Reduction of Excessive Overjet in Pediatric Malocclusion Using Myofunctional Therapy Accompanied by Electromyography Activity Evaluation in Orofacial Muscles

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Abstract

Treatment of pediatric malocclusion patients with excessive overjet with oral and facial muscle function therapy harmonious balance between size of teeth,the length of dental arch,and the facial profile.To correct diagnosis in longterm care of pediatric growth and development age,a complete clinical examination is required,including electromyography examination of orofacial muscles. Acses oral myofunctional changes in the muscles,before and after treatment.

Used E-Dentosmart electromyography diagnostic for orofacial muscle measurement.The study conducted by functional analysis and electromyography in 27 pediatric patients with overjet morethan 4mm,no history of sleep problems,pediatric patients without previous orthodontic treatment,no tonsils/adenoid hypertrophy,no malformation or systemic disease.Three groups defined for the study group:The treatment group(n=11);Untreated group(n=9) and control group(n=7),the three groups were aged 7-13 years,(mean age: 8.9±1.3= years).

There was a significant difference in the group using preorthodontic appliances,in masseter muscles before and after with pvalue<0.0001,there was also a significant difference before and after using preorthodontic exercise device with pvalue<0.001.No significant difference was found in the group not using preorthodontic exercise devices and the control group in each studied.Examination and measurement with dentosmartEMG in children,showed significant differences between treatment group,untreated group and control group.

There is a significant change in the improvement function of the craniocervico mandibular system in the normal physiology with myofunction therapy.Physiologically ideal facial and tongue muscle performance is a key factor in producing normal maxillary growth development and enabling correct tooth position.Myofunctional therapy able to restore normal resting posture of the tongue according to the pattern of oral muscles,and face nasal breathing,normal lip posture and proper swallowing pattern

Clinical article (J Int Dent Med Res 2022; 15(2): 656-668)

Keywords: Malocclusion, myofunctional therapy, eletromyography activity.

Received date: 21 February 2022 **Accept date:** 25 March 2022

Introduction

Oral Myofunctional Therapy (OMT) is defined as "treatment of dysfunction of the muscles of the face and oral cavity, with the aim of improving orofacial functions, such as chewing and swallowing and supporting nasal breathing." OMT is also used to perform interceptive treatment of anterior open bites[1-6]. In the early 20th century, Angle stated that abnormal oral soft tissue pressure and respiratory problems were important factors in the development of malocclusion, and if the shape of the ideal occlusive relation can be achieved then the normal function will also be achieved[7,8]. Alfred Rogers (2011) as a myofunctional therapist stated that the proper function of the muscles onthe oral cavity needs to be directed through exercises of the muscles of the oral cavity, in order to form a good occlusion. This exercise is

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then referred to as "Myofunctional Therapy", which is applied in the world of dentistry to date and aims to form new neuromuscular patterns and improve abnormal resting function and posture[7,8]. Straub in *American Journal of Orthodontics* (1960) stated that improper tongue function, bottle feeding, and side sleeping habits and incorrect sleeping position were the main causes of malocclusion. In Obstructive Sleep Apnea (OSA), OMT such as tongue exercises and oropharyngeal exercises can be used as an alternative to surgery[9-12].

Soft Tissue Dysfunction

The aberrant Cranio Cervico Mandibular System (CCMS) complex interaction causes dysfunction of the soft tissues involved to develop continuously during the swallowing process, including the tongue is not in an ideal position in the mouth, lip valves are not kept closed at rest and breathing occurs through the mouth. Furthermore, aberrant forces transmitted directly to the teeth and jaws by the tongue, including the conduction of forces from the masseter, buccinators and mentalis muscles, will negatively affect maxillary and mandibular growth[18,19]. Any deviation that occurs in the performance of oral function is defined as soft tissue dysfunction. This causes deviations in craniofacial growth and development[19,20].

It is important to know how the facial muscles (masseter, temporalis, mentalis) and tongue transmit forces (contractions) to the teeth to stimulate maxillary and mandibular growth, and maintain teeth in the correct position.[21] Understanding the physiological activity of muscles related to oral function provides the ability to identify the cause of the problems observed with changes in the shape and size of the maxilla, as well as in the position of the teeth[21,22].

The masseter and buccinator are the main muscles of the cheek and are attached to the maxilla and mandible[23]. At rest, the pressure of the masseter and buccinators on the buccal side of the mandibular posterior teeth is equivalent to that released by the tongue on the lingual side, about 2g/cm2. On the other hand, the pressure on the maxillary posterior teeth delivered by the masseter and buccinators muscles is higher than on the lingual side of the tongue[2.7], compared to 1.0g/cm^2 [24]. However, this pressure changed during chewing and swallowing. During mastication, the buccinators are very active at the beginning of the closing motion, producing tension on the attachment site[25]. The pressure on the lingual side of the maxillary posterior teeth is greater than on the buccal side, therefore, balance is achieved when the position of the posterior teeth is maintained by the force of the cheek and tongue. This normal pattern will change in patients when there are deviant oral habits, such as pushing the tongue, sucking fingers, including breathing through the mouth. For example, in suctioning patients, buccal pressure on posterior teeth delivered by buccinators can increase up to 21 g/cm^2 and cheek pressure on canines to three to four times higher, reaching values up to 80g/cm^2 [26-28.35]. Improvement pressure on the arch with greater cheek and lip pressure on the posterior teeth including the canine area results in a narrow maxillary arch with a triangular shape[29]. Therefore, neutralizing the forces transmitted by the masseter and buccinators muscles on the buccal aspect of the posterior teeth including the canines, is a key factor when stimulating mandibular and maxillary growth and development during treatment[30].

The mentalis muscle is attached to the body of the mandible at the root of the mandibular incisor and to the skin of the chin in the mentolabial sulcus. Its function is to lift and promote the lower lip and skin of the chin.[23,31] The mentalis muscle helps keep the lower lip in a centric position and increases its activity when the activity of the lower orbicularis oris decreases.[31] In certain situations, the mentalis muscle acts as an antagonist to the orbicularis oris muscle. For example, in patients with mouth-breathing habits, swallowing activity of the mentalis muscle is higher than that of the lower orbicularis oris muscle.[31,32] In addition, mouth-breathing alters craniofacial growth and posture leading to head hyperextension, retrognathic movement of the mandible, and increased facial size on the lower part, the hyoid bone is lowered, and the tongue is in an anterior-inferior position, causing decreased orofacial muscle tone and improvement on overbite and overjet[39].

Swallowing dysfunction is characterized by abnormal movement of the tongue pushing anteriorly or laterally against the dental arches during the swallowing process.40 The percentage of swallowing disorders in children with abnormal development is between 25% and 35%[40,41]. Since malocclusion produces changes in the muscles of mastication, so do these patients. In children with swallowing dysfunction, the strength of tongue contractions is altered and results in changes in the electrical activity of the perioral muscles[42,43]. Orofacial muscles such as the masseter, temporal, mentalis and orbicularis oris muscles work in harmony on oral functions such as swallowing, speaking, and mastication which have an impact on shape and the position of the arch of the jaw thus it will affect craniofacial growth and facial shape to affect the incidence of malocclusion[44-47]. Swallowing dysfunction is directly related to changes in facial morphology that have a direct influence on the occurrence of malocclusion[48,49]. To correct malocclusion or orofacial muscle dysfunction due to For swallowing dysfunction, various types of functional devices are used in Dentistry, especially at the age of child development[50,51]. Several studies have shown that functional appliances, both removable and fixed, produce intraoral forces that modulate postural and functional activity of the masticatory muscles[52,53]. Activity Masticatory muscles are very important to pay attention to during the treatment of cases of malocclusion, such as cases of Class II division 1 malocclusion caused by genetic and environmental factors with large overjet, especially in the success of orthodontic correction and evaluation of changes in facial posture of a child[46-48]. One of the methods to evaluate facial muscle activity, surface electromyography is the most widely applied technique in dentistry today. In addition, several other non-invasive methods such as myoscan analysis and dynamometry[40,49].

Research objective of this study is to analyze the effect of using a myofunctional device in combination with myofunctional exercise by evaluating the strength of the perioral muscles (i.e. tongue, lips, temporalis muscles, masseter muscles and mentalis) through Dentosmart electromyography (EMG) measurements in malocclusion patients in children with large overjet. Evaluation of the examination is carried out during the resting position, swallowing and clenching (chewing)[50-55].

Myofunctional pre-orthodontic device excessive overjet

Myofunctional devices have been widely used in Europe since the 1930s, especially focusing on changes in muscle conditions that affect the position and function of the mandible[56,57]. Myofunctional devices in correcting protrusive malocclusion with excessive overjet combined with tooth and bone modification effects are performed with the mandible positioned downward future[18,58]. To optimize treatment for changes involving skeletal factors, myofunctional treatment should be performed during the pubertal growth spurt. Various tools have been used to deal with this problem, the prefabricated functional device (PFA) used in this research is the myobrace device (Myoresearch system).[13,59-65] This removable appliance is made of a soft elastomeric material and incorporates a soft tissue barrier around the teeth, in addition to a frankel wire in the center of the appliance as a reinforcement. Myofunctional devices aim to correct malocclusion at the age of growth and development of children and have the effect of functional correction, lateral expansion of maxillary teeth, correcting crowding of anterior teeth, and facilitating mandibular bone growth[13,66-72]. These devices are combined with myofunctional exercises on muscle physiological function and facial cavities, by combining functional software design (forward mandibular posture) with eruption guidance (soft tissue protection) [13,73]. Prefabricated functional devices are now increasingly being developed by adjusting the device material including size so that it can be adjusted to the size and width of a person's jaw. Prefabricated myofunctional devices are also used only part time (myobrace) although other types of functional devices are often used full time (Twin Block, Herbst)[56].

Clinical impact and treatment time Myofunctional devices

In general, myofunctional appliances are able to correct several types of individual malocclusions in the growth and development phase, several studies have shown that myofunctional devices can stimulate and increase the length of the mandible by about 2-4 mm compared to no treatment [13-18,73]. Tooth changes can occur through the lingual tipping process of the mandible upper incisors, overjet reduction, overbite reduction, overcrowded lower incisors and Class II to Class I molar positioning. Myofunctional devices are recommended as treatment for the early mixed dentition phase especially during the pubertal growth spurt. It should be noted that correction of Class II malocclusion, especially in overjet reduction after the pubertal growth stage, requires an indication of considerations such as the risk of trauma, psychological problems and trauma overbite[13,73].

Materials and methods

A total of 21 pediatric patients who came to RSGM UNHAS and were recorded with their parents before with an average age of 6.9 ± 1.3 years, classified as class II jaw relationship with excessive overjet. Patients were selected from a group of 43 children examined. Patients who met the inclusion criteria were invited to participate in this study and they were informed on consents to follow the Research Ethics of the Faculty of Dentistry, Hasanuddin University and have been registered (Ethical Approval Recommendation No. 0144/PL.09/KEPK FKG-RSGM UNHAS/2019). Exclusion criteria were history of chronic inflammatory disease, rhinitis, craniofacial disorders. The inclusion criteria were: pediatric patients with overjet more than 4 mm, no history of sleep problems (snoring, apnea, and restless sleep), pediatric patients without previous orthodontic treatment, no tonsils / adenoid hypertrophy, and no malformations or systemic disease may affect the response to the research process and follow-up care.

Of the 21 children who were initially selected, there were only 11 children who were willing and accepted to participate in the study and formed a group of children who received treatment. The group was then instructed to wear a pre-orthodontic appliance (myobrace myofunctional trainer) two to three hours during the day at rest, and at night while sleeping until the morning with the lips pressed together. A total of 9 other children refused to use the pre-orthodontic appliance (trainer), the group was the control group as the untreated group. As a normal control group in the study, 7 children with the same age with class 1 malocclusion were invited to participate in this study. Thus, three groups were defined for the study group: The treated group (n = 11); The untreated group (n = 9) and the normal control group (n = 7), with a total of 27 pediatric patients involved in the study. The use of a pre-odontic appliance (myobrace myofunctional trainer) at home involved the help of the parents of the children in the treated group. From the three groups, they were further grouped based on the activity of the physiological functions of the oral cavity, namely observations and measurements during swallowing and when clenching teeth. This grouping was based on measuring the strength and weakness of the effects of masticatory muscle contractions when performing stomatognathic physiological functions in pediatric patients in this study. Surface EMG activity of the right and left Masseter muscles, Anterior Temporalis muscles and mentalis muscles was recorded and recorded using an E-dentosmart electromiograph which has passed the formality of use (Patent No. Kemenkumham Republic of Indonesia: HKI 3-HI.05.01.02.S00201907890). The skin was cleaned and then moisturized with a conductive paste prior to electrode placement. EMG recordings were obtained 5-6 minutes later and the EMG signal was amplified. EMG activity was recorded in the LCD monitor (μV=microvolts). During recording, the patient sat with his head held high against the dental unit, with his legs straight on the floor.

Working mechanism of the dentosmart EMG device

The dentosmart electromyography device consists of several components, namely in Figure (1), namely: 1. Surface electrode as a signal receiver for the masseter, temporalis and mentalis muscles; 2. Battery as power supply; 3. Raspberry pi as single-board circuit; 4. Android smartphone as a display of the diagnosis results by using the application; 5. Electromyography as a recorder of the electrical activity of muscles and ic (integrated circuit) MCP3008 as a signal converter; 6. 5 inch LCD as the interface display of the data operating system.

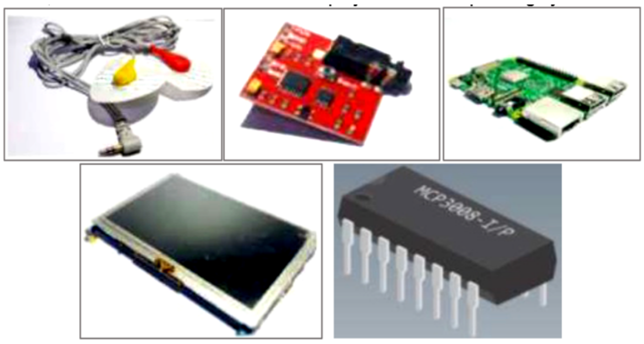

Figure 1. Components of dentosmart electromyography.

In figure (2). The Body component which is data processing starting from all forms of stimulation received by the sensor will be recorded by the EMG, the surface electrode is connected to the EMG which is then interpreted in the form of a digital signal. EMG components in principle require two 9V power supplies to work properly. Then this signal is received by the MCP3008 IC to convert the signal from analog to digital. This is necessary because the Raspberry Pi device or component can only receive digital signals. From this signal a calculation will be made to determine the level of abnormalities or problems experienced by the Masseter, Temporalis and Mentalis muscles.

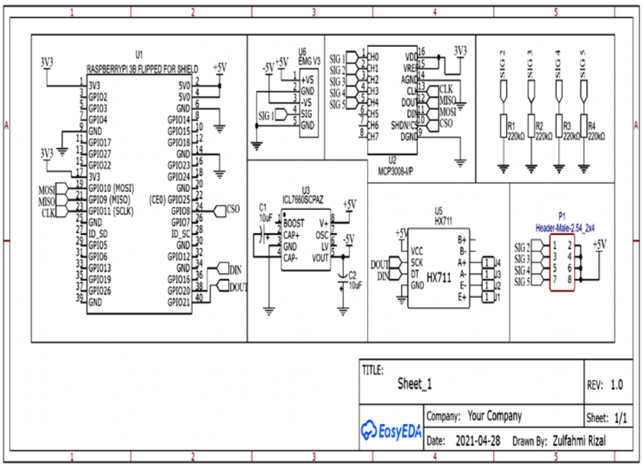

Figure 2. Component design of body Elektromiography (EMG) Dentosmart.

In figure (3) the design of the device whose mechanism consists of, 1. surface electrode sensors attached to the Massester, Temporalis and mentalis muscles to detect the electrical activity of these muscles, and determine whether the muscles are contracting or not, 2. Body components that have been described in figure (1). 3. 5 inch LCD, on the raspberry pi component, an lcd is also needed as the interface of the operating system installed on the raspberry pi to program and control the raspberry pi itself. 4. Output using an android Smartphone, the program made in the form of calculations that will be carried out by the Raspberry Pi which will automatically send the diagnosis results to an Android-based smartphone that has been connected via wifi.

Interpretation of abnormal contractions of facial muscles and jaw joints using an android smartphone device whose readings are carried out in 3 conditions, namely biting, relaxing, and teeth clenching/clenching the teeth maximally using numerical limits.

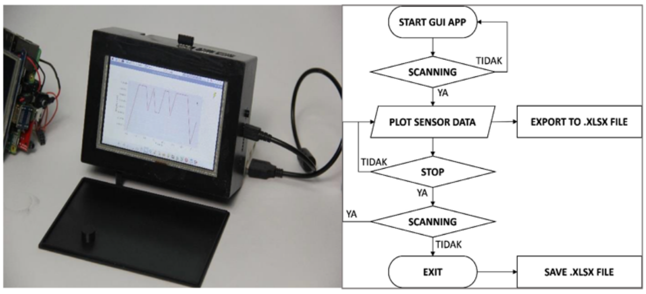

Figure 3. Instruments and working mechanism of Dentosmart Electromyography (EMG).

Dentosmart Electromyography Examination

Placement of a series of EMG devices on the skin using a silver/silver chloride (Ag/AgCl) adhesive with a bipolar electrode surface (Noraxon Dual Scottsdale, AZ, USA) placed on the left and right anterior temporal muscles, the superficial masseter muscle on the left and right parallel to muscle fibers, as well as in the chin area (mental muscles). The skin area for EMG insertion was cleaned with 70% ethyl alcohol and dried with the cotton swab used before electrode placement. EMG recordings were taken 5 minutes after EMG placement in the specified muscle area. The electrical activity of the temporal and masseter muscles was measured using electromyography with three tests: (1) masticatory muscle activity in the clinical resting position; (2) minimal contraction when swallowing and (3) maximum contraction in the intercuspal position where the patient is asked to clench as hard as possible for 5 seconds; A rest period of at least 5 minutes is permitted between each of these recordings. The movement was repeated at least three times to ensure stability was achieved.

The first movement pattern was stopped, as was observed differently on the other two repetitions. In one subject, all EMG data were calculated from the last two EMG records. The patients were allowed to relax for 1 minute in each activity. The EMG signal were amplified, digitized, and digitally filtered. The Dentosmart suite of tools was linked to a data computer that presented the data graphically and recorded it for further quantitative and qualitative analysis. The basic components of the analysis of data obtained from each patient after the process of swallowing, mastication, resting position and cleaning. Normalization of the data was carried out according to the following formula: the mean value (μV) during the swallowing position or the average value (μV) during the maximal contraction in the clenching position. For each muscle, the EMG potential was expressed as a percentage of the maximal contraction value (unitV/V% units).

The data collected in Phase 1 were analyzed statistically by the Tukey Kramer test (evaluation), Kruskal-Wallis test (evaluation b) and Student's t test (evaluation c); The data collected in Stage 2 were statistically analyzed by ANOVA and Tukey-Kramer, except for cases with non-normal data distribution which were analyzed by Kruskal-Wallis non-parametric test.

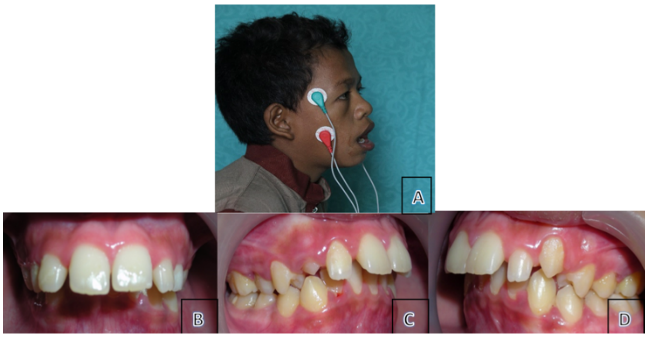

Figure 4. Intraoral photo of one of the patients who participated in this study (A) View of the dentosmart EMG device installation; (B) Anterior view of teeth before treatment: (C & D) Left and right lateral views of tooth occlusion before orthodontic functional appliance treatment.

This image of figure 4 shows a patient in the orofacial muscle strength examination with an electromyography device. Patients with large dental over jets before treatment with myofunctional therapy were asked to open their mouths to see how much muscle strength was generated.

Orofacial Muscle Function Exercise

The use of a removable device consisting of a series of intraoral devices placed in the oral cavity for two hours daily at rest plus a night during sleep in this study was combined with myofunctional exercises. Myofunctional exercises were carried out two to three times a day in the form of a series of breathing exercises using the nose, tongue muscle exercises, swallowing exercises, and lip and cheek exercises directed and trained by dentists who have received previous myofunctional training. Orthodontic functional devices are expected to help correct aberrant oral muscle habits and widen the shape of the arch while exerting the strength of the orofacial muscles to align the teeth and jaw.

The first stage of myofunctional exercise treatment was correction of bad habits by directing and teaching the treated patients in this study to breathe through the nose, and avoid breathing through the mouth, then train the tongue position to be in the correct position (proper tongue position is proper tongue placement). Above the palate of the oral cavity, the tip of the tongue is about 1/2 inch behind the front teeth). The entire body of the tongue (including the back of the tongue) should be pressed against the palate, and the lips should be kept closed and the teeth not in contact, then direct the patient to swallow correctly and keep the lips closed when not eating or speaking (rest position).

The first exercises for the tongue helped to get an idea of the shape of the oral cavity and where the tongue was located. The first tongue movement felt the back of the incisor with the tip of the tongue. The second exercise was how to feel when the posterior part of the tongue is at rest. Next make a big smile and wide open lips. The next step is to swallow while keeping your teeth clenched. In this exercise session, the patient will feel the back of the tongue pressing against the roof of the oral cavity (palate).

Statistical analysis was carried out using IBM SPSS Statistics for Windows Software, version 21 (IBM Corp., Armonk, NY, USA). Outcomes in individual groups were tested with paired t-tests to determine significant changes for each group. Then, the difference between the EMG values recorded before treatment and after treatment for 6 months was calculated. Data analysis using two-way ANOVA followed by Post Hoc LSD (Least Significant Difference) test with a significance level of 95%. Pearson correlation test was conducted to see a strong relationship between variables.

The study sample consisted of patients who received treatment with myofunctional devices and those who did not receive treatment and were instructed to fill out an initial basic myofunctional assessment form, namely personal data of patients involved in the study, overjet and overbite calculations before using myofunctional devices and myofunctional exercises, breathing patterns (nose or mouth), lip attachment (competent or not), lip strength (normal or not), and tongue position at rest and during swallowing (normal or abnormal), shoulder movement during swallowing, and spontaneous eye blinking when swallowing and clenching (table). 1). Myofunctional exercises were given to treated patients that involve the tongue, soft palate, and are designed to improve suction, swallowing, chewing, breathing, and speech functions.

Variable	MT group (n=11)	No-MT group (n=9)	Normal Control (n=7)
Sex:			
Female (n=)	8 (0,7%)	6 (0,6%)	5
Male (n=)	3 (0,3%)	3 (0,3%)	2
Overjet (> 4mm)	11 (100%)	9 (100%)	0
Overbite (> 4mm)	10 (0,9%)	7 (0,7%)	0
Oral breathing (%)	9 (0,8%)	7 (0,7%)	0
Lip incompetence (%)	10 (0,9%)	9 (100%)	1
Lip hypotonia (%)	9 (0,8)	7 (0,7%)	1
Normal tongue resting position (%)	2 (0,18)	2 (0,2%)	6
Normal tongue position during swallowing (%)	2 (0,18)	3 (0,3%)	7
Shoulder movement when swallowing	9 (0,8%)	8 (0,8%)	0
Spontaneous eye blinking when swallowing and clenching	9 (0,8%)	8 (0,8%)	1

Table 1. Initial Myofunctional Evaluation of Two Groups of Children and Control.

The use of myofunctional devices (myobrace) at home is monitored and recorded by parents and shows data that the level of cooperation of pediatric patients who receive treatment is quite good and adaptive. Pediatric patients in the group that received treatment with myofunctional devices slept regularly, and were able to keep the device in the mouth throughout the night while sleeping. Some patients can also use the device during the day, namely during breaks to watch television, or while playing games. Likewise at night, patients can cooperatively use the device in the mouth, although there are still those who must be assisted by their parents at the beginning of use. Some complaints were in the form of side effects felt by patients at the beginning of using the tool, namely pain in the teeth and fatigue in the facial area in the morning after removing the instrument from the mouth. These complaints were felt during the first two to three weeks of treatment, and after that the patient can adapt back to the device later to continue the treatment process.

Results

This table 2 shows the Dentosmart EMG measurement when the patient made swallowing movements, in this table there is a significant difference in the group using pre-orthodontic appliances, in the left and right masseter muscles before and after with a p value <0.0001.

In the left and right temporal groups, there was also a significant difference before and after using the pre-orthodontic exercise apparatus with p<0.001. Similarly, in the mentalis muscle, there was a statistically significant difference. On the other hand, no significant difference was found in the group not using pre-orthodontic exercise devices and the control group in each muscle that studied.

Muscle	Pre-Orthodontic Device Wearing Group						
	Before	SD	After	SD	Difference	SD	p-value
Left Masseter	212.75	± 26.24	457.4	± 67.36	-324.65	±68.82	***
Right Masseter	213.38	± 29.91	472	± 68.29	-328.62	±69.24	***
Left Temporalis	234.09	± 28.45	438.8	± 71.21	-264.71	±70.89	**
Right Temporalis	224.47	± 29.49	439.8	± 69.34	-245.33	±70.40	**
Mentalis	276.43		410.22		-233.79		
	Kelompok Tidak Memakai Piranti Pra-Ortodonti						
	Before	SD	After	SD	Difference	SD	p-value
Left Masseter	210.32	±24.39	388.7	±43.35	-178.38	±37.86	NS
Right Masseter	248.22	± 23,84	392.2	±42,38	-93.98	±36.28	NS
Left Temporalis	229.31	± 21.80	388	±42.27	-88.69	±37.53	NS
Right Temporalis	208.47	± 21.64	385.7	±43.88	-107.23	±38.34	NS
Mentalis	282.18		365.22		-163.04		
	Kelompok Kontrol Normal						
	Before	SD	After	SD	Difference	SD	p-value
Left Masseter	422.28	± 74.19	457.1	±50.89	-64.82	±45.07	NS
Right Masseter	429.17	±74.49	472.6	±49.97	-63.43	±45.76	NS
Left Temporalis	420.52	±71.72	463	±51.11	-2.48	±45.14	NS
Right Temporalis	419.17	±71.01	442.5	±51.58	-13.33	±45.16	NS
Mentalis	410.22		411.02		-0.8		

Table 2. Dentosmart Measurements on Ingestion EMG.
**= P<0,001; ***= P<0,0001; NS= No statistical significance.

Muscle	Pre-Orthodontic Device Wearing Group						
	Before	SD	After	SD	Difference	SD	p-value
Left Masseter	202.75	±26.24	564.4	± 67.36	-431.65	±68.82	***
Right Masseter	223.38	± 29.91	557	± 68.29	-423.62	±69.24	***
Left Temporalist	204.09	±28.45	563.8	± 71.21	-419.71	±70.89	**
Right Temporal	214.47	±29.49	557.8	±69.34	-393.33	±70.40	**
Mentalist	276.43		534.7		-348.36		
	Group Not Wearing Pre-Orthodontic Device						
	Before	SD	After	SD	Difference	SD	p-value
Left Masseter	210.32	±24.39	328.5	±43.35	-218.18	±37.86	NS
Right Masseter	238.22	± 23,84	312.2	±42,38	-113.98	±36.28	NS
Left Temporalist	219.31	± 21.80	332	±42.27	-132.69	±37.53	NS
Right Temporal	208.47	± 21.64	337.7	±43.88	-159.23	±38.34	NS
Mentalist	292.18		365.29		-263.11		
	Kelompok Kontrol						
	Before	SD	After	SD	Difference	SD	p-value
Left Masseter	522.28	± 74.19	539.19	±50.89	-116.91	±45.07	NS
Right Masseter	529.17	±74.49	573.23	±49.97	-164.06	±45.76	NS
Left Temporalist	520.52	±71.72	558.31	±51.11	-167.79	±45.14	NS
Right Temporal	519.17	±71.01	569.11	±51.58	-159.94	±45.16	NS
Mentalist	510.22		522.23		-112.01		

Table 3. EMG Clenching Measurement.
**= P<0,001; ***= P<0,0001; NS= No statistical significance.

Table 3 compares before and after using pre-orthodontic exercise equipment when performing clenching movements. In the group using pre-orthodontic exercise devices, there was a significant difference in the left and right masseter groups with p<0.0001. In the examination of clenching movements, examination of the left and right temporalis muscles there was also a significant difference with a p value of <0.001 in the group using pre-orthodontic exercise devices. However, in the group that did not use pre-orthodontic exercise devices and the control group, there was no significant difference in the muscles studied.

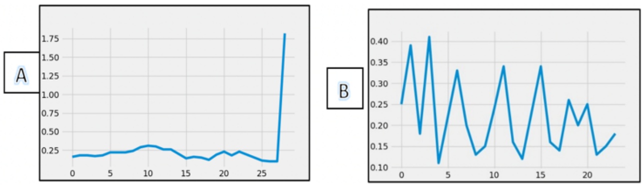

Figure 5. EMG display of tongue muscle strength when swallowing in a normal control group (a) Before treatment and, (b) After 6 months of treatment.

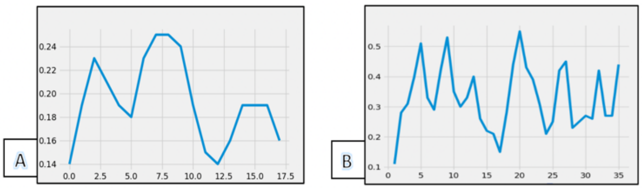

Figure 6. EMG display of lip muscle strength (orbicularis oris) during swallowing and clenching in the treatment group with myofunctional therapy (a) Before treatment and, (b) After 6 months of treatment.

Figures 5 and 6 show an EMG graph of the muscles. The graph in Figure 5 shows the tongue muscle strength in the control group before and after treatment. The graph shows that there is a significant change in the strength of the tongue muscles when used for swallowing.

Figure 6 shows the muscle strength of the aunt during swallowing and clencing in the treatment group with myofunctional therapy. Significant changes in muscle strength were seen on the appearance of the EMG device before treatment and after 6 months of treatment.

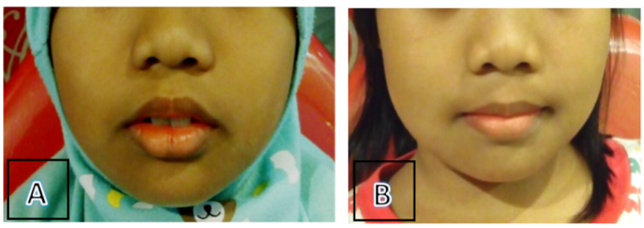

Figure 7. Intraoral photograph of one of the patients participating in this study who received orthodontic myofunctional appliance treatment (A) Before (B) After treatment.

The clinical appearance of the face of one of the pediatric patients who took part in the study who received myofunctional therapy (figure 7) showed changes in facial posture, especially on the lips before being incompetence (figure 7A) and after the treatment resulted in competent lips (figure 7B). Similarly, in the previous overjet size, the overjet distance was 5 mm, but after treatment it resulted in an overjet of less than 2 mm. There is a significant change in the improvement of the function of the craniocervico mandibular system in the normal physiology of the maxilla and mandible with myofunctional therapy[74,75].

	MT group (11)			No-MT group (9)		
	T0	T1	p^a	T0	T1	p^a
	11	11		9	9	
Oral breathing	15 (83.3)	3 (16.6)	0.0002	15 (83.0)	14 (78.0)	1.0
Lip incompetence	11 (61.1)	7 (39.0)	0.3	8 (44.4)	9 (50.0)	1.0
Lip hypotonia	14 (78)	6 (33.3)	0.003	13 (72.0)	12 (66.7)	1.0
Abnormal tongue resting position	17 (94.4)	12 (66.6)	0.03	16 (88.8)	16 (88.8)	1.0
Abnormal tongue position during Swallowing	15 (8.3)	11 (61.1)	0.3	15 (83.3)	15 (83.3)	1.0

Table 4. Myofunctional evaluation of T0 and T1 MT myofunctional therapy. [a]Chi-square test.

Examination and measurement with dentosmart EMG in children, showed a significant difference between the treatment group (miofunctional trainer), the untreated group (non-MT) and the control group (Table 2). When we compared the dentosmart-EMG measurements in the MT group before and after 2 months of treatment, we observed significant improvement in all parameters, whereas no difference was observed in the non-MT group. Myofunctional evaluation improved after 2 months of treatment in 18 children, as shown by a reduction in oral breathing habits and lip hypotonia (Table 3).

Lip posture group during clinical swallow evaluation.	P-value of lip posture during clinical swallow evaluation.	Group mentalis muscle contraction during swallowing.	P-value of mentalis muscle contraction during swallowing.
Group C X Grup T1	p<0.01*	Group C X Grup T1	p<0.001*
Group C X Grup T2	NS	Group C X Grup T2	p<0.001*
Group T1 X Grup T2	p<0.01*	Group T1 X Grup T1	NS

Table 5. Comparison between groups C, T1 and T2 on lip posture during clinical evaluation of swallowing and on mentalis muscle contractions during swallowing.

Table 4 shows a significant comparison of the values between the lip posture group during clinical evaluation of swallowing and the mentalis muscle contraction group during swallowing. Where the value of aunt's posture during clinical swallowing evaluation is greater, namely p<0.01 when compared to the value of mentalis muscle contraction when swallowing, which is p<0.001.

Evaluation of lip posture during swallowing showed that 58.8% of group T1 and 100% of group C displayed lip seals, whereas 41.7% of group T1 showed interposition of the lower lip with respect to the maxillary incisors. On the other hand, 100% of the T2 group had lip flaps during this function. Comparing group C with groups T1 and T2. Mentalis muscle contraction was observed in 70.5% of the T1 group, whereas 64.7% of the T2 group and 100% of the C group did not show these contractions during swallowing (Table 1).

In table 5 the evaluation of the evaluation of lip posture after completion shows that in the group receiving functional therapy, improvements in the group undergoing myofunctional therapy. In the lip incompensation examination, there was a decrease in the group receiving myofuntional treatment and in the group not receiving treatment there was no change. Likewise in oral breathing, lip hypotonia, abnormal tongue rest position, and swallowing.

Tongue strength (kPa)	MT group (11)	No-MT group (9)	Control group (7)	p values[a]
	31.9 ± 10.7	32.4 ± 9.4	± 13.6	Healthy vs no-MT group, <0.001 Healthy vs MT group, <0.001 MT group vs no-MT group, 0.5
Peak pressure (kPa)	34.2 ± 10.2	34.4 ± 9.9	± 12.7	Healthy vs no-MT group, <0.001 Healthy vs MT group, <0.001 MT group vs no-MT group, 0.9
Endurance (s)	28.1 ± 8.9	23.3 ± 5.9	± 7.2	Healthy vs no-MT group,

Table 6. Differences in Dentosmart-EMG measurements between the three groups of children AMann-Whitneyy-test.

Discussion

Oral habits such as mouth breathing, abnormal swallowing, thumb sucking, lip sucking, and nail biting can directly affect the quality of life and the stomatognathic system and results in poor jaw development. In the study of myofunctional therapy, one of the most important ways to improve it is to maintain the balance of the muscles around the oral cavity, avoiding dysfunction through several ways such as swallowing with the correct tongue position, lips remain competence and breathing through the nose[13,15,17]. The aim of the study was to evaluate the activity of the EMG muscles in the Temporalis, Masseter and mentalis muscles in three conditions, namely rest position, swallowing and clenching. The results of this study are expected to lead to the conclusion that changes in the load contraction conveyed by the masticatory muscles of the maxilla and mandible, both in the resting position and in the maximum functional state (swallowing and clenching) are achieved in malocclusion patients with large overjets during treatment by using functional trainer tools and myofunctional exercises regularly and consistently.

The results of this study showed that the contraction strength of the Temporalis muscle, Masseter muscle and mentalis muscle on the evaluation of muscle contraction strength using electromyography (EMG Dentosmart) significantly increased in patients who were treated for a period of 6 months with a combined myofunctional appliance (pre-orthodontic trainer). with myofunctional exercises. With this myofunctional exercise, it is expected to be able to correct bad oral habits as in the study of Begnoni G, et al (2020) which explained that myofunctional therapy is effective for improving swallowing disorders by activating the pattern of muscular physiology,[77] therefore pediatric patients with malocclusion such as class II division 1, irregular teeth (crowded) and jaw growth that is not harmonious will have the best chance to have the growth and development of teeth and jaws of the right size and wide enough to allow the teeth to erupt and occupy their ideal position. Comparison of the strength of the contractions of the masticatory muscles observed during the initial EMG examination and after treatment using a myofunctional device while performing the stomatognathic physiological function of mastication showed significant differences, both statistically and clinically in the facial appearance of pediatric patients who were included in the study (Fig. 7). Patients with overjet conditions that exceed normal standards, exhibit tongue movement characteristics that are related to their morphological characteristics. In patients with a large overjet, the tip and dorsum of the tongue are positioned anteriorly and inferiorly at rest and the tip of the tongue is more protrusive during mastication and swallowing[78, 79]. The posture of the tounge on the patients with overjet would usually in between the lower incisor anterior surface and palatal surface of the maxillary incisors, thus pushing the maxillary anterior teeth forward and conversely the mandibular front teeth are underdeveloped.

The results of the electromyography assessment were shown by the results of the electromyographic amplitude with two different conditions, namely during swallowing and during tooth clenching with changes in the strength of contraction between the treated group, the untreated group and the normal control group. This also confirms the observed results that EMG muscle activity in patients with large overjet who did not receive treatment (myofunctional devices) showed a lack of development of masticatory muscle strength as measured over the same period. Our study data conclude that orthodontic myofunctional trainer positively affects masticatory muscles and anterior mandibular developmental changes. This study also showed that there was a significant change in the improvement of the function of the craniocervico mandibular system in the normal physiology of the maxilla and the mandible.

Our results are in line with the results of a previous study by Ramirez (2014) which stated that treatment with a pre-orthodontic trainer device significantly increased the amplitude of EMG activity of the Temporal and Masseter muscles in the clench position in patients with Class II division 1.73 malocclusion. The study showed that functional appliances were able to increase post-treatment EMG muscle activity to the same level in patients with normal dental occlusion (normal controls). Helkimo (1977), in his research suggested that masticatory muscle activity during maximum contraction of the muscles involved depends on occlusal factors such as the number of posterior occlusal contacts. A higher number of posterior contacts determines a more stable intercuspal support, this condition ultimately allows the masticatory muscles to reach a higher level of muscle activity during the clenching and chewing processes[89].

The data in our study are also in line with Riise's (1982) study which stated that temporal muscle activity at rest and functional activity was greater when there was occlusal disturbance. Long-term hyperactivity of occlusal disturbances can be followed by structural adaptations, such as tooth movement, muscle reactions, and remodeling of the temporomandibular joint even further causing pathological conditions that can alter the stomatognathic system[90-92]. Usumez S, et al (2004) reported in his study that pre-orthodontic trainers induce forward mandibular position changes in patients with Class II division 1 malocclusion, because the angles of the SNB and ANB are significantly increased. These results have proven that the clinical changes in the oral cavity, especially the mandible that are observed when treating with functional appliances are the result of increased muscle activity and not of mandibular growth. This result was caused by an increase in muscle activity, which allows for mandibular anterior movement and reduces the Class II sagittal relationship[93]. Uysal T, et al (2012) reported that pre-orthodontic trainers increased the muscle activity of some of the Temporal masticatory muscles, Masseter muscles and muscles of EMG mentality. The increase in masticatory muscle activity is indicated by the amplitude results related to the force generated by contractions in the treated muscles.[94] These results confirm our study that there was an increase in masticatory muscle activity seen in the amplitude results of the study group that received functional equipment and muscle training treatment of orofacial.

Orofacial myofunctional disorders must be viewed in their entirety when oral dysfunction affects the growth and development of oral structures[83,84]. The ability to breathe through the nose with the tongue in a normal position over the palate and the lips closed are essential for optimal craniofacial growth and development[85]. This is the basis for our research on the need for myofunctional exercises to support the use of myofunctional pre - orthodontic appliances (myobrace). Aberrant orofacial muscle pressure on the facial bones can affect growth over a period of time. Incompetence of the lips can push and change the position of the upper incisors[86]. Palatal-lingual stability maintains the palatal arch and supports the mid and lower anterior faces. Low resting posture of the tongue and inability to close the lips due to low activity of the orbicularis oris and buccinator muscles correlate with Class

II and Class III malocclusions [87-89].

Dental clinicians or practitioners have applied various therapies in cases of pediatric malocclusion in the growth and development process, from simple treatments in the form of preventive education to more comprehensive treatments using orthodontic appliances. Cases rather than finding and addressing the etiology (causes) of problems that arise will result in less-than-optimal treatment outcomes, even failure due to relapse (relapse) in the future because they are not directed to a treatment mechanism that truly addresses soft tissue dysfunction as the cause. Major cause of malocclusion from a physiological point of view. Therefore, knowing the need for malocclusion treatment is important for clinicians to know so that the determination of action can be in accordance with risk factors and the type of malocclusion that occurs for the success of a treatment[96]. Myofunctional exercises involving the muscles of the face and neck aim to improve proprioception, tone and muscle mobility, as well as improving physiological function in a biofunctional and permanent manner[13,98-102]. Myofunctional devices with a combination of orofacial muscle training are designed to work by changing the mechanism of muscle action reflexively, which allows changes in attitude through exercise, so as to modify muscle movement perioral and tongue position during swallowing toward normal position and function[73]. When soft tissue dysfunction is present, craniofacial growth and development is affected by producing changes in the relationship between the maxilla and mandible, as well as changes in jaw shape. Furthermore, the maxilla does not develop transversely properly and becomes triangular, causing the mandible to be positioned more distally[17]. Even worse, the increased activity of the mentalis muscles pushes the mandible backwards and the lack of transverse development of the maxilla and mandible causes crowding of the teeth, making the problem worse[18].

Conclusion

The strength of contraction of the temporalis, masseter and mentalis muscles on the evaluation of muscle contraction strength using electromyography (EMG Dentosmart) was significantly increased in patients treated over a 6 Month period with myofunctional appliances (pre-orthodontic trainer) combined with myofunctional exercises. Clinical changes on the face of most children in the study who received myofunctional therapy (myobrace) showed changes in facial posture, especially incompetence lips resulting in competence lip posture, as well as reduction in overjet size after treatment resulted in overjet less than 2 mm. There is a significant change in the improvement of the function of the craniocervico mandibular system in the normal physiology of the maxilla and mandible with myofunctional therapy. Physiologically ideal facial and tongue muscle performance is a key factor in producing normal maxillary growth and development and enabling correct tooth position. Myofunctional Therapy is able to restore normal resting posture of the tongue according to the pattern of oral muscles, tongue position, and face; nasal breathing; normal lip posture; and proper swallowing pattern.

Declaration of Interest

The authors report no conflict of interest.

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