

SURFACE ELECTROMYOGRAPHY OF THE MASSETER MUSCLE DURING CHEWING: A SYSTEMATIC REVIEW

Eletromiografia de superfície do músculo masseter durante a mastigação: uma revisão sistemática

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ABSTRACT

The chewing, a complex action controlled by the central nervous system, is one of the most important functions of the Stomatognathic System. During this action, the electrical activity of the masticatory muscles may be quantified using a surface electromyography. In order to systematically review the literature, on the methods and foods used in EMGS masseter muscle during mastication, we carried out a search in the databases SciELO, Brazil, Lilacs and Medline / Pubmed, from September to October 2009. We included population-based studies and excluded review studies without clear methodological definition and studies with children, adolescents and elderly. About 657 articles were found at the intersection of the following descriptors and their corresponding in English: chewing *and* masseter *and* electromyography, which 12 of them selected. It was found that the methods involved in the execution of surface electromyography of the masseter muscle during mastication, vary according to each author, and there is no standard for a specific food in order to perform the examination.

KEYWORDS: Masseter Muscle; Electromyography; Mastication

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■ INTRODUCTION

Chewing is one of the most important functions of the Stomatognathic System and is therefore studied by several authors. This physiological act, whose purpose is to break the food into smaller particles, preparing them for swallowing and digestion it is a learning function, different from breathing, sucking and swallowing, which are innate and initially controlled reflexively. The learning process of this function is started from the moment that the first primary teeth emerge, the lower incisors and superiores¹.

The chewing function depends on an integrated complex of muscles, ligaments, bone and teeth structures, controlled by the central nervous system. The muscles involved in chewing carry out movements and postures that approaching, or away from the teeth, or exacerbate the interocclusal pressure².

The lower jaw develops range of motion (lifting, lowering, protrusion, retraction, lateralization), influenced by muscles responsible for chewing. The jaw elevation is performed by the masseter muscle, anterior temporal muscle and pterygoid medial muscle³.

The masseter muscle have muscle fibers when suffer contraction, projecting the jaw projecting upward promoting contact between the dental arches. The chewing efficiency is guaranteed by the force exerted on the contraction of this muscle⁴.

At the end of the XVIII century Luigi Galvani, an electrical engineer, spoke that a skeletal muscle when electrically stimulated suffer contraction, and on the other hand, produces electric current when contracted voluntarily, French dystrophy in the middle of last century was the first to apply electricity in skeletal muscles intact. However the credit for developing the technique that promotes the uptake of electrical potentials generated in the muscle, the electromyography, corresponds to the English physiologists and North American Adrian and Bronk and D. Denny-Brown⁵.

The Surface Electromyography (EMGS) is intended for study of bioelectric phenomena that occur in skeletal muscle fibers during rest, stress and maximum contraction⁶. Electrodes are placed under the skin overlying the muscle to be evaluated, which capture the sum of the electrical activity of all actived muscle fibers. It is characterized by being a noninvasive and easy to perform. The electromyography registration allows you to observe electrophysiological behavior of several muscles in different physiological conditions. The EMGS has been widely used by physicians, speech therapists, physiotherapists and professionals in Physical Education for the study of human motion⁷.

In speech therapist clinical is common the assessment of muscle activity through physical examination by means of observations, filming and/or palpation. This methodology is required in orofacial rehabilitation process, but these data are not concise, not susceptible to quantification, because they may be influenced by the subjectivity of the professional, limiting an accurate recording.

With technological development, the use of measuring instruments with high precision is increasingly common in clinical practice, among which stands out electromyography as a method available in the market for over 40 years and have greater accuracy and objectivity to register the electrical activity of a muscle or a group of muscle⁸ may help in diagnosis and therapy of motor orofacial disorders⁹.

The methods applied in the execution of the electromyographic examination may vary from examiner to examiner. So, this study aimed to review the methods in the literature and food used in EMGS of masseter muscle during mastication.

■ METHOD

We performed an electronic search in the databases SciELO-Brazil, Lilacs and Medline/Pubmed from September to October 2009.

The research was conducted by two authors/evaluators that discussed about the intersection of the following descriptors and their counterparts in English and portuguese, and chewing and electromyography and masseter muscle, all included in the Medical Subject Headings (MeSH). Another strategy used was a manual search of reference lists of identified articles and selected. The discrepancies presented by the authors were informed by a third author/reviewer. The research did not have language restrictions. It was not considered a limit to the time of publication, and being the selected articles for inclusion and exclusion criteria.

We excluded review articles and longitudinal design, animal studies, works whose study population were composed of subjects with diseases, research using invasive electromyography, articles involving other assessment tools, studies that simulate non-physiological or pathological conditions; articles that do not evaluate the function of mastication; articles studying the efficacy of drugs; articles studying physiological effects of therapeutic maneuvers or therapies; articles with the population consisting of children, teen agers or the elderly.

As inclusion criteria, the articles that studied the electrical activity of the masseter muscle during chewing of food in young adults were selected. The methodological quality of all studies was evaluated independently by three reviewers and agreement of this analysis resulted in the elaboration of Table 1.

It was found a total of 657 articles at the intersection of chewing and electromyography and masseter muscle descriptors in the SciELO-Brazil, Lilacs and Medline/Pubmed databases.

Following the inclusion and exclusion criteria defined in the method and subtracted from those contained repeated references in more than one database, we selected a total of 12 articles.

The articles were organized as the author, place and year of publication, population studied, methods used in the electromyographic evaluation of the masseter muscle and results findings.

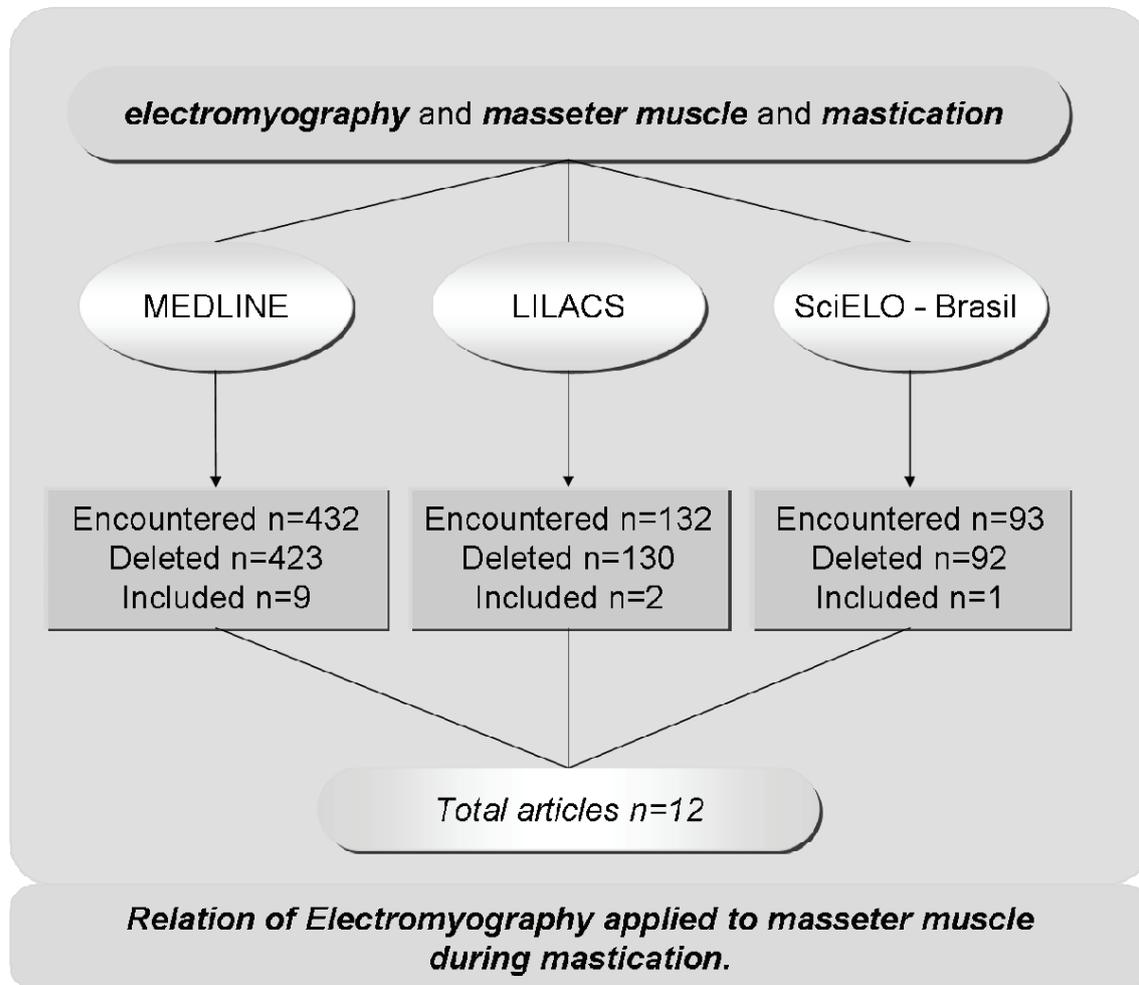


Figure 1 – Number of articles found and selected after exclusion and inclusion criteria according descriptors and database

■ LITERATURE REVIEW

The statistical treatment was not applied to this study due to the heterogeneity found in the selected articles.

The quantitative or references found and selected in the databases for this study shows that 75% of them were contained in Medline/Pubmed, 16.7% in LILACS and 8.3% in Scielo-Brazil.

The publication dates ranged between 1989 and 2009; two publications occurred in 1999; between the years 1992-1996 were not found publications who met the inclusion criteria proposed in this research as well as in the years 2007, 2005, 2001 and 1990. This statement leads to the inference that in the period of 1997 to 2004 there was an increase in publications dealing with the theme of this study. This may be related to the emergence of new equipment that enable the realization of easier electromyography.

During the articles selection through the inclusion and exclusion criteria, it was observed that most of the publications discarded used chewing non-food substances to test masticatory function and more frequent study population consisted of children, elderly or those with diseases or disorders pre-existing groups. These facts can be related to the scientific need to better characterize human development as well as changes inherent to certain diseases. The research of the characteristics of normality for certain functions are still largely unexplored.

With respect to the people who composed the selected studies, there was disparity in the number of individuals. The samples ranged between 10 and 50 subjects studied^{10,11} being the average number of individuals equal to 24 per research. The criterion for evaluating the electrical characteristics of a muscle must consider certain peculiarities that vary between individuals. For this reason, comparisons of muscle patterns when coupled with findings in

Table 1 – Studies that analysed the electrical activity of masseter muscle during chewing published between 1989 to 2009, identified by author, publication year, sample, method of electromyography and results

Author / Year	Place	Sample	EMG used method	Results
Kimoto K, <i>et al</i> , 2000 ¹⁰	Aarhus-Dinamarca	50 adults volunteers	Masseter muscle EMG at work and balance sides during chewing.	Electrical activity at work side was major than balance side.
Diaz-Tay J <i>et al</i> , 1991 ¹¹	USA	10 health volunteers	Masseter muscle EMG during tost peanut chewing.	Masseter muscle activity vary according to the food volume.
Mioche L, P Bourdiol, Monier S, 2003 ¹²	Oxford-England	25 young adults	Masseter muscle EMG during meat chewing: hard; soft and succulent. The volunteers chewing the meat and after 7s or when cake were ok to deglutition they spitted the cake.	The mean of muscle activity was major during chewing hard meat. When the cake were ok to deglutition, more saline were added to the hard meat than the soft meat.
Peyron MA, Lassauzay C, A Woda, 2002 ¹³	Massachusetts-USA	15 volunteers young adults from male gender	Masseter muscle EMG during chewing of 4 different level of gelatine hard.	A gradative increase at masseter muscle electrical activity were observed as well as the hard level of food increased.
Shiau YY, Peng CC, Hsu CW, 1999 ¹⁴	Aarhus-Dinamarca	12 volunteers from male gender	Masseter muscle EMG during chewing test with various hard food level.	The increased of electrical activity is associated by the food hard level.
Horio T, Kawamura Y, 1989 ¹⁵	Aarhus-Dinamarca	29 normals young volunteers	Masseter muscle EMG during chewing from 5 different food.	The chewing of hard food results in an increased electrical activity, as well as, there are an increase on the time of chewing and at the number of msaticatory strokes.
Acosta-Ortiz R, <i>et al</i> 2004 ¹⁷	Aarhus-Dinamarca	22 volunteers, 12 women and 10 men with age mean of 29.3 years	Masseters muscles EMG during different jaw and chewing activities, classified as high and low signal EMG.	Direct porposional relation between percentage values found at masseter muscle electrical activity during volunteer jaw and masticatory.
Mioche L, P Bourdiol, Martin JF, Noël Y, 1999 ¹⁸	England	36 young adults	Masseters muscles EMG during chewing of 5 different food texts.	There was na increased at electrical activity as well as the food text increase the hard.
Wilding RJ, Shaikh M, 1997 ¹⁹	USA	24 assintomatic adults	Masseters muscles EMG during the first 15 masticatory strokes.	Tremours jaw during mouth open and close during masticatory were predictors to masticatory perform.
Rahal A, Goffi-Gomez MVS, 2009 ²⁰	São Paulo-Brazil	30 health individuals with 21 to 30 years old	Masseters muscle EMG during approachin teeth intercuspitation and habitual chewing of grape pass. Mean of 3 approaching teeth and 15seconds of habitual chewing.	Express in microvolts (μ V). Mean difference between right and left masseter, during maximum intercuspitation, was 20.0 μ V. During the habitual chewing, was at 10.3 μ V with a confiance interval of (95%) between 6,7 and 13,8 μ V. Significant statistical difference between right and left masseter muscle, at approaching teeth and habitual chewing.
Oncins MC, Freire RMAC, Marchesan IQ, 2006 ²¹		26 health individuals	Masticatory muscles EMG during rest and masticatory cycles.	The masseter at the same side of masticatory preference, presents major values of electrical activity.
Falda V, Guimarães A, Bérzin F, 1998 ²²	São Paulo-Brazil	19 normocclusais patients	Masseters muscles EMG during deglutition and unilateral mastication left and right in 2 steps: the first without occlusal interference and the second with this occlusal interference present.	The deglutition with occlusal interference had a significant increased of muscle activity and this duration when compared to the chewing at the same situation.

the same individual at different times and activities can better express the reality of electric power muscle. It is believed that this fact has influenced the limited number of members among the samples referenced, since the comparisons are not made between individuals but between pairs of muscles in each subject.

It was also observed a preference for studies with individuals of male gender¹¹⁻¹⁵ in 42% of the studies, while populations consist of both genders were elected by 58% of the authors. No article investigated the events in isolation of their goals in a women group. The fact that they study more the male population may be related to the amount of variables that affect the hormonal in women¹⁶ also being extensively explored in the literature that female muscular activity levels are lower when compared to male⁴.

The location of publication, it was found that 50% of articles were published in periodics European^{10,12,14,15,17,18}. Other publications occurred in American journals (USA – 50%, Brazil – 50%)^{11,13,19,20}. Of the 12 selected articles, 9 were published in international journals, this fact leads us to think that there is a preference for international publications, possibly because there are more such journals that address more specific subjects of this study, as well as achieve more readers.

By analyzing the methods used for electromyographic evaluation, we noted that all references made to capture the electrical signal of the right and left masseter muscle simultaneously. Not reached a consensus of the best food for the study of mastication. Peanut¹¹, meat¹², gelatine¹³, and grape²⁰ were elected for four articles for the evaluation of mastication, other studies have manipulated various food consistencies in their tests^{10,14,15,17-19,21,22}. The isolated study of chewing was reported in 58% of references^{11,12,14,15}.

The mastication associated with chewing jaw movements observation was isolated object of study in 25% of articles^{17,19,20}. The lack of standardization of the food being used in research with electromyography difficult the reproducibility of the methods referenced. Perhaps because it is a food consistency property is not controlled by undergoing numerous variations (temperature, viscosity, etc.), the mentioned studies have sought to categorize the foods according to a "hardness scale"^{10,14,15,17-19,21,22}, when tested more than one food type, or uniformed a consistency to a isolated study^{11,12,13,20}.

Concerning the time of acquisition of muscle electrical potentials during chewing, there was variation according to each researcher. In a guided experiment¹⁴ researchers instructed the evaluated subjects chewing a soft meat and then lasts a hard

meat for a sustained period of 7s (each consistency) or until the cake is ready to be swallowed. Other researchers^{9,19,20} electromyographic analysis of the stipulated 15 chewing strokes, as well as the electrical events observed during 15 seconds of the masseter chewing raisins. Other authors evaluated the chewing in free time^{11-15,17}. This variation of the execution time of electromyographic acquisitions contribute to the prevention of comparison between studies. Diversity in times of chewing analyzed may not accurately represent the actual demand of electrical activity, so it is believed that the studies involving analysis of all masticatory process present results closer to the actual demand of muscle electrical activity.

As the main results in the references arranged, all works reported that there are higher levels of electrical activity of masseter muscle during chewing hard food, therefore, the higher the level of hardness greater food massettes the electrical activity of the masticatory process. The chewing time and number of chewing strokes was increased when the hardness level of food increased from^{11-13,15,20}. They also found that a muscle is usually found with greater electrical activity when compared to its partner^{10,11,20}, this implies that there is no balance of electrical activity between the right and left masseter muscles during mastication, so, it is often have a predominant chewing side.

An article²⁰ analyzed the electrical activity of masseter muscle expressed in microvolts. This type of analysis does not show normalization of the electromyographic signal, since not get a standard that can confirm the estimated demand of electrical activity in a given activity²³. This fact decreases the reliability of the results and do not allow to estimate potential differences in the execution of different tasks.

■ CONCLUSION

The results from this study show that:

1. The methods involved in the execution of surface electromyography of the masseter muscle during mastication, presents vary according to each author, there is no standard for a specific method for carrying out the examination;
2. There is no consensus on the best food to be used for chewing during electromyographic evaluation of masseter muscle.

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RESUMO

A mastigação, ato complexo controlado pelo sistema nervoso central, é uma das funções mais importantes do Sistema Estomatognático. Durante esse ato a atividade elétrica da musculatura mastigatória pode ser quantificada por meio da eletromiografia de superfície. Com o objetivo de revisar sistematicamente na literatura os métodos e alimentos mais utilizados na EMGS do músculo masseter durante a mastigação, foi realizada uma busca nas bases de dados SciELO–Brasil, Lilacs e Medline/Pubmed no período de setembro a outubro de 2009. Foram incluídos os estudos de base populacional e excluídos os estudos de revisão sem definição metodológica delineada e estudos realizados com crianças, adolescentes e idosos. Foram encontrados 657 artigos no cruzamento dos seguintes descritores e seus correspondentes em inglês: *mastigação and eletromiografia and músculo masseter*, dos quais 12 deles foram selecionados. Verificou-se que os métodos envolvidos na execução da eletromiografia de superfície do músculo masseter, durante a mastigação, apresentam variações de acordo com cada autor, não havendo padronização de um alimento específico para execução do exame.

DESCRIPTORIOS: Músculo Masseter; Eletromiografia; Mastigação

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