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Brief communication

# Chewing and swallowing in obese individuals referred to bariatric surgery/gastroplasty – a pilot study

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## ABSTRACT

**Objective:** to describe the chewing and swallowing pattern of obese individuals indicated for bariatric surgery/gastroplasty before the procedure, using standardized clinical protocols.

**Methods:** a cross-sectional descriptive case-control study that presents preliminary data for a larger investigation. Eight participants matched for age and sex were divided into two groups (four in the research group and four as controls) and submitted to clinical speech therapy assessment using the "Questionnaire on eating behavior and the anatomofunctional conditions of the stomatognathic system" from the Expanded Protocol of Orofacial Myofunctional Evaluation with Scores (OMES-E) and the maximum tongue pressure test.

**Results:** when compared to controls, participants from the research group exhibited a predominantly unilateral chewing preference; reported that they just "swallowed food"; repeated swallowing of liquid and solid foods, with facial muscle tension; increased cheek volume and the presence of flaccidity; shorter meal and chewing times; increased tension of the lips, mentalis and facial muscles at rest and during swallowing; predominance of insufficient ability with associated movements and/or tremors during lip, tongue, jaw and cheek movements; and lack of knowledge regarding speech therapy.

**Conclusion:** orofacial myofunctional dysfunctions were more frequent in patients from the research group when compared to controls. A need to increase the number of participants in this case series and conduct a post-surgery reassessment, in order to provide a longitudinal description of the chewing and swallowing pattern, was verified.

**Keywords:** Bariatric Surgery; Gastroplasty; Mastication; Deglutition; Tongue

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## INTRODUCTION

Obesity is a chronic multifactorial disease with high prevalence levels that affects 23% of the adult population in Latin America and the Caribbean, that is, around 140 million people[1].It is often accompanied by metabolic, vascular, respiratory, orthopedic, dermatological and psychological comorbidities, which affect quality of life[2].

Pharmacological measures, dietary reeducation and physical exercise have been adopted to tackle obesity, but in some cases may be insufficient to maintain or lose weight, exacerbating feelings of frustration and anxiety in these individuals. In these situations, surgical intervention to mechanically restrict eating is an alternative[3].

As with all weight loss treatments, bariatric surgery and gastroplasty require monitoring by an inter- or multidisciplinary team, who provide the necessary support to change established habits and adjust to the new physical conditions, psychological impacts and adversities that emerge, in addition to favoring long-term results[3].

Postoperative negative effects such as choking, vomiting, gastroesophageal reflux, sensation of food sticking and swallowing and chewing-related complaints[4] have prompted the inclusion of speech therapists in these teams[3]. Speech therapists monitor patients before and after surgery, providing guidance and assessment as well as preventive and rehabilitative measures relevant to their field, particularly in relation to chewing (mastication) and swallowing (deglutition), which are vital to the eating process[3].

As such, the aim of this study is to describe preliminary results regarding the chewing and swallowing pattern of obese individuals indicated for bariatric surgery/gastroplasty, prior to the procedure, using standardized clinical protocols.

## METHODS

The study was approved by the Research Ethics Committee of the Ceilândia Campus of the University of Brasília (UNB), Brazil, under report no. 2.665.236 and CAAE protocol no. 82672118.1.0000.8093, and informed consent was given to conduct the study and use the resulting data.

A cross-sectional descriptive case-control design was used, presenting preliminary data from a larger investigation. This first stage contributed to assessing the proposed methodology and identifying any necessary adjustments. All participants were volunteers, divided into two groups – research and control. The research group (RG) consisted of obese individuals (class III) indicated for bariatric surgery and controls (CG) were healthy subjects with no speech-related complaints, matched for age and sex with the RG.

Inclusion criteria for the RG were individuals of both sexes, aged 18 years or older, clinically stable, who volunteered to take part after responding to an invitation on social media, indicated for bariatric surgery/gastroplasty and assessed, diagnosed and monitored by a medical team. Exclusion criteria (RG) were:

a) neurological pathologies that prevent understanding the instructions and actions needed to perform the speech therapy intervention; b) previous head or neck pathologies or surgeries; c) those submitted to prior orofacial myofunctional speech therapy; d) contraindication for speech therapy; e) inability to orally ingest food; and f) history of head or neck tumors or trauma.

Inclusion criteria for the CG were healthy individuals with no complaints or abnormalities of stomatognathic structures and/or functions, confirmed by applying the OMES-E protocol[5]. As a cutoff point for inclusion in this group, participants had to score at least 210 points on the OMES-E instrument. The following exclusion criteria (CG) were adopted: lack of speech-related comorbidities, cognitive or conscious impairments that prevent understanding the verbal information requested for the study assessment.

Participants underwent a battery of tests to characterize their chewing and swallowing pattern. in a one-hour session, at an appropriately equipped location. Disposable gloves, wooden spatulas and a Glatzel mirror were also used to evaluate nasal airflow. Due to the participants' calorie restrictions, crackers (Club Social Original®) and water (200ml disposable cup) were used to assess chewing and swallowing of solids and liquids.

The following instruments were applied:1) Questionnaire on eating behavior and the anatomo-functional conditions of the stomatognathic system[6]; 2) Tongue pressure analysis using the Biofeedback Pró-Fono lip and tongue pressure system (PLL Pró-Fono); 3) OMES-E (Expanded protocol of orofacial myofunctional evaluation with scores)[5].Below is a detailed description of the protocols.

The survey on eating behavior and the anatomo-functional conditions of the stomatognathic system[6] contains questions developed by speech therapists

at the Ceará Obesity Center in Fortaleza, Ceará State, Brazil, aimed at identifying the eating behavior of obese individuals and anatomofunctional conditions of the stomatognathic system.

Maximum tongue pressure was analyzed using the Biofeedback Pró-Fono lip and tongue pressure system (PLL Pró-Fono), a portable device that measures the pressure exerted by the upper and lower lips on an air-filled bulb or by the dorsal surface or tip of the tongue against the bulb positioned on the palate.It consists of a pressure sensor connected to an electronic circuit board, housed in plastic casing. The pressure sensor is connected to the air-filled bulb via flexible plastic tubing. The device detects variations in air pressure and converts these signals into a kilopascal (kPa) versus time (s) graph. During the test, participants were seated on a comfortable chair with their feet flat on the floor and head parallel to the horizontal plane. They were given instructions on performing the test and the device was positioned in the oral cavity, in accordance with the cleaning and hygiene criteria stipulated by the team. Tongue pressure was evaluated in the following situations:Maximum lifting pressure of the tip of the tongue: participants raised the tip of the tongue and pressed it against the bulb, positioned in the retroincisal region; Maximum lifting pressure of the dorsal surface:participants pressed the dorsal surface of the tongue against the bulb. Three consecutive measurements were performed for all of the tests, holding maximum pressure for 15 seconds with a 15-second rest between them,and considering the average of the three measurements in each task.

The OMES-E protocol[5] was compiled based on previous assessment models, with the inclusion of numerical scales that reflect the physical characteristics and orofacial behavior of subjects. Thus, the components and functions of the stomatognathic system were analyzed in terms of their appearance/posture, mobility and swallowing (liquid and solid), chewing and breathing functions.Participants were assessed in accordance with the protocol, by visual inspection during the session and subsequent analysis of the recorded images. A Canon Power Shot SX400IS camera was placed on a 1.20m high tripod about 100cm from the subject, who remained seated in chair. The OMES-E was validated for young people and adults, showing 86% correlation with the reference protocol as well as sensitivity and specificity for the diagnosis of orofacial myofunctional disorders in the latter[7]. In this case series, maximum scores on OMES-E items were deemed as adequate appearance, posture/position, mobility and functioning, where scores lower than those expected (mild, moderate or severe) were considered inadequate.

The results of the study are presented via simple descriptions, based on descriptive, absolute and relative values of the scores and answers obtained by each group of participants.

## RESULTS

All eight participants were volunteers, aged 28 to 45 years (average age 35.12 years), matched for age and sex, with four in the RG and four controls (CG).

**Table 1.** General characterization of the participants

| | Research Group | | | | Controls | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| Age | 28 years | 34 years | 34 years | 45 years | 28 years | 36 years | 34 years | 42 years |
| Sex | Female | Male | Female | Male | Female | Male | Female | Male |
| Weight | 107 kg | 155 kg | 107 kg | 127 kg | 65 kg | 77 kg | 48 kg | 76 kg |
| Height | 1.60m | 1.84 m | 1.61 m | 1.63 | 1.63m | 1.76 m | 1.55 m | 1.75m |
| BMI (Kg/m2) | 42 | 45.78 | 41.55 | 42.43 | 24.45 | 24.86 | 19.98 | 24.82 |
| Class | Class III obesity | Class III obesity | Class III obesity | Class III obesity | Normal | Normal | Normal | Normal |
| On medication | Yes | Yes | Yes | Yes | No | No | No | No |
| Complaint | Difficulty chewing, preferred chewing side, mouth breathing. Regular sleep apnea diagnosed by polysomnography | No complaints | No complaints | No complaints | No complaints | No complaints | No complaints | No complaints |

Legend: kg = kilograms; m = meters.

Table 1 shows general information on the participants.

The results obtained are described in Tables 2 and 3 and Figure 1, with the following data presented: questionnaire on eating behavior and the anatomofunctional conditions of the stomatognathic system (Table 2); OMES-E (Table 3) and tongue pressure analysis (Figure 1).

**Table 2.** Results of the questionnaire on eating behavior and the anatomofunctional conditions of the stomatognathic system

| Questionnaire item | Characterization | RG (%) n=4 | CG (%) n=4 |
|---|---|---|---|
| Self-image | Above "normal" weight | 100 | 75 |
| | Normal weight | 0 | 25 |
| Most frequent type of food | Pasta, sweets and meat | 50 | 0 |
| | Pasta and meat | 25 | 0 |
| | Fruit, vegetables and meat | 25 | 0 |
| | Fruit, vegetables and meat | 0 | 50 |
| | Vegetables and meat | 0 | 25 |
| | Pasta, vegetables,sweets and meat | 0 | 25 |
| Meal time | Less than 10 min | 100 | 50 |
| | 10 to 30 min | 0 | 25 |
| | More than 30min | 0 | 25 |
| Time between meals | 3hrs or more | 75 | 100 |
| | 1 to 2 hrs | 25 | 0 |
| Sensitivity to flavor | No sense of taste | 50 | 0 |
| | Normal sense of taste | 50 | 100 |
| Chewing performance | Just swallows the food | 75 | 0 |
| | Chews well | 25 | 100 |
| Hyperphagia | Eats sweets when anxious or nervous | 25 | 50 |
| | Eats "tasty food" when anxious or nervous | 50 | 0 |
| | Eats peanuts/carbohydrates when anxious or nervous | 25 | 0 |
| | Does not eat when anxious | 0 | 50 |
| Knowledge of speech therapy | Yes | 50 | 25 |
| | No | 50 | 75 |
| How speech therapists can help | Yes | 50 | 25 |
| | No | 50 | 75 |

Legend: RG = research; CG = control group; % = frequency; n=number of participants; min = minutes; hrs = hours

With respect to eating behavior, the RG showed worse performance in terms of the type of food eaten (more pasta and fewer vegetables), time spent on meals (shorter), sensitivity to flavor (low threshold), chewing performance (impaired) and hyperphagia (all RG subjects reported eating more when nervous or anxious).

In regard to facial symmetry, the left side of the face was broader in three RG subjects andthree controls had a symmetrical appearance. The middle third of the face was larger in two RG participants and the lower third in another twoas well as one control.

With respect to the cheeks, the RG showed altered tension and configuration due to mild drooping (n=3), with three subjects exhibiting greater volume on both sides and a slightly larger right cheek in one control.

Abnormal tongue position was observed in the RG due to compression caused by dental occlusion, andin the CG as a result of tongue thrust associated with (negative) overbite and/or (positive) overjet. All those with tongue abnormalities(RG and CG) exhibited increased tongue volume.

In general, altered lip, tongue and jaw mobility in the RG was due to insufficient or nonexistent ability and/or tremors, andin the CG, insufficient ability with or without tremors.

Analysis of lip behavior during swallowing revealed increased contraction in both groups, which was mild (n=3) to moderate (n=1) in the RG and mild (n=1) in the CG.

Altered tongue behavior in controls was caused by tongue thrust and positive overjet or negative overbite.

Other signs of swallowing dysfunction in the RG were tension in the facial muscles, andaltered posture during chewing.

Masticatorydysfunctions in the research group were caused by a lack of bite force.

The chewing pattern in the groups was characterized as RG = mild (n=3) and chronic (n=1) unilateral preference; CG = bilateral and alternate (n=1), simultaneously bilateral (n=1), mild (n=1) and chronic preferred side (n=1).

In terms of swallowing efficiency, poor performance in both groups was related to repeated swallowing of the bolus.

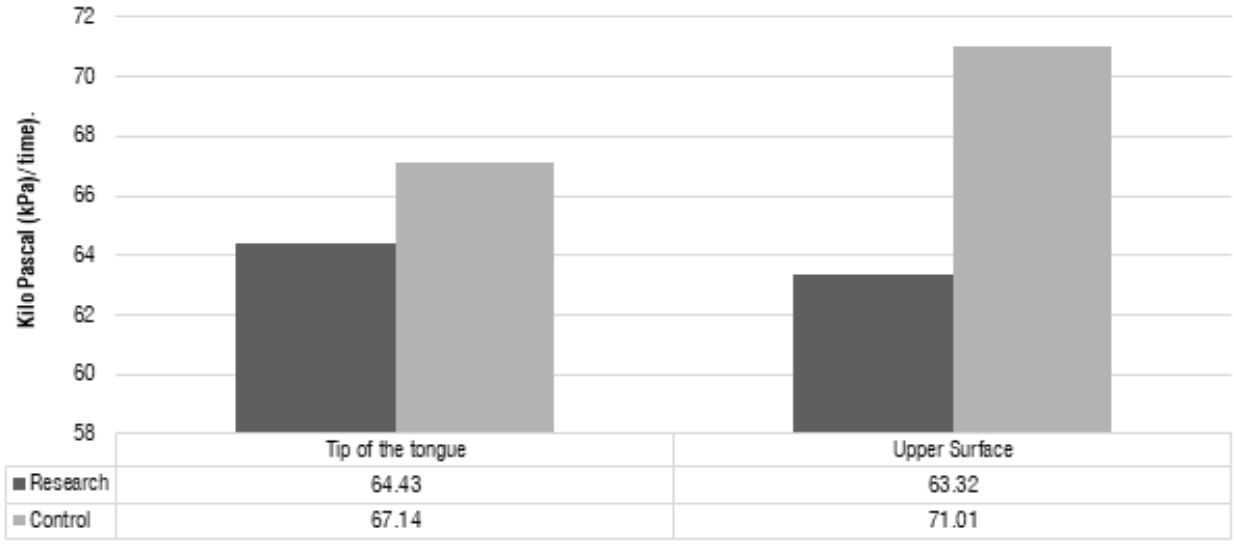
Functional analysis of occlusion showed alterations in **interincisal distance** below (n=2) and above expected values (n=1) in controls and higher than expected (n=1) in the RG; positive **overjet** in the CG and negative in the RG; lower-than-expected **protrusion** in both groups; positive (n=2) and negative (n=1) **overbite** in the RG, in addition to controls (2 positive and 1 negative).

Figure 1 graphically illustrates maximum tongue pressure analysis and compares the values obtained by the two groups.

**Table 3.** Results of the OMES-E protocol

| Item | Organ/Function | Characterization | RG n=4 | CG n=4 |
|---|---|---|---|---|
| | | | % dysfunction | |
| APPEARANCE AND POSTURE/ POSITION | Face | Symmetry | 100 | 25 |
| | | Proportion between the facial thirds | 100 | 25 |
| | Cheeks | Volume | 75 | 25 |
| | | Tension and Configuration | 75 | 0 |
| | Mandible/maxilla relation | Vertical jaw relation | 75 | 100 |
| | | Anteroposterior relation | 75 | 25 |
| | | Midline relation | 50 | 25 |
| | Lips | Resting lip function | 75 | 0 |
| | | Volume and Configuration | 50 | 0 |
| | | Labial commissure | 100 | 0 |
| | Mentalis muscle | Condition-Appearance | 75 | 0 |
| | Tongue | Position-appearance | 100 | 100 |
| | | Appearance-volume | 50 | 25 |
| | Hard palate | Width | 50 | 0 |
| | | Height | 25 | 0 |
| MOBILITY | Lips | Protrusion | 50 | 25 |
| | | Retraction | 75 | 0 |
| | | Right lateralization | 100 | 75 |
| | | Left lateralization | 100 | 50 |
| | Tongue | Protrusion | 75 | 25 |
| | | Retraction | 50 | 0 |
| | | Right lateralization | 75 | 25 |
| | | Left lateralization | 75 | 25 |
| | | Raising | 75 | 50 |
| | | Lowering | 75 | 0 |
| | Mandible | Lowering | 100 | 25 |
| | | Raising | 75 | 0 |
| | | Right lateralization | 100 | 25 |
| | | Left lateralization | 100 | 25 |
| | | Protrusion | 100 | 25 |
| | Cheeks | Inflating | 75 | 25 |
| | | Sucking | 75 | 25 |
| | | Retracting | 75 | 25 |
| | | Transferring air from left to right | 100 | 25 |
| FUNCTION | Breathing | Pattern | 0 | 0 |
| | Swallowing | Lip behavior | 100 | 25 |
| | | Tongue behavior | 0 | 75 |
| | | Other behaviors and signs of dysfunction | 100 | 0 |
| | | Swallowing efficiency - solids | 50 | 25 |
| | | Swallowing efficiency - liquids | 25 | 25 |
| | Chewing | Bite | 25 | 0 |
| | | Type | 100 | 50 |
| | | Other behaviors and signs of dysfunction | 25 | 0 |
| FUNCTIONAL ANALYSIS OF OCCLUSION | | Midline | 50 | 50 |
| | | Overbite | 75 | 75 |
| | | Interincisal distance | 25 | 75 |
| | | Protrusion | 50 | 25 |
| | | Overjet | 25 | 25 |
| | | Right lateralization | 50 | 25 |
| | | Left lateralization | 50 | 25 |
| | | TMJ Noise | 75 | 25 |
| TOTAL SCORE | | Scores (maximum 230 points) | Group average | |
| | | | 170 | 219.5 |

Legend: RG = research; CG = control group; % = frequency; n=number of participants.




| | Tip of the tongue | Upper Surface |
|---|---|---|
| Research | 64.43 | 63.32 |
| Control | 67.14 | 71.01 |

**Figure 1.** Results of tongue pressure analysis when raising the dorsal surface and tip

## DISCUSSION

In general, the results corroborate those reported in the literature for the area[8,9], that patients with class III obesity indicated for bariatric surgery tend to exhibit abnormalities in the structures and functioning of the stomatognathic system.

The literature[4,8-10] indicates that bariatric surgery is more common among women,largely due to hormonal and esthetic issues and because they tend to be more careful about their health[10].This was not the case in the present study, possibly because of the size of the sample.

The eating behavior observed in the RG was also in line with findings described in the literature.

Obese individuals typically favor a carbohydrate--based diet. When food is ingested, particularly that containing carbohydrates, the blood glucose level increases and the pancreas releases insulin to absorb and distribute glucose to the tissue in the form of energy, which also leads to a feeling of fullness (satiety).Food intake is regulated by the limbic system, located in the lateral (feeding center) andventromedial region (satiety center) of the hypothalamus. When adipocytes reach maximum fat storage, leptin is released and inhibits the feeding center, providing a feeling of satiety. Excessive carbohydrate consumption combined with genetic predisposition, low energy expenditure and eating energy-dense nutrient-poor foods increase BMI[11].

A previous study found that overeating and incidents of hyperphagia may be positively related to the emotional state and BMI of individuals, with a more pronounced effect in women[12].

Anxiety is a predictor of food intake, prompting the individual to eat in an attempt to regulate limbic system imbalance[11-13].

The results obtained in orofacial myofunctional assessment to characterize chewing and swallowing patterns provided possible characterizations of the sample studied.Minor facial asymmetry was observed in the RG (n=4), with a correlation between the broader side of the face and preferred chewing side, corroborating data obtained in a previous study with obese children[14].Both internal and external factors contribute to this characterization, including genetics, unilateral chewing pattern, malocclusion and temporomandibular joint (TMJ) dysfunction[14].

All the RG subjects and two controls displayed preferred unilateral chewing, corroborating a previous study[8] in which chewing and swallowing problems were more common in obese individuals.

Unilateral chewing tends to result in hypertrophy of the preferred side, particularly in the masseter, buccinator and temporal muscles. Predictors for this type of chewing pattern include occlusal abnormalities (premature contact, occlusal interference, type of bite), missing teeth, parafunctional habits, and TMJ dysfunction[15]. Thus, bilateral chewing is considered ideal, with chewing cycles evenly distributed between both sides of the face[5,7].

Decreased muscle tone and mobility in the speech organs directly affects chewing performance, bolus quality and swallowing. During swallowing, the RG

exhibited tension in the face muscles, with the tongue remaining in the oral cavity. Half the participants displayed repeated swallowing of the solid and liquid bolus. These data corroborate those obtained in a study with obese individuals[16], except for lip tension during swallowing, which did not occur in this baseline study. Another investigation[14] found that swallowing was less efficient in obese children than controls, which was not observed here.

When compared to the CG, patients indicated for bariatric surgery had shorter chewing times and reported they 'just swallowed' their food. Shorter chewing times are frequently reported in the literature among subjects with a high BMI[9]. Research aimed at understanding the relationship between chewing time[17], number of chews and satiety[18] found that longer chewing times resulted in less food intake and hunger. The consistency of the food eaten is also important, with liquids providing less satiety than solids[19]. This is because of the shorter oral transit time (OTT) needed for liquids, meaning they have less time to activate the oropharyngeal sensory receptors and elicit the cephalic phase of digestion, which affects the inhibition of the feeding center and activation of the satiety center[19].

Only the RG displayed an increased nasolabial sulcus for their age. The face is formed by soft (skin, adipose tissue, etc.) and hard tissue (bone and cartilage). Each compartment of subcutaneous fat tissue has distinct morphological characteristics[20]. Fat cells in the face tend to be more active than those in the abdomen. Adipocytes also vary according to BMI, sex (women tend to have larger fat cells than men), and their location in the face, whereby those in the nasolabial region are larger than fat cells in the deep medial cheek. According to the literature[20], a high fat volume in these compartments inhibits synthesis in adjacent fibroblasts, altering the mechanical properties of the skin. High fat levels can also activate inflammatory factors that may contribute to this process. As such, the higher the degree of obesity, the greater the effects on skin aging, corroborating the data obtained here.

Our results demonstrated that tongue thrust occurred at rest and during swallowing in the CG, who were deemed to have a normal orofacial myofunctional system, possibly due to the occlusal abnormalities observed in these participants.In a study[21] with 100 participants, aimed at assessing occlusion in the Brazilian population, only 7% showed normal occlusion and 93% malocclusion. The authors concluded that although participants had good socioeconomic status, malocclusion did not affect their appearance and the need for orthodontic treatment went unnoticed until adulthood due to dentoskeletal and muscle compensation, which concealed the problem.

Controls also exhibited altered tongue posture and mobility, the most common signs being greater tongue volume (n=2), poor mobility (n=4), and overbite (occlusion) (n=3). Researchers[22] studying the oral motor system of 21 obese women found that 72% exhibited altered tongue mobility and muscle tone, which was also very large and rested high in the mouth, limiting space inside the mouth, corroborating our findings in this case series. In another study[8], the authors found statistical evidence of reduced tongue tonicity in obese patients, but no significant difference in mobility when compared to controls.

Two RG subjects had slightly narrow hard palates with mildly increased volume in relation to height. In these cases, the tongue was also compressed in the mouth, possibly due to the narrowness of the palate. The literature suggests that contributing factors to narrowing of the palate are insufficient force exerted by the tongue when incorrectlypositioned in the mouth, the use of bottles or pacifiers, thumb sucking, mouth breathing, and association with genetic syndromes[23]. The small number of participants precluded making inferences about the relation between obesity and altered palate formation; only the characteristics observed in the research group were described.

According to the literature, patient knowledge of speech therapy is an important factor in treatment adherence and perceiving any abnormalities, making it easier to develop suitable coherent approaches during intervention[3]. Five participants in the present study reported no knowledge of speech therapy and therefore had no related complaints, but their results confirmed the presence of some form of abnormality during assessment. This highlights the need to publicize this branch of science and its potential benefits.

We identified a need to increase the number of participants in this case series and conduct a post-surgery reassessment in order to provide a longitudinal description of the chewing and swallowing pattern. The benefit of interventions targeting the orofacial myofunctional system of patients indicated for bariatric surgery/gastroplasty can also be confirmed.A limitation of this study and proposed improvement for future research is the need to use more than one inclusion criterion for the control group.All participants should have adequate occlusion. Thus, it is suggested that both a minimum

score of 120 points on the OMES-E and the presence of Angle class I malocclusion be considered in order to reduce possible biases.

Given the abnormalities observed in the research group, the inclusion of speech therapists in multidisciplinary teams (doctors, psychologists, nutritionists etc.) is highly recommended, since they are trained to treat the structures and functioning of the orofacial myofunctional system.

## CONCLUSION

This study described the characteristics observed in four individuals presented with class III obesity indicated for bariatric surgery, and the respective control cases used for comparison purposes. Orofacial myofunctional dysfunctions were more frequent in patients from the RG when compared to controls. The data provided by this study might contribute to future research in the area.

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