External Fixation of Subglottic Tracheal Stents

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Bronchoscopically placed silicone stents are used increasingly for treating patients with tracheal stenosis due to benign or malignant airway disease. When stenosis occurs in the immediate subglottic region, however, complications of stent insertion, especially migration, are troublesome. The purpose of this report is to describe a technique of external fixation of subglottic stents that may be used when tracheotomy, Montgomery T-tubes, or other therapeutic measures are undesirable or have failed. This technique may also be considered in carefully selected patients with severe malacia and subglottic stenosis who have failed indwelling stent placement because of stent migration.

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FFB=flexible fiberoptic bronchoscope; KTP=potassium titanyl phosphate; Nd:YAG=neodymium-yttrium aluminum garnet; RB=rigid bronchoscopy

When tracheal stenosis results from trauma, inflammatory disorders, or prolonged endotracheal intubation, conservation of laryngeal function after treatment is essential. Management of subglottic stenoses is particularly challenging because open surgical resection is often difficult without a structure-free subglottic space. In addition, many patients are elderly or have severe underlying illnesses, making them unsuitable candidates for tracheal reconstruction. Tracheostomy followed by Montgomery T-tube insertion is often successful, but may be undesirable in patients with recurrent stomal infections or substantial tracheal tumor growth. Some patients refuse tracheostomy for esthetic reasons.

During the last decade, therefore, endoscopic resections have been widely performed to maximize preservation of tracheal epithelium. Results after carbon dioxide (CO2), neodymium-yttrium aluminum garnet (Nd:YAG), or potassium titanyl phosphate (KTP) laser resection are probably better than those obtained after balloon or rigid bronchoscopic dilatation alone, but repeat procedures may be necessary. When endoscopic resection is incomplete, tracheal stenting is often advocated. Loss of cartilaginous support and lack of extrinsic compression, however, makes subglottic stents prone to distal or proximal migration, causing cough, dyspnea, hoarseness, and respiratory distress. In carefully selected patients with subglottic stenosis and malacia who are not candidates for surgical resection, tracheotomy, or Montgomery T-tubes, or patients who have had repeated migration of indwelling stents, external stent fixation may be desirable. We extrapolated from techniques used to maintain laryngeal stents in place, and devised a method by which indwelling subglottic stents could be sutured and fixed externally during endoscopic insertion. This report describes the results of this technique in five patients, and discusses its potential role alongside other endoscopic therapeutic modalities used in patients with refractory subglottic tracheal stenosis.

**Procedure**

Stents were inserted as part of endoscopic treatment of severe subglottic tracheal stenosis. Rigid bronchoscopy (RB) was performed with a nonventilating rigid bronchoscope (EFER-Dumon, Bryan Corp, Woburn, Mass) with the patient under general anesthesia after premedication with 125 mg of methylprednisolone (Solu-Medrol) intravenously (IV). When necessary, Nd:YAG laser resection was performed using standard techniques. The flexible fiberoptic bronchoscope (FFB) was used through the rigid tube to clear the airways of secretions and blood before and after stent placement. Straight silicone stents were inserted into the area of stenosis using a specially designed instrument (Stent Introducer System, EFER, LaCiotat, France). This system allows stent insertion under direct endoscopic guidance after dilating the area of stenosis with the rigid tube. Stents are loaded into an introducer and manually expelled into the stenosis. In high stenoses, the bronchoscopist must gently maintain the distal extremity of the RB between the vocal cords. Exact positioning of the stent is accomplished under direct endoscopic control by grasping it with universal forceps, and if necessary, wedging it against the tip of the rigid tube as it is moved into position. A poorly placed stent can be pulled into the rigid tube and withdrawn with the bronchoscope, taking care to avoid cricoid cartilage and vocal cord injury. After reoxygention and aspiration of pharyngeal secretions, the bronchoscope is reinserted and stent placement is reattempted.

Once the stent is in the correct position, the rigid tube is placed so that its beveled tip is wedged against the stent’s proximal extremity, preventing proximal migration. Universal forceps are introduced and the stent is grasped to prevent distal migration.

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during further manipulations. The anterior neck is prepped and draped in usual sterile fashion. Under direct videobronchoscopic control, a 14-gauge intravascular angiocatheter (Jelco) is inserted through the skin, subcutaneous tissues, anterior tracheal wall, and anterior wall of the silicone stent. A second catheter is inserted about 1 cm distal to the first. The needles are removed, and the teflon catheter sheaths are left in place inside the stent lumen. A 0-polyester or 0-polypropylene suture is inserted through the distal angiocatheter and directed toward the vocal cords. The suture is threaded through a wire retention loop (in our case, a Becton dypider) that has been inserted through the proximal catheter (Fig 1). Once secured, the wire retention loop is removed through the catheter, thereby withdrawing the suture proximally. Both catheters are removed, and the suture is pulled taut, taking care to not tear the stent. The free ends of the suture are passed through a polypropylene button that is tied snugly to the anterior neck. Stent position is verified endoscopically, bronchial cleansing is performed, and the patient is extubated.

**CASE REPORTS**

**CASE 1**

A 68-year-old woman with a history of chronic obstructive pulmonary disease and left upper lobe resection for tuberculosis was referred for increasing dyspnea. Medical history included endotracheal intubation, mechanical ventilation, and permanent tracheotomy after abdominal surgery. The FFB revealed abundant granulation tissue along the anterior tracheal wall in the immediate subglottic region, prompting RB and laser resection. Severe malacia was apparent at the site of the tracheotomy. Recurrent dyspnea that has repeated rigid bronchoscopic examination; tracheomalacia was noted and granulation tissue was again removed from the subglottic region. A 12 mm/40 mm straight silicone stent was inserted, but was loose fitting. A 14 mm/50 mm stent was inserted, but would not expand entirely despite preliminary tracheal dilatation to 12 mm. The 12/40 stent was, therefore, reinserted and sutured into place. Six months later, the tracheotomy stoma had fully healed and there was no evidence of inflammation around the button. The stent was removed by rigid bronchoscopy and the trachea appeared normal. Shortly thereafter, however, dyspnea recurred, and another stent was inserted and sutured into place. The patient did well for 11 months when rigid bronchoscopy was again required to remove granulation tissue that had grown along the anterior tracheal wall proximal to the stent. The patient is asymptomatic more than 2 years since initial stent placement.

**CASE 2**

A 47-year-old man with steroid-dependent asthma and a history of tracheotomy, prolonged mechanical ventilation, and placement of a 12 mm/16 mm Montgomery T-tube was referred because of recurrent stomal infections. The T-tube was placed 3 years previously to support a long segment of malacic trachea. Malacia began in the subglottis and extended to within 2 cm of the main carina. Persistent leakage around the external sidearm of the T-tube caused multiple infections. With the patient under general anesthesia, the T-tube was removed via the tracheotomy site, and a 16 mm/100 mm silicone stent was inserted endoscopically. Because of malacia and a very large tracheal lumen, the stent was sutured into place and fixed, this time, to a subcutaneous button. Two days later, however, cough and dyspnea prompted FOB, which revealed granulation tissue and a large blood clot partially occluding the stent. Removal resulted in moderate improvement. The patient had difficulty clearing secretions despite inhaled bronchodilators and saline aerosol treatments. Purulent drainage was noted at the site of the subcutaneous button. Granulation tissue was again removed and significant tracheomalacia was discovered beyond the distal extremity of the stent. Cultures of bronchial secretions were positive for methicillin-resistant Staphylococcus aureus, but cultures of the cutaneous drainage revealed no organisms. Antibiotics were administered and the patient returned to his home in another state: coughing, but without other symptoms. One week later, the patient was unable to clear secretions effectively and had skin breakdown at the site of the subcutaneous button, which prompted hospitalization. The stent was removed, and an 18-mm diameter Montgomery T-tube was inserted. The patient has been well for 9 months, although still struggling with abundant tracheobronchial secretions.

**CASE 3**

A 53-year-old woman with a 6-year history of malignant melanoma was referred for increasing dyspnea secondary to a large mediastinal mass compressing the posterior cervical trachea. Open biopsy confirmed metastatic disease. The RB was performed to dilate the upper third of the trachea, to exclude intraluminal invasion, and to insert a 14 mm/50 mm straight silicone stent that was sutured into place 2 cm below the vocal cords. Symptoms improved substantially, although two tumor-debulking procedures were required for pain relief. Surveillance bronchoscopies revealed few secretions and no formation of granulation tissue. The stent remained in place until the patient’s death 6 months later from cerebral metastases.

**CASE 4**

A 56-year-old man was referred for laser debulking of an oropharyngeal cancer with subglottic tracheal invasion requiring emergent tracheotomy. Seven months earlier, tracheotomy for acute airway obstruction had been necessary, but external beam radiation therapy effectively decreased tumor size and permitted decannulation. The RB revealed a large, exophytic mass in the subglottis. After laser resection, a 14 mm/50 mm straight silicone stent was inserted but migrated into the right main bronchus 3 days later. It was removed emergently. During the next 3 months, four rigid bronchoscopies were performed to remove large amounts of necrotic tumor from the anterior wall of the upper third of the trachea. One month after the last procedure, recurrent dyspnea required intubation. Bronchoscopy revealed recurrent tumor and substantial loss of the cartilaginous support of the anterior tracheal wall. A 14 mm/50 mm stent was inserted and sutured into place. Tumor debulking was necessary on two occasions before the patient’s death 3 months later.

**CASE 5**

An 84-year-old woman with diabetes mellitus, Guillain-Barré syndrome, and respiratory failure requiring intubation, tracheotomy, and prolonged mechanical ventilation was referred for bronchoscopy. Severe tracheal stenosis with malacia and granulation tissue of the upper trachea was discovered. Rigid bronchoscopic laser resection enlarged the subglottic region to 10 mm. A 16 mm/40 mm straight silicone stent was inserted, but would not expand. A 14 mm/40 mm stent was placed but was subsequently removed because it was loose-fitting. A No. 6 uncuffed, nonbent tracheotomy cannula was, therefore, inserted, but the patient continued to have respiratory difficulty. Two weeks later, a 14 mm/50 mm specially manufactured silicone stent with an outer ring at its proximal tip was inserted. The next day, stent migration prompted reintervention to suture the stent into place. One week later, granulation tissue was removed from below the vocal cords. Further stent obstruction has not occurred, and bronchoscopic follow-up has been uneventful.

**DISCUSSION**

Management of subglottic stenosis demands clinical experience and collaboration between otolaryngologists, thoracic surgeons, and interventional pulmonologists. Curative, single-stage laryngotraqueal resection and reconstruction is frequently success-
ful, but it may cause vocal cord and recurrent laryngeal nerve damage. Unfortunately, many potential candidates for open surgical intervention have concomitant medical illnesses that increase surgical risk. Results from more conservative approaches, such as the endoscopic microtrapdoor technique using the CO₂ laser, have been promising, but this procedure is usually limited to small, thin stenoses less than 10 mm in length. Palliation, therefore, with Montgomery T-tubes is often used, and has several advantages: T-tubes are fixed by their sidearm, rarely migrate, provide easy access for bronchoscopy, and can be removed at the bedside. Disadvantages, however, include required maintenance of a tracheotomy, stomal infections, and respiratory discomfort because of obstruction by dried airway secretions. Some patients refuse the tracheotomy and “protruding” sidearm for esthetic reasons.

Another therapeutic alternative, bronchoscopic laser resection and dilatation, is safe, provides rapid palliation with little associated morbidity, and can be repeated in case of recurrence. When possible, multiple radial incisions of circumferential scar tissue are made with the CO₂ or Nd:YAG laser. More recently, the green, 532-nm wavelength (KTP) laser has also been used because of its dual cutting and coagulating properties. When resection is incomplete or impossible because stenoses are complex, caused by extrinsic compression, or are associated with tracheomalacia, stenting is desirable. Both coated-metal and straight silicone stents have been successfully used. Uncoated self-expanding metal stents should probably be avoided, especially for treating benign strictures, because of their tendency toward continued expansion and risk of perforation: once inserted, removal is difficult, if not impossible. Straight silicone stents, on the other hand, are safely and rapidly removed in case of obstruction by secretions, granulation tissue formation, or migration. Stents placed within 2 cm of the vocal cords, however, are particularly prone to complications. Inflammatory granulation tissue formation and tumor overgrowth cause obstruction and airway compromise that may require emergent endotracheal intubation with an uncuffed, small caliber endotracheal tube. Proximal migration may cause dysphonia, cough, or airway distress. Migration distally results in stricture recurrence.

The external fixation technique described in this report is an additional modality that may be considered in carefully selected patients who have failed other therapies. For example, patients with subglottic stenosis who are not candidates for surgical correction, who have had multiple recurrences of stent migration, or who refuse tracheotomy and tracheostomy. We do not advocate external stent fixation instead of Montgomery T-tubes, rigid bronchoscopic dilatation, or routine endoscopic stent insertion, nor do we recommend using external fixation every time a subglottic silicone stent is placed. We do believe, however, that external fixation of an easily removable silicone stent is preferable to insertion of a metal stent into the upper third of the trachea.

External stent fixation has potential for great misuse, and precise rigid bronchoscopic technique is essential. After stent insertion the tip of the rigid tube is gently maintained between the vocal cords while forceps grasp the stent to prevent its displacement.

FIGURE 1. Both angiocatheters are inserted through the anterior wall of a silicone stent (Dumon). The braided, polyester suture is grasped within the loop of the threader (Bodkin).
Both angiocatheters are inserted percutaneously, perpendicular to the stent and trachea to avoid perforation of the posterior wall of the trachea and prosthesis. Sutures are tied snuggly, but not tight enough to cause laceration of the anterior wall of the stent. We chose nonabsorbable, blue polypropylene (Prolene), or green braided polyester (Tevdek) sutures because of their known nonreactivity. In addition, these colors are easily discerned during videobronchoscopy. The threader (Bodkin), an instrument originally designed to thread a bobber for fly fishing, makes suture manipulation and retrieval relatively simple. Diagrams depicting the specially designed instrument (Stent Introducer System) for stent placement and our method of external stent fixation are presented in Figure 2.

Technical success was achieved in each case. Symptoms resolved, none of the stents migrated, and quality of life was maintained, although granulation tissue formation or tumor overgrowth required repeat bronchoscopic intervention. None of our patients with cutaneous buttons developed skin infections. In one instance, however, the stent was sewn to a subcutaneously placed button (case 2). Indeed, successful subcutaneous fixation of laryngeal keels and stents has been previously reported.15 Our patient had a long-standing tracheotomy and recent peristomal infection. Not surprisingly, subcutaneous infection occurred, prompting us to fix all other buttons externally. A potential problem of this technique is skin infection or abscess formation due to maceration below the fixed button. Careful skin care, especially while shaving, is, therefore, essential. Another potential drawback of this technique is dis-
comfort while swallowing because of unsatisfactory mobility of the button with the laryngotracheal complex during deglutition. None of our patients voiced this complaint. Theoretically, problems with deglutition could be avoided by suturing the stent to the outer wall of the trachea rather than to an externally fixed button. Emergent stent removal, however, would be cumbersome because a cutaneous incision and dissection are necessary to remove the buried suture.

Endoscopic management of tracheal stenosis, of which stent insertion has become an essential component, has become an attractive therapeutic alternative for many patients with high tracheal strictures. In many instances, subglottic stents provide palliation of dyspnea while preparing patients for open surgical resection. In others, stenting, sometimes associated with laser resection, is curative. Provided that bronchoscopic surveillance is maintained to detect and treat complications, we suggest that external fixation of an indwelling silicone stent also has a place, albeit a small one, among other modes of palliative therapy for patients with subglottic tracheal stenosis. In summary, this technique may be considered to prevent stent migration and provide symptomatic relief of dyspnea in carefully selected patients who have failed or who have refused other therapeutic measures.

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