TABLE 246-3 Common Causes of Neck Masses in Adults

Disorder	Physical Finding	Pathology	Management
Ranula	Sublingual area swelling	Mucus retention cyst due to ductal obstruction of the sublingual gland	Surgical excision
Laryngeal papillomas	Sessile, warty-appearing lesions on the soft palate or tonsillar pillars	Human papillomavirus type 6 or 11 infection	Surgical excision
Palatine torus	Boney smooth painless mass of the hard palate	Exostoses of the palate	No treatment needed in most cases
Mandibular torus	Boney smooth painless growth of the mandible under the tongue	Exostoses of the mandible	No treatment needed in most cases
Branchial cleft cysts	Painless, fluctuant masses close to the angle of the mandible	Incomplete obliteration of the branchial apparatus during development	Antibiotics if infected, surgical excision
Thyroglossal duct cysts	Soft, mobile, subhyoid bone midline mass	Remnant of the thyroid anlage	Antibiotics if infected, surgical excision
Lymphoma	Multiple, rubbery low-neck masses, night sweats, fever, malaise	Malignant process	Biopsy, referral to ENT and oncology
Acute retroviral syndrome	Generalized adenopathy, unprotected sex by history	Human immunodeficiency virus infection	Antiretroviral medication
Squamous cell carcinoma	Firm, possibly fixed cervical lymph node	Oral lesion metastatic to cervical node	Biopsy, referral to ENT and oncology
Parotid tumors	Nonpainful masses under or anterior to the ear	Benign or malignant process	Biopsy, referral to ENT and oncology as needed
Sialoadenitis	Tender swelling in area of parotid, submandibular, or sublingual salivary gland	Salivary gland infection	Antibiotics, salivary stimulants, also see chapter 122, "Neck Masses in Children"
Thyroid enlargement	Diffuse nodular thyroid enlargement or solitary nodular thyroid	Benign or malignant process	See chapters 228, "Hypothyroidism," and 229, "Hyperthyroidism"

Abbreviation: ENT = otolaryngology.

TREATMENT

Keep the patient NPO (nothing by mouth) and sitting upright, monitor with pulse oximetry, and maintain IV access. Obtain a CBC and coagulation studies, and type and cross-match blood. Examine the oropharynx to see if bleeding can be visualized. A grayish-white eschar is normal following a tonsillectomy. **Apply direct pressure to the bleeding tonsillar bed using a tonsillar pack or a 4×4 gauze on a long clamp, moistened with either thrombin or lidocaine and epinephrine.** To prevent loss of the pack into the airway, place a suture through the pack and tape the suture to the face. Place pressure on the lateral pharyngeal wall, avoiding midline manipulation, to decrease stimulation of the gag reflex. Massive bleeding is rare, but when it occurs, intubation may be the only means of protecting the airway. This is always difficult, with oropharyngeal edema from recent surgery and blood obscuring visualization of the cords. Plans should be made for an emergent cricothyrotomy prior to attempting intubation.

Pressure alone can be adequate for control of posttonsillectomy hemorrhage until the otolaryngologist arrives. Alternatively, if a bleeding site can be visualized, bleeding may be cauterized with silver nitrate after local infiltration with 1% lidocaine with epinephrine. Otolaryngologic consultation in the ED is always needed because patients may have a second or even third posttonsillectomy hemorrhage,[37] and surgery or endovascular embolization may be necessary for definitive control.[38]

REFERENCES

The complete reference list is available online at www.TintinalliEM.com.

CHAPTER 247

Complications of Airway Devices

John P. Gaillard

TRACHEOSTOMY TUBES AND CANNULAS

A tracheostomy is an opening between cartilaginous rings in the trachea and the skin, with a tracheostomy tube placed into the stoma to facilitate ventilation. Tracheostomy is usually performed by an otolaryngologist as an elective or semi-elective procedure and is not an emergency procedure. Most tracheostomies are performed on chronically ill patients requiring prolonged mechanical ventilation.

There are many types of tracheostomy tubes available, including those made of plastic, silicone, nylon, and metal. Most hospitals stock only a few types of tracheostomy tubes, and one must be familiar with the types available. Tracheostomy tubes vary in diameter, total length, the length before and after the curve, and the presence or absence of a cuff (**Figure 247-1**). The size of the tracheostomy tube is usually defined by the inner diameter, ranging in adults from 5 to 10 mm and in pediatric patients from 2.5 to 6.5 mm. Most pediatric and adult tracheostomy tubes have a 15-mm standard respiratory connection that may be used with ventilator tubing or a bag-valve device.

Fenestrated tracheostomy tubes have an opening along the dorsal surface of the body of the tube. The fenestration allows the passage of air through the tracheostomy tube to the vocal cords so the patient can speak. Irritation from the fenestration may promote growth of granulation tissue, which may extend into the fenestration, leading to bleeding, obstruction, and difficulty removing the tracheostomy tube. If any difficulty is encountered removing a fenestrated tracheostomy tube, obtain surgical or ear, nose, and throat consultation.

Most adult tracheostomy tubes have a removable inner cannula, which allows secretions to be cleared from the lumen without removing the entire tube from the trachea. In assessing an adult tracheostomy patient, remove and examine the inner cannula for crusting or obstruction. Both disposable and reusable inner cannulas may be cleaned by using a small brush dipped in a solution of hydrogen peroxide and then

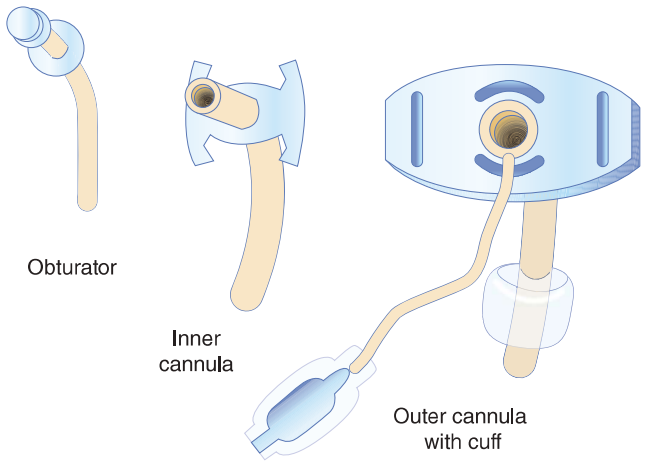


FIGURE 247-1. Common components of most tracheostomy tube sets.

rinsing the cannula with warm tap water. If the correct size of disposable inner cannula is not available in the ED, use the existing inner cannula temporarily, or change the entire tracheostomy tube. **Pediatric tracheostomy tubes never have an inner cannula because of the small inner diameter, so the entire tube must be removed for cleaning.**

COMPLICATIONS OF TRACHEOSTOMIES

Complications due to the surgery are grouped according to the timing since the tracheostomy and the technique. Summed complication rates from randomized controlled trials show 10.0% for percutaneous technique and 8.7% for open tracheostomy.[1] Bleeding, obstruction, dislodgement, and infection are all potential early complications, occurring within the first week. Late complications are those that occur after 1 week. Granulation, tracheal stenosis, a fistula (tracheocutaneous, tracheoesophageal, or tracheoinnominate) plus any of the early complications may be late complications.[1-4] Risk factors for tracheal stenosis are intubation duration of more than 1 week and having an endotracheal tube larger than 7.5 mm.[4]

Patients with tracheostomy tubes can develop respiratory distress. **Figure 247-2** is a step-by-step approach to assess and treat respiratory distress. In the ED, the provider must be proficient in the following skills (as outlined in the sections that follow): replacement of an uncuffed with a cuffed tracheostomy tube for mechanical ventilation, replacement of a tracheostomy tube after accidental decannulation, correction of a tube obstruction, and control of bleeding or infection at the tracheostomy site. It is important to determine a few key elements about the tracheostomy: when and why was the procedure performed, what type of tracheostomy tube is the patient using currently, and can the patient be orally intubated if needed? **Patients who have undergone a laryngectomy or who have tumors or scarring that occlude the upper airway cannot be orally intubated.**

Tracheostomy Tube Obstruction Consider mucus plugging of the trachea or mainstem bronchi distal to the tube. If the tracheostomy is patent and is in the airway, leave it in place. If the tracheostomy tube is obstructed, mucous plugging is commonly the cause. Secretions may act as a ball-valve mechanism, allowing air in but restricting exhalation. Suctioning may relieve the obstruction. Preoxygenation and placement of sterile saline solution into the trachea will aid in suctioning. Prolonged use of large suction catheters without preoxygenation will cause hypoxemia. If mucous plugging cannot be relieved by suctioning, the inner cannula of the tracheostomy tube and, occasionally, the entire tracheostomy tube may need to be removed and cleaned.

Tracheostomy Dislodgement It is possible for the tracheostomy tube to become dislodged from the trachea but still be in the neck. In this case, a suction catheter cannot be passed through the tube, and on x-ray, the tracheostomy tube may be seen to extrinsically compress the trachea (**Figure 247-3**). In this circumstance, remove the entire tracheostomy tube. It may be difficult to accurately identify the actual tracheal stoma when replacing the tube (see "Changing a Tracheostomy Tube" section below). A nasopharyngoscope or flexible bronchoscope should be inserted into the visible stoma in an attempt to identify the tracheal opening. If the opening still cannot be identified, obtain ear, nose, and throat or surgical consultation. If the patient cannot maintain the airway, oral intubation will be necessary.

Tracheostomy Site Infection Indwelling tracheostomy tubes are contaminated with normal or pathogenic flora. Surgical site infection is more common in patient post open tracheostomy (7%) than percutaneous insertion (3.4%).[5] Stomal skin infection, tracheitis, and bronchitis can be a recurring problem. Infection may be polymicrobial, including *Staphylococcus aureus*, *Pseudomonas*, and *Candida*. Antibiotics are indicated in the setting of clinical disease. Stable patients can be treated with amoxicillin-clavulanate, 875 milligrams PO twice daily.[6] Unstable patient should receive piperacillin-tazobactam, 3.375 grams IV, plus vancomycin, 1000 milligrams IV. Use a fluoroquinolone for *Pseudomonas*. Dressing changes with gauze soaked in 0.25% acetic acid are effective for local wound infections.

Tracheostomy Site Bleeding Bleeding can occur at any time after a tracheostomy. Granulation tissue in the stoma, trachea, or thyroid or erosion of the thyroid vessels, the tracheal wall (frequently from suction trauma), or the innominate artery are all sources of hemorrhage. Slow bleeding originating from the stoma may be controlled by packing the site with saline-soaked gauze. If this is ineffective, remove the tube and examine the stoma and tracheal wall. Local bleeding can be controlled with silver nitrate. Electrocautery should be done by a surgeon. If bleeding is brisk, replace the tracheostomy tube with a cuffed endotracheal tube with the cuff below the bleeding site.

Tracheoinnominate artery fistula is a rare but life-threatening complication of tracheostomy. Cuff pressure >25 mm Hg, tracheostomy below the third tracheal ring, and deformed neck or chest are all risk factors.[7] Bleeding results from vessel erosion caused by either direct pressure of the tip of the tracheal cannula against the innominate artery or from a cuff with inappropriately high pressures due to overinflation. Most patients with a tracheoinnominate artery fistula present within the first 3 weeks after tracheostomy, with the peak incidence between the first and second week. Some patients may have a sentinel arterial bleed or hemoptysis. Bleeding may be mild or severe and should be thoroughly investigated because of the potential for sudden massive hemorrhage.[8] Immediate otolaryngologic and thoracic surgery consultation is required, and operative repair is lifesaving.

If patients present with massive bleeding, the first maneuver is to hyperinflate the cuff to control brisk bleeding while planning operative intervention. If bleeding persists, slowly withdraw the tube while exerting pressure against the anterior trachea. If these interventional maneuvers do not control the bleeding, then place a cuffed endotracheal tube from above to prevent pulmonary aspiration of blood. Passing the endotracheal tube past the tracheoinnominate fistula will require direct visualization with a flexible nasopharyngoscope or bronchoscope through the tube and an assistant to withdraw the tracheostomy tube as the endotracheal tube passes.[5] **Stomal hemorrhage is then controlled with digital pressure of the innominate artery against the manubrium.** This is known as the Utley maneuver.[9] Tamponade of the hemorrhage should be maintained during transport to the operating room, as the patient will need emergent surgery with rigid bronchoscopy.

Tracheal Stenosis Tracheal stenosis may present weeks to months after decannulation and results from mucosal necrosis and subsequent scarring. Signs and symptoms include dyspnea, wheezing, stridor, and the inability to clear secretions. A chest radiograph may demonstrate the narrowed tracheal airway. Medical treatment includes humidified oxygen, nebulized racemic epinephrine, and steroids. Operative treatment involves rigid bronchoscopy with laser excision of the scar bands, and stenting or tracheal reconstruction in more severe cases.

MECHANICAL VENTILATION WITH A TRACHEOSTOMY TUBE

If the patient requires mechanical ventilation, an uncuffed tracheostomy tube will result in a large air leak, and it will be difficult to ventilate the patient. In this case, the uncuffed tube should be exchanged for a cuffed tube. If a tracheostomy tube is not readily available, an endotracheal tube may be inserted into the stoma to maintain airway security. If the

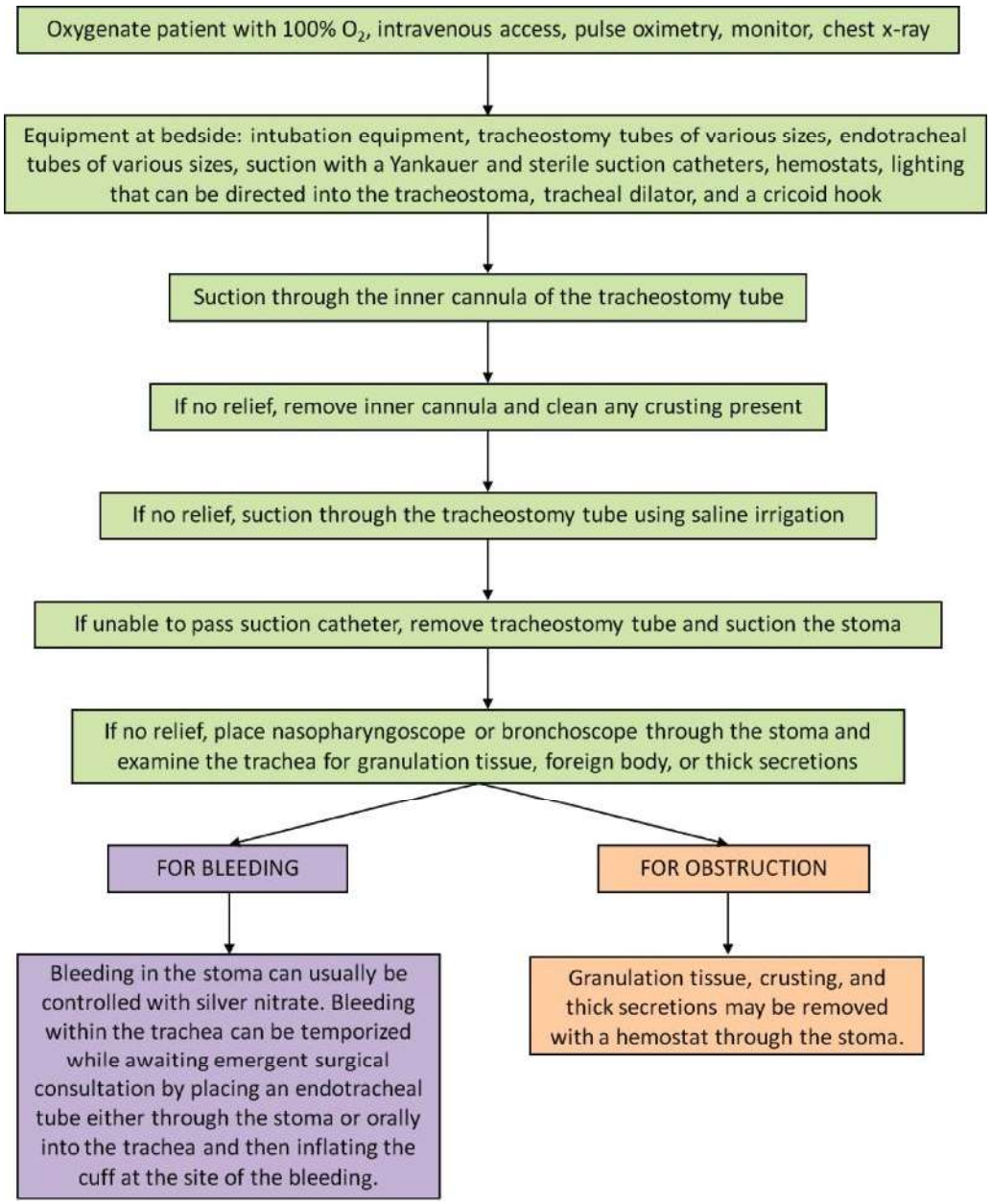


FIGURE 247-2. Steps in assessing a tracheostomy patient with respiratory distress.

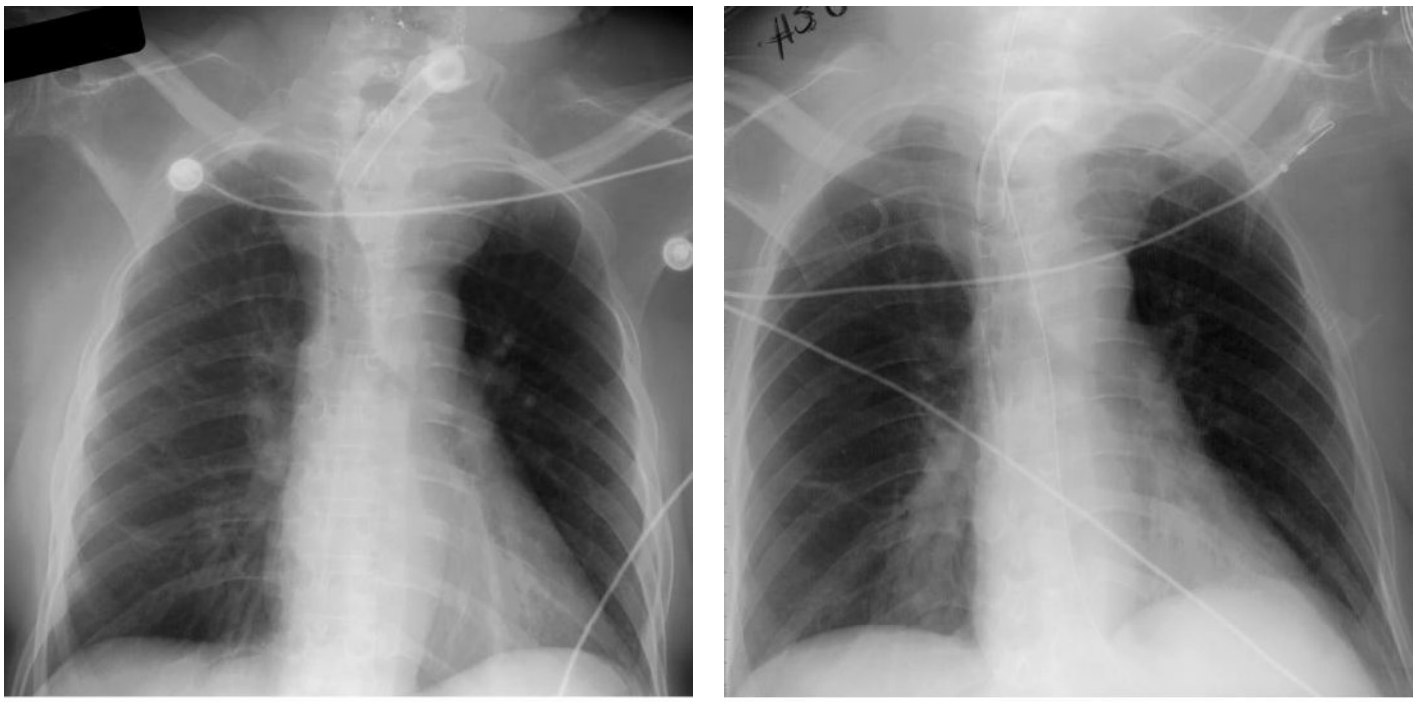
stoma cannot be cannulated, the patient may be orotracheally intubated to secure the airway—unless the patient has a laryngectomy (see the following "Larnygectomy Patients" section).

CHANGING A TRACHEOSTOMY TUBE

The amount of difficulty encountered when changing a tracheostomy tube depends on when the procedure was performed and on patient anatomy. **If the tracheostomy is <7 days old, the tract will not be mature and manipulation may easily create a false passage within the soft tissue of the neck. In addition, a tract may easily collapse at any time in patients with obese necks or neck masses. If the situation is not emergent and the tracheostomy is <7 days old, tracheostomy tubes should be changed by a surgeon familiar with the procedure.**

An uneventful tracheostomy change depends on adequate preparation and is best accomplished with an assistant. The spontaneously breathing, stable patient can easily breathe through a patent stoma without the tube in place, so there is no reason to rush through this procedure. The needed equipment is listed in **Table 247-1**. If a cuffed tube is used, test the balloon before use and make sure the balloon is completely deflated before insertion. A cricoid hook can be inserted just under the cricoid and used to lift and stabilize the trachea. The dilator is particularly useful if a larger tube is to be inserted, but if dilation is needed and time permits, obtain surgical consultation. Dilation may require injection of local anesthesia. Become familiar with the cricoid hook and tracheal dilator before using them. To minimize soft tissue damage, use an obturator whenever a tracheostomy tube is replaced. When the obturator is placed within the outer cannula, the tube presents a solid, rounded end that is less likely to damage the neck soft tissue during tube insertion (Figure 247-1). **After placement, quickly remove the obturator and place the inner cannula, because the patient cannot breathe through the tracheostomy tube when the obturator is in place.**

Once the equipment is ready, place the patient supine with a shoulder roll to extend the neck. Remove the old tube and gently suction and examine the stoma. In most cases, the opening in the trachea and the posterior tracheal wall can be seen. Gently direct the fresh tube with the balloon deflated into the opening, curving it downward into the trachea (**Figure 247-4**). The movement should be smooth and gentle. If resistance



A B

FIGURE 247-3. **A.** Patient with a large goiter and a No. 4 Shiley tracheostomy tube with the tip of the tube outside the trachea and compressing the tracheal wall. **B.** Same patient with a longer No. 6 Shiley tracheostomy tube with the tip of the tube correctly placed inside the trachea.

is met, the tube is likely caught on the cartilaginous tracheal wall. Remove the tube and reexamine the stoma, and again place the tube directly into the tracheal opening. If the tube still cannot be placed, consider placing a smaller tracheostomy tube. **However, a smaller tube will also be shorter and may not be long enough for the patient's neck.** Another helpful method is to place a small suction catheter or nasogastric tube into the trachea and thread the tracheostomy tube over the catheter using a modified Seldinger technique.

Once the tube is in place, verify correct tube position by inserting a suction catheter into the tube or attaching an end-tidal carbon dioxide detector. It should easily pass beyond the length of the tracheostomy tube without resistance. If there is a question about placement, pass a nasopharyngoscope or flexible bronchoscope through the tube for direct visualization of placement or obtain an x-ray.

Patients with accidental decannulation who are not in distress can have the tracheostomy tube replaced as described. **If the tube has been out for several hours, the stoma may begin to close and dilation may be needed before tube insertion.** In these cases, and if the stoma is small or the tracheostomy is the patient's only airway, ear, nose, and throat or surgical consultation is recommended for tube replacement.

LARYNGECTOMY PATIENTS

It is impossible to orally intubate patients who have had a laryngectomy. The only access to the tracheobronchial tree is through the tracheostoma in the neck. Occasionally, laryngectomy patients will have a laryngectomy tube in the stoma, similar in appearance to a tracheostomy tube. Laryngectomy patients can be distinguished from tracheostomy patients by history and physical examination and by the fact that laryngectomy patients are unable to vocalize (or breathe) when the laryngectomy tube is occluded. **Laryngectomy patients can be emergently intubated by placing an endotracheal tube into the tracheostoma.** Do not advance the tube too far, as the carina may be only 4 to 6 cm from the tracheostoma.

TABLE 247-1 Equipment Needed to Change a Tracheostomy Tube

Suction device with both a Yankauer tip and suction catheters that fit inside the tracheostomy tube
Good lighting directed into the tracheostoma
An appropriate size tracheostomy tube with obturator in place
Another tracheostomy tube one size smaller than planned
Tracheostomy tube tie
Cricoid hook and tracheal dilator (if physician is familiar with their use)

LARYNGEAL STENTS

The surgical management of severe laryngotracheal stenosis often employs the insertion of tracheal stents for various periods of time. Placement of an endolaryngeal stent renders a patient tracheostomy dependent until the stent is removed because the solid stent blocks the airway at the level of the larynx (**Figure 247-5**). **Stents and their associated tracheostomy tubes should only be removed by a surgeon familiar with the devices and their placement.** There are many different endolaryngeal stent designs and materials, including silastic molds secured by cutaneous buttons (a stent secured by a strap that exits the tracheal stoma and is attached to the skin), the Aboulker stent complex (a metal tracheostomy tube wired to a silastic stent used in pediatric airway reconstruction), and the Montgomery T-tube stent (**Figure 247-6**). Although endolaryngeal stents are secured by buttons or straps, dislodgement is a known complication of these devices. If a stent becomes dislodged but the tracheostomy tube remains in position, airway security is usually not an issue. Consult the otolaryngologist for extrusion or dislodgment of a stent.

The Montgomery T-tube configuration is commonly used in adult laryngotracheal reconstruction.[10] It is a modification of a tracheostomy tube that does not have an inner cannula. Humidification and suctioning of the T-tube is essential to prevent mucous plugging. These tubes are also used in tracheal stenosis as a bridge to surgery, a treatment for those patients who are not surgical candidates, and in cases where there is a long segment of stenosis.[10] Airway obstruction should be addressed by first suctioning both the upper and lower limbs of the T-tube (**Figure 247-6**). If suctioning both limbs of the T-tube does not

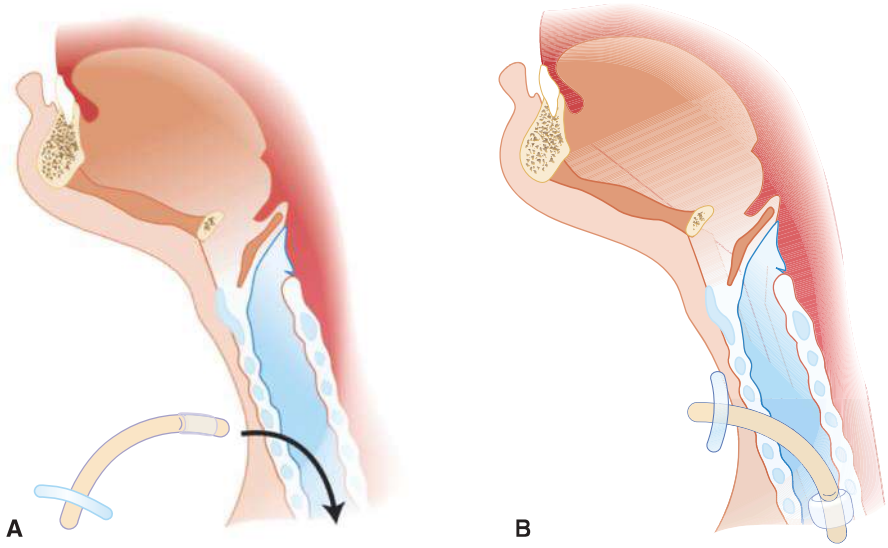


FIGURE 247-4. Insertion (A) and placement (B) of the tracheostomy tube. Cuffed tubes should be inserted with the cuff deflated.

relieve the obstruction, the T-tube should be removed and the trachea cannulated with an appropriately sized tracheostomy tube or an endotracheal tube. Do not try to use a bag-valve device through the T-tube because most tubes do not take a standard 15-mm connector.[11] Removal requires a strong, steady pull on the T-tube and should only be attempted if the operating surgeon is unavailable or the patient is in airway distress.

SPEECH DEVICES

The Passy-Muir valve is a one-way valve that fits directly over the opening of an uncuffed tracheostomy tube and allows the patient hands-free speech. When the patient inhales, the valve opens and allows air to pass into the trachea and lungs. Speech is created when the patient exhales with enough force to close the Passy-Muir valve. The exhaled air is directed around the tracheostomy tube and through the vocal cords (**Figure 247-7**). Because the patient exhales around the tracheostomy tube, **a Passy-Muir valve should never be used with a cuffed tube.** If a patient with a Passy-Muir valve develops signs of airway obstruction or an inability to speak, the speaking device should be removed from the tracheostomy tube so that air can pass freely during both inhalation and exhalation. If this does not relieve symptoms, check the tracheostomy tube itself for obstruction.

A tracheoesophageal prosthesis allows speech in postlaryngectomy patients. This one-way valve is surgically placed between the posterior wall of the tracheal stoma and the anterior wall of the cervical esophagus. To speak, patients exhale while occluding the stoma with their thumb or finger, thus forcing the exhaled air into the esophagus. The air vibrates the esophagus (as a belch does), and the resultant tone is used to provide speech (**Figures 247-8 and 247-9**).

The most common complication associated with tracheoesophageal prosthetic valves is leakage, either around the valve or through the valve lumen. Both types of leakage may be confirmed by looking at the prosthesis while the patient drinks a colored liquid (e.g., grape juice). Leakage commonly occurs due to enlargement of the tracheoesophageal fistula.[12]

Leakage increases the risk of aspiration pneumonia. A temporary solution to a leaking valve begins with removal of the entire prosthesis and replacement with a larger Foley catheter into the tracheoesophageal fistula. This will prevent the tracheoesophageal fistula from closing completely as the fistula contracts in size. Leakage through a voice prosthesis

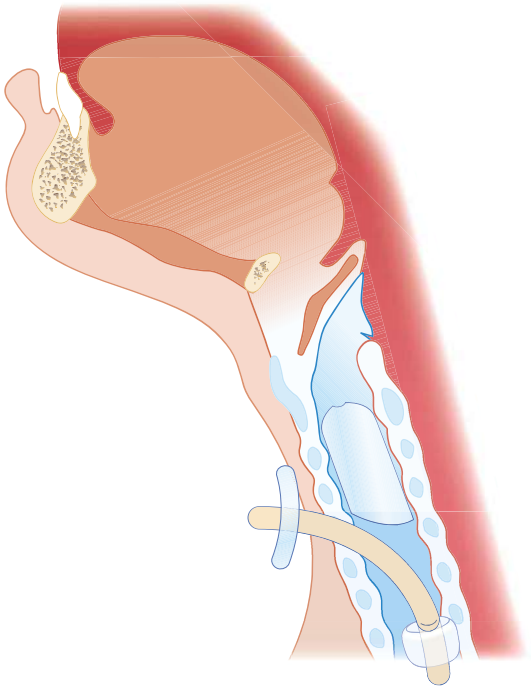


FIGURE 247-5. Relation of the tracheostomy tube to the laryngeal stent. The stent lies within the lumen of the trachea, superior to the tracheostomy tube.

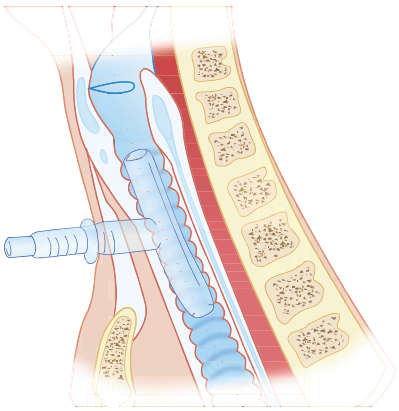


FIGURE 247-6. Suctioning is required of both the upper and lower limbs of the Montgomery T-tube. If necessary, the entire T-tube can be removed.

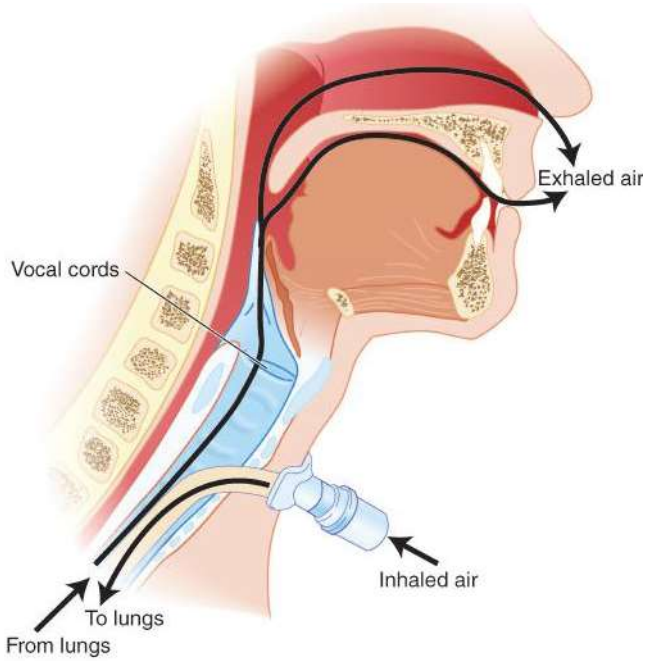


FIGURE 247-7. The Passy-Muir valve is a one-way valve that fits directly on the opening of the tracheostomy tube. Speech is created when the patient exhales as air is passed up through the vocal cords and out of the mouth.

FIGURE 247-8. Tracheoesophageal prosthesis. The bobbin-shaped device is placed with the smaller flange in the esophagus and the tagged flange in the posterior tracheostoma.

FIGURE 247-9. Tracheoesophageal prosthesis in place in a laryngectomy patient. The prosthesis is in place, and the tag is usually held with tape. Finger occlusion of the tracheostoma with exhalation leads to increased airway pressure, which opens the one-way valve and allows air to enter the esophagus. This vibrates and allows the patient to speak.

is predominantly due to valve damage caused by fungal colonization or contact of a duckbill-style device against the posterior esophageal wall and is treated by replacement of the prosthesis with a temporary tube (usually a Foley catheter). Once a Foley catheter is placed and secured, the patient is unable to speak. Arrange otolaryngologist follow-up the next day. Do not inflate the balloon on the Foley catheter, as this will interfere with swallowing.

Another common complication with tracheoesophageal prostheses is valve aspiration or valve extrusion. A loose valve or coughing while changing a valve can result in aspiration of the valve into the airway. Aspiration results in persistent cough, dyspnea with discomfort, and even respiratory distress. If there is suspicion of aspiration or if the prosthesis is dislodged, obtain a chest x-ray to visualize the radiopaque valve and consult an otolaryngologist. The tracheoesophageal puncture tract will close quickly, typically within 24 to 48 hours after the tube is dislodged. A Foley or red rubber catheter inserted into the tract will maintain its patency. **Do not attempt temporary catheter placement if the tract is <2 weeks old, as a false passage may result.**

Pharyngeal stricture and stomal stenosis are other complications associated with tracheoesophageal prosthetic valves.[13] Granulation tissue and polyp formation around the valve prosthesis may also occur and dislodge or obstruct airflow and prevent speech. Application of silver nitrate cauterization will treat the granulation tissue, but it is critical that a portion be sent to pathology to verify the histopathology of the tissue.

Whenever a patient presents to the ED with a complication due to an airway device, the provider should be able to troubleshoot many of the common problems. If there is concern, it is advisable to consult an otolaryngologist.

REFERENCES

The complete reference list is available online at www.TintinalliEM.com.