RESEARCH

COMPARISON OF BEDSIDE DIAGNOSIS METHODS WITH FIBEROPTIC ENDOSCOPIC EVALUATION OF SWALLOWING IN PATIENTS WITH POST-STROKE DYSPHAGIA

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Abstract

Introduction: Post-stroke dysphagia increases mortality and morbidity due to aspiration pneumonia and malnutrition. We aimed to compare the applicability of the bedside water swallow test, the National Institutes of Health Stroke Scale, and the modified Mann Assessment of Swallowing Ability with the fiberoptic endoscopic evaluation of swallowing in determining dysphagia.

Materials and Methods: Our study included 40 patients admitted to a tertiary hospital from July to October 2021 with acute ischemic stroke. We prospectively noted each patient's age, gender, medical conditions, test scores, and the presence of pneumonia during hospitalization.

Results: Of the 40 patients, 27 (67.5%) were male and 13 (32.5%) female, and their mean age was 68.72 years. Eleven (27.5%) patients had aspiration, 6 (15%) had penetration, and 17 (42.5%) had therefore dysphagia. A statistically significant difference was noted between the patients with and without dysphagia for the bedside water swallow test, the modified Mann Assessment of Swallowing Ability, 2% or more oxygen desaturation, the combination of the bedside water swallow test and the modified Mann Assessment of Swallowing Ability, and saturation ($p = 0.004$, $p = 0.03$, $p = 0.042$, $p = 0.002$, and $p = 0.042$, respectively). A statistically significance for the prediction of aspiration ($p = 0.049$) was only detected using the bedside water swallowing test–modified Mann Assessment of Swallowing Ability combination.

Conclusion: Bedside dysphagia screening may be used to determine the presence of post-stroke dysphagia. Notwithstanding, only the bedside water swallowing test–modified Mann Assessment of Swallowing Ability combination successfully predicted aspiration.

Key words: Dysphagia; Endoscopy; Pneumonia; Stroke.

INTRODUCTION

Stroke is a common health problem and one of the leading causes of death and disability in adults worldwide (1). The prevalence of stroke ranges between 0.9% and 4.1% in the Turkish population (2-4). Moreover, Türk Börü et al. (5) found that stroke prevalence among the young population (< 45 years) in Turkey was 0.6%.

Post-stroke dysphagia (PSD) is a well-known complication of stroke, and its prevalence varies between 28% and 65%, with the variation depending on the test or method used to diagnose PSD and the timing of the evaluation (1, 6). PSD is directly related to aspiration pneumonia and malnutrition, which increases mortality, morbidity, the length of hospital stay, and economic burden (7). Even if the patients with PSD may achieve spontaneous recovery in time (1, 8), they have a significantly increased 5-year mortality rate in comparison to patients without PSD (adjusted hazard ratio: 1.84; 95% confidence interval [CI]: 1.57–2.16; $p < 0.001$) (8). The early detection of PSD therefore has a crucial role to play in preventing the aforementioned complications and improving swallowing functions through rehabilitation, which may include appropriate nutrition.

The diagnostic methods for dysphagia include a videofluoroscopic swallowing study (VFSS), a fiberoptic endoscopic evaluation of swallowing (FEES), and clinical bedside methods comprising different combinations (1). However, the necessary staff and/or instruments required to perform VFSS and FEES are not available in many hospitals worldwide (1, 9), so it may not be possible or practical for these tests to be performed for each stroke depending on the patient's condition (10). In this study, we aimed to investigate the applicability of the bedside water swallow test (BWST), the National Institutes of Health Stroke Scale (NIHSS), and the modified Mann Assessment of Swallowing Ability (mMASA) through comparison with the FEES to determine PSD.

MATERIALS AND METHODS

Study Design

Forty patients who were admitted to a tertiary hospital from July to October 2021 with first-time acute ischemic stroke confirmed via the diffusion-weighted magnetic resonance imaging were included our study. Each patient's age, gender, medical conditions, test scores for bedside water swallowing, the NIHSS, the mMASA, penetration–aspiration in the FEES, and the presence of pneumonia during their hospital stay were noted prospectively.

Inclusion and Exclusion Criteria

The patients with a complaint of dysphagia within 3 days following their hospital stay were enrolled. Any neurological diseases other than stroke, a history of previous stroke, poor consciousness, a history of head and neck cancer, a history of any surgical intervention or trauma to the head and neck, a history of dysphagia before the hospital stay, the presence of pneumonia before the hospital stay, and patients who refused to participate in the study were excluded.

Measurement of the Outcomes

All the patients were informed about dysphagia and the study, and their verbal and written consent form were obtained immediately following their hospital stay. The patients with dysphagia that started within 3 days following hospital admission (maximum 5 days if it started on a weekend) were visited, and the BWST, NIHSS, and mMASA were performed by two neurologists (MSB, ÜD). Two otolaryngologists (LY, BY) and a swallowing therapist (NE) noted the penetration–aspiration scale (PAS) score after the FEES had been performed. The clinicians were blinded to the performance of each other's tests. The scores for each patient were confirmed by the two independent physicians who performed the same tests.

Bedside Water Swallowing Test (BWST)

Each subject was asked to drink 10 ml of water

from a glass in a seated position, and oxygen saturation was measured from a finger on the non-hemiplegic side during swallowing and for 2 minutes thereafter. The presence of cough, voice change, a 2% or more drop in oxygen saturation, and water flowing from the corner of the mouth, the absence of laryngeal movement, and drinking the water by taking in small volumes instead of drinking once at a time were rated as one point each. The total score ranged from 0 to 6, a score ≥3 was considered as dysphagia (11).

National Institutes of Health Stroke Scale (NIHSS)

The NIHSS is globally accepted questionnaire that measures the severity of stroke. The total score ranges between 0 and 42, and higher results indicate greater impairment. The total score is interpreted as follows: 1–4, minor stroke; 5–15, moderate stroke; 16–20, moderate to severe stroke; and 21–42, severe stroke (12).

Modified Mann Assessment of Swallowing Ability (mMASA)

The mMASA questionnaire consists of 12 items with a total value of 100 points. A total score <95 indicates dysphagia (13).

Fiberoptic Endoscopic Evaluation of Swallowing (FEES) and Penetration-Aspiration Scale (PAS)

Penetration is described as the bolus staying above the vocal cords, while aspiration means that the bolus passes into the airway below the true vocal cords during swallowing. A PAS score can range between 1 and 8. A score >1 is considered as dysphagia, 2–5, indicates penetration, and >5 denotes aspiration (14). During the FEES in this study, a fiberoptic endoscope was inserted into the side of the nose without septal deviation, and a clear view of the laryngeal structures was obtained. The patient was asked to drink a total of 5 cc of liquid (blue food coloring-dyed water), divided into 1 cc for 5 s periods. The PAS score was then noted. Afterward, the same procedure was repeated with a thickened food (5 ml yoghurt). We used the FEES as a gold standard test to detect dysphagia in this study.

Combinations of the Tests

When the results were the same for each test, the scores were noted as a binary combination. Otherwise, the absence of dysphagia was indicated. As the saturation is part of the BWST, this combination was not included in our analysis.

Statistical Analysis

The data were analyzed using IBM Statistical Package for Social Sciences version 22.0 for Windows (SPSS Corp., Armonk, NY) with a 95% confidence interval (CI). The descriptive statistics were presented as mean ± standard deviation (SD) for the numerical variables and as the number of cases (%) for the categorical variables. The normality hypotheses were tested using the Kolmogorov–Smirnov and Shapiro–Wilk tests. Double-group comparisons of the normally distributed continuous variables (age, NIHSS values) were tested using the independent sample *t*-test; those that did not show normal distribution (BWST and mMASA values) were evaluated using the Mann–Whitney *U* test. A univariate analysis of the data was performed using a 2 × 2 table, and the results were compared using either Pearson's chi-square test or Fisher's exact test. A result of $p< 0.05$ was considered statistically significant.

This study was performed in line with the principles of the Declaration of Helsinki. It was approved by the institutional ethics committee (No. 2021/199, June 17, 2021) and conducted in accordance with the related privacy statements and applicable regulatory requirements.

RESULTS

A total of 40 patients comprising 27 (67.5%) males and 13 (32.5%) females were enrolled in this prospective study. The mean age of the patients was 68.72 (minimum: 52, maximum: 85, SD: 10.23) years.

Twenty-two (55%) patients had diabetes mellitus (DM), 38 (95%) patients had hypertension (HT), and 20 (50%) patients had both conditions. Seventeen (42.5%), patients had minor stroke, 22 (55%) had moderate stroke, and 1 (2.5%) had moderate to severe stroke.

Their PAS scores showed that 11 (27.5%) patients had aspiration, 6 (15%) had penetration, and 17 (42.5%) had therefore dysphagia. After reevaluating their PAS scores with thickened liquid, only one patient 1 (2.5%) who had a weak cough reflex showed a penetration to the larynx. That patient's oral intake was therefore stopped and a nasogastric tube was placed to prevent silent aspiration. The other patients with aspiration or penetration continued their oral intake of the thickened food, and none of the patients were observed as having pneumonia during their hospital stay. The swallowing rehabilitation continued after discharge.

The descriptive statistics of the outcome variables are summarized in *Table 1*. *Figures 1 and 2* represent the distribution of the values of the outcome variables of the patients with or without dysphagia, and those with and without aspiration, respectively. Statistical significance was detected in the mean values of the BWST between the patients with and without dysphagia (p = 0.006). The other outcome variables did not show a statistically significant difference between the patients with and without dysphagia, or the patients with and without aspiration (p>0.05).

No relationship was detected in the comparison of age (>65 years vs. ≤65 years), gender, the presence of DM, the presence of both DM and HT between the patients with and without dysphagia, and those with and without aspiration (p>0.05). *Tables 2 and 3* summarize the comparison between the outcome variables and the patients with and without dysphagia, and the patients with and without aspiration, respectively. We found a statistically significant difference in the BWST, the mMASA test, a 2% or more drop in oxygen saturation, the combination of the mMASA and BWST, and saturation between the patients with and without dysphagia (p = 0.004, p = 0.03, p = 0.042, p = 0.002, and p = 0.042, respectively). The combination of saturation and the mMASA test did not change the result when compared to a 2% or more drop in oxygen saturation alone (p = 0.042 for both). The combination of the mMASA test and BWST was only the test for which a statistically significant result was detected for the prediction of aspiration (*p=0.049*).

DISCUSSION

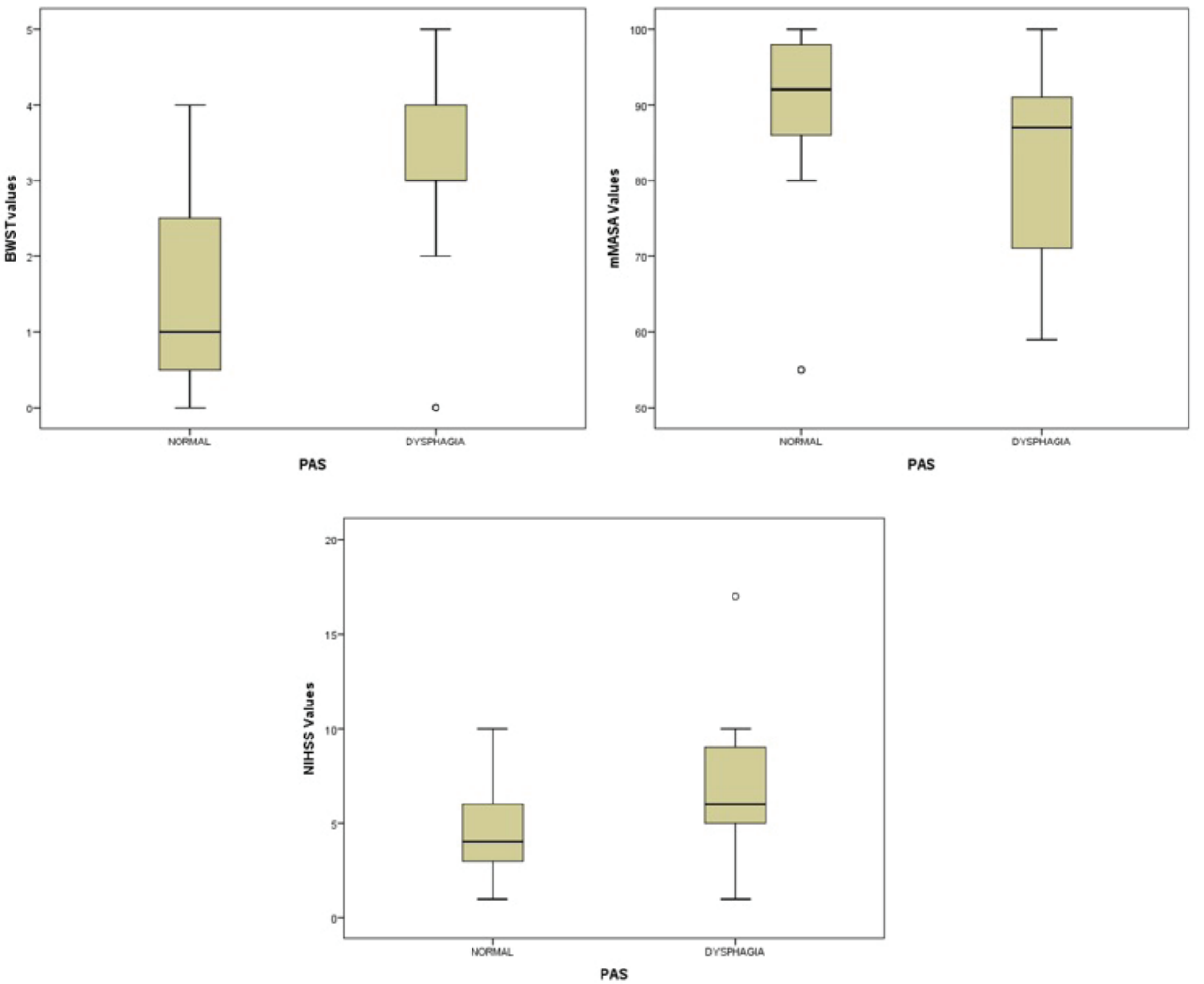
The global incidence of PSD, which carries an increased risk of morbidity and mortality due to aspiration pneumonia and malnutrition, has been

Table 1. The descriptive statistics of the scores of the outcome variables.

Variable	Minimum	Maximum	Mean	SD
BWST	0	5	2.25	1.69
mMASA	55	100	86.62	12.42
NIHSS	1	17	5.50	3.44
PAS	1	7	2.83	2.55

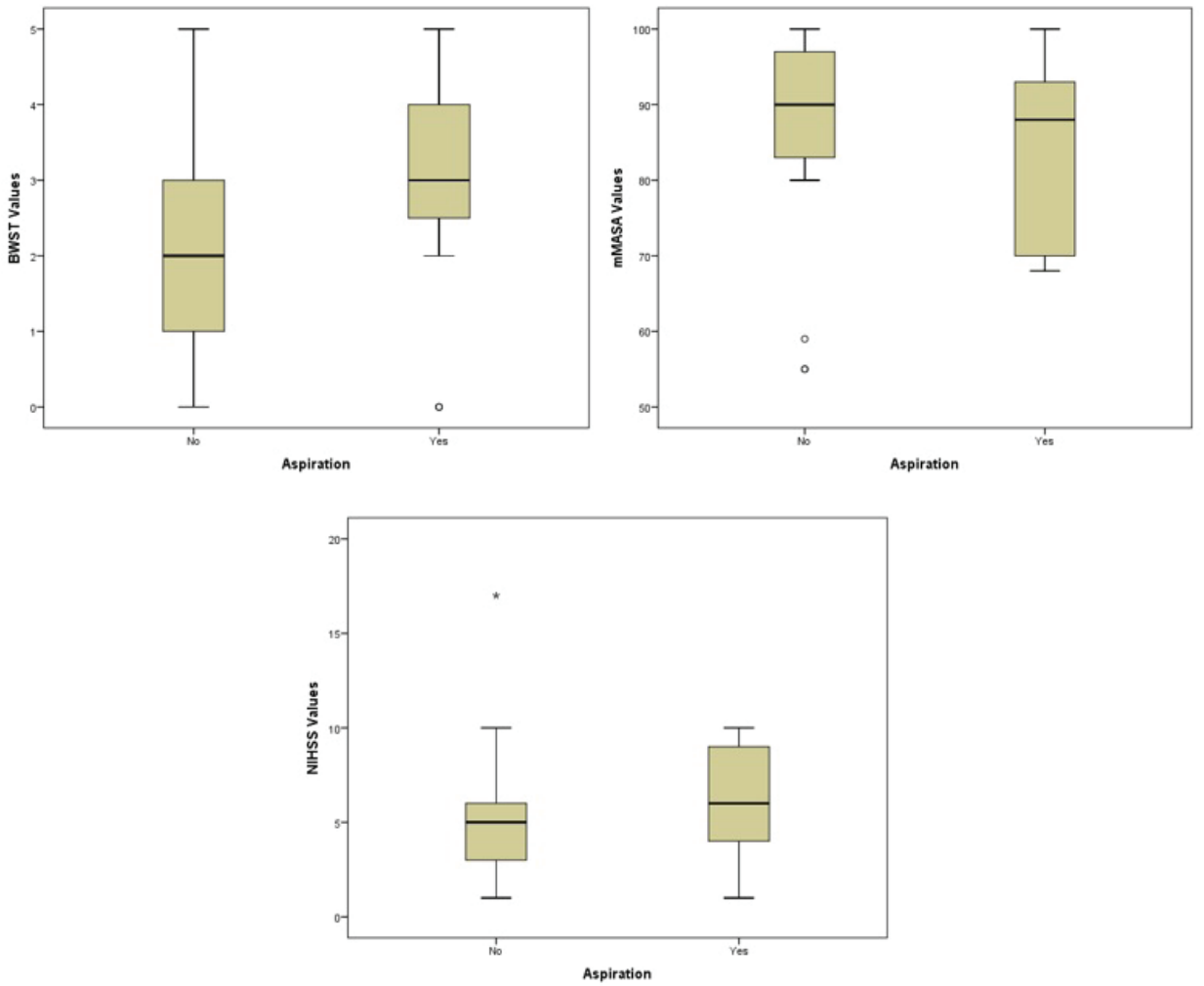
*BWST: Bedside water swallowing test, mMASA: Modified Mann Assessment of Swallowing Ability, NIHSS: National Institutes of Health Stroke Scale, PAS: Penetration-Aspiration Scale, SD: Standard deviation

Figure 1. The boxplots demonstrate the distribution of values of the outcome variables of the patients with or without dysphagia (BWST: Bedside water swallowing test, mMASA: Modified Mann Assessment of Swallowing Ability, NIHSS: National Institutes of Health Stroke Scale, PAS: Penetration- Aspiration Scale).



reported to be up to 81% (7, 15). Liquids infer a higher risk of aspiration than semisolids (16). An instrumental evaluation is preferred to determine PSD (17). Even though VFSSs are considered the gold standard method, the FEES is a reliable, portable, safe, and cost-effective option (1). Moreover, Wu et al. (18) found that the FEES has greater sensitivity in evaluating swallowing than the VFSS. Dysphagia screening with the FEES or VFSS or by a speech–language pathologist before any oral intake is also recommended in the 2019 guidelines of the American Heart Association and American Stroke Association to reduce risk of aspiration pneumonia, disability, and the need for long-term institutional care (17). However, no recommendations are provided on bedside dysphagia screening tests although it is noted that the instruments and/or staff required for dysphagia screening may not be available. The applicability of bedside assessment tools is therefore a topic of interest.

Figure 2. The boxplots demonstrate the distribution of values of the outcome variables of the patients with or without aspiration (BWST: Bedside water swallowing test, mMASA: Modified Mann Assessment of Swallowing Ability, NIHSS: National Institutes of Health Stroke Scale)



In this prospective double-blind study, we investigated the applicability of various bedside assessment tools, including the BWST, the mMASA, the NIHSS, oxygen saturation, and combinations thereof, in comparison with the PAS scores to detect both dysphagia and aspiration in patients with acute ischemic stroke. We found that the combination of the BWST with the mMASA test achieved both maximum sensitivity and specificity (76.4% and 73.9%, respectively) compared to the other tests. However, there was no major change when the mMASA test was combined with the BWST to determine dysphagia. The maximum sensitivity (88.2%) was observed for the mMASA, but it had low specificity at 43.4%. Oxygen desaturation of more than 2% showed maximum specificity at 86.9% but a low rate of sensitivity at 41.1%. On the other hand, the combined BWST and mMASA test was the only assessment tool combination to detect aspiration with good sensitivity (72.7%) and specificity (62%; see *Tables 2 and*

Table 2. Comparison between the outcome variables and the patients with and without dysphagia.

Variable	Dysphagia (n=17) n (%)	Normal (n=23) n (%)	p value	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
BWST							
Dysphagia	13 (76.5)	7 (30.4)	**0.004***	76.4	69.5	65	80
Normal	4 (23.5)	16 (69.6)					
mMASA							
Dysphagia	15 (88.2)	13 (56.5)	**0.03***	88.2	43.4	53.5	83.3
Normal	2 (11.8)	10 (43.5)					
NIHSS							
Minor	4 (23.5)	13 (56.5)	0.051	NC	NC	NC	NC
Modarate	12 (70.5)	10 (43.5)					
Saturation							
Dysphagia	7 (41.2)	3 (13)	**0.042***	41.1	86.9	70	66.6
Normal	10 (58.8)	20 (87)					
BWST+mMASA							
Dysphagia	13 (76.5)	6 (26.1)	**0.002***	76.4	73.9	68.4	80.9
Normal	4 (23.5)	17 (73.9)					
Saturation+mMASA							
Dysphagia	7 (41.2)	3 (13)	**0.042***	41.1	86.9	70	66.6
Normal	10 (58.8)	20 (87)					

BWST: Bedside water swallowing test, mMASA: Modified Mann Assessment of Swallowing Ability, NIHSS: National Institutes of Health Stroke Scale, PPV: Positive predictive value, NPV: Negative predictive value, *: statistically significant, NC: Not calculated as not detected a statistically significant difference.

3, respectively). We believe that the studied tests may be useful in the hospitals where the necessary equipment and/or staff is not available to perform VFSSs or FEESs. In daily clinical practice, the patients with PSD may be referred to a tertiary hospital which has VFSS or FEES to prevent any complication due to aspiration and/or malnutrition.

The global incidence of pneumonia after stroke has been reported as being 56.7% (7). However, none of the patients in our study developed pneumonia during their inpatient stays, which is in line with the results of the study by Marques et al (15). Early screening and a change of diet to thickener food may be the reason for our result. Another reason may be that our study did not include severe stroke patients, and follow-up was limited to inpatient stay only. The use of prophylactic antibiotics, acid suppressive medications, and antiemetic-prokinetic drugs, and oral care are some of the medically preventative approaches aimed at helping prevent pneumonia. We routinely administered proton pump inhibitors to the patients in our hospital to prevent bleeding possibly caused by stress or anticoagulants; however Arai et al. (19) reported in their meta-analysis that proton pump inhibitors are associated with a higher risk of pneumonia compared to histamine H2-blockers.

Older age, a higher NIHSS score, malnutrition, voice changes, and the location of the stroke were identified as predictors of PSD in a review by Jones et al. (20). In our study, we found no relationship between older age (≤65 years vs. >65 years) and NIHSS score (minor vs. moderate) and dysphagia. These results may be due to not include severe stroke patients and our limited study population.

Table 3. Comparison between the outcome variables and the patients with and without aspiration.

Variable	Aspiration Yes (n=11) n (%)	No (n=29) n (%)	p value	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
BWST							
Dysphagia	8 (72.7)	12 (41.4)	0.077	NC	NC	NC	NC
Normal	3 (27.5)	17 (58.6)					
mMASA							
Dysphagia	9 (81.8)	19 (65.5)	0.315	NC	NC	NC	NC
Normal	2 (18.2)	10 (34.5)					
NIHSS							
Minor	3 (27.3)	14 (48.2)	0.198	NC	NC	NC	NC
Modarate	8 (72.7)	14 (48.2)					
Saturation							
Dysphagia	3 (27.3)	7 (24.1)	0.838	NC	NC	NC	NC
Normal	8 (72.7)	22 (75.9)					
BWST+mMASA							
Dysphagia	8 (72.7)	11 (37.9)	**0.049***	72.7	62	42.1	85.7
Normal	3 (27.3)	18 (62.1)					
Saturation+mMASA							
Dysphagia	3 (27.3)	7 (24.1)	0.838	NC	NC	NC	NC
Normal	8 (72.7)	22 (75.9)					

BWST: Bedside water swallowing test, mMASA: Modified Mann Assessment of Swallowing Ability, NIHSS: National Institutes of Health Stroke Scale, PPV: Positive predictive value, NPV: Negative predictive value, *: statistically significant, NC: Not calculated as not detected a statistically significant difference.

Previous studies (9, 15) have reported the results of a combination of water tests and oxygen desaturation. In their study, Smith et al. (9) found that 2% or more oxygen desaturation had a sensitivity of 87% but a low specificity and a positive predictive value (PPV) at 36% and 39%, respectively, compared to the VFSS. In contrast, our results showed a specificity of 86.9% but a low sensitivity of 41.1% with a PPV of 70% and a negative predictive value (NPV) of 66.6%. The combination of saturation with the mMASA test did not change these values. Unlike in other studies, the BWST in our study included not only oxygen desaturation, but also the presence of cough, voice changes, water flowing from the corner of the mouth, the absence of laryngeal movement, and not drinking the water once at a time. These differences in the tests may be the reason of our results. Brodsky et al. (21) concluded that airway response with voice change improves the overall accuracy of aspiration detection. They also found that the water test using 90–100 ml was more sensitive (91% vs. 71%, respectively) but less specific (53% vs. 90%, respectively) than the use of 1–5 ml of water. We used 10 ml of water in our study, and our results are compatible with those of their meta-analysis (21). Combining the mMASA test and BWST was the only test to detect aspiration in our study, with the combination achieving a sensitivity of 72.7%, a specificity of 62%, NPV of 85.7%, and a PPV of 42.1%. To the best of our collective knowledge, this is the only study to have used this combination to determine PSD.

The main limitation of our study was small study population from a single center. Another limitation was that we used the original cut-off values of the tests to determine PSD and failed to perform receiver operating characteristics to define the cut-off point for PSD. This may need to be adapted through

the use of different cut-off values to detect aspiration in larger study populations. A further limitation is that our study included only minor and moderate ischemic stroke patients. Finally, we failed to investigate the results according to stroke localization because of the many variations and small study population. Further studies with larger populations and different test cut-offs are therefore needed to confirm and/or increase the sensitivity and specificity of tests used in our study.

In conclusion, our results showed that the BWST, the mMASA, a 2% or more drop in oxygen saturation, and the combination of the mMASA and BWST may be used to determine the presence of PSD. However, aside from the combination of the mMASA and BSWT, these tests were not capable of predicting aspiration.

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Conflict of Interest

The authors declared no potential conflict of interest with the respect of the research, authorship, and/or publication of this article.

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