Érica Mayumi Takase

AVALIAÇÃO DA DEGLUTIÇÃO DE ALIMENTOS E CÁPSULAS GELATINOSAS DURAS EM ADULTOS ASSINTOMÁTICOS

"EVALUATION OF SWALLOWING FOOD AND HARD GELATIN CAPSULES IN ASYMPTOMATIC ADULTS"

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"AVALIAÇÃO DA DEGLUTIÇÃO DE ALIMENTOS E CÁPSULAS GELATINOSAS DURAS EM ADULTOS ASSINTOMÁTICOS"

Orientador Profº Drº Agricio Nubiato Crespo

"EVALUATION OF SWALLOWING FOOD AND HARD GELATIN CAPSULES IN ASYMPTOMATIC ADULTS"

Tese de Mestrado apresentada ao Programa de Pós-Graduação em Ciências Médicas da Faculdade de Ciências Médicas da Universidade Estadual de Campinas para obtenção de título de Mestra em Ciências Médicas, área de concentração em Ciências Biomédicas.

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RESUMO

As medidas de duração e a localização do bolo no disparo da fase faríngea são significantes no estudo da deglutição. Objetivo: avaliar a interferência da consistência alimentar e da idade do sujeito na duração das fases oral, de transição e faríngea na deglutição de alimentos e cápsulas e avaliar a localização de cápsulas no disparo da fase faríngea em adultos assintomáticos. Método: Realizou-se a videofluoroscopia em 60 sujeitos, entre 27 e 55 anos de idade, avaliados com alimentos contrastados nas consistências liquida e pudim, na colher de sopa; e cápsulas gelatinosas duras #00 e #3 contendo sulfato de bário, deglutidas com alimentos nas consistências líquida e pudim, em livre oferta. Realizou-se análise intra e inter julgadores. A análise estatística baseou-se nos testes Mahn-Whitney, Wilcon-Cox, Macnemar, no modelo log-linear Gama e modelo com resposta Gama e função de ligação inversa. Resultados: Avaliou-se 14 sujeitos do sexo masculino e 46 do feminino. Alimentos contrastados não apresentaram diferenças estatisticamente significantes na duração das fases oral e de transição (p= 0,419 e p=0,482) entre as consistências liquida e pudim, porém em relação à fase faríngea a consistência mais viscosa apresentou maior tempo de duração (p= 0,000). Houve aumento da duração das fases oral e faríngea e diminuição da fase de transição de adultos mais velhos, em ambas as consistências. Na avaliação da duração com cápsulas #00 a fase faríngea não mostrou diferença estatisticamente significante (p= 0,325) entre as consistências líquida e pudim e a fase oral apresentou maior tempo de duração (p= 0,000) na consistência mais viscosa. A duração das fases oral e faríngea aumentaram em adultos mais velhos, em ambas as consistências. A cápsula #3 apresentou maior porcentagem de localização em dorso de língua em comparação à #00, e cápsula #00 maior porcentagem em base de língua e valécula em comparação à #3. Foram encontradas diferenças estatisticamente significantes entre as diferentes cápsulas na deglutição com líquido (p= 0,016) e pudim (p= 0,037). Conclusão: A consistência alimentar interferiu na duração da fase faríngea de alimentos contrastados e na duração da fase oral de cápsulas #00, com aumento do tempo para alimentos mais viscosos. O aumento da idade influenciou na duração das fases da deglutição, tanto de alimentos contrastados quanto na deglutição de cápsulas, em ambas as consistências, com aumento das fases oral e faríngea e diminuição da fase de transição na deglutição de alimentos sem cápsulas. Cápsulas menores desencadearam o disparo da fase faríngea em região mais anterior em comparação às cápsulas maiores.

Descritores: Deglutição – Adulto – Fase oral – Faringe – Capsulas

ABSTRACT

Measurements of duration and location of bolus in pharyngeal phase triggering are significant in deglutition study. Objective: to evaluate interference of food consistency and age of individuals in duration of oral, transition and pharyngeal phases of food and capsules deglutition; evaluate capsules position in triggering of pharyngeal phase in asymptomatic adults. Methods: Videofluoroscopy was performed in 60 individuals, all of them between 27 and 55 years of age, which were tested with liquid and pudding consistencies food that were administered by tablespoon; and also were tested hard gelatin capsules #00 and #3 fulfilled with barium sulphate, which were swallowed along with liquid and pudding consistencies food, in free volume. It was performed intrajudge and interjudge analysis. Statistical analysis was based on Mahn-Whitney, Wilcon-Cox and Macnemar tests and on Gamma log-linear model and model with Gamma response and inverse-link function. Results: 14 male subjects and 46 female subjects were evaluated. There was no statistically significant difference in duration of oral and transition phases (p= 0,419 e p=0,482) between liquid and pudding consistencies, however in pharyngeal phase the most viscous consistency had a longer duration (p= 0,000). In older adults, it was observed an increment in duration of oral and pharyngeal phases and there was reduction in duration of transition phase, in both consistencies tested. In evaluation with capsules #00, in pharyngeal phase there was no statistically significant difference (p= 0,325) between liquid and pudding consistencies and oral phase had a longer duration (p= 0,000) with the more viscous consistency. Duration of oral and pharyngeal phases increased in older adults considering both consistencies tested. Capsule #3 presented higher percentage of occurrence in tongue dorsum compared to capsule #00, and capsule #00 presented higher percentage of location occurrence in tongue base and vallecula compared to capsule #3. There was statistically significant difference between different capsules swallowed with liquid (p= 0,016) and pudding (p= 0,037). Conclusion: Food consistency interfered with the duration of pharyngeal phase of food tested and interfered with oral phase of capsules #00, with time increased for more viscous food. Older age affected the duration of deglutition phases considering food and capsules tested, in both consistencies, with increased duration of oral and pharyngeal phases and decreased duration of transition phase in deglutition of food without capsules. Smaller capsules onset pharyngeal phase in most anterior region compared to larger capsules.

Keywords: Deglutition – Adult – Oral stage – Pharynx – Capsules

SUMÁRIO

1. Introdução

O processo da deglutição apresenta variabilidades entre os indivíduos, dificultando a definição de referências normativas que auxiliem nas decisões clínicas e análises científicas. Trata-se de um processo contínuo que envolve diferentes estruturas e mecanismos neuromotores, essenciais para a coordenação, organização e interrelação entre suas fases. Baseadas em características anatômicas e funcionais estas fases recebem três ou quatro divisões a depender dos autores. Dodds (1989) e Logemann (1983) as descrevem com as seguintes denominações: preparatória oral, oral, faríngea e esofágica [1-2].

A fase preparatória oral é caracterizada pela mastigação, tendo como objetivo a transformação do alimento em um bolo coeso, preparando-o para a deglutição. Na fase oral inicia-se a propulsão do bolo alimentar pelos movimentos ondulatórios antero-posteriores da língua que ejetam o alimento para a faringe. Durante a fase faríngea ocorre a elevação e anteriorização da laringe, proteção das vias aéreas, movimentação do palato mole em direção à parede posterior da faringe, contração dos músculos constritores e ampliação promovida pelos músculos dilatadores. A fase esofágica é responsável pela peristalse esofágica, que tem como objetivo transportar o bolo através do esôfago cervical e torácico até o estômago[1-2].

Com base nos conhecimentos sobre a dinâmica simultânea e sequencial da deglutição, a coordenação entre o final da fase oral e o início da fase faríngea é também importante. Dá-se o nome de fase de transição ou "delayed swallow reflex". É caracterizada pela presença do alimento na faringe antes do início da elevação laríngea. Inicia-se quando a cabeça do bolo atinge o ponto em que a borda inferior da madíbula cruza com a base da língua e finaliza com a elevação laríngea [2-4].

A identificação de um referencial para a localização do disparo da fase faríngea é ainda objeto de estudo. São diversas as estruturas descritas na literatura como sendo locais de disparo, tais como dorso da língua, base da língua, valécula e seios piriformes, não havendo concenso mesmo em estudos com sujeitos assintomáticos [5]. Mesmo sem localizações de referências, alguns estudos utilizaram-se do termo "atraso no disparo da fase faríngea" como uma das características de pacientes disfágico [6-8].

Além do disparo da fase faríngea, outro dado citado nos estudos sobre o processo da deglutição é a duração das suas fases. O estudo de medidas temporais fornece dados objetivos que podem auxiliar na avaliação, orientação e reabilitação de pacientes disfágicos. Apesar de sua importância não se observou concenso sobre seus valores referenciais [9].

Alguns fatores podem influenciar na duração das fases da deglutição, entre eles, a viscosidade do alimento, expressos em centipoises (cP) ou miliPascal por segundo (mPa/s). Trata-se de uma propriedade física, e caracteriza-se pela resistência de um fluido contra uma força aplicada. A característica da viscosidade do bolo pode interferir, por exemplo, na força de ejeção da língua e no transporte faríngeo [10].

Outro fator que pode influenciar na deglutição é a idade, que por si só, progressivamente e com maior impacto a partir dos 40 anos, causa mudanças quantitativas e qualitativas nas fases oral, faríngea e esofágica. Os estudos sobre o impacto das modificações advindas do processo de envelhecimento mostraram que, mesmo entre adultos, o avanço da idade poderia ser perceptível através de alterações funcionais. Entre estas modificações estão a diminuição do controle neuromuscular, perda da elasticidade e atrofia dos tecidos (mucosa, estruturas musculares, tecidos subjacentes e de sustentação), diminuição quantitativa da salivação ou xerostomia, alterações sensoriais entre outros [11-12].

Estudos com diferentes consistências e volumes alimentares são facilmente encontrados na literatura, porém são escassos os estudos com deglutição de medicamentos, apesar da alta importância no tratamento de pacientes disfágicos. A compreensão do mecanismo neuromuscular necessario para a deglutiçao de medicamentos, visando encontrar a forma mais segura e eficaz, é relevante na orientação adequada ao paciente e da indústria farmacêutica.

Entre os estudos nesta área destaca-se o trabalho de Channer e Virjee (1982) realizado com 50 sujeitos entre 20 e 87 anos, avaliados pela videofluoroscopia. Durante a deglutição de cápsulas gelatinosas duras observou-se a correlação positiva entre maior tempo de trânsito da cápsula e histórico de disfagia, queixas pregressas de dificuldade e sensação de incômodo na deglutição de comprimidos [13].

Estudo de Perakis, Burkhead e Postma (2009) também procurou simular a deglutição de medicamentos. Avaliou-se a deglutição de pílulas testes (drágeas de M&M) em 60 pacientes com idade entre 40 e 54 anos que apresentavam queixas de disfagia. Os sujeitos que apresentaram dificuldade na deglutição das pílulas durante a nasofibroscopia foram avaliados por meio da videofluoroscopia que detectou alterações esofágicas. O resultado demonstrou que a inclusão destas pílulas durante os exames aumentou a sensibilidade para o diagnóstico de patologias do esôfago. [14].

Apesar da importância do estudo sobre a deglutição de medicamentos observou-se escassez de trabalhos nesta área.

Levando-se em consideração que o processo da deglutição é um ato complexo, com respostas motoras que se modificam por alterações tais como consistência alimentar e idade do sujeito, estudos sobre a duração das fases da deglutição e localização do disparo da fase faríngea com diferentes consistências alimentares e cápsulas gelatinosas duras são relevantes para que referências normativas possam ser estabelecidas.

Dessa forma, esta tese é composta por três artigos que apresentam os resultados das avaliações de adultos assintomáticos, de diferentes faixas etárias, avaliados por meio da videofluoroscopia. Sendo os dois primeiros submetidos à publicação internacional e o terceiro à revista nacional de indexação internacional.

O primeiro artigo teve como objetivo a avaliação da duração das fases da deglutição de diferentes consistências alimentares. O segundo, avaliou a duração das fases da deglutição de cápsulas gelatinosas duras #00 com alimentos nas consistências líquida e pudim. Por fim, o terceiro avaliou a localização de cápsulas de diferentes tamanhos, deglutidas com diferentes consistências, no disparo da fase faríngea.

2. Objetivos

Objetivos

2.1 - Objetivo geral:

Avaliar a interferência da consistência alimentar e da idade nas durações das fases da deglutição e avaliar a influência do tamanho das cápsulas na localização do disparo da fase faríngea de adultos assintomáticos.

2.2 - Objetivos específicos:

1- Avaliar a interferência da consistência alimentar e da idade na duração das fases oral, de transição e faríngea na deglutição de alimentos nas consistências líquida e pudim em adultos assintomáticos;

2- Avaliar a influência da consistência alimentar e da idade na duração das fases oral, de transição e faríngea na deglutição de cápsulas gelatinosas duras #00 deglutidas com alimentos nas consistências líquida e pudim em adultos assintomáticos;

3- Avaliar a localização de cápsulas gelatinosas duras #00 e #3 deglutidas com alimentos nas consistências líquida e pudim no disparo da fase faríngea da deglutição de adultos assintomáticos.

3.Capítulos

IMPACT OF FOOD CONSISTENCY AND AGE ON THE DURATION OF THE PHASES OF SWALLOWING IN ASYMPTOMATIC ADULTS

Érica Mayumi Takase
Irene Harumi Kamata Barcelos
Deborah Brandão
Lucia Figueiredo Mourão
Agrício Nubiato Crespo

ABSTACT

Swallowing is a complex process, with motor responses that are modified by changes in food characteristics as well as the subject's age. **Objective:** Evaluate the impact of food consistency and the age on the duration of the oral, transition and pharyngeal phases of swallowing in asymptomatic adults. **Methods:** By means of videofluoroscopy, 60 subjects, between the ages of 27 and 55 years, were evaluated with liquid and pudding consistencies. **Results:** Analysis of the duration measures of the oral and transition phases showed no statistically significant differences (p=0.419 and p=0.482) between the liquid and the pudding consistencies. To the pharyngeal phase, the pudding consistency presented a greater duration time (p=0.000) in relation to the liquid consistency. With respect to older age, an increase in duration of the oral and pharyngeal phases (for adults over 41 years of age) and a decrease in the transition phase was observed with both consistencies. **Conclusion**: Food consistency does have an impact on the duration of the pharyngeal phase, with a rise in swallowing time for a bolus of higher viscosity. Aging gradually increases the duration of both the oral and pharyngeal phases in adults over the age of 41 years and decreases the duration of the transition phase.

KEY WORDS: Videofluoroscopy — Adult — Deglutition — Oral — Pharyngeal — Measurement

Previous studies on swallowing have found that variability across individuals is large, which makes it difficult to define normative references that constitute limitations for clinical decision-making and scientific analysis [1]. The swallowing process usually occurs smoothly and effortlessly; a fact which belies the complexity of the neuromuscular apparatus that executes and orchestrates the swallowing sequence [2]. Based on what

is known about the simultaneous and sequential dynamics of the oral, transition and pharyngeal phases, time is significant because it is the first step toward establishing objective measures of swallowing function and can provide assistance in understand the physiology of the process. Previous studies have found that there is a relationship between the duration of oral transit in swallowing and the pharyngeal clearance of the bolus. Slower in the first was associated with a slower in the second [3].

Viscosity is one of several factors that influence the duration of the swallowing phases. Swallowing tolerance and suitable viscosity can be determined via videofluoroscopy. The viscosity value, expressed incentipoises (cP or millipascals (mPa/s), defines the resistance of a fluid against an applied force. This rheological characteristic can be reproduced following defined prescriptions. Food viscosity affects intra-bolus pressure, oral ejection level force, and pharyngeal transport. Thus, establishing viscosity values suitable for a dysphagia patient permits the qualification of their real swallowing tolerance[4].

Another important factor identified as being responsible for changes in the duration of the oral, transition and pharyngeal phases is age. The natural aging process leads to physiological changes in the swallowing process, such as decreased strength in the muscles responsible for mastication, a reduction in ejection force, reduced hyoid elevation, etc [5]. Understanding the nature of swallowing in individuals without swallowing problems is a prerequisite for an evaluation of the nature and the extent of dysphagia in persons with compromised swallowing. The intent of the present study was to examine how the duration of the oral, transition and pharyngeal phases of swallowing varies with age and bolus viscosity in a comprehensive sample of the normal adults.

MATERIALS AND METHODS

PARTICIPANTS

Dynamic videofluoroscopic swallowing studies were performed on 60 consecutive normal adult volunteers. This research was conducted with the approval of the Committee of Ethics in Research of the State University of Campinas (Unicamp) under number 863/2009 and the signed Consent Form of all the participants.

All the subjects met the following inclusion criteria: aged between 25 and 55 years, preserved oral sensitivity, not users medicines that could cause dysphagia as collateral effect and absent of a history of central nervous system or neuromuscular

disorders, head and neck cancer, neurological surgery, psychiatric disorders, diabetes mellitus or craniofacial abnormalities as well as complaints and signals of dysphagia.

The subjects were volunteers recruited by the research team on the premises of the State University of Campinas, and consisted mainly of relatives of patients at the Hospital das Clinicas (Unicamp).

EVALUATION OF VIDEOFLUOROSCOPIC SWALLOWING STUDY

The subjects were studied by means of videofluoroscopy (VFS) in the Radiology Department of the University of Campinas (Brazil) and were assisted by the speech language pathologist, the radiology technician and the radiology physician.

Swallowed material was presented to the subject using a tablespoon. Subjects were offered: two tablespoon (7ml) of liquid (35g of condensed milk added to 150 ml of liquid barium sulfate Bariogel® 100% and two tablespoons of water - 350 cP) and two tablespoon (7 ml) of pudding (35g of condensed milk added to 150 ml of liquid barium sulfate Bariogel® 100% and two tea spoon of thickener Thicken-easy®- 5400 cP). The food consistencies were reproduced as studies of Sordi, Mourão and Silva (2012) and the classification was based on the description put forth by American Speech-Language-Hearing Association [6-7]. To analyze the data we chose to use the second swallowing performed with each consistency, the first of which served as adaptation to examination.

The videofluoroscopic swallowing examination (VFS) provided X-ray imaging of the oral and pharyngeal stages, which could be recorded onto videotape or digital imaging systems. The fluoroscopy exposure was at a maximum of 5 minutes. The VFS was analyzed frame-by-frame and the time of the physiologic events in the swallowing phases was recorded in milliseconds.

VFSs were conducted using remote controlled Xray equipment (Flexavision-Shimadzu, 800mA, 120 kVp). All the fluoroscopy studies were recorded with a Panasonic Super-VHS PV-S7670 videocassette recorder. Participants were positioned standing and viewed radiographically in the lateral view. The fluoroscopic tube was focused on the oral cavity anteriorly from the lips, posteriorly to the pharyngeal wall, and superiorly from the nasopharynx.

The duration of swallowing was obtained using the Virtual Dub software (25 fps, 40 milliseconds per frame). Data from each subject were blindly analyzed by two independents researchers. The two investigators reviewed each videotape and analyzed

liquid and pudding swallows using slow-motion frame-by-frame analysis.

The measurement criteria for the duration of the oral phase beginning at moment the tongue base starts moving to eject the bolus, finishing when the bolus tail passes the point where the lower edge of the mandible crosses the tongue base; transition phase ("delayed swallow reflex") beginning when the bolus head reaches the point where the lower edge of the mandible crosses the tongue base, finishing at the onset of laryngeal elevation. Only subjects who showed the transition phase in both consistencies are part of this analysis; and pharyngeal phase beginning when the bolus head reaches the point where the lower edge of the mandible crosses the tongue base, finishing when the bolus tail passes the pharyngo-esophageal sphincter[8-10].

The authors defined the bolus head as the first part and the bolus tail as the final part of the bolus to cross the line.

STATISTICAL METHODOLOGIES

INTRA-JUDGE AND INTER-JUDGE ANALYSIS

For intra-judge reliability, the investigator randomly selected and reanalyzed 30% of the patient's VFS tapes. For inter-judge reliability, a second judge analyzed 100% of the patient's videotapes.

ANALYSIS OF THE IMPACT OF FOOD CONSISTENCY ON THE DURATION OF THE PHASES OF SWALLOWING

In order to evaluate the time differences between liquid and pudding consistencies for each of the swallowing phases, descriptive analysis and the Mahn-Whitney test were performed in each phase on data which had a level of significance of 0.05.

ANALYSIS OF THE IMPACT OF AGE ON THE DURATION OF THE PHASES OF SWALLOWING

To evaluate age's influence on the duration of the swallowing phases, the Gamma log-linear model as well as the model with Gamma response and inverse-link function were applied. In order to correlate the mean duration time with age, a technique of generalized linear models with Gamma distributions and a log link functions were employed.

RESULTS

- INTRA-JUDGE AND INTER-JUDGE ANALYSIS

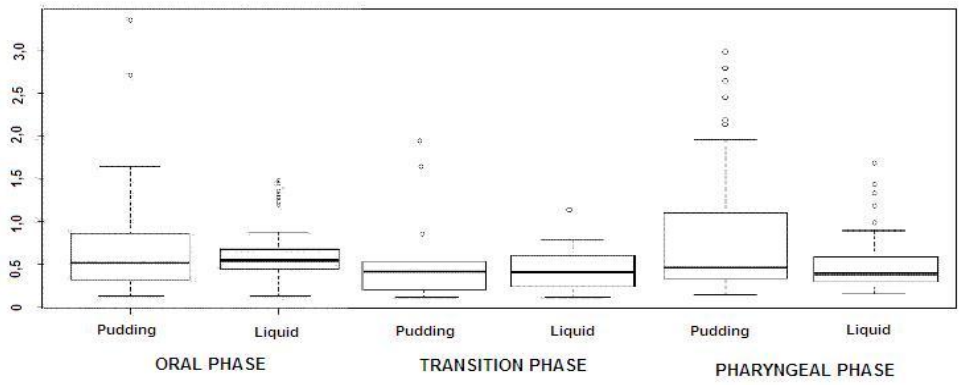
For intra-judge analysis, a significant correlation between the first and second ratings was observed (oral phase liquid r = 0.137, pharyngeal phase liquid r= 0,932, transition phase liquid r= 1,000, oral phase pudding r= 0,142, pharyngeal phase r= 0, 686, transition phase pudding r= 0,581, $p < 0.05$).

For inter-judge analysis the results of the primary investigator were compared to the results of the second investigator. Significant correlations between judges were observed (oral phase liquid r = 0.778, pharyngeal phase liquid r= 0,533, transition phase liquid r= 338, oral phase pudding r= 0,078, pharyngeal phase pudding r= 0,505, transition phase pudding r=0,068, $p < 0.05$).

The findings indicated that adequate reliability was achieved in the two categories, both on the intra-judge and the inter-judge assessments. Data analysis indicated that the judges were consistent and suggested that the VFS was reliable for an examination of how the timing of the oral, transition and pharyngeal swallowing phases varied with age and bolus viscosity. The results of the first investigator were used for data analysis because they showed more consistency in the intra-judge analysis.

The study group consisted of 14 males (22,2%) and 46 females (77.8%) who ranged in age from 27 to 55 years.

ANALYSIS OF THE IMPACT OF FOOD CONSISTENCY ON THE DURATION OF SWALLOWING PHASES

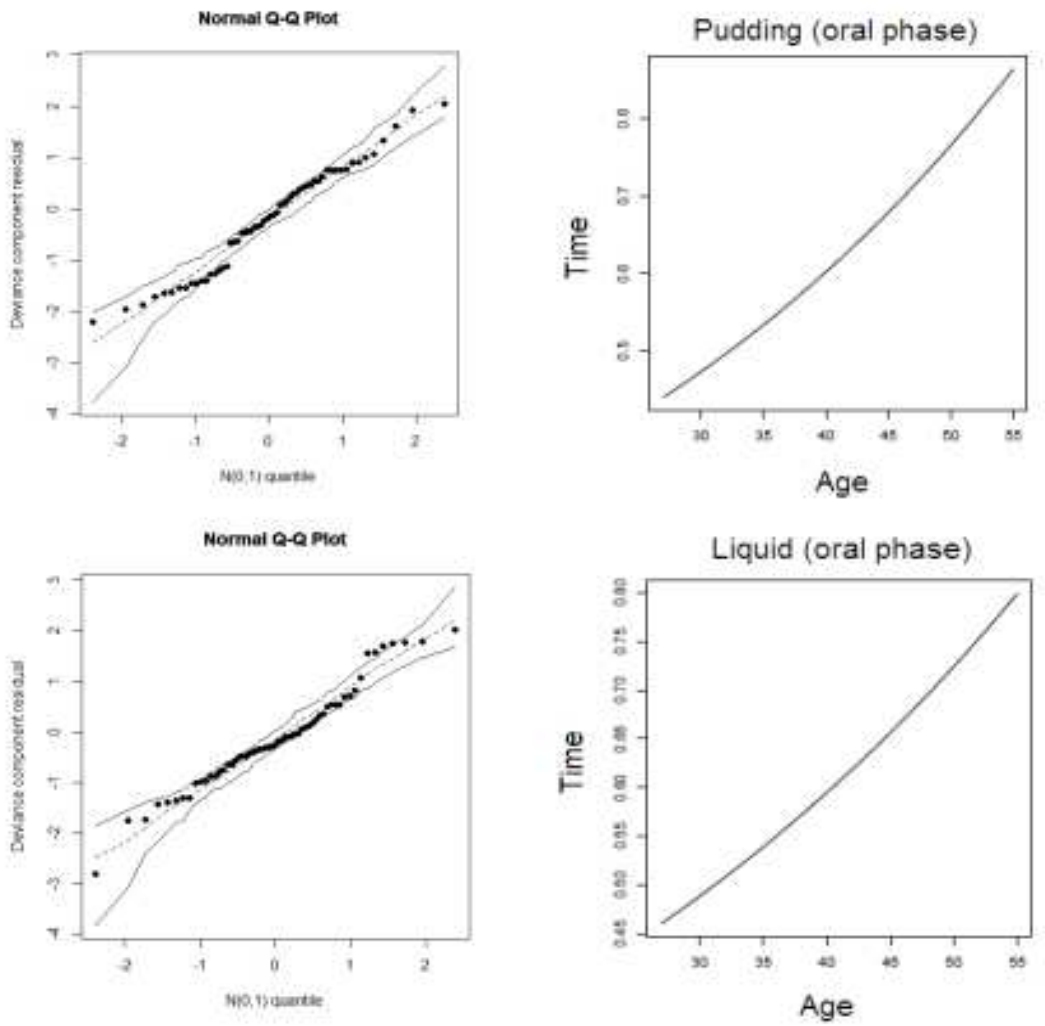


Boxplot 1: Times of the oral, transition and pharyngeal phases for pudding and liquid food consistencies

Boxplot 1 presents the duration measurements for the the oral, transition and pharyngeal phases, demonstrating that the oral and transition phases do not show statistically significant differences (p=0.419 and p=0.482) between the liquid (mean of 0.628s and 0.431s) and the pudding (mean of 0.701s and 0.585s) consistencies. However, with respect to the pharyngeal phase, the pudding consistency (mean of 0.935s) presented greater duration time (p=0.000) in relation to the liquid consistency (mean of 0.625s).

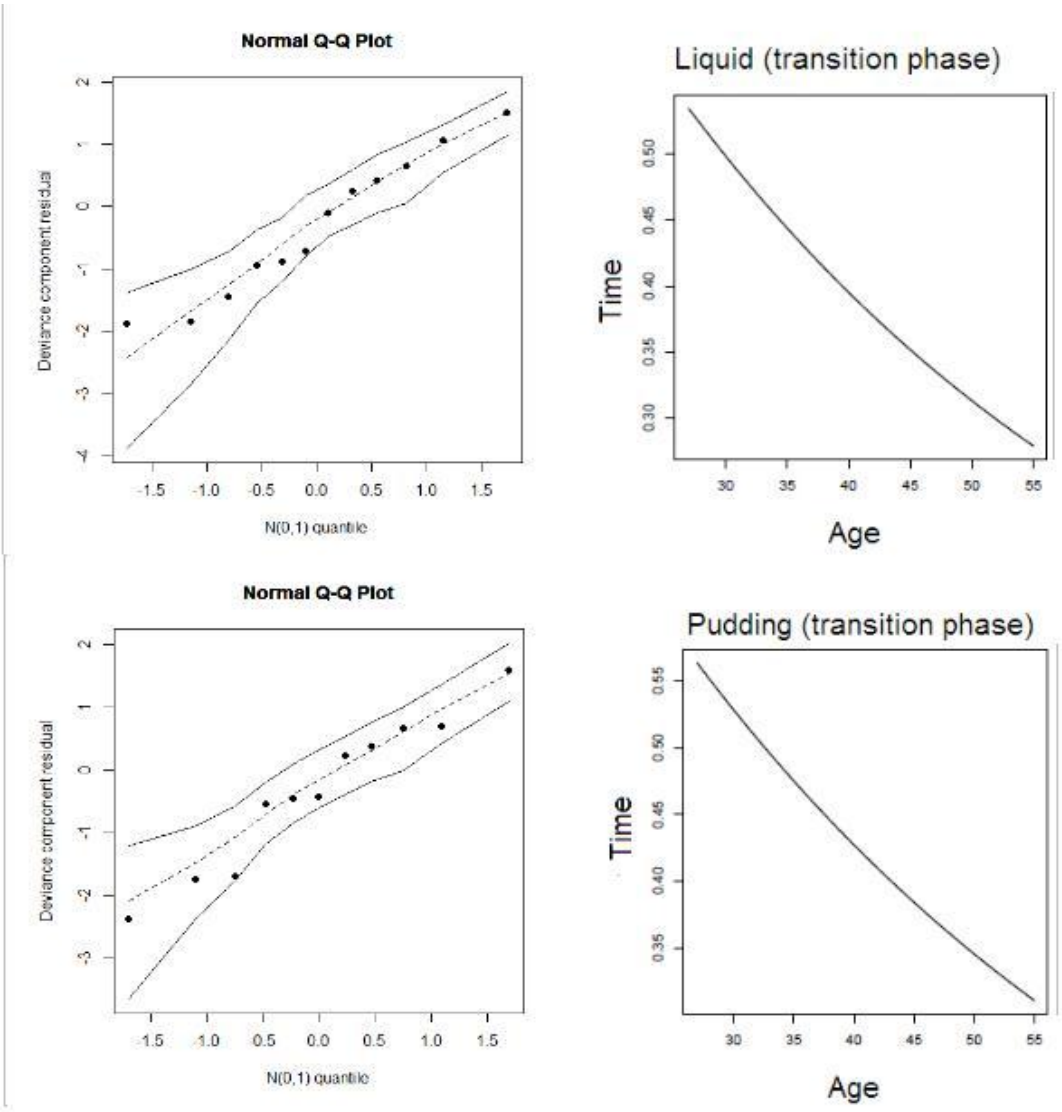
38.33% of the individuals in the sample presented the transition phase with both consistencies and only these individuals were considered for analysis in this phase.

ANALYSIS OF THE IMPACT OF AGE ON THE DURATION OF SWALLOWING PHASES



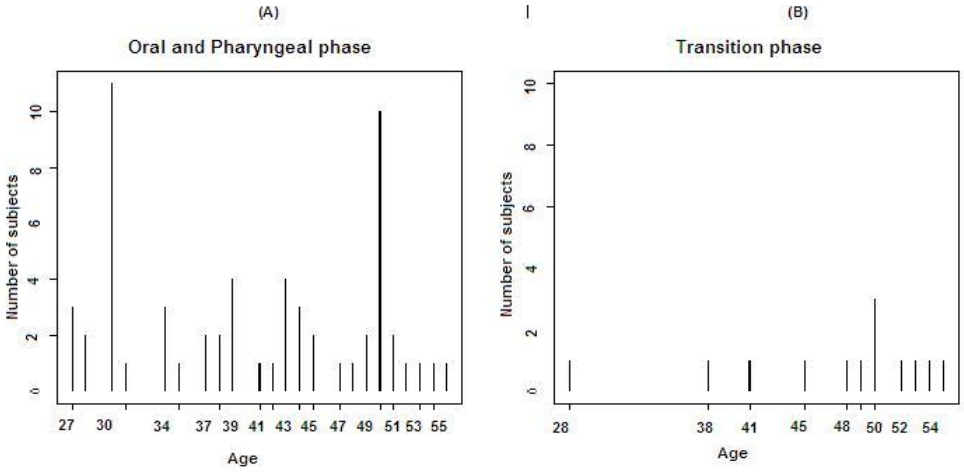
Grafic 1: Representation of correlation between the subject's age and the duration of the oral phase when swallowing liquid and pudding.

One can see that the duration of the oral phase when swallowing liquid and pudding consistencies increased as age increased.



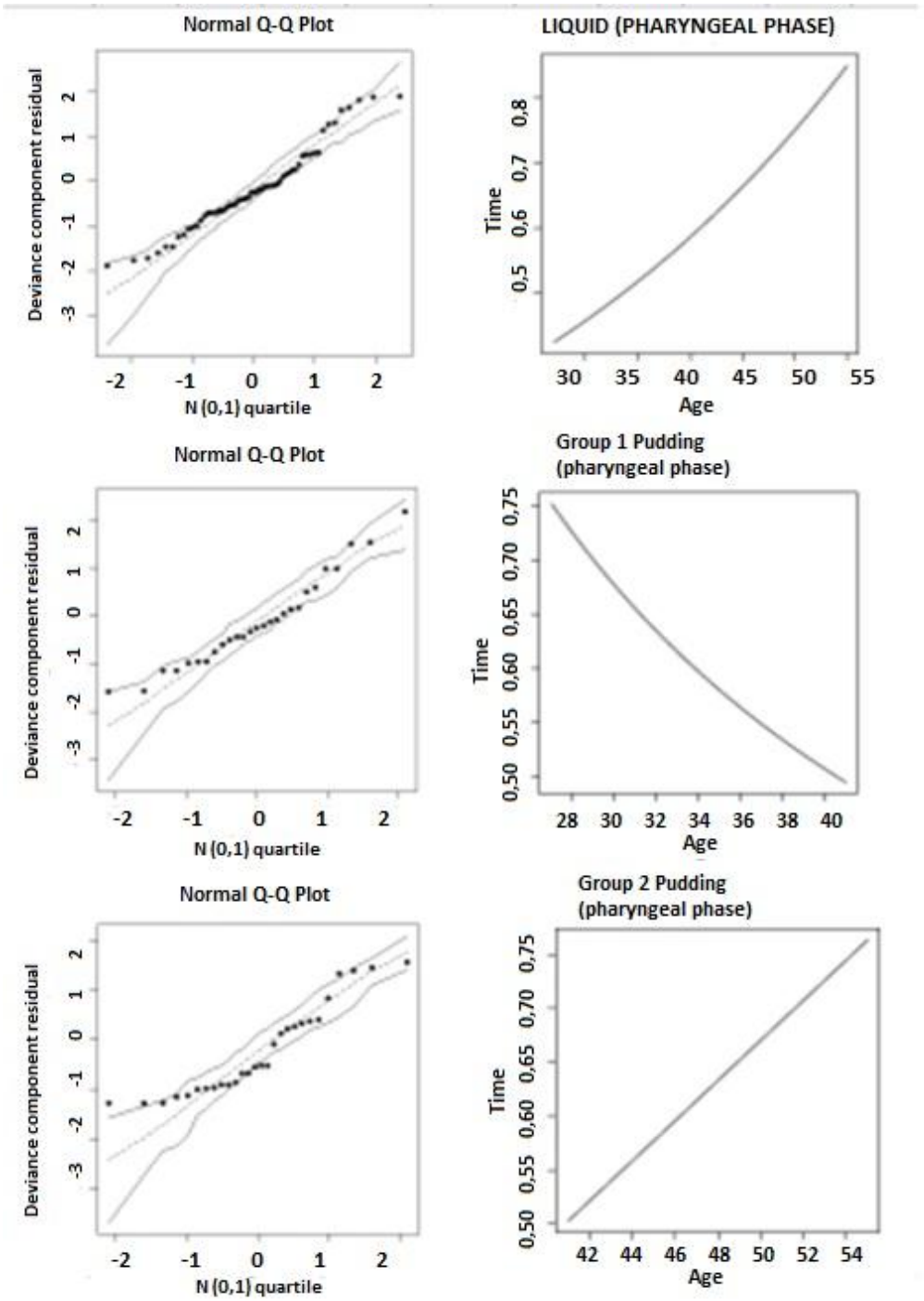
Grafic 2: Representation of correlation between the subject's age and the duration of the transition phase in the swallowing of liquid and pudding

Grafic 2 affirms that with an increase in age there is a decrease in duration of the transition phase of swallowing with both consistencies. It is important to highlight the fact that only the subjects that exhibited this phase with both consistencies were included in this analysis (38.33%). Older adults were most likely to exhibit this phase, as shown in Grafic 3:



Grafic 3: Distribution of the the subjects' age in the analysis of the oral and pharyngeal phases (A) and in the transition phase (B)

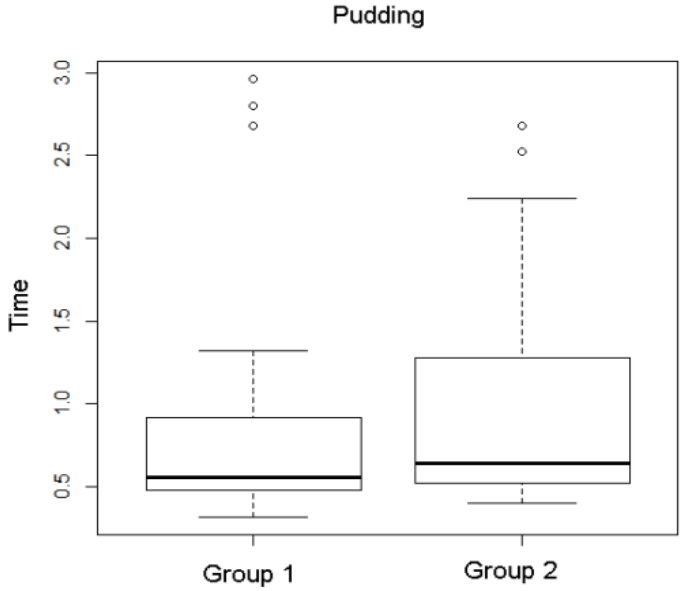
Statistical analysis of the pharyngeal phase with the pudding consistency demonstrated that subjects with ages less than or equal to 41 years (50%) and individuals with ages greater than 41 years (50%) presented different results, making it necessary to distribute these subjects into two groups: Group 1 and Group 2, respectively.



Grafic 4: Representation of correlation between the subjects age and the duration of the pharyngeal phase in the swallowing of liquid and pudding

Grafic 4 demonstrates that with liquid and pudding (group 2) consistencies when

there was an increase in age there was also an increase in the duration. In Group 1, the opposite occurred with the younger adults; with an increase in age there was a decrease in duration when swallowing food in the consistency of pudding.



Grafic 5: Times of the pharyngeal phase in Group 1 and 2 for food in the consistency of pudding.

Grafic 5 shows the pharyngeal phase times for Groups 1 and 2, demonstrating that individuals in the second group exhibited longer duration times when swallowing pudding.

DISCUSSION

- IMPACT OF FOOD CONSISTENCY ON THE PHASES OF SWALLOWING

The process of swallowing occurs in a dynamic, sequential and simultaneous manner. Knowing the duration time of the phases allows an individual's complaints and signals of incoordination/slowness in the actualization of the oral, transition and pharyngeal phases to be objectively observed – a occurrence which may affect the diagnosis and development of care for patients with dysphagia[9].

Certain factors, including food consistency, are cited as being responsible for changes in the temporal relationship between the onsets of specific motor events [11]. Results from previous studies demonstrate that when swallowing foods of thinner consistencies one can observe a decrease in tongue strength [12], as well as shorter times related to ejection and the duration of hyoid bone movement, consequently serving to shorten the oral phase [13]. In this study, the times related to swallowing liquid were found to be less than the times related to swallowing pudding. However, this

difference was not significant.

Similar to the studies of Cassiani et al (2011), the results obtained in this study showed that, with respect to the oral phase, modifications to food consistency did not alter duration times. Although the mean times for the oral phase in the studies of Cassiani et al (2011) was 0.42s for liquid and 0.41s for pudding (ranging in quantity from 5mL to 10mL) in subjects aged from 29 to 77 years, they were less than the mean times found in this study (mean time of 0.628s and 0.701, respectively), while food was administered in the quantity of 7mL [3].

Similar to the findings obtained from studies on the oral phase of swallowing, literature regarding the transition phase also demonstrates great variability. Some studies present mean values between -0.22 and 0.52 seconds, which are in agreement with our results. Studies about the temporal variability of swallowing in asymptomatic adults confirm that consensus has yet to be achieved with respect to defining the duration values of the swallowing phases. Differences in results could be attributed in part to the different volumes and consistencies of the food boluses being studied, the different locations used to define the start and end of each phase, the broad spectrum of groups which have been examined and the small number of individuals assessed in these works[14].

There is a lack of studies on the duration of the the oral and transition phases of swallowing in comparison to studies on the pharyngeal phase, and there is no consensus on the impact of food consistency on pharyngeal transit [15].

Some studies affirm that more viscous food boluses cause more prolonged peristaltic waves of contraction, consequently reducing the speed of propagation[16-17]. Other studies have concluded that both the pharyngeal pharyngeal transit time and the pressure amplitude of the bolus in the hypopharynx increase with the greater viscosity of the food[18]. In opposition to these findings, other studies have failed to confirm that an increased viscosity of the food bolus, despite causing an increase in the amplitude of the pharyngeal contraction, would increase the pharyngeal transit time and the bolus pressure on the hypopharynx [19-21].

With respect to the present study, comparisons between the two food consistencies (liquid and pudding) relating to the duration of the pharyngeal phase demonstrate that there is an increase in duration with a consistency of greater viscosity. This finding corroborates previous assertions put forth by studies that were performed using a smaller number of subjects. These studies also conclude that food consistency

does interfere with pharyngeal transport. Among these, the studies carried out with 9 and 11 asymptomatic adults associated an increase in viscosity with an increase in the duration of the peristaltic waves of the pharyngeal muscles, the duration of hyoid movement, and the duration of the opening and relaxation of the upper esophageal sphincter. Although the volume of the bolus was not measured in this study, one of the hypotheses for the increase in pharyngeal transit time was attributed to foods which were more viscous and of greater volume, causing a lower flow and therefore the greater permanence in the pharyngeal cavity compared to less viscous food [22-23].

As previously mentioned, in this study there was no significant difference between the different consistencies in the values obtained during the oral phase. Therefore, the changes found in the pharyngeal phase do not appear to be influenced or dependent on variations in the time of the oral phase. As previously mentioned, in this study there was no significant difference between the different consistencies in the values obtained during the oral phase. Therefore, the changes found in the pharyngeal phase do not appear to be influenced or dependent on variations in the time of the oral phase. Changes in the pharyngeal transit time are attributed to different food consistencies and other factors such as the ejection form of the bolus, the protection of airways and other interdependent and mutually reinforcing events that propel the bolus through the oropharyngeal cavity[24].

Previous studies have cited variations between 0.3s and 1s in the duration time of the pharyngeal phase[25]. The present study found a mean time of 0.625s for liquid and 0.935s for pudding, in accordance with other findings [26-27]. The results presented here corroborate the claims of previous studies and demonstrate that even in asymptomatic adults there is wide variability in findings [28].

- THE IMPACT OF AGE ON THE DURATION OF THE STAGES OF SWALLOWING

The decline of physiological functions accelerates with advancing age. There is a cumulative effect in the progressive degeneration of the organism [29-30]. This fact corroborates our present findings which found that progressively older subjects presented longer durations in the oral and pharyngeal phases (Group 2) with both consistencies. Although they all performed the duties of the swallowing phases satisfactorily, subjects of older age already differentiated from other subjects in the sample with regards to the levels of performance achieved – a result already observed in some research [31-32].

This occurrence could be caused by gradual changes that result from aging – changes which can interfere in all the stages of swallowing. With advancing age, there is an increase in the tongue's fatty and connective tissue, a decrease in muscle tone and mucosa elasticity as well as in underlying and supportive tissues, a reduction in sensitivity and coordination, among other neuromuscular changes. Slowing mobility and an increase in the opening time of the cricopharyngeal sphincter as well as other characteristics all may relate to difficulties in triggering the pharyngeal phase [33-34].

With regards to the results obtained from Group 1, adults under 41 years of age presented a decrease in pharyngeal phase duration with increasing age. A large number of the subjects in this group were concentrated in their thirties (36.66%), i.e. close to the minimum age. This large concentration of could have had an affect on the results.

Some studies have compared certain swallowing characteristics of older and younger adults, including one study that observed a decrease in the duration of the supraglottic closure and the maximum vertical excursion of the hyoid bone with increasing age [35]. These findings, identified even in an adult age group, demonstrate some of the changes which aging could cause and which are relevant to the understanding of the swallowing process.

A study conducted with adults from different age groups showed that subjects between the ages of 18 and 40 years present two zones of acceleration of the bolus in the pharynx, one on the base of the tongue and the other directly above the esophageal sphincter; of the two, the second was absent in most older individuals (70 to 85 years). Besides this characteristic, the study also noted that there was a decrease in the gradient pressure of the bolus in more distal locations in both types of subjects, although this decrease was more accentuated in the older subjects compared to the younger subjects [36]. These are theories that corroborate our findings that there is an increase in duration of the oral and pharyngeal phases (Group 2) in older subjects.

Taking into consideration the fact that only patients who exhibited the transition phase with both consistencies could be analyzed (38.33%), it is relevant to point out that mostly older adults participated in this comparative study. In this group of subjects, laryngeal elevation occurred with food positioned in more posterior locations. The transition phase is also known as being the "delay in the triggering of the pharyngeal phase". The results showed that, unlike what happened in the oral and pharyngeal phases (Group 2), older adults presented a decrease in duration, possibly resulting from

compensatory strategies [37]. These results differ from previous studies, in which the transition phase in older adults as well as other time measures exhibited an increase in duration [7, 38].

In the analysis of Group 2, we considered that the possible utilization of compensatory strategies could relatively reduce phase time. For example, the supraglotic closure in older adults is faster than in young adults.This could be a reflex in the attempt to protect the airways from the relative delay of the pharyngeal phase or a consequence of the fact that the oral phase is relatively more difficult, requiring more propulsion and resulting in faster laryngeal elevation [39].

Some of the methodological limitations of this work should be pointed out here, including a discrepancy in the number of subjects of different sexes and a non-uniform distribution of the different age groups. This shows us that it is necessary to have studies with sufficient sample sizes so that normative references can be identified.

CONCLUSION

Food consistency does have an impact on the duration of the pharyngeal phase, with a rise in swallowing duration for a bolus of higher viscosity. Aging gradually increases the duration of both the oral and pharyngeal phases and decreases the duration of the transition phase.

REFERENCES

1-Molfenter SM, Steele CM. Physiological variability in the deglutition literature: hyoid and laryngeal kinematics. Dysphagia. 2011; 26 : 67–74.

2-Dodds WJ. The physiology of swallowing. Dysphagia. 1989; 3: 171-8.

3-Cassiani RA, Santos CM, Parreira LC, Dantas RO. The relationship between the oral and pharyngeal phases of swallowing. CLINICS. 2011; 66(8): 1385-8.

4-Costa MMB, Almeida JT, Sant´Anna E, Pinheiro GM. Viscosities reproductive patterns for use in videofluoroscopy and rehabilitation therapy of dysphagic patients. Arq Gastroenterol. 2007; 44(4): 297-303.

5-Bardan E, Kern M, Arndorfer RC,Hofmann C, Shaker R. Effect of aging on bolus

kinematics during the pharyngeal phase of swallowing. Am J Physiol Gastrointest Liver Physiol. 2006; 290 (3): 458- 65.

6-Sordi M, Mourão LF, Silva LBC. Rheological behavior and labels of texture-modified foods and thickened fluids as used for dysphasia's services. Rev. CEFAC. 2012; 14(5): 925-32.

7-American Speech-Language-Hearing Association. Roles of speechlanguage pathologists in swallowing and feeding disorders: technical report. ASHA Desk Reference. 2002; 3:181-99.

8-Logemann J. Evaluation and treatment of swallowing disorders. Texas Pro-Ed. 1983.

9-Kim Y, McCullough GH, Asp CW. Temporal measurement of pharyngeal Swallowing in Normal Populations. Dysphagia. 2005; 20: 290–6.

10-Kendall KA; McKenzie S; Leonard RJ, Gonçalces MI; Walker A. Timing of Events in Normal Swallowing: A Videofluoroscopic Study. Dysphagia. 2000; 15: 74-83.

11-Mendell DA, Logemann JA. Temporal sequence of swallow events during the oropharyngeal swallow. J Speech Lang Hear Res. 2007; 50: 1256-71.

12-Pouderoux P, Kahrilas PJ. Deglutitive tongue force modulation by volition, volume, and viscosity in humans. Gastroenterology. 1995; 8:1418–26.

13-Perlman AL, Schultz JG, Van Daele DJ. Effects of age, gender, bolus volume, and bolus viscosity on oropharyngeal pressure during swallowing. J Appl Physiol. 1993; 75:33–7.

14-Molfenter SM, Steele CM. Temporal Variability in the Deglutition Literature. Dysphagia. 2012; 27(2): 162-77.

15-Yamada EK, Siqueira KO, Xerez D, Koch HA, Costa MMB. The influence of oral and pharyngeal phases on the swallowing dynamic. Arq Gastroenterol. 2004; 41(1):18-23.

16-Dooley CP, Schlossmacher B, Valenzuela JE. Effects of alterations in bolus viscosity on esophageal peristalsis in humans. Am J Physiol. 1988; 254:8-11.

17-Johnson ER, McKenzie SW, Rosenquist CJ, Lieberman JS, Sievers AE. Dysphagia following stroke: quantitative evaluation of pharyngeal transit times. Arch Phys Med Rehabil. 1992; 73:419–23.

18-Dantas RO, et al. Effect of swallowed bolus variables on oral and pharyngeal phases of swallowing. Am J Physiol. 1990; 258:675–81.

19-Ergun GA, Kahrilas PJ, Logemann JA. Interpretation of pharyngeal manometric recordings: limitations and variability. Dis Esophagus. 1993; 6:11– 6.

20-Kim CH, Hsu JJ, O´Connor MK, Weaver AL, Brown ML,Zinsmeister AR. Effect of viscosity on oropharyngeal and esophageal emptying in man. Dig Dis Sci. 1994; 39: 189–92.

21-Raut VV, McKee GJ, Johnston BT. Effect of bolus consistency on swallowing – does altering consistency help? Eur Arch Otorhinolaryngol. 2001; 258: 49–53.

22-Dantas RO, Dodds WJ. Influence of swallowed food bolus viscosity on pharynx motility. Arq Gastroenterol. 1990; 27:164-8.

23-Taniguchi H, Tsukada T, Ootaki S, Yamada Y, Inoue M. Correspondence between food consistency and suprahyoid muscle activity, tongue pressure, and bolus transit times during the oropharyngeal phase of swallowing. J Appl Physiol. 2008;105:791–9.

24-Martin-Harris B, Michel Y, Castell DO. Physiologic model of oropharyngeal swallowing revisited. Otolaryngology–Head and Neck Surgery. 2005; 133:234-40.

25-Logemann JA. Effects of aging on the swallowing mechanism. Otolaryngol Clin North Am. 1990; 23:1045-56.

26-Daniels SK, Schroeder MF, De George PC, Corey DM, Rosenbek JC. Effects of verbal cue on bolus flow during swallowing. Am J Speech Lang Pathol. 2007; 16:140-7.

27-Hamlet SL, Muz J, Patterson R, Jones L. Pharyngeal transit time: assessment with videofluoroscopic and scintigraphic techniques. Dysphagia. 1989; 4:4-7.

28-Lof GL, Robbins J. Test-retest variability in normal swallowing. Dysphagia. 1990;

4:236-42.

29-Harman D. Free radical theorie of aging. Mutation Research. 1992; 275:257-66.

30-Harman D. Aging: overview. Ann. N. Y. Acad. Sci. 2001; 928:1-21.

31-Kuhl V, Eicke BM, Dieterich M, Urban PP. Sonographic analysis of laryngeal elevation during swallowing. J Neurol. 2003; 250:333–7.

32-Kays S, Robbins J. Effects of sensorimotor exercise on swallowing outcomes relative to age and age-related disease. Semin Speech Lang. 2006; 27:245–59.

33-Cook IJ et al. Timing of videofluoroscopic, manometric events, and bolus transit during the oral and pharyngeal phases of swallowing. Dysphagia. 1989; 4:8-15.

34-Weetch R. Feedding problems in elderly patients. Nursing Times. 2001; 97(16):60-1.

35-Kang BS, Oh BM, Kim IS, Chung SG, Kim SJ, Han TR. Influence of aging on movement of the hyoid bone and epiglottis during normal swallowing: a motion analysis. Gerontology. 2010; 56(5):474-82.

36-Bardan E, Kern M, Arndorfer RC, Hofmann C, Shaker R. Effect of aging on bolus kinematics during the pharyngeal phase of swallowing. Am J Physiol Gastrointest Liver Physiol. 2006; 290:458- 65.

37-Hind JA, Nicosia MA, Roecker EB, Carnes ML, Robbins J. Comparison of effortful and noneffortful swallows in healthy middle-aged and older adults. Arch Phys Med Rehabil. 2001; 82:1661–5.

38-Robbins J, Hamilton JW, Lof GL, Kempster GB. Oropharyngeal swallowing in normal adults of different ages. Gastroenterology. 1992; 103 (3):823-9.

39-Kendall KA, Leonard RJ, McKenzie S. Airway protection: Evaluation with videofluoroscopy. Dysphagia. 2004; 19:65–70.

EFFECT OF FOOD CONSISTENCY AND AGE ON THE SWALLOWING OF HARD GELATIN CAPSULES

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Lucia Figueiredo Mourão
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Irene Harumi Kamata Barcelos
Agrício Nubiato Crespo

ABSTRACT

There are several factors that can affect the process of swallowing, including food consistency and age. **Objective:** Evaluate the effect of food consistency and age on the duration of the oral, pharyngeal and transition phases in the swallowing of capsules in asymptomatic adults. **Methods:** By means of videofluoroscopy, 60 subjects (14 male and 46 females), between the ages of 27 and 55 years, were evaluated with hard gelatin capsules #00 containing barium sulfate, swallowed with food in the consistencies of liquid and pudding in free supply. **Results**: Analysis of the transition phase was disregarded because only one of the subjects exhibited this phase with both consistencies. Pharyngeal phase showed no statistically significant difference (p=0.325) between the liquid and pudding consistency. In the oral phase, the pudding resulted in a longer duration (p=0.000) compared to the liquid. With regards to age, an increase in duration of the oral and pharyngeal phases was observed with both consistencies in older adults. **Conclusion:** Swallowing capsules with the food consistency of pudding presented higher transit times than with the liquid consistency. The duration of oral and pharyngeal phases increases with advancing age.

KEY WORDS: Videofluoroscopy — Adult — Deglutition — Oral — Pharyngeal — Capsules

Swallowing is a complex process, with motor responses that modify according to stimulus, volume, age and consistency of the bolus – a continuous process that involves different structures and neuromotor mechanisms and is essential to the coordination and interaction between swallowing phases [1]. One of the factors that may modify the process of swallowing is aging. With advancing age, changes associated with aging occur throughout the body, including changes which affect the structures responsible for the phases of swallowing. Among these changes are the loss of mucus elasticity, sensory alterations, weakness, and decreased coordination [2]. Going beyond the necessity for studies on the swallowing process of different types and quantities of food,

it is also important to assess the swallowing of capsules in asymptomatic subjects of various age groups. Previous studies on the affect posture and drink volume has on swallowing capsules concluded that there was a positive correlation between a history of dysphagia, difficulty in swallowing tablets and sensing tablet stasis (mainly in the throat), and delayed capsule transit [3].

Another study of 60 patients with dysphasia complaints, who were submitted to Functional endoscopic evaluation swallowing (FEES) with different food consistencies, also looked at the swallowing of “testing pills” (caplets of M&M candy), taken in safe consistencies for each subject (liquid or honey/pudding). Four subjects could not swallow these “pills”, and regurgitated them. These patients did not have difficulties swallowing solids. After the FEES, the subjects were submitted to a videofluoroscopy of swallowing, and this procedure produced a wide variety of pathologies in the upper portion of the esophagus which had not been detected in the FEES. Therefore, the inclusion of a pill swallowing assessment during an exam, improves the diagnosis of esophageal pathologies, provides further information that may affect the patient's care, and among other things, allows for better guidance on the best food consistency for each subject in order to help them swallow their medicines [4].

In addition to appropriate consistency, another important factor in swallowing studies is the temporal measurement of the swallowing phases. This provides the standardization of quantitative measures to create normative data. Measuring the temporal aspects of swallowing allows investigators to make comparisons between different populations, identify changes in swallowing physiology and establish normative data on the duration of specific events. This data allows for the more accurate identification of swallowing abnormalities and more objective descriptions of how they deviate from the norm. Most of these swallowing measures reflect the duration of specific motor responses, such as the duration of laryngeal closure, the upper esophageal sphincter (UES) opening or bolus transit times. Normative data for many measures have not been established, which includes temporal measures for the swallowing of capsules [5-9]. Capsules, which are unlike virtually any other substance humans ingest, are lighter than water and subsequently float on it, making them difficult to swallow. This study measures duration and evaluates the impact of age on the duration of the swallowing phases with pills taken with two different consistencies.

MATERIALS AND METHODS

PARTICIPANTS

Dynamic videofluoroscopic swallowing studies were performed on 60 consecutive normal adult volunteers. This research was conducted with the approval of the Committee of Ethics in Research of the State University of Campinas (Unicamp) under number 863/2009 and the signed Consent Form of all the participants.

All the subjects met the following inclusion criteria: aged between 25 and 55 years, preserved oral sensitivity, not users medicines that could cause dysphagia as collateral effect and absent of a history of central nervous system or neuromuscular disorders, head and neck cancer, neurological surgery, psychiatric disorders, diabetes mellitus or craniofacial abnormalities as well as complaints and signals of dysphagia.

The subjects were volunteers recruited by the research team on the premises of the State University of Campinas, and consisted mainly of relatives of patients at the Hospital das Clinicas (Unicamp).

EVALUATION OF VIDEOFLUOROSCOPIC SWALLOWING STUDY

The subjects were studied by means of videofluoroscopy (VFS) in the Radiology Department of the University of Campinas (Brazil) and were assisted by the speech language pathologist, the radiology technician and the radiology physician.

For the evaluation, the subjects were offered four hard gelatin capsules #00 (0,95mL, between 500 and 1000mg), in which barium sulfate Bariogel® 100% paste was inserted in order to visualize the capsule path during the videofluoroscopy (the lateral position was the privileged). Two capsules were taken with the liquid consistency (75 cP, water + soluble powder juice, flavor passion fruit) and two with the pudding consistency (7350 cP, 4 tea spoons of thickener Thicken-easy® in 100 mL of water + soluble powder juice, flavor passion fruit) in unlimited volume. The food consistencies were reproduced as studies of Sordi, Mourão and Silva (2012) and the classification was based on the description put forth by American Speech-Language-Hearing Association [10-11]. To analyze the data we chose to use the second swallowing performed with each consistency, the first of which served as adaptation to examination.

The unlimited volume aspect may be clinically important because it provides results which are closer to each subject's normal swallowing habits, besides serving as an additional tool for establishing etiology and the location - oral, pharynx, esophagus – of the causes of dysphagia or odynophagia [12].

Instruction given: "Place the capsule on the tongue along with the amount of food

you usually use when you take medication. Look foward and swallow".

The videofluoroscopic swallowing examination provided X-ray imaging of the oral and pharyngeal stages, which could be recorded onto videotape or digital imaging systems. The fluoroscopy exposure was at a maximum of 5 minutes. The VFS was analyzed frame-by-frame and the time of the physiologic events in the swallowing phases was recorded in milliseconds.

VFSs were conducted using remote controlled Xray equipment (Flexavision-Shimadzu, 800mA, 120 kVp). All the fluoroscopy studies were recorded with a Panasonic Super-VHS PV-S7670 videocassette recorder (25 fps). Participants were positioned standing and viewed radiographically in the lateral view. The fluoroscopic tube was focused on the oral cavity anteriorly from the lips, posteriorly to the pharyngeal wall, and superiorly from the nasopharynx.

The duration of swallowing was obtained using the Virtual Dub software (40 milliseconds per frame). Data from each subject were blindly analyzed by two independents researchers. The two investigators reviewed each videotape and analyzed liquid and pudding swallows using slow-motion frame-by-frame analysis.

The measurement criteria for the duration of the oral phase beginning at moment the tongue base starts moving to eject the capsule, finishing when the capsule tail passes the point where the lower edge of the mandible crosses the tongue base; transition phase ("delayed swallow reflex") beginning when the capsule head reaches the point where the lower edge of the mandible crosses the tongue base, finishing at the onset of laryngeal elevation. Only subjects who showed the transition phase in both consistencies are part of this analysis; and pharyngeal phase beginning when the capsule head reaches the point where the lower edge of the mandible crosses the tongue base, finishing when the capsule tail passes the pharyngo-esophageal sphincter [5, 6, 13].

The authors defined the capsule head as the first part and the capsule tail as the final part of the capsule to cross the line.

STATISTICAL METHODOLOGIES

INTRA-JUDGE AND INTER-JUDGE ANALISYS

For intra-judge reliability, the investigator randomly selected and reanalyzed 30% of the patients' VFS tapes. For inter-judge reliability, a second judge analyzed 100% of the patients videotapes.

ANALYSIS OF THE IMPACT OF FOOD CONSISTENCY ON THE DURATION OF THE PHASES OF SWALLOWING

In order to evaluate the time differences between liquid and pudding consistencies for each of the swallowing phases, descriptive analysis and the Mahn-Whitney test were performed in each phase on data which had a level of significance of 0.05.

ANALYSIS OF THE IMPACT OF AGE ON THE DURATION OF THE PHASES OF SWALLOWING

To evaluate age's influence on the duration of the swallowing phases, the Gamma log-linear model as well as the model with Gamma response and inverse-link function were applied. In order to correlate the mean duration time with age, a technique of generalized linear models with Gamma distributions and a log link functions were employed.

RESULTS

INTRA-JUDGE AND INTER-JUDGE ANALISYS

For intra-judge analisys, a significant correlation between the first and second ratings was observed (oral phase liquid r = 0,091, pharyngeal phase liquid r=0,377, oral phase pudding r= 0,142, pharyngeal phase pudding r= 0,739, $p < 0.05$).

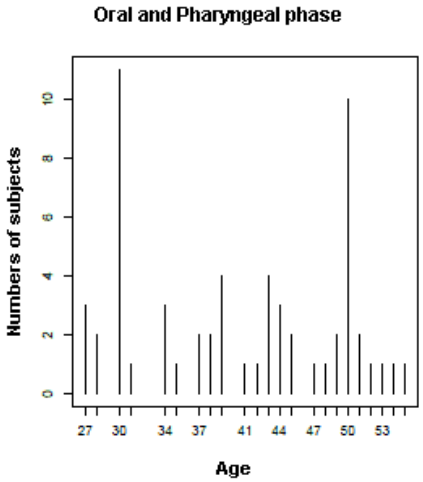
For inter-judge analisys, the results of the primary investigator were compared to the results of the second investigator. Significant correlations between judges were observed (oral phase liquid r = 0,331, pharyngeal phase liquid r= 0,080, oral phase pudding r= 0,061, pharyngeal phase pudding r= 0,613, $p < 0.05$).

Analysis of the transition phase was disregarded because only one subject exhibited this phase with both consistencies. While only one subject exhibited this phase when swallowing with the liquid consistency, only eight subjects exhibited this phase when swallowing with the pudding consistency.

The findings indicated that adequate reliability was achieved in the two categories, both on the intra-judge and the inter-judge assessments. Data analysis indicated that the judges were consistent and suggested that the VFS was reliable for an examination of how the timing of the oral, transition and pharyngeal swallowing phases varied with age and bolus viscosity. The results of the first investigator were used for

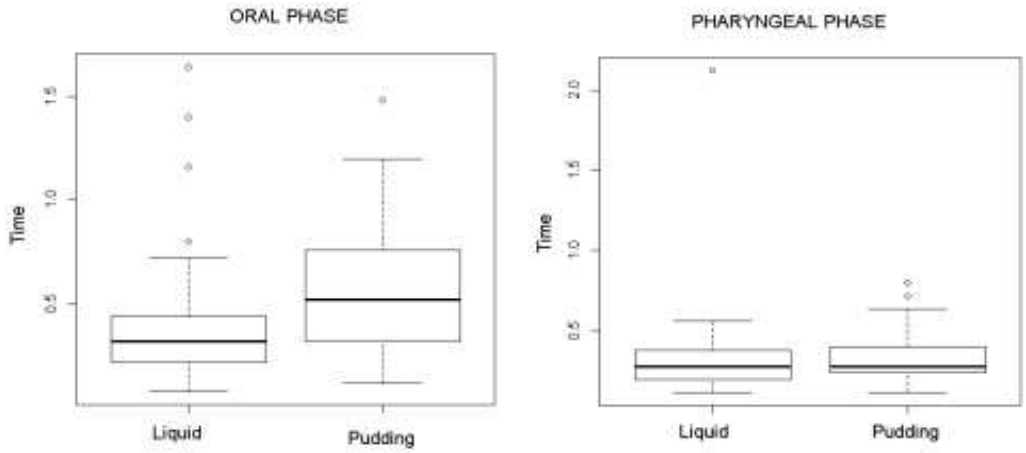
data analysis because they showed more consistency in the intra-judge analysis.

The study group consisted of 14 males (22,2%) and 46 females (77.8%) who ranged in age from 27 to 55 years, distributed according to Grafic 1:



Grafic 1: Distribution of subject ages

ANALYSIS OF THE IMPACT OF FOOD CONSISTENCY ON THE DURATION OF THE PHASES OF SWALLOWING

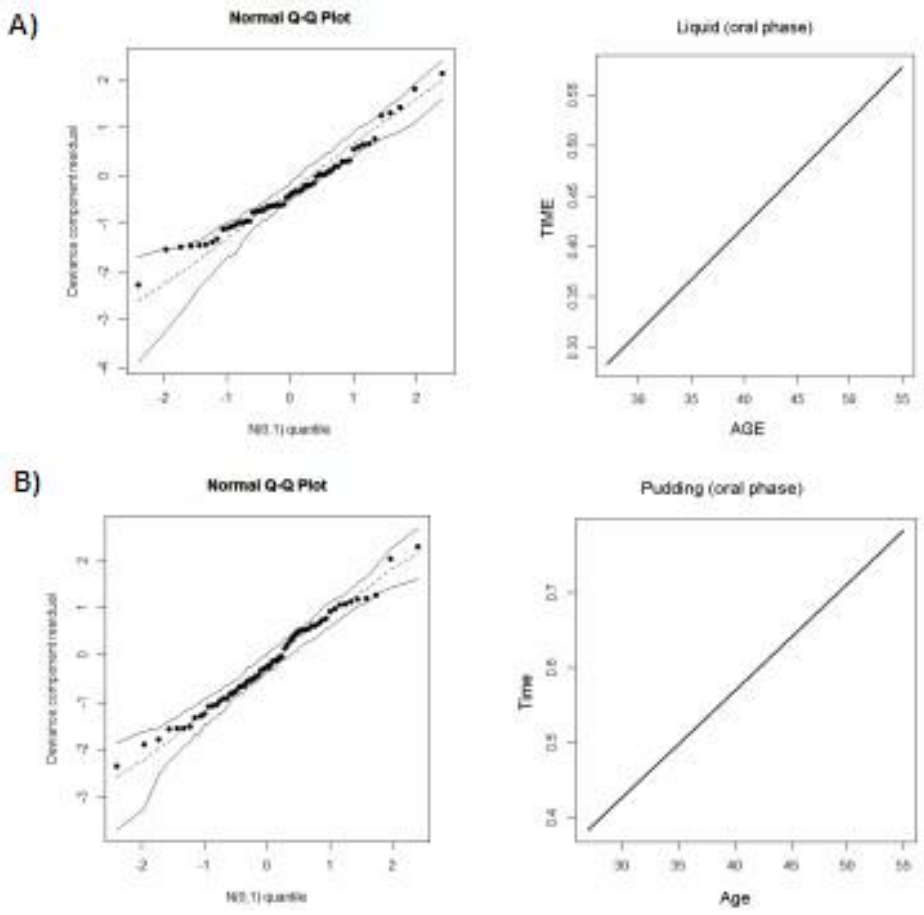


Boxplot 1: Duration (ms) for the oral and pharyngeal phases of swallowing capsules #00 with the consistencies of liquid and pudding.

According to the data from Boxplot 1, duration measures of the pharyngeal phase showed no significant difference in swallowing capsules #00 (p=0.325) between the liquid and pudding consistencies. However, in relation to the oral phase, a statistically significant difference was found (p=0.000) in which the pudding consistency exhibited a

higher duration time in relation to the liquid consistency ($p<0.05$).

ANALYSIS OF THE IMPACT OF AGE ON THE DURATION OF THE PHASES OF SWALLOWING

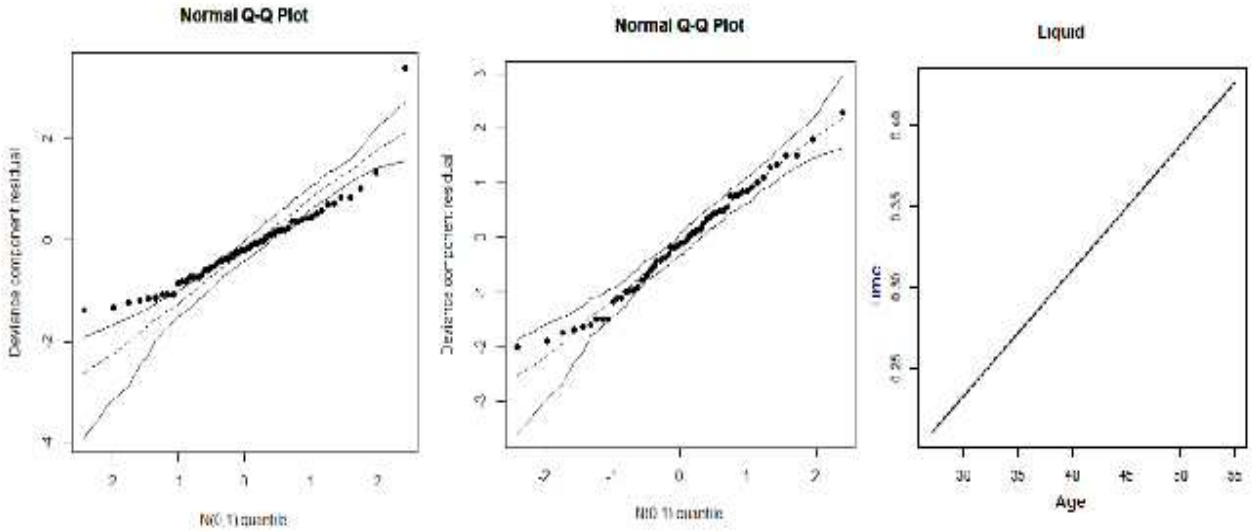


Grafic 2: Representation of correlation between the subject's age and the duration of the oral phase when swallowing capsules with the help of liquid (A) and pudding (B).

From grafic 2, it is possible to observe that, when swallowing capsules with the help of food in the consistencies of liquid and pudding, the duration of the oral phase increased as age increased.

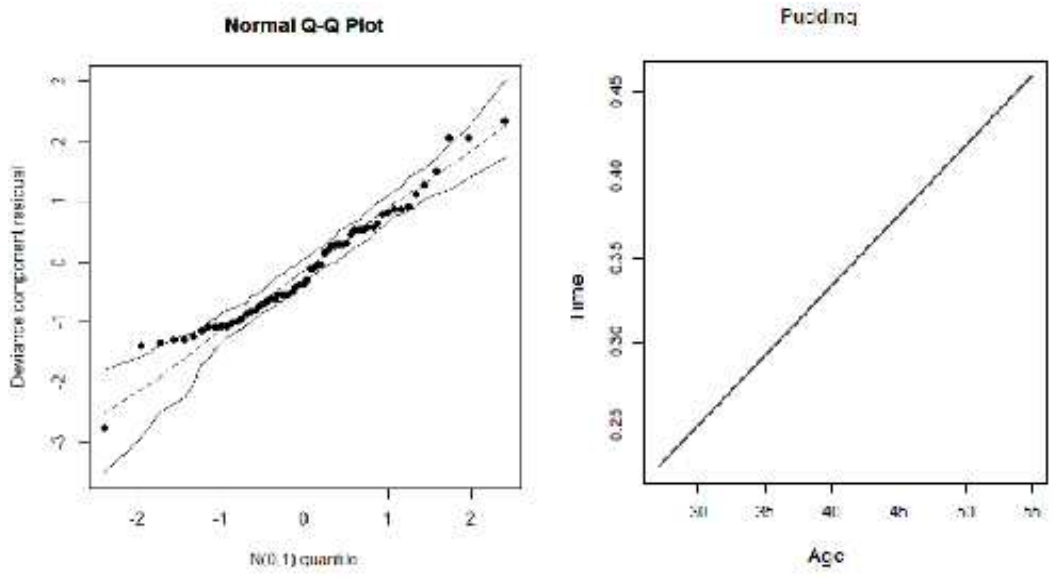
One of the subjects (a 50 year old female with a duration of 2.12s) exhibited discrepant results in the duration of the pharyngeal phase compared to the other participants. Here we present the results obtained with and without the data from this subject:

(A) (B) (C)



Grafic 3: Normal q-q Plot without adjustment (A), with adjustment (B) and the representation of correction between the subject's age and the duration of the pharyngeal phase (C)

Grafic 3 shows that an increase in age caused an increase in the duration of the pharyngeal phase when swallowing capsules with the help of food in the consistency of liquid. With regards to the swallowing of capsules with food in the consistency of pudding, the following results were obtained:



Grafic 4: Representation of correlation between the subject's age and the duration of the pharyngeal phase when swallowing capsules with pudding

According to the data in grafic 4, it is possible to affirm that with increasing age, there is the longer duration of the pharyngeal phase.

DISCUSSION

THE IMPACT OF FOOD CONSISTENCY ON THE DURATION OF SWALLOWING PHASES

The greater understanding of swallowing in asymptomatic adults is relevant since the data in these types of studies help patients with dysphagia. There are still no standardized values on time duration for the oral, transition and pharyngeal phases during the swallowing of food, despite the fact that there are various studies in this area [5, 13-15]. A review of the literature on the temporal measures of swallowing in asymptomatic adults found 119 different temporal parameters – the three most frequent intervals were duration of the transition phase, pharyngeal transit time and duration from the laryngeal closure to the opening of the upper esophageal sphincter [16].

Besides the need for studies with food, other types of materials should also be evaluated, including the swallowing of capsules – data which is lacking in the literature. Research performed on healthy volunteers enabled us to study the dynamics of swallowing capsules for dysphagic patients and evaluated the transit time of the capsule

from the mouth to the stomach (6.0± 2.4s). Four of the fourteen subjects who ingested the capsule with 15ml of water exhibited the retention for the upper esophageal sphincter, in the bronchoalveolar constriction or in the lower esophageal sphincter. Of these for subjects, three said they were unaware of stasis [17].

The present study aimed to evaluate the transit time of the capsule. Unlike the previously cited study, measures of duration times were based on the phases of swallowing and were performed with the aide of different food consistencies. The results obtained from this study regarding the pharyngeal phase demonstrate that modifying food consistency when swallowing capsules did not alter duration time.

These results contradict studies which evaluated the duration of the pharyngeal phase when swallowing food without the presence of capsules, where statistically significant differences demonstrated a longer duration for food of higher viscosity [18-19]. Among such studies is Dantas et al (1990) which reported values of pharyngeal transit times of 0.47s and 0.40s for foods with the consistencies of liquid and pudding – values higher than those found in our study (0.331s and 0.333s) [20].

With respect to the oral phase, an increase was observed in duration for the thicker consistency. Processes occurring during the oral phase, including the qualification of food, were characterized by the perception of the bolus's characteristics, such as its consistency, volume, density, degree of humidity, and other physical-chemical specificities which can affect the organization and the ejection of food and, consequently, the duration of the oral phase [21]. The oral cavity is rich in sensory receptors that can transmit specific patterns and intensities which inform the swallowing centers in the nervous system [22].

Previous studies have shown that when swallowing food of thinner consistencies there is a decrease in the strength of the tongue [23]. This claim is compatible with our findings, since this can alter the speed of bolus propulsion and, consequently, increase the duration of the oral phase. Other authors conclude that, for foods of thinner consistencies, times for ejection and the duration of hyoid bone movement were lower, shortening the oral phase [24]. There is no consensus on these results, and additional studies are necessary.

The bolus transit time is commonly regarded as the time it takes for the passage of the head and the tail of the food bolus. In the present study, however, the passage of the head and the tail of the capsule, not of the food bolus which led, was evaluated. Accordingly, the anteriorposterior dimension of the capsule is notably smaller than the

anterior-posterior dimensions of the entire bolus. Thus, the evaluation of the duration time of swallowing performed in this study cannot be compared to studies done with other methods [25].

Only one subject presented the transition phase with liquid. Eight presented the transition phase with pudding. Only one subject presented the transition phase in both consistencies. The duration of the swallowing phases were evaluated within each subject, and therefore statistical comparisons of the duration of the transition phases can not be established. However, our results do allow us to affirm that the triggering of the pharyngeal phase in a more posterior region was more frequent with the presence of a more viscous bolus versus a liquid.

These finding are relevant to the care of patients with dysphagia. Choosing a safer and less difficult consistency is extremely important because it enables improved swallowing functions [26].

IMPACT OF AGE ON THE DURATION OF THE PHASES OF SWALLOWING

Age is another characteristic that should be considered. The aging process occurs in a gradual and continuous manner, and among adults there can be differences that affect swallowing. Neuromuscular changes; changes in coordination, force, and sensitivity; and changes in a patient's need for medical care all stem from aging [27]. In this way, understanding if older adults present different duration values for the phases of swallowing compared to younger adults could point to modifications and difficulties in this process.

Previous studies have analyzed the affect of age on the phases of swallowing in adults of different age groups. They observed that older age delays hyolaryngeal excursion, transit time between phases, the duration of the pharyngeal phase, the opening of the upper esophageal sphincter, and total swallowing duration [28]. There is consensus among the studies regarding the continuous and progressive increase in swallowing difficulty due to aging. The results of this study corroborate this information. When swallowing capsules with different consistencies, advancing age was associated with gradual increases in the durations of the oral and pharyngeal phases.

This increase could be due to several factors, such as a need for compensatory maneuvers, slowness of the muscle contraction onset, and other sensory difficulties [29].

Study performed with pills contrasted with barium, simulating the swallowing of pharmaceutical pills, revealed variation in speed though the hypopharynx, pharynx and

upper esophageal sphincter in all age groups. In young adults, two zones of acceleration were observed: one on the base of the tongue and the second in the passage through the upper esophageal sphincter. In older adults, only the first zone was found. A decrease in the gradient pressure was observed in all subjects, being higher in older adults. The kinetic and dynamic condition of the bolus was significantly altered in these subjects when compared to the younger ones [30]. These findings reinforce our results. The decrease in gradient pressure and in bolus acceleration zones could be responsible for longer durations in the oral and pharyngeal phases in older adults when swallowing capsules.

Selecting the most appropriate and safe food consistency for a subject of a particular age group can assist in the clinical guidance of those who require medication. Additional studies are needed.

CONCLUSION

When swallowing capsules with the help of liquid and pudding food consistencies, the duration of oral and pharyngeal phases increases with advancing age. Swallowing capsules with the food consistency of pudding presented higher transit times than with the liquid consistency. Age and consistency both influence the process of swallowing capsules.

REFERENCES

1- LOGEMANN, JA (1994). Evaluation and Treatment of Swallowing Disorders. American Journal of Speech-Language Pathology 3: 41-44.

2- SCHINDLER JS; KELLY JH (2002). Swallowing disorders in the elderly. Laryngoscope 112 (4):589-602.

3- CHANNER KS; VIRJEE J (1982). Effect of posture and drink volume on the swallowing of capsules. Br Med J 285: 1702.

4- PERAKIS, H; BURKHEAD, L; POSTMA, G.(2009). Pill swallowwing trial can increase diagnostic utility of the fiberoptic endoscopic evaluation of swallowing (FEES). In: proceedings of the 17th Dysphagia Research Society AMeeting; March 4-7; New Orleans, LA, United States.

5- KENDALL KA; McKENZIE S; LEONARD RJ, GONÇALVES MI; WALKER A (2000).

Timing of Events in Normal Swallowing: A Videofluoroscopic Study. Dysphagia 15: 74-83.

6- KIM, Y; McCULLOUGH, GH; ASP, CW. Temporal Measurements of Pharyngeal Swallowing in Normal Populations. Dysphagia 2005; v. 20, p.290-296.

7- RADEMAKER AW; PAULOSKI BR; LOGEMANN JA; SHANAHAN TK(1994). Oropharyngeal swallow efficiency as a representative measure of swallowing function. Journal of Speech and Hearing Research 37:14–325.

8- KAHRILAS PJ; LOGEMANN JA; KRUGLER C; FLANAGAN E (1991).Volitional augmentation of upper esophageal sphincter opening during swallowing. American Journal of Physiology 260: 450–456.

9- DANTAS RO.; DODDS WJ (1990). Effect of bolus volume and consistency on swallow-induced submental and infrahyoid electromyographic activity. Brazilian Journal of Medical & Biological Research 23: 37–44.

10- SORDI M, MOURÃO LF, SILVA LBC (2012). *Rheological behavior and labels of texture-modified foods and thickened fluids as used for dysphasia's services*. Rev. CEFAC 14(5): 925-932.

11-American Speech-Language-Hearing Asso ciation (2002). Roles of speechlanguage pathologists in swallowing and feeding disorders: technical report. ASHA Desk Reference 3:181-99.

12- VAIMAN M; EVIATAR E; SEGAL S (2004). Evaluation of Normal Deglutition with the Help of Rectified Surface Electromyography Records. Dysphagia 19 (2): 125-132.

13- OMARI TI et al (2006). Assessment of intraluminal impedance for the detection of pharyngeal bolus flow during swallowing in healthy adults. Am J Physiol Gastroinstest Liver Physiol 290(1):183-188.

14-LOGEMANN JA; PAULOSKI BR; RADEMAKER AW; COLANGELO LA;KAHRILAS PJ; SMITH CH (2000). Temporal and biomechanical characteristics of oropharyngeal swallow in younger and older men. J Speech Lang Hear Res 43: 1264–1274.

15- HAMLET SL, MUZ J, PATTERSON R, JONES L (1989). Pharyngeal transit time: assessment with videofluoroscopic and scintigraphic techniques. Dysphagia 4: 4-7.

16- MOLFENTER SM, STEELE CM (2012). Temporal Variability in the Deglutition Literature. Dysphagia 27(2): 162-177

17- CHISAKA H; MATSUSHIMA Y; WADA F; SAEKI S; HACHISUKA K (2007). Dynamics of Capsule Swallowing by Healthy Young Men and Capsule Transit Time from the Mouth to the Stomach. Dysphagia 21 (4): 275-279.

18- DANTAS, RO; DODDS, WJ (1990). Influence of the viscosity of the swallowed food bolus on the motility of the pharynx. Arq. Gastroenterol. 27(4): 164-168.

19- ERTEKIN, C; AYDO, GDUI.; YUCEYAR, N; PEHLIVAN, M (2007)- Effects of bolus volume on oropharingeal swallowing. Na electrophysiologic study in man. Am. J. Gastroenterol. 92(11): 2049-2053.

20- DANTAS RO et al. (1990). Effect of swallowed bolus variables on oral and pharyngeal phases of swallowing. Am J Physiol 258:675–681.

21- COSTA MMB (1996). Uso de bolo contrastado sólido, líquido e pastoso no estudo videofluoroscópico da dinâmica da deglutição. Radiol Bras 29: 35-39.

22- MILLER AJ (1982). Deglutition [review]. Physiol Rev 62:129–184

23- POUDEROUX P, KAHRILAS PJ (1995). Deglutitive tongue force modulation by volition, volume, and viscosity in humans. Gastroenterology 8: 1418–1426.

24- PERLMAN AL, SCHULTZ JG, VAN DAELE DJ. Effects of age, gender, bolus volume, and bolus viscosity on oropharyngeal pressure during swallowing. J Appl Physiol 1993; v. 75, P. 33–37.

25- DODDS WJ; STEWART ET; LOGEMANN JA (1990). Physiology and Radiology of the Normal Oral and Pharyngeal Phases of Swallowing. *AJR* 154: 953-963.

26- GLASSBURN DL, DEEM JF (1988). Thickener viscosity in dysphagia management: variability among speech-language pathologists. Dysphagia 13: 218-222.

27- PLANT RL (1998). Anatomy and physiology of swallowing in adults and geriatrics. Otolaryngologic Clinics of North America 31 (3): 477-488.

28- ROBBINS J, HAMILTON JW, LOF GL, KEMPSTER GB (1992). Oropharyngeal swallowing in normal adults of different ages. Gastroenterology 103 (3):823-829.

29- MENDELL DA; LOGEMANN JA (2007). Temporal sequence of swallow events during the oropharyngeal swallow. Journal of Speech, Language, and Hearing Research 50: 1256– 1271.

30- BARDAN E, KERN M, ARNDORFER RC,HOFMANN C, SHAKER R (2006). Effect of aging on bolus kinematics during the pharyngeal phase of swallowing. Am J Physiol Gastrointest Liver Physiol 290 (3): 458- 465.

AVALIAÇÃO DA LOCALIZAÇÃO DE CÁPSULAS NO DISPARO DA FASE FARÍNGEA EM ADULTOS ASSINTOMÁTICOS

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Agrício Nubiato Crespo

RESUMO

A localização do bolo no disparo da fase faríngea traz informações sobre o modelo sensorio-motor do início da deglutição. **Objetivo:** avaliar a localização de cápsulas gelatinosas duras no disparo da fase faríngea em adultos assontomáticos. **Métodos:** Realizou-se videofluoroscopia da deglutição em 60 indivíduos (14 homens e 46 mulheres), entre 27 e 55 anos foram avaliados com cápsulas gelatinosas duras #00 e #3 preenchidas com sulfato de bário, ingeridas com alimentos líquido e pudim em livre oferta. Considerou-se o primeiro movimento de elevação laríngea como indicador do disparo da fase faríngea da deglutição. A análise estatística utilizou-se o teste de Macnemar. **Resultados**: Cápsulas #3 apresentaram maior porcentagem de localização no dorso da língua em comparação à cápsula #00, e cápsulas #00 apresentaram maior porcentagem de localização na base da língua e valécula em comparação à #3. Foram encontradas diferenças estatisticamente significantes entre as diferentes cápsulas na deglutição com líquido (p= 0,016) e pudim (p= 0,037). **Conclusão:** O tamanho da cápsula influenciou na localização do disparo da fase faríngea. Cápsulas menores iniciaram a fase faríngea na região mais anterior (dorso da língua) em comparação às cápsulas maiores.

Palavras chaves: Videofluoroscopia – Adulto – Deglutição – Cápsulas – Faringe

ABSTRACT

The location of the bolus during the pharyngeal phase triggering provides information about the initiation of the sensorimotor model of the deglutition onset. Objective: evaluate hard gelatin capsules position in triggering of pharyngeal phase in asymptomatic adults. **Methods**: Videofluoroscopy was performed in 60 subjects (14 male and 46 females), between the ages of 27 and 55 years, were evaluated with hard gelatin capsules #00 and #3 containing barium sulfate, swallowed with food in the

consistencies of liquid and pudding in free supply. The first moviment of laringeal elevation was the criteria for the location of triggering of pharyngeal phase. Statistical analysis was based on Macnemar test. **Results**: Capsule #3 presented higher percentage of location in tongue dorsum compared to capsule #00, and capsule #00 presented higher percentage of location occurrence in tongue base and vallecula compared to capsule #3. There was statistically significant difference between different capsules swallowed with liquid (p= 0,016) and pudding (p= 0,037). Conclusion: The capsule size influenced the location of the pharyngeal phase triggering. Smaller capsules started pharyngeal phase in the most anterior region (tongue dorsum) compared to larger capsules.

KEY WORDS: Videofluoroscopy — Adult — Deglutition — Pharyngeal — Capsules

A deglutição normalmente é um processo fisiológico ordenado, com um sistema de complexos neuromusculares que executam e orquestram as ações de modo sequencial, coordenados pelo córtex cerebral, tronco cerebral e nervos cerebrais [1, 2]. Esse processo é dividido em três (oral, faríngea e esofágica) ou quatro fases (incluindo-se a fase preparatória oral) [3]. A fase faríngea pode ser descrita como o momento em que ocorre a proteção das vias aéreas, com fechamento involuntário da laringe pela epiglote, prevenção da regurgitação nasal pela aproximação do palato mole contra a parede posterior da faringe, início da contração muscular dos músculos constritores da faringe, movimentação do bolo através do complexo faringolaríngeo que neste momento está receptivo ao bolo devido à ampliação promovida pelos músculos dilatadores e pela elevação e anteriorização de todo complexo incluindo a laringe [4].

Estudos prévios relataram que a localização do bolo no disparo da fase faríngea é um importante dado, pois fornece informações sobre o modelo sensório-motor do início da deglutição. A ausência ou maior duração deste processo pode ser considerado como um sinal significante de disfagia, entretanto, a posição do bolo no disparo da fase

faríngea pode variar entre os sujeitos. O disparo da fase faríngea depende de várias influencias, dessa forma, este dado não pode ser utilizado isoladamente na distinção entre pacientes assintomáticos e disfágicos [5]. Este processo requer rápida sucessão de movimentos e coordenação para que haja proteção das vias aéreas. Alguns a consideram como resposta reflexa em cadeia e outros como processo decorrente de uma sequência programada como uma unidade pelo centro encefálico [6]

Estudos realizados com alimentos sugeriram que em sujeitos assintomáticos o disparo da fase faríngea poderia ocorrer antes da entrada do alimento na faringe (valécula, parede posterior da faringe, seios piriformes ou transição faringo-esofágica), sendo que estas localizações poderiam não ser resultantes de alterações [7.] lém do estudo com diversos tipos e consistências alimentares [8-11], é importante que se realize pesquisas sobre o processo da deglutição de outros tipos de materiais, tais como as cápsulas, que podem ser ingeridas com diferentes alimentos. Este estudo teve como objetivo a avaliação da localização de cápsulas de diferentes tamanhos, ingeridas com diferentes consistências alimentares, no disparo da fase faríngea da deglutição.

MATERIAL E MÉTODO

PARTICIPANTES

Esta pesquisa foi submetida e aprovada (863/2009) pelo Comitê de Ética em Pesquisa e recebeu o consentimento e assinatura de todos os participantes. Realizou-se a videofluoroscopia da deglutição em 60 adultos assintomáticos com idade entre 27 e 55 anos, voluntários recrutados pelos pesquisadores.

Todos os sujeitos tiveram como critérios de inclusão: sensibilidade oral preservada, não uso de medicamentos que podem causar efeitos colaterais que alterem a alimentação, ausência de queixas e sinais de disfagia, ausência de histórico de doenças do sistema nervoso central, doenças neuromusculares, câncer de cabeça e

pescoço, cirurgias neurológicas, desordens psiquiátricas, diabetes mellitus ou anomalias craniofaciais.

ESTUDO COM VIDEOFLUOROSCOPIA DA DEGLUTIÇÃO

Os sujeitos foram avaliados por meio da videofluoroscopia da deglutição (VFD), em posição lateral, e foram assistidos por uma fonoaudióloga, um técnico de radiologia e uma médica radiologista.

Foram oferecidas aos sujeitos quatro cápsulas gelatinosas duras #00 (capacidade de 0,95mL, peso de 500 a 1000mg) e quatro #3 (capacidade de 0,3mL, peso de 200 a 300mg) preenchidas com sulfato de bário, permitindo suas visualizações durante as avaliações. Duas cápsulas de cada tamanho foram ingeridas com alimentos na consistência líquida (centipoise= 75cP, constituído por água + suco em pó solúvel, sabor maracujá) e duas cápsulas de cada tamanho com pudim (centipoise= 5350cP, constituído por 4 colheres de espessante alimentar Thicken-easy® + 100 mL de água + suco em pó solúvel, sabor maracujá) em livre oferta. A consistência alimentar foi reproduzida a partir de estudos de Sordi, Mourão e Silva (2012) e a classificação foi baseada na descrição apresentada pela American Speech-Language-Hearing Association [12, 13]. Para a análise dos dados optou-se por utilizar a segunda deglutição realizada com cada cápsula e cada consistência, sendo que a primeira serviu como adaptação ao exame.

A livre oferta é considerada clinicamente importante pois fornece resultados próximos à deglutição habitual de cada sujeito, servindo como ferramenta adicional para o estabelecimento e localização – oral, faríngea, esofágica – das causas de disfagia e odinofagia [14].

Os sujeitos receberam a seguinte instrução: “coloque a cápsula sobre a língua juntamente com a quantidade habitual de alimento que você utiliza quando toma alguma medicação. Olhe para a frente e degluta”.

A videofluoroscopia da deglutição (VFD) utilizou-se de imagens dinâmicas de raio-x das fases oral e faríngea. Os pacientes foram submetidos à no máximo 5 minutos de exposição. Os exames puderam ser posteriormente analisados quadro-a-quadro em milissegundos.

VFD foram realizadas em um aparelho de raio-x telecomandado (FlexavisionShimadzu, 800mA, 120 kVp) e todos os exames foram gravados no videocassete Panasonic Super-VHS PV-S7670 videocassette, 25 frames por segundo. Os participantes permaneceram em pé e realizou-se incidência do tubo fluoroscópico em posição lateral.

As imagens foram avaliadas utilizando-se o software Virtual Dub (milisegundos). Os exames foram avaliados por dois pesquisadores independentes, que não tiveram acesso à identidade de cada sujeito. Cada investigador revisou cada videotape e avaliou a deglutição utilizando análise quadro-a-quadro em slow-motion.

CRITÉRIO DE LOCALIZAÇÃO DO BOLO

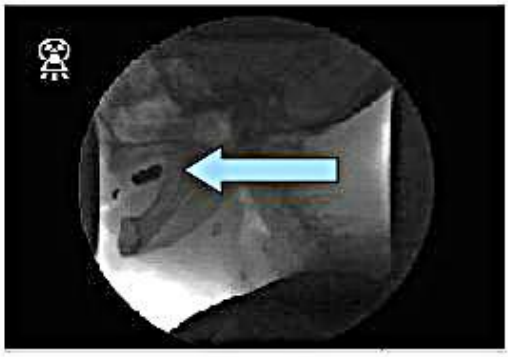

Figura 1: cabeça de cápsula em dorso de lingua

Figura 2: cabeça de cápsula em base de lingua

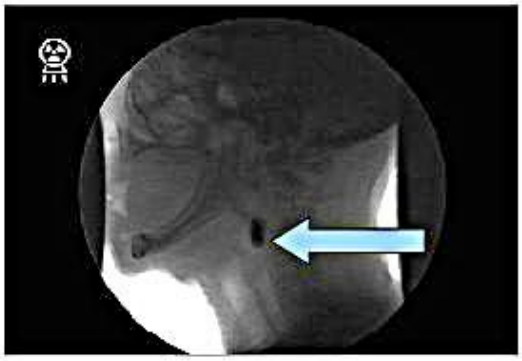

Figura 3: cabeça de cápsula em valécula

METODOLOGIA ESTATÍSTICA

ANÁLISE INTRAJULGADORES E INTERJULGADORES

Para a reavaliação intrajulgadores, a pesquisadora randomizou, selecionou e reavaliou 30% dos exames de videofluoroscopia gravados em arquivo digital. Para reavaliação interjulgadores, uma segunda avaliadora analisou 100% dos exames.

ANALISE DA LOCALIZAÇÃO DO BOLO

Para a análise da localização da cápsula no início da fase faríngea utilizou-se o teste de McNemar para considerar os dados pareados, nível de significância de 0,05.

RESULTADOS

Os resultados indicaram que a confiabilidade adequada foi alcançada nas duas categorias, tanto na intra-julgadores quanto nas avaliações inter-julgadores. Para a análise dos dados os resultados do primeiro investigador foram utilizados visto que apresentaram maior consistência na análise intra-julgadores.

COMPARAÇÃO DA LOCALIZAÇÃO DO ALIMENTO NO INÍCIO DA FASE FARÍNGEA

Considerou-se o primeiro movimento de elevação laríngea como indicador do início da fase faríngea da deglutição, observando-se a localização em que se encontrava a cabeça da cápsula. Dessa forma, obteve-se os seguintes resultados:

(A) (B)

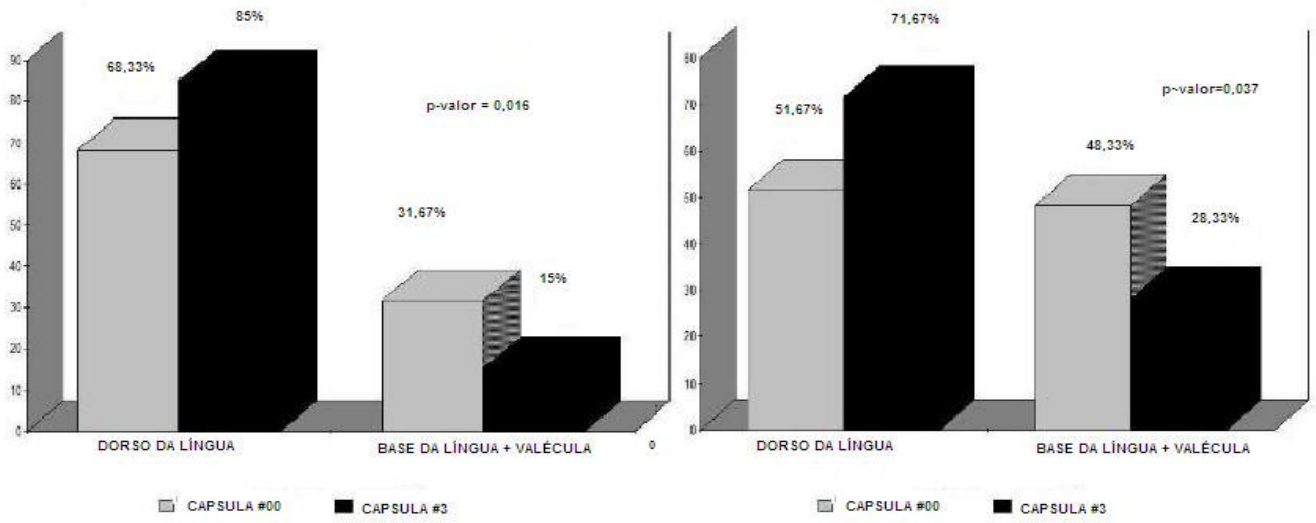

Grafico 1. Comparação da localização da cápsula com (A) auxilio de alimento na consistência liquido, (B) auxilio de alimento na consistência pudim.

A partir dos resultados do grafico 1, realizou-se o teste de McNemar. Os resultados apresentaram diferenças estatisticamente significantes entre as proporções das localizações das cápsulas # 00 e 3 no disparo da fase faríngea, tanto na deglutição com a consistência líquida quanto pudim. Os resultados demonstraram maior porcentagem de localização no dorso da língua para ambas as cápsulas, porém com concentração mais elevada na deglutição de cápsula #00 em comparação à #3, com diferenças estatisticamente significantes na deglutição com líquido e pudim. Diferentemente do ocorrido na porção posterior (base de língua e valécula) em que a concentração da cápsula #3 foi maior em relação à #00, com diferenças também estatisticamente significantes em ambas as consistências.

DISCUSSAO

O disparo da fase faríngea na deglutição é um tema discutido na literatura visto que não há um consenso acerca de seu processo. Algumas teorias o definiram como uma série de movimentos musculares involuntários, plenamente coordenados e controlados pelo sistema nervoso central, que utiliza os núcleos dos pares cranianos bulbares: glossofaríngeo (IXpar), núcleo ambíguo do vago (X par) e hipoglosso (XII par). Impulsos destes nervos são transportados para a formação reticular no tronco cerebral, onde se localiza o centro da deglutição, que se coordena com o centro respiratório, de modo que durante a deglutição a respiração seja interrompida [15].

Outras teorias descreveram o reflexo da deglutição como sendo suscitado a partir de áreas específicas da faringe e laringe, tais como valéculas, parede posterior da faringe, recessos piriformes ou transição faringoesofágica, que são ativadas após uma variedade de estímulos (quimicos, mecânicos, elétricos) que desencadeiariam uma série de eventos fisiológicos [16].

O início da fase faríngea de indivíduos saudáveis poderia ocorrer após a entrada do alimento na faringe, fato que isoladamente não significaria alteração ou sinal de disfagia [17]. Os resultados aqui encontrados demonstraram que a maioria dos indivíduos apresentaram inicio da fase faríngea da deglutição antes da entrada da cápsula na faringe, ocorrendo predominantemente no dorso da língua, tanto para cápsulas #00 quanto para #3.

Diversos autores se utilizaram da cabeça do bolo como ponto de referência para o início do disparo da fase faríngea. Porém não houve consenso quanto a estrutura a ser considerada como marco, sendo apontadas como possíveis pontos de referência as fauces, valécula, base da língua e junção da língua com a mandíbula [18]. Apesar do predomínio da localização no dorso da língua, neste estudo, assim como em outros realizados previamente, foi possível observar que o posicionamento variou entre

indivíduos, não havendo uma localização específica, como por exemplo o conceito de que sejam os pilares anteriores (palatoglosso) a sede da maior sensibilidade aferente e que a resposta faríngea iniciar-se-ia por seu estímulo [19, 20].

A localização do bolo alimentar no disparo da fase faríngea da deglutição pode ser utilizada na atuação clínica da disfagia, visto que esta informação demonstraria o inicio do reflexo sensório-motor do processo. Porém, como citado anteriormente, a posição do bolo alimentar no início da fase faríngea pode variar entre indivíduos, não podendo ser utilizada como único critério na distinção entre a deglutição assintomática e a deglutição do paciente disfágico, sugerindo que o desencadeamento da deglutição depende de múltiplas influências.

Entre estas influências encontra-se a percepção proprioceptiva sensorial oferecida pelo bolo. Estudo prévios indicaram que a motilidade da faringe se modificou com a natureza do alimento deglutido [21-23]e que a consistência de maior viscosidade estaria relacionada à um maior controle neuromuscular em comparação às consistências menos viscosas, de modo a oferecer maiores estímulos proprioceptivos que influenciariam o início da fase faríngea em estruturais mais anteriores, tais como base da língua [24,25] Esta teoria não pode ser observada neste estudo, visto que cápsulas maiores apresentaram disparo da fase faríngea em localização mais posterior em comparação às menores apesar de oferecerem maiores estímulos proprioceptivos. Este fato pode ser resultante da maior dificuldade do controle na ejeção e coordenação entre cápsula e alimentos, agravado pelo tamanho da cápsula.

Levando-se em consideração que a cavidade oral é um local rico em receptores sensoriais que podem transmitir padrões e intensidades específicos que levam informações para os centros da deglutição no sistema nervoso central [6], o tamanho do bolo poderia influenciar na organização e ejeção do alimento [26]. Porém no presente

estudo, a menor cápsula, apesar de gerar estímulos menos perceptíveis, resultou no início da fase faríngea em localização mais anterior.

Estudos anteriores realizados com diferentes volumes de bolo alimentar concluiram que a maior ou menor percepção do alimento na fase oral não interferiu na modulação da força da língua [27], na taxa ou duração da elevação máxima do osso hióide [28] ou na duração da atividade eletromiográfica da submentoniana ou infra-hióideos [29]. Outro trabalho observou também que o intervalo de tempo entre o movimento inicial de anteriorização do hióide e a chegada do bolo na faringe permaneceram constantes apesar da alteração no volume [30]. Apesar de apresentarem objetivos distintos, os achados deste presente estudo diferiram dos trabalhos acima citados visto que o volume do material deglutido interferiu nos resultados encontrados.

No presente estudo consideramos a cápsula como referência e não o alimento que a acompanhou. Portanto, a comparação da localização do disparo da fase faríngea de nosso estudo talvez não possa ser comparada a outros estudos que se utilizaram do alimento como referência.

Outros estudos sobre a deglutição de cápsulas são necessários, visto que a literatura mostrou-se escassa. Trabalhos nesta área podem fornecer informações adicionais que auxiliem as indústrias farmacêuticas e no cuidado ao paciente.

Devem-se apontar aqui algumas limitações metodológicas deste trabalho, entre eles a discrepância entre o número de sujeitos dos diferentes gêneros, a distribuição não uniforme das diferentes faixas etárias, a livre oferta do alimento, cujo volume variou entre os participantes e a não possibilidade de visualização do alimento (não contrastado). Mostram-se necessários estudos com amostras amplas, de modo que referencias normativas possam ser encontradas.

CONCLUSÃO

O tamanho da cápsula influenciou na localização do disparo da fase faríngea, sendo que cápsulas menores apresentaram maior porcentagem de localização em região mais anterior (dorso da língua) em comparação às cápsulas maiores, tanto na deglutição com alimentos na consistência líquida, quando pudim.

REFERÊNCIAS BIBLIOGRÁFICAS

1- DODDS WJ. The physiology of swallowing. Dysphagia. 1989; 3(4) : 171-8.

2-BASS NH, MOREEL RM. The neurology of swallowing. Em: Groher ME, editor. Dysphagia: diagnosis and management. 2nd ed. Boston: Butterworth-Heinemann; 1992. p. 1-29.

3-DODDS, WJ; STEWART, ET; LOGEMANN, JA. Physiology and radiology of the normal oral and pharyngeal phases of swallowing. AJR. 1990; 154: 953-63.

4-LOGEMANN, JA. Evaluation and Treatment of Swallowing Disorders. Am J Speech Lang Pathol. 1994; 3: 41-4.

5-STEPHEN JR; TAVES DH; SMITH RC; MARTIN RE. Bolus location at the initiation of the pharyngeal stage of swallowing in healthy older adults. Dysphagia. 2005; 20(4): 266-72.

6-MILLER AJ. Deglutition. Physiol Rev. 1982; 62 (1): 129-84.

7-SAITOH E; SHIBATA S; MATSUO K; BABA M; FUJII W; PALMER JB. Chewing and food consistency: effects on bolus transport and swallow initiation. Dysphagia. 2007; 22(2):100-7.

8-POMMERENKE WA. A study of the sensory areas eliciting the swalowing reflex. Am J Physiol. 1928;84(1) :36-41.

9-DUA KS, REN J; BARDAN E; XIE P; SHAKER R. Coordination of deglutive glottal function and pharyngeal bolus transit during normal eating. Gastroenterology. 1997;112(1): 73-83.

10-WATANDO A; EBIHARA S; EBIHARA T; OKAZAKI T; TAKAHASHI H, ASADA M et al. Effect of temperature on swallowing reflex in elderly patients with aspiration pneumonia. J Am Geriatr Soc. 2004; 52 (12): 2143-4.

11-ALI GN; LAUNDL TM; WALLACE KL; DECARLE DJ; COOK IJ. Influence of cold stimulation on the normal pharyngeal swallow response. Dysphagia. 1996; 11 (1): 2-8.

12-SORDI M, MOURÃO LF, SILVA LBC. Rheological behavior and labels of texture-modified foods and thickened fluids as used for dysphasia's services. Rev. CEFAC. 2012. 14(5): 925-32.

13-American Speech-Language-Hearing Association. Roles of speechlanguage pathologists in swallowing and feeding disorders: technical report. ASHA Desk Reference. 2002; 3:181-99.

14-VAIMAN, M; EVIATAR, E; SEGAL, S. Evaluation of Normal Deglutition with the Help of Rectified Surface Electromyography Records. Dysphagia. 2004;19 (2): 125-32.

15-HOLSTAGE G; GRAVELAND G; BIJKER-BIEMOND C; SCHUDDEBOOM I. Location of motoneurons innervating soft palate, pharynx and upper esophagus. Anatomical evidence for a possible swallowing center in the pontine reticular formation. Brain Behav Evol. 1983; 23(1):47-62.

16-KITAGAWA J; SHINGAI T; TAKAHASHI Y; YAMADA Y. Pharyngeal branch of the glossopharyngeal nerve plays a major role in reflex swallowing from the pharynx. Am J Physiol Regul Integr Comp Physiol. 2002; 282(5):1342–7.

17-MATUSO K, PALMER JB. Anatomy and physiology of feeding and swallowing: normal and abnormal. Phys Med Rehabil Clin N Am. 2008;19(4):691-707.

18-LEONARD R, MCKENZIE S. Hyoid-bolus transit latencies in normal swallow. Dysphagia. 2006;21(3): 183-90.

19-LAZZARA G, LAZARUS C, LOGEMANN JA. Impact of thermal stimulation on the triggering of the swallowing reflex. Dysphagia. 1986;1(2): 73-7.

20- SCIORTINO K; LISS JM; CASE JL; GERRITSEN KG; KATZ RC. Effects of mechanical, cold, gustatory, and combined stimulation to the human anterior faucial pillars. Dysphagia. 2003;18(1):16-26.

21- DANTAS RO, DODDS WJ. Influence of swallowed food bolus viscosity on pharynx motility. Arq Gastroenterol.1990;27(4): 164-8.

22-DANIELS SK, FOUNDAS AL. Swallowing physiology of sequential straw drinking. Dysphagia. 2001;16(3):176-82.

23-MARTIN-HARRIS B; BRODSKY MB; MICHEL Y; LEE FS; WALTERS B. Delayed initiation of the pharyngeal swallow: normal variability in adult swallows. J Speech Lang Hear Res. 2007; v.50(3): 585-94.

24-YAMADA EK; SIQUEIRA KO; XEREZ D; KOCH HA; COSTA MMB. The influence of oral and pharyngeal phases on the swallowing dynamic. Arq Gastroenterol. 2004;41(1): 18-23.

25-SHAKER R; REN J; ZAMIR Z; SARNA A; LIU J; SUI Z. Effect of aging, position, and temperature on the threshold volume triggering pharyngeal swallows. Gastroenterology. 1994;107(2): 396-402.

26-COSTA MMB. Uso de bolo contrastado sólido, líquido e pastoso no estudo videofluoroscópico da dinâmica da deglutição. Radiol Bras.1996; 29: 35-9.

27-POUDEROUX P; KAHRILAS PJ. Deglutitive tongue force modulation by volition, volume and viscosity in humans. Gastroenterology. 1995; 108 (5):1418-26.

28-KENDALL KA; McKENZIE S; LEONARD RJ; GONÇALVES MI; WALKER A. Timing of events in normal swallowing: a videofluoroscopic study. Dysphagia. 2000;15(2):74-83.

29-DANTAS RO, DODDS WJ. Effect of bolus volume and consistency on swallow-induced submental and infrahyoid electromyographic activity. Braz J Med Biol Res. 1990; 23(1):37–44.

30-MADDOCK DJ, GILBERT RJ. Quantitative relationship between liquid bolus flow and laryngeal closure during deglutition. Am J Physiol. 1993;265 :704–11.

4.Conclusões Gerais

Conclusões Gerais

Do estudo da interferência da consistência alimentar e da idade na duração das fases da deglutição com e sem cápsulas e avaliação da localização de cápsulas gelatinosas duras no disparo da fase faríngea em adultos assintomáticos, podemos concluir que:

1- A consistência alimentar interferiu na duração da fase faríngea de alimentos contrastados e na duração da fase oral de cápsulas #00, com aumento do tempo para alimentos mais viscosos.

2- O aumento da idade influenciou na duração das fases da deglutição, tanto de alimentos contrastados quanto na deglutição de cápsulas, em ambas as consistências, com aumento das fases oral e faríngea e diminuição da fase de transição na deglutição de alimentos sem cápsulas.

3- O tamanho da cápsula interferiu na localização do disparo da fase faríngea. Cápsulas menores desencadearam o disparo da fase faríngea em região mais anterior (dorso da língua) em comparação às cápsulas maiores.

5.Referências Bibliográficas

1- DODDS WJ (1989). The physiology of swallowing. Dysphagia 3: 171-178.

2- LOGEMANN J(1983).Evaluation and treatment of swallowing disorders.Texas Pro Ed.

3- KENDALL KA; McKENZIE S; LEONARD RJ, GONÇALVES MI; WALKER A (2000). Timing of Events in Normal Swallowing: A Videofluoroscopic Study. Dysphagia 15: 74-83.

4- KIM, Y; McCULLOUGH, GH; ASP, CW. Temporal Measurements of Pharyngeal Swallowing in Normal Populations. Dysphagia 2005; v. 20, p.290-296.

5-SAITOH E et al (2007). Chewing and food consistency: effects on bolus transport and swallow initiation. Dysphagia 22: 100-107.

6- ALOYSIUS A et al (2008). Swallowing difficulties in Duchenne muscular dystrophy: indications for feeding assessment and outcome of videofluoroscopic swallow studies. European Journal of Paediatric Neurology 12: 239-245.

7- SHAPIRO J (2000). Evaluation and treatment of swallowing disorders. Comprehensive Therapy 26: 203-209.

8- ERTEKIN C et al (1998). Electrodiagnostic methods for neurogenic dysphagia. Electroencephalography and Clinical Neurophysiology/Electromyography and Motor Control. 109: 331-340.

9- WECKMUELLER J; EASTERLING C; ARVEDSON J (2011). Preliminary temporal measurement analysis of normal oropharyngeal swallowing in infants and young children. Dysphagia 26 (2): 135-143.

10- COSTA MMB, ALMEIDA JT, SANT´ANNA E, PINHEIRO GM (2007). Viscosities reproductive patterns for use in videofluoroscopy and rehabilitation therapy of dysphagic patients. Arq Gastroenterol 44(4): 297-303.

11- EKBERG O; FEINBERG MJ (1991). Altered swallowing function in elderly patients without dysphagia, radiology findings in 56 cases. American Journal Roentgenology 156, p.1181-84.

12- FARRELL JJ. FRIEDMAN LS (2001). Esophageal diseases in the elderly. Clinical Perspectives in Gastroenterology 4 (6): 363-368.

13- CHANNER KS; VIRJEE J (1982). Effect of posture and drink volume on the swallowing of capsules. Br Med J 285: 1702.

14- PERAKIS, H; BURKHEAD, L; POSTMA, G (2009). Pill swallowwing trial can increase diagnostic utility of the fiberoptic endoscopic evaluation of swallowing (FEES). In: proceedings of the 17th Dysphagia Research Society AMeeting; 2009 March 4-7; New Orleans, LA, United States.

ANEXO I – TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Eu,_____

RG _____

dou meu consentimento livre e esclarecido para participar como voluntário(a) do projeto de pesquisa: **Avaliação do disparo da fase faríngea na deglutição de cápsulas e de alimentos de diferentes consistências em adultos assintomáticos,** sob responsabilidade dos pesquisadores profº drº Agricio Nubiato Crespo e Érica Mayumi Takase. Receberei uma cópia deste termo. Fui esclarecido(a) pelos pesquisadores responsáveis e fui informado (a) que:

- O objetivo desta pesquisa é estudar a deglutição (engolir), mais especificamente observar onde se localiza o alimento no momento em que ocorre o processo de proteção que impede que o alimento vá da garganta até os pulmões.

- Para isso realizarei uma entrevista inicial em que darei informações pessoais, tais como dados sobre minha saúde, uso de medicamentos, doenças etc. Para a realização de exame serão realizadas radiografias no momento da deglutição dos alimentos com a consistência parecida com suco engrossado, pudim e cápsulas de dois tamanhos, parecidas com as cápsulas de medicamentos, mas que terão apenas uma substância que auxiliará na visualização das radiografias, e que serão ingeridas com água e com alimento na consistência parecida com pudim.
- Utilizarei um avental que me protegerá da cintura ao joelho.
- Não há desconfortos previsíveis, porém caso ocorram, os procedimentos poderão ser interrompidos a qualquer momento pelas pesquisadoras ou por minha solicitação;
- A participação na pesquisa não implica em nenhum gasto adicional e, portanto, os pesquisadores não prevêem nenhuma forma de reembolso. Estou isento (a) de qualquer gasto financeiro referente à pesquisa. No caso de ocorrerem quaisquer despesas em função da participação na pesquisa, estas serão pagas integralmente pelos pesquisadores. O reembolso destina-se as despesas que ocorram pela participação exclusiva na pesquisa e que não teria se não participasse.
- Os pesquisadores responsáveis garantem o sigilo da minha identidade e de dados confidenciais ou que, de algum modo, possam me provocar constrangimentos ou prejuízos, garantindo que os dados serão utilizados exclusivamente para fins de estudo e/ou de pesquisa.
- Tenho liberdade de interromper minha participação neste estudo a qualquer momento, sem prejuízo de qualquer espécie.
- Posso solicitar quaisquer esclarecimentos sobre a pesquisa a qualquer momento.

Data:

Assinatura:_____

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