Influence of the masticatory function on the swallowing in the healthy elderly

A influência da função mastigatória na deglutição orofaríngea em idosos saudáveis

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ABSTRACT

Purpose: Verify if the masticatory characteristics influence the findings of the oropharyngeal swallowing in the elderly. **Methods:** Data from 47 healthy elderly subjects (29 female and 18 male) were analyzed and evaluated by the application of the mastication clinical protocol and the functional clinical examination of the oropharyngeal swallowing. The mastication evaluation was recorded in video; the mastication type, the bolus formation, and the mastication time were analyzed. During the clinical evaluation of the swallowing, patients` performance was verified when food with different consistencies was tested. After this evaluation, subjects were classified according to the dysphagia level. Data was analyzed in a descriptive way using comparison and correlation statistical tests. **Results:** The average mastication time was 32.45 seconds. Most subjects presented bilateral mastication (62%), adequate bolus formation (75%) and about half (47%) had moderate oropharyngeal dysphagia. According to the statistic analysis, there was no correlation among the level of swallowing dysfunction, the mastication type and the bolus formation. However, there was a statistically significant moderate positive correlation between the level of swallowing dysfunction and the mastication time. **Conclusion:** It was verified that a relationship between the mastication time and the dysphagia level exists. However, no influence of mastication type and bolus formation on the swallowing of the elderly was found in this study.

Keywords: Deglutition; Mastication; Deglutition disorders; Aged; Aging

RESUMO

Objetivo: Verificar se as características da mastigação influenciam os achados da deglutição orofaríngea em idosos. **Métodos:** Foram analisados os dados de 47 idosos saudáveis - 29 mulheres e 18 homens - avaliados por meio da aplicação do protocolo clínico da mastigação e exame clínico funcional da deglutição orofaríngea. A avaliação da mastigação foi registrada em vídeo, tendo sido analisado o tipo mastigatório, a formação do bolo alimentar e o tempo mastigatório. Durante a avaliação clínica da deglutição foi verificado o desempenho dos pacientes quando testados alimentos de diferentes consistências, sendo que, após a realização da avaliação clínica, os indivíduos foram classificados quanto ao grau de disfunção da deglutição orofaríngea. Os dados foram analisados de modo descritivo e utilizando-se testes estatísticos de comparação e correlação. **Resultados:** A média do tempo mastigatório foi de 32,45 segundos. A maioria dos indivíduos apresentou tipo mastigatório bilateral (62%), formação do bolo alimentar adequada (75%) e cerca de metade (47%), quadro de disfagia orofaríngea de grau moderado. De acordo com a análise estatística, não houve correlação entre o grau da disfunção da deglutição e o tipo mastigatório e a formação do bolo alimentar, porém, houve correlação positiva moderada entre o grau da disfunção da deglutição e o tempo de mastigação. **Conclusão:** Para os idosos deste estudo, o tempo mastigatório influenciou o grau de disfunção da deglutição, não tendo sido encontrada relação para o tipo mastigatório e formação do bolo alimentar quanto aos achados da deglutição orofaríngea.

Descritores: Deglutição; Mastigação; Transtornos de deglutição; Idoso; Envelhecimento

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INTRODUCTION

In Brazil, the growth of the elderly population has arisen the interest of professionals in the development of researches on this theme. There has also been a concern for the training of human resources based on gerontological care[1]. Thus, the understanding of physiological changes that result from the aging process and the association between the different stomatognathic functions and the systems have been the focus of research both in the Speech-Language Pathology area and in the Dentistry area.

The physiological changes, arising from aging, in the swallowing provide a high risk of dysphagia[2]. Videofluoroscopic and radiographic studies in the elderly showed alterations in the oral phase such as control difficulties and bolus ingestion; decrease in masticatory force and increase in the amount of connective tissue in the tongue. They also showed dysfunctions in the pharyngeal phase, characterized by bolus retention and pharyngeal constrictor paresis, reduction of the laryngeal elevation degree, delay in the onset of the hyolaryngeal excursion, as well as a modest increase in the pharyngeal transit in women and an increase in the time of pharyngeal pressure wave in men. Furthermore, the studies mentioned the need of multiple swallows, a greater occurrence of cough, polyphasic laryngeal movements and a greater probability of inspiration after swallowing[3]. Regarding the esophageal phase, an increase in its length occurs due to the extension of the relaxation time of the upper esophageal sphincter (UES), a decrease in the UES pressure with the preservation of the response to esophageal distension and abnormalities in the pharyngoesophageal segment[4]. Sometimes, the aging effects on the normal function are confused with the findings found in specific diseases or degenerative conditions[5].

Observations on the influence of age in the masticatory adaptation in the edentulous elderly showed an association between senility and the increase in the number of masticatory cycles for standardized food and in the electromyographic activity of the masseter and temporal muscles with respect to the duration of the cycles and the duration of the phases opening[6], as well as a hyperactivity of the masticatory muscles during the resting posture and a mild hypoactivity of such muscles during mastication[7]. The elderly masticatory conditions may also be affected due to a dental arch deficiency or the use of inappropriate denture. With tooth loss, there is a decrease in the bite force, as well as in the masticatory efficiency; there is an improvement after the oral rehabilitation with dentures and, in this case, the fixed dental prosthesis shows to be superior when compared to the removable denture prosthesis[8]. Jaw stabilization by posterior teeth occlusion or dentures is important in the swallowing function.

Literature reveals there is an influence of mastication on swallowing. In a study, a correlation was verified between the masticatory characteristics, the pressure of the tongue and the head movement during swallowing, in adults, in the evaluation of solid chewing[9]. On the other hand, through a questionnaire about the eating process, another study verified there was a significant influence of the difficulty to chew on the swallowing difficulty and on the presence of cough and food residue[10].

Many studies show the impact of increasing age on masticatory and swallowing functions. However, observing the literature, it is possible to notice that there isn´t a study on the influence of the masticatory conditions on the swallowing dysfunction level in the elderly population.

Thus, the purpose of this study was to verify whether the characteristics of mastication in the elderly influence on the findings of the oropharyngeal swallowing in order to search for new knowledge about this specific population, enabling future actions aimed at the prevention, diagnosis and rehabilitation of masticatory and swallowing disorders, resulting in a better quality of life.

METHODS

Casuistry

This study was part of the research project "Voice, Speech and Orofacial Functions of the Elderly Undergoing Different Oral Prosthetic Rehabilitation Strategies", which was approved by the Research Ethics Committee of the Bauru School of Dentistry, *Universidade de São Paulo* (USP), under the process n. 111/2006. Everybody was informed on the use of the data for this research and signed the Informed Consent Form, agreeing in taking part of the study.

A total of 47 elderly subjects were selected, 29 women and 18 men, users of removable partial denture prosthesis (RPDP), removable complete denture prosthesis in both dental arches (RCDP) and rehabilitated with removable complete denture prosthesis in the upper arch and mandibular fixed dental prosthesis (MFDP). Characteristics of the subjects included in the study are described in Chart 1.

Chart 1. Characteristics of the subjects according to gender, age and type of dental prosthesis

Gender	**n (%)**
Men	18 (38.30)
Women	29 (61.70)
Age	
Minimum	60
Maximum	82
Mean	68.08
SD	5.59
Denture type	**n (%)**
Partial denture prosthesis	17 (36.17%)
Removable complete denture prosthesis	18 (38.3%)
Complete fixed dental prosthesis	12 (25.53%)

Note: SD = standard deviation

The following inclusion criteria were considered: both genders; age equal to or over 60 years old (minimum=60; maximum=82; average = 68.08 ± 5.59 years) and a good general and oral health condition. The exclusion criteria were: history of neurological and head and neck oncologic diseases; psychiatric diseases; dentofacial deformities or anomalies; laryngeal surgeries; alcoholism and smoking; use of medicine that could cause xerostomia, such as antidepressants, antispasmodics, bronchodilators, anticholinergics, antihistamines and sedatives; need of replacing the dental prosthesis.

All subjects were submitted to a mastication and swallowing clinical evaluation, which was performed by a speech language pathologist.

Mastication evaluation

The mastication evaluation was performed according to the AMIOFE Protocol[11] using the images recorded in video. The mastication type was analyzed from the visual counting of the number of chewing strokes performed, considering: chronic unilateral – whenever about 95-100% of the masticatory cycles happened in the same side (1 = altered pattern); 2) preferential unilateral – whenever the masticatory cycles occurred in the same side of the oral cavity in 66-94% of the times; 3) simultaneous bilateral – whenever food was minced in both sides, 4) alternating bilateral – whenever food was minced in the right and left sides, alternately, predominance of up to 65% of the cycles in the same side was possible (2, 3 and 4= normal patterns)[11]. To verify the capacity of food bolus formation, subjects were requested to move the lips apart, allowing the visualization of the formation of a homogeneous mass on the longitudinal sulcus of the tongue. Thus, a classification was done based on the presence or absence of bolus formation[12]. Mastication time was also evaluated, being represented by the duration of mincing, pulverization, organization and subsequent propulsion of the bolus by the tongue before being swallowed. The patient was guided to perform the mastication of the food simultaneously to the triggering of the timer, which was stopped when the movement of laryngeal elevation for the swallowing was visualized[13].

Swallowing evaluation

During the clinical swallowing evaluation, the performance of the subjects was verified when solid food was tested – 1 cm thick half a loaf of bread. This evaluation was recorded with a digital camcorder to help in the subsequent analysis of data.

During the swallowing process, the subjects were evaluated clinically and by means of shooting; the following parameters, which were indicated and established in other studies, were analyzed: alteration of the lip sphincter; tongue incoordination; oral transit time; alteration of the cervical auscultation; alteration in the laryngeal elevation[14]; respiratory alteration; vocal alteration; cough and/or phlegm and the pulse oximetry[15].

After the clinical evaluation, subjects were classified regarding the level of dysphagia according to the Protocol for Rating the Degree of the Oropharyngeal Swallowing Dysfunction, used in the Speech-Language Pathology and Audiology Clinic, which had been proposed in a study[16] (Chart 2).

Statistical analysis

The Mann Withney Test was used to establish the comparison between genders regarding mastication type, bolus formation during chewing and level of swallowing dysfunction.

The Spearman Correlation Test was used to verify the association between the scores of the mastication evaluation and the classification of the level of swallowing dysfunction in the healthy elderly. Furthermore, associations between the ages and the evaluations of mastication and swallowing were also done.

Chart 2. Classification of the level of oropharyngeal swallowing (according to Totta 2008)

Classification	Observed aspects
Normal swallowing (level 0A)	No alterations are observed in any of the aspects evaluated among the consistencies tested;
Functional swallowing (level 0B)	It represents the swallowing without risks of penetration and aspiration, but difficulties are expected, such as: excessive participation of the cervical and/or facial muscles, head movement, adequate oropharyngeal transit time and absence of other factors;
Oropharyngeal dysphagia Mild (level I)	Presence of the clinical signs mentioned in the level IA, it may also involve anterior mouth spillage, residue in oral cavity, increased time of oropharyngeal transit and absence of the other factors;
Oropharyngeal dysphagia Moderate (level II)	Presence of signs that suggest the presence of laryngeal penetration (cough, phlegm, altered cervical auscultation, vocal quality alteration, alteration in the laryngeal elevation and respiratory alteration). Signs of the level IB can be found, besides nasal reflux and multiple swallows;
Oropharyngeal dysphagia Severe (level III)	Presence of the aspects described in level II, with substantial residue in the oral cavity, reduction or difficulty in laryngeal elevation, inefficient or absent cough, plus signs that suggest presence of aspiration such as the cyanosis (change in facial color).

Table 1. Distribution of the subjects and descriptive measures concerning the mastication time

Mastication time n (%)				Bolus formation n (%)			Mastication time *	
CU	PU	AB	SB	Inadequate	Partial	Adequate	Minimum - maximum	Mean+ SD
8 (17)	10 (21)	25 (53)	4 (9)	2 (4)	10 (21)	35 (75)	16 – 77	32.45±12.12

*In seconds

Note: CU = chronic unilateral; PU – preferential unilateral ; AB = alternating bilateral; SB = simultaneous bilateral; SD = standard deviation

RESULTS

Regarding the mastication evaluation, more than half of the subjects showed bilateral alternating or simultaneous mastication (83%). Bolus formation was classified as adequate for the majority of the subjects (75%) and the average time of food mastication corresponded to 32.45 seconds. The results of the mastication evaluation, regarding the mastication type, bolus formation and mastication time are described in the Table 1.

Regarding the classification of the level of swallowing dysfunction of solid food in the healthy elderly, through the clinical evaluation, about half of the subjects were classified with a moderate level of dysphagia (47%), followed by functional swallowing (23%), mild dysphagia (21%) and normal swallowing (9%) (Table 2).

There was no difference between genders in the mastication evaluation and in the classification of the level of swallowing dysfunction according to the Mann-Whitney Test (Table 3).

The Spearman Correlation test showed there was no correlation between the age of the participants and the results of mastication type, bolus formation, time of mastication and level of swallowing dysfunction (Table 4).

A significant moderate positive correlation was found between the level of swallowing dysfunction and the time of mastication, indicating that the greater the mastication time, the more elevated the level of swallowing dysfunction (Table 5).

Table 2. Distribution of the subjects according to the classification of the level of swallowing dysfunction of solid food

Level of swallowing dysfunction	n (%)
Normal swallowing	4 (9)
Functional swallowing	11 (23)
Mild dysphagia	10 (21)
Moderate dysphagia	22 (47)

Table 3. Descriptive measures concerning the mastication and swallowing of solid food

Gender	Mastication and swallowing	p-value
Male x Female	Mastication type	0.69
	Bolus formation n	0.61
	Mastication time	0.39
	Degree of the swallowing dysfunction	0.10

Mann Withney Test (p<0.01)

DISCUSSION

Literature has referred that the physiological changes inherent to the aging process may lead to difficulties in the performance of the functions of the stomathognatic system[6]. Many studies have shown the impact of increasing age on masticatory and swallowing functions. However, we haven´t found any studies on the influence of the masticatory conditions on the swallowing dysfunction level in the elderly population, and this is the purpose of this study.

The results of this study showed that more than half of the subjects presented bilateral alternating or simultaneous mastication. Such results differ from the ones found in the literature,

Table 4. Correlation between age and the results of the evaluations of mastication and swallowing of solid food

n				Correlation coefficient	p-value
47	Age	X	Mastication type	-0.17	0.25
			Bolus formation	0.02	0.91
			Mastication time	-0.125	0.40
			Level of swallowing dysfunction	-0.07	0.65

Spearman Correlation Test (p<0.01)

Table 5. Correlation between the results of the evaluation of mastication and the level of swallowing dysfunction of solid food

			Correlation coefficient	p-value
Level of swallowing dysfunction	X	Mastication type	0.15	0.33
		Bolus formation	-0.21	0.16
		Mastication time	0.48	0.001*

Spearman Correlation Test (p<0.01)

which showed a bigger number of the elderly subjects classified as having unilateral mastication type[17-19] associated with the difficulty of adaptation to the new dentures or to a previously established pattern[17], they can return to the bilateral pattern after six months of adaptation in the cases of fixed dental prosthesis[18]. It is possible to verify that similar findings regarding the mastication characteristics occurred when the elderly have gone through the phase of dentures adaptation, and the differing studies are those that evaluated the elderly with new dental prosthesis or in the phase of adaptation, showing the great influence of the oral rehabilitation on the chewing performance.

Bolus formation was classified as adequate for the majority of the subjects and the average time of food mastication corresponded to 32.45 seconds. Regarding the bolus formation, the findings are similar to the ones found in the elderly who were adapted to the mandibular fixed denture prosthesis[18]. However, they differed from the results found in another study[19], which observed difficulty in the preparation and organization of the solid food in more than half of the subjects. However, not all subjects evaluated in the study were rehabilitated with dental prosthesis. Some were identified as edentulous or with tooth flaws, which differs from the oral rehabilitation of those who participated in the present study. The characteristics of the mastication time in the elderly submitted to different prosthetic oral rehabilitation strategies were also similar to those found in literature[16,20].

In the clinical evaluation of the oropharyngeal swallowing, it was possible to verify a greater number of subjects classified with a moderate level of dysphagia, followed by functional swallowing, mild dysphagia and normal swallowing, corroborating with a study[9] that had found an impaired swallowing in most of the elderly evaluated. The elderly population presents a high risk of oropharyngeal dysphagia as a consequence of the aging physiological process effects on different phases of the swallowing[19]. Some studies have shown that most of the elderly develop adaptations in the swallowing with the alterations due to aging[19].

There was no difference in the comparison between the results of the mastication evaluation regarding the characteristics of gender and age. Some of the studies found in literature aimed to compare gender and age with the masticatory fuction. In a study that evaluated mastication in 67 adult patients, no difference was verified between genders in the total number of cycles per sequence, but the average frequency of mastication was slightly higher in the male gender[6]. In another study, there was no difference in the average frequency of masticatory cycles between young adults and elderly subjects, agreeing with the present study[21].

Likewise, there was no difference in the comparison between the results of the mastication evaluation regarding the characteristics of gender and age. Results diverge from the ones found in the literature since one study had verified a difference between men and women adults compared to the elderly regarding the water intake, associated with a bigger oral and pharyngeal cavity of men in relation to women, enabling a greater volume to be swallowed[22]. In another study, carried out with young, middle aged and elderly subjects, age and gender were found to influence on the swallowing behavior. The effect of gender was more evident in younger subjects and the effects of age were more evident in men[23]. In this case, the discordance of the findings mentioned with the present study could be explained by the absence of a balance regarding the number of subjects from each decade, as well as to the distinct methodological procedures followed in each result.

According to this research results, there was no statistical significance regarding the influence of the conditions of the mastication type and the bolus formation on the level of swallowing dysfunction in the elderly. However, a significant correlation was found between the level of swallowing dysfunction and the time of mastication, showing that with the increase of mastication time, impairment occurred in the swallowing function.

The increase in the time of preparation and bolus control may alter the oral swallowing phase, besides putting the integrity of the airways at risk due to the possibility of food penetration and aspiration. In a study with a videofluoroscopic analysis of the swallowing in the elderly with stroke[24], it was observed that patients who aspirated had a delay in the triggering time of the pharyngeal phase of the swallowing and the time of the pharyngeal transit increased. These are predictive measures of aspiration. It is possible to infer that the increased mastication time, verified in this study, influenced on the larger triggering time of the pharyngeal phase of the swallowing, increasing the risk of penetration.

This study aimed to verify the influence of the masticatory characteristics on the swallowing in the healthy elderly. The masticatory characteristics in the elderly must be observed as a predictive factor of alterations related to the oral phase of the swallowing, increasing the possibility of oropharyngeal dysphagia. The clinical evaluation limitations must be considered as it can underestimate or overestimate the level of dysphagia, presenting a high number of false negative or false positive clinical signs that represent risk of aspiration or penetration, effectively confirmed by instrumental evaluation[25].

Further studies must be carried out in order to verify the impact of the masticatory aspects on the oropharyngeal dysphagia, considering different age groups, type and condition of the oral rehabilitation, besides using instrumental methods to evaluate swallowing.

CONCLUSION

There was a relation between the mastication time and the swallowing classification showing that the longer the mastication time, the bigger the level of swallowing dysfunction in the elderly. However, there was no influence of the mastication

type and bolus formation on the findings of the oropharyngeal swallowing.

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