REVISTA CEFAC
SPEECH, LANGUAGE, HEARING SCIENCES AND EDUCATION JOURNAL
Rev. CEFAC. 2022;24(6):e9622 https://doi.org/10.1590/1982-0216/20222469622

Original articles

Speech pathology in facial aesthetics: effects of two strategies for the suprahyoid muscles

Daniele Barreto da Cunha Ferreira[1]
https://orcid.org/0000-0003-2384-5631

Renata Maria Moreira Moraes Furlan[2]
https://orcid.org/0000-0001-7588-9316

Yasmin Salles Frazão[3]
https://orcid.org/0000-0001-8311-6831

Andréa Rodrigues Motta[2]
https://orcid.org/0000-0002-1582-3785

[1] Universidade Federal de Minas Gerais - UFMG, Programa de Pós-graduação em Ciências Fonoaudiológicas, Belo Horizonte, Minas Gerais, Brasil.

[2] Universidade Federal de Minas Gerais - UFMG, Faculdade de Medicina, Departamento de Fonoaudiologia, Belo Horizonte, Minas Gerais, Brasil.

[3] Universidade de São Paulo, Faculdade de Odontologia de Bauru - FOBUSP, Programa de Pós-graduação em Fonoaudiologia, Bauru, São Paulo, Brasil.

Study conducted at Programa de Pós-graduação em Ciências Fonoaudiológicas da Universidade Federal de Minas Gerais.

Conflict of interests: Nonexistent

ABSTRACT

Purpose: to verify the effects of tongue pressure exercises against the incisive papilla, used both alone and in combination with functional swallowing training, on the electrical activity of the suprahyoid muscles and the self-perception of aesthetic changes in the submandibular region. Chi-square, Fisher's exact, Mann-Whitney, Kruskal Wallis, and Wilcoxon tests were used. The significance level was set at 5%.

Methods: an experimental, analytical, prospective study on 27 women, aged 30 to 78 years, divided into two treatment groups (G1 and G2), and a control group (CG). Individuals were submitted to 8 weeks of training, in which G1 performed only tongue pressure exercises against the incisive papilla, and G2 performed the same exercises in combination with swallowing training, while CG was not submitted to any intervention. The suprahyoid muscle electrical activity was obtained with surface electromyography at the beginning and end of the study when subjects also answered a self-perception questionnaire on possible aesthetic results. Pearson's chi-square, Fisher's exact, Mann-Whitney, Kruskal Wallis, and Wilcoxon tests were used. The significance level was set at 5%.

Results: statistically significant differences were found between the initial and final electrical activity in both G1 and G2, which was not found in CG. There was no significant difference between the groups regarding their self-perception of visual or muscle improvements.

Conclusion: both strategies analyzed were equally effective to increase suprahyoid muscle recruitment, though with no impact on the self-perception of aesthetic changes in the submandibular region.

Keywords: Speech, Language and Hearing Sciences; Esthetics; Myofunctional Therapy; Aging; Deglutition

Received on: October 9, 2022
Accepted on: November 20, 2022

Corresponding address:
Renata Maria Moreira Moraes Furlan
Faculdade de Medicina da UFMG
Avenida Professor Alfredo Balena, 251 - Santa Efigênia
CEP:30130-100 - Belo Horizonte, Minas Gerais, Brasil
E-mail: renatamfurlan@gmail.com

INTRODUCTION

Facial aging is a multifactorial process that takes place in all structures of the face and has been studied in various areas. The beginning and speed of age-related changes differ between structures, individuals, and ethnic origins[1].

Muscle changes such as mass and strength loss may be present in the muscle aging process[2], which may also result from inadequate orofacial muscle movements and changes in the form and function of the structures involved[3].

Another tendency observed in facial aging is flaccidity and accumulation of fat in the submandibular region[4], which contributes to an excessive volume in the neck region. The submandibular region is where the suprahyoid muscles are located. This muscle group is situated above the hyoid bone and encompasses the digastric (anterior and posterior belly), mylohyoid, stylohyoid, and geniohyoid muscles, which mainly work moving the mandible down and backward, with an important function also in swallowing, as they elevate the hyoid bone[5].

Speech therapy has a myofunctional approach to facial aesthetics, working on the muscles that balance orofacial functions (breathing, mastication, swallowing, and speech) and toning up face and neck muscles[3,6]. Three types of exercises can be used in orofacial muscles: isotonic exercises (which improve mobility and increase oxygenation and movement amplitude), isometric exercises (whose objective is to increase muscle strength), and resistance exercises (used contrary to movement)[7].

Santos and Ferraz[8] reported a clinical case whose facial symmetry improved after applying a treatment protocol with eight sessions of functional manipulation of the masticatory facial muscles and isometric exercises. In a prospective longitudinal observational study[9], 11 women were submitted to 10 therapy sessions with static and dynamic exercises. The authors verified positive changes in their facial aesthetics, such as decreased wrinkles and folds, which were noticed not only by the evaluators and participants but also by other people. Matos et al.[10], in a prospective longitudinal observational study, conducted 10 therapy sessions with an aesthetic and functional focus in four women. The authors report attenuated wrinkles, improved facial symmetry, and balanced muscle tension and mastication and swallowing functions. Franco and Scattone[11], likewise in a clinical case with five speech therapy sessions mainly focused on muscle stretching and function rebalance, reported decreased expression lines and folds around their mouths. These studies suggest the occurrence of changes in facial muscles and anthropometric measures after speech therapy aimed at facial aesthetics using facial massage techniques and isotonic and isometric exercises in facial expression orofacial function muscles. Among other benefits, they also point to pattern changes in these functions, with positive results in attenuating wrinkles and expression lines[8-11]. However, they present limitations related to their sample and study design.

Tongue movement exercises act indirectly on the suprahyoid muscles and can help strengthen them[12-14]. Various exercises have been described, such as sliding the tip of the tongue in the anteroposterior direction from the hard to the soft palate, pressing the tip of the tongue against the incisive papilla, and pressing the tongue dorsum against the palate[8,15,16]. Strategies such as massages, facial manipulations, and functional training are also used in speech therapy to treat facial aesthetics, aiming to achieve greater suprahyoid muscle contraction and reduce submandibular drooping [2,3,8,9,15,17,18]. Positive results were reported in such interventions, although they were mostly subjectively assessed with self-perception questionnaires on the changes obtained with the treatment, questionnaires answered by other people or the researchers' observations of changes achieved with the treatment and photographic analyses before and after the treatment[3,9,18,19].

Research has aimed to verify the effectiveness of techniques used in speech therapy to treat facial aesthetics[3,17,18], but there is still a gap in the knowledge of the effects of such exercises, particularly with studies researching the effectiveness of individual exercises and techniques, rather than grouped in treatment programs[2,17,20]. A literature review on the topic verified that available national studies generally have low methodological quality, few subjects, and incomplete procedure descriptions, which means insufficient scientific evidence to clinically apply the findings[21]. Moreover, few articles approach the effect on the neck and suprahyoid muscles[8,15,17,19,22,23], and the described strategies most used in this region, the myofunctional exercises, do not have quantitative evidence of improvements in the said muscles[15,19,22].

When the tongue is lifted against the palate in swallowing, the suprahyoid muscles are engaged[16] and, though using only submaximal force, this movement is made many times a day. If adequately performed (by lifting the tongue), it is believed that the suprahyoid muscle activity will be balanced, avoiding or minimizing their flaccidity and submandibular drooping.

Thus, this study aimed to verify the effects of tongue pressure exercises against the incisive papilla, performed both alone and in combination with functional swallowing training, on the electrical activity of the suprahyoid muscles and the self-perception of aesthetic changes in the submandibular region.

METHODS

This experimental analytical prospective study was conducted at Universidade Federal de Minas Gerais, Brazil, after being approved by the Research Ethics Committee under number 66031517.0.0000.5149. All participants signed an informed consent form.

The sample comprised 27 females, aged 30 to 78 years, with a mean age of 54.5 years (SD = 15.86), a median of 53.0 years, a minimum age of 30, and a maximum age of 78 years.

The inclusion criteria were as follows: a) age between 30 and 80 years, b) females, c) not having been submitted to speech-language-hearing treatment in the last 12 months, d) absence of skin lesions or orofacial eruptions, e) absence of neuromuscular changes, and f) not having been submitted to head and neck surgery. These criteria were verified by surveying each candidate's medical history before the research began. The following were the exclusion criteria: a) not attending the three scheduled consecutive meetings; b) not performing the assessments proposed in this study.

Participants were divided into three groups with nine of them in each, namely: Study Group 1 (G1), which performed isometric exercises to strengthen the suprahyoid muscles by pressing the tip of the tongue against the hard palate in the region of the incisive papilla; Study Group 2 (G2), which performed the same isometric exercises in combination with functional swallowing training; and Control Group (CG), which did not undergo any intervention; instead, they only came for the initial and final assessments. Participants were randomly allocated into these groups, by drawing lots.

The study was conducted in three stages. Stage 1 was the first session, involving all participating groups. This stage was used for the electromyographic assessments, to take their body weight measures, and briefly assess dental aspects (number of teeth, missing teeth, and denture use). Weight variations were verified because they could impact the participants' self-perception. It was also necessary to verify the homogeneity of the groups regarding missing teeth and denture use because they change the activation of the suprahyoid muscles. Such cases have muscle compensations during bolus preparation, such as crushing the food with the tongue, swallowing less homogeneous boluses with larger portions, and choosing softer foods in their usual diet[24].

Then, G1 was instructed to perform the said exercises, G2 was instructed to perform the same exercises in combination with functional swallowing training, and CG only scheduled a date to come back for the final assessment, which occurred in Stage 3.

Stage 2 had eight weekly sessions attended by G1 and G2. The following activities were carried out in these sessions: exercise for G1 and the same exercise in combination with functional swallowing training for G2. On this occasion, participants of both groups were instructed about the training frequency they should keep at home. The strategies used in each group are described in Chart 1.

Chart 1. Strategies used in each group

Groups	Strategies used
Group 1	While seated, participants were instructed to place the tip of the tongue on the incisive papilla and pressure it. They should keep this position for up to 10 seconds; this time was progressively increased, as follows: 5 seconds from the first to the third session and 10 seconds from the fourth session. Participants were instructed to make 10 daily repetitions of the exercise series once a day.
Group 2	Participants were submitted to the same training as G1, in combination with functional swallowing training. They participated in activities to make them aware of tongue movements and positions when swallowing. Participants were instructed to place the tip of the tongue on the incisive papilla when swallowing and pressure it in the cranial direction. They trained this position and movement in the sessions, swallowing all consistencies (liquid, pureed, and solid). Participants were instructed to make the same movement so tongue position in swallowing would be automatic in all meals at home.
Control group	Not submitted to any orofacial myofunctional intervention throughout the research.

Each participant received brief weekly explanations of the activities they should carry out at home, as well as a control sheet to record their daily exercises.

Stage 3 was the final session, in which all study participants underwent electromyographic reassessment, answered a questionnaire on the self-perception of visual and muscle changes, and had their weight measures taken again.

All participants were submitted to electromyographic assessment in the first and last sessions by an evaluator who did not participate in the therapy sessions and did not know either the group to which each participant belonged (G1, G2, or CG) or the moment at which they were (whether before or after the therapy). Participants sat on a chair, their feet on a rubber mat, hands resting on their legs, backs against the support, and their heads upright.

In this assessment, the electrodes were connected to 8-channel electromyography equipment (EMG System do Brasil Ltda®), which records the muscle electrical activity in microvolts (μV). The signal was filtered with 20-Hz high-pass and 500-Hz low-pass filters, 1000x amplification gain, and > 100-dB common-mode rejection ratio. The data were processed in a 16-bit analog-digital converter (EMG System do Brasil Ltda®) with a 1-kHz sampling rate. The active electrodes had 20x amplification gain. The data were processed with specific software for data acquisition and processing (AqDados, version 5.05, Lynx Tecnologia Eletrônica Ltda.). Two channels were used, while the other ones were disabled.

Each participant's skin surface on the submandibular region and on the olecranon of the right ulna was cleaned with gauze damped with 70% alcohol. The electrodes were positioned after waiting about 30 seconds for the skin to dry. The electrical signs were obtained with disposable pre-gelled, circular, double, self-adhesive surface electrodes (Ag/AgCl) manufactured by DoubleTrace® LH-ED4020, measuring 10 mm in diameter, keeping 20 mm in between electrodes.

To place the electrodes on the suprahyoid region, participants were asked to press as tight as possible the tip of the tongue against the hard palate, on the incisive papilla, keeping the mouth open, while the evaluator palpated the region to identify the place where the electrode would be positioned – i.e., the anterior belly of the digastric muscle[25]. This procedure was performed bilaterally. The ground electrode was positioned on the olecranon of the participant's right ulna.

After positioning the electrodes, the muscle electrical activity was assessed while participants performed the said exercise for 5 seconds and maximum voluntary contraction, by incompletely swallowing with effort, thus normalizing the signal[26]. In this exercise (incomplete swallow with effort), individuals were asked to swallow saliva, interrupt it when the tongue was attached to the palate, and then press the tongue against the palate. They were allowed 2 minutes to rest between measurements. The recording started when the participant began the exercise and ended after 5 seconds recorded by the computer program.

The electrical activity analyzed 3-second windows taken from each electromyogram, eliminating the initial second and analyzing the 3 subsequent ones to homogenize the analysis windows, thus ensuring the same duration in all of them. The beginning of the muscle contraction was considered the moment when the signal amplitude was twice the standard deviation obtained at rest. This procedure was conducted by a researcher blind to the group to which the participant belonged and the collection moment (whether before or after the intervention). The signal was analyzed in the amplitude domain with the root mean square (RMS). Values obtained while pressing the tongue against the palate were normalized based on the incomplete swallow with effort.

In the last session, besides submitting them to the abovementioned electromyographic assessment, the individuals answered a questionnaire on the self-perception of the changes that had taken place after the treatment (visual changes – improved submandibular flaccidity; muscle changes – increased strength under the chin). The questionnaire had two questions: a) How would you classify the visual changes (improvement) around the chin by the end of this treatment? B) How would you classify the muscle changes (increased strength) under the chin by the end of this experiment? The answer options were as follows: excellent, very good, good, or average. Participants also answered a question on how committed they were to perform the activities during the treatment, with the following answer options: average, good, very good, and excellent.

The variables were descriptively analyzed. The Pearson's chi-square or Fisher's exact test was used for the categorical variables, and the Mann-Whitney, Kruskal-Wallis, and Wilcoxon nonparametric tests were used for the continuous variables, as they had asymmetrical distribution. In all analyses, the significance level was set at 5% ($p \leq 0.05$).

RESULTS

The comparisons of participants' characteristics per group are presented in Table 1. The groups were homogeneous regarding age, missing teeth, denture use, and weight difference.

Table 1. Comparison of sample characteristics between the groups

Characteristics*	Group			p-value
	G1 (N=9)	G2 (N=9)	CG (N=9)	
Age				
Mean	50.00	56.33	57.33	
Median	51.00	56.00	55.00	
Standard deviation	15.98	17.96	14.28	0.602[B]
Minimum	32.00	31.00	30.00	
Maximum	78.00	78.00	74.00	
Missing teeth				
Absent	6 (66.7%)	2 (22.2%)	5 (55.6%)	0.145[A]
Present	3 (33.3%)	7 (77.8%)	4 (44.4%)	
Denture use				
No	6 (66.7%)	2 (22.2%)	7 (77.8%)	0.837[A]
Yes	3 (33.3%)	7 (77.8%)	2 (22.2%)	
Weight difference (Final - Initial) (Kg)				
Median	0.22	0.44	0.11	
Mean	0.00	1.00	0.00	
Standard deviation	0.97	1.01	0.60	0.682[B]
Minimum	-1.00	-1.00	-1.00	
Maximum	2.00	2.00	1.00	

Captions: G1 = Group 1 – exercises; G2 = Group 2 – exercises + functional training; CG = Control Group; N = number of participants; A = chi-square test; B = Kruskal-Wallis test; *$p<0.05$.

Initial and final intragroup electromyography values are shown in Table 2. There were statistically significant differences only in the groups that had speech therapy, in which the electromyographic activity increased.

Table 2. Intragroup comparison between normalized initial and final muscle electrical activity values

Group	Initial electrical activity (%)	Final electrical activity (%)	p-value
Group 1 (N=9)	69.30	105.58	**0.011***
Group 2 (N=9)	78.81	114.95	**0.021***
Control Group (N=9)	100.13	117.64	0.260

Captions: Group 1 = exercises; Group 2 = exercises + functional training; Control Group = no intervention; N = Number of participants. Wilcoxon's Test, *$p<0,05$

In intergroup analysis, no difference was found at any moment of the intervention between normalized electromyography values in subjects of the treatment groups, comparing one with the other and with the control group (Table 3).

Table 3. Comparison between normalized electrical activity values in subjects of the treatment and control groups at the different intervention moments

Characteristics	Group			p-value
	G1	G2	CG	
Initial EMG				
Median	68.37	71.35	99.37	0.124
Mean	69.30	78.81	100.13	
Standard deviation	26.78	36.08	34.88	
Minimum	18.86	23.07	50.99	
Maximum	104.87	120.02	172.06	
Final EMG				
Median	131.22	126.04	116.81	0.852
Mean	105.58	114.95	117.64	
Standard deviation	99.12	67.44	37.88	
Minimum	76.68	38.90	49.91	
Maximum	392.95	233.89	175.12	

Captions: EMG = Electromyography; G1 = Group 1 – exercises; G2 = Group 2 – exercises + functional training;
CG = Control Group – no intervention. Kruskal-Wallis test. *$p < 0.05$

Table 4 shows self-perception results regarding visual improvement and muscle changes before and after the intervention. There were no statistically significant differences between the groups in this assessment.

Table 4. Participants' visual and muscle self-perception at the end of the research

Variable	Group			p-value
	G1	G2	CG	
Visual self-perception				
No improvement (average)	5 (55.6)	2 (22.2)	-	0.167[A]
Improvement (excellent/very good/good)	4 (44.4)	7 (77.8)	-	
Muscle change self-perception				
Excellent	5 (55.6)	3 (33.3)	-	0.067[B]
Very good	3 (33.3)	5 (55.6)	-	
Good	1 (11.1)	1 (11.1)	-	

Captions: G1 = Group 1 – exercises; G2 = Group 2 – exercises + functional training; CG = Control Group – no intervention.
A = Pearson's chi-square test, B = Fisher's exact test, *$p < 0.05$

Participants classified their commitment to the treatment as good (6 individuals, 33.3%), very good (7 individuals, 38.9%), and excellent (5 individuals, 27.8%). No participant reported an average or poor commitment. There was no significant difference in commitment between the groups ($p = 0.104$; Fisher's exact test).

DISCUSSION

The two analyzed strategies increased the use of the suprahyoid muscles, verified with SEMG. This finding agrees with those of other authors who demonstrated that counter-resistance tongue exercises increase the electrical activity of suprahyoid muscles[12]. This increase is not necessarily related to structural changes in the activated muscles, but to the recruitment of more motor units and/or increased motor recruitment speed and coordination, resulting in greater skill to perform the task[27,28].

Both strategies had similar effects on the increase of suprahyoid muscle electrical activity, with no difference between G1 and G2 regarding muscle recruitment. In other words, including functional swallowing training was not enough to significantly increase the muscle electrical activity values in research participants. The literature points out that swallowing tasks with effort recruit suprahyoid muscles more than counter-resistance exercises[14]. However, the swallowing training, in this case, did not involve effort, only changes in tongue position, which may have been insufficient for greater suprahyoid muscle activation results within 8 weeks.

No significant difference was found between G1 and G2 regarding aesthetic improvements in the submandibular region. On the other hand, intragroup data show that four G1 participants (44.4%) and seven G2 participants (77,8%) reported improved visual self-perception. Concerning the muscles, 88.9% of participants in both groups reported improvements, which is coherent with the surface electromyography results and indicates that the exercises, either alone or in combination with functional therapy, can make both visual and muscle changes. The fact that not all participants observed aesthetic changes in the submandibular region may be related to factors such as excessive fat and flaccid skin, self-perception difficulties, or the need for longer therapies. Future research in the area can investigate the topic more in-depth to seek other techniques to aesthetically improve the region approached in this study, as well as other intensities to perform these techniques.

Using myofunctional exercises in speech therapy to treat oral-motor functions is widely discussed, despite the few publications on this issue. It is important to observe the exercise periodicity and time necessary to promote muscle changes. The combination of 10 repetitions of 5-to-10-second isometric contractions once a day may not have been enough to reach noticeable aesthetic results. Hence, further research is needed to investigate the effects of different exercise/task performance frequencies.

Besides the few speech pathology publications on facial aesthetics, most of those that were found used training programs with various stages and strategies to work out the whole face[3,8,9,11,15,19]. Some studies aimed to prove the effectiveness of techniques used alone[10,18,22,29,30], but only two of them included the suprahyoid muscles[22,30]. One study verified increased thickness in these muscles and a rejuvenation effect[30], whereas the other one did not find any aesthetic effect[22].

A study in 10 male and female individuals, aged 31 to 66 years, used eight weekly treatment sessions and found positive results in the suprahyoid and neck region in 57% of patients[19]. However, it did not research myofunctional exercises alone, but in combination with massages, facial manipulation, and functional training in a treatment protocol that was not described in detail. Moreover, the result was obtained only with a self-perception questionnaire filled out by participants.

Likewise, a study in 11 women aged 40 to 50 years, meeting twice a week for 5 weeks, also verified positive results, with decreased submandibular flaccidity in 63.6% of individuals. These results were obtained with questionnaires on facial changes perceived by them or others and with assessments and photographic and video documentation taken by specialized speech-language-hearing therapists. The treatment included muscle release maneuvers, stretching, and two myofunctional exercises, one of which was to press the tongue against the palate for 4 seconds and then relax[9].

An aspect to be highlighted in the present study is the data obtained with SEMG to prove the results – unlike what was found in other speech pathology publications addressing facial aesthetics, which used only photographic and video documentation or self-perception questionnaires to assess study results. Another important aspect is that the groups in the present study did not have different ages, weight variations, missing teeth, denture use, or baseline values of muscle electrical activity measured in Stage 1, thus avoiding possible data interpretation biases. The amount of subcutaneous adipose tissue interferes with electrical signal pick-up in SEMG; however, this bias is neutralized with signal normalization.

The limitations of this research include the few participants, which hinders the generalization of results, and the rather wide age range. This limitation was minimized by the lack of age differences between the groups and by data normalization in EMG.

Other limitations are the absence of photographic assessment with images judged by professionals in the field and recorded measures of the assessed area, neck circumference, and body mass index, which would complement the data on weight. The self-perception questionnaire assessment method poses subject memory biases regarding their condition before the intervention. To minimize this bias, quantitative data on muscle electrical activity were included among the research variables.

The authors suggest that future research use larger samples to compare age groups, different myotherapy exercises, and the effects of swallowing training alone, also including photographic assessments and less subjective methods to assess the results, such as ultrasound and/or photogrammetry.

Even though the study focused on facial aesthetics, its results apply to myofunctional therapy in general. Myotherapy is a stage in myofunctional therapy that indicates exercises to adjust muscle conditions, preparing them to perform functions. Few studies have addressed the physiology of exercises applied to orofacial muscles. Therefore, this paper presents additional relevant information on exercises of tongue pressure against the incisive papilla, which is often used in clinical practice.

CONCLUSION

In the study sample, the two strategies – exercises of tongue pressure against the incisive papilla and this same exercise in combination with functional swallowing training – were equally effective to increase suprahyoid muscle recruitment, which was verified with surface electromyography. However, they did not have a significant impact on the self-perception of visual and muscle improvements in the submandibular region.

REFERENCES

1. Cotofana S, Fratila AA, Schenck TL, Redka-Swoboda W, Zilinsky I, Pavicic T. The anatomy of the aging face: a review. Facial Plast Surg. 2016;32(3):253-60.
2. Souza CB, Guerra JG, Barbosa MA, Porto CC. Rejuvenescimento facial por intervenção miofuncional estética. Revisão integrativa. Med Cutan Iber Lat Am. 2013;41(4):165-71.
3. Frazão Y, Manzi SB. Eficácia da intervenção fonoaudiológica para atenuar o envelhecimento facial. Rev. CEFAC. 2012;14(4):755-62.
4. Thomas WW, Bloom JD. Neck contouring and treatment of submental adiposity. J Drugs Dermatol. 2017;16(1):54-7.
5. Shaw SM, Martino R, Mahdi Ali, Sawyer FK, Mathur S, Hope A et al. Architecture of the suprahyoid muscles: a volumetric musculoaponeutotic analysis. J Speech Lang Hear Res. 2017;60(10):2808-18.
6. Toledo PN. Fonoaudiologia na estética facial. In: Silva HJ, Tessitore A, Motta AR, Cunha DA, Berretin-Felix G, Marchesan IQ, editors. Tratado de Motricidade Orofacial. São José dos Campos: Pulso Editorial, 2019. p.795-803.
7. Allende FI, Silva HJ. Fisiologia do músculo estriado esquelético e do exercício em Motricidade Orofacial. In: Silva HJ, Tessitore A, Motta AR, Cunha DA, Berretin-Felix G, Marchesan IQ, editors. Tratado de Motricidade Orofacial. São José dos Campos: Pulso Editorial, 2019. p.101-10.
8. Santos CCG, Ferraz MJPC. Atuação da Fonoaudiologia na estética facial: relato de caso clínico. Rev. CEFAC. 2011;13(4):763-8.
9. Arizola HGA, Brescovici SM, Delgado SE, Ruschel CK. Modificações faciais em clientes submetidos a tratamento estético fonoaudiológico da face em clínica-escola de Fonoaudiologia. Rev. CEFAC. 2012;14(6):1167-83.
10. Matos KDF, Loreto PM, Nery TCS, Souza VAM, Souza CB. Análise da eficácia de um trabalho fonoaudiológico com enfoque estético. Rev Fragmentos de Cultura. 2010;20(3):413-32.
11. Franco MZ, Scattone L. Fonoaudiologia e Dermatologia: um trabalho conjunto e pioneiro na suavização das rugas de expressão facial. Fono atual. 2002;5(22):60-6.
12. Namiki C, Hara K, Tohara H, Kobayashi K, Chantaramanee A, Nakagawa K et al. Tongue-pressure resistance training improves tongue and suprahyoid muscle functions simultaneously. Clin Interv Aging. 2019;14:601-8.
13. Fujiwara S, Fujiu-Kurachi M, Hori K, Maeda Y, Ono T. Tongue pressure production and submental surface electromyogram activities during tongue-hold swallow with different holding positions and tongue length. Dysphagia. 2018;33(4):403-13.
14. Oommen ER, Kim Y. Submental muscle activation during lingual tasks in healthy adults. J Nutr Health Aging. 2018;22(9):1133-7.
15. Pavez A, Silva TM. Fonoaudiología y estética facial: experiencia de Brasil en la atención primaria de Salud. Rev Chil Fonoaudiol. 2015;14:45-54.

16. Reis VS, Araújo TG, Furlan RMMM, Motta AR. Correlation between tongue pressure and electrical activity of the suprahyoid muscles. Rev. CEFAC. 2017;19(6):792-800.
17. Van Borsel J, De Vos M-C, Bastiaansen K, Welvaert J, Lambert J. The effectiveness of facial exercises for facial rejuvenation: a systematic review. Aesthet Surg J. 2014;34(1):22-7.
18. Silva NL, Vieira VS, Motta AR. Eficácia de duas técnicas fonoaudiológicas da estética facial no músculo orbicular dos olhos: estudo piloto. Rev. CEFAC. 2010;12(4):571-8.
19. Paes C, Toledo PN, Silva HJ. Fonoaudiologia e estética facial: estudo de casos. Rev. CEFAC. 2007;9(2):213-20.
20. Ferreira TS, Mangilli LD, Sassi FC, Fortunato-Tavares T, Limongi SC, Andrade CR. Speech and myofunctional exercise physiology: a critical review of the literature. J Soc Bras Fonoaudiol. 2011;23(3):288-96.
21. Valente MFL, Ribeiro VV, Stadler ST, Czlusniak GR, Bagarollo MF. Esthetic logopedics intervention in Brazil: literature review. Audiol., Commun. Res. 2016;21:e1681.
22. De Vos M-C, Van den Brande H, Boone B, Van Borsel J. Facial exercises for facial rejuvenation: a control group study. Folia Phoniatr Logop. 2013;65(3):117-22.
23. Alam M, Walter AJ, Geisler A, Roongpisuthipong W, Sikorski G, Tung R et al. Association of facial exercise with the appearance of aging. JAMA Dermatol. 2018;154(3):365-7.
24. De Felício CM, Cunha CC. Relações entre condições miofuncionais orais e adaptação de próteses totais. PCL Rev Iberoam Prót Clín Laboratorial. 2005;7(36):195-202.
25. Furlan RMMM, Rezende BA, Motta AR. Comparison of the electric activity of the suprahyoid muscles during different lingual exercises. Audiol., Commun. Res. 2015;20(3):203-9.
26. Balata PMM, Silva HJ, Nascimento GKO, Moraes KLR, Pernambuco LA, Freitas MCR et al. Incomplete swallowing and retracted tongue maneuvers for electromyographic signal normalization of the extrinsic muscles of the larynx. J Voice. 2012,26(6):813e1-7.
27. De Luca CJ. The use of surface electromyography in biomechanics. J Applied Biomech. 1997;13:135-63.
28. Rahal A. Exercícios miofuncionais orofaciais. In: Motta AR, Furlan RMMM, Tessitore A, Cunha DA, Berretin-Felix G, Silva HJ et al., editors. Motricidade Orofacial – a atuação nos diferentes níveis de atenção à saúde. São José dos Campos: Pulso Editorial; 2017. p.71-5.
29. Gabana-Silveira J, Mangilli L, Sassi F, Braga A, Andrade C. Adolescents with HIV and facial lipoatrophy: response to facial stimulation. Clinics. 2014;69(8):574-8.
30. Hwang UJ, Kwon OY, Jung SH, Ahn SH, Gwak GT. Effect of a facial muscle exercise device on facial rejuvenation. Aesthet Surg J. 2018;38(5):463-76.