

A Five Year Experience of The Tracheostomy Procedure In a Medical Intensive Care Unit

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ABSTRACT

Objective: Tracheostomy formation is one of the most commonly performed surgical procedures in the intensive care unit (ICU). This study aimed to analyze tracheostomy indications, complications and survival rates, and to compare characteristics and outcomes of patients who had undergone surgical tracheostomy (ST) and percutaneous dilational tracheostomy (PDT).

Methods: It was a prospective nonrandomized study conducted at a university hospital ICU. It included 88 consecutive adult patients receiving elective tracheostomy between September 2015 and February 2020.

Results: The main indications for tracheostomy were prolonged mechanical ventilation, airway protection and pulmonary hygiene. The patients received a tracheostomy after a median of 17 (9-25) days of endotracheal intubation. Twenty-five percent of the patients were mobilized and 27% started oral feeding after tracheostomy. The survival rates at 28 days after tracheostomy, hospital discharge and 1 year were 64.8%, 40.9% and 15.9%, respectively. The ratio of the patients with ST was 36%. There were no differences in demographic data, comorbidity, admission diagnosis, complication rate, tracheostomy indication and survival rate between ST and PDT groups. Although duration of intubation before tracheostomy were similar between the groups, the time passed from informed consent for tracheostomy to the tracheostomy procedure was longer in the ST group (PDT, 3 [1-6]; ST, 6 [2-11] days; p=0.011). All ST patients had preoperative consultations from other clinics and the mean number of consultation per patient was 2.7.

Conclusion: Both ST and PDT were safe procedures in the ICU. Since several consultations were requested, the implementation of the procedure was delayed for ST compared to PDT.

Keywords: Consultation, complication, percutaneous dilational tracheostomy, surgical tracheostomy, survival.

Introduction

Tracheostomy procedure is one of the most commonly applied procedures in the intensive care invasive unit (ICU) among patients who need long-term mechanical ventilation (MV). The presence of a tracheostomy provides better patient comfort, pulmonary and oral hygiene and opportunities for oral feeding and speech (1,2). Patients with tracheostomy are easily mobilized, and more likely join physical therapy and conditioning regimens since they have more secured airways (1). It may allow easy weaning due to shorter and rigid design of the tracheostomy tube which decreases airflow resistance and associated work of breathing. Tracheostomy in the ICU is performed in 2 ways. The conventional method is done in the operating room by using surgical techniques. The new method, which was first described by Ciaglia et al in 1985, is called percutaneous dilational tracheostomy (PDT) where tracheostomy is accomplished

by modified Seldinger technique (3). Although there are not any significant differences between surgical tracheostomy (ST) and PDT regarding length of stay (LOS) in the ICU and hospital and complication and mortality rates, PDT is cost effective and relatively easy to carry out (4-6). The rates of delayed complications, like tracheal stenosis are also similar in the both techniques (7). PDT is performed at the bedside, and thus, eliminates the risk of transporting critically ill patients outside the ICU. Physicians without surgical training can learn this technique rapidly. Therefore, PDT has gained wide acceptance and has become the predominant method of tracheostomy formation in the ICU (2). Contraindications to PDT include unclear neck landmarks, clinical conditions causing a difficult airway for laryngeal intubation in the event of unintentionally airway control loss and the presence of an unstable cervical spine (2).



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Timing of tracheostomy remains controversial. Studies comparing early tracheostomy (in the first week of endotracheal intubation) with late tracheostomy (any time after the first week of laryngeal intubation) did not show any differences regarding ICU and hospital LOS, ventilator-associated pneumonia, tracheostomy-related complication and mortality (8,9). However, early tracheostomy was associated with less sedative usage (8). On the other hand, a significant number of patients uphold on MV in the late tracheostomy approach could be liberated from ventilatory support without need for a tracheostomy (8). A consensus conference on artificial airways in patients receiving MV recommends tracheostomy in patients expected to be under MV for more than 3 weeks (10).

The aim of this study was to define indications for tracheostomy, to study the complication incidence and short-and long-term survival rates in patients receiving tracheostomy, and to compare characteristics and outcomes of patients who underwent PDT and ST.

Materials and Methods

This prospective nonrandomized observational study was conducted in a 9-bed medical ICU at a university hospital between September 2015 and February 2020. The study population included all intubated patients aged ≥ 18 selected for tracheostomy placement, and none of the patients had coronavirus disease 2019. Tracheostomy decision was made if following criteria were met: ventilatory support with $\text{FiO}_2 \leq 50\%$ and positive end-expiratory pressure (PEEP) ≤ 8 cmH_2O ; hemodynamic stability with no vasopressor need; platelet count > 50.000 cells/ μL and international normalized ratio < 1.5 . Exclusion criteria included skin or soft tissue infection of the neck and uncorrectable coagulopathy. The time at which the procedure took place was based on the individual patient factors. If the tracheostomy procedure was unavoidable due to underlying diseases, such as amyotrophic laterals sclerosis, Guillain-Barré syndrome, myopathy and laryngeal mass compression, tracheostomy was performed in the first week of the ICU admission. Tracheostomy was delayed up to 3 weeks and weaning trials were attempted during this period. The procedure was done over the 3-week time of laryngeal intubation in some patients because of hemodynamic instability or poor prognosis foreseen at that time, and when these patients were stabilized, tracheostomy was performed. The study protocol was approved by the ethics review board of the university (Number:2015/171). Informed consent for the tracheostomy procedure was obtained from the relatives of the patients.

All tracheostomy decisions were made by the ICU physicians, except for 3 patients with laryngeal diseases in whom the department of ear, nose and throat (ENT) surgeons made the tracheostomy decision. Patients who were decided to have tracheostomy were evaluated in terms of PDT or ST compliance by the ICU physicians. ST was preferred for patients with previous tracheostomy or neck surgery, pathology of the neck or neck deformities, unidentifiable anatomy of the neck, thyromegaly, inability to adequately extend the neck, morbid obesity (body mass index ≥ 40), glottic edema and presence of vessels that left insufficient space for PDT insertion. Then, ST

preferred patients were consulted by the department of ENT for the procedure. If the procedure was approved by the department of ENT, the preparation of patients for surgery was started with anesthesia consultation. Other departments were also consulted if the department of anesthesiology requested. All ST took place in the operating room under general anesthesia by a team of ENT surgeons, except for 2 tracheostomies that were performed at the bedside with intravenous sedation provided by the ICU physicians. The surgical procedure was at the surgeon's discretion. The procedure was performed either with a longitudinal, or a transversal incision and with a tracheal window. Biçakçilar tracheostomy tube (Biçakçilar Medical, Istanbul, Turkey) no. 7 or 8 ID was inserted. Shiley extended-length tracheostomy tube (Medtronic plc, Boulder, CO, USA) no. 8 was used in the patients with thick neck anatomy. Tracheal stay sutures were not routinely placed. Perioperative complications of ST were obtained by checking anesthesia paper charts and by direct communication with the doctors.

After the decision of PDT was made, it was opened right away if patients were hemodynamically stable. All PDT were performed at the bedside by the two ICU physicians, one in charge of airway management and the second performing the procedure. The patients were anesthetized with propofol and remifentanyl, and paralyzed with rocuronium bromide. Local anesthesia (lidocaine 2%) was used in all cases. All patients were mechanically ventilated with 100% oxygen for 5 minutes prior to the procedure with zero PEEP in order to decrease the risk of pneumothorax. PDT was performed by Griggs technique as described previously (11). The endotracheal tube was repositioned just below the vocal cords by direct laryngoscopy, thus minimizing the risk of cuff puncture during the procedure. Patients were positioned supinely by using a shoulder role to achieve neck hyperextension. Following identification of the anatomical landmarks, lidocaine was used for local anesthesia. The trachea was then identified by introducing the needle until aspiration of air. A guidewire was inserted in the trachea at the level of the first or second tracheal interspace and a small (1-2 cm) transverse incision was made at the site of the skin puncture. A 14-G dilator was passed over the guidewire to make stoma formation on the anterior wall of the trachea. Then, the guidewire dilating forceps was advanced along the wire until the trachea was penetrated. The forceps was opened to dilate the tracheal wall and the tissues anterior to the trachea. The forceps was removed and a tracheostomy tube was advanced along the wire trough the stoma into the trachea. The placement of the tracheostomy tube was confirmed by auscultating the lung fields and viewing tidal volumes on the MV. A Tracheo S.E.T tracheostomy kit (Xmed S.r.l., Mirandola, Italy) no. 7 or 8 ID for PDT was used. All PDT were performed blindly as the ICU physicians were internists trained in critical medicine and they were not qualified in fiber optic bronchoscopy. All patients had the tracheostomy tube secured by fabric ties around the neck. A portable chest radiograph was obtained after the both types of tracheostomy procedures to confirm tube location and to exclude complications, such as pneumothorax and subcutaneous emphysema.

The following data were recorded: age, sex, comorbidity, admission diagnosis, acute physiology and chronic health evaluation II (APACHE II) score, reason for tracheostomy, Glasgow coma score

(GCS) on the day of tracheostomy, number of days intubated, number of consultations asked for ST, perioperative complication, decannulation, home-ventilation support, LOS in the ICU and hospital and survival rates. Additionally, complete blood count, liver and kidney function tests, C-reactive protein, lactate, PEEP and FiO_2 were recorded on the day of the procedure. The GCS-verbal scale of intubated patients was numbered V1 (no verbal response). Therefore, the GCS was scored 3 (E1, M1, V1) in deeply comatose patients and 11 (E4, M6, V1) in conscious intubated patients.

Perioperative complications, occurred between initiation of the procedure and 24 hours postoperatively, included bleeding, pneumothorax, subcutaneous emphysema, peritracheal insertion (false passage), endotracheal tube dislocation during the tracheostomy procedure, hypotension (systolic blood pressure <90 mm Hg), arrhythmia, cardiac arrest, death secondary to a complication and inability to complete tracheostomy. If the bleeding was controlled by digital pressure, it was called a minor bleeding. If bleeding was controlled by other measures, it was called a major bleeding. Since there was not a step-down unit in the hospital, all patients with tracheostomy were sent to the inpatient clinics with or without home-mechanical ventilation (HMV) before the hospital discharge. The ICU physicians were responsible for arranging HMV.

Variables with normal distribution were expressed with mean and standard deviation, and compared using Student t test. Variables with non-normal distribution were represented as median and interquartile range, and compared using Mann-Whitney U test. Categorical variables were reported as percentage and comparisons between groups were conducted using the χ^2 and Fisher exact tests. A p value <0.05 was regarded as significant. The statistical analysis was performed using the Statistical Package for the Social Science 21 version.

Results

Eighty-eight patients had tracheostomy during the study period. The demographic data, admission diagnosis, tracheostomy indications, LOS in the ICU and hospital and the survival rates of the patients are shown in Table 1. The mean APACHE II score was 27.9 ± 6.4 and median GCS on the day of tracheostomy was 6 (5-8) (range, 3-11). The patients received tracheostomy after a median of 17 (9-25) (range, 3-39) days of endotracheal intubation. The tracheostomy procedure was performed in a median of 3.5 (1-7) (range, 1-15) days after informed consents for tracheostomy were signed. The applied PEEP and FiO_2 on the day of tracheostomy were 5.4 ± 0.9 (range, 5-8) cmH_2O and $36\% \pm 8\%$ (range, 21-50%), respectively. The main reasons for tracheostomy were prolonged MV, airway protection against aspiration in the patients with low GCS and pulmonary hygiene. The conditions causing low GCS, inability to clear respiratory secretion, neuromuscular disorder and laryngeal pathology were described in the table 2. Forty-four patients (50%) developed hypotension during the intravenous sedation which was controlled by fluid and vasopressor administration. Twenty-two patients (25%) were mobilized and 24 (27.3%) started oral feeding after tracheostomy. Four patients

Table 1. Demographic data, admission diagnosis, tracheostomy reason, length of stay and survival rate

Parameters	n = 88
Age, year [†]	70.9 ± 17.5
Men, n (%)	35 (39.8)
Admission diagnosis, n (%)	
Respiratory failure	
Pneumonia	51 (58)
Status asthmaticus	1 (1.1)
Cerebrovascular disease	
Bleeding	8 (9.1)
Infarct	9 (10.3)
Encephalitis	1 (1.1)
Status epilepticus	1 (1.1)
Post-CPR [‡]	12 (13.6)
Sepsis	
Urosepsis	2 (2.3)
Intraabdominal sepsis	2 (2.3)
Pancreatitis	1 (1.1)
Cause of tracheostomy, n (%)	
Prolonged MV	23 (26.1)
Airway protection	14 (16)
Pulmonary hygiene	12 (13.6)
Prolonged MV and airway protection	13 (14.8)
Prolonged MV and pulmonary hygiene	15 (17.0)
Neuromuscular disease	8 (9.1)
Larynx disease	3 (3.4)
ICU LOS, day [†]	39 (24-67)
Hospital LOS, day [†]	46 (31-74)
28-day survival, n (%) [§]	57 (64.8)
ICU survival, n (%)	46 (52.3)
Hospital survival, n (%)	36 (40.9)
1-year survival, n (%)	14 (15.9)

[†]Values were expressed as mean±standard deviation. [‡]All patients had cardiopulmonary resuscitation before ICU admission. [§]Values were expressed as median and interquartile range (25p-75p). [¶]It indicates 28-day survival after tracheostomy. CPR: cardiopulmonary resuscitation; ICU: intensive care unit; LOS: length of stay; MV: mechanical ventilation.

(4.5%) had decannulation before the hospital discharge. Although the 28-day survival rate after the tracheostomy procedure was 64.8%, hospital and 1-year survival rates decreased to 40.9% and 15.9%, respectively. Half of the patients were discharged with HMV. Of 18 patients with HMV, 12 patients (66.7%) were in advanced stages of cancer, dementia/Parkinson's disease, chronic lung disease or cerebral palsy, and the rest of the patients had neuromuscular diseases.

ST was applied to 32 patients (36.4%). There were not any significant differences in demographic data, comorbidity, admission diagnosis, APACHE II, GCS, tracheostomy indication,

Table 2. Causes of low GCS, ineffective airway clearance, neuromuscular disorder and laryngeal pathology*

Parameters	n (%)
Low Glasgow coma score [†]	
Anoxic encephalopathy	11 (12.4)
Intracerebral bleeding	7 (7.9)
Cerebrovascular infarct	7 (7.9)
Cranial tumor	1 (1.1)
Encephalitis	1 (1.1)
Ineffective secretion removal [‡]	
Dementia/Parkinson's disease [¶]	13 (14.7)
Cerebral palsy	4 (4.5)
Cachexia due to chronic disease [§]	5 (5.6)
Cerebrovascular disease	4 (4.5)
Hydrocephaly	1 (1.1)
Neuromuscular disease	
Amyotrophic lateral sclerosis	5 (5.6)
Duchenne muscular dystrophy	1 (1.1)
Guillain-Barré syndrome	1 (1.1)
Myasthenia gravis	1 (1.1)
Laryngeal pathology	
Vocal cord paralysis	1 (1.1)
Laryngeal edema	1 (1.1)
Laryngeal mass compression	1 (1.1)

*Patients with prolonged mechanical ventilation (23, [26.1%]) were not included in this table. [†]They had tracheostomy for airway protection. [‡]They had tracheostomy for pulmonary hygiene. [¶]All patients with dementia/Parkinson's disease were at their terminal stages and bedridden 100% of daytime. [§]This group included two cancer patients and 3 patients with oxygen and home-mechanical ventilation dependent chronic obstructive pulmonary disease.

PEEP, FiO₂, LOS and laboratory parameters between PDT and ST groups (Table 3). The perioperative complication rates were also similar between the two groups (Table 4). All tracheostomy procedures were completed successfully. Each group had one cardiac arrest complication. The cardiac arrest in the PDT patient happened after the completion of the procedure and chest-X-ray demonstrated a pneumothorax. The patient did not respond to CPR despite the thorax tube insertion. The cardiac arrest in the ST patient developed while performing the tracheostomy procedure in the operating room. The patient responded to CPR and was discharged with tracheostomy. None of the patients had major bleeding. Although duration of intubation before tracheostomy were similar between the groups (PDT, 17 [9-25] days; ST, 17 [9-28] days; p=0.253), the time passed from the approval of informed consent for tracheostomy to the procedure was significantly longer in the ST group than in the PDT group (PDT, 3 [1-6] days; ST, 6 [2-11] days; p=0.011). All patients with ST had preoperative anesthesia and ENT consultations, and 40% of these patients were also consulted with other clinics. The mean number of consultations per patient was 2.7±1 (range, 2-5). Oral feeding (PDT, 19 [33.9%]; ST, 5 [15.6%]; p=0.083) and mobilization (PDT, 17 [30.4%]; ST, 5 [15.6%]; p=0.125) rates were similar in

Table 3. Comparison of the patients with percutaneous dilational and surgical tracheostomies

Parameters	PDT n = 56	ST n = 32	p
Age, year [†]	74 ± 16.3	64 ± 19	0.117
Men, n (%)	31 (55.4)	22 (68.8)	0.262
APACHE II [‡]	28.2 ± 6.9	27.2 ± 5.6	0.434
GCS [†]	6 (5 - 8.3)	6.5 (5 - 8.8)	0.823
Comorbidity, n (%)			
Cardiac diseases	19 (33.9)	9 (28.1)	0.574
Hypertension	22 (39.3)	13 (40.6)	0.902
Dementia/Parkinson's disease [¶]	11 (19.6)	6 (18.8)	0.919
Diabetes mellitus	10 (17.9)	9 (28.1)	0.260
CVD	12 (21.4)	6 (18.8)	0.650
CKD (Stage 2-5D)	3 (5.4)	5 (15.6)	0.107
Cancer	7 (12.5)	4 (12.5)	1.000
COPD	12 (21.4)	5 (15.6)	0.507
ALS	4 (7.1)	1 (3.1)	0.434
Others [§]	5 (8.9)	3 (9.4)	0.944
Cause of admission, n (%)			
Respiratory failure	35 (62.5)	17 (53.1)	0.390
Cerebrovascular disease	12 (21.4)	7 (21.9)	0.961
Post-CPR	6 (10.7)	6 (18.8)	0.291
Sepsis	3 (5.4)	2 (6.3)	0.862
Thrombocytes x 10 ³ /L [†]	292 ± 149	288 ± 120	0.895
INR [†]	1.18 ± 0.21	1.17 ± 0.16	0.742
Creatinine, mg/dL [†]	0.92 (0.5 - 1.37)	0.99 (0.63 - 1.97)	0.259
ALT, U/L [†]	22 (13 - 37)	14 (9 - 32)	0.122
C-reactive protein, mg/dL [†]	9.3 ± 7.7	12.8 ± 9.9	0.102
Lactate, mmol/L [†]	1.5 ± 0.5	1.4 ± 0.7	0.492
FiO ₂ , % [†]	0.37 ± 0.08	0.34 ± 0.06	0.113
PEEP, cmH ₂ O [†]	5 (5 - 5)	5 (5 - 6)	0.714
Cause of tracheostomy, n (%)			
Prolonged MV	16 (28.6)	7 (21.9)	0.492
Airway protection	9 (16.1)	5 (15.6)	0.936
Pulmonary hygiene	8 (14.3)	4 (12.5)	0.814
Prolonged MV and airway protection	7 (12.5)	6 (18.8)	0.427
Prolonged MV and pulmonary hygiene	9 (16.1)	6 (18.8)	0.748
Neuromuscular diseases	7 (12.5)	1 (3.1)	0.138
Larynx disease	0	3 (9.4)	0.020
HMV, n (%)	12 (21.4)	6 (18.8)	0.764
ICU LOS, day [†]	37 (26 - 61)	42 (23 - 77)	0.646
Hospital LOS, day [†]	46 (31-63)	51 (29 - 92)	0.490

[†]Values were expressed as mean±standard deviation. [‡]Values were expressed as median and interquartile range (25p-75p). [¶]All patients with dementia/Parkinson's diseases were at their terminal stages and bedridden. [§]Others included Duchenne muscular dystrophy (n=1), chronic encephalitis (n=1), hydrocephaly (n=1), myasthenia gravis (n=1) and cerebral palsy (n=4).

APACHE: acute physiology and chronic health evaluation; ALT: alanine aminotransferase; ALS: amyotrophic lateral sclerosis; CPR: cardiopulmonary resuscitation; CVD: cerebrovascular disease; CKD: chronic kidney diseases; COPD: chronic obstructive pulmonary disease; D: dialysis; FiO₂: fraction of inspired oxygen; GCS: Glasgow coma score; HMV: home mechanical ventilation; INR: international normalized ratio; MV: mechanical ventilation; PDT: percutaneous dilational tracheostomy; PEEP: positive end-expiratory airway pressure; ST: surgical tracheostomy.

Table 4. Perioperative complications

Complications n, (%)	PDT [†] (n = 56)	ST [†] (n = 32)
Hypotension	27 (51.8)	17 (46.9)
Minor bleeding	13 (23.2)	8 (25)
Subcutaneous emphysema	3 (5.4)	1 (3.1)
Pneumothorax	1 (1.8)	0
Cardiac arrest	1 (1.8)	1 (3.1)
Arrhythmia	1 (1.8)	0
Esophagus perforation	0	1 (3.1)
Endotracheal tube dislocation	1 (1.8)	0
False passage	1 (1.8)	0

†Comparisons between PDT and ST were not statistically significant (χ^2 or Fisher exact test).

the both groups. There were not also any differences in survival rates at 28 days after tracheostomy (PDT, 33 [58.9%]; ST, 24 [75%]; $p=0.098$), hospital discharge (PDT, 21 [37.5%]; ST, 15 [46.9%]; $p=0.390$) and 1 year (PDT, 7 [12.4%]; ST, 7 [21.9%]; $p=0.247$) between the two groups.

Discussion

Tracheostomy in the ICU is performed in two ways. The surgical technique is the oldest method and special education is needed for this technique. The other method is PDT which is a relatively new method and physicians without any surgical training can perform it after a short training. Another advantage of PDT is the performance of tracheostomy at bedside which eliminates the risks of transporting critically ill patients outside the ICUs (2). However, studies did not show any differences in survival rates, early or late complications, success rates, and LOS in the ICU and hospital between the two methods (4,5,12,13). Our results were compatible with the literature in this sense. Nevertheless, the patients with ST had almost 3 consultations from other clinics for general anesthesia preparation. These consultations, compared to PDT, resulted in extended waiting time for ST after informed consent was signed. Although the patients with the larynx and neck abnormalities received ST, perioperative complications were not high in ST. First, this could be explained by the surgeons' skills. Second, all ST were elective and performed after all risk factors for complications were searched thoroughly by the surgeons. Third, we did not perform PDT by using fiber optic bronchoscopy (FOB) guidance. This could be a reason not to have low complication rates in the patients with PDT who did not have any neck abnormalities compared to the patients with ST. FOB allows the physicians to locate tracheostomy site easily, to monitor all stages of the tracheostomy procedure and to fix the complications immediately when happened, such as false passage or tracheal bleeding. Studies showed lower complication rates in patients with FOB guided PDT than in patients with blindly performed PDT (14). We did not study the relationship between complication

rates and the experience of the operating physicians which is as important as inherent problems of the both techniques. Powell et al demonstrated that the physician with more experience in PDT had less perioperative complications than the physician with less experience (15). A study including 500 patients with PDT displayed a statistically significant relationship between the experience of the physician and the likelihood of complications in the patients using the multiple dilator technique, with a higher rate of complications in the first 30 patients (16). Additionally, there is a learning curve for the both types of the tracheostomy procedures, spanning several years. A metaanalysis done by Dulgeroy et al reported a significantly lower ST complication rate performed between 1985 and 1996 in comparison to those performed prior to 1985 (17). A prospective observation showed gradually decreased perioperative complication rates in the patients with PDT from the year of 1993 to the year of 1999 (18).

The incidence of the tracheostomy procedure is increasing among ICU patients (19). Mainly patients with prolonged MV receive tracheostomy during the ICU care as occurred in the present study (5,7,13). Other two important reasons for tracheostomy are airway protection from aspiration and respiratory hygiene (5,13). In the current study, the patients who received tracheostomy in order to protect the airways had significantly lower GCS than other patients which was similar with the literature (20). The patients who had tracheostomy to provide respiratory hygiene in this study were at advanced stages of dementia/Parkinson's disease, cerebral palsy, chronic lung disease or cancer. These patients were admitted to the ICU due to pneumonia-related respiratory failure (21). Since they did not have enough strength to clean respiratory secretion, they received tracheostomy. Moreover, the rate of HMV was high among them due to malnutrition and sarcopenia, generally seen in patients with terminal diseases (22). The patients with neuromuscular diseases also left the hospital with HMV. MV is the main therapeutic intervention to support respiratory muscle function in these patients as the underlying neuromuscular disease progresses (23).

The mortality rate in our patients was higher than the literature that were reported between 20%-48% (7,9,12). The high hospital mortality rate was most probably due to the underlying diseases of the patients. An important number of the study population was bedridden due to terminal stages of chronic diseases, such as dementia/Parkinson's disease, cancer and chronic lung disease, and these patients generally had a high risk of death (24-26). The second reason of high mortality was the inclusion of a considerable amount of the patients who had CPR prior to the ICU admission where 58% of these patients died before the hospital discharge. Patients who have undergone CPR generally have a low survival rate in contrast to other ICU patients (27). The third reason of low survival rate was the high number of older patients compared to the other studies (5,12). ICU mortality rates were reported to be notably elevated in older tracheostomized or nontracheostomized patients (19,28). An important number of the patients died inpatient services which was similar to the literature (29). This can be explained in two ways (29). First, these patients could not be decannulated as they had serious impairment of respiratory function. Consequently, they were more likely to die after ICU discharge. The second

reason could be poor tracheostomy care in the wards which could be responsible for complications, such as obstruction of the cannula, and subsequent increased mortality.

There were some limitations of this study. First, this was a single centered study with limited number of the patients which could create issues when generalizing the results. Second, patients with terminal stage of illnesses underwent tracheostomy in order to be discharged from the ICU as withdrawing or withholding therapies are outlawed in the country. Therefore, an important number of the patients had tracheostomy in whom the tracheostomy procedure would not be considered in some other countries. Third, we did not follow postoperative complications, such as stoma infection, tracheal stenosis, tracheostomy tube displacement and inability to place tracheostomy tube, tracheostomy tube occlusion and bleeding which are important parameters affecting morbidity and mortality in tracheostomized patients. Fourth, this was not a

randomized study and the type of the tracheostomy procedure was defined by the ICU physicians where difficult necks were given to ST. This may cause biases in comparison of the results regarding PDT and ST. Sixth, we did not compare the cost between ST and PDT which can be an important criterion in selecting the type of the procedure as the methods of lowering cost in the ICU are well accepted by hospital managers.

Conclusion

We found that both ST and PDT were safe procedures in the ICU. However, more consultations were asked for the patients who had ST and this resulted in the delay of the procedure after the tracheostomy decision was made. Although the 28-day survival rate after the tracheostomy procedure was high, hospital discharge rate was not notable. This was most probably due progressive underlying diseases of the patients.

AUTHOR CONTRIBUTIONS:

Concept: TA; **Design:** TA, EST; **Supervision:** TA, EST; **Resources:** TA, EST, EG; **Materials:** TA, EST, EG; **Data Collection and/or Processing:** TA, EST, EG; **Analysis and/or Interpretation:** TA; **Literature Search:** TA, EST, EG; **Writing Manuscript:** TA, EST, EG; **Critical Review:** TA, EST.

Ethics Committee Approval: The study protocol was approved by the ethics review board of the Düzce University, approval number: 2015/171, date:17.09.2015.

Informed Consent: Informed consent for the tracheostomy procedure was obtained from the relatives of the patients.

Peer-review: Externally peer-reviewed.

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