ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2021;000: 1−7

ORIGINAL RESEARCH

Association Between the Swallowing Reflex and the Incidence of Aspiration Pneumonia in Patients With Dysphagia Admitted to Long-term Care Wards: A Prospective Cohort Study of 60 Days

Tomoya Omura, ST, MS,[a,b] Miwa Matsuyama, DDS, PhD,[c] Shota Nishioka, ST,[b] Shomu Sagawa, ST,[b] Masaya Seto, ST,[b] Mitsugu Naoe, PT[b]

From the [a]Department of Oral Health Care and Rehabilitation, Doctor's Course of Oral Health Science Graduate School of Oral Sciences, Tokushima University, Tokushima; [b]Department of Rehabilitation, Naruto-Yamakami Hospital, Tokushima; and [c]Department of Oral Health Care and Rehabilitation, Institute of Health Biosciences, Tokushima University Graduate School, Tokushima, Japan.

Abstract

Objective: To investigate the association between the Simple Swallowing Provocation Test (SSPT) and the incidence of aspiration pneumonia in patients with dysphagia in long-term care (LTC) wards.

Design: The study design was a prospective cohort study. Participants were followed for 60 days from admission.

Setting: LTC wards.

Participants: Study participants were patients with dysphagia aged ≥65 years who were admitted to LTC wards between August 2018 and August 2019. In total, 39 participants were included in the analysis (N=39; 20 male, 19 female; mean age, 83.8±8.5y). Participants were divided into 2 groups based on SSPT results: normal swallowing reflex (SSPT normal group) and abnormal swallowing reflex (SSPT abnormal group). The covariates were age and sex, primary disease, history of cerebrovascular disease, Glasgow Coma Scale, body mass index, Geriatric Nutritional Risk Index, the Mann Assessment of Swallowing Ability, Food Intake Level Scale, FIM, and Oral Health Assessment Tool.

Interventions: Not applicable.

Main Outcome Measures: The outcome was the incidence of aspiration pneumonia during the first 60 days of hospitalization, and the predictive factor was SSPT: 0.4 mL.

Results: The incidence of aspiration pneumonia was 33.3% in the SSPT normal group and 76.2% in the SSPT abnormal group. The φ coefficient (a measure of association for 2 binary variables) was 0.43, the risk ratio (the ratio of the probability of an outcome in an exposed group to the probability of an outcome in an unexposed group) was 2.29, and the 95% confidence interval was 1.14-4.58 for the SSPT abnormal group.

Conclusions: Our findings suggest that the SSPT provides a valid index for the development of aspiration pneumonia in older patients with dysphagia admitted to LTC wards.

Archives of Physical Medicine and Rehabilitation 2021;000:1−7

Aspiration pneumonia is a common disease associated with older patients with dysphagia, and mortality is increasing.[1] Aspiration pneumonia has a high recurrence rate, resulting in decreased swallowing function and diminished activities of daily living (ADL). Additionally, aspiration pneumonia leads to poor outcomes such as prolonged hospital stays and increased mortality.[2-5] Therefore, detecting patients at risk of developing aspiration pneumonia early in hospitalization is important for subsequent prevention.

Disclosures: none

0003-9993/$36 - see front matter © 2021 The American Congress of Rehabilitation Medicine. Published by Elsevier Inc. All rights reserved.
https://doi.org/10.1016/j.apmr.2021.06.012

Various reports have been published on risk factors related to aspiration pneumonia.[6-9] A review by Martino et al[10] reported that the risk of pneumonia was 3.17 (95% confidence interval [CI], 2.07-4.87) times higher in patients with dysphagia than in patients without dysphagia, and 11.56 (95% CI, 3.36-39.77) times higher in patients with dysphagia with aspiration.[10] Dysphagia is an important risk factor for aspiration pneumonia,[11,12] and the presence of silent aspiration is known to increase the risk of aspiration pneumonia.[13,14] Therefore, the detection of aspiration and silent aspiration is important for predicting aspiration pneumonia.

Swallowing screening is performed to detect dysphagia and aspiration, and the efficacy of some swallowing screening tests has been validated.[15-17] However, swallowing screening is not sufficient to detect silent aspiration.[18] The Simple Swallowing Provocation Test (SSPT) developed by Teramoto et al measures the latent time from the injection of distilled water into the oropharynx to the onset of the swallowing reflex by injecting 0.4 mL (first step SSPT) and 2.0 mL (second step SSPT) through a nasal 5Fr feeding catheter.[19,20] The SSPT has been shown to distinguish patients at risk of aspiration from those with normal swallowing function.[20] Previous studies confirmed the validity of SSPT using videofluoroscopic examination of swallowing.[21] The sensitivity for the detection of aspiration and silent aspiration was 73% and 75% for the first step and 13% and 17% for the second step, respectively. The specificity for the detection of aspiration and silent aspiration was 40% and 38% for the first step and 80% and 86% for the second step, respectively. These data suggest that the SSPT has limited applicability as a screening tool for aspiration, silent aspiration, or penetration because of its low sensitivity. However, the SSPT has been reported to assist in the detection of patients at risk of aspiration pneumonia.[20] The accuracy of predicting aspiration pneumonia is higher with the SSPT than with the water swallowing test.[19,22] The SSPT is unique in that it is performed with the patient in the supine position. Aspiration pneumonia in older persons is reported to be caused by silent aspiration during nighttime sleep.[23] Therefore, it may be possible to use the SSPT to detect the risk of aspiration pneumonia in older patients. This test may also be useful for patients who cannot undergo other tests because of cognitive and/or linguistic dysfunction.[21] Previous studies have found an association between the SSPT and aspiration pneumonia in patients with acute ischemic stroke and residents of a geriatric health services facility.[24,25] However, there have been no studies on the association between the SSPT and aspiration pneumonia in long-term care (LTC) wards in Japan that provide long-term care for older adults with severe physical and cognitive problems under the national health care insurance system. Patients in LTC wards are generally admitted from acute/subacute hospital wards after acute treatments or from home because of exacerbation of their disease conditions. Japanese LTC wards are comparable with skilled nursing homes in Western countries,[26] and 63% of cases of nursing and health care–associated pneumonia (the Japanese version of health care–associated pneumonia)[27] in LTC wards have been reported to be associated with aspiration.[28] A previous study reported that all patients who developed nursing and health care–associated pneumonia in LTC wards had dysphagia.[29] It is presumed that patients with dysphagia admitted to LTC wards are more likely to develop aspiration pneumonia; therefore, prediction of aspiration pneumonia is important for these patients.

In this study, we aimed to clarify the association between the SSPT and the incidence of aspiration pneumonia in patients with dysphagia admitted to LTC wards and to assess the reliability of the SSPT in identifying patients with dysphagia at high risk of aspiration pneumonia.

List of abbreviations:

ADL	**activities of daily living**
CI	**confidence interval**
LTC	**long-term care**
MASA	**Mann Assessment of Swallowing Ability**
SSPT	**Simple Swallowing Provocation Test**

Methods

Study design

The study design was a prospective cohort study. Participants were registered as a cohort on admission and were followed for 60 days from admission.

Participants

Study participants were patients with dysphagia aged ≥65 years admitted to LTC wards from August 2018 to August 2019. Dysphagia was determined by the Mann Assessment of Swallowing Ability (MASA)[30] at admission. The total score of the MASA is 200 points, and the cutoff value is 177 points. The results of the MASA are interpreted as no abnormality (≥178), mild dysphagia (168-177), moderate dysphagia (139-167), and severe dysphagia (≤138). Participants with ≤177 points were registered as part of the cohort. Exclusion criteria were participants who were discharged within 60 days, participants with missing data, and participants who were not assessed within 1 month of admission. This study was conducted with approval from the Naruto Yamakami Hospital Ethics Committee (1/1/01). Informed consent was obtained in writing from the participants or from an alternate in the case of participants with communication difficulties. The analysis was conducted with consideration of protecting patients' personal information.

The sample size was calculated based on the difference in the incidence of aspiration pneumonia between the SSPT abnormal group and the normal group in a previous study of a geriatric health services facility.[25] The incidence of aspiration pneumonia was set at a power level of 80% and a significance level of 5%, assuming a normal group (30%) and an abnormal group (75%). It required 18 participants in each group, making a total of 36 participants. Exclusion criteria were participants discharged within 60 days of admission and participants with missing data.

Outcome measure

The primary outcome measure was the incidence of aspiration pneumonia during the first 60 days after hospitalization. Aspiration pneumonia was diagnosed by a physician based on the

Clinical Practice Guidelines for Nursing- and Healthcare-associated Pneumonia.[27] The clinical diagnostic criteria for aspiration pneumonia are shown in box 1.

Box 1 Clinical Diagnostic Criteria for Aspiration Pneumonia

Diagnostic criteria of pneumonia

To be diagnosed with pneumonia, a case must satisfy conditions (1) and (2):

(1) A shadow indicating alveolar infiltration is observed on chest radiography or chest computed tomography.

(2) There are 2 or more of the following signs: fever of 37.5°C or higher, abnormally elevated C-reactive protein, peripheral blood leukocytes ≥9000/μL, or airway symptoms such as excess sputum.

Confirmed cases (direct observation of aspiration)

A: Cases in which the aspiration was specifically confirmed (via food and vomiting) and was accompanied by the onset of pneumonia.

B: Cases of patients diagnosed as having pneumonia and confirmed by contents aspirated from the airway.

Nearly confirmed cases (presence of dysphagia)

A: Cases in which the diagnostic criteria are met and swallowing dysfunction, such as choking, is clinically observed during eating and drinking.

B: Cases that fall under A or B of confirmed cases and that meet the diagnostic criteria (1) or (2) for pneumonia.

Suspected cases (possibility of dysphagia)

A: Cases with the following underlying clinical conditions or diseases with the possibility of aspiration or dysphagia and that meet the diagnostic criteria (1) or (2) for pneumonia.

B: Cases in which objective tests show dysphagia during the clinical course (swallowing provocation test).

Underlying clinical conditions or diseases with the possibility of dysphagia:

- Cerebrovascular diseases (chronic or acute)
- Neurodegenerative disease and/or neuromuscular disease that can cause dysphagia
- Impaired consciousness and progressive dementia
- Digestive disorders that can cause vomiting and gastroesophageal reflux (including after gastrectomy).
- Oropharyngeal and mediastinal tumors and their postoperative state and associated tracheoesophageal fistulas.
- Tracheostomy and nasogastric tubal feeding
- Other underlying diseases that can cause dysphagia

Assessment items

The predictive factor was an SSPT with 0.4 mL water (SSPT: 0.4mL). In previous studies, the SSPT was a 2-step method based on the response to 0.4 mL water with an additional test with 2 mL.[20] However, in this study, the response to 0.4 mL water alone was used to simplify the examination and the result determination. The SSPT was conducted alone by 3 precalibrated speech-language-hearing therapists with more than 3 years of clinical experience as described by Teramoto et al.[19,20] In the preliminary survey, the degree of concordance of the 3 measurers in 3 healthy participants was >90%. The patient was placed in a supine position, and a 5Fr feeding catheter[a] (outside diameter 1.7mm, length 40cm) was inserted nasally for about 13 cm and into the oropharynx. The swallowing reflex was induced by a bolus injection of 0.4 mL of distilled water, injected in bursts of approximately 1-2 seconds to keep the velocity of injection similar between trials. Participants were unaware of the timing of the actual injection. The water bolus injection was administered near the end of expiration. The latent time from the beginning of the water bolus injection to the onset of swallowing (ie, laryngeal elevation) was measured with a stopwatch. The swallowing reflex was confirmed by visual inspection of laryngeal elevation. A swallowing reflex observed within 3 seconds was classified as normal, and no reflex within 3 seconds was classified as abnormal. Three trials were performed, and the average of 2 short latencies was used. The SSPT was based solely on whether the swallowing reflex occurred within 3 seconds. The covariates were age, sex, primary disease, history of cerebrovascular disease, Glasgow Coma Scale, MASA, Food Intake Level Scale,[31] body mass index, Geriatric Nutritional Risk Index (nutrition index of older adults),[32] FIM (ADL index), and Oral Health Assessment Tool (index of oral condition).[33] All (covariates) data were assessed within 1 month of admission.

Statistical analysis

Participants were divided into 2 groups: those with a normal swallowing reflex (SSPT normal group) and those with an abnormal swallowing reflex (SSPT abnormal group) based on the SSPT results. Descriptive statistics were performed after data acquisition, and the 2 groups were compared for each assessment item. Logistic regression analysis was used as a multivariate analysis to extract predictive factors associated with aspiration pneumonia (the objective variable). Mann-Whitney *U* tests, Fisher exact test, and chi-square tests were used for comparisons between the 2 groups. Chi-square tests were also used to calculate the φ coefficient, risk ratio, and 95% CI between SSPT: 0.4 mL and aspiration pneumonia. SSPT: 0.4 mL and assessment items that showed a significant difference between the 2 groups were used as explanatory variables.

We also calculated the sensitivity, specificity, positive predictive value, negative predictive value, accuracy, false-negative rate, and false-positive rate of SSPT: 0.4 mL to confirm the prediction accuracy of aspiration pneumonia. We used IBM SPSS Statistics version 25[b] for statistical analyses, with the alpha level "α=0.05."

Results

We enrolled 54 consecutive patients with dysphagia who were hospitalized during the study period. Participants excluded were those who were discharged within 60 days of admission (n=7), those with missing data (n=3), and those who were not assessed within 1 month of admission (n=5). In total, 39 participants were included in the analysis (20 men, 19 women; mean age, 83.8±8.5y). Eighteen cases were allocated to the SSPT normal group, and 21 cases were allocated to the SSPT abnormal group (table 1).

Twenty-two participants (56.4%) developed aspiration pneumonia within 60 days of hospitalization. There was a significant difference in the incidence of aspiration pneumonia between the 2 groups. The incidence rate was 33.3% (6 cases) in the SSPT normal group and 76.2% (16 cases) in the SSPT abnormal group (fig 1). Comparison between the 2 groups revealed significant differences in the assessment items of age, sex, and primary disease (disuse syndrome was more common

Table 1 Participant basic attributes

Characteristics	Total (N=39)	SSPT Abnormal Group (n=21)	SSPT Normal Group (n=18)	*P* Value
Age (y), mean ± SD	83.8±8.5	81.1±8.6	86.9±7.3	.032
Sex (n), male/female	20/19	15/6	5/13	.007
Primary disease				.018
Cerebrovascular disease, n (%)	15 (38)	10 (48)	5 (28)	.204
Disuse syndrome, n (%)	17 (44)	5 (24)	12 (67)	.007
Parkinson disease, n (%)	2 (5)	2 (10)	0 (0)	.490
Cancer, n (%)	1 (3)	0 (0)	1 (6)	.462
Chronic obstructive pulmonary disease, n (%)	2 (5)	2 (10)	0 (0)	.490
Orthopedic disease, n (%)	2 (5)	2 (10)	0 (0)	.490
History of cerebrovascular disease Yes/no, n	22/17	11/10	11/7	.584
GCS, median (range)	13 (11-14)	13 (11-14)	12 (11-14)	.876
MASA, median (range)	140 (94-151)	134 (92-147)	141 (110-151)	.499
FILS, median (range)	2 (2-7)	2 (2-7)	3 (2-6)	.770
BMI, median (range)	18.0 (16.1-19.5)	18.1 (16.8-19.3)	18.0 (16.0-21.6)	.833
GNRI, median (range)	76.5 (66.5-83.5)	79.2 (67.6-92.3)	70.5 (65.5-85.7)	.220
FIM (score), median (range)	23 (18-32)	23 (18-35)	20 (18-30)	.852
OHAT (score), median (range)	6 (4-8)	6 (4-8)	6 (3-7)	.487

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); FILS, Food Intake Level Scale; GCS, Glasgow Coma Scale; GNRI, Geriatric Nutritional Risk Index; OHAT, Oral Health Assessment Tool.

in the SSPT normal group) (see table 1). The φ coefficient (a measure of association for 2 binary variables) was 0.43, the risk ratio (the ratio of the probability of an outcome in an exposed group to the probability of an outcome in an unexposed group) was 2.29, and the 95% CI was 1.14-4.58 for the SSPT abnormal group (table 2). The results showed that patients with abnormal swallowing reflexes on SSPT had a 2.29 times higher incidence of aspiration pneumonia than patients with normal swallowing reflexes. In the logistic regression analysis, the objective variable was aspiration pneumonia, and the explanatory variables were SSPT: 0.4 mL, age, sex, and primary disease. The results showed that SSPT: 0.4 mL was a predictive factor associated with aspiration pneumonia. The odds ratio was 6.40, and the 95% CI was 1.57-26.03 (*P*=.01). The prediction accuracy of SSPT: 0.4 mL for aspiration pneumonia was 73% sensitivity, 71% specificity, 76% positive predictive value, 67% negative predictive value, 72% accuracy, 27% false-negative rate, and 29% false-positive rate (table 3).

Discussion

The SSPT measures the swallowing reflex with a small amount of water injected through a 5Fr feeding catheter inserted nasally 13 cm into the oropharynx.[19,20] This test has been shown to distinguish patients at risk for aspiration from those with normal swallowing function.[20] Additionally, it has been reported to assist in the detection of patients at risk of aspiration pneumonia.[20,24,25] The SSPT has the advantage of being able to be performed on patients with dementia or communication disorders.[34] However, a disadvantage is that it only evaluates the pharyngeal swallowing reflex. We investigated the association between the SSPT results

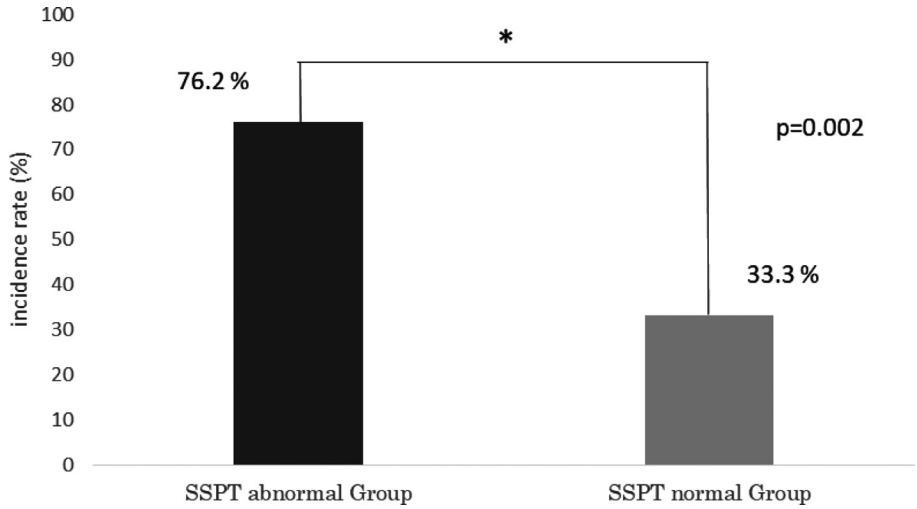

Fig 1 Incidence of aspiration pneumonia. Comparison of the incidence of aspiration pneumonia between the SSPT abnormal group and the SSPT normal group.

Table 2 φ coefficient and risk ratios for aspiration pneumonia

	Aspiration Pneumonia					
Group	Onset	Nononset	*P* Value	φ Coefficient	Risk Ratio	95% CI
SSPT abnormal group, n (%) n=21 (53.8%)	16 (76.2)	5 (23.8)	.007	0.43	2.29	1.14-4.58
SSPT normal group, n (%) n=18 (46.2%)	6 (33.3)	12 (66.7)	.007	0.43	0.36	0.16-0.82

and the incidence of aspiration pneumonia in older patients with dysphagia after the acute phase by means of a prospective cohort study. The results showed that the incidence of aspiration pneumonia was 2.3 times more common in patients with an abnormal swallowing reflex in the SSPT than in those with a normal swallowing reflex. Furthermore, logistic regression analysis suggested that the SSPT could be a predictive factor for aspiration pneumonia. It was found that abnormal SSPT results may be associated with the development of aspiration pneumonia (odds ratio, 6.4; 95% CI, 1.57-26.03). The odds ratios and 95% CI of a previous study were 10.11 and 3.36-30.36, respectively, with equivalent widths of CIs.[24]

Several studies have investigated the association between the SSPT and the incidence of aspiration pneumonia in patients with acute ischemic stroke[24] and residents in a geriatric health services facility.[25] In contrast, we examined older patients with dysphagia after the acute phase using the SSPT and found that the incidence of aspiration pneumonia was 56.4%, which was higher than that of patients with acute ischemic stroke (14%).[24] Age is considered to be one of the significant factors of aspiration pneumonia.[29,35] The participants in this study were approximately 10 years older (mean age, 83.8y) than those in the previous study (median age, 73y).[24] Age may have been a significant factor in the incidence of aspiration pneumonia. Not only the age, but also dysphagia, low ADL, and malnutrition have been reported as risk factors for aspiration pneumonia.[29,35,36] The results of this study showed that the scores of MASA, Food Intake Level Scale, FIM, and Geriatric Nutritional Risk Index were all poor. It was presumed that the participants in this study had many potential risks for aspiration pneumonia at baseline.

The sensitivity and specificity were respectively 73% and 71% in this study compared with 66.7% and 83.5% in the previous study.[24] Aspiration is not directly linked with the incidence of aspiration pneumonia,[10] but the more risk factors present the higher the incidence of aspiration pneumonia.[34] This suggests that participants of this study, who had many risk factors for aspiration pneumonia as well as abnormal swallowing reflexes were more likely to experience aspiration pneumonia. Therefore, the sensitivity may have been higher than in previous studies.

The false-negative rate (the percentage of patients with aspiration pneumonia who had a normal SSPT) was 27% in this study, which was comparable with the results of the previous study (26%-27% with aspiration as the outcome[21,37] and 33% with aspiration pneumonia as the outcome).[24] Warnecke et al[37] used fiberoptic endoscopic evaluation of swallowing and reported that in patients with false-negative SSPT results, the rate of leakage to the pisiform sinus was significantly higher than in cases with a true negative SSPT result. This report suggests that the SSPT may not adequately detect the risk of aspiration in patients with sole or predominant impairment in the oral phase of swallowing and a relatively intact pharyngeal phase.[24] Although the study did not examine the oral phase in detail, it was thought that aspiration before swallowing associated with leakage to the pisiform sinus may affect the development of aspiration pneumonia, as noted in previous studies. When using the SSPT in clinical practice, it is important to understand that there is a false-negative rate of 26%-33%. Because there are many predictive factors for aspiration pneumonia,[35] the SSPT should be combined with other predictive factors when used in clinical settings.[24]

In this study, the SSPT normal group was significantly older than the SSPT abnormal group, possibly because of the different proportions of primary disease in the participants. The rate of cerebrovascular disease was 28% in the normal SSPT group and 48% in the abnormal SSPT group. The rate of disuse syndrome was 67% in the normal SSPT group and 24% in the abnormal SSPT group. The causes of the requirement for care are mostly cerebrovascular diseases in the younger than 80 age group, whereas asthenia due to a ripe age increases in the older than 80 age group.[38] Among cerebrovascular diseases, patients with basal ganglia infarction in particular have been reported to have delayed swallowing reflexes,[39] suggesting that participants younger than the SSPT normal group may have been included in the SSPT abnormal group.

In contrast with previous studies that were retrospective,[24,25] our study was a prospective cohort study with a total of 39 cases (18 in the normal group and 21 in the abnormal group). The φ coefficient was 0.43, indicating that the effect size was sufficient. The width of the 95% CI for the risk ratio was narrow at 3.44, suggesting that the sample size was appropriate.

Table 3 Predictive accuracy of aspiration pneumonia

		Aspiration Pneumonia		
Variables		Onset, n	Nononset, n	Total
SSPT: 0.4 mL	Abnormal group, n	True-positive: 16	False-positive: 5	21
	Normal group, n	False-negative: 6	True-negative: 12	18
Total		22	17	39

Approximately 80% of patients admitted to LTC wards are aged >75 years,[40] and 72.1% of patients have low ADL levels and need medical care.[26] The demographics of the participants in our study were similar to this, with an average age of 83.3 years and low ADL levels. Therefore, it is speculated that many LTC wards have similar characteristics to this study.

Study limitations

This study has some limitations. First, the 95% CI for the SSPT as a predictive factor was wide. Second, this study investigated participants in a single institution, raising an issue with external validity. Further studies that include data from multiple institutions should be conducted to verify the reliability of the SSPT.

Conclusions

This is the first prospective cohort study to examine the association between the swallowing reflex and the incidence of aspiration pneumonia in older patients with dysphagia (mean age, 83.8y) in LTC wards. Our findings suggest that an abnormal swallowing reflex on the SSPT with the 0.4-mL water test is associated with the incidence of aspiration pneumonia, and older patients with an abnormal swallowing reflex could have 2.3 times the risk of aspiration pneumonia compared with those with a normal reflex. We conclude that the SSPT could be a predictive factor for aspiration pneumonia in older LTC inpatients.

Suppliers

a. 5Fr atom feeding catheter; Atom Medical Corporation.
b. IBM SPSS Statistics, version 25; IBM Japan.

Keywords

Cohort studies; Deglutition disorders; Long-term care; Pneumonia, aspiration; Rehabilitation

Corresponding author

Tomoya Omura, ST, MS, Department of Rehabilitation, Naruto-Yamakami Hospital, 205-29, Naruto-cho Tosadomariura, Naruto, Tokushima 772-0053, Japan. *E-mail address:* tomo.0917vv@gmail.com.

Acknowledgments

We thank all members of the Naruto-Yamakami Hospital for their help with this research. We also thank Helen Jeays, BDSc AE, from Edanz Group (https://en-author-services.edanzgroup.com/ac) for editing a draft of this manuscript.

References

1. Ikeda K, Takatoshi I. Historical overview of pneumonia deaths in Japan. Ann Rep Tokyo Metr Inst Pub Health 2018:69:271-7.
2. Hayashi M, Iwasaki T, Yamazaki Y, et al. Clinical features and outcomes of aspiration pneumonia compared with non-aspiration pneumonia: a retrospective cohort study. J Infect Chemother 2014;20:436–42.
3. Hilker R, Poetter C, Findeisen N, et al. Nosocomial pneumonia after acute stroke: implications for neurological intensive care medicine. Stroke 2003;34:975–81.
4. Komiya K, Rubin BK, Kadota JI, et al. Prognostic implications of aspiration pneumonia in patients with community acquired pneumonia: a systematic review with meta-analysis. Sci Rep 2016;6:38097.
5. Yoon HY, Shim SS, Kim SJ, et al. Long-term mortality and prognostic factors in aspiration pneumonia. J Am Med Dir Assoc 2019;20:1098–104.
6. Manabe T, Teramoto S, Tamiya N, Okochi J, Hizawa N. Risk factors for aspiration pneumonia in older adults. PLoS One 2015;10:e0140060.
7. Masiero S, Pierobon R, Previato C, Gomiero E. Pneumonia in stroke patients with oropharyngeal dysphagia: a six-month follow-up study. Neurol Sci 2008;29:139–45.
8. Sue Eisenstadt E. Dysphagia and aspiration pneumonia in older adults. J Am Acad Nurse Pract 2010;22:17–22.
9. van der Maarel-Wierink CD, Vanobbergen JN, Bronkhorst EM, Schols JM, de Baat C. Risk factors for aspiration pneumonia in frail older people: a systematic literature review. J Am Med Dir Assoc 2011;12:344–54.
10. Martino R, Foley N, Bhogal S, Diamant N, Speechley M, Teasell R. Dysphagia after stroke: incidence, diagnosis, and pulmonary complications. Stroke 2005;36:2756–63.
11. Arnold M, Liesirova K, Broeg-Morvay A, et al. Dysphagia in acute stroke: incidence, burden and impact on clinical outcome. PLoS One 2016;11:e0148424.
12. Jukic Peladic N, Orlandoni P, Dell'Aquila G, et al. Dysphagia in nursing home residents: management and outcomes. J Am Med Dir Assoc 2019;20:147–51.
13. Sakai K, Hirano H, Watanabe Y, et al. An examination of factors related to aspiration and silent aspiration in older adults requiring long-term care in rural Japan. J Oral Rehabil 2016;43:103–10.
14. Nakashima T, Maeda K, Tahira K, et al. Silent aspiration predicts mortality in older adults with aspiration pneumonia admitted to acute hospitals. Geriatr Gerontol Int 2018;18:828–32.
15. Bours GJ, Speyer R, Lemmens J, Limburg M, de Wit R. Bedside screening tests vs. videofluoroscopy or fibreoptic endoscopic evaluation of swallowing to detect dysphagia in patients with neurological disorders: systematic review. J Adv Nurs 2009;65:477–93.
16. Brodsky MB, Suiter DM, Gonzalez-Fernandez M, et al. Screening accuracy for aspiration using bedside water swallow tests: a systematic review and meta-analysis. Chest 2016;150:148–63.
17. Daniels SK, Anderson JA, Willson PC. Valid items for screening dysphagia risk in patients with stroke: a systematic review. Stroke 2012;43:892–7.
18. Ramsey DJ, Smithard DG, Kalra L. Early assessments of dysphagia and aspiration risk in acute stroke patients. Stroke 2003;34:1252–7.
19. Teramoto S, Fukuchi Y. Detection of aspiration and swallowing disorder in older stroke patients: simple swallowing provocation test versus water swallowing test. Arch Phys Med Rehabil 2000;81:1517–9.
20. Teramoto S, Matsuse T, Fukuchi Y, Ouchi Y. Simple two-step swallowing provocation test for elderly patients with aspiration pneumonia. Lancet 1999;353:1243.
21. Kagaya H, Okada S, Saitoh E, Baba M, Yokoyama M, Takahashi H. Simple swallowing provocation test has limited applicability as a screening tool for detecting aspiration, silent aspiration, or penetration. Dysphagia 2010;25:6–10.
22. Teramoto S, Yamamoto H, Yamaguchi Y, Ouchi Y, Matsuse T. A novel diagnostic test for the risk of aspiration pneumonia in the elderly. Chest 2004;125:801–2.

23. Kikuchi R, Watabe N, Konno T, Mishina N, Sekizawa K, Sasaki H. High incidence of silent aspiration in elderly patients with community-acquired pneumonia. Am J Respir Crit Care Med 1994;150:251–3.
24. Kamiya Y, Ichikawa H, Kuriki A, et al. Evaluation of swallowing in acute ischemic stroke patients using both a simple swallowing provocation test and a water swallowing test. Jpn J Stroke 2010;32:254–60.
25. Minatani S, Ohta K, Muramoto S, Inoue T, Kanada Y. Evaluation of the screening tests for the aspiration pneumonitis in the care health center for the elderly. J Jpn Soc Respir Rehabil 2008;18:59–65.
26. Igarashi A, Yamamoto-Mitani N, Morita K, Matsui H, Lai CKY, Yasunaga H. Classification of long-term care wards and their functional characteristics: analysis of national hospital data in Japan. BMC Health Serv Res 2018;18:655.
27. Kohno S, Imamura Y, Shindo Y, et al. Clinical practice guidelines for nursing- and healthcare-associated pneumonia (NHCAP) [complete translation]. Respir Investig 2013;51:103–26.
28. Ishida T, Tachibana H, Ito A, Yoshioka H, Arita M, Hashimoto T. Clinical characteristics of nursing and healthcare-associated pneumonia: a Japanese variant of healthcare-associated pneumonia. Intern Med 2012;51:2537–44.
29. Matsumura T, Oki Y, Mitani Y, Takahashi M, Fujimoto Y, Ishikawa A. Development of nursing and healthcare-associated pneumonia among cerebrovascular disorder patient in long-term care facility. J Jpn Soc Respir Care Rehabil 2013;23:284–7.
30. Mann G. MASA: the Mann Assessment of Swallowing Ability. New York: Cengage Learning; 2002.
31. Kunieda K, Ohno T, Fujishima I, Hojo K, Morita T. Reliability and validity of a tool to measure the severity of dysphagia: the Food Intake LEVEL Scale. J Pain Symptom Manage 2013;46:201–6.
32. Bouillanne O, Morineau G, Dupont C, et al. Geriatric Nutritional Risk Index: a new index for evaluating at-risk elderly medical patients. Am J Clin Nutr 2005;82:777–83.
33. Chalmers JM, King PL, Spencer AJ, Wright FA, Carter KD. The oral health assessment tool—validity and reliability. Aust Dent J 2005;50:191–9.
34. Baba Y, Teramoto S, Hasegawa H, Machida A, Akishita M, Toba K. [Characteristics and limitation of portable bedside swallowing test in elderly with dementia: comparison between the repetitive saliva swallowing test and the simple swallowing provocation test] [Japanese]. Nihon Ronen Igakkai Zasshi 2005;42:323–7.
35. Langmore SE, Skarupski KA, Park PS, Fries BE. Predictors of aspiration pneumonia in nursing home residents. Dysphagia 2002;17:298–307.
36. Mitani Y, Oki Y, Fujimoto Y, et al. Relationship between the Functional Independence Measure and Mann Assessment of Swallowing Ability in hospitalized patients with pneumonia. Geriatr Gerontol Int 2018;18:1620–4.
37. Warnecke T, Teismann I, Meimann W, et al. Assessment of aspiration risk in acute ischaemic stroke—evaluation of the simple swallowing provocation test. J neurol neurosurg psychiatry 2008;79:312–4.
38. Ministry of Health, Labour, and Welfare. Comprehensive survey of living conditions: 2019. Available at: https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00450061&tstat=000001141126&cycle=7&tclass1=000001141143&tclass2val=0. Accessed April 1, 2021.
39. Nakagawa T, Sekizawa K, Arai H, Kikuchi R, Manabe K, Sasaki H. High incidence of pneumonia in elderly patients with basal ganglia infarction. Arch Intern Med 1997;157:321–4.
40. Ministry of Health, Labour, and Welfare. About examination about the way of medical treatment bed. Available at: https://www.mhlw.go.jp/stf/shingi2/0000145095.html. Accessed February 15, 2020.