# PREFERENCE SIDE MASTICATORY AND FACIAL SYMMETRY IN TOTAL LARYNGECTOMY: CLINICAL AND ELECTROMYOGRAPHIC STUDY

## *Preferência de lado mastigatório e simetria facial em laringectomizados totais: estudo clínico e eletromiográfico*

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**ABSTRACT**

**Purpose**: to observe whether a relationship exists between the preference of chewing side, facial anthropometry and electrical activity of masseter muscle in total laryngectomy. **Methods**: data collection, performed in the Speech Therapy Cancer Hospital of Pernambuco (HCP), with the participation of fifteen volunteers laryngectomized males and mean age of 64 years. We performed measurement of distances between points and anthropometric facial ex ch in hemifaces of volunteers and later executed EMG of the masseter muscles, bilaterally, in his habitual intercuspal (MHI), unilateral right and left chewing and during mastication. Filming took place during mastication to identify the side of the preference side. **Results**: individuals whose right side is the masticatory predominance showed of the left side of the face to a greater extent (72.37 mm), while those whose prevalence of side left masticatory had higher estensão the side right (68.85 mm). In unilateral chewing right the electrical activity of the right masseter had an average 123.57% , while the left masseter showed an average 84.85% of the activity in relation to MHI (p = 0.016). **Conclusion**: in laryngectomized anthropometric facial measurements correlate with the preference side chewing and the values of the masseter EMG during mastication.

**KEYWORDS**: Anthropometry; Mastication; Electromyography; Laryngectomy; Laryngeal Neoplasms

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## INTRODUCTION

Laryngeal cancer is a tumor that most affect the head and neck region representing approximately 25% of malignant tumors in this area[1]. Squamous cell carcinoma is the most observed type, lying more frequently in glottis region[2].

Smoking and drinking alcohol are the main causes related to laryngeal cancer emergence. However, the occupational carcinogens agents contact (amianto, strong inorganic acids, cement dust and free crystalline silica) and intake of salted meat and fats may be associated to a considerable risk for the laryngeal cancer triggering[3]. In addition, genetic and endogenous factors are also among the

etiological factors for this cancer type[4]. The vocal abuse and this misuse are aggravating factors for this pathology development[5]. As the incidence, males subjects between 50 and 60 years are the most achieved[4].

In relation to the treatment, some authors mention that can be performed by radiotherapy, chemotherapy or surgery[5]. However, the adequate treatment indication is associated with lesion size, location, nature and staging[6]. In cases of advanced staging tumors with undertake more than one laryngeal region, the more indicated therapy is the total laryngectomy[7]. In this method, the laryngeal skeleton structures are removed (vocal folds, epiglottis and attachments)[7-9], two or three traqueal rings[6] and adjacents muscles[10]. From the anatomical and physiological standpoint, the remaining structures will adapt[8,10] promoting stomatognathic system (SE) functions interference and, consequently causing complaints related to mastication[11].

The ideal chewing is that one who occurs with a bilaterally alternating form, without noise or exaggerated perioral muscles participation[12]. The food court occurs with the front (incisive) teeth and the lips are closed. In bilaterally alternating way, the masticatory force is distributed interspersing moments of work and rest generating synchrony and balance of muscles of the SE and its functions[13].

When the chewing occurs by an unilaterally way, when there is a preference for most chewing on one side of the mouth, there are commitment of the SE function, causing imbalance of the forces involved upon chewing and changes in the dental system, muscle and skeletal that can cause facial asymmetries[14].

The pattern chewing unilateral causes muscle changes in which are identified higher power levels in the food processing side (working side), while the muscles of the hand without food (balancing side) is elongated and less tone[13].

A practical and non-invasive method for assessing chewing regarding power of the muscles involved in this act, is surface electromyography. An examination wich has an objective result and represents an important tool to assist clinical diagnosis as to muscle functions[15].

The aim of this study was to observe whether there is a relationship between the masticatory preference side, facial symmetry and electrical activity of the masseter muscle in total laryngectomyzed.

## METHODS

This is an observational, cross-sectional, descriptive design case series. Data collection was performed in the Speech Therapy Ambulatory at Cancer Hospital of Pernambuco (HCP) between February and June 2010.

Fifteen males volunteers total laryngectomized participated in this study, with an average age of 64 years. All volunteers signed an informed and free consent term according to Resolution 196/96 of the National Health Council.

The selection of volunteers was according to the following inclusion criteria: previous total laryngectomy with neck dissection; being in speech therapy ambulatory in outpatient at the HCP; possess ability to chew/digest solid food. The exclusion criteria for this group were: neuromuscular and/or degenerative disease; severe face edema accompanied by pain during mastication; temporomandibular dysfunction and edentulism without prosthesis. All subjects used dental prosthesis removable top.

To data collect it was established three steps:

***1st) Taking anthropometric facial measures*** – The volunteers were invited to sit in a chair so comfortable with the head and trunk erect, and eyes on the horizon; and so, there was held the anthropometric points marking in hemifaces, *ex* (outer corner of the eye) and *ch* (cheilion-labial)[16], with the aid of a dermatographyc pencil. Subsequently, using a digital caliper (JOMARCA® *Starnieless Hardened*, 0.01mm of accuracy) was performed to measure of the distance in millimeters, between the two points marked on hemifaces; each measurement was recorded three times and the mean of the found values was considered as the estimated measure for the distance.

***2nd) Electromyography of the masseter muscles evaluation*** – With the volunteer remained in the position described in the first stage above, the surface electromyographic evaluation was performed with values obtained in microvolts (μV) through the Miotool 200/400 – 4 channel (Miotec®) device with Miograph 2.0 *software*, using the gain in 1000, 4 SDS500 sensors, reference cable (earth), calibrator and disposable surface electrodes Meditrace®. The electrodes were placed on the skin overlying the masseter muscle, bilaterally and longitudinally arranged muscle fibers, after local cleaning by friction with gauze soaked in 70% alcohol, in order to minimize the impedance. The reference electrode (earth) was placed at the distal end of the right humerus volunteer to avoid interference during the signals recording. The records obtained were generated by maximum usual intercuspation (MIH), maintained for 5 seconds and repeated three times, relying on one-minute intervals for rest between each action; unilateral right and left chewing with ten seconds of duration, each one, and usual mastication of a French bread a piece with a 15s of

duration and 60s of rest. The average value found in the three records of MIH was used for the EMG signal normalization, serving as baseline (100%) for other calculations. Times of signal capture during chewing, we analyzed the central intervals always excluding the beginning and end of each activity of the record and using the average amplitude value in μV, at the *root mean square* (RMS) to transform it taking in percentage based on the value related to the MHI average of each muscle.

***3rd) Identification of preference masticatory side*** – The volunteers were videotaped while performing the electromyographic evaluation, at the time of usual mastication, with the aid of a digital camcorder Sony Digital Hand Cam VCR TRV 130 NTSC, which remained attached to a tripod with a 1.5m of distance to the chair where was the volunteer, and proportional height to the face of each participant. After the recordings reviewing, the usual mastication was characterized according to the preference for masticatory side (right or left). It was agreed that *masticatory preference side* that showed more than 60% of cycles during mastication.

This study was approved by the Ethics and Human Research Committee in the HCP with protocol registration number 42/2009 issued by the HCP.

Data analysis were used measured statistics: mean, median and standard deviation and Pearson correlation coefficient. The program used for data entry was th statistical calculations SPSS (*Statistical Package for the Social Sciences*) version 15.

## RESULTS

When analyzing the preference mastication side we found that 46.7% of the total laryngectomyzed presented as the right side dominant while 53.3% had the left side as preferably during the chewing act (Figure 1).

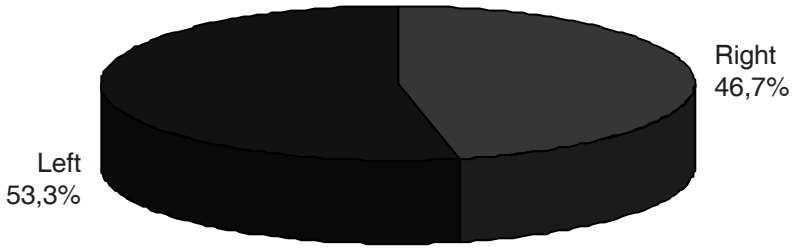


**Figure 1 – Patients distribution according to the mastication preference side**

The table 1 presents the mean anthropometric measurements of the face (extending between the outer corner of the eye to the labial comissure from the same hemiface) according to the predominance of the mastication side. It is found that: the average of the measure on the right side of the face was approximated among volunteers who had right or left side mastication preference (right side: 68.05 mm, left side: 68.85 mm) and not see significant differences between the two subgroups; the average of the measure on the left side of the face was higher among subjects with masticatory right side preference compared to the left side (left side: 72.37 mm, right side: 65.91 mm), a difference that revealed significant ($p = 0.013$). When analyzing this event in the sample highlights that: when the masticatory preference was on the right side, the left hemifacial average was higher (left side: 72.37 mm, right side: 68.05 mm – $p = 0.004$); and when the masticatory preference was on the left side, the right hemifacial average was higher (68.85 mm x 65.91 mm – $p < 0.001$) and in both situations see significant differences between hemifaces measurements.

The mean, median and standard deviation of the percentage values of the electrical activity of the masseter muscles obtained during unilateral chewing right, left and usual are described in Table 2.

**Table 1 – Correlations between facial measurements and mastication preference side**

| Variable | Mastication preference side | | p value |
|---|---|---|---|
| | Right | Left | |
| | Mean ± SD (1) | Mean ± SD (1) | |
| Right facial measurement | 68,05 ± 4,47 | 68,85 ± 2,20 | **p (3) = 0,677** |
| Left facial measurement | 72,37 ± 4,95 | 65,91 ± 2,46 | **p (3) = 0,013*** |
| p value | p (3) = 0,004* | P (3) < 0,001* | |

(*): Significant difference between the sides.
(1): SD means standard deviation.
(2): Through the *Student t test* for independent samples.
(3): Through paired *Student t test*.

**Table 2 – Relationship between electromyographic activity of the masseter muscles and mastication**

| Variable | Estatistics | | |
|---|---|---|---|
| | Mean | Median | SD (1) |
| Right unilateral mastication in right masseterter muscle | 123,57 | 114,90 | 57,74 |
| Right unilateral mastication in left masseter muscle | 84,85 | 90,60 | 36,58 |
| p value | p(2) = 0,016* | | |
| Left unilateral mastication in right masseter muscle | 91,85 | 79,40 | 60,00 |
| Left unilateral mastication in left masseter muscle | 88,83 | 86,00 | 45,31 |
| p value | p(2) = 0,816 | | |
| Right masseter muscle in usual mastication | 82,11 | 79,90 | 44,03 |
| Left masseter muscle in usual mastication | 25,77 | 25,50 | 15,53 |
| p value | p(2) = 0,104 | | |

(*): Significant difference between the sides.
(1): SD means standard deviation.
(2): Through to paired *Student t test*.

In right unilateral mastication the electrical activity of the right masseter muscle recorded average 123.57% and 84.85% from the left masseter muscle in relation to MIH. These data revealed a significant difference between the sides (p = 0.016).

In left unilateral mastication the electrical activity of the right masseter muscle recorded average 91.85% and 88.83% from left masseter muscle in relation to MIH (p = 0.816).

During usual mastication the average of electrical activity of the right and left masseter muscle was, respectively, were 82.11% and 25.77% (p = 0.104).

No statistical differences were found between the right and left masseter muscle in relation to left unilateral and usual mastication.

The table 3 examines the association between the electrical activity of masseter muscles during usual mastication and facial measurements. In this table we can see that the percentage of cases in which the side of greater electrical activity is the right side the higher; when the side of the greater extent of the face was the left side (66.7% x 44.4%), though not any significant relation between the two variables in the analysis can be prove (p > 0.05).

When we correlating the electrical activity of masseter muscles and masticatory preference side (Table 4), significant associations were not observed, however, the results indicated high percentage differences.

**Table 3 – Relationship between electrical activity of masseter muscles and facial measurements**

| Side face greater extent measured | Electrical activity of masseter muscles | | | | | | p value |
|---|---|---|---|---|---|---|---|
| | Right | | Left | | Total Group | | |
| | N | % | N | % | N | % | |
| Right | 4 | 44,4 | 5 | 55,6 | 9 | 100,0 | p (1) = 0,608 |
| Left | 4 | 66,7 | 2 | 33,3 | 6 | 100,0 | |
| Total group | 8 | 53,3 | 7 | 46,7 | 15 | 100,0 | |

(1): Through the *Fisher exact test*.

**Table 4 – Relationship between electrical activity of masseter muscles and mastication preference side**

| Masseter muscle electrical activity | Mastication preference side | | | | | | p value |
|---|---|---|---|---|---|---|---|
| | Right | | Left | | Total group | | |
| | N | % | N | % | N | % | |
| • Right unilateral mastication | | | | | | | |
| - Right | 5 | 71,4 | 8 | 100,0 | 13 | 86,7 | p (1) = 0,200 |
| - Left | 2 | 28,8 | - | - | 2 | 13,3 | |
| • Left unilateral mastication | | | | | | | |
| - Right | 3 | 42,9 | 3 | 37,5 | 6 | 40,0 | p (1) = 1,000 |
| - Left | 4 | 57,1 | 5 | 62,5 | 9 | 60,0 | |
| • Usual mastication | | | | | | | |
| - Right | 5 | 71,4 | 4 | 50,0 | 9 | 60,0 | p (1) = 0,378 |
| - Left | 2 | 28,6 | 4 | 50,0 | 6 | 40,0 | |
| TOTAL | 7 | 100,0 | 8 | 100,0 | 15 | 100,0 | |

(1): Through the *Fisher exact test*.

## DISCUSSION

The anatomical and physiological knowledge of the involved aspects at the dynamics of the masticatory muscles is important for understanding the biomechanical mandibular effects[17] which reflect in the craniofacial complex development. These knowledge are the basis for therapeutic planning and understanding of normal variations and pathological existing in the stomatognathic system functions.

A study[11] that aimed to evaluate the quality of life of patients who underwent total laryngectomy, it was questioned the performance of some SE functions. Low rate of complaints in relation to chewing was identified when compared to factors involving speech, smell, taste, salivation and anxiety. Even indicators revealing low rate of complaints in chewing, this parameter was present as an impediment to a better quality of life. In laryngectomized individuals whose cervical region is morphologically altered, the biomechanics of mandibular functions, such as chewing, can suffer interference.

Regarding this study data found in relation to anthropometric face measurements (outer corner of the eye to mouth commissure) we observed that the measures of right and left sides were in approximate in the laryngectomyzed population. The study did not demonstrate significant differences between the facial measurements. This result can be explained by the fact that the prevalence side chewing presented balanced in this sample.

When an individual mastication is performed so as to unilaterally preferentially, the adjacent muscles to this side develops higher levels of activity and thus configures itself more shortened compared to its pair in the other side[13].

Researchers[18] report that healthy individuals, without morphological changes, always have a side with higher masticatory preference.

When comparing the greater facial side with the side of higher masticatory preference, it was found that the average measured on the right side of the face was approached in patients who have chewing preference for right or left side and shows

no difference significant between the two groups; the mean measure of the left side of face was higher among patients with masticatory right side in relation to left side, this difference reveals significant.

When these events was analyzed in the same patient it was observed that when the masticatory preference was at the right side the average was higher on the left side and when this preference was at the left side the average was higher on the right side and in both situations it was verified significant difference between the measure sides.

This relationship shows that, as in individuals without anatomofunctional[13], in laryngectomyzed the side of greater muscle demand during mastication (predominantly work side) presents shortened compared to lower demand side (predominantly balance side). This data can serve as a predictor parameter of clinical evaluation to identify the work and balance side, where the verification measures between *ch* and *ex* anthropometric hemifaces points can reveal the masticatory preference side of the assessed individual.

High percentage of correlation between electrical activity of masseter and preference masticatory side were identified in this sample. In a study involving healthy adults, researchers observed the masticatory preference through the electromyography and concluded that in 83% of evaluated cases, this technique served as the parameter to detect the preference masticatory side[19]. Being the surface electromyography an easy and applicability method[14], this test can help clinical practices regarding the evaluation process of masticatory muscles, and enable parameters identification related to the pattern mastication. The findings obtained in this research leading to the proposition that, in laryngectomyzed, the masseter muscle electromyographic evaluation presents similar conditions to those found in individuals without structural changes.

Research with normal subjects aimed to analyze the asymmetry between the electric potential of masseter muscles, showed that there are existence of asymmetry values within the normal range pattern between the left and right masseter muscles when in relation to mastication function. This normal pattern seems to reflect a good stomatognathic system functional performance[20].

In this study, the electromyographyc potential of masseter muscles obtained during mastication (right and left unilateral mastication and usual mastication) showed higher percentages in the right masseter muscle, highlighting the right unilateral mastication. It was found that the right masseter muscle showed higher average values of electrical activity when compared to the left masseter muscle during usual mastication, right and left unilateral mastication.

It's likely that in laryngectomized individuals whose mandibular biomechanics is altered by the absence of cervical muscles with important role in the stabilization and maintenance of head posture, the evidence of asymmetry between the electric potentials of the masseter muscles, muscles responsible for movements promotion involved to mandibular functions, are offsets to fit the new morphologic condition.

Statistically significant difference occurs between the masseter muscles during right unilateral mastication. In this type of mastication, the food was processed only on the right side of the mouth, and according to results obtained in this research, this action influenced the electromyographic activity increased of that side. The findings indicates that in patients who underwent laryngectomy there are persistent of normal standards related to the asymmetry of electrical activity between the masseter muscles during mastication.

The electromyography values of masseter muscles during mastication allows us to reinforce a trend that there is greater electrical activity of the adjacent muscle of the masticatory side preference.

Associating the side of the greater extent of the face and the electrical activity of masseter muscles during usual mastication, it was found that the percentage of cases in which the masseter muscle with greater electrical activity is the right side, was higher when the side of the greater extent of the face was the left, but not any significant relation between the two analyzed variables. However there is evidence that in larger samples, this inverse relationship pointing the longest side of the face as the side of lower electrical activity is statistically confirmed. This fact may also have a relation with the work and balance sides[19] during mastication, as above described.

## CONCLUSION

In total laryngectomyzed patients the facial side with less anthropometric measure corresponds to the preference side mastication and this presents the masseter muscle with greater electrical activity.

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**RESUMO**

**Objetivo**: observar se existe relação entre a preferência do lado mastigatório, antropometria facial e atividade elétrica do músculo masseter em laringectomizados totais. **Métodos**: a coleta de dados, realizada no setor de Fonoaudiologia do Hospital de Câncer de Pernambuco (HCP), contou com a participação de quinze voluntários laringectomizados totais do gênero masculino e idade média de 64 anos. Foi realizada aferição das distâncias entre os pontos antropométricos faciais *ex* e *ch* nas hemifaces dos voluntários e posteriormente executado exame eletromiográfico dos músculos masseteres, bilateralmente, nos momentos de máxima intercuspidação habitual (MIH), mastigações unilaterais direita e esquerda e durante mastigação habitual. Realizou-se filmagem durante a mastigação habitual para identificação do lado de preferência mastigatória. **Resultados**: os indivíduos cuja preferência mastigatória foi do lado direito, apresentaram o lado esquerdo da face com maior medida (72,37mm); já os indivíduos cuja preferência mastigatória foi do lado esquerdo, apresentaram maior medida da face do lado direito (68,85mm). Quando a mastigação apresentou-se unilateral direita a atividade elétrica do masseter direito atingiu média de 123,57% enquanto o masseter esquerdo alcançou média igual a 84,85% de atividade em relação à MIH (p = 0,016). **Conclusão**: em laringectomizados as medidas antropométricas faciais correlacionam-se com o lado de preferência de mastigação e os valores eletromiográficos dos masseteres durante a mastigação.

**DESCRITORES**: Antropometria; Mastigação; Eletromiografia; Laringectomia; Neoplasias Laríngeas

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