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ORIGINAL ARTICLE

Clinical Utility of the 3-ounce Water Swallow Test

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Abstract The 3-ounce water swallow test is frequently used to screen individuals for aspiration risk. Prior research concerning its clinical usefulness, however, is confounded by inadequate statistical power due to small sample sizes and varying methodologies. Importantly, research has been limited to a few select patient populations, thereby limiting the widespread generalizability and applicability of the 3-ounce test. The purpose of this study was to investigate the clinical utility of the 3-ounce water swallow test for determining aspiration status and oral feeding recommendations in a large and heterogeneous patient population. Fiberoptic endoscopic evaluation of swallowing (FEES) was performed in conjunction with the 3-ounce water swallow test on 3000 participants with a wide range of ages and diagnoses. A total of 1151 (38.4%) passed and 1849 (61.6%) failed the 3-ounce water swallow test. Sensitivity of the 3-ounce water swallow test for predicting aspiration status during FEES = 96.5%, specificity = 48.7%, and false positive rate = 51.3%. Sensitivity for identifying individuals who were deemed safe for oral intake based on FEES results = 96.4%, specificity = 46.4%, and false positive rate = 53.6%. Passing the 3-ounce water swallow test appears to be a good predictor of ability to tolerate thin liquids. However, failure often does not indicate *inability* to tolerate thin liquids, i.e., low specificity and high false-positive rate. Use of the 3-ounce water swallow test alone to make decisions regarding safety of liquid intake results in over-referral and unnecessary restriction of liquid intake for nearly 50% of patients tested. In addition, because 71% of participants who failed the 3-ounce water swallow test were deemed safe for an oral diet, nonsuccess on the 3-ounce water swallow test is not indicative of swallowing failure. The clinical utility of the 3-ounce water swallow test has been extended to include a wide range of medical and surgical diagnostic categories. Importantly, for the first time it has been shown that if the 3-ounce water swallow test is passed, diet recommendations can be made without further objective dysphagia testing.

Keywords Deglutition · Deglutition disorders · Aspiration · Dysphagia screening

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Accurate identification of individuals who are at risk for oropharyngeal dysphagia is critically important because of the high incidence of pneumonia associated with unrecognized prandial aspiration [1–4]. A clinically useful screening test for dysphagia should provide both high sensitivity and specificity, i.e., accurate identification of individuals who aspirate and require further testing while ruling out nonaspirators who do not require intervention [5, 6]. In clinical practice, a screening test for oropharyngeal dysphagia has three goals: (1) to determine the likelihood that aspiration is present, (2) the need for formal swallow evaluation, and (3) when it is safe to recommend resumption of oral alimentation. One of the Joint

Commission on the Accreditation of Healthcare Organizations' stroke performance measures requires that a screen for dysphagia be performed on all ischemic and hemorrhagic stroke patients prior to ingestion of food, fluids, or medications by mouth [7]. However, the optimal means of screening individuals who are at risk for oropharyngeal dysphagia and aspiration is controversial and evolving [8–25].

The 3-ounce water swallow test is a widely used method of screening individuals who are at risk for oropharyngeal dysphagia and aspiration [10]. Individuals are required to drink 3 ounces (90 cc) of water without interruption. Criteria for referral for further assessment of swallowing include inability to complete the task, coughing, choking, or a wet-hoarse vocal quality exhibited either during or within 1 min of test completion [10]. The contribution of the 3-ounce water swallow test to the detection of aspiration during clinical (bedside) swallowing screening has been reported [10, 11, 15, 18, 21]. No clear consensus has developed because of inadequate statistical power due to small sample sizes and varying methodologies.

The clinical utility of the 3-ounce water swallow test has focused primarily on adult individuals with neurological disease, i.e., stroke. Studies have reported variable sensitivity and specificity results [10, 11, 15, 18, 21], ranging from sensitivity as high as 0.86 but with specificity as low as 0.50 [21]. The clinical usefulness of the 3-ounce water swallow test in more heterogeneous patient populations is unknown.

The purpose of the present study was to examine the clinical usefulness of the 3-ounce water swallow test for determining aspiration status and oral feeding recommendations in a large and heterogeneous population sample. Three research questions were posed: Does the 3-ounce water swallow test identify individuals who aspirate thin liquids? Does a failed 3-ounce water swallow test identify individuals who are also unsafe for oral alimentation based on results of an instrumental swallow assessment? Does a successfully passed 3-ounce water swallow test permit specific diet recommendations to be made without further objective swallow assessment?

Methods

This study was approved by the Human Investigation Committee, Yale University School of Medicine. All fiberoptic endoscopic swallow evaluations performed between December 1999 and September 2006 were included. Data from a total of 3000 inpatients from a large, urban, tertiary-care, teaching hospital were included. Table 1 gives participant demographics and Figure 1 shows number of participants by age.

Table 1 Participant demographic information

Gender[a]	
Females	N = 1324 (44.3%)
Males	N = 1669 (55.6%)
Age[b]	
Females	X = 70.14 years (range = 3.0–105.0 years)
Males	X = 66.8 years (range = 2.2–105.0 years)

[a] Data are missing for 7 (0.2%) participants

[b] Data are missing for 18 (0.6%) participants

Procedures

The standard fiberoptic endoscopic evaluation of swallowing (FEES) protocol was followed with slight modifications [26, 27]. Briefly, each naris was examined visually and the scope passed through the most patent naris without administration of a topical anesthetic or vasoconstrictor to the nasal mucosa, thereby eliminating any potential adverse anesthetic reaction and assuring the endoscopist of a safe physiologic examination [28]. The base of tongue, pharynx, and larynx were viewed, and swallowing was evaluated directly with six food boluses of approximately 5 ml each. All patients were allowed to swallow spontaneously, i.e., without a verbal command to swallow. FEES equipment consisted of a 3.6-mm-diameter flexible fiberoptic rhinolaryngoscope (Olympus, ENF-P3), light source (Olympus, CLK-4), camera (ELMO, MN401E), and color monitor (Magnavox, RJ4049WA01).

The first food challenge consisted of three boluses of puree consistency (yellow pudding) followed by three liquid boluses (white milk) because these colors have excellent contrast with pharyngeal and laryngeal mucosa [29]. Aspiration was defined as entry of material into the airway below the level of the true vocal folds [30], and silent aspiration occurred when there were no external behavioral signs such as coughing or choking [31]. A safe swallow was defined as no aspiration during FEES.

The endoscopist (SBL) who performed all FEES ratings in the present study recently participated in an investigation that determined intrarater reliability with FEES using non-blue dyed food trials [29]. Intrarater agreement was 100% for tracheal aspiration.

Immediately following completion of FEES, the same investigator (SBL) administered the 3-ounce water swallow test [10]. Each participant was given 3 ounces of water and asked to drink from a cup or straw without interruption, and results were recorded. Criteria for test failure included inability to drink the entire amount, coughing or choking up to 1 min after completion, or presence of postswallow wet-hoarse vocal quality [10].

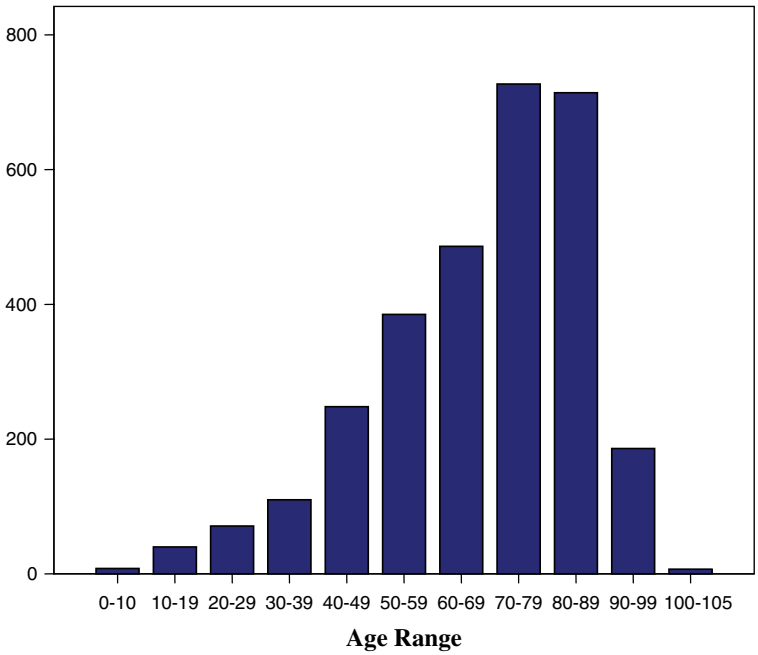

Fig. 1 Participants by age

Statistical Analysis

FEES results served as the outcome variable and were the criterion standard to which the 3-ounce water swallow test results were compared. A 2×2 contingency table was used to evaluate results of the 3-ounce water swallow test. If aspiration was present on FEES when a participant failed the water swallow test, a *true-positive* rating resulted. If aspiration was not present on FEES when a participant passed the water swallow test, a *true-negative* rating resulted. If aspiration was not present on FEES but the participant failed the water swallow test, a *false-positive* rating resulted. If aspiration was present on FEES but the participant passed the water swallow test, a *false-negative* rating resulted. Sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio, and negative likelihood ratio were computed. Confidence intervals for the estimated parameters were computed by a general method (based on constant χ^2 boundaries) [32].

Results

3-ounce Water Swallow Test and Liquid Aspiration Based on FEES Results

The answer to our first research question, "Does the 3-ounce water swallow test identify individuals who aspirate thin liquids?" is provided in Table 2. A total of 1151 of 3000 participants (38.4%) passed the 3-ounce water swallow test. A total of 1849 of 3000 (61.6%) individuals failed the 3-ounce water swallow test. Despite failing the 3-ounce water swallow test, 1029 of those 1849 (55.7 %) were able to tolerate thin liquids based on FEES results. In addition, 254 of those 1849 (13.7%) individuals who failed the water test were deemed safe for modified liquid intake, i.e., thickened liquids. Finally, 565 of the 1849 (30.6%) individuals who failed the water swallow test were also deemed to be unsafe for liquid intake based on FEES results.

To determine if the 3-ounce water swallow test was a reliable predictor of aspiration dependent upon medical diagnosis, sensitivity, specificity, positive predictive value, and negative predictive value were calculated for individuals in 14 diagnostic categories. Results of these analyses

Table 2 2×2 Contingency table of the 3-ounce water swallow test for detecting aspiration

3-ounce water test	Aspiration on FEES	
	Positive	Negative
Positive	664 a = true positive	1185 b = false positive
Negative	24 c = false negative	1127 d = true negative

Sensitivity = a/(a + c) = 664/(664 + 24) = 96.5% (95% CI = 94.9–97.6)

Specificity = d/(b + d) = 1127/(1185 + 1127) = 48.7% (95% CI = 48.3–49.1)

Positive Predictive Value = a/(a + b) = 664/(664 + 1185) = 35.9% (95% CI = 35.3–36.3)

Negative Predictive Value = d/(c + d) = 1127/(24 + 1127) = 97.9% (95% CI = 97.0–98.6)

Positive Likelihood Ratio = sensitivity/(1–specificity) = 0.965/(1–0.487) = 1.883 (95% CI = 1.835–1.917)

Negative Likelihood Ratio = 1–sensitivity/specificity = (1–0.965)/0.487 = 0.072 (95% CI = 0.048–0.105)

Table 3 Water test and liquid aspiration by diagnostic category[a]

	SENS	SPEC	PPV	NPV	+LR	–LR
Cardiothoracic surgery (N = 180)	95.5 (88.5–98.4)	49.1 (45.1–50.8)	52.1 (48.3–53.7)	94.9 (87.2–98.2)	1.88 (1.61–2.20)	.09 (.03–.25)
Esophageal surgery (N = 63)	90.9 (65.3–98.4)	67.3 (61.9–68.9)	37.0 (26.6–40.1)	97.2 (89.4–99.5)	2.78 (1.71–3.16)	.14 (.02–.56)
Head and neck surgery (N = 111)	100.0 (94.7–100.0)	40.0 (34.6–40.0)	62.9 (59.6–62.9)	1.00 (86.5–1.00)	1.67 (1.45–1.67)	.00 (.00–.15)
Neurosurgery (N = 232)	100.0 (93.6–100.0)	42.2 (40.4–42.2)	33.3 (31.2–33.3)	100.0 (95.6–100.0)	1.73 (1.57–1.73)	.00 (.00–.16)
Medical (N = 492)	95.0 (89.9–97.7)	51.1 (49.4–51.9)	38.5 (36.4–39.6)	96.9 (93.8–98.6)	1.94 (1.78–2.03)	.10 (.05–.20)
Pulmonary (N = 451)	96.1 (91.5–98.3)	54.0 (52.2–54.9)	45.0 (42.5–46.1)	97.2 (94.0–98.8)	2.09 (1.91–2.18)	.07 (.03–.16)
Cancer (N = 125)	93.8 (81.5–98.2)	53.8 (49.6–55.3)	41.1 (35.7–43.1)	96.2 (88.6–98.9)	2.03 (1.62–2.20)	.12 (.03–.37)
Other (N = 391)	97.5 (91.7–99.3)	58.2 (56.7–58.7)	37.5 (35.3–38.2)	98.9 (96.4–99.7)	2.33 (2.12–2.40)	.04 (.01–.15)
Left stroke (N = 227)	97.8 (89.3–99.6)	45.3 (43.1–45.8)	31.3 (28.5–31.8)	98.8 (94.1–99.8)	1.79 (1.57–1.84)	.05 (.01–.25)
Right stroke (N = 203)	92.7 (81.7–97.4)	40.7 (38.0–41.9)	28.4 (25.0–29.8)	95.7 (89.1–98.5)	1.56 (1.32–1.68)	.18 (.06–.48)
Brainstem stroke (N = 38)	100.0 (68.5–100.0)	54.8 (47.7–54.8)	33.3 (22.8–33.3)	100.0 (87.0–100.0)	2.21 (1.31–2.21)	.00 (.00–.67)
Parkinson's disease (N = 18)	100.0 (69.2–100.0)	58.3 (42.9–58.3)	54.5 (37.7–54.5)	100.0 (73.6–100.0)	2.40 (1.21–2.40)	.00 (.00–.72)
Dementia (N = 86)	100.0 (82.2–100.0)	25.4 (21.6–25.4)	22.1 (1.81–22.1)	100.0 (85.2–100.0)	1.34 (1.05–1.34)	.00 (.00–.82)
Other neurological (N = 364)	97.1 (92.1–99.0)	43.1 (37.3–45.4)	45.2 (42.9–46.1)	97.9 (94.4–99.3)	2.12 (1.93–2.20)	.05 (.02–.15)

SENS = Sensitivity; SPEC = Specificity; PPV = Positive Predictive Value; NPV= Negative Predictive Value; +LR= Positive Likelihood Ratio; –LR = Negative Likelihood Ratio

[a] 95% confidence intervals are in parentheses

are presented in Table 3. Sensitivity ranged from 90.9% for individuals who were post esophageal surgery to 100.0% for individuals who were post head and neck surgery, neurosurgery, brainstem stroke, Parkinson's disease, and dementia. Specificity ranged from 25.4% for individuals with dementia to 67.3% for those who were post esophageal surgery. Positive predictive value ranged from 22.1% for individuals with dementia to 62.9% for individuals who were post head and neck surgery. Negative predictive values were considerably higher, ranging from 94.9% for individuals who were post cardiothoracic surgery to 100.0% for individuals in five diagnostic categories, including those who were post neurosurgery and those with brainstem stroke.

3-ounce Water Swallow Test and Diet Recommendations Based on FEES Results

The answer to our second research question, "Does a failed 3-ounce water swallow test identify individuals who are also unsafe for oral alimentation based on results of an instrumental swallow assessment?" is provided in Table 4. Despite failure on the 3-ounce water swallow test, 1304 of 1847 participants (70.6%) were nonetheless able to tolerate an oral diet based on FEES results. To determine if the 3-ounce water swallow test was a reliable predictor of oral intake status dependent upon medical diagnosis, sensitivity, specificity, positive predictive value, and negative predictive value were calculated for individuals in 14 diagnostic categories. Results are presented in Table 5. Sensitivity ranged from 87.5% for individuals who were post esophageal surgery to 100.0% for individuals who were post head and neck surgery, neurosurgery, brainstem stroke, Parkinson's disease, and dementia. Specificity ranged from 24.7% for individuals with dementia to 64.8% for those who were post esophageal surgery. Positive predictive value ranged from 17.3% for individuals with right hemisphere stroke to 52.8% for individuals who were post head and neck surgery.

Table 4 2 × 2 Contingency table of the 3-ounce water swallow test for ability to tolerate oral diet[a]

3-ounce water test	Aspiration on FEES	
	Positive	Negative
Positive	543 a = true positive	1304 b = false positive
Negative	20 c = false negative	1131 d = true negative

Sensitivity = a/(a + c) = 543/(543 + 20) = 96.4% (95% CI = 94.6–97.7)

Specificity = d/(b + d) = 1131/(1304 + 1131) = 46.4% (95% CI = 46.0–46.7)

Positive Predictive Value = a/(a + b) = 543/(543 + 1304) = 29.4% (95% CI = 28.8–29.8)

Negative Predictive Value = d/(c + d) = 1131/(20 + 1131) = 98.3% (95% CI = 97.4–98.9)

Positive Likelihood Ratio = sensitivity/(1–specificity) = 0.964/(1–0.464) = 1.801 (95% CI = 1.753–1.834)

Negative Likelihood Ratio = 1–sensitivity/specificity = (1–0.964)/0.464 = 0.076 (95% CI = 0.050–0.117)

[a] Data are missing for 2 of 3000 (0.07%) participants

Table 5 Water test and diet recommendations by diagnostic category[a]

	SENS	SPEC	PPV	NPV	+LR	–LR
Cardiothoracic surgery (N = 178)	96.0 (87.6–98.9)	44.5 (41.2–45.7)	40.3 (36.8–41.5)	96.6 (89.5–99.1)	1.73 (1.49–1.82)	.09 (.02–.30)
Esophageal surgery (N = 62)	87.5 (55.4–97.7)	64.8 (60.1–66.3)	26.9 (17.1–30.1)	97.2 (90.1–99.5)	2.49 (1.39–2.90)	.19 (.03–.74)
Head and neck surgery (N = 111)	100.0 (93.7–100.0)	34.4 (29.7–34.4)	52.8 (49.5–52.8)	1.00 (86.5–1.00)	1.52 (1.33–1.52)	.00 (.00–.21)
Neurosurgery (N = 232)	100.0 (92.8–100.0)	40.9 (39.1–40.9)	29.5 (23.0–29.5)	100.0 (95.6–100.0)	1.69 (1.52–1.69)	.00 (.00–.19)
Medical (N = 491)	94.5 (88.2–97.6)	47.8 (46.3–48.5)	29.2 (27.2–30.1)	97.4 (94.5–98.9)	1.81 (1.64–1.89)	.12 (.05–.26)
Pulmonary (N = 450)	93.9 (87.0–97.3)	47.6 (46.0–48.3)	28.5 (26.4–29.6)	97.2 (94.1–98.8)	1.79 (1.61–1.88)	.13 (.06–.28)
Cancer (N = 125)	93.5 (80.9–98.2)	53.2 (49.0–54.7)	39.7 (34.4–41.7)	96.2 (88.6–98.9)	2.00 (1.59–2.17)	.12 (.03–.39)
Other (N = 391)	96.2 (87.4–99.0)	53.4 (52.1–53.8)	24.0 (21.9–24.7)	98.9 (96.4–99.7)	2.06 (1.82–2.14)	.07 (.02–.24)
Left stroke (N = 229)	96.3 (82.5–99.3)	41.1 (39.2–41.5)	17.9 (15.4–18.5)	98.8 (94.4–99.8)	1.64 (1.36–1.70)	.09 (.02–.45)
Right stroke (N = 202)	95.8 (80.7–99.3)	38.2 (36.2–38.7)	17.3 (14.6–17.9)	98.6 (93.3–99.7)	1.55 (1.27–1.62)	.11 (.02–.53)
Brainstem stroke (N = 39)	100.0 (71.6–100.0)	58.1 (50.7–58.1)	38.1 (27.3–38.1)	100.0 (87.4–100.0)	2.39 (1.45–2.39)	.00 (.00–.56)
Parkinson's disease (N = 18)	100.0 (57.5–100.0)	50.0 (37.8–50.0)	36.4 (20.9–36.4)	100.0 (75.7–100.0)	2.00 (0.94–2.00)	.00 (.00–1.12)
Dementia (N = 87)	100.0 (81.1–100.0)	24.7 (21.0–24.7)	20.3 (16.5–20.3)	100.0 (85.3–100.0)	1.33 (1.03–1.33)	.00 (.00–.90)
Other neurological (N = 364)	98.7 (93.1–99.8)	49.8 (48.4–50.1)	33.8 (31.9–34.2)	99.3 (96.4–99.9)	1.97 (1.80–2.00)	.03 (.00–.14)

SENS = Sensitivity; SPEC = Specificity; PPV = Positive Predictive Value; NPV= Negative Predictive Value; +LR= Positive Likelihood Ratio; –LR = Negative Likelihood Ratio

[a] 95% confidence intervals are in parentheses

Negative predictive values were considerably higher, ranging from 96.2% for individuals with cancer to 100.0% for individuals in five diagnostic categories, including those who were post neurosurgery and those with brainstem stroke.

To answer our third research question, "Does a successfully passed 3-ounce water swallow test permit specific diet recommendations to be made without further objective swallow assessment?," a cross tabulation examining diet recommendation and water test results was performed. Of the 1151 participants who passed the 3-ounce water swallow test, 648 (56%) were cleared for a regular diet, 149 (13%) were cleared for a soft diet, 45 (4%) were cleared for a chopped diet, 289 (25%) were cleared for a puree diet, and 3 (0.3%) were cleared for a liquid diet based on FEES results. Seventeen of the 1151 (1.5%), although passing the water swallow test, were made nil by mouth based on FEES results, i.e., false negatives.

Discussion

The purpose of this study was to determine the clinical utility of the 3-ounce water swallow test for determining aspiration status in a large and heterogeneous population sample. Results indicated that the 3-ounce water swallow test was sensitive for determining aspiration of thin liquids. This was confirmed by instrumental assessment, as 96.5% of participants who aspirated on FEES also failed the water swallow test. In addition, the 3-ounce water swallow test had a high negative predictive value (97.9%), indicating that most individuals who passed the water swallow test, i.e., had a negative response, also did not aspirate during instrumental examination. In most instances, therefore, passing the 3-ounce water swallow test appears to be a good predictor of a patient's ability to safely tolerate thin liquids.

However, failing the 3-ounce water swallow test often does not indicate *inability* to tolerate thin liquids safely. Specificity for determining liquid aspiration during instrumental assessment was low, 48.7%, and the false-positive rate was high, 49.7%. Thus, nearly half of all individuals who failed the water swallow test did not aspirate during instrumental examination. The combination of low specificity with a high false-positive rate for aspiration status on the 3-ounce water swallow test compared with FEES would result in approximately half of patients screened being referred unnecessarily for further swallow evaluation. Because one of the purposes of a screening test is to reliably and efficiently determine the need for a formal swallow evaluation, the 3-ounce water swallow test fails because it over-refers for formal swallow assessment and unnecessarily restricts liquid intake for nearly half of the patients tested.

This study also examined the clinical utility of the 3-ounce water swallow test for determining whether an individual could safely tolerate oral intake. Results were similar to those for liquid aspiration. The 3-ounce water swallow test was a sensitive test with a high negative predictive rate for determining an individual's ability to safely tolerate oral intake. However, the test had a low specificity (46.4%) and a high false-positive rate (53.6%). Because nearly 71% of participants who failed the water

swallow test were deemed safe for some form of oral intake based on results of instrumental assessment, *failure on the 3-ounce water swallow test did not accurately reflect true oral feeding status*.

Prior to the present study, there were no data to support recommendations for an oral diet based on a successful 3-ounce water swallow test. In actuality, passing the 3-ounce water swallow test indicated only that thin liquids were tolerated and an instrumental dysphagia evaluation was needed to determine diet recommendations for puree or solid food consistencies [10]. For the first time with objective data, it was shown that if the water swallow test was passed, patients can have an oral diet without further diagnostic dysphagia testing. Specifically, a puree diet is recommended for edentulous patients and a soft or regular consistency diet is recommended for dentate patients.

Clinical judgment and experience, in conjunction with objective information, are essential factors in the care of the individual with dysphagia. Although the vast majority of patients, i.e., 98.5%, who passed the 3-ounce water swallow test were recommended for and were successful with oral alimentation, additional patient-specific factors must be taken into consideration in order for an oral diet to be safe and successful. For example, the clinician must be aware that patients with dementia need to be evaluated regarding following directions and self-feeding skills, patients with stroke require assessment for neglect, limb apraxia, and nondominant upper-extremity use, patients with traumatic brain injury need to be monitored regarding impulsivity and task attentiveness, and patients who are deconditioned and easily fatigued require diet modifications and assistance with eating. All patients with dysphagia benefit from encouragement and monitoring as work toward the goal of normal eating progresses. The dysphagia specialist, therefore, must synthesize objective, subjective, and behavioral data on an individual basis to promote safe and successful eating.

Conclusions

The results of this study have expanded the clinical usefulness of the 3-ounce water swallow test across a wide range of medical and surgical diagnostic categories. Importantly, if the test is passed, not only thin liquids but other food consistencies can be recommended confidently and without further instrumental dysphagia assessment. That is, following a successful 3-ounce water swallow test and taking into consideration any patient-specific factors that may impact resumption of safe oral intake, recommendations for specific diet consistencies can be made, e.g., puree, chopped, soft-solid, or regular diet.

A caveat of the 3-ounce water swallow test is that due to a high false-positive rate and low specificity, it is not an efficient screening tool for identification of individuals who are at risk for aspiration of thin liquids, i.e., nearly half of patients will be referred unnecessarily for further dysphagia testing despite the fact that almost 75% were able to tolerate an oral diet successfully. However, over-referral for an instrumental evaluation, although conservative, is not in and of itself a negative because it allows for greater objective identification of aspiration and the potential to determine diet recommendations and therapeutic strategies to promote resumption of safe oral alimentation.

References

1. Holas MA, DePippo KL, Reding MJ. Aspiration and relative risk of medical complications following stroke. Arch Neurol 1994;51:1051–1053.
2. Martin BJ, Corlew MM, Wood H, Olson D, Golopol LA, Wingo M, Kirmani N. The association of swallowing dysfunction and aspiration pneumonia. Dysphagia 1994;9:1–6.
3. Schmidt J, Holas M, Halvorson K, Reding M. Videofluoroscopic evidence of aspiration predicts pneumonia and death but not dehydration following stroke. Dysphagia 1994;9:7–11.
4. Langmore SE, Terpenning MS, Schork A, Chen Y, Murray JT, Lopatin D, Loesche WJ. Predictors of aspiration pneumonia: How important is dysphagia? Dysphagia 1998;13:69–81.
5. Fletcher RH, Fletcher SW, Wagner EH. Clinical Epidemiology: The Essentials. Baltimore: Williams & Wilkins, 1988.
6. Leder SB, Espinosa JF. Aspiration risk after acute stroke: Comparison of clinical examination and fiberoptic endoscopic evaluation of swallowing. Dysphagia 2002;17:214–219.
7. The Joint Commission, Primary stroke centers: Stroke performance measurement implementation guide, 2006, pp 4–34. Available at http://www.jointcommission.org. Accessed 1 June 2007.
8. Chong MS, Lieu PK, Sitoh YY, Meng YY, Leow LP. Bedside clinical methods useful as screening test for aspiration in elderly patients with recent and previous strokes. Ann Acad Med Singapore 2003;32:790–794.
9. DePippo KL, Holas MA, Reding MJ. The Burke dysphagia screening test: Validation of its use in patients with stroke. Arch Phys Med Rehabil 1994;75:1284–1286.
10. DePippo KL, Holas MA, Reding MJ. Validation of the 3-oz water swallow test for aspiration following stroke. Arch Neurol 1992;49:1259–1261.
11. Garon BR, Engle M, Ormiston C. Reliability of the 3-oz water swallow test utilizing cough reflex as sole indicator of aspiration. Neurorehabil Neuro Repair 1995;9:139–143.
12. Gottlieb D, Kipnis M, Sister E, Vardi Y, Brill S. Validation of the 50 ml3 drinking test for evaluation of post-stroke dysphagia. Disabil Rehabil 1996;18:529–532.
13. Hind NP, Wiles CM. Assessment of swallowing and referral to speech and language therapists in acute stroke. QJM 1998;91:829–835.
14. Lim SH, Lieu PK, Phua SY, Seshadri R, Venketasubramanian N, Lee SH, Choo PW. Accuracy of bedside clinical methods compared with fiberoptic endoscopic examination of swallowing (FEES) in determining the risk of aspiration in acute stroke patients. Dysphagia 2001;16:1–6.

15. Mari F, Matei M, Ceravolo MG, Pisani A, Montesi A, Provinciali L. Predictive value of clinical indices in detecting aspiration in patients with neurological disorders. J Neurol Neurosurg Psychiatry 1997;63:456–460.
16. McCullough GH, Rosenbek JC, Wertz RT, McCoy S, Mann G, McCullough K. Utility of clinical swallowing examination measures for detecting aspiration post-stroke. J Speech Lang Hear Res 2005;48:1280–1293.
17. McCullough GH, Wertz RT, Rosenbek JC. Sensitivity and specificity of clinical/bedside examination signs for detecting aspiration in adults subsequent to stroke. J Commun Disord 2001;34:55–72.
18. McCullough GH, Wertz RT, Rosenbek JC, Mills RH. Inter- and intrajudge reliability of a clinical examination of swallowing in adults. Dysphagia 2000;15:58–67.
19. Miyazaki Y, Arakawa M, Kizu J. Introduction of simple swallowing ability test for prevention of aspiration pneumonia in the elderly and investigation of factors of swallowing disorders. Yakugaku Zasshi 2002;122:97–105.
20. Nishiwaki K, Tsuji T, Liu M, Hase K, Tanaka N, Fujiwara T. Identification of a simple screening tool for dysphagia in patients with stroke using factor analysis of multiple dysphagia variables. J Rehabil Med 2005;37:247–251.
21. Rosenbek JC, McCullough GH, Wertz RT. Is the information about a test important? Applying the methods of evidence-based medicine to the clinical examination of swallowing. J Commun Disord 2004;37:437–450.
22. 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;81:1517–1519.
23. Tohara H, Saitoh E, Mays KA, Kuhlmeier K, Palmer JB. Three tests for predicting aspiration without videofluorography. Dysphagia 2003;18:126–134.
24. Wu MC, Chang YC, Wang TG, Lin LC. Evaluating swallowing dysfunction using a 100-ml water swallowing test. Dysphagia 2004;19:43–47.
25. Daniels SK, McAdam CP, Brailey K, Foundas AL. Clinical assessment of swallowing and prediction of dysphagia severity. Am J Speech Lang Pathol 1997;6:17–24.
26. Langmore SE, Schatz K, Olsen N. Fiberoptic endoscopic examination of swallowing safety: A new procedure. Dysphagia 1988;2:216–219.
27. Langmore SE, Schatz K, Olsen N. Endoscopic and videofluoroscopic evaluations of swallowing and aspiration. Ann Otol Rhinol Laryngol 1991;100:678–681.
28. Leder SB, Ross DA, Briskin KB, Sasaki CT. A prospective, double-blind, randomized study on the use of topical anesthetic, vasoconstrictor, and placebo during transnasal flexible fiberoptic endoscopy. J Speech Lang Hear Res 1997;40:1352–1357.
29. Leder SB, Acton LM, Lisitano HL, Murray JT. Fiberoptic endoscopic evaluation of swallowing with and without blue-dyed food. Dysphagia 2005;20:157–162.
30. Logemann JA. Evaluation and treatment of swallowing disorders, 2nd ed. Austin, TX: Pro-Ed, 1998.
31. Leder SB, Sasaki CT, Burrell MI. Fiberoptic endoscopic evaluation of dysphagia to identify silent aspiration. Dysphagia 1998;13:19–21.
32. Fleiss JL. Statistical Methods for Rates and Proportions, 2nd ed. New York: John Wiley & Sons, 1981.

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