

ELECTROMYOGRAPHY OF THE MASTICATORY MUSCLES: ANALYSIS IN THE ORIGINAL AND RMS VALUE

Eletrmiografia dos músculos mastigatórios: análise em valor original e RMS

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ABSTRACT

Purpose: to compare the electrical activity of masseter and temporal muscles, (anterior fascicle) at rest, in maximum voluntary isometric contraction and chewing, taking the original value analysis (μv) and Root Mean Square (RMS). **Methods:** observational and descriptive study. Surface Electromyography was held in the masseter and temporal muscles (anterior portion) bilaterally, in 18 women between 27 and 50 years of age. The assessment was carried out in three situations: at rest, in maximum voluntary isometric contraction and habitual chewing dried vine fruit without seeds, as food. The electromyography used was the BIOPAK, Bioresearch Associates, four-channel, model 800 and bipolar surface electrodes (Bio Trodoon gel). The signal records were obtained in microvolts, and analyzed and compared in the original signal and RMS root mean square. **Results:** when we compare the electrical activity of masseters and temporal muscles (anterior fascicle), there is no statistically significant differences between the original and RMS values at rest. Both in maximum voluntary isometric contraction and habitual chewing, we find statistically significant higher values to RMS. There was a predominance of electrical activity in muscles masseters when compared to the temporal muscle, anterior fascicle, both chewing and in maximum voluntary isometric contraction. **Conclusion:** there is a minimum of electrical activity at rest. Both the tooth clenching and mastication of dried vine fruit we find RMS average values greater than original mean values. There has been greater electrical activity of muscles masseters when compared to the temporal muscle, both in maximum voluntary isometric contraction as chewing.

KEYWORDS: Electromyography; Mastication; Rest; Masticatory Muscles; Isometric Contraction

■ INTRODUCTION

Surface electromyography (SEMG) is the test that is used to register the electrical potential of skeletal muscles. Muscle movement is produced by an electric discharge that generates muscle fiber shortening. This capture of this signal may be non-invasive, using surface electromyography,

or invasive, in other words, intra-muscular. The non-invasive method has allowed health professionals to have a greater interest in using this resource as a complementary tool for diagnosis, especially dentists, physical therapists and speech-language pathologists, since it is easy to conduct.

The analysis of the EMG trace enables the identification of muscle behaviors in different situations, such as during rest, mastication, swallowing and during maximum voluntary isometric contraction, among others. Data analysis is conducted through the study of the relationship between the frequency and intensity of the registered electric activity, and may thus determine muscle behavior¹.

The capture of the electric signal is obtained in microvolts(μv), and may follow variations of the mathematical process of the signal, such as: values of minimum or maximum amplitude; integrated

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Conflict of interest: non-existent

value; linear envelope; spectral or signal frequency variables. One formula that is frequently used in electrical signal analysis is the use of the *root mean square (RMS)*, obtained by calculating the root of the mean of the squares. Another is the capture of the *original value* that refers to the mean that is calculated by the software or through a mathematical formula. Specialized literature is very controversial in regards to the use of the original value or other mathematical calculations to quantify the electromyographic signal. Authors²⁻⁴ tend to analyze their results according to their original values, in microvolts (μV). Other authors⁵⁻⁹ have been conducting studies and analyzing their results using *root mean square (RMS)*.

Thus, the purpose of this study was to compare the electrical activity of mastication muscles, masseter and temporal (anterior fascicle) during rest, maximum voluntary isometric contraction and during mastication, in original values and in *root mean square (RMS)*, in μV , in healthy women.

METHODS

This is a cross-sectional, observational study. The data were collected at the Center for Diagnosis and Treatment of the TMJ, in the city and state of São Paulo, and was approved by the Research Ethics Committee of the Federal University of São Paulo UNIFESP/EPM under number CEP 1944/11. Procedures occurred after each participant signed a free consent term. The sample was composed by 18 women, with ages varying in between 27 and 50 years, with a mean of 34 years, with no complaints of Temporomandibular Joint Dysfunction (TMJD). The participants were submitted to a brief interview in order to obtain personal identification and dentition status data.

Inclusion Criteria

- Being female
- Having 14 to 16 dental elements in both the superior and inferior arches
- Having a healthy stomatognathic system.

Exclusion Criteria

- Presence of fixed or removable dental prosthesis, implants and/or absence of dental element.
- Women with syndromes and craniofacial malformations.
- Presence of Temporomandibular Joint dysfunction.
- Presence of habits (nail biting; teeth clenching or bruxism).
- Use of bite splints.

- Pain, discomfort or tension in the temporomandibular area.
- Presence of arthritis; rheumatism; osteoporosis; oral breathing; sinus infection; hoarseness; vertigo; ear infections and tinnitus.
- Dental occlusion disorder.
- Having undergone Speech-Language Therapy.

Procedure

EMG Assessment

All volunteers were placed sitting down on a chair with their feet on the ground, superior and inferior members relaxed and uncrossed, head without rest and oriented with the Frankfurt plane parallel to the ground, open eyes and hands placed on the thighs, in order to maximize signal capture and minimize the interference of noise during examination.

Alcohol 70° INPM, sterile gauze and disposable surgical gloves were used to clean the surface of facial skin. The surface double electrodes that were used were disposable, round with bipolar sensors, of the HAL brand. The metallic material of the conductive area composed of silver-silver chlorine (Ag-AgCL) provided low contact impedance and had a stable behavior in time and the chemical reactions in the surface of the skin.

Electrode placement followed the longitudinal direction of muscle fibers in order to avoid possible muscle interferences. The electrodes were placed on the thickest part of the masseters and anterior portion of the temporal muscles, on both sides, after palpation during dental clenching.

The device used for examination was the BIOPAK System, Bioresearch Associates, BioPAK board; 04 channel amplifier model 800; surface bipolar electrodes (Bio Trodo no gel); special chords to connect the electrodes to the amplifier; software (Bio PAK for Windows).

The procedures were conducted by two examiners, one Speech-Language Pathologist and one Laboratory Technician from the Center for Diagnosis and Treatment of the TMJ. The recording of the electromyographic signal was carried out in a room for this purpose, with temperature (20°C) and lighting (dim light) control.

Obtaining the EMG registers

The capture of the electrical signals was recorded in microvolts (μV), of the masseter muscles and the anterior fascicles of the temporal muscles, and occurred during the following situations:

- **Rest:** conducted with the participant sitting down with relaxed lips in rest position, remaining so for 10 seconds for register.
- **Dental clenching:** each participant was instructed to clench her teeth with maximum

possible strength called maximum voluntary isometric contraction (MVIC) for two seconds, for each contraction visible in the computer monitor. This procedure was repeated three times, separated by two-second intervals. The analysis was conducted using the mean of the three dynamics contractions¹⁰.

- **Habitual mastication:** each participant was asked to chew three seedless raisins, for 10 seconds, in their habitual manner.

It is Worth noting that in this study we will adopt the term original value to represent the real values obtained in μV and RMS for the values obtained with the square root, that are also measured in μV .

Statistical Analysis

The results were analyzed using the SPSS (Statistical Package for Social Sciences) software,

in its 20.0 version and the Wilcoxon Signed Ranks Test was conducted in order to verify possible differences between the original electromyographic values and RMS values in the situations of rest, maximum voluntary isometric contraction and habitual mastication.

The level of significance adopted in these analyses was 5%.

The statistically significant results will be marked with an asterisk (*).

RESULTS

During rest the original and RMS values were similar. In the analysis of the electrical activity, there was greater activity of the temporal muscles (left and right), when analyzing both the original value and the RMS (Table 1).

Table 1 –Confrontation of the mean values for the left and right masseter and temporal muscles, with original and RMS values, during rest

Muscle		REST			
		Temporal		Masseter	
μV		R	L	R	L
Original		1.86	1.97	1.35	1.24
RMS		1.86	1.97	1.35	1.24

Wilcoxon Test *p value < 0.001.

Key: RMS= *root mean square*; μV = microvolts; temporal = anterior fascicle of the temporal muscle; R= right side; L= left side.

In the maximum voluntary isometric contraction the means in RMS were significantly greater when compared to the means in original values. The values of the masseters were significantly greater

when compared to the left and right temporal muscles (anterior fascicle), both in original values and in RMS (Table 2).

Table 2 –Confrontation of the mean values for the left and right masseter and temporal muscles with the original and RMS values, during maximum voluntary isometric contraction

Muscle		CLENCHING			
		Temporal		Masseter	
μV		R	L	R	L
original		99.72	115.57	156.44	156.94
RMS		100.31*	116.38*	157.65*	158.23*

Wilcoxon Test *p value < 0.001.

Key: RMS= *root mean square*; μV = microvolts; temporal = anterior fascicle of the temporal muscle; R= right side; L= left side.

During mastication, the mean RMS values were significantly greater when compared to the mean original values, both in the temporal and masseter muscles, independently of side, right or left. The

values for the masseter muscles were greater in relation to those of the temporal muscles (anterior fascicle), in the right and left sides, for both original values and RMS (Table 3).

Table 3 – Confrontation of the mean values of the left and right temporal and masseter muscles with the original and RMS values during mastication

Muscle μV	MASTICATION			
	Temporal		Masseter	
	R	L	R	L
Original	74.66	71.01	104.01	90.41
RMS	105.50*	100.43*	148.10*	129.96*

Wilcoxon Test *p value < 0.001.

Key: RMS= *root mean square*; μV = microvolts; temporal = anterior fascicle of the temporal muscle; R= right side; L= left side.

■ DISCUSSION

The findings of this study were confronted with those in the specialized literature, with the purpose of comparing the electrical activity of the masseter and temporal (anterior fascicle) muscles during rest, maximum voluntary isometric contraction and mastication, in the original value (μV) and in *Root Mean Square* (RMS). The sample was composed by 18 healthy women in between 27 and 50 years of age, in order to eliminate interferences of mandible bone growth and of altered functions, since the knowledge about the facial muscles of normal individuals is crucial to the field of Speech-Language Pathology. Among the many variables that comprise the stomatognathic system, such as anatomy, physiology, histology, among others, there is the electrical activity of muscles that will provide us with information about muscle behavior in different situations¹¹.

This analysis is of great importance to the field of Speech-Language Pathology in order to better understand what the normal electrical activity of the facial muscles is, as this will provide a correct diagnosis and therapy procedures to be conducted in clinical practice. Researchers are also concerned in analyzing healthy individuals so that the physiology of orofacial muscles can be better understood^{12,13}.

When conducting sample examinations, the period of examination (morning) was taken into account, since there is a variation in muscle tone throughout the day, a factor that can influence the electric activity of muscles¹¹. Another research¹⁴ studied surface EMG comparing temporal (anterior fascicles) and masseter muscles of healthy individuals and, after repeating the same test, of teeth clenching and mastication, three times in the

same day, has verified that there was a statistically significant difference in the results of electrical activities in different times of day.

Table 1 shows that the means of the original and RMS values of the anterior fascicles of the temporal muscles and of the masseter muscles are similar during rest. This fact is expected since the means were both obtained during rest, or, without muscle movement which involves minimal electric activity in levels considered normal, according to the specialized literature¹⁵. We believe that this factor may be explained by the muscle tone maintenance factor existent in the muscle itself¹⁶, where the state of habitual rest presents a state of constant contraction¹¹.

The findings are in agreement with those described by other authors^{2,4,13,17,18} who state that there is a minimum electrical activity during rest in the muscles associated with mastication. However, the findings of the present study disagree with those found by some authors^{8,9,19} that show that muscles in rest position do not manifest electrical activity and, therefore, there is no motor unit of contraction. Furthermore, studies show that when analyzing electromyographic activity in both branches of the digastric muscle in certain mandibular movements of healthy individuals, have also found silence in the electromyographic signal, not only during rest, but also during head rotation and teeth clenching²⁰.

In the present study, there was electrical activity of the anterior fascicle of the right and left temporal muscles during rest, with greater activity when compared to the left and right masseter muscles, independently of the analysis having been performed in original value or RMS. These values were statistically significant and are in agreement with those described by some authors^{2,4,13,17}. It is

believed that this fact occurs because the temporal muscle (anterior fascicle) is not considered a muscle of force, but a muscle that determines the postural tone of the mandible, the mandible's stabilizer in rest position, as referred by¹¹.

During maximum voluntary isometric contraction (Table 2) it was verified that the mean values in RMS were significantly greater in the left and right temporal muscles (anterior fascicle) and in the left and right masseters. There were no studies found in literature that have conducted this same analysis. It is believed that the fact that the masseter is a force muscle justifies a greater electrical activity in the situation of maximum voluntary isometric contraction. The findings agree with the one described by authors²who, in their studies, have described the original values. Other authors¹⁷ have used the RMS value, and have observed that the left and right masseter muscle also has a greater action potential when compared to the temporal muscle (anterior fascicle) in this same situation.

During raisin mastication (Table 3) it was seen that the mean values in RMS were significantly greater when compared to the mean of the original value, both in the temporal and masseter muscles, independently of the side, left or right. In the comparison of the temporal muscles (anterior fascicles) and the masseters, the latter presented

higher values. There were no studies found in literature that have performed an analysis such as this. Based on the knowledge of the biomechanics of mastication, the masseter muscle is related to strength, which confirms the finding of a greater electrical activity of this muscle when compared to the anterior fascicle of the temporal muscle during mastication²¹. Some authors have used the original values and agree with a greater electrical activity of the masseter muscle²⁻⁴. Other researchers have used the RMS value and have found similar results¹²⁻¹⁷. Based on literature findings, individuals with Class I malocclusion had masseter muscles with higher action potential when compared to the temporal muscle. This fact occurs because the temporal muscle positions the mandible and is not a strength muscle⁹.

■ CONCLUSION

There is minimum electrical activity during rest. Greater mean RMS values were found in both teeth clenching and mastication when compared to mean original values. There was greater electrical activity in the masseter muscles when compared to the temporal muscles, both in maximum clenching and in mastication, in both values (original and RMS).

RESUMO

Objetivo: comparar a atividade elétrica dos músculos masseter e temporal, porção anterior, no repouso, contração isométrica voluntária máxima e na mastigação em análise valor original (μV) e em *Root Mean Square* (RMS). **Métodos:** estudo observacional, descritivo. Foi realizado eletromiografia de superfície nos músculos masseter e temporal, porção anterior, bilateralmente, em 18 mulheres entre 27 e 50 anos de idade. O exame foi realizado em três situações: durante o repouso, na contração isométrica voluntária máxima e mastigação habitual, com uva passa sem semente como alimento. O eletromiógrafo utilizado foi o BIOPAK, da Bioresearch Associates, de quatro canais, modelo 800 e eletrodos bipolares de superfície (Bio Trodo no gel). Os registros do sinal foram obtidos em microvolts, e analisados e comparados em sinal original e em *root mean square*- RMS. **Resultados:** ao comparar a atividade elétrica dos músculos masseteres e temporais, porção anterior, não foi encontrado diferenças estatisticamente significantes entre os valores originais e RMS durante o repouso. Tanto na contração isométrica voluntária máxima quanto na mastigação habitual, foi encontrado valores maiores de maneira estatisticamente significativa para RMS. Houve predomínio de atividade elétrica nos músculos masseteres quando comparado ao músculo temporal, porção anterior, tanto na mastigação quanto na contração isométrica voluntária máxima. **Conclusão:** existe um mínimo de atividade elétrica no repouso. Tanto no apertamento dentário quanto na mastigação de uva passa foi encontrado valores médios de RMS maiores que valores médios originais. Houve maior atividade elétrica dos músculos masseteres quando comparado ao músculo temporal, tanto na contração isométrica voluntária máxima quanto na mastigação.

DESCRITORES: Eletromiografia; Mastigação; Descanso; Músculos Mastigatórios; Contração Isométrica

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