

Relação Entre o Tipo de Acidente Vascular Cerebral Isquémico e o Grau de Disfagia, Pneumonia de Aspiração e Mortalidade:

A Experiência de 3 Anos de uma Unidade de AVC Portuguesa

Relationship Between Type of Ischemic Stroke with Degree of Dysphagia, Aspiration Pneumonia, and Mortality: A Three-Year Portuguese Stroke Unit Experience

Adelaide Moutinho¹ (<https://orci.org/0000-0001-8007-1383>), Filipa Vilabril² (<https://orci.org/0000-0001-7554-7009>), Rafael Jesus³ (<https://orci.org/0000-0002-9137-2314>), Rita Gamboa Cunha¹ (<https://orci.org/0000-0002-6908-6637>), Sheila Koch Jamal¹ (<https://orci.org/0000-0002-2758-0688>), Marta Meleiro Lisboa¹ (<https://orci.org/0000-0003-0955-1741>), Sandra Tavares¹ (<https://orci.org/0000-0002-3773-1531>), Andreia Veiga³

Resumo:

Introdução: A pneumonia de aspiração é uma complicação grave do acidente vascular cerebral (AVC), estando relacionada com a sua gravidade e comprometimento funcional, e aumentando a mortalidade, tempos de hospitalização e custos em saúde. O objetivo deste estudo é relacionar a pneumonia de aspiração com o tipo e gravidade do AVC isquémico e respetivas consequências e desfechos.

Material e Métodos: Estudo retrospectivo que analisou 1116 doentes admitidos numa Unidade de AVC de Portugal admitidos entre 2017 e 2019, selecionando e caracterizando os de etiologia isquémica, de acordo com a classificação de Bamford. O estado funcional foi quantificado pela escala modificada de Rankin e pela de Barthel, a gravidade do AVC pela escala do National Institutes of Health, e a disfagia pelo Gugging Swallowing Screen. Estas escalas foram determinadas à admissão e à alta. A pneumonia de aspiração foi identificada com base em critérios clínicos, laboratoriais e radiológicos.

Resultados: População de 937 indivíduos com predomínio masculino (51,5%) e idade média 75,6 anos. Pneumonia de aspiração presente em 19,5%. Enfartes totais da circulação anterior com maior prevalência de pneumonia de aspiração (74,3%). Estados funcionais, gravidade do AVC e grau de disfagia foram piores no grupo com pneumonia de aspiração. Taxa de mortalidade global de 11,6%, com demora média 11,0 dias, sendo significativamente mais altas no grupo com pneumonia de aspiração (40,4% e 13,8 dias, respetivamente).

Discussão/Conclusão: A pneumonia de aspiração está

relacionada com a gravidade do AVC, estado funcional e grau de disfagia, comportando taxas de mortalidade e demoras médias mais altas.

Palavras-chave: Acidente Vascular Cerebral/mortalidade; Distúrbios da Deglutição/mortalidade; Pneumonia de Aspiração/mortalidade.

Abstract:

Introduction: Aspiration pneumonia is a severe complication of stroke, related to higher stroke severity, functional impairment and dysphagia grade, increasing mortality rate, length of hospitalization and health costs. The study aims to analyse the relationship between aspiration pneumonia, the clinical type and severity of ischemic stroke and its consequences and outcomes.

Material and Methods: A retrospective study analysed 1116 patients admitted to a Portuguese stroke unit between 2017 and 2019, selecting and characterizing ischemic strokes according to Bamford Stroke Classification. The functional status was quantified with the modified-Rankin and Barthel scales, the severity of stroke was evaluated with the National Institutes of Health Stroke Scale, and the dysphagia status was assessed with the Gugging Swallowing Screen. These scales were evaluated at admission and discharge. Aspiration pneumonia was identified based on clinical, laboratory and radiologic findings.

Results: A population of 937 individuals (51.5%), and average age 75.6 years old. Prevalence of aspiration pneumonia of 19.5%. Total anterior circulation infarction with higher rate of aspiration pneumonia (74.3%). The functional status, severity of stroke, and grade of dysphagia were worse in the aspiration pneumonia group. The overall mortality rate was 11.6%, with an average length of 11.0 days of hospitalization, being statistically significant ($p < 0.01$) in the aspiration pneumonia group (40.4% and 13.8 days, respectively).

¹Serviço de Medicina Interna do Centro Hospitalar de Trás-os-Montes e Alto Douro, Vila Real, Portugal

²Serviço de Medicina Física e Reabilitação do Centro Hospitalar de Trás-os-Montes e Alto Douro, Vila Real, Portugal

³Serviço de Neurologia do Centro Hospitalar de Trás-os-Montes e Alto Douro, Vila Real, Portugal

DOI: 10.24950/O/296/20/3/2021

Discussion/Conclusion: Aspiration pneumonia is related to the severity of stroke, functional status, and grade of dysphagia, being related to higher mortality rates and longest length of stay.

Keywords: *Deglutition Disorders/mortality; Pneumonia, Aspiration/mortality; Stroke/mortality.*

Introduction

As a common clinical disease, stroke can lead to different degrees of dysphagia and cough reflex impairment. It has been reported that 37%-74% of patients with acute stroke had dysphagia: among them 14% have aspiration pneumonia (AP),¹⁻³ being this a major cause of increased risk of mortality and dependency, resulting in higher health costs.⁴⁻⁶

Some risk factors like more severe strokes such as the ones with impairment of consciousness, older age, and frailty before stroke are associated with dysphagia as well as with AP.^{1,4,6-7} Specifically, the poorer scores of performance quantified by modified-Rankin Scale (mRS) and the higher severity of stroke quantified by National Institutes of Health Stroke Scale (NIHSS) are positively correlated to the development of dysphagia and aspiration pneumonia.^{1,5,8-11}

The aim of this study is to analyze the relationship between aspiration pneumonia and the type and severity of ischemic stroke (according to Bamford Stroke Classification (BSC) and NIHSS), the degree of dysphagia (quantified by the Gugging Swallowing Screen (GUSS)), and patients' functional status (mRS and Barthel scale). Simultaneously, it was to compare the length of hospitalization and rate of mortality of stroke patients who develop aspiration pneumonia with the ones who do not.

Material and Methods

The retrospective database analysis includes all patients (n = 1116) admitted with acute stroke between 1st January 2017 and 31st December 2019 to the stroke unit of Centro Hospitalar de Trás-os-Montes e Alto Douro, Portugal, being excluded the ones with haemorrhagic stroke (n = 179). The transient ischemic attacks are not included in this database, nor analyzed in our study. The diagnosis of stroke was based on clinical presentation and brain imaging, either cerebral computed tomography or magnetic resonance.

Two groups of stroke patients were compared: patients with and without aspiration pneumonia; in two different times during the hospital admission: at the time of admission and at the hospital discharge.

All patients admitted to this unit have an evaluation made by a doctor regarding the functional status by quantifying the modified-Rankin Scale (mRS) and Barthel scale; and concerning the severity of the stroke, considering clinical and imaging elements, defining the ischemic stroke according to Bamford Stroke Classification in total, partial or lacunar

anterior circulation infarctions (TACI, PACI, LACI, respectively), and posterior circulation infarctions (POCI) and quantifying the National Institutes of Health Stroke Scale. Considering the severity of the stroke, we used the categories of mild (NIHSS 0-4), mild-moderate (NIHSS 5-15), moderate-severe (NIHSS 16-20), and severe (NIHSS 21-42). The degree of impairment of functional status was categorized as null (mRS 0-1, Barthel 100), mild (mRS 2, Barthel 75-99), moderate (mRS 3-4, Barthel 50-74), and severe (mRS 5, Barthel 0-49). The functional evaluation and the one regarding the severity of the stroke are repeated when the patient is discharged from the stroke unit. As well as part of the initial evaluation, a specialized rehabilitation nurse performs the Gugging Swallowing Screen (GUSS), which is validated as bed-side screening instrument to identify acute stroke patients at risk of aspiration and dysphagia,^{1,2} enabling the quantification of null (GUSS= 20), mild (GUSS 15-19), moderate (GUSS 10-14) and severe dysphagia (GUSS 0-9).

Aspiration pneumonia diagnosis was based on clinical symptoms and signs (cough, purulent respiratory secretions, respiratory distress, fever, rales, bronchial breath sounds), combined with laboratory and imaging findings (elevation of inflammatory markers, lobar or segment opacification on X-ray), and in some cases microbiological isolation in patients' sputum.

Statistical analysis was made using Microsoft Excel™ and SPSS™. Descriptive statistical analysis was made, using absolute values and frequencies. The continuous normally distributed variables were identified by kurtosis and skewness measurement, and characterized by average and standard deviation, and being compared using T-test. The Chi-square test and Fisher test were used to evaluate association or independency of categorical variables, the latter when the first could not be applied. The significance levels used were $p < 0.01$ and $p < 0.05$.

Results

DEMOGRAPHIC DATA OF THE RECRUITED POPULATION

During the three years analyzed in the study, there were 937 patients admitted with ischemic stroke in our unit, 32% (n = 301) in 2017, 35% (n = 328) in 2018 and 33% (n = 308) in 2019.

The studied population showed a gender distribution of 51.5% (n = 483) male patients, with an average age of 75.6 years old (standard deviation (SD) 12.76 years old). The youngest patient was 19 years old, while the oldest was 101 years old.

The mortality rate within all ischemic stroke patients was 11.6% (n = 109), and the length of stay was in average 11.0 days (SD 9.44 days).

STROKE CLINICAL CLASSIFICATION AND STRATIFICATION OF SEVERITY

Clinically and according to Bamford Stroke Classification, there was an overall larger frequency of TACI with

39.3% (n = 368), followed by LACI with 22.6% (n = 212), POCI with 19.7% (n = 185) and PACI with 18.4% (n = 172). However, considering the severity according to NIHSS, we found larger frequencies of mild to moderate (NIHSS 5-15) and mild strokes (NIHSS 0-5), with 37.4% and 36.5%, respectively.

FUNCTIONAL STATUS

Comparing the scales evaluated at admission and at discharge, we found that in the overall population there was an amelioration of all functional scales, with an average improvement of -0.43 points in the modified Rankin scale, greater in the PACI subgroup (-0.7 points); and +19.71 points in Barthel scale, with a larger improvement in the POCI subgroup (+18.78 points). Considering the dysphagia grades, we found an overall average improvement of +1.48 points, with greater impact in the TACI subgroup (+2.43 points), and lesser enhancement of GUSS in PACI subgroup.

The variability of functional scales, dysphagia grade, and severity of stroke through hospital admission, according to Bamford Clinical classification is demonstrated in Table 1.

ASPIRATION PNEUMONIA

The overall incidence of aspiration pneumonia was 19.5% (n = 183). We found a higher prevalence in the TACI subgroup with 74.3% of aspiration pneumonias (n = 136), followed by POCI with 14.8% (n = 27).

According to the functional status, there were more aspiration pneumonia in the mRS severe impairment group (mRS=5)

with 76.5% (n = 140) patients, and in the Barthel's severe impairment group (Barthel [0-49]), with 92.3% (n = 169) patients having aspiration pneumonia.

Considering the severity of the stroke, we found a higher prevalence of aspiration pneumonia with severe stroke, classified by NIHSS higher than 20 points, with 50.8% (n = 93) patients, followed by the mild-moderate severity group with 27.9% (n = 51).

The group with severe dysphagia with GUSS less than 9 points was the one with higher prevalence of aspiration pneumonia with 56.3% (n = 103) cases, followed by the ones with mild dysphagia (GUSS between 14 and 19), with 34.3% (n = 63) cases.

Considering the outcome of the aspiration pneumonia patients, we found a mortality rate of 40.4% representing 67.9% of overall deaths, and a length of hospitalization of 13.8 days (SD 10.8 days), with statistical significance when compared to the overall population.

The relationship between stroke clinical classification, functional status at admission, dysphagia grade, and aspiration pneumonia is revealed in Table 2.

Discussion and Conclusion

Dysphagia is a frequent consequence of stroke, reaching a 74% prevalence in some studies, being its active and early search related to lesser aspiration pneumonia and complication rates.¹⁻² Aspiration pneumonia is one of the more serious consequences of poststroke dysphagia, affecting up to one-third of acute stroke patients in some studies,¹² involving

Table 1: Relation between functional status, dysphagia score, severity and clinical classification of the ischemic stroke.

		Bamford clinical classification				Total strokes
		TACI	PACI	LACI	POCI	
mRS*	Admission	4.39 (0.98)	2.76 (1.36)	2.52 (1.26)	3.03 (1.44)	3.40 (1.46)
	Discharge	4.28 (1.56)	2.06 (1.40)	1.90 (1.39)	2.42 (1.79)	2.96 (1.88)
	Δ†	-0.11	-0.70	-0.62	-0.61	-0.43
Barthel*	Admission	15.50 (22.85)	57.12 (30.64)	62.39 (29.13)	53.04 (33.35)	41.16 (35.00)
	Discharge	33.51 (31.93)	73.59 (28.35)	76.80 (29.42)	71.83 (32.07)	60.88 (36.15)
	Δ†	+18.01	+16.47	+14.41	+18.78	+19.71
GUSS*	Admission	11.76 (6.21)	18.25 (3.36)	18.84 (2.76)	16.57 (5.71)	15.50 (5.92)
	Discharge	14.19 (4.99)	18.26 (3.32)	19.03 (2.51)	17.60 (5.13)	5.89 (4.50)
	Δ†	+2.43	+0.01	+0.18	+1.02	+1.48
NIHSS*	Admission	16.88 (8.36)	6.66 (7.67)	4.22 (3.61)	6.80 (7.89)	10.15 (9.15)
	Discharge	11.65 (8.41)	3.42 (4.66)	2.39 (2.92)	3.59 (5.13)	5.89 (7.20)
	Δ†	-5.23	-3.23	-1.83	-3.21	-4.25

* average value of the scales applied at admission and discharge, with standard deviation value between parenthesis; † average variability of the scales evaluated between discharge and admission; ‡ Considering the severity of the stroke, we used the categories of mild (NIHSS 0-4), mild-moderate (NIHSS 5-15), moderate-severe (NIHSS 16-20), and severe (NIHSS 21-42). The degree of impairment of functional was categorized as null (mRS 0-1, Barthel 100), mild (mRS 2, Barthel 75-99), moderate (mRS 3-4, Barthel 50-74), and severe (mRS 5, Barthel 0-49). Gugging Swallowing Screen (GUSS), null (GUSS= 20)

Table 2: The risk of aspiration pneumonia according to stroke clinical classification, patient functional status and dysphagia at time of hospital admission.

		Aspiration pneumonia		p value*	Total strokes	
		n†	%		n‡	%
Total		183	19.5		937	
Bamford classification						
TACI		136	74.3	<0.0001	368	39.3
PACI		11	6.0	1.52E-06	172	18.4
LACI		9	4.9	1.75E-10	212	22.6
POCI		27	14.8	5.87E-02	185	19.7
Functional status at admission						
Null	mRS = [0-1]	1	0.5	3.12E-09	131	14.0
	Barthel = 100	2	1.1	4.46E-07	112	12.0
Mild	mRS=2	5	2.7	6.25E-07	134	14.3
	Barthel [75-99]	3	1.6	2.93E-05	93	9.9
Moderate	mRS [3-4]	37	20.2	2.31E-09	371	39.6
	Barthel [50-74]	9	4.9	6.15E-10	205	21.9
Severe	mRS = 5	140	76.5	<0.0001	301	32.1
		169	92.3	<0.0001	527	56.2
Severity of the stroke at admission						
Mild	NIHSS [0-4]	12	6.6	<0.0001	343	36.5
Mild-moderate	NIHSS [5-15]	51	27.9	3.11E-03	350	37.4
Moderate-severe	NIHSS [16-20]	27	14.8	1.26E-04	74	7.9
Severe	NIHSS [21-42]	93	50.8	<0.0001	170	18.1
Dysphagia at admission						
Null	GUSS = 20	11	6.0	<0.0001	504	53.8
Mild	GUSS [14-19]	63	34.3	8.27E-03	250	26.7
Moderate	GUSS [10-14]	6	3.3	9.80E-02	17	1.8
Severe	GUSS [0-9]	103	56.3	<0.0001	166	17.7
Length of stay §		13.8 (10.8)		0.0005	11.0 (9.4)	
Mortality rate		40.4%		0.0059	11.6%	

* significance level considered $p < 0.01$, † n meaning total number of cases regarding aspiration pneumonia; ‡ n meaning total number of cases regarding the whole population studied; § average length of stay in days, with standard deviation between parenthesis

almost 20% of our stroke population. As we showed in our study, where dysphagia is present in 46.1% of stroke patients, the group with the lowest GUSS scores, classified with severe dysphagia, was the one with higher rates of aspiration

pneumonia. However, we found that the second highest frequency of AP was in the group with mild dysphagia (GUSS 14-19). That can be explained by the fact that mild dysphagia may go unnoticed until complications arise, coupled with the

fact that our dysphagia evaluation occurs only when the patient is already on the stroke unit, after a variable period of stay in the emergency department. This makes us conclude, in line with the literature,^{2,4,8,9,12,13} that the sooner dysphagia is assessed, the higher chance physicians have to identify patients with dysphagia, with higher risk of aspiration pneumonia.

In the available literature, it is established that the cough reflex depends not only on medullary reflex pathways, but also on cortical facilitatory pathways, with known association between dysphagia and severe stroke according to NIHSS, supratentorial and TACI strokes.^{5-7,9-11,14} In agreement with the published literature, there was a higher AP prevalence with statistical significance in the TACI group. However, considering the severity of the stroke, we not only found a higher prevalence of aspiration pneumonia with severe stroke, classified by NIHSS higher than 20 points, with 50.8% (n = 93) patients, but also in the mild-moderate severity group with 27.9% (n = 51). Even though that was not evaluated in our study, we believe that this high prevalence of AP in mild-moderate stroke reflects the effect of thrombolysis and thrombectomy in TACI patients, with considerable improvement of neurological deficits and a consequent decrease in NIHSS at the time of stroke unit admission, without decreasing the pre-treatment risk of aspiration.

Stroke patients with better functional indices are less likely to have dysphagia and to develop aspiration pneumonia.^{1,4,6,8,15} According to the functional status, our study revealed that severe functional impairment (mRS=5 and Barthel = [0-49]) was related to AP with statistical significance. That agrees with the severity of the stroke that we found in the aspiration pneumonia group.

The development of aspiration pneumonia in stroke populations increases their complications and mortality rates, as well as the length of hospitalization and health costs.^{2,4-6,10,12,15,16} In agreement with the literature, we found that patients who evolved with aspiration pneumonia had a 2.8 days longer length of hospital stay, compared to the overall population (13.8 days vs 11.0 days). On the same page, the mortality rate of aspiration pneumonia was 28.8% higher than the overall stroke population (40.4% vs 11.6%), being in this series the most frequent cause of death.

The great strength of this study is the size of the data pool that it complies, with more than 1000 patients admitted in just three years, as well as the objective data ascribed by functional scales applied both at admission and discharge of the patients. However, there are several limitations. First, the retrospective nature of the study compromises the diagnostic evaluation of aspiration pneumonia, which is based on clinical records, and some laboratorial findings, not always being the timeline of development of this entity clearly defined. On the other hand, patients submitted to thrombolysis or thrombectomy should be categorized, but as the latter procedure is not made in our institution, we decided to exclude it, because of the lack of other institutions' clinical records, and the possible bias inherent.

Concluding, aspiration pneumonia is related to the severity of the stroke, the consequent impact on functional status, and the grade of dysphagia, being linked to higher mortality rates and longest length of stay. The early dysphagia assessment with simple clinical tools is imperative to define patients with unexpected aspiration hazards, to promote early detection and aspiration pneumonia prevention.

ACKNOWLEDGEMENTS

The authors thank the Neurology Department Director, Dr. Mário Rui Silva, and the Internal Medicine Director at the time of the study design, Dr^a. Paula Vaz Marques for the support. ■

Responsabilidades Éticas

Conflitos de Interesse: Os autores declaram a inexistência de conflitos de interesse na realização do presente trabalho.

Fontes de Financiamento: Não existiram fontes externas de financiamento para a realização deste artigo.

Confidencialidade dos Dados: Os autores declaram ter seguido os protocolos da sua instituição acerca da publicação dos dados de doentes.

Proteção de Pessoas e Animais: Os autores declaram que os procedimentos seguidos estavam de acordo com os regulamentos estabelecidos pelos responsáveis da Comissão de Investigação Clínica e Ética e de acordo com a Declaração de Helsínquia da Associação Médica Mundial.

Proveniência e Revisão por Pares: Não comissionado; revisão externa por pares.

Ethical Disclosures

Conflicts of interest: The authors have no conflicts of interest to declare.

Financing Support: This work has not received any contribution, grant or scholarship

Confidentiality of Data: The authors declare that they have followed the protocols of their work center on the publication of data from patients.

Protection of Human and Animal Subjects: The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Provenance and Peer Review: Not commissioned; externally peer reviewed.

© Autor (es) (ou seu (s) empregador (es)) e Revista SPMI 2021. Reutilização permitida de acordo com CC BY-NC. Nenhuma reutilização comercial.

© Author(s) (or their employer(s)) and SPMI Journal 2021. Re-use permitted under CC BY-NC. No commercial re-use.

Correspondence / Correspondência:

Adelaide Moutinho – m.adelaide.moutinho@gmail.com

Serviço de Medicina Interna do Centro Hospitalar de Trás-os-Montes e Alto Douro, Vila Real, Portugal

Rua dos Lagoeiros, 43, 5000-508 – Vila Real

Received / Recebido: 15/12/2020

Accepted / Aceite: 20/04/2021

Publicado / Published: 21 de setembro de 2021

REFERENCES

- Ouyang M, Boaden E, Arima H, Lavados PM, Billot L, Hackett ML, et al. Dysphagia screening and risks of pneumonia and adverse outcomes after acute stroke : An international multicenter study. *Int J Stroke*. 2020;15:206-15. doi: 10.1177/1747493019858778.
- Park KD, Kim TH, Lee SH. The Gugging Swallowing Screen in dysphagia screening for patients with stroke: A systematic review. *Int J Nurs Stud*. 2020;107.
- Field M. Implementing Cough Reflex Testing in a Clinical Pathway for Acute Stroke : A Pragmatic Randomised Controlled Trial implications such as aspiration pneumonia and. *Dysphagia*. 2018;33:827-39. doi: 10.1007/s00455-018-9908-5.
- Teuschl Y, Trapl M, Ratajczak P, Matz K, Dachenhausen A, Brainin M. Systematic dysphagia screening and dietary modifications to reduce stroke-associated pneumonia rates in a stroke-unit. *PLoS One*. 2018;13:e0192142. doi: 10.1371/journal.pone.0192142.
- Teh WH, Smith CJ, Barlas RS, Wood AD, Bettencourt-Silva JH, Clark AB, et al. Impact of stroke-associated pneumonia on mortality, length of hospitalization, and functional outcome. *Acta Neurol Scand*. 2018;138:293-300. doi: 10.1111/ane.12956.
- Yu KJ, Moon H, Park D. Different clinical predictors of aspiration pneumonia in dysphagic stroke patients related to stroke lesion. *Medicine*. 2018;97:e13968. doi: 10.1097/MD.00000000000013968.
- Aoki S, Hosomi N, Hirayama J, Nakamori M. The Multidisciplinary Swallowing Team Approach Decreases Pneumonia Onset in Acute Stroke Patients. *PLoS One*. 2016;11:e0154608. doi: 10.1371/journal.pone.0154608.
- Virvidaki IE, Dimakopoulos G, Giannopoulos S, Nasios G, Michou E. Predictive value of a novel pragmatic tool for post - stroke aspiration risk : The Functional Bedside Aspiration Screen. *Neurogastroenterol Motil*. 2019;31:e13683. doi: 10.1111/nmo.13683.
- Mandell LA, Niederman MS. Aspiration Pneumonia. *N Engl J Med*. 2019;380:651-663. doi: 10.1056/NEJMra1714562.
- Arnold M, Liesirova K, Broeg-morvay A, Meisterernst J. Dysphagia in Acute Stroke : Incidence, Burden and Impact on Clinical Outcome. *PLoS One*. 2016;11:e0148424. doi: 10.1371/journal.pone.0148424.
- Ribeiro PW, Cola PC, Gatto AR, Silva RG, Luvizutto GJ, Braga GP, et al. Relationship Between Dysphagia, National Institutes of Health Stroke Scale Score, and Predictors of Pneumonia After Ischemic Stroke. *J Stroke Cerebrovasc Dis*. 2015;1-7. doi: 10.1016/j.jstrokecerebrovasdis.2015.05.009
- Feng M, Lin Y, Chang Y, Chen C, Chiang H, Huang L, et al. The Mortality and the Risk of Aspiration Pneumonia Related with Dysphagia in Stroke Patients. *J Stroke Cerebrovasc Dis*. 2019;28:1381-7. doi: 10.1016/j.jstrokecerebrovasdis.2019.02.011
- Krajczyk E, Krajczyk M, Luniewski J, Bogacz K, Szczegieliński J. Assessment of the effects of dysphagia therapy in patients in the early post-stroke period: A randomised controlled trial. *Neurol Neurochir Pol*. 2019;53:428-34.
- Cohen DL, Roffe C, Beavan J, Blackett B, Fairfield CA, Hamdy S, et al. Post-stroke dysphagia: A review and design considerations for future trials. *Int J Stroke*. 2016;11:399-411. doi: 10.1177/1747493016639057.
- Sanivarapu RR, Gibson JG. Aspiration Pneumonia. *StatPearls*. 2019;651-63.
- Sun J, Li Z. Study on the correlation between barium radiography and pulmonary infection rate in the evaluation of swallowing function. *Clinics*. 2018;73:e182. doi: 10.6061/clinics/2018/e182.