Percutaneous Dilatational Tracheostomy

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KEYWORDS

• Percutaneous dilatational tracheostomy • Mechanical ventilation • Airway • Obstruction

KEY POINTS

- Percutaneous dilatational tracheostomy (PDT) is a safe procedure that can be performed at the bedside.
- There is a learning curve associated with PDT.
- Patient selection is important in the success of PDT.

Introduction

Tracheostomy was first described by the Greeks some 4000 years ago. Tracheostomy was subsequently documented by the Roman and Arabic literature as a method of relieving airway obstruction.[1–3] This procedure is now primarily performed for those patients requiring prolonged airway assistance for its ease of managing oral secretions, elimination of dead space during mechanical ventilation, and reduction in anxiety associated with oral tracheal intubation with few complications.[1,4,5] Open tracheostomy (OT) was the standard practice until Ciaglia and colleagues[2] reported the first percutaneous dilatational tracheostomy (PDT) in 1985 in an effort to provide a safe, efficient, and minimally invasive way for patients in respiratory failure to obtain a secure, semi-permanent airway.[6] Since that time, both the technique and indications of PDT have undergone modifications as surgeons have gained more experience with this procedure. The average reported time to perform this procedure is approximately 15 minutes. The procedure can be safely performed at the bedside and avoids moving the patient to the operating room.[1,7–10]

The indications for PDT (Box 1) are similar to the indications for OT. These indications can be divided into the 4 broad categories:

1. Inability to maintain or protect the airway
2. Upper airway obstruction caused by stenosis or cancer
3. Primary pulmonary failure requiring prolonged ventilator assistance
4. To avoid long-term complications associated with prolonged endotracheal intubation

Tracheostomy is also performed in the setting of major maxillofacial trauma and bilateral recurrent laryngeal nerve injury.[1,11,12]

Contraindications for PDT (see Box 1) are divided into absolute and relative contraindications. The absolute contraindications include unstable cervical spine injuries, coagulopathy, need for emergency airway, and age less than 15 years. Relative contraindications include the inability to palpate landmarks because of obesity and/or the presence of a short neck, enlarged thyroid isthmus/goiters, high-riding innominate artery, and previous tracheostomy.[12,13]

Surgical technique

Preoperative planning

The most important aspect of preoperative planning is patient selection, which includes evaluating patients from a physiologic and anatomic standpoint. This approach cannot be overemphasized. Physiologic stability, adequate oxygenation not requiring aggressive ventilator support, and absence of coagulopathy must be ensured. The next important step is to evaluate the anatomy of the neck and palpate the landmarks of the anterior neck. The thyroid and cricoid cartilages should be palpable, along with the trachea down to the sternal notch. There should be at least 3 to 4 cm of space between the cricoid cartilage and the sternal notch (Fig. 1). If these landmarks are not palpable, then PDT is contraindicated and an OT should be planned. Endotracheal intubation will already be in place for patients undergoing PDT and serves as a means to allow for oxygenation and ventilation during the procedure when sedation or general anesthetic is needed. In addition, this provides secure airway access if the PDT attempt is unsuccessful.

Prep and patient position

The prep and patient positioning should be the same as in an OT. The patient should be placed on 100% fraction of inspired oxygen (Fio_2) in a volume control mode of mechanical ventilation and have adequate sedation and analgesia. A shoulder roll should be placed to allow for extension of the neck. Ideally, both arms should be tucked. Betadine or chlorhexidine prep can be used from the chin to the midchest. The preparation should also include loading the tracheostomy tube onto the appropriately sized smaller, nongraduated dilator. The cuff

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Box 1. Percutaneous tracheostomy: indications and contraindications

Indications
- Inability to maintain/protect airway
- Upper airway obstruction/cancer (laryngectomy)
- Prolong ventilator requirements

Absolute contraindications
- Unstable cervical spine injuries
- Coagulopathy
- Emergency airway
- Pediatric age (<15 years old)

Relative contraindications
- Obesity
- Short neck
- Enlarged thyroid isthmus/goiters
- High-riding innominate artery
- Previous tracheostomy
- High positive end-expiratory pressure requirement
- High fraction of inspired oxygen (Fio_2) requirement

should be checked for leaks by fully inflating it and it should then be completely collapsed.

Surgical approach: supine position

Surgical procedure

Ciaglia method

This procedure (Box 2) requires 2 experienced surgeons: one to operate the bronchoscope and another to perform the procedure. A flexible bronchoscope should be placed at the distal end of the endotracheal tube (ETT) by an experienced endoscopist. Any adhesive securing the ETT to the patient should be removed and the scope and ETT should be withdrawn to a level just below the vocal cords. Care must be taken not to withdraw the bronchoscope and ETT above the vocal cords, because this would create the need for reintubation. A 2-cm to 2.5-cm vertical incision should be made through the skin centered 2 fingerbreadths above the sternal notch. Under direct vision, a 14-gauge cannula is inserted into the midline of the anterior tracheal wall, ideally between the first and second tracheal rings (Fig. 2). The surgeon should use the nondominant hand to stabilize the trachea during this maneuver. Next the Seldinger guidewire is inserted into the trachea (Fig. 3). Once the guidewire is confirmed to be endotracheal, the tract is then dilated with the short, firm tracheal dilator. A generously lubricated single gradual dilator is then placed on the guidewire track after seating it on the guiding catheter and advanced into the trachea to the skin marking site (Fig. 4). The dilator is then removed, leaving the guidewire and guiding catheter in place. The tracheostomy tube and loading dilator are then inserted into the trachea as a single unit (Fig. 5). Once this maneuver is completed, all dilators and wires are removed. The bronchoscope is removed from the ETT, the ventilator circuit is moved to the tracheostomy, and the bronchoscope is inserted into the tracheostomy tube to confirm positioning of the tube and to remove any blood clots or mucous plugs accumulated during the procedure. A chest radiograph should be taken to evaluate for pneumothorax.

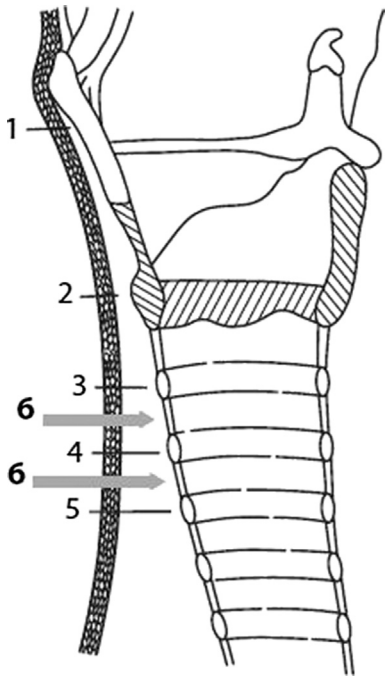

Fig. 1 Landmarks. 1, Thyroid cartilage; 2, cricoid cartilage; 3, first tracheal ring; 4, second tracheal ring; 5, third tracheal ring; 6, access site. (*Courtesy of* Cook Medical, Inc, Bloomington, IN; with permission.)

Modified Ciaglia method

At our institution, a modification on the standard Ciaglia method has been adopted by several surgeons (see Box 2). A bronchoscope is used initially to position the tip of the ETT at the level of the carina and it is then removed. A 2-cm to 2.5-cm vertical incision should be made through the skin centered 2 fingerbreadths above the sternal notch. The 14 gauge cannula is advanced into the subcutaneous tissue through the midpoint of this incision. While stabilizing the trachea with the nondominant hand, the surgeon advances the needle into the anterior wall of the trachea while applying constant, gentle aspiration. Passage of the cannula into the endotracheal space is confirmed with the return of air or saliva in the syringe. Next the Seldinger guidewire is inserted into the trachea. The bronchoscope is then reinserted and passed to the tip of the ETT, at which point the operator should be able to see the guidewire passing into one of the mainstem bronchi. The ETT and bronchoscope are then withdrawn as a unit until the origin of the wire entering the trachea is identified. The reminder of the procedure is the same as for the Ciaglia method. This method is most beneficial in avoidance of inadvertent loss of the airway, which can happen with blind withdrawal of the ETT, as well as inadvertent bronchoscope damage during initial tracheal access with the 14 gauge cannula.

Caveats/potential complications

Complications can be divided into early and late complications (Boxes 3 and 4). The reported rate of complication using the Ciaglia technique described earlier is between 4.1% and 12%. Most of these complications are minor, with an associated learning curve. The list of early and late complications is shown in Box 3. Many of the early complications are preventable or can usually be managed by experienced surgeons when using the technique described earlier. Late complications of cellulitis and abscess around the tracheostomy