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# Characterization of posterior leakage in swallowing

## *Caracterização do escape posterior tardio na deglutição*

### Keywords

Deglutition Disorders  
Deglutition  
Signs and Symptoms  
Medical Test  
Aging

### Descritores

Transtornos de Deglutição  
Deglutição  
Sinais e Sintomas  
Exame Médico  
Envelhecimento

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Received: March 17, 2019

Accepted: August 27, 2019

### ABSTRACT

**Purpose:** To describe and characterize a finding, i.e., delayed posterior leakage of food residue during swallowing, according to age, gender and food consistency, which occurred in the event. **Methods:** Data were collected through the analysis of each functional videonasoscopy test of swallowing previously recorded in a specialist outpatient clinic. The study population included 200 patients, both males and females, aged between 46 and 87 years, with and without an underlying pathology for dysphagia. The images were studied individually by the researcher and analyzed by judges in order to identify and select images that would confirm the presence or absence of the study event. **Results:** Delayed escape was found in 45 out of the 200 analyzed tests. The tests selected for the study showed delayed posterior bolus leakage in at least one consistency. The highest frequency of delayed posterior leakage occurred with fluids. The analysis showed the significance of the study event with the population related to older ages in the sample analyzed. **Conclusion:** Delayed posterior leakage occurs predominantly in the liquid consistency in older populations with no gender predominance.

### RESUMO

**Objetivo:** Descrever e caracterizar um achado, o escape posterior tardio de resíduo alimentar na deglutição, segundo idade, gênero e consistência do alimento, que ocorreu no evento. **Método:** A coleta de dados ocorreu por meio da análise de cada exame de videonasosopia funcional da deglutição anteriormente gravado em um ambulatório especializado. A população do estudo contemplou 200 pacientes de ambos os gêneros, na faixa etária entre 46 e 87 anos, com e sem patologia de base para disfagia. As imagens foram estudadas individualmente pelo pesquisador e analisadas por juízes, com o objetivo de identificar e selecionar imagens que constatassem a presença ou ausência do evento em estudo. **Resultados:** Verificou-se o escape tardio em 45 exames do total de 200 analisados. Os exames selecionados para o estudo apresentaram o escape residual posterior tardio em pelo menos uma consistência. A maior frequência do escape posterior tardio ocorreu com o líquido. A análise mostrou significância do evento em estudo com a população que apresentava idades mais avançadas da nossa amostra. **Conclusão:** O escape posterior tardio ocorre predominantemente na consistência líquida, em população mais idosa e sem predomínio de gênero.

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**Financial support:** nothing to declare.

**Conflict of interests:** nothing to declare.



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## INTRODUCTION

Swallowing is a synergistic, sequential and harmonic neuromuscular process<sup>(1)</sup>. It is divided into different phases involving the manipulation of the bolus through chewing movements, preparation of the bolus for ejection and swallowing itself. It is responsible for efficiently transporting food from the mouth to the stomach, i.e., without any risk of penetration and aspiration. The act of swallowing enables nutrition and hydration, but it can be stated that this stomatognathic function goes beyond these purposes<sup>(2,3)</sup>. Food is also a social act; thus, it plays an important role in people's quality of life<sup>(1)</sup>.

Deviations from this function signal dysphagic processes characterized by swallowing disorders. Moreover, they are always a symptom of an underlying cause. Such disorders may increase the risk of lung infections, malnutrition, dehydration and mortality<sup>(4-6)</sup>.

Clinical evaluation can be performed together, whenever possible, with objective complementary tests. One of the instrumental evaluations considered as a gold standard is the functional videonasoendoscopy of swallowing, which aims to observe the dynamics of swallowing, enabling the identification of anatomical and/or functional alterations to the structures. This test enables an analysis of the efficiency of the pharyngeal phase of swallowing<sup>(6-8)</sup>.

Based on the findings of functional videonasoendoscopy of swallowing, performed at a referral hospital in the city of Porto Alegre, an event caught the attention of members of the team performing the test. The images of many tests, in different patients, showed that the contrasted residue had gone down after swallowing of the test food samples was physiologically finished. During the evaluations, there was a need to describe this event, but there were no protocols describing and/or classifying the occurrence of it. There is an aspect similar to premature leakage, but it does not correspond to the expected physiological stage for it. Thus, the aim of the present study was to describe and characterize this leakage of food residue, considered to be delayed by the team and not described in the current literature.

## METHODS

This is a retrospective observational cross-sectional study. The project was evaluated by the Scientific Committee and the Research Ethics Committee of the Hospital de Clinicas de Porto Alegre and approved under protocol number 2.262.802.

Convenience sampling was performed, and the sample was composed of 200 tests that were performed in an outpatient clinic specialized in swallowing disorders, and then analyzed.

According to the inclusion criteria, this study had both male and female patients, with and without an underlying pathology with impact on swallowing, as well as with and without complaints for this function. Patients who do not have a specific underlying disease may present, with advancing age,

a decline in the swallowing function as a result of the aging process, with or without perception of the disorder. After an analysis of this condition, the researchers chose to include such patients in the study. Subjects with anatomical structural disorders were excluded from the sample.

All subjects included in the research or their guardians signed an Informed Consent Form.

The patients underwent functional videonasoendoscopy of swallowing as an instrumental assessment of possible alterations in the swallowing process. The test was performed by otorhinolaryngologists with a flexible fiber optic endoscope (Henke Wolf Ultra-Slim 3.4mm 30cm Flexible Nasal Endoscope), which was introduced through the nasal cavity to the laryngopharynx without topical anesthetic application, eliminating interference in sensitivity in this region.

To perform the evaluations, the subjects were positioned on a chair facing the doctor. During the test, the patient remained with his or her body still, in control of the cephalic segment, with an average head angle as per the Frankfurt plane, simulating his or her position during a normal meal. During the procedure, the otorhinolaryngologist performed a detailed evaluation of the structures that make up the vocal tract anatomy. First, the following structures were analyzed: lateral and posterior pharyngeal walls, base of the tongue, epiglottic vallecula, epiglottis and piriform recesses, vestibular vocal folds and true vocal folds at rest. With the fiber optic endoscope positioned in the laryngopharynx region, the speech-language pathologist offered foods in different amounts and consistencies (pasty, liquid and solid), stained with anise blue food coloring (manufactured by Duas Rodas Industrial Ltda.). The foods in use were water for liquid consistency, thickened water for pasty consistency, and cream cracker for solid consistency. The tests were video-recorded and labeled on a DVD for further analysis.

Data collection occurred by analyzing each previously recorded test. The images were individually studied by the researcher in order to identify and select the ones that could confirm the study event. Subsequently, the images were analyzed by three expert judges to confirm the findings in the selected tests.

Importantly, the position of the optical fiber may change during the videonasoendoscopy of swallowing, hence the otorhinolaryngologist needs to readjust the frame and reposition the optical fiber endoscope. While the test is video-recorded, a wide view is required, including the base of the tongue, in which important events may occur for an interpretation of the swallowing function.

In order to name the occurrence under analysis, the event was called delayed posterior bolus leakage, in which the term delayed refers to the direction of the food residue, backwards, towards the laryngopharynx. The term delayed refers to time, because the event occurs after swallowing is finished.

Given the purpose of characterizing the population that showed delayed posterior bolus leakage, the following variables were analyzed: age, gender, underlying pathology and food consistency in which the event occurred.

Quantitative variables were described as mean and standard deviation and categorical variables as absolute and relative frequencies. To compare the consistencies, the Cochran test was applied. To assess the association between categorical variables, both Pearson's chi-square test and analysis of adjusted residuals were applied. The level of significance was set at 5% ( $\leq 0.05$ ) and the analyses were performed in the SPSS) version 21.0.

## RESULTS

A total of 200 functional videonasoendoscopy tests of swallowing were analyzed and the study event under was found in 45 (22.5%) of these tests. The sample consisted of subjects aged between 46 and 87 years. Table 1 shows the sample of the present study.

The tests selected for the study showed delayed posterior bolus leakage in at least one consistency. Table 2 shows one of the cross-checks performed, which refers to the occurrence of leakage with age group.

**Table 1.** Sample characterization

Variables	n=45
Age (years) - mean $\pm$ SD	65.2 $\pm$ 9.7
Age range - n(%)	
<60	13 (28.9)
60-69	17 (37.8)
$\geq 70$	15 (33.3)
Gender - n(%)	
Males	20 (44.4)
Females	25 (55.6)
Pathology - n(%)	
Neurological disease	28 (62.2)
Gastric reflux	1 (2.2)
Neoplasms	3 (6.7)
No underlying pathology	13 (28.9)

**Caption:** n = number of subjects; SD = standard deviation

## DISCUSSION

Swallowing is a physiological process that requires proper coordination and integrity of organs, muscles and nerves to be efficient and coordinated. Aging is a natural process that causes neural, structural and functional decline, impacting the swallowing phases<sup>(9,10)</sup>. The present study found a mean age range of  $65.2 \pm 9.7$  among the subjects, most of whom had an underlying disease, which certainly potentiated the decline in swallowing efficiency. However, there was a high percentage of individuals (28.9%), without an underlying pathology, who also presented delayed posterior bolus leakage at the time of evaluation (Table 1).

The oral preparatory phase consists of food intake. Comminution and lubrication are required to form a cohesive and suitable food bolus to enable better conduction of the bolus in the pharyngeal and esophageal regions. Lips, cheeks, tongue and dental arch are important structures for maintaining food in the oral cavity, thus preventing anterior and/or posterior leakage<sup>(11,12)</sup>.

Swallowing of the elderly is impacted by aging. There is a natural physiological degeneration of nerve and muscle fibers and craniofacial anatomical components. This functional decline is defined as presbyphagia<sup>(13)</sup>. In the elderly, the oral phase may be severely affected because there are deleterious aspects such as longer preparation of the food bolus, anterior leakage as a result of difficulty in lip closure, decreased masticatory and propulsive force, delayed bolus ejection, reduced tongue mobility, loss of natural teeth, poorly adapted dental prostheses and reduction of the lingual papillae, which compromises sensory afference<sup>(14)</sup>. In addition, the pharyngeal and esophageal phases are also impacted; for example, reduced laryngeal elevation, upper esophageal sphincter opening, and peristaltic movement<sup>(15)</sup>.

The hypothesis of the team is that the study event is a characteristic of presbyphagia, which refers to the natural aging that impairs a person's functionality. It is characterized by physiological disorders of the swallowing mechanism resulting from neural and muscular aging<sup>(16)</sup>. Notably, there are consequences of aging in the other swallowing phases.

**Table 2.** Swallowing test data according to age group

Variables	<60 years (n=13)	60- 69 years (n=13)	70 years or older (n=15)	P
<i>Consistencies - n(%)</i>				
<i>Pasty</i>				
None	8 (61.5)	6 (35.3)	10 (66.7)	0.162
Yes, in the same consistency	5 (38.5)	11 (64.7)	5 (33.3)	
<i>Liquid</i>				
None	9 (69.2)*	7 (41.2)	3 (20.0)	0.031
Yes, in the same consistency	4 (30.8)	10 (58.8)	12 (80.0)*	
<i>Solid</i>				
None	5 (38.5)	7 (41.2)	6 (40.0)	0.592
Yes, in the same consistency	0 (0.0)	3 (17.6)	1 (6.7)	
Yes, in previous consistency	8 (61.5)	6 (35.3)	7 (46.7)	
Yes, in the same consistency and previous consistency	0 (0.0)	1 (5.9)	2 (6.7)	

\*Statistically significant association by the test of residues adjusted to 5% significance

**Caption:** n = number of subjects; P = probability of significance

However, the aim of this study, i.e., to characterize delayed posterior leakage, relates to the efficiency of the oral phase of swallowing, hence the main focus will lie on this process.

The tongue is the main agent of this phase; it forms, positions and searches for the bolus in the oral cavity. Tongue movements in the vestibule and the floor of the mouth are a strategy so that no food residue remains in the oral cavity.

Faced with a lack of mobility and sensitivity, there is a risk that food may remain in these regions and cause posterior disorganization. The oral phase of swallowing begins from the posterior propulsion of the bolus by the tongue, from the oral cavity to the oropharynx, beyond the tonsillar arch, and ends with the triggering of the swallowing reflex, an important process for the continued transport of the food bolus. No food residue will remain in the oral cavity if this phase is efficient<sup>(2,12,17)</sup>. In delayed posterior leakage, the bolus goes down after swallowing is physiologically finished, so the occurrence of delayed leakage is a consequence of inefficiency in the oral phase, i.e., food residues remain in different regions of the oral cavity.

The incidence of dysphagia lacks epidemiological data. Incidence is estimated to range between 16% and 22% in individuals over 60 years old, and from 20% to 40% in patients with Parkinson's disease and stroke<sup>(18)</sup>. The information found in the literature corroborates the findings of the study, in which the event prevailed in individuals with neurological diseases.

Delayed bolus leakage was found in different patients of the sample. The profiles of the sample subjects, age and underlying pathology, are influenced by the population referred for the instrumental evaluation. In the tests included in the present study, delayed bolus leakage occurred after the patients had finished swallowing the food they had ingested, considering three swallows after food intake or until the oral cavity had no food residue left. This leakage was found to occur in the interval between one food intake and another, and in some cases, the residue went down during the subject's speech and/or mouth opening.

Evaluation of swallowing starts with the pasty, the liquid and, finally, the solid consistency. The event was identified in all consistencies; however, the patient who presented delayed leakage in one consistency did not necessarily present it in the others. The sample included subjects who presented delayed leakage in all consistencies or only in one/two (Table 2). Importantly, in some cases, leakage occurred in one episode, and not necessarily throughout the testing of that consistency.

It should be noted that delayed leakage episodes during the intake of pasty and liquid consistencies occurred in the respective consistencies tested. When the solid consistency was ingested, the liquid consistency had gone down, in the previous intake, during chewing.

The analysis of the event with the age group shows a significant result in the older population of our sample, since it confirms the hypothesis of the researchers. Another finding is that delayed posterior leakage occurs more frequently in the liquid consistency, which requires greater functional organization, as it demands greater coordination of the oral phase.

Given the above, premature posterior leakage<sup>(19,20)</sup> has to be distinguished from delayed posterior leakage. The difference

lies in the moment when leakage occurred - whether before or after swallowing initiation.

Based on the physiology of each swallowing phase, one can make inferences about the study event. As discussed earlier, inefficiency in the oral phase may have triggered delayed posterior leakage during swallowing. It can be inferred that food is deposited on the floor of the mouth and/or vestibules and generates a disorganization after swallowing is finished. Thus, as with early posterior leakage, management strategies have to be adopted to avoid residues in the pharyngeal region, which pose the risk of penetration and/or laryngotracheal aspiration. It is inferred that delayed posterior leakage is typical of presbyphagia and functional and structural disorders resulting from natural aging of all human beings, and it is aggravated when occurring concomitantly with an underlying pathology.

A limitation of this study was inadequate positioning of the fiberoptic tube during imaging or damage to audio and image data, which resulted in the exclusion of these tests from analysis.

## CONCLUSION

The data analyzed and described above enabled the characterization and description of delayed posterior leakage of swallowing. The study event occurred in 22.5% (45) of the total tests (200). The event always occurred after the food previously offered had been swallowed.

Late leakage occurs predominantly in liquid consistency, in older individuals in our sample, with no gender predominance.

This finding has important clinical repercussions, hence management strategies need to be used to avoid food residues in the pharyngeal region, as they may pose risk of penetration and/or laryngotracheal aspiration. Importantly, further research is needed to collect more data and evidence on the findings of this study.

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### Author contributions

*Each author has made an important contribution to the outcome of this work. JB, AVS, LSH and GCM participated in data collection and analysis with CSR, the lead author, who performed the analysis, interpretation of data and writing of the article; SD supervised this work with great dedication and commitment, participated in the conception of the study, analysis and writing of the article.*