

The Significance of Accumulated Oropharyngeal Secretions and Swallowing Frequency in Predicting Aspiration

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Abstract. This study retrospectively investigated the value of both endoscopically visible oropharyngeal secretions in the hypopharynx and swallowing frequency in the prediction of aspiration of food and liquid. Fiberoptic endoscopic evaluation of swallowing (FEES) was performed on a total of 69 individuals that included hospitalized elderly, nonhospitalized elderly, and young normal subjects. A four-level rating scale for determining the severity of accumulated oropharyngeal secretions was developed and employed to rate subjects prior to the presentation of food or liquid during the FEES. Spontaneous dry swallows were also counted during the observation period of the FEES. It was found that the accumulation of endoscopically visible oropharyngeal secretions located within the laryngeal vestibule was highly predictive of aspiration of food or liquid. There were significantly fewer spontaneous swallows in hospitalized subjects when compared with nonhospitalized subjects. There was also a significant decrease in the frequency of spontaneous swallows in aspirating hospitalized subjects when compared with nonaspirating hospitalized subjects. Results are discussed in terms of integrating this information with clinical bedside examination techniques.

Key words: FEES — Endoscopy — Oropharyngeal secretions — Spontaneous swallows — Obliteration — Deglutition — Deglutition disorders.

The ability to predict aspiration without the assistance of an instrumental examination has long been desired by clinicians for determining the safety of swallowing in dysphagic patients. Though the clinical bedside examina-

tion has become more sophisticated over the years, it is still of questionable sensitivity in predicting aspiration. Splaingard [1] indicated that careful clinical bedside evaluation by a speech language pathologist is neither very specific nor sensitive in detecting aspiration in an inpatient rehabilitation population. Logemann [2] found that even the most experienced clinicians fail to identify approximately 40% of aspirating patients during a bedside examination. By utilizing the predictive value of several clinical factors, Linden et al. [3] reported the ability to accurately prognosticate or rule out aspiration 2/3 of the time. An indicator frequently used in the clinical bedside examination and considered sensitive in predicting aspiration is the presence of a voice quality variously described as wet/hoarse, wet/gurgly, or wet dysphonic. This aberrant voice quality suggests an accumulation of oropharyngeal secretions, food, or liquid that has penetrated the laryngeal vestibule directly in the path of the phonatory airstream. Though the direct visualization of aspiration of secretions via endoscopy has been documented [4], no attempt has been made to visually determine the significance or severity of accumulated secretions.

In a normal individual, oropharyngeal secretions are cleared from the hypopharynx by periodic spontaneous swallows throughout the day. In a dysphagic individual, the accumulation of these secretions is thought to reflect an impairment in the efficiency of laryngopharyngeal clearance [5]. Among the factors contributing to a reduction in secretion clearance in a dysphagic subject would be a reduction in the frequency of spontaneous swallows, a weakness in the pharyngeal response during the swallow, or a combination of weakness and decreased swallowing frequency.

The purpose of our investigation was to retrospectively determine whether the visualization of the specific location and gross estimation of volume of these secretions within the laryngopharynx via nasendoscopy could

predict aspiration of food or liquid during an instrumental assessment of swallowing. We were additionally interested in whether the ability or inability of a subject to clear accumulated secretions was associated with the frequency of the subject's spontaneous swallowing.

Methods

Subjects

Three groups were examined in our study. Two groups of male veterans between the ages of 60 and 100 were administered a Fiberoptic Endoscopic Examination of Swallowing (FEES) [6] as part of a testing protocol for subjects enrolled in the Geriatric Oral Science Project (GOSP). One of the veteran groups consisted of 47 elderly hospitalized patients aged 60–100 years. Each member of the hospitalized group had a medical history that included at least one of the following: chronic obstructive pulmonary disease, diabetes mellitus, or neurologic pathology (cerebrovascular accident, Parkinson's, multiple sclerosis, amyotrophic lateral sclerosis and/or cerebral resection). A group of 17 normal nonhospitalized, elderly individuals aged 60–83 years were administered the same examination using an identical protocol. FEES examinations were also conducted on 5 younger normal subjects aged 24–40 years.

Instrumentation and Methods

Flexible fiberoptic laryngoscopy was performed using an Olympus ENF-P3 flexible endoscope (Olympus Corporation, Lake Success, NY, USA). The flexible endoscope was passed transnasally to the hypopharynx, a vantage point that provided a full view of the laryngeal vestibule. The endoscope was coupled to a chip camera (Elmo Corp., New Hyde Park, NY, USA) and a For-A Video Timer character generator (For-A Corp., Tokyo, Japan). Studies were recorded with a S.C. VHS video cassette recorder. The video timer was used to generate time characters onto each video frame (every 30.3 msec).

Each FEES examination was performed in compliance with a protocol calling for an ordered presentation of food and liquid [6]. Prior to the initial presentation of food or liquid, a drop of green food dye was placed on the tongue of the subject. This dye mixed with the subject's saliva and eventually flowed to the hypopharynx so that all secretions in the hypopharynx appeared green. Aspiration status was determined by reviewing the videotaped studies and identifying the aspiration of food or liquid on the FEES examination. Aspiration was defined as any food or liquid passing below the level of the true vocal folds.

Secretion Scale Development

The judgment of amount and location of secretions was made by reviewing a 2–5 min segment of the FEES examination during which observations were made of phonatory and airway protection abilities. This segment of tape (observation segment) included the view immediately following the entry into the hypopharynx and concluded at that point in the protocol just prior to the presentation of food or liquid to the subject. Because no standards were available in the literature for visually rating the severity of standing secretions, an expert panel was assembled consisting of two otolaryngologists who routinely used fiberoptic laryngoscopy in their practice. A four-step scale was devised for determining severity. Because the amount of secretions in the hypo-

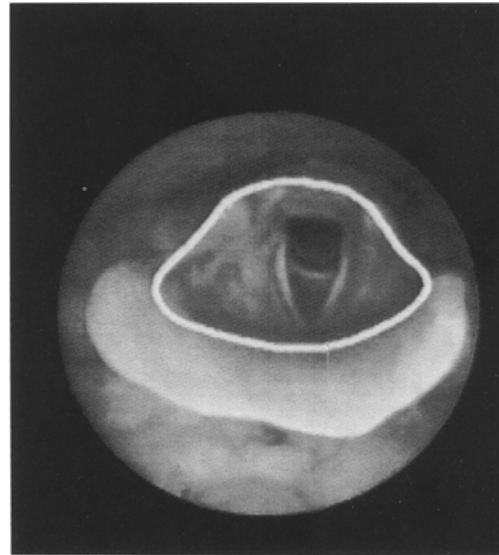


Fig. 1. Illustration of the border areas used to score the secretions. The laryngeal vestibule is defined as the area within the white border.

pharynx can increase or decrease as they accumulate and are cleared during the observation segment, there are transitional scores included in the scale. The range for each step was identified as follows:

0. Most normal rating. No visible secretions anywhere in the hypopharynx or some transient bubbles visible in the valleculae and pyriform sinuses. These secretions were not bilateral or deeply pooled.
1. Any secretions evident upon entry or following a dry swallow in the channels surrounding the laryngeal vestibule that were bilaterally represented or deeply pooled. This rating would include cases where there is a transition in the accumulation of secretions during the observation segment. A subject could start with no visible secretions but accumulate secretions in an amount great enough to be bilaterally represented or deeply pooled. Likewise, a subject would be rated as a "1" if initially presenting with deeply pooled bilateral secretions and ending the observation segment with no visible secretions.
2. Any secretions that changed from a "1" rating to a "3" rating during the observation period.
3. Most severe rating. Any secretions seen in the area defined as the laryngeal vestibule (Fig. 1). Pulmonary secretions were included if they were not cleared by swallowing or coughing at the close of the segment.

Observation segments of FEES procedures performed on 12 inpatients not enrolled in GOSP were independently viewed and rated by the 2 otolaryngologists and 1 speech-language pathologist. The resulting ratings produced 100% agreement. The speech-language pathologist then rated the observation segments for all subjects in this study on the four-step scale.

Finally, the number of spontaneous dry swallows produced by each subject was determined by counting dry swallows from the same observation segment that was previously analyzed. The tape was monitored for screen obliterations which represented the event of a spontaneous dry swallow. The authors had previously determined from videotaped split screen images of simultaneous fluoroscopy and fiberoptic endoscopy that screen obliterations occurring at a characteristic point in time and lasting approximately 650 msec represent the moment of swallowing.

Table 1. Secretion ratings, aspiration status and swallowing frequency for all subjects

Characteristic variable		Hospitalized elderly (n = 47)	Normal elderly (n = 17)	Normal young (n = 5)
Secretions rating	0	14 (29%)	11 (65%)	4 (80%)
	1	15 (32%)	6 (35%)	1 (20%)
	2	5 (11%)	0	0
	3	13 (28%)	0	0
Aspiration	No	18 (38%)	16 (94%)	5 (100%)
	Yes	29 (62%)	1 (6%)	0
Swallow freq. ^a (swallows/min.)		0.89 (± 0.85) ^a	2.82 (± 1.71) ^a	2.96 (± 0.88) ^a

^aFisher's Exact test ($p < 0.001$).

Results

The differences between the hospitalized elderly subjects and the two normal groups become evident when all were compared according to the variables of interest in this study. Logistic regression was used to determine how pharyngeal secretion ratings predicted aspiration. Fisher's Exact test and *t* tests were used to test for associations of aspiration and differences in swallowing frequency between patient groups (hospitalized/nonhospitalized).

Secretion Ratings

Secretion ratings were significantly different for hospitalized patients compared with normal subjects ($p < 0.001$ Fisher's Exact test). None of the elderly normals or young normals were observed to have secretions resting within the bounds of the laryngeal vestibule during the observation segment of the FEES (Table 1). The majority (15/22, 68%) of young and older normals were judged to have no evidence of secretions throughout the observation period of the FEES. Only hospitalized patients were found to have secretions within the bounds of the laryngeal vestibule and 70% (33/47) were judged to have a secretion rating of "1" or greater.

Aspiration

Thirty of the 64 GOSP subjects (46.87%) aspirated food or liquid during the FEES examination (Table 1). The vast majority of those that aspirated were hospitalized patients with one elderly normal demonstrating trace aspiration during the FEES (Table 1). None of the younger normals were observed to aspirate. The secretions ratings of those hospitalized patients who aspirated were significantly different from those who did not aspirate ($p < 0.001$ Fisher's Exact test). All of the hospitalized patients with a secretions rating of "2" or above were

Table 2. Hospitalized subjects' scaled ratings of secretions, subsequent aspiration

Rating	Aspirated	Did not aspirate	Total
0	3 (21%)	11 (79%)	14
1	8 (53%)	7 (47%)	15
2	5 (100%)	0	5
3	13 (100%)	0	13

Fisher's Exact Test ($p = 0.001$)

observed to aspirate on the FEES (Table 2). A univariate logistic regression model was fit for the hospitalized group. When the likelihood of aspiration associated with each single step increase in the composite rating scale was calculated, the odds of aspirating increased more than sevenfold (odds ratio = 7.38). This resulted in a risk of aspiration that septupled as the composite score changed from an 0-rating to a 1-rating. This septupling continued with each step to the most severe rating of "3".

Swallowing Frequency

Swallowing frequency was determined during the observation period of the FEES study with the endoscope placed within the bounds of the hypopharynx. When the two elderly groups were compared, there was a significant difference in frequency of swallowing, with the hospitalized patients swallowing less frequently (0.89/min) than the normal elderly subjects (2.82/min) ($p < 0.001$, Fisher's Exact test). When the inpatient group was compared with the younger normal subjects, the difference was even greater. Young normals swallowed more frequently than either of the other two groups, at about 2.96 swallows per min (Table 1). Finally, swallowing frequency was significantly reduced in those hospitalized subjects who aspirate when compared with those hospitalized patients without aspiration ($p = 0.047$) (Table 3).

Table 3. Hospitalized subjects' aspiration status and swallowing frequency

	Aspirated (n = 29)	Did not aspirate (n = 18)	<i>p</i> -Value
Swallowing frequency (swal/min)	0.72 (± 0.78)	1.16 (± 0.91)	0.047 ^a

^aT test was performed on square root transformation, but raw value is reported.

Discussion

In this study we examined the aspiration status, frequency of spontaneous swallowing, and degree of accumulation of oropharyngeal secretions in hospitalized elderly, non-hospitalized elderly, and young normal subjects by analyzing findings from FEES studies performed on each subject. The major findings were as follows. The accumulation of oropharyngeal secretions in the laryngeal vestibule predicted aspiration of food or liquid. Hospitalized elderly subjects swallowed significantly less frequently than nonhospitalized elderly subjects. Those hospitalized patients who aspirated demonstrated significantly fewer spontaneous dry swallows than nonaspirating hospitalized patients.

The prediction of aspirating food or liquid based on a combination of clinical bedside findings is a difficult task. Attempts have been made to determine a subject's ability to manage secretions [3,7], but they have been built on inferences garnered from auditory cues. Previous investigations have suggested that the inability to manage secretions is most typically seen in individuals with severe multiple pharyngeal and laryngeal abnormalities [3]. In this study, with the aid of direct visualization via endoscopy, a continuum of severity in the accumulation of secretions was revealed. This continuum ranged from no secretions visible endoscopically to visually notable secretions that filled the laryngeal vestibule. In order for a wet dysphonia to be heard, the secretions must interfere with the flow of air during phonation. In this study, those patients with secretions pooling within the laryngeal vestibule were clearly the most severely impaired in terms of their likelihood of aspirating food or liquid. If these secretions remain outside of the laryngeal vestibule they would have no effect on the production of a wet dysphonia. Yet, these patients are still 7 times more likely to aspirate than those individuals with no evidence of secretions.

An additional factor for clinically determining an individual's ability to manage secretions is the frequency of spontaneous swallowing of secretions. The frequency of swallowing in all of the groups of subjects observed in the present investigation was higher than those reported

in other studies. This may be due to the effect of the endoscope on salivary flow. Helm et al. [8] reported an increase in saliva flow for a period of 4 h after patients were intubated with a 5-mm pH monitor tube. Similarly, Kapila et al. [9] reported an elevated frequency of swallowing in normal subjects when employing nasopharyngeal catheterization, and they attributed this increase to a change in salivary flow.

There is a natural variation in the frequency of spontaneous swallowing in normal individuals that is dependent on the time of day, level of activity, and level of alertness. A reduction in the frequency of swallowing during sleep when compared with waking states has been well documented [10,11]. Lear et al. [10] found the mean swallowing frequency to be 0.088 swallows/min in sleeping subjects and 0.612 swallows per min in normal subjects while reading. The potential significance of this reduction in swallow frequency might be seen in sleeping individuals who have been reported to aspirate nasopharyngeal secretions, as seen scintigraphically [12]. Huxley et al. [13] reported the risk of aspirating secretions was greater during a period of depressed consciousness when airway protective mechanisms such as the spontaneous swallow were presumed to be the least active. The inpatient group in this investigation demonstrated significantly fewer spontaneous swallows than the elderly and younger controls. More importantly, the aspirating hospitalized patients swallowed significantly less frequently than the hospitalized nonaspirating group. Though the level of consciousness for the inpatient group was not directly assessed for the purpose of this investigation, it is possible that this population demonstrated a reduction in the level of alertness due to recent neurologic events or the effects of medication.

An alternate explanation for the accumulation of secretions in the hypopharynx is the likelihood that the pharyngeal response during the dry swallows was weak and therefore less efficient in clearing the accumulated secretions. The effort involved in generating a swallow may also be a contributing factor in those subjects that are weakened. A slight reduction in swallowing frequency found in combination with a weakened pharyngeal response could result in an even greater accumulation of secretions in the pharynx.

In this study, there remained a group of patients who demonstrated the ability to clear secretions and yet still aspirated. Of the 14 hospitalized subjects with a "0" secretion rating, 3 (21%) aspirated food or liquid during the FEES. These events of aspiration might have been due to some other abnormality in the swallow, e.g., bolus propulsion and laryngeal protection mistiming. Obviously, this pattern of dysfunction would not have been detected from merely observing the secretions, but would

need to be identified during the presentations of food or liquid boluses.

Conclusions

This study confirmed, through direct visual inspection, that there is a strong association between the presence of oropharyngeal secretions in the laryngeal vestibule and the likelihood of aspiration of food or liquid. Patients who demonstrate trouble in clearing oropharyngeal secretions from the laryngeal vestibule for whatever reason will also likely demonstrate the same trouble with food or liquid while swallowing. It is known that accumulation of secretions within the laryngeal vestibule produces a wet dysphonic voice quality, but there is no clinical indicator for secretions located outside the bounds of the laryngeal vestibule. The presence of these secretions is still important because of their predictive value for aspiration. To positively identify the severity of secretions they must be visualized directly, and this is only possible with an imaging device such as endoscopy.

There was a significant decrease in the frequency of swallowing in our aspirating hospitalized group. The frequency of spontaneous swallows can be easily sampled at bedside with simple instrumentation or palpation of the larynx to monitor elevation associated with the pharyngeal stage of the swallow. The frequency of swallowing for all patients in this study may have been elevated because of the placement of the endoscope. Before swallowing frequency becomes a clinically useful indicator for the hospitalized dysphagic patient, norms must be compiled regarding the frequency of spontaneous swallows without the presence of the endoscope. Additionally, the inclusion of a measure of pharyngeal strength and its effect on the amount and location of visible pharyngeal secretions would be beneficial. The effect of alertness on secretion clearance in the dysphagic subject should also be taken into consideration in future studies. Identifying the key features that predict aspiration while administering a clinical bedside examination should continue as a focus of future research. However, until the clinical examination becomes more sensitive, we concur with previous investigators who insist that instrumental exami-

nations such as the FEES or Modified Barium Swallow are a necessary adjunct in positively identifying and planning treatment for those patients at risk for aspiration.

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