Montgomery T-Tubes

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Introduction

This chapter will review the T-tube device including its indications, contraindications, placement, and other management issues. The evolution of this device provides a bridge to the airway, specifically when tracheal disease of either benign or malignant nature creates significant airway compromise. This device can be both a bridge to definitive treatment or serve as the only treatment. It is important to understand optimal patient selection, sizing of the device, as well as technique of placement and removal.

History and Device Description

The first prototype for the Montgomery T-tube was introduced by Dr. William W. Montgomery in 1964, for use in the setting of cervical trachea reconstructive surgery. It was manufactured from rigid acrylic material in two separate pieces but found to be costly and difficult to manufacture and insert. The following year, the revised one piece T-tube was introduced which was manufactured from flexible silicone material. It was easier to insert with less mucosal irritation even with prolonged usage.

The vertical limb of the T-tube is placed in the tracheal lumen, while the horizontal limb protrudes out through the tracheostomy site. The design of the uncuffed tube allows minimal mucosal reaction by using silicone and tapered ends minimizing friction and interaction with the airway mucosa. Also, the junction of the T is widened by the curvature allowing decreased tissue reaction at the tracheostomy site. The curvature at the T junction also allows the suction catheter to be directed either superior or inferior by simple movement of the external limb to the opposite side. For instance, if the suction catheter is to be directed inferiorly, the external limb should be pushed superiorly prior to inserting the suction catheter.

Many modifications to the original device have been made since its introduction, but the fundamental structure and functionality remain unchanged (Figs. 31.1 and 31.2). There are now a wide variety of these devices which allow for a more custom fitting. Significant modifications include addition of ridges and grooves on the external limb of the tube to allow attachment of a ring washer and speaking valve. This also prevents accidental dislodgement of the external limb into the trachea during suctioning and to allow patients to speak with the T-tube, respectively. The external limb was made longer to accommodate obese patients. The thoracic T-tube has an extra long distal vertical limb to allow treatment of thoracic stenosis that may be more distal. Other important modifications include a Montgomery T-tube fused with a Y stent forming a T-Y stent, which provides airway support to the entire airway from the tracheostomy site to the bilateral main stem airways.

The T-tube size ranges from the pediatric 6.0 mm diameter to 16 mm accommodating different airway sizes in both small children and adults. It minimizes the risk of migration which is especially important given its proximity to the vocal cords. In cases of stenosis or surgical resection of high tracheal disease, the proximal portion of the T-tube can be placed above the vocal cords. The wide variety of options provides either a clear or radiopaque T-tube. For the patient who has a proximal subglottic stenosis, the proximal T-tube limb is tapered to accommodate this while providing a more viable airway. The length of the individual arms allow for patient specific customization. Measurements can be provided to the manufacturer and a custom tube can be made very efficiently. However, the physician is also free to customize the standard tube onsite at the time of the procedure. It is very important when shortening the limbs the intraluminal ends must be smoothed and beveled to reduce formation of granulation tissue. This can be done by cutting the

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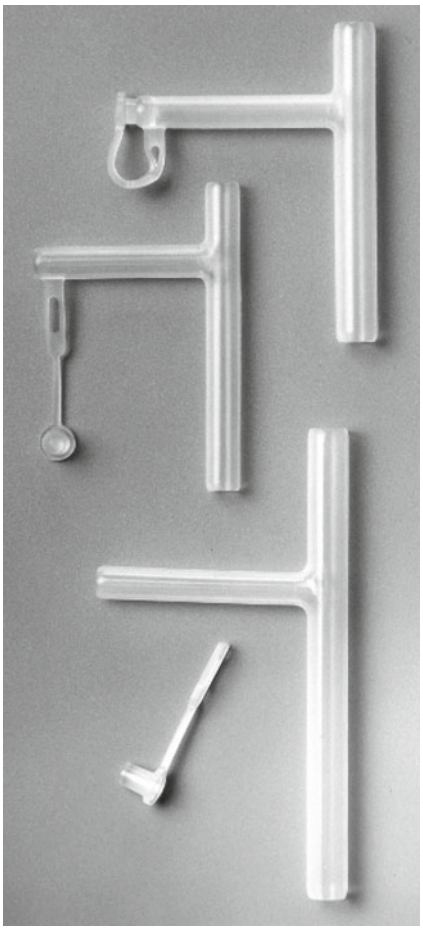

Fig. 31.1 T-tube (Printed with permission from Hood Laboratory)

tube with a scalpel blade and smoothing the edges with sandpaper. There is a customizing kit that can be ordered by the manufacturer. To properly size both the diameter and length of the T-tube, CT scan imaging of the trachea with virtual images, 3D reconstruction, coronal, axial, and sagittal views are very helpful. Bronchoscopic visualization pre-procedure is also helpful to assist with measurement confirmation. It is important to be mindful if the proximal disease permits, to avoid allowing the proximal vertical limb to be at or < 5 mm from the true vocal cords. It is also important to assure that the internal airway limbs of the stent cover the pathologic site and that all limbs fully open upon placement. If there is notable persistent infolding of any of the limbs after placement, then this likely indicates that the stent diameter is too large and must be replaced with a smaller diameter tube. Ideally, the fit would be flush to the mucosa limiting any sliding movement of the tube against the dynamic tracheal walls.

Indications

Initially developed for use in the setting of providing support for a reconstructed trachea and tracheal resection and anastomosis, and acute tracheal injury, the indication has expanded to cover other etiologies of upper airway obstruction requiring structural support. The indication can be divided based on the etiology of airway disease: neoplastic and nonneoplastic.

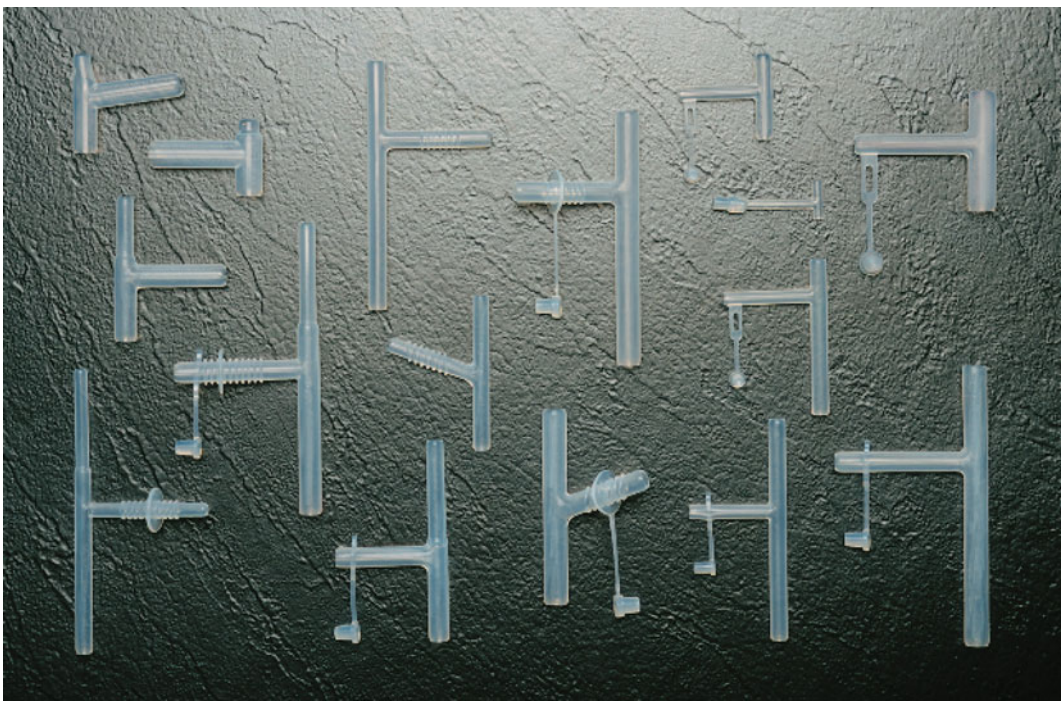

Fig. 31.2 Variation of T-tubes (Printed with permission from Hood Laboratory)

Neoplastic Etiology

This category includes airway obstruction secondary to either primary tracheal tumors or metastatic diseases of the airway. Metastatic cancers that can involve the trachea such as the esophagus, as well as those mediastinal tumors that may result in extrinsic airway compression such as thyroid or lymphoma, may create comprise to airway function.

Nonneoplastic Etiology

This category of disease includes postanastomotic stricture and postintubation stenosis. Less common reasons include stenosis associated with tuberculosis, amyloidosis, sarcoidosis, and postradiation stricture. Aneurysms of the vascular structure surrounding the airway or congenital abnormalities can cause extrinsic compression and airway obstruction. It must be noted that surgical correction of nonneoplastic tracheal stenosis is the gold standard, and stents such as the T-tube should be used in surgically uncorrectable cases either due to prohibitive patient surgical risk factors and technical difficulties or as a bridge to definitive surgical correction. However, there have been many cases where the T-tube has been left in place for prolonged periods of time up to 16 years without any significant complications or patient intolerance. A T-tube due to its anchored placement may be more optimal than a standard cylindrical silicone tracheal stent based on disease that may be more proximal in the trachea with the possibility of tracheal stent migration to the vocal cords. In those patients who require more frequent pulmonary toilet with a suboptimal cough, the T-tube provides a much needed access into the airway for suctioning that would not be possible with a tracheal stent alone. A T-tube may be more comfortable and more cosmetically appealing to patients.

In respect to the surgical management of tracheal disease, the T-tube can be used as an adjunct to surgical management:

1. Temporary airway support prior to definitive surgical resection.
2. Compliment high tracheal and subglottic resection postsurgery: the T-tube is placed at the time of the surgery and left in place for prolonged period, allowing appropriate airway remodeling and preventing postsurgical stenosis.
3. Failed primary tracheal resection: in patients who develop restenosis postsurgically or partial separation of anastomosis can benefit from prolonged T-tube use.
4. Primary definite therapy with T-tube if surgically unfeasible: the T-tube can be placed either indefinitely or for a prolonged period to allow airway remodeling.

Contraindications

In patients likely to require prolonged positive pressure ventilation in the immediate future, the T-tube would not be the recommended option due to the proximal air leak from the proximal tracheal limb of T-tube. This will be discussed further in detail below. Placement of a Montgomery T-tube must be cautiously considered in patients with significant thick respiratory secretions due to a higher incidence of possible stent occlusion from mucus impaction. One case series showed a 9.3% complication rate secondary to secretion retention, requiring intervention such as bronchoscopy. Caution should always be used when the tube inner diameters are small, as seen in children due to the risk of airway obstruction from dried secretions. Meticulous care in sizing, position, and cleaning is required.

In cases of the proximal vertical limb of the T-tube extending above the vocal cords preventing full glottis closure, there is an increased risk of aspiration. Patients who already have a clear history of aspiration should not undergo T-tube placement.

Insertion and Removal

The presence of a tracheostomy opening is a mandatory prerequisite for placement of the T-tube. The original insertion method described by Dr. Montgomery with some modifications is as follows: the airway is secured with a rigid tracheoscopy tube with jet ventilation applied via a working side channel of the tracheoscope, and then using a hemostat, grasp the inferior limb of the vertical tube after folding it upon itself. This is inserted through the tracheostomy opening inferiorly. The hemostat is released and then used to grab the proximal vertical limb next inserting it superiorly. The external limb is pulled gently to allow the other limbs to open up and be directed appropriately (Fig. 31.3).

There have been many new approaches and modifications to the original method described. One popular method suggested by Cooper et al. in 1981 involves using the rigid bronchoscope and an umbilical tape threaded through the horizontal limb, proximal limb of the T-tube, then through the tracheostomy opening and exit through the rigid bronchoscope at the vocal cords. By inserting the inferior limb then pulling on the umbilical cord, this allows quick insertion and alignment of the T-tube. Subsequently, many authors published variations of this method using the umbilical tape and either the rigid bronchoscope or endotracheal tube.

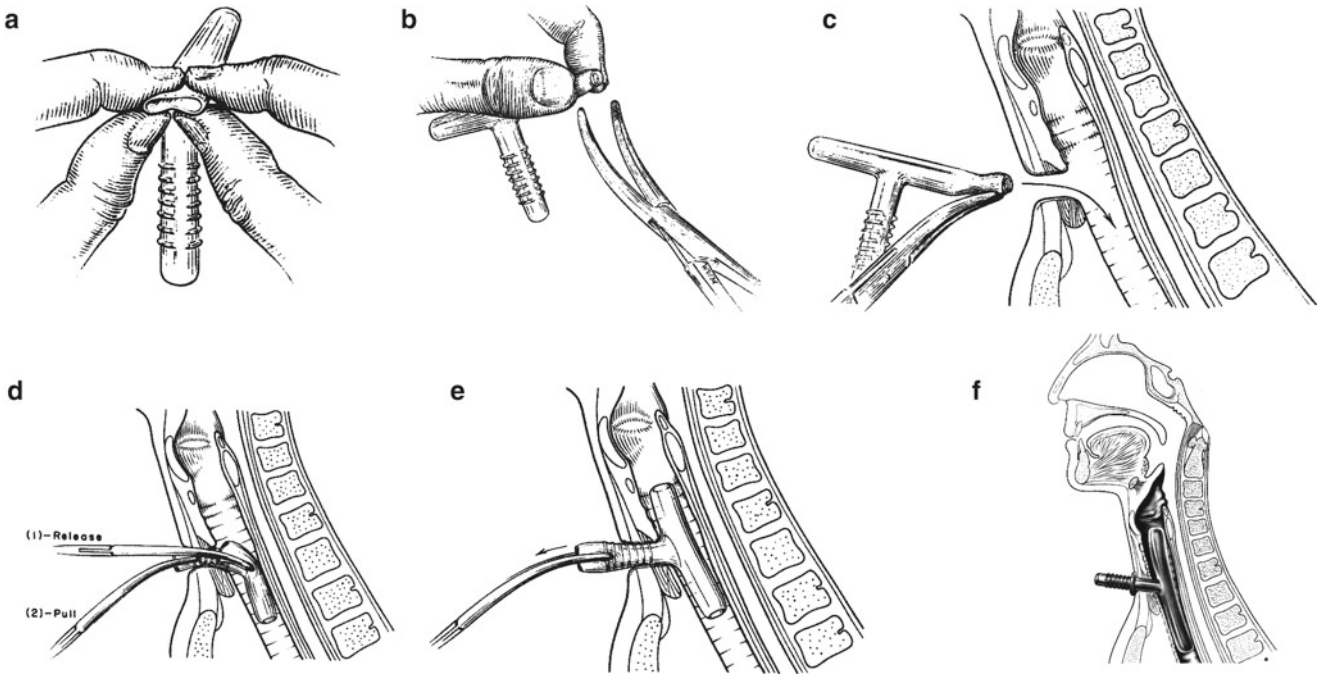

Fig. 31.3 Demonstration of one method of placing a T-tube (Printed with permission from Boston Medical)

Other interesting methods suggested by some authors involve loading the T-tube onto the endotracheal tube prior to insertion. A size 6.0 mm endotracheal tube in the adult can either be inserted through the horizontal limb into the distal vertical limb or the proximal vertical limb of the T-tube then inserted into the trachea and exited inserted into the trachea and exited out through the tracheostomy site, then pulled back into the tracheostomy site.

The removal of the T-tube is usually done under general anesthesia and is simpler than the insertion. A generous amount of lubricant with or without lidocaine applied to the external tracheal site is helpful. The horizontal limb is pulled away from the trachea with a gentle traction until the T-tube is dislodged from the airway. In emergency, the removal can be performed while the patient is awake. The bronchoscopic exam postremoval is necessary to assess the stability of the airway postremoval. The unstable airway must be addressed immediately postremoval for safety. It is always important to have a difficult airway intubation tray, a percutaneous dilational tracheostomy tray, a tracheostomy surgical tray, and a variety of sizes of tracheostomy tubes at the bedside.

Data Review

The available data on the efficacy of T-tube come mainly from retrospective review of case series and case reports. Due to the nature of the medical problems being treated with the T-tube, as well as the relatively low prevalence rate, there has been no randomized clinical trial comparing the T-tube to other alternative methods of airway management.

Two of the largest published retrospective review series describe 140 and 75 patients, respectively.

These patients received a T, TY, or a modified extended T-tube. Eighty-six patients had a benign etiology due to postintubation stenosis. The majority of patients demonstrated that the T-tube was effective in providing a long-term airway. Only 12 patients required the T-tube more than 5 years. The longest reported use of the T-tube in a patient was 16 years. The 20% of patients who failed to respond to the T-tube were due to airway edema or granulation tissue, requiring removal within the 2 months of insertion. The overall serious complication rates were low. One death due to tracheal hemorrhage was directly attributed to the T-tube occurring at 5 months postinsertion.

Another published series described 75 patients with complex benign lesions requiring the T-tube. The majority of the patients had postintubation stenosis (76%). Over half of the patients had contraindications to surgery with the T-tube being the only treatment. Complications occurred in 27 patients with 20 requiring some intervention in the form of ablation for granulation tissue, bronchoscopic cleaning, and temporary replacement with a tracheostomy tube cannula. The T-tube failure rate reported was very low. No death related to the T-tube was reported. In most published series, in approximately half of the patients, the T-tubes were able to be removed successfully in those patients who either underwent definitive surgery or their primary disease was

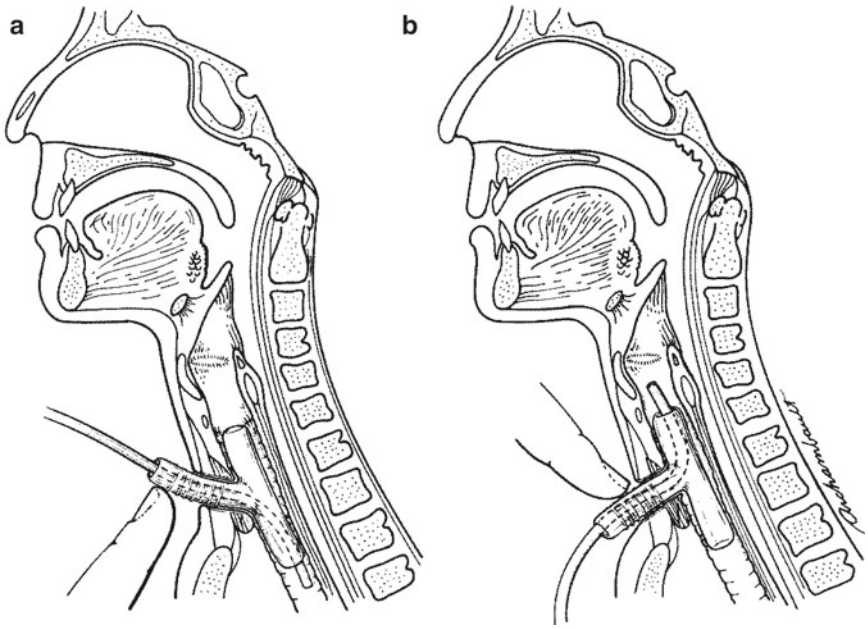

Fig. 31.4 Demonstration of technique for suctioning with T-tube in place (Printed with permission from Boston Medical)

successfully treated. In those whom surgery was contraindicated, the successful removal rate decreased approximately to one fourth.

Maintenance

The T-tube must be cared for meticulously in order to prevent occlusion with inspissated mucus. A high level of care is needed immediately postinsertion and for the subsequent 7 days, including plugging the external limb to prevent dry air and allowing the patient to speak. Frequent suctioning with hypertonic saline or acetylcysteine nebulization appears to assist with clearance of secretions. The use of a physiotherapy valve described as a flutter valve for pulmonary toilet is also helpful. The frequency of nebulization and suctioning can be decreased after the first week based on the patients individual needs. By positioning the horizontal limb of the T-tube, a suction catheter can be directed either superiorly (Fig. 31.4a) or inferiorly (Fig. 31.4b).

Anesthesia

During the earlier stages of placing T-tubes, there was the problem with anesthesia due to concerns of both air and volatile anesthetic gas leakage through the upper limb of the T-tube during insertion. Dr. Montgomery recommended in his original paper to simply place a Shiley arterial embolectomy catheter from tracheostomy site/horizontal limb of the T-tube into the upper vertical limb to obstruct the lumen. This leads to a closed circuit between the anesthetic equipment and lower respiratory airways. Now that total intravenous anesthesia (TIVA) is the standard, this does not pose the same concern.

There are methods advocated by other authors, which include insertion of an laryngeal mask airway (LMA) and either providing ventilation through the LMA and proximal vertical tracheal limb portion of the T-tube. When using the LMA to ventilate, the external limb must be occluded and vice versa.

Hebeler T-tube is a T-tube with an internal balloon in the proximal limb of the tracheal stent that can be inflated to create a closed circuit for ventilation.

In case of an airway emergency case, the 6.0-mm endotracheal tube can be passed through the tracheal stent portion of the T-tube to establish the airway. The internal/external diameters of both the T-tube and the endotracheal tube must be used in selecting the appropriate size to have readily available prior to the procedure.

Additional Considerations

There have been a number of novel approaches to providing anesthesia and positive pressure ventilation in the patient that may already have a preexisting T-tube. This can be unfamiliar territory to most emergency room physicians, intensivists, anesthesiologists, and general pulmonologists when a patient presents either with acute respiratory failure or for an elective

procedure requiring general anesthesia. It is always advisable to consult otolaryngology and interventional pulmonary medicine for acute management. In the decision to ultimately remove the T-tube and either replace it with a cuffed endotracheal tube or a cuffed tracheostomy tube directly into the pre-existing tracheostomy tube site, it is imperative to stabilize and maintain the airway while expertise and equipment are being brought to the bedside. It should be noted that the T-tube provides additional challenges due to the nonstandard fitting at the external opening of the horizontal limb to the usual anesthesia/ventilator circuit. A tracheal tube connector measuring 15 mm is required. Depending on the nature of the proximal tracheal disease in the patient with a T-tube in situ, another alternative would be to perform an awake intubation with bronchoscopic visualization.

One-way speaking valves can also be provided to the patient and be attached to the extraluminal portion of the T-tube to prevent misplacement.

Summary

The T-tube is a unique and effective device in the management of variety of proximal airway diseases providing a dual function of tracheostomy tube and tracheal stent. It is well tolerated by patients without significant serious complications, although its use in younger patients must be done with extra caution. Because of its unique features, it will continue to be an important part of therapeutic options in airway management. Knowledge of this device is important not only for those placing the T-tube but also for any clinician caring for patients with airway diseases.

Suggested Reading

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