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Bronchoscopy-guided percutaneous tracheostomy during the COVID-19 pandemic

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ABSTRACT

Background: Assessment of the efficacy and complications associated with performing bronchoscopy-guided percutaneous tracheostomy in COVID-19 and non–COVID-19 patients.

Methods: Prospective observational study conducted between March of 2020 and February of 2022. All adult patients who underwent elective bronchoscopy-guided percutaneous tracheostomy were included. The efficacy of the procedure was evaluated based either on the success rate in the execution or on the need for conversion to open technique. Percutaneous tracheostomy-related complications were registered during the procedure. We performed 6-month follow-up for identifying late complications.

Results: During the study period, 312 bronchoscopy-guided percutaneous tracheostomies were analyzed. One hundred and eighty-three were performed in COVID-19 patients and 129 among non–COVID-19 patients. Overall, 64.1% (200) of patients were male, with a median age of 66 (interquartile range 54–74), and 65% (205) presented at least 1 comorbidity. Overall, oxygen desaturation was the main complication observed (20.8% [65]), being more frequent in the COVID-19 group occurring in 27.3% (50) with a statistically significant difference versus the non–COVID-19 patients' group (11.6% [15]); $P < .01$). Major complications such as hypotension, arrhythmias, and pneumothorax were more frequently observed among COVID-19 patients as well but with no significant differences. Percutaneous tracheostomy could be executed quickly and satisfactorily in all the patients with no need for conversion to the open technique. Likewise, no suspension of the procedure was required in any case. During 6-month follow-up, we found an incidence of 0.96% ($n = 3$) late complications, 2 tracheal granulomas, and 1 ostomal infection.

Conclusion: Bronchoscopy-guided percutaneous tracheostomy can be considered an effective and safe procedure in COVID-19 patients. Nevertheless, it is highly remarkable that in the series under study, a great number of COVID-19 patients presented oxygen desaturation during the procedure.

Introduction

The percutaneous tracheostomy (PT) technique was described originally by Shelden in 1955,[1] but it was associated with a high rate of complications, which limited its use. It was not until 1985 that Pasquale Ciaglia[2] developed a method using the Seldinger technique that facilitated the introduction of devices of different caliber to progressively dilate the trachea until cannulation. In the following years and even nowadays, PT remains as one of the most frequently performed procedures in the setting of acute respiratory failure.[3]

In the context of critically ill patients and compared to open surgical techniques, PT offers advantages such as avoiding potentially dangerous transfers outside the intensive care unit (ICU), which results in a lower rate of infectious complications and a decrease in costs for the health system.[4] Percutaneous tracheostomy is usually indicated as a weaning strategy in patients who require prolonged mechanical ventilation (MV) to prevent potential complications of orotracheal intubation such as ventilator-associated pneumonia, sinusitis, and tracheal lesions. Additionally, it confers an increase in patients' comfort, improves bronchial hygiene, and reduces the need for deep sedation.[5,6] However,

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patients with severe acute respiratory distress syndrome secondary to COVID-19 present prolonged and fluctuating periods of hypoxemia[7] and hemostasis disorders.[8]

The aim of the present study was to compare the rate of technique conversion, to compare the need to suspend the procedure, and to compare the proportion of complications related to bronchoscopy-guided PT in COVID-19 and non−COVID-19 patients.

Methods

A prospective observational study was conducted as of March of 2020 until February of 2022 in the ICU of a high-complexity university hospital in Buenos Aires, Argentina. We performed a consecutive sampling strategy; therefore, all adult patients who underwent elective bronchoscopy-guided PT due to prolonged weaning from MV were included. The prolonged weaning mentioned is defined as the process that either requires >3 spontaneous ventilation trials (SVT) or a period of weaning that lasts for >7 days from the first SVT.[9] The PT candidates were evaluated on a case-by-case basis by the ICU medical team, in the event that the leading cause of MV initiation was solved, and pO2/fraction of inspired oxygen (FiO2) ratio was >200 with a FiO2 of ≤60%.

All patients admitted to ICU due to respiratory failure had a real-time polymerase chain reaction (RT-PCR) during the period of study (from nasal swab or a lower respiratory tract sample). We consider COVID-19 patients to be all patients with positive RT-PCR tests. If the patient presented a negative RT-PCR test, but high clinical suspicion, we performed another RT-PCR. Persistent positive results did not limit the decision to proceed with PT.

This study was approved by the institutional ethics committee. Our article complies with the Strengthening the Reporting of Observational Studies in Epidemiology statement guidelines for observational cohort studies[10] (Supplementary Table S1).

Variables and outcomes

Demographic variables such as age, sex, Acute Physiology and Chronic Health disease Classification System II score, comorbidities, and in-hospital mortality of the series were registered. Mechanical ventilation days until PT and anesthesia and surgical times were informed as well. Anesthesia time mentioned before was defined as the period in which sedoanalgesia changed. A goal of Richmond Analgesia Sedation Scale−5 was targeted by using ketamine (1 to 2 mg/kg bolus), rocuronium (1 mg/kg bolus), and propofol in continuous infusion (maximum dose of 1.8 mg/kg/h). Once the surgical procedure was completed, the previous Richmond Analgesia Sedation Scale goal was restored. Surgical time was counted from the placement of the surgical field until the connection of the tracheostomy cannula to the mechanical ventilator.

Due to the lack of universally accepted definitions for PT-related complications, the British Thoracic Society criteria were used as a reference[11]:

- *Oxygen desaturation*: decrease >4% in the saturation of oxygen by pulse oximetry or the saturation of oxygen was <90%, for more than a minute
- *Arrhythmias*: 40% increase or decrease in heart rate (HR) relative to the baseline HR, HR >110 beats per minute, HR <50 beats per minute, and/or changes in heart rhythm evidenced by continuous electrocardiography
- *Hypertension*: 30% increase in systolic blood pressure (SBP) relative to baseline SBP
- *Hypotension*: 30% decrease in SBP to baseline blood pressure or mean blood pressure <65 mm Hg
- *Bleeding:*
  - *No bleeding*: either no bleeding or traces of blood that do not require continuous suction
  - *Minor bleeding*: bleeding that requires continuous suction of the airway and bleeding stops up spontaneously
  - *Moderate bleeding*: bleeding that requires hemostatic maneuvers with the endoscope including adrenaline, tranexamic acid, or cold saline infusion
  - *Major bleeding*: bleeding that requires resuscitation with crystalloids, transfusions, or suspension of the procedure

  Other major complications such as nonplanned extubation, airway injury, esophageal perforation, pneumothorax, pneumomediastinum, and cardiac arrest were considered. Patients were followed up during 6 months from PT to register late complications, which were defined as those complications that appeared after 7 days of PT.[12] Late complications included were: granuloma (benign growth of granulation tissue in the trachea), tracheal stenosis (a pathologic narrowing of the tracheal lumen), tracheomalacia (weakening of the tracheal wall leading to dynamic expiratory collapse and airway obstruction, defined as >50% reduction in cross-section area of the trachea during forced expiration), stoma infection, and tracheoesophageal fistula.

The primary outcomes of this study were (1) to compare the proportion of the combined outcome (technique conversion or need to suspend the procedure) between COVID-19 and non−COVID-19 patients during bronchoscopy-guided PT; (2) to analyze if COVID-19 is an independent risk factor of oxygen desaturation during bronchoscopy-guided PT.

The secondary outcomes of this study were: (1) to compare the proportion of PT-related complications reported by the British Thoracic Society[11]; (2) to compare the proportion of late complications.

Ventilator settings and personal protective equipment

During the preparation of the PT, the volume-controlled mode was set to obtain a tidal volume of 6 to 8 mL/kg theoretical weight, with 100% FiO2. Positive end-expiratory pressure (PEEP) was titrated according to the compliance-guided method. A swivel connector was used to maintain MV while performing the bronchoscopy without major air leakage. Induced apnea cycles (with necessary preoxygenation) were performed during the procedure to reduce viral dispersion.[13] Health care personnel were protected with personal protective equipment that was used in all procedures.[14]

Bronchoscopy technique

Both operators, the surgeon and the bronchologist, were suggested to position themselves with a clear view of the bronchoscope screen. Before starting the procedure, a focused airway anatomy check was performed. Additionally, a bronchial toilet was recommended to further optimize bronchoscopic vision. Afterward, the endotracheal tube was withdrawn up to the subglottic space with the balloon cuff deflated, under direct bronchoscopic vision. The bronchologist maintained a direct vision of the working space, guiding the surgeon operator to puncture the midline trachea.[15] Finally, bronchoscopic control was performed through the cannula to corroborate the correct positioning and aspirate either secretions or hematic remains. A single-use video-bronchoscope was used in all procedures (Ambu aScopeTM 3 Regular 5.0/2.2).[16]

Bronchoscopies were performed by a trained intensive care physician.

Surgical technique

Modifications were made to the classical Ciaglia technique. This modified technique consisted of a transverse cervical incision 2 centimeters above the sternal notch, with subsequent dissection of subcutaneous cellular tissue with electrocautery. Subsequently, a vertical incision opening of the platysma muscle was performed, avoiding injuring the muscular fibers with a digital maneuver. The tracheal rings were then palpated, choosing the site puncture between the second and third tracheal rings. Subsequently, the surgeon proceeded to tracheal puncture under direct bronchoscopy vision using a 14 gauge caliber needle in the midline trachea. The guidewire was then advanced, while dilating the anterior face of the trachea with a single dilator, according to Seldinger's technique. Once the dilation was achieved, the cannula was placed.[17] A PT set with a single dilator kit (TRACOE experc, Nieder-Olm, Germany) and an electrosurgical generator (Covidien Force FX, Dublin, Ireland) with electrocautery (Covidien Rocker switch pencil) was used. All percutaneous procedures were performed by a trained chest surgeon.

Statistical analysis

The categorical variables were presented as proportions and compared by χ^2 analysis or Fisher exact test as appropriate. The quantitative variables were presented as mean and SD or median and IQR and compared by Student's *t* test or Mann-Whitney *U* test, according to distribution.

To assess the relationship between COVID-19 and oxygen desaturation, first, we performed univariate analyses of the exposure and all the potential confounders. The potential confounders in the causal relation between COVID-19 and risk of oxygen desaturation were: age, sex, Acute Physiology and Chronic Health disease Classification System II score, comorbidities (eg, hypertension, diabetes mellitus, oncologic disease, coronary artery disease, solid organ transplant [different from lung transplant], lung transplant, chronic obstructive pulmonary disease, interstitial lung disease, and asthma), and MV days until PT. We did not adjust for paO2/FiO2 ratio and PEEP because all patients presented a paO2/FiO2 ratio >200 (necessary criteria to perform tracheostomy), and PEEP was titrated in all patients by compliance-guided method.[18]

Second, a multivariable logistic regression model was performed to assess the COVID-19 effects on oxygen desaturation while adjusting for the potential confounders. COVID-19 status was forced into the model to assess its significance in determining oxygen desaturation likelihood, followed by stepwise inclusion of all the potential confounders described before. Variables with *P* values < .1 were maintained in the model and variables with biological plausibility. We tested the linear relation between continuous variables and the log odds with the Box-Tidwell test. All analyses were performed using R software, version 1.4.1717 (R Foundation for Statistical Computing, Vienna, Austria) and STATA v.16 (StataCorp, LLC, College Station, TX). We did not perform imputation for missing data.

Sample size

Because of the prospective nature of this study and the limited number of bronchoscopy-guided PT, our study had a fixed sample size of 312 bronchoscopy-guided PT with a ratio of 0.7 between non–COVID-19 and COVID-19 patients. With this sample size, we have adequately powered (80%) to detect a difference of at least 5% in the proportion of technique conversion or the need to suspend the procedure (0.1% in non–COVID-19[19,20] vs 5% in COVID-19 patients), with an alpha of .05 and a 2-sided test. Regarding oxygen desaturation outcome, we proposed to build a logistic regression model to adjust the potential confounders with approximately 4 to 6 covariables, we would need 10 oxygen desaturation events per variable included in the model,[21] around a total of events of 60. We have a fixed sample size, but the observed number of oxygen desaturation was superior to 60.

Results

During the study period, 312 bronchoscopy-guided percutaneous tracheostomies were analyzed. One hundred and eighty-three were performed in COVID-19 patients and 129 among non–COVID-19 patients. Overall, 64.1% ($n = 200$) of patients were male, with a median age of 66 (IQR 54–74). Sixty-five percent ($n = 205$) presented at least 1 comorbidity. Hypertension was the most common comorbidity, affecting 50.0% ($n = 150$). Regarding MV days before PT, COVID-19 patients underwent PT on a median time of 19 days (IQR 15–24) vs 13 days (IQR 9–17) among non–COVID-19 patients ($P < .01$). Table I shows the demographic and clinical characteristics of the participants. The cause of MV of non–COVID-19 patients is listed in Supplementary Table S2. The proportion of missing data was <5% in all variables (Supplementary Table S3).

Overall, desaturation was the main complication observed (20.8% [$n = 65$]), but it was more frequent in the COVID-19 group occurring in 27.3% ($n = 50$). Table II shows the early and late PT-related complications. Different distributions of variables among patients with and without oxygen desaturation are presented in Table III. The crude odds ratio of oxygen desaturation in COVID-19 patients was 2.85 (95% CI 1.52–5.35; $P < .01$), and the adjusted odds ratio was 3.31 (95% CI 1.54–7.11; $P < .01$). The adjusted odds ratio of the model is presented in Supplementary Table S4.

Bleeding was present in 7.37% ($n = 23$) of the procedures, without differences among groups (7.75% [10] in non–COVID-19 patients vs 7.10% [13] in COVID-19 patients; $P = .99$). Also, major complications such as hypotension, arrhythmias, and pneumothorax were more frequently observed among COVID-19 patients but without reaching significant differences (hypotension: 6.01% [$n = 11$] vs 3.88% [$n = 5$], $P = .56$; arrhythmia: 1.64% [$n = 3$] vs 0.78% [$n = 1$], $P = .66$; pneumothorax: 0.55% [$n = 1$] vs 0% [$n = 0$], $P = .99$; among COVID-19 and non–COVID-19, respectively).

Percutaneous tracheostomy could be executed quickly and satisfactorily in all the patients without the need for conversion to open technique, with a median anesthesia time of 12 minutes (IQR 10–15) and surgical time of 5 minutes (IQR 4–9). Likewise, no suspension of the procedure was required in any case. Nevertheless, 1 patient (0.78%) in the non–COVID-19 group presented sudden cardiac arrest immediately after PT.

During 6-month follow-up, we found an incidence of 0.96% ($n = 3$) late complications, 2 tracheal granulomas, and 1 ostomal infection.

Discussion

In this unicenter prospective study analyzing 312 bronchoscopy-guided PT, this technique can be considered a safe procedure in COVID-19 patients. We observed a low incidence of major complications including pneumothorax, nonplanned extubation, or airway injury.

Major complications in COVID-19 patients could result not only in an increase in patient morbidity and mortality but also in a higher risk of viral exposure to the health care practitioners involved during the subsequent treatment of the complication.[14,22]

Table I
Patients' demographic characteristics

	All ($n = 312$)	Non–COVID-19 ($n = 129$)	COVID-19 ($n = 183$)	*P* value
Demographics				
Male sex, *n* (%)	200 (64.1%)	79 (61.2%)	121 (66.1%)	.44
Age, median (IQR)	66 (54–74)	68 (53–74)	65 (55–74)	.60
BMI, median (IQR)	28 (24–32)	26 (23–31)	29 (25–32)	.01
APACHE II score, median (IQR)	13 (9–18)	14 (8–21)	12 (9–17)	.08
MV days before tracheostomy, median (IQR)	17 (12–21)	13 (9–17)	19 (15–24)	< .01
In-hospital mortality, *n* (%)	84 (26.9%)	44 (32.6%)	40 (22.1%)	.01
Comorbidities, *n* (%)				
Hypertension	156 (50.0%)	70 (54.3%)	86 (47.0%)	.25
Diabetes mellitus	63 (20.2%)	27 (20.9%)	36 (19.7%)	.90
Oncologic disease	49 (15.7%)	28 (21.7%)	21 (11.5%)	.02
Coronary artery disease	49 (15.7%)	35 (27.1%)	14 (7.65%)	< .01
Transplant (different from lung transplant)	27 (8.65%)	15 (11.6%)	12 (6.56%)	.17
Lung transplant	11 (3.53%)	10 (7.75%)	1 (0.55%)	< .01
COPD	15 (4.81%)	7 (5.43%)	8 (4.37%)	.87
Interstitial lung disease	8 (2.56%)	7 (5.43%)	1 (0.55%)	.01
Asthma	7 (2.24%)	1 (0.78%)	6 (3.28%)	.24

APACHE, Acute Physiology and Chronic Health disease Classification System II; *BMI*, body mass index; *COPD*, chronic obstructive pulmonary disease; *MV*, mechanical ventilation.

Table II
Early and late complications

	All ($n = 312$)	Non–COVID-19 ($n = 129$)	COVID-19 ($n = 183$)	*P* value
Early complications, *n* (%)				
Oxygen desaturation	65 (20.8%)	15 (11.6%)	50 (27.3%)	< .01
Bleeding	23 (7.37%)	10 (7.75%)	13 (7.10%)	.99
Type 1	17 (5.45%)	7 (5.43%)	10 (5.46%)	.99
Type 2	3 (0.96%)	1 (0.78%)	2 (1.09%)	.99
Type 3	3 (0.96%)	2 (1.55%)	1 (0.55%)	.57
Hypotension	16 (5.13%)	5 (3.88%)	11 (6.01%)	.56
Arrhythmia	4 (1.28%)	1 (0.78%)	3 (1.64%)	.66
Nonplanned extubation	4 (1.28%)	1 (0.78%)	3 (1.64%)	.66
Hypertension	3 (0.96%)	0 (0.00%)	3 (1.64%)	.29
Pneumothorax	1 (0.32%)	0 (0.00%)	1 (0.55%)	.99
Atelectasis	1 (0.32%)	0 (0.00%)	1 (0.55%)	.99
Cardiac arrest	1 (0.32%)	1 (0.78%)	0 (0.00%)	.42
Airway injury	0	0	0	-
Esophageal perforation	0	0	0	-
Late complications, *n* (%)				
Granuloma	2 (0.64%)	0	2 (1.09%)	.51
Stoma infection	1 (0.32%)	1 (0.77%)	0	.41
Tracheomalacia	0	0	0	-
Tracheal stenosis	0	0	0	-
Tracheoesophageal fistula	0	0	0	-
Timing, median (IQR)				
Anesthesia time, min	12 (10–15)	12 (10–20)	12 (10–15)	.23
Surgical time, min	5 (4–9)	6 (4–10)	5 (4–8)	.08

Nevertheless, the use of bronchoscopic guidance during PT has been a controversial subject even before the present pandemic. Intraoperative direct airway visualization adds to the technical security of the procedure, mainly reducing the risk of inadvertent injuries to the posterior wall of the trachea by facilitating the location of the most suitable cannulation site.[23] On the other hand, bronchoscopy is a high-risk aerosol-generating procedure with the potential for direct SARS-CoV-2 exposure and hospital-acquired infection[24]; thus this procedure during the pandemic was limited.[25]

Case series of COVID-19 patients reporting non-bronchoscopy-guided PT complications have different results. Sallie et al[26] in a 101 COVID-19 patients series informed 18% of minor bleeding, but after the procedure, 2 patients required emergency bronchoscopy for bleeding resolution. Breik et al[27] in a 77 PT prospective cohort informed a low prevalence of minor bleeding, but 2 patients underwent major complications (false passage of cannula), and 2 procedures required conversion to surgical technique. Finally, Riestra et al[28] and Turri-Zanoni et al,[29] in a 10-case series each, informed neither procedure-related complications nor viral transmission to health care workers.

We observed a higher proportion of oxygen desaturation during the procedure among COVID-19 patients, even though PT was carried out with longer days of MV when COVID-19-related hypoxemia is presumably to be in resolution. In the multivariable analysis, COVID-19 was an independent risk factor of oxygen desaturation during PT, but without association with worse outcomes during 6-month follow-up. In this sense, Cohen et al[20] using a similar protocol PT with periods of apnea, recently reported that 46% of COVID-19 patients presented transient desaturation during bronchoscopy-guided PT, but with no immediate negative effects. However, it is worth mentioning because hypoxia in COVID-19 patients is a robust risk factor for fatal outcome.[30]

During 6-month follow-up, we found a low incidence of late complications. Nevertheless, no systematic bronchoscopy was performed to detect asymptomatic late complications such as tracheal granulomas. Only symptomatic late complications

Table III
Distributions of variables between patients with and without oxygen desaturation

	All ($n = 312$)	Non-oxygen desaturation ($n = 247$)	Oxygen desaturation ($n = 65$)	P value
Demographics				
Male sex, *n* (%)	200 (64.1%)	161 (65.2%)	39 (60.0%)	.52
Age, median (IQR)	66 (54–74)	67 (55–74.5)	65 (50–73)	.20
BMI, median (IQR)	27.7 (24–31.2)	27 (23.4–30.6)	30.2 (27.6–34.6)	< .001
APACHE II score, median (IQR)	13 (9–18)	13.0 (9–19)	12 (8–16)	.13
MV days before tracheostomy, median (IQR)	17 (12–21)	16.5 (12–21)	17 (13–23)	.42
In-hospital mortality, *n* (%)	84 (26.9%)	64 (25.9%)	20 (30.8%)	.53
Comorbidities, *n* (%)				
Hypertension	156 (50.0%)	122 (49.4%)	34 (52.3%)	.78
Diabetes mellitus	63 (20.2%)	47 (19.0%)	16 (24.6%)	.41
Oncologic disease	56 (17.9%)	42 (17.0%)	14 (21.5%)	.50
Coronary artery disease	49 (15.7%)	44 (17.8%)	5 (7.69%)	.07
Transplant (different from lung transplant)	27 (8.65%)	24 (9.72%)	3 (4.62%)	.29
Lung transplant	11 (3.53%)	10 (4.05%)	1 (1.54%)	.47
COPD	15 (4.81%)	12 (4.86%)	3 (4.62%)	.99
Interstitial lung disease	8 (2.56%)	8 (3.24%)	0 (0.00%)	.21
Asthma	7 (2.24%)	4 (1.62%)	3 (4.62%)	.16

APACHE, Acute Physiology and Chronic Health disease Classification System II; *BMI*, body mass index; *COPD*, chronic obstructive pulmonary disease.

requiring bronchoscopy interventions were objectified. However, granulation tissue as a sequela of inflammation and ulceration could be attributable not only to the PT surgical procedure but also to a number of diverse conditions and predisposing factors, including prolonged intubation, malnutrition, suboptimal cuff pressure, sepsis, and gastroesophageal reflux.[31–33]

Patients with COVID-19 presented a longer period of MV before PT in comparison with non–COVID-19 patients. From a nonsurgical standpoint, there are aspects to emphasize when deciding the best timing to perform PT in the context of this particular disease. COVID-19-related acute respiratory distress syndrome patients are usually exposed to deep sedation, neuromuscular blockade, and prone position ventilation.[34,35] The previous increases acquired muscle weakness and delirium prevalence, thus prolonging weaning. Therefore, the decision to perform PT was adjusted to individual clinical evolution. Given the case that if it had been performed in a period when severe hypoxemia remained, an important percentage of patients could not be ready to start weaning, and a considerable number of patients would have had a positive RT-PCR for SARS-CoV-2. Given that scenario, health personnel would have been exposed to infection without obtaining a substantial benefit for patients.

This study had several limitations. First, non–COVID-19 patients had different pathologies with heterogeneous pulmonary impact. Despite this, all patients had indicated PT due to prolonged weaning. Thus, we consider this population to compare with COVID-19 patients because they were exposed to the same pandemic ICU scenario. Second, we considered, in the COVID-19 group, all hospitalized patients with respiratory failure and positive RT-PCR for SARS-CoV-2. Nevertheless, some patients potentially presented another cause of respiratory failure (such as heart failure or pulmonary embolism). However, the COVID-19 patients' group had a lower burden of comorbidities (only 7% had coronary diseases, and 4.3% presented COPD); thus we assume that respiratory failure was secondary to SARS-CoV-2 infection in the majority of patients in this group. Third, this was a single-center study, which reduces its external validity. Fourth, we did not register days between COVID-19 diagnosis and PT, and we consider that this variable may be related to PT complications. However, we performed a comparison between days of MV before PT. In this analysis (presented in Table III), we observed that patients with and without oxygen desaturation had nonsignificant differences between days of MV before PT. Fifth, we did not register precise PEEP and FiO2 requirements previous to the PT moment. However, we know that all patients had at least a paO2/FiO2 ratio >200, FiO2 <60%, and the PEEP was titrated by compliance-guided method, reducing potential bias. Finally, there are no universally accepted definitions for PT-related complications; therefore, our results may vary when compared to other series.

In conclusion, bronchoscopy-guided PT can be considered an effective and safe procedure in COVID-19 patients. Nevertheless, it is highly remarkable that in the series under study, a great number of COVID-19 patients presented desaturation during the procedure.

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Conflict of interest/Disclosure

The authors have no conflicts of interests or disclosures to report.

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Supplementary materials

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