



Revista CEFAC

ISSN: 1516-1846

revistacefac@cefac.br

Instituto Cefac

Brasil

Favero, Talita Cristina; Toniolo da Silva, Ana Maria; Bonfanti Haeffner, Leris; Ruviano
Busanello-Stella, Angela; Correa, Eliane

MASTICATORY MUSCLE ELECTRICAL ACTIVITY PATTERN IN OBESE AND
EUTROPHIC CHILDREN

Revista CEFAC, vol. 17, núm. 5, septiembre-octubre, 2015, pp. 1509-1519

Instituto Cefac
São Paulo, Brasil

Available in: <http://www.redalyc.org/articulo.oa?id=169342586016>

- How to cite
- Complete issue
- More information about this article
- Journal's homepage in redalyc.org

redalyc.org

Scientific Information System

Network of Scientific Journals from Latin America, the Caribbean, Spain and Portugal

Non-profit academic project, developed under the open access initiative

MASTICATORY MUSCLE ELECTRICAL ACTIVITY PATTERN IN OBESE AND EUTROPHIC CHILDREN

Padrão de atividade elétrica dos músculos mastigatórios em crianças obesas e eutróficas

Talita Cristina Favero⁽¹⁾; Ana Maria Toniolo da Silva⁽²⁾, Leris Bonfanti Haeffner⁽³⁾,
Angela Ruviaro Busanello-Stella⁽⁴⁾, Eliane Correa⁽⁵⁾

ABSTRACT

Purpose: to compare the masticatory muscle electrical activity pattern of obese and eutrophic children during muscle on-off timing using surface electromyography. **Methods:** a total of 32 children from 6 to 12 years of age were divided into two equal groups - 16 obese and 16 eutrophic children - and assessed. The variables studied included the electromyography activity of the muscles of mastication (anterior temporalis, masseter and orbicularis oris) during rest, maximum voluntary contraction, mastication (regular and directed), and swallowing. For statistical analysis, the median, and the first and third quartiles were found and the Wilcoxon test was used, considering significance level of $p < 0.05$. **Results:** obese children showed similarities in muscle activation compared with eutrophic children during maximum voluntary contraction and rest. However, for dynamic activities - regular and directed mastication and swallowing - obese children had lower muscle activation medians than eutrophic children in most proposed situations, both in the activation period (on) and in the inactivation period (off), with significant statistical difference ($p < .05$). **Conclusion:** obese children, probably due to excessive facial adiposity, present changes in the conditioning of the masticatory muscles, which are reflected in the performance of the stomatognathic system.

KEYWORDS: Nutritional Status; Child; Stomatognathic System; Electromyography; Mastication; Deglutition

■ INTRODUCTION

Obesity is a chronic, complex disease of multifactorial etiology that determines several complications in childhood and adulthood¹. The increasing number of obese people in the world indicates a strong environmental contribution to genetic

program. Changes in lifestyle and eating habits, increased inactivity and consumption of high energy density foods can explain this scenario².

Obesity, among nutritional disorders, generates the greatest amount of musculoskeletal problems. Critical periods of progressive obesity onset occur on the first 12 months of life, in kindergarten and during puberty. Progressive obesity is associated with hyperplastic obesity, making it difficult to control body weight in adulthood. This implies the importance of further studies on the obese population with excessive weight gain and its contribution to changes in the performance of the stomatognathic system (SS)³.

Changes in the morphology, tone, and posture of the structures of SS, which may occur due to excess weight, directly interfere with its functioning. The imbalance of the stomatognathic system can affect the postural system as a whole, just as postural

⁽¹⁾ Universidade Federal de Santa Maria (UFSM), Santa Maria, RS, Brasil.

⁽²⁾ Departamento de Fonoaudiologia - Universidade Federal de Santa Maria (UFSM), Santa Maria, RS, Brasil.

⁽³⁾ Departamento de Pediatria - Universidade Federal de Santa Maria (UFSM), Santa Maria, RS, Brasil.

⁽⁴⁾ Departamento de Fonoaudiologia - Universidade Federal de Santa Catarina (UFSC), Florianópolis, SC, Brasil.

⁽⁵⁾ Departamento de Fisioterapia - Universidade Federal de Santa Maria (UFSM), Santa Maria, RS, Brasil.

Conflict of interest: non-existent

changes may negatively impact the stomatognathic system^{4,5}.

Excess weight in young populations and its implications on the SS has been rarely addressed in Phonoaudiology⁶. It is well known that muscle dysfunction may act on the facial and postural growth and development of the individual. Thus, stomatognathic system components can sometimes act as agents of structural changes, and sometimes be the targets of such changes⁷.

With the purpose of assisting on the evaluation and diagnosis of these patients, electromyography (EMG) comes as a possibility to objectively analyze muscle electrical activity and, it has also been studied in Phonoaudiology in recent years. The use of a device that captures and expands muscle action potential is useful for patient diagnosis, since it reflects their neuromuscular system condition^{8,9}.

Portney (1993)¹⁰ states that as an assessment procedure, clinical EMG involves the finding and recording of muscle fiber electrical potential, providing important data for patient diagnosis and determining rehabilitation goals for patients with muscle disorders, such temporomandibular dysfunctions. Based on that, and because there are only few researches on this matter, the aim of this study was to compare the masticatory muscle electrical activity pattern of obese and eutrophic children during muscle on-off timing using surface electromyography (EMG).

■ METHODS

This research project has been previously submitted to evaluation and was approved by the Ethics Committee of the institution of origin under protocol number 01120243000-10.

This was a cross-sectional, analytical observational and quantitative field study developed at the Orofacial Motricity Lab of the Phonoaudiological Assistance Service from UFSM from May 2012 to March 2013.

The procedures for children screening in this study were: anamnesis, ENT and dental evaluation, and surface EMG assessment. A total of 230 1st to 6th graders from a public middle school located in Santa Maria - RS, Brazil, were submitted to the initial screening process. Of these, 32 completed all phases of research evaluation, 20 female and 12 male.

Parents and / or guardians of children were informed about the purpose and methodology of the study and asked to sign a Free, Prior and Informed Consent (FPIC), in accordance with Resolution 196/1996 of the Brazilian Health Council.

The following were used as inclusion criteria: both genders, aged from 6 to 12 years, and having a parent or guardian sign the FPIC. Individuals were excluded if they presented signs of neurological impairment, absence of third molar tooth (for occlusal stability), changes in dental anatomy due to restorations or trauma, and if they had a history of orthodontic treatment, orofacial motricity phonoaudiological therapy, facial or bariatric surgery, and craniofacial malformations.

The anamnesis was conducted individually with caregivers who agreed to participate in the study, to gather data on children profile, complaints, family history, medical complications, motor development and difficulties, health and respiratory issues, sleeping and treatments; eating facts from breastfeeding to current habits, as well as chewing, swallowing, oral habits, and information on communication, speech, hearing, voice and education.

Children weight, height and nutritional status were measured throughout the stages of evaluation, by using a 100g precision G-Tech® digital scale, and a measuring tape fixed on wall with no footer, to then determine their BMI. Anthropometric variables were transformed into z-scores, in accordance with the growth curves of the World Health Organization¹¹. Children whose BMI z-score was ≥ -2 were considered eutrophic, and $< +1$ and $+2 \geq$ were considered obese.

ENT examination was intended to evaluate and diagnose children respiratory pattern and its probable etiology. Children underwent clinical examination, as well as cephalometry, when further investigation was required to classify respiratory behavior (nose-breather, habitual mouth-breather or obstructive mouth-breather). Tonsils were classified according to the degree of obstruction on the level of the oropharynx. Tonsil obstruction of up to 25 % of the oropharynx was rated as Grade I; 25-50 % obstruction as Grade II; 50-75 % obstruction as Grade III; and greater than 75 % as Grade VI¹². The same criteria used to assess the degree of obstruction produced by tonsillar hypertrophy were used to evaluate obstruction caused by increased adenoid tissue.

The dental evaluation aimed to observe the type of dentition and occlusion of children through clinical examination. The type of molar ratio was considered for occlusion, in accordance with the classification of Angle (1899)¹³, as well as transverse relationship. The following was also observed: midline, configuration of the hard palate, presence of overjet, overbite, and teeth conservation, in order to meet the study criteria for inclusion or exclusion⁸.

All children underwent electromyographic evaluation of the right anterior temporalis (RT), left anterior

temporalis (LT), right masseter (RM), left masseter (LM), upper orbicularis (UO), and lower orbicularis (LO), through tests that could show their behaviors.

Electromyography was preceded by skin impedancimetry. This procedure was conducted to ensure greater safety in the collection and greater reliability of the electromyography results, since there could be interference in the passage of electric current due to facial adiposity. SK-100 ICEL-KAISE was used to determine impedance. When impedance averaged less than or equal to 10 (+ / -1.8) Ω , the electromyographic examination was then performed ¹⁴.

The assessment of muscle activity was performed through bilateral electromyographic recordings of the masseter and temporal muscles in the conditions of rest, maximum voluntary contraction, habitual mastication, directed mastication, and swallowing. For the orbicular muscles, the same tests were performed, except for directed mastication, once it did not apply to this muscle group. The proposed tests strictly followed an electromyographic miofunctional evaluation protocol developed for the purposes of this research and based on the literature ^{15; 8; 16}.

Children were comfortably seated in a chair when evaluated. Their trunk was straight upward, the soles of their feet rested against the floor (or on a wooden box, if too little to reach the floor) and head positioned according to the Frankfurt horizontal plane, parallel to the ground. The posture of the children was monitored throughout the evaluation.

For each of the tests, three collections were performed. Before acquiring the EMG recordings, children were previously trained to ensure the consistency of results. All movements were monitored by the researcher and, if any inappropriate movement was noted, the collection was stopped and started over. To avoid possible muscle fatigue, children were instructed to remain at rest for a period of 2 minutes between records.

The following are tests conducted in the electromyographic evaluation:

Rest - In this test, the child was instructed to remain seated in the usual position of rest, with lips and jaw relaxed and upright torso. This position lasted 20 seconds in the electromyographic recording ¹⁴. We applied the following verbal command: "... relax, look forward and stay in this position ...".

Maximum voluntary contraction (MVC) - a Parafilm® (Parafilm M Laboratory Film) measuring 3 cm long, 1cm wide and folded into five equal parts^{17;18;19} was positioned bilaterally on the occlusal surfaces of posterior teeth, and children were told to bilaterally and simultaneously contract their masticatory muscles, with maximal intercuspation, biting with maximum force, and remaining so for 5 seconds.

We used the following verbal command: "... press it, press it, press it...". For the orbicularis muscle group, in the second phase of the evaluation, children were asked to pressed one lip against the other, also for a period of 5 seconds, while the evaluator used the same verbal command.

Habitual mastication - To perform this test, children were instructed to chew the usual way a piece of French bread (2 x 2cm) and tell the examiner with a hand signal (positive) whenever they swallowed it ⁹. For this test, we used the following verbal command: "eat this bread the same way you usually do at home."

Directed mastication - Children were initially told to chew a Trident gum (produced by Warner-Lambert e Com. Ltda - Adams Division) for an average of 20 seconds to obtain a uniform consistency before records. This gum was chosen because it is easily handled, also for being popular, and for being well accepted among children and widely used in related research. Next, for the electromyographic collections, children were requested to determine their favorite chewing side and after that, they were asked to use that side only for chewing up to 20 seconds ¹⁴.

Swallowing liquid - In this test, children were asked to suck 10ml of water (measured with a syringe) from the glass through a straw and hold it in their mouths, with sealed teeth and lips until they received an order to swallow. Five sips were registered for each of the three collections.

In the EMG signal collection, double electrodes containing gel were used, as well as disposable silver circular adhesive - silver chloride (Ag / AgCl), with a diameter of 10 mm (Hal Indústria e Comércio Ltda.) with a 20mm distance between electrodes center to center. For skin oil removal, before attaching the electrodes, 70% alcohol was used to facilitate both the fixation of the electrode and the transmission of electrical activity ²⁰. To examine the masseter muscle, electrodes were placed bilaterally between the lower border of the zygomatic arch and the angle of the jaw ²¹; and to examine the temporal muscle they were placed on its anterior part, perpendicular to the zygomatic arch above and behind the frontal process of the zygomatic arch ²².

To examine the orbicularis muscle, an electrode was positioned on the upper lip, just above its edge, perpendicular to the filter, and another on the lower lip, just below its edge. For the three muscles, electrode positioning followed the longitudinal direction of its fibers. A ground electrode was also fixed on the glabellar region, to avoid interference of electromagnetic currents ¹⁶.

The equipment used for the electromyographic tests were the Electromyograph Miotool produced

by Miotec Equipamentos Biomédicos Ltda. and belonging to the Laboratory of Orofacial Motricity from the Department of Phonoaudiology/UFSM.

To capture the electromyographic signal, an acquisition system with 4 channels was used. For data acquisition, the Miograph® software was used, they were scanned by an A / D (analog - digital) conversion board with 14 bit resolution and signals with sampling frequency of 2000 samples / second / channel, bandpass cut filter from 20-500 Hz, with an amplification gain of 1000 times and common rejection mode of 110 dB, installed on a Itautec SA laptop with an Intel Pentium processor and Windows 7 Pro. Equipment calibration followed standard specifications by manufacturers.

It should be noted that the computer was using its own battery, there was no connection to the power grid, and the floor was covered with Paviflex. During data collection, the researcher and the patient remained in the location; all electronic devices that could possibly generate an electromagnetic field, as well as light sources, were turned off.

The clipping of the rest and MVC test records was made considering 5 sequential seconds of the best collection (best electromyographic signal, lower occurrence of electrical interference or variation based on FFT (Fast Fourier Transform) curve analysis). As for the dynamic activities (habitual and directed mastication, and swallowing) the clipping of three sequential cycles of the best collection was made.

Muscle activation values obtained in samples were quantified in root mean square (RMS) and expressed in microvolts (μV). The rectification of data was made, in order to counter the negative phases (full- wave) or transforming negative values of raw signal (half- wave). To select the values corresponding to periods of muscle activation and inactivation, the total activation mean of each period was used, plus three standard deviations. The value obtained from the application of this formula was considered the muscle activation mean, such

that values higher than this mean were classified as activation period (on) and the values below as inactivation period (off)²³.

Subsequently, values were normalized by simple rule of three and the results were expressed in percentage. For MVC and rest testing 100 % was considered peak muscle activation during MVC. For other tests (dynamic activities) values were normalized based on the mean muscle activation during MVC^{24; 25}.

Data were placed on tables using Microsoft Excel 2007 and then statistically analyzed using Stata version 10.0. The Shapiro- Wilk test was used to verify the normality of the variables. Median, first and third quartiles were calculated by Wilcoxon test to detect differences between groups. For all tests, a significance level of 5 % ($p < 0,05$) was adopted.

■ RESULTS

A total of 32 children were included in the study, 20 female and 12 male, aged between 6 and 12 years. Regarding nutritional status, 16 were classified as eutrophic and 16 as obese, with a statistically significant difference between groups ($p < 0.001$). Of all children, 50 % were classified as mouth-breathers, and the remaining as nose-breathers, with no statistical difference between groups ($p = 0.480$).

Table 1 presents the temporal muscle electrical activity medians for MVC and rest situations, and activation period (on) for situations of habitual and directed mastication, and swallowing in relation to nutritional status. It was observed that obese and eutrophic children had similar percentages of activation when muscles were at rest. Statistically significant difference was noted between groups ($p = 0.046$) for the left temporal muscle during MVC. For the other situations, obese subjects showed lower activation percentage than the control group, with statistically significant difference ($p < 0.022$) between groups during directed mastication activity for the left temporal muscle.

Table 1 – Temporal muscle electrical activity medians for maximum voluntary contraction and rest situations and activation (on) period of dynamic activities in relation to nutritional status, with normalized and percentage measured data.

Variables	Nutritional Status		p
	Eutrophic Children md (1 ^o /3 ^o q)	Obese Children md (1 ^o /3 ^o q)	
Rest			
Right Temporalis	1.3 (1.0-1.5)	1.4 (1.2-2.2)	0.235
Left Temporalis	1.2 (1.0-2.2)	1.8 (1.3-3.1)	0.077
Maximum Voluntary Contraction			
Right Temporalis	48.6 (42.1-53.01)	52.0 (47.5-55.7)	0.146
Left Temporalis	46.6 (43.5-49.30)	51.6 (45.7-55.2)	0.046
Habitual Mastication			
Right Temporalis	313.7 (240.3-399.5)	237.8 (171.9-189.6)	0.055
Left Temporalis	269.2 (213.6-334.8)	223.1 (196.5-298.5)	0.258
Directed Mastication			
Right Temporalis	215.05 (167.1-283.4)	198.7 (136.7-115.5)	0.152
Left Temporalis	221.61 (163.8-361.8)	140.4 (78.2-190.8)	0.022
Swallowing			
Right Temporalis	45.50 (17.97-68.91)	16.6 (11.3-32.6)	0.214
Left Temporalis	16.37 (9.48-63.08)	19.9 (12.7-29.1)	0.851

Md (1st - 3rdQ)= median (first and third quartiles); **Wilcoxon Test*.

Table 2 presents the temporal muscle electrical activity medians in relation to nutritional status in situations tested during muscle inactivation (off). Similar percentage of muscle activity was found between groups for all situations tested, with no statistically significant difference.

Table 3 presents the masseter muscle electrical activity medians for MVC and rest situations, and

activation period (on) for the dynamic situations in relation to nutritional status. It was observed that, just as the temporal muscle, muscle activation percentages during situations of rest and MVC were similar between groups. In other activities, the eutrophic children showed higher muscle activation, with statistical difference ($p < 0.013$) for the right masseter muscle during habitual mastication .

Table 2 – Temporal muscle electrical activity medians in relation to nutritional status in situations tested during the period of muscle inactivation (off), with normalized and percentage measured data.

Variables	Nutritional Status		p*
	Eutrophic Children md (1 ^o /3 ^o q)	Obese Children md (1 ^o /3 ^o q)	
Habitual Mastication			
Right Temporalis	32.2 (23.9-40.5)	25.3 (15.9-31.6)	0.055
Left Temporalis	30.5 (22.3-38.6)	25.0 (16.4-28.4)	0.070
Directed Mastication			
Right Temporalis	17.6 (12.2-22.8)	14.5 (8.7-17.2)	0.214
Left Temporalis	15.6 (10.8-28.6)	10.8 (6.2-17.6)	0.070
Swallowing			
Right Temporalis	3.9 (1.7-7.2)	2.6 (1.7-6.0)	0.547
Left Temporalis	2.4 (1.7-5.2)	2.9 (1.7-4.3)	0.955

Md (1st - 3rdQ)= median (first and third quartiles); **Wilcoxon Test*.

Table 3 – Masseter muscle electrical activity medians for maximum voluntary contraction and rest situations and activation (on) period of dynamic activities in relation to nutritional status, with normalized and percentage measured data.

Variables	Nutritional Status		p*
	Eutrophic Children md (1 ^o /3 ^o q)	Obese Children md (1 ^o /3 ^o q)	
Rest			
Right Masseter	1.1 (0.8-1.5)	1.5 (2.0-1.1)	0.181
Left Masseter	1.3 (0.9-1.6)	1.4 (1.1-1.9)	0.258
Maximum Voluntary Contraction			
Right Masseter	46.8 (36.6-53.3)	47.8 (42.7-50.6)	0.792
Left Masseter	47.3 (45.2-50.3)	48.9 (44.7-52.6)	0.510
Habitual Mastication			
Right Masseter	378.9 (272.1-495.6)	211.5 (152.5-267.9)	0.013
Left Masseter	269.6 (170.9-405.2)	224.6 (173.0-274.1)	0.291
Directed Mastication			
Right Masseter	236.4 (168.9-318.8)	155.7 (103.3-228.9)	0.097
Left Masseter	169.7 (93.3/398.3)	134.6 (51.1-177.8)	0.228
Swallowing			
Right Masseter	22.7 (3.5-55.3)	22.3 (14.9-31.9)	0.547
Left Masseter	22.4 (13.3-56.3)	21.7 (16.7-38.9)	0.851

Md (1st - 3rdQ)= median (first and third quartiles); **Wilcoxon Test*.

Table 4 presents the masseter muscle electrical activity medians in relation to nutritional status in situations tested during muscle inactivation (off). It was observed that the percentages of activation were similar in all situations tested, except for the activity of habitual mastication for the right masseter

muscle, which reported superiority of activation for the eutrophic group, with statistically significant difference ($p = 0.038$). In this analysis, there was also significant difference in muscle activation (left and right) among members of the eutrophic group ($p = 0.012$) during habitual mastication.

Table 4 – Masseter muscle electrical activity medians in relation to nutritional status in situations tested during the period of muscle inactivation (off), with normalized and percentage measured data.

Variables	Nutritional Status		p*
	Eutrophic Children md (1 ^o /3 ^o q)	Obese Children md (1 ^o /3 ^o q)	
Habitual Mastication			
Right Masseter	41.2 (29.1-50.3) ^a	24.3 (15.4-36.6)	0.038
Left Masseter	27.7 (17.9-40.2) ^a	24.1 (19.3-31.9)	0.410
Directed Mastication			
Right Masseter	17.9 (14.5-25.7)	12.4 (8.0-18.7)	0.065
Left Masseter	15.7 (7.9-30.4)	12.0 (8.8-15.6)	0.429
Swallowing			
Right Masseter	3.9 (2.4-9.1)	3.5 (2.8-5.3)	0.792
Left Masseter	3.7 (2.2-7.3)	3.7 (2.8-4.2)	0.940

Md (1st - 3rdQ)= median (first and third quartiles); **Wilcoxon Test*. Similar letters present significant statistical difference: ^a 0.012.

Table 5 presents upper and lower orbicular muscle electrical activity medians to the situations of MVC and rest and activation period (on) of habitual mastication and swallowing in relation to nutritional status. There was similarity in muscle activation between groups during rest and MVC. As for the activities of habitual mastication and swallowing, obese children had lower activation percentage median than eutrophic children, with statistically significant differences for the lower orbicularis

muscle during habitual mastication ($p = 0.008$). There were differences in activation for upper and lower orbicular muscles among the members of the eutrophic group during MVC, with activation percentage of 45.4 % for upper orbicular and 43.3 % for lower orbicular ($p = 0.03$). Both groups showed significant differences in the activation of the orbicularis muscle among their members for the activities of habitual mastication and swallowing, with higher percentages of activation in the lower orbicularis.

Table 5 – Orbicularis oris muscle electrical activity medians for maximum voluntary contraction and rest situations and activation (on) period of dynamic activities in relation to nutritional status, with normalized and percentage measured data.

Variables	Nutritional Status		p*
	Eutrophic Children md (1 ^o /3 ^o q)	Obese Children md (1 ^o /3 ^o q)	
Rest			
Superior Orbicularis	2.0 (1.3-3.5)	2.0 (1.2-2.2)	0.547
Inferior Orbicularis	1.9 (1.1-3.8)	2.0 (0.9-3.1)	0.638
Maximum Voluntary Contraction			
Superior Orbicularis	45.4 (43.4-47.6) ^a	46.2 (43.4-48.5)	0.509
Inferior Orbicularis	43.1 (37.7-45.5) ^a	45.5 (42.4-49.2)	0.097
Habitual Mastication			
Superior Orbicularis	221.5 (143.9-320.4) ^b	190.7 (146.6-212.5) ^d	0.274
Inferior Orbicularis	414.9 (275.0-565.6) ^b	260.1 (179.1-337.7) ^d	0.008
Swallowing			
Superior Orbicularis	124.5 (90.9-156.7) ^c	112.8 (81.2-120.7) ^e	0.386
Inferior Orbicularis	202.0 (117.0-231.6) ^c	175.3 (123.4-221.1) ^e	0.706

Md (1st - 3rdQ)= median (first and third quartiles); **Wilcoxon Test*. Similar letters present significant statistical difference: ^a 0.03; ^b 0.001; ^c 0.006; ^d 0.026; ^e 0.002.

Table 6 presents the orbicularis oris muscle electrical activity medians in relation to nutritional status in situations tested during muscle inactivation (off). It was observed that the obese had lower percentage of muscle activity than eutrophic for lower orbicularis during habitual mastication, with statistically significant difference ($p = 0.029$). There was no statistical difference in muscle activation

between the upper and lower orbicular muscles during habitual mastication and swallowing when comparing groups. However, when analyzing the values within each group, both obese and eutrophic children had greater activation percentage for lower orbicularis in all proposed situations, with statistically significant difference ($p < .05$).

Table 6 – Orbicularis oris muscle electrical activity medians in relation to nutritional status in situations tested during the period of muscle inactivation (off), with normalized and percentage measured data.

Variables	Nutritional Status		p*
	Eutrophic Children md (1 ^o /3 ^o q)	Obese Children md (1 ^o /3 ^o q)	
Habitual Mastication			
Superior Orbicularis	42.1 (28.1-52.6) ^a	32.5 (21.6-40.7) ^c	0.132
Inferior Orbicularis	62.3 (39.9-90.5) ^a	43.2 (24.9-52.7) ^c	0.029
Swallowing			
Superior Orbicularis	13.3 (9.6-22.6) ^b	11.7 (6.1-17.2) ^d	0.451
Inferior Orbicularis	21.3 (14.8-26.7) ^b	19.8 (10.9-27.2) ^d	0.547

Md (1st - 3rdQ)= median (first and third quartiles); **Wilcoxon Test*. Similar letters present significant statistical difference: ^a $p=0.003$; ^b $p=0.010$; ^c $p=0.010$; ^d $p=0.023$.

■ DISCUSSION

Studies involving evaluations of obese stomatognathic system are scarce, which makes this study relevant, although it is difficult to compare its results.

Regarding the EMG data of the anterior temporal muscle during activation (on), it was observed that obese children had similar activation percentage to eutrophic children, when muscles were at rest and MVC; whereas for dynamic situations, obese had lower activation percentage than that observed in the control group. The literature concerning these data shows that the discrepancy of electrical activity and the statistical difference found in some activities involving the temporalis muscle can be correlated to the pattern of lateral chewing preference and altered head posture present in some children^{26,27,28}.

With respect to data on the masseter muscle during activation (on), also both at rest and MVC, obese showed similar activation percentage to eutrophic, which was not confirmed during the dynamic activities proposed, where eutrophic obtained important superiority of muscle activity. In this regard, and given the importance of the masseter muscle exercises during the masticatory process, the literature states that the obese individual may have problems related to chewing because they do not have an oral musculature strengthened by

having dental changes or by decreasing the masticatory speed²⁹.

It is known that this possible muscle deconditioning of obese children, here translated by the inferiority of electrical activity compared to eutrophic children, is probably due to the preference for fast food, whose consistency is characterized by being more shredded, cooked and soft, usually composed of carbohydrates that increase satiety. Lieberman et al (2004)³⁰ have showed that consumption of processed foods has decreased facial growth of the mandibular and maxillary arches in humans in response to decreased occlusal force and masticatory required for grinding food.

In relation to the orbicularis oris muscle, it is known that patients with incompetent lips cannot seal their lips naturally and effortlessly; a condition that favors tooth protrusion by reduced labial pressure on them, generating a facial imbalance. The absence of lip contact causes muscle imbalance that can affect various functions, such as breathing, swallowing, phonation, and the harmonious growth and development of the face^{31; 32; 33}.

In relation to this and the data collected from the dynamic activities of the orbicular muscles during the activation period (on), it was observed that the obese subjects showed lower activation percentage than eutrophic subjects, with statistically significant

differences for lower orbicularis in habitual mastication ($p = 0.008$), this difference was not confirmed for the upper orbicularis ($p = 0.274$) in this same activity. Some authors claim that the change in the usual position of the lips is a sign of hypotonicity³⁴ or hypofunction of the orbicularis oris muscle, especially during mastication³⁵.

Studies report that both segments of the orbicularis oris muscle function as separate and independent entities. The default behavior of the upper and lower segments of the orbicularis oris, assessed at youth presenting normal occlusion, shows absence of significant electromyographic activity in this muscle during mastication and swallowing, as well as in the resting state. The medial and lateral regions, upper and lower segments, can function as independent bodies among themselves, even though they constitute the same muscle^{36-38; 16}.

Regarding the data on the proposed dynamic activities during the period of inactivation (off) of the muscle groups covered in this study, it was observed, for the temporal muscle, a lower percentage of muscle activity in obese compared to eutrophic children in the analyzed situations. The same occurred for the masseter muscles, for which the medians of action percentage were also higher for the eutrophic group. Repeatedly, in the analysis of the values obtained for the orbicular muscles, a superiority of muscle activity in eutrophic was noted, however, for this muscle group, it was observed that there was still a significant difference of activity between muscle units, with greater activation for the lower orbicularis compared to the upper orbicularis, for both groups during the situations tested.

Muscle activity recorded over the period of inactivation (off) was found proportional to the activation period (on) in all situations tested for all muscle groups. That is, the higher the percentage of

muscle activation on the on period, the greater was the value for the inactivation period (off). The high muscle activity, with values above the rest event, observed in the periods between activation cycles (off periods) reveals the absence of a complete muscle relaxation after contraction.

These findings are consistent with the study of Basmajian and De Luca (1985)³⁹, who state that during the complete rest period the muscle does not lose its tone, even when neuromuscular activity is nil. Thus, the results obtained in this study are considered to agree with the findings from the literature, as the subjects did not reach a state of complete muscle relaxation both between the cycles of activation (off period) and during rest periods. Furthermore, the fact that, even in the period of muscle inactivation (off), the obese children have presented lower values of muscle activity than those of eutrophic children confirms their inferiority of muscle conditioning compared to their eutrophic peers.

■ CONCLUSION

From the analysis of the results obtained in this study, it was possible to conclude that obese individuals have similar muscle activation compared to eutrophic individuals during activities of MVC and rest. However, for most dynamic activities - habitual and directed mastication and swallowing - obese children had lower muscle activation medians than eutrophic children, both in the activation period (on) and in the inactivation period (off), for all muscle groups studied.

Thus, these findings support the hypothesis that obese children, probably due to excessive facial adiposity, present changes in the conditioning of the masticatory muscles, which are reflected in the performance of the stomatognathic system.

RESUMO

Objetivo: comparar o padrão de atividade elétrica dos músculos mastigatórios de crianças obesas e eutróficas durante os períodos de ativação (*on*) e inativação (*off*) muscular por meio da eletromiografia de superfície. **Métodos:** foram avaliadas 32 crianças, entre 6 e 12 anos de idade, divididas em dois grupos iguais – 16 obesas e 16 eutróficas. As variáveis estudadas incluíram a atividade eletromiográfica da musculatura mastigatória (músculo temporal anterior, masseter e orbicular da boca) durante as atividades de repouso, contração voluntária máxima, mastigação (habitual e direcionada) e deglutição. Para a análise estatística calculou-se a mediana, primeiro e terceiro quartis e utilizou-se o teste de *Wilcoxon*, considerando nível de significância de $p < 0,05$. **Resultados:** os obesos apresentaram semelhanças de ativação muscular em relação aos eutróficos durante as atividades de contração voluntária máxima e repouso. Porém, para as atividades dinâmicas – mastigação habitual, mastigação direcionada e deglutição - os obesos apresentaram medianas de ativação muscular inferiores aos eutróficos na maioria das situações propostas, tanto no período de ativação (*on*) quanto no período de inativação (*off*), com diferença estatística significativa ($p < 0,05$). **Conclusão:** crianças obesas, provavelmente em função do excesso de adiposidade facial, apresentam alterações no condicionamento da musculatura mastigatória, que se refletem durante a realização das funções do sistema estomatognático.

DESCRITORES: Estado Nutricional; Criança; Sistema Estomatognático; Eletromiografia; Mastigação; Deglutição

■ REFERENCES

- Ebbeling CB, Pawlak DB, Ludwig DS. Childhood obesity: public-health crisis, common sense cure. *Lancet*. 2002;360:473-8.
- Sociedade Brasileira de Pediatria, (2008). Departamento de Nutrologia. Obesidade na Infância e Adolescência – Manual de Orientação. URL: http://www.sbp.com.br/show_item2.cfm?id_categoria=89&id_detalhe=2740&tipo_detalhe=s
- Machado PG, Mezzomo CL. A relação da postura corporal, da respiração oral e do estado nutricional em crianças – uma revisão de literatura. *Rev CEFAC*. 2011;13(6):1109-18.
- Motonaga SM, Berte LC, Anselmo-Lima WT. Respiração bucal: causas e alterações no sistema estomatognático. *Rev Bras Otorrinolaringol*. 2000; [Acesso em: 26 de fevereiro de 2015] 66(4):373-9. Disponível em: http://www.rborl.org.br/conteudo/acervo/print_acervo.asp?id=2482
- Bianchini EMG. Disfunções da articulação temporomandibular: relações com a articulação da fala [dissertação]. São Paulo (SP): Faculdade de Fonoaudiologia, Pontifícia Universidade de São Paulo; 1998.
- Fernandes AR, Casonatto J, Christofaro DGD, Ronque VER, Oliveira AR. Risco para o excesso de peso entre adolescentes de diferentes classes econômicas. *Rev Assoc Med Bras*. 2008;54(4):334-8.
- Marchesan IQ. Protocolo de avaliação miofuncional orofacial. In: Krakauer LH, Di Francesco RC, Marchesan IQ. (Org.). Respiração oral. São José dos Campos: Pulso, 2003. P. 55-79.
- Krob CL. Efeito do exercitador facial em crianças respiradoras orais: avaliação eletromiográfica. [Dissertação] Santa Maria (RS): Universidade Federal de Santa Maria; 2008.
- Figueiredo AB. Avaliação fonoaudiológica clínica e eletromiográfica da motricidade orofacial do obeso: estudo comparativo. [Dissertação]. São Paulo (SP): Universidade de São Paulo; 2010.
- Portney L. Eletromiografia e testes de velocidade de condução nervosa. In: O'Sullivan SB, Schmitz TJ editores. *Fisioterapia: Avaliação e Tratamento*. São Paulo: Manole, 1993. P. 183-217.
- Onis MDE, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. *Bulletin of the World Health Organization*. 2007;85:660-7.
- Hiyama S, Ono T, Ishiwata Y, Kuroda T, Ohyama K. Effects of experimental nasal obstruction on human masseter and suprahyoid muscle activities during sleep. *Angle Orthodontist*. 2003;73:151-7.
- Angle EH. Classification of Malocclusion. *Dental Cosmos*. 1899;41(3):248-64.
- Berlese DB, Copetti F, Weimann ARM, Fontana PF, Haeffner LSB. Atividade dos músculos masseter e temporal em relação às características miofuncionais das funções de mastigação e deglutição em obesos. *Distúrb Comun*. 2012;24(2):215-21.

15. Ferla A. Padrão de atividade elétrica dos músculos temporal anterior e masseter em crianças respiradoras bucais e em crianças respiradoras nasais. [Dissertação]. Santa Maria (RS):Universidade Federal de Santa Maria; 2004.
16. Siqueira VCV, SousaMA, BérzinF, Casarini CAS. Análise eletromiográfica do músculo orbicular da boca em jovens com Classe II, 1ª divisão, e jovens com oclusão normal. *Dental Press*. 2011;16(5):54-61.
17. Berretin-Felix G, Genaro KF, Trindade IEK, Trindade Júnior AS. Masticatory function in temporomandibular dysfunction patients: electromyographic evaluation. *J. Appl. Oral Sci*. 2005;13:360-5.
18. Biasotto-Gonzalez DA, Bérzin F. Electromyographic study of patients with masticatory muscles disorders, physiotherapeutic treatment (massage). *Braz J Oral Sci*. 2004;3:516-21.
19. Biasotto DA. Estudo eletromiográfico dos músculos do sistema estomatognático durante a mastigação de diferentes materiais. [Dissertação]. Piracicaba (SP): Universidade Estadual de Campinas; 2000.
20. Goiato MC, Garcia AR, Santos DM. Electromyographic evaluation of masseter and anterior temporalis muscles in resting position and during maximum tooth clenching of edentulous patients before and after new complete dentures. *Acta Odontol Latinoam*. 2007;20(2):67-72.
21. Rahal A, Goffi-Gomez MVS. Avaliação eletromiográfica do músculo masseter em pessoas com paralisia facial periférica de longa duração. *Rev Cefac*. 2007;9(2):207-12.
22. Santos MTBR, Biasotto-Gonzalez DA, Bérzin F. Avaliação eletromiográfica dos músculos temporal anterior e masseter em pacientes com sequela de acidente vascular encefálico isquêmico. *Pesqui Bras Odontopediatria Clin Integr*. 2004;4(1):15-8.
23. Briesemeister M, Schmidt KC, Ries LGK. Changes in masticatory muscle activity in children with cerebral palsy. *J Electromyography Kinesiol*. 2013;23:260-6.
24. Faller L, Nogueira Neto GN, Button VLSN, Nohama P. Avaliação da fadiga muscular pela mecanomiografia durante a aplicação de um protocolo de EENM. *Rev. bras. fisioter*. 2009;13(5):422-9.
25. Jardini RSR. Avaliação eletromiográfica do músculo bucinador flácido usando o Exercitador Facial. *Pró-Fono R Atual Cient*. 2002;4:331-42.
26. Felício CM. Fonoaudiologia aplicada a casos odontológicos. São Paulo: Pancast, 1999.
27. Corrêa ER, Marchiori SC, Silva AMT. Electromyographics muscle EMG activity in mouth and nasal breathing children. *J Craniomandibular Pract*. 2004;22:145-50.
28. Oncins MC, Freire RMA, Marchesan IQ. Mastigação: análise pela eletromiografia e eletrognatografia. Seu uso na clínica fonoaudiológica. *Distúrbios da Comunicação*. 2006;18(2):155-65.
29. Onucleo (2013). Obesidade e Fonoaudiologia. URL: <http://www.onucleo.com/index.php/fono/315-obesidade-fonoaudiologia>
30. Lieberman DE, Krovitz GE, Yates FW, Devlin M, Claire MS. Effects of food processing on masticatory strain and craniofacial growth in a retrognathic face. *J Hum Evol*. 2004;46:655-77.
31. Lowe AA, Takada K. Associations between anterior temporal, masseter, and orbicularis oris muscle activity and craniofacial morphology in children. *Am J Orthod*. 1984;86(4):319-30.
32. Camargo MCF, Azevedo JRO, Briso MLG. Dispositivo indutor de vedamento labial - DIVEL. *Jornal Brasileira de Ortodontia e Ortopedia Facial*. 2001;6(33):256-61.
33. Jung MH, Yang WS, Nahm DS. Effects of upper lip closing force on craniofacial structures. *Am J Orthod Dentofacial Orthop*. 2003;123(1):58-63.
34. Cattoni DM, Fernandes FDM, Francesco RCD, Latorre MRDO. Características do sistema estomatognático de crianças respiradoras orais: enfoque antropológico. *Pro Fono R Atual Cient*. 2007;19(4):347-51.
35. Junqueira P. Avaliação e Diagnóstico Fonoaudiológico em Motricidade Oral. In: Ferreira LP, Befi-Lopes DM, Limongi SCO, Pupo AC, Furkim AM, Chiari BM, Bianchini EM, Ramos SM. *Tratado de Fonoaudiologia*. Roca; 2004. P. 230-53.
36. Nieberg LG. An electromyographic and cephalometric radiographic investigation of the orofacial muscular complex. *Am J Orthod*. 1960;46(8):627-8.
37. Essensfelder LRC, Vitti M. Análise eletromiográfica dos músculos orbicularis oris em jovens portadores de oclusão normal. *Ortodontia*. 1997;10(3):180-91.
38. Zilli AS. Estudo eletromiográfico dos músculos orbiculares da boca, segmentos superior e inferior (região medial), em jovens com maloclusão Classe I de Angle [dissertação]. Piracicaba (SP): Universidade Estadual de Campinas; 1994.
39. Basmajian JV, De Luca CJ. *Muscles alive: their functions revealed by electromyography*. Baltimore: Williams & Wilkins, 1985.

Received on: December 19, 2014

Accepted on: March 30, 2015

Mailing address:

Talita Cristina Favero

Universidade Federal de Santa Maria

Av. Roraima, 1000. Centro de Ciências da Saúde -

CCS Campus Universitário - Prédio 26

Santa Maria – RS – Brasil

CEP: 97015-560

E-mail: fgatalita.favero@gmail.com