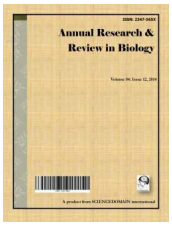

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Effects of Muscular Temporomandibular Disorder on Masticatory Muscles' Thickness

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Authors' contributions

This work was carried out in collaboration between all authors. Authors AMCL, CANB and CB designed the study and wrote the protocol. Authors SCHR, MP and BF performed the statistical analysis and wrote of the manuscript. Authors MSPN, PBV and SS managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This study analyzed the impact of muscular *temporomandibular* disorder (TMD) on masseter and temporalis muscles' thickness. Eighty subjects (aged 21–60, both male and female) with *complete* dentition were divided into study (those with muscular temporomandibular disorder, n=40) and control (healthy individuals, n=40) groups. TMD classification was done using the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) questionnaire. Ultrasound images (via Sonosite Titan) were used to measure the thickness of masticatory muscles. Images were acquired in two conditions: with the mandibular muscles at rest and with dental clenching at maximum voluntary contraction. Muscle thickness data was tabulated and statistically analyzed

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(SPSS 22.0; *t* student test; ($p \leq .05$). There were significant statistical differences in temporalis muscle thickness between the two study groups, with lower temporalis muscle thickness in the muscular TMD group. Our findings indicate that muscular *TMD* changed the morphology of subjects' temporalis muscles.

Keywords: Temporomandibular disorder; stomatognathic system; thickness; masticatory muscles.

ABBREVIATIONS

RDC/TMD : Research Diagnostic Criteria for Temporomandibular Disorders
SPSS : Statistical Package for Social Sciences

1. INTRODUCTION

Temporomandibular disorder (TMD) refers to morphofunctional changes, multifactorial in origin, involving the temporomandibular joint, masticatory muscles, and associated structures, which are part of the stomatognathic system complex [1–3].

TMD affects about 4–10% of the world's population, and it is more common in women than men [4]. According to the American Academy of Orofacial Pain, *TMD* can be classified into muscular, discal, and joint types; discal can be further subdivided into three subtypes: (1) with reduction, (2) without reduction and with limitation of opening, and (3) without reduction and without limitation of opening) [5]. Muscular *TMD* presents in a complex way; affected individuals exhibit signs and symptoms of orofacial pain such as sensitivity to muscle palpation, restriction of excursive movements of the mandible, unilateral chewing habits, increases in skin surface temperature, asymmetry in muscular activity and headaches [6,7].

It is important to be aware of the masticatory muscles' thickness in individuals with muscular *temporomandibular* disorder; this can be a key factor in understanding possible morphofunctional changes that this condition can cause in the stomatognathic system [8]. Ultrasound is a valuable tool for observation of these changes, and for evaluation and diagnosis of TMD [9–11].

In light of the effects *TMD* can have on the masticatory muscles, this study examined the thickness of participants' masseter and temporalis muscles. The objective was to identify anatomical parameters for professionals in medical and dental fields who work with individuals to treat of chronic orofacial pain.

2. MATERIALS AND METHODS

2.1 Ethical Approval

All subjects gave written informed consent to participate in the study, which was approved by the Research Ethics Committee of the Dental School of Ribeirão Preto, University of São Paulo (process n. 0070.0.138.000-11) in accordance with Resolution 466/12 of the Brazilian National Health Council. All authors hereby declare that all experiments were examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

2.2 Participants

The study population was comprised of 80 subjects, ages 21–60, both male (n=40) and female (n=40), complete dentition and nasal breathers. These participants were selected among patients of the occlusion and orofacial pain service of the Faculty of Dentistry of Ribeirão Preto, University of São Paulo.

The subjects were divided into a study group of those with muscular TMD (TDG, n=40) and a control group of healthy individuals, (CG, n=40), matched subject-to-subject by sex, age, weight and height. Anamnestic clinical examinations were performed to collect personal data, medical and dental histories, information on parafunctional habits and clinical indications of TMD (determined according to the Research Diagnostic Criteria for Temporomandibular Disorders [RDC/TMD Axis I and II]) [12].

The exclusion criteria were as follows: absence of teeth (with the exception of the upper and lower third molars); presence of discal and/or joint temporomandibular disorder; prior orthodontic or otorhinolaryngological treatment or speech-language therapy; presence of neurological disorders; and use of

antihistamines, sedatives, homeopathy or other central nervous system–depressant drugs that could affect muscular activity.

2.3 Muscle Thickness Analyses

The Titan portable ultrasound (SonoSite, Bothell, WA, USA) (Fig. 1), with a linear transducer excitation frequency of 10 MHz, was used for measuring the thickness of participants' masseter and temporalis muscles. A conductive gel was used for the transducer coupling on the skin, and to prevent depression on the surface.

Fig. 1. Titan portable ultrasound

During the test, the subjects remained seated and skewed sideways, without head-fixing. The location of the muscles was confirmed by palpation, and by the movement of the linear transducer [9,10]. A single skilled healthcare professional trained in this technology conducted all of the tests.

Measurements of the thickness of the masseter and temporalis muscles were collected for each individual in two clinical conditions: first, with the muscles at rest, and then with dental clinching at maximum voluntary contraction. This pair of measurements was repeated three times, with a two-minute rest interval between each set of measurements. The means of the three measures in each clinical condition were then analyzed.

The linear transducer was placed transversely to the direction of the muscle fibers in two locations. First, measurements were gathered at the center of the masseter muscle, located approximately 1.5–2.0 cm above the angle of the mandible towards the upper eyelid (Fig. 2). Then measurements of the temporal muscle were taken, about 1.0–1.5 cm posterior to and above the external angle of the palpebral commissure (Fig. 3).

Fig. 2. Positioning of the linear transducer over the right masseter muscle

Fig. 3. Positioning of the linear transducer over the right temporalis muscle

The degree of error for this ultrasound technique was calculated by recording images, and by taking double-thickness measurements of both the masseter and temporalis muscles on two different occasions, using Dahlberg's formula [13].

2.4 Statistical Analyses

SPSS software, version 22.0 for Windows (SPSS version 21.0, IBM®, USA) was used for statistical analyses in this study. The results were obtained through descriptive analyses (means and standard error) for each variable. The values were compared to a significance level of 5%, or a 95% confidence interval.

3. RESULTS

The ultrasound images of the masseter and temporalis muscles of individuals without and

with muscle TMD collected during this study were well defined. This allowed for exact measurements related to muscles' thickness to be obtained, and accurate determinations of statistical significance to be reached in comparisons of the CG and TDG.

The means and standard errors of masticatory muscles' thickness in both the rest and dental clenching conditions for CG and TDG are shown in Table 1.

There was no statistically significant difference ($p \geq .05$) between CG and TDG in masseter muscles' thickness in either the rest or clenching condition. There were notable differences, though, in terms of the temporal muscles. In the mandibular rest condition the thickness of right temporal muscle for TDG was lower when compared to CG (0.43 ± 0.00 and 0.59 ± 0.02, respectively, $p = .015$). The same occurred for left temporal muscles when compared the groups TDG and CG (0.42 ± 0.00 and 0.60 ± 0.02, respectively, $p = .001$). In the condition of dental clenching it was observed lower values for both temporalis muscles when compared the groups (0.51 ± 0.01 and 0.67 ± 0.02 for right temporal, $p = .001$; 0.49 ± 0.01 and 0.68 ± 0.02 for left temporal, $p = .001$).

4. DISCUSSION

In the last years there was an increase in the prevalence of *TMD* in individuals seeking medical and dental services, which means it is crucial for providers to have knowledge of the possible morphological and functional changes in the stomatognathic system that can result from this condition. The most common changes are chronic pain [14] and a change in the thickness of the masticatory muscles [15–17].

The normal patterns of masticatory muscles' thickness are well-documented [10]. These muscles' morphology and function can be influenced by factors such as age, gender, craniofacial morphology, parafunctional habits and *temporomandibular d*isorders [18,19].

Some of our results were discordant with those previously reported in the literature. We observed that the masseter and temporalis muscles, when contracted, showed greater thicknesses than when relaxed. This agrees with earlier findings verified by international research on the subject [10]. However, in prior studies, individuals with and without TMD have not shown any meaningful differences in muscle thickness when submitted to the indicated posture conditions of the mandible [20], yet we identified significant differences between these two groups of individuals. These differences are discussed in detail below.

In the present study, the values of the masseter and temporalis muscles' thickness in the mandibular rest and dental clenching conditions were lower in the TDG than the CG. Uncomfortable, sometimes painful, chronic sensory experiences in the face and jaw resulting from psychological stress [21,22], in addition to non-physiological contractions of the masticatory muscles, promote functional limitation of individuals with temporomandibular disorder. These factors may increase the probability of atrophy of skeletal muscle fibers due to muscle fatigue [23,24]. This study did not evaluate muscle fatigue; however, this hypothesis is the most likely explanation for the reduced masseter and temporal muscle thicknesses we found in the TDG.

A preliminary study has already revealed, by comparison of the masseter muscles' thickness in healthy young individuals and those with temporomandibular disorder, an increase in the thickness of these muscles in young individuals with TMD [25]. The morphological change of the striated skeletal muscle might be related to a functional overload, or an increase in muscle tension, as well as energy production. This could lead to breakage in protein chains, and release of amino acids which are then picked up by the skeletal muscles, promoting an increase in the volume of the muscles due to an increase in tension and pH in the muscle tissue [26,27].

To determine which hypothesis is more appropriate for understanding the differences between the findings of our study and those from prior research, it is important to think about the circumstances of individuals with muscular temporomandibular disorder. Probably one of the hypotheses could be the age at which TMD develops. The sooner this disorder is installed, the greater the muscle damage, because this muscle stopped working correctly for a long time, leading to a decrease in muscle thickness. Another factor could be if the muscle itself is triggering the process of muscle fatigue, generating muscle disuse because of painful symptoms. The presence of painful symptomatology prevents the individual from correctly maintaining muscle strength, and can enter into fatigue more quickly.

Table 1. Means, standard error (±) and statistical significance ($p \leq 0.05$) thickness (cm) of the left and right masseter (LM and RM) and left and right temporalis (LT and RT) muscles in the rest and dental clenching in maximal voluntary contraction (MVC) conditions, in both the control (CG) and TMD (TDG) groups

Muscles and clinical condition	CG	TDG	*p* value
Rest			
RM	0.91 ± 0.03	0.90 ± 0.02	.163
LM	0.93 ± 0.03	0.92 ± 0.02	.094
RT	0.59 ± 0.02	0.43 ± 0.00	.015
LT	0.60 ± 0.02	0.42 ± 0.00	.001
MVC			
RM	1.20 ± 0.03	1.19 ± 0.03	.132
LM	1.21 ± 0.03	1.17 ± 0.03	.107
RT	0.67 ± 0.02	0.51 ± 0.01	.001
LT	0.68 ± 0.02	0.49 ± 0.01	.001

This current study has limitations. One of the most important is the lack of consideration of individuals' stress, muscle fatigue, period of temporomandibular disorder, and pain levels to determine the degree that these variables have influenced changes in masticatory muscle morphology. Therefore, further studies are necessary to explore which variables will be useful in precisely delineating the influence of these factors and their consequences in the stomatognathic system. This is particularly the case with regard to muscle thickness in individuals with temporomandibular disorder.

Despite these limitations, the results of this study showed that, when analyzing the thickness of masticatory muscles in patients with temporomandibular disorder, morphological aspects should be considered by the scientific community, particularly in the areas of anatomy, occlusion and orofacial pain. The findings regarding changes in the temporalis muscles' thickness in subjects with TMD will be of particular value to health professionals in understanding the precise dynamics of masticatory muscles before morphofunctional changes in the stomatognathic system, which will help in the development of dentistry treatments, particularly those for the amelioration and rehabilitation of orofacial pain and temporomandibular disorder.

5. CONCLUSION

The present study indicates that muscular TMD causes changes in the thickness of the temporalis muscles.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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