Original Article

https://doi.org/10.1590/2317-6431-2022-2666en

Audiology Communication Research
ISSN 2317-6431

Association between the number of swallowing, pharyngeal residue and bronchopulmonary aspiration in multiple sclerosis

Associação entre o número de deglutições, resíduo faríngeo e broncoaspiração na esclerose múltipla

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ABSTRACT

Purpose: To verify the association between the number of swallows and the presence of pharyngeal residue and bronchoaspiration in people with Multiple Sclerosis. **Methods:** An observational cross-sectional study of videofluoroscopic examinations of 231 swallows from individuals with Multiple Sclerosis. Three speech therapists evaluated IDDSI 1 (International Dysphagia Diet Standardisation Initiative) (5ml and 10ml) and IDDSI 4 (8ml) deglutitions for pharyngeal residue and penetration/ aspiration. Swallows with no pharyngeal residue were classified as swallows without pharyngeal residue (SWTR) and those with pharyngeal residue (SWR), the latter subdivided into pharyngeal residue in all or occasional offerings (SWR1 e SWR2). The number of swallows was analyzed by a blind evaluator and compared with demographic and clinical data. **Results:** Of the 231 swallows, 73 (31.6%) showed pharyngeal residues. The mean number of swallows was similar in the deglutitions with and without pharyngeal residues in each consistency and volume and in the variables age, gender, type of Multiple Sclerosis and functional disability. There was an association between the mean number of swallows and the absence of penetration/aspiration when comparing deglutitions with and without pharyngeal residues, in SWR2 and in individuals over 50 years of age. When analyzing intragroup, an association was observed in SWR, being higher in the absence of penetration/ aspiration and in SWR2. **Conclusion:** There was no correlation between the number of swallows and the presence of residues in pharyngeal recesses in multiple sclerosis. However, the number of swallows was higher when there was residue and absence of dysphagia and penetration/aspiration, and in older individuals.

Keywords: Multiple sclerosis; Deglutition disorders; Pharyngeal residue; Respiratory aspiration; Physiology

RESUMO

Objetivo: verificar a associação entre o número de deglutições e presença de resíduo faríngeo e broncoaspiração em pessoas com esclerose múltipla. **Métodos:** estudo transversal observacional de exames de videofluoroscopia de 231 deglutições de indivíduos com esclerose múltipla. Três fonoaudiólogas avaliaram as deglutições de IDDSI 1 (*International Dysphagia Diet Standardisation Initiative*) (5 ml e 10 ml) e IDDSI 4 (8 ml) quanto à presença de resíduo faríngeo e de penetração/aspiração. Deglutições que não apresentaram resíduo faríngeo foram classificadas como deglutições sem resíduos faríngeos (DSR) e as que apresentaram, como deglutições com resíduos faríngeos (DCR), sendo estas últimas subdivididas em resíduos faríngeos em todas as ofertas ou eventuais (DCR1 e DCR2). O número de deglutições foi analisado por um avaliador cego e comparado com os dados demográficos e clínicos. **Resultados:** das 231 deglutições, 73 (31,6%) apresentaram resíduos faríngeos. O número médio de deglutições foi semelhante nas deglutições sem e com resíduos faríngeos em cada consistência e volume e nas variáveis idade, gênero, tipo de esclerose múltipla e incapacidade funcional. Houve associação entre a média do número de deglutições e a ausência de penetração/aspiração, quando comparada às deglutições sem e com resíduos faríngeos, nas DCR2 e em indivíduos acima de 50 anos. Ao analisar intragrupo, observou-se associação nas DCR, sendo maior na ausência de penetração/aspiração e nas DCR2. **Conclusão:** não houve correlação entre o número de deglutições e a presença de resíduos em recessos faríngeos na esclerose múltipla. Todavia, o número de deglutições foi maior quando houve resíduo e ausência de disfagia e de penetração/aspiração, em indivíduos mais velhos.

Palavras-chave: Esclerose múltipla; Transtornos de deglutição; Resíduo faríngeo; Aspiração respiratória; Fisiologia

Study carried out at Departamento de Fonoaudiologia, Faculdade de Medicina, Universidade Federal de Minas Gerais – HC-UFMG – Belo Horizonte (MG), Brasil.

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Conflict of interests: No.

Authors' contribution: ACS participated in the design of the study, data collection, analysis and interpretation of data and writing of the article; MIRG participated in data analysis and interpretation and manuscript correction; LCCV participated in the design of the study, analysis and interpretation of data and correction of the manuscript.

Funding: None.

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Received: April 29, 2022; **Accepted**: September 12, 2022

INTRODUCTION

Multiple sclerosis (MS) is a chronic, inflammatory, autoimmune, neurodegenerative disease that causes the demyelination of the myelin sheath that covers the neurons of the white and gray matter in the central nervous system (CNS)[1,2]. The disease has a heterogenous cause and is related to individual intrinsic and extrinsic factors[2] affecting around 2.3 million people worldwide[3], generally young adults aged between 20 and 40 years, being more common in women[1], at the proportion of 2:1[3]. Its country-wide prevalence varies according to the geographic latitude[1-3], in Brazil, approximately between 5.01 and 20 out of every 100 thousand residents[3] have MS.

MS is subdivided into the following clinical types: Recurrent remitting (RRMS) affects around 85% of individuals and usually emerges between 20 and 35 years old through well-defined outbreaks and remissions of neurological deficits with good recovery. The disease does not progress in the intervals between outbreaks. Primary progressive (PPMS) affects 10% of individuals and generally manifests at 40 years old and progresses from the start with a slow, gradual neurological deficit. Secondary progressive (SPMS) has an initial condition like the RRMS and then becomes progressive[1-3].

Dysphagia is a frequent symptom in individuals with MS[4,5] and both the oral and the pharyngeal phases may be compromised[6]. Dysphagia occurrence in the disease varies between 33% and 43%[5,7,8], being more frequent in individuals with greater impairment according to the Expanded Disability Status Scale (EDSS), even though people ranked with lower impairment might present signs and symptoms of swallowing disorders[9]. Generally, dysphagia manifests upon damage of the corticobulbar fibers, brainstem injury, or impairment of the lower cranial nerves[4-6,8]. Individuals can be either asymptomatic or present varying symptomology, such as thick saliva, longer oral transit time, presence of pharyngeal residue, cough during or after nutrition, choking, bronchoaspiration of the bolus, and fatigue during nutrition, among other symptoms[8].

The pharyngeal residue is the retention of material that remains in the pharynx after swallowing, considered a sign of impairment of swallowing efficiency, and can be present in the vallecula, piriform sinuses, or in both structures[10]. The presence and amount of residue in the pharynx are related to the risk of aspiration[10,11]. A study involving patients with a cerebrovascular accident, amyotrophic lateral sclerosis, and Parkinson's disease found the presence of pharyngeal residues in the pasty and thickened liquid consistencies in 63.3% and 59.7% of the cases, respectively[12].

Videoendoscopy (VED) and videofluoroscopy of swallowing (VFS) are instrumental methods considered gold-standard to assess the swallowing and presence of pharyngeal residues[12]. However, VFS is regarded as more adequate in cases that require a physiopathology assessment of all swallowing phases in people with dysphagia, thus allowing the understanding of the swallowing biomechanics regarding the symptoms[11,12].

The number of swallows of the bolus is characterized by the number of swallows required to complete the clearing of the digestive tract[13]. The presence of two or more spontaneous swallows for a single bolus is defined as multiple swallows and indicates motor changes and sensitivity in the oral and pharyngeal phases. Therefore, individuals with multiple spontaneous swallows present residues in the oral cavity and pharyngeal recesses[13].

The presence of residues in pharyngeal recesses may lead to laryngotracheal aspiration and a potential worsening of the general health condition of the individual with MS. Thereby, the aspects involved in the swallowing physiopathology must be assessed to prepare conduct protocols that minimize and prevent complications caused by dysphagia. For such a purpose, it is essential to investigate whether the presence of multiple swallows is a clinical sign of pharyngeal residue, which, in these cases, would allow accessing a simple, fast diagnosis resource in the absence of instrumental tests. Thus, this study aimed to analyze the association between the number of swallows, the presence of pharyngeal residues, and bronchoaspiration in people with multiple sclerosis.

METHODS

This is an observational analytical cross-sectional study based on data from a base of tests of swallowing videofluoroscopy in individuals with multiple sclerosis at an outpatient reference center at the Clinical Hospital of the Federal University of Minas Gerais – HC/UFMG. All individuals had a diagnosis provided by a neurologist of the service through a clinical assessment and image and laboratory tests. All participants signed an Informed Consent Form (ICF) at the moment of collection. This study was approved by the Research Ethics Committee of the Federal University of Minas Gerais – CEP-UFMG, decision 294/09.

We analyzed the swallows of 77 individuals – 65 females and 12 males – aged between 19 and 61 years (mean age of 40 years). The individual clinical evolution was detected as follows: three with primary progressive (PPMS), 13 with secondary progressive (SPMS), and 61 with recurrent remitting (RRMS). The degree of neurological impairment of all individuals was classified according to the Expanded Disability Status Scale (EDSS), based on the assessment of the functional systems and the patient's walkability, with scores varying between 0 and 10[14].

The videofluoroscopy tests were performed by a radiologist and a speech-language therapist in an X-ray-shielded room at the Radiology Service of the HC/UFMG. The device used was a serigraph by Philips, model Diagnostic RX 0722, coupled to a TV screen and the DVD device by Semp Toshiba, model SD4071, recording the images in 30 frames per minute. All tests whose DVDs were damaged, thus preventing the images from being visualized, were excluded.

The side view videofluoroscopy images and the consistencies provided were analyzed based on the International Dysphagia Diet Initiative Standardisation scale (IDDSI)[15] as follows: 5 ml and 10 ml of IDDSI 1 (grape juice added with barium at the proportion of 1:1) and 8 ml of IDDSI 4 (smashed banana) provided separately.

Three speech-language therapists with an average experience in the use and interpretation of videofluoroscopy of 12 years performed the assessment simultaneously and consensually to verify the presence of residue in pharyngeal recesses and bronchoaspiration. To avoid influencing the evaluation of the tests, the speech-language therapists were unaware of the participants' clinical history concerning the dysphagia complaints and the clinical evolution of the disease. The real-time image analysis (30 frames/second), frame-by-frame and static, was performed as many times as the professionals requested.

The presence of pharyngeal residue was defined as the accumulation of some volume of the bolus material in the pharynx region, larger than a narrow layer or a covering fold of the structure, thus distinguishable from a simple adhesion of the barium in the anatomic structure[16]. After the end of the spontaneous swallowing and the return of the larynx to the resting position, we considered the presence of pharyngeal residue upon the presence of two or more spontaneous swallows for a single bolus[13].

The presence of dysphagia and bronchoaspiration was analyzed through the O'Neil scale[17] and the Rosenbek scale of penetration and aspiration[18], respectively.

Our final sample was composed of 231 swallows: 77 images each for the IDDSI 1 – 5 ml, IDDSI 1 – 10 ml, and IDDSI 4 – 8 ml. It is worth mentioning that quantifying the pharyngeal residue volume was not part of our study scope since the goal was to investigate whether the number of swallows was a clinical sign of pharyngeal residue or bronchoaspiration in the MS, regardless of the amount.

The samples of swallowing were divided into swallowing without pharyngeal residue (SWTR) and swallowing with pharyngeal residue (SWR). The SWTR included swallows without pharyngeal residue and the SWR included swallows with residue in vallecules or piriform recesses. This group was subdivided into two classifications: SWR1 – swallows with residues in pharyngeal recesses in the three supplies (5 ml of IDDSI 1 and 10 ml of the IDDSI 4), and SWR2 – swallows with pharyngeal residue in one or two supplies (Figure 1).

The number of swallows per supply was analyzed by an evaluator who was not aware of to which group the swallows belonged and had not participated in the first step – analysis of pharyngeal residue presence. For the analysis of interevaluator agreement, another examiner, with experience in the use and interpretation of videofluoroscopy, performed a blind analysis of the number of swallows of 20% drawn from the sample.

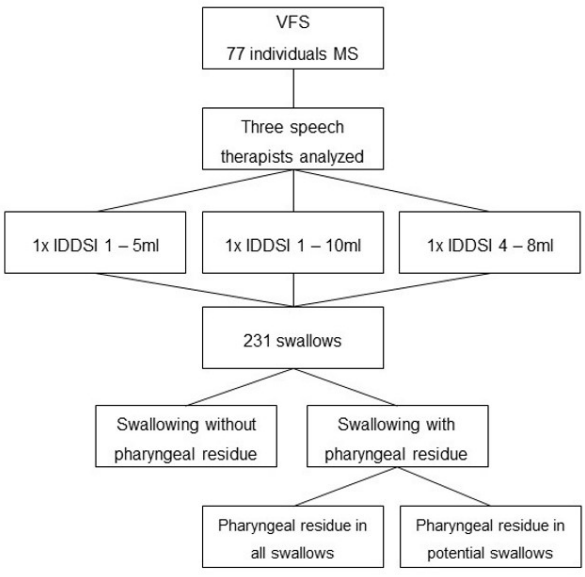

Figure 1. Flowchart of data collection
Subtitle: VDF= videofluoroscopy; in = multiple sclerosis; IDDSI = International Dysphagia Diet Standardisation Initiative; IDDSI 1 = very slightly thickened liquid; IDDSI 4 = pasty

The Intraclass Correlation Coefficient (ICC) reached 0.83 of agreement on the number of swallows between the evaluators, thus indicating an excellent agreement[19].

The data analysis considered the following variables: number of swallows by bolus, gender, age, consistency, and volume, type of disease presentation, degree of functional inability (EDSS), and presence of bolus bronchoaspiration.

The age variable was analyzed by decade, the form of disease presentation, and the clinical types PPMS and SPMS, for being the least frequent. The degree of functional inability was ranked as mild upon an EDSS of ≤3.5, moderate between 4.0 and 6.5, and severe >6.5[20]. Dysphagia was classified according to the O'Neil scale as the absence of swallowing disorder (levels 6 and 7) and the presence of oropharyngeal dysphagia (level ≤5), while bronchoaspiration was classified based on the Rosenbek scale as the absence of food input in the lower airway (level 1) and presence of penetration or aspiration (level ≥2).

All analyses were performed on the IBM SPSS Statistics software version 24. The data were analyzed descriptively through central trend measures, dispersion, and proportions. Mann-Whitney and Kruskal-Wallis tests compared the number of swallows between the groups and categories of explanatory variables. All analyses considered a significance level of 5%.

RESULTS

We found similar data on gender, age group, type of MS, degrees of functional inability, and presence of bronchoaspiration in the patients with and without pharyngeal residue. Both groups (SWTR and SWR) had a prevalence of female individuals, aged between 30 and 49 years, and RRMS clinical type. We observed a higher frequency of mild motor inability, bronchoaspiration/penetration (9.1%), and the presence of dysphagia (19.5%) in the group with pharyngeal residue compared with the group without pharyngeal residue (Table 1).

Out of the 231 swallows analyzed, 73 (36.1%) presented residues in vallecules or piriform sinuses (SWR) and 158 (68.4%) showed no pharyngeal residues (SWTR) (Figure 2). For the analysis of the number of swallows in the cases with potential pharyngeal residues, the supplies ingested without pharyngeal residues were analyzed along with the other cases of SWTR to avoid influencing the result of the number of swallows in the presence of pharyngeal residue.

The presence of residue of the IDDSI 4 consistency was more frequent both in the swallows with pharyngeal residues (SWR1) and in the swallows with potential pharyngeal residues (SWR2) (Figure 3).

The SWTR and SWR had similar mean numbers of swallows, being more frequent in the IDDSI 1 – 10 m l and IDDSI 4 – 8 ml compared with the IDDSI 1- 5 ml (Table 2).

In an analysis of the sample in its entirety regardless of the consistency and volume, a comparison between SWTR and SWR showed a greater mean number of swallows in the absence of dysphagia (p=0.021) and upon the presence of residue and absence of penetration/aspiration (p=0.015) in the SWR. A comparison between the SWR1 and SWR2 revealed a greater mean number of swallows for those with potential pharyngeal residues and individuals aged between 50 and 61 years (p=0.031 or without penetration/aspiration (p=0.047) (Table 3).

The intragroup analysis of the number of swallows showed a higher mean number of swallows in the SWR in the absence

Table 1. Demographic and clinical characterizations of the patients with multiple sclerosis

		SWTR		SWR		SWR1		SWR2	
		N	%	N	%	N	%	N	%
Gender	Female	32	41.6	33	42.9	8	19.5	25	61.0
	Male	4	5.2	8	10.4	6	14.6	2	4.9
Age group	19 to 29 years	8	10.4	6	7.8	2	4.9	4	9.8
	30 to 39 years	11	14.3	11	14.3	4	9.8	7	17.1
	40 to 49 years	12	15.6	13	16.9	5	12.2	8	19.5
	50 to 61 years	5	6.5	11	14.3	3	7.3	8	19.5
MR Type	RRMS	31	40.3	30	39.0	10	24.4	20	48.8
	PPMS	2	2.6	1	1.3	0	0	1	2.4
	SPMS	3	3.9	10	13.0	4	9.8	6	14.6
EDSS	Mild	15	19.5	21	27.3	8	19.5	13	31.7
	Moderate	17	22.1	14	18.2	4	9.8	10	24.4
	Severe	4	5.2	6	7.8	2	4.9	4	9.8
O'Neil	Absence of dysphagia	33	91.6	33	80.4	10	71.4	23	85.1
	Presence of dysphagia	3	8.3	8	19.5	4	28.5	4	14.8
Rosenbek	Absence of penetration/aspiration	33	42.9	34	44.2	11	26.8	23	56.1
	Presence of penetration/aspiration	3	3.9	7	9.1	3	7.3	4	9.8

Subtitle: SWTR = swallows without pharyngeal residue; SWR = swallows with pharyngeal residue; SWR1 = pharyngeal residue in all swallows; SWR2 = pharyngeal residue potential; N= number of patients; in = multiple sclerosis; RRMS = recurrent remitting multiple sclerosis; PPMS = primary progressive multiple sclerosis; SPMS = secondary progressive multiple sclerosis; EDSS = Expanded Disability Status Scale

Table 2. Number of swallows between swallows with and without residue according to the consistency and volume

	SWTR			SWR (SWR1 + SWR2)			p-value
	Min	Max	Mean (± SD)	Min	Max	Mean (± SD)	
IDDSI 1 - 5 ml	1	3	1.88 (0.52)	1	2	1.88 (0.33)	0.883*
IDDSI 1 -10 ml	1	4	2.04 (0.66)	1	3	2.24 (0.52)	0.147*
IDDSI 4 - 8ml	1	4	2.02 (0.65)	1	3	2.06 (0.63)	0.605*
Total	1	3.7	1.97 (0.61)	1	2.7	2.08 (0.55)	0.124*
	SWR1			SWR2			p-value
	Min	Max	Mean (± SD)	Min	Max	Mean (± SD)	
IDDSI 1 - 5 ml	1	2	1.93 (0.27)	1	2	1.67 (0.58)	0.648**
IDDSI 1 -10 ml	2	3	2.29 (0.47)	1	3	2.18 (0.60)	0.323**
IDDSI 4 - 8ml	1	3	2.00 (0.68)	1	3	2.12 (0.60)	0.725**
Total	1.3	2.7	2.07 (0.51)	1	2.7	2.10 (0.60)	0.293**

(*)Mann-Whitney Test; (**)Kruskal-Wallis Test; significant if p<0.050

Subtitle: SWTR = swallows without pharyngeal residue; SWR = swallows with pharyngeal residue; SWR1 = pharyngeal residue in all as swallows; SWR2 = swallowing with pharyngeal residue potential; Min = minimum; Max = maximum; SD = standard deviation; IDDS = International Dysphagia Diet Standardisation Initiative; IDDSI 1 = very slightly thickened liquid; IDDSI 4 = pasty

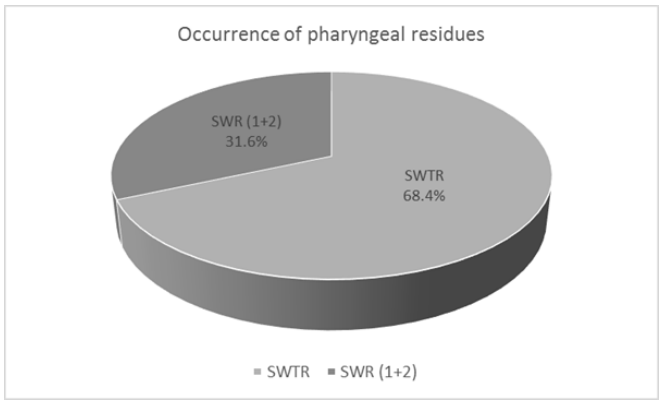

Figure 2. Frequency of residue in the 231 swallows of patients with multiple sclerosis

Subtitle: SWTR = swallows without pharyngeal residue; SWR = swallows with pharyngeal residue

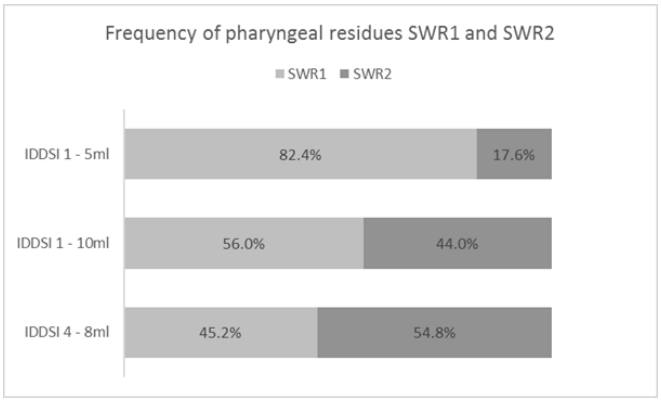

Figure 3. Frequency of residue between swallows with pharyngeal residue in all swallows and swallows with pharyngeal residue potential, according to the consistency and volume of the 73 swallows with residue

Subtitle: SWR1 = pharyngeal residue in all swallows; SWR2 = swallows with pharyngeal residue potential; IDDS = International Dysphagia Diet Standardisation Initiative; IDDSI 1 = very slightly thickened liquid; IDDSI 4 = pasty

Table 3. Comparison of the number of swallows of all as supplies between swallows with and without pharyngeal residue

			SWTR				SWR (SWR1 + SWR2)				p-value
			Min	Max	Mean	Standard deviation	Min	Max	Mean	Standard deviation	
All as consistencies	Gender	Female	1	4	1.96	0.63	1	4	2.06	0.60	0.270
		Male	2	3	2.06	0.25	2	3	2.15	0.37	0.613
	Age group	19 to 29 years	1	4	2.00	0.68	2	3	2.09	0.30	0.608
		30 to 39 years	1	3	1.98	0.61	1	3	2.11	0.46	0.474
		40 to 49 years	1	4	1.90	0.54	1	3	1.96	0.61	0.638
		50 to 61 years	1	2	2.07	0.64	1	4	2.22	0.65	0.313
	MS Type	RRMS	1	4	1.99	0.59	1	4	2.09	0.52	0.166
		PPMS + SPMS	1	3	1.90	0.67	1	3	2.05	0.62	0.441
	EDSS	Mild	1	4	2.00	0.62	1	4	2.05	0.51	0.550
		Moderate	1	4	2.01	0.56	1	3	2.17	0.56	0.228
		Severe	1	3	1.75	0.72	1	3	2.00	0.67	0.357
	O'Neil	Absence of dysphagia	1	4	1.96	0.61	1	4	2.14	0.52	**0.021***
		Presence of dysphagia	2	2	2.12	0.60	1	3	1.88	0.62	0.395
	Rosenbek	Absence of penetration/ aspiration	1	4	1.96	0.61	1	4	2.15	0.52	**0.015***
		Presence of penetration/ aspiration	2	2	2.12	0.60	1	3	1.77	0.60	0.129
			SWR1				SWR2				p-value
			Min	Max	Mean	Standard deviation	Min	Max	Mean	Standard deviation	
	Gender	Female	1	3	2.00	0.59	1	4	2.10	0.62	0.439
		Male	2	3	2.17	0.38	2	2	2.00	0.00	0.688
	Age group	19 to 29 years	2	3	2.17	0.41	2	3	2.00	0.00	0.846
		30 to 39 years	2	3	2.25	0.45	1	3	1.86	0.38	0.261
		40 to 49 years	1	3	2.00	0.53	1	3	1.90	0.74	0.765
		50 to 61 years	1	3	1.89	0.60	1	4	2.56	0.53	**0.031***
	MS Type	RRMS	1	3	2.07	0.52	1	4	2.13	0.54	0.352
		PPSM + SPMS	1	3	2.08	0.51	1	3	2.00	0.82	0.676
	EDSS	Mild	1	3	2.00	0.51	1	4	2.13	0.52	0.605
		Moderate	1	2	2.08	0.51	1	3	2.25	0.62	0.332
		Severe	2	3	2.33	0.52	1	3	1.50	0.58	0.100
	O'Neil	Absence of dysphagia	1	3	2.13	0.43	1	4	2.15	0.60	0.066
		Presence of dysphagia	1	3	1.92	0.67	1	3	1.75	0.50	0.565
	Rosenbek	Absence of penetration/ aspiration	1	3	2.15	0.44	1	4	2.15	0.60	**0.047***
		Presence of penetration/ aspiration	1	3	1.78	0.67	1	3	1.75	0.50	0.342

(*)Mann-Whitney Test; significant if p<0.050

Subtitle: SWTR = swallows without pharyngeal residue; SWR = swallows with pharyngeal residue; SWR1 = pharyngeal residue in all as swallows; SWR2 = swallowing with pharyngeal residue potential; in = multiple sclerosis; RRMS = recurrent remitting multiple sclerosis; PPMS = primary progressive multiple sclerosis; SPMS = secondary progressive multiple sclerosis; EDSS = Expanded Disability Status Scale; Min = minima; Max = maximum; SD = standard deviation

of penetration and aspiration compared with the presence of bronchoaspiration (p=0.031). In the SWR2, the individuals aged over 50 years also presented a greater mean number of swallows than the younger age groups (p=0.041) (Table 4).

DISCUSSION

Our results did not point to an increase in the number of swallows in the presence of residue in individuals with MS. We also found multiple swallows in the absence of pharyngeal residue. The damages caused by MS in the neurological control of swallowing are known to impair structures directly involved in the pharyngeal phase[8], which may hamper the propulsion of the bolus from the pharynx to the esophagus. These changes in the swallowing biomechanics can be related to the presence of pharyngeal residues, which is frequent in dysphagia symptomology[12,21,22].

Studies investigating the presence of pharyngeal residues in esophageal-neurogenic dysphagia revealed that its frequency

Table 4. Intragroup comparison of the number of swallows of all swallowing supplies

			SWTR					SWR (SWR1 + SWR2)				
			Min	Max	Mean	Standard deviation	p-value	Min	Max	Mean	Standard deviation	p-value
All consistencies	Gender	Female	1	4	1.96	0.63	0.386	1	4	2.06	0.60	0.632
		Male	2	3	2.06	0.25		2	3	2.15	0.37	
	Age group	19 to 29 years	1	4	2.00	0.68	0.689	2	3	2.09	0.30	0.486
		30 to 39 years	1	3	1.98	0.61		1	3	2.11	0.46	
		40 to 49 years	1	4	1.90	0.54		1	3	1.96	0.61	
		50 to 61 years	1	2	2.07	0.64		1	4	2.22	0.65	
	MS Type	RRMS	1	4	1.99	0.59	0.465	1	4	2.09	0.52	0.837
		PPMS + SPMS	1	3	1.90	0.67		1	3	2.05	0.62	
	EDSS	Mild	1	4	2.00	0.62	0.169	1	4	2.05	0.51	0.650
		Moderate	1	4	2.01	0.56		1	3	2.17	0.56	
		Severe	1	3	1.75	0.72		1	3	2.00	0.67	
	O'Neil	Absence of dysphagia	1	4	1.96	0.61	0.244	1	4	2.14	0.52	0.116
		Presence of dysphagia	2	2	2.12	0.60		1	3	1.88	0.62	
	Rosenbek	Absence of penetration/aspiration	1	4	1.96	0.61	0.244	1	4	2.15	0.52	**0.031***
		Presence of penetration/aspiration	2	2	2.12	0.60		1	3	1.77	0.60	
			SWR1					SWR2				
			Min	Max	Mean	Standard deviation	p-value	Min	Max	Mean	Standard deviation	p-value
	Gender	Female	1	3	2.00	0.59	0.370	1	4	2.10	0.62	0.940
		Male	2	3	2.17	0.38		2	2	2.00	0.00	
	Age group	19 to 29 years	2	3	2.17	0.41	0.397	2	3	2.00	0.00	**0.041***
		30 to 39 years	2	3	2.25	0.45		1	3	1.86	0.38	
		40 to 49 years	1	3	2.00	0.53		1	3	1.90	0.74	
		50 to 61 years	1	3	1.89	0.60		1	4	2.56	0.53	
	MS Type	RRMS	1	3	2.07	0.52	0.946	1	4	2.13	0.54	0.726
		PPMS + SPMS	1	3	2.08	0.51		1	3	2.00	0.82	
	EDSS	Mild	1	3	2.00	0.51	0.366	1	4	2.13	0.52	0.104
		Moderate	1	2	2.08	0.51		1	3	2.25	0.62	
		Severe	2	3	2.33	0.52		1	3	1.50	0.58	
	O´Neil	Absence of dysphagia	1	3	2.13	0.43	0.318	1	4	2.15	0.60	0.339
		Presence of dysphagia	1	3	1.92	0.67		1	3	1.75	0.50	
	Rosenbek	Absence of penetration/aspiration	1	3	2.15	0.44	0.069	1	4	2.15	0.60	0.339
		Presence of penetration/aspiration	1	3	1.78	0.67		1	3	1.75	0.50	

(*)Mann-Whitney or Kruskal-Wallis Test; significant if p<0.050

Subtitle: SWTR = swallows without pharyngeal residue; SWR = swallows with pharyngeal residue; SWR1 = pharyngeal residue in all swallows; SWR2 = swallowing with pharyngeal residue potential; in = multiple sclerosis; RRMS = recurrent remitting multiple sclerosis; PPMS = primary progressive multiple sclerosis; SPMS = multiple sclerosis secondary progressive; EDSS = Expanded Disability Status Scale; Min = minima; Max = maximum; SD = standard deviation

is higher[21-27] than its absence[12]. Patients with ischemic cerebrovascular accident showed an association between the presence of pharyngeal residue and laryngotracheal aspiration, with a greater frequency of bolus input in the lower airways in patients presenting pharyngeal residue (77%) than in those with no accumulation of food (32%)[21]. Thus, these signs must have an early and adequate assessment for dysphagia not to cause complications that increase comorbidity and mortality by the disease.

By analyzing the answers to the DYMUS-BR questionnaire *(*Questionnaire for the Assessment of Dysphagia in Multiple Sclerosis*)*, the authors reported the "feeling of stuck bolus" as one of the most reported signs by the patients[8]. The presence of pharyngeal residue can be a common sign in esophageal-neurogenic dysphagias since the sensorial and motor changes impair the swallowing phases, especially oral and pharyngeal. Changes in the retraction of the base of the tongue, hypotonia of the pharynx constrictor muscles and the pharyngoesophageal segment, and sensorial changes that hinder the clearing perception may cause the retention of the bolus. Consequently, the sensation of pharyngeal residue is generally reported by the patients and associated with stasis in the pharyngeal region[25].

Our study found, on average, two swallows per bolus in the swallows with and without residue. The finding agrees with a

study that found similar values in other esophageal-neurogenic diseases, with mean swallowing numbers in the individuals with cerebrovascular accident and Parkinson's disease of 2.20 and 3.47, respectively[28].

As for the number of swallows according to consistency and volume, we found a higher number of swallows for the IDDSI 4 and the IDDSI 1 in greater volume. Studies have demonstrated that the presence of pharyngeal residue in esophageal-neurogenic dysphagias is more frequent for the pasty consistency and in food with greater viscosity[12,22,27]. Herein, the IDDSI 4 also presented greater pharyngeal residue; however, the IDDSI 1 showed that the larger the volume the more frequent the pharyngeal residue. Thus, multiple swallows are possible for the propulsion of the bolus in such cases of pharyngeal residue[25,26]. Thereby, despite the IDDSI 4 consistency being considered safer for patients with dysphagia, in neurodegenerative diseases such a strategy should be carefully analyzed.

Our study found no association between the number of swallows with and without pharyngeal residue and consistency and volume. It is believed that the stage of the disease and motor ability can interfere with the individual number of swallows. The sample was mostly composed of mild to moderate stages according to the EDSS. The sensorimotor preservation of the structures must be considered in the clinical assessment, as well as weakness and muscle fatigue that damage the swallowing process. Thus, clinical signs of fatigue, penetration, or aspiration must be observed, in addition to the patient's self-report throughout the function.

Swallows belonging to the SWR without dysphagia or penetration/aspiration presented a greater number of swallows than the SWTR. According to the literature, patients with neurodegenerative diseases with a risk of dysphagia may present several symptoms, such as odynophagia, muscle hypotonia, weakness, fatigue, and discomfort, among others[8,26]. Dysphagia in MS can start as a mild degree in the Expanded Disability Status Scale (EDSS) and is more prevalent from moderate to severe degrees[8]. Naturally, it is expected that as the disease progresses, dysphagia worsens and the number of swallows increases to favor the propulsion of the bolus. However, our study found that the increase in the number of swallows was related to the absence of dysphagia and penetration/aspiration in the swallows with pharyngeal residue, suggesting a positive factor. Such a scenario is likely to be associated with the capacity of these individuals to feel food retention in the pharyngeal recesses due to better sensorial and biomechanic skills still unaffected by the disease. Thereby, our results suggest that multiple swallows favored the spontaneous clearing of the bolus.

Significant values were found in the age group between 50 and 61 years for the swallows with potential pharyngeal residues (SWR2) with a mean superior to that of the other younger age groups analyzed herein. The natural aging of the structures impacts the swallowing function[29], a process that can be maximized when associated with neurological disease[30]. The structural damage caused by neuronal demyelination in the MS affects nerves and fibers responsible for the function. In elderly individuals with Parkinson's disease, there was an association between the need for multiple swallows and the presence of pharyngeal residues. In addition, after multiple swallows, 16% of the individuals were not able to proceed with the clearing and there was no pharyngeal contraction in some cases[25]. The presence of multiple swallows in the age group of older adults with MS can be explained by the degeneration of nerve fibers, lower muscle strength, and consequently mobility loss. However, sensorial preservation may have been responsible for allowing for an attempt of clearing the pharyngeal recesses.

Identifying the clinical signs that indicate changes in the swallowing biomechanics allows for a diagnosis in the absence or inability of performing instrumental tests. The verification of the number of swallows by bolus is a simple, fast, and non-invasive procedure that represents no risk to the patient. Only a few studies have addressed the theme. The presence of multiple swallows may indicate several changes in the swallowing biomechanics.

Our study analyzed a high number of swallows whose results revealed that older individuals and non-dysphagic individuals presented a greater number of swallows in the presence of pharyngeal residues and an association between the presence of residue, increase in swallows, and absence of penetration/aspiration. Therefore, we might infer that in patients with pharyngeal residues, the presence of multiple swallows can indicate the individual's attempt to avoid bronchoaspiration, representing an important clinical sign to be observed during intervention with the MS patient. We suggest that other studies analyze whether the volume of the pharyngeal residue and the supply of different amounts of bolus interfere with the number of swallows. Our study scope is relevant to improve the procedures of assessment and speech therapy and promoting quality of life.

CONCLUSION

Our study found no association between the number of swallows and the presence or absence of pharyngeal residue in MS. Therefore, the number of swallows in individuals with MS is not a predictive sign of the presence of residues in pharyngeal recesses. However, there was an increase in the number of swallows in the presence of pharyngeal residue and the absence of dysphagia or penetration/aspiration in older individuals.

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