратом Trainer достоверно увеличилась ЭМГ-активность периоральной и жевательной мышцы, при этом изменений электрической активности подбородочной мышцы не наблюдалось.

Ключевые слова

мышцы лица, миофункциональная терапия, жевательные мышцы, поверхностная электромиография