ICU tracheotomies in patients with COVID-19: a lesson learned for future viral pandemic

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Abstract

Introduction The coronavirus SARS-CoV-2 pandemic has resulted in a large number of patients requiring intubation and prolonged mechanical ventilation. The current knowledge on the tracheotomies regarding the time form intubation, method and ventilatory parameters optimal for their performance in the mechanically ventilated patients with COVID ARDS are scarce; thus, the aim of this study is to present new data regarding their safety, adverse events and timing.

Materials and methods This retrospective observational study is based on the data of 66 critically ill COVID patients including demographic data, timing and technique of tracheotomy, ventilatory parameters in the time of procedure, as well as complication and survival rate.

Results A number of 66 patients with COVID-related pneumonia were included in the study, among whom 32 were tracheotomized—25 patients underwent an early tracheotomy and 7 patients had late tracheotomy. The median duration of mechanical ventilation before the tracheotomy in the early group was 8 days (IQR 6–10) compared to 11 days (IQR 11–12.5.) p < 0.001) in late group. Risk of death in tracheotomy patients was significantly growing with growing level of PEEP and FiO2 at the moment of decision on tracheotomy, OR = 1.91 CI95 (1.23;3.57); p = 0.014 and OR = 1.18 CI95(1.03;1.43); p = 0.048, respectively.

Conclusion Early percutaneous tracheotomy is safe (both in terms of risk of viral transmission and complication rate) and feasible in COVID-19 patients. Stability of gas exchange, and ventilatory parameters are the main prognostic factors of the outcome.

Keywords COVID-19 · Open surgical tracheotomy · Percutaneous tracheotomy · Tracheotomy

Introduction

The coronavirus SARS-CoV-2 pandemic causing acute respiratory failure has resulted in a large number of patients requiring intubation and prolonged mechanical ventilation.

The intensive care guidelines give a lot of information about mechanical ventilation in the ARDS patients, including lung protective ventilation, prone position and use of muscle relaxants [1, 2]. Despite the tremendous number of studies analysing the very detailed aspect of mechanical ventilation, the data on the tracheotomies in the ARDS patients are scarce. In comparison to the orotracheal tube, the tracheotomy tube can prevent complications related to the oropharyngeal and laryngeal lesions, such as postintubation subglottic stenosis [3], improves patient comfort, allows a decrease in doses of sedative drugs, facilitates weaning from mechanical ventilation and potentially reduces the rate of ventilator associated pneumonia [4, 5]. There are no guidelines on the timing, method and ventilatory parameters optimal for the performance of the tracheotomy. The UK and North America recommendations suggest delaying the tracheotomy until 14 days of mechanical ventilation to allow better prognosis of the outcome and to reduce the viral load of the patients [6–9]. On the other hand, the French group
favours an early tracheotomy to facilitate weaning and transfer patients to a ventilatory weaning unit making free ICU beds for new patients [10].

The aim of the study was to describe the clinical data and outcome of critically ill COVID patients undergoing tracheotomy and to evaluate its timing, safety and adverse events, as well as to compare mortality, duration of mechanical ventilation, length of ICU stay and VAP occurrence between tracheotomized and non-tracheotomized patients, and between an early and late tracheotomy group.

**Materials and methods**

This retrospective observational study was performed in an Intensive Care Unit in Poznan University Hospital in Poland. The tracheotomies were categorized as early, when performed before the 10th day of mechanical ventilation, and late, when performed after the 10th day of mechanical ventilation. Tracheotomies were performed by two experienced ICU physicians at the bedside using the Ciaglia percutaneous technique (PT) with continuous bronchoscopic surveillance, or with an open surgical approach (OST) by two experienced ENT surgeons. The decision to perform tracheotomy was made by the treating physicians and was based on the predicted length of mechanical ventilation beyond 14 days post-intubation, and stable respiratory parameters. Among the rest of 34 nontracheotomized patients, 6 (9%) were treated with HFNO (high flow nasal oxygenation) with a mean duration of 6.6 days, 8 (12%) patients were successfully extubated and 20 (59%) patients died before the decision to perform tracheotomy. Demographic, laboratory and clinical data of the patients with and without tracheotomy are presented in Table 1.

Data analysis was carried out using R: A Language and Environment for Statistical Computing, version 4.0.5. Data are presented as n (% of group) for nominal variables and as mean ± SD or median (Q1;Q3) for continuous data. Normality of distribution was assessed via Shapiro-Wilk test, based on visual assessment of histograms and based on the level of skewness and kurtosis. Comparison of groups for nominal data was based on chi-square test or Fisher exact test, as appropriate. Between-group analysis of continuous data was conducted using independent t test and Mann–Whitney U test, as appropriate. For groups comparison OR (odds ratio) for nominal variables and MD (mean/median difference) for continuous variables were calculated, both with 95% confidence interval. Additional analysis included logistic regression to determine factors significantly impacting risk of death. Univariate models were created using as predictors variables with \( p < 0.25 \) in groups comparison analysis. All tests were based on 0.05 significance level.

**Results**

Between the 10th of November, 2020, and 28th of February, 2021, a number of 66 patients with COVID-related pneumonia were admitted to the Poznań University of Medical Science and included in the study. Their mean (SD) age was 63 [11] years and among them 48 (73%) were male. Mean (SD) SOFA and APACHE II score on admission were 9.7 (3.3) and 20.8 (7.8), respectively. 63 (95%) patients had chronic medical disease with hypertension in 50 (76%) patients, diabetes in 22 (33%) patients, obesity in 11 (16.7%), and chronic kidney disease in 9 (13.7%) patients, being the commonest among them. 60 (91%) of the analysed patients required mechanical ventilation with the mean (SD) duration of mechanical ventilation of 12.8 (8.8) days. 32 patients underwent tracheotomy within first 14 days of hospitalization. Among the rest of 34 nontracheotomized patients, 6 (9%) were treated with HFNO (high flow nasal oxygenation) with a mean duration of 6.6 days, 8 (12%) patients were successfully extubated and 20 (59%) patients died before the decision to perform tracheotomy. Demographic, laboratory and clinical data of the patients with and without tracheotomy are presented in Table 1.

25 (78%) patients underwent an early tracheotomy and 7 (22%) patients had late tracheotomy. The median duration of mechanical ventilation before the tracheotomy in the early group was 8 days [IQR 6-10], compared to 11 days [IQR 11-12.5], \( p < 0.001 \) in the late group. Patients in the late tracheotomy group had significantly higher body weight (112.86 ± 23.9 kg vs. 87.3 ± 19.6 kg; \( p = 0.031 \)) and BMI (36.6 ± 9.3 vs. 28.1 ± 5.5 with a \( p \) value of 0.055 being almost statistically significant). There was no statistically significant difference in the PEEP value, FiO2 and P/F ratio either on the day of tracheotomy or 48 h after the tracheotomy in the early and late tracheotomy groups. However, a higher percentage of patients in the late tracheotomy group required controlled mode of ventilation 48 hours after the tracheotomy [3 (43%) vs. 2 (8%)]. A comparable number of patients was discharged from the ICU in both groups; 4 (57%) patients in the late group vs. 12 (48%) patients in the early group. Based on logistic regression, late tracheotomy was significantly impacted by weight and BMI. All factors were increasing the risk of late tracheotomy, for weight
During the analysed period, none out of 60 healthcare workers who participated in the tracheotomy procedure got infected with SARS-CoV-2.

Four patients (12.5%) underwent an open surgical tracheotomy while the rest 28 (87.5%)—a percutaneous tracheotomy. The overall rate of adverse events was 17%. Half [2] of the patients suffered from severe surgical site infection after the surgical tracheotomy and malpositioning of the tube requiring surgical handling, while in the percutaneous group only one minor stomal infection occurred and was treated with antibiotics alone. Bleeding occurred in 4 patients after percutaneous tracheotomy, all of them required blood products transfusion (3 of them were fully heparinized due to ECMO circuits).

An analysis comparing 32 patients with tracheotomies revealed 14 (44%) patients who survived and were discharged from the ICU and 18 (56%) patients who died—the mortality rate of patients who underwent tracheotomy was 56%. There was no statistically significant difference in the age, gender and BMI between the groups of survivors and non-survivors. The mean values in the SOFA and APACHE score on admission were comparable between the survivors and non-survivors (SOFA 9.7 ± 3.5 vs. 9.6 ± 1.9; p = 0.99 and APACHE 21.5 ± 7.6 vs. 17.6 ± 6.1; p = 0.12). Patients who survived had lower values of PEEP, FiO2 on the day of tracheotomy and 48 h after the procedure. The data presenting the main ventilation parameters are presented in Table 3.

As per logistic regression analysis (Table 4), risk of death in tracheotomy patients was significantly growing with growing level of PEEP and FiO2 at the moment of decision on tracheotomy, OR = 1.91 CI95[1.23; 3.57]; p = 0.014 and OR = 1.18 CI95[1.03; 1.43]; p = 0.048 respectively. FiO2 level 48 h after tracheotomy was also significantly increasing the risk of death, OR = 1.29 CI95[1.11; 1.65]; p = 0.009.

### Table 1 Comparison of patients with and without tracheotomy

|                                | All (N = 66) | Tracheotomy (N = 32) | Non-tracheotomy (N = 34) | OR/MD (95 CI) | p     |
|--------------------------------|--------------|----------------------|--------------------------|---------------|-------|
| Sex, male, n (%)               | 48 (72.7)    | 25 (78.1)            | 23 (67.6)                | 1.69 (0.49;6.11) | 0.497 |
| Age, years, mean ± SD          | 63.09 ± 11.36| 59.94 ± 11.06        | 66.06 ± 10.97            | −6.12 (−11.54;−0.70) | 0.028 |
| SOFA, mean ± SD                | 9.71 ± 3.29  | 9.63 ± 2.86          | 9.79 ± 3.70              | −0.17 (−1.79; 1.45) | 0.836 |
| APACHE, mean ± SD              | 20.83 ± 7.83 | 19.81 ± 7.20         | 21.79 ± 8.38             | −1.98 (−5.82;1.85) | 0.306 |
| LIS (lung injury score), median (Q1;Q3) | 3.50 (3.00;3.80) | 3.50 (3.35;3.80) | 3.40 (2.10;3.80) | 0.10 (−0.01;0.80) | 0.184 |
| Hospitalization time, days, mean ± SD | 13.29 ± 8.71 | 19.19 ± 8.07 | 7.74 ± 4.76 | 11.45 (8.15; 14.75) | <0.001 |
| Result of ICU stay, n (%)      |              |                      |                          |               |       |
| Survival                       | 30 (45.5)    | 16 (50.0)            | 14 (41.2)                | 1.42 (0.48;4.23) | 0.621 |
| Mortality                      | 36 (54.5)    | 16 (50.0)            | 20 (58.8)                |               |       |
| Mechanical ventilation, days, median (Q1;Q3) | 9.00 (4.75;18.25) | 19.00 (13.50;21.00) | 5.00 (1.25;8.00) | 14.00 (10.00;16.00) | <0.001 |
| VAP (ventilatory associated pneumonia), n (%) | 34 (51.5) | 24 (75.0) | 10 (29.4) | 6.95 (2.16;24.82) | <0.001 |
| Ferritin on admission, mean ± SD | 1 291.11 ± 670.33 | 1 281.69 ± 658.42 | 1 300.84 ± 693.18 | −19.15 (−359.99;321.70) | 0.911 |
| IL6 on admission, median (Q1;Q3) | 91.00 (31.00;215.00) | 91.00 (44.00;207.50) | 94.00 (26.50;209.25) | −3.00 (−50.00;50.00) | 0.762 |
| D-dimer on admission, median (Q1;Q3) | 5.15 (1.70;20.00) | 4.99 (1.86;17.18) | 5.70 (1.66;21.00) | −0.72 (−4.59;2.18) | 0.808 |
| LDH on admission, median (Q1;Q3) | 634.00 (425.50;748.00) | 684.00 (491.50;779.00) | 560.50 (372.00;695.25) | 123.50 (−19.00;235.00) | 0.083 |
| CRP on admission, median (Q1;Q3) | 124.44 ± 92.85 | 134.50 ± 108.36 | 114.69 ± 75.30 | 19.81 (−26.70;66.32) | 0.397 |
| PCT on admission, median (Q1;Q3) | 0.51 (0.21;1.38) | 0.47 (0.21;1.42) | 0.57 (0.21;1.38) | −0.11 (−0.35;0.27) | 0.916 |

Both groups compared with Fisher exact test for chi-square test for nominal variables and with t test or Mann–Whitney U test for continuous variables. OR—odds ratio in the tracheotomy vs. nontracheotomy group, MD—mean/median difference (the tracheotomy group minus nontracheotomy group), both with 95% confidence interval (CI)

OR = 1.06 CI95[1.02; 1.12]; p = 0.021, for BMI OR = 1.20 CI95[1.04; 1.46]; p = 0.011.

Demographic and clinical parameters of the early and late tracheotomy patients are presented in Table 2.

During the analysed period, none out of 60 healthcare workers who participated in the tracheotomy procedure got infected with SARS-CoV-2.

Discharged from the ICU and 18 (56%) patients who died—the mortality rate of patients who underwent tracheotomy was 56%. There was no statistically significant difference in the age, gender and BMI between the groups of survivors and non-survivors. The mean values in the SOFA and APACHE score on admission were comparable between the survivors and non-survivors (SOFA 9.7 ± 3.5 vs. 9.6 ± 1.9; p = 0.99 and APACHE 21.5 ± 7.6 vs. 17.6 ± 6.1; p = 0.12). Patients who survived had lower values of PEEP, FiO2 on the day of tracheotomy and 48 h after the procedure. The data presenting the main ventilation parameters are presented in Table 3.

As per logistic regression analysis (Table 4), risk of death in tracheotomy patients was significantly growing with growing level of PEEP and FiO2 at the moment of decision on tracheotomy, OR = 1.91 CI95[1.23; 3.57]; p = 0.014 and OR = 1.18 CI95[1.03; 1.43]; p = 0.048 respectively. FiO2 level 48 h after tracheotomy was also significantly increasing the risk of death, OR = 1.29 CI95[1.11; 1.65]; p = 0.009.
Discussion

Technique

The majority (88%) of cases in our study underwent percutaneous tracheotomy and surgical method was preferred when patients were very obese and with difficult access to the anterior surface of the neck. The proportion of these two techniques differed considerably between previous studies on tracheotomy in COVID-19 patients [13]. Basing on recent meta-analysis [14], the open tracheotomy was performed in 2047 patients (55.7%), and percutaneous

| Table 2 | Tracheotomy patients—early vs. late tracheotomy |
|---------|-----------------------------------------------|
| Sex, male, n (%) | 25 (78.1) | 19 (76.0) | 6 (85.7) | 1.86 (0.16; 101.42) | > 0.999 |
| Age, years, mean ± SD | 59.94 ± 11.06 | 59.76 ± 11.81 | 60.57 ± 8.56 | 0.63 (-7.83; 9.46) | 0.843 |
| Weight, kg | 92.88 ± 22.92 | 87.28 ± 19.65 | 112.86 ± 23.95 | 19.98 (3.00; 48.15) | 0.031 |
| BMI | 29.97 ± 7.29 | 28.13 ± 5.55 | 36.56 ± 9.31 | 6.59 (-23.17; 0) | 0.055 |
| Number of days from intubation to tracheotomy, median (Q1;Q3) | 9.00 (6.00;10.00) | 8.00 (6.00;9.00) | 11.00 (11.00;12.50) | 2.00 (1.00;7.00) | < 0.001 |
| Number of days from tracheotomy to ICU discharge | 10.00 (8.00;13.00) | 10.00 (8.00;13.00) | 9.50 (7.50;14.75) | -0.50 (-6.00;14.00) | 0.807 |
| Number of days from tracheotomy to death | 9.00 (4.00;11.00) | 5.0 (3.25;11.00) | 7.50 (6.25;15.00) | -2.00 (-7.00;25.00) | > 0.999 |
| SOFA, mean ± SD | 9.63 ± 2.86 | 9.28 ± 2.94 | 10.86 ± 2.34 | 1.23 (-0.74;3.89) | 0.164 |
| APACHE, mean ± SD | 19.81 ± 7.20 | 19.52 ± 7.53 | 20.86 ± 6.28 | 1.04 (-4.83;7.50) | 0.644 |
| LIS (lungs injury score), median (Q1;Q3) | 3.50 (3.30;3.80) | 3.50 (3.30;3.65) | 3.80 (3.65;3.80) | 0.30 (0.01;0.50) | 0.039 |
| Hospitalization time, days, median (Q1;Q3) | 19.00 (14.50;21.50) | 18.00 (12.00;23.00) | 19.00 (15.02;20.50) | 1.00 (-3.00;9.00) | 0.465 |

Both groups compared with Fisher exact test for chi-square test for nominal variables and with t test or Mann–Whitney U test for continuous variables. OR—odds ratio in the late vs. early group, MD—mean/median difference (the late group minus early group), both with 95% confidence interval (CI)

| Table 3 | Tracheotomy patients—survivors vs. non-survivors |
|---------|-----------------------------------------------|
| PEEP on the day of tracheotomy | 10.14 ± 2.71 | 11.29 ± 2.57 | 8.50 ± 2.02 | 2.79 (1.04;4.55) | 0.003 |
| FiO2 on the day of tracheotomy | 40.17 ± 7.51 | 42.65 ± 8.31 | 36.67 ± 4.50 | 5.98 (1.05;10.91) | 0.019 |
| P/F on the day of tracheotomy | 189.69 ± 52.93 | 176.59 ± 59.62 | 208.25 ± 36.33 | -31.66 (-68.34;5.02) | 0.088 |
| PEEP 48 h after tracheotomy | 9.04 ± 3.71 | 10.31 ± 3.77 | 7.33 ± 2.96 | 2.98 (0.36;5.60) | 0.027 |
| FiO2 48 h after tracheotomy | 43.21 ± 12.15 | 50.06 ± 11.58 | 34.08 ± 4.48 | 15.98 (9.37;22.58) | < 0.001 |
| P/F 48 h after tracheotomy | 197.15 ± 68.72 | 152.17 ± 42.71 | 235.71 ± 64.55 | -83.55 (-150.00;17.10) | 0.019 |
| Hospitalization time, days, median (Q1;Q3) | 19.00 (14.50;21.50) | 19.00 (12.75;20.75) | 19.00 (17.00;22.50) | 0.50 (-3.00;8.00) | 0.493 |
| Mechanical ventilation, days, median (Q1;Q3) | 19.00 (13.50;21.00) | 19.00 (12.75;20.75) | 19.00 (17.00;22.50) | 0.50 (-3.00;6.00) | 0.595 |
| VAP, n (%) | 24 (75.0) | 19 (76.0) | 9 (63.3) | 2.69 (0.41;21.67) | 0.252 |

Both groups compared with Fisher exact test for chi-square test for nominal variables and with t test or Mann–Whitney U test for continuous variables. OR—odds ratio in the late vs. early group, MD—mean/median difference (the dead group minus survival group), both with 95% confidence interval (CI)
Complications

Regarding the type of tracheotomy, percutaneous or surgical in patients with COVID-19, there were no significant differences in complication rates (bleeding and stomal infections) between the two methods according to Long et al. [15]. The authors reported complications in 16% of procedures—3% of stomal infections only in the open tracheotomy group, minor bleeding in 7.5% and a need to perform an open procedure after tube dislodgement during percutaneous technique in one of 144 patients.

Similar results were observed in study conducted by Rovira et al. [16] where complications occurred in 18.9% of 201 patients with no differences between an open and percutaneous technique, both during (bleeding, hypoxia, misplacement, tracheal injury) and after the procedure (bleeding, cuff leak, tube dislodgement, hypoxia and pneumothorax). Breik et al. [17] reported 13% of complications with self-limiting bleeding and tube dislodgement the commonest among them, with similar rates in percutaneous and surgical technique. In Tang et al. study [18] bleeding occurred in 17.5%, 5% required blood products transfusion, tracheotomy infection in 1.2% and subcutaneous and mediastinal emphysema in 1.2% of patients with no difference between the early (< within 14 days following intubation) and late tracheotomy group. We observed a similar complication rate of 17%. Due to the small number of patients who underwent surgical tracheotomy and different anatomical characteristics of patients, we cannot compare these two techniques in our study.

Survival

In our study, the Survival rate was similar in patients with and without tracheotomy (50% vs. 41%, respectively). Patients with tracheotomy had much longer mean mechanical ventilation time (19 vs. 5 days) and had higher incidence of ventilator associated pneumonia (75% vs. 29.4%). However, the group of nontracheotomized patients included two extremes—there were patients whose clinical status improved fast and allowed extubation within 7 days, or were without secured airways on HFNO and, on the other hand, there were deteriorating patients with a poor prognosis due to severity of gas exchange abnormalities and multig-
Timing

Prolonged orotracheal ventilation necessitates deeper sedation or even muscle paralysis leading to increased risk of ICU acquired weakness, prolonged mechanical ventilation and hospital length of stay as well as poses a risk of tracheal stenosis [24]. Timing of tracheotomy in critically ill patients is still inconclusive, with a definition of early tracheotomy varying from 4 to 14 days among the studies. A Cochrane review [25] showed lower mortality rates and greater probability of discharge from ICU in the early (less than 10 days postintubation) tracheotomy group with inconsistent data regarding the time of mechanical ventilation and pneumonia occurrence. On the other hand, TracMan trial [26] found no difference in mortality or duration of mechanical ventilation in the early (within 4 days following intubation) tracheotomy group. In our retrospective study, all tracheotomies, except one case, were performed within 14 days from intubation, with a mean time of 9 days. In a meta-analysis including tracheotomies in 462 COVID-19 patients [23], the pooled cumulative incidence of early tracheotomy (within 7 days from intubation) was 5.2%, the pooled cumulative incidence of intermediate tracheotomy (between day 8 and 13) was 21.2%, and the pooled cumulative incidence of late tracheotomy (14 days or more after intubation) was 71.5%. The estimated overall mean timing was calculated as 13.6 ± 3.1 days after intubation, with a range of 0–42 days. Tang et al. [18] found out that tracheotomy before the 14th day was associated with increased mortality rate, but patients in the late tracheotomy group had lower SOFA and APACHE II scores. Botti et al. emphasize due to lack of establishment of optimal timing that tracheotomy should be performed on case-by-case basis and based on local healthcare resources and potential benefits for patients [27].

However, during the pandemic, the approach to timing of tracheotomy changed significantly. Chao et al. [19], who originally recommended postponing the performance of tracheotomy with an open technique beyond 21 days from intubation, changed their management during the course of SARS-CoV-2 pandemic. An updated practice from the authors’ institution showed mean timing of tracheotomy between the 10th and 14th day, and the percutaneous technique being performed as a standard [19, 21]. Similarly, despite the New York Head and Neck Society standard to perform tracheotomy on the 14th day, their mean timing was 10 days from intubation [28]. A study from Brazil showed that COVID patients with severe comorbidities have improved prognosis with an early tracheotomy performed 4–5 days from intubation [21]. Rosano et al. [22] analysed a group of 121 COVID patients with a median of tracheotomy performed on the 6th day and 98% of cases performed before the 10th day of intubation. In a multivariable analysis, early percutaneous tracheotomy was independently associated with decreased hospital mortality. 55% of tracheotomized patients were discharged from the hospital.

We performed a comparison analysis of patients with an early tracheotomy performed in 25 patients (median time of 8 days postintubation) and late tracheotomy in 7 patients (median 11 days). Only one patient underwent tracheotomy more than 14 days after implementing invasive mechanical ventilation. There were no differences in both groups in terms of mortality or ventilator parameters on the day of tracheotomy. The decision to perform tracheotomy was based on relative stability of lung mechanics and gas exchange and those patients with higher PEEP and FiO2 values, as well as those who still benefited from prone position were deferred from the procedure until reaching a stable P/F ratio.

There were no differences between the early and late tracheotomy group in terms of duration of mechanical ventilation (18 vs. 19 days), ICU length of stay (18 vs. 19 days) and VAP occurrence (76 vs. 71.4%). The cumulative time of mechanical ventilation was longer due to transfer of the patients to other facilities and rehabilitation centers with a mean time to decannulation averaging 42 days. A recent study by Liao et al. [29], on a group of 1000 ICU tracheotomized patients, revealed a decannulation rate of 16.7%, with an average time to decannulation of 40.9 days, which is consistent with our findings on COVID-19 patients with ARDS.

In a Spanish national cohort study, including 1890 COVID-19 patients who underwent tracheotomy, the authors found that 1 month after the performance of the tracheotomy, 52% of the patients were weaned from mechanical ventilation, 35% still required mechanical ventilation and 24% died [13]. As mentioned above, there are several benefits of an early tracheotomy with shorter duration of analgosedation, mechanical ventilation, ICU and hospital stay, but are they always true for the weaning process of COVID-19 pneumonia patients is still an open question.

The authors of meta-analysis [14] found that tracheotomy led to successful mechanical ventilation weaning in 54.9% of patients, decannulation in 34.9% of cases within 18 days on average, and postulate that there is a need for finding prognostic factors for successful outcome.

Prognostic factors

Sustained FiO2 ≤ 50% and PEEP ≤ 8 cm H2O any time during the course of treatment are strong predictive factors for a good outcome, raising the potential for these patients to be weaned down early, thus increasing ICU capacity [30]. No demographic or laboratory data as well as severity of illness based on prognostic scales utilized in intensive care unit did not predict the successful weaning and decannulation. In our study, an analysis comparing 32 patients who underwent tracheotomy showed that the survivors had lower PEEP,
FiO2 and better P/F ratio on the day of tracheotomy and 48 hours post-tracheotomy. In a logistic regression model, PEEP and FiO2 on the day of tracheotomy and 48 hours post-tracheotomy were independent factors increasing risk of dying. It was proven in this study that those with lower PEEP and FiO2 values were extubated earlier, those with lower parameters in the time of tracheotomy and 48 hours after the procedure had a higher overall survival rate.

Limitations

The biggest limitation of this study is the small sample size—among 66 patients, 32 were tracheotomized and among them 25 underwent the procedure before 10 days and 7 after 10 days postintubation.

Conclusion

As suggested in our study early percutaneous tracheotomy is safe (both in terms of risk of viral transmission to healthcare personnel and complication rate) and feasible in COVID-19 patients. Stability of gas exchange and ventilatory parameters are the main prognostic factors of the outcome and when they are achieved tracheotomy may be safely performed.

Author contributions AG: substantial contribution to conception and design, acquisition of data, analysis and interpretation of data, and drafting the article. JS: substantial contribution to conception and design, acquisition of data, analysis and interpretation of data, and drafting the article. PN: substantial contribution to conception and design, data analysis, and revising the article. MW: substantial contribution to conception and design, revising the article, and final approval of the version to be published. KK: revising the article and final approval of the version to be published.

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