Hypothesis: Fiberoptic endoscopic evaluation of swallowing (FEES) will identify patients who are at high risk for pulmonary aspiration due to swallowing dysfunction after prolonged intubation. Based on the results of FEES, dietary recommendations can be made to decrease the incidence of aspiration after prolonged intubation.

Design: Patients who were intubated for at least 48 hours were evaluated for swallowing dysfunction by bedside FEES within 48 hours of extubation. Differences in potential risk factors between aspirators and nonaspirators were analyzed. Dietary recommendations were made and patients were followed up for signs of clinically significant aspiration.

Setting: Community teaching hospital.

Patients: Fifty-one consecutive patients with no previously documented swallowing disorder who required a minimum of 48 hours of intubation for mechanical ventilation.

Interventions: Fiberoptic endoscopic evaluation of swallowing was performed by a speech pathologist. Initial diet orders were determined by results of the swallowing study.

Main Outcome Measures: Incidence of swallowing dysfunction following prolonged intubation and incidence of clinically significant aspiration following initiation of oral feeding.

Results: Incidence of swallowing dysfunction was 56% (27/48); 12 (25%) of 48 patients were silent aspirators. In comparing aspirators with nonaspirators, no significant differences in potential risk factors or comorbidities were seen. Nineteen (70%) of the 27 patients aspirated with thin-consistency test liquids, and the other 8 (30%) with puree consistency. No patients in this study group developed a clinically significant aspiration following initiation of appropriately modified diets.

Conclusions: Fiberoptic endoscopic evaluation of swallowing identified swallowing dysfunction in more than 50% of patients intubated for longer than 48 hours, many of whom are silent aspirators. Dietary recommendations based on FEES results prevented clinically significant aspiration.

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Swallowing dysfunction is frequently observed following prolonged endotracheal intubation and may contribute to an increased risk of pulmonary aspiration after extubation. Since deglutition is a complex process that involves the coordination of several physiologic systems, the cause of swallowing dysfunction following prolonged intubation is thought to be multifactorial. Several proposed mechanisms for this problem include muscle atrophy from disuse during intubation, suppression of the cough and gag reflexes, inconsistent triggering of the swallowing reflex, diminished proprioception, and residual effects of narcotics. Because of this complexity, an objective clinical method to identify swallowing dysfunction has been difficult to achieve, and its true incidence remains poorly defined.

Various techniques that have been developed to assess swallowing function include manometry, manofluorography, scintigraphy, electromyography, pH monitoring, and ultrasound analysis. Traditionally, videofluoroscopy has been considered the gold standard for swallowing evaluation. However, the clinical utility of this test is compromised by the need to transport often fairly ill patients to the radiology department and the requirement for specialized equipment and personnel that are not readily available in many hospitals. Consequently, subjective bedside evaluation of the gag reflex is commonly used to evaluate swallowing ability.
PATIENTS AND METHODS

During a 6-month period (October 1, 1999, through March 31, 2000), 51 consecutive surgical and medical ICU patients who were older than 18 years and who required a minimum of 48 hours of intubation for mechanical ventilation were considered for the study. Three patients were eliminated because of a previously documented swallowing disorder. Demographic and clinical data were tabulated for the remaining 48 patients, who were prospectively evaluated according to the following protocol.

A bedside FEES was performed by a speech pathologist within 48 hours of extubation using the technique described by Langmore et al and Leder and Ross. A portable FEES system (model 7195; Kay Elemetrics, Lincoln Park, NJ) was used to perform the studies. Elements of the system included a CCD camera (model wat-202b; Water, Las Vegas, Nev), Hi-8 videocassette recorder (Sony EVQ-950H), 300-W xenon light source (model 7150; Kay Elemetrics), color monitor (Sony Trinitron KV-9PT30), a 3.3-mm flexible rhinolaryngoscope (model EF-100; Vision Sciences, Natick, Mass), and an endosheath (Vision Sciences). Topical anesthesia was not used because it was unnecessary for patient comfort.

The endoscope was passed through the most patent nostril to view the epiglottis, pharynx, and true vocal cords as patients were fed 1/2- to 1-tsp boluses of test material. Swallowing trials were performed using mixtures of food of thick and thin consistency that were colored blue for contrast and begun with puree boluses followed by milk and then crackers. The interior larynx and airway were examined for evidence of food penetration within the laryngeal vestibule and aspiration of food below the true vocal folds before and after each swallow. Silent aspiration, defined as lack of cough or gag reflex as the food or liquid bolus passed into the trachea, was also noted.

Based on the results of FEES, dietary recommendations were made and patients were observed for signs of clinically significant aspiration throughout their hospitalization. Patients were allowed nothing by mouth if puree was aspirated. If thin liquids were aspirated, a diet of liquids thickened to a honey consistency was ordered, and if normal swallowing was noted, they were advanced to a regular diet as tolerated. FEES was periodically repeated in patients who had swallowing dysfunction to determine if their diet could be advanced or they needed other feeding access via percutaneous endoscopic gastrostomy, jejunostomy, or nasogastric feeding tube.

Outcome measures used to evaluate patients included any clinical evidence of aspiration, such as increased pulmonary secretions or development of pneumonia. The ultimate ability to advance to and tolerate a regular diet as well as the requirement for placement of long-term feeding access were defined as secondary outcomes.

Patients were subdivided into 2 groups, aspirators (n=27) and nonaspirators (n=21), according to performance on FEES. The unpaired t test was used to analyze differences in the mean duration of intubation and the mean age of patients between the 2 groups. Differences between groups for sex, the use of a nasogastric tube or feeding tube, and presence of comorbid risk factors, including chronic obstructive pulmonary disease, diabetes mellitus, and gastroesophageal reflux disease, were analyzed using the Fisher exact test. Statistical significance was defined as P<.05.

Fiberoptic endoscopic evaluation of swallowing (FEES) is a newer, less resource-intensive technique of assessing deglutition that offers several advantages when compared with videofluoroscopy. Specifically, FEES can be performed unassisted at the bedside by a speech pathologist with standard fiberoptic instrumentation, thus avoiding the radiation exposure and possible barium aspiration encountered with videofluoroscopy. Furthermore, FEES is a more sensitive study that may be reliably repeated to sequentially document the resolution of swallowing disorders.

As a result, it is rapidly becoming the procedure of choice for swallowing evaluation in many clinical settings, including the intensive care unit (ICU), as well as in the monitoring of swallowing function in patients who have experienced a cerebrovascular accident and those with chronic neuromuscular disorders. The objectives of this study are to analyze our experience with FEES and to define its role in the identification of swallowing disorders and the prevention of clinically significant aspiration following prolonged intubation.

RESULTS

The overall incidence of aspiration determined by FEES was 56% (27/48). Significantly, 12 (25%) of 48 patients were silent aspirators. Mean duration of intubation was 8 days for aspirators and 7.7 days for nonaspirators (P=.88). In additional comparisons between aspirators and nonaspirators, no significant differences were seen in demographics, clinical variables, or comorbidities (Table). Further analysis demonstrated an incidence of aspiration of 50% in men compared with 61% in women (P=.56). Of clinical significance, 19 (70%) of 27 patients who aspirated did so with thin-consistency feedings; the other 8 (30%) aspirated with puree material.

Patients found to be aspirators on the initial FEES were followed up clinically and had additional studies as indicated by their day-to-day progress and overall state of health. A total of 27 additional studies were done. Seven patients required only 1 follow-up study, 5 patients received 2, 2 patients had 3 additional studies, and 1 patient underwent 4 follow-up evaluations.

No patients in this study group developed a clinically significant aspiration while in the hospital, and there were no deaths. Seventeen (63%) of the 27 aspirators showed improved swallowing and tolerated an oral diet by the time of discharge. The remaining 10 patients (37%) required alternative long-term feeding access, which was used throughout their hospitalization and after discharge to outside facilities.

The standard hospital charges for a videofluoroscopic barium swallow was twice the amount billed for FEES ($300 vs $150). The difference was mainly due to
the cost of technical support and interpretation of the study by a radiologist.

**COMMENT**

Normal swallowing consists of 4 integrated phases. These include the oral preparatory phase or mastication; the oral phase in which the tongue propels food posteriorly, triggering the swallowing reflex; the pharyngeal phase with the bolus moving through the pharynx; and the esophageal phase of peristalsis. This complex process requires intact sensation and motor function and coordination of the mandibular, labial, lingual, and buccal muscles, soft palate, cricopharyngeal sphincter, larynx, pharynx, and esophagus. Discoordination at any point will cause malfunction of this complex system and potentially result in tracheobronchial aspiration.1

The presence of an orotracheal tube has been shown to alter the mechanoreceptors and chemoreceptors of the pharyngeal and laryngeal mucosaes, causing dysfunction of the swallowing reflex.2 Laryngotracheal sequelae, including traumatic injury and mucosal ulcers, are also very common after prolonged intubation and may add to swallowing difficulties.3,6,11 In addition, tracheotomies and many neuromuscular disorders have been definitively linked to swallowing dysfunction.2,12,13 For these reasons, such patients were excluded from our study group.

In a recent study by Leder and colleagues,14 FEES demonstrated swallowing dysfunction in 45% of critically ill trauma patients after prolonged intubation, with 20% having silent aspiration. The present investigation, which included a broader spectrum of both medical and surgical ICU patients intubated for more than 2 days, corroborated these findings. The clinically significant incidence of silent aspiration in both of these series underscores the unreliability of the gag reflex and subjective bedside evaluations as tests of swallowing function. This subgroup of silent aspirators may be at the highest risk for postextubation pulmonary complications.

Our findings differ from those of a Washington University study15 of patients who had undergone cardiac surgery, in which barium cineradiography revealed swallowing dysfunction in only 4% of patients. Most of the patients in the Washington University study with normal swallowing were extubated within 48 hours of intubation, whereas those with documented swallowing dys-

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<tr>
<th>Demographics and Clinical Variables</th>
<th>Aspirators</th>
<th>Nonaspirators</th>
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<tbody>
<tr>
<td>Demographics</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Age, mean, y</td>
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<td>M/F</td>
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<tr>
<td>Clinical variables, No. (%)</td>
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<td>Nasogastric tube</td>
<td>8 (30)</td>
<td>7 (33)</td>
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<tr>
<td>Feeding tube</td>
<td>4 (15)</td>
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<td>Chronic obstructive pulmonary disease</td>
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<td>Gastroesophageal reflux disease</td>
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function were extubated on postoperative day 5.2 ± 1.7. In our experience, although aspirators on average were intubated for a slightly longer period than nonaspirators, this variable also failed to reach statistical significance. The difference in these observations may be attributed to the heterogeneity of our patient population compared with a defined series of cardiac surgical patients undergoing elective procedures.

An increased incidence of aspiration has been reported in patients older than 65 years with tracheotomies.7 Although we did find the mean age of aspirators to be slightly greater than that of nonaspirators, no significant difference was demonstrated. Similarly, we found no significant difference in the incidence of aspiration in men vs women. In corroboration with previous reports,2,14 we found that the presence of a nasogastric tube did not influence the aspiration risk in our patient group. Because the incidence of the remaining comorbidities was similar in both groups, we concluded that none added to a patient’s risk of aspiration after prolonged intubation.

Initial dietary recommendations were standardized according to the results of FEES. Interestingly, many patients required the addition of thickeners to their initial diets, a departure from the clear liquid menu traditionally prescribed for fasted medical surgical patients. Sequential reevaluation of patients with swallowing dysfunction allowed diet advancement to be based on objective resolution of these abnormalities. In addition, patients with more chronic swallowing difficulties were identified for establishment of alternative enteral feeding routes. We believe that these interventions contributed to our observation that none of the study group developed a clinically significant aspiration.

Our experience confirms that FEES is easily performed at the bedside with minimal if any discomfort or complication risk to the patient. In comparison to videofluoroscopy, the technique is less costly and allows for direct visualization of the pharynx and larynx throughout deglutition by a speech pathologist specifically trained to evaluate swallowing function. Therefore, both overt and silent aspiration are reliably and clearly identified with endoscopic images, which may serve as a baseline for subsequent evaluations in the postextubation period.

In this study, we found that more than 50% of patients intubated for more than 48 hours had swallowing dysfunction, and many were silent aspirators. Since no clinical factors were associated with an increased risk of swallowing dysfunction, we currently use bedside FEES to evaluate the swallowing function of all patients requiring prolonged intubation. The results of FEES are used to make initial and subsequent dietary recommendations that may decrease the likelihood of aspiration. Furthermore, since 37% of aspirators required long-term feeding access, further investigation should be undertaken to define treatment of chronic swallowing disorders in this challenging cohort of patients.


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Second, had you discontinued narcotic and sedative use for at least 24 hours prior to the endoscopy as de Larminat's study had done, and how might the presence of residual sedation have influenced the results? Would the use of a sedation scale be of any help in determining the suitability of patients for a FEES study?

Third, were there any distinguishing characteristics of the 10 who required long-term feeding access, and could you have identified these at-risk patients prior to extubation?

Fourth, did silent aspirators correlate either with the duration of intubation or with the occurrence of laryngeal ulceration?

Last, do we really need all of these FEESs or can patients be screened for the more interventional and, therefore, more costly studies by the clinical parameters of voice quality, laryngeal elevation and return, oromotor function, and swallowing latency as has been well documented and promulgated by Jeri Logemann?

The authors have presented their institutional experience with fiberoptic endoscopy to evaluate swallowing in order to identify patients at risk for aspiration following extubation. Since no patient had a clinically significant aspiration, the question remains whether all or just a subset of intubated patients would benefit from this more intervention-level assessment.

Dr Ajemian: In response to the first question, we did not look at a control group of patients who were not intubated. We made a clinical observation that several of our patients had aspirated shortly after extubation. Therefore, we were interested in the incidence of aspiration in patients who had been recently extubated, but that probably would be a good point to take on in a future study.

Second, to address the issue of sedation, we did not discontinue all narcotics. Instead, we used the Glasgow Coma Scale with a minimum score of 12 to screen patients who were eligible for the FEES study.

As for the 10 patients who required long-term feeding access, we did look at individual risk factors; however, it was such a small population, no solid conclusions could be made from these data. We are continually evaluating these patients with further FEESs, and we hope to report the results of the long-term outcomes in a follow-up paper. Specific consideration will be given to clinical findings that could predict patients at high risk for swallowing dysfunction who may require long-term access for feeding.

Silent aspiration did not correlate with duration of intubation or laryngeal trauma. Actually, we were unable to correlate silent aspiration significantly with any clinical variable. As such, we feel very strongly that all patients who have had prolonged intubation should undergo a FEES examination prior to initiation of oral feeding.

Could patients be screened with bedside evaluations of swallowing prior to the FEES to determine high-risk patients who would benefit from this more invasive examination? We have felt in our experience and through our literature search that bedside evaluations of swallowing tend to be unreliable and subjective in nature. In our experience, FEES is a minimally invasive objective study in which there is visualization of the vocal cords throughout the entire swallowing process. Therefore, with the FEES examination, one is able to visualize and quantify the severity of aspiration during the swallowing of different consistency feeds, which is far superior to subjective bedside evaluations of deglutition.

**DISCUSSION**

Gene Grindlinger, MD, Portland, Me: Nosocomial pneumonia, of which aspiration is a contributing factor in some, remains a major cause of morbidity, mortality, and cost in ICU patients. Though the transient swallowing disorder and aspiration risk that attends intubation in most patients is well documented in the dysphagia literature, it has not received similar attention in the broader context of critical care. The authors have done a wonderful job of correcting that deficit.

The authors present the results of 48 consecutive patients who were studied by fiberoptic endoscopy to assess the presence of swallowing dysfunction following extubation. All patients had been intubated for a minimum of 48 hours and underwent their studies at the bedside by a speech pathologist. Based on the results of the fiberoptic evaluation, dietary recommendations were made. Fiberoptic endoscopy was periodically repeated in patients who had swallowing dysfunction identified to determine if their diet could be advanced or they required alternative feeding access. The overall incidence of aspiration was 58%. Twenty-five percent of the patients were silent aspirators. Significantly, no patient developed a clinically significant aspiration while in the hospital, although 10 of the 48 patients studied required alternative long-term feeding access. Of the 27 aspirators, 12, or 63%, showed improved swallowing on follow-up endoscopic studies.

I have a number of questions for the authors. First, can you speculate as to whether this is a more generalizable phenomenon in critically ill patients or, asked another way, have you evaluated nonintubated patients of comparable severity of illness in order to control for the effect of intubation itself?

**REFERENCES**


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