Critical Review:
Is fiberoptic endoscopic evaluation of swallowing (FEES) as effective as videofluoroscopic swallowing study (VFSS) in detecting abnormal swallow signs in adults with dysphagia?*

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This critical review examines the efficacy of fiberoptic endoscopic evaluation of swallowing (FEES) in comparison to videofluoroscopic swallowing study (VFSS) with respect to the detection of abnormal swallow signs in adults with dysphagia. Eight articles obtained through online computerized databases were reviewed. These included one randomized clinical trial, one retrospective cohort study, and six within-subject designs. Overall, results of this review provide suggestive evidence that FEES is equally effective to VFSS in detecting dysphagic signs in adults. Recommendations for further research and clinical practice are discussed.

Introduction

Dysphagia is an impairment in the normal swallowing process that occurs secondary to etiologies that may be neurogenic, oncologic, structural, congenital or surgical in nature (CASLPO, 2007). Incidence of dysphagia has been associated with malnutrition, weight loss, dehydration, aspiration pneumonia, respiratory difficulties, prolonged hospital stays and even death (Allen & Belafsky, 2013). Research to date has suggested that bedside swallowing examination does not provide a sufficient evaluation of dysphagia, as it is unable to detect silent aspiration (Leder et al., 1998). As such, instrumental methods of swallowing evaluation have been widely adopted as an adjunct to bedside swallowing assessment. Instrumental evaluation of swallowing allows the Speech-Language Pathologist to directly visualize anatomic structures associated with swallowing, examine their physiologic function, and evaluate the efficiency of treatment strategies in increasing swallowing safety (ASHA, 2000; CASLPO, 2007). Presently, the two most widely used swallowing evaluation instruments are videofluoroscopic swallowing study (VFSS) and fiberoptic endoscopic evaluation of swallowing (FEES).

VFSS is a dynamic fluoroscopic technique that allows the clinician to view the oral, pharyngeal, laryngeal, and upper esophageal swallowing structures in order to ascertain their physiology, identify the safest method of nutritional and hydrational intake for the patient, and determine whether swallowing rehabilitation strategies may be suitable (CASLPO, 2007). However, the use of VFSS for dysphagia services may present several patient-centred drawbacks, including exposure to radiation, high cost, and the necessity to transport/position medically fragile populations.

Although VFSS remains the most widely used instrumental swallowing assessment tool in Canada, FEES has emerged as a valuable alternative in the assessment and management of dysphagia in adults (CASLPO PSG, 2007). FEES involves the passing of an endoscopic camera through the nose and into the upper pharynx to allow for the direct visualization of the larynx and pharynx during swallowing. As with VFSS, FEES allows the clinician to view the anatomic and physiologic properties of the patient's swallowing structures, determine the nature and severity of their impairment, make recommendations about the safest method of nutrition and hydration, and explore potential rehabilitation strategies. FEES is a controlled act that may be delegated to Speech–Language Pathologists or performed in collaboration with physicians (CASLPO, 2007). Research has demonstrated FEES to be an inexpensive, safe and reliable tool to assess laryngeal aspiration, penetration and residue as well as to evaluate the efficacy of airway protection manoeuvres in individuals with stroke-based dysphagia (SIGN, 2010; RCSLT Policy Statement, 2007). Unlike VFSS, FEES is amenable to bedside assessments and does not expose patients to radiation.

It is crucial that Speech-Language Pathologists adopt best practice guidelines that both take into account patient-centred concerns and align with the current evidence base. Because FEES provides direct visualization of the anatomy and physiology of the swallow while eliminating several of the patient-centered drawbacks associated with VFSS, it has the potential to offer clinicians an additional tool to consider when selecting appropriate dysphagia evaluation protocols. As such, it is important to ascertain whether current evidence demonstrates FEES to be an equally effective tool in the assessment and management of dysphagia in adults, to inform the health

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care community of current evidence, and to adapt clinical practice accordingly.

Objectives

The primary objective of this paper is to critically evaluate existing literature that compares the use of VFSS and FEES and determine whether these tools have been demonstrated to be equally sensitive to abnormal swallowing signs in adults with dysphagia. The secondary objective is to provide evidence-based recommendations for clinical practice surrounding the use of these instrumental swallowing evaluation tools.

Methods

Search Strategy

Articles were obtained through online computerized databases, including PubMed, Scopus, CINHAL and Google Scholar, using the following search terms: ((“deglutition disorders”) OR (dysphagia)) AND ((modified barium swallow) OR (videofluoroscopy)) AND ((fiberoptic endoscopic evaluation of swallowing) OR (nasendoscopy)). Reference lists of selected papers were also consulted for additional articles.

Selection Criteria

Articles included in this review were required to experimentally compare the efficacy of VFSS and FEES in detecting abnormal swallowing signs in adults with dysphagia. Inclusions were not limited by date of publication or by study design.

Data Collection

The literature search yielded eight articles that met the selection criteria. Articles consisted of one randomized clinical trial, one cohort study, and six within-subject designs.

Results

Langmore, Schatz and Olson (1991) was one of the earliest studies comparing FEES and VFSS. They examined agreement between FEES and VFSS in detecting abnormal swallowing signs and compared the sensitivity, specificity, positive predictive values and negative predictive values obtained by the two measures. Using a prospective, within-subject design, experimenters examined 21 males who had dysphagia resulting from diverse etiologies including cerebrovascular accident, neurologic disease, and vocal fold paralysis. Subjects were assessed using both FEES and VFSS within a 48-hour period, but the order in which these examinations were conducted varied. The occurrence of 4 abnormal swallowing signs (premature spillage, laryngeal penetration, tracheal aspiration and pharyngeal residue) was scored as either present or absent (+/-). Different investigators scored the FEES and VFSS examinations and were blinded to the subject’s other score. Experimenters found high (90%) agreement between VFSS and FEES. When compared against VFSS, they found FEES to have high sensitivity for three of the four above-mentioned measures (slightly lower sensitivity was noted for detection of premature spillage), but lower overall specificity. They concluded that FEES is a valid, reliable tool for evaluating oropharyngeal dysphagia but that further research is needed to support its use.

This research represents an early contribution to establishing FEES as a valid tool for the instrumental assessment of swallowing. A strength of this study is its use of appropriate statistical analyses to compute true and false positive/negative rates. In addition, the use of multiple blinded raters is a strength of the experimental method, as this reduces potential for bias. A limitation of the study is its small, exclusively male sample of participants with diverse dysphagia etiologies, which may restrict the generalizability of the findings. In addition, there is no indication of whether investigators scoring the participants displayed inter- and/or intra-rater reliability, nor is there information about the amount of experience raters have in scoring each procedure. As FEES was a relatively new procedure at the time this study was conducted, it is reasonable that raters may have had less experience analyzing abnormal swallow signs with this tool. Another limitation of the study is that VFSS and FEES were not conducted simultaneously. Patient-specific factors, such as fatigue, can influence the impact of dysphagia from one swallow to the next. This raises concern about the degree to which a direct comparison can be made between the two examinations.

Overall, this study provides an equivocal level of evidence that FEES and VFSS are equally effective in detecting abnormal swallowing signs.

Wu, Hsiao, Chen, Chang and Lee (1997) examined whether FEES and VFSS are equally effective in ascertaining the safety of swallows in individuals with dysphagia. Using a prospective, within-subject design, experimenters examined 28 adults with chronic dysphagia due to multiple etiologies, including cerebrovascular accident, Parkinson’s disease and head injury. Subjects underwent both FEES and VFSS within a two-week period, and swallows were evaluated on six signs (premature oral spillage, pharyngeal stasis, laryngeal penetration, aspiration, cough reflex and velopharyngeal incompetence). Each subject’s data was evaluated by at least two experienced, blinded raters. Experimenters concluded that FEES was more sensitive

in detecting five of the six above-listed swallow signs (lower sensitivity to premature spillage). They suggested that FEES may yield fewer false negative results and that it is a more reliable method than VFSS for detecting swallowing safety.

A substantial limitation of the study is that the experimenters reported primarily qualitative data (i.e., number of swallows that were unsafe as a proportion of total number of swallows). Only one statistic that demonstrated FEES to be significantly more sensitive in assessing the cough reflex was reported. Since the data presented in the article displays no statistical rigor, it is difficult to fully support the authors' conclusions. In addition, the authors acknowledge that not conducting VFSS and FEES simultaneously limited the degree to which results can be directly compared. Further, the small sample size limits its generalizability because it is likely not fully representative of the population of adults with dysphagia. The authors also did not indicate whether intra- or inter-rater reliability was computed, which limits the degree to which raters can be considered to provide consistent ratings. A strength of this study is the relatively high number of abnormal swallowing signs that were investigated. This allows for a detailed comparison of dysphagia signs using VFSS and FEES. In addition, the blinding of raters is a strength, as this process reduces potential biases in the findings.

Based on the relative strengths and weaknesses outlined above, this study presents an equivocal level of evidence that FEES and VFSS are equally effective at evaluating swallowing safety in adults with dysphagia.

Madden, Fenton, Hughes and Timon (2000) compared milk-swallow FEES and VFSS to determine whether both are equally sensitive in detecting four abnormal swallowing signs (laryngeal elevation, pooling, aspiration and cough reflex). The authors asserted that the limitations of VFSS, including patient exposure to radiation, limit its use and sought to determine whether FEES is a viable alternative. This within-subject design included 17 adults with dysphagia due to cerebrovascular accident or head and neck cancer who underwent both VFSS and FEES within a two-week timespan. Statistical analyses were conducted to compute sensitivity, specificity, and positive/negative predictive values. Experimenters found FEES to be a highly sensitive and specific measure across all four swallowing signs and to have high positive/negative predictive values. They concluded that FEES should be used as the primary tool for dysphagia screening with selective implementation of VFSS, as required.

A limitation of the study is its small sample size, which restricts generalization to the population of adults with dysphagia as a whole. Further, the experimenters did not clearly outline who was evaluating the data, whether these individuals demonstrated inter- and/or intra-rater reliability, and whether raters were blinded to other ratings. As in previous studies, Madden et al. (2000) did not conduct FEES and VFSS simultaneously, which limits direct comparison between the two evaluations. A strength of this study is its use of appropriate statistical analyses to compute true and false positives/negatives. The inclusion of patients with relatively limited dysphagia etiologies (only head and neck cancer and cerebrovascular accident) is another methodological strength. Although participant inclusion on the basis of only two etiologies limits possible generalization to the population of adults with dysphagia, it provides a less diffuse demographic sample than found in most other studies.

Overall, this study demonstrates an equivocal level of evidence that FEES is as sensitive as VFSS in detecting abnormal swallowing signs.

Aviv (2000) examined whether flexible endoscopic evaluation of swallowing with sensory testing (FEESST) or VFSS is superior in evaluating dysphagia and guiding behavioral and dietary recommendations. The FEESST protocol is identical to FEES, but with the inclusion of sensory testing of the superior laryngeal nerve through air pulse stimuli (Aviv, 2000). This randomized clinical trial included 126 participants, 76 of whom underwent VFSS and 61 who underwent FEES. Experimenters sought answers to two research questions: 1) which diagnostic test will result in fewer incidences of aspiration pneumonia after one year, and 2) which diagnostic test will result in lengthier pneumonia-free intervals? Patients were randomly assigned to either the VFSS or FEESST groups and five abnormal swallowing signs were evaluated (premature spillage, pharyngeal residue, laryngeal penetration, aspiration, and reflux). Findings were subject to a basic treatment algorithm that determined participants' behavioral and dietary management recommendations. Over the course of one year, patients were monitored for episodes of aspiration pneumonia. Statistical analyses included chi-square test to determine whether a significant difference existed between groups, and Wilcoxon's signed rank test to determine whether the pneumonia-free intervals significantly differed. Experimenters found no significant differences between the FEESST and VFSS groups in terms of either pneumonia incidence or length of pneumonia-free intervals. They concluded that both tools are equally effective in making behavioral and dietary recommendations for individuals with dysphagia.

Further, the author argued that FEESST offers several advantages compared to VFSS, including sensory testing, portability, and lower cost.

There are many strengths to this study, including its design; the findings of randomized clinical trials provide a high level of evidence. In addition, the article thoroughly outlined the patients and methods, including a detailed description of the protocols used for VFSS and FEESST. Samples of the testing forms used in the experiment and a copy of the treatment algorithm were provided. Appropriate statistical analyses were performed to analyze group differences and repeated measurements. In addition, the moderate sample size in this study sets it apart from previous research. One limitation of the study, acknowledged by the author, is that significantly more patients with chronic neurological disease and skull base tumors were randomly allocated to the VFSS group.

This study represents a highly suggestive level of evidence that the efficacy of FEESST and VFSS is equal in evaluating abnormal swallow signs and in making treatment recommendations.

Rao, Brady, Chaudhuri, Donzelli and Wesling (2002) conducted a prospective, within-subject study to compare the sensitivity and specificity values for VFSS and FEES in evaluating three abnormal swallow signs (pharyngeal residue, laryngeal penetration, and tracheal aspiration). 11 adults with dysphagia of various etiologies, including cerebrovascular accident, closed head injury and anoxic encephalopathy underwent both FEES and VFSS simultaneously. Experimenters calculated sensitivity and specificity twice—once using VFSS as the *gold standard* and once with FEES as the gold standard—in order to compare the validity of these tools. An experienced rater was used to establish inter-rater reliability, and the rater was blinded to examination results. Kappa correlations and Fisher's Exact Tests were computed, revealing that sensitivity values were greater when FEES was held as the gold standard, and specificity values were greater with VFSS used as the gold standard. Percentage of agreement between the tools was also investigated and found to be high (<80%) for all signs. The experimenters conclude that the efficacy of both tools is equal in detecting abnormal swallowing signs. Furthermore, the investigation provides support for considering both tools to be the gold standard in instrumental dysphagia evaluation.

A limitation of this study is its small sample size consisting of participants with diverse dysphagia etiologies. Once more, generalizability to the adult dysphagia population is limited. In addition, an acknowledged limitation of the study is that experimenters introduced swallowing strategies and safety protocols to minimize residue, penetration and aspiration in participants. This meant that participants received inconsistent bolus types and sizes, thus limiting the degree of comparability between participants. The experimental design did, however, have numerous strengths, including appropriate statistical analyses and the simultaneous use of both VFSS and FEES. Performing both evaluations simultaneously allows for a direct comparison to be made between ratings for each swallow. In addition, the analysis of sensitivity and specificity with each instrument respectively considered as the gold standard provided an additional layer of statistical rigor that was not present in previous studies reporting similar data.

Overall, this study provides a suggestive level of evidence that FEES and VFSS are both equally effective tools in determining abnormal swallowing signs with high sensitivity and specificity.

Tabaee et al. (2006) conducted a retrospective cohort study comparing the results of VFSS and FEESST in dysphagia evaluations to determine the degree of agreement between the tools. Results were included in the analysis if patients received both VFSS and FEEST within a two-week timespan across a four year period. In all, 54 adults with dysphagia met the inclusion criteria for the study. Results of VFSS and FEESST evaluations were categorized according to severity of findings (normal, mild dysphagia, moderate dysphagia, and severe dysphagia), then data was statistically analyzed using unweighted and quadratic weighted Kappa to determine agreement in detection of abnormal swallowing signs (pooling, penetration, and aspiration). Comparisons between VFSS and FEESST examinations revealed full agreement in 52% of cases, minor disagreement in 13% of cases and major disagreement in 35% of cases. Overall, the authors judged that only a fair amount of agreement existed between results of both tests. The experimenters concluded that the measures may not be comparable and that there is a need for further studies examining these tools before conclusively defining an evidence-based instrumental approach to dysphagia.

A strength of the study is its use of appropriate and thorough statistical analyses to ascertain agreement between VFSS and FEES. In addition, the authors provided insight into clinical application of these tools by researching retrospectively. Several studies reported high agreement between these tools when examined prospectively, but it is important to acknowledge that these values may not accurately reflect clinical practice. The authors recognized several limitations to their

study, including its retrospective nature and limited sample size. Also, VFSS and FEESST being performed at different points in time limited the comparability between the two tests. In addition, analysis was performed based on medical records rather than the examinations themselves and raises concerns about inter-examiner reliability. A further limitation is the lack of information about participant characteristics, including dysphagia etiologies and severities. Although the experimenters did state that results were grouped according to dysphagia severity to assess comparative agreement, it is unclear how many patients were included in each group and how this categorization was made.

Considering its strengths and limitations, this study provides an equivocal level of evidence in determining the agreement between VFSS and FEESST.

Kelly. Leslie, Beale, Payten, and Drinnan (2006) investigated whether the type of instrumental swallowing evaluation tool (i.e., FEES or VFSS) impacted ratings of pharyngeal residue. This prospective, within-subject design had 15 adult participants with heterogeneous dysphagia etiologies. Participants underwent simultaneous FEES and VFSS, which was recorded for analysis by 17 skilled, blinded clinicians who rated all swallows on pharyngeal residue severity according to a descriptive scale. Intra- and inter-rater reliability were calculated using kappa and rated as strong. There was a strong correlation between the swallows that were rated as leaving residue across both tools, suggesting a high level of agreement between findings using FEES and VFSS. A five-way ANOVA was computed to systematically assess factors that may influence ratings of residue according to type of examination, bolus type, order of rating, rater and patient. Analysis revealed ratings using FEES to be consistently more severe. The experimenters concluded that type of instrumental swallowing evaluation tool does influence perception of pharyngeal residue and, therefore, these tools cannot be used interchangeably in a clinical context.

A limitation of this study is the use of a small sample of participants with heterogeneous dysphagia etiologies, which restricts the generalizability of findings. In addition, the authors asserted that an immediate clinical implication of findings is that FEES and VFSS cannot be used interchangeably. In this study, however, only one sign of an abnormal swallow (pharyngeal residue) was examined. The extent to which this might hold true for the numerous other abnormal swallowing signs remains unknown and, therefore, limits the strength of this assertion. There are also many strengths to this study. Experimenters employed strong statistical methods to account for multiple factors and they provided sound rationale for their choices. In addition, since FEES and VFSS were executed simultaneously, this allowed for direct comparisons to be made between recordings of each swallow. Accuracy of data is further reinforced by the use of multiple experienced clinical raters with good intra-rater and inter-rater reliability to score each swallow.

Taken as a whole, this study provides a suggestive level of evidence that both FEES and VFSS have a high level of agreement in their ability to detect pharyngeal residue, but differ significantly in terms of perception of residue severity.

Kelly, Drinnan and Leslie (2007) investigated whether the type of instrumental dysphagia evaluation used (i.e., VFSS or FEES) impacted scoring of penetration and aspiration. This prospective, within-subject design had 15 adult participants with dysphagia caused by various etiologies. Participants underwent simultaneous FEES and VFSS, which was recorded for analysis by 17 skilled, blinded clinicians who rated all swallows using the Penetration-Aspiration Scale (Rosenbek et al., 1996). Intra- and inter-rater reliability were calculated using weighted Kappa and rated as subjectively good. A five-way ANOVA was computed to systematically assess differences that may influence Penetration-Aspiration scores. Factors included: the type of examination, bolus type, order of rating, rater and patient. Analysis revealed Penetration-Aspiration scores with FEES to be consistently higher. The ANOVA revealed that four out of the five factors influenced scores, with type of instrument, rater, and patient factors having the most significant impact. The experimenters conclude that the type of instrumental swallowing evaluation tool does impact perception of penetration and aspiration. In addition, the authors cautioned that using these tools interchangeably could misrepresent an individual's dysphagia as improving or worsening when changes may be due to instrument used. They further stated that whether the differences between FEES and VFSS have an impact on prediction of aspiration pneumonia requires further research, and that currently neither can be considered a superior method.

This study has a number of strengths. The authors used appropriate statistical analyses that accounted for multiple factors and provided sound rationales for the methods they used. In addition, performing VFSS and FEES simultaneously allowed for direct comparison of the same swallows. Data were scored by multiple blinded, experienced clinicians with good intra- and inter-rater reliability, which strengthens their accuracy. In addition, this is the only study reviewed that employed a validated rating scale to score abnormal

swallowing signs. A drawback to this study is its small, heterogeneous sample as this limits the degree to which findings can be generalized to the population of adults with dysphagia. In addition, although four out of five factors analyzed in the ANOVA model were statistically significant, experimenters did not clearly discuss the potential impact of factors other than type of instrument on penetration-aspiration scores. Other factors that significantly influenced penetration-aspiration scores were bolus type, rater and patient. This weakens the credibility of the argument that the type of swallowing evaluation tool has a greater impact on perception of penetration and aspiration than other factors analyzed.

Overall, this study provides an equivocal level of evidence that penetration and aspiration are perceived as more severe using FEES than VFSS.

Discussion

The notion that VFSS is the gold standard for instrumental evaluation of swallowing has come under scrutiny (Rao et al., 2003; Langmore, 2003). High cost, patient exposure to radiation, restricted examination time/re-testability and the requirement of several healthcare professionals to complete the procedure are some of the clinical limitations outlined in current literature (Kidder et al., 1998; Aviv, 2000). FEES has been recognized as another valuable tool in the instrumental evaluation of dysphagia in adults that has the potential to eliminate some of the drawbacks associated with VFSS (Aviv, 2000).

The studies reviewed here offer an overall suggestive level of evidence that FEES and VFSS are equally effective in detecting abnormal swallowing signs. The simultaneous measurement of swallows with VFSS and FEES and rigorous statistical analyses are considerable methodological strengths displayed by the Rao et al. (2003), Kelly et al. (2006), and Kelly et al. (2007) studies. Aviv (2000) demonstrated a highly suggestive level of evidence by including a moderate sample size and using a randomized clinical trial design. Many of the studies reviewed, however, shared two main methodological concerns: (a) small, heterogeneous samples, and (b) failure to execute FEES and VFSS simultaneously. These concerns, respectively, restrict the generalizability of research findings and limit the degree to which data recorded using VFSS and FEES can be directly compared. Langmore et al. (1991), Madden et al. (2000), and Tabaee et al. (2006) provided equivocal evidence due to these limitations in their methods. Wu et al. (1997) additionally lacked appropriate statistical analyses, further limiting the strength of the evidence provided by their research.

Future research comparing the efficacy of FEES and VFSS would benefit from the use of more homogeneous samples to elucidate the role of specific dysphagia etiologies on instrumental swallowing evaluation. In addition, studies that incorporate larger sample sizes and execute VFSS and FEES simultaneously would both broaden generalizability of findings and improve degree to which data can be directly compared. Finally, future research should investigate the effect that VFSS view (i.e. anterior-posterior, lateral) may have on swallow ratings. As FEES provides one consistent view of the anatomy and physiology of swallowing, it is important to consider the role that different VFSS views may have on the perception of abnormal swallow signs.

Clinical Implications

Since current evidence is suggestive that both dysphagia evaluation tools yield similar outcomes, it is important to consider other factors that may influence the clinical decision to use one instrument over the other. In addition to the aforementioned drawbacks, VFSS may be a less practical evaluation tool for medically fragile patient populations due to their limited mobility. FEES has been demonstrated to be a rapid, safe and effective method of dysphagia evaluation for critically ill patients (Hafner et al., 2008). In addition, there is a high prevalence of dysphagia amongst individuals with neurodegenerative diseases (Altman et al., 2013). A growing body of literature supports the use of FEES with neurodegenerative populations. FEES can be used at bedside, with the patient lying down, and concurrent to the use of nutritional and/or respiratory supports (D'Ottaviano et al., 2013). In addition, FEES allows the clinician to perform numerous evaluations throughout the progression of the disease and to investigate a multitude of therapeutic strategies without exposing patients to prolonged radiation or moving them to other care facilities (Leder et al., 2004; Robert et al., 2006; D'Ottaviano et al., 2013; Warnecke et al.). FEES also has the potential to be used in dysphagia management to provide individuals with visual feedback while learning various swallowing strategies (Robert et al., 2006). Current research suggests that FEES is helpful in demonstrating swallowing strategies to critically ill populations and to individuals with amyotropic lateral sclerosis (Leder et al., 2004; Hafner et al., 2008). Further, video-assisted swallowing therapy using FEES has been demonstrated to be an effective approach to the management of dysphagia in individuals with Parkinson's disease (Manor et al., 2013).

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