

Electromyographic Evaluation of Mandibular Biomechanic

Evaluación Electromiográfica de la Biomecánica Mandibular

*Maria Julia P. Coelho-Ferraz; **Fausto Bérzin; ***Cesar Amorim & ****Dagmar de Paula Queluz

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SUMMARY: The study of the craniomandibular biomechanics is related to the system of predominant lever and of the relation between function and mechanically induced deformations. This study has the purpose of evaluating the chewing muscular dynamics in the surface electromyography Seventeen people of both sex, medium aged about 25, were selected, white skin and presenting Class I of Angle without apparent sign and symptom. The electromyographic data were obtained bilaterally from the masseter muscles, anterior temporal portion at the rest position and isometric position. Medtrace® passive bipolar surface electrodes were used coppled to a pre-amplifier, forming a circuit corresponding to a differential circuit. The registrations of the electric signals were caught by EMG- 800C equipment of Brazil EMG System Ltda with eighth channels, sample frequency of 2 KH and 16 bits resolution, digital filter with a band pass of 20-500 Hz. A comparison was through “t” Student or a Man- Whitney test according to the normality or not of the distribution, respectively. The results have shown important differences between the tasks but without sexual dimorphism. All these results indicate to the electrical activity of the temporal muscle in its anterior portion was bigger than the masseter muscle in rest position and the masseter muscle presented a higher potential of action than the anterior temporal muscle in isometric.

KEY WORDS: Mandibular biomechanical; Electromyography.

INTRODUCTION

The knowledge on the anatomical and physiologic aspects of the dynamics of the masticatory muscles is important for the understanding of the effects of the mandibular biomechanics on the growth and development of the craniofacial complex, serving as base for the therapeutic planning and understanding of the variations of the development and their relationships with the results reached by the Jaw Functional of Maxillary and Orthodontic treatment, as well as similar disciplines, such as Phonoaudiology and Physiotherapy (Ferraz *et al.*, 2007).

Observing the evolutionary process, Creanor & Noble (2000) mentioned that have been formulated affirmatives that the locomotion and the feeding are the two factors primarily responsible for the adaptors modifications in the morphology of the mammals.

In this aspect, the teething is put as an important element for obtaining of the appropriate nutrition for the

survival. Like this, the modification of the masticatory apparel happened in each case, the measure that each group of animals obtained a larger benefit of the available alimentary source gradually for him.

In what it refers to diagnosis tools to evaluate the mandibular kinesiology, the surface of electromyography (EMGS) that studies the kinesiology of the muscular groups, it represents a useful diagnosis technique for dentists, physiotherapists, phonoaudiologists therapeutic occupation, neurologists, otorhinolaryngologists, orthopedic specialists and of professionals of other areas that need objective parameters for clinical evaluation of the muscular activity, as well as to evaluate the therapeutic results. The electromyography (EMG) also investigates general muscular alterations, it determines the beginning of muscular activation and it evaluates the coordination or unbalance of the different muscles involved in the kinesiology of the muscles. In studies involving patient with temporo-

* Researcher of Department of Social Dentistry of Piracicaba Dental School, Brazil.

** Professor and Department Chair, Department of Morphology of Piracicaba Dental School, Piracicaba, São Paulo, Brazil.

*** Engineering, S. J. Campos, São Paulo, Professor, Department of Social Dentistry of Piracicaba Dental School, Piracicaba, São Paulo, Brazil.

**** Professor of Department of Social Dentistry of Piracicaba Dental School, Piracicaba, São Paulo, Brazil.

mandibular dysfunction (TMD), the electromyography is used with surface electrodes to determine the electric activity of the position of mandibular rest and the hyper or hypoactivity of such muscles, as well as to examine the balance of the muscles during the mastication, bruxism and parafunctional activity (Portney, 1993; Pedroni *et al.*, 2004; Bérzin, 2004; Moyers, 1949; Möller, 1969; Lund & Widemer, 1989).

Vitti & Basmajian (1977) studied the integrated action of the muscles of the mastication in 29 individuals with normal occlusion. They verified that the temporal muscle is active during the centric closing of the jaw, movement to the ipsilateral side, incisal mastication, mastication in molar, normal mastication and during the occlusion centric forced.

In the masseter muscle, activity was observed during the closing of the jaw, in the movement to the contralateral side, in the mandibular protrusion with or without contact occlusal, in the saliva and water deglutition, in the normal mastication, molar right or left and incisive and during the forced centric occlusion.

According to the authors, the participation activates of both muscles in the forced occlusion characterized a protecting function of the disk to articulate and too much woven of temporomandibular articulation (TMA) during the maximum closing.

Bérzin concluded that in individuals with normal occlusion, the sign electromyographic generated varies 2 milivolts on average. And during the mastication or clenching, in considered individuals normal, the temporal muscles present a smaller electric potential than the one of the masseter (muscles of force of the mastication).

Bomjardim *et al.* (2005) and Lemos *et al.* (2006) moderated that the masticatory performance can be dependent of the force of maximum bite, however another varied related to the masticatory efficiency and to the force generated in the mastication should be taken in consideration.

Many physiologic factors as the size, the composition and the mechanical advantage of the muscles of elevator mandibular, the sensibility of the teeth, muscles and temporomandibular articulation can influence the maximum force of bite.

Considering the importance of the study of the craniomandibular biomechanics, it was evaluated the dynamics masticatory muscular printed in the electromyography surface.

MATERIAL AND METHOD

The materials for the research were used in accordance to the standards of the Health Ministry under the resolution number 196/96 of National Health Council and the study was approved by the Ethics Committee in Human Research of the Piracicaba Dental School, UNICAMP/Brazil.

For this study were chosen seventeen people of both genders with an average age of 25, selected of a total of approximately 250 volunteers linked to the Piracicaba Dental School (UNICAMP). Some previous authorization in written was asked to the volunteers evaluated by anamnesis and clinical deontological exam. Facts related to symptomatology, para-functional habits, general health and psychological and emotional factors were taken into consideration in the research. As far as symptomatology, the research was about the presence of pain in the right or/and left TMA, as well as the presence of noises or clicks, along with limitation in TMA during the masticatory movements, based on Wijer (1998). When the frequency or persistency of these factors is observed, the person was excluded.

The electromyography data were obtained, bilaterally, of the masseter muscles, anterior portion of temporal in rest position and maximum bite. Were utilized surface passive electrodes for kids of Ag/AgCl, circular format, dischargeable of Meditrace® Kendall-LTP, model Chicopee MA01, attached to a pre amplifier with gain of 20 times forming a differential circuit. The records of the electric signals were captured by the equipment EMG-800C of EMG System of Brazil Ltda of eight channels, frequency of 2KHz and 16 bits of resolution, digital filter with pass band of 20 to 500Hz.

The data were submitted to statistical analysis by the program SPSS 11.0.4 to Mac OsX (Chicago, IL, EUA). Establishing the comparison through the test "t" of Student or test of Mann-Whitney according to the distribution being normal or not, respectively.

RESULTS

The test t for independent samples was used to know if there is difference of the variable studied that presented normal distribution (parametric) among the individuals of female and male gender. The average differences were not significant with level of significance established in 5 % (Table I).

Table I. Mean value and standard deviation(SD) of the electromyography variables and t Student between the male and female people.

Variables	Gender	Mean	SD	p-valor*
RMS masseter in maximum bite	male	20,13	4,84	0,06
	female	16,44	4,94	
RMS temporal in maximum bite	male	110,95	60,41	0,27
	female	105,13	30,21	
	female	63,88	4,05	

* p<0,05

Table II. Mean Rank and Mann-Whitney test between the male and female gender.

Variables	Gender	Mean Rank	p-valor*
RMS masseter rest	male	15,10	0,38
	female	18,50	
RMS temporal rest	male	17,75	0,93
	female	17,40	

* p<0,05

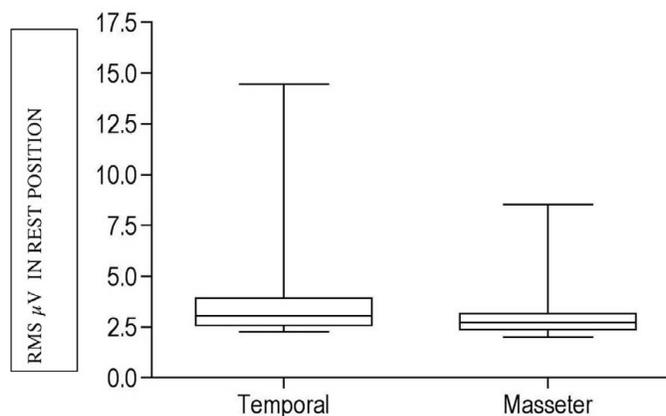


Fig. 1. Electrical activity of the elevator muscles of jaw in the rest position.

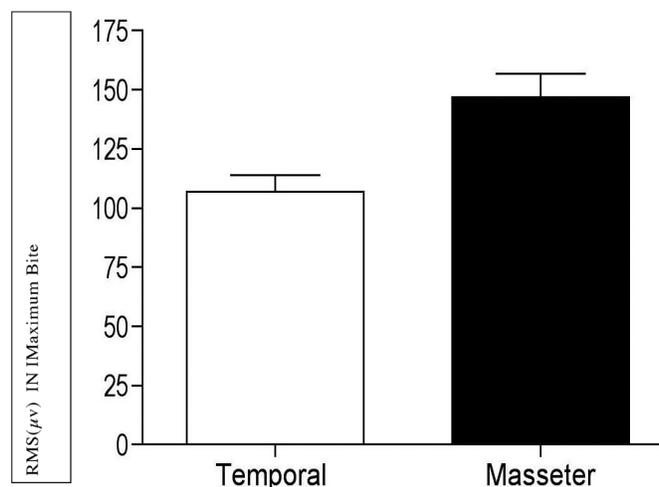


Fig. 2. Electrical activity of the elevator masticatory muscles in isometric.

The test of Mann-Whitney was used to compare, among the individuals of male and female gender, the average of those variables which presented non-parametric distribution with level of significance established of 5% (Table II).

To verify the behavior of the muscular dynamics in this sample the test of Mann-Whitney it was used to know, in the rest position, the activity of the masseter and temporal (anterior part) muscles were different. The test showed that, in this condition, that is, in the rest position (Fig.1), the RMS of the temporal (anterior part) muscle is larger than the RMS of the masseter muscle ($t = 2.05$ $P=0.02$).

The test t for independent samples was used to know, in the isometric (clenching bilateral), the activity of the masseter and temporal (anterior part) muscles were different. The test showed that, in this condition, that is, in the isometric (Fig. 2), the RMS of the masseter muscle is larger than the one of the temporal (anterior part) muscle ($t=3.32$ $p=0.001$).

DISCUSSION

Camani Altube (1952), Hylander (1975, 1977, 1985), Devlin & Watell (1986), Okeson, 2000; Herring & Liu (2001); Meyer *et al.* (2002); Christensen & Mohamed (1996), they related the mandibular biomechanics with the study of the levers with fulcrum in ATM.

The option in this study was to evaluate the mandible biomechanics based on the study of the levers in individuals of both genders, with complete permanent dentition, with no orthodontics or jaw functional orthopedic for the last ten years, with the aim of minimize possible interferences of functional adaptation in the mandible dynamics.

There was no sexual dimorphism to some electromyography measures related to the masticatory dynamic.

The surface electromyography represents a tool for diagnosis in the study of the neuromuscular functions of the craniofacial system (Portney; Pedroni *et al.*; Bérzin; Moyers; Möller; Lund & Widemer). Nevertheless, to obtain an electromyography record according to the requirements of SENIAN (European Recommendations for Surface Electromyography) and ISEK (International Society of Electromyographic and Kinesiology), it was adopted the electromyographic taking protocol utilized in the Laboratory of Electromyography of the Department of Morphology of Piracicaba Dental School of Unicamp.

To justify the need or not of normalization of the sign eletromiográfico, it was fallen back upon the definition that it is an attempt to reduce the differences among the registrations of a same subject, or of different subjects, turning the interpretation of the reproduced data.

Portney, Knutson *et al.* (1994), De Luca (1997) defended the importance of the normalization. However, the own De Luca affirmed that the normalization supplies data similar to the different individuals, tending to suppress them differentiates of the associated data among the studied groups.

For the present study, in the processing of the collected sign, she chose, then, for the determination of RMS, whose analysis form presents advantages, because it expresses in a quantitative way the muscular electric activity (Basmajian & De Luca, 1985), for contemplating the physiologic alterations of the EMG signal, reflecting the width, the number, the shot frequency and the form of the potentials of action of the units motive active.

The behavior of the dynamics masticatory muscular in this sample, for the rest postural, the electric activity of the temporal (anterior part) muscle was larger than the masseter muscle ($t = 2.05$ $p=0.02$) and in the isometric, the masseter muscle presented a larger action potential than the temporal (anterior part) muscle ($t=3.32$ $p=0.001$). These discoveries are concordant with Throckmorton & Dean (1994), Naeije *et al.* (1989), Ferrario *et al.* (1993) and Wöelfel *et al.* (1960).

Bérzin where the muscle temporary previous portion is one more positioners the jaw with smaller electric potential than the masseter muscles that they are muscles of force.

Knowledge on the biomechanics of the masticatory muscles aid vastly in the development of strategies in the Jaw Functional of Maxillary, Orthodontic, implantology, prosthesis as well as in Phonoaudiology and Physiotherapy.

The bioengineer concepts and the systems of forces that unite the stomatognatci structures can be influenced by genetic and acquired factors, being important to facilitate our understanding regarding the tecidual answer front to the higidez condition or in the dysfunction.

In conclusion considering the characteristics of the sample utilized, the methodology used and complete analysis of the presented data, it was possible to conclude that the behavior of the muscular masticator dynamics, in this study, reveals that the electrical activity of the temporal muscle in its anterior portion was bigger than the masseter muscle in rest position and the masseter muscle presented a higher potential of action than the anterior temporal muscle in maximum bite.

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RESUMEN: El estudio de la biomecánica craneomandibular se relaciona con el sistema de palanca predominante y la relación entre la función y deformaciones mecánicamente inducidas. Este estudio tuvo el propósito de evaluar la dinámica muscular de la masticación en la superficie electromiográfica en 17 personas de ambos sexos, con edad media de 25 años, de piel blanca y que presentaban clase I de Angle, sin aparentes signos y síntomas. Los datos electromiográficos fueron obtenidos bilateralmente desde los músculos maseteros, la porción anterior del músculo temporal en posición de descanso y en posición isométrica. Electrodo bipolares de superficie pasiva Medtrace ® fueron utilizados acoplados a un pre-amplificador, formando un circuito que corresponde a un circuito diferencial. Los registros de las señales eléctricas fueron capturados por el equipo EMG- 800C de Brazil EMG System Ltda. con 8 canales, frecuencia de muestreo de 2 KH y 16 bits de resolución, un filtro digital con una banda de paso de 20-500 Hz. La comparación fue hecha mediante “t” Student o la prueba Man-Whitney de acuerdo con la normalidad o no, de la distribución, respectivamente. Los resultados mostraron importantes diferencias entre las tareas realizadas, pero sin dimorfismo sexual. Todos estos resultados muestran a la actividad eléctrica del músculo temporal en su porción anterior, mayor que el músculo masetero en posición de reposo, y que el músculo masetero presenta un mayor potencial de acción que la parte anterior del músculo temporal en posición isométrica.

PALABRAS CLAVE: Biomecánica mandibular; Electromiografía.

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Correspondence to:
Dr. Maria Julia P. Coelho-Ferraz,
Department of Social Dentistry
Piracicaba Dental School.
148 Al João Senra
CEP: 1348-1299
Colinas de São João
BRAZIL

Email: mjcoelhoFerraz@hotmail.com

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