ORIGINAL ARTICLE

Prevalence of Post-extubation Airway Penetration and Aspiration Among Critically Ill Patients Assessed by An Eight-point Penetration Aspiration Scale Using Flexible Endoscopy – A Cross-sectional Study

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Received on: 16 April 2019; *Accepted on:* 26 June 2023; *Published on:* 31 August 2023

Abstract

Introduction: Prolonged endotracheal intubation was found to be a risk factor for pulmonary aspiration following the extubation. In this study, we have tried to analyze the prevalence of airway penetration and aspiration among mechanically ventilated patient who received mechanical ventilation for a period of 48 hours or more.

Materials and methods: This cross-sectional study was done among non-neurologic critically ill patients who had an endotracheal tube for more than 48 hours and who got extubated subsequently. Such patients were taken for a fiber optic endoscopic swallow study after the initial assessment by a speech pathologist. Airway penetration and aspiration was assessed by an eight-point penetration aspiration scale after giving a test feed.

Results: Data of 99 patients were analyzed. Mean duration of intubation was 5.9 days. 1% of the patients had aspiration and 20% of the patients had varying degrees of penetration. Duration of endotracheal intubation, age, sex, co-morbidities, admission diagnosis, and size of the endotracheal tube were found to have no association with penetration and aspiration.

Conclusions: Prevalence of post-extubation aspiration was low among non-neurologic critically ill patients on short-term ventilation. Duration of endotracheal intubation, age, sex, co-morbidities, and endotracheal tube size were not found to be significantly associated with the development of airway penetration.

Key message: Contrary to previous studies, this study has shown that among non-neurologic critically ill patients who had an endotracheal tube for a shorter period before extubation, the prevalence of airway penetration and aspiration was low when assessed by an eight-point penetration aspiration scale using flexible fiber optic endoscopy. Hence, in such a cohort of patients, a routine swallowing evaluation by flexible endoscopy is not recommended.

Keywords: Airway penetration, Aspiration, Critically ill, Fiber optic endoscopic swallow study.

Indian Journal of Critical Care Medicine (2023): 10.5005/jp-journals-10071-24518

Background

Prolonged endotracheal intubation can lead to direct trauma to laryngeal structures as well as impairment in laryngeal anatomy. It has also been shown that this may lead to impairment in swallowing and subsequent aspiration. In a cohort study done among patients who received mechanical ventilation for more than 48 hours on the prevalence of penetration using fiber optic endoscopic swallow study (FEES), the prevalence was found to be 58% (with 95% confidence interval of 0.40–0.73).[1] In another cross-sectional study using FEES as the diagnostic tool, the prevalence of penetration was 35.6% and aspiration was 22% among patients who got extubated following mechanical ventilation.[2] In this study, we have tried to estimate the prevalence of aspiration and penetration graded by a penetration aspiration scale using flexible endoscopy among patients who received mechanical ventilation for a minimum period of 48 hours and got extubated subsequently.

Materials and Methods

This was a cross-sectional study with a record-based data collection done among patients who had an endotracheal tubes for more than 48 hours and who got subsequently extubated. Ethics committee clearance was obtained prior to initiating this study. Considering the 50% prevalence of post-extubation penetration and aspiration and 20% relative precision, the sample size was calculated to be 100 patients. Patients were initially evaluated for swallowing by a speech pathologist by using a screening test. Those patients

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How to cite this article: Vijayan D, Suresh Kumar VK, Harikrishnanan, Menon J, Ragitha, Jacob M, *et al*. Prevalence of Post-extubation Airway Penetration and Aspiration Among Critically Ill Patients Assessed by An Eight-point Penetration Aspiration Scale Using Flexible Endoscopy – A Cross-sectional Study. Indian J Crit Care Med 2023;27(9):651–654.

Source of support: Nil

Conflict of interest: None

Table 1: Eight-point penetration aspiration scale

Point	*Description*
1	Material does not enter the airway
2	Material enters the airway, remain above the vocal folds, and is ejected from the airway
3	Material enters the airway, remain above the vocal folds, and is not ejected from the airway
4	Material enters the airway, contacts the vocal folds, and is ejected from the airway
5	Material enters the airway, contacts the vocal folds, and is not ejected from the airway
6	Material enters the airway, passes below the vocal folds, and is ejected in to larynx or out of the airway
7	Material enters the airway, passes below the vocal folds, and is not ejected from the trachea despite effort
8	Material enters the airway, passes below the vocal folds, and no effort is made to eject

who did not clear the screening test were taken up for flexible endoscopy by a laryngologist as per the hospital policy. This was done between 24 and 48 hours of extubation. Such patients were positioned in semi-recumbent position. Nostrils were anesthetized by a topical anesthetic agent. Then after explaining the procedure to the patient and after obtaining informed consent, a flexible video laryngoscope was inserted through the anesthetized nostril, and the endoscope was kept above the larynx. Following this, 15 mL of white color ice cream was given as the test feed and the patient was asked to swallow it. The degree of penetration and aspiration was assessed using an eight-point penetration-aspiration scale (Table 1). Patients having any neurological diagnosis at admission, pre-existing neurological diseases or having laryngeal pathology were excluded from the study. Data entry was done in MS Excel and data analysis was done using Epi-Info version 3.5.3. Proportions were expressed as percentages and 95% confidence intervals. For risk factors, quantitative variables were analyzed by comparing means using the student's *t*-test, or Kruswal Wallis/Mann–Whitney test for non-normally distributed variables. Categorical variables were analyzed using the Chi-square test.

Results

About 100 patients were included in this cross-sectional study, which included 62 males and 38 females. The mean age of the patient was 55 with a standard deviation (SD) of 18.4. Diabetes mellitus (63%) and hypertension (61%) were the major co-morbidities. Thirty-seven patients (36.6–95% confidence limits 27.27–46.8%) had sepsis which was the most common diagnosis. The mean duration of mechanical ventilation was 5.9 days with a SD of 3.1. About 90% of the patients had single intubation attempts and 10% had multiple intubation attempts. About 98% of the patients had elective intubation and 2% of patients had emergency intubation. The endotracheal tube with an internal dimension of 8 mm was present in 50% of the patients. About 79% of patients (95% confidence interval (CI) 70.5–87.2%) had no penetration or aspiration assessed by using the eight-point PAS and 21% had some degree of penetration or aspiration. Among these 20% of patients (95% CI 12.8–29.5%) had varying degrees of penetration of the test feed used as indicated by points 2–5 in the eight-point PAS and 1% of patients had aspiration of the test feed as indicated by the points scale 6–8. Age, sex, co-morbidities, and admission diagnosis were found to have no significant association with penetration assessed by the eight-point penetration-aspiration scale. Similarly, the duration of mechanical ventilation and size of the endotracheal used had no association with penetration and aspiration.

Table 2: Distribution of various grades of penetration and aspiration

Grade of penetration and aspiration	*Frequency*	*95% Confidence interval*
1	79 (79%)	69.7–86.5%
2	10 (10%)	4.9–17.6%
3	1 (%)	0.03–5.5%
4	7 (7%)	2.9–13.9%
5	2 (2%)	0.24–7%
6	1 (1%)	0.03–5.5%

Discussion

Post-extubation supra glottic and infraglottic aspiration of varying degrees was found to be high among critically ill patients.[1,2] Most commonly used bedside technique to assess post-extubation swallowing function is the multifaceted swallowing evaluation done by a speech pathologist. But this test was found to have low reproducibility and varying sensitivity when tested in clinical studies.[3] Hence, more advanced tests have been proposed regularly by speech pathologists whenever the situation demands. The most common tests are the video fluoroscopic swallow study (VFSS) and the fiber optic endoscopic evaluation of swallowing (FEES).

Penetration-aspiration scale is an eight-point scale developed and validated for the VFSS evaluation. Scale 1 indicates the normal state and Scales 2–5 indicate varying degrees of penetration and Scale 6–8 indicate varying degrees of aspiration.[4] A study done by Colodny N has shown FEES was just reliable as VFSS when PAS was used.[5] A similar study by Butler SG has shown excellent inter-rater and intra-rater reliability when PAS was used for FEES.[6]

Duration of mechanical ventilation was found to be a risk factor for post-extubation aspiration. A retrospective observational study evaluated by video fluoroscopy done in non-neurologic critically ill patients had shown that post-extubation supraglottic and infra glottic aspiration was higher with a longer duration of mechanical ventilation. Multivariate regression analysis had shown the duration of endotracheal intubation was significantly associated with aspiration (OR 1.09, 95% confidence intervals 1.01–1.18). Spearman correlation analysis had shown a positive linear correlation between the duration of intubation and aspiration. However, the median duration of mechanical ventilation was 15 days vs 10 days.[7] A similar retrospective cohort study done in trauma patients has shown that the age of the patient and duration of mechanical ventilation were the risk factors for the post-extubation swallowing dysfunction.[8] A randomized prospective trial done in critically ill trauma patients using FEES had shown the age of more than 55 years was the risk factor for post-extubation aspiration.[9] Another retrospective review done in cardiac surgery patients who received prolonged mechanical ventilation, perioperative sepsis, and duration of mechanical ventilation were found to be the risk factors for post-extubation dysphagia.[10] Contrary to the above studies, in this study, the overall prevalence of aspiration was found to be low (1%) though it showed varying degrees of penetration(19%) (Table 2). This trial has excluded patients having various neurological disorders which is a strong risk factor for airway penetration and aspiration. Unlike other studies age, sex,

Table 3: Association of various risk factors and airway penetration

					95% CI*		
	PAS 2–5*	*PAS1*		*OR**	*Lower*	*Higher*	*p-value*
Age							
Age >55	9	47	56	0.5571	0.2072	1.4975	0.24
	16.07%	83.93%					
Age <55	11	32	43				
	25.58%	74.42%					
Sex							
Female	7	31	38	0.8337	0.2995	2.3211	0.73
	18.42%	81.58%					
Male	13	48	61				
	21.31%	78.69%					
Diagnosis							
Sepsis	6	30	36	0.7	0.2428	2.0181	0.51
	16.67%	83.33%					
Other diagnosis	14	49	63				
	22.22%	77.78%					
Comorbidities							
Present	15	60	75	0.95	0.305	2.9588	0.93
	20.00%	80.00%					
Absent	5	19	24				
	20.83%	79.17%					
Tube size							
7 or less	14	56	70	0.9583	0.3279	2.8009	0.94
	20.00%	80.00%					
7.5 or more	6	23	29				
	20.69%	79.31%					
Number of intubation efforts							
One	16	74	90	0.2703	0.0652	1.1198	0.057
	17.78%	82.22%	100.00%				
Two	4	5	9				

co-morbidities, and duration of endotracheal intubation were not found to be risk factors for post-extubation penetration (Table 3). The mean duration of intubation was 5.9 days in this study. In most of the previously quoted studies, the mean duration of endotracheal intubation was high.[7] This may be the reason why this study did not show the duration of endotracheal intubation as a significant risk factor for the development of post-extubation penetration. The size of the endotracheal tube was also found to be not a risk factor for the development of post-extubation penetration. Linear regression was done and the correlation coefficient (R^2) was 0.001. Current sedation practices and maintaining cuff pressure in the desired safe range might have nullified the impact of tube size on penetration and aspiration. However, this warrants further evidence from controlled trials.

The major strength of this study is that the study analyzed a larger sample of critically ill patients than previously quoted studies and the mean duration of endotracheal intubation was less than the previous studies which is more closer to the reality of the current practice of early conversion to tracheostomy as practiced in many centers.

The major drawback of the study is that this study tested feed having pureed consistency and those with thin liquid consistency were not tested. This is important because it is known that as the consistency of the feed moves from the thin to the thick end of the viscosity continuum, the risk of aspiration penetration decreases but at the cost of post-swallow residue in the pharynx. A study done on 190 dysphagic patients showed that consistency of the test feed and method of delivery were found to be the determinants of penetration and aspiration.[11] At the same time, there is insufficient evidence to suggest a particular viscosity value will be safe in terms of penetration aspiration and post-swallow residue. There is also a possibility that other characteristics of the feed like hardness, cohesiveness, and slipperiness may have an influence on penetration aspiration.[12] It is further complicated by the fact that the characteristics of the feed vary across the world. All these facts warrant further evaluation to test penetration aspiration and post-swallow residue utilizing locally available feed materials having varying properties.

The incidence of post-extubation aspiration among patients receiving prolonged endotracheal intubation needs further

evaluation. This becomes valid for those units practicing delayed conversion to tracheostomy. However, for units practicing early conversion to tracheostomy, this may not be relevant as per the evidence from this study, and a routine FEES may not be cost-effective for such a cohort of patients.

Conclusion

Over all, the prevalence of post-extubation aspiration was low among non-neurologic critically ill patients on short-term ventilation though they showed varying degrees of penetration. For those patients receiving short-term ventilation duration of endotracheal intubation, age, sex, co-morbidities and endotracheal tube size were not found to be significantly associated with the development of airway penetration. The prevalence of airway penetration and aspiration among patients on prolonged endotracheal intubation among critically ill patients with neurological disorders needs further evaluation. Furthermore locally available feed preparations having varying properties need to be tested to find out the safe preparations.

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