

Swallowing with and without verbal commands: videofluoroscopic findings

Deglutição com e sem comando verbal: achados videofluoroscópicos

Rita de Cássia de Araújo Almeida¹, Renata Cavalcante Barbosa Haguette², Izabella Santos Nogueira de Andrade³

ABSTRACT

Purpose: To characterize the swallowing process of different food consistencies and quantities, with and without verbal commands, through videofluoroscopy. **Methods:** Quantitative cross-sectional, observational study held in the period between January and March 2010 with 40 healthy subjects with no apparent signs of swallowing problems. Mean age was 23 years and 5 months ($SD \pm 2.5$), with a minimum age of 20 years and a maximum of 30 years, and 87.5% of the subjects were female (35/40). A videofluoroscopy swallowing study (VFSS) was carried out with the ingestion of barium in the liquid, thick liquid, pureed and solid consistencies. Two swallowing tests were held during the administration of the liquid consistency, with and without verbal commands. The place of beginning of the pharyngeal phase of swallowing in different structures was analyzed, as well as the presence of premature spillage of food, delayed oral transit time, multiple swallowing, stasis, and laryngeal penetration and/or aspiration in both situations. **Results:** The beginning of the pharyngeal phase took place in the base of the tongue and in the valleculae for most consistencies and quantities, with the exception of the liquid swallowing (5 ml), which started in the valleculae. There was no influence of the verbal command both in the place where the pharyngeal phase of swallowing started, and the presence of stasis of residue. However, the command was effective in reducing oropharyngeal findings. **Conclusion:** The pharyngeal phase of swallowing occurred in the base of the tongue and valleculae. The verbal commands influenced the dynamics of swallowing.

Clinical Trials – NCT01120587

Keywords: Eating behavior; Deglutition; Fluoroscopy/methods; Pharynx/physiology; Barium/administration & dosage

INTRODUCTION

The act of swallowing is the result of a neuromuscular mechanism, which aims to transport the bolus from the mouth to the stomach effectively⁽¹⁾. The procedure is complex and dynamic, and essential for the nutrition and hydration of the body⁽²⁾. It can be divided into the following phases: anticipatory⁽³⁾; oral-preparatory and oral – voluntary; pharyngeal and esophageal – involuntary⁽⁴⁾.

The analysis of the swallowing process is carried out through a clinical evaluation, with the ingestion of different amounts and consistencies of food, during which symptoms and signs

that indicate possible alterations in the control and movement of the bolus, food retention or stasis in the oropharyngeal passage, possible larynx penetrations or aspirations are observed. However, this analysis does not allow the quantification of each one of these events, neither of the silent laryngeal aspirations⁽⁵⁾.

To observe the anatomic structures and the dynamic analysis, in real-time, of the phases of swallowing, the videofluoroscopy swallow study (VFSS) is considered the diagnostic test, the gold standard for the study of physiology and swallowing disorders^(6,7).

It is noteworthy that, with the VFSS, you can effectively analyze the pharyngeal phase of swallowing, characterized by a series of physiological events, the soft palate rises, the vocal folds adduct, there is the peristaltic contraction of the pharyngeal constrictor muscles, the larynx moves up and forward, the epiglottis folds backwards, which begins with the stimulation of sensory receptors, located mainly in the oropharyngeal cavity⁽⁴⁾.

We discuss the exact moment when the pharyngeal phase is initiated^(8,9), and propose that healthy subjects may present it after the entry of food into the pharynx. The pharyngeal phase may be initiated in the valleculae, posterior pharyngeal wall, pyriform

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(1) Clínica Trajano Almeida – Fortaleza (CE), Brazil.

(2) Graduate Program (Doctorate degree) in Public Health, Universidade Estadual do Ceará – UECE – Fortaleza (CE), Brazil.

(3) Undergraduate Program in Speech-Language Pathology and Audiology, Universidade de Fortaleza – UNIFOR – Fortaleza (CE), Brazil.

Correspondence address: Rita de Cássia de Araújo Almeida. Av. Santos Dumont, 5753, sala 1508, Torre São Mateus II, Papicu, Fortaleza (CE), Brazil, CEP: 60150-162. E-mail: ricassia_araujo@yahoo.com.br

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sinuses, or in the pharyngoesophageal segment, not necessarily resulting in changes in the condition of healthy subjects. However, it may be influenced by the consistency or amount of food bolus, as well as by verbal commands to swallow⁽⁹⁾.

The impact of verbal commands in the swallowing process is not well known yet. However, it is verified that, with the verbal command, the formation and propulsion of the food bolus are influenced⁽⁸⁾. Due to the dynamic characteristic of the swallowing, the changes observed in the oral preparatory and oral phases under verbal command, may influence the beginning of the pharyngeal phase.

Studies show a significant variation between the presence and absence of verbal command in the cerebral cortex. It is emphasized that in the presence of verbal command there is more cortical representation, and that both hemispheres are activated in this situation⁽¹⁰⁾.

In fact, this study aims to characterize the swallowing process of different food consistencies and quantities, with and without verbal command, by means of the videofluoroscopy swallowing study.

METHODS

The study was conducted under the approval of the Research Ethics Committee of the University of Fortaleza (UNIFOR) No. 193/2006, in accordance with resolution No. 196/96 of the National Health Council/Ministry of Health (CNS), which regulates researches with human beings (*In anima nobili*). All participants signed a Term of Consent.

A quantitative, cross-sectional, single, observational study was carried out in the period between January and March 2010, in an Advanced Center for Diagnosis and Treatment in the city of Fortaleza, Ceará, Brazil.

The sample consisted of 40 healthy young adults of both sexes. The inclusion criteria were: chronological age between 20 and 30 years; no signs of swallowing disorders; no surgeries/treatments in area of the head or neck, except for dental ones. Subjects who have already undergone cardiac, thoracic, and/or abdominal surgery were excluded.

The mean age of the subjects was 23 years and 5 months (SD±2,5), with a minimum age of 20 years and a maximum of 30 years; 87.5% of them (35/40) were female.

The Videofluoroscopy Swallowing Study Protocol was used for data collection⁽¹¹⁾(Appendix1). It addresses issues regarding the ingestion of barium in the liquid, thick liquid, pureed and solid consistencies.

The videofluoroscopy swallowing study was carried out using a KX012 seriescopy device (Toshiba®), coupled with an image intensifier (Intecal®) and a computerized system for recording image and sound to make the subsequent analysis possible. All exams were carried out by a speech therapist, the researcher, and a radiologist.

During the VFS study, subjects remained in a sitting position, and the images were taken in the anteroposterior and lateral positions, with upper and lower limits ranging from the mouth to the esophagus.

For the liquid consistency, water was added to the liquid barium (Bariogel®), at a one-to-one ratio (15 ml of water to

15 ml of barium); in the thick liquid, 25 ml of liquid barium were used; for the pureed, two 5 ml spoons of thickener (Thick&Easy®) were used for every 30 ml of liquid barium; and in the solid, half of a wafer biscuit was dunked into liquid barium.

During the study, subjects remained seated, initially in lateral position, ingesting all consistencies, and then, on a second moment, in the anteroposterior position, with the evaluation of the liquid and solid consistencies only.

In lateral position, for the liquid and thick liquid consistencies, they were administered 5 ml on the spoon and 20 ml on the cup, respectively. The pureed consistency was offered in three consecutive 5 ml spoons, and the solid was offered in the form of half wafer biscuit dunked into pure barium.

Two tests were carried out with the liquid consistency in the amount of 5 ml:

- Swallowing with verbal command – The subject placed the spoon near the mouth and waited for the command of the researcher, who used the following verbal command: “You can now swallow!”;
- Swallowing with no verbal command – The subject was instructed to have another spoonful after the swallowing with verbal command, this time without any kind of verbal command.

It is noteworthy that all guidelines referring to both tests were given prior to the examination.

In the anteroposterior position, the liquid consistency was offered only in the amount of 20 ml in the cup, while the solid remained the same as the lateral view.

The following variables were considered when assessing the VFSS:

- Place of beginning of the pharyngeal phase of swallowing – observed at the beginning of the movement of the hyoid bone in the presence of the food bolus, on the base of the tongue, valleculae, epiglottis, aryepiglottic fold, pyriform sinuses, or pharyngoesophageal segment;
- Premature spillage – food going to the wrong way into the oropharynx before the movement of the bolus;
- Increased oral transit time – comparison between the longest times of the voluntary phases of swallowing with and without verbal command;
- Multiple swallowing – number of swallowing processes required to reduce food stagnation;
- Stasis of residue – presence of food residues after swallowing three times, in the regions of the base of the tongue, valleculae, epiglottis, pyriform sinuses, or pharyngoesophageal segment. It was classified into mild (less than 25%) moderate (between 25 and 50%), and severe (residues exceeding 50%) according to the amount of filling of the whole structure^(14,15).
- Laryngeal penetration – penetration of food into the larynx to the level of the vocal cords, characterized into before, during or after the beginning of the pharyngeal phase; and classified, according to the amount of food penetrated, into mild (less than 10%), moderate (between 10 and 25%) and severe (more than 25% of the bolus)⁽¹⁶⁾;
- Laryngeal aspiration – penetration of food into the larynx, below the vocal cords, characterized into before, during or

after the beginning of the pharyngeal phase; and classified, according to the amount of food aspirated, into: mild (less than 10%), moderate (between 10 and 25%) and severe (more than 25% of the bolus)⁽¹⁶⁾;

- Absence of oropharyngeal findings – absence of increased oral transit time, premature spillage, multiple swallowing, laryngeal penetration/aspiration.

The following variables were considered, according to the findings of the VFSS:

- Place of beginning of the pharyngeal phase of swallowing for the different consistencies and quantities of food;
- Comparison between the beginning of the pharyngeal phase of swallowing with and without verbal command, for the liquid consistency (5 ml);
- Influence of liquid swallowing (5 ml) with and without verbal command on the presence and location of stasis;
- Influence of liquid swallowing (5 ml) with and without verbal command on the presence of oropharyngeal findings.

For the investigation of the results, the descriptive analysis of the percentage was used, in order to evaluate the place of beginning of the pharyngeal phase of swallowing for different consistencies and quantities of food. The inferential statistical analysis was used, by means of the test of equality proportion between two samples, in order to assess the influence of liquid swallowing (5 ml) with and without verbal command in the swallowing process, adopting a significance level of $p < 0.05$.

RESULTS

Table 1 shows the distribution of the structures of the oropharynx according to the place where the pharyngeal stage of swallowing begins for each food consistency.

It was observed that only for the 5 ml liquid swallowing, the initiation of the pharyngeal phase took place predominantly at the valleculae (47.5%). For all the other consistencies and quantities, it was observed that the pharyngeal phase begun predominantly at the base of the tongue and at the valleculae, respectively.

In the correlation analysis between consistency, quantity and place of initiation of the pharyngeal stage, it was possible to identify that the initiation of the pharyngeal phase take place at the valleculae and at the base of the tongue without any distinction between these two structures, for all consistencies of food, except for the solid, which occurs at the base of the tongue ($p = 0.014$).

Table 2 describes the distribution of cases of liquid swallowing (5 ml) with and without verbal command according to the variables: place of beginning of the pharyngeal phase of swallowing, presence of stasis of residue and oropharyngeal findings.

In this analysis, it became clear that the verbal command did not influence the place of beginning of the pharyngeal phase of swallowing. It was also verified that the verbal command had no influence on the episodes of stasis, larynx penetration and/or aspiration.

On the other hand, the increased oral transit time ($p = 0.011$) and the premature spillage of food ($p = 0.048$) were more prevalent in the swallowing without verbal command. In addition, the verbal commands inhibited the presence of any oropharyngeal findings ($p = 0.012$).

DISCUSSION

In the present study, it was observed that the pharyngeal phase of swallowing was initiated at the base of the tongue and at the valleculae for all food consistencies and quantities.

For a long time, the pharyngeal phase of swallowing was considered to be initiated by the stimulation of sensory receptors at the region of the tonsillar pillars, especially the anterior pillar⁽¹⁷⁾. Recent studies have shown that the initiation of the pharyngeal stage may occur, in addition to the base of the tongue, at the valleculae for liquid⁽¹⁸⁻²⁰⁾, and especially for thick liquid and pureed consistencies⁽²¹⁾, suggesting that the variability of places of initiation of the pharyngeal phase of swallowing is a physiological characteristic.

When it comes to the solid consistency, the initiation of the pharyngeal phase was related to the base of the tongue in 62.5% of the cases, as opposed to studies that suggest it begins mainly at the valleculae^(19,20). Thus, the higher density of solid food provides a more appropriate neuromuscular control when compared to other consistencies, resulting in more proprioceptive stimuli, which brings the pharyngeal stage to superior structures, such as the base of the tongue^(22,23).

The influence of the verbal command on the place of beginning of the pharyngeal phase of swallowing was not significant in this study. It was observed that the predominant places of beginning of the pharyngeal phase of swallowing with and without verbal command were the base of the tongue and the valleculae, contradicting the theory that the pharyngeal phase of swallowing starts at the valleculae without verbal command

Table 1. Place of beginning of the laryngeal phase of swallowing for different consistencies and quantities of food

Structures	Liquid				Thick liquid				Pureed		Solid	
	5 ml		20 ml		5 ml		20 ml		15 ml		1/2 biscuit	
	n	%	n	%	n	%	n	%	n	%	n	%
Base of the tongue	17	42.5	18	45.0	20	50.0	19	47.5	21	52.5	25	62.5
Epiglottis	3	7.5	3	7.5	3	7.5	2	5.0	4	10.0	1	2.5
Aryepiglottic fold	0	0.0	2	5.0	0	0.0	1	2.5	0	0.0	0	0.0
Pyramidal sinuses	1	2.5	1	2.5	0	0.0	0	0.0	0	0.0	0	0.0
Pharyngo-esophageal segment	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Valleculae	19	47.5	16	40.0	17	42.5	18	45.0	15	37.5	14	35.0

Table 2. Dynamics of the liquid swallowing (5 ml) with and without verbal command

		With command		Without command		p-value
		n	%	n	%	
Place of beginning of the laryngeal phase of swallowing	Base of the tongue	19	47.5	17	42.5	0.653
	Epiglottis	2	5.0	3	7.5	0.644
	Aryepiglottic fold	1	2.5	0	0.0	0.314
	Pyramidal sinuses	0	0.0	1	2.5	0.314
	Pharyngo-esophageal segment	1	2.5	0	0.0	0.314
	Valeculae	17	42.5	19	47.5	0.653
Stasis	No stasis	28	70.0	25	62.5	0.478
	Base of the tongue	3	7.5	4	10.0	0.692
	Epiglottis	0	0.0	0	0.0	-
	Aryepiglottic fold	0	0.0	0	0.0	-
	Posterior pharyngeal wall	0	0.0	0	0.0	-
	Pyramidal sinuses	1	2.5	1	2.5	1.000
	Pharyngo-esophageal segment	2	5.0	1	2.5	0.556
Oropharyngeal findings	Valeculae	7	17.5	10	25.0	0.412
	No oropharyngeal findings	38	95.0	30	75.0	0.012*
	Increased oral transit time	0	0.0	6	15.0	0.011*
	Multiple swallowing	0	0.0	0	0.0	-
	Premature spillage	1	2.5	6	15.0	0.048*
	Laryngeal penetration	1	2.5	0	0.0	0.314
Laryngeal aspiration	0	0.0	0	0.0	-	

* Significant values ($p \leq 0.05$) – Test for equality of two proportions

and at the base of the tongue with verbal command⁽⁸⁾.

There is a significant difference between the activation of cortical structures with and without verbal command in healthy individuals, as evidenced by the use of magnetic resonance^(10,24-26). However, the videofluoroscopy analysis of swallowing did not demonstrate the influence of the verbal command on the swallowing dynamics, in contrast with previous studies, which suggested a more efficient swallowing, with the activation of multiple areas of the cerebral cortex, in healthy individuals under verbal command^(10,27-30).

In agreement with previous studies, it was observed that except for the absence of increased oral transit time, and the decreased premature spillage of food, every other biomechanical events occurring during swallowing with command are similar to the ones of the swallowing without command^(10,22).

In the swallowing without verbal command, it is verified that only the primary sensorimotor cortex is activated, while in the opposite situation, the cingulate gyrus, the parieto-occipital region, and the insular cortex are also activated, providing a better sensory input that favors a more organized swallowing⁽¹⁰⁾.

Studies on the normality process help physicians better understand the physiological mechanisms and its variables, favoring a more accurate and reliable diagnosis of dysphagia,

and promoting more appropriate procedures. It is currently believed, from the observation of the swallowing dynamics of healthy individuals, that there is not only one pattern of “normal” swallowing.

It is believed that the findings in this study may contribute to the establishment of criteria for the diagnosis, rehabilitation and prognosis of dysphagia.

It is important to emphasize that researches on this topic must be carried out with systematic observations of the VFSS, and the administration of various food consistencies and quantities to individuals with swallowing disorders, so as to verify the effectiveness of the verbal command in speech therapy for oropharyngeal dysphagia.

CONCLUSION

In this sample, the initiation of the pharyngeal phase of swallowing occurred mainly at the base of the tongue and the valleculae, for most food consistencies and quantities.

There was an influence of the verbal command on the swallowing dynamics of healthy individuals.

It is important to emphasize the need for other studies covering the proposed subject, especially with individuals with dysphagia, so as to observe the effectiveness of the verbal command.

RESUMO

Objetivo: Caracterizar a deglutição de consistências e quantidades alimentares diferentes, com e sem comando verbal, por meio da videofluoroscopia da deglutição. **Métodos:** Estudo quantitativo, transversal e observacional em 40 indivíduos saudáveis e sem queixas de deglutição, realizado no período de janeiro a março de 2010. A média de idade dos indivíduos foi de 23 anos e 5 meses ($DP \pm 2,5$), com idade mínima de 20 anos e máxima de 30 anos, sendo 87,5% (35/40) do gênero feminino. Realizou-se avaliação videofluoroscópica da deglutição com ingestão de bário nas consistências líquida, líquido-pastosa, pastosa e sólida. Durante a administração da consistência líquida, realizaram-se duas provas de deglutição, uma com e outra sem comando verbal. Foram analisados o local do início da fase faríngea da deglutição em diferentes estruturas, a perda prematura do alimento, o aumento do tempo de trânsito oral, a presença de deglutições múltiplas, a presença de estase alimentar e a presença de penetração e/ou aspiração laríngea nas duas situações. **Resultados:** O início da fase faríngea ocorreu na base da língua e valéculas para a maioria das consistências e quantidades, com exceção da líquida (5 ml) cuja deglutição foi ativada em valéculas. Não houve influência do comando verbal para o local do início da fase faríngea da deglutição e presença de estase alimentar, entretanto o comando foi eficaz para a diminuição dos achados orofaríngeos. **Conclusão:** A fase faríngea da deglutição ocorreu em base de língua e valéculas. Houve influência do comando verbal na dinâmica da deglutição.

Clinical Trials – NCT01120587

Descritores: Comportamento alimentar; Deglutição; Fluoroscopia/métodos; Faringe/fisiologia; Bário/administração & dosagem

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Appendix 1. Videofluoroscopy Swallowing Study Protocol⁽¹¹⁾

Date of examination: _____

Tape: _____

1) Identification

Name: _____ Identification _____

Referral: _____

Complaint: _____

2) Medical treatment

HPI: _____

3) Clinical assessment of speech

a) Stomatognathic system: _____

b) Oral communication: _____

c) Swallowing: _____

Lateral view	Liquid (ml)		Thick liquid (ml)		Pureed		Solid	
Oral preparatory phase	5	20	5	20	5			
Oral incontinence								
Delayed onset of the oral swallow								
Alterations in the formation of the bolus								
Premature loss of the bolus								
Penetration before swallow								
Aspiration before swallow								
Silent aspiration								
Oral Phase	Liquid (ml)		Thick liquid (ml)		Pureed		Solid	
↓ / Ø AP tongue movement								
Penetration before swallow								
Aspiration before swallow								
Silent aspiration								
Increased oral transit time								
Stasis on the floor of the mouth								
Stasis on the hard palate								
Stasis on the tongue								
Stasis on the remaining structure								
Pharyngeal phase								
↓ / Ø contact tongue x pharynx								
↓ time of contact tongue x pharynx								
Pharyngeal swallow started on:								
Penetration before swallow								
Silent aspiration								

	Liquid (ml)			Thick liquid (ml)			Pureed			Solid
	5		20	5		20	5			
Nasopharyngeal regurgitation										
↓ / Ø of laryngeal elevation										
Stasis on the base of the tongue										
Alterations in the vestibule closure										
Alterations in the glottic closure										
Penetration during swallow										
Aspiration during swallow										
Silent aspiration										
Valleculae stasis										
Increased pharyngeal transit time										
Stasis on the PPF										
Penetration after swallow										
Aspiration after swallow										
Silent aspiration										
Stasis on the arytenoids										
Stasis on the FES										
Stasis on the OS										
Penetration after swallow										
Aspiration after swallow										
Silent aspiration										
Functional swallowing										

Anteroposterior view	Solid	Thick liquid
↓ / Ø medial movement of the larynx R/L		
↓ / Ø bolus directed laterally		
↓ / Ø chewing U / B		
Valeculae Stasis R / L		
Stasis on the pyriform sinuses R/ L		

Note: HPI = history of the present illness; AP = anteroposterior; PPW = posterior pharyngeal wall; FES = pharyngoesophageal segment; PS = pyriform sinuses

Spontaneous maneuvers: _____

Number of swallows to clear the valleculae: (1) does not clear (2) more than two

Head posture: (1) down (2) back (3) Turned to the left (4) Turned to the right (5) Inclined to the left (6) Inclined to the right

Swallowing maneuvers: (1) Supraglottic swallow (2) Super-supraglottic swallow (3) Mendelsohn (4) Effortful Swallow

Clear maneuver: (1) Multiple Swallow (2) Protective Reflex

Effectiveness of maneuvering: _____

Conclusion: _____

Dysphagia severity scale⁽¹²⁾: 7 6 5 4 3 2 1

Penetration/aspiration scale⁽¹³⁾: 1 2 3 4 5 6 7 8

Examiners: Speech Therapist. _____ Registration No. _____

Doctor. _____ Registration No. _____