Percutaneous Dilational Tracheostomy

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KEYWORDS

• Percutaneous dilational tracheostomy • Chronic respiratory failure • Critical illness

KEY POINTS

- Indications for percutaneous dilational tracheostomy (PDT) include but are not limited to upper airway obstruction and respiratory failure requiring prolonged mechanical ventilation.
- PDT is often performed at the bedside under bronchoscopic visualization.
- The use of ultrasound for preoperative screening and intraoperative guidance may be helpful; however, the data are limited.
- When performed by experienced operators, PDT is a safe procedure with minimal complications.
- A multidisciplinary PDT team has been shown to have significant benefits on performance and complication rates.

HISTORY

The human endeavor of making an incision into the windpipe in order to relieve an obstruction to breathing dates back to antiquity. Two ancient Egyptian tablets from 3600 BC depict a lancet pointed into the neck of a seated person.[1] The *Rigveda*, a sacred Hindu book published around 2000 BC, references tracheotomy; Alexander the Great (356–323 BC) reportedly used his sword to open the trachea of a choking soldier. The concept was described in 160 AD when Galen, a famous physician of the Roman empire, stated, "if you take a dead animal and blow air through its larynx (through a reed), you will fill its bronchi and watch its lungs attain the greatest dimension".[2]

In the seventh century BC, Paul of Aegina, a Byzantine Greek physician, described tracheotomy for therapeutic purposes in his medical encyclopedia, *Medical Compendium in Seven Books*, to prevent suffocation from inflammation of the mouth or palate. The first percutaneous approach to tracheotomy was thought to have been performed many centuries later in 1626 by Italian surgeon, Sanctorio Sanctorius, using a "ripping needle" to introduce a silver cannula through the tracheal wall.[1]

Despite these sporadic recordings over the centuries, when the age of modern medicine approached, tracheotomy was rarely performed due to high associated mortality. In the final month of 1799, George Washington, recently retired as president of the United States, lay dying in bed (**Fig. 1**). His airway was severely compromised from a suspected case of bacterial epiglottitis. In only the year prior, the medical literature described a surgical technique allowing access to the trachea in cases of upper airway obstruction. However, as Washington lay gasping for air, a team of his closest and most trusted physicians decided against tracheotomy (a procedure considered highly experimental and radical at the time) and opted instead for bloodletting, removing 80 oz (2365 mL) of blood over

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Fig. 1. President George Washington on his deathbed with upper airway obstruction, surrounded by his most trusted doctors contemplating his treatment.

12 hours. Washington ultimately succumbed to his death, and debate still continues as to whether tracheotomy may have saved the first president's life.[3]

In the early twentieth century, tracheostomy gained popularity after the famous American surgeon Chevalier Jackson standardized an open surgical technique. Dr Jackson's approach was thought to have reduced the mortality associated with tracheotomy from 25% to 1%.[1] With the increased use of mechanical ventilation in the mid-twentieth century and the decreased mortality of the procedure, the practice of using tracheostomy tubes for prolonged ventilatory support became more routine and widespread.[4] In 1955, the physician, C. Hunter Shelden, and colleagues[5] described a percutaneous method for tracheostomy tube placement as an alternative to the surgical approach. Twelve years later, Toye and Weinstein used the Seldinger guidewire to improve its safety[1]; in 1985, Pasquale Ciaglia and colleagues[6] further refined the procedure, leading to what is considered the most popular and widely applied technique today for percutaneous dilational tracheostomy (PDT).

INDICATION

Indication for tracheostomy tube placement falls into 2 broad categories: for relief of upper airway obstruction and as an alternative method to endotracheal tube (ETT) intubation for prolonged ventilator support and long-term airway maintenance. However, other uses exist (**Box 1**).

In the setting of upper airway obstruction, the method by which to secure the airway often depends on the clinical scenario and emergent nature of the obstruction. Causes of upper airway obstruction must be considered in guiding the management plan, with causes that include maxillofacial trauma, laryngeal injury and edema, obstructing upper airway tumors, and other benign anatomic conditions that render laryngotracheal intubation difficult to perform.[7] In an emergency due to an inability to maintain airway patency or ventilate using standard techniques (bag mask, laryngeal mask airway, or ETT intubation), PDT is often not the initial procedure of choice but rather rapid cricothyrotomy (via an incision through the cricothyroid membrane) or surgical tracheostomy.[4] Although PDT can be performed emergently,[8,9] it is generally accomplished in a more controlled setting.

Prolonged ventilator dependence remains the most common indication for tracheostomy, thus, acting as an alternative to ventilation via an ETT.[7] Underlying conditions can range from intrinsic respiratory failure to debilitating systemic or neuromuscular illness that requires chronic airway protection or ventilator support. The benefits of prolonged ventilation via a tracheostomy tube over an ETT have been proposed. These advantages include an enhancement of patient comfort, improved oral hygiene and pulmonary toilette, allowance for oral nutrition and speech, and easier mobilization and engagement with physical

Box 1
Potential percutaneous dilational tracheostomy indications

- Prolonged intubation
- Improved comfort and mobilization while on mechanical ventilation
- Relief of upper airway obstruction
- Severe obstructive sleep apnea
- Bilateral vocal cord paralysis
- Inability to ventilate from underlying systemic neuromuscular disease

therapy.[10–12] In addition, 2 large trials have identified an association between tracheostomy tube placement and shortened duration of sedation, fewer unplanned extubations, and decreased use of sedating medications.[13,14] Nevertheless, the published data have not demonstrated an impact on mortality or rate of ventilator-associated pneumonia (VAP).

Tracheostomy tube ventilation has been purported to facilitate weaning from mechanical ventilation. One hypothesized mechanism is related to a decrease in airflow resistance associated with tracheostomy tubes over ETTs. Conceptually, according to Poiseuille's law, airflow resistance is proportional to air turbulence, tube diameter, and tube length[10,15] (Fig. 2). Therefore, the decreased length of tracheostomy tubes and removable inner cannula (which allows for evacuation of secretions) is thought to result in decreased airflow resistance. In addition to changes in airflow, the ease with which a tracheostomy tube can be removed and reconnected to the ventilator has been theorized to result in more aggressive weaning attempts.[7]

Despite these proposed benefits, evidence from well-designed studies to substantiate tracheostomy tube ventilation over prolonged ETT intubation is lacking; consequently, there are no clear guidelines. As a result, patient selection is often subjective and the timing of tracheostomy tube placement varies widely.

TIMING

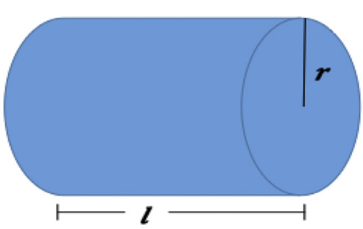
The optimal timing of tracheostomy tube placement remains controversial. Prospective and retrospective studies comparing early versus late tracheostomy have provided mixed results. Ideally, tracheostomy is reserved only for those requiring prolonged ventilation. However, because prediction models are imperfect, a strategy of early tracheostomy has the potential to lead to unnecessary tube placements.

A 2010 prospective multicenter Italian study of 600 patients on mechanical ventilation found a nonsignificant trend toward reduction in the incidence of VAP (the primary outcome) without a survival benefit among early (after 6–8 days) versus late (after 13–15 days) tracheostomy.[13] A 2013 large prospective multicenter randomized study from the United Kingdom (the TracMan trial), enrolling 909 patients who were expected to remain on mechanical ventilation for at least 7 days, found no difference in 30-day or 2-year mortality between early (within 4 days) and late (after 10 days) tracheostomy.[16] The patients were mostly medical (79.2%) with respiratory failure as the primary admission diagnosis in 59.5%. This study also found no difference in median intensive care unit (ICU) length of stay, hospital length of stay, or duration of mechanical ventilation. There was a decreased use of sedation in the early arm; however, there were significantly fewer tracheostomies performed in the late cohort, thus, highlighting the clinician's inability to accurately predict which patients will require prolonged mechanical ventilation. The lead investigator has summarized the results stating, "if you had 100 patients requiring tracheostomy, doing it early results in 2.4 days less sedation overall, but you would perform 48 more, with 3 more procedural complications and no effect on mortality or ICU length of stay".[17]

A 2015 meta-analysis of 13 trials involving 2434 patients further confirmed no difference in all-cause ICU mortality in early versus late tracheostomy.[18] Similar findings have been identified in other meta-analyses.[19–21]

However, subanalysis in a 2012 retrospective study revealed that a cohort of patients with neurologic deficits (which tended to be patients requiring ventilation for airway protection rather than respiratory failure) benefitted from earlier tracheostomy with decreased ICU length of stay and presumed improved cost-effectiveness.[22] Conversely, a 2014 meta-analysis of 3 randomized controlled trials of patients with severe brain injury found no survival benefit or reduction in VAP rates.[23]

In summary, the decision on timing is best individualized and based on clinical judgment, taking into account factors such as the etiology of respiratory failure, predicted duration of mechanical ventilation, the number of daily weaning attempts, the risk of prolonged ETT ventilation, and the inherent risks of tracheostomy itself. In practice, many centers wait at least 10 to 14 days before tracheostomy is considered, although there is no standard practice and certain sub-populations (ie, neurology patients requiring prolonged ventilation support) may benefit from earlier placement.



$$R = \frac{8nl}{\pi r^4}$$

Fig. 2. Poiseuille's law of flow resistance. l, length; n, viscosity; r, radius; R, resistance.

CONTRAINDICATIONS

Few absolute contraindications for tracheostomy exist (Table 1). These include cellulitis/deep tissue infection at the insertion site and inexperience on the part of the proceduralist. Relative contraindications for tracheostomy (both surgical and PDT) include coagulopathy/thrombocytopenia and clinical instability (ie, severe acute respiratory failure, septic shock). Another relative contraindication includes recent neck or mediastinal surgery. Although PDT within the first 48 hours after cardiac surgery has an increased risk of mediastinitis,[24] evidence has found no difference in outcomes between PDT and open surgical tracheostomy after coronary artery bypass grafting surgery.[25]

Other relative contraindications include anatomic abnormalities (overlying goiter, short neck, or difficulty with neck hyperextension). PDT should be performed with caution in patients with cervical spine injury who have limitations in neck extension. However, one study demonstrated PDT to be safe and feasible in trauma patients with cervical spine fracture.[26] Although PDT in obese patients is a relative contraindication, it has been demonstrated to be performed safely by experienced operators.[27]

TRAINING IN PERCUTANEOUS DILATIONAL TRACHEOSTOMY

A properly trained operator can perform PDT safely with or without prior formal surgical training. Proceduralists often come from varied backgrounds that include general surgery, otolaryngology, interventional pulmonology, critical care medicine, general pulmonology, emergency medicine, and anesthesiology. Regardless of underlying specialty, it is generally recommended that performers of PDT be appropriately trained in advanced airway management and emergent airway techniques, develop a comprehensive understanding of procedural indications and contraindications, and understand how to recognize and manage complications.[1,28]

Training in PDT is performed in 2 parts: initial achievement of competency followed by maintenance of competency over time. Prior guidelines based on expert consensus from the American College of Chest Physicians have recommended that a minimum of 20 supervised PDT procedures be performed initially followed by at least 10 per year in order to achieve and maintain competency.[28] These numbers are often accomplished in specialty training fellowships, post-training apprenticeships (ie, mini-fellowships), and, in some cases, supplemented by continuing medical education courses with hands-on practice on low- or high-fidelity simulators, live or dead animals, or cadavers.[29,30]

PDT is included as a core procedure within most formal interventional pulmonology training fellowships. Recently, a multi-society accreditation committee established common standards for interventional pulmonology fellowship training and recommended that a minimum performance of 20 PDT procedures be necessary for certification of competency.[31] Given the increase in PDT performance, there is also a call for increased practice of PDT within otolaryngology–head and neck surgery residency training programs.[32]

Table 1
Contraindications to percutaneous dilational tracheostomy

Absolute	Relative
Infection at insertion site	Coagulopathy
Operator inexperience	Clinical instability (hemodynamic or respiratory)
	Recent neck or cardiac surgery
	Anatomic abnormalities of the neck
	High ventilator/positive end-expiratory pressure requirements

PREPROCEDURE PREPARATION

Preparation for PDT begins with a review of the patients' history and a physical examination. Attention should be paid to the current respiratory status and the underlying cause of respiratory failure that may help predict the duration of mechanical ventilation. The physical examination should focus on neck anatomy and mobility, as inability to adequately hyperextend the neck can limit proper positioning. Careful palpation of tracheal landmarks should help identify the thyroid cartilage, cricoid cartilage, and the first through third tracheal rings (Fig. 3). The examiner can also assess for any palpable pulsating vessels near the site of entry. Laboratory values should be reviewed, including prothrombin time, international normalized ratio, partial thromboplastin time, complete blood count (including platelet count), and blood urea nitrogen (to evaluate for uremia). Reversal of underlying coagulopathy should be performed when indicated. The use of ultrasound during PDT is discussed later.

PDT can be performed at the bedside in the ICU. However, high-risk patients and those with difficult

Fig. 3. Preoperative landmarks from top to bottom: thyroid cartilage, cricoid cartilage, first tracheal ring, second tracheal ring, sternal notch.

anatomy or noncorrectable coagulopathy should be considered instead for surgical tracheostomy in the operating room.

A comprehensive PDT team often includes an anesthesiologist or physician trained in airway management and basic bronchoscopy (who can be positioned at the head of the bed to control the ETT, perform bronchoscopy to provide visualization from within the trachea, and to supply anesthetic medications), a physician to perform the tracheostomy tube insertion, and a respiratory therapist and/or nurse (**Box 2**). A multidisciplinary PDT team approach, which includes physicians, nurses, speech-language pathologists, respiratory therapists, and tracheostomy coordinators, has been demonstrated to have a favorable impact on performance and complication rates.[22,33]

Tracheostomy tubes are available in a variety of sizes and configurations in order to fit differing patient populations. The size and length of the tube is often selected for body habitus, sex, current ETT size, and suctioning requirements. Poorly fitted tubes can lead to loss of tidal volume, patient discomfort, irritation to the tracheal wall, difficulty with ventilation, need for premature tracheostomy tube change, and airway loss. No established criteria exist in helping the operator predict the most ideal tube size. However, nonstandard tracheostomy tubes (eg, those tubes with size adjustments that fit specific anatomic variants) should be considered if patients are male with an ETT size of 8.0 or greater, and have a trachea-to-skin distance greater than 4.4 cm on a computed tomography (CT) scan.[34]

Box 2
A comprehensive multidisciplinary tracheostomy team

- Physician: to manage airway and bronchoscope
- Physician: to perform the tracheostomy tube insertion
- Respiratory therapist
- Tracheostomy coordinator
- Nurse
- Speech-language pathologist

USE OF ULTRASOUND FOR PERCUTANEOUS DILATIONAL TRACHEOSTOMY

Ultrasound anatomy of the trachea and its surrounding structures was first described in 1995,[35] and the first real-time ultrasound-guided PDT was reported in 1999[36] (**Fig. 4**). Several advantages have been proposed for the use of ultrasound in the preoperative and intraprocedural settings. These advantages include (1) identification of aberrant pretracheal vasculature to avoid procedural bleeding complications, (2) identification of a satisfactory puncture location, (3) aid in the ideal selection of tube size and length, and (4) allowance of real-time guidance for the insertion of the introducer needle.[37] However, the data are limited because of the lack of clinical trials, most of which have been small and single-center studies without control groups.

Two prospective studies have compared ultrasound with bronchoscopy for PDT guidance. One study randomized 23 patients to real-time ultrasound guidance alone versus bronchoscopy alone. An initial midline puncture was achieved with greater success in the ultrasound arm (72.7% vs 8.3%).[38] Another randomized controlled trial of 177 PDT cases evaluated real-time ultrasound guidance with and without bronchoscopy.[39] They found that the use of bronchoscopy resulted in longer procedural times (13.9 vs 10.7 minutes) and a greater risk of peripheral oxygen desaturation (16.8% vs 3.7%); however, all other end points, including success and complication rates, were comparable between both groups.

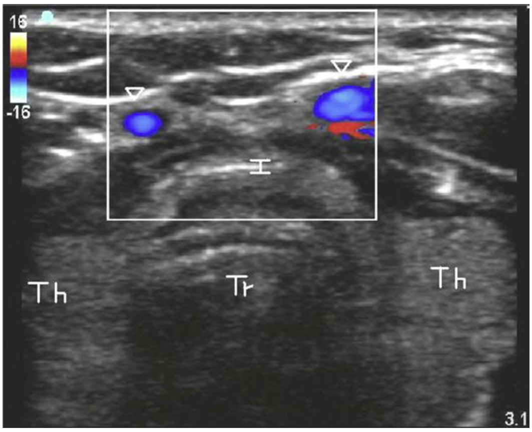


Fig. 4. Sonographic image of the trachea and surrounding structures with pretracheal veins depicted with color duplex imaging. Arrowheads, pretracheal veins; I, isthmus of the thyroid; Th, lobes of the thyroid; Tr, tracheal lumen. (*From* Rajajee V, Fletcher JJ, Rochlen LR, et al. Real-time ultrasound-guided percutaneous dilatational tracheostomy: a feasibility study. Crit Care 2011;15:R67; with permission.)

A few other studies have demonstrated that the originally intended puncture site was changed in a significant number of cases based on ultrasound findings (with change rates ranging from 23.1% to 50.0%).[40–42] Whether this translates to improved efficacy and safety remains unclear.

PERFORMANCE OF THE PERCUTANEOUS DILATIONAL TRACHEOSTOMY PROCEDURE

There is no single technique or universal consensus in regard to the actual performance of PDT. By convention, however, patients are well sedated, preoxygenated with a FiO_2 of 1.0, and adequately ventilated. Standard practice includes instituting neuromuscular blockade under general anesthesia to reduce the risk of posterior tracheal wall injury.

Ideal positioning is completed by hyperextending the neck, often with the aid of a roll placed under the scapula. The tracheal structures, including the cricoid and laryngeal cartilages, are palpated; an insertion site between the first and second, or second and third, tracheal rings are selected. Within a sterile field, lidocaine with epinephrine is injected into the subcutaneous tissue to aid in hemostasis and provide analgesia.

Although several PDT insertion methods exist (ie, Griggs', Fantoni, Frova/Quintel, Ambesh),[43] a common technique in use today is the Ciaglia method, a modified Seldinger technique using serial dilation with progressively larger hydrophilic coated dilators under bronchoscopic visualization.[6] It has now been modified into a commercially available kit that uses a single conical dilator. This insertion method is described in this article.

After subcutaneous injection of lidocaine and epinephrine (Fig. 5A), a 1.0- to 1.5-cm vertical or horizontal incision is made through the skin and superficial subcutaneous fascia (Fig. 5B). The soft tissue is dissected bluntly and the tracheal rings are palpated. A bronchoscope is inserted distally through the ETT and then withdrawn slowly until there is transillumination of the anterior neck incision (Fig. 5C). This transillumination allows an estimation of the distance needed to withdraw the ETT above the level of insertion. The ETT is pulled back; and, under bronchoscopic

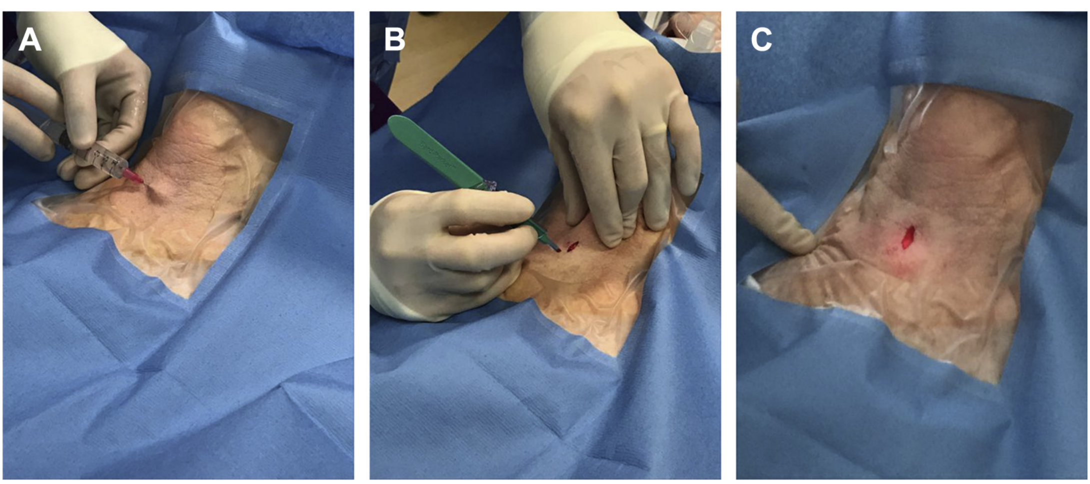


Fig. 5. Performance of PDT, part 1. (*A*) Subcutaneous injection of lidocaine with epinephrine; (*B*) 1-cm vertical incision; (*C*) transillumination using the bronchoscope following blunt dissection.

visualization, a 15-gauge needle is inserted midline through the anterior tracheal wall (Fig. 6A, B). A J-tipped guidewire is advanced through the needle into the airway (Fig. 6C, D) and the needle is removed. The tract is first dilated with a short 14F dilating catheter (Fig. 7A, B) followed by a single tapered dilator (Fig. 7C, D). The tracheostomy tube is inserted on a separate obturator over the guidewire, and the cuff is inflated inside the trachea (Fig. 8). The bronchoscope is removed from the ETT and inserted into the tracheostomy tube to confirm proper positioning. The tracheostomy tube is then connected to the ventilator, and the tube is secured on the neck.

COMPLICATIONS OF PERCUTANEOUS DILATIONAL TRACHEOSTOMY

In the hands of an experienced operator on a properly selected patient, PDT is a safe procedure. Procedural-related mortality has reported rates of 0% to 0.7%, with most other complications considered to be minor.[43] Complications may fall into those that occur in the acute phase (during the perioperative period) and the chronic phase (in the weeks or months after the procedure). Acute complications include bleeding, wound infection (local or deep), subcutaneous emphysema, tube obstruction, false lumen insertion,

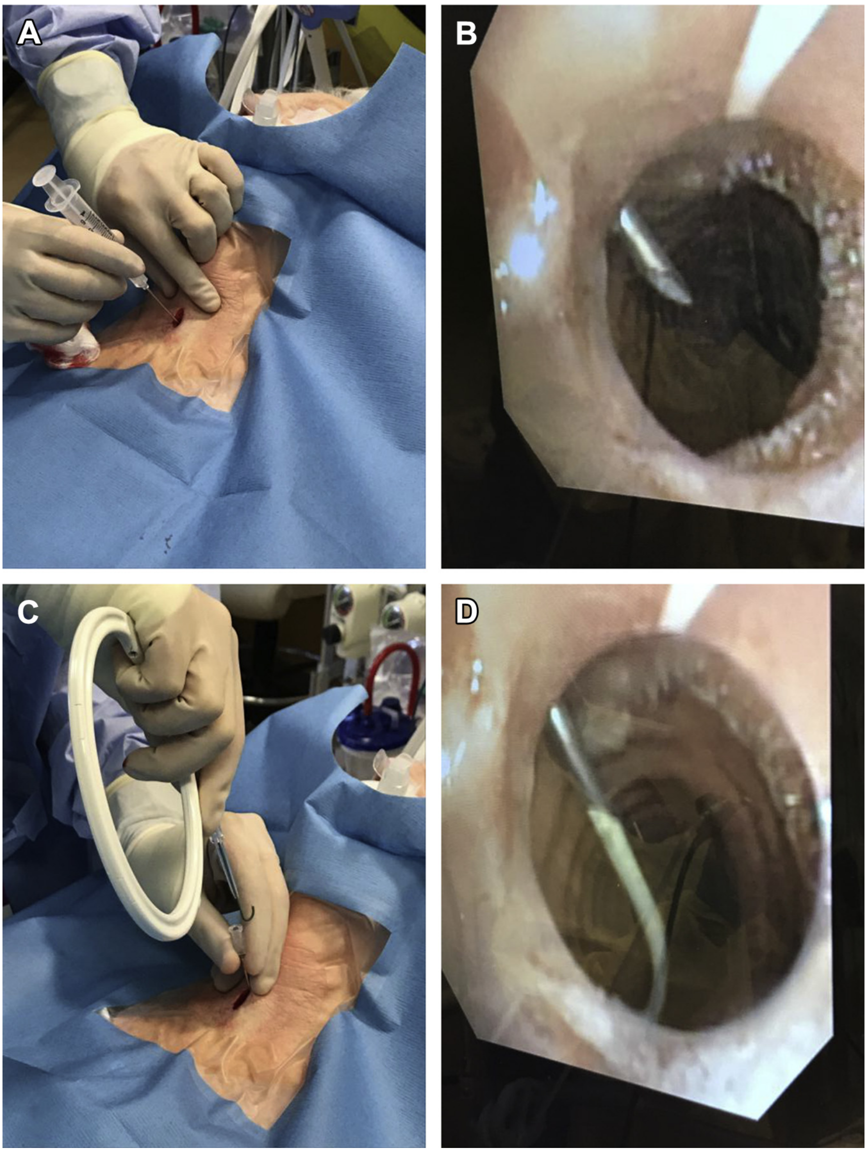


Fig. 6. Performance of PDT, part 2. (*A*) Insertion of introducer needle with (*B*) endoscopic view. (*C*) Insertion of guidewire with (*D*) endoscopic view.

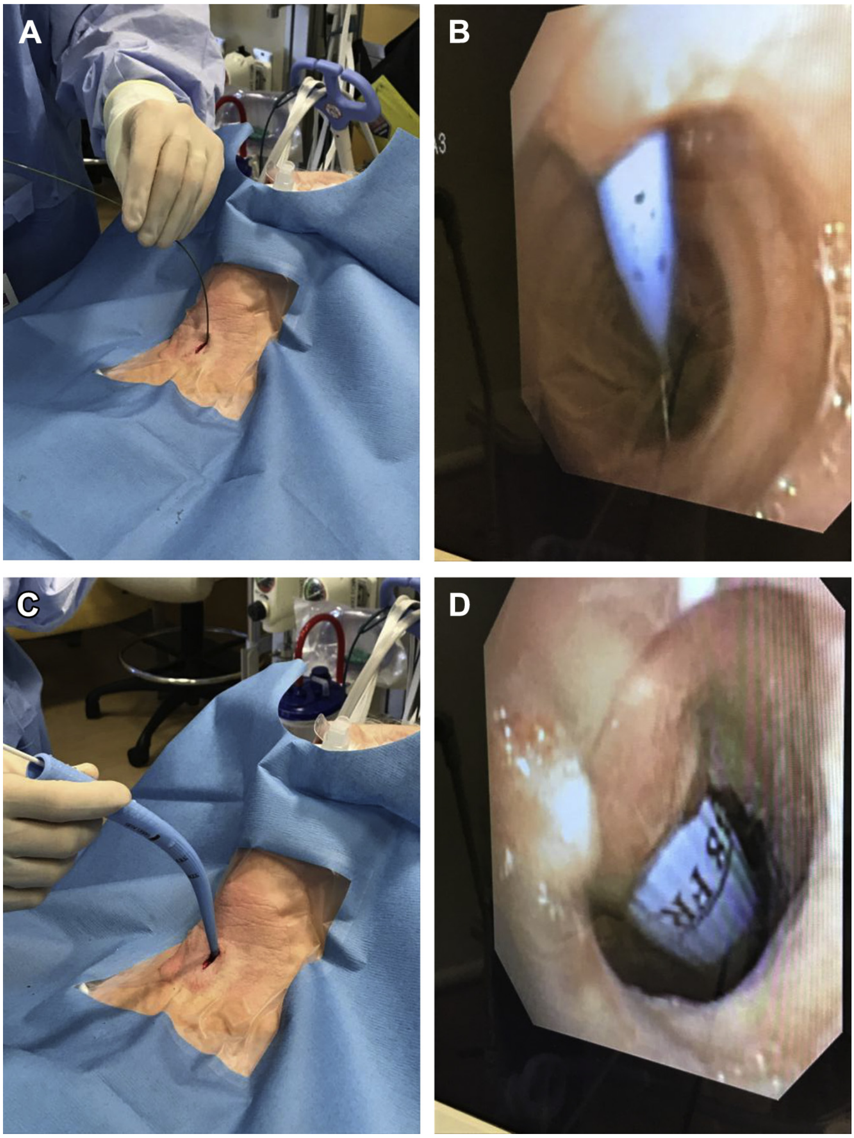


Fig. 7. Performance of PDT, part 3. (*A*) Insertion of a 14F dilator over wire and (*B*) endoscopic view. (*C*) Insertion of dilator and (*D*) endoscopic view.

and early tube displacement within 5 days after placement. Although most bleeding is minor, all forms should be taken seriously because even minor bleeding can be life threatening (due to obstruction or the inability to secure the airway). Conversion to orotracheal intubation should be performed in the setting of a necrotizing wound infection, failure to reestablish adequate ventilation from tube obstruction, and early tube displacement in order to secure airway patency and avoid the risk of a false tract.

Chronic/delayed complications include dysphagia, tracheomalacia, tracheo-innominate artery fistula (TIF), trachea-esophageal fistula, granuloma formation, cellulitis, delayed stomal closure, mucosal wall ischemia/necrosis, and post-tracheotomy tracheal stenosis (PTS). PTS is often thought to be related to damage incurred from the tracheostomy tube itself. Like postintubation tracheal stenosis, a variety of mechanisms have been implicated, including cuff pressure necrosis, traumatic injury at time of placement, prolonged irritation to the tracheal wall by the tracheal tube tip, or frequent suctioning.

Bleeding is both an acute and delayed complication of PDT. Bleeding rates have been reported to be 0.6% to 5.0%, most of which are minor.[44] Early bleeding (within 48 hours of tracheostomy tube placement) is mostly from superficial veins.[45] The operator can make several adjustments to

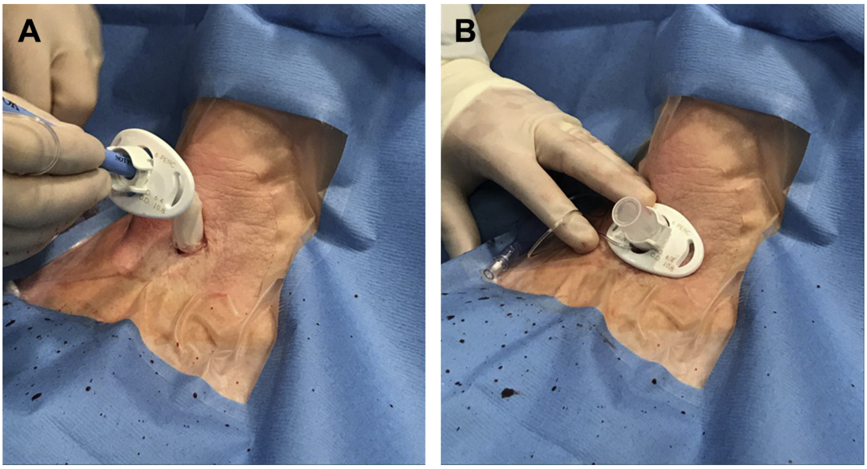


Fig. 8. Performance of PDT, part 4. (*A*) Insertion of tracheostomy tube over introducer. (*B*) Tracheostomy tube in final position.

reduce the risk of stomal bleeding during the procedure: minimize the incision length at the site of entry, use lidocaine with epinephrine, and secure the flange (neck plate) firmly around the tracheostomy tube to the neck. In addition, most superficial bleeding can be controlled by packing the site with hemostatic gauze, reversing any underlying coagulopathy, and/or administering desmopressin if patients are uremic.

TRACHEO-INNOMINATE ARTERY FISTULA

TIF formation is among the most feared complications of PDT and can be fatal if not recognized early. It can appear as both an acute or delayed form of bleeding. TIF is a medical emergency with an estimated mortality rate greater than 80%.[46] Although rare (occurring in <1% of all PDT and surgical tracheostomies[46]), most occur as self-limited mild bleeding 1 to 3 weeks after tracheostomy, followed by sudden massive hemorrhage several hours later.[47] The initial mild bleeding episode, which can occur within the tracheostomy tube or around the tracheostomy site, is often termed a *sentinel bleed*. If patients are suspected to have a TIF, but are clinically stable, CT of the neck with contrast can help confirm the diagnosis.

The mechanism by which TIF occurs is generally thought to be due to erosion from either the cuff or tip of the tracheostomy tube. Risk factors for TIF include high cuff pressures, low tube insertion sites, and repetitive head movements.

Once recognized, prompt surgical attention is vital in the initial management. Patients should be evaluated in the operating room (OR) for immediate repair before any significant bleeding develops. If active or severe hemorrhage is already present, the tracheostomy tube should be removed and patients orally intubated with an ETT, placing the inflated cuff distal to the bleeding source. Using a finger inserted into the stoma, digital pressure can be applied with anterior force while patients are transported to the OR for repair.

Because the innominate artery typically crosses the trachea 9 to 12 rings (4–8 cm) below the cricoid, risk can be reduced by ensuring the tracheostomy stoma is above the third tracheal ring. In addition, care should be taken to keep tube cuff pressures less than 25 mm Hg in order to reduce the development of focal ischemic necrosis.[48,49] Once ventilation is no longer required, consideration can be made for changing to an uncuffed tube, downsizing the tube, or removing it entirely.

POST-TRACHEOSTOMY MANAGEMENT

Post-tracheostomy management includes considerations regarding nursing care, respiratory care, tube cuff pressure, secretion management, speech, nutrition, and tube changes. The wound should be kept clean and dry. Tube cuffs require routine monitoring to maintain pressures in the range of 20 to 25 mm Hg.[44] Cuff pressures greater than 25 to 35 mm Hg risk mucosal injury. Patients' head should be elevated to 45° during periods of tube feeding to minimize aspiration risk, and any oral feeding should be supervised by a caregiver to assess for aspiration. Those with prolonged illness or concern for swallowing dysfunction should first undergo formal swallow evaluation before oral feeding is commenced.

Tracheostomy tube change is a routine part of the long-term management. Indications for changing a tracheostomy tube include (1) the first change (by convention often after 7–14 days after placement); (2) to reduce the size of the tube on the path to decannulation; (3) to change the tube in the case of malposition, cuff leak, or tube fracture; and (4) as a routine change (often every 60–90 days to limit granulation tissue formation, minimize biofilm accumulation, and prevent degradation of the tube).[50,51]

Within the first 5 to 7 days, it is generally recommended that the tracheostomy outer cannula remain secured in place without removal in order to allow for the cutaneous-endotracheal tract to mature.[44] Changing the outer cannula within this early period carries a risk of collapse of the cutaneous-endotracheal tract and loss of airway. The first 48 hours after placement is considered a "dangerous period" for tube change, and "changes should not be undertaken without adequate emergency equipment and illumination similar to that available for the initial procedure."[52] The risk of airway loss during tracheostomy tube exchanges can be minimized by delaying the procedure if there are factors that prolong tract immaturity (ie, steroid use, poor wound healing), keeping a smaller tracheostomy tube at the bedside, and considering the use of an exchange catheter or bronchoscope in higher-risk cases.[50] If the tracheostomy tube completely dislodges within the first week following placement, some algorithms call for orotracheal intubation with cuff placed distal to the stoma.[47,53] After the airway is secured, the stoma can be redilated and the tube replaced in a controlled setting.

SUMMARY

Although tracheostomy has been described for centuries, it has only come into routine clinical use within the last 100 years when the procedure was established to be safe and beneficial. Tracheostomy tubes can be inserted surgically or percutaneously. Tracheostomy is performed for upper airway obstruction, though more often to allow prolonged mechanical ventilation in place of ETTs. A major benefit over ETT ventilation includes improved comfort and mobility. The timing of the tracheostomy is controversial; however, many centers recommend consideration after 10 to 14 days of intubation in patients expected to remain ventilator dependent. Preparation, performance, and postoperative management for PDT are best provided by a multidisciplinary team. Although PDT is a safe procedure in the hands of experienced operators, both early and late complications can arise. A major, albeit rare, complication is TIF. TIF requires early recognition given its high mortality rate. The use of ultrasound for preoperative screening and intraoperative guidance may be helpful; however, the data are limited. Tracheostomy tube change is a routine part of post-tracheostomy management. One must also take caution during early tracheostomy tube exchange (especially within 7 days), given that immaturity of the stomal tract can risk loss of the airway.

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