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IMAGING METHODS

Accuracy of two forms of infrared image analysis of the masticatory muscles in the diagnosis of myogenous temporomandibular disorder

Delaine Rodrigues-Bigaton, PT, PhD [a], Almir Vieira Dibai-Filho, PT [a,*], Amanda Carine Packer, PT [a], Ana Cláudia de Souza Costa, PT [a], Ester Moreira de Castro, PT [b]

[a] Laboratory of Therapeutic Resources, Postgraduate Program in Physiotherapy, Methodist University of Piracicaba, Piracicaba, SP, Brazil
[b] Health Sciences School, Methodist University of Piracicaba, Piracicaba, SP, Brazil

Summary   The aim of the present study was to assess the accuracy of two forms of infrared image analysis (area and extension) of the masseter and anterior temporalis muscles in the diagnosis of myogenous temporomandibular disorder (TMD). A cross-sectional study was carried out involving 104 female volunteers from the university community. Following the application of the Research Diagnostic Criteria for Temporomandibular Disorders, the volunteers were divided into a TMD group ($n = 52$) and control group ($n = 52$), and evaluated using infrared thermography. The area and extension of the masseter and anterior temporalis muscles were measured on the images. The receiver operating characteristic (ROC) curve was used to determine diagnostic accuracy (area under the curve), best cutoff point, sensitivity and specificity. A significant difference in skin temperature between groups was only found in the measurement of the area of the left anterior temporalis muscle ($p = 0.011$). The area under the ROC curve was less than the reference values for all muscles evaluated in the analyses of area and extension. Thus, neither method of infrared thermography tested for the quantification of the masseter and anterior temporalis muscles (analysis of area and extension) is consistent with the RDC/TMD for the diagnosis of myogenous TMD in women.
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* Corresponding author. Avenida do Café, 2361, Apto 518, Vila Amélia, Ribeirão Preto, CEP: 14050-230, SP, Brazil. Tel.: +55 016 8149 6448.
  E-mail address: dibaifilho@gmail.com (A.V. Dibai-Filho).

Introduction

Temporomandibular disorder (TMD) is a chronic condition characterized primarily by the presence of pain, with the myofascial form of this disorder the most prevalent in the population (Manfredini et al., 2011b). TMD has a multi-factor aetiology, complex diagnosis and pathological mechanism that involves different structures of the sto-matognathic system, such as the masticatory muscles, temporomandibular joint (TMJ) and or joint disc (Leeuw, 2008; Oral et al., 2009).

A number of studies have been published on methods for the evaluation and diagnosis of TMD. Fonseca et al. (1994) developed an index in Portuguese for assessing the severity of TMD that can be easily employed in both research studies and clinical practice (Chaves et al., 2008). Ribeiro-Rotta et al. (2011) establish that the magnetic resonance imaging and computed tomography in the evaluation of joint changes in individuals with TMD should be used with caution, especially in cases of financial restrictions; more-over, studies are needed to determine the actual benefits to patients submitted to these exams. Analysing individuals with myofascial pain, Manfredini et al. (2011a) found no evidence to recommend surface electromyography of the masticatory muscles for the diagnosis of myogenous TMD.

Besides these assessment tools, the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) (Dworkin and LeResche, 1992) has been commonly applied in several investigations and populations. It is a measure made up of two axes. Axis I is used to evaluate physical aspects of TMD and axis II is used to evaluate psychosocial aspects, chronic pain, depression, anxiety and other symptoms. Moreover, the proper application of the RDC/TMD requires the examiner to undergo a training and cali-bration process.

Infrared thermography is another tool that can be applied to individuals with myogenous TMD due to the changes in the microcirculatory dynamics, i.e., there is a decrease in the skin temperature due to compression of blood vessels conditioned by muscle hyperactivity (Gratt et al., 1994a; Barão et al., 2011). This method has been employed by different professionals in the health sciences to investigate the skin temperature, which is affected by the heat conducted from deeper tissues and by the activity of the autonomic nervous system (Brioschi et al., 2007; Holey et al., 2011).

Several studies have employed infrared thermography as an assessment tool for individuals with neck pain (Dibai Filho et al., 2012), breast cancer (Wishart et al., 2010) and diabetic neuropathy (Bagavathiappan et al., 2010). Moreover, authors have employed infrared thermography to assess the effects of physiotherapeutic (Holey et al., 2011) and dental (Barão et al., 2011) resources on skin temper-ature. However, the literature on the diagnostic accuracy of this method is scarce.

In the TMD diagnosis, Gratt et al. (1994a) report 84% accuracy, 80% sensitivity and 88% specificity in the differ-entiation of individuals with TMJ alteration and healthy controls. Canavan and Gratt (1995) report 89% accuracy, 85% sensitivity and 92% specificity using thermography of the TMJ region in the differentiation of asymptomatic

individuals and those with mild to moderate TMD. McBeth and Gratt (1996) report 87% sensitivity and 86% specificity in a study involving control subjects, individuals in ortho-dontic treatment and individuals with TMD. Moreover, Canavan and Gratt (1995) and McBeth and Gratt (1996) used a clinical examination to diagnose TMD, whereas Gratt et al. (1994a) used a clinical examination and radiography for the same purpose. In contrast to these studies and using the RDC/TMD, a recent study reports low sensitivity (range: 38.5—76.9%) and specificity (range: 22.8—71.2%) with the use of infrared thermography on the masticatory muscles (Dibai Filho et al., 2013).

Infrared image analysis is one aspect that still requires attention from professionals using infrared thermography by the lack of standardization. According to recent study (Dibai Filho et al., 2013), the analysis of the centre of the muscle is not accurate for the diagnosis of myogenous TMD, and suggests that future studies should evaluate a larger portion of the surface of the masticatory muscles.

Given the above and considering the aforementioned study, the aim of the present study was to assess the ac-curacy of two forms of infrared image analysis (area and extension) of the masseter and anterior temporalis muscles in the diagnosis of myogenous TMD.

Methods

Study design

The present cross-sectional study received approval from the Human Research Ethics Committee of the Methodist University of Piracicaba (SP, Brazil), under protocol n° 15/11. Each volunteer agreed to participate by signing a statement of informed consent.

Population

The sample size was determined based on the study by Pogrel et al. (1989). The outcome variable was the absolute skin temperature of the anterior temporalis muscle. For the calculation, 32.82 ± 0.51 °C and 33.24 ± 0.95 °C were used for the control group and TDM group, respectively. Considering a statistical power of 80% and alpha of 0.05, 52 volunteers were determined for each group. The sample size calculation was performed using Ene software version 3.0 (Barcelona, Spain).

The volunteers were female from the university com-munity cities of Piracicaba and Americana, SP, Brazil, recruited from November 2010 to April 2011. Following the application of the RDC/TMD (Dworkin and LeResche, 1992), volunteers with and without TMD were included in the study. Those with TMD were diagnosed with myofascial pain (Ia) or myofascial pain with limited mouth opening (Ib). The inclusion of volunteers in the TMD and control groups was performed consecutively, until be accounted the number of 52 in each group. Only women were included due to the higher prevalence of TMD in this gender (Oliveira et al., 2006).

There is no instrument in the literature considered gold standard for the diagnosis of TMD. However, the present