

Brief communication

Relationship between the electrical activity of suprahyoid musculature and tongue pressure during swallowing in the elderly

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**ABSTRACT**

Purpose: to correlate the electrical activity of the suprahyoid musculature and tongue pressure during swallowing, in the elderly.

Methods: thirteen elderly aged from 60 to 80 years participated in this study. They were submitted to electromyographic assessment and tongue pressure measurement while swallowing. After the evaluation, the relationship between suprahyoid musculature activity and tongue pressure during swallowing was verified. To obtain the electrical signal, surface electromyography was used and electrodes were placed in the submental region. They swallowed saliva and held the tongue against the palate for three seconds to record the maximum voluntary contraction, as well as saliva, and then, 50ml of water for the electromyographic recording. Tongue pressure was measured using the Iowa Oral Performance Instrument during swallowing of 10ml of water. Swallowing was performed with a bulb positioned between the dorsum of the tongue and the hard palate. Statistical analysis was carried out by using Spearman's rank correlation coefficient.

Results: there was a relationship between the electrical activity of the suprahyoid musculature and tongue pressure, during water swallowing ($p=0.093\%$), showing an increase in the maximum tongue pressure level as the electrical activity increased, while swallowing.

Conclusion: the values of tongue pressure and electrical activity of the suprahyoid musculature are related when swallowing in the presence of a greater volume of liquid to be swallowed.

Keywords: Swallowing; Muscle; Pressure; Tongue

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INTRODUCTION

Aging is an intrinsic, progressive and degenerative process that causes physiological changes in the organism, affecting cells, tissues, organs and systems¹. Because of aging, the swallowing function tends to be modified by the functional alterations in the stomatognathic system (SS). It is possible to observe alterations in the oral mucosa, reduction in the alveolar bone, and alterations in function, pressure, resistance and number of muscle motor units².

Swallowing is a process in which food is transported from the mouth to the stomach, and it involves a complex coordination of lip, pharynx, larynx and esophagus musculatures. It is performed in the following stages: oral stage (conscious and voluntary), pharyngeal stage (conscious and involuntary), and esophageal stage (unconscious and involuntary, controlled by the somatic and autonomous nervous system). Understanding the role of musculature in swallowing is indispensable for the diagnosis and therapeutic practice³. The suprahyoid musculature, formed by the mylohyoid muscle, geniohyoid muscle and anterior belly of the digastric muscle⁴, is the main muscle group for the investigation of swallowing.

Comprehending how the musculature works in swallowing is decisive for the diagnosis and the therapeutic practice. Since the clinical myofunctional assessment is subjective, the electromyographic exam can be used to quantify and demonstrate the functioning of these muscles while swallowing³.

In the electromyography (EMG), the muscles are observed in action while swallowing, so it is possible to identify the greater contribution of the mylohyoid, the anterior belly of the digastric and the geniohyoid, as well as the minimal contribution of the genioglossus and the platysma muscles³. The electromyography analyzes the electrical signals of the muscles, aiding in reliable assessment, diagnosis and speech-language-hearing treatment⁵. It is an exam that can be used as an alternative to assist in clinical swallowing assessment, furnishing to the patient a faster evaluation⁶.

The tongue has an important role in performing the orofacial functions and in balancing the stomatognathic system, in addition to influencing the craniofacial growth, which, in its turn, interferes with the stomatognathic functions. Knowing how this organ works in activities as chewing, swallowing and speaking favors the understanding of disorders in the craniofacial complex and their repercussions. To this end, the literature has been striving to develop, both quantitatively

and qualitatively, methods for measuring the function performed by the tongue in the oral cavity⁷.

In the effort to obtain an objective measurement of the tongue's strength, be it axial, cranial or lateral, various instruments have been developed. The Iowa Oral Performance Instrument (IOPI) has doubtless been one of the methods most employed in the investigations of the lingual pressure/strength⁸. The tongue's strength can be assessed by both qualitative and quantitative methods, though the qualitative assessment is more used in speech-language-hearing clinical practice. In this procedure, the tongue tone/tension is usually tested by requiring the patient to press the tongue against the assessor's gloved finger, or against a spatula, while the speech-language-hearing therapist maintains a resistance. As for the quantitative assessment, it is conducted using instruments that show the value of the strength exerted by the subject, which allows the tongue strength diagnosis to be more precise⁹.

Regarding the elderly, they present diverse alterations in the functions of the stomatognathic system, some of which may directly impair swallowing, such as: alteration in the oral mucosa, reduction in the alveolar bone, and alterations in function, strength, resistance and number of muscle motor units.

This study aimed at correlating the electrical activity of the suprahyoid musculature and the tongue pressure in the swallowing process of the elderly.

METHODS

This is a cross-sectional, quantitative, analytical study, approved by the Research Ethics Committee (REC) of the Universidade Federal de Pernambuco, under number: 2.175.148. The study was carried out at the elderly attention center of the Universidade Federal de Pernambuco (NAI-UFPE) and at the elderly outreach university program (UNATI), in Recife, Pernambuco, Brazil.

To compose the study sample, a population of 13 elderly was selected, whose age ranged from 60 to 80 years, participants of the NAI-UFPE and the UNATI at the time the research was being carried out. As inclusion criterion, the individuals had to be in the age group of 60 to 80 years, regardless of gender, not undergoing speech-language-hearing therapy at the time the collection for this research was being conducted; furthermore, they had to present absence of central or peripheral neurological disorders, absence of head and neck tumors and traumas, absence of difficulties to swallow liquids and/or history of dysphagia,

as reported by the subject of the research at the moment of the initial interview.

The selected subjects performed the suprahyoid musculature electrical activity test and the tongue pressure level assessment. For the suprahyoid musculature test, electrodes were positioned bilaterally on the submental region, anterior to the neck, referring to the suprahyoid muscle group, positioned parallelly to the fibers of the anterior belly of the digastric muscle. Prior to positioning the electrodes, the skin in the area was cleaned with 70% alcohol, cotton and gauze pads in order to ensure the fixation of the electrode on the skin, and to avoid altered exam results due to chemical, aesthetic and pollutant substances possibly present on the skin.

For the normalization of the electromyographic signal, the maximum voluntary contraction (MVC) was collected. For this procedure, the patient was asked to swallow saliva and hold the tongue against the palate for three seconds. The value collected at this moment was the basis (100%) for comparison to the values collected in the following swallowing tasks (swallowing saliva and then 50ml of water), which were computed in percentage values compared to the MVC¹⁰.

For the electromyographic record, the individual was instructed to swallow three times the saliva, both in the usual manner and with 50ml of water, which was served in a plastic disposable cup. The subject was seated, with the feet rested on the floor, when the exam was conducted. The tongue pressure level test was taken through the IOPI; during this test, the subject remained seated with the feet rested on the floor.

The IOPI is formed by a pressure transducer connected to an air bulb, in which measures of exerted pressure are taken; the result is expressed in kilopascal (kPa). The device measures tongue pressure by means of the maximum peak pressure exerted on the bulb. After instructions, the individual performed the usual maximum strength and then swallowed 10ml of water, with the bulb positioned inside the oral cavity, being assessed the swallowing test that followed habitually. The tongue pressure level test was performed three times; the three values obtained were added and

divided to reach a mean, whose exact value was the basis for the data analysis of the test.

The data bank was created with the use of the Microsoft Excel program. This data bank was fed by typing the transcription from the analogical to the digital media. The data related to the percentage of the electrical activity of the suprahyoid musculature and tongue pressure when swallowing saliva and 50ml of water were transferred to the program, with the purpose of performing the comparison and analysis of the collected data.

Spearman's rank correlation coefficient nonparametric test, with $p = 5\%$, was used for the data statistical analysis, to measure the correlation between the tongue pressure level and the electrical activity of the suprahyoid musculature, considering that the number of observations was inferior to 15 subjects.

RESULTS

Table 1 shows the values obtained by the 13 subjects of the research regarding the relation between the electrical activity of the suprahyoid musculature and the tongue pressure level while swallowing saliva, as well as the values obtained by the 13 subjects of the research regarding the relation between the electrical activity of the suprahyoid musculature and the tongue pressure level when swallowing water. The statistical values of the collected data corresponding to the electrical activity of the suprahyoid musculature and tongue pressure while swallowing are described in the figures and tables presented. In the maximum tongue pressure test performed while swallowing saliva, the mean obtained was of 29.46, median of 28 and standard deviation of 11.43. In the tongue pressure level test while swallowing 10 ml of water, the mean obtained was of 55.46 kPa, median of 54 and standard deviation of 5.35. In the suprahyoid musculature electrical activity test when swallowing saliva, the mean obtained was of 59.77, median of 63.27 and standard deviation of 12.14. In the suprahyoid musculature electrical activity test when swallowing 50 ml of water, the mean obtained was of 24.72%, median of 24.63 and standard deviation of 3.82.

Table 1. Collected and statistical values of tongue pressure (kPa) and percentage values of the electrical activity (%) of the suprahyoid musculature when swallowing saliva and water

Subjects	Saliva		Water		
	S	TPL (kPa)	SMEA (%)	TPL (kPa)	SMEA (%)
S1		10	36.28	61	22.57
S2		15	35.82	48	19.23
S3		24	53.59	49	22.58
S4		25	72.87	50	24.58
S5		26	55.48	51	18.25
S6		27	59.45	53	27.63
S7		28	63.27	53	28.79
S8		29	61.45	54	23.59
S9		31	65.76	56	25.53
S10		32	73.28	60	32.67
S11		37	71.83	61	24.68
S12		45	63.64	62	24.63
S13		54	64.24	63	26.63
Mean (SD)		29.46 (11.43)	59.77 (12.14)	55.46 (5.35)	24.72 (3.82)
Median		28	63.27	54	24.63

Spearman's test

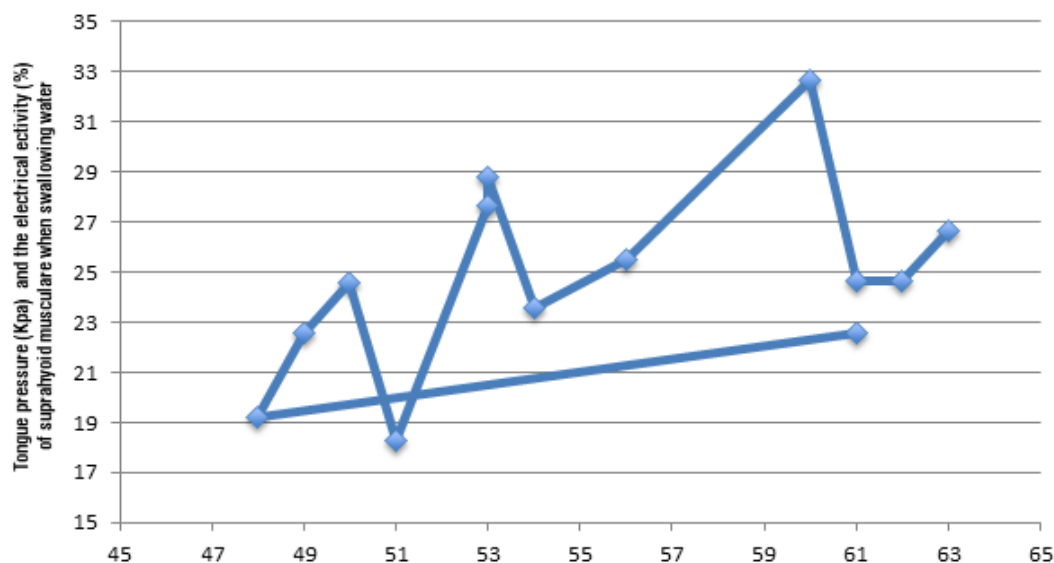
Legend: TPL – Tongue pressure level; SMEA – Suprahyoid musculature electrical activity

S – Subject; SD – Standard deviation

*Significance TPL - ($p = 0.009$); SMEA - ($p = 0.093$)

Figure 1 presents the results of the relation between the electrical activity of the suprahyoid musculature and the tongue pressure level when swallowing water. In the chart, it is possible to observe that such a relationship was not found. When swallowing saliva, the tongue is more active, keeping a high tongue pressure

level, contrary to the suprahyoid musculature electrical activity, which presents a reduced level of electrical activity. There was no statistically significant relation, as the value was $p = 0.093\%$. This result contrasts with that obtained when swallowing water.



(*Spearman test = 0.093%)

Figure 1. Relationship between tongue pressure (kPa) and the percentage of electrical activity (%) of the suprahyoid musculature when swallowing water

Figure 2 brings the results of the relation between suprahyoid musculature electrical activity when swallowing and tongue pressure level when swallowing of saliva. The chart presents the muscle activity, showing that the maximum tongue pressure level

increases as the suprahyoid musculature electrical activity also increases while swallowing. Thus, such a relationship was observed between the tongue and the suprahyoid musculature while swallowing. The statistically significant value was $p = 0.009\%$.



(*Spearman test = 0.009%)

Figure 2. Relationship between tongue pressure (kPa) and the percentage of electrical activity (%) of the suprahyoid musculature when swallowing saliva

DISCUSSION

Currently, there is a concern in the speech-language-hearing sciences regarding swallowing in the elderly, due to the natural age-related limitation to this function that influences directly on their nutrition and quality of life.

In contrast, the repercussion of the relation between the elderly's suprahyoid musculature electrical activity and tongue pressure when swallowing does not seem to be clear, as there is in the literature a shortage of papers sketching the behavior of such a relationship in swallowing in this group of individuals.

The results in this research partially confirm the expected hypothesis, for, with them, it is possible to analyze that one individual, when swallowing, can exert different tongue pressure levels and suprahyoid musculature electrical activity.

The mean value of maximum peak pressure level in habitual swallowing with saliva found in this study was greater, when compared to other results described in the literature, within the compatible age group for

analysis (60 to 96 years). In a study with 45 elderly, which used maximum tongue pressure level test without swallowing water, the mean pressure level found was of 44.6 kPa¹¹, value lower than that obtained in this study (55.46 kPa). Nevertheless, it should be highlighted that this study was conducted in a small group in Brazil, where the mean maximum pressure level is still being studied.

In the maximum suprahyoid musculature electrical activity in swallowing with water in this study, the mean value found was of 51.3%. These findings corroborate with the results of research found in the literature assessing and relating musculature electrical activity in the function of swallowing¹².

It was possible to observe that there is no relation between the electrical activity of the suprahyoid musculature and the tongue pressure levels when swallowing saliva. As it is habitual, this activity is more adapted, so that there is no demand of effort on the part of the tongue and the suprahyoid musculature to perform the function in a healthy population. On the other hand, in swallowing water, since there is volume to be

swallowed, the tongue and the suprahyoid musculature need to make effort. Hence, the suprahyoid musculature electrical activity and the tongue pressure level present close relation, in which the electrical activity of the suprahyoid musculature increases in direct proportion with the tongue pressure levels, as these also increase when swallowing with volume.

Considering the findings in this research, it was possible to infer that, when relating the activity of both musculatures in swallowing, the suprahyoid musculature and the tongue are related when there is a stimulus requiring swallowing effort, i.e., when there is volume to be swallowed.

Therefore, it is increasingly important to use methods enabling the investigation of how the activities of the suprahyoid musculature and of the tongue when swallowing correlate. Certainly, continuing to use electromyography and the tongue pressure assessing methods as aids in coming to the relation between both musculatures will bring benefits to the understanding of the combined dynamics of these structures when swallowing. Attention is called to the importance of analyzing these parameters in various age groups.

CONCLUSION

The values of tongue pressure level and suprahyoid musculature electrical activity show a relationship when a greater volume of water is swallowed, due to the more intense activity of the musculatures to swallow, differently from the swallowing of saliva, which is habitual and does not need a greater suprahyoid musculature activity.

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