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The Diagnostic and Therapeutic Value of Bronchoscopy in Covid-19 Patients on Veno-Venous Extracorporeal Membrane Oxygenator (Ecmo) Support: A Single Center Experience

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Abstract

Introduction: Mechanically ventilated patients COVID-19 patients on veno-venous extracorporeal membrane oxygenation (VV-ECMO) support often require bronchoscopy for pulmonary toilet. However, bronchoscopy in these patients may lead to tracheobronchial bleeding from instrumentation and via aerosolization. The aim of this study was to assess the indications, benefits, and complications of bronchoscopy in critically ill patients with COVID-19 on VV-ECMO.

Methods: This was a single center observational cohort study comprising of adults with COVID-19 infection that required mechanical ventilation and VV-ECMO from January 1, 2019 to November 1, 2021 and needed bronchoscopy. The primary outcome was improvement in patient outcome dened as either in improvement in PaO_2 levels or VV-ECMO parameters 6 hours after the procedure. Secondary outcomes included microbiological data from the BAL samples. Mann-Whitney U and $\chi 2$ tests were used to compare continuous and categorical variables, respectively. Wilcoxon rank sum test for comparing correlated non-parametric continuous data. The median difference was calculated using the H

Results: A total of 89 bronchoscopies were performed in 44 patients with COVID-19 on VV-ECMO. Median (IQR) PaO2 was 64 (57-75) mmHg prior to bronchoscopy, whereas it was mildly improved to 70 (58-89)mmHg, 6 hours after the procedure [Hodges-Lehman median difference (95% CI): 4.5 (2.0 – 8.0) mm Hg,p <0.01]. There was no significant difference in VV-ECMO parameters before and after the procedure. 10patients had different microorganisms in broncheo-alveolar lavage that were not diagnosed with trachealaspirate. No patient developed new bleeding post bronchoscopy requiring interruption of anticoagulation. No proceduralist reported testing positive for COVID-19 up to 2 weeks post bronchoscopy.

Conclusions: Bronchoscopy is a feasible and relatively safe procedure in COVID-19 patients on VV-ECMO and might be beneficial in select patients to improve oxygenation and tailor antibiotic therapy. Larger studies are required to evaluate the overall impact on patient's recovery with serial bronchoscopies.

Keywords: Bronchoscopy; ECMO; COVID -19

Introduction

Coronavirus disease 2019 (COVID-19) can, in the most severe cases, progress to profound respiratory decompensation necessitating mechanical

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ventilation and veno-venous extracorporeal membrane oxygenation (VV-ECMO) support [1,2]. These patients requiring prolonged intubation and mechanical ventilation are subject to several complications, such as ventilator associated pneumonia and ventilator associated lung injury. Flexible bronchoscopy is often required for clearing secretions, pulmonary toilet, and obtaining samples for microbiological culture; however, the safety of bronchoscopy in these patients remains controversial due to the potential harms of viral aerosolization [3]. Moreover, patients on VV-ECMO are often anticoagulated, which places them at a higher risk of iatrogenic tracheobronchial bleeding from bronchoscopy [4]. The aim of this report is to assess the indications, benefits, and complications of bronchoscopy in critically ill patients with COVID-19 on VV-ECMO.

Methods

Study design and cohort

This is a single center observational cohort study comprising of adult patients (≥18 years) who were admitted to the ICU with severe respiratory failure secondary to COVID-19 infection that required mechanical ventilation and VV-ECMO from January 1, 2019 to November 1, 2021. COVID-19 was diagnosed by nasopharyngeal swab reverse transcriptase polymerase chain reaction (RT-PCR) assays. All patients undergoing bronchoscopy were included. The study was approved by the institutional IRB (IRB Protocol: 2000031759).

Bronchoscopy Procedure

The decision to perform bronchoscopy was at the discretion of the ICU attending and was performed by the ICU attending with/without the ICU fellow. All bronchoscopies were performed in negative pressure rooms with personal protective equipment that included, an N95 mask, gown, gloves, hair and eye protection. All patients were appropriately sedated and were preoxygenated for 2 minutes with an FiO_2 of 1.0 and an FdO_2 of 1.0 immediately prior to the procedure. Flexible diagnostic bronchoscopes were used in all cases with diameters ranging between 2.0 – 2.8 mm (Olympus, BF-XP190, PA, USA). Bronchoalveolar lavage (BAL) was performed in patients with clinical or radiological signs that suggested a suspicion of associated respiratory superinfection.

Covariates

Study covariates included demographic data, mode of ventilation, indication for bronchoscopy, VV-ECMO flow and sweep, duration of mechanical ventilation, length of ICU stay, patient disposition.

Outcomes

The primary outcome was improvement in patient outcome defined as either in improvement in PaO_2 levels or VV-ECMO parameters 6 hours after the procedure. Secondary outcomes included microbiological data from the BAL samples.

Statistical analyses

Categorical variables were described using frequencies and proportions. Normality of distributions were tested with Kolmogorov-Smirnov and Shapiro-Wilk tests. Means and Standard deviations (SD) or Median and interquartile range (IQR) were reported based on the distribution. Mann-Whitney U and $\chi 2$ tests were used to compare continuous and categorical variables, respectively. Wilcoxon rank sum test for comparing correlated non-parametric continuous data. The median difference was calculated using the Hodges-Lehman estimator. All statistical tests were performed using the SAS (v 9.4) statistical software package. A 2-sided p-value of <0.05 was considered to be statistically significant.

Results

From January 1, 2019 to November 1, 2021 a total of 89 bronchoscopies were performed in 44 patients with COVID-19. Characteristics of the patients, ICU stay, ventilator settings and VV-ECMO flow are summarized in table 1. Briefly, the median (IQR) age of the patients was 49 (42 - 57) years, and 10 (22.7%) of them were female. All the patients were either intubated or had a tracheotomy tube. The predominant ventilatory mode during bronchoscopy was Airway Pressure Release Ventilation (APRV): 40 (44.5%) and Pressure Assist/control: 34 (38.2%).

Indications for bronchoscopy were as follows: Worsening/persistent hypoxemia: 48 (53.9%), atelectasis/mucus plugging: 22 (24.7%), assessment of airways during tracheostomy: 13 (14.6%), persistent hemoptysis: 6 (6.7%). Median (IQR) PaO_2 was 64 (57-75) mmHg prior to bronchoscopy, whereas it was improved to 70 (58-89) mmHg, 6 hours after the procedure [Hodges-Lehman median difference (95% CI): 4.5 (2.0–8.0) mm Hg, $p<0.01$]. There was no significant difference in VV-ECMO parameters before and after the procedure (Table 1). Only one patient had a periprocedural complication, which was a pneumothorax requiring chest tube placement. Heparin infusion was interrupted prior to bronchoscopy for 12 patients. The indication of bronchoscopy in these patients was during tracheotomy [n=4 (4.5%)] or for bleeding in the tracheobronchial tree [n=8 (9.0%)]. No patients required interruption of anticoagulation therapy nor were there any incidents of postprocedural bleeding after bronchoscopy.

A total of 56 bronchoalveolar lavage (BAL) samples from 26 patients were collected during the study period. Tracheal aspirate (TA) and BAL culture results are summarized in table 2. The difference in diagnostic yield of tracheal aspirate vs. BAL was not statistically significant (TA 40.9% vs. BAL 50%, p=0.24). However, 10 patients had different

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microorganisms in BAL that were not diagnosed with tracheal aspirate; one culture grew Pseudomonas, 2 cultures grew Serratia, 1 culture grew Enterobacter and 5 cultures grew Candida.

No proceduralist reported testing positive for COVID-19 up to 2 weeks post bronchoscopy.

Table 1: Baseline and hospital characteristics of patients with COVID-19 who underwent bronchoscopy (N=44)

Variable	Distribution
Age in years, Median (IQR)	49 (42 – 57)
Female Sex, (n%)	10 (22.7)
Race, (n%)	
African American	6 (13.6)
Hispanic	18 (40.9)
White	18 (40.9)
Others	2 (4.5)
Charlton Comorbidity Index, median (IQR)	1 (0 – 2)
ICU characteristics	
Length of hospital stay in days, median (IQR)	49 (33 – 70)
Length of ICU stay in days, median (IQR)	43 (27 – 55)
Duration of mechanical ventilation in days, median (IQR)	32.5 (22 – 53)
Ventilator mode at the time of bronchoscopy, (n%)*	
Volume Assist/Control	4 (4.5)
Pressure Assist/Control	34 (38.2)
Pressure support	4 (4.5)
Pressure regulated volume control	4 (4.5)
Airway pressure release ventilation	40 (44.5)
Tracheostomy mask	3 (3.4)
Tracheostomy during hospitalization, (n%)	34 (77.3)
Bronchoscopies per patient, median, median (IQR)	2 (1 – 3)
Days from COVID-19 diagnosis to bronchoscopy, median (IQR)	26 (18 – 36)
Complications after bronchoscopy	
Pneumothorax, n (%)	1 (2.3)
Extracorporeal membrane oxygenation characteristics	
Duration of ECMO, median, IQR (days)	24.5 (16 – 34)
ECMO flow prior to bronchoscopy in L/min, median (IQR)	5.2 (4.3 – 5.8)
ECMO flow 6 hours after bronchoscopy in L/min, median (IQR)	5.2 (4.3 – 5.8)
ECMO FdO2 prior to bronchoscopy, median (IQR)	1.0 (1.0 – 1.0)
ECMO FdO2 6 hours after bronchoscopy, median (IQR)	1.0 (1.0 – 1.0)
ECMO sweep prior bronchoscopy, median (IQR)	6 (3.7 – 9)
ECMO sweep 6 hours after bronchoscopy, median (IQR)	6 (3 – 9)
Disposition, (n%)	
Long term rehabilitation facility	21 (47.7)
Home	1 (2.3)
Death	22 (50)
Follow up in days, median (IQR)	282 (218 – 491)

* Total number of ventilator modes was calculated with an N=89 as 89 bronchoscopies were performed

Table 2: Tracheal aspirate and Bronchoalveolar Lavage culture results

Culture Results	Tracheal aspirate, n (%) (n=171)	Bronchoalveolar Lavage, n (%) (n=56)
Positive culture	70 (40.9%)	28 (50%)
Methicillin-sensitive Staphaureus	16 (9.4%)	3 (5.4%)
Stenotrophomonas maltophilia	2 (1.2%)	1 (1.8%)
Escherichia coli	9 (5.3%)	5 (8.9%)
Pseudomonas aeruginosa	7 (4.1%)	5 (8.9%)
Klebsiella pneumonia	6 (3.5%)	3 (5.4%)
Group B streptococcus	2 (1.2%)	-
Morganella Morganii	3 (1.8%)	-
Achromobacter xylosoxidans	1 (0.6%)	-
Achromobacter denitrificans	1 (0.6%)	-
Klebsiella oxytoca	3 (1.8%)	1 (1.8%)
Enterobacter cloacea	4 (2.3%)	1 (1.8%)
Proteus mirabilis	1 (0.6%)	1 (1.8%)
Streptococcus pneumonia	1 (0.6%)	-
Acinetobacter baumanii	1 (0.6%)	-
Serratia marcescens	2 (1.2%)	2 (3.6%)
Pseudomonas oryzihabitans	1 (0.6%)	-
Burkholderia multivorans	1 (0.6%)	-
Burkholderia cepacia	1 (0.6%)	-
Citrobacter koseri	2 (1.2%)	1 (1.8%)
Escherichia fergusonii	1 (0.6%)	-
Enterobacter aerogens	3 (1.8%)	-
Moraxella catarrhalis	1 (0.6%)	-
Haemophilus influenzae type b	1 (0.6%)	-
Candida albicans	-	5 (8.9%)
Negative culture	101 (59.1%)	28 (50%)

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Discussion

In this study, we summarized our bronchoscopy experience in patients with severe COVID-19, who were intubated and underwent VV-ECMO during their disease course. This is one of the few studies, that assessed the feasibility of bronchoscopy in COVID-19 patients on ECMO support. Worsening/persistent hypoxemia was the main indication for bronchoscopy followed by atelectasis/mucus plugging. Although there was a statistically significant improvement in PaO_2 levels after bronchoscopy, this difference was clinically modest at best [median difference (95% CI) 4.5 (2.0 – 8.0) mm Hg]. Not surprisingly, this improvement did not translate into clinical benefit in terms of expedited VV-ECMO weaning after bronchoscopy. There was no significant change in VV-ECMO parameters before and after the procedures.

Secondary bacterial pneumonia was a common finding. While BAL cultures had higher positive culture rate (50%) than tracheal aspirates (41%), this difference did not reach statistical significance. These rates are similar to those reported in previous studies [5-7]. Notably, ten patients had different microorganisms in BAL that were not diagnosed with tracheal aspirate, which reinforces BAL's diagnostic value.

Strengths of this study include being among the few reports of evaluating the feasibility of bronchoscopy in severely ill COVID-19 patients, who underwent ECMO. Limitations of this study include the biases associated with retrospective study design and single-site studies. The tracheal aspirates were not obtained simultaneously with BAL, making head-to-head comparison difficult. However, they were taken within a couple of days of the BAL in most instances. Given the descriptive nature of the study, no formal power calculation was performed.

Conclusions

Bronchoscopy is feasible and relatively safe procedure in COVID-19 patients on VV-ECMO and might be beneficial in select patients to improve oxygenation and tailor antibiotic therapy. Larger studies are required to evaluate the overall impact on patient's trajectory with scheduled bronchoscopies.

Supplementary Material: None

Conflicts of interest: None

Disclosures

Dr. Bardia serves as a consultant for Takeda Pharmaceuticals.

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References

1. Zeng Y, Cai Z, Xianyu Y, et al. Prognosis when using extracorporeal membrane oxygenation (ECMO) for critically ill COVID-19 patients in China: A retrospective case series. Crit Care 24 (2020): 148.
2. Heinsar S, Peek GJ, Fraser JF. ECMO during the COVID-19 pandemic: When is it justified? Crit Care 24 (2020): 650.
3. Loor K, Álvarez A, Felipe Montiel A, et al. Safety, diagnostic, and therapeutic value of flexible bronchoscopy in critically ill COVID-19 patients. Can J Anaesth 68 (2021): 434-435.
4. Arachchillage DJ, Rajakaruna I, Scott I, et al. Impact of major bleeding and thrombosis on 180-day survival in patients with severe COVID-19 supported with veno-venous extracorporeal membrane oxygenation in the United Kingdom: a multicentre observational study. Br J Haematol 196 (2022): 566-576.
5. Mondoni M, Sferrazza Papa GF, Rinaldo R, et al. Utility and safety of bronchoscopy during the SARS-CoV-2 outbreak in Italy: a retrospective, multicentre study. Eur Respir J 56 (2020): 2002767.
6. Chang SH, Jiang J, Kon ZN, et al. Safety and Efficacy of Bronchoscopy in Critically Ill Patients With Coronavirus Disease 2019. Chest 159 (2021): 870-872.
7. Ora J, Puxeddu E, Cavalli F, et al. Does bronchoscopy help the diagnosis in COVID-19 infection? Eur Respir J 56 (2020): 2001619.