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Kadir Arslan,
Ayça Sultan Şahin

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

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Kadir Arslan, Ayça Sultan Şahin
University of Health Sciences Turkey, Kanuni Sultan Süleyman Training and Research Hospital, Department of Anesthesiology and Reanimation, İstanbul, Turkey

Kadir Arslan MD, (✉),
University of Health Sciences Turkey, Kanuni Sultan Süleyman Training and Research Hospital, Department of Anesthesiology and Reanimation, İstanbul, Turkey

E-mail : kadir.arslan@sbu.edu.tr
ORCID ID : orcid.org/0000-0003-4061-0746

ABSTRACT *Objective:* The Coronavirus disease-2019 (COVID-19) pandemic has resulted in a critical need for optimal tracheostomy time. This study investigated the effects of early and late tracheostomy procedures 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 into Group 1 (early <10 days) and Group 2 (late ≥10 days) and evaluated before and after the COVID-19 pandemic. Demographic data, clinical features, and mortality were analyzed.
Results: A total of 137 patients were included in the study. Among the study population, 62% were male, and 29.1% underwent early tracheostomy. Although the mean age of 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 ICU hospitalization among patients who underwent tracheostomy before the pandemic, whereas COVID-19 was observed during the pandemic period. The COVID-19 pandemic had no significant effect on early-late tracheostomy rates, length of stay in the ICU, and mortality. During the pandemic, there was a significant difference in mortality among patients with cranial pathology.
Conclusion: 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, intensive care unit, intubation, mortality

ÖZ *Amaç:* Koronavirüs hastalığı-2019 (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'ye yatış endikasyonu kraniyal 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 kraniyal 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 kraniyal patolojili hastalar dışında mortalite üzerinde anlamlı etki yapmadığını saptadık.
Anahtar Kelimeler: Trakeostomi, COVID-19, yoğun bakım ünitesi, entübasyon, mortalite

Introduction

A 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 failure, 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, aspiration of the respiratory tract, reducing the need for sedation, facilitating patient discharge from the ICU, allowing oral feeding, and enabling speech (2,3). There is no absolute consensus on the need for tracheostomy opening in patients who are followed up in the ICU. However, there is no agreed-upon time frame for defining tracheostomy as early or late (4).

As a cause of viral pneumonia, Coronavirus disease-2019 (COVID-19) causes prolonged hospitalizations, and mechanical ventilators are needed for various patient groups in the ICU (5,6). The incidence of acute hypoxemic respiratory failure and acute respiratory distress syndrome (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 patients with COVID-19, it has been reported to be safe (9,10).

This study aimed to investigate the effects of early and late tracheostomy procedures 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 initiated in accordance with the principles of the Declaration of Helsinki. Percutaneous tracheostomy procedures were performed in the ICU of University of Health Sciences Turkey, Kanuni Sultan Süleyman Training and Research Hospital (ICU) before and after the COVID-19 pandemic for four years (01.03.2018-01.03.2022). The data were reviewed retrospectively using the hospital information system.

Before the COVID-19 pandemic, an 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 established, and ICU services were provided to patients with 50 beds. In this descriptive study, a sample size was not chosen. All patients who underwent percutaneous tracheostomy in the ICU within the last 4 years between the relevant dates were included in the study. The current study did not include patients who underwent surgical tracheostomy procedures in the operating room and were previously tracheotomized.

Demographic data of patients, indications for admission to ICUs, comorbidities, tracheostomy opening times, length of stay in ICU, length of stay on mechanical ventilator after tracheostomy, 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 during the pre- and post-pandemic periods were analyzed. To provide standardization in the diagnosis of admission to the ICU, patients were divided into groups with cranial pathologies and those with respiratory pathologies and analyzed in the pre- and post-pandemic periods. Epidural, subdural, intracranial hemorrhages, traumatic brain injuries, and stroke were considered cranial pathologies. Pneumonia, other conditions causing respiratory failure, sepsis, and COVID-19 were accepted as respiratory pathologies.

Statistical Analysis

The 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). The 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 study population, and the mean age was 62.2±18.3 years. Early tracheostomy was found in 29.1% (n=40) of all tracheostomy (Group 1). The mean age and length of stay in the ICU of 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 entire 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 tracheostomy were performed before and 62.1% (n=71) during the pandemic. Although 0.72 (52/36/2) tracheostomy were performed per bed per year before the pandemic, it was found that 0.85 (85/50/2) tracheostomy 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).

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 and late tracheostomy rates between the periods (p= 0.488). The discharge rate was significantly lower in patients with cranial pathology during the pandemic period

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

Variable	All populations (n=137)	Group 1 Early tracheostomy (n=40)	Group 2 Late tracheostomy (n=97)	p-value
Age (years)	62.2±18.3	55.318.6±	65.1±17.6	**0.006**
Sex, 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 tracheostomy (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

The 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, COVID-19: coronavirus disease-2019

Table 2. Characteristics of patients tracheotomized 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
Sex, 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 tracheostomy (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

The 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, COVID-19: coronavirus disease-2019

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 failure and pneumonia (n=13)	Non-COVID-19 respiratory failure 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, suicide, pancreatitis, assault, status epilepticus, COVID-19: coronavirus disease-2019

(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 the patients during the pandemic period was significantly lower than that 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 between the pandemic and 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, 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, the COVID-19 pandemic did not significantly affect

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
Sex, 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 tracheostomy	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

The 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, stroke, COVID-19: coronavirus disease-2019

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**
Sex, 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 tracheostomy (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

The 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, other respiratory problems, and COVID-19, COVID-19: coronavirus disease-2019

mortality, except in tracheotomized 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 during the pre-pandemic period (11). Another study reported that more tracheostomy were opened in men 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 tracheostomy were performed in the entire population and men during COVID-19. Similarly, the mean age of patients during the pandemic period was lower than that during the pre-pandemic period, although this difference was not significant. We believe that this is because the severe course of COVID-19 in young people, especially men, causes prolonged hospitalization in the ICU and the need for tracheostomy.

The literature has not agreed on the optimum tracheostomy time and the early and late definitions of tracheostomy. Edipoğlu et al. (4) reported that early (≤10 days mechanical ventilation) and late (>10 days) tracheostomy results were performed in 65% of the patients, and mortality was high in the late tracheostomy group. However, it was not significant. A Cochrane review of 8 studies, including 1977 patients, examined the 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, no high-quality evidence was available for specific subgroups (13). However, some studies have also reported that opening of a tracheostomy or the time of tracheostomy does not affect mortality in patients who are 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 do not recommend tracheostomy within the first 2 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. (12) reported that the mean number of days to be intubated until tracheostomy in COVID-19 patients was 19±6 days. Another study reported that the number of intubated days until tracheotomy was significantly higher (19±7 vs. 23±5 days) in patients with COVID-19 (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 patients are essential in the decision to perform tracheostomy in ICUs. It is recommended that the tracheostomy be opened quickly in patients who are not expected to be extubated within a short time (such as central nervous system pathologies, neuromuscular diseases, and medulla spinalis injuries). In cases in which the course of the disease cannot be predicted precisely, such as moderate cerebral damage, neuromuscular diseases with attacks, and moderate to severe chronic lung pathologies, the decision for tracheostomy can be difficult. Studies conducted in 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 procedures during the pandemic were due to COVID-19. A study from the USA reported that tracheostomy was most frequently performed due to ARDS in patients with COVID-19 (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 of patients with cranial pathologies was significantly higher during the pandemic than before the pandemic (73.3% vs. 22.7%). All patients with cranial pathology during the COVID-19 period were negative for COVID-19. The high mortality rate may be due to late hospital admissions and the regulations in health systems during the pandemic period. There was no significant increase in the mortality rate 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, the length of stay with a mechanical ventilator, and the need for sedation, but it has no effect on mortality (4,21,22). The tracheostomy management in critical care (Trac-Man) study reported that early tracheostomy (first 1-4 days) did not affect mortality and length of stay in the ICU (23). In our study, although the duration of stay in the ICU was significantly lower in patients with early tracheostomy than in the entire population, no significant difference was observed in the 90-day mortality rates.

Study Limitations

The main limitations of this study are its single-center, retrospective design, and the relatively low number of cases. In addition, early-late complications related to tracheostomy 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 ICU stay. In addition, the COVID-19 pandemic did not cause significant changes in the rates of early- to late tracheostomy. There was a significant increase in the mortality rate of patients who underwent tracheostomy in the ICU due to cranial pathologies only during the pandemic. In similar pandemics that we will encounter, tracheostomy 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). The study was initiated in accordance with the principles of the Declaration of Helsinki.

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: K.A., Concept: K.A., A.S.Ş., Design: K.A., A.S.Ş., Data Collection or Processing: 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.

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