Influence of Masticatory Behavior on Muscle Compensations During the Oral Phase of Swallowing of Smokers

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Abstract

Introduction Chewing and swallowing are physiologically interconnected functions, which share motor structures and supranuclear regions of the central nervous system (CNS), involving a sensorimotor synchrony.

Objective To analyze the influence of masticatory behavior on muscular compensations in the oral phase of swallowing in smokers compared with nonsmokers.

Methods A cross-sectional study comparing smokers and nonsmokers composed of 24 participants in each group. The aspects of food crunching, masticatory pattern, masticatory speed, atypical muscular contractions, and lip closure were analyzed during mastication. In swallowing, aspects of contraction of the orbicular and mental muscles, head movement and presence of deglutition, mastication, smoking, and of stomatognathic system of residues after swallowing were characterized.

Results Statistically significant differences were identified between the study groups related to food grinding pattern, masticatory velocity, and mental contraction during swallowing. There was no significant association between masticatory function and compensations during swallowing.

Conclusion Differences were observed in the pattern of chewing and swallowing in smokers compared with nonsmokers, but no influence of masticatory performance was observed in the presence of muscle compensations during the oral phase of swallowing.

Keywords
- deglutition
- mastication
- smoking
- stomatognathic system

Introduction

Chewing performs an active role in craniofacial growth, favoring the development of muscle action, of the temporomandibular joint, as well as periodontal development.[1] Chewing and swallowing are physiologically interconnected, since they share motor structures and supranuclear regions for its execution,[2] involving a sensorimotor synchrony capable of coordinating the following processes involved in swallowing. Swallowing is the earliest acquired stomatognathic function during the embryonic period and coordinates with the other abilities from the association between cortical, subcortical and brainstem areas.[2] Related to the

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motor control, it can be divided into four phases: preparatory oral, oral, oropharyngeal, and esophageal.[3]

The oral preparatory phase involves chewing, which performs the mechanical grinding of the food into small fragments,[4] with closure of the lips and tongue movements as important aspects for the proper positioning of the food bolus.[5] The oral phase begins with the tongue movements to place the food bolus on the posterior region through its wave movements, to direct it to the pharyngeal and esophageal phases.[3] Structural and sensitivity disorders during the oral preparatory and oral phases can interfere in the efficacy of swallowing.[6] Intrinsic and extrinsic factors can contribute to alter these processes, characterizing them as atypical by the presence of compensatory events. Regarding extrinsic factors, tobacco consumption results in structural alterations, such as tooth loss[7] and modification of sensory perception,[8] which cause disorders in the functionality of the stomatognathic system, which adapts to the structure presented.[9]

From the data of the same sample included in the present study, it was observed greater occlusal alteration associated to the masticatory performance,[7] besides the reduction of the olfactory and gustatory perception associated with muscular compensations during the oral phase of swallowing[8] in smokers. Nevertheless, the relationship between masticatory performance and muscular deglutition compensations in this population has not yet been elucidated to evaluate whether these adaptations are directly associated with smoking or if they are from a deviated masticatory behavior. Thus, the objective of the present study is to analyze the masticatory and swallowing patterns of smokers and nonsmokers and to verify if there is an association between masticatory behavior and the presence of muscular swallowing compensations in smokers.

Methods

This is a comparative cross-sectional study, which was approved by the Research Ethics Committee of the institution of origin under the protocol number 3636/11. All of the participants agreed to participate in the study and signed the informed consent form after being explained the study objectives and procedures. The sample consisted of 48 subjects, divided into 2 study groups equally distributed, paired by gender and age in a 1:1 ratio: smokers and individuals who never smoked and were not exposed to passive consumption of the substance (►**Fig. 1**). Smokers were recruited from the pulmonology clinic of the institution, and nonsmokers volunteered to participate.

As inclusion criteria, the subjects should not have diagnosis of neurodegenerative or systemic diseases, salivary alterations, disorders in the upper airways, be using medication or treatments for the stomatognathic system, or present with congenital or genetic alterations of the sensorimotororal system.

Aiming to establish the characteristics and the association of mastication and swallowing functions, we have performed an evaluation of these functions through clinical observation by a single professional with experience in the area.

To perform the evaluation of the masticatory function, the subject was asked to ingest bread in the usual way. During mastication, the following parameters were recorded from an adapted protocol[10]: food grinding, performed with the posterior teeth, with the anterior teeth or with the tongue; masticatory pattern, classified in alternating bilateral, unilateral right, unilateral left or simultaneous bilateral; masticatory speed, considered adequate, increased or decreased; presence or absence of atypical muscle contractions; besides lip closure during the masticatory act, considered as adequate or with partial closure.

After the masticatory evaluation, the muscular behavior of the perioral region was analyzed during swallowing. Thus, aspects of contraction of the orbicular and mental musculature were evaluated. To delineate orbicularis muscle compensation, this variability was graded into four aspects: absent, when there was no movement of this musculature during swallowing; mild, when only contraction of the labial commissures was present; medium, contraction of the labial commissures

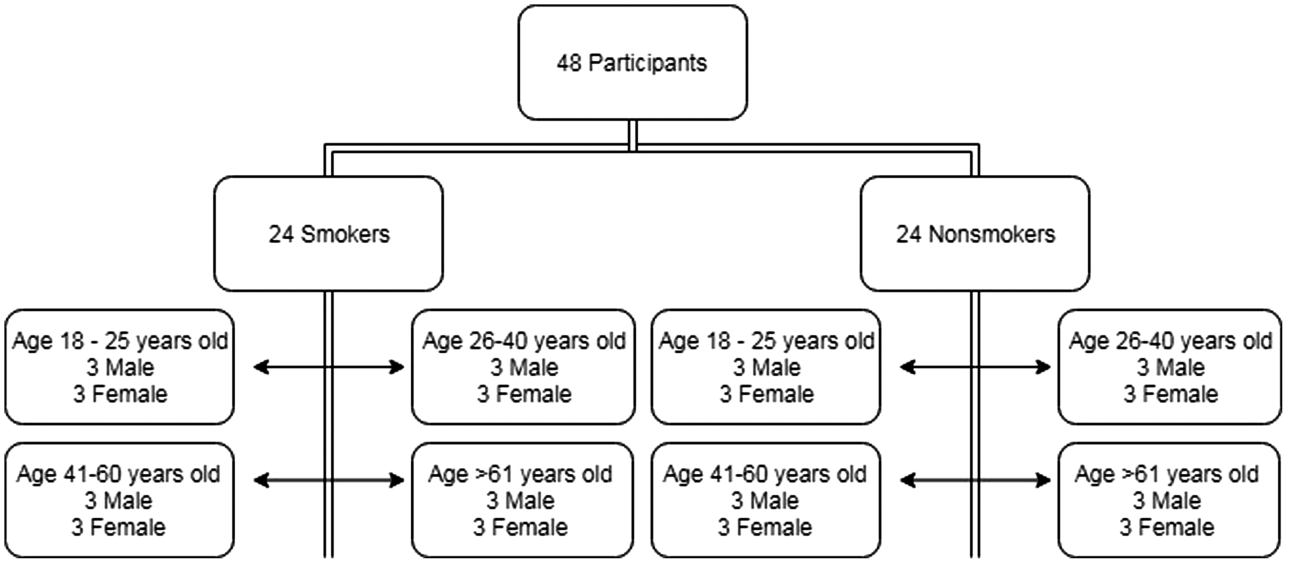

Fig. 1 Pairing of individuals in the study groups.

associated with slight contraction in the center of the lips; and accentuated contraction of the labial commissures associated with intense contraction of the center of the lips. To describe the compensation of the mental muscle contraction, it was defined as: absent, when there was no movement of this musculature during swallowing; mild, when there was only muscle elevation; medium, slight contraction; and accentuated, intense contraction. In addition, aspects of head movement during swallowing and presence of oral residues after swallowing were also observed.

The data were analyzed through descriptive statistics and statistical tests. The Fisher exact test was used to compare masticatory and swallowing variables between groups and to evaluate the relationship between time and amount of smoking aspects with masticatory variables and the association between chewing and swallowing aspects. The results were considered significant at a maximum significance level of 5%, and the statistical software used for the analysis was IBM SPSS Statistics for Windows, Version 21.0 (IBM Corp. Armonk, NY, USA).

Results

Comparing the sample by masticatory behavior (►**Table 1**), it was observed that nonsmokers perform grinding of food with the posterior teeth, while smokers present a pattern of kneading of food with the tongue. In addition, the masticatory speed of smokers was decreased compared with nonsmokers, and there was no difference between the groups for other masticatory variables. There was no association between masticatory performance with time and amount of tobacco consumption, stratifying the sample in 20 years and 20 cigarettes per day of consumption, respectively ($p > 0.05$).

Regarding swallowing performance (►**Table 2**), there was a difference between the groups in mental contraction, which was absent when associated with nonsmokers, and with mean contraction among smokers, with no statistically significant difference for other variables.

No relationship was observed between masticatory findings on muscle compensations during the oral phase of swallowing of smokers in any of the analyzes performed ($p > 0.05$).

Discussion

The impact of smoking on stomatognathic functions in the absence of tumor lesions is still poorly described in the literature. Therefore, the results obtained in the present study, although restricted, allow analyzing the influence of this habit on oral myofunctional changes. These modifications occur insidiously, and probably because of this, are not even associated to tobacco consumption by users and even by health professionals.

The results obtained allowed to observe the variability of food grinding between the groups, revealing that smokers use the tongue as a compensatory mechanism to crush food. This compensation is associated with a higher prevalence of dental losses in smokers.[11,12] The lack of these elements can alter the masticatory balance,[13] causing a compensation in the abilities of stomatognathic functions.[14] Regarding the masticatory difficulty, tooth loss is directly related to this alteration, since, in the absence of teeth, the tongue interposes in the edentulous place, modifying the pattern.[14]

Considering the masticatory speed, it was verified that smokers have a slower pattern. It occurs due to the reduction of dental pieces, which increases the time spent for adequate

Table 1 Comparison between groups regarding masticatory behavior

Variable	Category	Group				*p-value*
		Nonsmokers		Smokers		
		n	%	*n*	%	
Food griding	Posterior teeth	22	91.7	13	54.2	0.011*
	Anterior teeth	2	8.3	7	29.2	
	With tongue	–	–	4	16.7	
Masticatory pattern	Bilateral	15	62.5	9	37.5	0.287NS
	Unilateral right	5	20.8	6	25.0	
	Unilateral left	1	4.2	4	16.7	
	Simultaneous bilateral	3	12.5	5	20.8	
Masticatory speed	Adequate	16	66.7	13	54.2	0.048*
	Increased	5	20.8	1	4.2	
	Decreased	3	12.5	10	41.7	
Atypical muscle contractions	Absent	18	75.0	22	91.7	0.245NS
	Present	6	25.0	2	8.3	
Lip clousure	Adequate	21	87.5	23	95.8	0.609NS
	Partial	3	12.5	1	4.2	

NS, Not Significative.
*$p < 0.05$.

Table 2 Comparison between the groups regarding the swallowing behavior

Variable	Category	Group				*p*
		Non-Smokers		Smokers		
		n	%	*n*	%	
Contraction of the orbicular muscle	Absent	2	8,3	–	–	0,130[NS]
	Mild	11	45,8	6	25,0	
	Medium	7	29,2	9	37,5	
	Accentuated	4	16,7	9	37,5	
Contraction of the mentual muscle	Absent	10	41,7	1	4,2	0,003*
	Mild	11	45,8	13	54,2	
	Medium	–	–	5	20,8	
	Accentuated	3	12,5	5	20,8	
Head movement	Absent	21	87,5	17	70,8	0,286[NS]
	Present	3	12,5	7	29,2	
Oral residues after swallowing	Absent	22	91,7	19	79,2	0,416[NS]
	Present	2	8,3	5	20,8	

NS, Not Significant.
*$p < 0,05$.

preparation of the food before swallowing. As the efficiency of the masticatory pattern is decreased, since it is performed by tongue kneading,[7] it is expected that the masticatory speed will be in deficit. In addition, the gustatory capacity of smokers is reduced due to structural changes caused by smoking.[8] This difficulty to taste the food properly can decrease the masticatory speed, since the process occurs without adequate sensorial stimulation.[15,16]

It is considered that an inefficient masticatory pattern will allow the ingestion of fragments that are larger and less moistened by the saliva, resulting in a greater effort during swallowing that can be accompanied by compensatory movements of the head and facial musculature.[11] In smokers, it was not possible to establish an association between the masticatory pattern and the appearance of swallowing compensations, since the increased muscular compensations are due to other factors related to smoking that influence this motor activity response.[8,17] It is important to point out that, since there is no association between the masticatory characteristics of time and the amount of tobacco consumption, the inference that this deviant masticatory pattern is due to an adaptation of the system to structural alterations, such as tooth loss and reduction of perception, and not directly related to tobacco exposure, becomes plausible, corroborating the findings previously described.

Based on the data collected in the present sample and on other studies in the literature that corroborate these findings, the present study group proposes a qualitative hypothesis model[18] that associates tobacco consumption to the stomatognathic functions, which is presented in ►**Fig. 2**. It is believed that the formulation hypothesis model should be analyzed in longitudinal studies with large sample sizes, an adequate methodology to establish causality, to confirm or refute these association findings, which would allow an in-depth analysis on the risks to the stomatognathic functions associated with smoking.

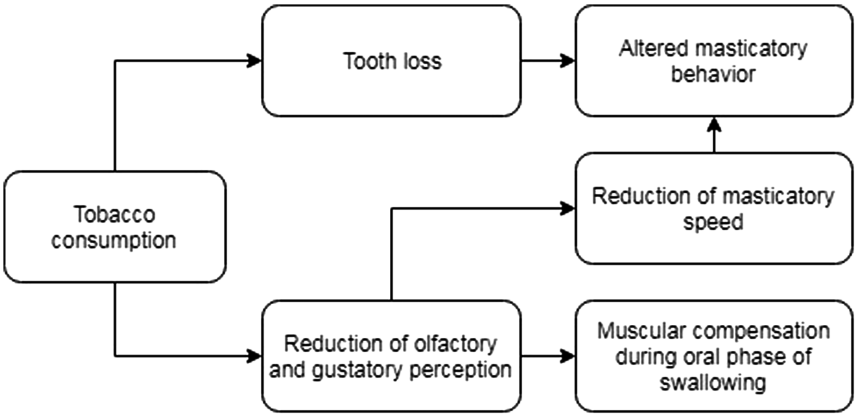

Fig. 2 Hypothesis model of influence of tobacco consumption in stomatognathic functions disorders.

Conclusion

The present study allowed us to observe changes in the pattern of mastication and swallowing behavior in smokers, with atypical patterns in both functions compared with nonsmokers. It was observed that the masticatory characteristics are not associated with time and amount of tobacco consumption, but it is a consequence of the structural alterations of the stomatognathic system. In addition, the appearance of muscular compensations during swallowing are associated with the smoking habit and not with the masticatory pattern itself, as described in a previous study of this sample.

Conflicts of Interests

The authors have no conflicts of interests to declare.

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