MEDICAL SCIENCE MONITOR

CLINICAL RESEARCH

e-ISSN 1643-3750
© Med Sci Monit, 2015; 21: 246-253
DOI: 10.12659/MSM.893111

Received: 2014.11.22
Accepted: 2014.12.15
Published: 2015.01.20

Impact of Functional Appliances on Muscle Activity: A Surface Electromyography Study in Children

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ABCDEFG 1 **Krzysztof Woźniak**
BCDEF 1 **Dagmara Piątkowska**
BCEF 1 **Liliana Szyszka-Sommerfeld**
BC 2 **Jadwiga Buczkowska-Radlińska**

1 Department of Orthodontics, Pomeranian Medical University of Szczecin, Szczecin, Poland
2 Department of Conservative Dentistry, Pomeranian Medical University of Szczecin, Szczecin, Poland

Corresponding Author: Dagmara Piątkowska, e-mail: dagmara_piatkowska@onet.eu
Source of support: Self-financing

Background: Electromyography (EMG) is the most objective tool for assessing changes in the electrical activity of the masticatory muscles.
The purpose of the study was to evaluate the tone of the masseter and anterior temporalis muscles in growing children before and after 6 months of treatment with functional removable orthodontic appliances.

Material/Methods: The sample conisted of 51 patients with a mean age 10.7 years with Class II malocclusion. EMG recordings were performed by using a DAB-Bluetooth instrument (Zebris Medical GmbH, Germany). Recordings were performed in mandibular rest position, during maximum voluntary contraction (MVC), and during maximum effort.

Results: The results of the study indicated that the electrical activity of the muscles in each of the clinical situations was the same in the group of girls and boys. The factor that determined the activity of the muscles was their type. In mandibular rest position and in MVC, the activity of the temporalis muscles was significantly higher that that of the masseter muscels. The maximum effort test indicated a higher fatigue in masseter than in temporalis muscles.

Conclusions: Surface electromyography is a useful tool for monitoring muscle activity. A 6-month period of functional therapy resulted in changes in the activity of the masticatory muscles.

MeSH Keywords: **Electromyography • Masticatory Muscles • Myofunctional Therapy**

Full-text PDF: http://www.medscimonit.com/abstract/index/idArt/893111

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

Background

The cause-and-effect relationship between function and morphology has been reported in many previous studies, which indicates the paramount role of function over shape [1–3]. The treatment of malocclusions during the growth period through the use of functional orthodontic appliances is therefore justified, and thus achieves equilibrium in the masticatory muscles and consequent further harmonious development of the jaws.

There are many types of functional removable appliances that produce changes through various mechanisms, but in essence they all create a pattern of functions that encourages a new morphological pattern in dental and skeletal facial structures [4]. The main reason for using functional removable appliances is to establish muscular balance, eliminate oral dysfunction, and allow for proper grown of both the maxilla and the mandible. Another purpose has been to correct or diminish maxillary incisor protrusion [5]. Monitoring muscular activity during the course of functional treatment can be helpful in guiding the therapy [6].

Changes in muscle activity has been analysed through many supplementary studies [7–10]. EMG is an element in the quantitative assessment of patients in dentistry [11], and the most objective and reliable diagnostic tool for assessing changes in the electrical activity of the masticatory muscles, thus determining the effectiveness of the orthodontic procedures applied. In children, surface electromyography (sEMG) is commonly performed because it is a non-invasive and easy way to monitor muscle activity through the use of surface electrodes instead of a needle or fine wires used in the intramuscular type of electromyography.

The purpose of this study was to evaluate the tone of the masseter and anterior temporalis muscles in growing children before and after 6 months of treatment with functional removable orthodontic appliances. Additionally, muscle symmetry, Activity Index, and Torque coefficient before and after 6 months of therapy were also analysed.

Material and Methods

Sample

We selected 51 patients with a mean age 10.73 (31 girls – mean age 10.78; and 20 boys – mean age 10.65) with Class II malocclusion from the patients referred to the Pomeranian University in Szczecin.

All the patients and their parents gave informed consent to all clinical and electromyographic procedures.

After a conventional clinical assessment, impressions of the jaws were taken and the overbite and overjet were measured on the diagnostic casts. The mean overbite and overjet before treatment were 3.20 mm and 5.52 mm, respectively.

The patients were treated with the following functional appliances: a doppelplatte appliance (32 subjects), an activator (14 subjects), and a Lehmann appliance (5 subjects). The construction bite for the doppelplatte was taken, showing an average protrusion for the mandible of 4.26 mm and 3.46 mm between the first permanent molars. The activator and Lehmann appliances had construction bites with an average of 3.57 mm and 3.60 mm, respectively, in the forward displacement of the mandible, and vertical distances of 3.57 mm and 3.60 mm, respectively, between the first permanent molars. The patients were instructed to wear the appliances for at least 14–16 hours during the day.

A quantitative EMG assessment before and after 6 months of functional therapy was performed as follows.

Instrumentation

EMG recordings were performed using a DAB-Bluetooth instrument (Zebris Medical GmbH, Germany) at the start of the investigation and after 6 months of treatment with the functional appliances. During the EMG examination, each patient was sitting on a comfortable chair without head support. The patients were instructed to assume a natural head position.

Surface EMG signals were detected by 4 silver/silver chloride (Ag/AgCl), disposable, self-adhesive, bipolar electrodes (Naroxon Dual Electrode, Naroxon, USA) with a fixed inter-electrode distance of 20 mm. The electrodes were placed on the superficial masseter and the anterior temporalis muscles on both the left and the right sides parallel to the muscular fibers. The positions of the electrodes were exactly the same as previously described by Ferrario and Sforza [11]. Temporalis anterior muscle: vertically along the anterior margin of the muscle; masseter muscle: parallel to the muscular fibres with the upper pole of the electrode at the intersection between the tragus-labial commissura and exocanthion-gonion lines. The reference electrode was situated inferior and posterior to the right ear [11].

In order to reduce impedance, the skin was carefully cleaned with 70% ethyl alcohol and dried prior to the placement of the electrode. The recordings were performed 5 minutes later.

The DAB-Bluetooth instrument was interfaced with a computer which presented the data graphically and recorded it for further analysis. The EMG signals were amplified, digitized, and digitally filtered.

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

Measurement protocol and EMG data analysis

The first recording for the standardization of EMG potentials was made as described by Ferrario et al. [12]. Two 10-mm thick cotton rolls were positioned on the mandibular second premolars and molars, or on the mandibular second milk molars and the first permanent molars of each patient, and a 3-second maximum voluntary clench (MVC) was recorded. For each muscle, the maximum EMG potentials were expressed as a percentage of this value (unit µV/µV%). This kind of standardization eliminates any variability in results due to skin and electrode impedance, electrode positioning, and relative muscular hypo- or hypertrophy [12–14].

EMG activity was then recorded during 3 different tests:

1. Rest activity of the masticatory muscles was performed in the clinical rest position.
2. Maximum voluntary clench (MVC) – static isometric test – was performed in the intercuspal position and the subject was invited to clench as hard as possible and to maintain the same level of contraction for 5 seconds.
3. Maximum effort test was performed during a 10-second maximum isometric contraction (MVC) of the jaws.

To avoid any effects of fatigue, a rest period of at least 5 minutes was allowed between each of the recordings.

To assess muscular activity as well as the coordination and symmetry of the homologous, synergistic, and antagonistic muscles, electromyographic indices were calculated.

To individualize the most prevalent pair of the masticatory muscles, the Activity Index (Ac) was assessed. It ranges from 0 (no activity of the masseter) to ∞ (no activity of the temporalis muscles) [14].

$$\text{Ac} = \sum_{i=1}^{N}(MR_i + ML_i) / \sum_{i=1}^{N}(TR_i + TL_i)$$

The asymmetry between the activity of the left and right jaw muscles was quantified by the Asymmetry Index (As). It ranges from 0% (total symmetry) to 100% (total asymmetry) [15].

$$\text{As} = \sum_{i=1}^{N}\left|R_i - L_i\right| / \sum_{i=1}^{N}(R_i + L_i)\cdot 100$$

To evaluate a possible laterodeviating effect on the mandible caused by unbalanced right and left masseter and temporalis muscles, a Torque Coefficient (Tc, unit%) was calculated as follows:

$$\text{Tc} = \sum_{i=1}^{N}\left|(TR+ML)_i - (TL+MR)_i\right| / \sum_{i=1}^{N}[(TR+ML)+(TL+MR)]_i \cdot 100$$

Tc ranges between 0% (no torque during the test) and 100% (a significant laterodeviating effect on the mandible) [16].

Statistical analysis

The Kruskal-Wallis test and the Mann-Whitney U test were used to statistically analyze the results. In addition, ANOVA/ANCOVA (Analysis of Variance/Analysis of Covariance) tests were also performed. The level of significance was set at 5% for all statistical analyses.

Results

Rest activity

The results of the EMG recordings in the clinical rest position before and after 6 months of functional orthodontic therapy are presented in Tables 1 and 2.

The rest activity for both the masseter and temporalis muscles was the same in the groups of girls (4.47 µV/µV%) and boys (3.59 µV/µV%). The factor which determined this activity was the type of muscle ($P<0.0005$). The rest activity of the temporalis muscles was higher (4.64 µV/µV%) than the masseter muscles (3.42 µV/µV%).

The 6-month period of treatment did not affect the rest activity of both the muscles. The mean total activity of the muscles before treatment was 4.10 µV/µV%; and after 6 months of therapy it was 3.96 µV/µV% ($P<0.7881$). The process of treatment also did not influence rest activity with regard to the groups of boys and girls ($P<0.6452$), or with regard to particular muscles ($P<0.6881$).

The assessment of masseter activity in relation to the temporalis muscles (Ac) at rest showed higher activity in girls (1.03) than in boys (0.74), $P<0.0929$. The activity index was not influenced by the 6-month functional orthodontic treatment ($P<0.3853$).

The analysis of variance in the asymmetry index (As) did not show any significant difference in either girls (23.19%) or boys (22.63%) ($P<0.8279$).

This index was not affected by the type of muscles ($P<0.2987$) or the treatment procedures ($P<0.4672$).

The analysis of the Torque coefficient (To) also did not indicate any significant influence of the treatment in this respect ($P<0.03055$). Different patterns of changes with regard to this index were observed in the groups of girls and boys ($P<0.0845$).

Maximum voluntary contraction (MVC)

The results of EMG recordings in maximum voluntary contraction before and after 6 months of treatment with functional appliances are presented in Tables 3 and 4.

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System]
[ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica]
[Chemical Abstracts/CAS] [Index Copernicus]

Table 1. Rest activity of the temporalis muscles on both the right and left sides before and after six months of treatment with functional appliances.

Side	Gender	N	Mean	−95% CI	+95% CI	Median	Min.	Max.	SD	SEM
Before therapy										
Right side	Girls	31	4.70	3.38	6.02	3.67	1.25	14.2	3.60	0.65
	Boys	20	4.03	2.81	5.26	2.86	1.50	10.0	2.62	0.58
	Total	51	4.44	3.53	5.35	3.22	1.25	14.2	3.24	0.45
Left side	Girls	31	5.05	3.74	6.35	4.23	1.09	16.6	3.56	0.64
	Boys	20	4.81	2.84	6.78	3.37	0.88	17.2	4.21	0.94
	Total	51	4.95	3.89	6.02	3.75	0.88	17.2	3.79	0.53
After six months of therapy										
Right side	Girls	31	5.40	3.54	7.25	3.59	1.12	21.1	5.06	0.91
	Boys	20	4.73	2.59	6.87	3.54	1.01	20.7	4.58	1.02
	Total	51	5.13	3.77	6.49	3.59	1.01	21.1	4.84	0.68
Left side	Girls	31	4.20	2.95	5.44	3.42	0.94	17.5	3.39	0.61
	Boys	20	4.21	3.10	5.32	3.98	1.18	9.3	2.37	0.53
	Total	51	4.20	3.36	5.05	3.57	0.94	17.5	3.01	0.42

Table 2. Rest activity of the masseter muscles on both the right and left sides before and after six months of treatment with functional appliances.

Side	Gender	N	Mean	−95% CI	+95% CI	Median	Min.	Max.	SD	SEM
Before therapy										
Right side	Girls	31	4.04	2.72	5.37	3.15	0.50	15.4	3.62	0.65
	Boys	20	2.65	1.68	3.63	2.26	0.46	7.5	2.08	0.46
	Total	51	3.50	2.61	4.39	2.40	0.46	15.4	3.16	0.44
Left side	Girls	31	4.83	3.36	6.30	2.93	0.55	13.8	4.01	0.72
	Boys	20	2.69	1.86	3.51	2.44	0.48	6.9	1.76	0.39
	Total	51	3.99	3.02	4.96	2.86	0.48	13.8	3.45	0.48
After six months of therapy										
Right side	Girls	31	3.33	1.96	4.69	2.05	0.25	19.0	3.73	0.67
	Boys	20	2.35	1.75	2.95	1.91	0.63	4.8	1.29	0.29
	Total	51	2.94	2.09	3.80	2.05	0.25	19.0	3.03	0.42
Left side	Girls	31	4.26	2.68	5.84	2.63	0.37	20.5	4.31	0.77
	Boys	20	3.28	2.30	4.26	2.69	1.41	10.8	2.09	0.47
	Total	51	3.88	2.86	4.89	2.67	0.37	20.5	3.61	0.51

The total activity of the evaluated muscles in intercuspal position was slightly lower in girls (98.35 μV/μV%) than in boys (101.38 μV/μV% $P<0.5935$). The factor which determined this activity was the type of muscle fibers ($P<0.0002$). The temporalis muscles had a higher activity (106.19 μV/μV%) than the masseter muscles (93.54 μV/μV%). The sex of the patients did not affect the MVC activity ($P<0.0911$).

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

Table 3. The activity of the temporalis muscles of both the right and left sides during maximum voluntary contraction (MVC) in the intercuspal position before and after functional orthodontic therapy.

Side	Gender	N	Mean	–95% CI	+95% CI	Median	Min.	Max.	SD	SEM
Before therapy										
Right side	Girls	31	102.71	93.08	112.34	100.86	59.95	173.88	26.24	4.71
	Boys	20	106.35	92.69	120.02	103.70	64.30	180.82	29.19	6.53
	Total	51	104.14	96.49	111.79	102.10	59.95	180.82	27.21	3.81
Left side	Girls	31	113.79	102.08	125.49	103.38	71.16	195.45	31.91	5.73
	Boys	20	128.56	108.52	148.59	120.74	51.12	200.31	42.81	9.57
	Total	51	119.58	109.21	129.95	108.67	51.12	200.31	36.88	5.16
After six months of therapy										
Right side	Girls	31	92.46	79.82	105.10	86.05	34.03	168.82	34.46	6.19
	Boys	20	102.42	87.76	117.07	102.96	21.66	150.85	31.31	7.00
	Total	51	96.36	87.00	105.73	96.37	21.66	168.82	33.30	4.66
Left side	Girls	31	94.58	84.60	104.57	97.41	34.85	149.13	27.22	4.89
	Boys	20	108.65	90.61	126.69	112.37	30.33	175.99	38.55	8.62
	Total	51	100.10	90.95	109.24	102.98	30.33	175.99	32.52	4.55

Table 4. The activity of masseter muscles of both the right and left sides during maximum voluntary contraction (MVC) in the intercuspal position before and after functional orthodontic therapy.

Side	Gender	N	Mean	–95% CI	+95% CI	Median	Min.	Max.	SD	SEM
Before therapy										
Right side	Girls	31	92.37	83.07	101.67	92.44	32.93	137.48	25.35	4.55
	Boys	20	92.14	76.39	107.88	91.92	32.00	155.43	33.64	7.52
	Total	51	92.28	84.25	100.31	92.44	32.00	155.43	28.56	4.00
Left side	Girls	31	107.58	98.31	116.86	102.80	60.96	172.23	25.28	4.54
	Boys	20	93.03	75.33	110.72	90.55	24.25	170.05	37.81	8.45
	Total	51	101.87	93.08	110.67	97.87	24.25	172.23	31.28	4.38
After six months of therapy										
Right side	Girls	31	86.98	75.87	98.10	83.66	33.48	144.47	30.30	5.44
	Boys	20	92.58	77.18	107.98	87.41	33.11	159.25	32.90	7.36
	Total	51	89.18	80.42	97.94	85.62	33.11	159.25	31.15	4.36
Left side	Girls	31	96.29	84.54	108.04	91.64	39.45	172.04	32.03	5.75
	Boys	20	87.33	71.39	103.27	86.06	23.74	165.42	34.06	7.62
	Total	51	92.78	83.55	102.00	87.14	23.74	172.04	32.80	4.59

The impact of the 6-month orthodontic therapy for MVC activity of the muscles was on the borderline of statistical significance; this value was higher before (104.57 μV/μV%) than after treatment (95.16 μV/ μV%, *P*<0.0598). This effect was the same in each of the groups of girls and boys (*P*<0.6648). A significant decrease in MVC activity was observed in relation to the temporalis muscles (112.85 μV/μV% before, and 99.53 μV/μV% after therapy; *P*<0.0006).

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

Table 5. Changes in the mean power frequency (MPF%) of muscles during maximum voluntary contraction before and after 6 months of functional orthodontic therapy.

Side	Gender	N	Mean	−95% CI	+95% CI	Median	Min.	Max.	SD	SEM
Before therapy										
Right side	Girls	31	−6.37	−10.15	−2.59	−5.850	−35.65	12.20	10.31	1.85
	Boys	20	−8.85	−13.52	−4.18	−10.85	−28.30	19.95	9.97	2.23
	Total	51	−7.34	−10.20	−4.49	−6.95	−35.65	19.95	10.15	1.42
Left side	Girls	31	−10.40	−14.58	−6.22	−9.650	−33.20	11.15	11.40	2.05
	Boys	20	−13.95	−20.29	−7.61	−13.95	−37.85	8.55	13.55	3.03
	Total	51	−11.79	−15.25	−8.34	−11.20	−37.85	11.15	12.28	1.72
After six months of therapy										
Right side	Girls	31	−2.79	−7.56	1.98	−3.950	−32.35	25.65	13.00	2.34
	Boys	20	−9.21	−15.47	−2.95	−12.10	−37.15	23.25	13.38	2.99
	Total	51	−5.31	−9.08	−1.54	−4.00	−37.15	25.65	13.40	1.88
Left side	Girls	31	−10.22	−14.92	−5.51	−7.750	−42.00	9,10	12.83	2.30
	Boys	20	−9.98	−17.30	−2.66	−13.45	−39.30	24.65	15.64	3.50
	Total	51	−10.13	−14.02	−6.23	−8.65	−42.00	24.65	13.85	1.94

The assessment of the activity index (Ac) for the masseter muscles in relation to the temporalis muscles in MVC indicated higher activity of the masseter in girls (1.01) than in boys (0.86; $P<0.0904$). The influence of 6 months therapy for those activity proportions of both muscles was at the limit of statistical significance ($P<0.0724$). The relative increase of the masseter activity after functional orthodontic treatment was noticeable (Ac=0.86 before therapy, and Ac=0.99 after therapy) in both groups – girls and boys ($P<0.9751$).

Multivariate analysis of variance in the asymmetry index (As) did not show any significant differences in girls (9.44%) and boys (9.89%, $P<0.7902$). Neither the type of muscles ($P<0.3902$) nor the functional therapy ($P<0.2962$) determined the averages for this index.

The torque coefficient index (To) was significantly higher in boys (7.56) than in girls (5.02; $P<0.0269$) and it was not influenced by orthodontic therapy ($P<0.7751$).

Maximum effort

Changes in the mean power frequency (MPF%) of muscles during a 10-second maximum voluntary contraction in the intercuspal position before and after 6 months of functional treatment are presented in Table 5.

Changes in the MPF were determined by the type of muscles both before and after therapy. A greater decrease in MPF was observed with regard to the masseter (before and after therapy: –11.79%, $P<0.0021$; and –10.13%, $P<0.0009$, respectively) than to the temporalis muscles (before and after therapy: –7.34% and –5.31%, respectively). These changes were the same for both girls and boys ($P>0.05$). Six months of therapy did not influence the MPF shift either with regard to the temporalis muscles ($P<0.2451$) or to the masseter muscles ($P<0.6292$) in girls or boys.

Discussion

The noticeable rise in interest of electromyography in orthodontics is connected with the need for a reliable and effective treatment for malocclusions. Awareness of the causes of malocclusions confirms the influence of function on morphology and justifies the objectives of functional orthodontic therapy, which aim to improve the balance of the masticatory muscles and promote the further correct development of the facial skeleton.

Surface EMG permits an objective and non-invasive evaluation of the masticatory muscles. The masseter and the anterior temporalis muscles are the most frequently studied muscles because they are easily accessible for surface electrode recordings. The parameters which are the most frequently assessed by means of EMG are rest position and maximum

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

voluntary clenching (MVC). Additionally, in our research, maximum effort was also evaluated.

Rest activity is one of the most important static activities analysed. From the biomechanical point of view, the absence of electrical activity of the muscles at rest is the optimal condition. However, more recent research has shown that the clinical rest position is an active muscle position because of the tone of the muscles involved [17]. Thus, in proper occlusion this activity should be as low as possible.

The results of our study revealed no sex differences in the rest activity of both the masseter and temporalis muscles. This is in accordance with Ferrario et al. [13], who also did not observe any differences in the rest position of the masseter and temporalis muscles between females and males on the basis of the recordings performed in 92 healthy subjects. The same results relating to rest activity were described by Cha et al. [18]. The sample which they investigated included 105 patients with an average age of 22 years. Conversely, Pinho et al. [19] indicated a higher activity of the masseter and temporalis muscles in women (2.64 μV) than in men (1.37 μV).

The factor which determined the rest activity in our study was the type of muscle fibers. The temporalis anterior bellies had higher rest activities than the masseter muscles. These findings were in accordance with the fact that the temporalis muscles are the most involved at rest. The analysis of the changes in the rest electrical activity before and after 6 months of treatment did not show any differences.

Another important static condition which has been previously analyzed is maximum voluntary contraction (MVC). The results of our study showed no differences between the groups of girls and boys in this activity. These findings correspond to the results described by Ferrario et al. [16], who also did not notice any differences in the MVC activity of the masticatory muscles between males and females.

Moreno et al. [20] found higher MVC activity in males with regard to the masseter. This value was estimated at 193.21 μV on the right side and 195.09 μV on the left side, whereas in females it was 131.43 μV and 138.28 μV on the right and left sides, respectively,. The activity of the temporalis muscles was the same in both groups. Various studies described by Ferrario et al. [13] found that males had higher MVC activity (temporalis activity 181.9 μV; masseter activity 216.2 μV) than females (temporalis activity 161.7 μV; masseter activity 156.8 μV).

In our study of MVC, we observed higher activity in the temporalis muscles than in the masseter muscles. The maximum effort test indicated greater fatigue in the masseter than in the temporalis muscles.

Pancherz and Anehus-Pancherz [21] also observed lower MVC activity of the masseter muscles in comparison to the temporalis muscles. Their sample, similarly to our sample, included only patients with Class II malocclusions.

These studies are in accordance with a study described by Moss [22], who also confirmed higher MVC activity of the temporalis muscles than of the masseter muscles in patients with Class II malocclusions. In the control group with correct occlusions, the MVC activity of the masseter and temporalis muscles was almost at the same level.

Similar findings in this respect to our own studies seem to confirm the variability of decreased masseter activity regarding MVC in patients with Class II malocclusions.

An analysis of the record of changes in the electrical activity of muscles after 6 months of treatment through the use of functional appliances indicated its selective influence on muscle activity. The influence of functional therapy manifested itself mainly in the decrease of electrical activity in the evaluated muscles during maximum isometric contraction in the intercuspal position. This effect was predominant in the case of the temporalis muscles, whose activity significantly decreased in this situation after 6 months of treatment.

Ingervall and Thuer [23] also described a decrease in the MVC activity of the temporalis anterior muscles during functional orthodontic therapy. The mean values describing the activity of the anterior temporalis bellies before, after 4 months, and after 12 months of treatment were 279.6 μV, 257.4 μV, and 236.1 μV, respectively. Moreover, the authors also observed a decrease in the MVC activity of the temporalis posterior fibers.

An interesting study relating to the influence of functional orthodontic therapy was described by Erdem et al. [24]. The sample consisted of 25 children with Class II malocclusions without temporomandibular dysfunctions. Fifteen patients were treated by the use of an activator, and the remaining ones were in the control group. The activity of the temporalis and masseter muscles during clenching, chewing, and swallowing increased after 12 months in both groups, but the increase was greater in the treatment group.

Different results were presented by Uner et al. [25], who did not observe any significant changes with respect to the resting and MVC activity of the masseter and temporalis muscles after functional treatment.

Tartaglia et al. [26] verified the efficiency of the Pre-Orthodontic Trainer T4K functional positioner. The treatment was performed in a group of 10 boys aged 8–13 years. After 6 months of

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

therapy, overbite and overjet decreased. The therapy did not influence the activity of the masticatory muscles.

The overview of research presented above points to the difficulty in providing clear answers relating to the impact of functional therapy on the activity of the masticatory muscles. This difficulty stems from differences in research methodology, including the methods of selecting study groups, the period over which the treatment results were evaluated, and the methods for measuring or estimating the electrical activity of the muscles. Undeniably, however, the inclusion of electromyography in the repertoire of diagnostic methods allows objective assessment of the impact of therapy on function.

Conclusions

1. The activity of the muscles was determined by the kind of activity performed.
2. Sex did not influence the activity of the masticatory muscles in any of the activities performed.
3. A 6-month period of functional therapy resulted in changes in the activity of the masticatory muscles.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

References:

1. Więckiewicz M, Paradowska A, Kawala B, Więckiewicz W: SAPHO Syndrome as a Possible Cause of Masticatory System Anomalies – a Review of the Literature. Adv Clin Exp Med, 2011; 20(4): 521–25
2. Wieckiewicz M, Grychowska N, Wojciechowski K et al: Prevalence and Correlation between TMD Based on RDC/TMD Diagnoses, Oral Parafunctions and Psychoemotional Stress in Polish University Students. Biomed Res Int, 2014; 2014: 472346
3. Wieckiewicz M, Paradowska-Stolarz A, Wieckiewicz W: Psychosocial Aspects of Bruxism: The Most Paramount Factor Influencing Teeth Grinding. Biomed Res Int, 2014; 2014: 469187
4. Carels C, van der Linden FPGM: Concept of functional appliances mode of action. Am J Orthod Dentofacial Orthop, 1987; 92: 162–68
5. Uysal T, Yagci A, Kara S, Okkesim S: Influence of pre-orthodontic trainer treatment on the perioral and masticatory muscles in patients with Class II division 1 malocclusion. Eur J Orthod, 2012; 34(1): 96–101
6. Saccucci M, Tecco S, Ierardoa G et al: Effects of interceptive orthodontics on orbicular muscle activity: a surface electromyographic study in children. J Electromyogr Kinesiol, 2011; 21(4): 665–71
7. Wieckiewicz M, Zietek M, Nowakowska D, Wieckiewicz W: Comparison of Selected Kinematic Facebows Applied to Mandibular Tracing. Biomed Res Int, 2014; 2014: 818694
8. Drost G, Stegeman D, Engelen B, Zwarts M: Clinical applications of high-density surface EMG: A systematic review. J Electromyogr Kinesiol, 2006; 16(6): 589–602
9. Szeląg E, Paradowska-Stolarz A, Noga L et al: Does the Baccetti's Method of Establishing of Skeletal Age Have Clinical Ompotance? Dent Med Probl, 2013; 50(4): 449–53
10. Miernik M, Więckiewicz M, Paradowska A, Więckiewicz W: Massage Therapy in Myofascial TMD Pain Management. Adv Clin Exp Med, 2012; 21(5): 681–85
11. Ferrario VF, Sforza C, Zanotti G, Tartaglia M: Maximal bite forces in healthy young adults as predicted by surface electromyography. J Dent, 2004; 32(6): 451–57
12. Ferrario VF, Sforza C, Serrao G et al: The effects of a single intercuspal interference on electromyographic characteristics of human masticatory muscles during maximal voluntary teeth clenching. Cranio, 1999; 17(3): 184–88
13. Ferrario VF, Sforza C, Miani A et al: Electromyographic activity of human masticatory muscles in normal young people. Statistical evaluation of reference values for clinical applications. J Oral Rehabil, 1993; 20(3): 271–80
14. Ferrario VF, Sforza C, Tartaglia GM, Dellavia C: Immediate effect of a stabilization splint on masticatory muscle activity in temporomandibular disorders patients. J Oral Rehabil, 2002; 29(9): 810–15
15. Naeije M, McCarroll RS, Weijs WA: Electromyographic activity of the human masticatory muscles during submaximal clenching in the inter-cuspal position. J Oral Rehabil, 1989; 16(1): 63–70
16. Ferrario F, Sforza C, Colombo A, Ciusa V: An electromyographic investigation of masticatory muscles symmetry in normo-occlusion subjects. J Oral Rehabil, 2000; 27(1): 33–40
17. Suvinen TI, Kemppainen P: Review of clinical EMG studies related to muscle and occlusal factors in healthy and TMD subjects. J Oral Rehabil, 2007; 34(9): 631–44
18. Cha BK, Kim CH, Baek SH: Skeletal sagittal and vertical facial types and electromyographic activity of the masticatory muscles. Angle Orthod, 2007; 77(3): 463–70
19. Pinho JC, Caldas FM, Mora MJ, Santana-Penin U: Electromyographic activity in patients with temporomandibular disorders. J Oral Rehabil, 2000; 27(11): 985–90
20. Moreno I, Sanchez T, Ardizone I et al: Electromyographic comparison between clenching, swallowing and chewing in jaw muscles with varying occlusal parameters. Med Oral Patol Oral Cir Bucal, 2008; 13(3): 207–13
21. Panherz H, Anehus-Panherz M: Muscle activity in Class II, Division 1 malocclusions treated by bite jumping with the Herbst appliance. An electromyographic study. Am J Orthod, 1980; 78(3): 321–29
22. Moss JP: An investigation of the muscle activity of patients with Class II Division 2 malocclusion and changes during treatment. Trans Eur Orthod Soc, 1975: 87–101
23. Ingervall B, Thüer U: Temporal muscle activity during first year of Class II Division 1 malocclusion treatment with an activator. Am J Orthod Dentofacial Orthop, 1991; 99(4): 361–68
24. Erdem A, Kilic N, Eröz B: Changes in soft tissue profile and electromyographic activity after activator treatment. Aust Orthod J, 2009; 25(2): 116–22
25. Uner O, Darendeliler, Bilir E: Effects of an activator on the masseter and anterior temporal muscle activities in class II malocclusions. J Clin Pediatr Dent, 1999; 23(4): 327–32
26. Tartaglia GM, Grandi G, Mian F et al: Non-invasive 3D facial analysis and surface electromyography during functional pre-orthodontic therapy: a preliminary report. J Appl Oral Sci, 2009; 17(5): 487–94

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]