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ARTICLES

Chewing function in different life cycles: analysis with electromyography

Função mastigatória nos diferentes ciclos de vida: análise eletromiográfica

Función masticatoria en diferentes ciclos de vida: análisis con electromiografía

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Abstract

Introduction: Chewing is of significant importance for the development of the structures of the Stomatognathic System (SE), which is improved throughout life. Surface electromyography stands out as an important assessment tool capable of quantifying the electrical activity of the masticatory muscles, being a way to characterize the behavior of this stomatognathic function. Observing the complexity and importance of chewing, it is important to better understand the changes in this function during the life cycles. **Objective:** The objective of the study was to perform an electromyographic analysis of the muscles of mastication in individuals without orofacial complaints representing the cycles of childhood, adolescence, adulthood and senescence. **Method:** The sample consisted of 120 volunteers of both sexes, distributed in four groups according to the age group. The volunteers underwent chewing assessment by means of surface electromyography during rest, maximum voluntary contraction, unilateral right and left chewing and habitual chewing; as well as the verification of the bite force between the central incisor teeth, molars on the right side and molars on the left side. Facial anthropometric measurements of the direct and left hemifaces of the volunteers were also taken. **Results:** The results showed distinct

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Authors'contributions:
GKBON: study conception, methodology, data collection, article design.
RSB: Statistical analysis of data.
PJAC: Article revision .
HJS: Orientation, article concception, methodology.

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morphological and functional behaviors between the groups studied, as well as the influence of the gender variable on the electrophysiological responses of the masticatory function. **Conclusion:** it was found that the masticatory behavior varied according to age and sex, pointing to a trend of correlation between the anatomical and functional components involved in this stomatognathic function.

Keywords: Chewing; Electromyography; Bite force; Child; Adolescent; Adult; Aged.

Resumo

Introdução: A mastigação tem uma importância significativa para o desenvolvimento das estruturas do Sistema Estomatognático (SE), sendo esta aperfeiçoada no decorrer da vida. A eletromiografia de superfície destaca-se como uma importante ferramenta de avaliação capaz de quantificar a atividade elétrica dos músculos mastigatórios, sendo uma forma de caracterizar o comportamento dessa função estomatognática. Observando a complexidade e importância da mastigação, torna-se importante conhecer melhor as modificações desta função no decorrer dos ciclos de vida. **Objetivo:** O objetivo do estudo foi realizar análise eletromiográfica dos músculos da mastigação em indivíduos sem queixas orofaciais representantes dos ciclos da infância, adolescência, fase adulta e senescência. **Método:** A amostra foi composta por 120 voluntários de ambos os sexos, distribuídos em quatro grupos de acordo com a faixa de idade. Os voluntários foram submetidos à avaliação da mastigação por meio da eletromiografia de superfície durante o repouso, contração voluntária máxima, mastigações unilaterais direita e esquerda e mastigação habitual; bem como a verificação da força de mordida entre os dentes incisivos centrais, molares do lado direito e molares do lado esquerdo. Realizou-se, ainda, a tomada de medidas antropométricas faciais das hemifaces direta e esquerda dos voluntários. **Resultados:** Os resultados apontaram comportamentos morfológicos e funcionais distintos entre os grupos estudados, bem como a influência da variável sexo nas respostas eletrofisiológicas da função mastigatória. **Conclusão:** foi verificado que o comportamento mastigatório variou segundo a idade e o sexo, apontando uma tendência de correlação entre os componetes anatômicos e funcionais envolvidos nessa função estomatognática.

Palavras-chave: Mastigação; Eletromiografia; Força de mordida; Criança; Adolescente; Adulto; Idoso.

Resumen

Introducción: La masticación es de gran importancia para el desarrollo de las estructuras del Sistema Estomatognático (SE), que se mejora a lo largo de la vida. La electromiografía de superficie se destaca como una importante herramienta de evaluación capaz de cuantificar la actividad eléctrica de los músculos masticatorios, siendo una forma de caracterizar el comportamiento de esta función estomatognática. Observando la complejidad de esta función, es importante conocer mejor los cambios de esta función durante los ciclos de vida. **Objetivo:** El objetivo del estudio fue realizar un análisis electromiográfico de los músculos de la masticación en individuos sin quejas orofaciales representando los ciclos de niñez, adolescencia, adultez y senescencia. **Método:** La muestra estuvo formada por 120 voluntarios de ambos sexos, distribuidos en cuatro grupos según el grupo de edad. Los voluntarios fueron sometidos a valoración masticatoria mediante electromiografía de superficie en reposo, máxima contracción voluntaria, masticación unilateral derecha e izquierda y masticación habitual; así como la verificación de la fuerza de mordida entre los incisivos centrales, molares del lado derecho y molares del lado izquierdo. También se tomaron medidas antropométricas faciales de los hemifaces directo e izquierdo de los voluntarios. **Resultados:** Los resultados mostraron distintos comportamientos morfológicos y funcionales entre los grupos estudiados, así como la influencia de la variable género en las respuestas electrofisiológicas de la función masticatoria. **Conclusión:** se encontró que el comportamiento masticatorio varió según la edad y el sexo, apuntando a una tendencia de correlación entre los componentes anatómicos y funcionales involucrados en esta función estomatognática.

Palabras clave: Masticación; Electromiografía; Fuerza de la mordida; Niño; Adolescente; Adulto; Anciano.

Introduction

The stomatognathic system receives different intra and extraoral stimuli constantly, informing the particularities of each food during the masticatory process [1].

In the adolescence cycle, chewing can be performed bilaterally and alternately. The maturation of stomatognathic functions is due to stability in shape, the completion of the eruptive process of permanent teeth and the remodeling of the TMJs, which changes from a rectified configuration to a mature pattern, similar to that of adults, enabling more complex joint movements [2].

The kinematics of masticatory movements in adulthood reaches a complex level of performance in which the mandible develops various movements in spatial planes, influenced by the masticatory muscles. Mandibular elevation is performed by the masseter, anterior temporal and medial pterygoid muscles. The masseter has muscle fibers that, when contracted, project the mandible upwards, promoting contact between the dental arches. The chewing performance is guaranteed by the force exerted and electrical potential generated in the contraction of this muscle, in addition to the modulation exerted by the temporomandibular joints (TMJs) and by the neuromuscular system [3-4].

During senescence, changes occur in the orofacial muscle composition, which include a decrease in the number of motor units, with few fast-twitch fibers, resulting in a decrease in muscle strength, tone and mobility. The resorption of bone structures is evidenced, relating to the reduced vertical dimension of the lower third of the face and, consequently, a decrease in the oral opening, compromising the jaw movements and chewing speed, influencing the decrease in the number of chewing cycles. [5-6].

It is common that, in Speech-Language Pathology practice, muscle assessment occurs through physical examination (observations, filming and palpations). These data, however, are not concise and may be influenced by the professional's subjectivity, limiting a more accurate record. [7]

Surface electromyography stands out as an important electrophysiological assessment tool capable of quantifying the electrical activity of masticatory muscles, which can help in the diagnosis of muscle disorders quickly and objectively [8].

Surface Electromyography (SEMG) is intended for the study of bioelectrical phenomena that occur in skeletal muscle fibers during rest, exertion and maximum contraction. Electrodes are placed under the skin covering the muscle to be evaluated, which capture the sum of the electrical activity of all active muscle fibers. It is characterized by being a non-invasive and easy-to-perform method. The electromyographic recording makes it possible to observe the electrical behavior of different muscles under different physiological conditions. SEMG has been widely used by Physicians, Speech-Language Pathologists, Physiotherapists and Physical Education professionals for the study of human movement [9].

Observing the complexity and importance of chewing, it is important to better understand the changes in this function throughout life cycles. The present study aimed to perform a clinical and electromyographic evaluation of the masticatory muscles as a way to characterize the behavior of this stomatognathic function in different life cycles.

Method

This cross-sectional and analytical research was developed at the Clinical School of Speech Therapy, Department of Speech Therapy, Federal University of Sergipe (Campus Lagarto) and approved by the Research Ethics Committee of the Federal University of Sergipe. All volunteers who made up the sample and, when necessary, their legal representatives agreed with the scope of the research by signing an Informed Consent Form and/or an Assent Term (in the case of underage participants).

The study reference period took place between February and September 2016. A convenience sample consisted of 120 volunteers, of both genders and without orofacial complaints or dysfunctions. Four groups were formed according to age groups: the 1st group (G1) was composed of 30 children aged between 5 and 12 years; the 2nd group (G2) had 30 adolescents aged between 13 and 18 years; the 3rd group (G3) gathered 30 adults aged between 19 and 59 years; and the 4th group (G4) had 30 elderly aged between 60 and 79 years.

For sample selection, the following inclusion criteria were considered: both genders, age between 5 and 80 years, absence of orofacial complaints at the time of evaluation. The following criteria were adopted as exclusion factors: presence of orofacial complaints, use of poorly fitted or very worn dental prostheses, loss of more than three dental elements, presence of ulcerative lesions in the oral cavity or periorbicular region, use of orthodontic or orthopedic appliances in the maxilla or mandible, dental malocclusions, loss of orofacial sensitivity, neurological or cognitive impairment, dysphagia and presence of craniofacial syndromes or malformations.

The selection of the sample occurred through screening through clinical examinations of the occlusal classification (performed by a specialist dentist) and application of structured anamnesis on the health and integrity of the SS [10]. The clinical and instrumental evaluations of the stomatognathic system were performed by a Speech-Language Pathologist specialized in Orofacial Motricity.

The volunteers were instructed about all the procedures they would undergo and, those selected after screening, were referred for verification of facial anthropometric values. With the aid of a digital caliper (JOMARCA® Starnieless Hardened, 0.01mm accuracy), the distances were measured, in millimeters (mm), between the facial anthropometric points **ex** (external corner of the eye) and **ch** (cheilion- labial commissure) in each hemiface. Care was taken so that the pointed ends of the measuring equipment did not put pressure on or hurt the volunteer's face; each measure was verified three times and the arithmetic mean between the three values found was considered as the estimated measure for the respective distance between the chosen anthropometric points.

The next stage of evaluation included the acquisition of the bite force potential, measured in kilogram force (Kgf). The volunteer was asked to remain in a sitting posture, comfortably in a chair with a back support for spine support, without head support, knees and hips in 90º flexion and feet fully supported on the floor or on a bulkhead Adjustable fitting. The verification of the bite force was performed by performing three bites (between the incisor teeth and between the molar teeth bilaterally) with maximum force in a load cell (Miotec®), for five seconds each and intervals of thirty seconds between them for muscle rest.

After taking the bite force, the electromyographic potentials of the right and left masseter muscles were captured during rest, maximum voluntary contraction (MVC), right unilateral mastication, left unilateral mastication and habitual mastication. For optimal allocation of the electrodes that captured the myoelectric responses, inspection of the target muscles and previous cleaning of the skin that covered them was performed using a gauze pad soaked in 70º alcohol. In the event of hair in the region where the electrodes adhere, with the volunteer's consent, local trichotomy was performed with a disposable, single-use razor blade.

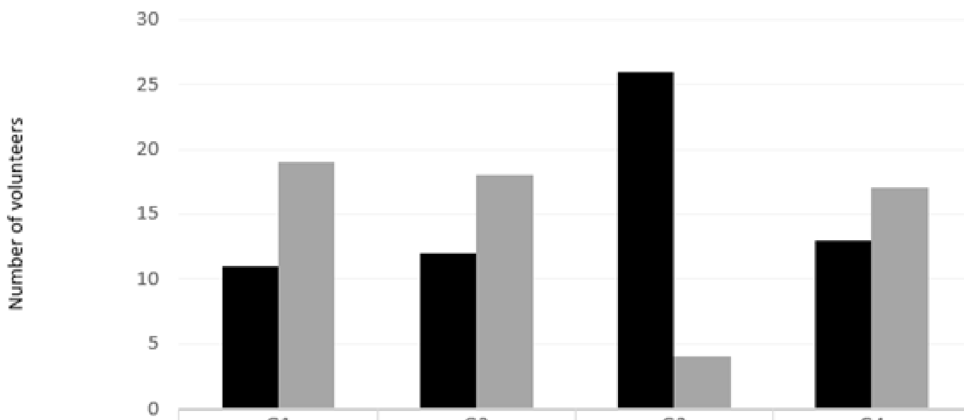
The electromyograph used was the MIOTOOL 200/400 - 4 channels (MIOTEC®) with Miograph 2.0 software, using 1000 gain, 4 SDS500 sensors, Reference cable (ground) and calibrator. To capture and conduct the electromyographic signal, disposable hypoallergenic surface electrodes 3M® brand were used, made of a material composed of Ag/AgCl, immersed in conductive gel. The electrodes were placed bilaterally on the volunteer's face in a bipolar configuration, in the region of greatest muscle mass and arranged longitudinally to the muscle fibers, following the following arrangement: Channel 1 - Right masseter muscle; Channel 2 - Left masseter muscle. To avoid interference, the reference electrode was positioned at a point distant from the location of recording of the assessed muscles, and the right arm ulna olecranon was agreed upon.

Before starting chewing, the recording of electrical activity was recorded during a thirty-second rest period in habitual centric occlusion; in the maximum voluntary contraction maintained for five seconds and repeated three times, with ten-second intervals between contractions; and during controlled maximum voluntary contraction (for the purpose of normalizing the electromyographic signal), because a cotton rod was positioned between the dental arches and bilaterally in the position of the last premolar and first molar, this maneuver also lasted for five seconds and was repeated three times counting ten-second intervals between contractions.

After that, a French bread weighing 25g was offered and the mastication was requested. The chewing process was carried out in three stages: 1st) A piece of bread was chewed in the usual way and the muscular electrical signals were captured during the first thirty seconds of this chewing process; 2nd) Another piece of bread was chewed only on the right side of the mouth and the acquisition of muscle electrical potential occurred during the first ten chewing cycles; 3rd) Another piece of bread was chewed only on the left side of the mouth and the recording of electrical muscle signals during this act took place during the first ten chewing cycles. Each fragment of French bread had a volume equivalent to that consumed in a habitual bite, respecting the particularities of each volunteer, so that there was no major interference in the chewing act. For data analysis, quantitative and qualitative measures were obtained: mean, median and standard deviation, absolute frequencies and percentages; Spearman's correlation coefficient (due to the sample size and the possibility of capturing non-linear associations) and the Mann-Whitney (to compare medians of independent groups, due to the sample size and the lack of need for normality in distribution). Data were entered into a spreadsheet in Microsoft Excel 2000 and all analyses were performed in the R 3.3.2 computational environment.

Results

The sample consisted of 120 volunteers of both sexes and distributed into 4 groups (G1, G2, G3 and G4) according to age range. G1 was composed of 30 children, 36.7% (n=11) male and 63.3% (n=19) female, with a mean age of 9 years; G2 was composed of 30 adolescents, 40% (n=12) male and 60% (n=18) female, with an average age of 17 years; G3 was composed of 30 adults, 86.7% (n=26) male and 13.3% (n=4) female, with a mean age of 32 years; and G4 was composed of 30 elderly people, 43.3% (n=13) male and 56.7% (n=17) female, with a mean age of 67.5 years (Figure 1).



	G1	G2	G3	G4
■ Male	11	12	26	13
■ Female	19	18	4	17

Figure 1. Distribution of volunteers according to sex

The anthropometric measurements were verified between the points ex (outer corner of the eye) and ch (cheilion-labial commissure) on the two hemifaces. In all groups, there was equivalence in the measurements when comparing the right hemiface with the left. When analyzing each group separately, taking into account the gender variable, there was no significant difference between the facial measurements. There was a slight upward trend in ex-ch measures between childhood and adulthood, followed by a decrease in senescence (Table 1).

Table 1. Comparison of facial anthropometric medians on the right and left sides by group and sex

Group	Sex	Right	Left	* descriptive level
G1	Male	59.440	59.820	1.0000
	Female	61.230	61.430	0.7509
G2	Male	68.390	68.655	0.8428
	Female	66.705	67.340	0.9369
G3	Male	73.805	73.840	0.5922
	Female	72.780	73.110	0.8857
G4	Male	63.820	63.960	0.9598
	Female	63.420	64.010	0.7596

* statistical analysis using the Mann-Whitney test

The investigation of the bite force values revealed no significant differences between the studied groups. There was a trend towards an increase in strength between the childhood and adolescence cycles, followed by a slight decrease in the adult phase and the senescence cycle. When the gender variable was taken into account, there was a slight increase in strength among men, except in the adult group (Table 2).

Table 2. Comparison of bite force medians on the right and left sides by group and sex

Group	Sex	Bite force	Força de mordida esquerda	*Nível descritivo
right	Bite force	57,340	58,330	0,8470
	left	*Descriptive level	51,200	1,0000
G1	Male	57.340	58.330	0.8470
	Female	52.370	51.200	1.0000
G2	Male	86.250	100.310	0.2415
	Female	73.220	79.535	0.2262
G3	Male	45.835	48.600	0.5643
	Female	56.150	56.950	1.0000
G4	Male	51.130	50.120	0.9598
	Female	49.880	45.320	0.8119

* Mann-Whitney test used

As for the electromyographic results during muscle rest, there was a similarity of myoelectric potentials between the groups; however, it was noticed among the elderly, a tendency to increase these potentials. When considering the gender variable in this analysis, it was seen that there is a slight increase in myoelectric potential among men when compared to the results of women (Table 3).

Table 3. Comparison of electromyographic medians during rest by group and sex

Group	Sex	Right	Left	*Descriptive level
G1	Male	3.640	3.020	1.0000
	Female	2.880	2.690	0.7703
G2	Male	3.200	3.535	0.7125
	Female	2.125	2.130	0.7666
G3	Male	2.010	1.785	0.6872
	Female	2.615	2.535	0.8857
G4	Male	3.320	4.810	0.4483
	Female	3.700	5.520	0.8384

* Mann-Whitney test used

The electromyography during the maximal voluntary contraction of the masseter muscles showed to increase until adulthood, with a decrease in the elderly group. There was no evidence of difference between the myoelectric potentials of the right and left masseters in the studied groups and the gender variable did not influence the results, but it was noticed that in males the values were found to be higher than in females (Table 4).

Table 4. Comparison of MVC electromyographic values by group and sex

Group	Sex	Right	Left	*Descriptive level
G1	Male	60.960	60.060	0.7969
	Female	56.660	60.860	0.5635
G2	Male	60.775	63.990	0.7125
	Female	55.160	53.605	0.8391
G3	Male	70.335	60.440	0.2788
	Female	77.525	63.215	0.4857
G4	Male	40.270	40.980	0.9598
	Female	39.020	45.930	1.0000

* Mann-Whitney test used

During chewing performed only on the right side, there was a significant difference in the myoelectric potentials of the female children's masseters. This characteristic was not identified in the other groups. In all groups, it was noticed that in this action the right masseter behaves with higher electromyographic potentials when compared to the left masseter, but there was no proven statistical evidence (Table 5).

Table 5. Comparison of electromyographic values of right unilateral chewing by group and sex.

Group	Sex	Right	Left	*Descriptive level
G1	Male	40.980	31.160	0.3000
	Female	34.040	23.750	**0.0215**
G2	Male	37.300	28.150	0.2189
	Female	38.140	29.115	0.1427
G3	Male	30.445	25.340	0.1367
	Female	51.850	44.915	0.6857
G4	Male	35.760	19.030	0.1534
	Female	29.700	21.030	0.2181

* Mann-Whitney test used

In the left unilateral chewing, a statistical difference was also evidenced between the myoelectric values registered in the right masseters compared to the left in the girls of the children's group. This difference was also identified in men from the adult group and male adolescents showed a strong tendency to this behavior. In the groups of children, adolescents and elderly, it was noticed that, in this type of chewing, the left masseter behaves with higher electromyographic potentials when compared to the right masseter, however, in the adult group, the opposite was observed (Table 6).

Table 6. Comparison of electromyographic values for left unilateral chewing by group and sex

Group	Sex	Right	Left	*Descriptive level
G1	Male	28.670	47.110	0.2785
	Female	20.370	38.910	**0.0345**
G2	Male	32.525	46.490	**0.1059**
	Female	30.340	34.960	0.2142
G3	Male	31.535	16.020	**0.0083**
	Female	58.500	36.255	0.3429
G4	Male	20.790	26.170	0.2260
	Female	21.970	27.340	0.8119

* Mann-Whitney test used

The electromyographic analysis of habitual chewing revealed a myoelectric balance between the right and left masseters in the studied groups, except among male adolescents, who had higher potentials in the left masseter (Table 7).

Table 7. Comparison of electromyographic values for habitual mastication by group and sex

Group	Sex	Right	Left	*Descriptive level
Children	Male	36.690	39.830	0.4779
	Female	28.560	27.010	0.9310
teenagers	Male	26.375	36.160	**0.0387****
	Female	34.740	31.595	0.8147
Adults	Male	18.155	22.835	0.4399
	Female	46.620	56.565	1.0000
Seniors	Male	25.790	22.980	0.8010
	Female	27.520	24.880	0.8651

* Mann-Whitney test used

The variables bite force, myoelectric activity and facial anthropometry were correlated in each group and between groups. These analyses identified positive correlations between left bite force and facial anthropometric values on the right side of the face during adolescence. In adults, a negative correlation was identified between the incision force and the anthropometric values of the right hemiface. A positive correlation was detected between right unilateral chewing and incision force in the elderly group, as well as a negative correlation between right bite force and left chewing in the same group (Table 8).

Table 8. General measurements of correlation between bite forces of central incisors, molars of the right and left hemiarches and electromyographic and facial anthropometric measurements

Parameters	**Variables**		
	Incision force	**Molar force D**	**Molar force E**
5 ⊢⊣ 11 years old			
EMG CVM – D	-0.177	-0.031	-0.295
EMG CVM – E	-0.009	-0.248	0.080
EMG habitual chewing – D	-0.184	0.055	-0.103
EMG habitual chewing – E	-0.053	-0.085	-0.019
Anthropometry D	-0.236	0.072	0.211
Anthropometry E	-0.224	0.070	0.066
12 ⊢⊣ 18			
EMG CVM – D	-0.191	-0.049	-0.332
EMG CVM – E	-0.280	-0.130	-0.087
EMG habitual chewing – D	-0.179	-0.224	-0.263
EMG habitual chewing – E	-0.254	-0.247	-0.107
Anthropometry D	0.005	0.075	**0.467***
Anthropometry E	-0.058	0.093	0.243
19 ⊢⊣ 59			
EMG CVM – D	0.125	0.075	0.145
EMG CVM – E	0.179	-0.168	-0.056
EMG habitual chewing – D	-0.021	0.084	0.120
EMG habitual chewing – E	0.062	-0.272	-0.134
Anthropometry D	**-0.399***	0.046	-0.074
Anthropometry E	0.025	0.005	-0.048
60 ⊢⊣ 79			
EMG CVM – D	0.334	0.194	0.170
EMG CVM – E	0.394	0.300	0.233
EMG habitual chewing – D	0.261	0.299	0.148
EMG habitual chewing – E	**0.446***	**0.452***	0.393
Anthropometry D	-0.038	-0.098	-0.187
Anthropometry E	-0.097	-0.166	-0.301

* Spearman correlation test performed

By associating the bite force with the predominant side of chewing, it can be seen that the childhood cycle had higher values of bite force on the right when the chewing preference side was on the right side, and when the side preferred by the chewing occurred on the left side and bite force was also greater on the left. In the adolescence and senescence cycles, it was also seen that the side with masticatory predominance on the left corresponded to the side with greater bite force. The group of adults did not show a strong association between chewing side and bite force, although a trend towards this association was identified (Table 9).

Table 9. Summary measures of bite force in each age group, according to chewing preference side

Bite force measurements	Side of predominance of chewing				*P_ value
	Right		Left		
	Mean (dp)	Median @ (p25-p75)	Mean (dp)	Median @ (p25-p75)	
5 ⊢⊣ 11 years old					
Incision bite force	27.23@ (6.34)	25.84@(22.96-31.42)	29.5@(5.94)	29.93@(24.78-33.6)	0.399
Right bite force	**57.2@ (6.79)**	**57.71@(55.32-60.94)**	48.11@ (8.35)	48.05@(42.61-55.68)	0.003*
Left bite force	49.08@ (7.46)	50.11@(47.89-52.15)	**56.77@ (7.19)**	**58.71@(51.98-60.67)**	0.012*
12 ⊢⊣ 18 years old					
Incision bite force	44.71@ (10.26)	46.68@(37.05-54.12)	42.87@ (15.97)	44.24@(35.58-50.57)	0.790
Right bite force	77.97@ (9.59)	77.77@(71.39-81.95)	78.18@ (18.78)	80.96@(69.66-92.64)	0.608
Left bite force	72.73@ (9.38)	71.13@(65.89-79.81)	**106.9@ (28.87)**	**100.47@(79.91-131.38)**	0.000*
19 ⊢⊣ 59 years old					
Incision bite force	30.69@ (21.66)	22.98@(13.87-41.33)	30.52@ (19.58)	27.95@(13.26-40.72)	0.917
Right bite force	51.67@ (26.93)	47.9@(29.43-76.7)	41.26@ (30.55)	32.71@(15.77-60.87)	0.235
Left bite force	44.54@ (25.13)	48.6@(20.18-63.64)	43.4@(31.3)	47.01@(12.02-68.98)	0.786
60 ⊢⊣ 79 years old					
Incision bite force	32.09@ (11.03)	37.16@(28.95-40.8)	38.98@ (12.87)	37.5@(31.68-47.87)	0.101
Right bite force	46.12@ (11.63)	47.47@(38.98-54.92)	55.42@ (14.19)	56.39@(44.17-68.09)	0.092
Left bite force	45.36@ (14.05)	44.82@(36.12-52.26)	**60.91@ (16.27)**	**60.61@(46.43-70.34)**	0.009*

Caption: *p-value calculated by the Mann-Whitney test

Discussion

From the results obtained in this research, it was possible to describe the behavior of the masticatory function in different age groups, taking into account the variables sex, bite force, anthropometric measurements of the face and electrical activity of the masseter muscles, in addition to establishing intra- and inter-group correlations.

The facial anthropometric assessment took into account the measurements between the points **ex** (external corner of the eye) and **ch** (cheilion-labial commissure) on the two hemifaces, revealing symmetry between the measurements. As for the evolution of this variable, a trend of progressive increase in measurements was noticed until adulthood and a decrease in the elderly group. The reported findings agree with the expected characteristics of senescence, where there is a decline in striated skeletal muscle tone and a consequent decrease in facial proportions[11].

In the present study, there was an increase in bite force power between the cycles of childhood and adolescence, reaching a level in adulthood and declining in senescence. These results are justified by the physiology of human development, which points to an increase in muscle power until adulthood and a decline in muscle tone and mass with aging [11].

Literature differs on the relationship between bite force, age and sex. Some studies indicate that there is a decrease in bite force with advancing age [12-13], as well as males present higher values of this strength compared to females. On the other hand, other researchers claim that there is no variation in bite force in different age groups or different sexes [14].

in a study [15] it was possible to observe that there was no correlation between age and bite force, only an inverse correlation between bite force and age in male patients with complete dentures. The opposite was identified in another study[16] where children had lower bite force than other age groups, with the exception of the elderly, showing that age is an influencing factor on bite force.

In addition to bite force, another magnitude analyzed was the electromyographic power of the masseter muscles during rest, maximum voluntary contraction (MVC) and right unilateral, left unilateral and habitual mastication. During muscle rest, with the volunteer in centric occlusion, there was a percentage of around 3% of electrical activity in the masseters. Only the elderly group showed a slight increase in this variable, reaching more than 5% of activity recorded in females. These data are in accordance with the results found in the literature[17], it was observed that in adults without orofacial complaints the presence of minimal electrical activity of the masticatory muscles during rest in habitual centric occlusion, which leads to the inference that this activity is essential (basal) for the maintenance of the mandibular posture. However, there is also evidence that surface electromyography during masseter rest does not present a difference correlated to gender and age variables. [15].

The electromyographic findings during MVC showed different behaviors between the groups, with a progressive increase in their percentage values until adulthood and a decline in these values during senescence. There was also a trend towards higher values among males when compared to females. These findings agree with a study that pointed out a greater electromyographic activity in the CVM of children and adolescents, decreasing in adults and elderly[13].

According to the literature[18], in children and adolescents the electromyographic findings during chewing are similar, corroborating the results found in this research.

Researchers[19] reported that so-called healthy individuals, without morphofunctional alterations of the stomatognathic system, always present a side of chewing preference. However, when chewing is performed in such a way as to be preferentially unilateral, the muscles adjacent to this side develop higher levels of activity and, consequently, are more shortened in relation to contralateral pair[20].

It was found in a research[21] the presence of a chewing preference side (LPM) in most of the evaluated subjects (77.6%) during habitual chewing. Other researchers showed the absolute occurrence of LPM, where 100% of the studied adult sample presented chewing preferentially on the right or left side[22]. These data corroborate the results found in the present study, where 100% of the participants presented the right or left side as chewing preference.

Regarding the LPM distribution, 62.86% of the volunteers had chewing preference to the right and 37.14% to the left. While a survey[23] found a balance in the distribution of LPM (left = 39.4% and right = 38.4%), other authors[20] identified a higher frequency of preference for the left side (62.1%).

During right unilateral chewing, a significant difference was found between the pairs of masseters of the girls who made up the group of children, where the right masseter had higher electromyographic indices when compared to the left masseter. This behavior was also identified in the other groups, regardless of the gender variable, although no statistical difference was evidenced.

In the left unilateral mastication, a statistical difference was identified between the pairs of masseters of girls from the children's group, male adolescents and adult males. When the gender variable was not taken into account, a greater electromyographic potential was observed in the left masseter of children, adolescents and elderly groups. The adult group showed opposite behavior, in which the right masseter had higher electrical potentials compared to the left masseter.

Habitual chewing during surface electromyography showed that there is a balance between the pairs of masseters in the different age groups studied. However, in the group of adolescents, there was an increase in myoelectric activity in the left masseter compared to the right in males.

When it comes to the masticatory process in relation to sex, the literature diverges from the findings found in this study. There was no relevance of gender in the statistics of chewing pattern in children; boys and girls have the same chewing aspect at this stage, according to the findings in the literature[24].

Researchers carried out a study with the aim of evaluating the influence of age on the electromyographic activity of masticatory muscles. The volunteers were aged between 7 and 80 years and surface electromyography data were obtained at rest, during maximum voluntary contraction and right and left laterality. Statistical difference was found in all clinical conditions between different age groups and the greatest electromyographic activity was registered in children and adolescents, decreasing in adults and elderly[13].

It was also found that the side with greater electromyographic activity during MVC and habitual chewing corresponded to LPM (80%); This result coincides with the data presented by researchers[17], in a study involving electromyographic investigation of chewing in adults, who pointed out a higher frequency of one side of chewing preference during habitual chewing (82.8%), as well as higher levels of electromyographic potential.

These data also corroborate the findings of a study [25] carried out with young adults undergoing electromyographic evaluation during mastication of biocapsules, where it was identified that when mastication occurs on the right side, the right masseter has higher electrical potential values when compared to left masseter as well as in reverse.

A pattern of functional asymmetry between the masseters was evidenced in the findings of this study. This fact occurred not only during chewing (usual, unilateral right and left), but also during MVC. It is likely that the occurrence of this event is related to the fact that 100% of the sample had an LPM.

A research[19] involving the investigation of the distinction between the electrical potentials of the masseters during mastication, it was verified the existence of asymmetry within the standards of normality between the myoelectric potentials of the masseters of adults.

On the other hand, another study[26] found in its findings involving adults with good oral health that, during unilateral chewing, whether right or left, there is no difference between the myoelectric potentials of the masticatory muscles.

The reproducibility of electromyographic activity in relation to static bite force of masticatory muscles and facial dimensions is the subject of studies with divergent points. Among the findings of this research, it was found that the bite force exerted on the molars of the left hemiarch showed a positive association with the facial measurement on the right side in the group of adolescents, as it corresponded to the side of masticatory predominance in the same group and in the elderly group. The bite force exerted on the molars of the right hemiarch showed a negative correlation with the electromyographic activity during left unilateral chewing in the elderly. The incision force showed a positive correlation with the electromyographic activity during right unilateral chewing in the elderly and a negative correlation with the facial measurement on the right side in the adult group. In all groups studied, the chewing preference side corresponded to the side with greater bite force, with proven statistical significance in the childhood cycle.

The correlations between the morphofunctional factors that make up chewing are the object of study among professionals who have the stomatognathic system as the target of attention. In a research carried out with young adults, a battery of observational and electrophysiological tests of the masticatory function was performed and it was found that there is no correlation between the electrical responses of masticatory muscles, bite force and the morphological indices of the face. When viewed in isolation, the electrical activity of the masticatory muscles seems to be associated only with the bite force[27].

In another study that evaluated the electromyographic activity of the masseter muscles in the adult public in different facial types during rest and chewing, no statistical difference was revealed between the electrical activity and the different facial types, as well as the sex and age variables did not interfere in the results[28].

In contrast to the findings described in this study, the literature indicates that direct correlations are identified between the right and left masseter muscles during maximum voluntary contraction, but there is no evidence of correlation between bite force and electromyographic activity[29].

Conclusion

According to the results found in the present study, it was found that chewing behavior varied according to age and sex, indicating a trend of correlation between the anatomical and functional components involved in this stomatognathic function.

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