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Surgical repair of tracheostenosis

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Tracheostenosis continues to be a significant health problem in the United States. Many patients are rendered dependent on a tracheotomy tube unless the stenosis is surgically corrected. Two basic approaches to surgical correction of tracheostenosis are expansion tracheoplasty versus tracheal resection and reanastomosis. This article discusses the indications of the 2 different treatment approaches and the patient selection for each. We will detail the surgical technique, pitfalls, and postoperative care.

Tracheostenosis continues to be a significant public health problem in the United States, with 4.9 cases per million reported annually.[1] The etiology of the tracheostenosis in adults includes primarily acquired idiopathic tracheostenosis, tracheostenosis secondary to prolonged endotracheal tube intubation, tracheostenosis secondary to placement of a tracheotomy tube and stenosis at the level of the stoma, and tracheostenosis related to the cuff of the tracheotomy tube and stenosis secondary to direct trauma, be that blunt or penetrating. Of patients undergoing prolonged intubation or tracheotomy, stenosis occurs in up to 10 to 20%, with only a small number developing clinical problems from the stenosis.[2] In current society, the high number of motor vehicle accidents that result in multiply traumatized patient requiring long-term intubation and tracheotomy is a major source of patients developing this disorder.

There are two major open treatment approaches to management of cervical tracheostenosis, with a goal of restoration of normal function. These include expansion tracheoplasty, and tracheal resection and reanastomosis. The selection of technique is driven by both the length of the tracheostenosis as well as other preexisting medical comorbidities. In general, the patients with long-segment and multilevel tracheostenosis and those with significant medical comorbidities, particularly diabetes, are better served by expansion tracheoplasty with or without cartilage grafting and T-tube placement as part of a multistage reconstruction. The patients with more focal stenosis who are fit for a major procedure and without significant comorbidities are best served with 1-stage tracheal resection and reanastomosis.

Preoperative evaluation of all patients includes careful history and physical examination. An assessment of vocal fold mobility and specifically glottic and supraglottic anatomy and function is critical to determine whether the patient has laryngeal function that would support tracheal reconstruction. This requires fiberoptic office evaluation. Likewise, examination of the neck is important to determine body habitus and previous neck surgery that may hinder mobilization of tracheal segments.

All patients should undergo direct laryngoscopy and rigid bronchoscopy with use of laryngeal telescopes before a formal repair. Many patients can be successfully dilated at the time of diagnostic bronchoscopy and potentially would be able to avoid an open procedure. Careful mapping of the length of the stenosis and the distance from the true vocal folds is critical to helping with patient selection. Several staging classifications for laryngotracheal stenosis have been developed and are described in Table 1.[3,4]

Segments of stenosis greater than 5 cm may not be able to be repaired using resection or reanastomosis techniques. In addition, stenosis that extends up to the level of the true vocal folds is best served using expansion techniques.

The authors advocate obtaining a fine-cut tracheal computed tomography (CT) scan without contrast using axial

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Table 1 Grading of subglottic stenosis

'Grade	Cotton	McCaffrey
I	Less than 70% stenosis	Stenosis less than 1 cm in length confined to subglottis or trachea
II	71-90% stenosis	Isolated subglottic stenosis greater than 1 cm in length
III	91-99% stenosis	Subglottic stenosis extending into the upper trachea but not involving the glottis
IV	Complete stenosis	Subglottic stenosis with glottic involvement

and coronal reconstructions to help confirm the anatomical location of the stenosis as well as its severity and length. This could also be useful to aid in understanding anatomy, which will be relevant to airway management at the time of any surgical procedure.

Indications

The indications for tracheal reconstruction are noted as follows. The first category includes the patients who have a stenosis that causes varying degrees of dyspnea but have not yet required tracheotomy. When a patient presents with a degree of stenosis resulting in significant functional impairment due to dyspnea, it is reasonable that this patient be considered for repair of the stenosis. The second category consists of patients who are tracheotomy dependent and desire decannulation.

It is worthwhile at this point to discuss how the character of stenosis—rigid or soft—affects the choice of repair. Nearly every patient should undergo a diagnostic evaluation using a CT scan and rigid endoscopy. Patients who have obvious cartilage collapse as observed on CT scan and rigid collapse as observed on bronchoscopy require an open repair. Patients, however, with primarily a soft-tissue stenosis that is dilatable by rigid endoscopy may be able to avoid an open repair. Patients who have a long segment structural cartilaginous collapse (typically this would be either the anterior wall or bilateral lateral collapse) are most appropriately treated with expansion tracheoplasty if the stenosis length is greater than 5 cm or if there are medical contraindications. The patients who have focal cartilage collapse of 5 cm or less and who do not have significant comorbidities should undergo tracheal resection and repair.

Expansion tracheoplasty

The technique of expansion tracheoplasty is reliant on the use of a tracheal T-tube. The 2 primary suppliers of these devices in North America are Hood and Boston Medical Products, which supplies the Montgomery tracheal T-tube. The T-tube acts as both stent and a patent airway, allowing the patient to breathe through the mouth and phonate while the T-tube is stenting the repair. T-tubes require meticulous care and hygiene, and patients need to be well instructed and comfortable with their maintenance. In addition, the patients' families have to be aware of how to deal with a T-tube that becomes obstructed and requires emergent removal and placement of a tracheotomy tube into the stoma.

The major advantage to the expansion tracheoplasty approach is that in most cases cartilage grafting is not necessary, and the morbidity of the procedure is no greater than that of a routine tracheotomy. For the patient who does not have an existing tracheotomy tube, the procedure is begun with laryngoscopy, bronchoscopy and dilation, and intubation with an endotracheal tube. An apron flap incision is elevated, exposing the trachea and the level of stenosis. Once the area of stenosis is visualized, a tracheofissure is planned so that the vertical portion of the T-tube will span the incised trachea and the horizontal limb of the T-tube will exit the wound through the incision (Figure 1).

Management of the T-tube intraoperatively requires preoperative planning. Once placed, the T-tube can be used to ventilate the patient intraoperatively. However, the patent upper end of the T-tube requires occlusion intraoperatively to allow ventilation of the patient. This is accomplished using a Fogarty catheter balloon, which is threaded through the horizontal limb of the T-tube and up into the upper

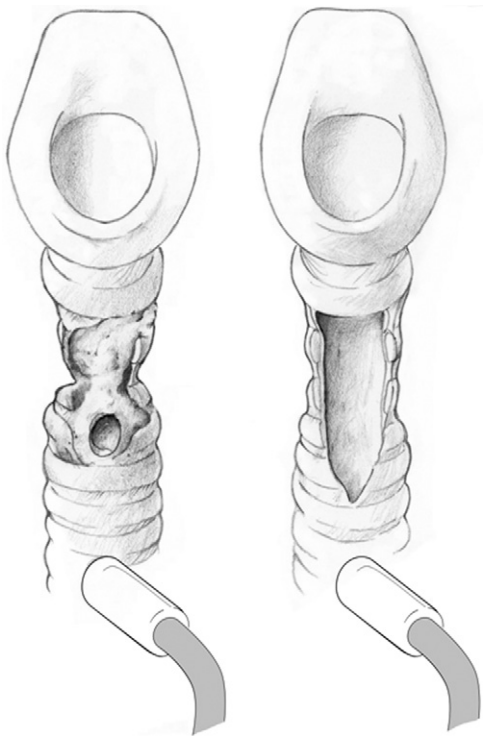

Figure 1 The vertical portion of the T-tube spans the incised trachea, whereas the horizontal limb extends through the tracheostome and incision.