

# Surface electromyography for temporomandibular disorders: systematic review\*

## *Eletromiografia de superfície em disfunção temporomandibular: revisão sistemática*

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### ABSTRACT

**BACKGROUND AND OBJECTIVES:** Surface electromyography (SE) provides a non invasive evaluation of the bioelectric phenomenon of the evaluated muscle at rest, as well as the comparison with its activity during muscle contraction. This study aimed at evaluating the effectiveness of SE in patients with temporomandibular disorders according to Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) axis I criteria.

**CONTENTS:** Literature was reviewed as from LILACS, Medline and Scielo databases in the period from January 1987 to February 2012. Randomized controlled clinical trials, clinical trials and clinical tests evaluating signs and symptoms of temporomandibular disorders (TMD) diagnosed according to RDC/TMD were included. Search strategy has resulted in 182 articles of which eight have fulfilled inclusion criteria, being one randomized clinical trial and seven longitudinal studies without randomization criteria. In all studies, SE was the method used to detect and evaluate electric activity of masticatory muscles (body of the masseter and anterior temporal bundle), being somewhat easily applied and following test standards. However, different experimental models and

sample selections were used, making difficult the comparison of results.

**CONCLUSION:** In spite of the limitations of this study, it was possible to observe that although SE should not be used to diagnose TMD, it may help the follow up of TMD treatment evolution.

**Keywords:** Electromyography, Masseter, Masticatory muscles, Research Diagnostic Criteria, Surface electromyography, Temporal.

### RESUMO

**JUSTIFICATIVA E OBJETIVOS:** A eletromiografia de superfície (ES) permite uma avaliação não invasiva do fenômeno bioelétrico durante o estado de repouso do músculo avaliado bem como a comparação com sua atividade durante a contração muscular. O objetivo deste estudo foi avaliar a efetividade do uso de ES em pacientes diagnosticados com disfunção temporomandibular segundo os critérios *Research Diagnostic Criteria for Temporomandibular Disorders* (RDC/TMD) eixo I.

**CONTEÚDO:** A revisão de literatura foi realizada a partir das bases de dados LILACS, Medline e Scielo, cobrindo o período de janeiro de 1987 a fevereiro de 2012. Ensaio clínicos randomizados e controlados, ensaios clínicos e testes clínicos que avaliaram ES, sinais e sintomas de distúrbios temporomandibulares (DTM) diagnosticados pelo critério RDC/TMD foram incluídos. A estratégia de busca resultou em 182 artigos, dos quais oito preencheram os critérios de inclusão, sendo que um caracterizava um estudo clínico randomizado e sete eram estudos longitudinais sem critérios de randomização. Em todos os estudos, o método utilizado para detectar e analisar a atividade elétrica dos músculos da mastigação (corpo do masseter e feixe anterior do temporal) foi a ES, sendo empregada com certa facilidade e seguindo os padrões para o exame. No entanto, foram utilizados diferentes modelos experimentais e seleção das amostras, causando dificuldades na comparação dos resultados.

**CONCLUSÃO:** Dentro das limitações deste estudo, foi possível constatar que embora a ES em DTM não deva ser utilizada para diagnóstico, ela pode auxiliar no acompanhamento da evolução dos tratamentos de DTM.

**Descritores:** Disfunção temporomandibular, Eletromiografia, Eletromiografia de superfície, Masseter, Músculos da mastigação, *Research Diagnostic Criteria*, Temporal.

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## INTRODUCTION

Temporomandibular disorder (TMD) is a generic term used for a set of musculoskeletal disorders which may affect the masticatory system<sup>1</sup>. The prevalence of TMD signs and symptoms in general population is considered high<sup>2</sup>. Females are more affected by the disease in 5:1 ratio, and between 20 and 50 years of age<sup>2,3</sup>. Current understanding points to TMDs as clinical conditions with multifactorial etiology because one or more factors may contribute for its triggering or perpetuation. Among these factors there are anatomic changes, macrotrauma, microtrauma, occlusal unbalances, parafunctional habits and systemic conditions, such as emotional stress<sup>1,3</sup>.

Surface electromyography (SE) provides the non-invasive evaluation of the bioelectric phenomenon with the evaluated muscle at rest, and then compares it to its activity during muscle contraction. This procedure is carried out with electrodes placed on patients' skin, in general bilaterally. Its relatively technical simplicity allows its use in Dentistry and in clinical research<sup>4</sup>.

TMDs investigation and evaluation should include behavioral, emotional and psycho-social factors, in addition to normally observed physical changes<sup>5</sup>. The idea of putting together these data to get a standardization of the diagnosis, aiming at further reliability and reproducibility was developed by Dworkin and LeResche<sup>6</sup> by means of a set of diagnostic criteria to investigate TMD. This set was called Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD), translated (history, evaluation questionnaire and clinical evaluation form) and culturally adapted to the Portuguese language (history and evaluation questionnaire) by Pereira et al.<sup>7</sup> and Kominsky et al.<sup>8</sup>, respectively.

This study aimed at evaluating, through systematic literature review, the effectiveness of SE for patients with temporomandibular disorders according RDC/TMD axis I criteria<sup>6</sup>.

## METHOD

The strategy was based on the computerized query of the literature applying keywords to Medline, LILACS and Scielo databases, covering the period from January 1987 to February 2012. Keywords used for the query were crossed in different combinations and were: "surface electromyography", "electromyography", "temporomandibular disorder", "emg", "tmd" and "RDC". Relevant articles were also reviewed with regard clinical SE efficacy as from sensitivity and specificity. Selected articles were submitted to evaluation by two reviewers, respecting inclusion criteria to determine final articles sample, according to their titles and abstracts. Inclusion criteria were:

- Studies with humans were masseter muscle and anterior temporal muscle bundle were evaluated by surface electromyography (SE);

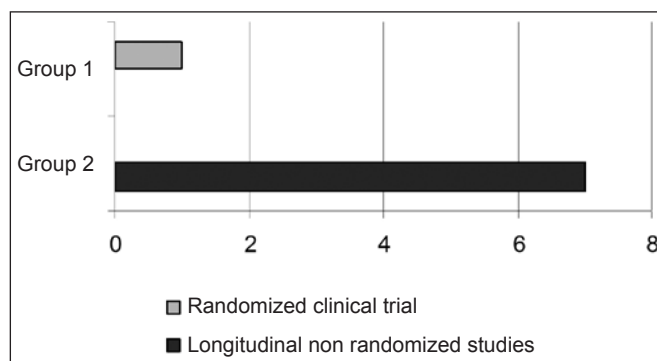
- Randomized clinical trials, controlled clinical trials and longitudinal prospective non randomized studies;
- Studies using the RDC/TMD questionnaire as diagnostic criteria;
- Studies in English, Portuguese, Italian, German and Spanish, published within the determined period. So, case reports, case reports follow-up and literature reviews, simple opinions and authors' opinions were excluded.

## RESULTS

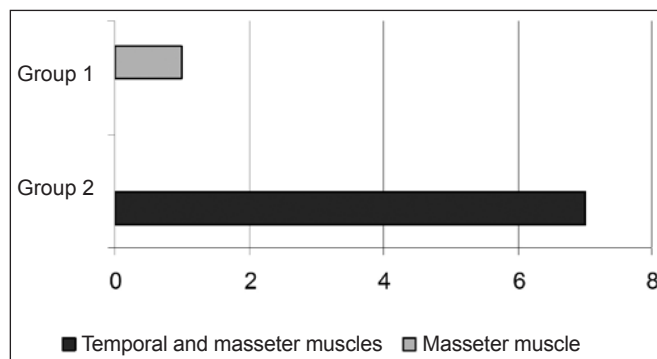
Query strategy has resulted in 182 articles. After applying inclusion/exclusion criteria, eight articles were qualified for final analysis, being the Kappa agreement index between reviewers equal to 1.00. From these studies, one was a randomized clinical trial and seven were longitudinal trials without randomization criteria (Graph 1).

Among selected studies, only one has not analyzed, in combination, muscle electric activity of masseter and temporal muscles. The remaining seven selected studies have evaluated the anterior temporal muscle bundle and the body of the masseter muscle (Graph 2).

Table 1 shows selected studies according to established methodological criteria.



Graph 1 – Studies design.



Graph 2 – Muscle evaluation by electromyography.

Table 1 – Studies based on the evaluation by electromyographic analysis of the activity of masticatory muscles.

Authors	Year	Design	n	TMD	Psychogenic	Control	Evaluated Muscles	Effectiveness of EMG
Tartaglia et al. <sup>12</sup>	2008	L	103	86	17	-	t, m	+
Rodrigues-Bigaton et al. <sup>23</sup>	2010	L	50	31	-	19	t, m	-
Venezian et al. <sup>24</sup>	2010	RCT	48	48	-	-	t, m	+
Botelho et al. <sup>25</sup>	2010	L	30	15	-	15	t, m	+
Tartaglia et al. <sup>26</sup>	2011	L	50	30	-	20	t, m	+
Manfredini et al. <sup>27</sup>	2011	L	72	36	-	36	t, m	-
de Felício et al. <sup>28</sup>	2012	L	60	42	-	18	t, m	+
Ivkovic et al. <sup>29</sup>	2008	L	68	30	-	38	m	+

EMG = electromyography; TMD = temporomandibular disorder; L = longitudinal; RCT = randomized clinical trial; t = temporal muscle; m = masseter muscle.

## DISCUSSION

In the search for auxiliary methods to provide better understanding of mechanisms involved with TMD, and to establish a more objective patients' evaluation, the authors decided for the electric evaluation of muscle electric activity, using surface electromyography, aiming at creating reference models and at comparing an asymptomatic healthy function with those situations of system disharmony or dysfunction<sup>9</sup>. SE is an additional evaluation method which allows the observation and quantification of muscle balance, through the electric activity, both in pairs of muscles and between muscles on both sides of the body<sup>10,11</sup>.

It is known that the primary parameter to identify TMD patients with regard to pain is its ratio with regard to decreased muscle strength, which may be observed by electromyographic activity, especially during tooth clenching activity<sup>12</sup>. Such findings are in line with the pain adaptation model and its further integration, since pain leads to individual muscle activity changes aiming at limiting movements and at protecting the system against new injuries, by decreasing agonist muscles activity<sup>13,14</sup>.

The literature suggests that SE to diagnose TMD has a much lower accuracy than was proposed by the manufacturers of such devices<sup>15,16</sup>. In addition, recent systematic literature reviews argue that selected studies corresponded to low relevance and low impact trials, in addition to having conflicting final results, possibly due to the summation of many variables such as: inadequate sample and control group selection, insufficient clinical conditions and incorrect use of equipment<sup>17,18</sup>. However, if due precautions are taken and a strict and standardized protocol is used, electromyography may be considered an efficient method to analyze the stomatognathic system, with good reproducibility and additional reference value only during clinical evaluation<sup>11,12,19-22</sup>.

The use of RDC/TMD diagnostic criteria is a major factor for standardization and comparison of studies<sup>6</sup>. Our study has found eight articles meeting such criteria. None of them were double-blind. All studies used SE to detect and analyze the electric activity of masticatory muscles (body of masseter and anterior temporal muscle bundle), being relatively easy to use and following the standards of the test. However, different experimental models and sample selections were used, making difficult the comparison of results.

According to some authors, SE evaluation of masticatory muscles allows the objective separation of different TMD subgroups diagnosed according to RDC/TMD criteria. Significant differences are always observed in electromyographic activities and symmetry of activities at rest and during tooth clenching, between TMD and healthy patients<sup>12,18,19,23-28</sup>.

The analysis of muscle electromyographic activity has also been used to evaluate TMD treatment efficacy by conventional methods associated or not to support therapies<sup>9,24,25,29</sup>. Low-intensity laser is an example of support therapy for TMD, which may also be relieved with electromyography. Although not promoting changes in electromyographic activity of evaluated muscles, this therapy has decreased observed painful symptoms<sup>24</sup>.

Still in line with data found in selected studies, it should be taken into consideration that dentists should not use electromyography or similar tools to diagnose patients who may have masticatory muscles myofascial pain. In addition, such devices should not be used in situations where the aim is an isolated evaluation, or as a complement for decision making and clinical approaches, since such tools do not meet the reliability and validity standards needed for such use<sup>27</sup>. However, it is observed that surface electromyographic evaluation may supply useful information for TMD diagnosis and for the therapeutic planning of the clinical case<sup>28</sup>.

It is observed that SE is, in principle, an adequate tool to evaluate neuromuscular function in Dentistry; if used according to specific recommendations and together with patients' history and accurate clinical and physical evaluation, EMG readings may supply objective information which may be well documented, in addition to valid and reproducible data about the functional condition of masticatory muscles of a given patient. Such data may also be compared to a healthy situation and may help the follow up of the treatment through patient's biofeedback<sup>9</sup>.

So, the primary parameter to identify patients with TMD-related pain is decreased muscle action, especially during tooth clenching<sup>12</sup>. The literature reports studies which are in line with the pain adaptation model and its further integration, since pain leads to changes in muscle activity aiming at limiting movement and at protecting the system against new injuries by decreasing agonist muscles activity<sup>13,14</sup>. This way, when a sensory stimulation is received, reflex protection mechanisms are activated, triggering a modulation of muscle

activity in the stimulated area which, associated to specific emotional situations, generates further muscle tension and, if associated to parafunctions such as tooth clenching and bruxism, lead to further muscle activity increase, which generates more pain and, consequently, more tension, and so on<sup>30</sup>.

## CONCLUSION

Considering technological advances in the areas of equipment and techniques, as well as in research resources and research projects about the critical evaluation of the use of SE in cases of temporomandibular disorder, one may conclude, within the limitations of this study, that:

1. SE may be indicated for the follow-up of the effectiveness of a support therapy used for a certain clinical situation;
2. Its effectiveness could have some value as additional research tool to study muscle TMD features;
3. It is a procedure which should not be used as the single diagnostic tool, since it has low specificity and sensitivity;
4. The clinical use of this method to diagnose temporomandibular disorders is uncertain and is currently not recommended.

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