Electromyographic Evaluation of Masticatory Muscle Activity in Patients with Temporomandibular Dysfunction

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Summary

The term temporomandibular dysfunction (TMD) encompasses a group of disorders of the masticatory muscles and temporomandibular joints. Major precipitating factors are occlusal, traumatic, psychosocial and systemic factors. The aim of this investigation was to determine possible altered muscular function in patients with TMD, as well as to determine the need for EMG application in TMD diagnosis.

Forty young adults participated in this study: 13 subjects with signs and symptoms of TMD and 27 asymptomatic subjects, sex and age matched. Surface EMG recordings were obtained from left and right anterior temporal muscle, left and right masseter muscle and from left and right digastric muscle in eight mandibular positions.

Right side to left side ratio of examined muscles myoelectrical signals in lateral occlusal and maximal lateral positions for the asymptomatic group showed significantly higher activity of the working side anterior temporal muscle ($p<0.05$). In the group of patients with TMD, regarding the same muscle, statistically significant differences were found only in the left occlusal and left maximal lateral position ($p<0.05$), at which greater activity was found for the working side temporal muscle. In the same positions of the right side no significant differences in anterior temporal muscle activity were found ($p>0.05$). Comparison of myoelectrical signals in the position of maximal intercuspation of teeth between the patients and the controls, showed significantly higher activity in right and left masseter muscle at 50% MVC ($p<0.05$) in the symptomatic group.

Results of this investigation showed the presence of altered masticatory muscle activity in TMD patients and confirmed the use of electromyography in TMD diagnosis.

Key words: *temporomandibular dysfunction, electromyography masticatory muscles.*

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Introduction

The term temporomandibular dysfunction (TMD) encompasses a group of disorders of the masticatory muscles and temporomandibular joint (1, 2). Current literature confirm that about 60 - 70% of the general population has at least one sign of temporomandibular disorder, yet only around one in four people with signs is actually aware of, or reports, any symptoms (3-5). Furthermore, only about 5% of people with one or more signs of TMD will actually seek treatment. Most of those who seek treatment are female and they outnumber male patients by at least 4:1 (3). Epidemiological studies suggest that signs and symptoms of TMDs are quite common in all age groups, including children and old people (6). However, symptoms are most commonly present in early adulthood (4, 5, 7).

Although the aetiology of TMD is complex and still largely unresolved, most important etiological factors are occlusal, traumatic, psychosocial and systemic factors (8). There are three cardinal features of TMD - orofacial pain, joint noise and restricted jaw function (3). Pain is the most common presenting complaint and is by far the most difficult problem to evaluate (9). Joint noise, however, is quite common in asymptomatic people in the general population, and it is of little clinical importance in the absence of pain (10). Restricted jaw function encompasses a limited range of mandibular movements in all directions. Like pain, restricted jaw function causes considerable anxiety for the patient, who faces difficulties in everyday activities such as eating and speaking. Beside these three major features several other factors are implicated: painful pressure on masticatory muscle insertion, facial pain, pseudopulpitic pain, tooth wear, mandibular deviations during opening and closing, tooth mobility, localised periodontal pockets (8).

The clinical course of TMD does not reflect a progressive disease but rather a complex disorder that is moulded by many interacting factors, which serve to maintain the disease (5). The main goals of treatment for TMD are to reduce or eliminate pain or joint noises, and to restore normal mandibular function. This is best achieved when other contributing factors such as stress, depression and oral parafunctional habits are incorporated into the overall treatment strategy (11).

Electromyography (EMG) is a method for measuring myoelectrical potentials, which, in the field of dentistry plays an important role. In this field masticatory muscle function is studied using surface electrodes. By recording masticatory muscle activity and by detailed quantitative analysis of obtained results attempts are made to clarify physiologic function and the role of neuromuscular system in functional activity of the mandible as well as the activity of these muscles in various movements. While some authors agree that masticatory muscles EMG could be a helpful adjunct in TMD treatment (12-15), others, although stressing its value in clinical research, show the limitations of its clinical application (16). The latest results, however, show that EMG is the method widely used for evaluation of orofacial muscular function or dysfunction in situ (17). A connection between masticatory muscles EMG and signs and symptoms of TMD as a state of TMJ, occlusion, oral parafunctional habits, jaw movement, bite force, ability of mastication is under research in order to obtain the relationship between masticatory muscle pathophysiology and TMD pathogenesis.

The aim of this investigation was to determine possible altered muscular function in patients with TMD, as well as to determine the need for EMG application in TMD diagnosis.

Subjects

Forty young adults participated in this study. The symptomatic group (S) consisted of 13 subjects (mean age 23. 9 years; sd. 1. 8 years). They were chosen among the patients referred to the School of Dental Medicine University of Zagreb, because of TMD problems. Patients were clinically examined according to the following study protocol: pain in the jaw, facial, neck and back muscles, palpable TMJ pain, audible TMJ sounds, presence of mandibular deviations during opening and closing, and limited mandibular function.

The asymptomatic, control group (C) consisted of 27 healthy subjects (mean age 22.4 years; sd 1.37 years). They were selected from dental students at the School of Dental Medicine, University of Zagreb and were age- and sex- matched with the symptomatic group. To be included in this group, each subject had to be free of signs and symptoms of myoarthropathies of the masticatory system.

All participants gave their written consent for participating in this study.

Methods

EMG recording and procedure

EMG registrations were taken on a 8-channel PC-based EMGA-1 apparatus for simultaneous recording of myoelectrical activity, (6 differential EMG channels, input impedance 100 MΩ, CMRR>95 dB at 50 Hz, bandwidth 2 Hz-1 kHz, programmable input sensitivity from 100 μVpp to 20 mVpp, an 8 bit resolution A/D conversion, 2 kHz sampling rate) (18-22).

Surface EMG recordings were obtained from left and right anterior temporal muscle, left and right masseter muscle and from left and right digastric muscle. The conductivity of the electrode-skin interface was increased using conductive gel after thorough cleaning of the skin with alcohol. The electrodes for the myoelectrical registration from masseter and anterior temporal muscle were placed 2 cm apart (23) in the main direction of the muscle fibres, using electrolytic gel. The electrodes for the myoelectrical registrations from the belly of anterior digastric muscle were placed in the main direction of their muscle fibres. The common ground electrode was clipped to the left wrist.

Experimental procedure

The investigation was performed according to the study protocol. First continuous biting with maximum voluntary contraction (MVC) in the position of maximal intercuspation of teeth was evaluated. Next maximal wide opening was evaluated in order to obtained standardized values for depressor muscles. The next part of the examination included EMG registrations in the following order: recordings at 25% and 50% levels of MVC effort, propulsion (P), maximal propulsion (Pmax), right occlusal (RO), maximal right lateral position (Rmax), left occlusal (LO) and maximal left lateral (Lmax) position of the mandible. The degree of elevator muscle muscular activity in mandibular eccentric positions was expressed as a percent of the maximum voluntary contraction. Since the depressor muscles are most active during wide opening it was necessary to express the degree of digastric muscle activity in mandibular boundary and eccentric positions as a percent of its maximum possible tension during maximal wide opening (24).

During registrations the root mean square (RMS) value of each signal was calculated, using:

$$U_{RMS} = \sqrt{\frac{1}{t_2 - t_1}\int_{t_1}^{t_2} u^2(t)dt}$$

where t_1 and t_2 represent positions of the cursor, and u(t) temporary value of muscular activity tension.

Statistical analysis

Statistical analysis was made using the statistical software SPSS 10.0 (Statistical Package for Social Science) for Windows. The measured values were analysed by means of descriptive statistics (X, SD, SE). Since the one-way Kolmogorov-Smirnov test indicated that assessed variables do not differ from the normal distribution, parametric statistical methods were used. The evaluation of statistical significant differences between the symptomatic and asymptomatic group was made using t-test for independent samples. The evaluation of statistical differences between each paired muscle of the right and left side was made using t-test for dependent samples.

Results

Figure 1 shows the values (mean value X, standard error SE) of all muscles myoelectrical signals in the examined positions in the asymptomatic group. Figure 2 shows the myoelectrical signals evaluated in the same positions in the symptomatic group.

The degree of elevator muscle muscular activity in mandibular eccentric positions was expressed as a percent of the maximum voluntary contraction in order to compare myoelectrical signals of particular muscles of the right and left side, as well as between groups. The degree of depressor muscle activity in mandibular boundary and eccentric positions was expressed as a percent of its maximum possible tension during maximal wide opening.

Table 1 shows right side to left side ratio of the examined muscle myoelectrical signals in lateral positions in asymptomatic as well as in the symptomatic group. In the asymptomatic group, regarding temporal muscle, statistically significant differences were found in the right occlusal (t=4.016; p=0.001) and maximal right lateral position (t=2.981; p=0.006), at which greater activity was found for right temporal muscle. Significant differences were also found in left occlusal (t=-3.350; p=0.002) and maximal left lateral position (t=-3.117; p=0.004), at which greater activity was found for the left temporal muscle.

In the group of patients with TMD, for the same muscle, statistically significant differences were found only in the left occlusal (t=-2.943; p=0.012) and left maximal lateral position (t=-2.734; p=0.018), while in the same positions of the right side no significant differences were found (p>0.05).

The evaluation of statistical significant differences between the symptomatic and asymptomatic group was made using t-test for independent samples (Table 2). Statistically significant differences were found for right and left masseter muscle at 50% level of MVC effort (RM t=-3.135, p=0.003; LM t=-2.219, p=0.033). As shown in Table 2, in the group of patients with TMD, for that position, the right masseter muscle activity was 60%MVC and left masseter muscle activity was 61%MCV. In the group of healthy patients the masseter muscle activity in the same position was 40% of maximal voluntary contraction.

Discussion

Although surface electromyography has been present for long time as a method in dental medicine for muscular activity research and evaluation, there is no unique attitude about its role in TMD diagnosis. While one group of authors (16, 25) disagree with regard to the value of EMG in TMD diagnosis and treatment evaluation, others stress its major role in diagnosing alterations in neuromuscular function (14, 15, 26). Considering both views, in this investigation our aim was to evaluate masticatory muscle activity alterations in TMD patients, as well as deviations from normal muscular activity while performing different mandibular movements.

This investigation results showed that in both groups in the position of maximal intercuspation of teeth, the masseter muscle was the most active muscle (Figure 1 and 2). In the lateral occlusal position the working side anterior temporal muscle was the most active muscle in both examined groups, although the values of myoelectrical signals were higher in the asymptomatic group. Santana and Mora (27) showed that the highest potential measured during lateral displacement of the mandible was that of the working side anterior temporal muscle, and that its potential was significantly higher than that of any other muscle, except the non-working side masseter. The results of other investigations confirm that the highest activity during lateral displacement was that of the working side temporal muscle (28, 29).

The investigation of right side to left side ratio of myoelectrical signals during lateral positions showed that in the asymptomatic group, regarding temporal muscle, statistically significant differences were found in the right occlusal and maximal right lateral position, at which greater activity was found for the right temporal muscle. Significant differences were also found in the left occlusal and maximal left lateral position, at which greater activity was found for the working side temporal muscle. In the symptomatic group, for the same muscle, statistically significant differences were found only in the left occlusal and left maximal lateral position. The changes in EMG activity pattern indicate the possible functional alteration in patients with TMD.

The use of electromyography in temporomandibular dysfunction diagnosis is based uponthe hypothesis that various pathologic and dysfunctional conditions, such as muscle hyperactivity, muscle fatigue and muscle imbalance, can be detected from the EMG recording (8). The term muscle hyperactivity has been used to describe any increased muscular activity over and above that necessary for function. Muscle hyperactivity thus includes not only the parafunctional activities of clenching, bruxing, and other oral habits but also any general increase in the level of muscle tonus (8, 30). Riggs et al. (31) found increased muscular activity by means of electromyography in patients with TMD. On the contrary, Liu et al. (26), as well as Kroon and Naeije (32) reported that muscle activity was lower in TMD subjects. Lyons and Baxendale (33) showed that the difference in muscular activity between the patients and the controls was not statistically significant.

The comparison of myoelectrical signals in the position of maximal intercuspation of teeth at 25% and 50% levels of MVC effort between the patients and the controls, showed significant differences for right and left masseter muscle at 50% MVC. The elevator muscle myoelectrical signals were higher in the symptomatic group, indicating the presence of muscle hyperactivity in patients with TMD.

This investigation has confirmed that EMG is a useful and non-invasive method in TMD diagnosis. However, EMG is not sufficient if applied alone, but together with other methods it forms a complementary approach in TMD diagnosis.

Conclusions

This investigation points out that changes in EMG activity pattern could indicate the possible functional alteration in patients with TMD.

The masseter muscle myoelectrical signals in the position of maximal intercuspation of teeth 50% levels of MVC effort were higher in the symptomatic group. With regard to right occlusal as well as right maximal lateral position, there was no dominance of the working side temporal muscle activity compared to the non-working side in the group of patients with TMD.