MASTICATORY MUSCLE ELECTRICAL ACTIVITY PATTERN IN OBESE AND EUTROPHIC CHILDREN

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

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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 adulthood [1]. 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 scenario [2].

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

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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 Phonoaudiology [6]. 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 changes [7].

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 Organization [11]. Children whose BMI z-score was ≥ -2 were considered eutrophic, and < +1 and +2 ≥ 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 VI [12]. 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 exclusion[8].

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 impedanciometry. 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 intercuspal, 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 Eutrophic Children md (1º/3ºq)	 Obese Children md (1º/3ºq)	p
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 (1º/3ºq)	Obese Children md (1º/3ºq)	
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 (1º/3ºq)	Obese Children md (1º/3ºq)	
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 Eutrophic Children md (1º/3ºq)	 Obese Children md (1º/3ºq)	p*
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 Eutrophic Children md (1º/3ºq)	 Obese Children md (1º/3ºq)	p*
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 (1º/3ºq)	Obese Children md (1º/3ºq)	
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 speed [29].

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 hypotonicity [34] or hypofunction of the orbicularis oris muscle, especially during mastication [35].

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 eutróficosna maioria das situações propostas, tanto no período de ativação (*on)* quanto no período de inativação (*off)*, com diferença estatística significante (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

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