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Swallowing Dysfunction in Nonneurologic Critically Ill Patients Who Require Percutaneous Dilatational Tracheostomy

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Background: **The aim of this study was to determine the incidence of swallowing dysfunction in nonneurologic critically ill patients who require percutaneous dilatational tracheostomy (PDT) for prolonged mechanical ventilation (MV) and to compare the duration of the cannulation period and length of stay in the critical care unit (CCU) in patients with and without swallowing dysfunction.**

Methods: **A total of 40 consecutive patients without neurologic disorders who require PDT for prolonged MV were included. Previous to the tracheostomy decannulation process, an otolaryngologist performed a fiberoptic endoscopic evaluation of swallowing (FEES). We used analysis of variance for the analysis; the results are presented as mean values ± SD.**

Results: **Mean age was 62 ± 15 years. Acute Physiology and Chronic Health Evaluation II and Sequential Organ Failure Assessment scores were 21 ± 2 and 9 ± 1, respectively. Time of MV previous to PDT was 20 ± 11 days, total MV duration was 38 ± 16 days, and CCU stay was 63 ± 27 days. The incidence of swallowing dysfunction in this group of patients was 38% (15/40). No difference was found in the age or time period of MV previous to PDT between groups. The time period between FEES to tracheostomy decannulation process was 19 ± 11 days in patients with swallowing dysfunction vs 2 ± 4 days in those patients without dysfunction ($P < .001$). Patients who developed swallowing dysfunction stayed longer in the CCU (69 ± 23 vs 47 ± 19 days, $P < .01$).**

Conclusions: **Nearly 40% of nonneurologic critically ill patients requiring PDT for prolonged MV presented swallowing dysfunction and experienced a significant delay in their tracheostomy decannulation process.**

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Abbreviations: APACHE II = Acute Physiology and Chronic Health Evaluation; CCU = critical care unit; FEES = fiberoptic endoscopic evaluation of swallowing; MV = mechanical ventilation; PDT = percutaneous dilatational tracheostomy; SOFA = Sequential Organ Failure Assessment

Patients who require translaryngeal prolonged intubation are at risk for developing swallowing dysfunctions that may predispose aspiration and the subsequent development of nosocomial pneumonia.[1] Nosocomial pneumonia is one of the major causes of infection in the ICU and is associated with an increase in patient morbidity and mortality and high costs of care.[2] In this setting, tracheostomy is one of the most common surgical procedures performed in this group of patients,[3] with an international prevalence of 10% to 20%.[4,5] Currently, bedside percutaneous dilation tracheostomy (PDT) has become the method of

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choice in critically ill patients because of its advantages compared with the classic open surgical tracheostomy performed in the operating room.[6]

Some authors have suggested the routine evaluation of swallowing function of selected patients in order to avoid complications associated with swallowing disorders and to provide patients with the rehabilitation needed for adequate recovery.[7-9] Clinical evaluation of swallowing is widely available; it does not require specialized technology and can be performed bedside. Nevertheless, around one-third of the tracheostomized patients who successfully complete the clinical evaluation show penetration or aspiration of saliva during the fiberoptic endoscopic evaluation of swallowing (FEES).[10] Videofluoroscopic evaluation of swallowing requires the transfer of patients outside the ICU, which proves difficult in critically ill patients. Moreover, FEES is reliable, practical, safe, and may provide relevant information in tracheostomized critically ill patients to decide the best moment for their decannulation and the initiation of oral feeding. Currently there are no studies that have assessed swallowing functionality specifically in nonneurologic critically ill patients undergoing a PDT. The aim of the present study was to establish the incidence of swallowing dysfunction in nonneurologic critically ill patients undergoing a PDT because of prolonged mechanical ventilation (MV) and to evaluate its impact in the tracheostomy decannulation process and in the length of stay in the critical care unit (CCU).

Materials and Methods

This was a prospective observational study performed in the Clinical Hospital University of Chile, a 600-bed tertiary and teaching facility, with a 55-bed medical-surgical CCU. The CCU consists of an ICU (12 beds) and an intermediate care unit (43 beds). The study was approved by the institutional ethics review board. Written informed consent was obtained from each patient's next of kin.

All the nonneurologic critically ill patients admitted to the ICU between July 2006 and June 2008 who required a PDT because of prolonged MV were included in the study. Exclusion criteria were neurologic reasons for admission (such as stroke, traumatic brain injury, neuromuscular illness, and so forth), age $<$ 18 years, or previous swallowing dysfunction. Demographic data, Acute Physiology and Chronic Health Evaluation (APACHE) II, Sequential Organ Failure Assessment (SOFA), time period of translaryngeal intubation previous to PDT, duration of MV, length of tracheostomy tube *in situ*, and length of stay in the CCU were recorded.

Patients were managed in similar ways through an analgesia-based sedation protocol, protective mechanical ventilation in semi-recumbent position, and a weaning protocol. Additionally, patients received stress ulcer and deep vein thrombosis prophylaxis and early enteral nutrition through a nasogastric or nasojejunal tube.

All the PDT were elective and performed in the ICU by two intensivists previously trained for this procedure using a modified standard method of the Ciaglia Blue Rhino technique (Cook Critical Care; Bloomington, IN). On each occasion a pulmonologist was present for fibrobronchoscopic assistance (Bronchoscope 1T30; Olympus Medical Systems Corp; Tokyo, Japan). PDT technique of institution has been previously described.[11]

FEES was performed in the CCU 3 to 5 days after the MV had been discontinued. The procedure was performed by an otolaryngologist (K. W.) with experience in the evaluation of swallowing to establish the presence or absence of swallowing dysfunction. All the patients received suctioning before the FEES and were examined with the head of the bed elevated to approximately 70°. FEES was performed introducing through the nose a flexible fiberoptic rhinolaryngoscope (ANF-S6 C/I with the light source LG-150; Shanghai AOHUA Photoelectricity Endoscope Co, Ltd; Shangai, China) reaching the hypopharynx, following the previously described methodology of Langmore et al.[12] Topical anesthetic was avoided in order not to disturb the proper evaluation of swallowing.[13] Patients who showed saliva pooling in the vallecula and pyriform sinuses were asked to swallow, and it was noted whether they were able to remove the accumulated material. Next, to assess the integrity of pharyngeal swallowing, trials were performed using semi-liquid (5-mL boluses of puree) and liquid foods (5 mL of juice) colored blue to optimize viewing. If patients successfully completed this phase, trials were conducted with solid foods (crackers). During the trials with food, the inside of the larynx was examined before and after each swallow to see if there was penetration or aspiration of food. FEES results were considered positive for swallowing dysfunction if the patient presented penetration or aspiration during the examination. Penetration was defined as material entering the laryngeal vestibule without going below the vocal chords. Aspiration was defined as material entering below the vocal chords. Silent aspiration was defined as the absence of cough or gag reflex as the bolus of food or liquid is passed into the trachea. At the time of this procedure patients had a 14 to 15 score in the Glasgow Coma Scale. During the procedure they received supplementary oxygen and their arterial oxygen saturation remained $>$90%. Patients diagnosed with swallowing dysfunction remained with tracheostomy tube *in situ* and without oral feeding, underwent swallowing rehabilitation with a speech and language therapist, and had weekly follow-up evaluations.

Statistical Analysis

The data are presented as frequencies and percentages for categorical variables and mean values ± SD for continuous variables. Kolmogorov-Smirnov test was used to check for normal distribution of data. Analysis of variance was used for comparative analysis of the groups. Statistical calculations were made using SPSS 17.0 (SPSS Inc; Chicago, IL) for Windows. A $P < .05$ was considered statistically significant.

Results

During the 24 months of the study, 82 patients underwent a PDT because of prolonged MV. Twenty patients were excluded because of acute brain pathology and three because of neuromuscular disease as the cause of translaryngeal intubation. Two patients were younger than 18 years of age, and two patients had history of dysphagia before the translaryngeal intubation. Additionally, three patients were transferred to another hospital before the FEES could be performed, 10 patients died before completing the

protocol, and two patients had their tracheostomy tube removed before FEES. Therefore, 40 consecutive nonneurologic critically ill patients were included.

Mean age was 62 ± 15 years (19 women, 21 men). APACHE II and SOFA scores were 21 ± 2 and 9 ± 1, respectively. The primary diagnoses for ICU admission were septic shock, hemorrhagic shock, ARDS, and severe acute pancreatitis (Table 1). Patients remained with translaryngeal intubation and MV for 20 ± 11 days before the PDT. Total time of translaryngeal intubation was 38 ± 16 days and mean length of stay in the CCU was 63 ± 27 days. FEES was performed at 43 ± 13 days of translaryngeal intubation. The procedure was well tolerated and no adverse events were registered in any patient.

The incidence of swallowing dysfunction was 38% (15 of 40 patients) (Table 2). Of these patients, 73% (11/15) had silent aspiration. There were no differences in the number of days of translaryngeal intubation before the PDT (19 ± 7 vs 20 ± 10, $P = .60$) or the duration of MV (39 ± 13 vs 36 ± 14, $P = .50$) between patients with or without swallowing dysfunction. We found no significant difference in age between the groups (63 ± 21 vs 62 ± 11, $P = .86$). In the subgroup of elderly patients (≥ 65 years) there was no significant difference in age between those patients with or without swallowing dysfunction (75 ± 7 vs 71 ± 6, $P = .16$). Of the 21 elderly patients, 53% (8/15) developed swallowing dysfunction and 52% (13/25) did not.

Total duration of the permanence of the tracheostomy tube was 50 ± 12 vs 31 ± 20 days in the patients with and without swallowing dysfunction, respectively ($P < .01$). Additionally, the time elapsed since the FEES to decannulation was 19 ± 11 days in the patients with swallowing dysfunction vs 2 ± 4 days in the patients without it ($P < .001$). In all patients the tracheostomy tube was successfully removed.

Length of ICU hospitalization was similar in both groups (42 ± 14 vs 37 ± 14, $P = .28$). However, patients who developed swallowing dysfunction stayed longer in the CCU (69 ± 23 vs 47 ± 19 days, $P < .01$) (Table 3).

Table 1—*Demographic Characteristics of the Study Population and Incidence of Swallowing Dysfunction*

Variables	Patients (N = 40)
Age, y	62 ± 15
Women (men)	19 (21)
APACHE II	21 ± 2
SOFA	9 ± 1
Reason for MV	
Septic shock	22
Respiratory	9
Abdominal	9
Urinary	2
Gynecologic	2
Hemorrhagic shock	6
Upper gastrointestinal bleeding	3
Lower gastrointestinal bleeding	2
Vascular injury	1
ARDS	4
Trauma	2
TRALI	2
Severe acute pancreatitis	8
Duration of translaryngeal intubation, d	20 ± 11
Length of time posttracheostomy, d	38 ± 21
Time between translaryngeal intubation to FEES, d	43 ± 13
Duration of MV, d	38 ± 16
Length of stay ICU, d	39 ± 14
Length of stay CCU, d	63 ± 27
Incidence of swallowing dysfunction, %	38

APACHE II = Acute Physiology and Chronic Health Evaluation; CCU = critical care unit; FEES = fiberoptic endoscopic evaluation of swallowing; MV = mechanical ventilation; SOFA = Sequential Organ Failure Assessment; TRALI = transfusion-related acute lung injury.

Discussion

Several authors using different techniques for assessment of swallowing in tracheostomized patients have reported an incidence of aspiration of 30% to 70%.[10,14-18] However, despite the known high incidence of swallowing dysfunction in patients with neurologic disorders,[19-21] these patients were not analyzed separately in previously published studies. To our knowledge, this constitutes the first study to establish, in an acute setting, the incidence of swallowing dysfunction in nonneurologic critically ill patients who undergo a PDT because of prolonged MV.

In a different setting, Tolep et al[22] examined with videofluoroscopy 35 consecutive tracheostomized patients chronically dependent on MV. They found an incidence of 31% of swallowing dysfunction in the group of patients with neuromuscular disorders. More recently, Sharma et al[23] studied a population of critically ill patients with videofluoroscopy and found a high incidence of global dysphagia (74%) more evident in patients with traumatic brain injuries (68%) and other neurologic diseases (89%). However, these authors do not state if the existence of previous dysphagia was considered as an exclusion criterion. In this context, one might assume that the inclusion of these patients in previous studies may have overestimated the true magnitude of the problem in the nonneurologic critically ill patients. In the present study, patients with acute brain pathology and neuromuscular disorders were excluded, as well as patients with previously diagnosed dysphagia. Still, around 40% of patients presented swallowing dysfunction, a relatively high percentage, considering the strict selection of the studied group. As has been previously suggested,[22] the need for tracheostomy because of

Table 2—*Swallowing Dysfunction According to Food Consistency*

Food Consistency	Swallowing Dysfunction (n = 15)
Puree, No. (%)	6 (40)
Juice, No. (%)	11 (73)
Crackers, No. (%)	4 (27)

prolonged translaryngeal intubation seems to identify patients at high risk of developing swallowing dysfunction and its potential associated complications.

Additionally, we documented for the first time a direct association between swallowing dysfunction and a significant delay of decannulation, despite an implemented rehabilitation program. We decided to evaluate specifically the period between the FEES and the decannulation because it would be less influenced by the duration of the MV and the timing of the FEES.

Unlike findings from other authors in ventilator-dependent tracheostomized patients,[15,17,20] we did not find a higher incidence of swallowing dysfunction in elderly patients. These results are consistent with previously reported findings in nontracheostomized elderly critically ill patients undergoing prolonged MV.[24] Elderly patients are at increased risk for stroke and neurogenic dysphagia. The exclusion of these patients and the fact that group was not subject to MV at the time of FEES could partly explain findings. Positive pressure ventilation may interfere with proper synchronization between breathing and swallowing, a situation that may be more pronounced in debilitated elderly patients.

Moreover, confirming previous observations in tracheostomized patients,[15,17,20] we also found no association between the duration of translaryngeal intubation and the incidence of swallowing dysfunction. However, it is important to note that in this series both groups of patients were subjected to translaryngeal prolonged intubation (19 ± 7 vs 20 ± 10). Currently there are no studies that have evaluated the impact of early PDT on the incidence of swallowing dysfunction in critically ill patients.

In the present study, we found no differences in the duration of MV among patients with and without swallowing dysfunction, which is not surprising given that the main determinant for the release of ventilatory support in tracheostomized patients is cardiovascular and respiratory stabilization and not the indemnity of the swallowing function. This could also explain why no difference was found in the length of stay in the ICU because patients are not transferred to the intermediate care unit if they still are on MV. Critically ill patients are often exposed to a wide variety of drugs (sedatives, neuromuscular blockers, aminoglycosides, glucocorticoids, and others) and are susceptible to medical complications during their evolution (nosocomial infections, organ dysfunctions, sepsis-associated delirium), the same complications that may promote the development of ICU-associated polyneuromyopathy and longer patient stay in high-dependency units.[25] This study corroborates previous research that found that the severity of illness of patients in combination with the aforementioned events could explain the development of swallowing dysfunction and the increased length of stay in the CCU.[26,27]

We are aware that our study has some limitations. It included a relatively small number of patients; however, it represents a selected population of critically ill patients assessed systematically for a period of 2 years avoiding confounding factors such as presence of acute neurologic pathology or previous dysphagia. We did not perform a formal assessment of swallowing before the translaryngeal intubation to confirm the absence of swallowing dysfunction at admission to the ICU.[26,27] The complex clinical condition (cardiovascular and/or respiratory) of these patients makes this approach impractical. Nevertheless, we interviewed the patients' families about symptoms specifically associated with aspiration and we had access to the medical records of all patients. Additionally, only one endoscopist performed all FEES evaluations; there was no interrater reliability performed and intrarater reliability was impossible.

Table 3—*Results of Comparative Analysis Between Patients With and Without Swallowing Dysfunction*

Variables	With Swallowing Dysfunction	Without Swallowing Dysfunction	*P* Value
Age	63 ± 21	62 ± 11	.86
Age ≥ 65 y	75 ± 7	71 ± 6	.16
Duration of translaryngeal intubation, d	19 ± 7	20 ± 10	.60
Duration of MV, d	39 ± 13	36 ± 14	.50
Length of time post-tracheostomy, d	50 ± 12	31 ± 20	< .01
Time between FEES to tracheostomy decannulation, d	19 ± 11	2 ± 4	< .001
Length of ICU stay, d	42 ± 14	37 ± 14	.28
Length of CCU stay, d	69 ± 23	47 ± 19	< .01

See Table 1 legend for expansion of abbreviations.

Conclusions

Nearly 40% of nonneurologic critically ill patients requiring PDT for prolonged MV presented swallowing dysfunction and experienced a significant delay in their tracheostomy decannulation process. Based on these findings we suggest performing FEES routinely before decannulation or initiating oral feeding in this group of patients.

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