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Dysphagia: elderly's impact of the larynx movements on the protection of aerial ways

Deglutição: impacto dos movimentos da laringe sobre a proteção das vias aéreas

Deglutición: impacto de los movimientos de la laringe en la protección de maneras aéreas

*Michele Rocha da Silva**
*Maria Cristina de Almeida Freitas Cardoso**

Abstract

Introduction: Swallowing is given through a sequence of synchronous movements, being those of the pharyngeal phase the elevation and anteriorization of the larynx. **Aim:** Analyzing the laryngeal movements during deglutition and verifying its impact on airway protection. **Methods:** Retrospective descriptive studies approved by Ethical Committees in Research through the protocols numbers 2013/008 and 362.826, by analyzing the image database. Fifty-two video fluoroscopic swallowing studies were analyzed, 26 from males and 26 from females with average age of 76 years. The exams were carried out over one year at a Radiology and Imaging Service in a Primary Health Center, where two independent assessors evaluated laryngeal movements during deglutition, presence of dysphagia, and airway protection quality with liquid and pasty consistencies. **Results:** The assessors agreed in all analyzes performed. Among the statistically significant laryngeal movements, inappropriate laryngeal elevation and anteriorization, i.e., lack of anteriorization, reduced elevation, and incomplete and repeated laryngeal elevation were the most harmful for airway protection. **Conclusion:** The impact of the lack of, or inappropriate laryngeal elevation and anteriorization movements affect the deglutition process and promote laryngeal penetration and tracheal aspiration, which leads to dysphagia.

Keywords: Fluoroscopy; Deglutition Disorders; Deglutition; Larynx; Elderly.

*Universidade Federal de Ciências de Saúde do Pará – UFCSP, Belém, PA, Brazil.

Authors' contributions:
MRS - Idealization of the study, data collection, analysis and discussion of results and final text elaboration; MCAFC – Idealization of the study, analysis of results, organization and text revision, and orientation of the study.

Correspondence address: Maria Cristina de Almeida Freitas Cardoso - sabrinavilanova@hotmail.com
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Resumo

Introdução: A deglutição se dá através de uma sequência de movimentos sincrônicos, sendo os da fase faríngea a elevação e a anteriorização da laringe. **Objetivo**: Analisar os movimentos da laringe durante a deglutição e verificar o seu impacto na proteção das vias aéreas. **Métodos:** Estudo retrospectivo descritivo aprovado por comitês éticos em pesquisa através dos protocolos números 2013/008 e 362,826, por análise de um banco de dados de imagem. Foram analisadas 52 deglutições através de exame de videofluoroscopia da deglutição, sendo 26 desses de sujeitos do gênero masculino e 26 do feminino, com idade média de 76 anos. Os exames foram realizados ao longo de um ano em um serviço de radiologia e imagem em um centro de saúde primário, onde dois avaliadores independentes avaliaram movimentos de laringe durante deglutição, presença de disfagia, e qualidade de proteção das vias aéreas para com as consistências líquida e pastosa. **Resultados:** os avaliadores concordaram em todas as análises executadas. Entre os movimentos de laringe estatisticamente significativos tem-se a elevação inadequada da laringe e a sua anteriorização, ou seja, a falta de anteriorização, a elevação reduzida e a elevação incompleta e repetida da laringe foram os mais nocivos para a proteção das vias aéreas. **Conclusão:** o impacto da falta ou da elevação inadequada da laringe e dos movimentos de anteriorização afetam o processo deglutição e promovem a penetração da laringe e a aspiração traqueal, o que caracteriza a disfagia.

Palavras-chave: Fluoroscopia; Transtornos de deglutição; Deglutição; Laringe; Idosos.

Resumen

Introducción: La Deglutición se da través de una secuencia de movimientos sincrónicos, siendo los de la fase faríngea, la elevación y anteriorización de la laringe. **Objetivo**: Analizar los movimientos de la laringe durante la deglución y verificar su impacto en la protección de las vías respiratorias. **Métodos:** Estudio descriptivo retrospectivo aprobado por Comités Éticos en Investigación través de los protocolos números 2013/008 y 362,826, por analise de base de datos de imágenes. Han sido analizados 52 degluticiones por examen de videofluoroscopia de la deglutición, siendo 26 del género masculino y 26 del femenino, con una edad promedio de 76 años. Los exámenes se realizaron durante un año en un servicio de radiología e imágenes en un centro de salud primario, donde dos evaluadores independientes evaluaron los movimientos de laringe durante la deglución, la presencia de disfagia y la calidad de la protección de las vías respiratorias. para con las consistencias liquidas y pastosa. **Resultados:** Los evaluadores acordaron todos los análisis realizados. Entre los movimientos de la laringe estadísticamente significativos, la elevación laríngea inadecuada y la anteriorización, es decir, la carencia de la anteriorización, la elevación reducida, y la elevación laríngea incompleta y repetida eran las más dañosas para la protección de la vía aérea. **Conclusión:** El impacto de la falta o elevación inadecuada de la laringe y los movimientos de la anteriorización afectan el proceso de deglución y promueven la penetración de la laringe y la aspiración traqueal, que caracteriza la disfagia.

Palabras claves: Fluoroscopia; Disfagía; Deglutición; Laringe; Ancianos.

Introduction

Deglutition is a complex, dynamic process that takes place with a sequential chain of sensory and motor events so as to transport material from the mouth to the stomach, thus hydrating and nourishing the body, with no particles of such material entering the airways. Deglutition phases are interrelated and can be divided into three phases, or four, if the preparatory phase is added: preparatory, oral, pharyngeal, and esophageal phases.[1-6]

The preparatory phase basically consists of mastication with its two or three phases (incision, grinding, pulverization), when the bolus is salivated. It is placed between the tongue and the hard palate before voluntary deglutition begins. During all the preparatory oral phase, the soft palate is in a lower position, helping prevent the bolus from entering the pharynx before deglutition. The soft palate is lowered by the contraction of the palatoglossal muscle. The pharynx and larynx remain at rest. The airway is open and nasal breathing continues until deglutition has taken place.[5, 7]

The oral phase is called voluntary because it can be controlled. The pharyngeal and esophageal phases are involuntary. In the oral phase, the bolus is sent by the tongue into the pharynx, thus starting the pharyngeal phase of deglutition. [5, 7]

During the pharyngeal phase, which takes the food from the oropharynx to the esophagus, a quick sequence of crucial events for deglutition begins, with the elevation and anteriorization of the larynx. This occurs through the contraction of the sub-mentonian muscles (mylohyoid, geniohyoid, and anterior digastric, besides the thyrohyoid), thus favoring the epiglottis inversion to occlude the airway. Simultaneously, the activity of the vocal fold adductor muscles increase, aided by the laryngeal constrictor muscles, which close the epiglottis, one of the most essential reflexes that enable deglutition without food, foreign bodies, or secretions being aspirated. [8,9]

The hyoid-laryngeal complex excursion can provide important data for the observation of functional airway protection. [8,9]

Videofluoroscopic swallowing study (VFSS), also known as modified barium swallow (MBS), enables visualizing all deglutition phases in real time. It allows the structures involved in this process, as well as penetration and laryngealtracheal aspiration events, to be analyzed. It is considered an important evaluation method for its ability and reliability in observing events and associated structures, particularly the hyoid bone, given its high-density image. [6,10-11]

This study aims to describe the laryngeal movements found during deglutition through videofluoroscopic swallowing study and to correlate these data with airway protection quality.

Methods

Fifty-two videofluoroscopic swallowing studies were selected between January 2010 and January 2011 from a Radiologic Center of one Hospital, 26 (50%) of which from males and 26 (50%) from females with average age of 76.85 years, standard deviation of 8.97. The whole sample had 113 exams, 30 of which were excluded for lacking complementary data, 21 for having only lateral plane images, and 10 for being from patients subjected to tracheotomy and/or cervical surgery. All elderly people showed signals and symptoms of dysphagia.

The videofluoroscopic swallowing studies were performed in a shielded x-ray room using Prestilix 1600X radiological equipment from GE Medical Systems® coupled to a Philips® DVD recorder.

After being recorded onto the DVD, the exams were sent to two speech therapist assessors, both with the same training and experienced in performing videofluoroscopic swallowing studies. The assessors analyzed three deglutitions with liquid consistency and three with pasty consistency using barium sulfate (BárioGel®) contrast medium with images taken in the lateral and anterior-posterior planes, which allowed the food to be visualized.

For the result analysis, a Laryngeal Biomechanics protocol was created that considered laryngeal movements such as elevation and anteriorization, lack of elevation, incomplete and repeated elevations, lateral excursion, marked anterior excursion, and laryngeal lowering, as well as the presence of dysphagia, penetration, and aspiration. These data were later tabbed in a Microsoft® Excel (2010) spreadsheet.

The data were summarized with mean, standard deviation, and absolute and relative frequencies. Age normality was verified through the Kolmogorov-Smirnov test and genders were compared using Student's t-test. The agreement between the assessors was verified through kappa coefficient. The associations between airway protection and laryngeal movements were analyzed through Fisher's exact test. The significance level adopted was 5%. All analyses were carried out using the software SPSS 19.0.

This study was approved by the Ethical Committee in Research of the participant at Radiology and Imaging Service in a Primary Health Center under protocol number 2013/008, as well as by the Ethical Committee in Research of the proposed institution under protocol 362.826. All patients had signed the informed consent of the hospital service.

Results

Of the 52 exams analyzed, dysphagia was found in 45 subjects (86.53%) and normality, in seven (13.47%). Table 1 shows the analysis of laryngeal movements in relation to the presence of penetration and aspiration for the liquid consistency, After the agreement between the assessors was confirmed by kappa coefficient, Fisher's exact test was carried out using a 5% significance level ($p \leq 0.05$).

Table 1. Association among laryngeal movements and aspiration and penetration for liquid consistency.

Laryngeal moviments	(n)	Aspiration Liquid		P value	(n)	Penetration Liquid		P value
		YES (n)	NO (n)			YES (n)	NO (n)	
Altered elevation	**20**	6	14	0.156	20	16	4	0.009*
Adequate elevation	**32**	4	28		32	13	19	
Altered anteriorization	23	9	14	0.003*	23	16	7	0.096
Adequate anteriorization	29	1	28		29	13	16	
Reduced elevation	31	10	21	0.003*	31	23	8	0.002*
Adequate elevation	21	0	21		21	6	15	
Lack of elevation	4	1	3	1.000	4	4	0	0.120
Adequate elevation	**48**	9	39		48	25	23	
Incomplete/repeated elevations	26	9	17	0.011*	26	21	5	0.001*
Adequate elevation	26	1	25		26	8	18	
Lateral excursion	3	1	2	0.481	3	2	1	1.000
Lack of lateral excursion	49	9	40		49	27	22	
Laryngeal lowering	**6**	1	5	1.000	6	3	3	1.000
Adequate position	46	9	37		46	26	20	

*Fisher exact test (p<0.05)

Table 2 shows the analyses of laryngeal movements in relation to the presence of aspiration and penetration for pasty consistency. Associations (p<0.05) were found for the consistencies analyzed between the presence of dysphagia and altered laryngeal elevation, and between dysphagia and incomplete elevation and repeated movements. A relation between dysphagia and reduced laryngeal elevation was only found for the liquid consistency.

Table 2. Association among laryngeal movements and aspiration and penetration for pasty consistency.

Laryngeal moviments	(n)	Aspiration Pasty		P value	(n)	Penetration Pasty		P value
		YES (n)	NO (n)			YES (n)	NO (n)	
Altered elevation	16	6	10	0.002*	16	10	6	0.001*
Adequate elevation	36	1	35		36	5	31	
Altered anteriorization	27	7	20	0.010*	27	14	13	0.000*
Adequate anteriorization	25	0	25		25	1	24	
Reduced elevation	27	6	21	0.101	27	13	14	0.002*
Adequate elevation	25	1	24		25	2	23	
Lack of elevation	3	2	1	0.044*	3	1	2	1.000
Adequate elevation	49	5	44		49	14	32	
Incomplete/repeated elevations	18	5	13	0.041*	18	11	7	0.000*
Adequate elevation	34	2	32		34	4	30	
Lateral excursion	2	0	2	1.000	2	1	1	0.498
Lack of lateral excursion	50	7	43		50	14	36	
Laryngeal lowering	5	2	3	0.129	5	3	2	0.137
Adequate position	47	5	42		47	12	35	

Fisher exact test (p<0.05)

Discussion

Of the 52 exams evaluated, 45 (86.53%) showed dysphagia. This value may be explained by the fact that an image database was used, and most patients were referred to a VFSS based on clinical signs or symptoms of dysphagia.

This study analyzed, with two independent assessors, three deglutitions for the liquid consistency and three deglutitions for the pasty consistency using barium sulfate as contrast medium. A minimum of three deglutitions for each consistency is recommended to guarantee that individual differences will be observed. [12] However, some studies have evaluated a single deglutition of each bolus type. [13]

Another important detail is that participants' age was 76.85 years. Studies have shown an increasing number of adults over 60 years old in the last decades. [14,15] In the present study, the substantial number of elderly referred to dysphagia investigation compared to younger people is pointed out.

Researches that assessed aging-related deglutition disorders show 16% to 22% of the population above 50 years of age with dysphagia, a number that reaches 70% to 90% among elderly people. [15-17] The participants' gender in this study had a balanced distribution: 26 (50%) male and 26 (50%) female.

Little is found in scientific studies in terms of evaluations and analyses of anomalous laryngeal movements such as lack of elevation, lateral excursion, incomplete and repeated elevations, and laryngeal lowering.[18,19]

One of the most commonly studied pharyngeal deglutition alterations is reduced laryngeal elevation. It is stated that the reduction in the larynx's vertical excursion contributes to the incomplete airway closure, which leads to a risk of aspiration and that a reduction in laryngeal anteriorization contributes to a reduction in the opening of the esophagus. [20-22] Likewise, this study found a significant relation ($p<0.005$) between laryngeal aspiration and penetration with the reduction in these movements for both the liquid and pasty consistencies. Regarding the lack of laryngeal elevation, a significant association ($p = 0.044$) was found with aspiration only for the pasty consistency, which contrasts with the studies that report that the pasty consistency is the safest and easiest.

The incomplete and repeated laryngeal elevation movement, still little studied, was shown to be significant for the two consistencies studied for both aspiration and penetration, with a total of 44 occurrences, 9 of which of aspiration and 31 of penetration.

The other movements, such as lateral excursion and laryngeal lowering, express a trend towards statistical significance ($p>0.05$). Since they are anomalous movements, they need a larger sample (n) so that these events can be better analyzed.

Conclusion

The inadequate laryngeal movements and alterations regarding elevation and anteriorization impair deglutition and airway protection, thus favoring laryngeal penetration and tracheal aspiration events that can lead to serious complications such as malnourishment, dehydration, and aspiration pneumonia.

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