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Original Scientific Paper

PERCUTANEOUS DILATATIONAL TRACHEOSTOMY IN COVID-19 PATIENTS IN THE COVID HOSPITAL INTENSIVE CARE UNIT: THE UNIVERSITY CLINICAL CENTER OF VOJVODINA EXPERIENCE

Aleksandra Plećaš Đurić[1,2], Vladimir Dolinaj[1,2], Sanja Maričić Prijić[1,2], Radmila Popović[1,2], Davor Križanović[1] and Velibor Čabarkapa[1,2]

[1]University Clinical Center of Vojvodina, Novi Sad, Serbia;
[2]Medical Faculty, University of Novi Sad, Novi Sad, Serbia

SUMMARY – Patients with acute respiratory distress syndrome due to COVID-19 require intensive care unit (ICU) admission with consecutive endotracheal intubation and invasive mechanical ventilation. In patients with long-term mechanical ventilation, percutaneous dilatational tracheostomy (PDT) may be considered. This retrospective analysis includes clinical data on patients treated at the ICUs of the COVID Hospital of the Clinical Center of Vojvodina in the period from September 3, 2021 to May 1, 2022, and underwent PDT. Patients were predominantly male (n=48; 65.8%). Weaning from mechanical ventilation was achieved in 31 (42.5%) and decannulation in 25 (34.2%) patients. The mean time from polymerase chain reaction SARS CoV-2 positivity until PDT was 15.59±6.85 days. The mean time of endotracheal intubation before the PDT procedure was 7.37±4.89 days. The mean weaning time from mechanical ventilation was 10.45±7.92 days. Twenty-five (34.2%) patients were decannulated at the mean time of 19.60±11.81 days. The complications were tracheostomy related bleeding (2 patients), pneumothorax (4 patients), subcutaneous emphysema (1 patient) and cricoid cartilage injury (1 patient). PDT is a simple, safe, and effective procedure performed in COVID-19 patients in the ICU.

Key words: *COVID-19; Percutaneous dilatational tracheostomy; Mechanical ventilation; Decannulation*

Introduction

The corona virus disease 2019 (COVID-19) is caused by the severe acute respiratory syndrome virus 2 (SARS CoV-2). It can be clinically manifested as mild, moderate, severe and critical illness[1]. Symptoms of mild COVID-19 are present in 81% of the population with fever, cough, myalgia, a change in taste or smell[2,3]. Moderate symptoms of the illness are clinical or radiographic evidence of the lower respiratory tract disease with preserved blood oxygen saturation above 94% without supplement oxygen therapy[3]. In 14% and 5% of patients, respectively, the clinical spectrum of the disease might be severe and critical[2].

Patients with severe pneumonia and acute respiratory distress syndrome (ARDS) require intensive care unit (ICU) admission with consequential endotracheal intubation and invasive mechanical ventilation[4]. In the COVID-19 patients on prolonged mechanical ventilation, tracheostomy is advocated. Some of the most important benefits of tracheostomy in COVID-19 patients are reduced requirement for sedation, improved

Correspondence to: *Aleksandra Plećaš Đurić, MD, PhD*, Teaching Assistant, Jovana Orosa 6, 21000 Novi Sad, Serbia
E-mail: aleksandra.plecas-djuric@mf.uns.ac.rs

weaning process of the patient from mechanical ventilation, reduced respiratory effort in patients in which pulmonary reserve is already limited, shortened dead space and improved toilet of the tracheo-bronchial tree[5]. There are two techniques of tracheostomy which might be performed in patients with critical forms of the disease, i.e., the percutaneous and surgical cervicotomy technique. So far, many guidelines and recommendations by different medical societies have been published[6].

The primary aim of our study was to analyze the timing of tracheostomy, success of weaning COVID-19 patients from mechanical ventilation, length of time from tracheostomy until decannulation, as well as the possible connection with patient survival. Secondary aim was to analyze complications that may occur as a consequence of percutaneous dilatation tracheostomy (PDT) as a single method of tracheostomy, according to the experience acquired at the special COVID Hospital of the University Clinical Center of Vojvodina.

Patients and Methods

The retrospective analysis included clinical data gathered from the electronic medical records (electronic medical histories) on patients treated at the ICU of the COVID Hospital of the Clinical Center of Vojvodina in the period from September 3, 2021 to May 1, 2022, who underwent PDT.

Timing of the PDT was based on the intensivist indications. According to the local protocol for performing percutaneous tracheostomy, patients had to fulfill the following criteria in order for the procedure to be performed: positive end expiratory pressure (PEEP) <10 cm H_2O, inspired oxygen (FiO_2) <0.6, and hemodynamic stability. Platelet count >50x10^9 cells and prothrombin time <1.6 R (ratio) was obligatory.

During the PDT procedure, continuous electrocardiography monitoring, pulse oximetry, and invasive blood pressure were performed. Patients were sedated with propofol and remifentanil, neuromuscular blocking was provided with the administration of rocuronium or cisatracurium. In all patients, preoxygenation with 100% oxygen was performed before the beginning of the procedure. During the intervention, patients were ventilated at the inspired oxygen fraction (FiO_2) value 100%. Proper extension and position of the neck was achieved by placing a firm roll under the patient's shoulders. Fiberoptic bronchoscopy was used for real-time visualization of the carina, tracheal rings, and in order to confirm identification of the correct puncture site at the front of the neck. The bronchoscopy swivel adapter was used to provide mechanical ventilation of the patient without air leakage.

The modified Ciaglia technique of PDT was used, i.e., Ciaglia Single Dilatater method with the TRACOE® experc Set vario, which includes a spiral reinforced tracheal cannula (TRACOE medical GmbH, Nieder-Olm, Germany).

According to the hospital protocol, an intensivist involved in the procedure wore personal protective equipment before entering the patient room, and before the beginning of the procedure a second sterile gown and gloves were taken.

At the end of the procedure, evaluation of the tracheal cannula position was performed with a fiberoptic bronchoscope and chest x-ray was obtained.

The mean time from intubation to performing PDT, mean time from PDT to spontaneous breathing, mean decannulation time, and complications were recorded. Survival was observed as discharge from hospital treatment.

Statistics

Results were expressed as absolute values and percentages. Statistical analysis was conducted using IBM SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Data were expressed as mean ± standard deviation.

Results

During the observed period, from September 3, 2021 to May 1, 2022, 890 patients were treated in the ICU. Of these, 482 (54.2%) patients were endotracheally intubated and on mechanical ventilation. Extubation was performed in 24 (4.9%) patients, while percutaneous tracheostomy was performed in 119 patients. Patients who were transferred to another hospital for further treatment (17 patients) and patients who were admitted for neurosurgical/neurological disorders that required prolonged mechanical ventilation (as a therapeutic procedure but without clinical and radiological signs and symptoms of ARDS as part of the COVID-19 infection, 15 patients) were excluded from the study and further statistical analysis. Patients with prolonged polymerase chain reaction (PCR) positivity (readmission to the ICU) and post-COVID syndrome (6 patients) were excluded from analysis, and so were surgical patients treated in our ICU due to COVID positivity and who required prolonged mechanical ventilation due to an underlying disease (7 patients). One patient had to be withdrawn from the procedure after initial fiberoptic bronchoscopy because of the existence of a tracheoesophageal fistula (Fig. 1). Final analysis included 73 patients. Basic characteristics and tracheostomy related outcomes in the study group are shown in Table 1.

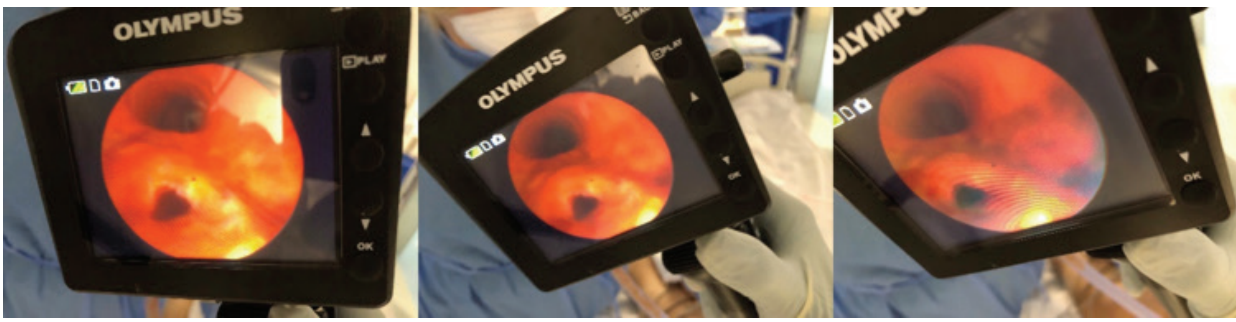

Fig. 1. Tracheoesophageal fistula.

Table 1. Basic characteristics and tracheostomy related outcomes in the study group

Parameter	Value
Age (years)	
Mean ± SD	63.71±10.48
Median	65
Gender	
Male (n/%)	48/65.8
Female (n/%)	25/34.2
Survival	
Yes (n/%)	31/42.5
No (n/%)	42/57.5
Time from PCR SARS CoV-2 positivity to tracheostomy (days)	
Mean ± SD	15.95±6.80
Median	16
Time from endotracheal intubation to tracheostomy (days)	
Mean ± SD	7.37±4.89
Median	6
Time from tracheostomy to weaning from mechanical ventilation (days)	
Mean±SD	10.45±7.92
Time from tracheostomy to decannulation (days)	19.60±11.81
Mean ± SD	
Complication	
Bleeding (n/%)	2/2.74
Cartilage damage (n/%)	1/1.36
Pneumothorax (n/%)	4/5.48

Patients undergoing PDT were predominantly male (n=48; 65.8%). The mean age of all patients was 63.71±10.48 (range 34-80) years. Spontaneous breathing and weaning from mechanical ventilation were achieved in 31 (42.5%) and decannulation in 25 (34.2%) patients. The mean time from PCR SARS CoV-2 positivity until performing PDT was 15.59±6.85 days. The mean time of endotracheal intubation before the PDT procedure, defined as the time from the first endotracheal intubation to tracheostomy, was 7.37±4.89 days. The mean weaning time from mechanical ventilation was 10.45±7.92 days. After tracheostomy, 25 (34.2%) patients were decannulated and the mean time from PDT until decannulation was 19.60±11.81 days. There was a positive correlation between the time from intubation to tracheostomy and achieving decannulation (R^2=0.168; p=0.02) (Fig. 2).

The most common immediate complications were tracheostomy related bleeding (2 patients) and cricoid cartilage injury (1 patient). Intermediate complication was pneumothorax (4 patients).

Discussion

In our study, we retrospectively analyzed medical histories of the SARS CoV-2 positive patients who were admitted to the ICU of the COVID Hospital of the University Clinical Center of Vojvodina from September 3, 2021 to May 1, 2022. Patients who were included in our study were critically ill and underwent percutaneous tracheostomy. All patients presented with a severe form of COVID-19 at the time of admission to the ICU. From September 3, 2021 until May 1, 2022, 890 patients were treated in the ICU. Mechanical ventilation as a treatment method was conducted in 482 patients with severe ARDS (PaO_2/FiO_2 ratio <100).

Percutaneous dilatation tracheostomy was performed in 73 (15.14%) patients. This rate is consistent with the rate of tracheostomies reported in the LUNG-SAFE trial[7]. In our study, 24 (4.9%) patients who were endotracheally intubated the weaning process from mechanical ventilation and extubation was achieved without PDT. In patients who underwent PDT, the weaning process from mechanical ventilation and overall survival rate was 42.5% (31 patients). In 25 (34.2%) patients who were tracheostomized and weaned from mechanical ventilation, decannulation was achieved. Our findings were similar to those reported by Chao *et al*. They reported that the survival rate of tracheostomized patients in a much smaller group of patients was 30.2% (16 patients)[8]. Angel *et al*. demonstrated the ventilator liberation rate of 33% and decannulation rate of 8%. Mortality rate in this study was only 7%[9]. In our

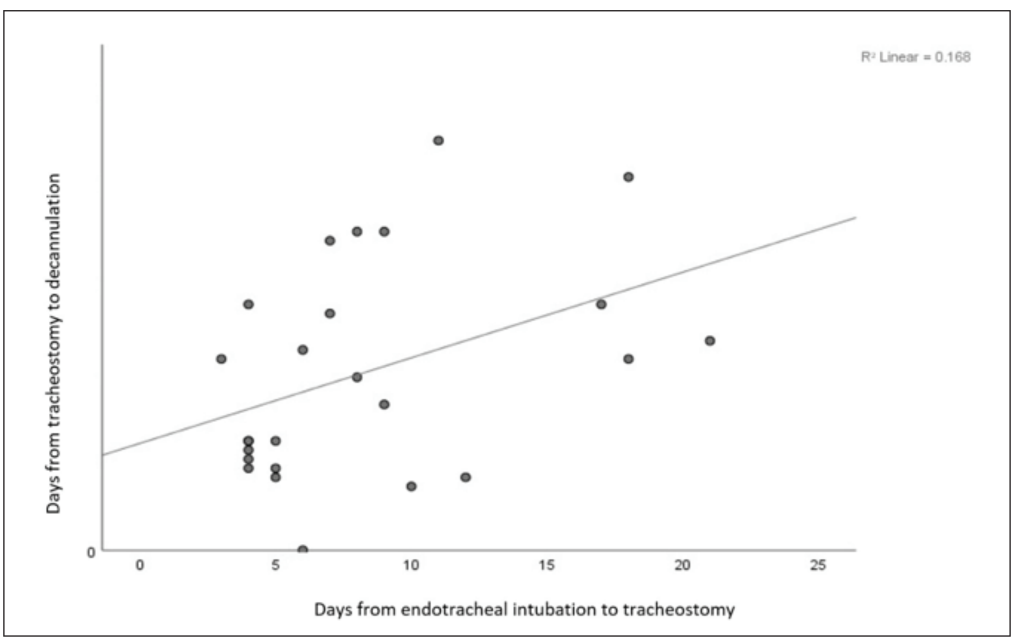

Fig. 2. Correlation between the time from endotracheal intubation to tracheostomy and time from tracheostomy to decannulation (p=0.02).

study, mortality rate was much higher (42.5%). The reason for the high mortality rate in our study might be the critical condition of the patients at the time of performing endotracheal intubation and initiation of mechanical ventilation, a very low PaO_2/FiO_2 ratio, and age of the patients. Namely, in the study by Angel *et al.*[9], the mean age in the group of 132 patients was 57±15 years, whereas in our group the mean age was 63.71±10.48 years. At the same time, the follow up period of tracheostomized patients in the study by Angel *et al.*[9] was only 18 days. In our study, survival was observed until the patient was discharged from our institution.

Optimal timing for tracheostomy in COVID-19 patients remains controversial[10]. It is almost impossible to identify the exact moment in which a patient's condition will either improve, remain stable or worsen with consequential further pulmonary complications. Patient selection for PDT in COVID-19 should be based on their clinical stability, as well as on risk assessment of disease transmission to medical stuff. The Indian Society of Critical Care Medicine (ISCCM) Expert Panel Practice Recommendations define early tracheostomy as performing tracheostomy within or equal to 7 days of mechanical ventilation initiation and late tracheostomy as any tracheostomy performed beyond 7 days[11]. An international consensus suggests that COVID-19 tracheostomy should be performed 10 days following endotracheal intubation. According to the mentioned international consensus, patients should be taken into consideration for PDT only if signs of clinical improvement are present[12]. Timing of PDT in our group of patients was based on the intensivist's indication and judgment. In order to perform the procedure safely, patients had to fulfill the following criteria: PEEP <10 cm H_2O, inspired oxygen (FiO_2) <0.6, and hemodynamic stability. The mean time of endotracheal intubation in our group of patients defined as the time from the first endotracheal intubation to PDT was 7.37±4.89 (range 2-22) days. A group of Spanish authors report on the median time for tracheostomy of 12 (range 4-42) days. In their study, 7% of patients underwent tracheostomy within the first 7 days of intubation[13]. In another study from Brazil, the authors noticed that in patients with severe comorbidities, early tracheostomy performed in 4-5 days from endotracheal intubation improved treatment outcome. At the same time, according to these authors, early tracheostomy might increase the risk of infection of healthcare providers[14]. A similar period between endotracheal intubation and PDT in COVID-19 patients (2-32 days) has been reported by Chao *et al.*[8]. In all available studies, discussion about the optimal time for tracheostomy in COVID-19 setting is a burden with a potential benefit for patients, in which early tracheostomy would improve the prognosis of the patient and the potential risk of disease transmission to healthcare workers during the tracheostomy procedure. The recommendations from the New York Head and Neck Society suggest that tracheostomy should not be delayed regardless of SARS-CoV-2 status in a situation in which tracheostomy would improve the patient prognosis[15]. The infectivity of SARS-CoV-2 is significantly reduced between 7-10 days following the onset of symptoms. The immune response to the virus appears around day 7 after the first symptom of the disease appears[16]. In our study, the mean time from positive test (RT-PCR SARS- CoV-2) to PDT was 15.59±6.58 days. Therefore, we believe that the risk of possible transmission of the infection to healthcare providers was low. The providers who participated in PDT did not miss any workdays due to symptoms or positive COVID-19 testing.

Spontaneous breathing and weaning from mechanical ventilation in our study were achieved in 42.5% of patients. Successful decannulation was observed in 34.2% of patients. The mean weaning time from mechanical ventilation was 10.45±7.92 days and mean time from PDT to decannulation was 19.60±11.81 days. Similar findings have been reported by Chao *et al.* in their group of 53 patients who underwent PDT, were SARS CoV-2 positive and had ARDS. These authors found positive correlation between the time from endotracheal intubation to tracheostomy and time from tracheostomy to weaning from mechanical ventilation[8]. We also found positive correlation between the pre-tracheostomy endotracheal intubation time and decannulation. The patients who undergo PDT earlier tend to achieve earlier decannulation. This result can be explained by the fact that sometimes PDT had to be delayed because the appropriate conditions for safe performance of the procedure could not be achieved. The patients with more severe disease without response to treatment in the early period of endotracheal intubation and mechanical ventilation have, according to our experience, less chance to survive. A positive correlation between PDT and earlier decannulation demonstrates that healthier patients were earlier selected for PDT. Murthy *et al.* concluded that patients who showed no clinical or radiological remission within 10 days might be more likely to require prolonged mechanical ventilation and have a more severe course of the disease, including lethal outcome[17]. The results of our study are also in line with the recommendations that early tracheostomy might reduce the duration of mechanical ventilation and might result in more ventilator-free days in critically ill patients[11].

Complications that may occur as a consequence of PDT procedure are categorized as immediate, intermediate, and late. According to the literature, complication rate of PDT in non-COVID patients varies from 2.1% to 20%[18]. Unfortunately, so far, we have not found literature reports about the frequency of PDT complications in COVID-19 patients, which might be higher. In our study, the cumulative rate of complications was 9.6%. The most common complication in our study was pneumothorax which occurred in 4 (5.48%) patients, bilateral in one of them (Fig. 3). Bilateral pneumothorax is a rare complication of PDT, especially when it is performed under fiberoptic bronchoscopy. Bilateral pneumothorax can be caused by posterior tracheal wall injury, or direct injury to the pleura after puncture of the anterior tracheal wall, especially when the puncture site is lower than usual[19,20]. Since we performed PDT in real-time fiberoptic bronchoscopy, a lesion of the posterior tracheal wall could be excluded. All our patients received therapeutic doses of low molecular weight heparin. Bleeding was noticed in 2 (2.4%) patients. These patients did not require any additional surgical intervention since spontaneous resolution happened. There are a few reports of a higher incidence of the bleeding complication in COVID-19 critically ill patients. Angel *et al*. report that 5.1% of patients had bleeding within the first 48 hours following PDT[9]. A possible explanation for the increased bleeding risk following PDT is in different anticoagulation regimens. At the time of attempted decannulation, we identified one patient with cricoid cartilage damage (Fig. 4).

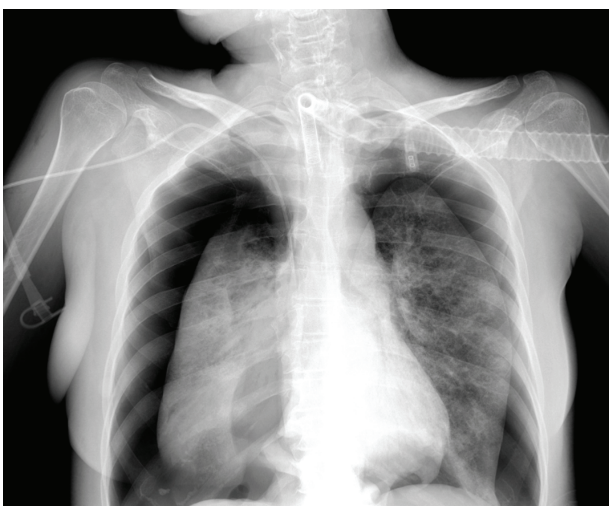

Fig. 3. Bilateral pneumothorax.

Conclusion

Percutaneous dilatational tracheostomy is the most preferred technique for performing tracheostomy in critically ill patients. Furthermore, it is a simple, safe and effective procedure performed in COVID-19 patients

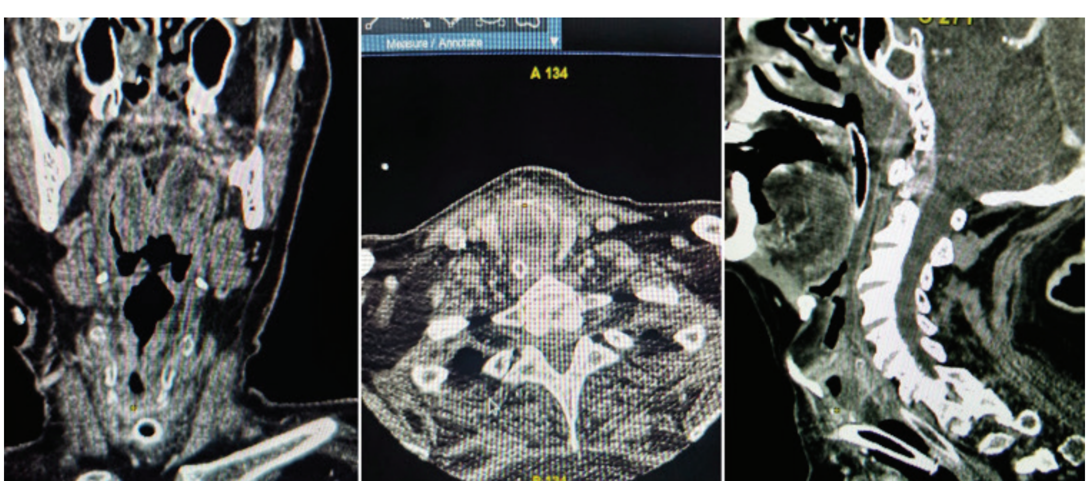

Fig. 4. Cricoid cartilage damage.

in the ICU. Our experience demonstrates that tracheostomy can be performed in a way that is considered safe for intensivists, while achieving the desired outcome for the patient. In the pandemic scenario with limited ICU resources, our preliminary data show that patients undergoing tracheostomy are more frequently weaned from mechanical ventilation in comparison to intubated patients whose treatment resulted in very poor outcome.

Our study had several limitations. Firstly, our data were collected retrospectively from medical records of patients. Secondly, this study was limited by the inability to achieve adequate randomization of patients. This limitation introduced the possibility of a bias towards tracheostomy because it does not eliminate the possibility that patients selected for tracheostomy were initially those with a higher chance of recovery. A well-designed prospective study, with cohort analysis is necessary to show the real benefit of tracheostomy in COVID-19 patients and determine optimal timing of this procedure.

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Sažetak

PERKUTANA DILATACIJSKA TRAHEOSTOMIJA U BOLESNIKA S COVID-19 U JEDINICI INTENZIVNOG LIJEČENJA: ISKUSTVO COVID BOLNICE KLINIČKOG CENTRA VOJVODINE

A. Plećaš Đurić, V. Dolinaj, S. Maričić Prijić, R. Popović, D. Križanović i *V. Čabarkapa*

Bolesnici sa sindromom akutnog respiracijskog distresa zbog COVID-19 zahtijevaju prijam u jedinicu intenzivnog liječanja (JIL) s posljedičnom endotrahealnom intubacijom i invazivnom mehaničkom ventilacijom. U bolesnika na produženoj mehaničkoj ventilaciji potrebno je razmotriti perkutanu dilatacijsku traheostomiju (PDT). Ova retrospektivna analiza uključuje kliničke podatke bolesnika koji su liječeni u jedinici intenzivnog liječenja u COVID bolnici Kliničkog centra Vojvodine u razdoblju od 3. rujna 2021. do 1. svibnja 2022. i koji su bili podvrgnuti PDT-u. Bolesnici su pretežito bili muškarci (n=48; 65,8%). Odvajanje od mehaničke ventilacije je postignuto u 31 (42,5%) i dekanilacija u 25 (34,5%) bolesnika. Srednje vrijeme od dokazanog pozitiviteta PCR testom na SARS CoV-2 do PDT je bilo 15,59±6,85 dana. Srednje vrijeme endotrahealne intubacije prije postupka PDT je bilo 7,37±4,89 dana. Srednje vrijeme odvajanja od mehaničke ventilacije je bilo 10,45±7,92 dana. Dekanilirano je bilo 25 (34,5%) bolesnika, a srednje vrijeme je bilo 19,60±11,81 dana. Komplikacije su bile krvarenje povezano uz traheostomu (2 bolesnika), pneumotoraks (4 bolesnika), subkutani emfizem (1 bolesnik) i ozljeda krikoidne hrskavice (1 bolesnik). PDT je jednostavan, siguran i učinkovit postupak u bolesnika s COVID-19 u JIL-u.

Ključne riječi: *COVID-19; Perkutana dilatacijska traheostomija; Mehanička ventilacija; Dekaniliranje*