

Fiber optic bronchoscopy-assisted percutaneous tracheostomy: a decade of experience at a university hospital

Traqueostomía percutánea con asistencia fibrobroncoscópica: una década de experiencia en un hospital universitario

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Table S1 - Contraindications for tracheostomy

Absolute
Deforming masses, radiation or major neck surgery*
Active anterior cervical infection
Anticoagulation or severe uncorrected coagulopathy
Severe respiratory failure
Uncontrolled intracranial hypertension
Relative
Obesity
Airway emergency
Inability to hyperextend the neck
Short neck (distance between the cricoid cartilage and sternal angle less than 2.5cm)
Coagulopathy or anticoagulation
Use of antiplatelet agents
Known tracheomalacia
Previous tracheostomy

Source: Modified by Zgoda M, Berger R. Tracheostomy in the critically ill patient: who, when, and how? A review. Clin Pulm Med. 2006;13(2):111-20.⁽⁸⁾ *Absolute contraindications for the execution of percutaneous tracheostomy.

Definitions of post-operative and operative complications:

1) Loss of airway: accidental extubation during the procedure with inability to access the trachea for more than 30 seconds. 2) Switch to open technique: need to suspend the percutaneous tracheostomy and to perform a classical surgical approach in either the critical care unit or the operating room. 3) Major bleeding: bleeding that causes low blood pressure on its own, requiring transfusion of ≥ 2 units of red blood cells, compromising the airway, or requiring a switch to surgical technique to control bleeding. 4) Minor bleeding: bleeding that stops with compression or some hemostatic maneuver, without causing hemodynamic instability, not requiring transfusion of red blood cells or surgery. 5) Pneumothorax/pneumomediastinum: presence of air in the pleural cavity

or mediastinal directly associated with the procedure. 6) Hemothorax: evidence of blood in the pleural space caused directly by the procedure. 7) Low blood pressure: fall in mean blood pressure under 60mmHg at any moment during the procedure. 8) Hypoxemia: fall in oxygen saturation under 90% at any moment during the procedure. 9) Displacement of the cannula: accidental expulsion of the tracheostomy cannula. 10) Infection of the wound: local inflammatory changes, purulent secretion from the wound with an increase in inflammatory parameters and/or microbiological documentation in a sample taken from the stoma of the tracheostomy. 11) Death: death of the patient due to a complication directly related to the percutaneous tracheostomy.

Description of the standardized procedure

Here, we will describe the sequential steps that were systematically applied by the authors. Prior to the start of the intervention, the nursing team applied a safety checklist to guarantee the adequate preparation of each patient (Table S2). During the entire procedure, patients remained sedated (midazolam + fentanyl), intubated and connected to MV. Patients were monitored by means of continuous cardiographic readings, continuous invasive blood pressure and pulse oximetry. After confirming adequate sedation and analgesia, patients received muscular blockage (rocuronium bromide) and were placed in supine position by installing a cushion under their shoulders to allow the neck to be extended. The skin of the neck was prepared with an antiseptic solution (2% chlorhexidine aqueous solution). Subsequently, the space between the first and second or second and third tracheal rings was identified. Once the surgical access site was identified, 2% lidocaine was perfused with epinephrine. Subsequently, a superficial horizontal incision (approximately 1.5cm) was made, followed by a blunt dissection of the soft tissue until

the tracheal cartilage could be accessed. The specialist's index finger was introduced into the incision, and the anatomical structures were directly palpated to accurately confirm the site of access.

Table S2 - Nursing checklist for the execution of a percutaneous tracheostomy

Criteria to evaluate			
A.	Prior to the procedure	Yes	No
A.1	Signed informed consent		
A.2	Patient fasting		
A.3	Patient with orotracheal tube $\geq 8.5^*$		
A.4	Complete tray prepared according to what is listed		
A.5	Physical ICU area cleared		
A.6	Resuscitation cart in the patient's unit		
B.	During the procedure	Yes	No
B.1	Medical tray prepared according to what is listed		
B.2	Transient intraocular pressure		
B.3	Perform NGT suction		
B.4	Trim orotracheal tube to 2 cm		
B.5	Perform suction of secretions		
B.6	Position patient on their back		
B.7	Pillow under scapular area		
B.8	Clear vascular access area		
B.9	Install venous extender		
B.10	Preparation of the skin according to institutional guidelines		
B.11	Use of aseptic technique during the procedure		
C.	After the procedure	Yes	No
C.1	Leave the patient comfortable on their back (30 - 45°)		
C.2	Perform tracheostomy healing		
C.3	Perform change in ventilator circuit immediately		
C.4	Recordkeeping and medication administration procedure		

ICU - intensive care unit; NGT - nasogastric tube. * Depending on whether a pediatric or adult fibrobronchoscopy will be used.

The authors have introduced a modification of the technique by means of the employment of a Trousseau dilator (Figure S1). The implementation of this maneuver allows a better in-depth vision of the pre-tracheal planes during tissue divulsion and tracheal puncture.⁽¹⁸⁾ Additionally, as a complementary safety measure, morbidly obese patients ($\text{BMI} \geq 40\text{Kg/m}^2$)

underwent a cervical echo-Doppler with the purpose of select with more precision the access site and identify vascular or non-vascular structures that could complicate or contraindicate the procedure (Figure S2). The authors did not guide the puncture using ultrasonography in real-time, but only as a marking device. Then, under fibrobronchoscopic view, the orotracheal tube was withdrawn to allow the trachea to be punctured. Transillumination through the trachea allowed us to clearly establish the puncture site. The trachea was punctured with a fine needle and then with the trocar. A J-tip guidewire was then advanced along the trocar at face level. The trocar was withdrawn, and a short, stiff dilator was inserted along the guidewire. Then, single enlargement with the curved hydrophilic dilator was performed, and the tracheostomy cannula was installed with an endocannula (Shiley® conventional or Shiley® XLT, Nellcor, CA, USA) (Figure S3) to subsequently withdraw the orotracheal tube. Subsequently, an evaluation was performed via fibrobronchoscopy through the tracheostomy cannula to rule out tracheal wounds or bleeding, and to suction airway secretions. Finally, the mechanical ventilator was connected to the fan, and the cannula was fastened to the skin with 2/0 silk in addition to fabric tape for affixing. Once the procedure was completed, a portable thorax x-ray was performed to verify the position of the cannula and to rule out complications.



Figure S1 - Trousseau dilator.



Figure S2 - Cervical marking echoscopy.



Figure S3 - Conventional Shiley® and Shiley® XLT cannulae.