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The significance of masticatory muscle's relaxation in the treatment of the temporomandibular disorders — Review article

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Abstract: Temporomandibular disorder (TMD) is a disease of multifactorial etiology and a complex of symptoms, related to disorders of the masticatory muscles, temporomandibular joints and the surrounding orofacial structures. One of the main problems in the course of TMD disorders is the systematic increase in the tension of the masticatory muscles (masseter muscles, temporalis and medial and lateral pterygoid muscles), what is the cause of many damages and the development of pathological conditions in the stomatognathic system.

The article discusses the differences in the structure of the masticatory and skeletal muscles, as well as the different nature and isoforms of myosin, which determines the much faster generation of contraction in the masticatory muscles and consequently easier generation of excessive, harmful tensions in the masticatory muscles.

The article describes the causes of increased tension in the masticatory muscles and methods of their relaxation used in the basic and supportive treatment of temporomandibular disorders. The use of occlusal splints, physiotherapeutic procedures and TMD treatment with botulinum toxin type A were characterized. A role of psychological support and the methods used for patients with TMD were emphasized.

Keywords: temporomandibular disorder, TMD, relaxation of the masticatory muscles, botulinum toxin injection, physiotherapy, manual therapy, exercise of masticatory muscles, allotypes, myosin.

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Introduction

Temporomandibular disorder (TMD) is a disease of multifactorial etiology and a complex of symptoms, related to disorders of the masticatory muscles, temporomandibular joints and the surrounding orofacial structures. It is a major cause of nondental pain in the orofacial region. These dysfunctions are mainly characterized by muscle's and joint's pain, joint (articular) sounds and incorrect or limited jaw function (decreased mandibular range of motion) [1–4]. It is the second illness among musculoskeletal disease and third dental disease of a social nature. The authors of the publication indicate that 39.2% have at least one symptom of TMD. The incidence rate is 3.9% among adults and 4.6 % among adolescents [5]. It is twice as common in women than in men. There is a peak occurrence between 20 and 40 years of age. It's incidence, unfortunately, is systematically increasing, the number of patients with the pain form is bigger and the age of patients is decreasing. It is a disease entity which, despite many scientific studies, still does not have a specific treatment algorithm and is a difficult task for a dentist [5–9].

One of the main problems in the course of TMD disorders is the systematic increase in the tension of the masticatory muscles (masseter muscles, temporalis and medial and lateral pterygoid muscles), what is the cause of many damages and the development of pathological conditions in the stomatognathic system. These are the damages to owns teeth like: pathological tooth wear (Fig. 1), wedge cavities, enamel fractures, damages of the prosthetic fixed and removal restorations, injuries to the periodontal tissues and gingival recessions, pathological growth of the masseter muscles (square face), loss of dental implants and development of tension headaches. The differential diagnosis includes diseases in which the masticatory muscle tension may significantly increase. This group includes diseases such as: focal or generalized dystonia, epilepsy, multiple sclerosis, cerebral palsy and Parkinson's disease [1, 3, 6].

Fig. 1. Teeth damage resulting from occlusal parafunction habits — grinding of the teeth.

The increase of the masticatory muscle tone correlates with the increase of bite forces, generated by the masticatory muscles. Both of these parameters adversely increase during parafunction, which means harmful movement habits (such as; grinding, clenching or tapping the teeth, biting nails, pressing the tongue against the teeth and frequent chewing gum) that are not concern with physiological activities [1, 2, 7]. This prolonged muscle contraction work and the lack of the necessary rest contribute to the development of pain (among others — lactic acid accumulation) in the masticatory muscles (with significant intensity) and numerous unfavorable morphological changes (pathological growth of the masseter muscles–square face). Nowadays, the authors of many publications [1–4, 6, 7, 9–11] believe that the increase of the muscle's tension and occlusal parafunctional habits activity are directly related to excessive psychoemotional excitability, excessive susceptibility to stress, and the inability to cope with stress. It is the limbic system and the endothelial-spinal pathway as its connection to the masticatory muscles, along with the gamma loop, which are responsible for the alarmingly increasing tension in the masticatory muscles, resulting from emotional tensions. For this reason, psychological support of patients with TMD and their education in coping with stress are very important [1, 3, 10].

Stal *et al.* [12] emphasize there is a different reactivity of masticatory muscles and skeletal muscles to stress, because both of these muscle groups have different embryonic origins; the masticatory muscles come from the mesenchyme of the first pharyngeal arch, and the skeletal muscles come from the mesoderm of somite's called myotome. The high activity of ATP-ase in the masticatory muscles plays an important role in the speed of generating contraction. Moreover, both muscle groups differ from each other in a different molecular structure, because the masticatory muscles have more contractile fibers per muscle mass. A very important issue is the different myosin allotypes and significant differences in the expression of the growth factor genes, heat shock protein and inhibitors of matrix metalloproteinases.

Korfage *et al.* [13] informed in their work, that an important advantage of fiber-type diversity, as observed in the jaw muscles, is that it optimizes the required function while minimizing energy use. The capacity for adaptation is reflected by the large variability in fiber-type composition among muscle groups, individual muscles, and muscle regions. Also, muscle fibers have the ability to adapt to environmental alteration by changing from one fiber type into another. A motor unit's ability to produce force is proportional to its cross-sectional area, which depends on the number and cross sectional area of the constituent muscle fibers. The ability to resist fatigue is dependent on the metabolic properties of the fiber (amount of the aerobic end — oxidation enzymes).

Human masticatory muscles are unusual in comparison to other skeletal muscles in that their fibers. The problem of classifying these muscles is sometimes related to the inability to classify them based on the histochemistry of ATP-ase into subtypes I,

IIA and IIB. This is related to the heterogeneity of the myosin heavy chain proteins and the morphology of the muscle fibers. The diameter of a Type II subclasses is smaller than a Type I subclasses. Human masseter expresses the myosin heavy chain I, IIA, and IIX isoforms, as in limb muscles, but also the developmental and cardiac isoforms. For this reason, the human masticatory muscles therefore regulate protein expression differently from typical limb muscles, what is related to the expression of a wide variety of myosin heavy-chain genes [12, 13].

From a physiological and morphological point of view the masticatory and limb muscles belong to two distinct allotypes. The information presented above on the physiological functions and the system of contractile proteins in the described muscles are most likely they explain why the muscles have evolved to meet the specialized functional requirements imposed. This information is also vitally needed to understand the contraction physiology of the masseter muscles and the physiological differences in the contraction mechanism compared to other skeletal muscles [12–14].

Compared to the muscle of the limb and trunk, the masticatory muscles possess a higher percentage of hybrid fibers, which express many myosin subtypes or more I type fibers. A large amount of hybrid fibers is associated with the plasticity of the masticatory muscles and more efficient energy consumption during the contraction. Compared to masticatory muscles, the limb and trunk muscles exhibit type II fibers which are larger in diameter compared to type I. This suggests that, in the masticatory muscles, the high presence of type I fibers with a small cross-sectional area (CSA) could facilitate the greater exchange of nutrients and O_2 with the extracellular environment, increasing fiber resistance to fatigue. Among other things, these features determine their uniqueness in relation to all other skeletal muscles in humans [14, 15].

Prolonged excessive muscle tension becomes the cause of non-physiological, excessive overloads the temporomandibular joints, which in turn leads to damage to the soft tissue elements within the joints. Ultrasound examinations of the joints often show pathological changes of the articular surfaces in the form of: retrograde changes — third degree, osteophytic changes, penetrating from the edge of the articular surfaces, and features of the defect as changes resulting from functional overload of the s-f joints [16, 17].

The excessive psychoemotional excitability, excessive susceptibility to stress and the inability to cope with stress [1, 2, 6–8, 10, 12]. It is the limbic system and the reticulospinal pathway, as the connection of this system with the masticatory muscles, together with the gamma loop, which are seen as the main reason for the disturbingly increasing tension in the muscles. Stress affects muscle function through gamma efferent fibers linked to the autonomic spindles, and through the autonomic fibers. The results of experimental studies show that in patients subjected to strong stressors, there is an immediate increase in the intensity and value of electric potentials of the masticatory muscles in the resting position of the mandible [10].

Due to a complex etiology, no specific algorithm for the management of muscle relaxation has been developed so far, but it should be extremely necessary in the treatment of temporomandibular disorders. Taking into account the causal treatment of excessive tension in the masticatory muscles, the most important thing is to make patients aware of the harmfulness of occlusive parafunctions and their negative impact on individual elements of the stomatognathic system, as well as the role of the psychoemotional factor in the development of temporomandibular disorders. The participation of dentists themselves in a psychological support (after a specialistic training) and the treatment conducted by psychotherapists and psychologists — are valuable and necessary. In particular, behavioral therapy, systematic desensitization and stress management education are recommended and sleep hygiene education [1–5, 7, 9]. Due to the participation of the psychoemotional factor in the development of TMD, mental relaxation of patients is very important. For this purpose, cognitive behavioral therapy and systematic desensitization are used, as well as education of awareness of etiological factors [2, 5, 7, 10].

One of the basic methods of relaxing the masticatory muscles in symptomatic treatment is a distance between the jaws (4–5 mm) and the use of occlusive splints. This appliance placed between the dental arches changes the peripheral sensory impulses, reducing the excessive activity of the masticatory muscles. Increasing the distance between the muscle attachments and stretching the muscle fibers relative to each other is a very important mechanism for reducing muscle tension. They play an important role due to alleviating muscle pain, breaking pathological occlusal habits, changing the occlusal forces to a more favorable one, relieving the temporomandibular joints and protecting the teeth from damage. Correcting the occlusion of one's own teeth may be a valuable method in the fight against excessive muscle tension, but it is the approach used in the second stage of treatment [1–3, 7, 11, 18–20], and some authors believe that incorrect occlusion contacts do not affect the tone of the masticatory muscles [4, 6].

Botulinum toxin type A (BTA) is one of the few drugs that are widely used in many fields of medicine. The indications for its use are constantly expanding. The use of this drug is primarily aesthetic medicine, but for many years numerous studies on the use of the toxin in dentistry have been conducted. BTA has been used in intramuscular injections, most often into the masseter muscles and the front part of the temporalis muscles. As in any case, when using botulinum toxin, the indications for its use, as well as contraindications, should be carefully considered. The therapeutic effect of intramuscular injections depends on the cross-section of the muscle, the dose administered and the method of injection, but mostly lasts about 3–4 month [1, 20, 21].

The favorable mechanism of blocking the neuromuscular conduction significantly reduces the tone of the masseter muscles, which is confirmed by electromyographic

evaluation. Moreover, the recovery of the conductivity takes place on the basis of the formation the new axonal bundles, which are in much smaller amount than the original connections, which is a very favorable phenomenon for obtaining muscle relaxation. Oral relaxation and nonprescription pain relievers drugs, anti-inflammatory agents and antidepressants (e.g. selective serotonin reuptake inhibitors) are used much less frequently, because they work only while the patients are taking them and the use of the occlusal splints usually brings quick relief from the pain. In extreme cases of aggressive (very intense) bruxism, antiepileptic drugs are used [20, 21].

Physiotherapeutic treatments, are currently considered to be very effective in supporting basic treatment with the use of occlusal splints and pharmacological treatment (botulinum toxin). These treatments include manual therapy, massage, sonophoresis, post-isometric relaxation and progressive muscle relaxation according to Jacobson [22–24]. Particularly noteworthy are the relaxing muscle exercises, which should be systematically performed by patients, as an opportunity to change the model of activity of the muscles lifting the mandible. Only the right amount of daily and systematic exercises and awareness of the harmfulness of parafunction (conscious abandonment of harmful habits) are able to reduce excessive muscle tension. Biasotto-Gonzalez *et al.* [17] presented the results of their research in which they measured the electrical activity of the masticatory muscles in a group of patients with TMD and in healthy people. Physiotherapeutic procedures performed in a group of patients resulted in a statistically significant decrease in the tension of the masticatory muscles in the electromyographic assessment of muscle activity [23–25].

Youngsook *et al.* [24] showed that the use of systematic relaxation exercises had a fundamental, positive effect on the reduction of the pain in the masticatory muscles, the improvement of the range and path of jaw motion, and the occlusion conditions. The many years of professional practice of the authors indicate the great importance of exercising by the patient. In addition to the relaxation action itself, the patient is aware of participation in rehabilitation, which is an important motivational element [26–29].

Summary

The treatment of TMD contains a very important component, which is the combating excessive, pathologically high tension in the masticatory muscles. The success of specialist treatment depends, among other things, on the extent to which we obtain a decrease in excessive tension in the masticatory muscles. This fact is also the prevention of further TMD progression. It is the most advantageous to use several therapeutic methods simultaneously.

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