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Fiberoptic Endoscopic Documentation of the High Incidence of Aspiration following Extubation in Critically Ill Trauma Patients

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Abstract. The purpose of this study was to investigate the incidence of aspiration following extubation in critically ill trauma patients. This prospective pilot study included 20 consecutive trauma patients who required orotracheal intubation for at least 48 hours. All subjects underwent a bedside transnasal fiberoptic endoscopic evaluation of swallowing at 24 ± 2 hr after extubation to determine objectively aspiration status. Aspiration was defined as the entry of a blue dyed material into the airway below the level of the true vocal folds, with silent aspiration occurring in the absence of any external behavioral signs such as coughing or choking. Aspiration was identified in 9 of 20 (45%) subjects and 4 of these 9 (44%) were silent aspirators. Therefore, silent aspiration occurred in 20% of the study population. Eight of the 9 (89%) aspirating subjects resumed an oral diet from 2–10 days (mean, 5 days) following extubation. All subjects had no evidence of pulmonary complications. It was concluded that trauma patients after orotracheal intubation and prolonged mechanical ventilation have an increased risk of aspiration. An objective assessment of dysphagia to identify aspiration may reduce the likelihood of pulmonary complications after extubation.

Key words: Aspiration — Silent aspiration — Fiberoptic endoscope — Trauma — Orotracheal intubation — Extubation — Deglutition — Deglutition disorders.

There is a paucity of data concerning the incidence of aspiration after prolonged orotracheal intubation. Even less data are available specific to aspiration risk and pulmonary complications in critically ill trauma patients after orotracheal intubation. Recent reports have noted that previously intubated patients are at increased risk for aspiration [1–3]. Additional investigations of swallowing dysfunction in critically ill trauma patients appear necessary to determine the risk of pulmonary aspiration following extubation, thereby potentially reducing the likelihood of respiratory complications during the critical recovery period.

Prolonged orotracheal intubation, i.e., longer than 8 hr [4], can often produce severe laryngotracheal complications [5], with one of the most potentially life-threatening problems being pulmonary aspiration after extubation [1,4]. The incidence and etiology of aspiration after extubation is currently unknown [1]. The likely causes of aspiration are multiple: alterations in glottic anatomy [3] caused by vocal fold ulceration and laryngeal edema [5–8], and/or by disruption of the swallowing reflex [2] caused by muscle atrophy, incoordination, and diminished proprioception [1].

We hypothesized that aspiration was occurring after prolonged orotracheal intubation, and that silent aspiration might be an occult cause of respiratory infections. In the present study, we investigated the incidence of aspiration following extubation in critically ill trauma patients.

Materials and Methods

Subjects

Twenty consecutive trauma patients requiring orotracheal intubation for at least 48 hr were studied prospectively as part of an approved protocol instituted in our trauma population at Yale-New Haven Hospital, a level I trauma center. Table 1 shows subject characteristics and aspiration status following extubation. Seventeen subjects were in-

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Table 1. Subject characteristics and aspiration status following extubation

Subject	Sex	Age	Intensive care unit	Endotracheal intubation	Nasogastric tube	Traumatic intubation	Aspiration
		Yrs:Mos	Days	Days			
1	F	21:00	19	16	Y	N	N
2	M	34:03	5	4	Y	Y	N
3	M	46:03	11	9	N	N	N
4	F	72:00	9	6	Y	Y	Y
5	M	26:09	4	3	N	N	N
6	M	38:00	45	45	N	Y	Y
7	M	26:06	13	13	Y	Y	Y
8	M	23:02	9	8	N	N	Y
9	F	38:02	7	7	N	N	Y
10	F	22:00	26	26	Y	N	N
11	M	50:01	11	9	N	N	Y
12	M	18:01	17	16	N	N	N
13	F	50:03	5	4	Y	N	N
14	M	39:10	14	14	N	N	N
15	F	47:09	21	16	Y	Y	Y
16	F	30:00	9	6	N	N	Y
17	M	38:03	22	21	N	N	N
18	F	32:09	3	2	N	N	N
19	M	47:08	17	15	N	N	N
20	F	31:11	3	20	Y	N	Y

volved in motor vehicle crashes (12 cars, 3 motorcycles, and 2 pedestrians), 2 were stabbed, and 1 was in a boating accident. There were 11 males and 9 females, aged 18 years 1 month to 72 years (mean, 36 years 8 months). Duration of endotracheal intubation ranged from 2 days to 45 days (mean, 13.0 days). At our hospital, a tracheotomy was performed only if a patient exhibited a medical condition or head injury that required mechanical ventilation for an indefinite period of time. Traumatic intubations occurred in 5 of 20 subjects. Eight subjects had a nasogastric tube and 12 did not.

Equipment

Equipment consisted of a 3.6 mm diameter flexible fiberoptic rhinolaryngoscope (Olympus, ENF-P3), 4.1 mm diameter disposable endoscope sheaths (Smith-Nephew Richards), light source (Olympus, CLK-4), videocassette recorder (Sony, SVO-1550), camera (ELMO, MN401E), and color monitor (Magnavox, RJ4049WA01).

Procedures

All subjects underwent a transnasal fiberoptic endoscopic evaluation of swallowing (FEES) at bedside in the intensive care unit to determine aspiration status prior to beginning oral feeding. No subject was sedated at time of testing. FEES evaluations were performed 24 ± 2 hr postextubation. Aspirating patients were routinely reevaluated at 2–3-day intervals depending on progress, medical condition, and clinical judgment [9].

The FEES is a reliable bedside procedure that permits objective visualization of aspiration, avoids irradiation exposure, is repeatable as often as needed, and can be videotaped for review [10–13]. The basic protocol for the FEES [10,11] examination was followed. A FEES allows for direct visualization of the entire pharyngeal swallow, except for a very brief period when the contracting pharyngeal walls obstruct the optical tip of the endoscope. No administration of a topical anesthetic or vasoconstrictor to the nasal mucosa prior to a FEES was done, as it has been shown that comfortable transnasal endoscopy can be performed without administration of topical anesthesia to the nasal mucosa [14]. This eliminated any potential adverse anesthetic reaction and assured the endoscopist of a safe physiological examination [14]. In the present study, a blue-dyed puree bolus was always given first, followed by a blue-dyed liquid bolus, and then a blue-dyed solid bolus, if indicated.

Aspiration was defined as the entry of blue-dyed material into the airway below the level of the true vocal folds [15], with silent aspiration occurring in the absence of any external behavioral signs such as coughing or choking [16]. Silent aspiration can only be identified and confirmed by visualization [17]. If aspiration was determined the subject was not fed.

Statistics

Statistical analyses were performed using a statistical software package (STATISTICA, Statsoft Inc., Tulsa, OK). Groups were compared with parametric, i.e., analysis of variance (ANOVA) or Student's *t* tests, or nonparametric, i.e., Fisher Exact test, statistics. Differences were considered statistically significant at $p < 0.05$.

Results

Tables 1 and 2 show the results of the FEES evaluations. The presence of a nasogastric tube was not associated with aspiration (Table 1). Specifically, of the 8 subjects with a nasogastric tube, 4 aspirated and 4 did not; and of the 12 subjects without a nasogastric tube, 5 aspirated and 7 did not. Traumatic intubations (Table 1), e.g., blood in endotracheal tube, esophagus intubated, or mul-

Table 2. Results of the fiberoptic endoscopic evaluations of swallowing (FEES)

	Aspiration	No aspiration
Total subjects	9	11
Silent aspiration	4	0
Laryngeal penetration	8	0
Pyriform sinus pooling	6	1
Vallecula pooling	7	4

tiple intubation attempts, were noted in 5 of 20 (25%) subjects and 4 of these 5 (80%) aspirated.

Table 2 shows that pooling of the bolus in the valleculae and pyriform sinuses and laryngeal penetration were associated with aspiration, whereas isolated vallecula pooling was not. Aspiration was exhibited in 9 of 20 (45%) subjects and 4 of these 9 (44%) were silent aspirators. For the total study population, 4 of 20 (20%) subjects silently aspirated. Eight of the 9 (89%) subjects identified as exhibiting aspiration resumed an oral diet from 2–10 days (mean, 5 days) following extubation. All subjects in the present study were without evidence of pulmonary complications.

Table 3 shows the demographics of our population, grouped by aspiration status. Only the Glasgow Coma Scale [18] rating on admission exhibited a significant difference ($p < 0.05$) regarding aspiration status.

Case Study

Trauma subject #15 was a 47-year-old female involved in a motor vehicle crash (pedestrian vs car). She was orotracheally intubated for 15 days. At the time of the FEES, a Salem sump was in the left naris, and oxygen, 4 L/min via nasal cannula, was required. Good labial closure, adequate lingual range of motion, and a symmetrical smile/pucker were exhibited. The fiberoptic endoscope was passed through the left naris and the base of the tongue, epiglottis, vallecula, pyriform sinuses, and larynx were viewed. The true vocal folds were mobile bilaterally, but without complete adduction on phonation and with bilateral arytenoid cartilage edema and vocal process granulomas secondary to intubation.

Initial FEES results with a puree bolus, indicated pharyngeal phase dysphagia with laryngeal penetration and aspiration without a cough reflex. Recommendations were to continue with nonoral feeding, change Salem sump to a #8 nasogastric feeding tube, and reevaluate in 2 days. A repeat FEES revealed a #8 nasogastric feeding tube in the left naris, with continued incomplete true vocal fold adduction on phonation and bilateral arytenoid cartilage edema and vocal process granulomas. Results indicated (1) successful swallowing of small liquid boluses but pharyngeal phase dysphagia and aspiration with a cough reflex with larger liquid boluses; (2) successful swallowing of puree boluses; and (3) successful swallowing of solid boluses. Recommendations were a soft diet, discontinue nasogastric tube, aspiration precautions (head of bed 90° or chair and small bolus sizes), and daily follow-up. The soft diet was tolerated successfully, a regular diet was recommended the next day, and the patient was discharged from further dysphagia monitoring.

Table 3. Means (and SDs) for demographics based on aspiration status

	Aspiration	No aspiration
Mean age	40:02	33:02
Mean RTS[a]	6.90 (1.33)	7.37 (1.19)
Mean GCS[b] on admission	8.89* (4.73)	13.00 (3.77)
Mean GCS at extubation	14.57 (0.79)	14.55 (1.04)
Mean AIS[c] (Head)	1.89 (1.62)	0.91 (1.58)
Mean ISS[d]	16.38 (8.45)	20.45 (11.42)
Mean days orotracheally intubated	14.44 (12.44)	11.82 (8.00)

*$p < 0.05$.
[a]RTS—Revised Trauma Score [37].
[b]GCS—Glasgow Coma Scale [18].
[c]AIS—Abbreviated Injury Scale [38].
[d]ISS—Injury Severity Score [39].

Discussion

The principal findings of the present pilot study were (1) trauma patients had an increased risk of aspiration, both overt and silent, after prolonged orotracheal intubation; and (2) trauma patients who had a low Glasgow Coma Score [18] on admission or traumatic intubation appeared to be at increased risk for aspiration. It is important to note, however, that there was no significant difference (Table 3) regarding Glasgow Coma Scale scores at the time of testing for aspiration, i.e., the patients were alert but still did not swallow normally. This indicates that similarly neurologically functioning patients can exhibit different swallowing behaviors following extubation. Silent aspiration occurred in 20% of the subjects, suggesting that an objective assessment of the pharyngeal phase of swallowing, e.g., with a FEES, can identify aspiration and could potentially prevent pulmonary complications [16].

It is known that alteration of the chemo- and/or mechanoreceptors involved with the swallowing reflex, located in the pharyngeal and laryngeal mucosae, are altered by the presence of an orotracheal tube [2]. Inhibition of the sensory abilities of the larynx was demonstrated by the absence of a cough or any other behavioral signs of aspiration in patients challenged with a liquid bolus both immediately and 4 hr following extubation, with the detrimental effect reduced significantly within 8 hr postextubation [19].

Pharyngeal phase dysphagia resolved spontane-

ously following extubation (mean of 5 days) in the present study, thereby allowing previously aspirating patients to resume an oral diet without development of pulmonary infectious complications. This finding was consistent with previous reports which found that delayed swallowing responses were no longer observed 2 days following extubation [2]; healing of most mucosal lesions caused by orotracheal tubes occurred rapidly following extubation [5]; and aspiration following extubation was transient [2,4] with increased aspiration occurring closer to the time of extubation [19]. It is recommended, therefore, to assess objectively dysphagia and aspiration and/or delay oral intake for at least 24–48 hr [4] to allow for optimal swallowing success.

The FEES allows for direct visualization of the pharynx and larynx before, partially during, and after the swallow. Before an actual swallow is attempted, visual confirmation of pooled secretions in the valleculae, pyriform sinuses, and especially the laryngeal vestibule, are highly predictive of aspiration of food or liquid [20]. Overt and silent aspiration before and during the initiation of the swallow, due to spillage of the bolus into the laryngeal vestibule, glottis, and trachea can be observed. Also, overt and silent aspiration both immediately after the swallow and later due to retention of the bolus in the valleculae, pyriform sinuses, posterior commissure, and laryngeal vestibule can be clearly identified via the endoscopic image. Major advantages of the FEES, therefore, when compared with radiological assessment of dysphagia in the critically ill trauma population, include ability of performing the evaluation at bedside, avoidance of irradiation exposure and use of barium, no time limit in performing the procedure, and repeatability [16,21].

Consistent with previous reports [2,22–24], the presence of a nasogastric tube did not influence aspiration status. In addition, age of the subjects did not influence incidence of aspiration, as 8 of 9 subjects who aspirated were 50 years of age or less (mean of 35 years) (Table 1). It has been reported, however, that incidence of aspiration increased in tracheotomized patients who were 65 years and older [22]. In this study, if more subjects were older than 65 years of age, a greater incidence of aspiration may have been observed. Nevertheless, aspiration occurred in 8 of 20 (40%) subjects who were 50 years of age or less, indicating an increased aspiration risk in even young trauma patients. Also, in agreement with a previous report [2], there was no difference between the duration of intubation and aspiration status (Table 3).

Aspiration has been shown to occur in patients with stroke [25,26], head and neck cancer [24,27,28], tracheotomy [22,29–36], and ventilator dependency [33]. It is standard practice in our medical center and others to delay oral feeding in patients who have documented aspiration in an effort to reduce the likelihood of aspiration pneumonia. Although delaying oral feeding in previously intubated trauma patients who have documented aspiration may increase length of stay, early identification of aspiration is recommended.

Despite the relatively small population in the present study, it is clear that critically ill trauma patients have an increased risk of aspiration following extubation. Aspiration in this population, however, is multifactorial. Prospective research using a larger sample size is needed to corroborate the findings of the present study and to investigate further other potential risk factors that may predict aspiration in this population. Specifically (1) How does duration of orotracheal intubation, i.e., other than a minimum of 48 hours, impact on aspiration status? (2) Which subject variables, e.g., age, brain injury, traumatic intubation, sedatives and neuromuscular blockers, and respiratory status, influence incidence of aspiration? Ultimately, the question to be answered is: Can the FEES, by identifying aspiration, especially silent aspiration [16], prevent the occurrence of pulmonary complications leading to a reduction in morbidity and, ultimately, hospital costs?

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