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Comparison between the functional aspects of swallowing and clinical markers in ICU patients with Traumatic Brain Injury (TBI)

Comparação dos aspectos funcionais da deglutição e indicadores clínicos em pacientes com traumatismo cranioencefálico em UTI

Juliana Lopes Ferrucci[1]
Fernanda Chiarion Sassi[2]
Gisele Chagas de Medeiros[1]
Claudia Regina Furquim de Andrade[2]

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ABSTRACT

Purpose: To characterize and compare the functional aspects of swallowing and clinical markers in intensive care patients with traumatic brain injury (TBI) in Intensive Care Unit (ICU). **Methods:** Participants of this study were 113 adults diagnosed with TBI. Data collection stage involved: clinical assessment of the risk for bronchoaspiration performed by a speech-language therapist; assessment of the functional level of swallowing (American Speech-Language-Hearing Association National Outcome Measurement System – *ASHA NOMS*); assessment of the patient' health status (Sequential Organ Failure Assessment - SOFA). **Results:** After the inclusion criteria were applied, patients were grouped according to their swallowing functional level: levels 1 and 2 – ASHA1 (n=25); levels 3, 4 and 5 – ASHA2 (n=37); levels 6 and 7 – ASHA3 (n=51). The statistical analyses indicated the following significant results: the ASHA3 group presented lower severity levels of TBI at the clinical assessment of bronchoaspiration, remained less time intubated (approximately um third less than the more severe group), remained fewer days in hospital and needed less therapy sessions to return to safe oral feeding. The clinical predictor signs for bronchoaspiration that best characterized the groups were the presence of altered auscultation and the presence of coughing after swallowing. Patients in the ASHA3 group presented these signs less frequently. **Conclusion:** The score obtained on the SOFA and the time of orotracheal intubation were identified as the prognostic indicators of functional swallowing. The presence of altered cervical auscultation and coughing were clinical predictors of dysphagia.

Descritores

Deglutição
Transtornos da Deglutição
Traumatismos Craniocerebrais
Pneumonia Aspirativa
Unidades de Terapia Intensiva
Fonoaudiologia

RESUMO

Objetivo: caracterizar e comparar os aspectos funcionais da deglutição e indicadores clínicos na população com traumatismo cranioencefálico (TCE) em unidade de terapia intensiva. **Método:** Participaram do estudo 113 adultos com diagnóstico de TCE. As etapas de coleta de dados envolveram: a avaliação fonoaudiológica clínica do risco de broncoaspiração, determinação do nível funcional da deglutição (*American Speech-Language-Hearing Association National Outcome Measurement System – ASHA NOMS*), determinação da gravidade clínica do indivíduo de acordo com a *Sequential Organ Failure Assessment* (SOFA). **Resultados:** Após a aplicação dos critérios de inclusão, os pacientes selecionados foram agrupados de acordo com os níveis funcionais de deglutição: níveis 1 e 2 – ASHA1 (n=25); níveis 3, 4 e 5 – ASHA2 (n=37); níveis 6 e 7 – ASHA3 (n=51). As análises estatísticas indicaram os seguintes resultados significantes: o grupo ASHA3 apresentou menor gravidade do TCE no momento da avaliação fonoaudiológica, menor tempo de intubação orotraqueal (um terço a menos que o grupo mais grave), ficou menos tempo hospitalizado e necessitou de menos sessões de atendimento fonoaudiológico para o retorno seguro para via oral de alimentação. Os sinais clínicos preditores de broncoaspiração que mais diferenciaram os grupos foi a presença de ausculta cervical alterada e presença de tosse após a deglutição, sendo que o grupo ASHA3 apresentou esses sinais com menor frequência. **Conclusão:** O escore SOFA e o tempo de intubação orotraqueal foram indicadores do prognóstico da funcionalidade da deglutição. A presença ausculta cervical alterada e tosse foram preditores clínicos de disfagia.

Correspondence address:
Claudia Regina Furquim de Andrade
Departamento de Fisioterapia, Fonoaudiologia e Terapia Ocupacional, Faculdade de Medicina, Universidade de São Paulo - FMUSP
Rua Cipotânea, 51, Cidade Universitária, São Paulo (SP), Brasil, CEP: 05360-160.
E-mail: clauan@usp.br

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Study conduct at Divisão de Fonoaudiologia, Instituto Central, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo – USP - São Paulo (SP), Brasil.

[1] Divisão de Fonoaudiologia, Instituto Central, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo -USP- São Paulo São Paulo, Brasil.

[2] Departamento de Fisioterapia, Fonoaudiologia e Terapia Ocupacional, Faculdade de Medicina, Universidade de São Paulo -USP- São Paulo, São Paulo, Brasil.

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INTRODUCTION

The Traumatic Brain Injury (TBI) is defined by the literature as any traumatic brain injury caused by an external physical force that causes anatomical damage and / or functional impairment of the scalp, skull, meninges, encephalon or blood vessels[1]. These brain lesions may result in death or result in the development of functional, cognitive, behavioral, and psychological sequelae[1].

Among the main causes of TBI, we can mention traffic accidents (collision and trampling), falls and physical aggressions, since the falls occurring mostly in the elderly population, and traffic accidents and aggressions are more frequent in young adults[2]. It is estimated that 1.5 million people die each year and hundreds of millions require emergency treatment as a result of traffic accidents and aggressions, thus characterizing a major global public health problem[3,4]. Because of its high incidence, high potential for disability and the impact on the economically active population, TBI stands out as a serious social and economic problem and is currently considered a "silent epidemic"[4].

Developing countries have few epidemiological studies on the extent and TBI impact. The TBI Statistics in Brazil are rare and address specific regions[5]. According to a recent study[6], which evaluated the cases of TBI in Brazil, using data from the Department of Information Technology of the Unified Health System (DATASUS) between 2008 and 2012, there were 125,000 hospitalizations per year resulting from TBI and an incidence of 65.7 admissions per 100,000 inhabitants per year. The hospital mortality was 5.1 / 100,000 / year and the case fatality rate was 7.7%. The average annual cost of hospital expenses with this population was US $ 70,960,000. In the same study[6], the age range of 20 to 29 years old presented a higher number of deaths during hospitalization.

Patients who are victims of TBI often present neurogenic oropharyngeal dysphagia as one of the sensorimotor sequelae[4]. Dysphagia is characterized by changes in the swallowing process, which can cause laryngotracheal aspiration, pneumonia and other respiratory problems, which may lead to worsening of the patient's clinical condition[6,7].

Oropharyngeal dysphagia in the TBI population is well documented in the literature, with prevalence varying from 38% to 65%[8]. However, there are relatively few studies that present specific indicators, focusing on the follow-up of these patients until hospital discharge and / or speech-language therapy. These studies identified variables associated with long-term oropharyngeal dysphagia, including low score in the Glasgow Coma Scale, computed tomography injury severity, scores at admission time, prolonged use of mechanical ventilation, and tracheostomy[9,10]. However, there are still limited studies that perform a detailed analysis of the relations between TBI severity, swallowing changes, type and results of the main treatments.

The definition of the prognostic indicators allows to support the rehabilitation team to better define patient recovery and also to facilitate the selection of the most appropriate and cost-effective care for individuals with swallowing disorders[11,12]. The clinical markers should be selected with caution when assessing the quality of health care and should be used to assess the quality of care provided to patients with dysphagia. In order to allow an adequate evaluation of clinical practice, the clinical markers should reflect the activities developed in the practice of each specific area, such as those found in manuals of clinical recommendations[13,14].

There are few studies in the literature that present indicators of the management of dysphagia in TBI or predictive factors of the occurrence of dysphagia in this same population. A survey conducted in 2014[4] determined factors predictive of placement of alternative feeding ways after a severe TBI case. The results of the study indicated that in the initial evaluation of the individual with TBI, variables such as increased age, low scores in the Glasgow Como Scale (CGE), presence of tracheostomy and aphonia significantly increased the severity of swallowing changes in patients, reducing the chances of withdrawal of the nasoenteral tube until the moment of hospital discharge.

Although it did not specifically perform with the TBI population, some studies had aimed to verify the association between the severity of dysphagia and the clinical risk factors of critically ill patients at the time of hospital admission[5,15,16]. In these studies, patients' severity scores were included according to the *Sequential Organ Failure Assessment* (SOFA) and *Acute Physiology and Chronic Health Evaluation II* (APACHE II) scales at the time of hospital admission. However, these studies found no correlation between the severity of dysphagia and the clinical severity of the patients at the time of admission. By and large, individuals with mild dysphagia or normal swallowing presented similar scores at scales when compared to patients with severe dysphagia.

Given the importance of the subject and the lack of data in the scientific literature, the objective of the present study was to characterize and compare the functional aspects of swallowing and clinical markers in the population with traumatic brain injury (TBI) in an intensive care unit (ICU).

METHODS

This is a retrospective cross-sectional observational study. This survey was approved by the Ethics Committee for Analysis of Projects and Research of the Hospital das Clínicas of the Faculty of Medicine of the University of São Paulo (CAPPesq HCFMUSP No. 1481550). Because it was a study based on the analysis of medical records, the Term of Free and Informed Consent was dispensed.

Participants

The sample consisted of individuals diagnosed with TBI who were submitted to the assessment of bedwetting swallowing, by medical request, by the Speech and Language Therapy Division of the Hospital das Clínicas of the Medical School of the University of São Paulo (HCFMUSP) in the period of January 2015 to June 2016.

The inclusion criteria used were based on data recorded in medical records: a) clinical and respiratory stability; b) over 18 years of age; c) absence of previous neurological diseases; d) absence of esophageal dysphagia; e) absence of

previous surgical procedures involving the head and neck region; f) absence of previous speech-language pathological comorbidities (communicative or auditory complaints or deficits); g) prolonged orotracheal intubation (IOTp - above 48h); h) no use of tracheostomy; i) have been subjected to speech-language therapy evaluation at bedside; j) absence of oral feeding at the moment of the speech-language evaluation.

A total of 346 individuals with TBI were admitted to HCFMUSP and received speech-language therapy during the 17 months studied. The organization chart (Figure 1) illustrates how the final selection of the sample of patients included in this study.

Procedures

The data collection stages involved: a) clinical speech-language assessment of the risk of bronchoaspiration, with determination of the functional level of swallowing according to the *American Speech-Language-Hearing Association National Outcome Measurement System* (ASHA NOMS)[17]; b) determination of the severity patient condition according to the *Sequential Organ Failure Assessment* (SOFA)[14].

Clinical speech-language assessment of the risk of bronchoaspiration

After the medical consultation request, the speech-language therapists' team performed the clinical assessment of swallowing at the bedside, which included the application of the *Protocolo Fonoaudiológico de Avaliação do Risco para Disfagia* (PARD - Speech-Language Pathology Protocol for Risk Evaluation for Dysphagia) and the classification of swallowing level according to *American Speech-Language-Hearing Association National Outcome Measurement System* (ASHA NOMS). Individuals who did not present saliva swallowing in the structural evaluation did not enter the study, since they had no indication of the application of PARD.

The PARD[18] is a protocol for risk assessment for bedside dysphagia. This protocol aims to help the speech-language therapist identify and interpret changes in swallowing dynamics. Its application includes the supply of controlled volumes of water and homogeneous pasty. The protocol determines whether the patient can receive larger volumes of liquids and / or foods of different consistencies and the need for supervision for safe feeding. The protocol is divided into 2 parts: water swallowing test and pasty swallowing test. For the present study, only the result of the water test was considered.

As determined by the protocol authors, individuals are evaluated during swallowing of 1 to 5 ml of water. In the Water Swallowing test, 11 items were analyzed: anterior oral escape, oral transit time, nasal reflux, number of swallows, laryngeal elevation, cervical auscultation, oxygen saturation, vocal quality, coughing, choking and other signs of clinical change (cyanosis, bronchospasm, alteration of vital signs). The results are marked as pass or fail for each evaluated item.

Recently published research investigated the predictors of dysphagia risk after prolonged orotracheal intubation [13], based

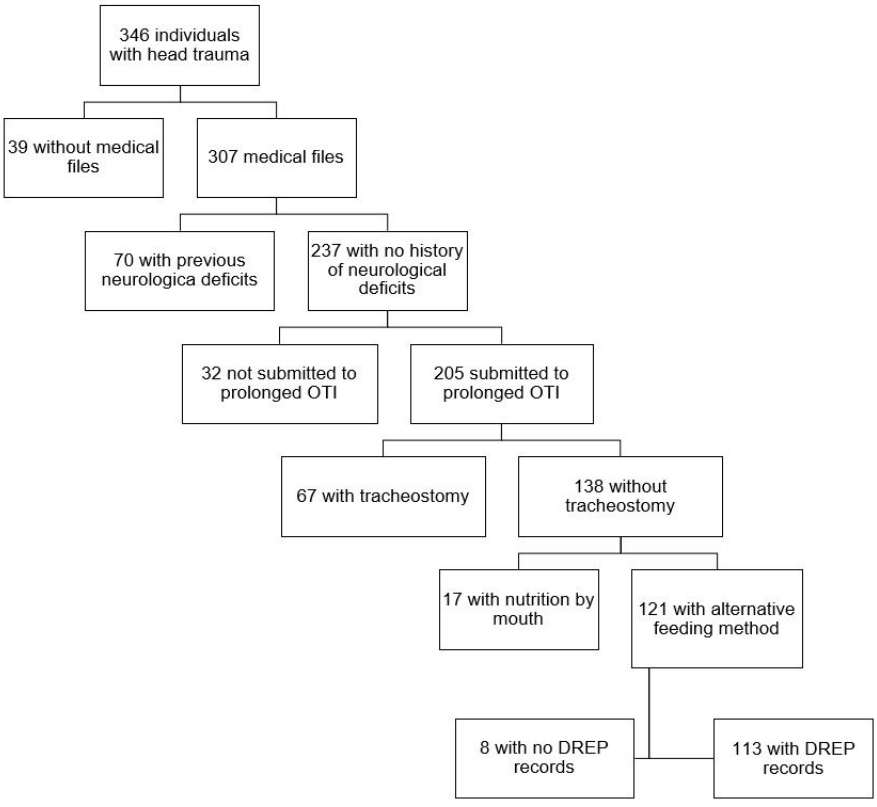

Figure 1. Flowchart for patient selection – OTI = orotracheal intubation; DREP = Dysphagia Risk Evaluation Protocol

Chart 1. Definition of *Protocolo Fonoaudiológico de Avaliação do Risco para Disfagia* (PARD - Speech-Language Pathology Protocol for Risk Evaluation for Dysphagia) for water swallowing test (5mL)

	Variables	Clinical Judgment
Water swallowing test (5mL).	Extra-oral escape	Passes - Water does not escape through the lips, manages the bolus properly
		Fails - Difficulty in bolus management, presence of draining through the lips.
	Multiple swallowing	Passes - Presence of a single swallowing per bolus
		Fails - More than one swallowing per bolus
	Cervical auscultation (the stethoscope should be positioned on the side of the junction between the larynx and the trachea, anterior to the carotid artery)	Passes - Presence of three characteristic sounds of swallowing, indicating that the cake passed through the pharynx - two clicks followed by an expiratory sound.
		Fails - When there is no presence of sounds or presence of other sounds not described above.
	Wet voice	Passes - No changes in the first minute after swallowing
		Fails - The voice sounds bubbling ("wet") in the first minute after swallowing
	Coughing	Passes - There is no coughing in the first minute after swallowing
		Fails - Presence of coughing (voluntary or not) followed or not by clearing during the first minute after swallowing
	Choking	Passes - There is no presence of choking after swallowing
		Fails - Presence of choking during or after swallowing

on the results of PARD in the water evaluation (5ml). In this study, the authors conclude that the predictors of dysphagia in this population were: extraoral escape; multiple swallowing; altered cervical auscultation; vocal quality after swallowing; presence of coughing after swallowing and presence of choking. Thus, these were the PARD items considered for analysis and correlation with the other data of the research.

The criteria for interpretation of these data are described in Chart 1.

Functional Deglutition Level

The ASHA NOMS[17] functional swallowing scale is a multidimensional tool that measures the level of supervision necessary for feeding and diet level, assigning a single number between 1 and 7. The feeding and supervision levels are classified using the ASHA NOMS scale at the time of the initial assessment (ASHA initial), based on the results of the PARD and at the time of termination of speech-language therapy (ASHA final) as follows:

Level 1: The individual is not able to swallow anything safely by oral. All nutrition and hydration are received through an alternative feeding route (e.g., nasogastric tube, gastrostomy);

Level 2: The individual is not able to safely swallow orally for nutrition and hydration, but may ingest some consistency only in therapy with maximum and consistent use of clues. Alternative feeding route is required;

Level 3: Alternative route of feeding is necessary, since the individual ingests less than 50% of the nutrition and hydration by oral; and / or swallowing is safe with the moderate use of clues to use compensatory strategies; and / or requires maximum diet restriction;

Level 4: The swallowing is safe, but often requires moderate use of clues for use of compensatory strategies; and / or the individual has moderate diet restrictions; and / or still need an alternative route of feeding and / or oral supplement;

Level 5: The swallowing is safe with minimal diet restrictions; and / or occasionally requires minimal clues for the use of compensatory strategies. Occasionally it can self-monitor. All nutrition and hydration are received orally during the meal;

Level 6: The swallowing is safe and the individual eats and drinks independently. Rarely does it need minimal clues for the use of compensatory strategies. Often the patient monitors his-self when difficulties occur. It may be necessary to avoid some specific food items (e.g., popcorn and peanuts); additional time for feeding may be necessary (due to dysphagia);

Level 7: The individual's ability to feed independently is not limited by the swallowing function. The swallowing is safe and effective for all consistencies. Compensatory strategies are used effectively when necessary.

To ensure the reliability of the data, all speech-language therapists responsible for the assessment of bedwetting swallowing received specific training to define the functional level of swallowing. The functional level of swallowing was determined in the first clinical evaluation and resolution of dysphagia or hospital discharge.

All patients in the study received individual treatment for swallowing rehabilitation until resolution of dysphagia or hospital discharge[19]. The patients were attended by speech-language therapists with experience in the area of dysphagia and trained to apply the same treatment program. For the treatment, procedures and techniques were used to rehabilitate deglutition, divided into direct and indirect therapies. The direct therapy was based on the use of food, even in minimal volumes, to provide swallowing training, and indirect therapy focused on the muscular organization through the use of exercises for oral motor training. It should be noted that, when necessary, maneuvers and airway protection postures were also used, favoring the safe return of oral feeding, allowing withdraw of the alternative feeding route.

Chart 2. Scoring System in the *Sequential Organ Failure Assessment* (SOFA)

SOFA score	0	1	2	3	4
Breathing	>400	≤400	≤300	≤200	≤100
PaO_2/FIO_2 (mmHg)				With respiratory support	With respiratory support
Coagulation	>150	≤150	≤100	≤50	≤20
Platelet × $10^3/mm^3$					
Liver					
Bilirubin (mg/dl)	<1.2	1,2-1,9	2,0-5,9	6,0-11,9	>12
(µmol/l)	<20	20-32	33-101	102-204	>204
Cardiovascular	No Hypotention	APA<70mmHg	dopamine≤5	dopamine>5	dopamine>15
			or	epinefrine≤1	epinefrine>0,1
Hypotension			dobutamine (qualquer dose)	or noraepinefrine≤0.1[a]	or noraepinefrine>0.1[a]
SNC	15	13-14	10-12	6-9	<6
Glascow Coma Scale					
Renal	<1.2	1.2-1.9	2.0-3.4	3.5-4.9	>5
Creatinine (mg/dl)	<110	110-170	171-299	300-440	>440
(µmol/l)	<110	110-170	171-299	300-440	>440
or urine output	-	-	-	<500ml/day	<200ml/day

[a]adrenergic agents given for at least one hour (doses given in microgram per kilo per minute)
Caption: SOFA = *Sequential Organ Failure Assessment*; PaO_2/FIO_2 = relation between the partial pressure of oxygen in the arterial blood and the inspired fractions of oxygen; mmHG = millimeters of mercury; Platelets × 10^3 / mm^3 = concentration of platelets in cubic millimeters of blood; mg/dl = milligrams per deciliter; µmol/l = micromole per liter; APA = Average blood pressure; ml = milliliter

Patient severity

The SOFA score[14] is a prognostic index applied daily in critical individuals during their stay in the ICU, in order to record the variables of the dysfunction or organic failure process over time and to quantify the degree of this dysfunction in each of the organs analyzed. The score obtained by the SOFA is used not to determine the outcome of the patient, but to describe the complications of the critical individuals. The two major goals of the SOFA score are: to improve understanding of organ dysfunction and the relation between organ damage, and to evaluate the effects of adopted medical treatment.

To determine the severity of the patient, scores from 0 (normal) to 4 (greater degree of impairment) are assigned to the different systems: respiratory, cardiovascular, hematological, hepatic, neurological and renal. Each system receives a separate score and the final score is obtained by adding all scores. The maximum score is 20, which is indicative of greater severity. The criteria for assigning the points are described in Chart 2.

The SOFA index was obtained at the time of admission to the hospitalization unit (SOFA 1) and on the day of the speech-language therapy assessment (SOFA 2).

Data analysis

The quantitative data were descriptive (average and standard deviation) and inferential comparing the groups (Kruskal-Wallis test for multiple comparisons, with post hoc analysis of pairs with Bonferroni correction, if it is significant). Qualitative data were given by descriptive analysis (total and percentage counts) and inferential comparing the groups (Pearson's Chi-square test with the Kruskal-Wallis test for post hoc analyzes of pairs with Bonferroni correction, if it is significant). For the comparisons, pre and post speech-language therapy intervention, it was used the Wilcoxon paired test. The inferential analysis to investigate the presence of correlation between variables was performed by the Spearman correlation coefficient. For the present study, patients who presented functional swallowing level on the ASHA NOMS scale of 6 or 7 at the time of resolution of dysphagia or at hospital discharge were considered like presenting a positive result. The significance level adopted in all analyzes was 5%.

RESULTS

After applying the inclusion criteria, the selected patients were grouped according to the functional levels of swallowing were determined in the initial evaluation: levels 1 and 2 - ASHA1 (n = 25); levels 3, 4 and 5 - ASHA2 (n = 37); levels 6 and 7 - ASHA3 (n = 51). Among the selected individuals, the causes of TBI recorded in medical records were: ASHA1 - 7 individuals with TBI due to fall and 18 individuals with TBI due to traffic accident; ASHA2 - 2 individuals with TBI due to aggression, 10 individuals with TBI due to fall and 25 individuals with TBI due to traffic accident; ASHA3 - 3 individuals with TBI due to aggression, 1 individual with TBI due to crushing, 18 individuals with TBI due to fall and 29 individuals with TBI due to traffic accident.

The groups were compared according to their demographic variables and medical records data, according to Table 1.

Pair comparisons were performed for variables that indicated significant intergroup differences:

- TBI severity according to ECG: significantly more severe in the ASHA 1 group when compared to the ASHA 3 - p <0.004 - and ASHA 2 - p = 0.016 groups,

Table 1. Intergroup comparison of demographic variables and general data

	ASHA1 (n = 25)	ASHA2 (n = 37)	ASHA3 (n = 51)	*p-value*
Age (years)	43.6	36.8	35.2	0.240
Average (± standard deviation)	(±19.2)	(±13.2)	(±11.2)	
Genre	M = 21 F = 4	M = 35 F = 2	M = 42 F = 9	0.223
Total number (percentage)	(84.0%) (16.0%)	(94.6%) (5.4%)	(82.4%) (17.6%)	
Severity of TBI according to the Glasgow scale	13.5	14.2	14.2	0.003*
Average (± standard deviation)	(±1.1)	(±0.7)	(±1.0)	
IOTs Numbers	1.1	1.2	1.1	0.293
Average(± standard deviation))	(±0.3)	(±0.4)	(±0.2)	
IOT time in hours	139.2	161.5	97.4	0.014*
Average (± standard deviation)	(±90.1)	(±107.0)	(±62.7)	
Hospitalization time in hours	28.4	26.6	16.6	0.005*
Average (± standard deviation)	(±24.2)	(±22.8)	(±11.9)	
Number of speech-language therapy sessions until VO return	2.7	1.4	1.0	0.003*
Average (± standard deviation)	(±2.6)	(±1.0)	(±0.0)	
Number of speech-language therapy until the hospital discharge	0.6	1.4	2.2	<0.001*
Average (± standard deviation)	(±2.2)	(±2.2)	(±2.5)	

*significant difference according to the Kruskal-Wallis test
Caption: ASHA1 – levels 1 to 2 on *American Speech-Language and Hearing Association National Outcome Measurement System* (ASHA NOMS); ASHA2 - levels 3, 4 and 5 in ASHA NOMS; ASHA3 – levels 6 and 7 in ASHA NOMS; TBI = Traumatic Brain Injury; M = male gender; F = female gender; IOT = orotracheal intubation; VO = oral feeding; n = number of participants

without significant differences between the ASHA 3 and ASHA 2 - p> 0.999, according to the Kruskal-Wallis test, with post hoc analysis of pairs with Bonferroni correction;

- IOT time in hours: significantly lower in the ASHA 3 group when compared to the ASHA 2 group - p = 0.002, without significant differences between the ASHA 3 and ASHA 1 groups - p = 0.946; neither between groups ASHA 1 and ASHA 2 - p = 0.143, according to the Kruskal-Wallis test, with post hoc analysis of pairs with Bonferroni correction;
- Hospitalization time in days: significantly lower in the ASHA 3 group when compared to the ASHA 1 group - p <0.039, without significant differences between the ASHA 3 and ASHA 2 groups - p = 0.051; neither between groups ASHA 1 and ASHA 2 - p> 0.999, according to the Kruskal-Wallis test, with post hoc analysis of pairs with Bonferroni correction;
- Number of speech-language therapy sessions until oral feeding return: significantly higher in the ASHA 1 group when compared to the ASHA 3 - p <0.001 - and ASHA 2 - p = 0.001 groups; without significant differences between the groups ASHA 3 and ASHA 2 - p = 0.589, according to the Kruskal-Wallis test, with post hoc analysis of pairs with Bonferroni correction;
- Number of speech-language therapy sessions until the discharge: significantly higher in the ASHA 3 group when compared to the ASHA group 1- p = 0.015, without significant differences between the ASHA 3 and ASHA 2 groups - p = 0.280; neither between groups ASHA 1 and ASHA 2 - p = 0.606, according to the Kruskal-Wallis test, with post hoc analysis of pairs with Bonferroni correction.

The Table 2 presents the intragroup comparative results for the risk of bronchoaspiration assessment.

Pair comparisons were performed for variables that indicated significant intergroup differences:

- Extraoral escape: the number of participants who failed was significantly higher in the ASHA 1 group when compared to the ASHA 3 - p = 0.007 - and ASHA 2 - p = 0.017 groups, without significant differences between the ASHA 1 and ASHA 2 - p> 0.999, according to Kruskal-Wallis post hoc analysis of pairs with Bonferroni correction;
- Multiple swallows: the number of participants who failed was significantly higher in the ASHA 1 group than in the ASHA 3 group - p <0.015, with no significant differences between the ASHA 3 and ASHA 2 groups - p = 118; neither between groups ASHA 2 and ASHA 1 - p> 0.999, according to Kruskal-Wallis post hoc analysis of pairs with Bonferroni correction;
- Noisy cervical auscultation: the number of participants who failed was significantly higher in the ASHA 1 group than in the ASHA 3 - p <0.001 - and ASHA 2 - p <0.001 groups, without significant differences between ASHA 2 and ASHA 3 - p groups > 0.999, according to Kruskal-Wallis post hoc analysis of pairs with Bonferroni correction;
- Coughing: significantly higher in the ASHA 1 group when compared to the ASHA 2 - p <0.001 - and ASHA 3 - p <0.001; without significant differences between groups ASHA 2 and ASHA 3 - p> 0.999, according to Kruskal-Wallis post hoc analysis of pairs with Bonferroni correction.

Table 3 shows the swallowing levels according to the ASHA NOMS scale after the speech-language therapy evaluation at the bedside (initial) and at the time of resolution of dysphagia or at hospital discharge (final).

Concerning to the 25 individuals included in the ASHA1 group, it was possible to observe that only one (n = 1) patient presented a positive result after the speech-language intervention. However, in general, more than 80% of the sample presented improvement in swallowing functional status. In relation to the ASHA2 individuals, 48% of the patients presented positive results after the speech-language intervention. Patients included in ASHA3 already had a safe swallow in speech-language therapist evaluation. However, it is possible to observe that there was a 14% increase in the number of patients that archived the maximum level of swallowing functionality at the outcome.

The Table 4 presents the comparison of the groups according to the severity of the clinical picture at the time of admission to the hospitalization unit.

The intergroup comparison for the SOFA 1 score indicated significant differences between the groups only for the "neurological" variable (significantly higher score in the ASHA 1 group when compared to the ASHA 3 group - $p = 0.02$, without significant differences between the ASHA groups 3 and ASHA 2 - $p > 0.999$, neither between groups ASHA 2 and ASHA 1 - $p = 0.058$, according to Kruskal-Wallis post hoc analysis of pairs with Bonferroni correction).

Table 2. Intergroup comparison according to the clinical evaluation of the risk of bronchoaspiration

Evaluated Items	ASHA1 (n = 25)	ASHA2 (n=37)	ASHA3 (n=51)	*p-value*
Extra-oral escape	5 (20.0%)	1 (2.7%)	1 (2.0%)	0.005*
Multiple swallowing	6 (24.0%)	6 (16.2%)	1 (2.0%)	0.010*
Noisy Cervical Auscultation	9 (36.0%)	1 (2.7%)	0 (0.0%)	<0.001*
Wet Voice	1 (4.0%)	1 (2.7%)	0 (0.0%)	0.403
Coughing	13 (52.0%)	4 (10.8%)	4 (7.8%)	<0.001*
Choking	3 (12.0%)	0 (0.0%)	2 (3.9%)	0.077

*significant difference according to Pearson's Chi-square test
Caption: ASHA1 – levels 1 to 2 on *American Speech-Language and Hearing Association National Outcome Measurement System* (ASHA NOMS); ASHA2 – levels 3, 4 and 5 in ASHA NOMS; ASHA 3 – Levels 6 and 7 in ASHA NOMS; n = number of participants

Table 3. Results of the ASHA NOMS swallowing level scale

Swallowing functional level	ASHA1 (n = 25)		ASHA2 (n = 37)		ASHA3 (n = 51)	
	Initial	Final	Initial	Final	Initial	Final
1 is not able to swallow anything by mouth	2	2	0	0	0	0
2 Can have some consistency with maximum use of clues	23	9	0	0	0	0
3. Ingest less than 50% of nutrition through the mouth with moderate use of clues	0	3	5	2	0	0
4. Swallowing is safe with moderate use of clues	0	7	12	7	0	0
5. Swallowing is safe with minimal use of clues	0	3	20	10	0	0
6. Swallowing is safe and rarely requires use of clues	0	0	0	9	22	15
7. Swallowing is efficient, the individual is independent	0	1	0	9	29	36

Caption: n – participants number; ASHA1 – level 1 to 2 on *American Speech-Language and Hearing Association National Outcome Measurement System* (ASHA NOMS); ASHA2 – levels 3, 4 and 5 in ASHA NOMS; ASHA3 – Levels 6 and 7 in ASHA NOMS

Table 4. Intergroup comparison according to the initial SOFA scale (SOFA 1)

Score on the SOFA scale Average (± standard deviation)	ASHA1 (n = 25)	ASHA2 (n = 37)	ASHA3 (n = 51)	*p-value*
Breathing	1.8 (±1.1)	1.6 (±1.2)	1.5 (±1.2)	0.714
Hematological	0.5 (±1.0)	0.5 (±0.8)	0.4 (±0.6)	0.889
Hepatic	0.1 (±0.4)	0.0 (±0.0)	0.02 (±0.1)	0.496
Renal	0.1 (±0.3)	0.3 (±0.8)	0.3 (±0.6)	0.451
Cardiovascular	2.4 (±1.7)	2.1 (±1.5)	2.2 (±1.4)	0.589
Neurological	3.4 (±1.0)	2.7 (±1.3)	2.7 (±1.2)	0.018*
Total	8.2 (±2.4)	7.3 (±2.5)	7.2 (±3.0)	0.348

*significant difference according to the Kruskal-Wallis test
Caption: n = number of participants; ASHA1 – Levels 1 and 2 on *American Speech-Language and Hearing Association National Outcome Measurement System* (ASHA NOMS); ASHA2 – levels 3, 4 and 5 in ASHA NOMS; ASHA3 – Levels 6 and 7 in ASHA NOMS; SOFA = *Sequential Organ Failure Assessment*

Table 5. Intergroup comparison according to the SOFA scale at the time of bronchoaspiration risk assessment (SOFA 2)

Score on the SOFA scale Average (± standard deviation)	ASHA1 (n = 25)	ASHA2 (n = 37)	ASHA3 (n = 51)	*p-value*
Breathing	0.85 (±0.87)	0.78 (±0.97)	0.78 (±0.97)	0.384
Hematological	0.39 (±0.81)	0.11 (±0.33)	0.11 (±0.33)	0.229
Hepatic	0.02 (±0.14)	0.22 (±0.67)	0.22 (±0.67)	0.147
Renal	0.09 (±0.49)	0.0 (±0.0)	0.0 (±0.0)	0.185
Cardiovascular	0.23 (±0.70)	0.0 (±0.0)	0.0 (±0.0)	0.468
Neurological	0.62 (±0.54)	1.56 (±0.73)	1.56 (±0.73)	0.024*
Total	2.14 (±1.59)	2.67 (±0.71)	2.67 (±0.71)	0.462

*significant difference according to the Mann-Whitney test
Caption: n = number of participants; ASHA1 – Levels 1 and 2 on *American Speech-Language and Hearing Association National Outcome Measurement System* (ASHA NOMS); ASHA2 – levels 3, 4 and 5 in ASHA NOMS; ASHA3 – Levels 6 and 7 in ASHA NOMS; SOFA = *Sequential Organ Failure Assessment*

The Table 5 presents the comparison of the groups according to the severity of the clinical picture at the time of risk of bronchoaspiration clinical evaluation.

The intergroup comparison in the SOFA 2 score indicated significant differences between the groups only for the "neurological" variable (significantly higher score in the ASHA 1 group when compared to the ASHA 3 group - $p = 0.022$, without significant differences between the ASHA 3 and ASHA 2 groups - $p > 0.999$, neither between groups ASHA 2 and ASHA 1 - $p = 0.110$, according to Kruskal-Wallis post hoc analysis of pairs with Bonferroni correction).

Two correlation analyzes were performed: one between the demographic and clinical variables correlated to the initial level of swallowing functionality and another between the final data on swallowing functionality, the SOFA scale scores and the results in the risk of bronchoaspiration assessment correlated to the initial level of swallowing functionality. The analyzes indicated that there was no significant correlation between the demographic variables and medical records data with the initial level of swallowing functionality. The initial score on the ASHA NOMS scale showed a significant negative correlation only about the score in the clinical evaluation of the risk of bronchoaspiration for the item "coughing" ($r = -0.220$ and $p = 0.019$), that is, the worse the swallowing function, the greater chance of coughing during the clinical evaluation of swallowing. It was not observed correlation about the other items.

DISCUSSION

The present study characterized and compared the functional aspects of swallowing in the population with traumatic brain injury, considering the clinical characteristics and the severity of the individuals. By and large, the results of the present study indicated that the ASHA3 group presented smaller TBI severity at the time of speech-language evaluation, smaller orotracheal intubation time (one-third less than the most severe group), less time hospitalized and it was the group that needs less speech-language therapy sessions for the safe return to oral feeding. The clinical signs predictive of bronchoaspiration that most differentiated the groups were the presence of altered cervical auscultation and the presence of coughing after swallowing, and the ASHA3 group presented these signs less frequently.

Concerning to the causes of TBI, we observed a higher incidence of traffic accidents (64%), followed by falls (31%), aggression (4%) and crushing (1%). The literature reports that, even in the least developed countries, automotive vehicles are the major cause of death and disability, especially in the young population[20], followed by falls, which that occur mostly in the population over 65 years of age[21]. A more recent epidemiological reviews have shown a change in the epidemiological picture, falls have been the major cause of TBI, especially in the elderly population[3,22].

The studied TBI population was characterized mostly by men (86.72%), corroborating the epidemiology of this population presented in other studies[2,22]. The literature reports that the average age of the TBI population varies widely[22]; in the present study the mean age was 37.58 years old. Only one study corroborated the age group found, which correlated alcohol intake with the TBI incidence[23]. Mandaville et al.[4] pointed to age as a prognostic factor for functional recovery of neurological damage, justifying that older individuals are more likely to have chronic underlying condition, and that this fact could increase hospitalization time. Besides that, older individuals are more likely to have long-term oropharyngeal dysphagia[4].

The literature also describes the relation between the time of orotracheal intubation and the severity of dysphagia[5,24-26]. The results of the present study indicated that the longer the intubation time, the greater the risk of bronchoaspiration. This relation can be explained by the impact of orotracheal tube staying in the oral, pharyngeal and laryngeal cavity, leading to muscle disuse, mucosal lesions and loss of proprioception related to changes in chemoreceptors and / or mechanoreceptors[21].

The results of the present study also indicated that the item related to the neurological aspect of the SOFA scale was the parameter that presented the greatest difference between the groups when considering the functionality of swallowing. The study by Mackay et al.[10] shows that 61% of individuals with TBI at a trauma center had dysphagia at hospital admission. Some researchers further suggest that the level of swallowing impairment is directly related to GCS scores (low scores) and longer time of

orotracheal intubation[11]. Besisdes that, it should be considered that at ICU admission, the patient is hemodynamically unstable, using vasoactive drugs, dependent on mechanical ventilation and requiring sedation, which may worsen neurological assessment and performance on prognostic scales[27].

To a better understanding and therapeutic design, studies have looked for identifying predictors that are related to the risk of aspiration, thus allowing the prioritization of care and the definition of conducts for the sooner and safer return of the oral route and for the withdrawal of alternative route[18]. In the literature, the following items were cited as predictors of dysphagia: prolonged intubation, considering that the longer this time, the worse will be the swallowing, and the younger the patient, the better will be the swallowing[4,12,28]. A study performed with non-neurological patients showed that individuals submitted to prolonged orotracheal intubation presented alterations in cervical auscultation and presence of coughing after water swallowing test[13]. The longer intubation time (mainly above 72 hours) in individuals with TBI was related to failure in the evaluation of bedside swallowing[29]. The tracheostomy presence and mechanical ventilation longer than two weeks in individuals with TBI are related to worse swallowing performance. These two factors may be related to the greater severity of TBI and the worse swallowing performance[28].

For a population with CVA, it was observed that factors such as dysphonia, dysarthria, coughing and change in vocal quality after swallowing are related to severe oropharyngeal dysphagia[30]. However, according to the literature, for individuals with severe TBI, these factors are not related to the withdrawal of the alternative feeding route[4]. In speech-language pathology terms, the predictors of dysphagia observed in individuals with TBI were coughing, altered vocal quality after swallowing, and altered GAG reflex[11]. According to the literature[27,28], the main swallowing abnormalities found in individuals with TBI are oral and / or pharyngeal disorders, characterized by impairment of bolus control, reduction of tongue control and movement, reduction of elevation and laryngeal closure, delayed swallowing reflex and presence of coughing and / or wet voice after swallowing.

In the present study, extraoral escape, presence of alterations in cervical auscultation and the presence of coughing after swallowing in the water test appeared as predictors of dysphagia, and coughing was the item that most correlated with the functionality of swallowing. Previous research has also suggested that coughing and impairment in bolus control are the major swallowing abnormalities found in individuals with TBI and dysphagia[10,11]. Coughing and swallowing are protective behaviors of the airways (pharyngeal phase of swallowing), preventing aspiration of saliva and food. The coordination of these behaviors is vital to protect the airways from events that promote aspiration[10,11].

With regard to swallowing functionality, speech-language rehabilitation proved to be efficient for those individuals who presented better functional level of swallowing at the end of speech-language therapy follow-up. This pattern of favorable progression of swallowing functionality during hospitalization is similar to the results found in the literature, indicating that from 75% to 94% of individuals with TBI recovered their ability to take oral intake[10]. It should be taken into account that in the hospital where the data collection of this work was performed, because it is a tertiary service, clinical stability is not always related to the complete rehabilitation of swallowing. Thus, the individual can be discharged from hospital, with resolution of the clinical picture, and still need speech-language therapy intervention. In this study, only 46% of the individuals received speech-language therapy hospital discharge, the others were referred to rehabilitation centers for speech-language therapy to follow-up check. This factor should be considered as one of the limitations of the present study.

Considering the number of speech-language therapy sessions until oral diet return, the results of the present study indicate that more sessions (2.7 days on average) were necessary for the individuals with worse swallowing functionality. In the literature, no references were found that address the time required for oral diet reintroduction. Hansen et al. [9] verified that in a maximum of 126 days all the individuals with TBI returned to the oral feeding, without restrictions of consistency, and after 56 days, more than 50% of the individuals were already on the diet oral. For Bremare et al.[30], 63.6% of the individuals returned to oral feeding in an average of 44 days and only one of the individuals (9.1%) recovered oral feeding in its entirety, in an average of 62 days. It should be noted that, for all studies, diet evolution was related to the severity of TBI, with the cognitive aspects and the initial result on the functional swallowing scale[9,30]. Still according to the literature[30], the main positive predictive factor for oral feeding is the average length of stay in the ICU, with a 80% probability of recovery from oral feeding when the stay is shorter than 7 days and 56% of recuperation when the stay is less than 24 days. When establishing clinical parameters that can predict aspects related to swallowing improvement during hospitalization, it is possible to assist in the management and planning of rehabilitation[26], as well as in the design of studies that show the efficacy of speech-language therapy[9].

Finally, it is important to highlight some limitations of the present study. Individuals who did not present saliva swallowing in the preliminary speech-language therapy evaluation and individuals using tracheostomy were excluded, since it was considered that they differed from the other nontracheostomized individuals of the sample, with regard to the evaluation procedures and clinical severity. The controlled inclusion of these individuals in future studies may assist in better design of speech-language rehabilitation about the TBI population. For this study, the GCS score was considered at the moment of the speech-language assessment. For this reason, when observing the severity of TBI in the patients included in this study, the majority was classified as mild. Future studies should include the analysis of the GCS score obtained at the beginning of hospital admission. Another consideration is that it would be important to associate the objective evaluation of swallowing individuals with the application of swallowing functionality

scales. The Video Fluoroscopic Swallowing Exam (VFSE) is considered the "gold standard" for evaluation of bronchopulmonary penetration / aspiration. In the present study, it was not possible to perform the VFSE of the individuals, due to limitations of the clinical picture, displacement, positioning, high cost, among others. Finally, the sample of patients included in the study was from a single institution and, therefore, the results should not be generalized, since they are due to the specific procedures adopted in that institution. It would be interesting that the results could be compared to the results of other treatment centers of patients with traumatic brain injury.

CONCLUSIONS

The present study performed the characterization of the functional aspects of swallowing about the TBI population. The SOFA score at admission, the GCS score and the IOT time were indicators of the prognosis of swallowing functionality. Regarding swallowing indicators, coughing and extraoral escape were clinical predictors of dysphagia in this population. Speech-language therapy intervention positively impacted the functionality of swallowing.

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Author contributions

JLF, data collection and analysis, essay writing; FCS, data analysis, essay writing and review; GCM, data collection, initial writing of the essay; CRFA, project orientation, writing and review of the article.