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Original Article

Factors Determining the Timing of Tracheostomy in Medical ICU of a Tertiary Referral Hospital

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Background: Tracheostomy is a common procedure for patients requiring prolonged mechanical ventilation. However, the timing of tracheostomy is quite variable. This study was performed to find out the factors determining the timing of tracheostomy in medical intensive care unit (ICU).

Methods: Patients who were underwent tracheostomy between January 2008 and December 2009 in the medical ICU of Seoul National University Hospital were included in this retrospective study.

Results: Among the 59 patients, 36 (61.0%) were male. Median Acute Physiology And Chronic Health Evaluation (APACHE) II scores and Sequential Organ Failure Assessment scores on the admission day were 28 and 7, respectively. The decision of tracheostomy was made on 13 days, and tracheostomy was performed on 15 days after endotracheal intubation. Of the 59 patients, 21 patients received tracheostomy before 2 weeks (group I) and 38 were underwent after 2 weeks (group II). In univariate analysis, days until the decision to perform tracheostomy (8 vs. 14.5, $p<0.001$), days before tracheostomy (10 vs. 18, $p<0.001$), time delay for tracheostomy (2.1 vs. 3.0, $p<0.001$), cardiopulmonary resuscitation (19.0% vs. 2.6%, p=0.049), existence of neurologic problem (38.1% vs. 7.9%, p=0.042), APACHE II scores (24 vs. 30, p=0.002), and $PaO_2/FiO_2<300$ mm Hg (61.9% vs. 91.1%, p=0.011) were different between the two groups. In multivariate analysis, APACHE II scores≥20 (odds ratio [OR], 12.44; 95% confidence interval [CI], 1.14～136.19; p=0.039) and time delay for tracheostomy (OR, 1.97; 95% CI, 1.11～3.55; p=0.020) were significantly associated with tracheostomy after 2 weeks.

Conclusion: APACHE II scores≥20 and time delay for tracheostomy were associated with tracheostomy after 2 weeks.

Key Words: APACHE; Intensive Care Units; Time; Tracheostomy

Introduction

Tracheostomy is a common surgical procedure in the intensive care unit (ICU) for patients requiring prolonged mechanical ventilation. Theoretically, a tracheostomy has some advantages over a translaryngeal endotracheal tube for respiratory physiology, nursing care, and psychology[1,2]. Although some beneficial effects of early tracheostomy have been reported[3], recent large studies were unable to show a reduced incidence of ventilator-associated pneumonia (VAP) and ICU mortality in patients with an early tracheostomy compared to those with a late tracheostomy[4,5]. Despite that it is a common procedure, the optimal time for a tracheostomy in the ICU is not yet clearly defined[1]. Furthermore, the selection of patients and timing of the decision for a tracheostomy are subjective, as no reliable tests have been established to predict the need for prolonged ventilation.

Intubation for 2 weeks is considered safe with the use of a low-pressure and high-volume endotracheal tube

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cuff[6]. According to nationwide surveys, a tracheostomy was performed within 14 days in 90% of German ICUs[7] and within 21 days in 68% of French ICUs[8]. The criterion for an early tracheostomy in clinical trials was defined from as early as 48 hours[3] to as late as 8 days[5].

Traditionally, 2 weeks was the time limit to make the decision for a tracheostomy in all patients requiring prolonged mechanical ventilation. The timing of a tracheostomy is diverse, and delaying a tracheostomy for more than 2 weeks is not uncommon in the ICU, but the reasons for such a delayed tracheostomy have not been investigated. This study was performed to determine the exact timing of a tracheostomy and factors influencing tracheostomy timing in the medical ICU of a tertiary referral hospital in Korea.

Materials and Methods

1. Study population

Patients who were admitted to the medical ICU (22 beds) of Seoul National University Hospital from January 2008 to December 2009 were recruited. Inclusion criteria were age ＞18 years, mechanical ventilation with translaryngeal intubation and first tracheostomy. Exclusion criteria were postoperative patients, multiple separate ICU admissions during the same hospital stay and uncontrolled or haematological malignancy. This protocol (H-1006-141-322) was approved by the Seoul National University Hospital Institutional Review Board.

2. Assessment of organ failure

Organ failure was defined as a Sequential Organ Failure Assessment (SOFA) score[9]≥2 on each item, as follows: PaO_2/FiO_2＜300 mm Hg, the use of inotropics or vasopressors, platelets＜100,000/mm^3, bilirubin≥2.0 mg/dL, creatinine≥2.0 mg/dL and Glasgow Coma Scale≤12. The development of organ failure was defined as the existence of the above criteria from ICU admission to the day of the tracheostomy.

3. Statistical analysis

p-values were calculated using the χ^2 test or Fisher's exact test for categorical variables and the Mann-Whitney U-test for continuous variables. Odds ratios (ORs) were calculated from the logistic regression model in the multivariate analysis. A $p<0.05$ was considered to indicate statistical significance. STATA version 11.0 (StataCorp., College Station, TX, USA) was used for the analysis.

Results

Fifty-nine patients were included in the study (Table 1). The median age of the patients was 68 years (range, 30～88 years), and male gender was predominant (61.0%). The common causes of medical ICU admission were respiratory failure (69.5%) and neurological problems (18.6%), sepsis (10.2%) and cardiac problems (1.7%). Cardiopulmonary resuscitation (CPR) was performed in five of 59 patients prior to medical ICU admission. Median Acute Physiology And Chronic Health Evaluation (APACHE) II score[10] and SOFA score on ICU admission day were 28 (range, 12～40) and 7 (range, 1～17), respectively. The patients were given mechanical ventilation support for 23 days (range, 6～95 days) and remained in the medical ICU for 28 days (range, 7～95 days). Under mechanical ventilation support, the decision to perform a tracheostomy was performed on day 13 (range, 2～28 days) and the actual bedside operation was done on day 15 (range, 5～31 days). The time delay for tracheostomy was 3 days (range, 0～21 days).

Patients were grouped according to the day of tracheostomy, i.e., whether it was performed before or after 2 weeks. Among the 59 patients, 21 (35.6%) received a tracheostomy before 2 weeks (group I), and 38 (64.4%) received one after 2 weeks (group II) (Table 2). In the univariate analysis, the decision and operation time of the tracheostomy were significantly different between the two groups. The time delay for tracheostomy was also different between group I and group II. Compared with group II, group I showed more frequent CPR (19% vs. 2.6%, p=0.049), more common neurological problems (38.1% vs. 7.9%, p=0.042) and lower

Table 1. Baseline characteristics of the 59 participants

Variable	No. (%) (n=59)
Age, yr	68 (30～88)
Male	36 (61.0)
Cardiopulmonary resuscitation	5 (8.5)
Reason for ICU admission	
Respiratory failure	41 (69.5)
Neurologic problem	11 (18.6)
Sepsis	6 (10.2)
Cardiologic problem	1 (1.7)
APACHE II scores	28 (12～40)
SOFA scores	
ICU admission day	7 (1～17)
Tracheostomy day	6 (2～18)
Mechanical ventilation days, day	23 (6～95)
ICU days, day	28 (7～95)
Hospital days, day	55 (11～731)
Organ failure assessment from ICU admission day to tracheostomy day	
PaO_2/FiO_2 < 300 mm Hg	48 (81.4)
Inotropics or vasopressor use	35 (59.3)
Platelet < 100,000/mm^3	18 (30.5)
Bilirubin ≥ 2.0 mg/dL	8 (13.6)
Creatinine ≥ 2.0 mg/dL	13 (22.0)
GCS score ≤ 12	16 (27.1)
Time for tracheostomy decision, day	13 (2～28)
Time for tracheostomy, day	15 (5～31)
Time delay for tracheostomy, day	3 (0～21)
In ICU mortality	17 (28.8)
Discharge	
Home	17 (28.8)
Transfer to other hospital	22 (37.3)
Death	20 (33.9)

Values are presented as number (%) or median (range).
ICU: intensive care unit; APACHE: acute physiology and chronic health evaluation; SOFA: sequential organ failure assessment; GCS: Glasgow Coma Score.

APACHE II scores (24 vs. 30, p=0.002). In the assessment of organ failure, group II patients showed a higher frequency of PaO_2/FiO_2 < 300 mm Hg (61.9% vs. 92.1%, p=0.011). Table 3 shows the multivariate analysis for a tracheostomy after 2 weeks. Our data revealed that higher APACHE II score (≥20) (OR, 12.44; 95% confidence interval [CI], 1.14～136.19; p=0.039) and time delay for tracheostomy (OR, 1.97; 95% CI, 1.11～3.55, p=0.020) were independent significant factors for performing a tracheostomy after 2 weeks.

Discussion

Early prediction of patients who will eventually need a tracheostomy is very difficult. The time for a tracheostomy varies, and the optimal time has not been established. Dunham and LaMonica[6] reported that endotracheal intubation for up to 2 weeks is not associated with increased complications related to translaryngeal intubation. The consensus conference recommends performing a tracheostomy after 3 weeks of translaryngeal intubation[11]. Compared to this relatively late tracheostomy, recent studies have shown a clinical benefit of an early tracheostomy[4,5,12,13]. Some studies have shown that early tracheostomy was related with early weaning from mechanical ventilation; however, a large randomised controlled trial failed to demonstrate a reduction in VAP and mortality through the use of an early tracheostomy[5].

According to our results, the median decision time for a tracheostomy was 13 days, and a tracheostomy was performed at day 15 after translaryngeal intubation. Compared to recent clinical trials, this could be considered a late tracheostomy. Some possible explanations for this include the following. First, the standardised tracheostomy protocol and early-tracheostomy decision algorithm may be helpful. The objective decision algorithm for a tracheostomy predicts prolonged ventilation more effectively[14], whereas the standardised protocol for a tracheostomy may minimise clinical variation[15]. Second, the time gap between decision-making and the actual operation of the tracheostomy was 3 days. Furthermore the time delay for tracheostomy was significantly different between group I and group II. This meant that 3 days were needed for interdepartmental consultation with otolaryngologists and surgical preparation for the tracheostomy and as the time delayed more, the actual tracheostomy was performed lately. As the standard method for a tracheostomy was a bedside surgical procedure at that time in our hospital, the time gap was inevitable. After recently introducing percutaneous dilatational tracheostomy in our medical ICU, we have been able to successfully shorten the gap.

Table 2. Univariate analysis of tracheostomy before and after 2 weeks

Variables	<2 weeks (n=21)	≥2 weeks (n=38)	p-value
Time for tracheostomy decision	8 (2～13)	14.5 (4～28)	<0.001
Time for tracheostomy	10 (5～13)	18 (14～31)	<0.001
Time delay for tracheostomy	2.1 (0～5)	3.0 (0～21)	<0.001
Age, yr	67 (33～81)	69 (30～88)	0.640
Male	15 (71.4)	21 (55.3)	0.223
Cardiopulmonary resuscitation	4 (19.0)	1 (2.6)	0.049
Reason for ICU admission			
Respiratory failure	11 (52.4)	30 (78.9)	0.355
Neurologic problem	8 (38.1)	3 (7.9)	0.042
Sepsis	2 (9.5)	4 (10.5)	1.000
Cardiologic problem	0 (0)	1 (2.6)	1.000
APACHE II scores	24 (12～37)	30 (12～40)	0.002
SOFA scores			
ICU admission day	7 (1～17)	7 (3～15)	0.981
Tracheostomy day	5 (2～15)	6 (2～18)	0.556
Mechanical ventilation days, day	17 (6～88)	32 (9～95)	0.003
ICU days, day	20 (7～91)	33 (15～95)	0.004
Hospital days, day	42 (11～264)	59.5 (21～731)	0.046
Organ failure assessment from ICU admission day to tracheostomy day			
PaO_2/FiO_2 <300 mm Hg	13 (61.9)	35 (92.1)	0.011
Inotropics or vasopressor use	11 (52.4)	24 (63.2)	0.420
Platelet <100,000/mm^3	4 (19.0)	14 (36.8)	0.155
Bilirubin ≥2.0 mg/dL	2 (9.5)	6 (15.8)	0.699
Creatinine ≥2.0 mg/dL	3 (14.3)	10 (26.3)	0.344
GCS score ≤12	8 (38.1)	8 (21.1)	0.159
Sum of organ failure no.	2 (0～5)	2 (0～5)	0.115
In ICU mortality	6 (28.6)	11 (28.9)	0.976
Discharge			
Home	5 (23.8)	12 (31.6)	0.636
Transfer to other hospital	9 (42.9)	13 (34.2)	0.659
Death	7 (33.3)	13 (34.2)	0.946

Values are presented as number (%) or median (range).
ICU: intensive care unit; APACHE: acute physiology and chronic health evaluation; SOFA: sequential organ failure assessment; GCS: Glasgow Coma Score.

Table 3. Multivariate analysis of tracheostomy after 2 weeks

Variables	OR (95% CI)	p-value
Age	1.00 (0.93～1.07)	0.888
Gender (female)	0.23 (0.03～1.71)	0.150
Cardiopulmonary resuscitation	0.92 (0.004～2.11)	0.135
Neurologic problem	0.29 (0.02～4.10)	0.362
APACHE II scores ≥20 (ICU admission day)	12.44 (1.14～136.19)	0.039
SOFA scores (ICU admission day)	0.91 (0.68～1.20)	0.490
SOFA scores (tracheostomy day)	0.93 (0.73～1.17)	0.518
PaO_2/FiO_2 <300 mm Hg	6.25 (0.22～179.79)	0.285
Time delay for tracheostomy, day	1.97 (1.11～3.55)	0.020

OR: odds ratio; CI: confidence interval; APACHE: acute physiology and chronic health evaluation; ICU: intensive care unit; SOFA: sequential organ failure assessment.

We found some similar patterns in the decision-making concerning tracheostomy. Most of the patients who were assessed with an irreversible brain injury (previous neurological problems or post CPR) received an early (<2 weeks) tracheostomy (Table 2), while patients who had higher APACHE II scores received a late (≥2 weeks) tracheostomy. If high mortality was expected on the day of medical ICU admission, the decision and procedure time for the tracheostomy were delayed. Also, a late tracheostomy was preferred in the event of respiratory failure (PaO_2/FiO_2 < 300 mm Hg).

Effects of a selection bias may exist due to the retrospective nature of this study. According to our results, the median time of tracheostomy was 15 days after endotracheal intubation. The patient must be alive at the time with tolerable operative conditions to receive a tracheostomy. If a patient showed unfavourable operative conditions, the tracheostomy might have be postponed. During these delays, the critically ill cases may have died before a tracheostomy. In other words, only those who survived longer in the medical ICU received a tracheostomy. Considering this selection bias, we did not compare the mortality according to the timing of the tracheostomy.

In conclusion, tracheostomy was performed a median of 15 days after endotracheal intubation in the medical ICU. Our data suggest that high APACHE II scores (≥20) may influence the timing of a tracheostomy in a medical ICU. And the time gap caused by interdepartmental consultation for tracheostomy was another independent factor for delayed tracheostomy.

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