

Maralice Zancan<sup>1</sup>  
Karen Fontes Luchesi<sup>1</sup>  
Claudia Tiemi Mituuti<sup>1</sup>  
Ana Maria Furkim<sup>1</sup>

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### Correspondence address:

Karen Fontes Luchesi  
Departamento do Curso de Graduação  
em Fonoaudiologia, Universidade  
Federal de Santa Catarina – UFSC  
Rua Campus Reitor João David  
Ferreira Lima, s/n, Trindade,  
Florianópolis (SC), Brazil, CP: 476,  
CEP: 88040-900.  
E-mail: karenluchesi@yahoo.com.br

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# Onset locations of the pharyngeal phase of swallowing: meta-analysis

## *Locais de início da fase faríngea da deglutição: meta-análise*

### ABSTRACT

**Purpose:** Literature review on the onset locations of the pharyngeal phase of swallowing in asymptomatic and symptomatic adults and elderly people. **Research strategies:** Research was conducted in the PubMed, BIREME and SciELO databases through the descriptors fluoroscopy (*fluoroscopia*), deglutition (*deglutição*) and pharynx (*faringe*). **Selection criteria:** Studies published between 2005 and 2015, carried out with adults and elderly people who underwent swallowing videofluoroscopy (SVF), and citing the onset location of the pharyngeal phase of swallowing. **Data analysis:** Descriptive analysis and meta-analysis were performed, evaluating the heterogeneity and the measures grouped with random effects through  $I^2$  statistics. For ratio calculation in the meta-analysis, the locations described in the articles were classified according to the *Modified Barium Swallowing protocol - Measurement Tool for Swallowing Impairment* (MBSImp). **Results:** Twelve articles were selected for descriptive analysis and seven for meta-analysis. Heterogeneity was found between studies, especially due to clinical and methodological differences. The random effect indicated predominance (58%) of the onset of the pharyngeal phase of swallowing at levels 0 and 1 of the MBSImp. In asymptomatic individuals, the onset of the pharyngeal phase was observed in the oral cavity, base of the tongue, dorsum of the tongue and vallecula. In symptomatic individuals, onset was mainly observed in the oropharynx, vallecula, hypopharynx and pyriform sinus. **Conclusion:** We noted a greater frequency of the onset of the pharyngeal phase of swallowing in the vallecula. The onset of the pharyngeal phase in the hypopharynx and pyriform sinus was more often observed among elderly individuals or with comorbidities that could alter swallowing.

### RESUMO

**Objetivo:** Revisar a literatura quanto aos locais de início da fase faríngea da deglutição em adultos e idosos, assintomáticos e sintomáticos. **Estratégia de pesquisa:** Foi realizada pesquisa nas bases PubMed, BIREME e SciELO através dos descritores fluoroscopia (*fluoroscopia*), deglutição (*deglutition*) e faringe (*pharynx*). **Critérios de seleção:** Estudos publicados entre 2005 e 2015, com adultos e idosos que realizaram videofluoroscopia da deglutição (VFD) e citaram o local de início da fase faríngea da deglutição. **Análise dos dados:** Foi realizada análise descritiva e meta-análise, com estudo da heterogeneidade e de medidas agrupadas com efeito aleatório por meio da estatística  $I^2$ . Para o cálculo de proporção na meta-análise, os locais descritos nos artigos foram classificados pelo *Modified Barium Swallowing - Measurement Tool for Swallowing Impairment* (MBSImp). **Resultados:** Ao final, foram selecionados 12 artigos para análise descritiva e sete para meta-análise. Foi encontrada heterogeneidade entre os estudos, especialmente, devido às diferenças clínicas e metodológicas. O efeito aleatório indicou predominância (58%) do início da fase faríngea da deglutição nos níveis zero e um do MBSImp. Em indivíduos assintomáticos, observou-se o início da fase faríngea na cavidade oral, base da língua, dorso da língua e valécula. Em indivíduos sintomáticos, o início foi observado, principalmente, em orofaringe, valécula, hipofaringe e recessos piriformes. **Conclusão:** Foi observada maior frequência de início da fase faríngea da deglutição em valécula. O início da fase faríngea em hipofaringe e recessos piriformes foi mais observado em indivíduos idosos ou com comorbidades que poderiam alterar a deglutição.

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<sup>1</sup> Universidade Federal de Santa Catarina – UFSC, Florianópolis (SC), Brazil.

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## INTRODUCTION

Swallowing is a physiological process that occurs due to neuromuscular actions involving sensitive cranial nerves, motor and parasympathetic nerves. This function also participate bones and musculature along with other structures<sup>(1)</sup>. Its purpose is to transport the bolus from the mouth to the stomach, promoting hydration and nutrition of the body. The physiology of swallowing can be divided into five stages: anticipatory, oral preparatory, oral, pharyngeal and esophageal<sup>(2)</sup>.

For the analysis of swallowing, swallowing videofluoroscopy (SVF) can be used, an objective evaluation that is considered the “gold standard”, where it is possible to verify issues related to the anatomy and physiology of swallowing<sup>(3)</sup>. It is performed using radiologic contrast and allows for a more accurate diagnosis as to swallowing disorders, helping in the therapeutic conduct and direction<sup>(4)</sup>.

Through the use of SVF, the pharyngeal phase can be better investigated. In this phase there is a succession of important, rapid, coordinated and accurate events, such as soft palate elevation, vocal fold closure, pharyngeal muscle contraction, laryngeal elevation and anteriorization and epiglottis lowering. These mechanisms occur involuntarily after the stimulation of sensory receptors, especially those located in the oropharyngeal cavity<sup>(2,5)</sup>.

There is no consensus in the literature regarding the location considered for normality at the onset of the pharyngeal phase of swallowing. The onset location of this phase of swallowing is regarded as an important fact, as the lack of onset or extended time for its occurrence can be a sign suggestive of dysphagia<sup>(6)</sup>. The location of this onset may be influenced by the volume and consistency of the bolus<sup>(2)</sup>, and according studies, by verbal commands and absence of dentition<sup>(7,8)</sup>.

In 1983, Logemann<sup>(9)</sup> suggested that the onset of the pharyngeal phase should be observed when the head of the bolus passes through the anterior pillars of fauces. Years later, the same author<sup>(10)</sup> suggested that the onset of the pharyngeal phase can occur when the head of the bolus passes through any point between the anterior pillars of fauces and the point where the base of the tongue intersects with the posterior part of the mandibular ramus. Douglas<sup>(11)</sup> distinguishes the onset location according to the pressure exerted by the bolus. He described more consistent excitatory bolus receptors in the anterior tonsillar pillars, tongue base and uvula. The fluid-sensitive receptors, according to the author, are located in the paraepiglottic channels. Nonetheless, it has been observed in some studies<sup>(6,12)</sup>, in which individuals considered asymptomatic, namely, those who do not have underlying diseases and/or clinical characteristics, may present the onset of the pharyngeal phase of swallowing elsewhere in the oropharyngeal tract without physiopathologic implications that indicate risk for laryngeal penetration or aspiration.

There is a hypothesis reported that the physiology to the pharyngeal swallowing action is a polysynaptic reflex action that triggers morphofunctional accommodation according to the descent of the pressurized bolus sent from the oral cavity,

by oral ejection for the pharyngeal chamber<sup>(13)</sup>. As a result, the lack of consensus is plausible, considering that each swallow is unique in terms of strength, velocity, mobility, range of motion and depends on the volume, taste, viscosity and temperature of the bolus.

## OBJECTIVE

The aim of this study was to review the literature in respect to the onset locations of the pharyngeal phase of swallowing in asymptomatic and symptomatic adults and the elderly.

## RESEARCH STRATEGY

Used in combination were the following descriptors in Portuguese: *fluoroscopia* [All fields] AND *deglutição* [All fields] AND *faringe* [All fields]. In English the descriptors used were: fluoroscopy [All fields] AND swallowing [All fields] AND pharynx [All fields]. All descriptors were used with the limiters human and English and Portuguese language. The search for articles was held in electronic databases, considered broad in national and international scope, namely: “Biblioteca Virtual em Saúde” (*Virtual Health Library* - BIREME), “Scientific Electronic Library” (SciELO) and “US National Library of Medicine National Institutes of Health” (PubMed).

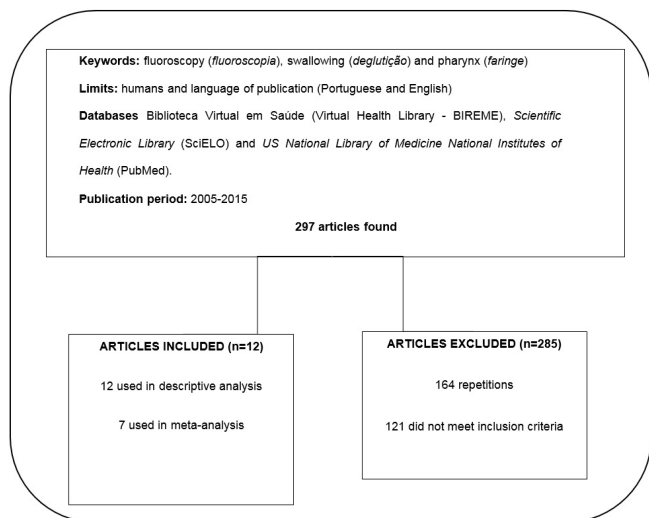
## SELECTION CRITERIA

The following inclusion criteria were adopted: studies published between 2005 and 2015, with adults and elderly individuals who underwent SVF and who described the location found for triggering the pharyngeal phase of swallowing. Only scientific research article publications of original research or case study were included.

Articles that were repeated between databases were deleted. For the initial selection, the titles and abstracts were read. Studies had their texts read in full by two researchers and submitted to quality analysis of prevalence studies (cross-sectional studies) by the JBI Critical Appraisal Checklist tool for Studies Reporting Prevalence Data<sup>(14)</sup>, excluding by consensus those studies that did not fulfill inclusion criteria or not shown to be eligible according to the instrument (Figure 1).

In order to perform the meta-analysis, even after applying the inclusion and quality criteria, only articles were included describing the absolute and/or relative frequency of individuals who had the pharyngeal phase of swallowing started without verbal command or change in head posture and description subject to classification according to the protocol of the Modified Barium Swallowing - Measurement Tool for Swallowing Impairment (MBSImp)<sup>(15)</sup>.

The above-mentioned protocol classifies the onset of the pharyngeal phase of swallowing in five levels (from zero to four) according to the observation of the head of the bolus at the moment of the first excursion sign of the hyoid bone, namely: (0) head of the bolus until the posterior region of the mandibular ramus; (1) head of the bolus in the vallecula;



**Figure 1.** Consultation with databases for literature review as to onset location of the pharyngeal phase of swallowing, according to search with the keywords fluoroscopy (fluoroscopia), swallowing (deglutição) and pharynx (faringe) (2005-2015)

- (2) bolus head on the posterior laryngeal surface of the epiglottis;
- (3) bolus head in the pyriform sinus; (4) lack of onset of the pharyngeal phase of swallowing.

## DATA ANALYSIS

Extracted from the articles were authors' names, year of publication, purpose of the study, onset location of the pharyngeal phase of swallowing, number of participants, age group, underlying diseases and/or clinical characteristics of the participants and consistencies and volumes tested in SVF.

For the descriptive analysis, the absolute and/or relative frequencies of the pharyngeal swallowing phase onset locations (with preservation of the different nomenclatures used in the selected articles) were calculated according to the age group (above or below 60 years), the presence or absence of comorbidities or clinical characteristics that could alter swallowing (asymptomatic or symptomatic) and the volumes and consistencies offered during SVF examination.

To perform the meta-analysis, the onset locations of the pharyngeal phase of swallowing cited by the authors were classified according to the MBSImp<sup>(15)</sup> and grouped as onset A (levels zero or one of the MBSImp) and onset B (levels two or three of the MBSImp) for application of statistical tests (Figure 2). Level four of the protocol was not included in the grouping of the articles, since the observation of the onset of the pharyngeal phase of swallowing was one of the inclusion criteria used in the selection of publications.

First, data were verified by using the heterogeneity statistic  $I^2$ . Then the summary measure of frequency of the onset of the pharyngeal phase at onset A and onset B was calculated using the software MedCalc® (version 16.1.2). We used the random effect model due to its recommendation as best for prevalence studies with more than one expected or possible event.



**Figure 2.** Illustrates “onset A” above and “onset B” below the mark, according to the grouping to perform meta-analysis with locations described for the onset of the pharyngeal phase of swallowing, according to systematic literature review with videofluoroscopy exam (2005-2015)

## RESULTS

### Overview

In total, 297 articles were located from the search in the selected databases. Of these, 285 studies were excluded due to repetitions between the databases and/or failure to fulfill inclusion criteria. Ultimately, only 12 articles remained, totaling 300 individuals studied (Figure 1, Chart 1).

In seven studies, individuals below the age of 60 in the sample accounted for 59% (178 individuals) of the total<sup>(2,6,7,12,16,17,22)</sup>. Above this age group, only 69 individuals were described in three different studies<sup>(8,18,19)</sup>. In two studies, both age groups were included and described only with the mean age of the participants<sup>(20,21)</sup>.

As to gender, 140 individuals were male (46%) and 140 were female (46%). One study made no reference to the gender of the participants<sup>(22)</sup>.

Seven studies consisted of an asymptomatic population, making up 57% (170 individuals) of the total investigated<sup>(2,6,7,12,16,17,22)</sup>. These individuals did not have any swallowing complaint or comorbidities that were known to influence swallowing dynamics. In five studies, the population was symptomatic for a total of 130 patients (43%)<sup>(8,18,19,21,22)</sup>. The underlying diseases or described clinical characteristics were: unilateral medullary infarction<sup>(21)</sup>, cricopharyngeal dysfunction<sup>(18)</sup>, post-removal of oral tumor<sup>(19)</sup>, absence of teeth<sup>(8)</sup> and bilateral lingual anesthesia of the inferior alveolar nerve with use of occlusal plate<sup>(22)</sup>.

For SVF assessments, one third of the selected studies (four articles) used liquid<sup>(2,6,18,20)</sup>. The volume of 5 ml was the most used (five articles), also in other consistencies<sup>(2,12,16,18,20)</sup>. In the other studies, the consistencies and volumes varied among them, as there was no standardization and therefore difficult to perform analysis between the consistency and the location of the onset of the pharyngeal phase of swallowing.

**Chart 1.** Publications describing the locations where the onset of the pharyngeal phase of swallowing was observed, according to a systematic review of the literature with videofluoroscopy swallowing, 2005-2015 (N=12)

Studies	Sample (N)	Age (mean or range in years)	Group characteristics	Consistencies*	Volumes	Onset locations of pharyngeal phase*
Almeida et al. <sup>(2)</sup>	40	23.5	Asymptomatics	liquid, liquid paste, paste, solid	5 ml and 20 ml of liquid and liquid paste; 15 ml of paste and 1/2 cookie	Base of tongue; vallecula
Uchimura et al. <sup>(6)</sup>	60	27.0-55.0	Asymptomatics	Gel capsules swallowed with liquid and pudding	Capsules with a capacity of 0.3 ml and 0.95 ml with liquid and pudding to free demand	Dorsum of the tongue; base of tongue; vallecula
Palmer et al. <sup>(7)</sup>	7	23.0	Swallowing with verbal command in asymptomatic individuals	Solid	8 g	Oral cavity; vallecula
Yamamoto et al. <sup>(8)</sup>	15	78.0	Older adults with and without dental prosthesis	Gelatin agar	10 g	Vallecula; hypopharynx
Stephen et al. <sup>(12)</sup>	10	71.6	Asymptomatics	Thin liquid	5 cc (5 ml)	Above, at or below the mandibular ramus
Stokely et al. <sup>(16)</sup>	20	31.0	Asymptomatics	Thin and ultra-thin liquid	5 ml	Above, at or below the mandibular ramus
Nagy et al. <sup>(17)</sup>	20	31.5	Asymptomatics	Ultra-thin liquid	10 cc (10 ml)	Vallecula
Chitose et al. <sup>(18)</sup>	1	80.0	Idiopathic cricopharyngeal dysfunction	Liquid	5 ml	Pyriform sinus
Umeda et al. <sup>(19)</sup>	53	65.0	Post-removal of oral tumor with change of posture for swallowing	Nectar	4 ml	Vallecula
Daniels et al. <sup>(20)</sup>	12	68.8	Asymptomatics	Liquid	5 ml	Above, at or below the mandibular ramus
Mikushi et al. <sup>(21)</sup>	41	64.0	Unilateral medullary infarction	Thick liquid	4 ml	Hypopharynx
Tei et al. <sup>(22)</sup>	20	24.0-30.0	Bilateral lingual anesthesia and inferior alveolar nerve with use of occlusal plate	Dry solid and wet solid	8 g (4 g solid and 4 g barium)	Oropharynx

\*Non-standard due to the preservation of nomenclature used by the authors

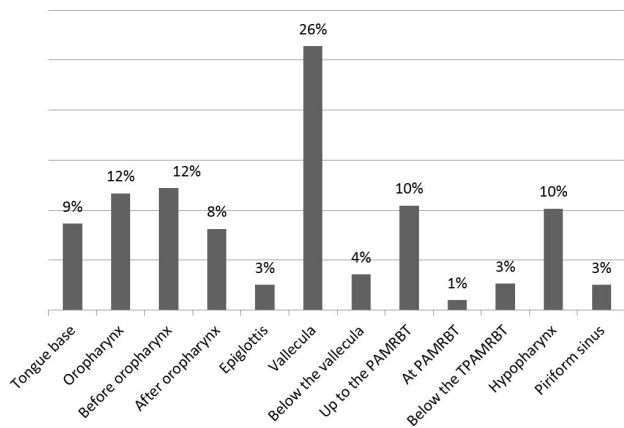
With regard to onset of the pharyngeal phase, 50% (six articles) reported discharge in the vallecula<sup>(2,6-8,17,19)</sup>; 25% (three articles) above, at or below the mandibular ramus<sup>(12,16,20)</sup>; 16% (two articles) to dorsum of the tongue<sup>(2,6)</sup>; 16% (two articles) to hypopharynx<sup>(8,21)</sup>; 16% (two articles) to oropharynx<sup>(21,22)</sup>; 8% (one article) to tongue<sup>(6)</sup>; 8% (one article) to pyriform sinus<sup>(18)</sup> and 8% (one article) to oral cavity<sup>(7)</sup>. In some studies, the onset location of the pharyngeal phase was observed in more than one region for the same individuals<sup>(2,6-8,21)</sup>. More than one location was also observed for pharyngeal phase onset in eight studies<sup>(2,6-8,12,16,20,21)</sup>, thus, some items were repeated in the calculation of the above percentages.

Only nine articles<sup>(2,7,8,12,17,18,20-22)</sup> reported the number of individuals who had pharyngeal phase onset in the locations described, totaling 196 swallows with the possibility of quantitative analysis on the frequency of the location of onset of the pharyngeal phase of swallowing (Figure 3).

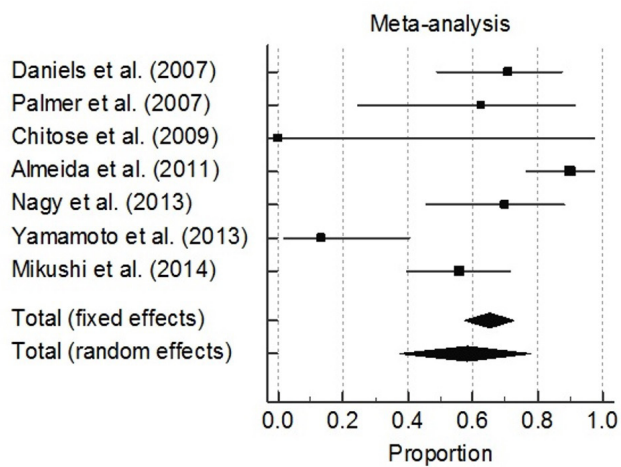
Seven articles<sup>(7,8,17,18,20,21)</sup> were included in the meta-analysis. Of the 12 articles selected, only seven described the absolute and/or relative frequency of individuals as to the onset location of the pharyngeal phase of swallowing, specifying regions that could be classified by MBSImp<sup>(15)</sup>. Due to the clinical differences of the individuals (mainly related to age and to the existence of symptomatic and asymptomatic populations regarding the swallowing function) and the methodological differences of the studies (such as use of different consistencies and volumes), articles included in the statistical calculations showed high heterogeneity (83%) (Figure 4).

Based on the random effect of the results (also used in the case of grouping of heterogeneous studies), the meta-analysis indicated predominance of onset A (head of the bolus to the posterior region of the mandibular ramus or in the vallecula at the moment of the first sign of hyoid bone excursion) with prevalence of 58% at the onset of the pharyngeal phase ( $p < 0.001$ ; 95% confidence interval (CI): 37.44-77.78).





**Figure 3.** Frequency relative of the locations described for the onset of the pharyngeal phase of swallowing, according to literature review with swallowing videofluoroscopy, 2005-2015 (n=196)



**Figure 4.** Forest plot showing the relative frequency (and confidence interval) of onset of the pharyngeal phase of swallowing with "onset A" (up to the posterior region of the mandibular ramus or valleculla), according to meta-analysis of systematic literature review with swallowing videofluoroscopy, 2005-2015 (n=7)

Many publications only cited the location considered ideal for the onset of the pharyngeal phase, for example, the region of the shadow of the mandibular ramus<sup>(23-25)</sup>, the fauces<sup>(26)</sup> and also the posterior nasal spine<sup>(27)</sup> and not describing the location in which the pharyngeal phase of swallowing was actually triggered. To a certain extent, this finding explains the small number of studies included in this review.

### Onset location of the pharyngeal swallowing phase: asymptomatic population

In the seven studies with asymptomatic population, that is, in studies with individuals without swallowing complaints or diseases that can knowingly impair this function, the onset of the pharyngeal phase occurred in the oral cavity<sup>(7)</sup>, base of

the tongue<sup>(2,6)</sup>, dorsum of the tongue<sup>(6)</sup>, above, at or below the mandibular ramus<sup>(12,16,20)</sup> and valleculla<sup>(2,6,7,17)</sup>.

In this population, the group of individuals under 60 years of age, the pharyngeal phase was described in four articles as triggered in the valleculla<sup>(2,6,7,17)</sup>; two cite the base of the tongue<sup>(2,6)</sup>; and one, the oral cavity<sup>(7)</sup>. In the group over 60 years of age, it was predominantly found below the mandibular ramus<sup>(12)</sup>. It is hypothesized that the occurrence of the onset of the pharyngeal phase of swallowing in lower anatomical regions in the elderly population is one of the reflexes of the aging of stomatognathic structures and functions.

Regarding the heterogeneities resulting from different consistencies offered during videofluoroscopy in asymptomatic population for swallowing solid consistency, there was onset of the pharyngeal phase in the oral cavity<sup>(7)</sup>, base of the tongue<sup>(2)</sup> and valleculla<sup>(7)</sup>. In the swallowing of liquid, onset was in the base of the tongue<sup>(2,6)</sup>, dorsum of the tongue<sup>(6)</sup>, above, at or below the mandibular ramus<sup>(20)</sup> and valleculla<sup>(2,6)</sup>. For ultrathin liquid, onset occurred above, at or below the mandibular ramus<sup>(16)</sup> and the valleculla<sup>(17)</sup>, and for thin liquid, above, at or below the mandibular ramus, not observing onset of the pharyngeal phase in the valleculla<sup>(12,16)</sup>. In the swallowing of pasty liquid and thick liquid, onset was in the base of the tongue and valleculla<sup>(2)</sup>. In the pudding consistency, onset occurred on the dorsum and base of the tongue, besides the valleculla<sup>(6)</sup>.

Unfortunately, the lack of standardization regarding the nomenclature of the consistencies used in the studies made it impossible to stratify the data in this aspect for greater representativeness of the statistical calculations of this meta-analysis.

As to the volume offered in the asymptomatic population, for swallowing the 5 ml volume, onset of the pharyngeal phase occurred at base of the tongue<sup>(2)</sup>, above, at or below the mandibular ramus<sup>(12,16,20)</sup> and in the valleculla<sup>(2)</sup>. With 10 ml, the onset of the pharyngeal phase was in the valleculla<sup>(17)</sup>; with 15 ml and 20 ml at the base of the tongue and valleculla<sup>(2)</sup>; with 1/2 cookie at base of the tongue<sup>(2)</sup>; with 8 g of solid (cookie), in the valleculla and oral cavity<sup>(7)</sup>.

In addition to the influence of food consistency and volume, studies have sought to know the influence of verbal command on the onset of the pharyngeal phase of swallowing in asymptomatic individuals. Almeida et al.<sup>(2)</sup> studied the influence, through SVF, of verbal commands on swallowing different consistencies and volumes in 40 healthy individuals without swallowing difficulties aged between 20 and 30 years. No influence of the verbal command was observed on the onset of the pharyngeal phase and the results of the study showed predominance of the onset of the pharyngeal phase in the valleculla followed by the base of the tongue to 5 ml of liquid. For the other consistencies and volumes (20 ml of liquid, 5 and 20 ml of pasty liquid, 15 ml of thick liquid, 1/2 biscuit for solid), the results were inverted, with a higher predominance on the onset of the pharyngeal phase on the base of the tongue, followed by the valleculla. There was only

one case of laryngeal penetration with verbal command, but no aspiration occurred.

Palmer et al. (7) in a study of seven adults aged 21 to 25, studied the effect of verbal command during swallowing by eating 8 g of solid consistency (cookie). In this study, the influence of the command was found, and without verbal command there was a predominance of the onset of the pharyngeal phase in the vallecula in five of the seven cases. With verbal command, in three cases, onset occurred in the oral cavity, three cases in vallecula, and in one case in the high oropharynx (after the posterior nasal spine above the mandibular angle). There was no reference to the occurrence of laryngeal penetration or laryngotracheal aspiration.

In the study by Nagy et al.<sup>(17)</sup>, the swallowing of 10 ml of ultrathin liquid with and without verbal command was observed. The sample consisted of 20 asymptomatic adults, with a mean age of 31.50 years. Without verbal command, the onset of the pharyngeal phase occurred 48% in the vallecula, 20% above the mandibular ramus, 20% in the pyriform sinus and 12% in the laryngeal surface of the epiglottis. With verbal command, the onset of the pharyngeal phase occurred 45% of the time in the vallecula, 35% above the mandibular ramus and 20% in the laryngeal surface of the epiglottis, as there was no longer the presence of discharge in the pyriform sinus. The presence of laryngeal penetration or laryngotracheal aspiration was not reported.

Daniels et al.<sup>(20)</sup>, in a study of 12 asymptomatic adults aged 56 to 78 years, examined the effects of verbal command on the onset of swallowing 5 ml of liquid. With verbal command, they found the triggering of the pharyngeal phase when the tip of the bolus was superior or adjacent to the mandibular ramus in 17 (71%) of the 24 swallowing tasks, to which participants were submitted. Additionally, onset of the pharyngeal phase was also observed in other regions, five (21%) of the 24 occurred at the vallecula level and two (8%) were below the vallecula. Without verbal command, onset occurred predominantly when the tip of the bolus was superior or adjacent to the mandibular ramus in 12 (50%) of the 24 swallowing tasks, at the vallecula level in five (21%) and below the vallecula in seven (29%). It was possible to discern that in the swallows without verbal command there was an increase in the triggering of the pharyngeal phase in inferior regions. Only one volunteer had laryngeal penetration during swallowing with and without verbal command, but there was no report as to where onset of the pharyngeal phase occurred in this case, making no inference as to the relation between the location of onset of the pharyngeal phase of swallowing and laryngeal penetration.

In the study by Uchimura et al.<sup>(6)</sup>, the authors evaluated the location of capsules of two different capacities (0.3 ml and 0.95 ml) at the time of triggering of the pharyngeal phase of swallowing in 60 asymptomatic adults aged 27 to 55 years. Two capsules of each size were ingested with foods in liquid consistency and two others, of different sizes, ingested with the pudding consistency. Onset of the pharyngeal phase occurred at the dorsum of the tongue when ingesting the capsules of

smaller capacity. With the capsules of greater capacity, onset occurred at the base of the tongue and vallecula. These findings were found both in the ingestion of capsules with food in the liquid consistency and in the pudding consistency. The authors did not report any occurrence of laryngeal penetration or laryngotracheal aspiration.

Stephen et al.<sup>(12)</sup> studied the location of the bolus in triggering the pharyngeal stage of swallowing. The population was composed of 10 asymptomatic individuals over 60 years of age, who underwent the ingestion of 5 ml of liquid. For analysis of the location of the onset of the pharyngeal phase, an intersection between the base of the tongue and the mandibular ramus was noted. In 46% of the swallows analyzed, the head of the bolus was above the intersection, 2% were at the intersection and 52% were below the intersection at the time of pharyngeal phase onset. There were no signs of penetration or aspiration in any of the swallows analyzed.

A study by Stokely et al.<sup>(16)</sup> with 20 asymptomatic individuals between 22 and 45 years old observed the swallowing of thin and ultrathin liquid. The onset of the pharyngeal phase occurred before reaching the mandibular ramus with the ultrathin liquid consistency. With thin liquid consistency, onset occurred after the bolus reached the mandibular ramus. The authors did not report the presence of penetration or aspiration.

#### **Onset location of the pharyngeal swallowing phase: symptomatic population**

In the five studies in which participants had characteristics and/or underlying diseases that could knowingly influence the dynamics of swallowing, as unilateral medullary infarction<sup>(21)</sup>, dental prosthesis<sup>(8)</sup>, post-withdrawal of tumor in the oral cavity<sup>(19)</sup> bilateral lingual anesthesia of the inferior alveolar nerve with occlusal plate use<sup>(22)</sup> and cricopharyngeal dysfunction<sup>(18)</sup>, the onset of the pharyngeal phase occurred in the oropharynx<sup>(21,22)</sup>, vallecula<sup>(8,19)</sup>, hypopharynx<sup>(8,21)</sup> and pyriform sinus<sup>(18)</sup> (Figure 4).

As to the population above 60 years of age who underwent SVF post oral tumor treatment, onset of the pharyngeal phase of swallowing was observed mainly in the vallecula<sup>(19)</sup>. In one individual over 60 years with idiopathic cricopharyngeal dysfunction, the beginning of the pharyngeal phase in the pyriform sinus was observed<sup>(18)</sup>. In relation to the population over 60 years with oral swallowing phase compromise (with missing teeth without prosthesis), 87% of pharyngeal phase onset was observed in the hypopharynx and 13% in the vallecula<sup>(8)</sup>. In a study of a population between 55 and 74 years with acquired neurological lesion (unilateral medullary infarction), 56% of swallows with the offer of 4 ml of thick liquid were triggered in the oropharynx<sup>(21)</sup>. In a study of a population with a mean age of 65 years after the removal of tumors in the oral cavity, the onset of the pharyngeal phase of swallowing occurred in the vallecula for the volume of 4 ml of consistency nectar<sup>(19)</sup>.

Yamamoto et al.<sup>(8)</sup> verified the impact of fully removable dental prosthesis use on swallowing in 15 elderly adults with a mean age of 78 years without swallowing complaints. SVF was performed with and without the use of the removable

prosthesis with the same consistency (gelatin agar) in 10 g volume for both situations. Onset of the pharyngeal phase was observed without the use of prosthesis predominantly in the hypopharynx and with the prosthesis, onset predominantly occurred in the vallecula in 13 of 15 individuals. It is inferred that the use of the dental prosthesis can influence the location of onset of the pharyngeal phase. No laryngeal penetration and/or laryngotracheal aspiration was reported.

In the study by Chitose et al.<sup>(18)</sup>, a case was reported of a 80-year-old patient with idiopathic cricopharyngeal dysfunction. The authors described that the onset of the pharyngeal phase occurred only when there was bilateral accumulation of barium in the pyriform sinus. There was no penetration or aspiration in this case.

Umeda et al.<sup>(19)</sup> studied the effects of reclined positions and sitting in swallowing in individuals who have undergone removal of oral tumor. The study sample consisted of 53 individuals with a mean age of 65 years. The tumors removed were located in the tongue in 22 patients, in the mandible in 20, in the oral mucosa in 5, in the buccal frenum 4 patients, in addition to other unspecified ones. The studied population was submitted to the ingestion of 4 ml of nectar consistency in the sitting and reclining position. In the reclined position, pharyngeal phase onset occurred predominantly in the vallecula and upper oropharynx (between the posterior nasal spine and mandibular angle). In the seated position, onset occurred predominantly in the vallecula and upper hypopharynx (between the border of the epiglottis and the upper esophageal sphincter).

The reclining position favors ejection of the bolus during swallowing, especially in patients who have undergone oral tumor resection. It was noted that, in the seated position, the onset location of the pharyngeal phase became lower, suggesting a possible increased risk for laryngeal penetration and tracheal aspiration<sup>(18)</sup>. Therefore, it can be considered that the individual's position during swallowing may also influence the onset location of the pharyngeal phase.

Mikushi et al.<sup>(21)</sup> evaluated the dominant side for the passage of a bolus in the pharynx, investigating the factors that make the bolus pass through the predominantly affected side in unilateral medullary infarction in 41 patients with a mean age of 64 years. In this study, in 23 (56%) individuals, the onset of the pharyngeal phase occurred in the oropharynx (between the soft palate and the vallecula) and, in 18 (44%), in the hypopharynx (below the vallecula until the pyriform sinus). The presence of laryngeal penetration or laryngotracheal aspiration was not reported.

In a population under 60 years who underwent the use of occlusal plates and bilateral lingual anesthesia of the inferior alveolar nerve, pharyngeal phase onset occurred predominantly in the oropharynx in wet solid and dry solid swallowing<sup>(22)</sup>. Tei et al.<sup>(22)</sup> investigated the interference of the masticatory condition in individuals with bilateral lingual paralysis, inferior alveolar nerve paralysis, and increased occlusal vertical dimension at the onset of swallowing. The sample consisted of a population without complaints of swallowing,

20 individuals between 24 and 30 years of age, but undergoing bilateral lingual anesthesia of the inferior alveolar nerve (using 2% xylocaine), and the use of occlusal plate. In dry solid swallowing, only four (20%) of the 20 participants did not experience onset of the pharyngeal phase before the bolus entered the oropharynx. With wet solid, 12 (60%) of the 20 participants had onset of the pharyngeal phase after the bolus entered the oropharynx, suggesting that onset may be influenced by the characteristics of the bolus. The authors considered as normal oropharyngeal discharge and pointed out that no participant presented penetration or aspiration.

The need for further studies with asymptomatic populations including larger samples, with swallowing of different volumes and consistencies, is necessary in order to obtain a greater degree of evidence regarding the factors associated with the onset of the pharyngeal swallowing phase.

It is inferred that conditions such as verbal command, absence of dentition, experiments with anesthesia of the extrinsic muscles of the tongue, modification of the occlusal vertical relationship, characteristics of the bolus and position of the individual during swallowing may influence the location of onset of the pharyngeal phase of swallowing.

## CONCLUSION

The onset of the pharyngeal phase of swallowing was observed more frequently when the head of the bolus was up to the posterior region of the mandibular ramus or in the vallecula at the time of the first sign of hyoid bone excursion. There was a high frequency of onset of the pharyngeal phase in the vallecula, both in the asymptomatic and symptomatic populations.

It was possible to observe pharyngeal phase onset in oral cavity, dorsum and base of tongue, oropharynx, vallecula, pyriform sinus and hypopharynx. There was no relation between the location of onset of the pharyngeal phase and the occurrence of laryngeal penetration and/or laryngotracheal aspiration.

Onset of the pharyngeal phase in the hypopharynx and pyriform sinus was evidenced in elderly individuals or with comorbidities that could alter swallowing.

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### Author contributions

*MZ was responsible for carrying out the project, collection, data tabulation and preparation of the manuscript; AMF was responsible for guiding the project and following the preparation steps, implementation and review of the manuscript; CTM collaborated with the collection of data and review of the manuscript; KFL was responsible for data analysis, project co-supervision and accompanied the drafting stages, implementation and review of the manuscript.*