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Swallowing disorders post orotracheal intubation in the elderly

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Abstract *Objectives:* The purpose of this study was to assess the prevalence and recovery time of swallowing dysfunction after prolonged endotracheal intubation in critically ill elderly patients compared to a younger cohort. *Design:* This was a prospective, interventional, clinical study set in a medical intensive care unit in a university-affiliated hospital. *Subjects:* The study involved 42 consecutive elderly patients (≥65 years old) and 42 controls (<65 years) matched for severity of illness requiring endotracheal intubation for more than 48 h. *Interventions:* A fiberoptic endoscopic evaluation of swallowing (FEES) was performed within 48 h post-extubation and on days 5, 9, and 14 for those with evidence of aspiration. *Results:* Swallowing dysfunction was assessed by the detection of test material below the true vocal cords. Aspiration was documented in 52% of the elderly and 36% of the control group (P=0.2). No significant difference in the co-morbidity index and the length of mechanical ventilation was found between aspirators and non-aspirators. None of the control group had swallowing deficits after 2 weeks, while 13% of the elderly participants showed persistent impairment in the swallowing reflex. By multivariate analysis, the preadmission functional status was the only determinant of a slowly resolving swallowing deficit (hazard ratio 1.68; 95% confidence interval 1.26–3.97). No post-extubation aspiration pneumonia was identified in either group. *Conclusions:* Critically ill elderly patients exhibit delayed resolution of swallowing impairment post extubation. FEES should be considered for those with impaired preadmission functional status.

Keywords Elderly · Swallowing · Endotracheal intubation · Aspiration · Pneumonia

Introduction

There is a growing body of evidence suggesting that intubation for longer than 48 h may cause at least transient injury to the larynx with a subsequent reduction in the protective mechanism and increased incidence of oropharyngeal secretions once the patient is extubated. The presence of an orotracheal tube has been shown to alter the mechanoreceptors and chemoreceptors of the pharyngeal and laryngeal mucosa, causing dysfunction of the swallowing reflex [1]. The mechanism of swallowing dysfunction is thought to be a combination of muscle "freezing" attributable to non-use while intubated and loss of proprioception attributable to mucosal lesions.

The prevalence of swallowing dysfunction post-extubation has been reported to occur in between 20% to 83% of those patients intubated longer than 48 h [2, 3]. This wide range of estimate has been attributed to the variation in the diagnostic tools and the characteristics of the population under study. The few studies that have ex-

amined the impact of age on swallowing dysfunction post orotracheal intubation have indicated that patients aged 55 years and older were at significant risk of post-extubation aspiration [4, 5]. However, these studies have included cases with predetermined conditions (stroke, neuromuscular disease or tracheotomies) that predispose to swallowing abnormalities and have assessed swallowing function for short periods only.

We have undertaken a prospective study to assess the prevalence and the time to resolution of swallowing dysfunction using fiberoptic endoscopic evaluation of swallowing (FEES) in critically ill elderly patients after prolonged mechanical ventilation compared to a younger age group. We have attempted also to identify important independent clinical factors at baseline that are associated with an increased risk of swallowing abnormalities. The results may serve to simplify the diagnostic assessment and thereby enable patients at risk to be accurately identified at presentation.

Materials and methods

Study design

This study was performed in a medical intensive care unit within a 500-bed tertiary referral center after approval of the Institutional Review Board. An informed consent was obtained from all participants or their health care proxy. Forty-two consecutive patients, 65 years of age and older, and 42 consecutive younger adults aged <65 years of age who were orotracheally intubated for 2 or more days were evaluated for swallowing disorders. Patients with vocal cord dysfunction, prior tracheostomy, oropharyngeal malignancy, cerebrovascular accident, Parkinson's or neuromuscular disease were excluded. A bedside fiberoptic endoscopic evaluation of swallowing (FEES) (model 7195; Kay Elemetrics, Lincoln Park, N.J.) was performed within 48 h post extubation using the technique described by Langmore and colleagues [6]. The procedure was videotaped to allow review at a later time. In brief, the endoscope was passed through the most patent nostril to view the epiglottis, pharynx and true vocal cords. No topical anesthetic or other preparation was used before placing the scope in the nose. An oxygen nasal cannula inserted into the adjacent nostril was applied during the procedure to maintain oxygen saturation >90%. 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. In each case, the nasogastric tube was removed prior to the procedure. Aspiration was defined as the entry of material into the airway below the levels of the true vocal cords. Silent aspiration was defined as lack of cough or gag reflex as the food or liquid bolus passed into the trachea.

Based on the results of FEES, nothing by mouth was ordered if puree was aspirated. If thin liquids were aspirated, a diet of liquids thickened to a honey consistency was requested, otherwise a regular diet was ordered for those with normal swallowing evaluation. For those at risk for aspiration, a repeat FEES was conducted on days 5, 9 and 14 from the date of extubation.

Data collection

For all patients, clinical and laboratory data were collected at the time of the swallowing evaluation. The data collected were of two categories: demographic and ICU related. Demographic data included age, gender, ICU admitting diagnosis, preadmission Activity of Daily Living [7] and Charlson index [8]. The ADL score was abstracted from a standardized patient-review instrument included in all patients' charts. Patients were assigned an ADL score in each of the six major areas of activity: eating, toileting, feeding, bathing, mobility and continence, ranging from 1 if they were fully independent, 2 if they were partially independent and 3 if they were completely dependent. The ADL score was calculated by adding the points assigned for each activity, and it ranged from 6 to18. The Charlson Index provides a prognostic taxonomy for comorbid conditions that singly or in combination assesses the risk of 1-year mortality. Each comorbid condition is assigned a weight ranging from 1 to 6 based on the number and seriousness of comorbid diseases. The index severity score is calculated by totaling the assigned weight for each of the patient's comorbidities.

ICU-related data included date of admission to the ICU, vital signs (temperature, heart rate, respiratory rate and BP), laboratory data, the Glasgow coma scale at the time of swallowing evaluation, complications post reintubation, length of mechanical ventilation, duration of sedation and weaning, and ICU stay. The generalized severity of illness was determined using the Acute Physiology and Chronic Health Evaluation (APACHE) II score [9] adjusted for age. Aspiration pneumonia post-extubation was considered present if the following criteria were met: clinical suspicion of pneumonia, temperature >38°C or <36°C, white blood cell count >12,000 cells/mm^3 and a new infiltrate on chest radiograph.

Statistical analysis

Normal distribution of data was checked for each variable. Results are expressed as mean±SD for parametric variables and as medians with range for nonparametric variables. Significance testing between group differences was performed by using, when appropriate, the chi-square test, Student's *t* test and Mann-Whitney U test. A forward stepwise logistic regression was performed to ascertain whether age was an independent predictor of swallowing disorder after correction for APACHE II score, comorbidity index and ADL score. Pairwise correlations between predictor variables were computed to assess for multicolinearities. A Cox proportional hazards model was used to quantify the relationship between the baseline variables (APACHE II, comorbidity index, the ADL score) and subsequent resolution of swallowing dysfunction. Time to resolution of swallowing deficit was analyzed using the Kaplan-Meier statistics. A $P<0.05$ was regarded as significant. A statistical software package (NCSS 2000; Kaysville, Utah) was used for data analysis.

Results

During the 4-month study period, 121 consecutive patients who required ventilation for more than 48 h were screened for enrollment. Thirteen refused participation, and 24 did not meet the inclusion criteria. The demographic characteristics of the study population are shown in Table 1. Pneumonia and sepsis accounted for the majority of admissions to the ICU in both cohorts. The two groups were comparable in term of APACHE II scores, days of mechanical ventilation, weaning time, duration of nasogastric tube placement and GCS (Table 2). All

patients had an oxygen saturation >90% following extubation and thereafter. There were no adverse events noted during the study from FEES. The prevalence of aspiration determined by FEES was 52% for the elderly and 36% for the control group (P=0.2). Eight (36%) out of the 22 elderly with documented aspiration on FEES were characterized as silent aspirators compared to 3 (20%) of the 15 in the control group (P=0.47). Of those elderly who were at risk for aspiration, the functional status was significantly impaired compared to those who did not (Table 2). However, there was no difference in the comorbidity index or the length of intubation between those patients.

Thirty-seven patients (22 elderly and 15 controls) with documented aspiration on the initial FEES (Table 3) were followed up with repeated examinations. Seventeen (40%) of the elderly had evidence of swallowing disorder after 5 days compared to 8 (19%) in the control group. After 2 weeks, the frequency of swallowing dysfunction dropped to 14% in those ≥65 years of age, while no swallowing deficit was documented in the control group (log rank test; P=0.005) (Fig. 1). At the end of the study period, all six elderly patients with persistent swallowing dysfunction required an alternative mode of long-term feeding access. Three out of six had severe chronic obstructive pulmonary disease, two had cognitive dysfunction and one had end stage cardiomyopathy. However, none of the patients in either group developed subsequent aspiration pneumonia while in the hospital.

Table 1 Demographic characteristics of the study population

	Elderly (n=42)	Control (n=42)	P value
Demographics			
Age, y	75.3±6.2	49.7±7.8	<0.001
Gender (M/F)	26/16	18/24	0.1
Charlson Index,n			0.01
0	4	12	
1–2	18	23	
3–4	12	5	
≥5	8	2	
Admission diagnosis, n (%)			
Pneumonia	19 (45)	15 (36)	0.5
Sepsis	11 (26)	8 (19)	0.6
COPD exacerbation	9 (22)	3 (7)	0.1
Liver failure	0	5 (12)	0.06
ARDS	1 (2)	5 (12)	0.2
Other	2 (5)	6 (14)	0.3

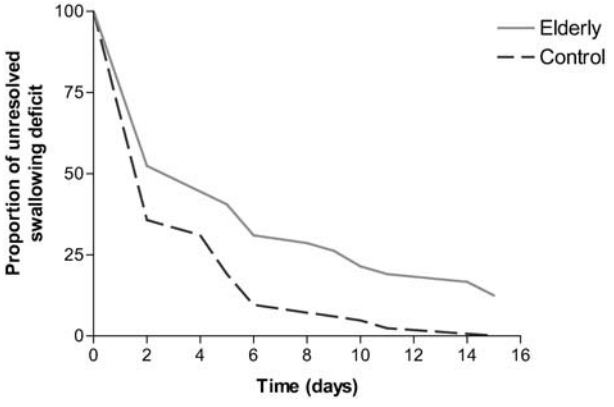

Fig. 1 Kaplan-Meier curve analysis of the resolution of the swallowing dysfunction in critically ill elderly subjects compared to a younger age group (P=0.005; log rank test)

Table 3 Swallowing deficit in patients at risk for aspiration according to food consistency

Food consistency	Elderly (n=22)	Control (n=15)	P value
Puree, n (%)	11 (50)	6 (40)	0.8
Milk, n (%)	19 (86)	8 (53)	0.06
Crackers, n (%)	7 (32)	3 (20)	0.5

Table 2 Comparison of the clinical characteristics of the elderly and the control group post FEES

	Elderly		Control	
	Swallowing dysfunction (n=22)	No swallowing dysfunction (n=20)	Swallowing dysfunction (n=15)	No swallowing dysfunction (n=27)
Activity of Daily Living	11.1±1.9	8.6±1.3*	6.6±1.1†	6.2±0.5
APACHE II on admission	22.4±4.9	19.1±4.9	22.7±3.5	21.2±4.2
Ventilator days, days	7.8±6.9	6.2±5.3	9.3±6.5	7.7±4.7
Duration of sedation, days	6.8±5.7	5.1±4.6	7.6±5.4	6.1±4.2
Weaning time, days	1.7±1.9	1.5±2.1	1.4±2.6	1.3±1.1
Duration of nasogastric tube, days	7.4±6.1	6.2±5.1	8.9±6.3	7.2±4.3
ICU days, days	14.4±3.3	9.4±3.3*	13.4±7.3	10.9±5.3
GCS	14.2±0.6	14.3±0.4	14.6±0.7	14.7±0.2

*P<0.01, when comparing the difference between those with and those without swallowing dysfunction in the elderly group. †P<0.01, when comparing the difference between the elderly and the control with swallowing dysfunction

Table 4 Summary of Cox regression hazard model

Variable	Coefficient	Standard error	Hazard ratio (95% CI)	*P* value
Comorbidity index	0.069	0.066	1.07 (0.87–2.64)	0.297
ADL score	0.524	0.111	1.69 (1.09–4.39)	0.014
APACHE II	0.01	0.087	1.010 (0.47–1.98)	0.906

In multivariate analysis, age [odds ratio 1.2; 95% confidence interval (CI) 0.48–2.9; *P*=0.7] was not found to be a predictor of swallowing dysfunction post extubation after correction for comorbidity index and ADL score. Cox regression analysis identified only the functional status to be associated significantly with delayed resolution of the swallowing dysfunction in those aged 65 years and older (Table 4).

Discussion

The process of deglutition requires the coordination of several physiologic systems to achieve a proper protection of the lower airways. Any malfunction pertaining to the swallowing reflex, the pharyngeal transition or the esophageal peristaltic activity is destined to predispose to tracheobronchial aspiration. Laryngotracheal injury and mucosal ulcerations have been reported to occur frequently in the presence of an endotracheal tube and require weeks to resolve [10, 11]. These pathologic changes may be more severe in the old so that they compromise the ability of the upper airway to protect itself against aspiration. Stroke, Parkinson's disease, prior tracheotomies and neuromuscular illnesses have all been associated with an increased incidence of swallowing dysfunction [2, 12, 13], and thus, routine evaluation for swallowing disorders in these conditions is considered routine. For these reasons, such patients were excluded from the present study.

Our findings showed that the overall rate of swallowing deficit post extubation in the elderly was comparable to what has been published previously in the literature. In a recent study by Leder and colleagues [2], FEES demonstrated swallowing dysfunction in 45% of critically ill trauma patients after prolonged intubation, with 20% having silent aspiration. Similarly, Ajemian and coworkers [14] reported that 56% of patients who underwent direct laryngoscope had evidence of swallowing dysfunction. Similarly, Tolep and coworkers [3] reported that 50% of patients who underwent direct laryngoscopy had evidence of swallowing dysfunction. The clinically significant incidence of silent aspiration in these investigations underlines the unreliability of subjective bedside evaluations in assessing swallowing deficit. In contrast to the study of Barquist and colleagues [4], we found that elderly patients are no more at risk for swallowing dysfunction post extubation than the younger age group. While it is true that the exclusion of elderly patients with prior risk factors for swallowing disorder would explain the lack of difference in the incidence of aspiration, a type II error can not be ruled out.

In corroboration with previous reports [1, 4, 15], neither age nor the duration of intubation correlated with an increase in swallowing dysfunction. Stauffer and colleagues [15] showed that there was no correlation between the duration of endotracheal intubation in intubated patients and the severity of laryngeal lesions. Furthermore, the lack of relationship between duration of mechanical ventilation and swallowing impairment was not surprising since extensive mucosal inflammation may be observed after as little as 24 h of endotracheal intubation [16]. Age was implicated, however, in significant delay in the resolution of the swallowing impairment. While none of the control group had residual deficit, 14% of the elderly showed evidence of aspiration. Different factors may be involved in the delayed swallowing recovery in the old post extubation. Although we discontinued sedation at least 24 h prior to extubation, residual effects of sedative drugs cannot be dismissed despite the fact that the Glasgow Coma Scale scores and the clinical neurologic status were normal at the time of the swallowing evaluation. Hypoxemia is another factor that has been shown to impair the swallowing process. A decrease in arterial pressure of oxygen has been shown to induce swallowing dysfunction [17]. Yet, in our study we can eliminate this factor since all our participants had oxygen saturation >90% during their ICU stay. The preadmission ADL was the only determinant of slow recovery in those 65 years and older. The impaired functional status is likely to reflect the overall discoordination and diminished proprioception that could manifest as impaired oral strength and inconsistent triggering of the swallow response.

Our experience suggests that FEES can be performed easily at the bedside with minimal complications for those elderly recently liberated from mechanical ventilation. Since the ADL score was highly correlated with increased risk of swallowing dysfunction post extubation, we have adopted the use of bedside FEES in guiding dietary recommendations for those with documented impaired functional status prior to intubation. However, we cannot determine with certainty whether aspiration pneumonia was prevented by adopting FEES. A prospective randomized trial of FEES versus conventional technique will be required to determine whether a difference in the rate of post-extubation pneumonia can be demonstrated.

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