

Is Surgical Tracheostomy Better Than Percutaneous Tracheostomy in Coronavirus Disease 2019–Positive Patients?

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GLOSSARY

COVID-19 = Coronavirus Disease 2019; **FFP3** = xxx; **ICU** = intensive care unit; **MERS** = Middle East respiratory syndrome; **OR** = operating room; **Pao₂/Fio₂** = arterial oxygen partial pressure to fractional inspired oxygen ratio; **PPE** = personal protective equipment; **PT** = percutaneous tracheostomy; **RNA** = ribonucleic acid; **SARS** = severe acute respiratory syndrome; **SARS-CoV** = severe acute respiratory syndrome coronavirus; **ST** = surgical tracheostomy; **TIVA** = total intravenous anesthesia

During the past decades, percutaneous tracheostomy (PT) has gained popularity over surgical tracheostomy (ST) for its safety and technique; several studies were performed to compare these 2 options with conflicting results. PT appears to be more intuitive and technically easier than ST; overall, it might show a reduced rate of operative complications.¹ However, it is relatively more expensive than ST and there are some technical aspects requiring careful attention. In fact, it is related to possible major complications, especially if performed without videobronchoscopic assistance.² Conversely, ST requires greater technical skill and longer operative time with an associated higher complication rate compared to PT; nonetheless, certain patient factors favor ST such as goiter, obesity, subcutaneous emphysema, or difficult neck anatomy.³ A recent meta-analysis by Klotz et al⁴ revealed that both procedures are safe and effective, without evident differences in terms of mortality rate and potential life-threatening events. However, PT significantly reduces the incidence of stoma infection but encompasses a few technical

issues, especially in particular conditions such as previous surgery, coagulopathy, or difficult airway management. These conclusions are confirmed by other meta-analysis and reviews.^{5,6} Definitive guidelines are lacking but the current consensus tends to consider PT the first option in case of elective noncomplicated tracheostomy in standard population.⁷

The Coronavirus Disease 2019 (COVID-19) outbreak is presenting several problems in terms of management of infected patients. Significant precautions are required to minimize infection of health care workers and virus spread within the hospital. This is of particular importance in procedures with a high aerosolization risk such as tracheal intubation, non-invasive ventilation, bronchoscopy, thoracotomy, and tracheostomy.

It is reported that 9.8%–15.2% of COVID-19 patients require prolonged invasive mechanical ventilation.⁸ On April 6, 28,976 patients affected by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in Italy were hospitalized; among them, 3898 (13.5%) were in intensive care units (ICU) requiring intubation and mechanical ventilatory support. Prolonged endotracheal intubation is still the most common indication for tracheostomy.^{3,8} At the epidemic peak, many patients were in need of tracheostomy to optimize ventilatory management and improve support during the weaning phase.

The lessons learned from the severe acute respiratory syndrome (SARS) outbreak in 2002 included that ST is preferred over PT, under epidemic condition, to minimize the risk of contamination. Indeed, PT produces more airway manipulation and aerosol spread

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due to serial trachea dilatations, bronchoscopy, and ventilator connection/disconnection.^{9,10} Several case reports and case series on PT and ST management in SARS-CoV patients were published during the SARS outbreak in 2004, focusing on technique, equipment, and surgical tips to avoid contamination.^{9–13} In that context, the preference for PT over ST was only anecdotally described.¹⁴ However, during the current SARS-CoV-2 outbreak in Italy, we performed either PT or ST in selected COVID-19 patients with particular precautions to minimize the aerosolization spread. We believe that PT can be safely performed during a respiratory epidemic and offers some advantages compared to ST as stated above.

At present, there is no clinical study comparing the safety and effectiveness of the 2 procedures in such a respiratory epidemic environment, and no guidelines regarding PT in COVID-19 setting are available so far. For this reason, we propose our decision-making flowchart in case of a COVID-19 patient requiring tracheostomy (Figure 1).

Considering the lack of guidelines, a focused assessment on technical aspects, based on the available literature and experience, could be of help to improve the strategy.

OPERATING ROOM

All invasive procedures on COVID-19 patients, especially those ones inducing high aerosol spread, should be performed in a negative-pressure operative room (OR), if available, or in isolated areas.¹⁵ In case a negative-pressure-dedicated OR is not available, a bedside approach in patients admitted to ICU is preferred. Indeed, the transfer of COVID-19 patients within the hospital should always be considered at high risk of contamination, even in separated paths and by using properly isolated stretchers with caregivers wearing protections. A bedside approach avoids the risks related to transportation and connection/disconnection from the ventilator. Accordingly, it is remarkable that while PT is worldwide performed at the bedside, ST is generally performed in the OR. However, Liao et al¹⁶ have recently reported ST feasibility in ICU rooms in more than 1000 patients. Certainly, some impediments should be considered, when approaching patient at the bedside, such as suboptimal patient position on a pneumatic bed, the need of dedicated instruments, limited space, and the presence of life-support equipment. This is of particular importance in ST which requires more surgical instrumentation and space for maneuver.¹⁷

PERSONAL PROTECTIVE EQUIPMENT

Personal barrier precautions are mandatory to avoid contamination. Since both PT and ST are considered at high risk for aerosolization, all the operators in the

room must wear third-level personal protective equipments (PPEs).¹⁵ These include FFP3 masks, face shield, helmets, goggles, long fluid-resistant gowns, double gloves, and overshoes. Remarkably, third-level PPE is crucial but it increases the technical demand of the procedures due to impediments in movements, heat, difficult communication, and reduced vision. Another tip to reduce contamination is the entrance/exit protocol. Entrance in the room should be monitored and restricted only to the involved staff. We believe that both PT and ST should be performed by expert teams only and trained workers.

TEAM EXPERIENCE

Expertise is crucial to minimize airway manipulation and to reduce the time of exposure. ST is characterized by an enhanced technical complexity and longer procedure time compare to PT. However, the time of exposure to aerosol is considered higher during PT due to repeated stoma dilation and bronchoscopic assistance. To reduce cannulation attempts, airway manipulation and unnecessary movements are required to minimize room contamination. Moreover, surrounding conditions, such as PPE and limited space, complicate the procedure in nonexpert hands. For these reasons, both PT and ST in COVID-19 patients should be performed by the most skilled operators available.⁸

ANESTHESIA MANAGEMENT

The role of anesthesiologists in elective tracheostomy is crucial, especially in critical patients. In our hospital, anesthesiologists with adequate skills routinely perform PT in critical areas. The PT in critical adult patients must involve 2 anesthesiologists: one for the airway management and drug administration, another to perform the tracheotomy. The presence of an anesthesiologist is also recommended during the surgical tracheotomy, especially for patients with deteriorated conditions. In fact, the airway management during both the procedures supervise the maintenance of a correct ventilation through the orotracheal tube that is connected to a closed viral-filtered system during surgical dissection. Moreover, the anesthesiologists are meant to carefully push the tube toward the carina to avoid the rupture of the tube cuff before the opening of the airway and insertion of the cannula; they thus remove the orotracheal tube and resume ventilation throughout the tracheostomy. The alternation of ventilation and apnea phases allows to reduce the dispersion of viral particles in the air. In both procedures, general anesthesia is essential to ensure no patient movement nor coughing during both ST and PT. The use of a total intravenous anesthesia (TIVA) is preferable because it reduces the environmental dispersion of gases. To achieve the

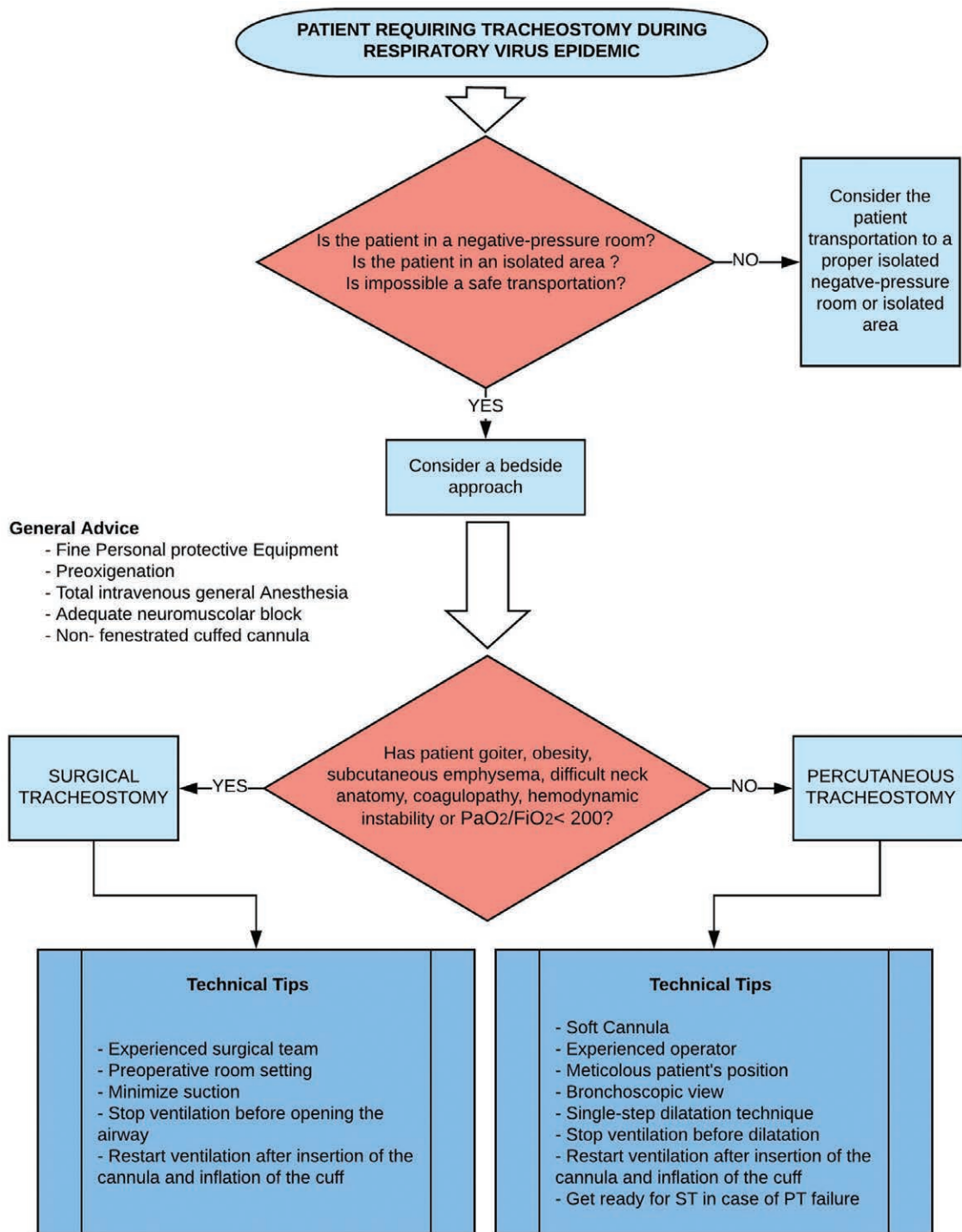


Figure 1. Decision-making flowchart to approach tracheostomy in COVID-19 patients. COVID-19 indicates Coronavirus Disease 2019; Pao₂/Fio₂, arterial oxygen partial pressure to fractional inspired oxygen ratio; PT, percutaneous tracheostomy; ST, surgical tracheostomy.

abolition of the state of consciousness, hypnosis, and the suppression of pain, we recommend the use of propofol as a hypnoinducer and the administration of fentanyl or remifentanyl as an opioid. Nonetheless, most authors focus on the importance of neuromuscular blockers to minimize cough reflex and patient's movement.^{10,12} The neuromuscular blockage

can be obtained with cisatracurium or rocuronium. Rocuronium gives the possibility of reversal with sugammadex promptly recovering neuromuscular function. Awake procedures should not be performed in COVID-19 patients to avoid reflexes, although its feasibility has been reported in selected patients. When performing PT, a surgical standing-by team

should be alerted to achieve tracheostomy within the same session, in case of complication of PT.

TECHNICAL TIPS

In the COVID-19 pandemic, some technical tips need to be considered during tracheostomy to reduce aerosol exposure. In case of ST, most of them have been already described during SARS outbreak and they include to minimize the use of electrocoagulation, to avoid suction or to use a close-circuit with viral filters, to disconnect ventilation just before tracheotomy, to use a tracheostomy cannula of adequate size to allow airway clearance. In detail:

1. Diathermy coagulation is thought to produce small aerosolized particles that may spread virus.¹⁸ Even if there is no evidence of human contamination through blood for SARS-CoV-2, coronavirus ribonucleic acid (RNA) could be detected in plasma or lymphocytes¹⁹ and a potential infection through surgical smoke requires consideration. Furthermore, until tracheotomy is completed, aerosol spread risk is low and surgeons should avoid massive coagulation.
2. Open suction systems should be avoided. Many reports showed that ST can be performed without the use of suction^{10,17}; if necessary, suction should be performed strictly connected to a closed system with a viral filter.
3. After tracheotomy, the spreading risk is extremely elevated. From that time, surgical steps should be carefully performed as fast as possible until the tracheostomy cannula is inserted and the cuff is inflated. Among the various surgical approaches to perform a tracheostomy, we believed that both the "H"-shaped and the reverse "U"-shaped tracheotomy provide an excellent window for the cannula. Before tracheotomy, the tracheal tube is withdrawn and the ventilation is stopped. This is mandatory to reduce aerosolization and contamination through the tracheal stoma. The procedure, from tracheotomy to cannulation, takes a few minutes in expert hands and can be performed in apnea with an adequate preoxygenation.
4. The adequate type of cannula depends on anatomy and availability. However, a non-fenestrated cuffed cannula must be preferred to reduce air spread from the peripheral airway.⁸ The cannula must be fixed to the skin with non-absorbable sutures in addition to tracheostomy tube straps to avoid accidental decannulation. Moreover, the cuff must be inflated before the cannula is connected to the ventilator.

Regarding PT, no considerations about safety and technical advices have been established in the literature during respiratory infection settings such as SARS, Middle East respiratory syndrome (MERS), and COVID-19 outbreaks. Including the aforementioned considerations about the bedside approach, PPE, team experience, and sedation, we believe that some further recommendations are required:

1. Meticulous preparation of the patient in a supine position improves ventilation and allows adequate face and neck coverage with sterile drapes. It is desirable to maintain barriers between the operators and the patient.²⁰ For this reason, we have developed a barrier with Acrylic Glass (Plexiglass) to be placed between the operators and the patient to minimize air contamination (Figure 2). Patient preparation, including adequate preoxygenation, operators dressing, and field covers, are equally important and crucial.
2. Bronchoscopic support is mandatory to avoid major complications such as tracheal injury. We suggest the use of disposable flexible bronchoscopes with monitor visualization to avoid the risks related to instrument disinfection and ocular contact.
3. Several dilation techniques have been proposed over the past years, without differences in terms of feasibility and risk of complications.²¹ Overall, the final choice of which technique is the best option is related to equipment and skills available in the hospital. Regardless of the chosen approach, to avoid repeated



Figure 2. A possible easy-to-arrange bedside barrier between patients and operators for highly contagious aerosolized respiratory fluids.

dilation reduces the time of exposure to aerosolization. For this reason, we believe that single-step techniques such as Ciaglia Blue Rhino or similar others should be considered safer in this particular setting.

4. As mentioned for ST, dilation steps of PT should be rapidly performed and only after having stopped ventilation.

In conclusion, the review of the available international literature, although nothing is stated regarding the COVID-19 pandemic, shows a superiority of ST in terms of aerosolization risk. Case reports, case series, and expert opinion are the only published papers up to date. There are no clinical trials comparing the safety of these 2 procedures in an epidemic setting. As a result of our analysis, we believe that PT could be performed safely as well as ST with minimal aerosolization spread, if the suggested precautions are strictly followed. Particular attention should be paid to the technical details aimed at reducing the time of exposure to aerosol. The technique to be performed eventually depends on the local hospital resources and professional skills. Indeed, ST remains the first option in case of goiter, obesity, pneumomediastinum, difficult anatomy, coagulopathy, hemodynamic, or respiratory instability. In such conditions, a bedside approach is safer and should be preferred over transferring the patient to OR during pandemic periods. ■

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DISCLOSURES

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