Indications for and Management of Tracheostomy

JUDI ANNE B. RAMISCAL, MICHAEL S. HAYASHI, and MIHAE YU

INTRODUCTION

A translaryngeal endotracheal tube (ETT) is the primary method of securing an airway in the majority of critically ill patients. In patients with penetrating neck trauma and obvious tracheal injury, placement of an ETT directly through the existing defect is an option for initial airway management, and here, early tracheostomy has a clear role. For the majority of patients, consideration for tracheostomy placement arises after the initial airway management, when ventilator support is required for extended periods of time. The decision to perform tracheostomy, however, is not always an easy one. With the increased use of high-volume, low-pressure ETT cuffs, there is no time interval when conversion to a tracheostomy is mandatory based on potential damage to the trachea from pressure necrosis. The main considerations for placement of a tracheostomy are the anticipated duration of ventilator support, secretion management, and patient comfort. Predicting the duration of ventilator support is difficult, and the optimal timing of tracheostomy in critically ill patients with acute respiratory failure is controversial.

Tracheostomy is one of the most commonly performed surgical procedures in critically ill patients (1). The modern surgical tracheostomy (ST) was first described in 1909 by Chevalier Jackson (2). In 1985, Ciaglia et al. (3) first described the technique of percutaneous dilatational tracheostomy (PDT); it has since become a common bedside procedure in the intensive care unit (ICU). Tracheostomy is typically an elective procedure and should not be performed on patients receiving high-pressure ventilator support (except on rare occasions when there are mechanical problems with the ETT) as loss of airway pressure during the procedure may cause significant morbidity. Although PDT has evolved into a safer and common procedure, continued awareness of the complications and pitfalls associated with this procedure is essential.

INDICATIONS AND TIMING

The primary indication for tracheostomy is the requirement for prolonged ventilator support and/or failure to wean from mechanical ventilation for 2 to 3 weeks (4). In 1989, the ACCP Consensus Conference on Artificial Airways in Patients Receiving Mechanical Ventilation recommended translaryngeal intubation for an anticipated need of the artificial airway up to 10 days and tracheostomy for an anticipated need of the artificial airway for greater than 21 days (5). It also recommended that the decision for tracheostomy be made as early as possible to minimize the duration of translaryngeal intubation. Other indications include severe head injury with inability to protect the airway, high spinal cord injuries, laryngeal trauma, upper airway obstruction, and for management of pulmonary secretions. Though a mortality benefit for tracheostomy is not consistently seen in the literature, the benefits of tracheostomy include sparing the larynx from further direct injury from the translaryngeal tube, improved comfort and presumed psychological benefit (6), ability to speak and eat, improved oral care, and possibly quicker wean from ventilation with earlier transfer from the ICU (5). In patients with limited reserve, tracheostomy reduces the work of breathing (shorter length of tubing than the ETT) and may allow more flexibility in weaning (7,8).

Optimal timing of converting a translaryngeal intubation to a tracheostomy remains controversial because there is no accurate way to predict the need for prolonged mechanical ventilation in the first few days. A high acuity of illness (Acute Physiology and Chronic Health Evaluation [APACHE] II scores >25) and the presence of shock at the time of ICU admission are two of the best predictors (9–11). Pena et al. (12) reviewed 56 cases of subglottic stenosis and found that 86% had a history of tracheal intubation, with a mean duration of 17 days. Current Eastern Association for the Surgery of Trauma (EAST) practice management guidelines support early tracheostomy (3 to 7 days) to decrease total days of mechanical ventilation and ICU length of stay in patients with severe head injuries. They also recommend early tracheostomy be considered in all trauma patients anticipated to require mechanical ventilation for greater than 7 days, such as those with neurologic impairment or prolonged respiratory failure (13).

Several studies have provided additional support for early tracheostomy. Rumbak et al. (14) randomized 128 medical patients to either early (within 48 hours) or late (14 to 16 days) percutaneous tracheostomy and found significantly shorter ICU stays, fewer days on the ventilator, and a lower mortality in the early tracheostomy group. A prospective review of trauma patients by Arabi et al. (15) also found that patients who received early tracheostomy (by day 7 of mechanical ventilation) had shorter ICU stays and fewer days on the ventilator. In a meta-analysis, Griffiths et al. (16) reviewed five clinical trials with a total of 406 patients that compared early (within 7 days) versus late tracheostomy in critically ill adult patients. Mortality and the risk of pneumonia were the same in the two groups, but early tracheostomy significantly reduced the duration of artificial ventilation and length of stay in the ICU. A retrospective study of patients with cervical spinal cord injury by Menaker et al. (17) supports early tracheostomy in patients with American Spinal Injury Association (ASIA) “complete” cervical spinal cord injury or “incomplete” injury with a motor score less than 10. Similarly, in a retrospective cohort study of patients with isolated severe traumatic brain injury, Alali et al. (18) found that early tracheostomy (8 or less
days from admission) led to a shortened duration of mechanical ventilation, ICU and hospital LOS, though there was no significant reduction in hospital mortality.

There continues to be debate over the actual impact of tracheostomy on overall outcome. In two studies of patients requiring prolonged mechanical ventilation, Combes et al. (19) found that tracheostomy was associated with lower ICU and in-hospital mortality rates, whereas Clec’h et al. (20) found no reduction in mortality but increased post-ICU mortality if the tracheostomy was left in place.

**PATIENT SELECTION**

All patients requiring prolonged mechanical ventilation are candidates for tracheostomy. The 2003 ACCP Guidelines for Interventional Pulmonary Procedures identified uncontrollable coagulopathy, infection over the site, extreme ventilator and oxygen demands, and tracheal obstruction as contraindications to PDT (21). Other mitigating circumstances to consider include hemodynamic instability, unfavorable anatomy, obesity, previous neck surgery or radiation, risk of infection to adjacent surgical wounds (neck and upper chest incisions), and central line sites. While cricothyroidotomy remains the recommended method of securing an emergency surgical airway, familiarity and expertise with PDT has allowed it to emerge as an alternative for emergency airway access in select situations.

**OPEN VERSUS PERCUTANEOUS TRACHEOSTOMY**

PDT has largely replaced the traditional open approach to tracheostomy as it has several advantages. PDT is usually performed in the ICU which eliminates the need to transport the patient to and from the operating room (OR); it also avoids the additional costs and logistics associated with use of the OR and possibly anesthesia. This transition of tracheostomy to a bedside ICU procedure has also allowed PDT to be performed by a broader range of providers.

Delaney et al. (22) identified randomized clinical trials that compared PDT to open or ST. Seventeen studies involving 1,212 patients were reviewed, and the authors concluded that PDT reduced the incidence of wound infection and may further reduce clinically relevant bleeding and morbidity and mortality when compared with ST performed in the OR. There are now large-series single-institution reports demonstrating that with proper preparation, PDT can be safely performed on most critically ill patients with low complication rates, even those deemed high risk (23,24). The choice between ST and PDT ultimately depends on the operator experience and individual patient issues.

Patient issues favoring ST include:
- Coagulation abnormalities: Larger blood vessels are more easily controlled under direct vision during ST, but the smaller wound opening and snug fit of the tracheostomy placed by PDT may help tamponade clinically relevant bleeding from small vessels at the wound edges.
- High level of oxygenation support with a high FiO2 and/or high PEEP: During PDT, the endotracheal tube is withdraw

**Surgical Tracheostomy**

ST can be performed in either the OR or the ICU. The patient usually has an endotracheal tube in place. A shoulder roll is placed to elevate the shoulders and extend the head, which elevates the larynx and exposes more of the upper trachea. The skin is prepped from the chin to below the clavicles. Sterile drapes are used to create a surgical field from the top of the larynx to the suprasternal notch. The thyroid notch and cricoid cartilage are identified by palpation (Fig. 40.1). Local anesthetic with a vasoconstrictor, such as epinephrine, is then injected into the skin and subcutaneous tissue overlying the second tracheal ring.

A 2-cm midline vertical or horizontal incision is then made. The vertical incision extends from the inferior edge of the cricoid cartilage toward the suprasternal notch whereas the horizontal incision is made over the second tracheal ring. Dissection is carried sharply through the platysma muscle and a vertical dissection through the middle of the strap muscles will avoid bleeding from the paired anterior jugular veins. Bleeding is controlled with cautery and/or hemostats and ties. Careful blunt dissection is then used to expose the thyroid isthmus, if this overlies the second and third tracheal rings it may need to be partially or completely transected to expose the trachea.

---

**FIGURE 40.1** Tracheal anatomy and placement of incision.
The patient is positioned, and the neck is prepped and draped as described for ST. The neck is palpated to identify the thyroid notch and cricoid cartilage. Local anesthetic with a vasoconstrictor is then injected into the skin and subcutaneous tissue inferior to the cricoid cartilage, followed by a 1.5-cm incision made either horizontally or vertically over the intended tracheostomy site. A curved hemostat is then used to dissect gently down to the anterior trachea. A fingertip is used to palpate the local anatomy including cricoid cartilage and tracheal rings. The endotracheal tube is withdrawn under direct bronchoscopic vision until the upper tracheal rings are visualized; the light from the scope may also be visible through the surgical field as it traverses this area. The bronchoscope and ETT should be adequately withdrawn to avoid impaling them; it is also recommended that the tip of the bronchoscope be positioned within the ETT.

Although seemingly easy, finding the airway with the needle is the most important and most difficult part of the procedure. The trachea should be stabilized with the nondominant hand and the trachea air column is located by directing the needle posterior and caudally in the midline. To avoid injury to adjacent structures and the subsequent associated complications, the depth and direction of needle insertion should not exceed what is expected to enter the airway. Entry into the trachea is visualized with the bronchoscope; the goal is to place the needle between the first and second or the second and third tracheal rings at the anterior midline of the trachea (see Fig. 40.1). If the percutaneous entry site into the trachea is undesirable, the steps may be revised to reposition needle entry as needed.

Once free flow of air is obtained, the outer sheath is advanced and the inner needle is removed. The J-wire is then advanced through the sheath into the trachea and should be visualized as it progresses to the lower airways by bronchoscopy. The sheath is then removed and serial dilation performed over the guidewire. Placing a finger on the tracheal opening between dilation and tracheostomy tube insertion will minimize the gas leak and loss of PEEP. Finally, the tracheostomy tube with a guide (the largest one that will fit within the tracheostomy tube) is threaded over the guidewire, and then into the trachea. The dilation and tracheostomy tube insertion requires significant force, and visualization of the process with the bronchoscope is invaluable in minimizing the risk of an unintended or unidentified injury to the posterior wall of the trachea.

After placement of the tracheostomy tube, the bronchoscope is inserted into the fresh tracheostomy to confirm placement and remove blood and secretions. The mechanical ventilator attachment can then be transitioned to the tracheostomy tube and the ETT removed. The ACCP recommends that trainees should perform at least 20 PDT in a supervised setting annually to maintain the skill set.

Other methods for percutaneous tracheostomy described in the literature include the translaryngeal, dilating forceps, PercuTwist, and balloon dilatational techniques, as well as combinations of these approaches (27).

**COMPlications**

The important complications of tracheostomy include infection, bleeding, inadvertent extubation, paratracheal placement, esophageal perforation, subcutaneous emphysema, and the creation of a fistula tract may not have stabilized. Another technique is to make a criss-cross incision on the trachea and simply insert the tracheostomy under direct vision after lifting the edges with a tracheal hook. Suturing the tracheostomy tube in place may help decrease the risk of accidental decannulation.

**Percutaneous Dilatational Tracheostomy**

The most common technique for performing PDT is that of Ciaglia. Originally, the technique used sequential dilators (3), but it has since been simplified to using a single tapered dilator. This dilator has a hydrophilic coating that is activated by immersing it in sterile water or saline. This procedure can be performed blindly, although many clinicians use fiberoptic bronchoscopy to observe the placement, as well as to prevent inadvertent injury to the posterior wall of the trachea and/or misplacement of the tracheostomy (25,26). The procedure requires at least two operators, one to control the ETT and one to perform tracheostomy tube placement; good preparation and communication are essential. For large necks, a longer tracheostomy tube—such as the Shiley XLT—may be necessary. The availability and functionality of all appropriate supplies should be confirmed before initiating the procedure. Loss of an airway can be life threatening, any procedure of the airway should include personnel who are skilled at intubating and managing the airway emergently.

The availability and functionality of all appropriate supplies should be confirmed before initiating the procedure. Loss of an airway can be life threatening, any procedure of the airway should include personnel who are skilled at intubating and managing the airway emergently.

The patient is positioned, and the neck is prepped and draped as described for ST. The neck is palpated to identify
pneumothorax, tracheal stenosis, tracheoinnominate fistula, tracheoesophageal fistula, tracheocutaneous fistula after decannulation, cardiopulmonary arrest, and death. In a meta-analysis of 1,212 patients, the most common clinically relevant complications noted were wound infections (6.6%) and bleeding (5.7%) (22). Intraprocedural and postprocedural airway complications remain an infrequent but important source of morbidity and mortality associated with tracheostomy. Inadvertent postoperative decannulation with inability to recannulate the trachea due to the absence of a formed tract may occur. Immediate endotracheal intubation is mandatory rather than attempting to push the tracheostomy tube back into a semiocluded orifice.

A specific complication of ST is the risk of airway fire. Occurring when a spark from the electrocautery ignites the oxygen leaking from the opened trachea, significant injury to the airway can result. This can be prevented by meticulous hemostasis during the pretracheal dissection, avoiding the use of electrocautery to make the tracheal incision or while the trachea is open, and decreasing the oxygen fraction through the ETT.

In 2013, the largest study to date addressing the safety of bedside PDT was performed, including over 3,000 procedures. Among the conclusions was that a low complication rate for the procedure was attainable across a broad spectrum of critically ill patients without the routine use of bronchoscopy. Of note, their practice involved a specific well-trained experienced procedure team and the routine use of preprocedural and equipment checklists. Bronchoscopy was still utilized in 2% of patients and early major complications included three airway losses and one major bleeding event requiring formal exploration with three procedure-related deaths in the 10-year study (23).

Obesity is associated with higher rates of complications in PDT, including posterior tracheal wall injury, malpositioning, and accidental decannulation (28,29); however, this technique may be safely used in experienced hands (30). The use of bronchoscopy and an extra-long tracheostomy (XLT) tube may help minimize the incidence of these complications (28,31).

Infrequent major complications, including death, related to PDT are well described in the literature, mainly as small series or case reports (32). Airway complications resulting in mortality included tracheostomy tube dislodgement, extraluminal placement, and intraprocedural loss of airway. Cannulation of the mediastinum may result in catastrophe with acute asphyxiation or subsequent sepsis from mediastinitis. Bronchoscopic guidance is recommended to increase the safety of PDT by preventing complications related to tracheostomy misplacement as well as perforation of the esophagus or pharynx. Routinely suturing the tracheostomy tube in place may also decrease the risk of inadvertent decannulation of a freshly placed tube (28). Ultrasound may also serve a role to delineate vascular structures and avoid major bleeding complications.

There is a learning curve using PDT, and it has been reported that complications are higher in the earlier cases of the operator (28). As PDT is increasingly performed by physicians across a variety of disciplines, patient safety must be ensured through careful patient selection and recognition of the pitfalls of this now common bedside procedure in the critically ill patient.

Key Points

- Tracheostomy may be required for patients who require prolonged mechanical ventilation; a high severity of injury or shock on admission may predict this need.
- Early tracheostomy may benefit specific patient populations, such as those with severe head and cervical spinal cord injury by decreasing ventilator days and ICU length of stay.
- The choice between ST and PDT depends on local operator expertise and patient-specific issues. Bedside PDT is performed as safely as ST in the OR and may be associated with more efficient use of health care resources.

References


