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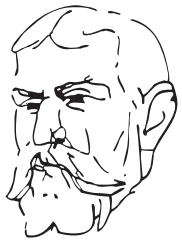

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PRACE ORYGINALNE / ORIGINAL ARTICLES

PRACA ORYGINALNA
ORIGINAL ARTICLE

EMG-CHARACTERISTIC OF MASTICATORY MUSCLES IN PATIENTS WITH CLASS II MALOCCLUSION AND TEMPOROMANDIBULAR DISORDERS

Lyubov V. Smaglyuk, Anastasiia V. Liakhovska
UKRAINIAN MEDICAL STOMATOLOGICAL ACADEMY, POLTAVA, UKRAINE

ABSTRACT

Introduction: A stable state of musculoskeletal system is provided by harmony of occlusion, the anatomy of temporomandibular joints, and the activity of the masticatory muscles under the control of peripheral and central nervous system. Surface electromyography (EMG) is a well-used modality and is used in dentistry to access the status of the muscles of mastication.

The aim of the research was to evaluate the EMG-characteristic of masticatory muscles in patients with TMD and Angle Class II malocclusion.

Materials and methods: The study comprised 23 patients with Angle Class II malocclusion and TMD. The average age of the subjects was 26,5 ± 2,3 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: EMG-activity of masticatory muscles are characterized by: 1) increased values of EMG-activity of temporal and masseter muscles – peak and average amplitude in tests of unilateral clenching and maximum clenching (values are greater than 2000 μV); 2) in unilateral clenching of jaws (on the left or right) the increased EMG-activity was detected on the balancing side; 3) in unilateral clenching of jaws (on the left or right) the increased muscle activity on the working side with disproportional (asymmetric) load distribution between masseter and temporal muscles has been found.

Conclusions: Patients with Angle Class II malocclusion and TMD were found features of EMG-activity of masticatory muscles.

KEY WORDS: Angle Class II, temporomandibular disorders, masseter, temporalis muscles

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INTRODUCTION

The main goal of orthodontic treatment of patients is to provide functional, morphological and esthetic balance in facial skeleton in the connection with healthy holistic organism [1, 2]. A stable state of musculoskeletal system is provided by harmony of occlusion, the anatomy of temporomandibular joints, and the activity of the masticatory muscles under the control of peripheral and central nervous system. Healthy function of temporomandibular joints (TMJ) should be accompanied by stable dental occlusion, freely entered and exited without interferences, dictated and directed by healthy relaxed masticatory muscles for long-term stability of all of the interrelated structures. Healthy TMJ adapt to functional demands and dental occlusion, because form follows function: the shape of hard structures results from the performed function [1].

Temporomandibular disorders (TMD) comprise a group of masculoskeletal disorders that affect alteration in the stricter and/or function of one or more of the following: TMJ, masticatory muscles, the dentition and its supporting structures, and the complex neuromuscular system. Each TMD patient has a unique composite of different elements, which can involve the TM joint and masticatory muscles and often cause the pain or dysfunction leading to manifestation of psychological stress. The causes of TMD are different. Some studies have documented the role of malocclusion as a destabilizing and predisposing factor of TMD. The other studies investigated not the cause-effect relationship of dental occlusion in patients with TMD [1, 3].

Surface electromyography (EMG) is a well-used modality and is used in dentistry to access the status of the muscles of mastication. Numerous study have substantiated the reliability and reproducibility of surface EMG in the evaluation of muscle function. The data of surface EMG of masticatory muscles is a clinically useful and objective method of quantifying the functional status of dentofacial region, especially TMJs. The TMD patients have an elevated resting EMG muscle activity and weak or asymmetrical functional EMG muscle activity. There is considerable agreement among both clinicians that masticatory muscles activity is increased in symptomatic patients [1, 3-5].

At the same time, the issues on the functional state of the masticatory muscles in patients with malocclusion, namely Angle Class II malocclusion and TMD are not fully elucidated in the publications to date.

THE AIM

The aim of the research was to evaluate the EMG-characteristic of masticatory muscles in patients with TMD and Angle Class II malocclusion.

MATERIALS AND METHODS

The study group of the research consists of 23 patients aged 21 to 28 years with Angle Class II malocclusion and symptoms of TMD without previous orthodontic treatment. The average age of the subjects was 26,5 ± 2,3 years. The patients were assigned into groups according to the divisions of the Class II malocclusion: II-1 (11 patients) and II-2 (12 patients). Women were 16 (69,6%), men were 7 (30,6%).

Clinical examination of all patients was performed according to the standard algorithm of the examination of the orthodontic patient with evaluation of all parameters of the aesthetic, morphological and functional status. The class of occlusion was determined according to the Angle's classification (1899). The vertical overlap (OB-Overbite) was diagnosed according to Proffit (1996) and 4 degrees were distinguished: OB = 0-2 mm; 3-4 mm; 5-7 mm; more than 7 mm. The overjet (OJ) was also evaluated according to Proffit (1996), classifying into 4 groups: -0-3,5 mm; 3,5-6 mm; 6-9 mm; more than 9 mm [6]. The TMJ functioning has been studied by the static and dynamic clinical examinations. Symptoms of dysfunction were considered as follows: in static examination: pain in the joints and muscles; in dynamic examination: lateral deviation of the mandible from the mesial-sagittal plane in mouth opening, restricted mouth opening; articular noise (cracking and clicking) on palpation, and auscultation; pain or tension in masticatory muscles (masseter, anterior muscle, lateral pterygoid muscle) on palpation [6]. Diagnosis of TMD was determined according to the Research Diagnostic Criteria (RDC/TMD) on the base of clinical symptoms [7]. EMG of masticatory muscles was performed according to the recommendations Sforza et al. and Tartaglia et al [3, 4]. The masseter and anterior temporal muscles of both sides (left and right) were examined. Disposable silver chloride bipolar surface electrodes (diameter 10 mm, Neirosoft, Russia) were positioned on the muscular bellies parallel to muscular fibers [3]. The skin was cleaned with 70% alcohol prior to the placement of the electrodes. In particular, on the anterior temporalis muscles, the electrodes were positioned vertically, 3 cm of the zygomatic arch, just lateral to the eyebrow (lateral to the orbit of the eye); on the masseter muscles, the electrodes were parallel to muscular fibers, between the cheek bone and the corner of the jaw, with the upper pole of the electrode at the intersection between the tragus-labial commissure and the exocanthion–gonion lines. A disposable reference electrode was applied to the forehead. sEMG activity was recorded using a computerized instrument Synapsis and software by Neirotech (Russia). The analog EMG signal was amplified and digitized. Patients were sitting in a natural position without muscular tension, arms, legs were not crossed, head was held equally without support. Lips were kept closed slightly, tooth – in physiological rest. To avoid the effect of fatigue, there was three minutes-rest between each test. EMG-activity was recorded in 3 tests, lasted 10s for each one. The first test or the maximum voluntary clenching (MVC) was performed in intercuspal position (without any material placed on the molar teeth) for evaluation of symmetry of the masseter and anterior temporalis muscles of the left and right sides. The second and third tests were one-side clenching, using cotton rolls on right and left sides respectively for evaluation of EMG-activity of masticatory muscles on working and balancing sides [3, 4].

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

The obtained data was statistically analyzed using the Student's t-test and the Fisher's criterion X2. The hypotheses were verified at the level of significance $p<0,05$.

RESULTS

Among 23 selected subjects with distal occlusion (Angle Class II), 11 (47,8%) patients were with Class II-1 malocclusion and 12 (52,2%) patients with Class II-2 malocclusion. The overjet in patients with Class II-1 was on the average of 7,3 ± 1,5 mm. Patients with Class II-2 were characterized by deep overbite and retrusion of the upper incisors. In all examined patients we found specific clinical symptoms of TMD. More detailed analysis of the structure of the TMD symptoms proved that articular noises (cracking and clicking) occurred more often during the mouth opening and closing. In 13 observations (56,5%) clicking was registered in combination with other symptoms of dysfunction and in 4 subjects (17,4%) it was diagnosed as individual symptom. A fairly high rate of the lateral deviation of the lower jaw during mouth opening was observed in 7 cases (30,4%). Pain In the maxillofacial area was diagnosed in 10 (43,5%) patients. Noteworthy, we diagnosed not a single but the combination of several symptoms of dysfunction, accounting for 65,2% of cases (15 patients). Such symptoms as restricted mouth opening and pain in the joint on palpation was diagnosed only in combination with other symptoms in 5 (21.7%) subjects of the group Class II-2, and 3 subjects (13.3%)of the geoup II-2 Class of malocclusion. 10 (43,5%) patients had TMD of group Ia (myofacial pain), 4 (17,4%) – of group IIa (disk displacement with reduction), 9 (39,1%) subjects had combination of Ia and IIa groups.

The combination of TMD with disorders of function of masticatory organ (breathing, swallowing, speech, mastication) was observed in 17 patients (73,9%). The largest number of cases with the symptoms of TMD was revealed in mastication, speech and swallowing disorders.

The analysis of the resulting EMG-data is presented in Tables I, II, III.

The results of the EMG of masticatory muscles of patients with Class II-1 and II-2 of malocclusion showed that in the test of clenching on the left side the bioelectrical activity of the muscles on the balancing (right) side was almost equal

Table I. EMG-activity of masticatory muscles in the test of clenching of teeth on the left side (μV)

Indices	M.masseter dextra		M.masseter sinistra		M.temporalis dextra		M.temporalis sinistra	
	II-1 (n=11)	II-2 (n=12)	II-1 (n=11)	II-2 (n=12)	II-1 (n=11)	II-2 (n=12)	II-1 (n=11)	II-2 (n=12)
Peak ampl. (μV)	1441,01 ±98,75	1347,65 ±58,55	2988,45 ±48,34	2876,35 ±88,55	1054,34 ±65,74	1834,09 ±87,72	1334,3 ±65,43	2034,02 ±93,52
	p≥0,05		p≥0,05		p≤0,001		p≤0,001	
Average ampl. (μV)	223,33 ±28,25	219,22 ±18,05	434,22 ±37,55	421,31 ±12,13	207,44 ±26,10	288,33 ±24,53	212,33 ±21,44	334,45 ±11,98
	p≥0,05		p≥0,05		p≤0,01		p≤0,001	

Table II. EMG-activity of masticatory muscles in the test of clenching of teeth on the the right side (μV)

Indices	M.masseter dextra		M.masseter sinistra		M.temporalis dextra		M.temporalis sinistra	
	II-1 (n=11)	II-2 (n=12)	II-1 (n=11)	II-2 (n=12)	II-1 (n=11)	II-2 (n=12)	II-1 (n=11)	II-2 (n=12)
Peak ampl. (μV)	2886,31 ±68,05	2547,45 ±62,34	1683,45 ±53,343	1506,15 ±79,66	1634,19 ±99,43	1954,23 ±68,88	1356,32 ±65,43	1890,04 ±32,52
	p≤0,01		p≥0,05		p≤0,01		p≤0,001	
Average ampl. (μV)	426,43 ±18,25	402,21 ±23,05	234,25 ±44,15	220,13 ±24,13	228,28 ±19,53	297,41 ±13,11	210,33 ±26,11	289,15 ±21,98
	p≥0,05		p≥0,05		p≤0,01		p≤0,05	

to values on the working (left) side that was not typical for normal functioning of the masticatory muscles ($p \leq 0,01$). At the same time high indices of bioelectrical muscle activity up to 2000 μV and more have been observed on the working (left) side. The comparison between the study groups showed higher values of the amplitude of the temporal muscles (peak and average) in patients with Class II-2 malocclusion in compare to similar values in patients with Class II-1 malocclusion ($p \leq 0,001$).

In the most cases in the test of clenching on the right side statistically significant difference of muscles amplitude of the balancing and working sides was found. The indices on the working side prevailed ($p \leq 0,05$), that is shown in Table II.

At the same time the high indices of bioelectrical activity of masticatory muscles on the working (right) side with values greater than 2000 μV were noted. The amplitude of EMG-activity of the temporal muscles (peak and average) was higher in patients with Class II-2 malocclusion as compared to patients with Class II-1 malocclusion ($p \leq 0.05$).

The example of the EMG of the masseter and temporal muscles in the test of teeth clenching on the right side of 25-year-old patient K. is presented in Figure 1.

The indices of the EMG-activity of the masseter muscles in the test of maximum voluntary clenching are presented in Tables III.

The results of EMG study during the test of maximum clenching showed higher values of the amplitude (peak and average) of the masseter and temporal muscles on the different sides. There was discovered statistically significant difference in EMG-activity in patients with Class II-1 and II-2. Higher values of the right masseter muscle (its prevalence in the Group II-1; $p \leq 0,001$), temporal muscle (its prevalence in the Group II-2 on the right and left sides; $p \leq 0,001$) were found. These facts proved the occurrence of certain disproportions in the functioning of the musculo-masticatory apparatus of the examined patients. Thus, in patients with Class II-1 and TMD a certain disproportion of the activity of masseter and temporal muscles with the prevalence of the right masseter muscle was noted. In patients with Class II-2 malocclusion and TMD the prevalence of EMG-activity of temporal muscles was occurred.

Discussion. Issues on achieving of the stable functional occlusion are widely elucidated in recent publications on orthodontics [6]. Long-term existence of occlusal disharmony causes displacement of the articular heads and occurrence of functional loads, which can lead to injury of the articular tissues, change of the shape of temporomandibular joint elements [8]. The analysis of publication data shows that Class II malocclusion causes TMD more often than normal occlusion [9]. According to [1, 8], the symptoms of TMD in patients with Angle Class II occur in 72% of cases.

Publications report about the variable etiology of TMD in Class II malocclusion. Functional disorders are crucial

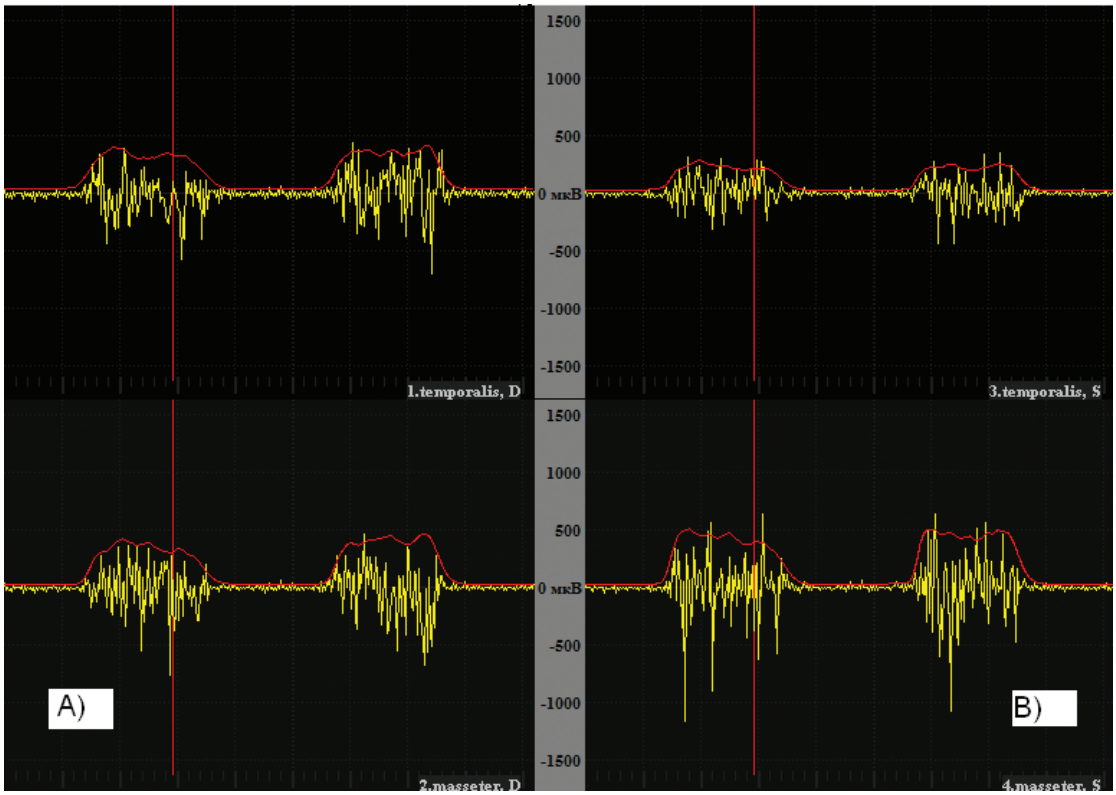

Figure 1. Fragment of EMG of 25-year-old patient K. during the test of clenching on the right side. EMG of muscle activity: a) on the right; b) on the left. The m. masseter amplitude prevails over the m.temporalis ampitude; insignificant difference between the indices of the working (MD, TD) and balancing (MS, TS) sides.

in the occurrence of pathological states of the TMJ [8, 9]. Symptoms of TMD in patients with distal occlusion, are observed in almost all cases, and associated with the following factors: palatine inclination of the anterior teeth of the upper jaw, deep anterior overbite, exaggerated curve of Spee, high and prominent cusps of the lateral teeth [1, 2, 8].

To sum up, the publications report that Angle Class II malocclusion is associated with changes in the state and function of TMJ. The authors highlight the worsening of the functional state of masticatory muscles both in TMD and Class II malocclusion. The relationship between the lateral pterygoid, temporal, masseter muscles and the articular disc through the muscle or connective tissue fibers influences on displacement of the disc during the movements of the mandible [10]. At the same time some authors hypothesize that neither temporal, nor masseter and lateral pterygoid muscles have a direct action on the articular disc, and only participate in signaling of its position [8, 11]. Consequently, data about EMG-activity of masticatory muscles in subjects with distal occlusion (Angle Class II malocclusion) and TMD are of great importance. The abovementioned can further promote objective validation of the methods of functional reorganization in the muscles during functional therapy.

Ultimately, publications show that distal occlusion is associated with TMD. However, no comparative characteristic of the structure of functional disorders of dento-jaw system was made, and their relationship with TMJ state in patients depending on the subdivision of malocclusion has not been proved to date. The authors observe the worsening of the functional state of masticatory muscles both in TMD and Class II malocclusion. Consequently, the purpose of our research was the enhancement of the efficacy of the TMJ dysfunction diagnosis in patients with Angle Class II malocclusion by the determination of the status of the electromyographic activity of the masseter muscles.

To summarize, the study of the dental status of patients with Angle Class II malocclusion revealed various clinical signs of TMD. It should be noted that, generally, we diagnosed not a single but the combination of several symptoms of dysfunction, accounted for 65,1±0,9% (in 28 individuals out of 43). Among the latter the following combinations of symptoms prevailed: cracking and clicking with lateral deviation of the mandible, as well as cracking and clicking, restricted mouth opening with pain in the maxillofacial area. At the same time cracking and clicking in the joint has been diagnosed as the individual symptom the most frequently (18,6±1,4%).

A detailed analysis of the structure and frequency of TMD proved, that clinical symptoms depends on the state of other functions of the dento-jaw area. It was found, that TMD occurred more frequently in patients with swallowing, chewing and speech dysfunctions, and, therefore, we hypothesize that the latter can act as the risk factors for occurrence of TMD.

Table III. EMG-activity of masticatory muscles in the test of maximum voluntary clenching (μV)

Indices	M.masseter dextra		M.masseter sinistra		M.temporalis dextra		M.temporalis sinistra	
	II-1 (n=11)	II-2 (n=12)	II-1 (n=11)	II-2 (n=12)	II-1 (n=11)	II-2 (n=12)	II-1 (n=11)	II-2 (n=12)
Peak ampl. (μV)	2713,35 ±52,38	1956,33 ±55,05	2083,35 ±48,43	1996,75 ±69,66	1867,39 ±59,12	2314,43 ±44,81	1659,12 ±45,14	2079,44 ±62,45
	p≤0,001		p≥0,05		p≤0,001		p≤0,001	
Average ampl. (μV)	419,43 ±16,25	292,41 ±43,05	354,21 ±56,18	298,23 ±54,13	287,49 ±19,56	398,22 ±10,51	266,32 ±19,11	344,15 ±21,98
	p≤0,001		p≥0,05		p≤0,001		p≤0,05	

CONCLUSIONS

Certain features of EMG-activity of masticatory muscles were found in patients with Angle Class II malocclusion and TMD, which are characterized by: 1) increased values of EMG-activity of temporal and masseter muscles – peak and average amplitude in tests of unilateral clenching and maximum clenching (values are greater than 2000 μV); 2) in unilateral clenching of jaws (on the left or right) the increased EMG-activity was detected on the balancing side; 3) in unilateral clenching of jaws (on the left or right) the increased muscle activity on the working side with disproportional (asymmetric) load distribution between masseter and temporal muscles has been found.

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The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Anastasiia V. Liakhovska
Ukrainian Medical Stomatological Academy
Shevchenko 23 str., 36011 Poltava, Ukraine
tel: +380669945461
e-mail: anvitatali@gmail.com

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