

Original articles

Deglutition pattern in Angle's Class II malocclusion

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ABSTRACT

Purpose: to analyze the electromyographic activity of the suprahyoid muscles during deglutition in participants with Angle's Class II malocclusion.

Methods: electromyographic data recordings were performed in the supra-hyoid muscles during swallowing and at rest, in 30 volunteers, 15 Angle's Class I participants and 15 Angle's Class II malocclusion, aged 15-27 years old. The Root Means Square values for both tests were analyzed, and for the deglutition test, the Linear Envelope was used to observe the type of muscle activation pattern.

Results: during the test at rest, there was no significant difference in Root Means Square values ($p=0.22$) between Class I and Class II subjects. During deglutition, it was found that Angle's Class II subjects had significantly higher RMS values ($p=0.01$) as compared to Class I volunteers. Regarding the type of muscle activation pattern, there was a significant difference between Class I and Class II participants with a predominance of type 1 peak for Class I and type 2 peak for Class II.

Conclusion: there was a difference in electromyographic recordings during deglutition in participants with Angle's Class II as compared to Class I participants with a tendency towards two contraction peaks, showing a greater imbalance during the function. There was no difference between groups in the rest position.

Keywords: Electromyography; Malocclusion, Angle Class I; Malocclusion, Angle Class II; Deglutition

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INTRODUCTION

Angle's Class II malocclusion is defined as an anteroposterior discrepancy, that is, in the molar sagittal relationship, even though there may not always be basal bone affected. When involved, alterations in sagittal position of the maxilla and/or mandibular are shown^{1,2}.

According to Angle's classification, Class II malocclusion is characterized by the position of the upper first molar in relation to the lower first molar in which the mesiobuccal cusp of the upper first molar is positioned anteriorly in relation to the buccal groove of the lower first molar. First division is characterized by protrusion of the upper incisors, which present a labial inclination. It represents a frequent problem, affecting close to 55% of the Brazilian population^{1,3}.

Dentofacial deformities determine specific myofunctional characteristics peculiar to the type of disproportion, such as alteration in habitual lip and tongue positions, muscular asymmetries, temporomandibular joint dysfunctions, and abnormal mastication, deglutition, speech and respiratory function⁴⁻⁶.

Deglutition is defined as the act of swallowing, resulting from a complex and dynamic neuromotor mechanism, which aims to transport the food bolus from the mouth to the stomach effectively. It requires precise coordination from the stomatognathic system and the structures of which it is composed^{7,8}.

The suprahyoid muscles are considered to be strategic for deglutition, since they participate in motor reflex mechanisms, lowering and stabilization of the mandible, elevation and forward movement of the hyoid bone, and have insertion with tongue musculature^{9,10}.

Surface electromyography (SEM) registers electric potentials of skeletal muscle. It evaluates muscular function, making it a useful tool for the study of muscle dynamics during functions of the stomatognathic system, including deglutition. It contributes to better comprehension of the physiological mechanism of normal and pathological deglutition¹¹⁻¹⁵. It is a method that is non-invasive, reproducible and of little discomfort for the patient during the exam^{11,16}.

Muscular behavior can be determined by studying the relation between the frequency and intensity of the electric registers. The electric signal is obtained in microvolts (μV), which can follow variations in the mathematical process of the signal, such as the minimum and maximum amplitude values, integrated value, the linear envelope, spectral or signal frequency variables. The root mean square (RMS) of the linear envelope

in the time domain can be used to analyze when the rectified signal is passed through a filter to decrease high frequency fluctuations, allowing a clear evaluation of the electromyographic signal amplitude^{14,17}.

The correlation of biomechanical events of deglutition has been described in the literature and its characteristics associated with electromyography establish the suprahyoid musculature as that which reflects the verification of this functional event. The characterization of deglutition using surface electromyography is attained by tracing electromyographic signals such as the increase in amplitude of these signals in relation to basal muscle tension (habitual posture), followed by a maximum amplitude peak of electromyographic signals and then return to the basal level of muscle contraction¹⁶.

An electromyographic analysis of deglutition can highlight differences in muscular activity, which can be identified and correlated with occlusion⁷.

The objective of this study was to evaluate the electromyographic activity of the supra-hyoid muscles during deglutition in participants with Angle's Class II, division 1 malocclusion.

METHODS

This prospective observational transversal study was approved by the Ethics in Research Committee of Fundação Hermínio Ometto (FHO) protocol number 20391513.0.0000.5385.

All volunteers signed a consent form after the procedures of the study were explained.

The sample was composed of participants aged 15-27 years, of both genders, 15 having Angle's Class I molars and 15 having Class II, first division malocclusion.

The volunteers obeyed the inclusion and exclusion criteria which were: the patients were not mouth-breathers, no tooth loss, no signs of temporomandibular joint dysfunction, no facial pain complaints, no use of muscle relaxant medication and no previous orthodontic treatment.

All procedures for the acquisition of the electromyographic signals were performed according to the guidelines established by the International Society of Electromyography and Kinesiology (ISEK)^{7,9}.

Electromyographic activity was registered by surface electromyography using the Miotool 400® (Miotec) equipment, 14 Bit signal acquisition, 2000 samples/second per channel acquisition rate, common rejection mode of 110 db. The Miograph software was

used with SDS 500 sensors, sample frequency of 2000 Hz, low-pass filter of 20 Hz and high-pass filter of 500 Hz. The Root Mean Square (RMS) values were calculated to represent the mean amplitude of the electromyographic signal⁷.

The electromyography room was adapted to reduce environmental interferences in the electromyographic registers. Electric and electromagnetic isolation was achieved by grounding the electric network that supplies the environment, having an independent electric network, and turning off and removing light sources (lamps, light bulbs and reactors). Volunteers, researchers and electromyographic equipment were positioned on rubber mats.

Before placing the electrodes, the area of the supra-hyoid muscles was cleaned with cotton and 70% alcohol. When necessary, men were asked to shave with disposable razors.

Child-size disposable Ag/AgCl Meditrace Kendall electrodes were trimmed and positioned on the supra-hyoid muscle region from the median below the chin in the posterior-anterior direction. The electrode fixation site was determined by testing the deglutition function, by asking the volunteer to swallow and thus identifying the position of the muscle. The reference electrode was positioned at the manubrium of the sternum. The inter-electrode distance was 1 cm.

The tests were performed with the volunteers seated, feet on the floor and the head at the natural position.

The acquisition of the electromyographic signal was achieved by performing three tests at rest and three tests during deglutition. At rest, electromyographic signal was collected over a period of 10 seconds. For the deglutition test, the volunteer received 5 ml of water, which was deposited into the oral cavity using a needleless disposable syringe. The volunteers held

the liquid while awaiting verbal command to swallow during the 5-second protocol.

The RMS data values were not normalized because a previous study demonstrated that the data normalized by means and peaks showed differences between the groups. However, the differences decrease in relation to those observed in the original non-normalized data, due to the fact that the muscles studied were of low caliber⁷.

The data was analyzed using the mean of the three tests at rest and during deglutition in RMS values, and by the type of tracing produced by the linear envelope during deglutition.

The types of tracings were classified as: predominantly one peak (Figure 1), in which a defined peak could be observed, considered adequate (type 1 tracing); more than one peak (Figure 2), in which the presence of more than one contraction episode during deglutition could be observed (type 2 tracing); and non-defined peak (Figure 3), classified by the absence of a defined peak (type 3 tracing)¹⁶.

The data was analyzed for homogeneity and normality. The RMS value data at rest and during deglutition were transformed with a logarithmic function and underwent the t-test for independent samples with a 5% significance level. The data for each peak type underwent the Mann-Whitney test with a 5% significance level.

RESULTS

The results in RMS values showed that there was no significant difference ($p=0.22$) between Class I and Class II participants at rest (Table 1). It was verified that Class II participants show significantly higher values ($p=0.01$) than Class I participants during deglutition (Table 1).

Table 1. Mean, standard deviation and p-values of the electromyography datas in root mean square values obtained during deglutition in suprahyoid muscles

Groups	RMS Rest			RMS Deglutition		
	Average	Standard Deviation		Average	Standard Deviation	
Class I	2.48	1.20	a	9.81	8.95	b
Class II	3.48	2.57	a	16.95	9.86	a
			$p=0.22$			
				$p=0.01$		

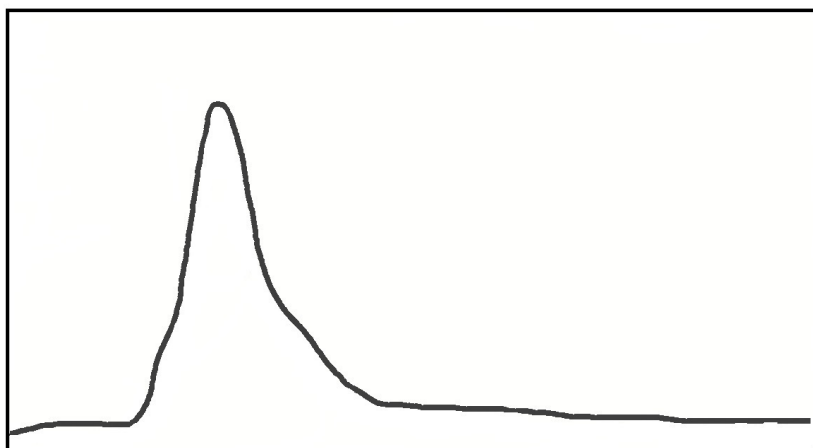
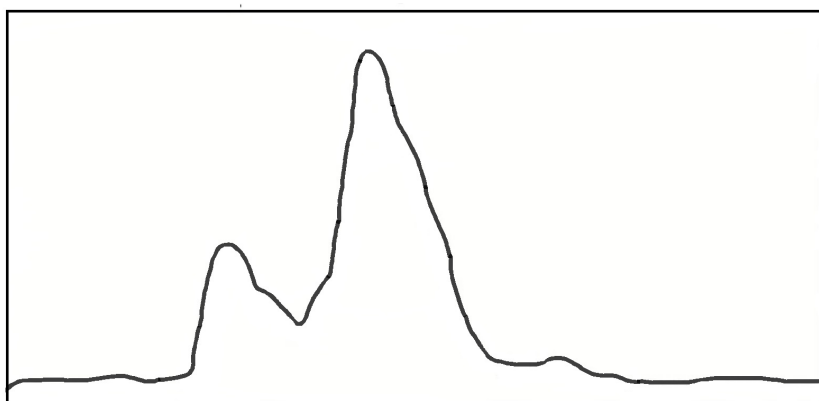
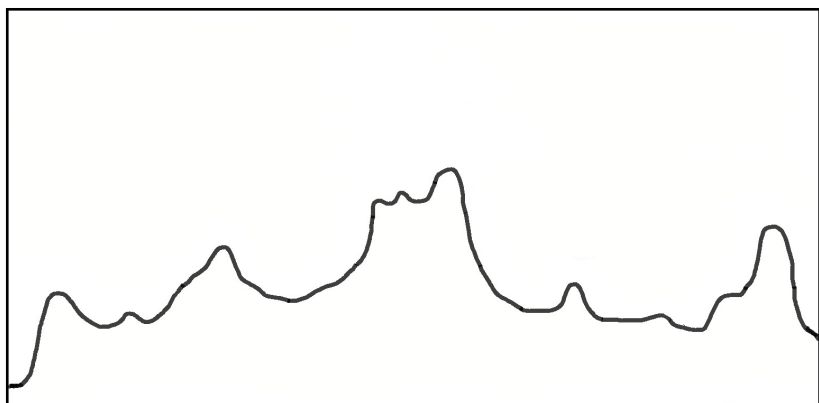
Values marked by distinct letters are significantly different from each other according to t-test for independent samples ($p<0.05$).
Legend: RMS = root mean square

Table 2. Type of tracing produced by the linear envelope during deglutition in Angle´s Class I and Class II malocclusion

Groups	Type of peak			
	Median	25%	75%	
Class I	1.000	1.000	1.750	B
Class II	2.000	2.000	3.000	A

p=0.02

Values marked by distinct letters are significantly different from each other according to Mann-Whitney test($p < 0.05$).

**Figure 1.** Type 1 tracing - predominantly one peak**Figure 2.** Type 2 tracing - more than one peak**Figure 3.** Type 3 tracing – nondefined peak

With regard to the type of peak, a significant difference was verified between Class I and Class II participants. Class I participants had predominantly one peak and Class II participants had more than one peak.

DISCUSSION

Deglutition is a complex sensory-motor mechanism that involves sequential excitation and inhibition of the central nervous system at different levels, and thus involves the whole stomatognathic system¹⁶.

A conjoint equilibrated action of the maxillomandibular structures with the muscular system is of utmost importance so that actions such as mastication, deglutition, speech and respiration occur efficiently^{7,18}.

The suprahyoid muscles have an important role in deglutition, participate in motor reflexes, and lower and stabilize the mandible^{9,10}.

For efficient deglutition, the mandible assumes a fixed, stable position, by intercuspation of the occlusal surfaces, immediately before the tongue pushes the food bolus towards the oropharynx. In turn, stabilization of the mandible allows the suprahyoid muscles to contract and consequently, movement of the hyoid bone upward and forward, guaranteeing safe deglutition. There is evidence that the mandibular rest position can be altered as a result of occlusal interferences, temporomandibular joint dysfunction, stress, nasal obstruction and head position¹⁹.

Although studies show evidence for differences in electromyographic activity between participants with different occlusal classifications¹⁹⁻²¹, in this experiment, there was no difference observed between the two types of occlusion studied at rest.

During the deglutition test, analysis of RMS values of Angle's Class I participants showed that the muscles worked in a more balanced manner during function. This fact was also observed in another study⁹.

The most prevalent type of peak was Type 1, with only one peak during function. The literature points to the expectation of an electromyographic curve with only one peak, with gradual increase and decrease in muscular activity¹⁶.

In Class II participants, a difference in RMS values was demonstrated in comparison to the Class I group²¹. Higher RMS values were obtained in Class II subjects, demonstrating a need for greater muscular effort, probably resulting in maxillomandibular and key occlusal fitting disproportion, and a prevalence of two contraction peaks⁷.

Another study that evaluated electromyographic activity during deglutition suggested that, in volunteers with normal occlusion, the mandible is stabilized during deglutition due to the contraction of the mandible elevator muscles and the anterior suprahyoid muscles. These muscles elevate the hyoid bone to its highest position, and consequently, the anterior third of the tongue reaches the hard palate. This strong elevation of the tongue shortens the floor of the mouth, which, together with the elevation of the hyoid bone, promotes a strong recruitment of the anterior suprahyoid muscles during deglutition⁹.

Angle's Class II participants presented a prevalence for Type 2 tracings. A modification in their morphology such as having a protruded maxilla, retruded mandible, or a combination of both, can promote functional adaptations, such as modifying tongue position and muscular activity for correct deglutition, in which the muscle requires more activity to perform deglutition⁷.

To know how stomatognathic functions occur in their normality and how the performance and modified according to the positioning of the bone and dental bases is essential for the speech-language pathologist to plan the myofunctional treatment^{22,23}.

CONCLUSION

From this study it can be concluded that there was a difference in deglutition between Angle's Class II participants and Class I participants, with a tendency towards two contraction peaks, showing greater unbalance during function. There was no difference between the groups at rest.

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