Percutaneous Dilatational Tracheostomy

9

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Abbreviation List

ACF	Anterior cervical spine fixation
AORN	Association of periOperative Registered Nurses
BMI	Body mass index
BVM	Bag-valve-mask
Cm	Centimeter
CPP	Cerebral perfusion pressure
DDAVP	Desmopressin acetate
ET	Endotracheal tube
FFP	Fresh frozen plasma
FiO_2	Fraction of inspired oxygen
ICP	Intracranial pressure
INR	International normalized ratio
kg	Kilogram
m^2	Meter squared
mcg	Microgram
mg	Milligram
min	Minute
ml	Milliliter
mm	Millimeter
mm Hg	Millimeter of mercury
MV	Mechanical ventilation
PDT	Percutaneous dilatational tracheostomy
PEEP	Positive end expiratory pressure
PTT	Partial thromboplastin time
RCP	Respiratory care practitioner
RN	Registered nurse

9.1 Introduction (Fundamentals)

The endotracheal tube is the preferred method for airway maintenance in the short duration. Poor patient comfort and airway complications limit its long-term utility, leading to an increase in the need for tracheostomy for both airway protection and chronic respiratory failure [1]. As a result, Cook Critical Care (Bloomington, IN) collaborated in the development of a single-use bedside percutaneous dilatational tracheostomy (PDT) kit [2]. Since that time, several devices have been developed from a variety of manufacturers, with slight variations in both technique and methodology [3].

PDT is now a commonly performed critical care procedure. It has fewer complications than traditional open tracheostomy and has gained wide acceptance as the preferred method for semi-elective and elective tracheostomy [4]. When compared to open tracheostomy, PDT has the benefit of bedside placement with less perioperative complications [5]. Bedside placement

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requires fewer resources and completely eliminates the need for transport of critically ill patient, which, in this population, carries a "mishap" rate of 33 % [6]. Avoiding the operating room also eliminates financial and time expenditures (including room times and personnel) which can also reduce cost [7, 8].

Advanced care providers of critical care services should be capable of performing PDT with attending oversight. Though uncomplicated in experienced hands, airway-related complications can be disastrous. Proper patient selection, meticulous attention to technique, proper practitioner training, and education are crucial to maximize success. PDT requires at least two trained proceduralists working together, and both must possess appropriate experience before independent involvement in either the cervical operator or the bronchoscopist role. In experienced hands, PDT is a better alternative to open tracheostomy with fewer procedural complications and equivalent long-term outcomes.

9.2 Indications

PDT is indicated in patients who require long-term airway management and/or protection or in patients who are unable to wean from mechanical ventilation via endotracheal tube. Many approaches are documented on the timing of tracheostomy, but consensus exists that patients should undergo tracheostomy if mechanically ventilated for, or anticipated to require mechanical ventilation for, longer than 10–14 days [9–12]. Particular patient populations, including those with severe stroke or traumatic brain injuries, have been shown to benefit from earlier tracheostomy [13, 14].

9.3 Contraindications

PDT is a very well-tolerated procedure, but there are some patients who may not be ideal candidates. Concerns about tracheostomy site, body habitus, concurrent injury, or overall medical condition may contribute. Relative contraindications include:

- Infection or skin/soft tissue pathology at tracheostomy site.
- Hemodynamic instability—initiation of analgesics, anxiolytics, and paralytic medication may result in irreversible hypotension.
- BMI > 35 kg/m^2—larger patients may have pre-cervical soft tissue that is too thick for the standard tracheostomy tube to traverse, resulting in incomplete or poor cannulation of the trachea and high risk for inadvertent decannulation; extra long tracheostomy tubes may be required.
- Cervical spine instability and/or fracture—to minimize the risk of complications such as pneumonia, early tracheostomy should be attempted once patients are medically stable [15]. Ordinarily, hyperextension facilitates landmark identification and palpation of the first few tracheal rings; in the absence of hyperextension, percutaneous method should be aborted unless landmarks are clearly identifiable. Removal of the rigid cervical collars should only be performed after chemical paralysis and in-line spine stabilization. In patient requiring anterior cervical instrumentation/fixation (ACF), tracheostomy can safely be performed as soon as 2 days after surgery. In a retrospective review of 1184 ACFs, 1.7 % of patients required postoperative tracheostomy which resulted in no documented postoperative wound infections [15]. Similarly, Northrup revealed that ACF can also be performed safely *after* tracheostomy with similar safety [16].
- Previous tracheostomy—PDT may still safely be performed utilizing the same tract. However, tissue bleeding can be more difficult to control, so dissection should be avoided.
- Elevated intracranial pressure—early tracheostomy in traumatic brain injury has been demonstrated to be beneficial, but maintaining intracranial pressure (ICP) <20 mmHg and cerebral perfusion pressure (CPP) >65 mmHg is important to avoid secondary brain injury. Patients should initially be evaluated by lowering the head of bed to flat and reassessing ICP and CPP with the patient in the supine

position; if elevation of ICP occurs and compromises cerebral perfusion, the procedure should be postponed.
- Severe hypoxemia—patients who require PEEP >10 cmH_2O or FiO_2>0.60 to prevent hypoxia should have PDT postponed. Changes in mean airway pressures and alveolar recruitment could occur during percutaneous tracheostomy or bronchoscopy, resulting in worsening hypoxia.
- Coagulopathy—patients with coagulopathy (INR >1.5) should be treated with fresh frozen plasma, factor concentrates, or other therapies either before or during the procedure. Thrombocytopenia of <50,000/mm^3 should be treated with platelets or desmopressin acetate (DDAVP) as clinically indicated.
- Unfractionated heparin infusion—the infusion should stop 3–6 h prior to starting the procedure to allow for normalization of the partial thromboplastin time (PTT). It is also prudent to reassess PTT prior to the procedure. Following PDT, it is safe to restart the heparin infusion within the first 3–6 h post procedure.

In addition, the manufacturers [2] include contraindications to the percutaneous method, including:

- Emergent airway settings
- Thyromegaly
- Non-palpable cricoid cartilage/absent landmarks
- Pediatric patients
- Non-intubated patients
- Positive end expiratory pressure (PEEP) >20 cmH_2O
- Uncorrected coagulopathy

9.4 Resources Required

Though PDT does not require the logistics and resources used in an open tracheostomy, two capable proceduralists are necessary. One proceduralist is responsible for the bronchoscopy and orotracheal airway management, while the second proceduralist is responsible for the tracheostomy procedure. In addition, a respiratory care practitioner (RCP) is required for maintaining the existing airway as well as changing endotracheal tube position as needed during the procedure. Some RCPs prefer to ventilate by bag-valve-mask device; however, mechanical ventilation can be used as long as the RCP remains at the bedside. An experienced ICU nurse (RN) is also required to administer medications, maintain accurate documentation, and assure the patient's monitoring and ICU level of care are unperturbed.

9.4.1 Monitoring

As in any critical care setting, patients must be maintained on continuous telemetry with a bedside monitor. Vital sign assessments and monitoring should be performed frequently during the bedside procedure, which is essential to avoid morbidity or mortality. Oxygen saturation, heart rate, and blood pressure should be monitored continuously. End-tidal carbon dioxide monitoring is helpful to confirm adequate ventilation. Monitoring equipment integrity must be considered before beginning the procedure.

Pulse oximetry should be utilized continuously. Poorly attached probes, dysfunctional devices, and diaphoretic patients could result in inaccurate data and should be remedied prior to any airway manipulation. Additionally, any variation in oxygen saturation should be met with immediate attention. A bronchoscope in the endotracheal tube can increase airway pressures which can result in low tidal volumes, hypoventilation, and hypoxia. Preemptive hyperoxygenation is important to minimize desaturation. Any decrease in oxygen saturation should be met with immediate cessation of bronchoscopy, removal of bronchoscope, and reassessment of the patient. If oxygen saturation does not return to baseline, consideration should be made to abort the procedure and reassess the patient.

Heart rate is an important indicator of pain and/or anxiety in a paralyzed patient. Analgesics and sedatives should be dosed reasonably and judiciously with any indication of pain. Bradycardia is an ominous sign if associated with hypoxemia or pulse oximetry that has been

interpreted as "not accurate." If bradycardia occurs, abort the procedure and reevaluate the airway immediately. Bradycardia can also be a response to vagal stimulation, especially in patients with spinal cord injury and/or brain injury. Patients with neurological injuries may benefit from chronotropes or vasopressors.

Blood pressure must also be continuously monitored. Hypertension is most commonly associated with pain or agitation and should be treated with analgesia or sedation. Hypotension is a common response to sedation and paralysis and usually responds to a fluid bolus. Significant hypotension should be met with a head-to-toe patient examination, evaluating for other diagnoses, including complicating pneumothorax or hemorrhage. Frequently, patients may become hypotensive immediately following the procedure as stimulation is minimized. This often resolves after sedation is lightened.

9.4.2 Equipment

- Cook Critical Care (Bloomington, IN) Ciaglia Blue Rhino® percutaneous tracheostomy tray.
- Shiley™ percutaneous tracheostomy tube with disposable inner cannula.[1]
- Sterile gowns and full barrier precaution devices, including gloves, cap, and mask for each participant.
- Chlorhexidine solution applicator device.
- 15 mm angled dual-access swivel adaptor.
- Bag-valve-mask (BVM) apparatus.
- 5 mm or smaller bronchoscope with cart, screen imaging is required given the need for both providers to visualize the trachea.
- Bedside table.
- Towel, pad, or other "rolls" to assist with hyperextension (unless contraindicated).
- Sterile water, approximately 100 ml.

In addition to the list above, an intubation tray and a surgical/open tracheostomy tray should be available.

9.5 Performing the Procedure

The Cook Critical Care (Bloomington, IN) Ciaglia Blue Rhino® Advanced Percutaneous Tracheostomy Set and technique will be explained here. Other devices, including the Portex® Griggs Forceps Kit, Cook Critical Care® Blue Dolphin Kit, Surgitech/Fresenius (Runcorn, Cheshire, UK) Rapitrach, and Rusch-Thermo Fisher® (Waltham, MA) PercuTwist (2002), each have similar yet distinct techniques.

Before any procedure is undertaken at the bedside, a formal "time-out procedure" should be performed. A "time-out procedure" consists of correctly stating the patient's identity (with name band and medical record number), confirms the exact procedure, and verifies procedural consent with providers. This not only identifies the patient but also demonstrates a unified goal for the team of providers.

Step 1: After proper patient selection, patient or proxy authorization, and site marking, a briefing is held to assure proper equipment, personnel, documentation, and other needs are met (according to institutional standard). Subsequently, the institutional Association of periOperative Registered Nurses (AORN) recommended "time-out" is performed. Once the time-out is complete, the patient may undergo supplemental sedation. Propofol (initially 0.05–0.5 mg/kg IV initial bolus with maintenance of 25–50 mcg/kg/min) or intermittent midazolam bolus (1–2 mg intravenous given every 3–5 min) should be used initially to achieve adequate sedation. Once sedation is at an appropriate level, analgesia should be provided with opiate analgesia, such as fentanyl (0.5–2 mcg/kg dosed every 3–5 min). Once a stable sedation level is achieved and patient's vital signs remain stable, a single dose of cisatracurium besylate (0.15–0.2 mg/kg IV) is recommended for chemical paralysis. Fentanyl is recommended for its short duration of action with minimal hemodynamic effects. Propofol is preferred for its short half-life, but patients may become hypotensive due to its vasodilatory

1 *The Shiley™ brand is specially designed for compatibility with the Blue Rhino insertion kit, including a tapered distal tip and inverted cuff shoulder for easier insertion* [2].

effects, especially in those with severe inflammatory response or distributive shock. After initiation of the procedure, further doses of analgesia or sedation should be provided every 3–5 min based upon perceived pain and agitation.

Step 2: The patient and bed position are both important. The patient's headboard should be removed if present, and the bed must be moved to provide space to accommodate both the bronchoscopic provider and respiratory care practitioner. The right-handed cervical operator should be positioned at the patient's right and on the left for the left handed. After the stable anesthetic plane is established, the head of bed is lowered so the patient is in a supine position, and a rolled pad or towel is placed beneath the patient's scapulae with sufficient elevation to permit hyperextension (Fig. 9.1). The occiput should remain on the mattress, foam ring, or small pillow. Absorptive pads should be used to avoid spillage of blood, preparatory solution, or irrigation on the bed linens. Hyperextension allows for slight cephalad projection of the trachea, permitting palpation of the tracheal rings. Reexamination of the neck should be performed by inspection and palpation. A systematic approach is best: palpate the thyroid cartilage and move inferiorly in a stepwise fashion locating the cricothyroid membrane, the cricoid cartilage, and the first and second tracheal rings. The ideal location for the needle puncture will be either in the first or second tracheal ring interspaces.

Step 3: The bed height is adjusted to accommodate both the bronchoscopist and operator. The bronchoscopist should ready the bronchoscope, including checking for suction and image quality. The operator should ready the PDT tray and equipment by first checking for package integrity and expiration date. The PDT tray is opened and, under sterile conditions, placed on a bedside table or Mayo stand. About 25–50 ml of sterile water is poured into the largest cavity in the Blue Rhino tray (Fig. 9.2). The *EZ-Pass*® hydrophilic coating is activated by sterile water or saline [2]. The operator should cleanse his/her hands and don a sterile gown, cap, mask, and gloves. The properly sized Shiley percutaneous tracheostomy tube is then opened and placed on the sterile tray. The tracheostomy balloon may be tested by institutional or practice standard. The bedside table or Mayo stand may be positioned over the patient for convenient access.

Step 4: The removable inner cannula will usually be found in the tracheostomy when the package is opened—this should be removed and placed in a convenient location, as the patient

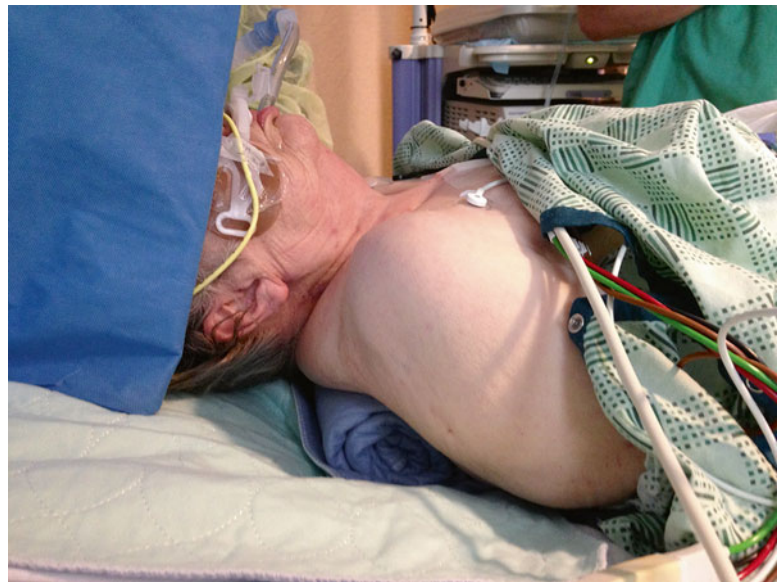

Fig. 9.1 Positioning with shoulder roll

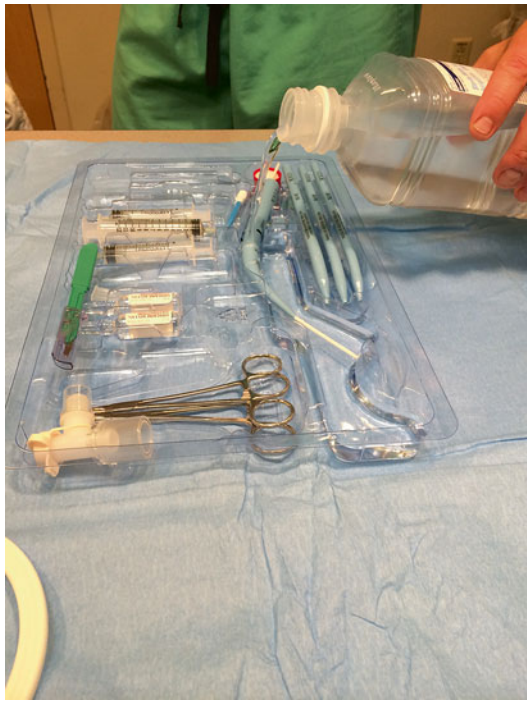

Fig. 9.2 Pouring sterile water onto hydrophilic coated (lubricated) dilator

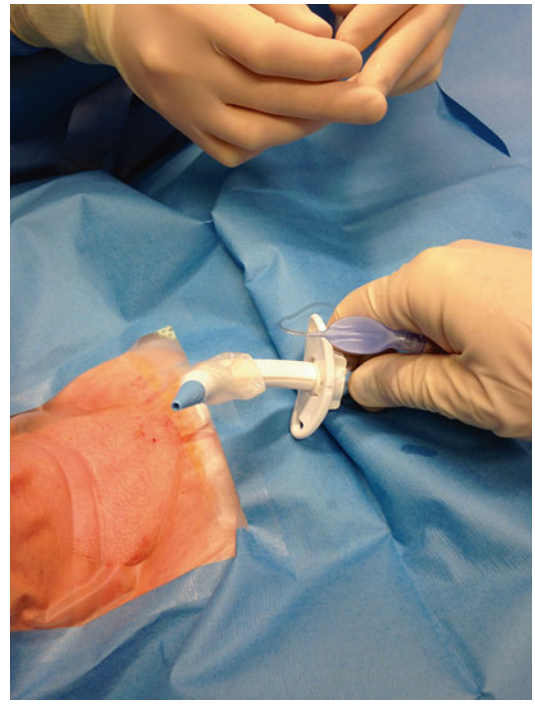

Fig. 9.3 Trach with loading dilator

cannot be ventilated without the inner cannula as a conduit. The tracheostomy tube should then be lubricated and the appropriately sized blue loading dilator inserted to the appropriate distance; approximately 2 cm of dilators tapered end should protrude through the distal portion of the tracheostomy (Fig. 9.3). Three *loading* dilators are included with the Cook PDT kit: 24 French (F), 26 F, and 28 F (Fig. 9.4). They correspond to size 4, size 6, and size 8 Shiley tracheostomy tubes, respectively. The white guiding catheter should be inserted into the narrow end of the Blue Rhino® *taper* dilator until the safety ridge is reached and all should be moistened with water (Fig. 9.5).

The patient's neck is then prepped with chlorhexidine solution and permitted to dry. Then the sterile drape, included in the Ciaglia kit, is applied making certain the center of the hole of the drape is located over the thyroid cartilage and sternal notch (Fig. 9.6).

Step 5: A syringe is prepared with *10 ml of the 1.5 % lidocaine with epinephrine* which is located in the disposable tray. Secure the 25

Fig. 9.4 Loading dilators

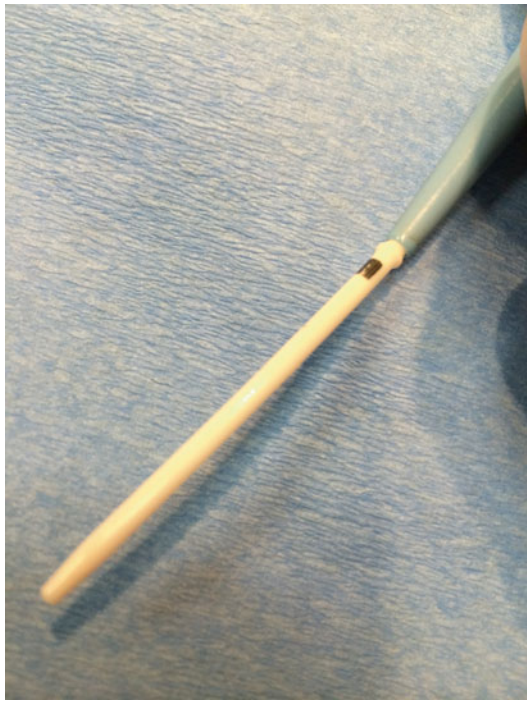

Fig. 9.5 Guiding catheter within tapered dilator

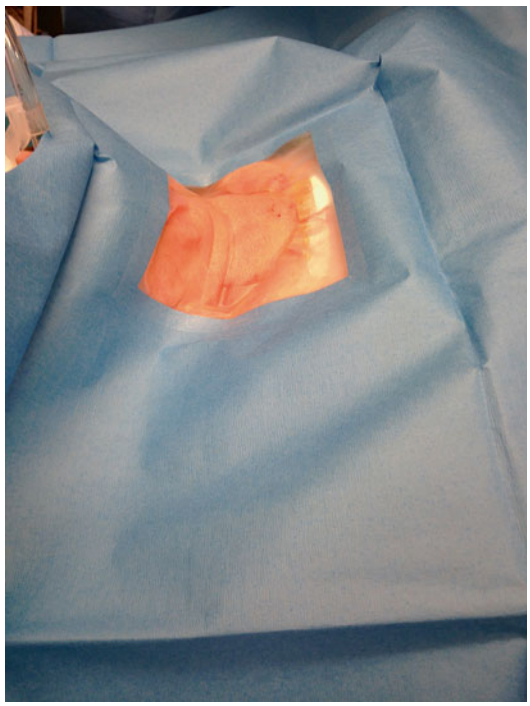

Fig. 9.6 Neck prepped and draped

gauge needle in place on this syringe. All sharps should be secured in the red and white foam sharp device cup.

Step 6: With the patient adequately sedated and paralyzed, the respiratory care practitioner should remove the patient from mechanical ventilation (MV) and manually ventilated with 100 % inspired oxygen. A 15 mm dual-access angled swivel adaptor should be attached to the endotracheal tube to allow for bronchoscopy and ventilation simultaneously.

Step 7: The bronchoscopist will apply a small amount of water-soluble lubricant to the scope shaft. The RCP will secure the endotracheal tube (ET) during the bronchoscopy. Prior to initiation of the procedure, the bronchoscope is advanced through the ET to the level of the carina. This will confirm that the bronchoscope could be advanced through the ET conduit. Significant secretions or concretions should be noted. Care should be taken not to injure the tracheal mucosa. Formal bronchoscopy is delayed until after tracheostomy is completed. During the procedure, the bronchoscope should be left within the endotracheal tube lumen and should only be utilized during the actual procedure to avoid hypoventilation and hypoxia.

Step 8: With the airway now secure, landmarks are identified, including the sternal notch, cricoid cartilage, etc. With the nondominant hand's thumb and middle finger, the trachea is secured in the midline, allowing use of the index finger to palpate the tracheal rings. First, inject 5–10 ml of the local anesthetic. Skin bleeding is usually minimized with an epinephrine-containing solution. Then, a vertical incision is made, approximately 1.5–2 cm in length, through the skin only, avoiding the deeper structures of the neck. This incision is centered about 2–3 cm superior to the sternal notch. A vertical incision is chosen to provide flexibility in the final location of the tracheotomy. This vertical incision allows for extension in either direction if needed. It can also avoid skin bleeding as most skin vascular structures are vertically located.

Step 9: Once the incision is completed, the thumb and middle finger of the operator's nondominant (superior) hand are placed on either side of the incision and used to center the trachea

in the midpoint of the incision and visualize soft tissues (Fig. 9.7). To better palpate the tracheal rings, some prefer to develop a small plane through the soft tissues of the neck using a small hemostat. In order to avoid unnecessary bleeding, dissection should be midline, minimal, controlled, and blunt (Fig. 9.8).

Step 10: The bronchoscopist and respiratory care practitioner work together to withdraw the ET to a level just below the vocal cords. The bronchoscope is first inserted to the level of the carina. Prior to withdrawing the endotracheal tube, transillumination (in a darkened room, withdrawing the bronchoscope from carina to the proximal ET, observe for transillumination in the incision—this measured distance should be noted) can help predict the proper distance to withdraw the ET tube (Fig. 9.9). As a rule of thumb, 18 cm is a reasonable distance to begin in most adult patients. As the respiratory care practitioner prepares to withdraw the ET, the bronchoscopist should readvance the scope so the tip is just above the carina. Caution must be utilized to avoid premature extubation. Without deflating

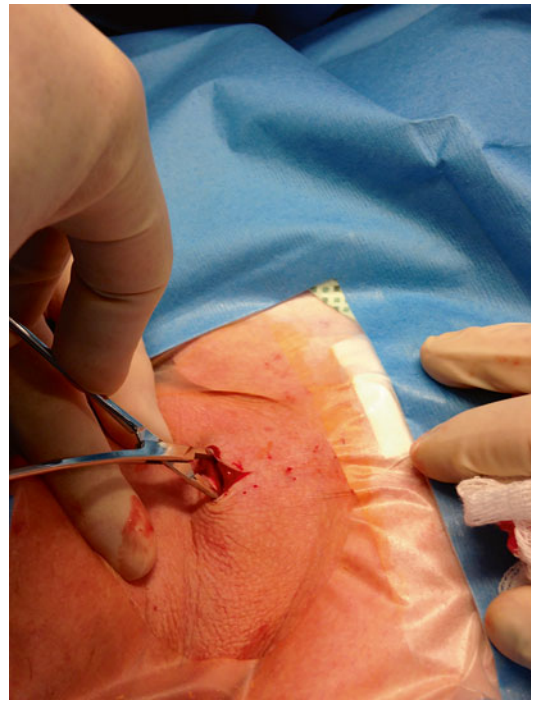

Fig. 9.8 Hemostat dilating soft tissue following skin incision

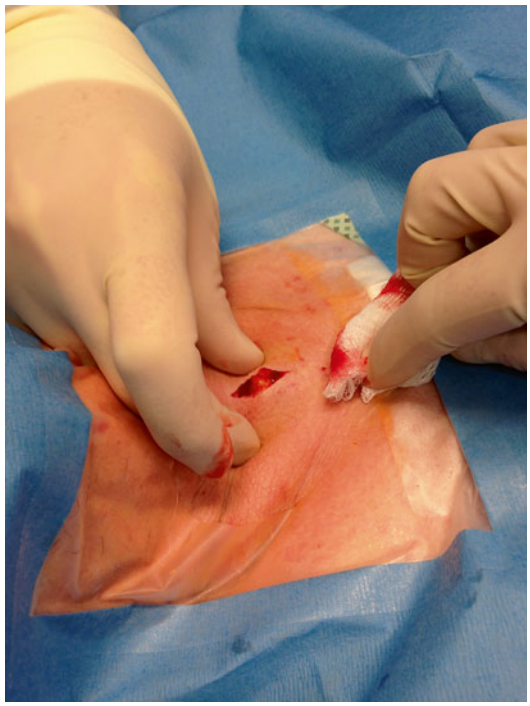

Fig. 9.7 Initial incision

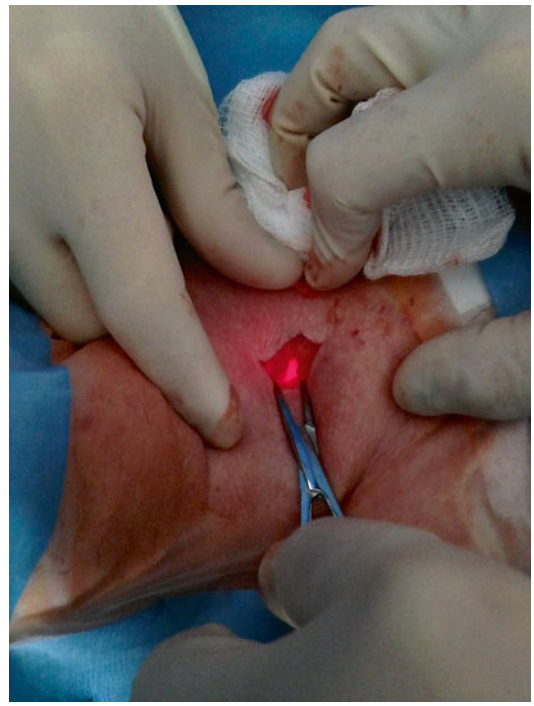

Fig. 9.9 Tracheal transillumination with bronchoscope

the ET tube cuff (to minimize aspiration of oral secretions), the RCP withdraws the ET the measured transilluminated distance. Remember, the bronchoscope should be maintained at the level of the carina during the ET withdrawal process. This allows the bronchoscope to be used as a "bougie" for re-intubation in the event of premature extubation. The RCP should resecure the tube at the new position. Once resecured, the bronchoscope should be retracted into the ET. Maintaining the bronchoscope inside the ET will prevent an inadvertent needle injury to the costly bronchoscope.

Step 11: Now that the incision has been created and the ET in proper position, tracheal puncture with the 15 gauge introducer needle is now performed. The 15 gauge introducer needle may be used without a syringe or may be attached to the hub of a 10 ml syringe containing 2–3 ml of water or saline (this allows for a better grasp of the needle, and bubbles in the syringe may help confirm tracheal placement). With the thumb and middle finger of the non-dominant hand securing the trachea and retracting the skin edges, the index finger of the same hand should be used to identify the landmark of the first or second tracheal ring space. The dominant hand should grasp the needle in the middle of the shaft and placed into the midline of the tracheal incision, aiming inferiorly with the bevel facing up. The tip should be advanced into the trachea with the bronchoscope visualizing tracheal entry (Fig. 9.10). The needle should be advanced into the midpoint of the trachea. Handling the needle in the mid-shaft can prevent deep needle penetration, minimizing posterior tracheal wall injury. The needle should enter the trachea at the 12 o'clock position; however, anywhere from 10 o'clock to 2 o'clock is acceptable. Once the needle is confirmed in the trachea, immediately insert the flexible stainless steel J-wire through the needle, visualizing its entry into the tracheal lumen, and subsequently remove the needle (Fig. 9.11).

Step 12: The blue 14 French introducer dilator (Fig. 9.12) should next be advanced over the wire and passed through the puncture site three times. The wire and introducer dilator are visualized bronchoscopically. The blue 14 French dilator is then removed while leaving the guidewire in place. It is imperative to always maintain control of the guidewire.

Step 13: The large tapered dilator containing the inner 8 French white guiding catheter is then threaded onto the guidewire. When handling the tapered dilator, it should be grasped firmly behind the "skin level" line since the hydrophilic coating makes the distal end of the dilator slippery. It is then advanced over the guidewire and followed bronchoscopically. The white guiding catheter's safety ridge should be abutting the tip of the

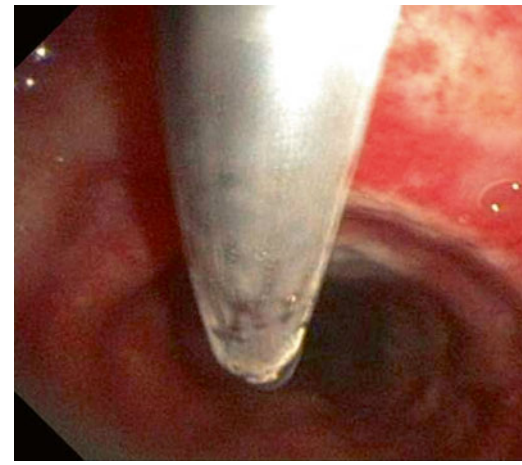

Fig. 9.10 Access needle visualized in trachea

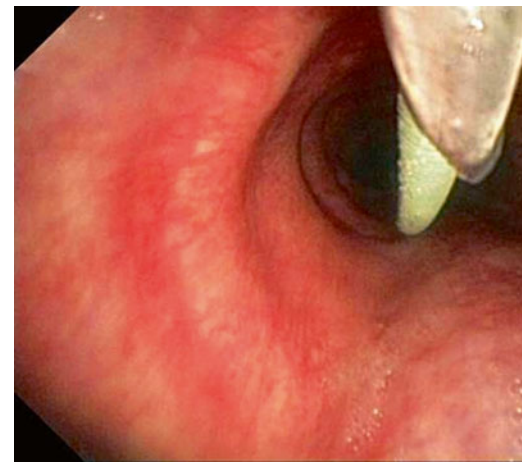

Fig. 9.11 Bronch visualizing wire (*green*) advancing into trachea

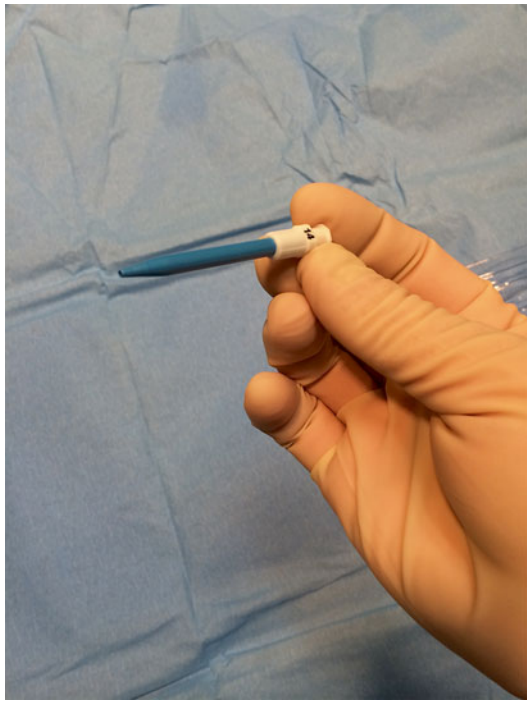

Fig. 9.12 Initial dilator

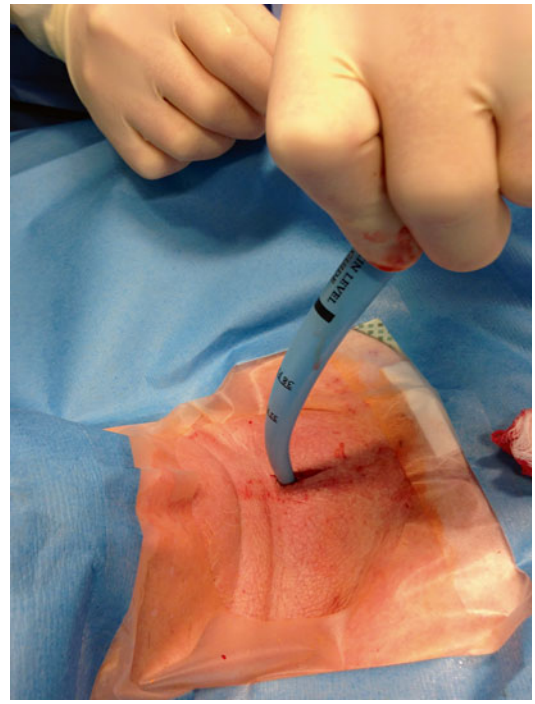

Fig. 9.13 Taper dilator being inserted

tapered dilator (Fig. 9.5). It is important to hold the dilator at a right angle to the puncture site, just as one would angle the suture needle when entering the skin (Fig. 9.13). Advance the dilator until the thick black line on the taper dilator, which reads "skin level," is at the skin level (Fig. 9.14). A second passage with the tapered dilator may be desirable if there is resistance with the initial passage. In patient with large necks, it might be necessary to advance the dilator past the "skin level" mark in order to achieve adequate tracheal dilation. The tapered dilator is then removed, though the white guiding catheter and guidewire *must* be left in place.

Step 14: Once the tapered dilator is removed, advance the tracheostomy tube with blue loading dilator as one unit over the white guiding catheter and guidewire. Again, care should be taken to abutt the saftey ridge of the white guiding catheter to the tip of the loading dilator. With gentle pressure, the tracheostomy/dilator unit should enter the trachea at a right angle, allowing the curve of the tracheostomy to advance naturally. Avoid forcing the device

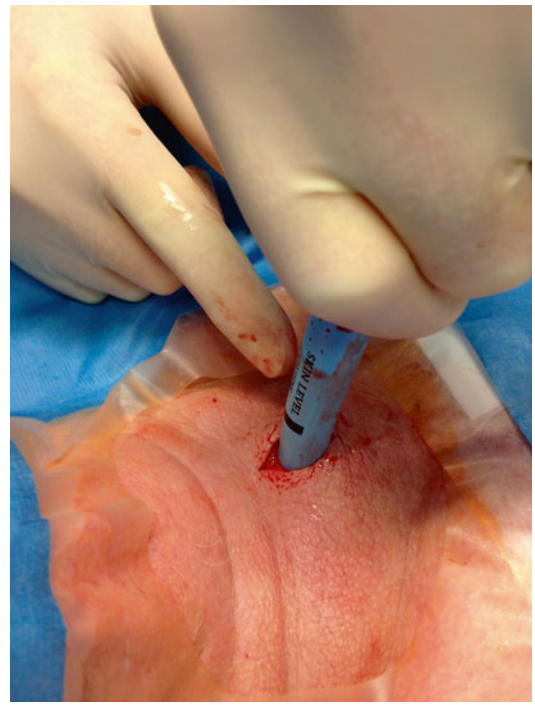

Fig. 9.14 Taper dilator being advanced to skin mark

through the incision, as too much pressure will bend the wire and white guiding catheter, permitting false passage into an extratracheal path or damaging the posterior tracheal wall. There will be some resistance when the deflated cuff of the tracheostomy tube is advanced through the anterior tracheal wall. This will be followed by an immediate loss of resistance. This should always be completed under bronchoscopic guidance confirming the cuff inside the trachea (Fig. 9.15).

Step 15: Once the tracheostomy/dilator unit is in the trachea, the operator should hold the tracheostomy in place while removing the dilator, white guiding catheter, and guidewire. The tracheostomy inner cannula should be immediately inserted and the cuff inflated (Fig. 9.16). The bronchoscope and 15 mm angled swivel adaptor should be removed from the ET and attached to the tracheostomy. Next, the bronchoscope is advanced through the tracheostomy to confirm endotracheal placement above the carina. The operator should secure and maintain control of the tracheostomy at all times.

Step 16: The tracheostomy should be secured appropriately with the institution's preferred securing device. The twill tracheostomy ties should be avoided, as they can result in inappropriately high pressure onto the skin of the neck. Similarly, suturing of the tracheostomy is not recommended as sutures can result in both pressure-related skin changes and ulceration. Additionally, sutures are not proven to prevent tracheostomy dislodgement [17]. If sutures are preferred or dictated by institutional standard, removal is advocated on post-procedure day 3 to avoid pressure-related skin changes.

Once the tracheostomy is secured, the patient should be reconnected to mechanical ventilation. Chest radiography may be the standard at some institutions, though it is not required unless complications or concern arise. Proper placement is confirmed by end-tidal carbon dioxide monitoring, vital signs, physical exam, bronchoscopy, and/or chest radiography. Vital signs should be continually monitored with the post-procedure guideline of the institution.

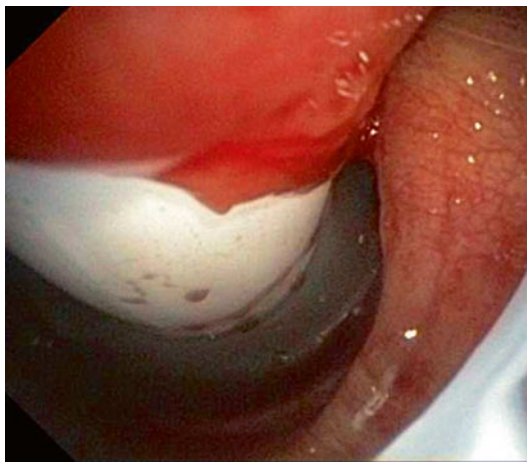

Fig. 9.15 Bronch confirming trach tube balloon within trachea

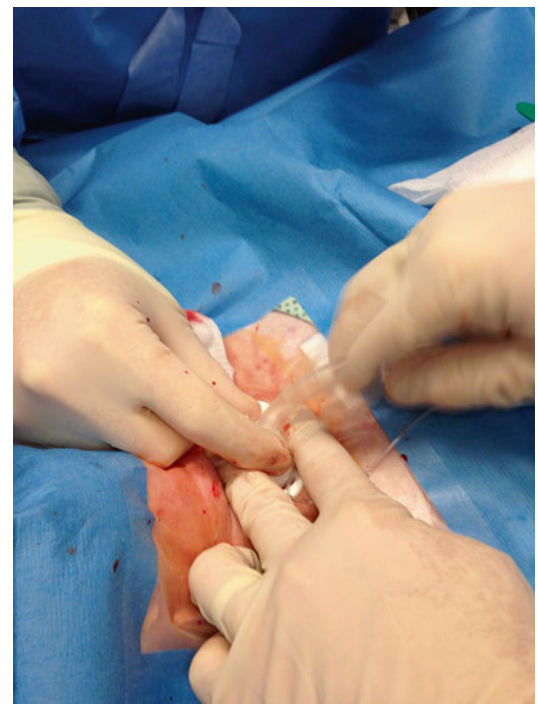

Fig. 9.16 Inner cannulae being inserted

9.6 Procedural Complications

Though percutaneous tracheostomy is a bedside procedure, it is not without associated serious risk. Proper patient selection, training, and experience will avoid most complications. Some complications will occur, including death (0.16–0.4 %), major bleeding (0.1 %), pneumothorax (0.2 %), posterior tracheal perforation (1.6 %), and loss of airway [18, 19]. The experienced use of bronchoscopy minimizes the incidence of airway loss and posterior tracheal wall injury, and though some providers prefer PDT without bronchoscopy, it is highly recommended [20]. Conversion to an open technique should always be available, either at the bedside or the operating room, as it remains the gold standard for tracheostomy.

Minor perioperative complications are quite manageable. The most commonly encountered complication is skin bleeding. If blunt dissection is minimized and bleeding is noted from the skin edge, the insertions of the PT will usually result in tamponade [21]. Visible bleeding is occasionally noted from small anterior skin vessels and may be controlled with 4–0 or 3–0 absorbable suture on a tapered needle.

Hypoxia is uncommon and minimal despite the use of bronchoscopy. If hypoxia occurs, immediate removal of the bronchoscope will usually improve oxygenation. Resume the procedure only when hypoxemia resolves.

9.7 Delayed Complications

Intermediate and late complications are difficult to accurately quantify and are infrequent. Tracheostomy tube occlusion, dislodgement, or cuff malfunction has a combined incidence of 0.3–0.8 % [17, 18]. In the event of tracheostomy dislodgement, secure an airway with either immediate replacement of the tracheostomy or by oral endotracheal intubation. Replacement of a dislodged tube in the first 72–96 h post-op may be met with difficulty in the absence of a defined tract. Oral endotracheal intubation should not be delayed if the tracheostomy cannot be easily and immediately replaced. Smaller-sized tracheostomy or endotracheal tubes may be placed into the tracheostomy site if re-intubation is not immediately available; this should only be performed by experienced providers. Extratracheal placement of a tube cannot only worsen airway obstruction, and it can result in a severe vascular, aerodigestive, or other tissue injuries.

While overall tracheal stenosis rates are noted to be 1.7 % [17], clinically evident tracheal stenosis after PDT has an incidence of 0.16–0.35 %, which is comparable to open surgical tracheostomy [18, 22]. Tracheo-innominate artery fistula is a dreaded, rare complication, with an incidence of <0.35 % [18].

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