Operative tracheotomy

W. Cooper Scurry, Jr, MD, Johnathan D. McGinn, MD

From the Department of Surgery, Division of Otolaryngology–Head and Neck Surgery, Penn State College of Medicine, Penn State Milton S. Hershey Medical Center, Hershey, Pennsylvania.

KEYWORDS
Tracheotomy;
Tracheostomy;
Airway obstruction;
Prolonged ventilation;
Tracheotomy care

Tracheotomy is a surgical procedure in which a tracheocutaneous airway is created in the anterior neck. Tracheotomy may be indicated in many situations such as prolonged endotracheal intubation, acute or chronic upper airway obstruction, bronchopulmonary hygiene, or in certain otolaryngologic surgical procedures. The basic technique and variations are described. Complications and a review of the literature is provided. © 2007 Elsevier Inc. All rights reserved.

Description of operative technique

In the routine, anesthetized, elective tracheotomy, a patient is positioned supine. Surgical landmarks, from superior to inferior, include the thyroid notch, the cricoid cartilage, and the sternal notch (Figure 1). A typical tracheotomy begins with a 2 to 3 cm horizontal incision in a natural, relaxed skin tension line midway between the cricoid cartilage and the sternal notch. A shoulder roll should provide moderate extension of the neck. Overextension of the neck can lead to narrowing of the airway or unintentional low placement of the tracheotomy. Local infiltration is performed with 1% lidocaine with 1:100,000 epinephrine for the purpose of vasoconstriction. After incision, electrocautery is then used to dissect through the subcutaneous fat. Cervical lipectomy may be performed, if it is deemed to be helpful in the obese patient and to help prevent postoperative fat necrosis. The platysma is divided, although the platysma is often thin in the midline of the neck. A midline raphe between the strap muscles should be identified. Dissection should then proceed in a vertical fashion through the raphe. Retractors are used bilaterally to retract strap musculature laterally, and a finger should be placed in the right inferior aspect of the wound bed to identify and prevent potential injury to a high riding innominate artery. Exact midline dissection continues until the thyroid gland is encountered (Figure 2). In the young adult, the thyroid gland can be retracted superiorly, however most often the isthmus must be divided. After division of the thyroid gland, the pretracheal fascia is encountered. Loose fascia is bluntly removed from the anterior trachea and the cricoid cartilage should be palpated superiorly. Exposure of the trachea can be dramatically improved...
by placing a single sharp hook into the cricoid cartilage and pulling in an anterosuperior direction.

At this point in the operation, the anesthesia team is alerted to remove tape or ties from the endotracheal tube and secure it manually. The inspired fraction of oxygen should be reduced if possible. The cuff of the endotracheal tube is deflated to limit the chance of balloon rupture during the tracheotomy in the event the endotracheal tube must be utilized to ventilate the patient again during the procedure. Tracheotomy is then planned between the second and third tracheal rings. Finger palpation of the cricoid cartilage should be used to verify the location of each tracheal ring (Figure 3).

After tracheotomy, the endotracheal tube is pulled back superiorly until the surgeon sees the tip of the tube just above the level of the tracheotomy. A tracheotomy tube with its obturator is then inserted into the trachea, the obturator is removed, the inner cannula is inserted, the cuff on the tracheotomy tube is inflated, and the respiratory circuit is connected to the tracheotomy tube. All retractors and the endotracheal tube are left in place while the anesthesia team assures that the patient can be adequately ventilated via the tracheotomy tube. This is done by bilateral chest auscultation and confirmed return of carbon dioxide from the respiratory circuit. After affirmation of accurate placement of the tracheotomy tube, retractors can be removed and the tracheotomy tube secured by suture to the skin of the anterior neck in the four corners of the tracheotomy tube flanges. The tracheotomy tube is also secured by means of a tracheotomy tie around the neck. The endotracheal tube may be removed after securing the tracheotomy tube. The tube is maintained until this point to allow for readvancement of the tube if the airway is lost during the procedure.

### Table 1: Indications for tracheotomy

<table>
<thead>
<tr>
<th>Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper airway obstruction with any of the following:</td>
</tr>
<tr>
<td>Stridor</td>
</tr>
<tr>
<td>Air hunger</td>
</tr>
<tr>
<td>Retractions</td>
</tr>
<tr>
<td>Obstructive sleep apnea with documented arterial desaturations</td>
</tr>
<tr>
<td>Bilateral vocal cord paralysis</td>
</tr>
<tr>
<td>Previous neck surgery or throat trauma</td>
</tr>
<tr>
<td>Previous neck irradiation</td>
</tr>
<tr>
<td>Prolonged or expected prolonged intubation</td>
</tr>
<tr>
<td>Inability of patient to manage secretions, including the following:</td>
</tr>
<tr>
<td>Aspiration</td>
</tr>
<tr>
<td>Excessive bronchopulmonary secretions</td>
</tr>
<tr>
<td>Facilitation of ventilation support</td>
</tr>
<tr>
<td>Inability to intubate</td>
</tr>
<tr>
<td>Adjunct to manage head and neck surgery</td>
</tr>
<tr>
<td>Adjunct to manage significant head and neck trauma</td>
</tr>
</tbody>
</table>

---

**Figure 1** Surgical landmarks and skin incisions.

**Figure 2** Lateral retraction of the strap musculature.

**Figure 3** Cricoid hook providing retraction and finger palpation of landmarks.
Postoperative details

Patients should normally be monitored in an intermediate or intensive care setting with continuous pulse oximetry overnight after tracheotomy. Careful, frequent tracheal suctioning via the tracheotomy should be ordered, and nurses should be familiar and comfortable with the care of the tracheotomized patient. The tracheotomy tube obturator should remain with the patient at all times before the first tracheotomy tube change. Cervical tracheotomy tube ties should not be removed or replaced by nursing staff until after the first tracheotomy change. First tracheotomy changes are performed on postoperative days 5 to 10. Tracheotomy changes are not usually performed before this time so that the newly formed tracheostome has time to mature. Such delay reduces the risk of replacement of the tube into a false passage. Unintentional displacement of the tracheotomy tube during the initial few days may best be treated by the available intensive care unit staff via oral endotracheal intubation, if appropriate to the patient’s clinical situation. Attempts to replace a “fresh” tracheotomy by inexperienced personnel may create false passages and delayed re-establishment of the airway. A displaced tracheotomy tube may be later replaced in a controlled fashion if the airway is reestablished by oral intubation. Patients with tracheotomies should be provided constant humidification. Saline bullets are often required with suctioning to prevent or break up mucus plugs.

Variations in technique

Skin incision

For elective tracheotomy, a horizontal skin incision made in a natural skin crease will typically heal in a less-conspicuous fashion. A vertical incision in the skin should be considered in an emergency tracheotomy because few major blood vessels will transverse the incision (ie, vessels vertically oriented). If the surgeon begins the operation in the midline with a vertical incision and then stays in the midline throughout the dissection, less bleeding should be encountered. Such an incision should extend from the level of the cricoid cartilage 3 cm inferiorly.

Tracheal incision

After a horizontal incision is made in the anterior tracheal wall, a tracheotomy punch device can be used to place an oval shaped hole in the trachea. This “window” resection may alternately be performed with an 11 blade scalpel and/or scissors (Figure 4).

A vertical tracheotomy often is used when the surgeon wishes to increase security by placing tracheal stay sutures; such sutures are placed around one or two tracheal rings in the anterior tracheal wall immediately lateral to the vertical tracheotomy. These sutures are left long enough to tape to the anterior chest wall (Figure 5). The sutures should be well labeled, such that in the case of a tracheotomy tube change or displacement of the tracheotomy tube, these sutures can be used to pull the trachea anteriorly and the tracheotomy tube can be more readily replaced without entering a false passage. This may be particularly helpful in children and the obese patient.
Alternatively, an inferiorly based trap-door flap may be created in the anterior trachea by creating two vertical incisions from the lateral extents of the tracheotomy. This “Bjork flap” can be reflected anteriorly and sewn to the inferior aspect of tracheotomy wound thus creating a more long term stoma (Figure 6). In one report of 95 patients, tracheotomy tubes were left in situ for a median of 5 days (range, 1-17 days) and after decannulation subsequent stoma closure was uneventful, 60% healing within 1 week. No patient developed tracheal fistula, clinical tracheal stenosis or cosmetically unacceptable scarring.4 Additionally, this measure may theoretically reduce the chance of false passage creation should the tracheotomy tube require replacement before maturation, as the tracheal flap closed the midline pretracheal space.

**Thyroid isthmus**

Because bleeding is the most common complication surrounding tracheotomy and the thyroid gland’s isthmus typically rests on the anterior tracheal wall at the planned tracheotomy location, the thyroid isthmus must be managed in a hemostatic manner. Though some authors recommend Heffner’s subthyroid tracheotomy,2,5-8 the thyroid isthmus can be suture ligated, or divided safely by monopolar electrocautery (Figure 7). Other surgeons advocate such division of the isthmus to decrease the risk of tube dislodgement during swallowing and to decrease the pressure of the tube on the anterior tracheal wall.2,9 A prospective study by Calhoun et al demonstrated that cautery division of the thyroid isthmus was safe and comparable to suture ligation techniques.10

**Complications**

In a study of 1,132 patients, complications occurred in 5-40% of tracheotomies, and the mortality rate of tracheotomy was 2%.11 Complications of tracheotomy can occur during the procedure, soon after the procedure, or even after decannulation of the tracheotomy tube. Intraoperative complications of tracheotomy may include loss of the airway and bleeding, but these major risks remain rare. In one study of 81 procedures, there was no loss of airway control, no airway obstruction, no blood loss exceeding 50 mL, and no aspiration. One patient (1.2%) had cardiovascular instability during the procedure.5 Fatal hemorrhage is a significant risk in the patient with a high riding innominate artery. This vessel may be injured during inferior dissection. If dissection is inadvertently performed lateral to the trachea due to distorted patient anatomy or morbid obesity, the carotid sheath may also be injured.

Early postoperative complications after tracheotomy include problems related to the airway, bleeding, and infection. Problems with the airway include airway crusting or plugging (5%), and dislodgement of the tracheotomy tube. Dislodgement of the tracheotomy tube can happen with moving or turning of a patient and can manifest as respiratory distress. Because the normal anatomic path of the trachea is in the posteroinferior direction as it enters the chest, replacement of the tracheotomy tube is not always easy after premature dislodgement (Figure 8). Airway distress can occur postoperatively resulting from the placement of the tracheotomy tube into a false soft-tissue passage other than the airway itself. Creation or placement of the tracheotomy tube into a false passage can occur in the operating room, after dislodgement and replacement, or during the routine tracheotomy change.

Bleeding can result from bloody secretions (22%) or catastrophic tracheoarterial fistula 0.6% (5 of 794 patients).12 Tracheobronchitis can occur after tracheotomy as well as pneumonia. Although tracheotomy allows for hygiene of the lower airway, it also alters mucociliary clearance by interrupting mucous flow up the trachea and eliminating the humidification and warming functions of the nose, predisposing to infection. Additionally, it reduces cough strength and efficacy and allowing access for external bacteria to the trachea.

![Figure 6](image6.png)

**Figure 6** Bjork flap; an inferiorly based flap of trachea is secured by suture to the anterior neck skin for a more permanent or long-term tracheostomy.

![Figure 7](image7.png)

**Figure 7** Division of the thyroid gland.
Late postoperative (postdecannulation) complications consist of tracheoesophageal fistula and tracheal stenosis. Tracheoesophageal fistula is a rare complication of tracheotomy and can often be explained by the combination of high cuff pressure and the presence of a rigid nasogastric tube.

Airway stenosis is the most commonly cited major late complication of tracheotomy. In one study, sixteen percent of tracheotomy survivors had asymptomatic stomal site tracheal narrowing and 8% required tracheal resection for symptomatic stomal site tracheal stenosis.5,12-15 Tracheal stenosis after tracheotomy has been thought to be secondary to an overly large tracheotomy or damage at the tracheotomy tube cuff site.15 In a recent study comparing horizontal trachea incision to a window-style tracheotomy incision, no significant difference was found in posttracheotomy tracheal stenosis.16 Other studies also have concluded that various incisions result in similar rates of tracheal stenosis,17,18 and the sum of the literature would suggest that the cause of tracheal stenosis after tracheotomy is multifactorial. Tracheal stenosis after tracheotomy can best be prevented by minimizing the size of the tracheotomy, the cuff pressure, the risk of infection, the movement of the tube, and gastroesophageal reflux.

**Conclusion**

In conclusion, tracheotomy is one of the most commonly performed procedures in the critically ill patient and has been performed since ancient times. Although a variety of techniques are used to perform this operation, the same basic surgical principles apply to each chosen technique. Thoughtful planning and persistent communication during all airway surgeries are required to assure the safest of conditions. Meticulous hemostasis and appropriate intraoperative and postoperative care of the stoma site can help to prevent the postoperative complications of bleeding and tracheal stenosis.

**References**