Masticatory Muscle Activity in Individuals with Temporomandibular Disorder

Aktywność mięśni żwaczy u osób z zaburzeniami stawu skroniowo-żuchwowego

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SUMMARY

Aim: The aim of our study was to investigate features related to EMG-activity of masticatory muscles in subjects with TMD.

Materials and Methods: The study comprised 22 patients with clinical symptoms of TMD. The average age of the subjects was 29.3 ± 4.4 years. Malocclusion was evaluated according to Angle classification, TMD – according to the Research Diagnostic Criteria (RDC/TMD). Registration of EMG-activity of masseter and anterior temporalis muscles was performed during maximum voluntary clenching, clenching on the right and left sides.

Results: Normal activity of the masticatory muscles is characterized by symmetrical and EMG-activity of the masticatory muscles on the left and right sides. EMG-activity of masticatory muscles in subjects with TMD are characterized by: 1) increased values of EMG-activity of temporal and masseter muscles; 2) disproportional and asymmetric muscle work of the masticatory muscles on the right and left sides.

Conclusions: Features of masticatory muscles activity in individuals with Angle Class I malocclusion and TMD were found.

Key words: EMG-activity, temporomandibular disorders, masseter, temporalis muscles

Słowa kluczowe: aktywność EMG, zaburzenia skroniowo-żuchwowe, żwacz, mięśnie skroniowe

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INTRODUCTION

The vast majority of authors define temporomandibular disorders (TMD) as a collective term that covers a number of clinical problems related to the masticatory muscles, occlusion, and structural components of the temporomandibular joint (TMJ). Main questions about temporomandibular joint dysfunction (TMD) in relation to malocclusion/orthodontic treatment seem to be of interest. It concerns correlations between TMD and different kinds of functional or morphologic malocclusions [1]. TMDs, as a group, are characterized by regional pain in the facial and preauricular areas or by limitation or interference in jaw movement. Frequent examination findings are hyperalgesia usually revealed via pressure application to the muscles of mastication or temporomandibular joints (TMJs) and noises in the TMJs. The most common subtypes of TMDs include pain-related disorders, such as myofascial pain and arthralgia, and disorders associated with the TMJ, primarily internal derangements and degenerative joint disease [2].

Diagnostic evaluation of the muscles activity is an integral part in the planning and set of measures for rehabilitation of dental patients. Electromyography is one of the methods of objective, minimally invasive muscle examination instrumental and highly informative method of functional diagnostics of muscles, namely recording of biopotentials of muscle fibers and activity of their motor units [3-5]. EMG has been used to identify different muscle patterns and compare diagnostic data in different individuals [6].

AIM

Therefore, the aim of our study was to investigate features related to EMG-activity of masticatory muscles in subjects with TMD.

MATERIALS AND METHODS

Two groups of individuals were studying: (1) study group: 22 subjects of 20-38 years aged with TMD, (2) control group: 26 age- and sex-matched individuals with normal occlusion and without clinical symptoms of any TMDs. The average age of subjects in study group was 29.3 ± 4.4 years. 8 (36.4%) were men, 14 (63.6%) were women. All subjects were found malocclusion of class I by Angle, that was characterized by neutral relationship on the first permanent molars and anomalies of tooth position in frontal area. Diagnosis of TMD was determined by the first

and second axis by RDC/TMD [7]. In control group 12 (46.2%) subjects were men, 14 (53.8%) were women. The average age of individuals was 28.8 ± 3.8 years. Exclusion criteria of the study for subjects of two groups were: previous orthodontic treatment, general diseases, traumas and clefts in maxillofacial region.

All subjects of both groups were performed come been computed tomography (CBCT) of temporomandibular joint (TMJ) and surface EMG. Surface EMG of anterior temporal, masseter muscles of both sides (left and right) was performed to using the electromyograph Synapsis (Neurotech company, Russia). The myograph is powered via the USB interface of a computer. During the EMG examination, the subjects, seated in an upright position with the head in natural posture, with legs standing on foot on a firm support (floor), hands quietly lie on the hips. Arms and legs were not be crossed [8]. Before the EMG test, the subjects were explained the purpose and features of EMG, to warn about the absence of pain sensations.

To record muscle bioelectrical activity, unipolar electrodes were used, which are connected to the electromyograph by 4 separate wires with separate inputs. Before applying the electrodes, the skin was cleaned and degreased with 70% solution of ethyl alcohol, which reduced the interelectrode resistance. Electrodes placement was very essential. Disposable silver chloride surface electrodes (diameter 10 mm, Neirosoft, Russia) were positioned on the muscular bellies parallel to muscular fibers [5, 9]. These points were identified by palpation in the area with the greatest muscle tension during teeth clenching. To determine the point of placement of the electrode on the masseter muscle, palpation was performed in the area above 3 cm in antero-superior direction of the lower jaw angle parallel to the lower third of the imaginary line connecting the lower jaw angle and the outer angle of the eye of the same side of the face. For the frontal part of the temporal muscle, palpation was performed along the anterior edge of the muscle parallel to the frontotemporal suture.

EMG-activity was recorded in 3 tests, lasted 30s for each one: maximum voluntary clenching, clenching of the standard cotton roll on the left side (left-side clenching), clenching of the standard cotton roll on the right side (right-side clenching). Maximum voluntary clenching was performed in intercuspal position. EMG data were processed using Neurotech's Synapsis software. EMG-activity for each muscle was estimated by maximum amplitude of the muscle contractions (μV).

The procedures received approval from the Bioethics Committee of the Ukrainian Medical Stomatological Academy (Poltava, Ukraine). All patients signed a statement of informed consent.

EMG-activity between sides (right and left/normal and clicking) were statistically analyzed using Student's paired t-test (level of significance p_1<0,05). Differences in the indicators of EMG-activity between the study (with TMD) and control (with normal occlusion) groups ere evaluated using analyses of Fisher's criterion X2. The hypotheses were verified at the level of significance p<0,05.

RESULTS

All subjects of the study group were diagnosed TMD according to RDC/TMD (group II b of muscle disorders). Clinical symptoms of TMD were identified in all patients of the group, namely pain from the temporomandibular joints (TMJs) or jaw muscles , pain on mandibular movement (63.3%), joint sounds, and locking/luxation of joints (on the right side (40.9%), on the left side (58.9%) , deviation of the lower jaw when opening and closing the mouth (86.4%). CBCT confirmed the change in the shape and position of the articular head on the clicking side. Osteoarticular changes were determined flattening (72.7%), sclerosis (18.2%), osteophyte (40.9%), decrease joint space (68.2%).

In subjects without symptoms of TMD, neuromuscular balance was determined, which is recorded as symmetrical EMG-activity of masticatory muscle on right and left sides. At maximum voluntary clenching test EMG-activity of temporal and masseter muscles on the left and right side is registered identical and symmetrical, the maximum amplitude of muscle potentials does not exceed 1000 mW. In subjects of the control group masseter muscles demonstrated a slighty higher EMG-activity than the anterior temporalis muscles (p>0.05).

EMG-activity of masticatory muscles of two groups in maximum voluntary clenching test is represented in Table 1.

Subjects with TMD had a masticatory pattern different from subjects of the control group. First of all, EMG-activity of masticatory muscles was higher in the study group, but the difference between control and study group in maximum clenching test was not statistically approved (p>0.05). To demonstrate asymmetrical muscle work, we analyzed separately EMG-activity of masticatory muscles in subjects of right and left clicking in TMJ in this test. The anterior temporal and masseter muscle EMG-activity differed

Table 1. EMG-activity of masticatory muscles in patients of the study and control groups in maximum voluntary clenching test

Group	Max. amplitude, μV			
	m.temporalis dextra	m.temporalis sinistra	m.masseter dextra	m.masseter sinistra
Study	1017.01±31.43	986.42±29.29	860.55±29.65	886.52±28.6
right TMJ clicking (n=9)	1432.21±42.38*	635.33±31.88	1074.22±37.61*	764.48±27.52
left TMJ clicking (n=13)	701.25±33.65*	1487.23±40.92	735.39±37.42	987.22±44.01
Control	835.29±31.38	808.54±34.61	923.28±38.03	917.32±37.55
p	>0.05	>0.05	>0.05	>0.05

* p_1<0,05

Table 2. EMG-activity of masticatory muscles in patients of the study and control groups in left-side clenching test

Group	Max. Amplitude, μV			
	m.temporalis dextra	m.temporalis sinistra	m.masseter dextra	m.masseter sinistra
Study	985,54±31.57*	1528,99±46.69	782.05±28.44	1296.44±40.91
right TMJ clicking (n=9)	1234.43±38.53	1456.76±53.72	909.56±35.32	1205.44±39.27
left TMJ clicking (n=13)	736.29±24.61*	1601.22±49.66	654.54±21.55*	1387.43±42.54
Control	608,16±54,53*	928,41±37.76	685,16±46,77*	965,68±43,40
p	>0,05	<0,05	>0,05	>0,05

*p_1<0,05

Table 3. EMG-activity of masticatory muscles in patients of the study and control groups in right-side clenching test

Group	Max. amplitude, μV			
	m.temporalis dextra	m.temporalis sinistra	m.masseter dextra	m.masseter sinistra
Study	1286.16±35.15	1060.22±36.96	1044.55±30.38	914.54±30.43
right TMJ clicking (n=9)	1566.54±48.23	623.44±23.14	1245.54±36.69	596.54±21.88
left TMJ clicking (n=13)	1005.77±22.07	1497.21±46.77	843.55±24.07	1232.54±38.98
Control	845.34±30.34*	651.43±25.66	943.64±32.51*	692.24±26.54
p	>0,05	<0,05	>0,05	<0,05

*p_1<0,05

between the left and right sides, and higher muscle activity was found on the side of TMJ clicking comparatively to the opposite side (right and left anterior temporal muscle in patients with right and left TMJ clicking respectively, right masseter muscle in subjects with right TMJ clicking, p<0.05). We found that EMG-activity of the temporal muscle in the side of TMJ clicking was higher than EMG-activity of masseter muscle on that side.

EMG-activity of the masticatory muscles of the subjects of two groups in tests of clenching teeth on the left and right sides are shown in Table 2 and Table 3 respectively.

On comparing the left and right sides in subjects of the control group with normal occlusion, there was significant statistical difference for EMG-activity of the masticatory muscles. Thus, EMG-activity was statistically higher on the working side (in left-side clenching test working side is left, in right-side clenching test working side is right) than on the balancing side (p<0.05). Such EMG-activity of masticatory muscles in control group in test of one-side clenching with cotton rolls could be considered as physiological and compatible with normal function.

EMG-activity of anterior temporalis and masseter muscles was higher in the study group, than in the control group, but there was no statistical difference (p>0.05), exept left anterior temporalis muscle (p<0.05). We have identified certain features of muscle function in the test of the left-side clenching in the study group. In the left-side clenching test EMG-activity of anterior temporalis (p<0.05) and masseter (p>0.05) muscle was higher on the working (left) side comparatively to the balancing (right) side. In subjects with left TMJ clicking there was a significant difference between EMG-activity of anterior temporalis and masseter muscle on the balancing and working sides (p<0.05). In subjects with right TMJ clicking was not observed a statistically significant difference in indicators on the working and balancing sided. This is due to the increased activity of the muscles on the balancing (right) side (p>0.05).

We found that in right-side clenching test subjects of the study group with left-side TMJ clicking were no statistically significant difference between EMG- activity of masseter and temporal muscles, indicating increased EMG-activity of muscles on the balancing side, that is the side with clinical symptoms in a joint.

DISCUSSION

The term "TMJ dysfunction" (or temporomandibular disorders (TMD) involves all disorders of the masticatory system. TMD is a collective term used for a number of clinical problems that involve the masticatory muscle complex, the temporomandibular joint (TMJ) and associated structures and remains an open challenge for modern dentistry [1, 2, 10]. According to Manfredini and a number of authors, TMJ dysfunction is a combined term that includes a group of conditions characterized by the damage to the TMJ structures or dysfunction of the masticatory muscles [7]. Approximately 33% of the population have at least 1 TMD symptom, and 3.6-7.0% of the population have TMD with sufficient severity to seek treatment [11, 12].

TMD is a polyetiological disease that is associated with a close and complex relationship in the functioning of all components of the stomatognathic system. Publications present a number of classifications of temporomandibular disorders,

which are mostly based on the clinical manifestations of the characteristic symptoms of the disease. Research diagnostic criteria for temporomandibular disorders (RDC/TMD) are the most commonly applied criteria. The main signs and symptoms involve TMJ pain and clicking, myofascial or oral masticatory muscle pain, and abnormal jaw movement. TMD constitute a major public health problem, as they are a main source of chronic oral facial pain, interfering with daily activities. These disorders are also commonly associated with other symptoms affecting the head and neck region, including headache, ear-related symptoms, cervical spine dysfunction, and altered head and cervical posture [7, 13].

To establish the EMG characteristics of muscles in TMD, we conducted a study involving 22 subjects with clinical manifestations of musculoskeletal TMD without malocclusion. All subjects underwent clinical examination, CBCT of facial region and surface EMG of the masticatory muscles. Based on the study, we identified certain features of muscle activity in TMD cases.

It has been found that increased EMG-activity of masticatory muscles, asymmetric muscles work on the right and left sides was the main characteristic feature of muscle work in subjects with TMD. It should also be noted that in subjects with reciprocal clicking in one of the joints there was a much higher EMG-activity of the temporalis muscle over the masseter muscle on the side of the TMJ clicking. Many studies indicate a violation of muscle function in the cases of clinical symptoms of TMD, but the study of EMG-ctivity of masticatory muscle in such tests is not mentioned in available sources.

CONCLUSIONS

Electromyography is origin, objective, minimally invasive highly informative method of functional diagnostics of muscles, in particular, of the orofacial region, and registration of biopotentials of muscle fibers and activity of their motor units. Normal activity of the masticatory muscles is characterized by symmetrical and EMG-activity of the masticatory muscles on the left and right sides. Characteristic features of muscle activity in subjects with TMD are high values of EMG-activity of the masticatory muscles, disproportional and asymmetric muscle work of the masticatory muscles on the right and left sides.

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