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Static Endoscopic Evaluation of Swallowing: Transoral Endoscopy During Clinical Swallow Evaluations

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Abstract

Objective—To determine the sensitivity and specificity for assessing pharyngeal residue, laryngeal penetration, and tracheal aspiration when comparing findings from the *Static Endoscopic Evaluation of Swallowing (SEES)* with findings from the Videofluoroscopic Swallow Study (VFSS).

Review Methods—Retrospective study at a tertiary academic medical center. Records were reviewed consecutive outpatients who underwent both SEES and VFSS evaluations. Video segments from SEES and VFSS examinations were blindly judged by experienced clinicians on a categorical/ordinal rating form for the absence, quantitative presence, and location of post-swallow residue, penetration, and aspiration. Statistical analysis was performed to identify intra- and inter-rater reliability and correlation between SEES and VFSS findings.

Results—Thirty-nine patients were identified who met the above inclusion criteria, for a total of 206 video segments. Inter and intra-rater reliability was judged by Cronbach's Alpha to be good to excellent. SEES findings revealed statistically significant correlations with VFSS findings ($p < 0.001$) with the absence, quantitative presence, and location of thin liquid and solid swallow residue, penetration, and aspiration. In addition, SEES was more sensitive to the presence of liquid residue, penetration, and aspiration than VFSS.

Conclusion—The *SEES* is an endoscopic screening procedure that strengthens the clinical swallowing evaluation by documenting the presence or absence of post-swallow residue, penetration, and aspiration. Accurate identification of a patient's risk for aspiration helps to direct further work-up. It is an expedient, repeatable, and clinical relevant procedure that can be easily incorporated into a clinician's practice.

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Level of Evidence: 4

Keywords

rigid; transoral; endoscopy; clinical swallow evaluation; swallowing; dysphagia; videofluoroscopy

Introduction

Clinical swallow evaluations grossly estimate swallowing function by incorporating a thorough patient history and gathering audio- visual- and tactile- subjective information (e.g., oral-motor examination, 3-oz. water test, swallowing palpation, and voice quality and coughing strength assessment) and objective information (e.g., orofacial strength measurements, and cervical, mandibular, and lingual range of motion measurements). Unfortunately, the accuracy of the clinical swallow evaluation to judge overall swallowing efficiency and aspiration risk is a largely debated topic. While some studies support the clinical swallow evaluation to correctly identify presence of aspiration, other studies conclude it may underestimate aspiration events in aspirators, and overestimate aspiration in non-aspirators.[1–10] Therefore, pending clinical findings, instrumental assessment is often recommended in order to obtain a more precise understanding of overall swallow function and aspiration risk.

Two well-studied, validated instrumental procedures used to comprehensively assess the dynamic nature of swallowing include the videofluoroscopic swallow study (VFSS/MBS) and the flexible endoscopic evaluation of swallowing (FEES),[11–20] These two examinations are accepted as procedures that provide complimentary diagnostic information regarding swallowing kinematics[21]. However, burden-benefit ratios need to be considered when determining the appropriateness of each exam. Whereas the VFSS provides simultaneous, non-obstructed, non-invasive visualization of all swallowing phases (i.e., oral preparatory, oral propulsive, pharyngeal, and esophageal), it increases the patient's overall annual radiation dose and may increase the risk of stochastic effects. Alternatively, FEES provides axial endoscopic visualization of the pharyngeal & laryngeal anatomy at rest and before, during, after the pharyngeal swallowing phase. While FEES facilitates opportunity to explore compensatory swallowing strategies, some of the limitations include procedural discomfort, impaired swallowing following the frequent elective use of topical anesthesia,[22, 23] the non-definable effects of endoscope presence within the pharynx during the swallow, and the inability to directly evaluate the oral or esophageal phases of swallowing visualization.

We developed the *Static Endoscopic Evaluation of Swallowing (*SEES) to improve the efficacy and efficiency of the clinical swallow evaluation by more accurately determining a patient's risk of aspiration and more appropriately directing further instrumental workup. The *SEES* is a transoral rigid endoscopic procedure intended to supplement the clinical swallow evaluation and strengthen impressions of swallow function by instrumentally visualizing pharyngolaryngoscopic mobility tasks, patterns of secretion pooling, and patterns of bolus residue before and after the swallow.

The aim of this study was to determine the efficacy of *SEES* as an evaluation technique by comparing SEES findings (i.e., the presence of pharyngeal residue, post-swallow laryngeal

residue/penetration, and post-swallow tracheal residue/aspiration) with VFSS findings (i.e., residue, penetration, and aspiration before, during, and after the swallow). For speech-language pathologists and physicians in the outpatient setting with access to rigid endoscopic equipment and experience and proficiency in the performance of rigid endoscopy, we propose that *SEES* can quickly and efficiently enhance the clinical swallow evaluation and help to direct further work up.

Materials & Methods

Records of consecutive patients who presented to the UCSF Voice and Swallowing Center between January 1st, 2013 and April 15th 2014, complained of dysphagia, globus sensation, and/or chronic cough, and were judged by a speech-language pathologist and/or laryngologists to be at risk for dysphagia were reviewed. If the patient underwent both a SEES (protocol outlined below) and a VFSS, they were included for evaluation. No patients were excluded if they met the above inclusion criteria.

The *Static Endoscopic Evaluation of Swallowing* (SEES) is a three-part endoscopic procedure using a transoral 70o Hopkins rod telescope.

- Part I: A rigid endoscope is passed transorally to the posterior oral cavity while the clinician holds on the anterior tongue tip with a piece of gauze. Pre-swallow pharyngoscopy is performed prior to any bolus presentations, to assess patterns of pre-swallow secretion pooling, pharyngeal squeeze maneuver, supraglottic hyperfunction, vocal fold mobility, airway closure during light breath hold and valsva maneuver, and abnormal anatomic findings. The scope is then removed.
- Part II: The patient is given a “normal” bite of a dry solid consistency (e.g., graham cracker) to swallow. The rigid endoscope is re-inserted following swallow completion to assess for the absence and quantitative presence, and location of post-swallow residue, penetration, and/or aspiration. The scope is then removed.
- Part III: The patient takes a “normal” cup sip of barium-impregnated water (~4 tsp of Varibar Barium Powder stirred into to 6 oz of water) to swallow. The rigid endoscope is re-inserted following swallow completion to assess for the absence and quantitative presence of post-swallow residue, penetration, and/or aspiration. The scope is then removed.

  Note: Clinical observations of the oral bolus preparation, oral bolus preparation, and post-swallow oral bolus residue are made during and after all swallows. “Normal” bites and sips representative of typically eating and drinking for the patient should be cued for. Questions are asked throughout the SEES to assess for sensation (e.g., “How did that go down? Did anything go the wrong way? Do you feel sticking, if so, can you point to where?”)

Archived SEES videos from subjects were separated into 3 segments: pre-swallow pharyngoscopy, post- dry solid swallow, post-thin liquid barium swallow. Archived VFSS videos were separated into 2 segments: thin liquid barium swallows (the first thin liquid cup sip within a given VFSS), and dry solid swallows (the first dry solid bite within a given VFSS). Ten percent of the video segments from each of the five video clip groups were repeated at random to assess intra-rater reliability. Videos were de-identified, randomized, and blindly judged by 3 speech-language pathologists (two of whom are board-certified specialists in swallowing and swallowing disorders/BCS-S) and 2 laryngologists (i.e., fellowship trained otolaryngologists in voice, swallowing, and airway disorders) – all with greater than 5 years of experience reviewing videofluoroscopic swallow studies and endoscopic examinations.

Raters were provided with standardized grading forms and asked to judge the location, absence, and quantitative presence (absent, trace-minimal, moderate-maximal) of either pre-swallow pharyngoscopic secretions (SEES only), dry cracker, or thin liquid barium, as indicated on each grading form. As anchors, 17 photos representing each condition were provided.

Reviewers' ratings were statistically analyzed. Categorical variables were evaluated with chi-square, and reliability analyses were compared using Cronbach's Alpha. All tests were two-sided with $p = 0.05$ as the criteria for statistical significance.

Analysis was made examining varying levels of correlation sensitivity. The quantity of residue, penetration, and aspiration was assessed investigating *general* presence (i.e., absent vs. present) and more specific *quantitative* presence (i.e., absent, trace-minimal, moderate-maximal). Location of residue, penetration, and aspiration was assessed by examining *larger* anatomic landmarks (i.e., pharynx, laryngeal vestibule, and trachea), and more specific *smaller* anatomic landmarks (i.e., valleculae, piriforms, post-cricoid, upper 1/3 of laryngeal vestibule, middle and lower 1/3 of laryngeal vestibule, on the vocal folds, below the vocal folds).

Results

Thirty-nine patients met the above inclusion criteria. Five of the SEES videos did not have thin liquid presentations, and three of the SEES videos did not have dry solid presentations. A total of 206 videos segments were created: 39 pre-swallow pharyngoscopy SEES videos; 36 dry solid SEES videos; 39 dry solid VFSS videos; 34 thin liquid SEES videos; and 39 thin liquid VFSS videos. A total of 19 randomly selected video segments were included for repeat analysis to assess intra-rater reliability. Five raters in total participated, three of who evaluate regularly using the SEES protocol, and two of who do not.

Reliability

Intra-rater reliability ranged from good to excellent (α 0.886 – 0.910). Inter-rater reliability ranged from good to excellent (α 0.890–0.958) when judging *general* absence-presence, and from acceptable to good (α 0.666–0.870) when evaluating *quantitative* absence-presence. Overall, there was higher reliability when judging general presence vs. quantitative

presence, and higher reliability when judging solids vs. judging thin liquids. Each of the five raters showed statistically significant agreement ($p<0.001$) between SEES & VFSS for solid and thin liquid boluses.

Thin Liquid Swallow Assessment

Overall SEES-VFSS agreement ($p<0.001$) was found for *general* and *quantitative* thin liquid presence-absence, with an agreement of 71.1% and 60% respectively.

Agreement was obtained when correlating *quantitative* presence of thin liquid pharyngeal residue ($p<0.001$), laryngeal vestibule penetration ($p<0.001$), and tracheal aspiration ($p=0.049$).

Agreement was established for *general* presence of pharyngeal residue ($p<0.001$), laryngeal vestibule penetration, ($p<0.001$), and tracheal aspiration ($p=0.021$) in the larger anatomic landmarks.

Overall agreement ($p=0.041$) was found when correlating general presence residue, penetration, and aspiration in the *smaller* anatomic landmark regions. However, when looking at specific anatomic sites, agreement at the levels of the valleculae, piriforms, post-cricoid, and upper 1/3 of the laryngeal vestibule regions did not reach statistical significance.

SEES more frequently identified presence of penetration, and aspiration.

Solid Swallow Assessment

Overall SEES-VFSS agreement ($p<0.001$) was established for *general* and *quantitative* solid bolus residue, with an overall agreement of 80.9% and 74.6% respectively.

Agreement ($p<0.001$) was noted when identifying both *general* and *quantitative* presence of solid bolus pharyngeal residue, and laryngeal vestibule, and tracheal aspiration.

Overall agreement ($p=0.022$) was found when correlating general presence residue, penetration, and aspiration in the *smaller* anatomic landmark regions, with significant agreement at all anatomic landmarks.

VFSS more frequently identified the presence of residue and penetration of solids.

Discussion

Endoscopic findings on SEES demonstrated statistically significant agreement with fluoroscopic findings on VFSS for the quantitative presence of solid and thin liquid residue, and for the occurrence of penetration and aspiration. SEES detected the presence of penetration and aspiration more often than VFSS, indicating a higher level of sensitivity. Intra- and inter-rater reliability was also statistically significant, suggesting ease and accuracy of interpretation.

In comparison to VFSS, SEES is at least as effective at identifying the presence of (though not the cause of) post swallow residue, penetration, and aspiration. Given this, SEES

eliminates potential radiation exposure if the sole rationale for a VFSS referral is to identify presence of these findings. In comparison with FEES, SEES has the benefit of avoiding procedural invasiveness *during* the swallow (i.e., no endoscope present in situ during the actual swallow potentially affecting velar and pharyngeal function). Additionally, while flexible endoscopic distal chip technology now offers high-definition image quality, these scopes are not universally used and often the tip of the scope becomes coated with residue which can be difficult to clear even with multiple additional swallows. Lastly, it is common practice (though not required) to electively use small amounts of topical anesthesia in the outpatient setting during FEES. This has been shown to affect swallow function to varying degrees.[22, 23] These advantages unique to SEES effectively eliminate factors that can negatively influence normal swallow findings from FEES.

By quickly and accurately evaluating pre-swallow pharyngolaryngoscopic tasks, assessing patterns of secretions pooling, and identifying patterns of residue, penetration, and aspiration, SEES can help to more appropriately direct further work-up. For instance, if SEES revealed laryngeal residue with thin liquids, then proceeding immediately to a FEES would likely be warranted to identify events leading to penetration and to explore effectiveness of compensatory strategies. If SEES revealed post-cricoid residue or retrograde flow, then VFSS would be indicated to objectively quantify hyolaryngeal excursion and upper esophageal sphincter distension and to grossly assess esophageal function. In patients with complaints of chronic cough and globus sensation, if SEES findings revealed paradoxical vocal fold movement and supraglottic hyperfunction but no bolus residue or penetration, then behavioral therapy targeting cervical and laryngeal tension may be appropriate before additional instrumental swallowing assessment.

Limitations of the study include the sequential nature with which the exams were performed, and the severity of swallowing disorders. In most instances, a SEES was initially performed on the patient, and a VFSS was completed 1–2 weeks after initial clinical swallow evaluation with SEES. Findings may have been different if the SEES was performed immediately before the VFSS, however this is not likely given the patient population were all outpatient and change in functional status between exams was marginal to none. Another potential limitation to this study is that many of the patients had minimal swallow dysfunction. Our results may have been confounded if the patients studied had more severe dysphagia. The reason most of the patients in this study had mild dysphagia is likely due to the fact that clinical suspicion of more severe dysphagia would have prompted us to perform a FEES, rather than a SEES, in order to provide a more immediate evaluation of swallow function, airway protection, swallowing safety status, and effectiveness of compensatory strategies. Future study should be conducted to directly compare findings on SEES with those on FEES in order to reduce time difference (i.e., 1–2 weeks) between exams and to increase range of dysphagia severity.

Although SEES is effective in identifying the presence of pharyngeal, laryngeal, and tracheal residue, it does not demonstrate the cause of these findings. SEES is not a dynamic swallow study and cannot directly evaluate swallowing kinematics, and therefore it should not be used to replace FEES or VFSS. When used appropriately, FEES and VFSS

comprehensively assess swallowing kinematics, the efficacy of compensatory strategies, and targets for swallowing therapy, rather than used as a pass-fail test for aspiration.

Conclusions

Findings of the absence and presence of pharyngeal residue, laryngeal penetration, and tracheal aspiration correlate strongly with between SEES and VFSS. This procedure synthesizes findings of pre-swallow pharynglaryngoscopy, patterns of secretion pooling, and patters of residue, penetration, and aspiration to enhance impressions of swallow function. It is expedient, repeatable, and clinically relevant and can easily be incorporated into the outpatient clinical swallow evaluation for those with access to rigid endoscopy. SEES provides an estimate of a patient's aspiration risk level and can be used to more accurately direct the need for further instrumental workup such as FEES and VFSS.

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