Original Article

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Laryngeal and swallowing characteristics in elderly after stroke: a preliminary study

Características laríngeas e de deglutição em idosos pós-acidente vascular encefálico: um estudo preliminar

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ABSTRACT

Purpose: To carry out a comparative analysis between the aspects of safety (penetration/aspiration) and efficiency (residues) of swallowing with the morphological characteristics and phonatory functional behavior of the larynx, in elderly after stroke, in the late phase. **Methods:** Observational and retrospective study carried out based on the analysis of recordings of Fiberoptic Endoscopic Evaluation of Swallowing and Laryngoscopy examinations of speech and swallowing in 24 patients. The following were considered: laryngeal asymmetry, arching of the membranous portion, increased volume of the vestibular folds, classification of glottic closure, presence of median and anteroposterior constriction during phonation. For swallowing, the Penetration and Aspiration scales, the Yale Pharyngeal Residue Severity Rating Scale to classify residues in valleculae and pyriform sinuses, and the pharyngeal residue scale proposed by Kelly et al. (2006) were used. The Mann-Whitney and Kruskal-Wallis tests were applied, considering a significance level of 5%. **Results:** Most patients presented arching of the membranous portion of the vocal folds and increased volume of the vestibular folds, as well as anteroposterior constriction of the arytenoids. Laryngeal penetration, presence of residues in valleculae, pyriform sinuses and pharynx were identified for IDDSI 0 and 4 consistencies, and aspiration with IDDSI 0. At IDDSI level 0, the presence of anteroposterior constriction of the arytenoids during phonation was associated with lower scores on the Penetration-Aspiration Scale (p=0.016) and the Pharyngeal Residue Scale (p=0.013). Lower scores on the residual scale in valleculas were observed according to the amount of epiglottis coverage (p=0.017) for IDDSI 4. Furthermore, the absence of vocal fold asymmetry was associated with lower pharyngeal residue scores (p=0.025) and vallecular residue scores (p=0.008) for IDDSI level 7. **Conclusion:** Swallowing safety and efficiency differ in individuals with late post-stroke presenting anteroposterior constriction, and swallowing efficiency also varies according to the degree of epiglottic coverage and vocal fold symmetry in these individuals.

Keywords: Stroke; Elderly; Deglutition disorders; Deglutition; Larynx

RESUMO

Objetivo: Realizar uma análise comparativa dos aspectos da segurança (penetração/aspiração) e da eficiência (resíduos) da deglutição com as características morfológicas e o comportamento funcional fonatório da laringe em idosos pós- acidente vascular encefálico em fase tardia. **Métodos:** Estudo preliminar observacional e retrospectivo, realizado a partir da análise de gravações de exames de videoendoscopia da fonação e deglutição de 24 pacientes. Considerou-se: assimetria laríngea, arqueamento da porção membranosa, aumento de volume das pregas vestibulares, classificação do fechamento glótico, presença de constrição mediana e anteroposterior durante a fonação. Para a deglutição, utilizaram-se as seguintes escalas: Escala de Penetração e Aspiração, *Yale Pharyngeal Residue Severity Rating Scale*, para classificar resíduos em valéculas e seios piriformes, e Escala de Resíduos em Faringe. Foram aplicados os testes de Mann-Whitney e Kruskal-Wallis, considerando nível de significância de 5%. **Resultados:** A maioria dos pacientes apresentou arqueamento da porção membranosa das pregas vocais e aumento do volume das pregas vestibulares, assim como constrição anteroposterior das aritenoides. Foi identificada penetração laríngea, presença de resíduos em valéculas, seios piriformes e faringe para as consistências da *International Dysphagia Diet Standardization Initiative* 0 e 4, e aspiração com o *International Dysphagia Diet Standardization Initiative* 0. No *International Dysphagia Diet Standardization Initiative* 0, na presença de constrição anteroposterior de aritenoides durante a fonação, foram observados menores níveis na Escala de Penetração e Aspiração (p=0,016) e Escala de Resíduos em Faringe (p=0,013). Menores escores na escala de resíduos em valéculas foram observados de acordo com a quantidade de cobertura da epiglote (p=0,017) para o *International Dysphagia Diet Standardization Initiative* 4. Ainda, na ausência de assimetria das pregas vocais, observaram-se menores níveis da Escala de Resíduos em Faringe (p=0,025) e de resíduos em valéculas (p=0,008) para *International Dysphagia Diet Standardization Initiative* 7. **Conclusão:** A segurança e a eficiência da deglutição são distintas nos indivíduos pós-acidente vascular encefalico tardio que apresentam constrição anteroposterior, assim como a eficiência da deglutição se distingue de acordo com a quantidade de cobertura da epiglote e assimetria das pregas vocais nesses indivíduos.

Palavras-chave: Acidente vascular encefálico; Idoso; Transtornos de deglutição; Deglutição; Laringe

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INTRODUCTION

One of the main factors for the increased prevalence of stroke is the aging of the population[1]. Specifically, individuals over 60 years of age, due to the possibility of comorbidities, are at greater risk of sequelae that make them dependent on other people[2]. The consequences from stroke range from changes in mobility, which interfere with the performance of daily activities, to the impairment of functions such as voice and swallowing.

Given the existence of common anatomical aspects and neurophysiological commands necessary for voice production and swallowing, in recent years the literature has focused on a better understanding of the relationship between the two functions. Considering this relationship, the vocal folds in the laryngeal structure not only play a role in phonation, but also function as protective mechanisms of the airways, preventing foreign contents from entering this region[3]. In addition, glottic closure is also an important generator of the supraglottic pressure necessary for the formation of the pressure gradient that favors the passage of the food bolus to the pharynx and esophagus[4]. Therefore, the larynx not only has the ability to produce speech, but also to facilitate the movement of the food bolus, protect the lower airways and prevent aspiration during swallowing.

Regarding the relationship between swallowing and voice in the post-stroke population, the literature points to the presence of mobilization in the laryngeal (phonatory) and supralaryngeal (articulatory) planes, which may occur as a secondary mechanism of airway protection during swallowing[5]. Furthermore, the presence of food stasis or saliva in the laryngeal region can lead to the auditory perception of what the literature calls a wet voice[5,6]. Dysarthrophonia resulting from stroke can be complex and depends on the location and extent of the injury[7]. The characteristics of dysarthrophonia include several speech alterations, such as articulatory imprecision, slowing of rhythm, monotony in intonation and changes in resonance. Among these characteristics, impairment of vocal quality is one of the five most common symptoms of dysarthrophonia. The alterations of the glottic source in patients with neurological damage frequently mentioned are roughness, breathiness, instability, in addition to alterations in laryngeal motor control, which reflects in the difficulty of controlling the muscles of the larynx[7].

The literature also describes that approximately 20% of post-stroke patients may present vocal fold paresis and reduced maximum phonation time (MPT), from the subacute and acute phases of the injury[8], and it is also possible to find a description of the relationship between reduced MPT with lower subglottic air pressure, delayed pharyngeal transit time and greater risk of laryngotracheal aspiration[9].

Given the above, there are few studies that describe the relationship between voice and swallowing, specifically in elderly patients diagnosed with stroke and in the late phase, that is, from six months after the injury occurred[9,10]. Therefore, knowing the anatomical relationship that involves the two functions and knowing that they can be directly affected by a neurological injury, such as a stroke, there is a need to strengthen speech therapy assessments by expanding new concepts related to vocal changes and dysphagia.

Thus, the objective of the present study was to perform a comparative analysis of the specific aspects of safety (presence or absence of laryngotracheal penetration and/or aspiration) and efficiency (presence or absence of pharyngeal and laryngeal residues) of swallowing[11], according to the morphological characteristics, with the functional phonatory behavior of the larynx in elderly people after a late-stage stroke.

METHODS

This is a preliminary, observational, cross-sectional study approved by the Human Research Ethics Committee of the Bauru School of Dentistry, University of São Paulo - CEP/FOB/USP, with protocol number 97392318.0.0000.5417 and waiving the requirement for a Free and Informed Consent Form (FICF). A total of 35 medical records and Fiberoptic Endoscopic Evaluation of Swallowing (FESS) and Fiberoptic Laryngoscopy exams from the database of the Speech Therapy Clinic of the Bauru School of Dentistry - University of São Paulo were analyzed. For the inclusion criteria, individuals with the following characteristics were selected: regardless of gender; age equal to or greater than 60 years; medical diagnosis of stroke; minimum disease duration of six months; stable health condition and absence of oncological, psychiatric, cardiac, respiratory, genetic, syndromic diseases and/or acquired head and neck trauma.

Procedures

Fiberoptic Endoscopic Evaluation of Swallowing and Laryngoscopy

The Fiberoptic Endoscopic Evaluation of Swallowing (FESS) clinical examination was conducted by an otorhinolaryngologist in cooperation with a speech therapist with a doctorate and postdoctorate in swallowing disorders.

Patients were instructed to remain seated, with their heads positioned in the direction of the body axis, without flexion or rotation. A standard ENF-P4 rhinolaryngofibroscope, CHL-25 halogen light source, and OTV-SC camera, all from Olympus, were used for evaluation. The images were recorded on a Philips DVD. Xylocaine gel was applied to the circumference of the flexible fiber optic to avoid discomfort in the nasal cavity during its insertion.

To assess laryngeal function during phonation and safety, patients were instructed to initially breathe without making a sound to allow observation of the laryngeal structures safely and were then asked to produce a sustained emission of the vowel /i/[12].

In the swallowing assessment, three consistencies classified according to the International Dysphagia Diet Standardization Initiative (IDDSI) were used[13]: IDDSI 0, 4 and 7. The stimuli were colored with blue food coloring and one offer was made for each consistency, in the following order: IDDSI 0 - thin liquid (10 ml), offered in a disposable cup (50 ml); IDDSI 4 - extremely thickened liquid (30 ml), prepared with 2 g of dietary grape juice powder (Clight) and thickened with food thickener, offered in a disposable cup (200 ml); IDDSI 7 - solid, a slice of water bread 1 cm thick and approximately 4 cm in diameter.

For IDDSI 0 and 4, patients were instructed to put the contents in their mouth and swallow it only after verbal guidance from the evaluator. For IDDSI 7, the food was placed into the

patient's oral cavity and they were asked to chew, organize and swallow the food bolus in the usual way.

Analysis of the larynx based on Fiberoptic Laryngoscopy examination

The analyses of the exams were performed by two speech therapists, specialists in voice disorders, with doctorate, properly trained and calibrated. Initially, the analyses were performed independently and, subsequently, the divergent aspects were determined by consensus. The classification of the morphological characteristics and laryngeal behavior considered the following description[12,13]: for morphological characteristics, the asymmetry of arytenoids and vocal folds was analyzed, referring to the mirror image of one hemilarynx in relation to the other. For arching of the membranous portion, the presence or absence of the free edge of the membranous portion of the vocal fold was identified, which assumed an arched position. The increase and quantity of volume of the vestibular folds and epiglottis in relation to the vocal folds were also considered, with the quantity observed as "no increase", "up to half", "more than half" and "full coverage"[12].

For laryngeal behavior characteristics, the classifications of glottic closure during phonation were considered, with glottic coaptation corresponding to the way in which the vocal folds come together during phonation. The presence of fusiform clefts was analyzed in the case of incomplete coaptation, which could encompass all or only part of the membranous region, as well as other types of clefts[12]. In addition to the classification of anteroposterior and median constriction during phonation of the vowel /i/, in this case, for the analysis of the laryngeal vestibule behavior, the presence or absence of anteroposterior and median constriction was observed, considering the distance of the arytenoids and the petiole of the epiglottis, in relation to the posterior wall of the glottis during breathing (in relation to phonation), and the median constriction based on the observation of the configuration of the vestibular folds during phonation. And finally, laryngeal asymmetry was observed, with asymmetry being considered the reduction of the movement of the vocal folds during phonation[12].

Analysis of the swallowing based on FEES examination

The images were analyzed by two speech therapists with at least a master's degree and training in oropharyngeal dysphagia. The analyses were performed independently and, in cases of disagreement, a reanalysis was performed jointly until a consensus was reached.

For the analysis of swallowing safety, the Rosenbeck Scale for penetration-aspiration was applied[14], considering the presence of contrasted food in the laryngeal vestibule, above the plane of the vocal folds, and the presence of contrasted food in the plane of the free edge of the vocal folds and/or below them.

Three scales were needed to comprehensively assess swallowing efficiency. To identify possible residues in valleculae and pyriform sinuses, the Yale scale was applied, which differentiates five levels of residues: level I - no residue; level II - traces of residue; level III - mild residues; level IV – moderate residues; level V - severe, full of residues up to the rima glottidis[15]. To assess the presence of residues in the pharynx, a scale was applied that also classifies residues into five levels: level I - no residue; level II - coverage of residues; level III - mild residues; level IV - moderate residues; level V - severe number of residues[16].

Data analysis

The results obtained were tabulated in a database and submitted to statistical analysis using comparison tests. Based on the laryngeal characteristics, the participants were divided into subgroups with and without the presence of each characteristic, and the results of the swallowing scales were compared between these subgroups using the Mann-Whitney test for all items evaluated, except for the item "How much the epiglottis covers the vocal folds", in which the Kruskal-Wallis test and Dwass-Steel-Critchlow-Fligner post-test were used, with a significance level of 5%. Aspects considered unobservable due to the examination conditions were not included in the statistical analysis.

Furthermore, to verify the inter-judge agreement of the swallowing and phonation scales, the Kappa statistic was used. For the morphological aspects of the larynx, Kappa values were 0.514 for increase in the vestibular folds and 0.588 for coverage of the epiglottis in the vocal folds, indicating moderate inter-judge agreement[17]. For the phonatory behavior of the larynx, Kappa values were 0.762 for anteroposterior constriction of the epiglottis petiole, 0.644 for median constriction, and 0.662 for asymmetry, indicating substantial inter-judge agreement. For all swallowing scales, Kappa value was 0.929, indicating perfect inter-judge agreement.

RESULTS

After applying the inclusion criteria, 24 individuals over 60 years of age were selected, with the sample consisting of 8 women and 16 men, with a medical diagnosis of chronic stroke, 3 of which were hemorrhagic and 21 of which were ischemic. The time since the injury ranged from 6 to 276 months (mean of 62.96 months). Regarding the number of stroke episodes, 18 individuals had 1 episode, 4 individuals had 2 episodes and 2 individuals had 3 episodes.

Regarding laryngeal morphology, the most frequent characteristics were arching in the membranous portion of the vocal folds (91.7%), increased volume of the vestibular folds (91.7%) and absence of asymmetry (79.2%). The most observed laryngeal behavior was anteroposterior constriction of the arytenoids in 87.5% of patients, followed by presence of median constriction (62.5%). Detailed information is presented in Table 1.

Regarding swallowing safety for the IDDSI 0 consistency, 12.5% of participants presented laryngeal penetration, only 1 patient presented aspiration with cough reaction, and 2 patients presented aspiration without any reaction. For IDDSI 4, 1 participant presented laryngeal penetration. Regarding swallowing efficiency, specifically for IDDSI 0, 33.3% of patients presented residues in pyriform sinuses (score 2 on the Yale scale) and, for IDDSI 4, residues were found in valleculae (score 3 on the Yale scale) in 29.2% of the sample (Table 2).

Table 1. Morphological and behavioral categorization of the larynx, according to the findings of Fiberoptic Laryngoscopy

Score	Morphology							Behavior			
	Laryngeal Asymmetry (LA)		Arching of the membranous portion (AMP)	Increased volume of the vestibular folds (IVVF)	Amount of increased vestibular folds (AIVF)	How much the epiglottis covers the vocal folds (ECVF)	Complete glottal closure	Anteroposterior constriction		Median constriction	Asymmetry
	Vocal folds	Arytenoids						Petiole of epiglottis	Arytenoids		
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
0	19 (79.2%)	13 (54.2%)	2 (8.3%)	2 (8.3%)	2 (8.3%)	14 (58.3%)	4 (16.7%)	10 (41.7%)	2 (8.3%)	8 (33.3%)	16 (66.7%)
1	5 (20.8%)	11 (45.8%)	22 (91.7%)	22 (91.7%)	10 (41.7%)	9 (37.5%)	11 (45.8%)	13 (54.2%)	21 (87.5%)	15 (62.5%)	7 (29.2%)
2	------	------	------	------	4 (16.7%)	1 (4.2%)	9 (37.5%)	1 (4.2%)	1 (4.2%)	1 (4.2%)	1 (4.2%)
3	------	------	------	------	8 (33.3%)	------					

Morphology: LA: (0) absence/ (1) presence; AMP: (0) absence / (1) presence; IVVF: (0) absence/ (1) presence; AIVF: (0) none/ (1) up to half of the vocal folds / (2) more than half of the vocal folds / (3) full coverage; ECVF: (0) none/ (1) up to half of the vocal folds / (2) more than half of the vocal folds / (3) full coverage; Behavior: (0) absence/ (1) presence/ (2) unobservable

Subtitle: n = number of participants; % = percentage

Table 2. Findings from Fiberoptic Endoscopic Evaluation of Swallowing (FESS), considering swallowing safety (Penetration and Aspiration Scale) and efficiency (Yale and Pharyngeal Residue scales)

Score	Consistencies											
	IDDSI 0				IDDSI 4				IDDSI 7			
	Penetration and Aspiration Scale 1	Pharyngeal Residue scale 2	Yale Scale		Penetration and Aspiration Scale[1]	Pharyngeal Residue scale[2]	Yale Scale		Penetration and Aspiration Scale[1]	Pharyngeal Residue scale[2]	Yale Scale	
			RV	RPS			RV	RPS			RV	RPS
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
1	17 (70.8%)	16 (66.7%)	8 (33.3%)	9 (37.5%)	23 (95.8%)	21 (87.5%)	12 (50.0%)	19 (79.2%)	22 (91.7%)	14 (58.3%)	10 (41.7%)	16 (66.7%)
2	------	3 (12.5%	6 (25.0%)	8 (33.3%)	------	--------	3 (12.5%)	2 (8.3%)	--------	5 (20.8%)	6 (25.0%)	4 (16.7%)
3	3 (12.5%)	4 (16.7%)	9 (37.5%)	6 (25.0%)	1 (4.2%)	2 (8.3%)	7 (29.2%)	2 (8.3%)	--------	2 (8.3%)	3 (12.5%)	1 (4.2%)
4	------	--------	--------	--------	--------	1 (4.2%)	2 (8.3%)	1 (4.2%)	--------	1 (4.2%)	3 (12.5%)	1 (4.2%)
5	------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
6	--------	1 (4.2%)	1 (4.2%)	1 (4.2%)	--------	--------	--------	--------	--------	2 (8.3%)	2 (8.3%)	2 (8.3%)
7	1 (4.2%)	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
8	2 (8.3%)	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
9	1 (4.2%)	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

[1]Penetration and Aspiration Scale[14]: (1) Contrast does not enter the airway; (2) Contrast enters the airway, remains above the vocal folds, without residue; (3) Contrast remains above the vocal folds, with visible residue remaining; (4) Contrast reaches the vocal folds, without residue; (5) Contrast reaches the vocal folds, with visible residue remaining; (6) Contrast passes the glottic level, but there is no residue at the subglottic level; (7) Contrast passes the glottic level with residue at the subglottic level, despite the patient's reaction; (8) Contrast passes the glottis with residue in the subglottis, without patient reaction; (9) Consistency not applied;
[2]Pharyngeal Residue Scale[16]: (1) none; (2) coverage; (3) mild; (4) moderate; (5) severe; (6) unobservable; Yale Scale for RV (residue in valleculae)[15]/RPS (residue in pyriform sinuses)[15]: (1) none; (2) traces; (3) mild; (4) moderate; (5) severe; (6) unobservable.

Subtitle: n = number of participants; % = percentage

Comparative analysis of swallowing assessment results according to laryngeal characteristics

Participants with anteroposterior arytenoid constriction during phonation presented lower levels on the Pharyngeal Residue Scale (p=0.013) and the Penetration and Aspiration Scale (p=0.016) when swallowing thin liquid - IDDSI 0 consistency (Tables 3 and 4, respectively).

For IDDSI 4 consistency – extremely thickened liquid (Table 5), there was a difference in the Valleculae Residue Scale, with lower scores observed based on the amount of coverage of the vocal folds by the epiglottis (p=0.017) when comparing participants who presented coverage levels 0, 1 or 2. The pairwise analysis, performed in the post-test, indicated that the difference occurred between levels 0 and 1 (p=0.045).

Participants who showed no vocal fold asymmetry had lower levels on the Pharyngeal Residue Scale (p=0.025) and the Valleculae Residue Scale (p=0.008) when swallowing solids – IDDSI 7 consistency (Tables 6 and 7, respectively).

DISCUSSION

The aim of this study was to perform comparative analyses of swallowing characteristics according to morphological characteristics and laryngeal behavior in elderly individuals with late stroke. In this sense, regarding morphology, the literature describes that, specifically in elderly patients with late stroke, the presence of laryngeal asymmetry and bilateral arching of the vocal folds is common[18], as found in this study. It is worth noting that such morphological characteristics may also be present in healthy elderly individuals[19], so that further

Table 3. Comparison of the results of the Pharyngeal Residue Scale considering the presence or absence of anteroposterior constriction of the arytenoids for consistency of the International Dysphagia Diet Standardization Initiative 0

	Anteroposterior constriction of the arytenoids - vowel i	Pharyngeal residue scale	p-value
1st Quartile	Absence	3.00	
	Presence	1.00	
Median	Absence	3.00	0.013
	Presence	1.00	
3rd Quartile	Absence	3.00	
	Presence	1.00	

Mann-Whitney test, considering $p \leq 0.05$

Table 4. Comparison of the results of the Penetration and Aspiration Scale considering the presence or absence of anteroposterior constriction of the arytenoids for consistency of the International Dysphagia Diet Standardization Initiative 0

	Anteroposterior constriction of the arytenoids - vowel i	Penetration and Aspiration Scale	p-value
1st Quartile	Absence	4.25	
	Presence	1.00	
Median	Absence	5.50	0.016
	Presence	1.00	
3rd Quartile	Absence	6.75	
	Presence	1.00	

Mann-Whitney test, considering $p \leq 0.05$

Table 5. Comparison of the results of the Yale scale (residues in valleculae) considering "How much the epiglottis covers" for consistency of the International Dysphagia Diet Standardization Initiative 4

	How much the epiglottis covers	Yale scale -valecullae	p-value
1st Quartile	0	1.00	
	1	1.00	
	2	4.00	
Median	0	3.00	
	1	1.00	*0.017
	2	4.00	
3rd Quartile	0	3.00	
	1	1.00	
	2	4.00	

Kruskal-Wallis test and Dwass-Steel-Critchlow-Fligner post-test, considering $p \leq 0.05$. *Statistically significant difference between levels 0 and 1 of "How much the epiglottis covers"

Subtitle: How much the epiglottis covers – (0) None/ (1) Half/ (2) More than half

Table 6. Comparison of the results of the Pharyngeal Residue Scale considering the presence or absence of vocal fold asymmetry for consistency of the International Dysphagia Diet Standardization Initiative 7

	Vocal fold asymmetry	Pharyngeal residue scale	p-value
1st Quartile	Absence	1.00	0.025
	Presence	2.00	
Median	Absence	1.00	
	Presence	2.00	
3rd Quartile	Absence	1.00	
	Presence	3.00	

Mann-Whitney test, considering $p \leq 0.05$

Table 7. Comparison of the results of the Yale Scale (valleculae residues) considering the presence or absence of vocal fold asymmetry for consistency of the International Dysphagia Diet Standardization Initiative 7

	Vocal fold asymmetry	Yale scale - valleculae	p-value
1st Quartile	Absence	1.00	
	Presence	2.00	
Median	Absence	1.00	0.008
	Presence	4.00	
3rd Quartile	Absence	2.00	
	Presence	4.00	

Mann-Whitney test, considering $p \leq 0.05$

studies should be conducted to identify which changes are due to the stroke and which are due to aging itself.

In laryngeal behavior during phonation, complete glottic closure, anteroposterior constriction of the arytenoids and epiglottis petiole, median constriction, and asymmetry in laryngeal behavior (reduction in vocal fold movement) were observed in most of the sample. Other studies carried out with fiberoptic laryngoscopy in elderly individuals affected by stroke showed changes in laryngeal motor control with decreased vocal fold mobility, presence of anteroposterior supraglottic constriction and median constriction[19,20]. Regarding glottic closure, this study showed that in most cases there was complete glottic closure, which may be related to the population studied, considering that laryngeal alterations due to neurological etiologies such as stroke can recover after acute states[21].

In the Fiberoptic Endoscopic Evaluation of Swallowing (FESS), the presence of laryngeal penetration and aspiration was predominant with IDDSI 0 consistency, being observed with IDDSI 4 in only one participant. A study that evaluated swallowing in patients with stroke, using a scintigraphic method, observed the presence of signs of aspiration of extremely thick liquid consistency in 15% of the patients evaluated[22]. It is worth noting that the central nervous system involved in the control of swallowing comprises, in addition to the brain stem, an extensive supramedullary network, as well as several cortical areas, such as the premotor areas, primary sensorimotor cortex and cingulate cortex[23]. It is known that this network responds in a plastic and compensatory way to lesions of the central and peripheral nervous system[24,25]. Therefore, considering that the sample of this study included individuals with an average injury time of 62 months, the hypothesis is raised that the neuroplasticity process may have influenced the recovery of dysphagic conditions and, consequently, the low occurrence of penetration/aspiration[26].

Regarding the comparative analyses between laryngeal functional characteristics and swallowing, it was observed that most patients who presented anteroposterior constriction of the arytenoids during phonation had no penetration/aspiration in the IDDSI 0 consistency (thin liquid). Regarding this subject, it is known that the arytenoids contribute to the closure of the laryngeal vestibule, preventing the entry of food into the lower airways[27]. The arytenoids, together with other laryngeal structures, play a fundamental role in ensuring safety during swallowing. In addition, failures in laryngeal sensitivity can be caused by increasing age and neurological alterations, such as stroke, causing structures in the larynx to modify and/or increase their functions. In this sense, this fact can be related to the presence of supraglottic constrictions as an aid to closing the laryngeal vestibule, preventing the passage of food and promoting safety during swallowing[18].

According to studies, in patients with a history of stroke, failures in the swallowing process due to sensory deficits resulting from changes in cortical sensory areas can generate compensations in the function. Therefore, it is expected that morphological and behavioral changes may arise in the larynx[3,18,28]. In this sense, another issue considered in this study was whether the nasal anesthetic xylocaine gel 2% used during the Fiberoptic Laryngoscopy and FEES could have influenced the results. Studies show that, based on protocols, nasal local anesthetics for laryngoscopy can be used in a quantity of 0.4 ml (2%) to provide comfort to patients during the analysis without side effects and without affecting laryngopharyngeal physiology and swallowing biomechanics[29].

It was also found that there were differences between the Pharyngeal Residue Scale according to laryngeal morphology, specifically for IDDSI 7 consistency (solid), and vocal fold asymmetry. In the presence of vocal fold asymmetry at rest, there were residues in the pharynx of levels I and II after swallowing IDDSI 7. It was observed that the reduction in pharyngeal and laryngeal movement may be linked to the presence of neurological alterations that may result in laryngeal deficits, pharyngeal paresis, reduced pharyngeal peristalsis, loss of reflexes and decreased muscle strength, which would cause the presence of asymmetry and accumulation of residues[17].

Finally, the sample of this article was mostly composed of individuals with a history of ischemic stroke. A study described that the frequency of dysphagia in cases of ischemic stroke was 31.7%, while in hemorrhagic stroke it was 58.6%, demonstrating that the presence of swallowing disorders is more frequent in ischemic lesions[30]. However, the authors highlight that the severity and size of the lesion are correlated with the severity of dysphagia[30]. Furthermore, the time of injury and issues related to brain neuroplasticity may influence clinical findings in voice and swallowing assessments. Thus, as limitations of this study, we highlight the time of stroke in the sample, which interferes with the identification of changes caused by neurological injury or by aging, as well as the absence of neuroimaging exams that would allow the detection of the area of brain injury. Therefore, since this is a preliminary study, we suggest continuing the investigation and deepening the issues studied with larger samples, in addition to conducting studies with a control group of healthy elderly individuals.

CONCLUSION

Swallowing safety and efficiency are different in late post-stroke individuals who present anteroposterior constriction, just as swallowing efficiency differs according to the amount of epiglottis coverage and vocal fold asymmetry in these individuals. These findings indicate that morphological and laryngeal behavior changes may be positive for swallowing in the population studied. Further studies are needed to deepen knowledge on this topic.

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