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Assessment of thickness and function of masticatory and cervical muscles in adults with and without temporomandibular disorders

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ABSTRACT

Objective: The aim of this study was to evaluate the maximal bite force (MBF), electromyographic (EMG) activity and thickness of the masseter, anterior part of the temporalis and sternocleidomastoid (SCM) muscles in a group of young adults with and without temporomandibular disorders (TMDs).

Design: Nineteen individuals comprised the TMD group (6 males/13 females, aged 25.4 ± 3.8 years), classified based on the Research Diagnostic Criteria for TMD (RDC/TMD), and 19 comprised the control group (6 males/13 females, aged 24.1 ± 3.6 years). The MBF was determined with a transducer placed between the dental arches at the first molars level (N). The muscles were evaluated bilaterally at rest and during maximal voluntary clenching (MVC) by assessing EMG activity and performing ultrasonography (USG). The mean values of these measures for both sides of the mouth were used. The normality of the distributions was assessed by the Shapiro–Wilks test. Variables between groups and genders were compared using two-way factorial ANOVA test and correlated using the Spearman coefficient ($\alpha = 0.05$). Unpaired *t* test was used to compare variables between TMD subgroups. Logistic regression analysis was used to identify the variables associated with the presence of TMD.

Results: MBF, EMG and USG data were similar among clinical groups and among TMD subgroups. The thickness of masseter and SCM muscles in the relaxed and clenching states were significantly higher in males than females. On the other hand, the EMG of the temporalis muscle in the rest state was significantly higher in females than males. Additionally, the MBF was positively correlated with the USG characteristics of masseter and SCM muscles, as well as with the EMG activity of masseter and temporalis muscles in the TMD group. In this group, there was also a positive correlation between the thickness of the masseter muscle and its activity. On the other hand, the thickness of the SCM muscle was negatively correlated with its activity. A lower MBF was independently associated with the presence of TMD.

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Conclusions: Subjects with TMD exhibited similar values of MBF, thickness and electrical activity of masticatory and cervical muscles when compared with controls; positive correlations observed between these variables may suggest a muscular alteration in TMD patients and a co-activation of masticatory and cervical muscles during mandibular movement. This fact may also be confirmed by the negative association between bite forces and presence of TMD.

1. Introduction

Temporomandibular disorders (TMDs) are a group of changes that affect the components of the stomatognathic system, such as the masticatory muscles, temporomandibular joints (TMJs) and/or related structures.[1–3] The aetiology of TMDs is multifactorial and may be associated with an imbalance among anatomical, neuromuscular and psychological factors. Such disorders are characterised by signs and symptoms that limit and/or impair physiological activity, which may include pain, limitation and deviation of mandibular movements, joint sounds, and muscle and joint sensitivity.[4,5] The affected individuals may also experience headaches, as well as neck and otologic symptoms.[6]

The jaw elevator muscles are commonly affected in cases of TMD[7] and may be impaired in their functional efficiency, with changes in electrical activity and force of contraction.[8] These muscles act in close coordination with the cervical muscles,[9–11] and an injury to one of these components can become mutually provocative.[9,10,12] The sternocleidomastoid (SCM) muscle has been shown to be important in maintaining the posture of the head[12,13] and may be affected by functional disorders, referring pain to the stomatognathic system.[12,14]

Thus, it is essential to understand the functional and morphological muscle changes in individuals with TMD. In relation to functional aspects, the measurement of maximum bite force (MBF) has been a useful method to quantify the strength of closing mandibular muscles and to understand masticatory function in patients with orofacial dysfunctions, helping to establish the diagnosis and treatment plan.[15] In individuals with TMD, the MBF may appear lower than in normal ones, due to an overload on the masticatory muscles.[15,16] In addition, surface electromyography (EMG) enables the acquisition of valid and reliable quantitative data on the functional condition of the masticatory muscles as a ''neuromuscular functional analysis'' and appears to be able to deliver additional diagnostic and therapy-relevant information.[17]

Nevertheless, the activity of masticatory muscles in patients with myogenic TMD is open to question. Svensson and Graven-Nielsen,[18] reviewing the literature about craniofacial pain considered that there is little experimental evidence to suggest an increase or decrease in EMG activity in human subjects during muscle pain. In this context, Yachida et al.[19] found no significant differences in EMG activity during sleep between patients with painful TMD and pain-free individuals, but observed a significant correlation between EMG activity and pain intensity. Conversely, significantly higher activity values were observed for the SCM and trapezius muscles at rest in patients with TMD, and the magnitude of this activity was influenced by the presence of pain.[10] During a maximal voluntary clenching (MVC) exercise, the mean peak EMG levels of the digastric and SCM muscles increased from those obtained in the rest position in healthy individuals, revealing a co-activation of the anterior neck muscles in mandibular movement[20] and a functional link between the cervical and masticatory muscles.[10] The muscular compensations between mandibular motor system and cervical structures may represent a mechanism necessary to obtain stability during masticatory function[21] and may influence the muscular structure.

Regarding the morphological analysis of muscle tissue, ultrasonography (USG) has proven to be helpful in the verification of structural changes in muscles such as muscular contracture,[22,23] hypertrophy, injury and alterations in superficial soft tissue. The technique is simple, noninvasive, low cost and easily accepted by patients.[24] USG can be considered a reliable technique for the evaluation of head and neck muscles in patients with TMD, including the anterior temporalis, superficial and deep masseter, anterior and posterior digastric and SCM muscles.[22] Moreover, USG is an important tool for evaluating the functional capacity of masseter muscle contraction during dental clenching and in the investigation of the relationship between electromyographic activity and muscle thickness.[25] However, this importance still remains controversial.[24] Furthermore, a positive correlation between the magnitude of bite force and USG thickness values of the masseter muscle has been reported.[24]

The use of EMG and USG in the evaluation of muscle strength may permit a better understanding of the participation of the masticatory and cervical muscles in performing the functions of the stomatognathic system, as well as a better understanding of the biomechanical and structural changes that may affect the muscular structures in individuals with TMD, serving as guidelines for the diagnosis and possible therapeutic approaches that could be offered to patients. Thus, it is essential to understand the muscular behaviour in patients with alterations of the temporomandibular complex. Therefore, the aim of this study was to evaluate the MBF, EMG activity and muscular thickness measured by USG of the masseter, anterior part of the temporalis and SCM muscles in a group of young adults with and without TMD. The primary hypothesis was that individuals with TMD would present different MBF, EMG and muscular thickness values in relation to healthy individuals, taking into account gender and clinical TMD groups in accordance with RDC/TMD diagnoses, Furthermore, we hypothesised also that there was a correlation and/or association of the MBF, EMG and muscular thickness values with the presence of TMD.