Original Article

Oropharyngeal dysphagia increased the risk of pneumonia in patients undergoing nasogastric tube feeding

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Background and Objectives: Aspiration pneumonia is a major cause of death in patients on nasogastric tube (NGT) feeding. This study aimed to evaluate the oropharyngeal dysphagia and stratify risk of pneumonia in patients undergoing NGT feeding. **Methods and Study Design:** The study included patients on NGT feeding who underwent UGI endoscopy at Tri-Service General Hospital, Taiwan. Endoscopy was performed to examine the pharyngolaryngeal region. The severity of oropharyngeal dysphagia was evaluated according to the visualized amount and location of pooling of secretions in the pharyngolaryngeal region; 60 patients showed absent or minimal amount of secretions (control group), 14 patients showed moderate-to-large amounts of secretions filling the pyriform sinus (pharyngeal group), and 27 patients showed secretions entering the laryngeal vestibule (laryngeal group). Demographic data and occurrence of pneumonia were analyzed. **Results:** The incidence of pneumonia was highest in the pharyngeal group (4.2±3.6 episodes/person-years), followed by the laryngeal (2.6±2.2 episodes/person-years) and control groups (1.7±3.8 episodes/person-years) (p=0.042). Multivariable regression showed significantly higher risk of pneumonia in the pharyngeal (adjusted odds ratio=2.7, 95% CI, 2.4-2.8, p<0.001) and laryngeal (adjusted odds ratio=2.0, 95% CI, 1.7-2.4, p<0.001) groups. The cumulative incidence rate of pneumonia was significantly higher in the laryngeal and pharyngeal groups than in the control group (log rank test, p<0.001). **Conclusions:** Endoscopic pharyngolaryngeal observation can evaluate the oropharyngeal dysphagia. Visual evidence of oropharyngeal dysphagia increase the risk of pneumonia in patients on NGT feeding.

Key Words: oropharyngeal dysphagia, dysphagia, aspiration pneumonia, nasogastric tube, enteral nutrition

INTRODUCTION

Nasogastric tubes (NGT) feeding are used for enteral delivering of nutrition and medications in patients with dysphagia.[1,2] Patients on NGT feeding are at risk for adverse events, such as aspiration, aspiration pneumonia, and death.[3-5] The prevalence of aspiration pneumonia in the literature varies from 21 to 95% of tube feeding patients, with a mortality rate ranging from 31.2 to 62%.[6-9]

Oropharyngeal dysphagia has been identified as a serious risk factor for patients developing aspiration pneumonia.[10,11] Evaluation of oropharyngeal dysphagia, oropharyngeal aspiration, and identification of patients at risk of aspiration pneumonia remains a challenge for clinicians.[11,12] Oropharyngeal aspiration may occur silently with the only symptoms being those of secondary pulmonary parenchymal disease.[11,13] Clinical symptoms of oropharyngeal aspiration include choking, coughing, or wet sounding voice during or after eating. Moreover, diagnosing oropharyngeal aspiration is difficult when no cough or airway protective responses are presented, and no characteristic features are observed on chest radiographs that facilitate the diagnosis of oropharyngeal aspirations.[11,13]

Endoscopy allows for the direct observation of food accumulation in the pyriform sinus and other risky phenomena such as food entering below the vocal cords, which is common with oropharyngeal dysphagia.[14-16] With upper gastrointestinal (UGI) endoscopy, clinicians can directly witness the accumulation of pooling secretions in the pyriform sinuses or leaking into the laryngeal

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vestibule and further stratify the severity of oropharyngeal dysphagia.[16-18]

To our knowledge, no study has yet evaluated oropharyngeal dysphagia in patients on NGT feeding. We aimed to evaluate the severity of oropharyngeal dysphagia and to follow-up with patients on NGT feeding who required hospital admission for pneumonia and, ultimately, to stratify the risk of pneumonia in patients on NGT feeding.

METHODS

Study design

Between January 2015 and July 2018, we performed cross-sectional UGI endoscopy with pharyngolaryngeal observation in patients on NGT feeding to evaluate the amount of pooled secretions and conducted prospective follow-up of those who required hospital admission due to pneumonia (Figure 1). The present study was approved by the Institutional Review Board of the Tri-Service General Hospital (TSGHIRB No.: 1-104-05-148). The patients were informed of the details of this study and were allowed to participate after providing informed consent.

The study enrolled a total of 1,362 patients who underwent routine UGI endoscopy were recruited in this study. We excluded 62 patients because of the following reasons: age <20-years, pregnant, or undergoing emergency endoscopy. Moreover, of the 1,300 patients with available data on pharyngolaryngeal observation during endoscopy, 68 patients were excluded due to poor pharyngolaryngeal views. Of the remaining 1,232 patients, 101 patients on NGT feeding were finally included in this study. The primary diagnoses of the included patients were neurological disease (n=49), head and neck cancer (n=13), and esophageal disorders (n=39).

Demographic data

Patient characteristics such as age, sex, body mass index, serum hemoglobin and albumin levels, swallowing level scale score, and incidence of pneumonia requiring admission were recorded. The swallowing level scale score was assessed using the American Speech-Language-Hearing Association National Outcome Measurement System.[19] Specifically, scores between 1 and 3 are typically seen in tube-dependent patients and those between 4 and 7 are usually seen in those on total oral intake. The swallowing level scale score ranges from 1 to 7, with lower numbers indicating greater oral intake limitation and increased risk of pneumonia.

Pneumonia was diagnosed based on radiological evidence of consolidation, serum white cell count >10,000/mm^3, temperature >38°C, and shortness of breath.[20] The average follow-up period following the UGI endoscopic evaluation was approximately 3 years. The incidence of hospital admission due to pneumonia was extracted from the medical records. The cost of hospitalization due to aspiration pneumonia was also extracted. Furthermore, the cumulative number of episodes of pneumonia that required hospital admission was calculated.

Endoscopy with pharyngolaryngeal observations[15,21,22]

Experienced UGI endoscopists were trained to perform the pharyngolaryngeal observations. The endoscopist chose the pre-medication per his/her preference. Most of the endoscopic procedures were performed using topical anesthesia without intravenous sedation. Patients fasted for at least 4 hours before the procedure and were placed in the left lateral decubitus position. The tip of the endoscope was inserted through the mouth-piece with the axis aligned with that of the patient's esophagus. By advancing the endoscope along the midline of the palate, the uvula was visualized over the base of the tongue. The scope was slightly rotated, passed the uvula, and gently advanced with anterior flexion to visualize the pyriform sinuses, laryngeal vestibule, vocal cords, and upper part

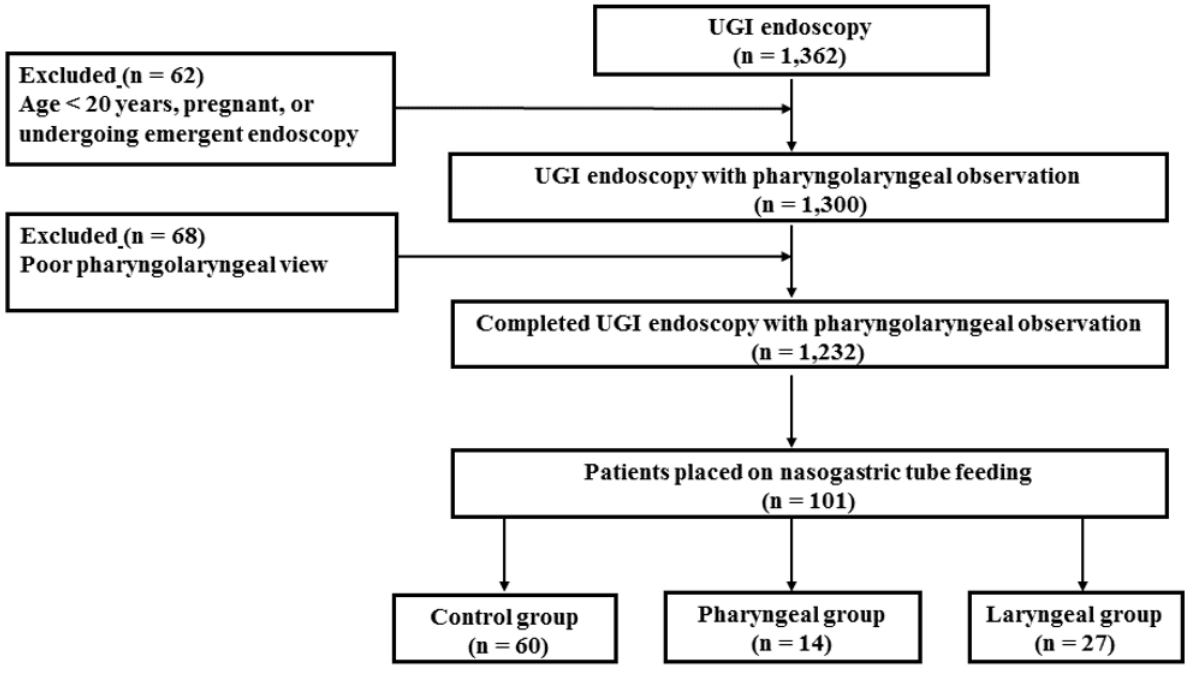

Figure 1. Flowchart of data processing. UGI: upper gastrointestinal.

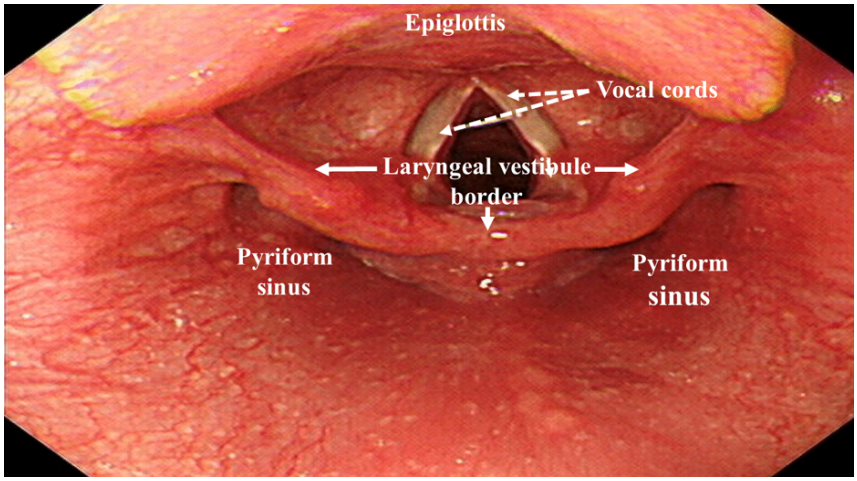

Figure 2. Endoscopic views of the pharyngolaryngeal region.

of the trachea (Figure 2). A digital video recorder (HVO-550MD; Sony, Tokyo, Japan) was connected to the monitoring system of the endoscope.

Severity of oropharyngeal dysphagia

The severity of oropharyngeal dysphagia was assessed using a modified fiberoptic endoscopic evaluation of swallowing.[16,18,23] The amount of pooled secretions in the pyriform sinus was categorized as follows: minimal, <25%; moderate, 25%–50%; and large, >50% secretions filling the pyriform sinuses. Based on the endoscopic observation of the pooled secretions in the pharyngolaryngeal region, the patients were divided into the following three categories: (A) <25% pooled secretions filling the pyriform sinus (control group); (B) 25%–100% pooled secretions filling the pyriform sinus but not entering into the laryngeal vestibule (pharyngeal group); and (C) those with pooled secretions entering into the laryngeal vestibule (laryngeal group) (Figure 3).

Protective cough reflex

Video endoscopy enabled dynamic imaging of the protective cough reflex. Suboptimal protective cough reflex was identified when the endoscopic view of pooling of secretions showed flow into the laryngeal vestibule, without attempt to or ability to perform vocal cords closure and secretions cleaning movement.[16,24]

Statistical Analysis

Statistical analyses were performed using SPSS 22.0 (IBM Inc., Armonk, NY, USA). Parametric continuous data were compared by analysis of variance (ANOVA). Categorical data were compared using the X^2 test and Yate's correction or Fisher's exact test. Regression analyses were performed to calculate the adjusted odds ratios (OR) with 95% confidence intervals (CIs) for the risk associated with pneumonia. Multivariate regression analyses were conducted to assess the risk of pneumonia with adjustment for age, sex, body mass index, and causes of dysphagia as potential confounding factors. A p value <0.05 was considered statistically significant.

RESULTS

Demographic data

Among the 101 patients enrolled, 60 patients showed absent or minimal amount of pooled secretions (control group), 14 patients showed moderate or large amounts of pooled secretions in the pyriform sinus (pharyngeal group), and 27 patients showed pooled secretions in the laryngeal vestibule (laryngeal group). There were no significant differences in age, sex, body mass index, serum hemoglobin and albumin levels, or swallowing level scale score among the three groups (Table 1).

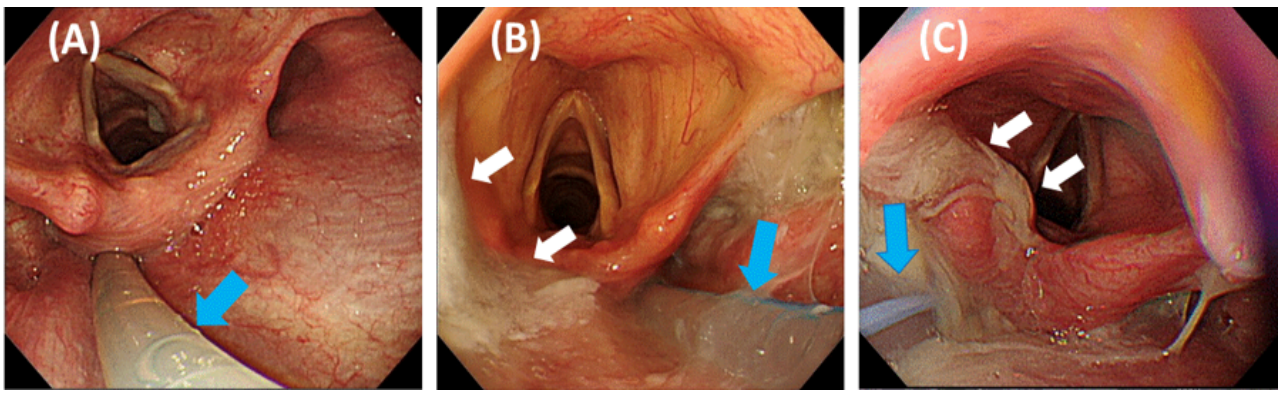

Figure 3. Endoscopic views of pooled secretions and nasogastric tube (blue arrow) in the pharyngolaryngeal region. A minimal amount of secretions in the pharyngolaryngeal region (A), large amount of pooled secretions (white arrow) in the right side of the pyriform sinus but not entering into the laryngeal vestibule (B), and pooled secretions (white arrow) leaking into the laryngeal vestibule (C).

Table 1. Demographic characteristics

Variable	Control group (n=60)	Pharyngeal group (n = 14)	Laryngeal group (n = 27)	*p* value
Age (years)	72.2±15.2	69.9±15.6	68.6±12.0	0.543
Sex, no. (%)				0.274
Female	22 (36.7%)	2 (14.3%)	9 (33.3%)	
Male	38 (63.3%)	12 (85.7%)	18 (66.7%)	
Body mass index (kg/m^2)	22.2±4.1	24.2±2.2	21.5±4.7	0.150
Hemoglobin (gm/dL)	10.7±1.8	10.7±1.7	10.1±1.5	0.265
Albumin (gm/dL)	3.2±0.5	3.2±0.5	3.0±0.5	0.353
Swallowing level scale score†	2.1±1.1	2.0±0.0	1.8±0.4	0.536
Occurrence of pneumonia, no. (%)	20 (33.3%)	11 (78.6%)	18 (66.7%)	0.001
Incidence of pneumonia (episodes/person-years)	1.7±3.8	4.2±3.6	2.6±2.2	0.042
Cost of hospitalization (USD/person-years)	8,432±6,532	26,991±23,178	15,032±23,231	0.004

†Swallowing level scale score: American Speech-Language-Hearing Association National Outcome Measurement System.

Occurrence, incidence, and hospitalization costs of pneumonia

Occurrence of pneumonia was the highest in the pharyngeal group (78.6%), followed by that in the laryngeal (66.7%) and control groups (33.3%) (p=0.001) (Table 1). The incidence of pneumonia was higher in the pharyngeal group (4.2±3.6 episodes/person-years) and laryngeal group (2.6±2.2 episodes/person-years) than in the control group (1.7±3.8 episodes/person-years) (p=0.042). The hospitalization costs pneumonia was highest in the pharyngeal group (26,991±23,178 USD/person-years) followed by the laryngeal (15,032±23,231 USD/person-years) and control groups (8,432±1,532 USD/person-years) (p=0.004).

Risk and cumulative incidence rate of pneumonia

Multivariable regression analyses demonstrated that the incidence of pneumonia was significantly higher in the pharyngeal (adjusted OR=2.7, 95% CI, 2.4-2.8, p<0.001) and laryngeal (adjusted OR=2.0, 95% CI, 1.7-2.4, p<0.001) groups (Table 2). Kaplan-Meier analysis indicated that the cumulative incidence rate of pneumonia was significantly higher in the laryngeal and pharyngeal groups than in the control group (p<0.001) (Figure 4).

Protective cough reflex

Endoscopic observation of pooled secretions flow into the laryngeal vestibule allowed for the dynamic imaging of the protective cough reflex in patients of the laryngeal group; of the 27 patients, 6 patients did not attempt or were unable to perform vocal cord closure and secretions clearing movement. Mortality rate was significantly higher in patients with suboptimal protective cough reflex (4/6, 66.7%) than in those with optimal protective cough reflex (2/21, 9.5%) (p=0.011) (Figure 5).

DISCUSSION

This study was the first to use UGI endoscopy for evaluating the severity of oropharyngeal dysphagia in patients on NGT feeding. The development of aspiration pneumonia in patients on NGT feeding depends on the presence of cough reflex, volume and pH level of aspirated material, and the integrity of the immune system.[11] NGTs that pass through the gastroesophageal sphincter may increase the gastroesophageal reflux,[25] while NGTs that pass through the upper esophageal sphincter may interfere with the protective cough reflex, thereby increasing the risk of aspiration.[3,26,27] Chronic stimulation of the pharynx by the NGT, resulting in desensitization of the protective cough reflex, may predispose patients to reflux events, thereby increasing the possibility of aspiration. Our find-

Table 2. Multivariable analysis of the risk factors associated with the occurrence pneumonia

Variable	Without pneumonia (n=52)	With pneumonia (n=49)	Crude odds ratio (95% CI)	*p* value	Adjusted odds ratio (95% CI)	*p* value
Age (years)	70.7±13.7	71.1±15.3	1.0 (0.9-1.0)	0.902	1.0 (1.0-1.1)	0.719
Sex, no. (%)						
Female	16 (48.5%)	17 (51.5%)	Reference		Reference	
Male	36 (52.9%)	32 (47.1%)	0.9 (0.4-2.0)	0.727	1.2 (0.4-3.6)	0.742
Body mass index (kg/m^2)	22.8±3.9	21.8±4.4	0.9 (0.9-1.0)	0.201	0.9 (0.8-1.1)	0.363
Hemoglobin (gm/dL)	10.9±1.8	10.1±1.6	0.8 (0.6-0.9)	0.024	0.8 (0.6-1.1)	0.230
Albumin (gm/dL)	3.2±0.8	3.0±0.4	0.4 (0.2-1.0)	0.053	0.7 (0.2-2.1)	0.521
Swallowing level scale score†	2.1±0.9	1.8±0.9	0.6 (0.3-1.2)	0.168	0.8 (0.4-1.4)	0.369
Oropharyngeal dysphagia						
Control group	40 (66.7%)	20 (33.3%)	Reference		Reference	
Pharynx group	3 (21.4%)	11 (78.6%)	7.1 (6.6-8.7)	<0.001	2.7 (2.4-2.8)	<0.001
Larynx group	9 (33.3%)	18 (66.7%)	4.0 (3.6-4.9)	<0.001	2.0 (1.7-2.4)	<0.001

CI: confidence interval.
†Swallowing level scale score, American Speech-Language-Hearing Association National Outcome Measurement System.

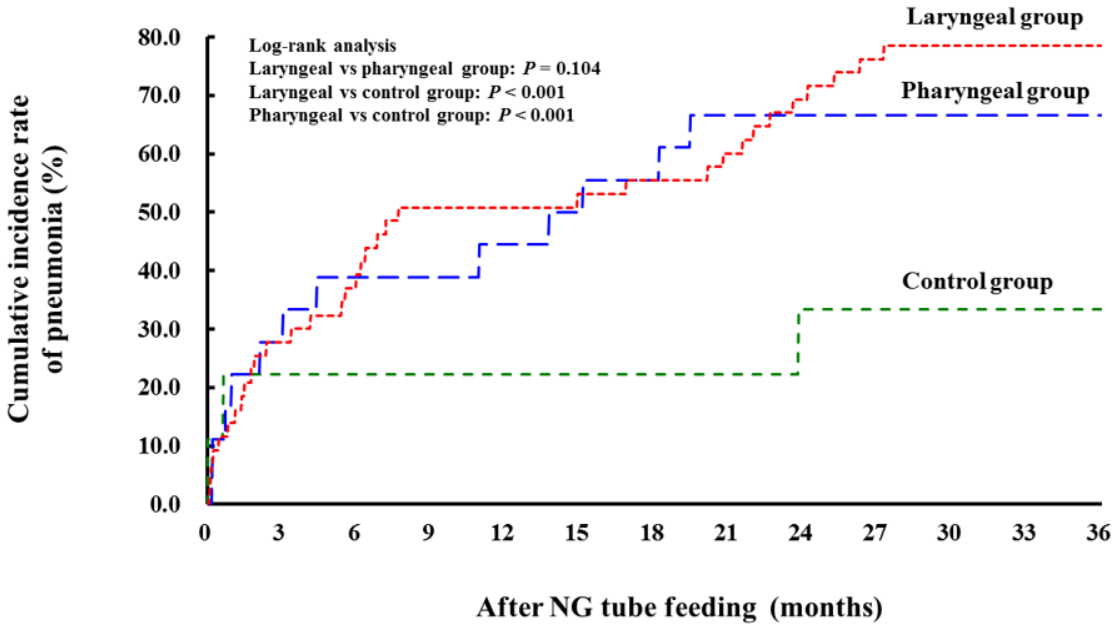

Figure 4. Kaplan-Meier analysis showing that the cumulative incidence rate of pneumonia was significantly higher in the laryngeal and pharyngeal groups than in the control group (laryngeal vs control group, $p<0.001$; pharyngeal vs control group, $p<0.001$).

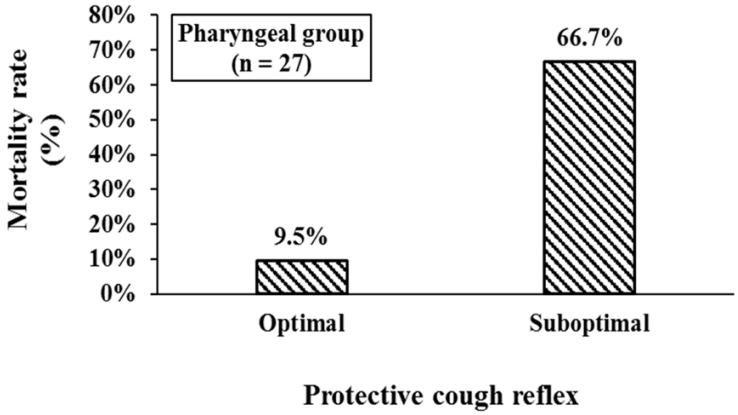

Figure 5. Mortality rate was significantly higher in patients with suboptimal protective cough.

ing that mortality rate is higher in patients with suboptimal protective cough reflex is consistent with these studies.

Previously published studies have largely focused on the risk of gastric contents aspiration.[28,29] Prevention and management of pneumonia in patients with gastric contents aspiration has been clearly recommended in previous practice guidelines.[29,30] Measured gastric residual volume is most commonly used to guide enteral feeding and prevention of aspiration pneumonia in NGT fed patients.[31,32] Nevertheless, aspiration pneumonia still occurs in those patients with lower gastric residual volume levels or with small bowel feeding.[33,34] Aspiration of oropharyngeal contents is a possible cause of pneumonia in these patients.

Patients on NGT feeding are usually diagnosed with neurological disorders accompanied by oropharyngeal dysphagia and present with secretion stasis in the pharyngolaryngeal region ; However, they may or may not experience symptoms such as choking, coughing, and have a wet sounding voice during or after eating.[11] Silent aspiration may be unconsciously, or even consciously, underreported in a real-world situation.

UGI endoscopy with simultaneous pharyngolaryngeal observation is easy to perform and well tolerated by patients. The methodology of this study provides clinical application closer to real-world situations, especially for the patients lying in bed, who are critically ill or have neurological conditions. UGI endoscopy allows direct visualization of the abnormal pooling of secretions in the pharyngolaryngeal region and assessment of the protective cough reflex, thereby identifying specific patients who may be at risk for oropharyngeal aspiration.[16] Patients with symptoms of oropharyngeal dysphagia are often referred for diagnostic evaluation and therapeutic interventions. Therefore, there is a need to propose a clinical protocol to reduce risk of pneumonia in NGT feeding by performing endoscopic pharyngolaryngeal observation (Figure 6).

For patients with absent or minimal amount of secretions in the pyriform sinus (control group), NGT feeding is preferred for short-term (<4 weeks) enteral nutrition.

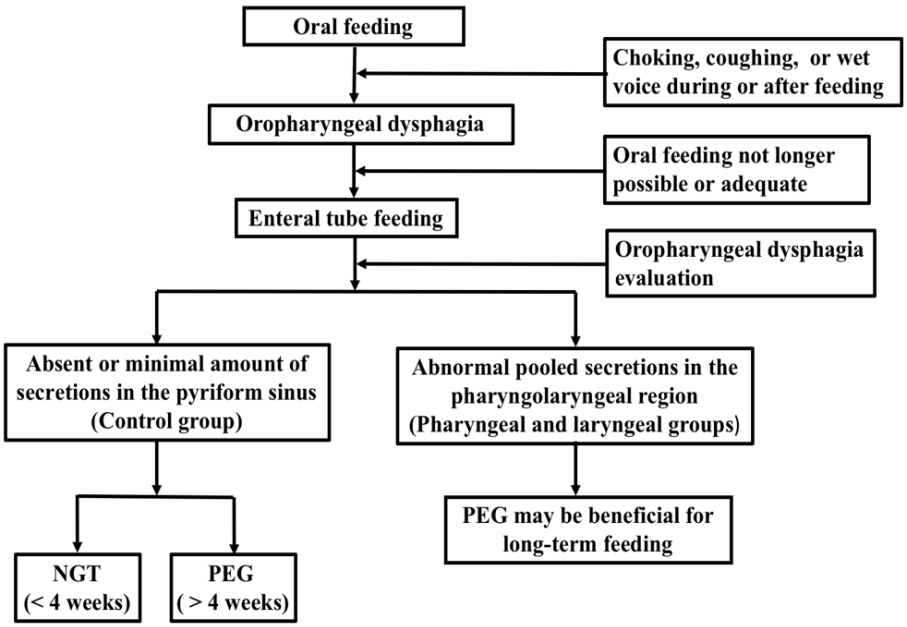

Figure 6. Clinical protocol to reduce risk of aspiration pneumonia in tube feeding by performing of endoscopic pharyngolaryngeal observation.

Percutaneous endoscopic gastrostomy (PEG) feeding is preferred if a period exceeding 4 weeks.[30] PEG may be beneficial for long-term enteral feeding in patients with abnormal amounts of secretions accumulation in the pyriform sinus (pharyngeal group) or leak into the laryngeal vestibule (laryngeal group) because of decreased risk of pneumonia requiring hospital admission.[35]

What can we do to reduce pneumonia in patients on NGT feeding? Strategies for preventing oropharyngeal secretions from entering into the pulmonary system should be adopted (Table 3). Bacteria, secretions, liquids, food, and gastric contents accumulate in the oral cavity, then leak into the airways, and may cause infection or pneumonia in patients on NGT feeding. Establishing regular oral cleaning and disinfection may reduce the risk of aspiration pneumonia. Maintaining oral health and preventing secretions or fluids leaking into the airway are considered essential for these patients.[34] The results of this study allow primary caregivers and multidisciplinary teams a way to develop a logical plan to monitor, assess, and prevent the occurrence of aspiration pneumonia in patients at risk for oropharyngeal aspiration (Table 3).

Management and prevention recommendations for reducing aspiration pneumonia in patients with oropharyngeal dysphagia associated with suboptimal protective cough reflex include: (1) keeping patients in a semi-recumbent position during or after NGT feeding,[34] (2) when maintaining patients in a semi-recumbent position at all times is unrealistic during clinical practice, keeping the patient's head turned to one side when not in the supine position,[34] (3) regular oral cleaning and tooth brushing,[34] (4) administering oral chlorhexidine in patients at risk for aspiration,[36] (5) following an oral health plan to remove debris, plaque, and poorly maintained teeth,[34,37] (6)

Table 3. Strategies for reducing pneumonia in patients with oropharyngeal dysphagia

Monitoring and assessment
Symptoms: coughing, choking, or wet voice during or after feeding
Assessment of swallowing function
Assessment of protective cough reflex
Oral cavity examination for residual food or liquid
Review of cough suppressants
Monitor endotracheal tube cuff pressure
Confirm NGT position: dislodge or coil in the oral cavity
Oral health assessment
Management and prevention
NGT feeding in a semi-recumbent position
Keep head turned to one side; not on supine position
Regular oral cleaning and tooth brushing
Oral chlorhexidine in patients at risk for aspiration
Remove debris, plaque, and poorly maintained teeth
Suctioning of oropharyngeal secretions
Endotracheal tube with subglotic suctioning
Avoid over sedation or suppressive cough medications
Swallow rehabilitation in patients with oropharyngeal dysphagia

NGT: nasogastric tube; PEG: percutaneous endoscopic gastrostomy.

suctioning of oropharyngeal secretions and using subglotic suction in patients with an endotracheal tube,[38] and (7) avoiding over sedation or suppressive cough medications for patients,[34] (8) swallow rehabilitation in patients with oropharyngeal dysphagia.[39]

Limitations

First, although UGI endoscopy allows for the direct visualization of pooling secretions in the pyriform sinuses and any that are entering into the laryngeal vestibule, it does not allow for the observation of pooled secretions entering below the vocal cords. It is uncertain to what degree the aspiration of colonized oropharyngeal contents contributes to pneumonia.[40,41] Moreover, in some patients, aspiration pneumonia does not necessarily develop even when oropharyngeal aspiration occurs.[11] Second, we did not measure the gastric residual volume and clinical data on feeding intolerance; hence, we were unable to describe the risk factors of aspiration, such as reflux of gastric contents or pooled oropharyngeal secretions.[28]

Conclusions

UGI endoscopy can be used to evaluate the severity of oropharyngeal dysphagia in patients on NGT feeding. Endoscopic witness of abnormal amount of pooling secretions filling the pyriform sinus or entering into the laryngeal vestibule increase the risk of pneumonia. Mortality rate was higher in patients with suboptimal protective cough reflex. Primary caregivers and multidisciplinary team members should develop a logical plan to monitor, assess, and prevent the occurrence of aspiration pneumonia in patients at risk for oropharyngeal aspiration.

AUTHOR DISCLOSURES

The authors declare no conflict of interest.

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