Turk J Intensive Care
DOI: 10.4274/tybd.galenos.2023.60362

ORIGINAL RESEARCH / *ÖZGÜN ARAŞTIRMA*

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Evaluation of Early and Late Tracheostomy Applications in Intensive Care Patients Before and After the COVID-19 Pandemic: Four-year Tertiary Center Experience

COVID-19 Pandemisi Öncesi ve Sonrasında Yoğun Bakım Hastalarında Gerçekleştirilen Erken ve Geç Trakeostomi Uygulamalarının Değerlendirilmesi: Dört Yıllık Tersiyer Merkez Deneyimi

Received/Geliş Tarihi : 01.10.2022
Accepted/Kabul Tarihi : 12.10.2023

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ABSTRACT *Objective:* With the COVID-19 pandemic, optimal tracheostomy time has become critical. This study investigates the effects of early and late tracheostomy applications performed in a tertiary center's Intensive Care Unit (ICU) on patient outcomes and mortality during the four years before and after the COVID-19 pandemic.
Materials and Methods: This retrospective cross-sectional study included patients who underwent percutaneous tracheostomy in the ICU between March 2018 and March 2022. Patients were classified as Group 1 (early <10 days) and Group 2 (late ≥ ten days) and evaluated in periods before and after the COVID-19 pandemic. Demographic data, clinical features, and mortality of the patients were analyzed.
Results: One hundred thirty-seven patients were included in the study. Of the population, 62% were male, and 29.1% underwent early tracheostomy. Although the mean age of the patients in Group 1 and the length of stay in the ICU were significantly lower, no significant difference was found between the groups in terms of mortality. Cranial pathologies were the most common indication for hospitalization in the ICU of patients who underwent tracheostomy before the pandemic, while COVID-19 was during the pandemic period. There was no significant effect of the COVID-19 pandemic on early-late tracheostomy rates, length of stay in the ICU, and mortality. During the pandemic, there was a significant difference in mortality only in patients with cranial pathology.
Conclusion: In this study, it was determined that early tracheostomy application decreased the length of ICU stay but did not significantly affect mortality. In addition, we found that the COVID-19 pandemic did not significantly affect mortality, except for early-late tracheostomy rates and patients with cranial pathology.
Keywords: Tracheostomy, COVID-19, intensice care unit, intubation, mortalit

ÖZ *Amaç:* COVID-19 pandemisi ile birlikte optimum trakeostomi zamanı önemli hale gelmiştir. Bu çalışmanın amacı, COVID-19 pandemisinden önceki ve sonraki 4 yıllık süreçte tersiyer bir merkezin Yoğun bakım ünitesinde (YBÜ) gerçekleştirilen erken ve geç trakeostomi uygulamalarının hasta sonuçları ve mortalite üzerine etkisini araştırmaktır.
Gereç ve Yöntem: Retrospektif kesitsel olan bu çalışmaya Mart 2018 ile Mart 2022 tarihleri arasında YBÜ'de perkütan trakeostomi açılan hastalar dahil edildi. Hastalar Grup 1 (erken <10 gün) ve Grup 2 (geç ≥ 10 gün) olarak sınıflandırılarak COVID-19 pandemisi öncesi ve sonrası dönemler halinde değerlendirildi. Hastaların demografik verileri, klinik özellikleri ve mortaliteleri analiz edildi.
Bulgular: Perkütan trakeostomi açılan 137 hasta çalışmaya dahil edildi. Tüm popülasyonun %62'si erkekti ve %29.1'ine erken trakeostomi uygulandığı saptandı. Grup 1'deki hastaların yaş ortalaması ve YBÜ'de kalış süresi anlamlı olarak düşük olmakla birlikte gruplar arasında mortalite açısından anlamlı farklılık saptanmadı. Pandemi öncesinde trakeostomi açılan hastaların en sık YBÜ'ne yatış

endikasyonu kranyal patolojiler iken pandemi döneminde COVID-19 idi. COVID-19 pandemisinin, erken-geç trakeostomi oranları, YBÜ'de kalış süresi ve mortalite üzerine anlamlı etkisi saptanmadı. Pandemi döneminde sadece kranyal patolojili hastaların mortalitelerinde anlamlı farklılık mevcuttu.
Sonuç: Bu çalışmada erken trakeostomi uygulamasının YBÜ kalış süresini azaltmakla birlikte mortalite üzerine anlamlı etki yapmadığı saptandı. Ek olarak COVID-19 pandemisinin, erken-geç trakeostomi oranları ve kranyal patolojili hastalar dışında mortalite üzerinde anlamlı etki yapmadığını saptadık.
Anahtar Kelimeler: Trakeostomi, COVID-19, yoğun bakım ünitesi, entübasyon, mortalite

Introduction

Tracheostomy is the opening of the tracheal ostium to the skin by creating an opening in the anterior wall of the trachea. With the development of percutaneous techniques, it has become a frequently applied procedure in intensive care unit (ICU) patients. Long-term respiratory failures, decreased level of consciousness, loss of airway reflexes, and trauma are the most common indications for tracheostomy (1). It has advantages such as ensuring airway safety, facilitating nursing care and aspiration of the respiratory tract, reducing the need for sedation, facilitating the patient's discharge from the ICU, allowing oral feeding, and enabling speech (2,3). There is no absolute consensus on when tracheostomy should be opened in patients followed in the ICU. However, there is no agreed time frame for defining tracheostomy as early or late (4).

As a cause of viral pneumonia, COVID-19 causes prolonged hospitalizations, and mechanical ventilators in various patient groups are needed in the ICU (5,6). The incidence of acute hypoxemic respiratory failure and ARDS in COVID-19 pneumonia has been reported in 17-29% (7). It has been reported that 10-15% of COVID-19 patients who develop ARDS need tracheostomy (8). Although some guidelines do not recommend early tracheostomy in COVID-19 patients, it has been reported to be performed safely (9,10).

This study aims to investigate the effects of early and late tracheostomy applications performed in the ICU of a tertiary center on patient outcomes and mortality during the four years before and after the COVID-19 pandemic.

Materials and Methods

Ethics committee approval was obtained from the University of Health Sciences Turkey, Kanuni Sultan Süleyman Training and Research Hospital Clinical Research Ethics Committee for this retrospective cross-sectional study (date: 30.06.2021 number:200). The study was started following the principles of the Declaration of Helsinki. Percutaneous tracheostomy procedures were performed in the intensive care unit of XXXX University Hospital (ICU) before and after the COVID-19 pandemic for four years (01.03.2018-01.03.2022). They were reviewed retrospectively through the hospital information system.

Before the COVID-19 pandemic, ICU service with 36 beds was provided by our hospital's Anesthesiology and Reanimation Clinic. As a result of the increasing need for beds after the pandemic, a new ICU was put into service, and ICU service was provided to patients with 50 beds. In this descriptive study, the sample size was not chosen. All patients who underwent percutaneous tracheostomy in the ICU during the four years between the relevant dates were included in the study. The study did not include patients who underwent surgical tracheostomy procedures in the operating room and were previously tracheostomized.

Demographic data of patients, indications for admission to ICUs, comorbidities, tracheostomy opening times, length of stay in ICU, length of stay on the mechanical ventilator after tracheostomy, APACHE-2 (Acute Physiology and Chronic Health Assessment-2) scores during hospitalization, discharge status (palliative care, home, inpatient service) and 90-day mortality were investigated. The patients were analyzed by classifying them as Group 1 (early <10 days, before ICU hospitalization reached ten days) and Group 2 (late ≥10 days, and tracheostomy opened after 10 days of ICU admission) according to the time of tracheostomy. In addition, early-late tracheostomy applications performed in the pre-pandemic and post-pandemic periods were analyzed. In order to provide standardization in the diagnosis of admission to the ICU, patients were divided into groups as those with cranial pathologies and those with respiratory pathologies and analyzed in pre- and post-pandemic periods. Epidural, subdural, intracranial hemorrhages, traumatic brain injuries, and strokes were considered cranial pathologies. Pneumonia, other conditions causing respiratory failure, sepsis, and COVID-19 were accepted as respiratory pathologies.

Statistical Analysis

SPSS 29.0 program (SPSS Inc., Chicago, USA) was used to analyze the data. Data are expressed as mean, standard deviation, number of patients (n), and percentage. The conformity of the variables to the normal distribution was evaluated analytically (Shapiro-Wilks test) and visually (histogram). Independent sample t-test was used to analyze quantitative data with normal distribution among the groups, and the Mann-Whitney U test was used to analyze quantitative variables that did not show normal distribution. The Pearson chi-square and Fisher's Exact tests were used to evaluate qualitative data. The statistical significance limit was accepted as $p<0.05$.

Results

A total of 137 patients who underwent percutaneous tracheostomy during the four years before and after the COVID-19 pandemic in the ICU were included in the study. Between the relevant dates, eight patients were found to have undergone surgical tracheotomy for various reasons (such as neck trauma and complicated head-neck structure), and these patients were not included in the study. There were 62% (n=85) men in the population, and the mean age was 62.2±18.3 years. Early tracheostomy was found in 29.1% (n=40) of all tracheostomies (Group 1). The mean age and length of stay in the ICU of the patients who underwent early tracheostomy were significantly lower than those who underwent late tracheostomy ($p=0.006$ and $p<0.001$, respectively). However, early and late tracheostomy applications did not significantly affect discharge and mortality in the whole population ($p=0.844$ and $p=0.969$, respectively) (Table 1).

When tracheostomy applications were analyzed by dividing them into pre- and post-COVID-19 periods, 37.9% (n=52) of tracheostomies were performed before and 62.1% (n=71) during the pandemic. While 0.72 (52/36/2) tracheostomies were performed per bed per year before the pandemic, it was found that 0.85 (85/50/2) tracheostomies per bed per year during the pandemic period. There was no significant difference in the number of patients who underwent early and late tracheostomy according to the periods ($p= 0.398$). Although the discharge rates were lower in patients with tracheostomy during the pandemic, no significant difference was found (38.8% vs. 51.9%, $p=0.134$). Similarly, although mortality rates were higher during the pandemic, no significant difference was found (60% vs. 46.1%, $p=0.114$) (Table 2).

Table 1. Demographic data and some clinical characteristics of the whole population before and after the COVID-19

Variable	All population (n=137)	Group 1 Early trakeostomy (n=40)	Group 2 Late trakeostomy (n=97)	p-value
Age (years)	62.2 ± 18.3	55.3 ± 18.6	65.1 ± 17.6	**0.006**
Gender, n (%)				0.105
Female	52 (37.9)	11 (27.5)	41 (42.2)	
Male	85 (62.0)	29 (72.5)	56 (57.7)	
Comorbity, n (%)	102 (74.4)	26 (65.0)	76 (78.3)	0.103
Intubation time (days)	17.7 ± 13.7	6.3 ± 1.9	22.3 ± 13.8	**<0.001**
APACHE-2 score	24.6 ± 9.5	25.7 ± 9.0	24.2 ± 9.7	0.304
Duration of ICU (days)	44.8 ± 28.8	29.6 ± 18.2	51.2 ± 30.0	**<0.001**
Duration of Mv after trakeostomy (days)	21.7 ± 17.2	19.5 ± 15.8	22.7 ± 17.8	0.162
Discharge, n (%)	60 (43.7)	17 (42.5)	43 (44.3)	0.844
Place of discharge, n (%)				0.568
Palliative care center	39 (28.4)	12 (30.0)	27 (27.8)	
To home	21 (15.3)	5 (12.5)	16 (16.4)	
Mortality (90-day), n (%)	75 (54.7)	22 (55.0)	53 (54.6)	0.969

Values are the number of patients (n), percentage, mean and standard deviation. ICU: Intensive care unit, APACHE-2: Acute Physiology and Chronic Health Assessment-2, Mv: Mechanical ventilation

Considering the indications for admission to the ICU of patients who underwent tracheostomy, cranial pathologies (epidural, subdural, intracranial hemorrhages, and traumatic brain injury) were observed most frequently before the pandemic. At the same time, COVID-19 was detected most frequently during the pandemic period (Table 3).

Tracheostomy was performed in 27% (n=37) of the patients due to cranial pathologies. All patients with cranial pathology during the pandemic were COVID-19-negative. In these patients, no significant difference was found between the early-late tracheostomy rates between the periods (p= 0.488). The discharge rate was significantly lower in patients with cranial pathology during the pandemic period (26.7% vs. 72.7%, p=0.006). Similarly, 90-day mortality rates were significantly higher during the pandemic (73.3% vs. 22.7%, p=0.002) (Table 4).

Tracheostomy was performed in 43.7% (n=60) of the patients due to respiratory pathologies. The mean age of

Table 2. Characteristics of patients tracheostomized before and after the COVID-19 pandemic

Variable	Pre-pandemic period (n=52)	Pandemic period (n=85)	p-value
Age (years)	64.7 ± 20.3	60.6 ± 17.0	0.115
Gender, n (%)			0.412
Female	22 (42.3)	30 (31.8)	
Male	30 (57.7	55 (68.2)	
Tracheostomy group			0.398
Early (<10 days)	13 (25.0)	27 (23.1)	
Late (≥ 10 days)	39 (75.0)	58 (76.9)	
Intubation time (days)	15.8 ± 8.7	18.8 ± 16.0	0.817
Comorbity, n (%)	38 (73.1)	64 (75.3)	0.773
APACHE-2 score	27.0 ± 11.2	23.1 ± 8.0	0.087
Duration of ICU (days)	44.4 ± 21.8	45.1 ± 32.5	0.618
Duration of Mv after trakeostomy (days)	22.6 ± 16.3	21.2 ± 17.9	0.335
Discharge, n (%)	27 (51.9)	33 (38.8)	0.134
Mortality (90-day), n (%)	24 (46.1)	51 (60.0)	0.114

Values are the number of patients (n), percentage, mean and standard deviation. ICU: Intensive care unit, APACHE-2: Acute Physiology and Chronic Health Assessment-2, Mv: Mechanical ventilation

Table 3. ICU admission diagnoses before and after the COVID-19 pandemic

Before the COVID-19 pandemic (n=52)	COVID-19 pandemic (n=85)
Epidural, subdural, intracranial hemorrhages and traumatic brain injury (n=16)	COVID-19 (n=26)
	Epidural, subdural, intracranial hemorrhages and traumatic brain injury (n=9)
Respiratory failures and pneumonia (n=13)	Non-COVID-19 respiratory failures and pneumonia (n=12)
Ischemic or hemorrhagic strokes (n=6)	Postoperative follow-up (n=10)
Postoperative follow-up (n=5)	Ischemic or hemorrhagic strokes (n=6)
Others* (n=12)	Others* (n=31)

Values were expressed as the number of patients, ICU: Intensive care unit
*Falls, traffic accidents, intoxication, malignancies, suicid, pancreatitis, assault, status epilepticus

Table 4. Clinical characteristics of patients who underwent tracheostomy due to cranial pathologies* before and after the COVID-19 pandemic

Variable	Pre-pandemic period (n=22)	Pandemic period (n=15)	p-value
Age (years)	63.3 ± 21.3	64.5 ± 17.5	0.862
Gender, n (%)			0.191
Female	7 (31.8)	8 (53.3	
Male	15 (68.2)	7 (46.7)	
Tracheostomy group			0.488
Early (<10 days)	6 (27.3)	6 (40)	
Late (≥10 days)	16 (72.7)	9 (60)	
Intubation time (days)	14.3 ± 7.5	14.2 ± 7.8	0.867
Comorbity, n (%)	14 (63.6)	11 (73.3)	0.724
APACHE-2 score	27 ± 13.2	23.2 ± 7.8	0.314
Duration of ICU (days)	47.9 ± 25.8	41.6 ± 24.7	0.276
Duration of Mv after trakeostomy	25.8 ± 19	24.1 ± 24.1	0.350
Discharge, n (%)	16 (72.7)	4 (26.7)	**0.006**
Mortality (90-day), n (%)	5 (22.7)	11 (73.3)	**0.002**

Values are the number of patients (n), percentage, mean and standard deviation. ICU: Intensive care unit, APACHE-2: Acute Physiology and Chronic Health Assessment-2, Mv: Mechanical ventilation
*Epidural, subdural, intracranial hemorrhages, traumatic brain injury and strokes

Table 5. Clinical characteristics of patients who underwent tracheostomy due to respiratory pathologies* before and after the COVID-19 pandemic

Variable	Pre-pandemic period (n=15)	Pandemic period (n=45)	p-value
Age (years)	75.4 ± 12.4	62.2 ± 15.4	**0.004**
Gender, n (%)			0.764
Female	7 (46.7)	19 (42.2)	
Male	8 (53.3)	26 (57.8)	
Tracheostomy group			1.000
Early (<10 days)	2 (13.3)	8 (17.8)	
Late (≥10 days)	13 (86.7)	37 (82.2)	
Intubation time (days)	18.7 ± 8.9	22 ± 15.8	0.745
Comorbity, n (%)	15 (100)	36 (85)	0.095
APACHE-2 score	28.1 ± 10.6	21.9 ± 7.8	**0.020**
Duration of ICU (days)	42.8 ± 16.5	45.6 ± 22	0.649
Duration of Mv after trakeostomy (days)	19 ± 14.2	18.8 ± 13.8	1.000
Discharge, n (%)	8 (53.3)	19 (42.2)	0.454
Mortality (90-day), n (%)	7 (46.7)	26 (57.8)	0.454

Values are the number of patients (n), percentage, mean and standard deviation. ICU: Intensive care unit, APACHE-2: Acute Physiology and Chronic Health Assessment-2, Mv: Mechanical ventilation
*Pneumonia and other respiratory problems and COVID-19

the patients during the pandemic period was significantly lower than before the pandemic (62.2±15.4 vs. 75.4±12.4, p=0.004). There was no significant difference in the early tracheostomy and mortality rates in patients with respiratory pathology during the pandemic compared to the pre-pandemic period (Table 5).

Discussion

In this study, which examined tracheostomy patients in the ICU during the four years before and after the COVID-19 pandemic, it was found that early tracheostomy was performed in approximately 29% of the entire population, and the mean age and length of stay in the ICU were shorter in this group of patients. In addition, early tracheostomy did not have a significant effect on discharge and mortality. The COVID-19 pandemic did not affect early-to-late tracheostomy rates. In addition, it was determined that the COVID-19 pandemic did not significantly affect mortality, except for tracheostomized patients due to cranial pathologies.

It has been reported that the mean age of patients who underwent tracheotomy in the ICU during the COVID-19 pandemic was lower than in the pre-pandemic period (11). Another study reported that more tracheostomies were opened in the male gender during the pandemic period than before the COVID-19 pandemic (12). The authors stated that the more severe course of COVID-19 in men led to this situation. Consistent with the literature, in our study, more tracheostomies were performed in the entire population and men during COVID-19. Similarly, the mean age of the patients in the pandemic period was lower than in the pre-pandemic period, although it was not significant. We think this is because the severe course of COVID-19 in young people, especially men, causes prolonged hospitalization in the ICU and the need for a tracheostomy.

The literature has not agreed on the optimum tracheostomy time and the early and late definitions of tracheostomy. Edipoglu et al. reported that early (≤10 days mechanical ventilation) and late (> ten days) tracheostomy results were performed in 65% of the patients, and mortality was high in the late tracheostomy group. However, it was not significant (4). A Cochrane review of 8 studies, including 1977 patients, examined outcomes of early (≤10 days mechanical ventilation) and late (>10 days) tracheostomy. The authors reported that although lower mortality was reported in the early tracheostomy group with a risk ratio of 0.83, there was no high-quality evidence for specific subgroups (13). However, some studies also report that opening a tracheostomy or time of tracheostomy does not affect mortality in patients followed up in the ICU (14-16). With the COVID-19 pandemic, the question of when to open a tracheostomy has become more critical. Guidelines did not recommend tracheostomy in the first two weeks of intubation to reduce viral load in patients intubated due to COVID-19 and expose healthcare workers to less risk of aerosol transmission (17). However, it has been stated that the tracheostomy can be opened safely without waiting 2-3 weeks with appropriate personal protective equipment and a modified percutaneous dilatational tracheostomy technique (18). Chao et al. reported that the mean number of days to be intubated until tracheostomy in COVID-19 patients was 19±6 days (12). Another study reported that the number of intubated days until tracheotomy was significantly higher (19±7 vs. 23±5 days) in COVID-19 patients (11). In our study, the number of intubated days until tracheostomy was found to be high (18.8± 16 vs. 15.8± 8.7), although it was not significant in the COVID-19 period.

The diagnosis and clinical condition of the patient are essential in the decision of tracheostomy in ICUs. It is recommended that the tracheostomy be opened quickly in patients who are not expected to be extubated in a short time (such as central nervous system pathologies, neuromuscular diseases, and medulla spinalis injuries). In cases where the course of the disease cannot be predicted precisely, such as moderate cerebral damage, neuromuscular diseases with attacks, and moderate-severe chronic lung pathologies, the decision for tracheostomy can be difficult. Studies reported from Turkey before the COVID-19 pandemic reported that tracheostomy was most frequently performed due to central nervous system pathologies (2,19,20). Another study from Turkey reported that 24.2% of tracheostomy applications during the pandemic period were due to COVID-19. A study from the USA reported that tracheostomy was most frequently performed due to ARDS in COVID-19 patients (12). Consistent with the literature, in our study, tracheostomy was performed most frequently (30.7%) in the pre-pandemic period due to central nervous system pathologies (epidural, subdural, intracranial hemorrhages, traumatic brain injury, and strokes) and most frequently (30.5%) in the pandemic period due to COVID-19. In our study, the mortality rate in patients with cranial pathologies

during the pandemic was significantly higher than before the pandemic (73.3% vs. 22.7%). All patients with cranial pathology in the COVID-19 period were COVID-19 negative. The high mortality rate may be due to late admission to the hospital and the regulations in health systems during the pandemic period. There was no significant increase in the mortality rates of patients who underwent tracheostomy due to respiratory problems during the pandemic. It has been reported that early tracheostomy reduces the length of stay in the ICU, length of stay on a mechanical ventilator, and the need for sedation but has no effect on mortality (4,21,22). In the Tracheostomy Management in Critical Care (Trac-Man) study, it was reported that early tracheostomy (first 1-4 days) did not affect mortality and length of stay in the ICU (23). In our study, while the duration of stay in the ICU was significantly lower in patients with early tracheostomy in the whole population, no significant difference was observed in 90-day mortality rates.

The main limitations of our study are that it is single-center, retrospective, and the number of cases is relatively low. In addition, early-late complications related to tracheostomies were not examined.

Conclusion

In conclusion, considering all patients before and after the pandemic, early tracheostomy did not significantly affect mortality, although it shortened the length of stay in the ICU. In addition, the COVID-19 pandemic did not cause significant changes in early-late tracheostomy applications and mortality rates. There was a significant increase in the mortality rates of patients who underwent tracheostomy in the ICU due to cranial pathologies only during the pandemic. In similar pandemics that we will encounter, tracheostomy applications can be performed healthily without getting stuck in timing.

Ethics

Ethics Committee Approval: Ethics committee approval was obtained from the University of Health Sciences Turkey, Kanuni Sultan Süleyman Training and Research Hospital Clinical Research Ethics Committee for this retrospective cross-sectional study (date: 30.06.2021 number:200).

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: K.A., Concept: K.A., A.S.Ş., Design: K.A., A.S.Ş., Data Collection and Process: K.A., Analysis or Interpretation: K.A., A.S.Ş., Literature Search: K.A., Writing: K.A.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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