



ORIGINAL RESEARCH

Safely performing percutaneous dilatational tracheostomies on COVID-19 patients in the intensive care unit: A standardized approach

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Abstract

Background: Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and the resulting coronavirus disease 2019 (COVID-19) have afflicted hundreds of millions of people in a worldwide pandemic. During this pandemic, otolaryngologists have sought to better understand risk factors associated with COVID-19 contamination during surgical procedures involving the airways such as tracheostomies.

Objective: This study provides a standardized technique of performing an ultrasound (US)-guided percutaneous dilatational tracheostomy (PDT) on COVID-19 patients in the intensive care unit (ICU). It also outlines safety strategies for health care providers that includes proper use of personal protective equipment (PPE) and regular testing of otolaryngologists for COVID-19 contamination.

Methods: This study analyzed data from 44 PDT procedures performed on COVID-19 patients in the ICU of hospitals in Sao Paulo and Santos, Brazil. The PDT procedures were conducted between April 2020 and August 2020, which coincided with a peak of the COVID-19 pandemic in São Paulo, Brazil. Surgeons were tested for COVID-19 using a two-stage serological enzyme-linked immunosorbent assay specific for SARS-CoV-2 antigens.

Conclusion: This study describes a safe standardized technique of US-guided PDT for COVID-19 patients in the ICU using a method that also decreases the risk of surgeon contamination.

KEYWORDS

airway management, COVID-19, intensive care units, Sars-cov-2, tracheostomy

1 | INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and the resulting coronavirus disease 2019 (COVID-19) have

afflicted hundreds of millions of people in a worldwide pandemic.^{1,2} During this pandemic, otolaryngologists and head and neck surgeons have sought to better understand risk factors associated with COVID-19 contamination during surgical procedures involving the airways such as

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tracheostomies.²⁻⁴ However, given that COVID-19 is readily spread via aerosolization, it is essential to establish safe practices for performing tracheostomies.^{2,5}

The literature currently offers some recommendations for safely performing tracheostomies on COVID-19 patients in the intensive care unit (ICU), but there is no consensus on the best practice.^{2,3,6} Several authors argue in favor of performing the procedure using the open surgical technique under general anesthesia in a negative pressure room.⁶⁻⁸ However, ICUs often lack both the infrastructure necessary to conduct an open tracheostomy as well as negative pressure rooms. Others suggest performing tracheostomies in the operating room (OR).⁹ However, transporting COVID-19 patients to the OR exposes both the medical team and hospital facility to potential contamination.

This study argues that using a standardized ultrasound (US)-guided percutaneous dilatational tracheostomy (PDT) procedure is the most effective way to perform tracheostomy on COVID-19 patients in the ICU. It also outlines effective safety strategies for health care providers that includes proper use of personal protective equipment (PPE) and regular testing of otolaryngologists and head and neck surgeons for COVID-19 contamination.

2 | METHODS

This study analyzed data from 44 PDT procedures performed on COVID-19 patients in the ICU of hospitals in Sao Paulo and Santos, Brazil. The PDT procedures were performed between April 2020 and August 2020, which coincided with a peak of COVID-19 pandemic in São Paulo, Brazil. Each PDT was conducted by a team of two surgeons operating in the ICU using a standardized US-guided technique. All the surgeons had expertise in both US and PDTs.

Surgeons were tested for COVID-19 using a two-stage serological enzyme-linked immunosorbent assay (ELISA) specific for SARS-CoV-2 antigens. Additionally, they were followed for signs and symptoms indicative of COVID-19 infection for 15 days following their most recent exposure to COVID-19 patients.

This study had IRB approval from all data-collecting institutions and was conducted in accordance with the ethical standards of the committee on human experimentation of the Helsinki Declaration of 1975 (revised in 1983). All participants gave written informed consent to participate in this study. Santa Casa de São Paulo School of Medical Sciences was the main institution involved in this study (4.205.057|CAAE: 35998420.0.0000.5479).

3 | RESULTS

This study was carried out over a period of 140 days between April 7 and August 25, 2020. The sample included 44 patients, all diagnosed with COVID-19 by positive reverse transcriptase polymerase chain reaction tests.

The indication for tracheostomy was prolonged orotracheal intubation. The minimum number of days in mechanical ventilation was 8 days, the maximum was 29 days, the mean number was 17.5 days, and the median number was 18.0 days (Figure 1).

The medical team studied consisted of five surgeons. Four were males and one was a female. The males were 32, 35, 39, and 42 years old and the female was 37 years old. One of the males was a former smoker with a history of high blood pressure, another was a smoker, and the two others did not have any notable comorbidities. The female had asthma. Three of the males and the female had O+ blood type and one of males had A- blood type.

Each time that a surgeon was involved in a PDT procedure was counted as one exposure. In total, there were 68 exposures distributed among the five surgeons in the following way: 27 (39.7%), 16 (23.5%), 13 (19.1%), 9 (13.2%), and 3 (4.4%). The mean number of exposures was 13.6 and median number was 13.

For each surgeon, the results of their SARS-COV-2 ELISA tests for each of the 15 days after their final PDT were negative. Further, at the time that this article was submitted for publication, no medical team members who assisted with the PDTs or any of the close contacts of the surgeons presented with COVID-19 symptoms.

4 | SURGICAL TECHNIQUE

After obtaining informed consent, each PDT was conducted using the following standardized method (Figures 2 and 3).

4.1 | Prior to procedure

1. All surgical materials were examined prior to entering the ICU room.
2. The number of professionals inside the ICU room during the procedure was minimize and each surgical team was limited to two surgeons.
3. Mechanical ventilation was set to assist-control (AC) mode, with the fraction of inspired oxygen (FiO₂) set to 100%. Both the hemodynamic and respiratory functions were closely monitored.
4. The surgeons maintained strict use of PPE including N95 or FFP2 masks, gowns, gloves, protective eyewear (goggles or face shield), and surgical aprons.
5. Each surgeon conducted a “buddy check” on the other to confirm appropriate use of PPE.

DAYS UNDER OROTRACHEAL INTUBATION

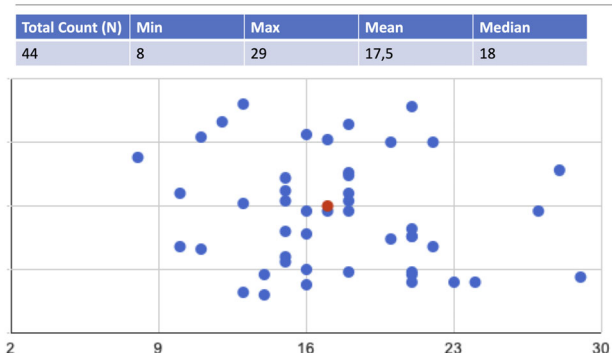


FIGURE 1 Days under orotracheal intubation

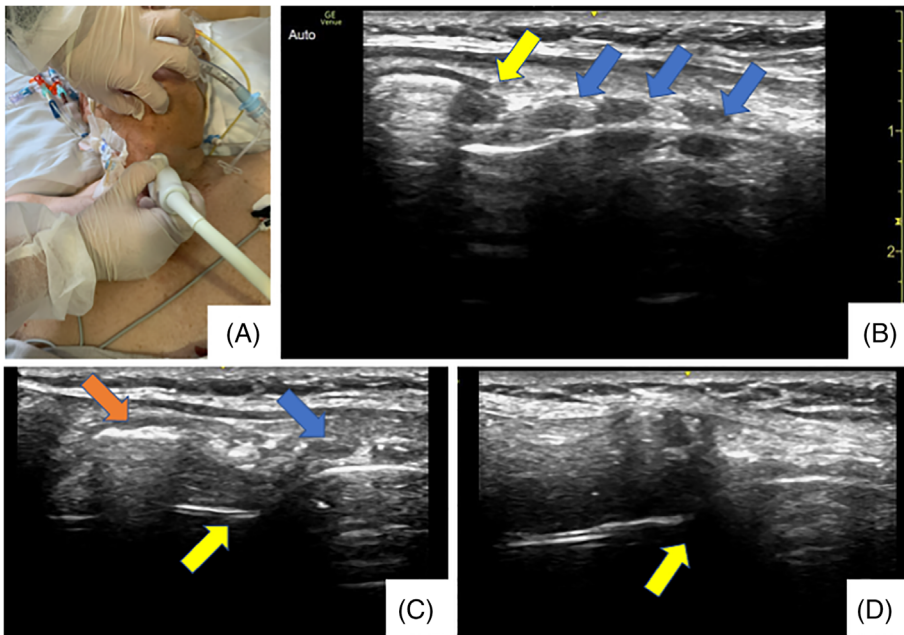


FIGURE 2 Tube position before procedure. (A) Ultrasound (US) probe in longitudinal position. (B) US image: Sagittal view of the trachea. Yellow arrow: Cricoid cartilage|blue arrows: Tracheal rings. (C) US image: Sagittal view of the trachea. Orange arrow: Thyroid cartilage|blue arrow: Tracheal ring|yellow arrow: Orotracheal tube. (D) US image: Sagittal view of the trachea. Yellow arrow: Tip of Orotracheal tube

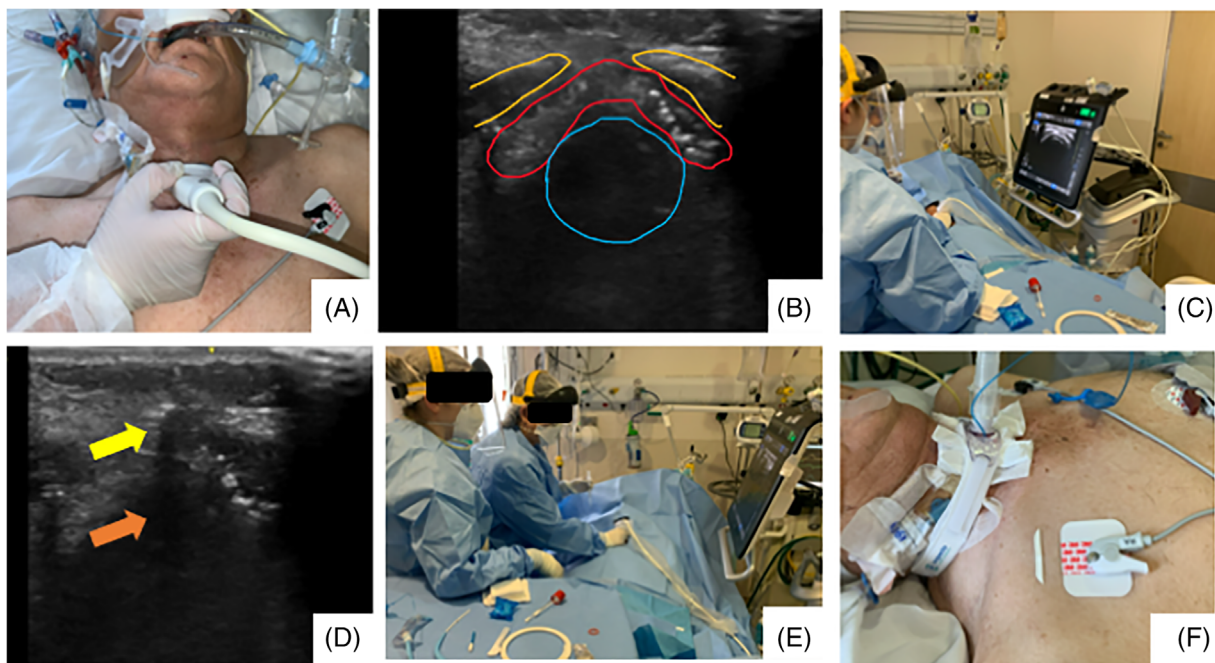


FIGURE 3 Percutaneous dilatational tracheostomy (PDT) procedure. (A) Ultrasound (US) probe in transversal position. (B) US image: Transversal view of the airway. In yellow: Strap muscles|in red: thyroid gland|in blue: Trachea. (C) Team visualizing transversal cut of the airway in ultrasound screen before puncture. (D) US image: Transversal view of the airway. Yellow arrow: Tip of the needle|orange arrow: Posterior acoustic shadow. (E) Team disposition during procedure. (F) Tracheostomy completed

4.2 | During procedure

1. Sedation and neuromuscular blocking agents were used.
2. Patients were placed in the cervical hyperextension position.
3. A neck US exam was carried out using a linear transducer to identify pertinent structures including the larynx, trachea, esophagus, thyroid, strap muscles, and anterior blood vessels.
4. Using the US machine, surgeons positioned the endotracheal tube (ETT) on the subglottis without ETT cuff deflation.
5. Surgeons then marked the cricoid cartilage, suprasternal notch, and the site of incision (which is ideally between the second and third tracheal rings).
6. Following aseptic procedures, the team prepared the surgical instruments and the PDT kit.

7. The US exam was repeated using a sterilized probe to confirm the site of ETT insertion.
8. Lidocaine was applied as local anesthetic before a skin incision was made.
9. Subcutaneous tissue was mildly dissected.
10. An US-guided puncture using an introducer needle was performed, entering the tracheal lumen below the second tracheal ring.
11. The J-tipped flexible guide wire was then introduced into the surgical site.
12. A 14 French initial dilator was used to compress the open airway.
13. If the clinical conditions permit, a respiratory pause is conducted on the mechanical ventilation machine.
14. The initial dilator is withdrawn, and the final dilator completes dilatation (per the PDT-kit guidelines).
15. The tracheostomy tube is then introduced, linked to a mechanical ventilation filter, and the assistant surgeon immediately inflates the cuff.
16. The ETT is clamped using a Kelly forceps and disconnected from the ETT.
17. The tracheostomy tube is connected to the mechanical ventilator.
18. Respiratory cycling is resumed.
19. The ETT, which is still clamped, is then removed.

4.3 | Following procedure

1. PPE is removed.
2. Surgeons “buddy check” to ensure that safety precautions were followed.

5 | DISCUSSION

Throughout the COVID-19 pandemic, the number of critically ill patients requiring tracheostomies has increased.^{2,4} Prior to this period, little was known about the risk of aerosol spread of COVID-19 to health professionals conducting airway procedures. While some have suggested that an open tracheostomy may reduce the risk of aerosol spread of viral COVID-19 particles,⁶ our team found that after 44 PDTs on COVID-19 patients in the ICU, there was no contamination of our team of surgeons.

Before the pandemic, PDT was the standard procedure for tracheostomies in the ICU.¹⁰ Our study has found that PDTs still can be safely performed at the bedside of COVID-19 patients in ICU. Performing PDTs in the ICU is safe for two reasons. First, it reduces the risk of exposing the hospital staff since does not require transporting patients to the OR. Second, PDT is a quick procedure lasting approximately 5 to 10 minutes that reduces the time the surgeon is exposed to a contaminated environment.

Several authors have also discussed the importance of performing airway procedures inside negative pressure rooms.^{11,12} However,

most ICUs in Brazil and many throughout the world either lack negative pressure rooms altogether or have limited access to it. In our study, no PDT was performed in negative pressure rooms.

To minimize surgeon exposure to air exhaled from COVID-19 patients receiving PDTs, we introduced minor changes to standard PDT protocol. First, PPE was incorporated into the PDT procedure. Second, the “buddy check” method was used when surgeons dress in and disposed of PPE. Third, bronchoscopy guidance was switched for the quicker US-guidance. Fourth, a step-by-step of ventilation standby was carried out. Fifth, mechanical ventilation was temporarily interrupted. Sixth, neuromuscular blockage was used to prevent the cough reflex. The combination of these modifications appears to have contributed to the safety of our procedure on COVID-19 patients.

We believe that temporary interruption of mechanical ventilation is an essential measure to minimize exposure to COVID-19 aerosol particles during both tracheal puncture and the dilatational procedure. When ventilation is temporarily interrupted, airflow through the needle and dilatation instruments decrease. Additionally, the minimal exposure of the tracheal surface characteristic in PDT limits the leakage of peri-instrumental air, which is an advantage over open tracheostomies where the tracheal surface often is exposed for prolonged periods.

An alternative explanation for our positive outcomes could relate to the timeframe of tracheostomy indications. In general, the viral load in COVID-19 patients eventually decreases over time.¹³⁻¹⁵ However, our PDT's were often performed on patients who had been intubated for between 10 and 20 days and thus likely had a decreased viral load that was less likely to contaminate the care team.^{16,17}

Despite our positive results, we cannot prove that the PDT technique and our protocol are effective at reducing the risk of contamination of surgeons performing PDTs on ICU patients. This is an observational study with a limited number of cases. Further, our study did not show direct evidence of aerosol reduction using our procedures. Still, as the number of COVID-19 cases remains high, observational studies like this are important contributions to understand the best clinical practice as well as to inform future studies. Research with more robust evidence that examine larger cohorts and randomized controlled trials are necessary but take longer and are not as feasible during the pandemic. It should also be highlighted that four of the five surgeons had O+ blood type, which may be a protective factor against COVID-19 contamination.¹⁸⁻²³

Notably, prior experience performing PDT's is essential to ensure positive results, especially when operating on COVID-19 patients in the ICU. Surgeons are not used to performing tracheostomies with full PPE. Wearing a mask, goggles, and a face shield can be obstructive. Further, the additional psychological stress associated with performing an airway procedure with the high risk of contamination makes performing PDT's on COVID-19 patients particularly challenging.²⁴

In conclusion, we have described a safe standardized technique of conducting US-guided PDT in COVID-19 patients that minimizes the risk of surgeon contamination.

CONFLICT OF INTEREST

The authors declare no conflict of interests.

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