Resting activity of selected masticatory muscles in healthy young women

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Abstract

Introduction: The resting muscle activity can be defined as the passive tonus of skeletal muscles. It is a low, passive muscle tone, which significantly contributes to maintaining proper posture. Changes in resting muscle activity may indicate dysfunction in neuromuscular stomatognathic system.

Aim: The aim of our study was to determine the mean resting activity of anterior temporalis and masseter muscles in healthy young women by using surface electromyography.

Material and methods: Eighty-five full dentate, normo-occlusion healthy young women were qualified for the study (mean age 22 years ± 2 years). Electromyographic activity of the anterior temporalis (TA) and masseter muscle (MM) was evaluated during resting mandibular position, during maximum intercuspation clenching, and during maximum voluntary clenching with cotton rolls between teeth. Shapiro-Wilk, Kolmogorov-Smirnov (with Lillierfors modification) and U Mann-Whitney test were used for statistical analysis. Statistical significance was assumed at 0.05.

Results: The mean resting activity of the TA muscles was significantly higher both on the right and left side (TA-R: 1,84μV; TA-L: 2,11μV;) comparing to MM (MM-R: 1,67μV; MM-L: 1,62μV) ($p<0.05$). Differences between mean sEMG activity of: TA-R/MM-R, TA-L/MM-L during maximum voluntary contraction, and

Key words:

temporalis, masseter, surface electromyography, women

TA-L/MM-L during maximum voluntary clenching with cotton rolls between teeth were not statistically significant ($p>0.05$). The mean sEMG activity of the MM-R during maximum voluntary contraction on cotton rolls was significantly higher comparing to TA-R (MM-R: 150,01 μV; TA-R: 115,58 μV) ($p<0.05$)
Conclusions: The resting activity of anterior temporalis muscles is higher than masseter muscle in healthy young women. The above differences were not observed during clenching activity. Gender differences should be taken into account in comparisons of muscles activity of the stomatognathic system.

Introduction

The resting muscle activity is the passive tonus of skeletal muscles. It is a low, passive muscle tone, which significantly contributes to maintaining proper posture [1]. As opposed to muscle tone, muscle contraction is an active controlled neuromotor activity that provides greater tonus levels to enhance stabilization or to perform certain movement [1]. Passive muscle tone is a component independent from the Central Nervous System (CNS), a result of internal molecular interactions of actomyosin filaments in sarcomere units of skeletal muscles and myofibroblast cells [1].

Surface electromyography (sEMG) in stomatology typically pertain to muscles related to mastication, swallowing and maintaining head's posture (masseter, temporalis anterior and posterior, digastric anterior, sternocleidomastoid) [2]. Examination of resting activity of masticatory muscles may contribute to early diagnostics and treating a myogenic type of temporomandibular disorders (TMD) providing quantitative date about the function of a stomatognathic system [3]. Further, sEMG analysis can be used as part of the treatment of these dysfunctions and monitoring of orthodontic or malocclusion treatment, which cause changes in the muscular activity of the masticatory muscles [3]. Increased results of surface electromyography may also indicate the presence of myofascial trigger points (TrPs) or protective co-contraction of muscles caused by ex. stomatognathic system operation, stress factors or pain [4,5]. Moreover, the higher bioelectric activity of masticatory muscles may be connected with bruxism [6]. Additionally, considering that TrPs may cause chronic tension-type headache, muscle stiffness, and limited range of motion in a temporomandibular joint (TMJ), sEMG analysis can be an effective way of diagnostics of these dysfunctions [7,8]. Thus far, examination of bioelectrical activity of masticatory muscles evidenced that people with TMD had a significantly larger asymmetry of temporalis anterior muscles contraction and higher resting activity of these muscles, which may be correlated with tinnitus [9,10].

Moreover, the electromyographic activity of the masticatory muscles differs in relation to sex. It was previously reported that the temporalis anterior muscle was predominant in women, while the masseter was predominant in men [11]. However, the mechanism, which leads to the increased temporal activity in women, remains unexplained.

Aim

The aim of presented study was to determine the mean resting activity of anterior temporalis and masseter muscles in healthy young women by using surface electromyography.

Materials and methods

Ethics statement

The research was carried out in accordance with the recommendations of the Helsinki Declaration and with the consent of the Bioethical Commission of the Medical University of Lublin (KE-0254/73/2017). The participants were informed about the objectives of the study and were aware of the possibility

of withdrawing from the study at any time. All women gave written permission for participation in the research.

Subjects description

142 women were invited to the study. All participants were clinically tested on the basis of the dual-axis diagnostic system of the TMD with the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) form [12,13].

The following exclusion criteria were applied: the presence of signs or symptoms of functional temporomandibular disorders, neurological disorders, past trauma to the jaw, presence of myofascial trigger points in the head and cervical spine muscles, pregnancy.

After applying the above criteria from 142 women, 85 participants were qualified for the study (mean age 22 years ± 2 years). To reduce the daily bioelectrical variability of the masticatory muscles (anterior temporalis - TA, masseter muscle - MM), the tests were performed in the morning hours. Before the test, a disturbance test was carried out to check the reliability of the sEMG signal.

Measurement plan

The study used an 8-channel BioEMG III™ surface electromyography apparatus with BioPak Measurement System measurement software (BioResearch Associates, Inc. Milwaukee, WI, USA). The sample rate was 2000 Hz for each channel and the filtering is to a bandwidth from 30 Hz to 1000 Hz. Measurement of the sEMG record was always carried out in the same position: the head was based on the headrest of the dental chair with the torso in a perpendicular position to the ground, with lower limbs straightened, placed freely and parallel. In the above-described position after previous skin cleansing with 90% ethyl alcohol solution, round Ag/AgCl electrodes with a diameter of 30 mm and a conductive surface of 16 mm (SORIMEX, Poland), were applied. The arrangement of surface electrodes was in accordance with the guidelines of the SENIAM program [14]. Two electrodes were placed on one muscle belly symmetrically on both sides, according to the course of the fibers of the frontal part of the anterior temporalis (right side: TA-R, left side: TA-L) and the superficial part of the masseter muscles (right side: MM-R, left side: MM-L). The reference electrode was placed on the forehead [15]. Patients were asked to close their eyes and not to swallow saliva, during which 10 seconds of resting muscles activity (TA, MM) was recorded [16]. Moreover, electromyographic activity of the TA and MM was evaluated during maximum intercuspation clenching, and during maximum voluntary clenching with cotton rolls between teeth.

Statistical analysis

The comparison of data was developed statistically and performed using the IBM SPSS STATISTICS 21 program. First, the normality of the variable distribution was verified using the Shapiro-Wilk test and the Kolmogorov-Smirnov test (with the Lilliefors modification). All distributions differed from the norm. On this basis, the nonparametric U Mann-Whitney test was included. Differences were considered statistically significant if the level of test probability was lower than the significance level assumed at 0.05.

Results

The mean resting activity of the TA muscles was significantly higher both on the right and left side (TA-R: 1,84μV; TA-L: 2,11μV;) comparing to MM (MM-R: 1,67μV; MM-L: 1,62μV) ($p<0.05$) (Tab. 1, Tab. 2). Differences between mean sEMG activity of: TA-R/MM-R, TA-L/MM-L during maximum voluntary contraction, and TA-L/MM-L during maximum voluntary clenching with cotton rolls between teeth were not statistically significant (Tab. 3, Tab. 4, Tab. 6) ($p>0.05$). The mean sEMG activity of the MM-R during maximum voluntary contraction on cotton rolls was significantly higher comparing to TA-R (MM-R: 150,01 μV; TA-R: 115,58 μV) ($p<0.05$) (Tab. 5).

Discussion

In many cases, changes in muscle activity occur simultaneously with other dysfunctions [17], nevertheless sEMG is used also to examine healthy people

Table 1.
Mean sEMG activity of temporalis anterior on the right side (TA-R) and masseter muscles on the right side (MM-R) during examination in resting mandibular position

	Mean sEMG activity (μV)	SD (μV)	Mean difference (μV)	SD difference (μV)	Z	p
TA-R	1,84	0,88	0,17	0,15	–2,160	0,031*
MM-R	1,67	0,73				

* significant differences (p<0,05)

Table 2.
Mean sEMG activity of temporalis anterior on the left side (TA-L) and masseter muscles on the left side (MM-L) during examination in resting mandibular position

	Mean sEMG activity (μV)	SD (μV)	Mean difference (μV)	SD difference (μV)	Z	p
TA-L	2,11	1,10	0,49	0,36	–2,919	0,004*
MM-L	1,62	0,74				

* significant differences (p<0,05)

Table 3.
Mean sEMG activity of temporalis anterior on the right side (TA-R) and masseter muscles on the right side (MM-R) during maximum intercuspation clenching

	Mean sEMG activity (μV)	SD (μV)	Mean difference (μV)	SD difference (μV)	Z	p
TA-R	111,31	68,70	5,31	27,81	-0,687	0,492
MM-R	116,62	96,51				

Table 4.
Mean sEMG activity of temporalis anterior on the left side (TA-L) and masseter muscles on the left side (MM-L) during maximum intercuspation clenching

	Mean sEMG activity (μV)	SD (μV)	Mean difference (μV)	SD difference (μV)	Z	p
TA-L	118,06	74,35	18,08	4,7	–1,614	0,107
MM-L	100,14	69,65				

Table 5.
Mean sEMG activity of temporalis anterior on the right side (TA-R) and masseter muscles on the right side (MM-R) during maximum voluntary clenching with cotton rolls between teeth

	Mean sEMG activity (μV)	SD (μV)	Mean difference (μV)	SD difference (μV)	Z	p
TA-R	115,58	64,97	34,43	27,61	–2,558	0,011*
MM-R	150,01	92,58				

* significant differences (p<0,05)

Table 6. Mean sEMG activity of temporalis anterior on the left side (TA-L) and masseter muscles on the left side (MM-L) during maximum voluntary clenching with cotton rolls between teeth

	Mean sEMG activity (μV)	SD (μV)	Mean difference (μV)	SD difference (μV)	Z	p
TA-L	121,05	68,75	15,7	0,54	–1,758	0,077
MM-L	136,75	68,21				

in order to determine reference values that are essential to compare it with people suffered from TMD [18]. Study of bioelectrical activity may be helpful in the diagnostics, assessment of therapeutic effects, observation and examination TMD patients.

The aim of presented study was to determine the mean resting activity of anterior temporalis and masseter muscles in healthy young women by using surface electromyography. The mean resting activity of the TA muscles was significantly higher both on the right and on left side comparing to MM. However, the above differences were not observed during clenching activity. The results of presented work are partially similar to the results of Campillo et al. [13]. The purpose of the above work was, among others, to determine the reference values for the bioelectric activity of masticatory muscles. The study involved 40 people (20 women and 20 men) aged 20 to 30 years (mean 22.8 ± 3.9 years) with theoretically ideal occlusion, applying restrictive exclusion criteria. The following bioelectric activities were established in women: 1.07μV for the anterior part of the left temporal muscle, 1.78μV for the anterior part of the right temporal muscle, 1.17μV for the left masseter, and 1.01μV for the right masseter. The result that differs the least from our research is the bioelectric tone of the right temporal muscle (difference 0.06 μV). Differences between masseter muscle tensions are 0.5 μV for the right muscle and 0.61 μV for the left muscle. The greatest discrepancy was noted for the right temporal muscle (1.04 μV). The difference in the discussed results can be explained by the use by Campillo et al. of more restrictive exclusion criteria than in our study.

The muscle tone of the masseter is similar to the results of the control group of Zieliński et al. study, which assessed the effect of sleep quality on muscle tone [19]. The bioelectric activity was registered at 1.574 μV, in our work it was 1.64 μV (difference 0.66 μV). At the same time, temporal muscle activity varied by 0.39 μV. The study group was similar to the age of participants in our research, however, a small number of the participants (in Zieliński's study and others n = 6) could have influenced the discussed result. The results of our work differ from the results of studies by Woźniak et al. [17]. Their aim was to assess the effect of the presence of unilateral posterior crossbite on the electrical activity of the temporal muscles and masseters in patients with subjective symptoms of TMD. The control group in the study

consisted of 100 people without subjective symptoms of TMD and malocclusion (54 females and 46 males) aged from 19.5 to 28.7 years (mean 22.42, SD = 1.06). The average bioelectric activity in females without malocclusion was 4.07μV for temporal muscles and 2.21μV for masseter muscles, which is higher than in presented study (2.1 μV temporal difference and 0.57 μV for masseter muscles). These differences may result from the application of various exclusion criteria within the study. The results of the control group in studies by Manfredini et al. differ from the ones achieved in our group: TA-R 3.2 ± 1.6 μV; TA-L 3.8 ± 2.4 μV; MM-R 2.9 ± 1.3 μV; MM-L 3.3 ± 1.8μV [20]. These differences can be related to several factors. In Manfredini et al. study, the study group was significantly smaller (n = 32) and sexually mixed. In addition, the group was age-diverse, which could also be affected by differences in the results of sEMG at rest. Melo et al. determined the average bioelectric activities of masticatory muscles at the level of: TA-R 2.81 ± 1.74 μV, TA-L 2.94 ± 1.98 μV, MM-R 1.87 ± 0.66 μV, MM-L 1.95 ± 0.75 μV [21]. Comparing the above results to the results of presented research, the smallest voltage difference was recorded for the right and left masseter muscle (respectively 0.2 μV and 0.33 μV). Significant differences were noted for the temporal muscles (0.97 μV for the right, 0.83 μV for the left). The reason for the different results of both studies may be the same as in the study of Manfredini et al.: smaller study group (n = 43), larger age divergence and group sexual diversity. All the above mentioned research as well as the and the work of Hugger et al. and Glaros et al. note, that the average bioelectrical activity of the temporal muscles is always greater than the one of the masseter muscles, which also coincides with the results of the presented study [22,23].

Analyzing the study of Wieczorek A. about the activity of temporal and masseter muscles can be observed a significant difference between males and females in the right temporalis anterior [24]. A higher voltage (131.12 μV) in TA-R was observed in a group of women, whereas in the group of men it was 119.65 μV. Secondly, the activity index in women showed a predominance of the TA in females (AcI = 10.52) and a predominance of the MM in males (AcI = −1.22). However, Ferrario et al. study indicates similarity in average resting activity between male and female, though shows lower mean maximum voluntary clench potentials in women (181.9 μV-TA and 216.2 μV-MM in men, 161.7 μV-TA and 156.8 μV-MM in women) [25]. Furthermore, TA activity in females tended to dominate at every contraction level, which attracts attention to the possibility of more frequent occurrence of asymmetry in women.

The results of the presented study may suggest that the reason for the more frequent occurrence of chronic tension-type headache in women are differences in temporal muscle tension [26]. Further, results of examinations suggest that the above differences in bioelectric activity should be taken into account in research on changes in bioelectrical activity in people with TMD.

Conclusions

1. The resting activity of anterior temporalis muscles is higher than masseter muscle in healthy young women. The above differences were not observed during clenching activity.

2. Gender differences should be taken into account in comparisons of muscles activity of the stomatognathic system.

Acknowledgments

The results of the present study do not constitute an endorsement of the product by the authors or the journal.

Conflict of interest

The authors declare that they have no conflict of interest.

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