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FACULDADE DE ODONTOLOGIA DE PIRACICABA

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Avaliação morfofuncional dos músculos mastigatórios e cervicais em adultos com e sem disfunção temporomandibular

Tese de Doutorado apresentada a Faculdade de Odontologia de Piracicaba da UNICAMP para obtenção do Título de Doutor em Biologia Buco-Dental, na Área de Anatomia.

Orientadora: Profª Drª Maria Beatriz Duarte Gavião

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RESUMO

As desordens temporomandibulares (DTM) consistem em um grupo de alterações que afetam o sistema estomatognático, especialmente o componente muscular. O objetivo deste trabalho foi avaliar a força máxima de mordida (FMM), a atividade eletromiográfica (EMG) e a espessura dos músculos mastigatórios e cervicais por meio da ultrassonografia (US), além da influência clínica da postura de cabeça, em adultos com e sem a presença de DTM. A amostra foi composta por 47 indivíduos, de ambos os gêneros, sendo 19 incluídos no grupo DTM (idade de 25,4±3,8 anos), classificados de acordo com o Research Diagnostic Criteria (RDC/TMD) e 28 incluídos no grupo controle (idade de 25,9±4,7 anos). Uma linha de prumo foi usada como referência para verificar o alinhamento e identificar clinicamente o lado de inclinação da cabeça. A FMM foi determinada por um transdutor de pressão posicionado entre os arcos dentais até o nível dos primeiros molares e os valores foram convertidos em Newtons. A EMG e a US foram avaliadas para os músculos masseter, temporal e esternocleidomastóideo (ECM), no repouso e em contração voluntária máxima (CVM), bilateralmente. A normalidade dos dados foi verificada pelo teste de Shapiro-Wilks e a comparação entre os dados realizada por testes paramétricos e não paramétricos, sendo a correlação obtida pela Correlação de Spearman ($p \leq 0.05$). Os resultados demonstraram diferenças estatisticamente significantes quando comparados os valores de FMM entre o grupo DTM (285,5±98,8 N) e controle (353,4±69,6 N). Diferenças significativas também foram observadas para a espessura do músculo masseter, entre o grupo DTM (11,2±1,9 mm, repouso; 13,4±1,9 mm, CVM) e o controle (12,7±1,8 mm, repouso; 14,8±2,0 mm, CVM) e entre o estado de repouso e contração, em ambos os grupos, para os músculos mastigatórios. Em relação ao gênero, a FMM foi menor nos indivíduos do sexo feminino com DTM, bem como a espessura dos músculos analisados, em ambos os grupos. Os valores de EMG para o ECM demonstraram diferenças significativas entre o estado de repous o (100,6±28,0%) e de CVM (105,6±101,9%) para o grupo controle, com maiores escores durante o apertamento dentário. Da mesma forma, diferenças significativas foram observadas entre o grupo controle e DTM para a EMG do ECM, durante a flexão de cabeça, para o ECM do lado direito (77,0 ±34,2%, DTM; 115,6 ±56,8%, controle) e esquerdo (80,7±46,1%, DTM; 113,1±49,5%, controle), e na espessura do ECM na extensão, para o lado esquerdo (10,0±2,0 mm, DTM; 10,9 ±1,5 mm, controle) e no repouso para o lado direito (10,4±1,8 mm, DTM; 11,5±1,8 mm, controle). Adicionalmente, correlações significativas foram encontradas entre os valores de FMM, US e EMG do masseter, temporal e ECM para o grupo DTM e também quando considerado o lado de inclinação de cabeça para o ECM. Pode-se concluir que pacientes com DTM apresentaram menores valores de FMM e alterações na função muscular capazes de afetar os músculos mastigatórios e cervicais, especialmente durante os movimentos mandibulares, revelando a existência de uma ligação funcional entre eles.

Palavras-chave: Força de Mordida, transtornos da articulação temporomandibular, eletromiografia, ultrassonografia, músculos mastigatórios, músculos do pescoço.

ABSTRACT

Temporomandibular disorders (TMD) are a group of changes that affect the stomatognathic system, especially the muscular component. The aim of this study was to evaluate the maximum bite force (MBF), the electromyographic activity (EMG) and the thickness of masticatory and neck muscles by means of ultrasonography (US), in addition to clinical influence of head posture, in adults with and without TMD. The sample consisted of 47 individuals of both genders, with 28 included in the control group (mean age 25.9±4.7 years old) and 19 in the TMD group (25.4±3.8 years old), classified according the Research Diagnostic Criteria (RDC / TMD). A plumb line was used as reference to verify the alignment and to define the side of head tilt. MBF was determined by a pressure transducer positioned between the dental arches to the level of first molars and the values were converted into Newtons. EMG and US were evaluated for the masseter, temporalis and sternocleidomastoid (SCM) at rest and at maximal voluntary contraction (MVC), bilaterally. Data normality was checked by Shapiro-Wilks and the comparison between the data done by parametric and nonparametric tests, with the correlation obtained by Spearman's correlation ($p \leq 0.05$). The results showed statistically significant differences when comparing values of MBF between TMD (285.5 ±98.8 N) and controls (353.4 ±69.6 N). Significant differences were also observed for thickness of the masseter muscle between the TMD (11.2±1.9 mm, rest; 13.4±1.9 mm, MVC) and the control group (12.7±1.8 mm, rest; 14.8±2.0 mm, MVC) and between the state of rest and contraction in both groups for the masticatory muscles. In relation to gender, MBF was lower in female subjects with TMD as well the thickness of the muscles analyzed, in both groups. The values of EMG for the SCM showed significant differences between the resting state (100.6 ±28.0 %) and MVC (105.6 ±101.9 %) in the control group, with greater scores during dental clenching. In the same way, significant differences were observed between the control and TMD for SCM activity during head flexion for right (77.0±34.2 %, TMD; 115.6 ±56.8 %, control) and left SCM (80.7 ±46.1 %, DTM; 113.1±49.5 %, control) and for the thickness of the SCM during extension, to the left side (10.0±2.0 %, TMD; 10.9±1.5 %, control) and at rest to the right side (10.4±1.8 %, TMD; 11.5±1.8 %, control). Additionally, a significant correlation was found between values of the MBF, US and EMG of the masseter, temporal and SCM for TMD group and also when considered the side of head tilt for SCM. Thus, it can be concluded that patients with TMD showed smaller values of MBF and changes in muscle function that may affect the masticatory and neck muscles, especially during the mandibular movements, revealing the existence of a functional link between them.

Key words: Bite force, temporomandibular joint disorders, electromyography, ultrasonography, masticatory muscles, neck muscles.

SUMÁRIO

INTRODUÇÃO

A Desordem Temporomandibular (DTM) consiste em um grupo de alterações que afetam os componentes do sistema estomatognático, como os músculos mastigatórios, as articulações temporomandibulares (ATM) e/ou as estruturas relacionadas (McNeill, 1997; Sonnesen *et al.*, 2001; Suvinen & Kemppainen, 2007; De Leeuw, 2008). A etiologia é multifatorial e pode estar associada ao desequilíbrio entre os fatores anatômicos, neuromusculares e psicológicos. Tais desordens são caracterizadas por sinais e sintomas que limitam e/ou incapacitam as atividades fisiológicas e podem incluir dor, limitação e desvio nos movimentos mandibulares, sons articulares, sensibilidade muscular e articular (Liebenson, 1992; Ciancaglini *et al.*, 1999). Os indivíduos acometidos também podem apresentar dor de cabeça, sintomas otológicos e cervicais (Parker, 1990).

Dentre os músculos mastigatórios, os elevadores da mandíbula comumente mostram-se acometidos nos casos de DTM. O músculo masseter pode ter eficiência funcional prejudicada, com alteração da atividade eletromiográfica e da força de contração (Liu *et al.*, 1999). Os músculos mastigatórios juntamente com os cervicais atuam em íntima coordenação e uma injúria em algum destes componentes pode alterar a estrutura vizinha (Santander *et al.*, 2000; Ferrario *et al.*, 2003; Pallegama *et al.*, 2004). O músculo esternocleidomastóideo (ECM) mostra-se importante na manutenção da postura craniocervical (Santander *et al.*, 2000; Kibana *et al.*, 2002) e atua na flexão, rotação e inclinação lateral da cabeça (Sommerich et al., 2000; So et al., 2004), podendo ser acometido pelas desordens funcionais e desencadear dor referida ao aparelho estomatognático (Santander *et al.*, 2000; Leiva *et al.*, 2003).

Pacientes com DTM podem apresentar desequilíbrio no padrão oclusal, o que leva a alterações na atividade do ECM e consequentemente uma inclinação lateral do pescoço, fato que demonstra uma relação entre o suporte oclusal, os movimentos mandibulares e a postura da cabeça (Kibana *et al.*, 2002). Adicionalmente, a inclinação lateral do plano oclusal e uma inadequada função dos músculos mastigatórios e cervicais causa um deslocamento da coluna cervical (Shimazaki *et al.*, 2003) afetando a posição da cabeça (Kibana *et al.*, 2002), a qual pode afetar a atividade eletromiográfica do ECM em pacientes com DTM (Santander *et al.,* 2000). Diante disso, torna-se imprescindível conhecer as modificações na força de contração muscular, na atividade eletromiográfica bem como as alterações estruturais dos músculos mastigatórios e cervicais além de verificar a influência da postura da cabeça em pacientes portadores de DTM.

A mensuração da força de mordida constitui-se em um método auxiliar para quantificar a força realizada pelos músculos de fechamento mandibular e entender a função mastigatória em pacientes com disfunções orofaciais, contribuindo no diagnóstico e no estabelecimento do plano de tratamento. Pode ser influenciada por vários fatores, incluindo a diferença entre os gêneros, a força muscular geral, o estado da dentição, o local de registro da força, o estado mental do indivíduo no momento do exame, maloclusões e separação entre os dentes (Bonjardim *et al.*, 2005). Nas DTMs, a força máxima de mordida pode apresentar-se reduzida, gerando uma sobrecarga nos músculos mastigatórios (Bonjardim *et al.*, 2005). Em mulheres com DTM e bruxismo, esta força mostrou-se reduzida, considerando o maior número de sinais e sintomas que as acometeram (Pizolato *et al.*, 2007).

Valores significativamente menores na força de mordida foram observados em pacientes com DTM quando comparados com indivíduos saudáveis, valores esses intimamente relacionados com a presença de sensibilidade muscular (Bonjardim *et al.*, 2005; Pereira *et al.*, 2007). A força máxima de mordida também foi avaliada mediante a aplicação de um estímulo doloroso, sendo a atividade eletromiográfica dos músculos masseter e temporal anterior registrada em níveis submáximos de carga, observando-se uma queda na força e na atividade muscular quando se aplica o estímulo doloroso (Wang *et al.*, 2000). Assim, foi constatado que a dor nos músculos elevadores da mandíbula é capaz de inibir o recrutamento da unidade motora e interferir na função muscular (Wang *et al.*, 2000).

Dessa forma, o estudo da eletromiografia (EMG) também contribui na análise da função e disfunção do sistema neuromuscular. A despolarização produzida por um estímulo gera atividade elétrica que se manifesta como potencial de ação da unidade motora (PAUM) e que é graficamente registrada como eletromiograma (Soderberg & Knutson, 2000). A EMG busca verificar o nível da atividade muscular, quantificar as alterações musculares, auxiliar no diagnóstico diferencial e fornecer dados substanciais para inspeção e manejo do tratamento necessário para a recuperação das funções fisiológicas normais (Landulpho *et al.*, 2004).

Ainda na análise dos tecidos musculares, a ultrassonografia (US) por imagem tem se mostrado como um método para avaliação de alterações estruturais dos músculos. Trata-se de uma técnica de aplicação simples, não invasiva, de custo reduzido e de fácil aceitação pelo paciente. Assim, está indicada para estudo muscular *in vivo*, facilmente reproduzível e amplamente utilizada no estudo dos músculos mastigatórios e da cintura escapular. Fornece informações sobre a espessura e a área de secção transversal do músculo, permitindo observar hipertrofias, lesões ou alterações em nível do tecido mole superficial. Tais aspectos não podem ser observados em radiografias e ao contrário dos exames por imagem, como a ressonância e tomografias, a ultrassonografia não gera exposição do paciente a radiações e efeitos biológicos cumulativos (Serra *et al.*, 2008).

A US pode ser considerada uma técnica confiável para avaliação dos músculos da cabeça e pescoço em pacientes com DTM, incluindo temporal anterior, masseter superficial e profundo, porção anterior e posterior do digástrico e ECM (Emshoff *et al.*, 1999). Em condições normais, pode ser usada como uma ferramenta útil na avaliação da capacidade funcional do músculo masseter durante apertamento dentário e na investigação da relação entre a atividade eletromiográfica e espessura muscular (Georgiakaki *et al.*, 2007). Tem sido observada correlação positiva entre a magnitude da força de mordida e a US para o músculo masseter. No entanto, este fato ainda permanece controverso com relação à atividade eletromiográfica muscular (Serra *et al.*, 2008).

O uso da EMG e da US associado à avaliação da força muscular pode ser útil na busca de melhor compreensão da participação tanto dos músculos da mastigação quanto de músculos cervicais no desempenho das funções do aparelho estomatognático e no entendimento das alterações biomecânicas e estruturais que podem acometer a musculatura envolvida na DTM, servindo de orientação para o diagnóstico e eventuais condutas terapêuticas que poderão ser oferecidas aos pacientes. Assim, torna-se fundamental conhecer o comportamento muscular frente a alterações do complexo temporomandibular. Com isso, o objetivo deste trabalho foi avaliar a força máxima de mordida, a atividade eletromiográfica e a espessura dos músculos mastigatórios e cervicais por meio da ultrassonografia, além da influência clínica da postura de cabeça, em adultos com e sem a presença de DTM.

CAPÍTULO 1

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

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ABSTRACT

Objective: To evaluate the Maximal Bite Force (MBF), Electromyography (EMG) activity and thickness measured by Ultrasonography (US) of masseter, anterior part of temporalis and sternocleidomastoid (SCM) muscles in a group of youth adults with and without temporomandibular disorders (TMD). **Design:** The participants comprised 28 individuals (15 males and 13 females, mean age of 25.9±4.7 years) in control group and 19 in TMD group (7 males and 12 females, mean age of 25.4±3.8 years) classified by Research Diagnostic Criteria (RDC) for TMD (RDC/TMD). MBF measures were determined with a pressure transducer placed between dental arches until primary molars level and values were converted into Newton. The EMG activity and thickness of masseter, temporalis and SCM muscles were evaluated at rest and during maximal voluntary clenching (MVC), bilaterally. Data were obtained by mean of three repetitions and, for each individual, the mean values of left and right sides was used. The normality of the distributions was assessed by Shapiro-Wilks test. Data comparisons for MBF, EMG and US from masseter and temporal muscles were evaluated by unpaired t test, as well as between genders. For the SCM thickness in TMD group and SCM activity, the values were analyzed by Mann-Whitney test to compare these data between groups. The significant level adopted was α=0.05. **Results:** On comparing MBF and masseter thickness between groups, significant higher values were found for the controls. Besides, the masseter and temporal were significant thicker in clenching state than in rest in both groups. The Control group showed higher EMG values during clenching than at rest. In relation to gender, MBF was significantly higher in male than in female with TMD as well as masseter, temporal and SCM thickness for both groups. Additionally, a significant correlation was found between values of the MBF, US and EMG of the masseter, temporal and SCM for TMD group. **Conclusions**: Patients with TMD presented smaller values of MBF and also of the thickness of masseter with differences between genders. However, the EMG did not show significant results when compared both groups, but it was observed the existence of a correlation between values of MBF, thickness and electrical activity, revealing a muscular alteration in TMD patients and a co-activation between masticatory and cervical muscles during mandibular movement.

Key words: Bite force; temporomandibular disorders; electromyography; ultrasonography; sternocleidomastoid; masticatory muscles.

INTRODUCTION

The temporomandibular disorders (TMD) are a group of changes that affect the components of the stomatognathic system, such as the masticatory muscles, temporomandibular joints (TMJ) and / or related structures (McNeill, 1997; Sonnesen *et al.*, 2001; Suvinen & Kemppainen, 2007). Its etiology is multifactorial and may be associated with an imbalance among anatomical, neuromuscular and psychological factors. Such disorders are characterized by signs and symptoms that limit and / or incapacitate their physiological activity and may include pain, limitation and deviation of mandibular movements, joint sounds, muscle and joint sensitivity (Liebenson, 1992; Ciancaglini *et al.*, 1999). The affected individuals may also experience headaches, neck and otologic symptoms (Parker, 1990).

Among the masticatory muscles, the jaw elevators are commonly affected in cases of TMD (Chandu *et al.*, 2005). The masseter muscle may have impaired in its functional efficiency with change in its electrical activity (EMG) and force of contraction (Liu *et al.*, 1999). These muscles associated with the cervical muscles acts in close coordination (Ferrario *et al.*, 2003; Pallegama *et al.*, 2004) and an injury to one of these components can become mutually provocative (Santander *et al.*, 2000, Ferrario *et al.* 2003; Pallegama *et al.*, 2004). The sternocleidomastoid muscle (SCM) shown to be important in maintaining the posture of the head (Clarke *et al.*, 1993; Santander *et al.*, 2000; Kibana *et al.*, 2002) and may be affected by functional disorders, referring pain to the stomatognathic system (Santander *et al.*, 2000; Leiva *et al.*, 2003). Given this, it is essential to know the changes in the strength of muscle contraction, the electromyographic activity as well as muscular structural changes in patients with TMD.

Measurement of bite force is 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 (Bonjardim *et al.*, 2005). In TMD, the maximum bite force (MBF) may appear smaller, causing an overload on the masticatory muscles (Bonjardim *et al.*, 2005). This force tends to be limited mainly in women with TMD associated with bruxism, due to higher number of signs and symptoms that affect these patients (Pizolato *et al.*, 2007). Besides, the study of electromyography (EMG) also helps in analyzing the function and dysfunction of the neuromuscular system (Soderberg & Knutson, 2000). EMG seeks to verify the level of muscle activity and to quantify the changes in muscle activation, important in to provide differential diagnosis and substantial data for inspection and management of treatment required for recovery of physiological functions (Landulpho *et al.*, 2004).

On electromyographic examination, the muscle hyperactivity of masticatory muscles has been observed in patients with myogenic TMD and this can contribute to derangement in TMJ (Pereira *et al.*, 2006). In the same way, significantly higher values were seen 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 (Pallegama *et al.*, 2004). During a maximal voluntary clenching (MVC), the mean peak of EMG levels of digastrics and SCM increased from rest position in healthy individuals, revealing a co-ativation of the anterior neck muscles in mandibular movement (Ciuffolo *et al.*, 2005) and a functional link between the cervical and masticatory muscles (Pallegama *et al.*, 2004). The muscular compensations between mandibular motor system and cervical structures may represent a mechanism necessary to find their stability during the masticatory function (Ries & Bérzin, 2007) and may to influence the muscular structure. Allied to EMG and MBF investigations, the ultrasonography (US) is a reliable diagnostic technique for the evaluation of cross-sectional dimensions and areas of head and neck muscles, permitting to acquire knowledge about the complex functioning of the stomatognathic system (Emshoff *et al.*, 1999).

Considering the analysis of muscle tissue, the US imaging has proved to be helpful in the verification of structural changes of the muscles like muscular contracture (Barber *et al.*, 2011), hypertrophy, injury or alterations in superficial soft tissue. It's a simple technique, noninvasive, with low cost and easily accepted by patients (Serra *et al.*, 2008). The US can be considered a reliable technique for evaluation of head and neck muscles in patients with TMD, including anterior temporal muscle, superficial and deep masseter, anterior and posterior digastric and SCM (Emshoff *et al.*, 1999). Under normal conditions, consist in an important tool for evaluating of the functional capacity of contraction of the masseter muscle during dental clenching and in the investigation of the relationship between electromyographic activity and muscle thickness (Georgiakaki *et al.*, 2007).

However, this fact still remains controversial (Serra *et al.*, 2008). Furthermore, it has been noted a positive correlation between the magnitude of bite force and US values of masseter muscle (Serra *et al.*, 2008).

The use of EMG and US associated with 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 and understanding 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. Given this, it is essential to understand the muscular behavior in cases of alteration of temporomandibular complex. Thus, the aim of this work was to evaluation the MBF, EMG activity and muscular thickness measured by US of masseter, anterior part of temporalis and SCM muscles in a group of youth adults with and without TMD.

METHODS

Sample and clinical examination

A convenience sampling strategy was used to enroll subjects to the study. A total of 47 individuals (22 males and 25 females), aged from 18 to 40 years, participated in the study. The Research Ethics Commission of Campinas University approved this study, under protocol number 037/2009 and all the volunteers signed a term of assisted consent following clarification and agreement to participate in the study. The sample was selected by means of anamneses and clinical exams guided by the inclusion/exclusion criteria. The inclusion criterion for control group was no signs or symptoms of TMD according to the Research Diagnostic Criteria (RDC) for TMD (RDC/TMD) (Dwoorkin & LeResche, 1992). For TMD group, the individuals showed at least one or more TMD diagnoses according to the RDC/TMD (Dwoorkin & LeResche, 1992). The exclusion criteria, for both groups, were presence of dental flaws and prosthesis rehabilitation; a history of trauma in face, temporomandibular joint and cervical spine; systematic or local disorders that could impair in the masticatory system; use of any medication and treatments that could interfere in muscular system.

The RDC/TMD uses a two axis system, taking into consideration physical diagnosis, pain-related disability, and psychological status. The physical findings (axis I) can be coordinated with the assessment of psychological distress and psychosocial dysfunctions associated with orofacial disability (axis II) (Dworkin and LeResche, 1992; Tartaglia *et al.*, 2008). It has been largely used to diagnosis and classify TMD patients and to prove an accepted and validated diagnostic tool for epidemiological and clinical research on TMD (Ries & Bérzin, 2007; Suvinen TI, Kemppainen, 2007; Tartaglia *et al.*, 2008; Palinkas *et al.*, 2010).

The RDC/TMD examination protocol included the assessment of the following signs and symptoms: range of jaw motion, TMJ sounds, and muscle and joint palpation for tenderness. The RDC/TMD classified the clinical diagnostic data into three mutually exclusive groups: I) Muscle diagnoses (myofascial pain or myofascial pain with limited range of motion); II) Disc displacements (with reduction, without reduction and with limited opening, without reduction and without limited opening); III) Arthralgia, osteoarthritis, osteoarthrosis. A subject can be assigned from zero diagnoses to five diagnoses (one muscle diagnosis plus one diagnosis from group II and one from group III for each joint). The diagnosis was made on the basis of clinical and history criteria (Dwoorkin & LeResche, 1992).

MBF, EMG and US data were collected with the subjects sitting in an upright position, with the head in natural posture, keeping the Frankfort plan approximately parallel to the floor (Bonjardim *et al.*, 2005; Castelo *et al.*, 2007; Ries *et al.*, 2008), arms extended along the body and the hands lying on their thighs. The volunteers were previously trained until felt comfortable to perform the tests and to build confidence in the procedures.

Maximal bite force measurement

MBF measures were determined with a pressure transducer, model TRFM_EMG, EMG System do Brasil Ltda (São Paulo, SP, Brazil), reading 0 to 200 kgf, sensitivity of 2mV/V, 12-bit of resolution, with 2m flexible cable, 30 AWG wires, twisted pair and shielded. The transducer was placed between dental arches until primary molars level (Bonjardim *et al.*, 2005; Castelo *et al.*, 2007). The values were obtained in Kgf and were later converted into Newtons (with an accuracy of 0.1N) (Bonjardim *et al.*, 2005; Castelo *et al.*, 2007). The volunteers were instructed to bite as forcefully as possible (Castelo *et al.*, 2007), during 5 seconds (sec), and three repetitions of the maximal bite force were done, with a 2 min rest interval between records (Bonjardim *et al.*, 2005; Castelo *et al.*, 2007). A verbal encouragement was given to obtain the maximum bite force. The MBF was determined as the peak value from the average of the three trials (Wang *et al.*, 2000).

Electromyographic evaluation

Myoelectric activity of the temporalis, masseter and SCM muscles were registered using an Electromyography EMG System do Brasil Ltda (São Paulo, SP, Brazil) 800C, of 08 channels, with 16 bites of resolution analogical/digital, a bandpass filter at 20–1,000 Hz, amplification of 50 times with a common mode rejection ratio of 130 dB to 60 Hz and impedance upwards of 10GΩ. The data were sent to a 14-bit A/D converter and sampled at 2,000 Hz. A disposable differential double electrode Medi-Trace Kendall-LTP (Tyco Healthcare, Kendall LTP, Canadá) was used with a inter-electrode distance of 25mm, connected to pre-amplifiers model PA 1010-VA with 20 times gain (Andrade *et al.*, 2009).

To reduce electrical impedance of the skin, the sites were cleaned with alcohol at 70% and trichotomy was done when necessary. Muscle function test was performed to guide electrode placement. For anterior part of temporalis, the electrodes were placed in front of the anterior border of the hairline; and for masseter muscle, 2cm above of the external angle of the jaw. For the SCM muscles, the electrodes were positioned in the midpoint of its length, from the mastoid process to the jugular notch of the sternum (Pallegama *et al.*, 2004). They were fixed on muscle belly, parallel to muscular fibres and perpendicular to the skin surface, located during dental clenching (Pallegama *et al.*, 2004; Ries & Bérzin, 2007; Andrade *et al.*, 2009). The reference electrode was placed at right fist (Pereira *et al.*, 2006).

The muscle activity was recorded in rest position for 10 sec and during maximum voluntary clench (MVC) with parafilm “M”, folded 15 times (1.5cm by 3.5cm) and placed bilaterally on the molars regions (Pereira *et al.*, 2006; Ries *et al.*, 2008) for 05 sec (Ries & Bérzin, 2007) and the individual received a verbal encouragement to perform the test. Each volunteer carried out three repetitions with an interval of 2 min between them (Ries & Bérzin, 2007) and the means of root mean square (RMS) were obtained. Data were normalized to the global maximum (RMS average) value obtained for each muscle in all trials on a per subject basis, and expressed in percentage as a fraction of MVC (Soderberg & Knutson, 2000; Forrester *et al.*, 2010). The EMG normalization is a procedure that shows the muscle's activity in relation to a voluntary contraction of reference and guarantees greater measurement stability (Soderberg & Knutson, 2000; Ries *et al.*, 2008).

Ultrasound imaging

The thickness of the masseter, anterior portion of the temporalis and SCM muscles were assessed bilaterally by ultrasonography (Just Vision Toshiba™, Otawara, Japan; 56-mm/10-MHz linear transducer), and the image was measured directly on screen with an accuracy of 0.1 mm. The locations for ultrasonography imaging (US) were determined by palpation (Castelo *et al.*, 2007; Andrade *et al.*, 2009) and in the same sites at electrode placement. The transducer was positioned perpendicular to the direction of the muscle fibres using an airtight inert gel on the skin surface (Castelo *et al.*, 2007; Andrade *et al.*, 2009) and its movement was in order to provide optimized imaging. The examination was done during rest position and dental clenching, for each side (left and right) (Castelo *et al.*, 2007; Andrade *et al.*, 2009) and a verbal encouragement was given to obtain the maximum effort. The tests were performed three times, with an interval of 2 minute between them. The thickness per side was calculated as the average of the three repetitions (Castelo *et al.*, 2007).

Measurement errors

The errors of measurement (*Se*) for the muscular thickness were assessed from repeated measurements on two separate occasions (m1, m2) of 15 randomly selected subjects (n), using Dahlberg's formula: Se √Σ (m1 - m2)2/2n. The error was 0.33mm for the contracted and 0.36 mm for the relaxed masseter; 0.29 mm for the contracted and 0.25

mm for the relaxed anterior temporalis and 0,25mm for the contracted and 0.34 mm for the relaxed SCM.

STATISTICAL ANALYSIS

The relaxed and contracted EMG and US values were not different between right and left sides in both groups, thus the side values were pooled for statistical analysis (Pereira *et al.*, 2006; Georgiakaki *et al.*, 2007). The normality of the distributions was assessed by Shapiro-Wilks test. Data that not normally distributed were log10 transformed to more closely approximate normality. It was not possible to transform the SCM thickness for TMD group and SCM activity for both groups, thus Mann-Whitney test was used to compare these data between groups. MBF, EMG and US data from masseter and temporal muscles were evaluated by unpaired *t* test. Unpaired *t* test was also used to evaluate the differences between genders. Spearman rank correlation analysis was used to evaluate the correlation between MBF, muscles thickness and activity data for both groups. A level of significance of 5% ($p \leq 0.05$) was adopted.

RESULTS

In accordance of the proposal methods, the sample distribution in relation to presence or absence of signals and symptoms of TMD and gender are demonstrated in Table 1, with a total of 19 individuals in TMD group (25.4±3.8), being that 10 individuals had more than one symptom by RDC/TMD, and 28 in control group (25.9±4.7). Maximal bite force, muscles thickness and electrical activity between each group are showed in table 2. Results statistically significant were found when compared maximal bite force and masseter thickness between TMD and control, with higher values for control group. Besides, the masseter and temporal were significant thicker in clenching state than in rest in both groups. The Control Group showed higher EMG values during clenching than at rest, revealing an activation of this cervical muscle during mandibular movement.

Table 1. Sample distribution (n) in accordance with RDC/TMD diagnosis and gender

	Male	Female	Total
TMD Group	7	12	19
Control group	15	13	28
Mean age ± SD (years)	24.7±4.4	26.9±4.0	25.7±4.3
TMD diagnoses			
IIa (Disc displacement with reduction)	-	2	2
IIIa (Arthralgia)	2	1	3
IIIb (Osteoarthritis of the TMJ)	1	-	1
IIIc (Osteoarthrosis of the TMJ)	1	-	1
Ia/IIa	-	2	2
Ia/IIIa	-	3	3
Ia/IIIc	-	1	1
IIa/IIIa	-	1	1
Ia/IIa/IIIa	2	1	3

RDC/TMD, research diagnostic criteria for temporomandibular disorders; TMD, temporomandibular disorders; TMJ, temporomandibular joint.

Table 2. Differences in maximal bite force, muscles thickness and activity between TMD (n=19) and control (n=28) groups.

		Muscle thickness (mm)						Muscle activity (% of MVC mean)					
TMD Group	MBF (N)	MR‡	MC‡	TR‡‡	TC‡‡	SCMR	SCMC	MR	MC	TR	TC	SCMR	SCMC
Median	278.0	11.4	13.4	6.5	8.0	10.2	10.2	93.0	79.8	97.6	91.6	83.7	82.1
Mean	**285.5****	**11.2****	**13.4***	6.5	7.9	10.7	10.7	101.5	93.2	100.4	101.0	100.4	91.7
SD	98.8	1.9	1.9	0.6	0.9	2.0	1.9	26.3	40.2	28.5	42.0	30.7	51.7
SEM	22.7	0.4	0.4	0.1	0.2	0.5	0.4	6.0	9.2	6.5	9.6	7.0	11.9
Control Group	MBF (N)	MR‡‡	MC‡‡	TR‡‡	TC‡‡	SCMR	SCMC	MR	MC	TR	TC	SCMR‡	SCMC‡
Median	332.7	12.6	14.3	6.5	7.6	11.9	11.9	90.8	89.3	83.7	96.1	86.2	64.7
Mean	**353.4****	**12.7****	**14.8***	6.5	7.8	11.6	11.6	99.0	105.6	99.7	99.3	100.6	105.6
SD	69.6	1.8	2.0	0.6	0.8	1.8	1.7	21.3	51.7	36.0	36.9	28.0	101.9
SEM	13.2	0.3	0.4	0.1	0.2	0.3	0.3	4.0	9.8	6.8	7.0	5.3	19.3

SD, standard deviation; SEM, standard error of the mean; MBF, maximal bite force; MR, masseter relaxed; MC, masseter clenching; TR, temporal relaxed; TC, temporal clenching; SCMR, sternocleidomastoid relaxed; SCMC, sternocleidomastoid clenching

*p<0.05; **p<0.01 (between groups in the same column)

‡p<0.01; ‡‡p<0.001 (between relaxed to contracted state for US and EMG data inside the groups)

In relation to gender (table 3), maximal bite force was significantly higher in male than in female with TMD. However, in controls it is tending to be similar between genders with greater scores in healthy female than TMD women. Moreover, masseter, temporal and SCM were significantly thicker in male than in female for both groups. When verified muscular thickness in females, the masseter and temporal in relaxed and clenching state were significantly lower in TMD than controls. On the other hand, eletromyographic activity was not significantly different in any case analyzed.

Table 3. Means values (±SD) of maximal bite force, muscle thickness and activity of males and females in TMD (n=19) and control (n=28) groups

	TMD Group		Control Group	
	Male (n=6)	Female (n=13)	Male (n=15)	Female (n=13)
Maximal bite force (N)	370.7±86.8*‡	246.2±78.8*‡	350.0±68.2	357.4±73.8‡
Muscle thickness (mm)				
MR	13.2±1.4*	10.3±1.3*‡	13.7±1.7*	11.5±1.0*‡
MC	15.4±1.7*	12.5±1.1*‡	15.9±2.0*	13.5±1.1*‡
TR	13.2±1.4*	10.3±1.3*‡	13.7±1.7*	11.5±1.0*‡
TC	15.4±1.7*	12.5±1.1*‡	15.9±2.0*	13.5±1.1*‡
SCMR	13.0±1.7*	9.6±0.8*	13.0±0.8*	10.0±1.0*
SCMC	12.9±1.8*	9.7±0.7*	12.9±0.9*	10.1±1.1*
Muscle activity (%)				
MR	90.2±18.9	106.7±28.3	100.7±23.9	97.1±18.7
MC	113.2±50.1	83.9±32.9	102.2±45.9	109.4±59.4
TR	83.1±20.9	108.4±28.6	93.0±24.0	107.5±46.0
TC	124.9±39.7	90.1±39.7	94.2±32.4	105.2±42.1
SCMR	88.7±28.5	105.8±31.2	102.8±32.1	98.1±23.4
SCMC	63.7±19.6	104.6±57.3	74.1±44.9	142.0±135.4

MR, masseter relaxed; MC, masseter clenching; TR, temporal relaxed; TC, temporal clenching; SCMR, sternocleidomastoid relaxed; SCMC, sternocleidomastoid clenching

*p<0.05 (between genders – intra-group comparisons)

‡p<0.05 (between females or males with and without TMD)

According to table 4, a significant correlation was found between values of the maximal bite force, thickness and activity of the masseter, temporal and SCM for TMD group. Furthermore, when the variables were analyzed for controls, a less number of significant positive correlations were observed (table 5).

Table 4. Matrix of correlation among maximal bite force, muscles thickness (contracted state) and activity for TMD group (n=19)

		MBF	Muscle thickness M	Muscle thickness T	Muscle thickness SCM	Muscle activity M	Muscle activity T	Muscle activity SCM
		-						
Muscle thickness	M	0.55^{*}	-					
	T	0.24	0.24	-				
	SCM	0.67^{**}	0.69^{**}	0.13	-			
Muscle activity	M	0.60^{**}	0.55^{*}	0.05	0.71^{**}	-		
	T	0.58^{**}	0.55^{*}	-0.12	0.60^{**}	0.87^{**}	-	
	SCM	-0.37	-0.65^{**}	-0.14	-0.60^{**}	-0.31	-0.40	-

MBF, maximal bite force; M, masseter; T, temporal; SCM, sternocleidomastoid

*p<0.05; **p<0.01 (obtained from Spearman correlation test)

Table 5. Matrix of correlation among maximal bite force, muscle thickness and activity for Control Group (n=28)

		MBF	Muscle thickness MC	Muscle thickness TC	Muscle thickness SCMC	Muscle activity MC	Muscle activity TC	Muscle activity SCMC
		-						
Muscle thickness	MC	0.09	-					
	TC	0.39^{*}	0.43^{*}	-				
	SCMC	-0.16	0.58^{**}	-0.04	-			
Muscle activity	MC	0.40^{*}	0.05	0.36	-0.27	-		
	TC	0.29	-0.03	0.21	-0.21	0.71^{**}	-	
	SCMC	0.32	-0.21	0.19	-0.25	0.39^{*}	0.50^{**}	-

MBF, maximal bite force; M, masseter; T, temporal; SCM, sternocleidomastoid

*p<0.05; **p<0.01 (obtained from Spearman correlation test)

DISCUSSION

The present study evaluated the MBF, thickness and eletromyographic activity of masticatory and cervical muscles in individuals with and without signs and symptoms of TMD. Differences in genders were also evaluated between and inside the clinical groups. A smaller number of males evaluated in TMD group may be related to differences in prevalence of TMD between genders. It have been related in literature that TMD are more prevalent in women than in men and affect approximately 7–15% of the adult population in North America, being that 80% of patients treated for TMD are women (Wang *et al.*, 2008). Sex differences may be associated to steroid hormones, including estrogen, progesterone and testosterone (Berkley, 1997; Wang *et al.*, 2008). Besides, genetics compounds, organ physiology, body structure, brain organization and function, stress, lifestyle, sociocultural roles, individual experiences, and other changes throughout the life span also contribute to gender differences (Berkley, 1997).

MBF, in this research, showed smaller significant values for TMD group when compared with controls. Differences in MBF were also observed between genders, with females presenting significant lower scores than males. These results corroborated with previous studies (Chong-Shan, 1989; Bonjardim *et al.*, 2005; Pereira *et al.*, 2007; Pizolato *et al.*, 2007), which suggest smaller values of MBF due to a higher number of signs and symptoms that affect women with TMD, causing an overload on the masticatory muscles. Lower values of MBF were also observed for females with TMD when compared with healthy women, inferring that force tends to decrease in women in presence of the dysfunction. On the other hand, there was no difference in MBF between males with and without TMD. These results corroborated with previous studies (Bonjardim *et al.*, 2005; Pizolato *et al.*, 2007), since women were more affected by the impacts of TMD than males. The smaller values for MBF in TMD women have been described in many researches (Chong-Shan, 1989; Bonjardim *et al.*, 2005; Pizolato *et al.*, 2007; Pereira *et al.*, 2007), whereas a significant negative correlation between the signs and symptoms of TMD were found, demonstrating that muscular tenderness was an influencing factor to reduce the MBF. In the same way, in the presence of pain, it was noted a decreased capacity to masticatory muscles to produce maximum effort, causing smaller scores of bite force

(Wang *et al.*, 2000; Bonjardim *et al.*, 2005; Pereira *et al.*, 2007) and EMG activity (Wang *et al.*, 2000).

Considering the EMG activity data, no statistical difference was noted between TMD and control groups and neither between genders for all muscles analyzed, corroborating with the study of Pereira *et al.* (2006). However, some studies observed lower values of masseter and temporal activities for TMD patients when compared with controls (Visser *et al.*, 1995; Tartaglia *et al.*, 2008). Although a smaller EMG activity was found to masseter muscle in patients, in some cases, no difference was noted for temporal muscles between groups (Visser *et al.*, 1994). Furthermore, a mean contractile activity during clenching was about half in TMD than observed in healthy subjects and higher at rest, demonstrating basal hypertonia (Pinho *et al.*, 2000) and a state of hyperactivity and tension of masticatory muscles in dysfunctional individuals (Chong-Shan, 1989). In the study of Visser *et al.* (1994), males showed higher masticatory activities than females, while in other studies no significant difference was observed between the gender during clenching (Pinho *et al.*, 2000; Tartaglia *et al.*, 2008). Further studies are necessary to elucidate these contrasting findings in order to clarify the real condition of TMD patients. In this research, a significant positive correlation was found between masseter, temporal and SCM activity for controls. However, a positive correlation for TMD just was observed between masseter and temporal activity, demonstrating an association in patterns of EMG activity between muscles and a dependence of their functional behavior.

Electromyography of SCM was compared between TMD and control groups and no difference were presented. In the same way, no difference in SCM activity was found between TMD and controls at rest or while clenching (Chandu *et al.*, 2005), but in presence of cervical muscle pain, Pallegama *et al.* (2004) related a resting electrical activities for SCM and trapezius muscles higher in TMD groups of patients when compared with controls, demonstrating a functional link between the masticatory and cervical muscles. SCM activity data, in this work, showed a significant difference when compared rest position and dental clenching for control group, revealing an alteration of muscular activity in response to mandibular movement. Additionally, a higher myoelectric activity was also registered in SCM muscle during contraction in maximal intercuspal position than in mandibular rest position for both control (Wang *et al.*, 2000; Ciuffolo *et al.*, 2005) and

TMD groups (Chandu *et al.*, 2005), representing a co-ativation of the craniocervical musculature during clenching (Chandu *et al.*, 2005; Ciuffolo *et al.*, 2005). Besides, it may indicate the presence of compensatory strategies that represents a mechanism necessary to find stability for the mandibular and cervical region during mandibular movements (Ries & Bérzin, 2007), especially due to trigeminal centers and chains of interconnecting muscles, tendons, ligaments, and fascia existing in the head and neck regions (Ciuffolo *et al.*, 2005).

The insertion of an occlusal interference positioned on a single tooth introduced an immediate asymmetrical occlusal pattern of contraction of the SCM muscle during clenching, showing a concept of a functional coupling between the stomatognathic apparatus and the neck locomotor apparatus, whereas alterations in one structure can be immediately trailed into the other one (Ferrario *et al.*, 2003). This activation also depends on the characteristics of the occlusal surfaces and contacts, at least in patients with TMD (Santander *et al.*, 1994; Zuniga *et al.*, 1995). According to Pallegama *et al.* (2004), TMD patients present greater muscular asymmetry than healthy individuals, indicating that greater muscular activity is required in order to execute mandibular movements and to keep the head erect, with higher probability of muscular fatigue and pain. For these authors, asymmetric activation of the SCM muscle may be seen as a mechanism of compensatory postural adjustments to maintain the head position that is related to activity in the jaw closing muscle (Ries *et al.*, 2008). Thus, despite of electromyographic evaluation of TMD still show controversial results in the literature, surface EMG activity of masticatory muscles allowed a fast and simple assessment of functional and dysfunctional characteristics of TMD patients and provide quantitative data on the function of superficial muscles with minimal discomfort to the patient and without invasive or dangerous procedures (Tartaglia *et al.*, 2008).

In managing of TMD, the MBF and EMG activity evaluation are largely used, providing information about characteristics of muscular function. In addition, muscle structural alterations observed in dysfunctional patients may be assessed by US (Serra *et al.*, 2008). This method provides an accurate and reliable imaging technique for measuring the thickness and cross-sectional area of the masticatory and cervical muscles being usefull in TMD (Bakke *et al.*, 1992; Emshoff *et al.*, 1995; Bakke *et al.*, 1996; Emshoff *et al.*, 1999; Raadsheerl *et al.*, 1999; Bertram *et al.*, 2003).

The present study found values statistically significant when compared masseter thickness between TMD and control, in relaxed and contracted state, being higher for control group, demonstrating a decrease in muscular thickness in dysfunctional patients. The masseter thickness at rest has been showed significant difference between the patient and healthy groups (Ariji *et al.*, 2004). On the other hand, the comparison of muscle thickness between the TMD and controls was not significant for temporal neither masseter muscles (Pereira *et al.*, 2006; Pereira *et al.*, 2007). These differences probably due to the sample with TMD, which, even when present, tended to be mild to moderate, and might not be sufficient to cause an alteration in muscle size, as also considered by Pereira *et al.*, (2007). Besides, the masseter and temporal thickness, in this research, presented significant increase from the relaxed to contracted state in both groups, agreeing with others (Ariji *et al.*, 2004; Pereira *et al.*, 2006; Pereira *et al.*, 2007). On the scan, this change was directly visible, as the muscle bulged during contraction and the septa curled (Bake *et al.*, 1992; Pereira *et al.*, 2006).

In relation to gender, masseter, temporal and SCM were significantly thicker in male than in female in both groups. Similar results were observed only for temporal muscle thickness in males of control group (Pereira *et al.*, 2006). When verified the results of our study, muscular thickness of masseter and temporal were significantly different in female with TMD and control, both in relaxed and clenching state, being less thick for dysfunctional females. The smaller thickness observed in TMD may be associated with the smaller bite force in TMD females volunteers. It has been reported that bite force magnitude depends of the size of the jaw muscles, which in turn are influenced by craniofacial morphology (Raadsheerl *et al.*, 1999). Considering TMD group, in this study, significant positive correlations were found between MBF, masseter and SCM thickness and also masseter and temporal activities. Positive correlations were also observed between masseter thickness and SCM thickness, masseter and temporal activity. Moreover, masseter thickness was negatively correlated with SCM activity in TMD group. In control group, MBF was positively correlated with temporal thickness and masseter activity. These facts show a correlation of the electrical activity, muscle strength and thickness between masticatory and cervical muscles and its alterations may be influenced by dysfunctional syndromes. Researchers found in the literature, related that MBF, masseter thickness and activity also were positively correlated in healthy female (Bake *et al.*, 1992). In contrast, there was no significant correlation between thickness and activity, in both groups, for adolescents, which could be explained by the age of the sample (Pereira *et al.*, 2006). The age of patient with TMD may interfere in the severity of symptoms with the highest prevalence occurring in women aged 20–40, and the lowest among children, adolescents and the elderly (Wang *et al.*, 2008). Participants of this study, in control group, presented masseter thickness positive correlated with temporal and SCM thickness. Healthy female young adults showed a positive correlation between masseter muscle thickness and its electromyographic maximum activity (Bake *et al.*, 1992; Georgiakaki *et al.*, 2007), fact that were seen just in TMD patients in this study.

Based on the observed results, the masticatory and cervical muscles present a link that is imbalanced by the dysfunction. In general a clear connection was seen between thickness and function of the muscle, as well as parameters associated with MBF. Electromyography is the most common available technique to evaluate the masticatory muscles of patients with symptoms of muscle pain and tenderness (Emshoff *et al.*, 1995) on palpation and presented an association with MBF, but the results still remains controversial. Pereira *et al.* (2006) relate that the thickness and composition of the soft tissues covering the muscles, consisting of connective tissue and fat which are low-pass filters, and the number and extent of occlusal contacts may affect the EMG signal, which could explain the achievement in our results and not included in the methodology used in this study. Moreover, US is an inexpensive and noninvasive diagnostic technique with relatively high sensitivity and specificity that should be used to supplement clinical examinations in patients with TMJ disorders (Emshoff *et al.*, 1995; Emshoff *et al.*, 1999; Bertram *et al.*, 2003). Addittionaly, it is an ease, speed and accuracy method useful to clinical measurement of muscular lengths in individuals presenting with contracture, such as those with stroke, multiple sclerosis or spastic cerebral palsy (Barber *et al.*, 2011). Thus, more studies are needed to evaluate the relationship between MBF, electrical activity and thickness of masticatory and cervical muscles in TMD.

CONCLUSION

It can be concluded that patients with TMD presented smaller values of maximal bite force and also of the thickness of masseter. In addition, dysfunctional women showed smaller values of masseter and temporal thickness and gender differences were found for all muscles analyzed. However, the EMG activity did not show significant results when compared both groups, but it was observed the existence of a correlation between values of maximal bite force, thickness and electrical activity. These results suggest an existence of functional association between masticatory and cervical muscles during mandibular movement and in the same way, an imbalance in the structures of stomatognathic system caused by the temporomandibular dysfunction may lead impairment in both muscular complexes.

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CAPÍTULO 2

Influence of head posture on cervical muscle thickness and activity in youth adults with and without TMD

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ABSTRACT

Objective: To evaluate the electromyography (EMG) activity and muscular thickness measured by ultrasonography (US) of sternocleidomastoid (SCM) muscles and the influence of head posture in a group of youth adults with and without temporomandibular disorders (TMD). **Design:** The participants comprised of 28 individuals (15 males and 13 females, mean aged of 25.9±4.7) in control group and 19 in TMD group (7 males and 12 females, mean aged of 25.4±3.8) classified by Research Diagnostic Criteria for TMD (RDC/TMD) and submitted to clinical evaluation to verify the side of head tilt. The EMG activity and US of SCM muscles were evaluated at rest, during maximal voluntary clenching (MVC) and during the flexion and extension of the head, bilaterally. Data were obtained by mean of three repetitions and the normality of the distributions was assessed by Shapiro-Wilks test. Inter- and intragroup EMG data were compared by Mann-Whitney and Kruskal-Wallis tests, respectively. Differences in US data, considering the muscle states, were evaluate by unpaired t test and ANOVA one-way followed by Tukey's post hoc test, respectively. **Results:** Statistically significant differences were found when compared TMD and controls for activity in flexion and for thickness in relaxed state for right SCM and during extension for left SCM with lower values of US for TMD. Inside the groups, the major SCM thickness was verified during flexion of the head for both groups. When considered head posture the main differences was noted when head was tilt to right side. In relation to EMG data, significant results were observed when compared TMD and controls during head flexion for right SCM and during clenching for both SCM muscles. **Conclusions:** The findings suggest that SCM thickness and activity are influenced by the presence of TMD during neck and mandibular movements as well as the side of head tilt. The alteration in activity and a decrease in muscular thickness of SCM muscle observed in TMD subjects may be due to an imbalance in craniocervical muscular system caused by dysfunction with greater considerations during movement of head flexion.

Key words: Temporomandibular disorders; electromyography; ultrasonography; sternocleidomastoid; posture.

INTRODUCTION

The temporomandibular disorders (TMD) are considered a set of changes that affect the structures of stomatognathic system, including the articular and muscular apparatus in the orofacial region and/or related components (McNeill, 1997; Sonnesen *et al.*, 2001; Suvinen & Kemppainen, 2007). The multifactorial etiology of TMD include an imbalance between neuromuscular, anatomical and psychological factors (Liebenson, 1992; Ciancaglini *et al.*, 1999) affecting mainly the temporomandibular joints (TMJ) and masticatory muscles. Other muscular groups as cervical complex also may be involved, showing a functional coupling between masticatory and neck locomotor systems that acts in close coordination (Ferrario *et al.*, 2003; Pallegama *et al.*, 2004) and alterations in one structure can be immediately trailed into the other one (Santander *et al.*, 2000, Ferrario *et al.* 2003; Pallegama *et al.*, 2004).

Among the cervical muscles, the sternocleidomastoid (SCM) may be affected by functional disorders, referring pain to the stomatognathic system (Santander *et al.*, 2000; Leiva *et al.*, 2003). It is considered to be an important muscle in maintaining the craniocervical posture (Santander *et al.*, 2000; Kibana *et al.*, 2002) and acts in flexion, rotation and lateral tilt of the head (Sommerich *et al.,* 2000; So *et al.,* 2004). Patients with TMD show disequilibrium in occlusal patterns and this alteration could promote imbalance in SCM activity, causing lateral tilt of the neck, demonstrating a relationship between occlusal support, jaw movements and head posture (Kibana *et al.*, 2002). An asymmetrical occlusal interference leads to an altered left/right side pattern of contraction of SCM muscles (Kibana *et al.,* 2002; Ferrario *et al.*, 2003). In the same way, voluntary teeth clenching normally provokes a co-ativation of the SCM muscle which support the concept of a functional coupling between these systems (Kibana *et al.*, 2002; Ferrario *et al.*, 2003; Pallegama *et al.*, 2004). Additionally, the lateral inclination of the occlusal plane and an inadequate function of masticatory and neck muscles may cause a displacement of the cervical spine (Shimazaki *et al.,* 2003) affecting the position of the head (Kibana *et al.*, 2002) which may affect the SCM electromyography (EMG) in patients with TMD (Santander *et al.,* 2000).

The EMG consists in a method to analyze the level of muscle activity and to quantify the changes in muscle activation, being useful in the management of dysfunctional behaviors (Landulpho *et al.*, 2004). The magnitude of EMG activity is directly influenced by presence of pain (Pallegama *et al.*, 2004) and TMD subjects presents more pain in the cervical region (Ries & Bérzin, 2007) which may affect the SCM activity and consequently the head posture. When head is in neutral position, a little or none neck EMG is required, probably due to its alignment to cervical column, showing to be active during vertical and turned postures of the head (Corneil *et al.*, 2001). The muscular compensations observed between mandibular motor system and cervical structures may represent a mechanism necessary to find their stability during the masticatory function (Ries & Bérzin, 2007) and may influence the muscular structure. Allied to EMG investigations, the ultrasonography (US) is a reliable diagnostic technique for the evaluation of cross-sectional dimensions and areas of head and neck muscles, permitting to acquire knowledge about the complex functioning of the craniocervical muscular system (Emshoff *et al.*, 1999).

In the evaluation of muscular thickness, the US imaging consists in a simple technique, noninvasive, with low cost and easily accepted by patients, able to provide information about structural changes of the muscles, such as hypertrophy, injury or alteration in superficial soft tissue (Serra *et al.*, 2008). The SCM muscle is characterized by an elongated shape anterior to the lateral aspect of the thyroid lobes, whereas the investing layer of the deep cervical fascia forms a sheet covering the muscle laterally (Emshoff *et al.*, 1999). It is easily visualized due to the large size and typical band shape like a solid hypoechogenic ultrasonographic pattern (Emshoff *et al.*, 1999). In the investigation of tissue motion in healthy volunteers, during isometric manual resistance of the head in flexion, in a seated position, the SCM muscle showed a deformation when compared to relaxed state (Peolsson *et al.*, 2010) especially in later phases of contraction (Jesus *et al.*, 2008).

The use of EMG and US may provide a better understanding of the involvement of the cervical muscles in patients with TMD. Besides, it may permit to comprise the biomechanical and structural changes in SCM muscles during the functions of the cervical and stomatognathic systems and the influence of head posture in all craniocervical apparatus. Given this, it is essential to know the changes in the electromyographic activity and muscular structural alteration of SCM muscles in patients with TMD since there were limited references in the literature. Thus, the aim of this work was to evaluate the EMG activity and muscular thickness measured by US of SCM muscles in a group of youth adults with and without TMD and verifies the influence of head posture on muscular behavior.

METHODS

Sample, clinical and physical examination

A convenience sampling strategy was used to enroll subjects to the study. A total of 47 individuals (22 males and 25 females), aged from 18 to 40 years, participated in this research. The Research Ethics Commission of State University of Campinas approved this study, under protocol number 037/2009 and all the volunteers signed a term of assisted consent following clarification and agreement to participate in the study. The sample was selected by means of anamneses, clinical and physical exams guided by the inclusion/exclusion criteria. The physical examination was done to observe the head posture, considered inclined for right and left side when it was clearly visible and neutral position (Gadotti *et al.*, 2005). The subjects kept in a seated position with the head in a natural posture and were asked to look at a fixed point (Gadotti *et al.*, 2005). A plumb line was used as reference to verify the alignment and to define the side of lateral tilt of the head (Gadotti *et al.*, 2005; Silva *et al.*, 2009a). The visual assessment of head and neck alignment by professionals is acceptable and comparable to other clinically available tools, for deviations of 10 degrees in a single plane visual (Passier *et al.*, 2010). This physical test was performed by an experienced clinician and researcher, previously calibrated and without information about the patient condition. The side of head tilt was identified in order to know its possible influence on muscular system and not to quantify this alteration.

The inclusion criterion for control group was the absence of signs and/or symptoms of TMD according to the Research Diagnostic Criteria for TMD (RDC/TMD) (Dworkin & LeResche, 1992). For TMD group, the individuals presented at least one TMD diagnosis according to the RDC/TMD (Dworkin & LeResche, 1992). The exclusion criteria, for both groups, were presence of dental flaws and prosthesis rehabilitation; a history of trauma in face, temporomandibular joint and cervical spine; systematic or local disorders that could impair in the masticatory system; use of any medication and treatments that could interfere in muscular system.

The RDC/TMD uses a two axis system, taking into consideration physical diagnosis, pain-related disability, and psychological status. The physical findings (axis I) can be coordinated with the assessment of psychological distress and psychosocial dysfunctions associated with orofacial disability (axis II) (Dworkin and LeResche, 1992; Tartaglia *et al.*, 2008). The RDC/TMD examination protocol included the assessment of the following signs and symptoms: range of jaw motion, TMJ sounds, and muscle and joint palpation for tenderness. The RDC/TMD classified the clinical diagnostic data into three mutually exclusive groups: I) Muscle diagnoses (myofascial pain or myofascial pain with limited range of motion); II) Disc displacements (with reduction, without reduction and with limited opening, without reduction and without limited opening); III) Arthralgia, osteoarthritis, osteoarthrosis. A subject can be assigned from zero diagnoses to five diagnoses (one muscle diagnosis plus one diagnosis from group II and one from group III for each joint). The diagnosis was made on the basis of clinical and history criteria (Dworkin & LeResche, 1992). It has been largely used to diagnosis and classify TMD patients and to prove an accepted and validated diagnostic tool for epidemiological and clinical research on TMD (Ries & Bérzin, 2007; Suvinen & Kemppainen, 2007; Tartaglia *et al.*, 2008; Palinkas *et al.*, 2010).

EMG and US data were collected with the subjects sitting in an upright position, with the head in natural posture, keeping the Frankfort plan approximately parallel to the floor (Bonjardim *et al.*, 2005; Castelo *et al.*, 2007; Ries *et al.*, 2008), arms extended along the body and the hands lying on their thighs. The volunteers were previously trained until felt comfortable to perform the tests and to build confidence in the procedures. Besides, a verbal encouragement was given to obtain the maximum effort for each muscular examination.

<u>Electromyographic evaluation</u>

Myoelectric activity of the SCM muscle were registered using an Electromyography EMG System do Brasil Ltda (São Paulo, SP, Brazil) 800C, of 08 channels, with 16 bites of resolution analogical/digital, a bandpass filter at 20–1,000 Hz, amplification of 50 times with a common mode rejection ratio of 130 dB to 60 Hz and impedance upwards of 10GΩ. The data were sent to a 14-bit A/D converter and sampled at 2,000 Hz. A disposable differential double electrode Medi-Trace Kendall-LTP (Tyco Healthcare, Kendall LTP, Canadá) was used with a inter-electrode distance of 25mm, connected to pre-amplifiers model PA 1010-VA with 20 times gain (Andrade *et al.*, 2009).

To reduce electrical impedance of the skin, the sites were cleaned with alcohol at 70% and trichotomy was done when necessary. Muscle function test was performed to guide electrode placement. The electrodes were positioned in the midpoint of SCM length, from the mastoid process to the jugular notch of the sternum (Pallegama *et al.*, 2004). They were fixed on muscle belly, parallel to muscular fibres and perpendicular to the skin surface (Pallegama *et al.*, 2004; Ries & Bérzin, 2007; Andrade *et al.*, 2009). The reference electrode was placed at right fist (Pereira *et al.*, 2006).

The muscle activity was recorded in rest position for 10 sec and in isometric maximum voluntary contraction (MVC) for 5 sec (Ries & Bérzin, 2007). The MVC was performed during clenching with parafilm “M”, folded 15 times (1.5cm by 3.5cm), placed bilaterally on the molars regions (Pereira *et al.*, 2006; Ries *et al.*, 2008), and during flexion and extension of the head. Each volunteer carried out three repetitions with an interval of 2 min between them (Ries & Bérzin, 2007) and the means of root mean square (RMS) were obtained. Data were normalized to the global maximum (RMS average) value obtained for each muscle in all trials on a per subject basis, and expressed in percentage as a fraction of MVC (Soderberg & Knutson, 2000; Forrester *et al.*, 2010). The EMG normalization is a procedure that shows the muscle's activity in relation to a voluntary contraction of reference and guarantees greater measurement stability (Soderberg & Knutson, 2000; Ries *et al.*, 2008).

Ultrasound imaging

The thickness of SCM muscles were assessed bilaterally by ultrasonography (Just Vision Toshiba™, Otawara, Japan; 56-mm/10-MHz linear transducer) and the image was measured directly on screen with an accuracy of 0.1 mm. The locations for ultrasonography imaging (US) were determined by palpation (Castelo *et al.*, 2007; Andrade *et al.*, 2009) and in the same sites at electrode placement (Arts *et al.*, 2010). The SCM muscle was measured next to the jugular vein between the dorsal and ventral fascias, in the halfway along the line from the mastoid bone to the clavicular margin (Arts *et al.*, 2010). The transducer was positioned perpendicular to the direction of the muscle fibres using an airtight inert gel on the skin surface (Castelo *et al.*, 2007; Andrade *et al.*, 2009) and its movement was in order to provide optimized imaging. The examination was done during rest position, dental clenching, flexion and extension of the head, for each side (left and right) (Castelo *et al.*, 2007; Andrade *et al.*, 2009) and performed three times, with an interval of 2 minute between them. The thickness per side was calculated as the average of the three repetitions (Castelo *et al.*, 2007).

Measurement errors

The errors of measurement (*Se*) for the muscular thickness were assessed from repeated measurements on two separate occasions (m1, m2) of 15 randomly selected subjects (n), using Dahlberg's formula: Se √Σ (m1 - m2)2/2n. The error was 0.34mm for the relaxed SCM, 0.25 mm for the contracted, 0.33mm during flexion and 0.34mm in head extension.

STATISTICAL ANALYSIS

The values were analyzed using the software programs Microsoft® Excel, Bioestat Version 5.0 and SPSS Version 16.0, considering $p \leq 0.05$. Shapiro-Wilk test was applied to verify the data distribution and normality. Data not normally distributed were $\log^{10}$ transformed to more closely approximate normality. It was not possible to transform the

EMG data, thus Mann-Whitney and Kruskal-Wallis tests were used for inter- and intra-group comparisons, respectively. Unpaired *t* test was used to evaluate the differences in US data inter-groups. ANOVA one-way and Tukey *post hoc* test were used to compare differences in US data intra-groups, considering the muscle states. Spearman rank correlation analysis was used to evaluate the relationship between SCM thickness and activity data according to the side of head tilt (right or left) for both TMD and control groups. A logistic regression model was developed to test the association between TMD (as the dependent variable) and the studied variables. The independent variables considered were: age, gender, head tilt, SCM thickness and activity during rest, clenching, extension and flexion. All of them were entered into the model, and then the least significant terms were regressively dropped until only those with $p \leq 0.05$ remained in the model (stepwise backward elimination).

RESULTS

The sample distributions in relation to presence or absence of signs and symptoms of TMD, genders and head posture are demonstrated in Table 1. A total of 19 individuals were included in TMD group (25.4±3.8 years old) and 28 in control group (25.9±4.7), being that the greater number of subjects verified head tilt for right and left side. Table 2 shows the sample distribution in accordance with RDC/TMD diagnoses and head posture. Differences in SCM thickness and activity between both groups and inside the groups are showed in Table 3. Statistically significant differences were found between TMD and controls for SCM thickness in relaxed state for right side and during head extension for left side, with greater values for control group. Intra-group comparisons showed significant differences between sides, especially for flexion compared with others muscle states in both groups. In relation to EMG, differences in SCM activity were found during flexion of the head between TMD and controls for both sides with lower values in dysfunctional individuals.

Table 1. Characteristics of the sample according to clinical groups

	TMD Group (n=19)	Control Group (n=28)
Mean age ± SD	25.4±3.8	25.9±4.7
Gender		
Male	6 (31.6%%)	15 (53.6%)
Female	13 (68.4%)	13 (46.4%)
Head posture		
Right	8 (42.1%)	13 (46.4%)
Left	9 (47.4%)	11 (39.3%)
Neutral	2 (10.5%)	4 (14.3%)

TMD, temporomandibular disorders

Table 2. Sample distribution (n) in accordance with RDC/TMD diagnoses, the affected temporomandibular joint side and head posture

RDC/TMD diagnosis	Affected TMJ Side	Head posture		
		Neutral	Right	Left
Ia	-	-	1	-
Ib	-	-	-	1
IIa	Right	-	-	1
	Left	-	1	-
IIIa	Left	1	-	1
	Right/Left	-	-	1
IIIb	Right	-	1	-
IIIc	Left	-	-	1
Ia/IIa	Right	-	-	1
	Right/Left	-	1	-
Ia/IIIa	Right	-	1	
	Left	-		1
	Right/Left	-	1	-
Ia/IIIc	Left	-	1	-
IIa/IIIa	Right	-	1	-
Ia/IIa/IIIa	Right	-	-	1
	Right/Left	1	-	1
Total		2	8	9

Ia, myofascial pain; Ib, myofascial pain with limited opening; IIa, disc displacement with reduction; IIIa, arthralgia; IIIb, osteoarthritis of the temporomandibular joint; IIIc, osteoarthrosis of the temporomandibular joint

Table 3. Comparisons of sternocleidomastoid thickness and activity between TMD (n=19) and control (n=28) groups (mean values and standard deviations)

		SCM thickness (mm)		SCM activity (%)	
		TMD	Control	TMD	Control
Right side	Relaxed	10.4±1.8[a*]	11.5±1.8[a*]	98.9±25.7	100.7±23.3
	Clenching	10.4±1.8[a]	11.4±1.8[a]	101.9±68.7	98.7±80.3
	Extension	10.2±1.6[a]	10.9±1.4[a]	90.9±55.1	106.2±67.7
	Flexion	13.1±2.5[b]	14.0±2.2[b]	77.0±34.2[*]	115.6±56.8[*]
Left side	Relaxed	10.9±2.2[a]	11.7±1.8[a]	101.9±36.2	100.5±32.9
	Clenching	11.0±2.2[a]	11.8±1.8[b]	81.5±41.3	112.6±126.3
	Extension	10.0±2.0[a*]	10.9±1.5[b*]	86.3±55.4	109.3±77.9
	Flexion	13.0±2.6[b]	13.9±2.3[a]	80.7±46.1[*]	113.1±49.5[*]

TMD, temporomandibular disorders; SCM, sternocleidomastoid

*$p<0.05$ (between TMD and control groups; unpaired t test)

Different lower case letters mean differences in intra-group muscle state (one-way ANOVA test): $p<0.05$

In relation to the side of the head tilt (Table 4), statistically significant differences in muscle thickness were noted between TMD and controls for right side of head tilt, right SCM in relaxed state, clenching and head flexion and for left SCM in all tests performed. No difference was noted in muscle thickness when head was positioned in neutral position and for left side. Moreover, the SCM thickness showed with greater thickness especially during flexion of the head in both groups. When analyzed the EMG data, values statistically significant was observed also when head was in right tilt during head flexion for right SCM and during clenching for both SCM muscles. Besides, the right SCM showed lower activity during flexion of the head for TMD group and left SCM during clenching for controls.

Table 4. Comparisons of sternocleidomastoid thickness and activity among types of head tilt between TMD (n=19) and control (n=28) groups (mean values and standard deviations)

		TMD Group			Control Group		
Head tilt:		Neutral (n=2)	Right (n=8)	Left (n=9)	Neutral (n=4)	Right (n=13)	Left (n=11)
Muscle thickness (mm)							
Right side	Relaxed	9.8±1.9	9.3±0.7[a*]	11.4±1.9[a]	11.5±1.2	11.0±1.5[a*]	12.1±2.3[ab]
	Clenching	10.0±1.6	9.4±0.8[a*]	11.5±1.9[a]	11.2±1.4	10.9±1.4[a*]	12.1±2.3[b]
	Extension	9.9±1.2	9.5±0.9[a]	10.9±1.9[a]	11.1±1.1	10.2±1.4[a]	11.6±1.4[b]
	Flexion	11.6±3.0	11.7±0.7[b*]	14.6±2.7[b]	14.0±2.1	13.4±2.1[b*]	14.6±2.3[a]
Left side	Relaxed	9.9±1.8	9.6±0.8[a*]	12.4±2.4[ab]	11.4±1.1	11.4±1.7[a*]	12.1±2.1[a]
	Clenching	9.6±1.6	9.7±0.5[a*]	12.4±2.4[ab]	11.7±1.2	11.5±1.7[a*]	12.1±2.1[a]
	Extension	8.9±2.0	9.0±0.9[a*]	11.1±2.3[b]	10.6±0.6	10.7±1.6[a*]	11.3±1.5[a]
	Flexion	11.3±2.2	11.5±0.9[b*]	14.8±2.7[a]	13.3±2.9	13.8±2.3[b*]	14.4±2.2[b]
Muscle activity (%)							
Right side	Relaxed	76.0±7.5	110.8±27.5[A]	93.5±22.6	85.5±4.2	104.6±24.1	101.6±25.5
	Clenching	86.2±39.1	114.8±57.8[A‡]	93.9±84.9	154.6±156.1	84.0±60.4[‡]	95.7±64.6
	Extension	52.6±11.7	101.7±55.8[AB]	89.7±60.1	76.0±23.2	100.8±66.9	123.5±78.2
	Flexion	70.2±12.9	66.1±21.4[B‡]	88.3±43.9	92.9±59.6	110.0±47.4[‡]	130.5±66.7
Left side	Relaxed	69.6±11.9	122.5±36.7	90.7±30.6	76.8±5.7	105.8±31.1[A]	102.8±38.7
	Clenching	61.4±25.8	106.2±46.5[‡]	64.0±28.4	192.2±281.9	76.7±51.5[B‡]	126.0±107.9
	Extension	46.8±2.7	94.0±48.3	88.1±66.5	84.9±44.2	104.2±74.6[AB]	124.3±92.7
	Flexion	67.6±13.7	74.8±38.9	88.9±57.3	90.8±42.8	113.7±53.8[A]	120.4±48.4

*$p<0.05$ (difference in US data between TMD and control groups; unpaired t test)
Different lower case mean differences in intra-group muscle state (one-way ANOVA test): $p<0.05$
‡$p<0.05$ (difference in EMG data between TMD and control groups; Mann-Whitney U test)
Different capital letter mean differences in intra-group muscle state (Kruskal-Wallis test): $p<0.05$

When observed the Table 5, a positive correlation was found between US and EMG of right SCM during flexion when the head was inclined to right side, in TMD group. The right SCM showed a negative correlation of these data for head with left tilt for TMD. In relation to control group, a negative correlation was noted between US and EMG during clenching for both SCM and during extension for right SCM, when the head was positioned to left side. It was not possible to apply the correlation test for head in the neutral position due to the lower number of the sample.

Table 5. Significant correlations between SCM thickness and EMG according to the side of head tilt for TMD and control groups

Group	SCM side	Head posture	Correlations	r_s	*P*-value
TMD (n=19)					
	Right	Right tilt	EMG Clenching x US Extension	-0.73	0.037
			EMG Extension x US Rest	-0.78	0.021
			EMG Flexion x US Flexion	0.88	0.004
		Left tilt	EMG Flexion x US Flexion	-0.75	0.020
Control (n=28)					
	Right	Left tilt	EMG Clenching x US Rest	-0.80	0.003
			EMG Clenching x US Clenching	-0.88	0.000
			EMG Clenching x US Extension	-0.84	0.001
			EMG Clenching x US Flexion	-0.69	0.017
			EMG Extension x US Clenching	-0.62	0.042
			EMG Extension x US Extension	-0.65	0.029
	Left	Left tilt	EMG Clenching x US Rest	-0.65	0.029
			EMG Clenching x US Clenching	-0.65	0.030
			EMG Clenching x US Extension	-0.71	0.013

SMC, US R, muscle thickness on rest; US C, muscle thickness on clenching; US E, muscle thickness on extension; US F, muscle thickness on flexion; EMG R, muscle activity on rest; EMG C, muscle activity on clenching; EMG E, muscle activity on extension; EMG F, muscle activity on flexion
r_s Spearman correlation coefficient

In the intention to demonstrate the association of the variables with TMD, the backward stepwise logistic regression was used (Table 6). The test showed that individuals with TMD have a greater probability to exhibit larger activity of SCM muscle than the controls during flexion in the studied sample. Other variables, such as EMG data and all US states, age, gender and head postures were not associated with TMD.

Table 6. Backward stepwise logistic regression to test the association of independent variables with TMD in the studied sample (n=47) (only the independent variables that remained in the final model are shown)

Dependent variable	Independent variables	Coef.	*p*- value	Odds ratio	95% CI	Significance of the model		
						R^2	*p*-value	Power
TMD	constant	10.716	-	-	-	0.35	0.02	0.68
	SCM EMG F	-0.023	0.047	0.97	0.95 – 0.99			

TMD, temporomandibular disorders; SCM EMG F, sternocleidomastoid activity during flexion

DISCUSSION

Considering the results of this study, in relation to head posture, the neutral position did not showed significant results, not affecting the tests performed, despite of the lesser subjects presenting this condition. It have been reported that in the rest mandibular position, the head posture did not change and was stable (Kibana *et al.*, 2002). According to Corneil *et al.* (2001), head in the central or neutral position (head rest position) requires little or no neck EMG activity probably because the head is aligned on top of the cervical and thoracic vertebrae (Corneil *et al.*, 2001). However, limited significant results were observed in individuals with head tilt to left side which may be associate to sample characteristics including preference side of mastication with 59,6% related to right side. The sample selected for this study was clinically characterized in relation to the predominantly side of head tilt and they were not grouped in accordance of this situation, resulting in different number of individuals in each head posture condition. Besides, the amplitude of head tilt was not measured resulting in a qualitative analyse. These factors could be considered as a limitation of the present research and should be verified in future studies in order to provide an additional understanding of TMD patients and craniocervical muscular complex.

Besides, the evaluation of head posture aims to verify the influence of lateral tilt on muscular system and not to quantify this alteration.

In the analyses of muscular US data, it was observed, in the present study, lower values for TMD group in relaxed state for right SCM and during extension for left SCM when compared with controls, fact that suggest a decrease in muscular thickness in dysfunctional subjects. In addition, the major SCM thickness was noted during flexion of the head in both groups, indicating to be a state of greater muscle contraction. In the investigation of tissue motion, also in isometric flexion of the head, provided by manual resistance, in a seated position, the SCM muscle shows a deformation compared to rest (Peolsson *et al.*, 2010), being that in the last phase of muscle contraction was seen greater thickness than in the starting phase (Jesus *et al.*, 2008; Peolsson *et al.*, 2010). Furthermore, during flexion of the head, TMD group presented lower activity when compared with controls for both SCM muscles. Similarly, the neuromuscular efficiency was reduced in patients with chronic neck pain, during submaximal isometric cervical flexion which represent an altered muscle strategy for dysfunction in other muscles (Falla *et al.*, 2004), as masticatory muscles in TMD patients. Greater myoelectric manifestations of SCM fatigue was observed also in isometric flexion at muscles ipsilateral to side of pain in patients with chronic unilateral neck pain (Falla *et al.*, 2004b), suggesting a specificity of the effect of pain on muscle function that may be observed in TMD patients and demonstrate the need for specificity therapeutic management of such cases. In the present work, no difference was noted between TMD and control at relaxed state, clenching and neither during extension of the head, in accordance with previous studies (Chandu *et al.*, 2005). The magnitude of EMG measurement is strongly influenced by the thickness and composition of the soft tissues covering the muscles that consisted in connective tissue and fat which are low-pass filter (Pereira *et al.*, 2006; Bergamini *et al.*, 2008) and also the number and extent of occlusal contacts (Pereira *et al.*, 2006), which not included in the methodology of this study and may influence the results. Detailed researches about morphofunctional characteristics of SCM muscle and its influence on TMD are scarce in the literature and meticulous approaches must be considered in order to provide more clarifications about interaction of the structures of craniocervical system.

When considered head posture, in the present research, differences in SCM thickness was presented when the head was inclined to right side between TMD and controls with lower values of US for dysfunctional individuals. Moreover, among the tests performed, flexion of the head demonstrated greater SCM thickness for TMD and controls. Similar researches evaluating the SCM muscle and its specific parameters in TMD are limited, however masticatory muscles have been studied showing significant results of masseter thickness at rest between patient and controls (Ariji *et al.*, 2004) and between genders, with healthy females adults presenting a positive correlation of masseter muscle thickness and its electromyographic maximum activity (Bake *et al.*, 1992; Georgiakaki *et al.*, 2007). In relation to EMG data, in this research, significant results were verified also in head tilt for right side, between TMD and controls, during head flexion for right SCM and during clenching for both SCM muscles, with the activity in clenching greater for TMD. In the same way, TMD patients present greater muscular asymmetry than healthy individuals, indicating that greater muscular activity is required in order to execute mandibular movements and to keep the head erect, with higher probability of muscular fatigue and pain (Pallegama *et al.,* 2004). Besides, the right SCM showed lower activity during flexion of the head for TMD group and left SCM during clenching for controls when compared with others muscle states. In this way, the head position and mandibular movements was able to influence the SCM thickness and activity, especially in clenching and flexion. It have been related that SCM muscle present major capacity in flexion and lateral tilt, with linear response to incremental increases in isometric loading in extension and contralateral tilt (Sommerich *et al.,* 2000; Corneil *et al.*, 2001; Svensson *et al.*, 2004). In this study, lateral movements were not performed and the load was constant, evaluating just the influence of head position and dysfunction on SCM characteristics. Similarly, head position have been studied in patients with chronic pain, indicating the progressively increase on SCM activity when head was moved from rest position to head right positions (Svensson *et al.*, 2004). Significant differences in the EMG pattern as well as in the levels of EMG activities upon variations in body positions were observed between healthy subjects and patients with myogenic craniomandibular dysfunction (Miralles *et al.*, 2008). The EMG was more asymmetric and presented a different behavior of bilateral SCM activity in TMD individuals depending on the positioning of the head and neck (Santander *et al.,* 2000). An asymmetric activation of the SCM muscle may be seen as a mechanism of compensatory postural adjustments to maintain the head position that is related to activity in the jaw closing muscles (Ries *et al.*, 2008).

Considering the SCM muscle characteristics, it has been described as a rotator of the head and neck and contributes to flexion, rotation and lateral tilt, being responsive to changes in craniocervical posture (Sommerich *et al.,* 2000; So *et al.,* 2004). It helps to stabilize the head and is essential to provide a stable position of the maxilla during clenching (Clark *et al.*, 1993; Ries & Bérzin, 2007; Ries *et al.*, 2008) and chewing cycle (Ries *et al.*, 2008). In view of the alterations analyzed, in this study a negative correlation was noted, for control group, between thickness and activity during clenching for both SCM and during head extension for right SCM, when the head was inclined to left side. The relationship between these morphofunctional characteristics of cervical muscles is limited, however a positive correlation was observed between the angle of lateral tilt of the neck with the asymmetry index of SCM muscle (Kibana *et al.*, 2002), demonstrating that morphological and functional characteristics of the muscle modify the head tilt and play a compensatory role in posture control (Shimazaki *et al.,* 2003). In addition, when observed the TMD patients, a positive correlation was found between activity and muscular thickness during flexion for right SCM when the head was inclined to right side and a negative correlation of these data when the head was positioned in a contralateral tilt side. The modification of muscular behavior could be due to the influence of the head position and the presence of the TMD. Moreover, in accordance with Ferrario *et al*. (2003) dysfunctional subjects may present an asymmetrical occlusal interference which could lead an altered left-right side pattern of contraction of their SCM muscles, whereas a previously symmetrical pattern became asymmetrical, showing the needs to verify routinely the TMD patients' occlusion. Similarly, a poor posture may cause muscle imbalance and pain which are highly correlated with developing temporomandibular dysfunction syndrome (Evcik *et al.*, 2004).

The association of the variables studied in this research with TMD revealed that the dysfunction led to a significantly higher probability of higher SCM activity during flexion probably due to it is to be considered the one of the main movements of the SCM muscle (Sommerich *et al.,* 2000; So *et al.,* 2004). Additionally, the abnormal cervical muscle function may cause a poor head posture, adversely affecting the development and morphology of the cervical spine and maxillofacial skeleton, which in turn leads to facial asymmetry and occlusal abnormality (Kondo & Aoba*,* 1999). In view of this information, it is possible to support the concept of a functional coupling between the stomatognathic apparatus and the neck locomotor apparatus, whereas an alteration in one structure can be immediately trailed into the other one (Ferrario *et al.*, 2003; Ries & Bérzin, 2007). These muscular compensations seen in TMD patients may represent a mechanism necessary to find stability for the mandibular and cervical systems during their functions (Ries & Bérzin, 2007). Several studies that analyzed the associations between cervical and masticatory systems with the head posture in TMD patients differ in the methodology and parameters of evaluation, being necessary to establish better patterns of investigations and more studies to clarify the influence and connection of the head posture on SCM muscle in dysfunctional individuals.

CONCLUSION

It can be concluded that SCM thickness and activity are influenced by dysfunction and mandibular movements, as well as the side of head tilt. The alteration in activity and a decrease in muscular thickness of SCM muscle observed in TMD subjects may be due to an imbalance in craniocervical muscular system caused by dysfunction with greater considerations during movement of head flexion. In this way, clinical cervical evaluation shows important in management of TMD patients.

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CONCLUSÕES GERAIS

De acordo com os estudos apresentados, pode-se concluir que pacientes com DTM apresentaram alterações nos valores de força máxima de mordida e espessura muscular, com diferenças entre os gêneros. Da mesma forma, foi possível observar o envolvimento dos músculos mastigatórios e cervicais e a existência de relação entre a força máxima de mordida, espessura e atividade eletromiográfica dos músculos analisados, revelando a existência de ligação funcional entre eles. Além disso, as características morfofuncionais do músculo esternocleidomastóideo foram afetadas pela presença da disfunção e pelo lado de inclinação da cabeça.

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APÊNDICE 1

Termo de Consentimento Livre e Esclarecido

Nº do registro no CEP: 037/2009

UNIVERSIDADE ESTADUAL DE CAMPINAS
FACULDADE DE ODONTOLOGIA DE PIRACICABA

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

TÍTULO: **"Avaliação eletromiográfica e estrutural dos músculos masseter e esternocleidomastóideo em pacientes com disfunção temporomandibular em diferentes cargas de mordida"**

Introdução

Você está convidado a participar da pesquisa acima citada, a ser desenvolvida pelas pesquisadoras Paulinne Junqueira Silva Andresen Strini e Profa. Dr. Maria Beatriz Duarte Gavião. O documento abaixo é o Termo de Consentimento Livre e Esclarecido que contém todas as informações necessárias sobre a pesquisa que será realizada. As informações contidas neste Termo, bem como a apresentação e a obtenção do consentimento, serão realizadas por nós, pesquisadoras responsáveis pela pesquisa. Sua colaboração neste estudo será de muita importância, mas se desistir a qualquer momento, isso não lhe causará nenhum prejuízo.

Estou ciente que:

Justificativa

Este trabalho justifica-se pela necessidade em compreender as alterações musculares e o comprometimento dos músculos da bochecha e pescoço em pacientes com Disfunção Temporomandibular (DTM), visto que a disfunção pode comprometer a estrutura do músculo e sua função. A presença de dor também pode prejudicar o funcionamento normal destas estruturas. Este estudo também se mostra importante em auxiliar o diagnóstico e a seleção de uma terapêutica apropriada, bem como fornecer informações a indivíduos saudáveis e orientações preventivas.

Objetivo

O estudo tem por objetivo avaliar a atividade eletromiográfica dos músculos masseter (bochecha) e esternocleidomastóideo (pescoço), bem como a espessura muscular, durante diferentes forças de mordida. Também busca analisar os sinais e sintomas de Disfunção Temporomandibular (DTM) (dor nos músculos da face e do pescoço e dor na articulação próxima ao ouvido) por meio do questionário de Critérios de Diagnóstico para Pesquisa das Desordens Temporomandibulares (RDC/TMD).

Metodologia

1. Para a realização da pesquisa, todos os voluntários serão submetidos à entrevista verbal para informar os dados pessoais, história médica e odontológica. Será realizado um exame clínico intra (dentro da boca) e extra-oral (face e pescoço), em consultório odontológico, com um espelho clínico. Assim, será realizado o preenchimento do questionário RDC/TMD e avaliação da presença de sinais e sintomas que caracterizem o quadro clínico de DTM.
2. Para a verificação da força de mordida, um tubo de borracha será posicionado entre os arcos dentários, sobre os dentes posteriores e será solicitado para realizar apertamento dentário, com força máxima.
3. Para o exame da atividade elétrica dos músculos, serão fixados eletrodos sobre a superfície da pele na região dos músculos masseter e esternocleidomastóideo. Este exame não provoca dor, nem choque ou desconforto ao voluntário. Uma coleta será realizada com o paciente sentado, em repouso e outra, na mesma posição, durante o apertamento dos dentes.
4. No exame de ultrassonografia, o tubo de metal (scanner) do ultrassom será colocado sobre a superfície dos músculos em estudo, na região da bochecha e pescoço, com a aplicação de um gel condutor entre a superfície da pele e o equipamento. Novamente, será solicitado ao participante que realize o apertamento dos dentes, e será identificada a espessura dos músculos analisados.
5. Os laboratórios das áreas de anatomia humana e odontopediatria estão adequadamente equipados para a realização do teste de força muscular e dos exames de eletromiografia e ultrassonografia.
6. Durante o período da pesquisa, os voluntários devem relatar aos pesquisadores, eventuais problemas de saúde ou ingestão de medicamento.
7. Cada voluntário será solicitado a comparecer ao Laboratório em dias e horários marcados, de modo a não comprometer suas atividades diárias. Para cada sessão, estima-se o tempo aproximado de 60 minutos, suficientes para realização de cada etapa deste trabalho. Na primeira sessão será agendada a próxima sessão, considerando a disponibilidade do voluntário. Estima-se a necessidade de duas sessões para a realização do estudo.

Possibilidade de inclusão em grupo controle

Para o grupo controle, estarão incluídos os indivíduos de ambos os sexos, entre 18 e 40 anos, com oclusão clinicamente normal e suporte molar bilateral (apresentem os dentes posteriores superiores e inferiores) e que não apresentem sinais e sintomas de DTM.

Métodos alternativos para obtenção da informação ou tratamento da condição

Para alcançar os objetivos desta pesquisa, os métodos a serem aplicados são os mais indicados para a obtenção correta da informação desejada, pois são exames de superfície, sem efeitos colaterais. Os métodos alternativos como a tomografia computadorizada ou imagem de ressonância magnética são exames com emissão de radiação e alto custo, respectivamente e, portanto mais complexos. Não será realizada nenhuma forma de tratamento.

Descrição crítica dos desconfortos e riscos previsíveis

A Mensuração da Força de Mordida, a Avaliação Eletromiográfica e o Exame de Ultrassonografia, são testes não invasivos e buscam mensurar a força de mordida durante uma contração muscular voluntária (apertamento dentário), a atividade elétrica gerada de um músculo em atividade, e a espessura muscular, respectivamente, portanto, não causam riscos previsíveis aos voluntários, visto que todas as variáveis são controladas. Da mesma forma, o preenchimento do questionário RDC não provoca nenhum incômodo ou desconforto ao indivíduo. Estes exames, quando realizados por profissional habilitado, com técnica adequada, como propõe a metodologia deste projeto, não causa quaisquer desconfortos e efeitos colaterais negativos.

Descrição dos benefícios e vantagens diretas ao voluntário

Dentre os benefícios esperados para os participantes desta pesquisa, para o grupo de pacientes com DTM, incluem o diagnóstico do quadro clínico, com a análise das características dos músculos, tanto na forma como na função, bem como o encaminhamento para centros especializados em tratamento. Para o grupo controle, os dados obtidos com a realização dos exames serão informativos e fornecerão resultados úteis ao aconselhamento, prevenção e acompanhamento de possíveis alterações que possam estar despercebidas ou que venham a acontecer.

Forma de acompanhamento e assistência ao sujeito

O acompanhamento e a assistência serão dados pelas pesquisadoras responsáveis, para sanar qualquer necessidade relacionada à pesquisa.

Forma de contato com os pesquisadores e com o CEP

O contato com um dos pesquisadores responsáveis ou CEP (Comitê de Ética em Pesquisa) poderá ser feito através de telefone ou endereço presente no fim deste termo de consentimento.

Garantia de esclarecimentos

Quaisquer dúvidas poderão ser esclarecidas antes, durante e após o desenvolvimento da pesquisa, entrando em contato com os pesquisadores ou com o CEP.

Garantia de recusa à participação ou de saída do estudo

Tenho a liberdade de desistir ou de interromper a colaboração neste estudo, no momento em que desejar, sem qualquer penalidade de qualquer natureza, mediante o contato com um dos pesquisadores responsáveis ou CEP.

Garantia de sigilo

Fica garantido o sigilo de dados confidenciais ou que, de algum modo, possam provocar constrangimentos ou prejuízos a minha pessoa, preservando sempre minha integridade e identidade.

Garantia de ressarcimento

Os voluntários desta pesquisa terão despesas apenas com o transporte até o laboratório desta instituição, sendo garantido o ressarcimento desses gastos.

Garantia de indenização e/ou reparação de danos

Não há riscos previsíveis para a realização desta pesquisa. Entretanto, se por ventura houver qualquer dano causado durante a realização dos exames, os pesquisadores tomarão medidas para repará-los.

Garantia de entrega de cópia

Tenho garantido o recebimento de uma cópia deste Termo de Consentimento Livre e Esclarecido.

Eu, abaixo assinado, concordo de livre e espontânea vontade, em participar como voluntário do estudo **“Avaliação eletromiográfica e estrutural dos músculos masseter e esternocleidomastóideo em pacientes com disfunção temporomandibular em diferentes cargas de mordida”**. Declaro que obtive todas as informações necessárias fornecidas pelas pesquisadoras responsáveis, bem como todos os eventuais esclarecimentos quanto às dúvidas por mim apresentadas.

Nome:____________________________________Data de nascimento: _____/_____/_____

Endereço: ____ Telefone: _________________

Identidade (RG): _____________________________ CPF: _________________________

Assinatura: ____Data: _____/_____/_____

"Em caso de dúvidas ou outros assuntos relativos à pesquisa, entre em contato com uma das pesquisadoras. Em relação a dúvidas quanto aos seus direitos, como voluntário de pesquisa, entre em contato com o CEP-FOP."

Pesquisadoras responsáveis:

Profa. Maria Beatriz Duarte Gavião
e-mail: mbgaviao@fop.unicamp.br

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Comitê de Ética em Pesquisa

(CEP)

Av. Limeira, 901
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www.fop.unicamp.br/cep

ANEXO 1

UNICAMP

Questionário de Critérios de Diagnóstico para Pesquisa das Desordens Temporomandibulares (RDC/DTM)

NOME:____

História Questionário

Favor ler cada pergunta e responder de acordo. Para cada pergunta abaixo, circule somente uma resposta.

1. Você diria que a sua saúde em geral é excelente, muito boa, boa, razoável, ou precária ?

Excelente	1
Muito boa	2
Boa	3
Razoável	4
Precária	5

2. Você diria que a sua saúde oral em geral é excelente, muito boa, boa, razoável, ou precária ?

Excelente	1
Muito boa	2
Boa	3
Razoável	4
Precária	5

3. Você já teve dor na face, nos maxilares, têmpora, na frente do ouvido, ou no ouvido no mês passado ?

Não	0
Sim	1

[Em caso de Não ter tido dor no mês passado, PULE para a pergunta 14]
Se a sua resposta foi Sim,

4.a. Há quantos anos atrás a sua dor facial começou pela primeira vez ? __ __ anos
[Se há um ano atrás ou mais, PULE para a pergunta 5]
[Se há menos de um anos atrás, marque 00]

4.b. Há quantos meses atrás a sua dor facial começou pela primeira vez ? __ __ meses

5. A sua dor facial é persistente, recorrente, ou foi um problema que ocorreu somente uma vez?

Persistente	1
Recorrente	2
Uma vez	3

6. Você alguma vez já foi a um médico, dentista, quiroprático ou outro profissional de saúde devido a dor facial ?

Não	1
Sim, nos últimos seis meses	2
Sim, há mais de seis meses atrás	3

7. Como você classificaria a sua dor facial em uma escala de 0 a 10 no presente momento, isto é exatamente agora, onde 0 é "sem dor" e 10 é a "pior dor possível" ?

0 1 2 3 4 5 6 7 8 9 10

Sem dor **A pior dor possível**

8. Nos últimos seis meses, qual foi a intensidade da sua pior dor, classificada pela escala de 0 a 10, onde 0 é "sem dor" e 10 é a "pior dor possível" ?

0 1 2 3 4 5 6 7 8 9 10

Sem dor **A pior dor possível**

9. Nos últimos seis meses, em média, qual foi a intensidade da sua dor, classificada pela escala de 0 a 10, onde 0 é "sem dor" e 10 é a "pior dor possível" ? [Isto é, sua dor usual nas horas que você estava sentindo dor].

0 1 2 3 4 5 6 7 8 9 10

Sem dor **A pior dor possível**

10. Aproximadamente quantos dias nos últimos 6 meses você esteve afastado de suas atividades usuais (trabalho, escola, serviço doméstico) devido a dor facial ? ____ dias

11. Nos últimos 6 meses, o quanto esta dor facial interferiu com suas atividades diárias de acordo com uma escala de 0 a 10, onde 0 é "nenhuma interferência" e 10 é "incapaz de realizar qualquer atividade" ?

0 1 2 3 4 5 6 7 8 9 10

Nenhuma interferência **Incapaz de realizar qualquer atividade**

12. Nos últimos 6 meses, o quanto esta dor facial alterou a sua capacidade de participar de atividades recreativas, sociais e familiares onde 0 é "nenhuma alteração" e 10 é alteração extrema" ?

0 1 2 3 4 5 6 7 8 9 10

Nenhuma alteração **Alteração extrema**

13. Nos últimos 6 meses, o quanto esta dor facial alterou a sua capacidade de trabalhar (incluindo serviço domésticos) onde 0 é "nenhuma alteração" e 10 é "alteração extrema" ?

0 1 2 3 4 5 6 7 8 9 10

Nenhuma alteração **Alteração extrema**

14.a. Você alguma vez teve travamento articular de forma que não foi possível abrir a boca por todo o trajeto ?

Não	0
Sim	1

[se nunca apresentou este tipo de problema, PULE para a pergunta 15]

Se a sua resposta foi Sim,

14.b. Esta limitação de abertura mandibular foi severa a ponto de interferir com a sua capacidade de mastigar ?

Não	0
Sim	1

15.a. Os seus maxilares estalam quando você abre ou fecha a boca ou quando você mastiga?

Não 0
Sim 1

15.b. Os seus maxilares crepitam quando você abre e fecha ou quando você mastiga ?

Não 0
Sim 1

15.c. Alguém lhe disse, ou você nota, se você range os seus dentes ou aperta os seus maxilares quando dorme a noite ?

Não 0
Sim 1

15.d. Durante o dia, você range os seus dentes ou aperta os seus maxilares ?

Não 0
Sim 1

15.e. Você sente dor ou rigidez nos seus maxilares quando acorda de manhã ?

Não 0
Sim 1

15.f. Você apresenta ruídos ou zumbidos nos seus ouvidos ?

Não 0
Sim 1

15.g. Você sente a sua mordida desconfortável ou incomum ?

Não 0
Sim 1

16.a. Você tem artrite reumatóide, lúpus, ou qualquer outra doença artrítica sistêmica?

Não 0
Sim 1

16.b. Você conhece alguém na sua família que tenha qualquer uma destas doenças ?

Não 0
Sim 1

16.c. Você já apresentou ou apresenta inchaço ou dor em qualquer das articulações que não sejam as articulações perto dos seus ouvidos (ATM)?

Não 0
Sim 1

[em caso de Não ter tido inchaço ou dor nas articulações, PULE para a pergunta 17.a.]
Se a sua resposta foi Sim,

16.d. É uma dor persistente que você vem tendo por pelo menos um ano ?

Não 0
Sim 1

17.a. Você teve alguma injúria recente contra sua face ou seus maxilares ?

Não 0
Sim 1

[em caso de Não ter tido injúria, pule para a pergunta 18]

Se sua resposta foi Sim,

17.b. Você teve dor nos maxilares antes da injúria ?

Não 0

Sim 1

18. Durante os últimos 6 meses você teve dor de cabeça ou enxaquecas ?

Não 0

Sim 1

19. Que atividades o seu problema atual dos maxilares impedem ou limitam ?

a. Mastigar

Não 0

Sim 1

b. Beber

Não 0

Sim 1

c. Exercitar-se

Não 0

Sim 1

d. Comer alimentos duros

Não 0

Sim 1

e. Comer alimentos moles

Não 0

Sim 1

f. Sorrir/gargalhar

Não 0

Sim 1

g. Atividade sexual

Não 0

Sim 1

h. Limpar os dentes ou a face

Não 0

Sim 1

i. Bocejar

Não 0

Sim 1

j. Engolir

Não 0

Sim 1

k. Conversar

Não 0

Sim 1

l. Manter a sua aparência facial usual

Não 0

Sim 1

20. No último mês, o quanto você tem estado angustiado por:

a. Dores de cabeça

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

b. Perda de interesse ou prazer sexual

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

c. Fraqueza ou tontura

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

d. Dores no coração ou peito

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

e. Sensação de falta de energia ou lerdeza

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

f. Pensamentos sobre morte ou relacionados ao ato de morrer

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

g. Falta de apetite

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

h. Chorar facilmente

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

i. Culpar a si mesmo pelas coisas

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

j. Dores na parte inferior das costas

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

k. Sentir-se só

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

l. Sentir-se triste

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

m. Preocupar-se muito com as coisas

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

n. Sentir nenhum interesse pelas coisas

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

o. Náusea ou distúrbio gástrico

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

p. Músculos doloridos

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

q. Dificuldade em adormecer

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

r. Dificuldade em respirar

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

s. Acessos calor / frio

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

t. Dormência ou formigamento em partes do corpo

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

u. Inchaço/protuberância na sua garganta

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

v. Sentir-se desanimado sobre o futuro

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

w. Sentir-se fraco em partes do corpo

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

x. Sensação de peso nos braços ou pernas

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

y. Pensamentos sobre acabar com a sua vida

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

z. Comer demais

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

aa. Acordar de madrugada

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

bb. Sono agitado ou perturbado

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

cc. Sensação de que tudo é um esforço/sacrifício

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

dd. Sentimentos de inutilidade

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

ee. Sensação de ser enganado ou iludido

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

ff. Sentimentos de culpa

Nem um pouco	Um pouco	Moderadamente	Muito	Extremamente
0	1	2	3	4

21. Como você classificaria os cuidados que tem tomado para com a sua saúde de uma forma geral ?

Excelente	1
Muito bom	2
Bom	3
Satisfatório	4
Insatisfatório	5

22. Como você classificaria os cuidados que tem tomado para com a sua saúde oral ?

Excelente	1
Muito bom	2
Bom	3
Satisfatório	4
Insatisfatório	5

23. Quando você nasceu ? Dia ___ Mês ___ Ano ___

24. Sexo masculino ou feminino ?

Masculino ----- 1
Feminino ------ 2

25. Qual dos grupos abaixo melhor representa a sua raça ?

Aleútas, Esquimó ou Índio Americano	1
Asiático ou Insulano Pacífico	2
Negro	3
Branco	4
Outro	5 ______________________ (favor especificar)

26. Alguns destes grupos representa a sua origem nacional ou ancestralidade ?

Porto Riquenho	1
Cubano	2
Mexicano	3
Mexicano Americano	4
Chicano	5
Outro Latino Americano	6
Outro Espanhol	7
Nenhum acima	8

27. Qual o seu grau de escolaridade mais alto ou último ano de escola que você completou?

Nunca freqüentou a escola / jardim de infância	00
Escola Primária	1 2 3 4
Escola Ginasial	5 6 7 8
Científico	9 10 11 12
Faculdade	13 14 15 16 17 18+

28a. Durante as últimas 2 semanas, você trabalhou no emprego ou negócio não incluindo trabalho em casa (inclui trabalho não remunerado em negócios/fazenda da família) ?

Não 0
Sim 1

[Se a sua resposta foi Sim, pule para a pergunta 29]
Se a sua resposta foi Não,

28b. Embora você não tenha trabalhado nas duas últimas semanas, você tinha um emprego ou negócio ?

Não 0
Sim 1

[Se a sua resposta foi Sim, PULE para a pergunta 29]
Se a sua resposta foi Não,

28c. Você estava procurando emprego ou de dispensa, durante aquelas duas semanas?

Sim, procurando emprego	1
Sim, de dispensa	2
Sim, ambos de dispensa e procurando emprego	3
Não	4

29. Qual o seu estado civil ?

Casado (a) esposa (o) em casa	1
Casado (a) esposa (o) fora de casa	2
Viúvo (a)	3
Divorciado (a)	4
Separado (a)	5
Nunca casei	6

30. Qual a sua foi a sua renda doméstica durante os últimos 12 meses ?
R$ ___.____,__ (Reais, moeda brasileira)
Não preencher. Deverá ser preenchido pelo profissional
____ US$ 0 US$ 14,999
____ US$ 15,000 US$ 24,999
____ US$ 25,000 US$ 34,999
____ US$ 35,000 US$ 49,999
____ US$ 50,000 ou mais

31. Qual o seu CEP ? _____ - ___

Formulário de Exame

NOME:____

1. Você tem dor no lado direito da sua face, lado esquerdo ou ambos os lados ?

nenhum 0
direito 1
esquerdo 2
ambos 3

2. Você poderia apontar as áreas aonde você sente dor ?

Direito		Esquerdo	
Nenhuma	0	Nenhuma	0
Articulação	1	Articulação	1
Músculos	2	Músculos	2
Ambos	3	Ambos	3

Examinador apalpa a área apontada pelo paciente, caso não esteja claro se é dor muscular ou
articular

3. Padrão de Abertura

Reto 0
Desvio lateral direito (não corrigido) 1
Desvio lateral direito corrigido ("S") 2
Desvio lateral esquerdo (não corrigido) 3
Desvio lateral corrigido ("S") 4
Outro 5 Tipo ______________________
(especifique)

4. Extensão de movimento vertical incisivos maxilares utilizados 11
21

a. Abertura sem auxílio sem dor __ __ mm
b. Abertura máxima sem auxílio __ __ mm
c. Abertura máxima com auxílio __ __ mm
d. Transpasse incisal vertical __ __ mm

Tabela abaixo: Para os itens "b" e "c" somente

DOR MUSCULAR				DOR ARTICULAR			
nenhuma	direito	esquerdo	ambos	nenhuma	direito	esquerdo 13	ambos
0	1	2	3	0	1	2	3
0	1	2	3	0	1	2	3

5. Ruídos articulares (palpação)

a. abertura

	Direito	Esquerdo
Nenhum	0	0
Estalido	1	1
Crepitação grosseira	2	2
Crepitação fina	3	3
Medida do estalido na abertura	__ __ mm	__ __ mm

b. Fechamento

	Direito	Esquerdo
Nenhum	0	0
Estalido	1	1
Crepitação grosseira	2	2
Crepitação fina	3	3
Medida do estalido de fechamento	__ __ mm	__ __ mm

c. Estalido recíproco eliminado durante abertura protrusiva

	Direito	Esquerdo
Sim	0	0
Não	1	1
NA	8	8

6. Excursões

a. Excursão lateral direita __ __ mm

b. Excursão lateral esquerda __ __ mm

c. Protrusão __ __ mm

Tabela abaixo: Para os itens "a" , "b" e "c"

DOR MUSCULAR				DOR ARTICULAR			
nenhuma	direito	esquerdo	ambos	nenhuma	direito	esquerdo	ambos
0	1	2	3	0	1	2	3
0	1	2	3	0	1	2	3
0	1	2	3	0	1	2	3

d. Desvio de linha média __ __ mm

direito	esquerdo	NA
1	2	8

7. Ruídos articulares nas excursões

Ruídos direito

	nenhum	estalido	Crepitação grosseira	Crepitação leve
Excursão Direita	0	1	2	3
Excursão Esquerda	0	1	2	3
Protrusão	0	1	2	3

Ruídos esquerdo

	nenhuma	estalido	Crepitação grosseira	Crepitação leve
Excursão Direita	0	1	2	3
Excursão Esquerda	0	1	2	3
Protrusão	0	1	2	3

INSTRUÇÕES, ITENS 8-10

O examinador irá palpar (tocando) diferentes áreas da sua face, cabeça e pescoço. Nós gostaríamos que você indicasse se você não sente dor ou apenas sente pressão (0), ou dor (1-3). Por favor, classifique o quanto de dor você sente para cada uma das palpações de acordo com a escala abaixo. Circule o número que corresponde a quantidade de dor que você sente.

Nós gostaríamos que você fizesse uma classificação separada para as palpações direita e esquerda.

0 = Sem dor / somente pressão
1 = dor leve
2 = dor moderada
3 = dor severa

8. Dor muscular extra-oral com palpação

	DIREITO	ESQUERDO
a. Temporal (posterior) "parte de trás da têmpora"	0 1 2 3	0 1 2 3
b. Temporal (médio) "meio da têmpora"	0 1 2 3	0 1 2 3
c. Temporal (anterior) "parte anterior da têmpora"	0 1 2 3	0 1 2 3
d. Masseter (superior) "bochecha/abaixo do zigoma"	0 1 2 3	0 1 2 3
e. Masseter (médio) "bochecha/lado da face"	0 1 2 3	0 1 2 3
f. Masseter (inferior) "bochecha/linha da mandíbula"	0 1 2 3	0 1 2 3
g. Região mandibular posterior (estilo-hióide/região posterior do digástrico) "mandíbula/região da garganta"	0 1 2 3	0 1 2 3
h. Região submandibular (pterigoide medial/supra-hióide/região anterior do digástrico) "abaixo do queixo"	0 1 2 3	0 1 2 3

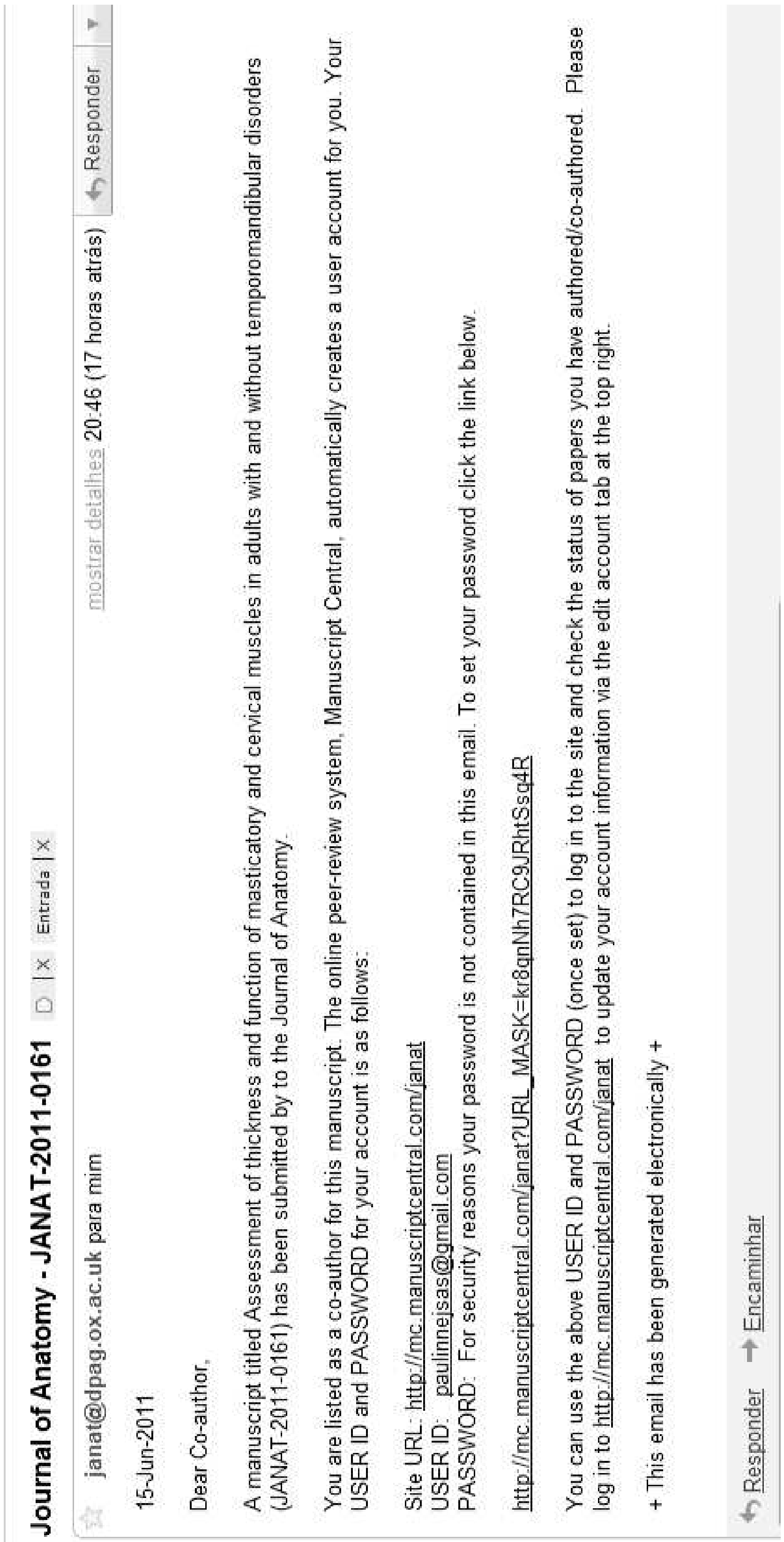
9. Dor articular com palpação

	DIREITO	ESQUERDO
a. Polo lateral "por fora"	0 1 2 3	0 1 2 3
b. Ligamento posterior "dentro do ouvido"	0 1 2 3	0 1 2 3

10. Dor muscular intra-oral com palpação

	DIREITO	ESQUERDO
a. Área do pterigoide lateral "atrás dos molares superiores"	0 1 2 3	0 1 2 3
b. Tendão do temporal "tendão"	0 1 2 3	0 1 2 3

ANEXO 2



Journal of Anatomy - JANAT-2011-0161 Entrada | X

janat@dpag.ox.ac.uk para mim — mostrar detalhes 20:46 (17 horas atrás) — Responder

15-Jun-2011

Dear Co-author,

A manuscript titled Assessment of thickness and function of masticatory and cervical muscles in adults with and without temporomandibular disorders (JANAT-2011-0161) has been submitted by to the Journal of Anatomy.

You are listed as a co-author for this manuscript. The online peer-review system, Manuscript Central, automatically creates a user account for you. Your USER ID and PASSWORD for your account is as follows:

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Responder Encaminhar

ANEXO 3

COMITÊ DE ÉTICA EM PESQUISA
FACULDADE DE ODONTOLOGIA DE PIRACICABA
UNIVERSIDADE ESTADUAL DE CAMPINAS

CERTIFICADO

O Comitê de Ética em Pesquisa da FOP-UNICAMP certifica que o projeto de pesquisa **"Avaliação eletromiográfica e estrutural dos músculos masseter e esternocleidomastóideo em pacientes com disfunção temporomandibular em diferentes cargas de mordida"**, protocolo nº 037/2009, dos pesquisadores Paulinne Junqueira Silva Andresen Strini e Maria Beatriz Duarte Gavião, satisfaz as exigências do Conselho Nacional de Saúde - Ministério da Saúde para as pesquisas em seres humanos e foi aprovado por este comitê em 06/05/2009.

The Ethics Committee in Research of the School of Dentistry of Piracicaba - State University of Campinas, certify that the project **"Electromyographic and structural assessment of masseter and sternocleidomastoid muscles in patients with temporomandibular dysfunction in different bite forces"**, register number 037/2009, of Paulinne Junqueira Silva Andresen Strini and Maria Beatriz Duarte Gavião, comply with the recommendations of the National Health Council - Ministry of Health of Brazil for research in human subjects and therefore was approved by this committee at .

Prof. Dr. Pablo Agustin Vargas
Secretário
CEP/FOP/UNICAMP

Prof. Dr. Jacks Jorge Junior
Coordenador
CEP/FOP/UNICAMP

Nota: O título do protocolo aparece como fornecido pelos pesquisadores, sem qualquer edição.
Notice: The title of the project appears as provided by the authors, without editing.

ANEXO 4

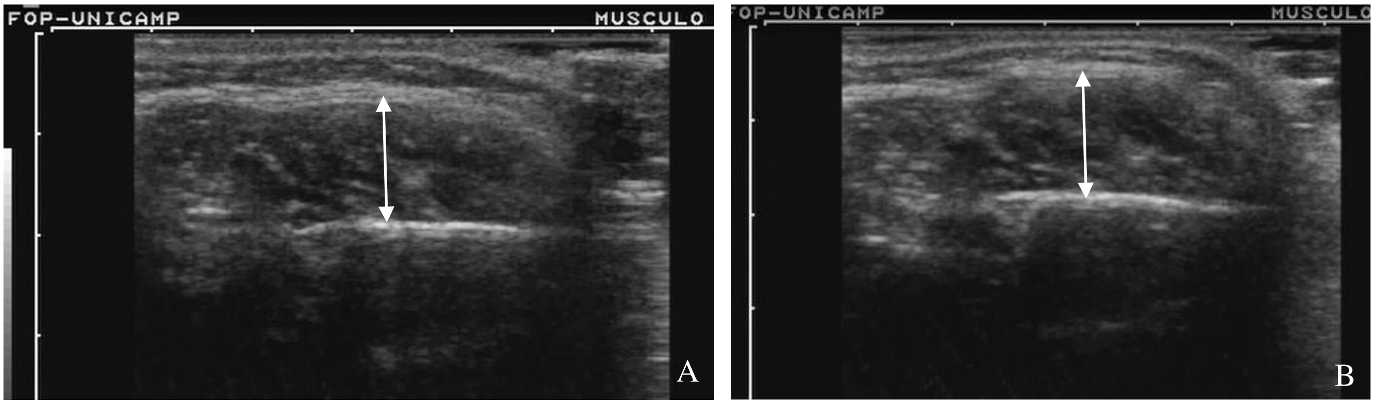

Figura 1. Ultrassonografia do músculo masseter em repouso (A) e durante apertamento dentário (B). As flechas indicam a espessura muscular mensurada.

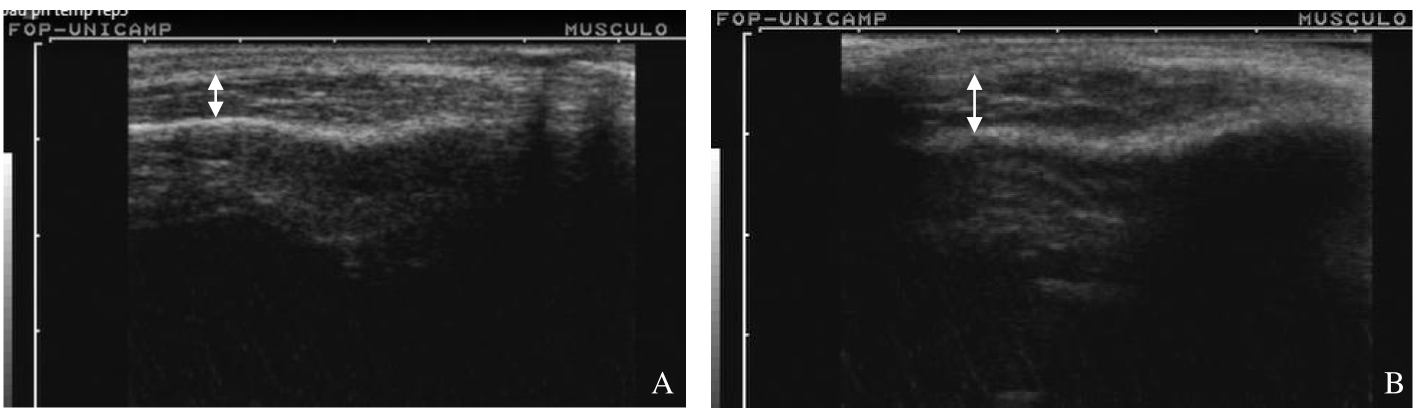

Figura 2. Ultrassonografia do músculo temporal (parte anterior) em repouso (A) e durante apertamento dentário (B). As flechas indicam a espessura muscular mensurada.

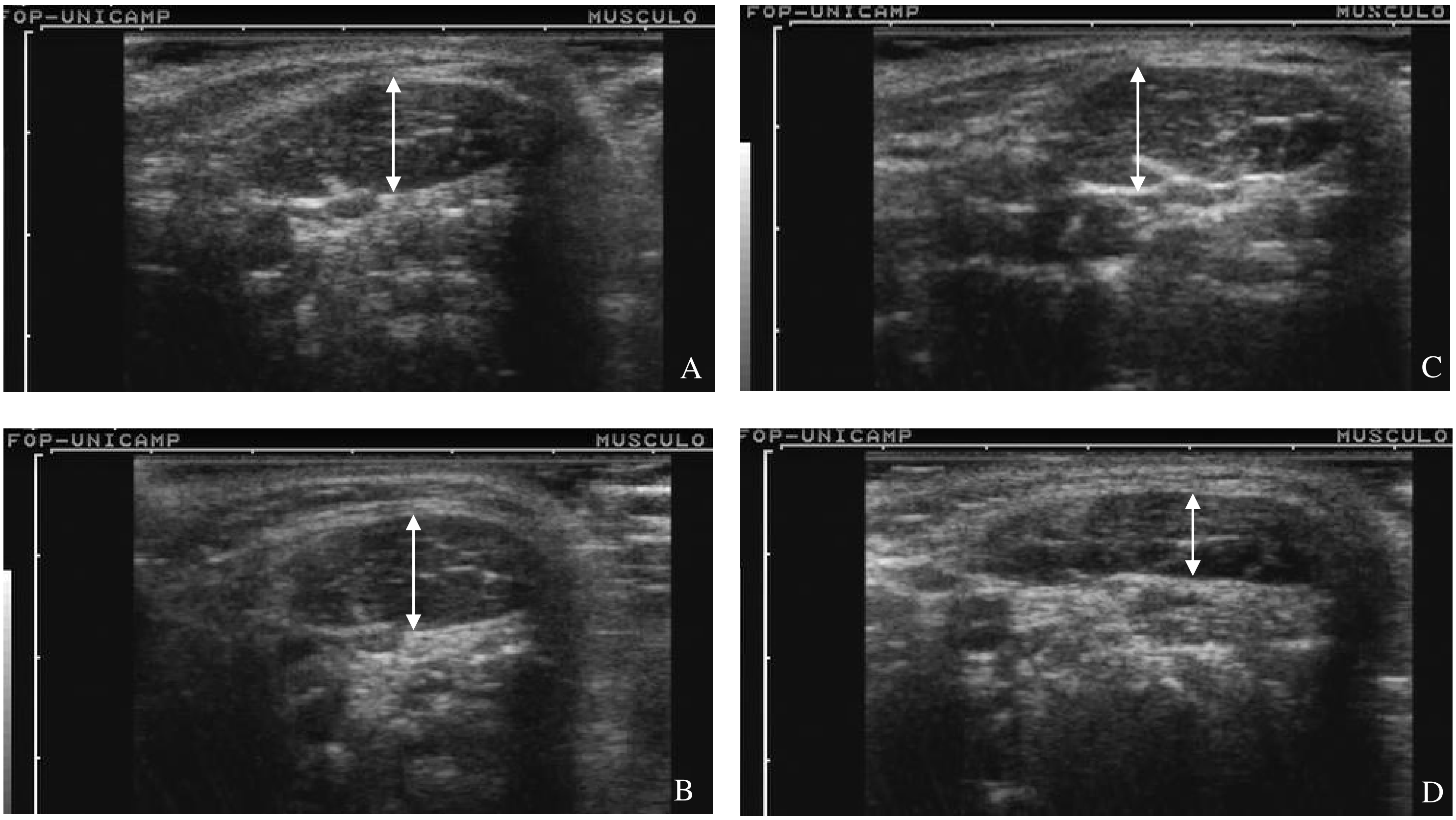

Figura 3. Ultrassonografia do músculo esternocleidomastóideo em repouso (A), no apertamento dentário (B), em flexão (C) e extensão (D) de cabeça. As flechas indicam a espessura muscular mensurada.