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*Artigo Original*

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# When tongue strength exercises reflect in the cervical region

## *Quando exercícios de fortalecimento da língua refletem na região cervical*

**Keywords**

Malocclusion
Tongue
Neck Pain
Speech-Language Pathologists
Physical Therapy Specialty

## ABSTRACT

**Purpose:** To compare the impact of isokinetic exercise (tongue suction on the palate) in the cervical region of Class I and Class II / 2nd Division participants, considering the average and the symmetry of Root Means Square (RMS) of suprahyoid and suboccipital muscles and cervical sensory reports. **Method:** 11 participants Class I and 19 Class II / 2nd Division, both genders, mean age 33.4 ± 14.1 years. For the analysis of RMS average and symmetry, electromyography was performed in the suboccipital and suprahyoid muscles, bilaterally, at rest and suction of water in the initial, intermediate and final phases. The cervical sensation was evaluated qualitatively during the exercises. **Results:** the mean RMS did not differ between Classes (p=0.7), but showed an increase in the intermediate phase in the suboccipital musculature (p=0.0001) and decrease in the suprahyoid musculature. In symmetry, the suprahyoid musculature showed a significant difference between classes (p=0.0001) during the intermediate phase. In the Class I participant the symmetry was reestablished in the final phase, a fact that did not occur in Class II / 2nd Division. Regarding the cervical sensation, only the Class II / 2nd Division had expressive complaints. **Conclusion:** The Isokinetic suctioning exercise of the tongue against the palate, had an expressive repercussion with reports of discomfort and neck pain in the Class II / 2nd Division participants. On average RMS, there was no difference between the classes, but in the intermediate phase, the suboccipital muscles showed a significant increase in the activity. Symmetry in the suprahyoid musculature had a significant difference between the classes and asymmetry in the intermediate phase.

**Descritores**

Má-oclusão
Língua
Cervical
Fonoaudiologia
Fisioterapia.

## RESUMO

**Objetivo:** Comparar o impacto do exercício isocinético "sucção da língua contra o palato" na região cervical em participantes Classe I e Classe II/2.ª Divisão, considerando a média e a simetria do *Root Means Square* (RMS) dos músculos supra-hióideos e suboccipitais, e relatos sensoriais cervicais. **Método:** Onze participantes Classe I e 19 Classe II/2.ª Divisão, ambos os gêneros, média de idade 33,4 ±14,1 anos. Para análise da média do RMS e da simetria, realizou-se eletromiografia dos músculos suboccipitais e supra-hióideos, bilateralmente, no repouso e na sucção de água nas fases inicial, intermediária e final. A sensação cervical foi avaliada qualitativamente durante os exercícios. **Resultados:** A média do RMS não apresentou diferença entre Classes (p=0,7), mas revelou, na fase intermediária, elevação na musculatura suboccipital (p=0,0001) e diminuição na musculatura supra-hióidea. Na simetria, a musculatura supra-hióidea mostrou diferença significativa entre classes (p=0,0001) durante a fase intermediária. No participante Classe I, foi restabelecida a simetria na fase final, fato que não ocorreu na Classe II/2.ª Divisão. Em relação à sensação cervical, somente os Classe II/2.ª Divisão apresentaram queixas expressivas. **Conclusão:** O exercício isocinético de sucção da língua contra o palato repercutiu de forma expressiva com relatos de desconforto e dor cervical nos participantes Classe II/2.ª Divisão. Na média do RMS, não houve diferença entre as classes, mas, na fase intermediária, a musculatura suboccipital apresentou elevação de atividade significativa. A simetria na musculatura supra-hióidea teve diferença significativa entre as classes e assimetria na fase intermediária.

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## INTRODUCTION

The discomfort or pain are states that restrict and may even evolve into disabling conditions. Therefore, criteria or indicators must be considered. In the case of therapeutic interventions, which aim to strengthen muscle[1], complaints, such as radiated pain[2], are reported frequently. But these are not always investigated, probably because they have a complex etiology whose biomechanics can not only trigger but potentiate such symptoms[3,4].

Functional units such as the tongue have a greater predisposition to these pictures because it is anchored in the hyoid bone, which is interconnected to sophisticated systems, such as the cranio-cervical and mandibular[3], whose complex gear[4] requires structures to be properly developed and positioned so that suboccipital muscles assist in cervical physiological curvature (lordosis) and guarantee head stability[5] so that the suprahyoid muscles exercise the cranio-mandibular lever[5] and the tongue can then move around.

The association of the tongue with the mandibular and cervical muscles[6], however, is not always highlighted. This is probably because specialists working in this area have traditionally limited themselves to the study of specific regions: speech therapists in the oral cavity and physiotherapists in the shoulder girdle and postural muscles of the head. However, in the alteration of the mandibular development, the connection of the tongue with the cervical region cannot always be disregarded, due to the interconnection of the mandible with the hyoid bone and the cervical spine[7]. Participants - Class II / 2nd Angle's division present occlusion with pronounced incisal vertical overlap, retrognathism and slightly tilted face down[8]. The change in head posture can lead to the musculature of the tongue, hyoid bone interconnection chain[9] and cervical spine to reorganize themselves[4] to ensure the balance of the stomatognathic system[10]. In particular, during the movement of the tongue, due to its posterior displacement[9] , according to mandibular retrognathism, not just the mandibular suprahyoid muscles[3], but also the postural muscles of the head, suboccipital[5] can be overwhelmed.

In these dentoeskeletal changes, orofacial myofunctional disorders (OMDs) resulting from flaccidity in the lingual musculature are also observed[11,12,13], such as the accommodation of the tongue on the oral floor and the interposition of the same between the arches during swallowing and speech, in which Myofunctional Orofacial Therapies (OMTs), to favor the dentoeskeletal and orthognathic orthopedic treatments, are recommended[11,12,13]. In these cases, language strengthening is one of the main goals to be achieved. During tongue movements, however, the mandibular and cervical muscles can also be overloaded[4]. However, little is known about the impact of these movements on the cervical region.

The practice of OMT to strengthen the musculature of the tongue is already mentioned in many studies[11,12,13], but cases with reports of discomfort or pain in the cervical region, during or after these exercises, are referred for physical therapy treatment[14]. The clarification about the association of discomfort or pain in the cervical region with the movements of the tongue does not always occur. Myotherapy interventions that involve tongue movement in patients with head deviation must, therefore, consider interdisciplinary assessment. Such understanding will allow specialists to have a more comprehensive view of the cases, so that indicators, such as the presence of muscle pain or discomfort, can be clarified and thus avoid losses, such as treatment limitation and even possible iatrogenesis in other regions of the body, such as neck pain[15].

The study aims to compare the impact of isokinetic exercises, tongue sucking against the palate with subsequent swallowing, in the cervical region, in Class I and Class II - 2nd Division participants, considering the RMS average, the symmetry of the supra muscles - hyoid and suboccipital, and sensory reports in the cervical region.

## METHOD

Experimental, quantitative and prospective study, performed at the Electromyography Laboratory of the Center for Studies and Research in Rehabilitation Dr. Gabriel Porto, Faculty of Medical Sciences, State University of Campinas-CEPRE / FCM / UNICAMP. Approved by the Research Ethics Committee-CEP / FCM / UNICAMP under number 39597414.2.0000.5404. All participants involved signed the Free and Informed Consent Form (ICF).

### Sample

Consisting of 30 participants, 11 from the Angle Class I control group and 19 from the Class II - 2nd Angle Division experimental group, male and female, aged between 18 and 59 years.

Inclusion criteria: healthy participants, with the presence of all dental elements, Class I molar relationship (without skeletal involvement) or Class II / 2nd Division molar relationship (retrognathic), with or without malocclusion. Exclusion criteria: participants with syndrome, chronic systemic disease, trauma or skeletal malformation, muscle pain, dental agenesis, patients with dental prosthesis, postural deviations, muscle pain, prescription of neurological and / or muscle relaxants and with temporomandibular disorder, according to RDC / DTM protocol 16, characterized with TMD according to Axis 1 of the protocol - muscle disorders, disc displacement, arthralgia, arthritis, arthrosis.

### Procedures

*Occlusal Analysis*

Performed by a dentist at the Dentistry Service of Hospital das Clínicas / FCM / UNICAMP. According to the Angle classification: Class I with mesiodistal relation of the mandible, upper incisor teeth overlapping one-third of the crown height of the lower incisor teeth, first upper and lower molars with the mesiobuccal cusp of the upper molar in occlusion in the buccal sulcus of the lower molar. Class II - 2nd Division with mandibular retrognathism and/or maxillary prognathism, distal occlusion of the lower first molar tooth to the upper first molar and vertical overlap between the upper and lower incisor teeth[17].

*Surface Electromyography*[18]

EExamination was carried out at the Electromyography Laboratory of the Speech Therapy Course / CEPRE / FCM / UNICAMP. The equipment used was the Myosystem I electromyograph coupled to a 650 MHz Pentium® 4 (Intel) computer and Myosystem BR software, version 2.52 (Data Hominis Tecnologia Ltda.). Signal conditioner with 12 bits of resolution and CMRR (Common Rejection Mode) of 112 db @ 60 Hz. The electromyographic signal was obtained with an Analog Digital (A / D) converter from Myosystem Prosecon Ltda., Model PCI-DAS 1200 with 12 bits of resolution with sampling frequency for 2,000 Hz collection, being filtered by 20 and 500 Hz bandwidth. Disposable bipolar Ag / AgCl electrodes model Chicopee MA 011 (Meditrace®, Kendall-LTP) were used with 1 cm in diameter, which were coupled to a pre-amplifier model PA1010-VA from Lynx Tecnologia Ltda., to create an active circuit differential.

*Fixing the electrodes*

DiIn the presence of hair, trichotomy and, subsequently, the astringency of the skin with 70% ethyl alcohol were performed. The participants then remained comfortably seated in a chair with their arms resting on their laps and their heads positioned parallel to the plane of the Frankfurt line connecting a point on the lowest part of the orbital margin to the tragus). They were instructed to keep their eyes fixed on the horizon to maintain the natural position of the head. The knees and hips were kept at 90 ° of flexion and the feet were supported on the floor. The reference electrode was positioned next to the participant's frontal bone and the other electrodes were fixed bilaterally, with an inter-electrode distance of 1 cm, in the suprahyoid muscle[19] and suboccipital musculature[20]. (Figure 1)

*Language strengthening exercises*

The maneuvers consisted of isokinetic movements of the tongue against the palate[11,12]. For this, a nasogastric tube with a diameter of four milliliters (4 mL) was connected to a 10 mL syringe containing water and positioned between the tip of the tongue and the papilla behind the upper incisor teeth. The volume of 70 mL of water was sucked intermittently into a total of seven syringes.

In the EMG records, four phases were considered: rest, beginning, intermediate and final, and the records were collected as soon as the participant started the syringe suction. The initial phase consisted of the RMS average for the suction of the first and second syringes. For the intermediate phase, the suction of the third, fourth and fifth syringes was considered, and the final phase, the suction of the sixth and seventh syringes. The variables average electrical activity and symmetry of the RMS were considered concerning the Occlusal Class, Phase and Class Effect.

EMG Signal Collection:

The duration of signal collection was measured during rest and water suction.

*Recruitment of Lingual Musculature*

It was obtained with a participant sucking water, using a disposable nasogastric tube, brand: Mark Med, short number: 04, attached to a disposable syringe without needle, BD Plastipak brand, 10 mL[21]. The syringe was filled with mineral water and the probe was positioned between the tongue and the incisive papilla region, making it possible to capture the muscular activity of the tongue from suction to swallowing the water. The evaluation was divided into four phases: Rest, Initial Suction, Intermediate Suction and Final Suction, with a five-minute rest between them. At rest and other phases, the signals obtained were at the beginning of each situation and ended after 10 seconds. Except for Rest, the initial and final suction phases corresponded to the average of two 10 mL

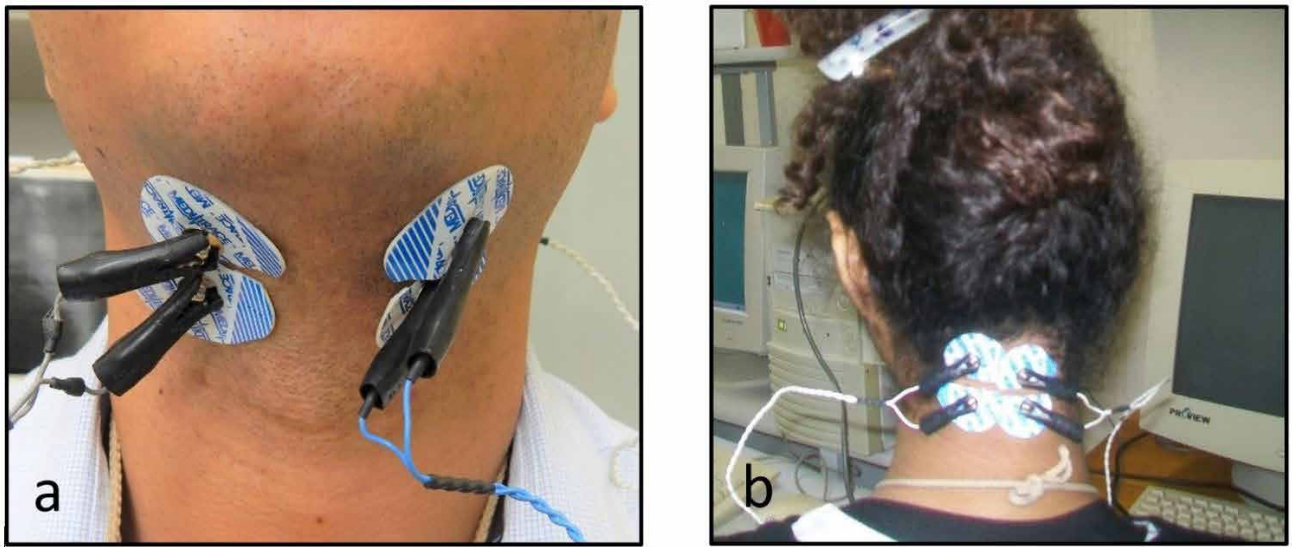


**Figure 1.** Fixation of the electrodes in the suprahyoid musculature (a) and the suboccipital musculature; note that it was necessary to perform trichotomy for the proper positioning of the electrodes (b)

syringes, while the intermediate one corresponded to the average of three syringes. In total, the participant performed several suctions in a total of 70 mL, corresponding to seven syringes.

As these were healthy participants, initially without reference to pain, no specific instrument was applied to investigate sensitivity. The sensations were determined from a pilot study whose predominant complaints were: discomfort, tiredness and pain. In these conditions, the participant was asked to define the location of the complaint, and the moment when it occurred was noted.

*Statistical analysis*

The analyzes were conducted independently in each of the compartments (Study of the Sample, Electromyography and Reports of Sensations), and separated according to the nature of the variables (parametric and non-parametric). The results were presented in the sequence defined by the type of analysis, below:

a) Exploratory Analysis

The statistical comparison of the groups by gender and age was performed by the method of *Mann-Whitney*, with correction of *Yates*. This method was chosen because the sample group did not have a normal distribution, which determined comparison by means and adopted a significance level of 5% (p = 0.05).

The parametric analysis of the sample confirmed similarity in the variance of the n, which justified the distinct number of participants found in this study. The results also showed that there was homogeneity in the characterization of the groups, equivalence concerning the age (p = 0.3003) and gender (p = 0.9405), not influencing the processing of electromyography data and reports of sensations.

b) Electromyography

The data were tabulated in the "txt" language for quantitative analysis. However, they were not submitted to normalization[18], since the literature[22] mentions that, by attenuating signs of artifacts and inter-individual differences of the participants, in the case of clinical studies, the profile that differentiates the groups can be uncharacterized. Once the Root Means Square (RMS) values are tabulated[18] in the pre-processing phase, the original variables were transformed into appropriate indicators for the analysis and interpretation of results. In the pre-processing of the data from the electromyography, the symmetry index was calculated. This indicator varied from zero, indicating an absence of symmetry, up to one, which indicates perfect symmetry in the amounts of muscle activation, that is, exactly equal values observed on the right and left sides[18].

The average RMS values for each muscle were also calculated, as described, and the symmetry, by calculating the average of the correlated values observed in the same muscle on the right and left sides.

The indicators obtained in the pre-processing phase were subjected to analysis of variance based on rank and adjusted in a mixed generalized linear model to test the effects of the Occlusal Class and Phase in the form of repeated measures since there was also an evaluation in the different phases.

The need to adopt the technique of variance analysis based on posts was only realized after the start of the analysis of the original data, since attempts to adjust a model with residues adhering to the Gaussian distribution were frustrated., which forced the application of a parametric / non-parametric hybrid method. In the planning phase of the analysis, the application of the Tukey test for multiple comparisons of means was defined. In all statistical tests, it was adopted the significance level of 5% (p=0.05).

In the investigation of Class I and Class II - 2nd Division participants regarding the repercussion of tongue strengthening exercises (phases: rest, initial, intermediate and final) in the cervical region, quantitative variables (mean and symmetry) of the muscles were considered suprahyoid and suboccipital, and descriptive (sensory reports) of the cervical region. With the digitalized electromyographic records, it was possible to calculate the average muscle electrical activity using the RMS, according to the following equation:

$$RMS_{Muscle} = ({}_{right}RMS + {}_{left}RMS)/2$$

And, for symmetry analysis, the following equation was adopted:

$$IS_{Muscle} = 1 - / {}_{right}RMS - {}_{left}RMS / ({}_{right}RMS + {}_{left}RMS)$$

$IS_{Muscle}$ is the symmetry index of each muscle studied, having been calculated indicators for the suprahyoid and suboccipital muscles; ${}_{Right}RMS$ is the value of the root of the mean square (Root Mean Square) of the muscle positioned on the right side and the ${}_{left}RMS$ corresponds to the value obtained in the homologous muscle. This indicator ranges from zero (indicating absence of symmetry) to one, which indicates perfect symmetry in the amounts of muscle activation, that is, exactly equal values observed on the right and left sides.

c) Studies of sensations reported by participants

Given the nominal nature of the measures, the analysis of the sensations was based on the construction of one-dimensional contingency tables, with a purely descriptive objective, and on two-dimensional contingency tables associated with the test of *Cochran*, *Mantel* e *Haenszel*, to compare the equality of scores in the groups. The significance level of 5% was adopted for the interpretation of results..

## RESULTS

### Gender

The analysis of gender confirmed the equivalence between the groups (p = 0.9405) (Table 1) of subjects Class I and Class II / 2nd Division (retrognathic).

**Table 1.** Comparison of numerical variables about gender between Class I and Class II / 2nd Division (dental open bite and mandibular retrognathism)

| Gender | Class | | TOTAL |
|---|---|---|---|
| | I | II/2nd Division | |
| Female (frequency) | 5 | 9 | 14 |
| (%) | 45.45% | 47.37% | |
| Male (frequency) | 6 | 10 | 16 |
| (%) | 54.55% | 52.63% | |
| TOTAL | 11 | 19 | 30 |

freq.: Frequency. Test statistic of Mann-Whitney: W=106,5; p-value=0,9405

## Age

The age analysis also proved the equivalence between the two groups (p = 0.3003) (Table 2).

**Table 2.** Comparison of numerical variables concerning age between groups

| Group | N | Average | Median | DP | Minimum | Maximum |
|---|---|---|---|---|---|---|
| Class I | 11 | 36.5 | 38 | 14.1 | 18 | 58 |
| Class II | 19 | 30.4 | 23 | 14.2 | 18 | 59 |

N: sample number; DP: Standard deviation. Test statistic of Wilcoxon: W=129; p-value=0,3003

## Average

On average, strong evidence (p <0.01) of differences between the mean RMS of the suprahyoid and suboccipital muscles was observed in at least two of the four phases studied. However, there was no evidence of significant effects of the class or interaction. A similar result was observed in the mean symmetry of the suboccipital muscles with strong indications (p <0.01) of differences between the mean symmetries only in the phases. In the suprahyoid muscle, the data revealed strong evidence (p <0.01) of the existence of significant interaction, which leads us to conclude that the phases and classes interact and generate effects resulting from the combination.

As there was no significant difference between the classes (Table 3), they were then added together for the analysis of comparison of the mean RMS of the suprahyoid and suboccipital muscles, according to the figures 1A and 1B.

**Table 3.** Analysis of variance based on the rank of RMS data (Mean and Symmetry) of suprahyoid and suboccipital muscles

| Variables / Effect | Degrees of freedom | | Test of F | |
|---|---|---|---|---|
| | Numerator | Denominator | Statistic | Value-p |
| Average of suprahyoid | | | | |
| Class | 1 | 26 | 0.12 | 0.7369 |
| Phase | 3 | 78 | 8.57 | 0.0001 |
| Class*Phase | 3 | 78 | 0.17 | 0.9146 |
| Average of suboccipitals | | | | |
| Class | 1 | 26 | 0.07 | 0.7913 |
| Phase | 3 | 78 | 6.83 | 0.0004 |
| Class*Phase | 3 | 78 | 0.19 | 0.9005 |
| Symmetry of suprahyoid | | | | |
| Class | 1 | 26 | 26.34 | 0.0001 |
| Phase | 3 | 78 | 14.21 | 0.0001 |
| Class*Phase | 3 | 78 | 6.00 | 0.0010 |
| Symmetry of the suboccipitals | | | | |
| Class | 1 | 26 | 2.05 | 0.1643 |
| Phase | 3 | 78 | 19.52 | 0.0001 |
| Class*Phase | 3 | 78 | 1.08 | 0.3641 |

RMS: Root Means Square, significance level: p <0.05; * interaction

The test of *Tukey* in the suprahyoid muscles revealed a significant difference only in the resting phase (Figure 1A). Note, however, that although not significant, there was an impressive decrease in activity during the intermediate phase, which coincided with the only phase in which the suboccipital musculature also showed a significant increase concerning the other phases (Figures 2A and 1B).

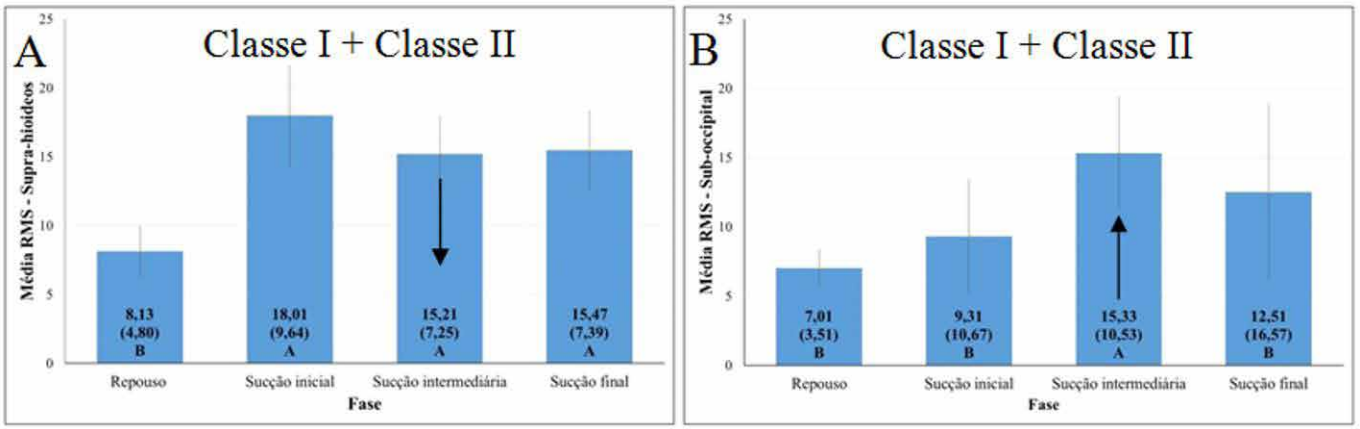


**Figure 2.** Means (standard deviation), confidence limits of the mean and *Tukey's* test to compare the RMS means of the suprahyoid muscles and the suboccipital muscle group. Bars with the same letters indicate means that differ from each other at the 5% significance level

## Symmetry

In the analysis of symmetry based on the RMS of the suboccipital muscles, the classes were added again, since, according to Table 3, there was also no significant difference between the classes (Figure 3).

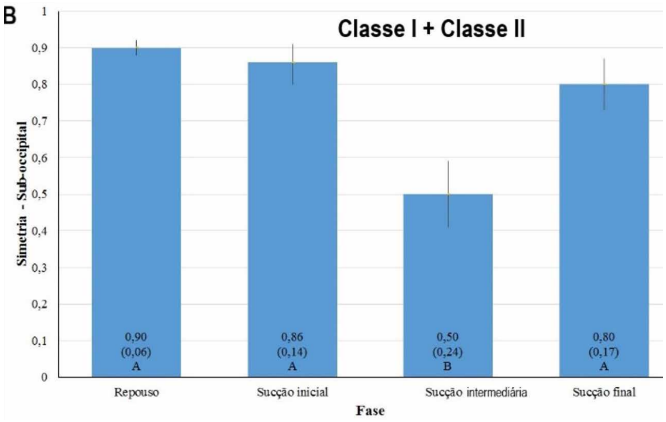


**Figure 3.** Means (standard deviation) confidence limits of the mean and Tukey's test for comparison of suboccipital muscle symmetry. A bar with the same letters indicates means that do not differ at the 5% significance level

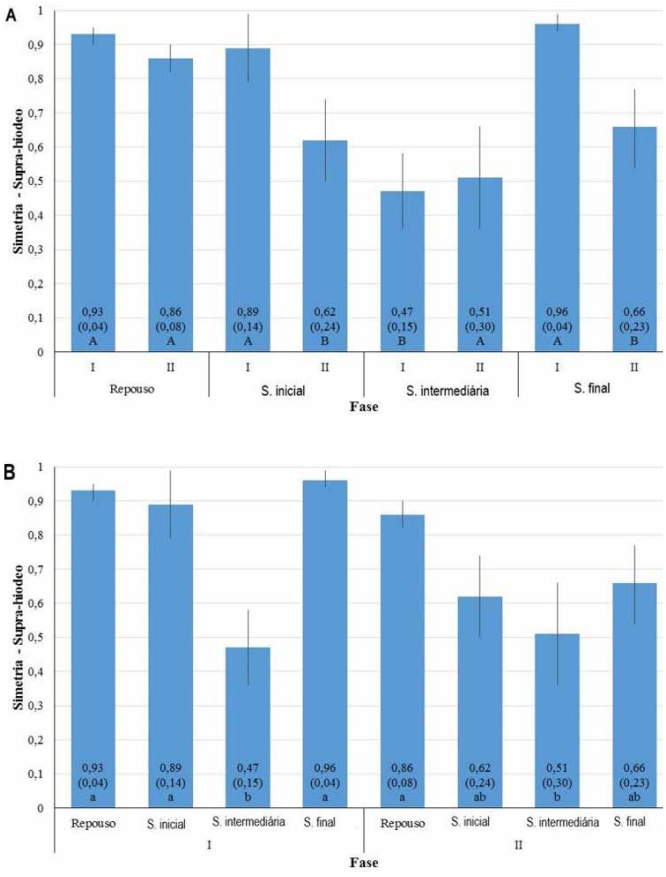


**Figure 4.** Means (standard deviation) confidence limits of the mean and Tukey's test to compare the symmetry of the suprahyoid muscles. A bar with the same letters indicates means that do not differ at the 5% significance level. S: Suction, Interm: intermediate. Note that the suprahyoid musculature showed a significant difference between the occlusal classes in all phases, except for resting (A) and asymmetry in Class I only in the intermediate phase, unlike what occurred in Class II / 2nd Division, which from the moment he started to perform the exercises maintained asymmetry in a systematic way (B)

The test shows that in both Class I and Class II, the asymmetry occurred only in the intermediate suction phase. It was interesting to note that, at this moment of asymmetry, there was an increase in activity in the suboccipital musculature (Figure 3B).

Finally, unlike what happened previously in the suprahyoid muscles, Class I participants showed a different behavior from Class II - 2nd Division participants, as well as throughout the phases (Table 3).

Comparing the effects within each phase (capital letters), it is observed that only in the resting phase the participants Class I and Class II were symmetrical. As they started to suck, however, Class I was more balanced than Class II - 2nd Division (Figure 4A), and the asymmetry occurred only in the intermediate phase and is restored in the final phase. In Class II, asymmetry is evident in the initial, intermediate phase without restoring balance even in the final phase (Figure 4B).

## Description of cervical sensation

In the report of the sensation, it is evident, in the intermediate and final phases, the high percentage of Class I participants (75%) without complaint, unlike what occurs in Class II / 2nd Division (14.5%) (Chart 1).

**Chart 1.** Report on different occlusal classes of cervical sensation along the tongue strengthening phases

| Class I | Phase 1 | Phase 2 | Phase 3 | Phase 4 |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |
| 11 | | | | |

| Class I | Phase 1 | Phase 2 | Phase 3 | Phase 4 |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |
| 11 | | | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |
| 16 | | | | |
| 17 | | | | |
| 18 | | | | |
| 19 | | | | |

| | Intermediate (F3) more final (F4) | |
|---|---|---|
| | Class I | Class II |
| No complaint | 75% | 14.5% |
| Nuisance | 11.5% | 17% |
| Tiredness | 4.5% | 22.5% |
| Exhaustion | 9% | 23.5% |
| Pain | 0% | 22.5% |

1: rest; 2: initial; 3: intermediate; 4: final

## DISCUSSION

The tongue strengthening exercises had a significant impact on the cervical region, with reports of discomfort and pain only in the participant Class II - 2nd Division, retrognathic. Such reports are justified by the muscular behavior in the tongue strengthening exercises in the different occlusal classes, evidenced by the mean RMS variables and symmetry of the suprahyoid and suboccipital muscles.

For speech therapy practice, these results are extremely relevant, since tongue strengthening exercises are widely used throughout myotherapy interventions in different situations 3. And the triggering of discomfort or pain complaints can not only hinder but even make it impossible to continue the exercises. Another factor to consider is the relevance of interdisciplinary assessments, speech therapy and physiotherapy, for the understanding of complaints in the region of the shoulder girdle, as we can see in the discussion below.

For signal analysis, the RMS was considered, since the signals had a balanced distribution throughout the abstractions. In the mean of the RMS regarding the occlusal class, the results did not reveal a significant difference. However, the data indicated that something occurred in the intermediate phase since the suprahyoid musculature showed a significant decrease in activity and the suboccipital musculature, a significant increase ($p = 0.0004$). In other words, the data indicate that, at the moment of a decline in the activity of the suprahyoid muscles, the cervical region performed a compensation whose results can be justified by three factors.

Firstly, due to the common neural command between the motor systems of the jaw and the neck, responsible for maintaining the balance of the head so that important functions, such as swallowing - which was part of the suction exercise proposed by the study, since the water was swallowed and both moments were considered in the collection -, can occur without complications[21,23]. The second factor to be considered is the suprahyoid musculature and the movements exerted by the tongue that can be correlated, due to the link they have with the hyolaryngeal complex[24]. Note that the exercise proposed in the study, by lifting the tongue to support itself on the palate and pulling the hyoid bone up, caused a change in the functional chain, especially the Trine of Beclard[25], where the hyoid bone, the hypoglossal nerve and the posterior part of the digastric muscle are located[3]. The latter, with insertion in the mastoid eminence of the temporal bone, closely related to the insertion of the suboccipital musculature in the neck region[3,5]. And, finally, the joint action of the tongue with the suboccipital muscles may also have been favored by the branches of the hypoglossal nerve present in the cervical loop[3,5].

In a more detailed analysis using symmetry[18] – that is, the right and left sides, which identify situations of adjustments and compensations -, in the suboccipital musculature, there was also no difference between the classes, but again about the intermediate phase. That is, in this phase, something triggered a breakdown in the posture of the head that, later, in the final phase, was rebalanced. In the symmetry of the suprahyoid muscles, there was a **significant difference between classes**. In Class I, the only moment of asymmetry of both the suprahyoid and suboccipital muscles was again in the Intermediate Suction[26], reinstated in the final stage. Muscle breakdown or inconsistency, in this case, agrees with studies[26,27] that indicate a reflex action to maintain movement and search for balance of the functional system. And, in Class II / 2nd Division, consistent data found asymmetry in the suprahyoid muscle throughout almost all phases, distinctly from what happened in Class I.

In Class II - 2nd Division, muscle behavior was probably affected by retrognathism, which causes flaccidity in the tongue musculature due to the open dental and skeletal bite of these cases. The flaccidity, therefore, justifies the unstable state in the Rest, Initial and Intermediate Suction phases, a fact that did not occur in the Final Suction, in which the two classes reestablished the symmetry in the suboccipital musculature, that is, postural balance of the head. This is probably because the participants were aware that it would be the last exercise. Such continuity, however, was not without cost for participants of Class II - 2nd Division, whose reports of tiredness, discomfort and pain occurred since the Initial Suction. Note that significant pain and discomfort complaints in the cervical region (63%) and base of the tongue (37%) culminated in all participants in the final suction. In the Class I participant, complaints of discomfort and pain were punctual and irrelevant in the lower middle dorsal region of the tongue in only five participants. The presence of discomfort and pain is noteworthy, as it is about young adults[28] (mean age $32.63 \pm 14.02$), homogeneous concerning gender and healthy, therefore, there is no need, even, for the application of a specific protocol for determining pain, as they do not yet have indications, such as the aging process, that can trigger such symptoms[29]. However, it was confirmed how much tooth / skeletal factors can interfere in these cases.

In the participants, Class II - 2nd Division, the cervical rectification resulting from retrognathism, by tensioning the suboccipital muscles, made the swallowing arduous, since probably the hyoid muscles contracted during the exercises and were unable to fully relax after the movement, mainly the posterior part of the digastric muscle. In tongue strengthening exercises, the isometric contraction required in the tongue triggered an increase in tension throughout his muscular belly, leading to overactivation of Golgi tendon organs[27,30]. A study reports that successive stimuli awaken free nerve endings responsible for system input, which, in the face of overload, slow down muscle action[26]. And with that, instead of strengthening the musculature, they promote a monosynaptic

reflex[30] whose response can cause tiredness, discomfort or pain. This is a picture consistent with the sensory reports obtained in this study.

FINAL CONSIDERATIONS: the present study presented a series of limitations, such as the use of postural assessment only for exclusion and the absence of quantitative devices to measure pain, which could bring more evidence with the increase of the sample. Such devices could also have contributed to the normalization of the data, thereby mitigating the possible inter-individual differences. Thus, future research must be conducted observing this important aspect.

## CONCLUSION

Isokinetic exercises, sucking the tongue against the palate with subsequent swallowing, had significant repercussions with reports of discomfort and pain in the cervical region only in Class II - 2nd Division participants. In the mean of the RMS, there was no difference between the classes, but, in the intermediate phase, the suboccipital musculature showed a significant increase in the activity. Regarding symmetry in the suprahyoid musculature, data revealed a significant difference between classes and asymmetry in the intermediate phase..


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## Author contributions

*The authors participated in the study, contributing to its design, development and completion. They contributed mainly with the point of view of a multidisciplinary team, since they have different backgrounds.*