Does the Masticatory Function Interfere With the Nutritional Status and Quality of Life in Individuals After Treatment for Head and Neck Cancer?

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Abstract

Head and neck cancer damages the oral health and chewing performance, impairing the nutritional status and quality of life even after treatment completion.

Objective: This study investigated the effect of treatment on the chewing function, the influence on oral health in chewing function and the relationships between chewing, nutritional status and quality of life in individuals after treatment of head and neck cancer.

Methods: The study was conducted on twenty individuals who were evaluated by surface electromyography; nutritional status; evaluation of oral health and quality of life.

Results: The results of electromyography showed an asymmetric pattern, with predominance of activity on the working side. The correlations evidenced that the greater the use of upper dentures and caries activity, the greater the asymmetry of muscle activity, while the greater need of lower denture led to more chewing cycles. The lower the body fat percentage, the greater the symmetry of muscle activity; and the lower the recruitment of temporalis muscles, the greater the physical limitation.

Conclusions: It was concluded that, in individuals after treatment of head and neck cancer, there was relationship between the correlated variables.

Introduction

According to the World Health Organization (WHO), head and neck cancer is the seventh most common in the world, being the fifth most frequent in the world male population and 12th most frequent in the world female population, whose main involved factors are smoking, alcohol abuse and presence of human papilloma virus (HPV).^{1,2}

The treatment is usually performed by surgery, chemotherapy and radiotherapy;³ the latter may have consequences on oral health, as mucositis, gingivitis, periodontal disease, dental caries, abscess and hyposalivation.^{4,5,6} These changes may also evolve, with long-term consequences, such as greater probability for development of dental caries and periodontal diseases,⁷ need for tooth extractions, reduction of saliva production and mouth opening, affecting chewing.⁸

The treatment may also cause changes in taste, dry mouth and appetite loss,⁹ with weight loss during and one month after treatment, thus it is necessary to follow the patient's nutritional status even after completion of radiotherapy.¹⁰

The nutritional status of patients with cancer may present risk of malnutrition, both due to the disease and treatments performed, estimating that, among deaths in individuals with cancer, 10 to 20% are caused by malnutrition.¹¹

Malnutrition in individuals with cancer impairs the quality of life, decreases the response to treatment, increases the risk of radiation-induced toxicity, besides reducing the performance of muscle function and increasing the risk of postoperative complications.¹²

The quality of life of patients with head and neck cancer may be affected even at treatment completion.¹³ Li, Otomaru and Taniguchi¹⁴ observed a high impact for psychological discomfort and low for disability, concerning

the oral health-related quality of life in this population. Additionally, application of the quality of life questionnaire UW-QOL, after surgical treatment or radiotherapy, demonstrated an important score for items related to chewing difficulties.¹⁵ In this sense, Biazevic et al¹⁶ observed that impaired chewing, as well as swallowing and speech functions, negatively affect the quality of life of patients after surgical treatment of oral and oropharyngeal cancer.

In the evaluation of masticatory function, surface electromyography (EMG) represents a reproducible and reliable method to assess the muscle activity and quantify the recovery of patients.^{17,18} Electromyography in this population was used in only one study, in which patients submitted to bone resection presented impaired muscle activity, especially when the mandible was involved.¹⁹

No papers were found in the literature investigating the relationship between the nutritional status and electromyographic activity of masticatory muscles in individuals after treatment of head and neck cancer, even though the literature addresses the occurrence of malnutrition and impaired masticatory function in this population.

The present study hypothesized that antineoplastic treatment causes damage to oral health, nutritional status and chewing deficiency, which are related, causing greater damage to the individual with head and neck cancer, which reduce the quality of life. Thus, this study investigated the effect of treatment of head and neck cancer on the masticatory function regarding the electromyographic activity, as well as the influence of oral health on the performance of masticatory function and the relationships between chewing, nutritional status and quality of life in individuals after treatment for head and neck cancer.

Methods

This study was approved by the Institutional Review Board of Bauru School of Dentistry (CAAE: 59800016.3.0000.5417). This study confirm that all experiments in accordance with relevant guidelines and regulations and was have been performed in accordance with the Declaration of Helsinki.

The sample calculation considered a significance level of 5% and sample power of 80% for the Spearman correlation, obtaining n=29 of adult individuals, both males and females, after surgical treatment, radiotherapy and/or chemotherapy for head and neck cancer. The study participants received dental treatment at the Clinical Research Center (CPC) of Bauru School of Dentistry, where the 29 individuals who met the inclusion criteria were invited, yet 9 participants were lost, either due to refusal to participate in the study, cancer relapse, lack of phone answer or death.

Thus, the study sample consisted of 20 adult and elderly individuals, aged 30 to 63 years, with mean age 53.2 years. The characteristics regarding gender, age, medical diagnosis and information about the treatments performed are presented in Table 1. All participants were clearly informed about the research procedures and signed an Informed Consent Form.

The following inclusion criteria were adopted: accomplishment of treatment for oral, oropharyngeal, pharyngeal or laryngeal cancer at least three months earlier, including radiotherapy, chemotherapy and/or surgery, combined or not, as well as exclusive oral diet.

Patients with a history of neurological disease or syndromes, undergoing treatment for cancer in any site, using tracheostomy and/or wheelchair were excluded, the latter because the calculations to measure weight and height applied to wheelchair users are different from those proposed for this study.

Table 1 – Individual data of the sample concerning gender, mean age, cancer site, period after treatment, site of treatment and type of RT

Patient	Gender	Age (years)	Cancer site	Patient	Treatment modality	Period after treatment	Site of treatment	Type of RT
1	F	46	Upper lip	1	CR + RT	13 months	Upper lip	IMRT
2	M	44	Nasopharynx	2	RT	8 months	Cervical region	IMRT
3	M	56	Larynx	3	CT + RT	64 months	Head and Cervical region	IMRT
4	M	51	Tongue base	4	CR	22 months	-	-
5	M	54	Tongue base and border	5	CR + CT + RT	53 months	Tongue	IMRT
6	M	48	Left tonsil	6	CT + RT	44 months	Cervical region	IMRT
7	M	41	Oropharyngeal	7	CT + RT	5 months	Cervical region	IMRT
8	M	49	Mouth floor	8	CR	31 months	-	-
9	M	58	Epiglottis	9	CR + CT + RT	12 months	Cervical region	IMRT
10	M	58	Oropharyngeal	10	CT + RT	6 months	Cervical region	IMRT
11	F	48	Left oral mucosa	11	CR + RT	4 months	Cervical region	IMRT
12	M	30	Soft palate	12	CR + CT + RT	3 months	Cervical region	IMRT
13	M	60	Tongue base and tonsil pillar	13	CR + CT + RT	32 months	Head and Cervical region	IMRT
14	M	62	Soft palate	14	CT + RT	14 months	Cervical region	IMRT
15	M	61	Tongue base	15	CT + RT	10 months	Cervical region	IMRT
16	M	61	Larynx	16	CT + RT	6 months	Cervical region	IMRT
17	M	59	Tongue (right border)	17	CR	17 months	-	-
18	M	63	Tongue base	18	CT+RT+CR	13 months	Cervical region	IMRT
19	F	62	Oropharyngeal	19	CT+RT+CR	36 months	Cervical region	IMRT
20	F	53	Nasopharynx	20	CR+RT+CT	42	Cervical	Cobalt

n=20 F - 4 Mean=53.2
M - 16

Descriptive analysis

Legend: M=male; F=female; E=left; n=number; RT=radiotherapy; CT=chemotherapy; CR=Surgery; IMRT: Intensity-Modulated Radiotherapy

Electromyographic evaluation of masticatory function

The electromyographic activity was recorded on an eight-channel electromyography equipment BTS FREEMG 300 (BTS Bioengineering Ltda). In preparation for the assessment, the individuals were seated on a fixed chair, with their feet touching the floor. Then, the skin was cleaned with 70% alcohol and gauze to reduce the impedance and bipolar silver chloride surface double electrodes (10-mm diameter, inter-electrode distance 21 ± 1 mm) were positioned parallel to the fibers of masseter and anterior temporalis muscles on both sides.

The exams selected to record the electromyographic activity were Maximum Voluntary Contraction (MVC), performed at two moments as described by Felício et al²⁰ and Tartaglia et al²¹.

The analysis also considered the mean of potentials evaluated in the 3 most constant seconds of MVC with cotton rolls as 100%, and the potentials obtained during chewing were expressed as a percentage of these values.²²

Then, a bivariate and simultaneous analysis of the differential activity of masseter and temporalis muscles was performed, with representation on the Cartesian axes by the *Lissajousplot*, in which the x coordinate represented the differential activity of the right-left masseter, and the y coordinate referred to the differential activity of the right-left temporalis. Thus, the following electromyographic indices were obtained:^{18,21,22} **Total Impact (%s); Impact per cycle (%s); Confidence Ellipse (%²); Mean Module (%); Phase (°); Chewing symmetry (%); Work and Balance (%); Chewing frequency (Hz).**

Evaluation of oral health

The oral status was assessed by analysis of the DMFT index, community periodontal index (CPI) and evaluation of the use and need of dentures. The patients were examined by a trained and calibrated dental professional.

Caries activity (DMFT): The DMFT index quantifies the caries activity by the mean of the total number of permanent decayed (D), missing (M) and filled (F) teeth. This examination was performed under artificial light, using a spatula for tissue retraction, dental mirror and a blunt-tip probe.

The tooth was considered as "decayed" if there was cavity, opacity along the surfaces or stain; "missing", if extracted or indicated for extraction; "filling", for teeth with amalgam or composite restorations or similar; and "absent", unerupted tooth or hypodontia.

Patients presenting caries or active white spot lesions were recorded as need for treatment. The codes and criteria for the dental status were performed according to the WHO guidelines.²³

The DMFT was calculated by adding the codes, thus it was calculated by dividing the sum of individual DMFTs by the number of patients, thus obtaining the classification of caries activity, namely 0-1.1 (Very low); 1.2-2.6 (Low); 2.7-4.4 (Average); 4.5-6.5 (High) and ≥ 6.6 (Very High).²³

Community Periodontal Index (CPI): The periodontal health was assessed using a blunt-tip periodontal probe, dental mirror and disposable tongue depressor, under artificial light. The probe was introduced in the gingival sulcus or periodontal pocket, inclined in relation to the tooth long axis, following the anatomical configuration of the root surface, with probing force lighter than 20g. Probing was initiated on the distobuccal area, moving to the central area and then to the mesiobuccal area. Thereafter, the lingual, distal and mesial areas were examined.²⁴ The codes and criteria for the CPI followed the WHO guidelines.²³

Use and need of dentures/edentulism: The evaluation of edentulism followed the WHO guidelines for epidemiological surveys. The type and location of dentures were considered, either lower or upper, according to the prosthetic spaces corresponding to the missing teeth observed on the physical examination, thus being classified according to the WHO codes and criteria.²³

Oral health-related quality of life

The study applied the Oral Health Impact Profile (OHIP-14), a short version of OHIP-49, containing 14 questions divided into 7 dimensions (functional limitation, physical pain, psychological discomfort, physical limitation, psychological limitation, social limitation and disability), and its application individually demonstrated the perception of individuals about the impact of their oral conditions on the quality of life.²⁵

The instrument was applied as an interview, and the participants were asked to respond according to their perception about their oral problems in the last twelve months.²⁶ A card with printed questionnaire responses was presented, aiming to ensure the understanding of possibilities of responses by the patient.

The final analysis was performed as described by Slade.²⁵

Anthropometric evaluation of nutritional status

Arm Circumference: The arm circumference (AC) represents the sum of the areas composed of bone, muscle and fat tissues of the arm.¹¹

Skinfold thickness: The skinfold thickness was expressed by the amount of body fat tissue, which may indicate the body energy reserves and the current nutritional status.¹¹ This included: tricipital skinfold thickness (TST); bicipital skinfold thickness (BST); subscapular skinfold thickness (SSST); supra-iliac skinfold thickness (SIST). From the measurement of skinfold thickness, the individuals were scored according to their fat reserves.

Muscle circumference of the arm (MCA): This parameter assesses the muscle tissue reserve (without correction of bone area). It is obtained from the values of AC and TST. The MCA adequacy was calculated based on the MCA value.²⁷

Percentage of body fat: After measurements of skinfold thicknesses TST, BST, SIST and SSST, the sum was obtained ($\sum 4PC$) and the body density was calculated as suggested by Durnin and Womersley.²⁸ The body density was converted into percentage of body fat by the equation of Siri²⁹ following the classification from very low to very high.³⁰

Body mass index (BMI): The weight and height measurements were used to calculate the BMI by dividing the body weight (Kg) by the height (m²). The values found were compared with the standards suggested by the World Health Organization (WHO) for adults, and for individuals older than 60 years as suggested by Lipschitz³¹.

Statistical analysis

The results of masticatory function, nutritional assessment, oral health and oral health-related quality of life were described by absolute and relative frequencies (n), and also by means and standard deviations.

The correlations of quantitative variables were calculated by the Pearson Correlation Coefficient, while the Spearman Correlation Coefficient was used for qualitative variables. All statistical tests were performed at a significance level of 5% (p<0.05).

For correlations, the classifications were determined according to the r value, namely weak from 0.10 to 0.30, moderate from 0.40 to 0.60, and strong from 0.70 to 1.0.³²

Results

Evaluation of masticatory function

For the POC index (Percentage Overlapping Coefficient), which analyzes the symmetry of muscle activity, the values found were close to 100%, indicating good muscle symmetry. The Torque presented value close to 0%, evidencing very little displacement of masticatory muscles, and the activity index (ACTIV) demonstrated predominance of activity of temporalis muscles compared to masseter muscles (Table 2).

Table 2 – Mean and standard deviation of electromyographic indices POC, Torque and ACTIV obtained in Maximum Voluntary Contraction

Electromyographic indices	POC		Torque	ACTIV
	Temporalis	Masseter		
Mean	78.22	80.27	9.08	13.28
SD	9.58	11.45	7.21	11.15

Descriptive analysis

Legend: POC = Percentage Overlapping Coefficient; Torque = Torque Coefficient; ACTIV = Activity Index; SD = Standard deviation

The unilateral chewing test was performed by 19 patients, because one was unable to perform unilateral chewing on the left side with chewing gum. It should be mentioned that some patients had difficulty to perform unilateral chewing due to edentulism or hyposalivation, and thus were unable to make the chewing gum homogeneous for the examination.

As shown on Table 3, the value obtained from the chewing symmetry index was low, considering that 0% is an asymmetric muscle pattern and 100% a symmetrical pattern. The values observed in the chewing frequency were similar between the right and left sides. Also, the same table presents the values of total impact and per cycle,

respectively showing the total activity and the activity divided by the number of masticatory cycles performed by the patients.

Table 3 – Mean and standard deviation of electromyographic indices Impact, Impact per cycle, Chewing symmetry and Chewing frequency, obtained by assessment of unilateral chewing

EMG index	Impact (%s)		Impact per cycle (%s)		Chewing symmetry (%)	Chewing frequency (Hz)	
	R	L	R	L		R	L
Mean	1654.93	1812.68	76.81	83.37	25.68	1.42	1.46
SD	1066.52	1093.94	43.98	49.76	26.76	0.20	0.22

Descriptive analysis

Legend: SD = standard deviation; R = right; L = left; EMG = electromyography; % = percentage; Hz = hertz; %s = percentage per second

Table 4 presents the values observed for the indices Confidence ellipse, Mean module, Phase and Working and balance. The angle obtained in the Phase for both right and left sides was increased. Analysis of the Working and balance evidenced that the masseter muscle showed greater activity on the working side than the temporalis muscle, even though both means were positive.

Table 4 – Mean and standard deviation of electromyographic indices, confidence ellipse, mean modulus, phase and working and balance in the evaluation of unilateral chewing

EMG indices	Confidence ellipse (% ²)		Mean modulus (%)		Phase (°)		Working and balance (%)	
	R	L	R	L	R	L	R	L
Mean	34924.05	35586.6	106.85	144.15	158.96	146.78	52.95	15.53
SD	52874.6	38068.7	94.94	132.59	111.09	113.55	101.67	52.11

Descriptive analysis

Legend: SD = standard deviation; R = right; L = left; EMG = electromyography; % = percentage; %² = square percentage; ° = angle

Correlations between masticatory function, oral health, nutritional status and oral health-related quality of life

Masticatory function and oral health

The study population presented a mean of 7.30 missing teeth and very low to low caries activity (45% and 55%, respectively). Evaluation of the community periodontal index evidenced that the individuals presented calculus (60%), gingival bleeding (50%) and periodontal pocket of 4 to 5mm (35%).

The use of dentures demonstrated lack of oral rehabilitation for 75% of patients in the lower arch and 60% in the upper arch, demonstrating that most patients did not use dentures. Consequently, when assessing the “need of

dentures”, most patients presented such need.

Analysis of the correlation between quantitative variables of masticatory function and oral health did not reveal statistically significant results.

Correlation between the qualitative variables of masticatory function and oral health revealed that the lower the need of lower denture, the greater the symmetry of muscle activity of the individual ($r: -0.504^*$ and $p:0.023$).

In the analysis of unilateral chewing, the higher the use of upper denture, the greater the asymmetry in the activity of masticatory muscles. Concerning caries activity, the greater this activity, the greater the asymmetry in chewing presented by the patient. It was also observed that the greater the need of lower denture, the more chewing cycles per second were performed during function (Table 5).

Table 5 – Correlation between masticatory function and oral health

Oral health	Chewing symmetry		Chewing frequency R	
	r	p	r	p
DMFT	-0.577**	0.01	-	-
Use of upper denture	-0.665**	0.002	-	-
Need of lower denture	-	-	0.522*	0.022

* $p < 0.05$ – Spearman correlation test

Legend: r = correlation coefficient; DMFT = caries activity; R = right

Masticatory function and nutritional status

Evaluation of the muscle circumference of the arm, achieved by calculation using the AC and TST values, an important parameter for body muscle evaluation, demonstrated that 60% of patients presented eutrophic status and 40% had some degree of malnutrition.

The BMI results achieved demonstrated that most patients (65%) were not eutrophic, i.e., most participants were not in adequate status concerning weight and height.

The body fat percentage, calculated using the four skinfold thicknesses measured on the patient, showed that 50% were within the recommended fat percentage, yet the other patients presented results indicating excess body fat (30%) or below the recommended level (20%).

Regarding the quantitative variables, the correlation between anthropometric data and masticatory function showed that the lower the percentage of body fat, the greater the chewing symmetry, i.e., the more symmetrical the muscle pattern during function, with an r value of -0.521^* and $p=0.019$.

Masticatory function and oral health-related quality of life

Application of the OHIP-14 questionnaire demonstrated that 55% of patients presented weak impact, 40% medium and 5% strong impact on the oral health-related quality of life. Table 6 shows the results of the seven dimensions that compose the OHIP-14 questionnaire.

Table 6. Presentation of results concerning the minimum and maximum values, median and standard deviation, for each dimension of the OHIP-14.

Dimensions	Minimum	Maximum	Median	Mean (sd)
Functional limitation	0.00	3.49	1.2450	1.40 (1.06)
Physical pain	0.00	4.00	1.0000	1.26 (1.19)
Psychological discomfort	0.00	4.00	1.0500	1.45 (1.25)
Physical limitation	0.00	4.00	1.0000	1.36 (1.33)
Psychological limitation	0.00	4.0	1.200	1.30 (1.24)
Social limitation	0.00	4.00	0.0000	1.05 (1.30)
Disability	0.00	4.00	1.0000	1.19 (1.13)
Overall	0.00	22.22		9.05 (6.37)
			6.1150	

Analysis of the relationship between quantitative variables of the quality of life questionnaire and masticatory function revealed that only the dimension of physical limitation showed correlation, in which the greater the physical limitation of the patient, the less the pair of temporalis muscles is used, considering the value lower than -100% observed for the activity index, with r of -0.586 and $p=0.007$.

Analysis of the correlation of qualitative variables of EMG data of chewing and the sum of results of the OHIP-14 did not reveal statistically significant results.

Discussion

This study evaluated the masticatory function performed by surface electromyography examination in individuals after treatment of head and neck cancer. The values found for the chewing frequency index were similar between right and left sides. When comparing the present results with the literature, the chewing frequency values were similar to the study by Dellavia et al,¹⁹ which was the only study found on a sample of patients after antineoplastic treatment, submitted to mandibulectomy. Some participants in the present study were submitted to surgery on the oral cavity, as shown on Table 1, being one surgery in the mandible, which may have contributed to the similar values observed.

The other electromyographic indices analyzed were compared to those of healthy individuals described in the literature. In the MVC test, the values obtained for the POC index were close to normality,^{18,33} indicating good symmetry of muscle activity. The Torque index values indicated very little lateral displacement of masticatory muscles, similar to the control group of healthy individuals by Ferrario et al.¹⁸ In the same study, the value was lower than observed in groups of patients with fixed denture and overdenture. For the Activity index, the result was similar to healthy individuals, indicating predominance of activity of the temporalis muscle.²¹

One possible hypothesis for the similar MVC results as those of healthy individuals described in the literature may be the posttreatment time of patients in this study, longer than one year, as well as the fact that they receive regular dental follow-up and, when needed, perform dental treatment for oral rehabilitation, which may have contributed to a better performance in the test that involved static activity of masticatory muscles.

The unilateral chewing test was performed by 19 patients, because one patient was unable to perform unilateral chewing on the left side with chewing gum. It should be mentioned that some patients had difficulty to perform unilateral chewing due to edentulism or hyposalivation, and thus they were unable to make the chewing gum homogeneous for the examination.

Concerning the Total impact and per cycle, the study observed higher values than described for healthy individuals,^{22,20} demonstrating greater muscle activity over time, with greater recruitment of motor units. The values found for Confidence Ellipse and Phase were also higher than reported for healthy individuals,^{18,20,22} respectively indicating greater variability in the patterns of contraction of masticatory muscles and incoordination of this musculature. The values of Mean module, Chewing symmetry and Working and balance were lower than those of healthy individuals,^{18,20,22,34} showing less activity on the working side and asymmetry of muscle pattern, since 0% indicates an asymmetrical pattern and 100% a symmetrical pattern. When comparing the Working and balance values between muscles, the masseter showed greater activity on the working side than the temporalis muscle.

The differences found may be related to the samples of reviewed studies, since participants in the present study were aged 30-63 years and had been submitted to radiation therapy and surgery, which may have affected the stomatognathic system. The results observed for unilateral chewing, i.e. during dynamic activity of the masticatory muscles, can be justified by the presence of muscle atrophy due to the period in which the patients remained edentulous, by the radiation that affects the muscle function, leading to trismus.¹⁸ It should be considered that the decision to intervene, by professionals who may assist in the aforementioned symptoms, may be different in patients at three to five months posttreatment who received adequate therapy throughout the treatment period and posttreatment.³⁵

This is the first study investigating the correlations between masticatory function assessed by electromyography, oral health, nutritional status and oral health-related quality of life. These findings are important to present how the health specialties in their different interfaces are related and can help, in combination, for the clinical improvement of patients and their quality of life.

In the evaluation of unilateral chewing, moderate correlation was found with the DMFT, in which the higher the caries activity index, the lower the symmetry of muscle activity during chewing. There were also moderate correlations in which the greater need of a lower denture led to lower chewing symmetry and fewer chewing cycles. Also, the more the patient used denture, the lower the symmetry in the activity of masticatory muscles. A study evaluated the chewing capacity and reported that edentulism and inability to use the denture interfere with the chewing efficiency after treatment of head and neck cancer³⁶.

The BMI results achieved were not correlated with the indices evaluated by the electromyographic examination. In this study, whose mean age of participants was 53 years, the mean BMI was 24.9 kg/m², scored as eutrophic, while 65% of patients were found to be non-eutrophic, being 20% with low weight and 45% with overweight. Carvalho et al.³⁸, also investigating a population after treatment of head and neck cancer, found a mean BMI of 21.64 kg/m², indicating eutrophy, similar to the present study. Mulasi et al.³⁹ investigated a population of patients 1 month and 3

months after treatment of head and neck cancer, with BMI of 27 kg/m², mean age 59 years, and according to the World Health Organization the value of 27 is considered overweight.

No correlation was found between the MCA variable and the indices assessed on electromyography. The MCA showed that more than half of the patients (60%) were eutrophic, thus it was expected to observe adequate masticatory muscle activity. However, some indices of chewing function were altered. The assessment of muscle tissue is an estimate and was performed on the arm of patients. This area lies outside the site of tumor and also outside the area submitted to radiation in patients with head and neck cancer in patients with head and neck cancer, where there may be possible consequences on the muscles. Thus, the MCA may not be an adequate parameter to compare the muscular activity, since the MCA evaluates an area not irradiated or with presence of tumor.^{27,11}

The variable body fat percentage showed moderate correlation with the POC index in the temporalis muscle, showing that the higher the body fat percentage, the lower the symmetry of muscle activity. This negative impact may be related to the choice of fatty foods, such as deep-fried foods, since the process of immersion in fat enhances the food flavor, and dysgeusia is a common complaint after treatment of oral cancer.^{36,37} Additionally, in the nutritional assessment, some patients were overweight, which may be related to the lack of physical activity combined to unhealthy eating, which contributes to an inadequate muscle function.

Regarding the dimensions of the OHIP-14 quality of life protocol, it was observed that the higher the score on physical limitation, the lower the recruitment of the pair of temporalis muscles. In physical limitation, the questions were related to food and meals impaired by problems with the teeth, mouth or denture. Thus, if the patient had any of these problems, consequently the chewing function could be affected, impairing the recruitment of the temporalis muscles during chewing. The total score of the OHIP-14 questionnaire did not show statistically significant relationship, which may have happened because the patients were in the average at 21.75 months posttreatment and received dental follow-up at the clinic where the study was conducted. Thus, any problem with the teeth, mouth or denture after treatment was being managed, contributing to the low and medium impact score of the oral health-related quality of life questionnaire.

The clinical implications of this study are important, since they emphasize that patients submitted to antineoplastic treatment may present damages to oral health, nutritional status and masticatory deficiency, which are interrelated, highlighting the importance of interdisciplinary follow-up of these patients, allowing lower impact of cancer treatment on the quality of life.

Therefore, the present findings demonstrate that, in individuals after treatment of head and neck cancer, caries activity, the use and need of dentures influenced muscle activity during chewing. Also, there was relationship between chewing function and nutritional status, since the lower the fat percentage in the individual, the greater the symmetry in chewing. Oral health-related quality of life was also related to the chewing function, and the greater the physical limitation, the lower the use of the pair of temporalis masticatory muscles.

Despite the study limitations, such as heterogeneous series, with different tumor location, post-treatment time, sample size different from the sample calculation and nutritional assessment, this represents the first study investigating the relationships between chewing, oral health, quality of life and nutritional assessment, highlighting the importance of interdisciplinary work among health professionals, contributing to the clinical recovery of individuals submitted to treatment for head and neck cancer.

Thus, future studies should consider more or other parameters on the nutritional status related to muscle tissue with the use of bioimpedance, which allows assessment of body composition regarding the lean mass and body fat, besides dietary assessment, allowing the quantification of foods consumed by patients in their daily lives. Finally, studies on samples that allow the analysis of posttreatment time and diagnosis of cancer will contribute to complement the knowledge about the aspects investigated in the present study.

Conflict of interest declaration: The authors declare that have no conflict of interest that might constitute an embarrassment to the publication of this article.

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