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ORIGINAL ARTICLE – OPEN ACCESS

The Impact of Percutaneous Tracheotomy on Mortality and Length of Stay in the Critical Care Unit for COVID-19 ARDS

Gülçin Hilal Alay, Derya Tatlısuluoğlu, Kadir Bulut, Güldem Turan

ABSTRACT

Objective: The aim of this study was to investigate the effect of percutaneous tracheotomy on mortality and length of stay in the intensive care unit (ICU) for patients with COVID-19-associated acute respiratory distress syndrome (ARDS).

Materials and Methods: This study included patients with coronavirus disease-19 (COVID-19-associated) acute respiratory distress syndrome who were treated with invasive mechanical ventilation in a pandemic intensive care unit. Patients admitted to the pandemic intensive care unit between March and July 2021 were retrospectively reviewed. Patients who underwent percutaneous tracheotomy and did not have a tracheotomy during the follow-up were statistically compared in terms of laboratory and clinical characteristics such as mortality and length of stay in the intensive care unit.

Results: The study included 102 orotracheally intubated patients diagnosed with COVID-19 acute respiratory distress syndrome. The number of tracheotomized and not-tracheotomized patients was 34 and 68, respectively. The mean age of the patients was 60.39±14.10 years. The mean time to perform percutaneous tracheotomy was 7.94±6.11 days. There was no significant difference in mortality rate between the two groups (p=0.298). However, patients who underwent tracheotomy had a longer length of stay in the intensive care unit compared to those who did not (35.00±24.60 days vs 13.20±11.69 days, p<0.001).

Conclusion: Our study found no statistically significant difference in mortality rate between the two groups in our study. Additionally, the length of stay in the intensive care unit was not better in tracheotomized patients. While tracheotomy has some advantages in other severe lung diseases, its effect on mortality in patients with severe lung disease associated with COVID-19 should be evaluated further in randomized controlled trials.

Keywords: Acute respiratory distress syndrome, COVID-19, mortality, tracheotomy

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Department of Intensive Care, Başakşehir Çam and Sakura City Hospital, İstanbul, Türkiye

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Correspondence
Gülçin Hilal Alay, Başakşehir Çam and Sakura City Hospital, Department of Intensive Care, İstanbul, Türkiye
Phone: +90 212 909 60 00
e-mail: gulcinhilalalay@gmail.com

INTRODUCTION

A tracheostomy may provide benefits for critically ill patients requiring invasive mechanical support due to the coronavirus disease-19 (COVID-19) pandemic. The procedure can aid in the weaning process, improve weaning parameter values, reduce the risk of unintended or unsuccessful extubations and decrease work of breathing. In this study, early initiation of tracheostomy helped prevent the issue of failed extubation, which can lead to negative outcomes such as reintubation and potential virus transmission (1).

Currently, there is no clear guidance on when to perform elective tracheotomies for COVID-19-infected intubated patients in the intensive care unit (ICU). Recent recommendations and guidelines emphasize the need for measures to protect medical staff and advise delaying the procedure to reduce viral load. While most authors suggest waiting at least 14 days after intubation before performing tracheotomy, more research is needed to determine the optimal timing (2–4). Concerns about the safety of healthcare workers during the high-risk aerosol-generating process of tracheotomy continue to be discussed. Some articles recommend avoiding tracheotomy in patients who have recently tested positive for COVID-19 by reverse transcription polymerase chain reaction (RT-PCR) due to the highly infectious nature of the virus (5).

Plaza et al. (6) conducted a study to evaluate airborne particle dissemination before, during and after tracheostomy and reported the highest dissemination rate during the procedure. However, in a tertiary healthcare facility, they found no symptoms of COVID-19 among healthcare workers in the first 15 days after tracheotomy in the first 30 patients. The general approach is to minimize contamination by using standard protective equipment such as N95 masks, gloves, surgical gowns, hair caps, eye protection and aerosol boxes.

It is uncertain whether some patients who have been intubated for an extended period would benefit from tracheotomy. Therefore, in our study, we aimed to compare the mortality rates and length of stay (LOS) between COVID-19-related ARDS patients who underwent tracheotomy and those who did not.

Table 1. Demographic and clinical characteristics of patients

	Overall (Mean±SD) (n=102)	Group 1 tracheotomized (Mean±SD) (n=34)	Group 2 not-tracheotomized (Mean±SD) (n=68)	p
Age (years)	60.39±14.10	61.05±12.12	60.05±15.07	0.876
Gender (n, %)				0.246
Male	58 (56.9%)	38 (37.25%)	20 (19.6%)	
Female	44 (43.13%)	30 (29.41%)	14 (13.72%)	
BMI (kg/m^2)	26.97±5.19	26.99±4.04	26.96±5.70	0.378
Comorbidities				0.352
Diabetes mellitus	22	12	10	
Hypertension	56	24	32	
CVD	36	12	24	
COPD	10	4	6	
Heart failure	10	2	8	
Malignancy	22	8	14	
ICU admission to intubation (days)	4.70±5.75	5.52±5.25	4.29±5.98	0.071
PaO_2/FiO_2 admission	93.58±26.48	89.94±18.79	95.41±29.54	0.966
PaO_2/FiO^2 intubation	72.66±16.19	75.37±12.55	71.31±17.67	0.292
SOFA score at admission	5.23±2.14	4.94±1.57	5.38±2.38	0.647
SOFA score at intubation	6.43±2.11	5.82±1.35	6.73±2.36	0.071
APACHE II score	18.86±4.50	18.05±4.38	19.26±4.54	0.189
Mechanical ventilation duration (days)	15.62±18.72	28.52±25.09	9.17±9.59	<0.001
Length of stay (days)	20.47±19.87	35.00±24.60	13.20±11.69	<0.001
Mortality (n, %)	98 (96.1%)	34 (33.3%)	64 (62.7%)	0.298

BMI: Body mass index; CVD: Cardiovascular disease; COPD: Chronic obstructive pulmonary disease; ICU: Intensive care unit; SOFA: Sequential organ failure assessment; APACHE: Acute physiology and chronic health evaluation; SD: Standart deviation

MATERIALS and METHODS

This retrospective investigation was conducted on patients with COVID-19-associated ARDS in the adult ICU of a tertiary healthcare facility between March 1, 2021 and July 1, 2021. The study was approved by the Başakşehir Çam and Sakura City Hospital ethics committee on July 13, 2021 (ethical approval number: 147) and patient data were retrospectively analyzed.

The inclusion criteria for the study were: 1) Confirmed COVID-19 diagnosis by RT-PCR, 2) acute respiratory distress syndrome (ARDS) diagnosed patients by the Berlin criteria (7), 3) Patients aged 18 years or older and 4) Patients who underwent intubation and mechanical ventilation for at least 72 hours. The exclusion criteria were patients who were not on mechanical ventilation, under 18 years old, pregnant, diagnosed solely by radiologic assessment without RT-PCR confirmation or died within 72 hours of admission.

A total of 119 patients who met the inclusion criteria were identified, of which 102 were included in this retrospective analysis. Seventeen patients were excluded from the study due to age (n=1), pregnancy (n=6) and radiologic diagnosis without RT-PCR confirmation (n=10).

During the COVID-19 pandemic, our hospital had two adult pandemic intensive care units, each with 16 beds. Symptomatic patients with positive COVID-19 RT-PCR testing were followed at inpatient pandemic services at this tertiary education and research hospital. Those requiring immediate medical attention due to respiratory distress, such as tachypnea, hypoxia, altered awareness or hypotension, were taken to the pandemic ICU and monitored there. Patients from other institutions who tested positive for COVID-19 by RT-PCR and required acute care in the ICU were also admitted to our center for treatment.

Patient data was obtained from the hospital's computer database and patient files. Sociodemographic information, including age, gender, body mass index (BMI) and comorbidities, were collected.

On the day of intubation, a complete blood count (CBC), glucose, D-dimer, C-reactive protein (CRP), procalcitonin, ferritin, fibrinogen and arterial blood gas analysis were performed. Fraction of inspired oxygen (FiO_2) values were retrieved from historical records. Upon admission to the ICU, the Sequential Organ Failure Assessment (SOFA) and Acute Physiology and Chronic Health Evaluation (APACHE) scores were also noted. The length of stay (LOS) was defined by the number of days spent in the ICU and the patients' intubation status was tracked by medical staff. The number of days a patient was under mechanical ventilation was recorded, along with mean Positive End-Expiratory Pressure (PEEP) and mean plateau pressures.

Table 2. Laboratory test results of patients at the time of intubation

	Overall (Mean±SD) (n=102)	Group 1 tracheotomized (Mean±SD) (n=34)	Group 2 not-tracheotomized (Mean±SD) (n=68)	p
WBC (x10^3 cells/mm^3)	13.17±7.73	13.91±9.96	12.80±6.39	0.795
Hb (gr/dL)	11.49±2.34	11.42±2.21	11.53±2.41	0.787
Platelet (x10^3 cells/mm^3)	243.86±122.11	244.58±95.59	243.50±134.07	0.921
Fibrinogen (mg/dL)	549.03±191.87	589.23±140.44	528.94±211.08	0.164
D-dimer (µg FEU/mL)	7.15±23.31	11.80±39.65	4.82±5.31	0.201
Neutrophil (x10^3 cells/mm^3)	11.11±5.32	10.33±3.77	11.50±5.93	0.865
Lymphocyte (x10^3 cells/mm^3)	1.53±5.61	3.14±9.58	0.72±0.58	0.023
CRP (mg/L)	126.60±95.78	126.47±90.23	126.66±99.09	0.887
Procalcitonin (ng/mL)	3.49±14.53	6.60±23.72	1.93±5.77	0.691
Glucose (mg/dL)	171±80.29	164.17±96.29	174.41±71.52	0.122
Ferritin (µg/L)	1720.09±2234.34	1191.58±1321.18	1984.35±2540.31	0.293

WBC: White blood cell; Hb: Hemoglobin; CRP: C-reactive protein; SD: Standart deviation

The included patients were divided into two groups based on their tracheotomy status. Group 1 had undergone tracheotomy, while Group 2 was orotracheally intubated but had not received a tracheotomy. Sociodemographic, laboratory and clinical characteristics, including survival status, were compared between the two groups.

The patients' survival status was noted during the follow-up period and ICU survival data were used.

Statistical Analysis

Statistical analysis of the study data was performed using the Statistical Package for the Social Sciences (SPSS) program (IBM SPSS Statistics for Windows, Version 20.0: IBM Corp.). Continuous data were tested for normal distribution using a single-sample Kolmogorov-Smirnov test. Quantitative values were reported as mean and standard deviation (SD) if normally distributed. Categorical variables were expressed as numbers and percentages. For two-group comparisons of continuous data with normal distribution, the Student's t-test was used. The Chi-square test and Fisher's exact test were used to compare categorical data between the two groups.

RESULTS

The study included 102 patients with COVID-19-associated ARDS who were intubated, with an average age of 60.39±14.10 years. Upon admission to the ICU, there was no difference in the PaO^2 (partial arterial oxygen pressure)/FiO_2 ratios between the two groups (Table 1). Of the 102 patients, 34 underwent percutaneous tracheotomy on day 7.94±6.11. The LOS in the ICU was longer in patients who underwent tracheotomy (28.8±15 days) compared to those who did not (18.52±12 days), with a statistically significant difference (p<0.001). Of the 102 patients, 98 died during the study period, with 34 in the tracheotomized group and 64 in the non-tracheotomized group. There was no significant difference in mortality between the two groups (p=0.298). The time from symptom onset to intubation was 12.68±7.06 for all patients, 13.46±7.7 for those with tracheotomy and 14.1±7 for those without (p=0.33).

The measured lactate levels at the time of ICU admission for all patients were 2.42±2.49, with no significant difference between the two groups (p=0.43). The mean lactate levels during intubation were 2.82±2.69 for all patients, 1.93±0.53 for those with tracheotomy and 2.43±1.84 for those without (p=0.21). Other laboratory parameters between the groups are shown in Table 2.

PEEP levels applied to the patients were 10.93±1.63 for those who underwent tracheotomy and 10.73±1.88 for those who did not (p=0.49). Plateau pressures were found to be 30.7±2.21 for patients with tracheotomy and 29.63±3.2 for those without, with a statistically significant difference (p<0.001).

DISCUSSION

Despite lower mortality rates in a study that favored early tracheotomy (1), our study did not find a significant difference in mortality between the tracheotomized and non-tracheotomized patients. However, our study was conducted during the peak of the pandemic when tracheotomy was performed at a high rate and our results were successful. Our clinic had adopted high tracheotomy rates upon this publication. Our study was retrospective and covered this period. In prior studies, early tracheostomy in the ICU was associated with decreased rates of hospital-acquired pneumonia, tracheal subglottic stenosis, shorter duration of mechanical ventilation and shorter ICU stays in morbidly obese patients (8). At the beginning of the COVID-19 pandemic, the American Academy of Otolaryngology-Head and Neck Surgery recommended delaying tracheostomy in the ICU until 2-3 weeks after intubation and preferably until a negative PCR test result was obtained (9). However, later systematic reviews recommended that test negativity was sufficient rather than limiting tracheotomy by time. The importance of early tracheostomy was emphasized due to prolonged ventilation and limited resources during the pandemic (10, 11).

In a multicenter study, early surgical tracheostomy was found to be a potentially invasive procedure that shortens the LOS of mechanical ventilation and ICU stay without changing complication and mortality rates (12). Tracheotomy is included in weaning protocols in mechanically ventilated patients with COVID-19 (13). Although we did not observe a change in mortality rates, the LOS in the ICU was prolonged in tracheotomized patients, likely due to prolonged weaning times caused by lung damage in COVID-19 ARDS patients.

In a single-center study involving 50 patients, surgical tracheostomy was performed for all patients hospitalized in the ICU for COVID-19-related ARDS. Patients were grouped into early (≤10 days) and late (>10 days) tracheotomy patients. Those with early tracheostomy required less invasive mechanical ventilation support time (14). The mean plateau pressure was higher in tracheotomized patients in our study, but it is difficult to interpret this finding because tracheotomized patients stayed longer in the ICU. In a retrospective cohort study conducted in Sweden, a shorter time between intubation and tracheotomy was associated with a shorter mechanical ventilation time (15). In a study of 44 patients, in which the median duration of tracheotomy was 7 days, no conclusion could be drawn about the optimal timing and individual patient evaluation was recommended (16). Although we did not distinguish between early and late tracheotomy times in our study, most patients received early tracheotomy.

No significant difference was found in terms of complications in studies comparing surgical and percutaneous methods (17–19). In our study, all patients underwent percutaneous tracheotomy. Tracheoesophageal fistula development was reported in only one patient at the 3-month follow-up after tracheotomy.

A single-center study conducted in the ICU during the pandemic period showed that percutaneous tracheotomy was associated with reduced mortality in 121 ICU patients, but this was attributed to the low use of sedative agents and no data on sedative agents were reported (1). After this study's publication, tracheotomies were performed more regularly at our clinic. However, our retrospective investigation revealed that tracheotomy did not lower mortality in patients with COVID-19-associated ARDS. In this study, the PaO_2/FiO_2 ratio on the 3rd day was 150 in those without tracheotomy and 145 in those with tracheotomy (1). However, in our study, the PaO_2/FiO_2 ratios were much lower at the time of admission and before intubation. We believe that the reason for this is that we followed up on patients with severe ARDS and the PaO_2/FiO_2 ratios were much lower at the time of admission and before intubation.

A limitation of our study is its retrospective design. It is impossible to attribute survival to tracheotomy alone in COVID-19 ARDS patients as pulmonary fibrosis and thromboembolic complications also contribute to mortality. Nonetheless, we conclude that early tracheotomy does not improve survival in severe ARDS patients.

CONCLUSION

Rapid respiratory decompensation, followed in severe cases by the requirement for endotracheal intubation and mechanical ventilation, is a hallmark of the novel coronavirus (COVID-19) global pandemic. A significant proportion of patients in hospitals, ranging from 3% to 17%, require invasive mechanical ventilation (20–24). While performing a tracheotomy in patients receiving prolonged mechanical ventilation can reduce the risk of subglottic stenosis and the need for sedative use, it remains a matter of clinical judgement to determine its necessity. However, it seems unlikely to conclude that tracheotomy can shorten mortality or ICU stay in these patients.

Ethics Committee Approval: The Başakşehir Çam and Sakura City Hospital Ethics Committee granted approval for this study (date: 13.07.2021, number: 147).

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