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ORIGINAL ARTICLE

Comparison of the Clinical Effects of Early and Late Percutaneous Tracheostomy Timing in Intensive Care Unit Patients

Yoğun Bakım Hastalarında Erken ve Geç Perkütan Trakeostomi Zamanlamasının Klinik Etkilerinin Karşılaştırılması

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ABSTRACT

Background/Aims: Percutaneous tracheostomy (PT) is defined as early or late PT by the time from the patient's intubation to the day of the PT procedure. In this retrospective study, we aimed to evaluate the effects of early and late tracheostomy timing on the duration of mechanical ventilation (MV), duration of intensive care unit (ICU) stay, length of hospital stay, complications, and mortality.
Methods: The files of critically ill patients from hospital records undergoing tracheostomy during the treatment in the Anesthesiology and Reanimation ICU between 1st March 2023, and 31st May 2024 were retrospectively evaluated. Patients in whom tracheostomy was performed before the 10th day and on the 10th day of intubation were grouped as early tracheostomy, and those in whom tracheostomy was performed after the 10th day were grouped as late tracheostomy.
Results: The study included 90 patients. The early tracheostomy group (n=45) was significantly younger than the late tracheostomy group (n=45). The mean age of the early tracheostomy group was 62.42 ± 16.78, while that of the late tracheostomy group was 69.58±16.20 (p=.043). The median length of ICU stay was 32 days (range: 6-270 days) in the early tracheotomy group and 45 days (range: 16-270 days) in the late tracheotomy group; and the length of ICU stay in the early tracheotomy group was significantly shorter than the late tracheotomy group (p=.025). Besides, the number of MV days was significantly greater in patients in the late tracheotomy group compared with patients in the early tracheotomy group [32 days (range: 6-230 days)] vs [40 days (range: 16-265 days)] (p=.032).
Conclusions: Early tracheostomy procedure is important and beneficial for the treatment of elderly intensive care patients because it reduces the duration of ICU stay and reduces the duration of MV.

Keywords: Elderly, Intensive Care Unit, Mortality, Tracheostomy

ÖZ

Giriş/Amaçlar: Perkütan Trakeostomi (PT), hastanın entübasyonundan PT işleminin yapıldığı güne kadar geçen süreye göre erken veya geç PT olarak tanımlanır. Bu retrospektif çalışmada erken ve geç trakeostomi zamanlamasının mekanik ventilasyon süresi, yoğun bakım ünitesinde kalış süresi, hastanede kalış süresi, komplikasyonlar ve mortalite üzerindeki etkilerini değerlendirmeyi amaçladık.
Gereç ve Yöntem: Anesteziyoloji ve Reanimasyon Yoğun Bakım Ünitesi'nde (YBÜ) 1 Mart 2023-31 Mayıs 2024 tarihleri arasında tedavileri sırasında trakeostomi uygulanan kritik hastaların dosyaları ve hastane kayıtları retrospektif olarak değerlendirildi. Entübasyonun 10. gününde ve 10. günden önce trakeostomi yapılan hastalar erken trakeostomi, 10. günden sonra trakeostomi yapılan hastalar geç trakeostomi olarak gruplandırıldı.
Bulgular: Çalışmaya 90 hasta dahil edildi. Erken trakeostomi grubu (n=45) geç trakeostomi grubundan (n=45) anlamlı olarak daha gençti. Erken trakeostomi grubunun yaş ortalaması 62.42 ± 16.78 iken, geç trakeostomi grubunun yaş ortalaması 69.58 ± 16.20 idi], p=.043. Erken trakeostomi grubunun yaş ortalaması 62.42 ± 16.78 iken, geç trakeostomi grubunun yaş ortalaması 69.58 ± 16.20 idi], p=.043. Ortanca YBÜ kalış süresi erken trakeotomi grubunda 32 gün (dağılım: 6-270 gün) ve geç trakeotomi grubunda 45 gün (dağılım: 16-270 gün) idi ve erken trakeotomi grubunda yoğun bakım kalış süresi geç trakeotomi grubuna göre anlamlı derecede kısaydı (p=.025). Ayrıca, mekanik ventilasyon süresi geç trakeotomi grubundaki hastalarda erken trakeotomi grubundaki hastalara kıyasla anlamlı olarak daha fazlaydı (32 gün [dağılım: 6 - 230 gün] vs. 40 gün [dağılım: 16 - 265 gün], p=.032).
Sonuçlar: Erken trakeostomi prosedürü, yoğun bakım ünitesi kalış süresini ve mekanik ventilasyon süresini azalttığı için yaşlı yoğun bakım hastalarının tedavisi için önemli ve faydalıdır.

Anahtar kelimeler: Mortalite, Trakeostomi, Yaşlı, Yoğun Bakım Ünitesi

Introduction

Percutaneous tracheostomy (PT) is a common procedure in Intensive Care Units (ICU). Approximately 20-24% of critically ill patients intubated in the ICU undergo tracheostomy (1). Critically ill patients may require prolonged respiratory support due to respiratory failure. In such cases, tracheostomy is a common procedure that has been proven to shorten MV time, reduce the need for sedation, and improve pulmonary hygiene (2). Its biggest advantages are that it is performed at the bedside in the ICU, the patient does not need to be transported to the operating room, the complications are low and it is performed in a short time. It also allows the patient to be fed orally and enhances the patient's communication. (3).

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It is defined as early or late PT according to the time from the patient's intubation to the day of the PT procedure. There are different opinions among intensivists about the timing of these periods. While some physicians accept the first two and four days for the definition of early tracheostomy, others accept the 6th, 10th, 14th, and 21st days for the definition of late tracheostomy (1, 4-6). There is still no consensus on the timing of early and late tracheostomy.

In this retrospective study, we aimed to evaluate the effects of early and late tracheostomy timing on the duration of MV, duration of ICU stay, length of hospital stay, complications, and mortality in patients with PT in the Anesthesiology and Reanimation ICU.

Material and Methods

The study was conducted after obtaining the approval of the Local Ethics Committee of Selçuk University Faculty of Medicine. It was conducted under the World Medical Association Declaration of Helsinki. The files and hospital records of critically ill patients who underwent tracheostomy during their treatment in the 3rd level 48-bed Anesthesiology and Reanimation ICU of Selcuk University Faculty of Medicine between 1st March 2023, and 31st May 2024 were retrospectively evaluated. Informed consent was obtained for all tracheostomies. Patients over 18 years of age undergoing PT were included in the study. Patients in whom PT was performed were divided into two groups according to the timing of tracheostomy. Patients in whom tracheostomy was performed on the 10th day of intubation and before the 10th day were grouped as early tracheostomy, and patients in whom tracheostomy was performed after the 10th day were grouped as late tracheostomy. All percutaneous tracheostomies were performed at the bedside under visualization with a fiberoptic bronchoscope. A single-step dilation method known as the modified Ciaglia technique was used for tracheostomies. In this technique, a flexible, hard rubber, hydrophilic-coated special dilator is used to reduce complications such as posterior wall damage and bleeding that may occur during multiple dilatations. Instead of multiple dilatations as in the classical 'Ciaglia' method, single dilatation over the guide wire and guiding catheter can be performed with this dilator. All PT techniques were performed according to the Seldinger guidewire principle. At the end of the PT, chest radiography was performed at the bedside after listening to respiratory sounds.

Patient's demographic features: age, gender, body mass index [BMI (kg/m2), cachexia: <18,5 kg/m2, normal: 18,5-25 kg/m2, overweight: ≥25 kg/m2], smoking, comorbidities: history of diabetes mellitus, chronic kidney disease (defined as estimated glomerular filtration rate <30 mL/min/1.73 m2), chronic heart disease (defined as current or previous history of cardiac dysfunction), hypertension, malignancy, cerebrovascular disease (defined as stroke or hemoragy), chronic respiratory disease (defined as chronic obstructive pulmonary disease or asthma), diagnosis on admission, Acute Physiology and Chronic Health Evaluation II (APACHE II) score, was collected.

Laboratory values in the last 24 hours before the tracheostomy procedure were recorded. White blood cell (K/uL), hemoglobin (g/dL), platelet count (K/uL), activated partial thromboplastin time (aPTT [sec]), international normalized ratio (INR) values of perioperative factors were recorded.

Early complications within 48 hours (wound site infection, subcutaneous emphysema, pneumothorax, minor bleeding, major bleeding, and mortality) were recorded.

Length of stay (LOS) in ICU (day), length of LOS at hospital (day), number of MV days, 30-day mortality, ICU mortality, ventilator-associated pneumonia (VAP), discharge, decanulation information, need for ventilator support at discharge were obtained from the patient's records.

Statistical Analysis

All statistical analysis was performed using R version 4.2.1 (www.r-project.org) statistical language. To check the normality of the data and homogeneity of the variance, Shapiro-Wilk's normality test and Levene test were used, respectively. Data were presented as mean ± standard deviation, median (range: min – max), or median [IQR: inter-quartile range] for numerical variables; and compared with student's t-test and Mann-Whitney U test. Data were described as count (n) and percentage (%); and compared with Pearson chi-square test, Fisher exact test, Chi-square test with Yates continuity correction, Fisher-Freeman-Halton test, and Two proportion Z-test according to the groups. A two-tailed p-value less than .05 was considered statistically significant.

Results

In our study, we found that PT was performed in 90 of 174 patients undergoing surgical and PT; of these

patients, 45 were in the early tracheostomy group and 45 (n=45) were in the late tracheostomy group (Figure 1). The mean age of 90 patients was 66±16.79

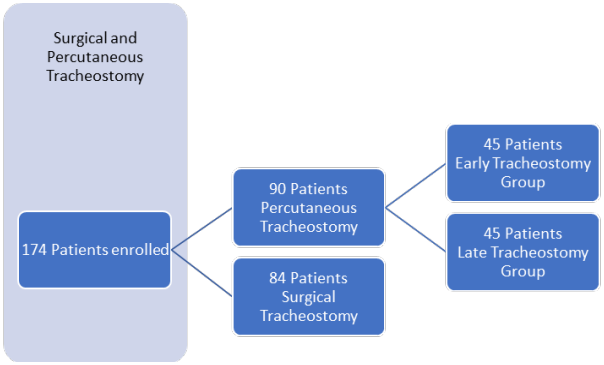

Figure 1. Flow diagram of patients in the study.

comorbidities, and diagnosis on admission were similar (Table 1).

Laboratory values in the last 24 hours before the tracheostomy procedure were the same in both groups (Table 2).

Tracheostomy-related complications included minor bleeding in 2 patients (66.7%) and wound site infection in 1 patient (33.3%) in the early tracheostomy group. In the late tracheostomy group, minor bleeding was observed in 2 patients (66.7%) and subcutaneous emphysema in 1 patient (33.3%). There was no difference between the two groups in terms of complications (Table 3).

Table 1. Baseline characteristics of patients at inclusion in the study.

	Total (*n*=90)	Early Tracheostomy (*n*=45)	Late Tracheostomy (*n*=45)	*p*-value
Demographical characteristics				
Age (years)	66±16.79	62.42±16.78	69.58±16.20	.043[1]
Gender (M/F)	56/34	29/16	27/18	.828[2]
BMI (kg/m²)				.102[3]
Normal	44 (48.9)	18 (40)	26 (57.8)	
Overweight	34 (37.8)	18 (40)	16 (35.6)	
Cachexia	12 (13.3)	9 (20)	3 (6.7)	
Smoking	30 (33.3)	13 (28.9)	17 (37.8)	.502[2]
Comorbidity				
Diabetes Mellitus	25 (27.8)	9 (20)	16 (35.6)	.158
Chronic Kidney Disease	12 (13.3)	3 (6.7)	9 (20)	.121[2]
Chronic Heart Disease	36 (40)	14 (31.1)	22 (48.9)	.132[2]
Hypertension	40 (44.4)	18 (40)	22 (48.9)	.525[2]
Malignancy	17 (18.9)	10 (22.2)	7 (15.6)	.591[2]
Cerebrovascular Disease	43 (47.8)	25 (55.6)	18 (40)	.205[2]
Chronic Respiratory Disease	18 (20)	9 (20)	9 (20)	>.999[2]
Diagnosis on Admission				
Post-cardiac arrest	8 (8.89)	4 (8.89)	4 (8.89)	>.999[6]
Neurological Diseases	34 (37.78)	21 (46.67)	13 (28.89)	.082[6]
Internal Diseases	30 (33.33)	13 (28.89)	17 (37.78)	.371[6]
Trauma	16 (17.78)	5 (11.11)	11 (24.44)	.098[6]
Dermatomyositis	2 (2.22)	2 (4.44)	0 (0)	.153[6]
APACHE II score	15.5 (3-64)	15 (3-60)	17 (5-64)	.278[7]

[1]Student's *t*-test; [2]Chi-square test with Yates continuity correction; [3]Pearson's chi-square test; [4]Fisher's exact test; [5] Fisher-Freeman-Halton test; [6]Two-proportion Z-test; [7]Mann-Whitney U test; Data were presented as mean±standard deviation, median (range: min-max) or median [IQR: Inter-quartile range] for numerical variables. Data were described as count (n) and percentage (%).

years. The early tracheostomy group was significantly younger than the late tracheostomy group. The mean age of the early tracheostomy group was 62.42 ± 16.78, while that of the late tracheostomy group was 69.58±16.20 (p=.043). Of the patients, 56 and 34 were males and females. APACHE II score, BMI, smoking,

The median ICU length of stay was 32 days (range: 6 – 270 days) in the early tracheostomy group and 45 days (range: 16 – 270 days) in the late tracheostomy group; and the ICU length of stay in the early tracheostomy group was significantly shorter than the late tracheostomy group (p=.025). Besides, the number of MV days was significantly greater in patients in the

Table 2. Comparison of pre-procedure laboratory values of the two groups.

	Total (n=90)	Early Tracheostomy (n=45)	Late Tracheostomy (n=45)	*p*-value
WBC (K/uL)	12.95±6.12	12.93±5.61	12.97±6.65	.976[1]
Hemoglobin (g/dL)	9.61±1.83	9.83±2.02	9.39±1.61	.253[1]
Platelet count (K/uL)	212.5 [155-322.75]	212 [152-296]	214 [166-335]	.623[7]
APTT (sec)	29.33±6.16	29.13±5.52	29.53±6.80	.759[1]
INR	1.18 [1.08-1.29]	1.15 [1.07-1.25]	1.22 [1.11-1.29]	.234[7]

WBC: White blood cell, APTT: Activated partial thromboplastin time, INR: International normalized ratio. [1]Student's t-test; [2]Chi-square test with Yates continuity correction; [3]Pearson's chi-square test; [4]Fisher's exact test; [5]Fisher-Freeman-Halton test; [6]Two-proportion Z-test; [7]Mann-Whitney U test; Data were presented as mean±standard deviation, median (range: min-max) or median [IQR: Inter-quartile range] for numerical variables. Data were described as count (n) and percentage (%).

Table 3. Comparison of complications of the two groups.

	Total (*n*=90)	Early Tracheostomy (*n*=45)	Late Tracheostomy (*n*=45)	*p*-value
Overall Complications	6 (6.7)	3 (6.7)	3 (6.7)	>.999[4]
Tracheostomy-related Complications				>.999[5]
Minor bleeding	4 (66.7)	2 (66.7)	2 (66.7)	
Wound Site Infection	1 (16.7)	1 (33.3)	0 (0)	
Subcutaneous emphysema	1 (16.7)	0 (0)	1 (33.3)	

[1]Student's *t*-test; [2]Chi-square test with Yates continuity correction; [3]Pearson's chi-square test; [4]Fisher's exact test; [5]Fisher-Freeman-Halton test; [6]Two-proportion Z-test; [7]Mann-Whitney U test; Data were presented as mean±standard deviation, median (range: min-max) or median [IQR: Inter-quartile range] for numerical variables. Data were described as count (n) and percentage (%).

Table 4. Comparison of the two groups by studied variables.

	Total (n=90)	Early Tracheostomy (n=45)	Late Tracheostomy (n=45)	*p*-value
ICU length of stay (days)	37 (6-270)	32 (6-270)	45 (16-270)	.025[7]
Hospital length of stay (days)	54 (6-270)	45 (6-270)	60 (16-270)	.088[7]
MV time (days)	35 (6-265)	32 (6-230)	40 (16-265)	.032[7]
30-days mortality	24 (26.7)	16 (35.6)	8 (17.8)	.095[2]
ICU mortality	68 (75.6)	34 (75.6)	34 (75.6)	>.999[2]
VAP After Tracheostomy	14 (15.6)	7 (15.6	7 (15.6)	>.999[2]
Patient Disposition				.677[5]
Discharge	4 (4.4)	3 (6.7)	1 (2.2)	
Palliative service	18 (20)	8 (17.8)	10 (22.2)	
Exitus	68 (75.6)	34 (75.6)	34 (75.6)	
Tracheostomy and MV status				>.999[5]
Tracheostomy with MV	9 (40.9)	4 (36.4)	5 (45.5)	
Tracheostomy without MV	2 (9.1)	1 (9.1)	1 (9.1)	
Decannulation before discharge	11 (50)	6 (54.5)	5 (45.5)	

ICU: Intensive care unit; LOS: Length of stay; VAP: Ventilator-associated pneumonia; MV: Mechanical ventilation.[1]Student's t-test; [2]Chi-square test with Yates continuity correction; [3]Pearson's chi-square test; [4]Fisher's exact test; [5]Fisher-Freeman-Halton test; [6]Two-proportion Z-test; [7]Mann-Whitney U test; Data were presented as mean±standard deviation, median (range: min-max) or median [IQR: Inter-quartile range] for numerical variables. Data were described as count (n) and percentage (%).

late tracheostomy group compared with patients in the early tracheostomy group (32 days [range: 6 – 230 days] vs. 40 days [range: 16 – 265 days], p=.032).

Hospital length of stay, 30-day mortality, ICU mortality, and VAP did not differ between the two groups. 68 (75.6%) patients died due to various reasons. Of the surviving patients, 4 (4.4%) were discharged from ICU and 18 (20%) were transferred to palliative service. Before discharge, 11 patients (32.3%) were decannulated who were breathing spontaneously and maintained airway protection. 2 patients (9.1%) were tracheostomized but didn't require a mechanical ventilator. 9 patients (40.1%) had tracheostomy and needed mechanical ventilators (Table 4).

Discussion

This study showed that LOS in ICU and MV days were significantly shorter in early PT patients than in late PT patients. While the mean age of the early group was significantly lower than the late group, the mean age in both groups was elderly critically ill patients over 60 years of age.

The appropriate timing for tracheostomy is still unknown and the evidence is still unclear. (4) The National Association of Medical Directors of Respiratory Care recommends that tracheostomy should replace endotracheal intubation in patients continuing to require MV three weeks after hospitalization. They stated that determining the optimal time for tracheostomy is one of the most important criteria when deciding to perform the procedure (7, 8). In a retrospective study by Bickenbach et al., early tracheostomies before 4th day of MV, intermediate tracheostomies between five to nine days, and late tracheostomies after 10 days were compared. There was a significant decrease in the incidence of VAP and sepsis in the early tracheostomy group compared to the late group. The late tracheostomy group had higher ventilator days and ICU length of stay. ICU mortality was significantly reduced in the late group compared to the early group, but not in the intermediate group (4). This study was conducted in a more specific surgical ICU and the patient population is different from our study. Our study was conducted in an ICU where not only surgical but also medical and surgical patients were admitted. The timing of the early and intermediate groups corresponds to the timing of our early group. Although the patient population was different, prolonged ICU length of stay and MV day decreased in the late tracheostomy group, similar to our study.

In a meta-analysis by Griffiths et al., they concluded that the duration of ICU stay and MV were significantly reduced in the early tracheostomy group compared to the late tracheostomy group. There was no difference in mortality rates (9). These results were similar in our study.

In a retrospective (case-control) study by Nasr et al., they grouped 1-10 days as early and 11-21 days as late tracheostomy group. While MV time and sedation time were found to be decreased, there was no difference in ICU length of stay, hospitalization time, and mortality. They concluded that patients who underwent early tracheostomy could be weaned from the mechanical ventilator rapidly (10). In our study, the duration of MV was also decreased.

Terragni et al. divided the patients into two groups early tracheostomy 6-8 days and late tracheostomy 13-15 days after MV support in their study including 419 patients. They reported that no significant difference in the incidence of VAP between the early and late tracheostomy group (7). Bickenbach et al. reported that; there was a significant decrease in the incidence of VAP and sepsis in the early tracheostomy group compared to the late group (4). In our study, we didn't find any difference in the incidence of VAP between the two groups.

Edipoglu et al. grouped the PT procedures in ICUs within one year as before and after 10 days. They found that the duration of ICU stay of the early tracheostomy group was significantly shorter than the late tracheostomy group, but they reported that there was no between-group difference in mortality (5). By these findings, we also found that the duration of ICU stay was significantly shorter in the early tracheostomy group, and similarly, we could not detect a significant difference in mortality.

Rumbak et al. showed that a tracheostomy performed within 2 days of hospitalization reduced the mortality rate, the occurrence of pneumonia, and length of ICU stay compared to a tracheostomy performed 14 to 16 days after endotracheal intubation (11). In our study, we didn't find any difference in the incidence of VAP and mortality rate between the two groups.

Tang et al. compared outcomes between early and late tracheostomy in Covid-19 ICU patients. They found that tracheostomies performed after 14 days were associated with increased mortality compared to early ones (12).

A recent study of 235 critically ill elderly patients found that the very early tracheostomy group had a shorter ICU stay and reduced hospital mortality, as well as a better postoperative survival rate. While the mean age of the three groups was over 60 years, the age in the very early tracheostomy group was significantly younger than that in the early tracheostomy group and the late tracheostomy group (6). In our study, the mean age in the early tracheostomy group was significantly younger than that in the late tracheostomy group. Similarly, the mean age was above 60 years in both groups. While the duration of ICU stay decreased, no difference was observed in mortality in early tracheostomy in our study, contrary to this study.

In previous studies; early complications related to percutaneous dilatational tracheostomy techniques range from 9.7% to 15% (13, 14). In this study, although the complication rates associated with tracheostomy were similar between the two groups, the complication rate in the early tracheostomy group was lower than in previous studies.

The limitations of this study are that it was retrospective, conducted in a single center and a single ICU, the number of cases was small, and we could not evaluate the follow-up of long-term complications such as tracheoesophageal fistula, esophageal injury, and stenosis. There is a need for multicenter, prospective studies in which forward-looking and long-term complications will be followed up. The fact that our study population was elderly and had comorbid diseases poses an increased risk for mortality. Prospective studies in younger critically ill patients are needed.

Conclusion

We consider that the early PT procedure is important and beneficial for the treatment of elderly intensive care patients because it reduces the duration of ICU stay and reduces the duration of MV. At the same time, we think that the older age of the late group may be due to the waiting period after discontinuation of anticoagulants and anti-aggregants due to comorbidities, severe hypoxia, and late consent for tracheostomy by relatives of elderly patients.

Informed Consent

Informed consent was obtained from all of the participants included in the study.

Ethical Approval

The protocol of this study was approved by the Clinical Research Ethics Committee of Selcuk University, Konya (Number and date: 2024/436, 30th July 2024).

Author Contribution

Conceptualization: YSB; Methodology: YSB; Formal analysis: YSB; Investigation: YSB; Resources: YSB; Writing-original draft preparation: YSB; Writing_review and editing, YSB. All authors have read and approved the published version of the manuscript.

Conflicts of Interest

The authors have no conflicts of interest to declare.

Supporting Institution

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Main Points

PT is a common procedure in ICUs. It is defined as early or late PT according to the time from the patient's intubation to the day of the PT procedure. There are different opinions among intensivists about the timing of these periods.

Patients in whom tracheostomy was performed on the 10th day of intubation and before the 10th day were grouped as early tracheostomy, and patients in whom tracheostomy was performed after the 10th day were grouped as late tracheostomy.

Early PT procedure is important and beneficial for the treatment of elderly intensive care patients because it reduces the duration of ICU stay and reduces the duration of MV.

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