Complication of benign tracheobronchial strictures by self-expanding metal stents

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Objectives: Self-expanding metal stents are used to palliate benign strictures. We examined the complications of this approach.

Methods: Between 1997 and 2002, we observed recurrent airway obstruction and extension of benign inflammatory strictures after the placement of tracheobronchial Microvasive Ultraflex stents and Wallstents (Boston Scientific Corp, Natick, Mass), in 10 patients with postintubation strictures and 5 with other indications; all but 1 patient were referred to us. Patients with tracheal (9), subglottic (1), combined tracheal and subglottic (3), and bronchial (2) strictures had been treated with covered and uncovered Wallstents (6) and Microvasive Ultraflex stents (9).

Results: After stent insertion, stricture and granulations within previously normal airway were seen in all patients. New subglottic strictures resulting from the stent caused hoarseness in 4 patients. A bronchoesophageal fistula was found in 1 patient at presentation and a tracheoesophageal fistula in another during extraction of a Wallstent. Primary surgical reconstruction, judged to have been feasible before wire stent insertion in 10 patients, was possible after stenting in only 7 and failed in 2. Palliative tubes were placed in 60% (9/15). Self-expanding metal stents may lengthen luminal damage, incite subglottic strictures, and cause esophagorespiratory fistula in inflammatory airway strictures. The injury is severe, occurs after a short duration of stenting, and precludes definitive surgical treatment or requires more extensive tracheal resection.

Conclusion: The current generation of self-expanding metal stents should be avoided in benign strictures of trachea and bronchi.

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In contrast to tracheal T-tubes, which are secured by a sidearm exiting from a stoma, endoluminal stents are kept in position by radial force applied against the wall of the airway. Earlier metal stents caused wire fracture and erosion of fixating prongs into the pulmonary artery¹ and their design was modified. The current generation of stents, among them the Microvasive Ultraflex and the Wallstent (Boston Scientific Corp., Natick, Mass), are widely used. Satisfactory short-term palliation of malignant obstruction is often achieved. Recently, preliminary results in small numbers of patients with benign tracheal disorders were reported and long-term use of these stents was proposed.^{2,3} Over the past 5 years, we have encountered complex strictures among patients with internal wire stents placed for benign disease. The purpose of this report is to describe these complications.

TABLE 1. Indications for placement of self-expanding wire stents in benign strictures

Indication	n
Postintubation tracheal stenosis	9
Recurrent postintubation stenosis after TRR	1
Acute intubation injury	1
Broncholith, tracheal fire	1
Tracheomalacia, sarcoidosis	1
Wegener's granulomatosis	1
Bronchomalacia	1

TRR, Tracheal resection and reconstruction.

Methods

Fifteen patients with benign airway obstruction due to metal airway stents were referred, between 1997 and September 2002, to the Division of Thoracic Surgery at Massachusetts General Hospital (MGH). One of 2 patients undergoing insertion of self-expanding metal stents for special indications at MGH during this period had complications and was included.

Contrast esophagography was used to confirm an esophagorespiratory fistula or to define its location. All patients underwent bronchoscopic examination under general anesthesia. Airway length and condition of the tracheobronchial wall were noted and compared with original endoscopy reports before the first prosthesis. Stent extraction was attempted during endoscopy under general anesthesia unless ingrowth into the tracheal wall precluded safe removal. When endoscopic extraction proved impossible, open removal was achieved through a vertically enlarged tracheostomy. Nearly complete removal of the stent was preferred and sometimes required piecemeal extraction. The stent portion embedded in the membranous wall was left in place to avoid a tracheoesophageal fistula.

The goal of intervention was a stable airway without progression of injury. Surgical reconstruction was deferred until the true extent of airway damage became apparent, even if temporary T-tube stenting was required. When the airway could not be reconstructed by resection, a silicone T-tube or TY-tube was inserted according to methods described elsewhere.⁴ When an esophagorespiratory fistula was identified, oral intake was discontinued and nutrition was administered through an enteral feeding tube. Definitive repair was performed once pneumonia had resolved and the condition of the patient allowed closure of the fistula.⁵

Results

Fifteen patients, from 25 to 66 years old, were evaluated with airway obstruction after the insertion of self-expanding wire stents elsewhere (14/15) or at MGH (1/15). Table 1 lists stent indications. One patient had endoscopic cryoablation of a broncholith in the right middle lobe. Laser treatment in this patient after the insertion of a stent in the bronchus intermedius was complicated by a flash fire; a second stent was placed in the trachea and the patient was transferred intubated. Six patients had undergone from 1 to more than 14 laser applications. Comorbidities included

Figure 1. Salvage therapy after stent failure in patients in whom the original tracheal lesion was judged resectable. Resection refers to laryngotracheal resection. Palliative tubes were placed in 7 patients (numbers **bold and underlined).**

advanced emphysema in 3 patients, congestive heart failure in 2, and diabetes mellitus in 4.

At presentation, all patients had symptoms of airway obstruction and 4 had purulent tracheitis. One patient had pneumonia due to a wire-related bronchoesophageal fistula. All patients had dyspnea and 8 had stridor. Six patients had a Wallstent and 9 had a Microvasive Ultraflex stent, each coated in 3 patients. The median duration of stenting was 8 months. Bronchoscopic examination demonstrated stenosis or granulations at either end or growing through the interstices of the stent. The injury pattern is given in Table 2. Coated stents were found covered with purulent debris and caused severe halitosis in 3 patients. Seven patients had high-grade circumferential strictures of 6-mm diameter or less, 4 subglottic and 3 tracheal. The location of strictures was above the stent in 7, below the stent in 2, and at both ends in 5. Five patients had clinical infection, and tracheal aspirates at bronchoscopy demonstrated pathologic organisms in 12 patients (Table 3).

Comparison with bronchoscopy notes before stenting found new strictures in adjacent airway segments in 11 patients. Among 9 patients with original injuries limited to the trachea, additional strictures were subglottic in 8, with new hoarseness in 4, and carinal in 1. The injury was judged resectable before stent insertion in 10 patients, but only 7 underwent tracheal resection.

Stents were completely or partially extracted in 13 patients. The treatment of 10 patients with lesions that were resectable before stenting is detailed in Figure 1. Of the other 5 patients, 1 patient underwent bronchial resection with closure of an esophageal fistula, 3 patients with unresectable lesions were treated with T- or tracheostomy tubes, and 1 patient underwent evaluation only.

Discussion

Endoluminal stents, metal or silicone, maintain their position by exerting friction and radial pressure on the wall of

TABLE 2. Complications and injury pattern following stent placement

Patient	Diagnosis	Complication	Lesion before stenting	Stent duration (mo)	Type of stent	Coated stent	Stenosis	
							Above stent	Below stent
1	Intubation injury	Obstruction	Trachea	1	Wall	No	x	
2	PITS	Obstruction	Trachea	7	Wall	No		x
3	PITS, status post resection	Obstruction	Trachea	26	Wall	No	x	x
4	Broncholith, tracheal fire	Obstruction, tracheitis	Bronchus intermedius	4	Ultraflex	No	x	x
5	PITS	Obstruction	Trachea	2	Wall	Yes	x	x
6	Sarcoidosis, malacia	Obstruction	Trachea	8	Ultraflex	Yes	x	x
7	PITS	Obstruction, tracheitis	Trachea	5	Ultraflex	Yes		
8	PITS	Obstruction, tracheitis	Subglottic space, trachea	30	Wall	Yes	x	
9	Bronchomalacia	Obstruction, BEF	Right main stem bronchus	26	Ultraflex	No	x	
10	PITS	Obstruction	Trachea	20	Wall	Yes		x
11	PITS	Obstruction	Trachea	55	Ultraflex	No	x	x
12	PITS	Obstruction	Trachea	25	Ultraflex	No	x	
13	PITS	Obstruction, tracheitis	Trachea	1	Ultraflex	No	x	
14	Wegener's granulomatosis	Obstruction	Subglottic space	48	Ultraflex	Yes	x	
15	PITS	Obstruction	Subglottic space	5	Ultraflex	No	x	

BEF, Bronchoesophageal fistula; PITS, postintubation tracheal stenosis.

TABLE 3. Organisms isolated from tracheal cultures in 12 patients at initial bronchoscopy

Organism	No. of patients
<i>Staphylococcus aureus</i>	7
<i>Pseudomonas</i>	4
<i>Candida albicans</i>	3
Yeast	1
<i>Streptococcus</i>	1
<i>Corynebacterium</i>	1
<i>Klebsiella</i>	1
<i>Acinetobacter</i>	1

Five patients had two or more isolates.

the airway. A modification of the migration-prone Dumon stent was introduced with the explanation that the new stent increased "stent-to-wall contact surface" and "airway-wall adherence."⁶ In other words, secure placement of endoluminal stents requires high pressures against the airway wall. The recurring stresses of coughing and breathing lead to irritation in the subglottic space, which may impair vocal cord function. Indeed, 8 of 12 cephalad strictures were subglottic and all 5 tracheal resections in these patients required complex laryngeal reconstruction, unusual for postintubation injuries. This pattern was also encountered by Burningham and associates,⁷ who attributed it to motion at the cricotracheal junction and recommended caution. Other complications have been reported, including an in-

flammatory response of the airway wall with granulation and strictures,⁸ esophagorespiratory fistula,⁷ and a pulmonary artery fistula.⁹ Similar injuries are also found in benign esophageal strictures treated with expandable metallic stents, leading Ackroyd and associates¹⁰ to warn against their use.

Wire mesh prostheses covered with polyvinyl chloride had no advantage because granulations still grew over either end. Purulence is often found causing halitosis. Granulations are probably promoted by bacterial or fungal infection of inflammatory strictures and by placement of stents near the vocal cords. Indeed, 80% of our patients had positive airway cultures. Noppen and associates encountered new airway colonization in 50% of stents, but not clinical infection.¹¹ However, their observation period was short (4 weeks). Exchanging or adding another stent did not relieve symptoms and lengthened the injury, rendering it unresectable. Removal of granulations was followed by their recurrence. A careful review of these prostheses should also include the numerous endoscopic procedures necessary, often at intervals of weeks, to keep the airway open. Complications may have a profound impact on the quality of life. In 5 patients with localized original lesions, endoluminal stenting resulted in the loss of any chance to regain a device-free airway, and in 4 patients hoarseness was caused by a new subglottic stricture.

Curative tracheal resection, predictably successful in original postintubation lesions,¹² is technically difficult in

these extensive, stent-induced injuries. We are concerned how easily surgical reconstruction is dismissed. Schmidt and associates,¹³ for example, inserted endoluminal silicone Dumon stents into 39 patients with postintubation injuries over 4 years, roughly 10 patients per year, and did not report tracheal resection. At a referral center for airway disorders, in contrast, we noted an annual rate of only 4 T-tubes (86 over 23 years, many of them temporary)⁴ and 18 tracheal resections (503 over 27 years) for postintubation strictures.¹² In our reported experience of over 500 tracheal resections, the operative mortality was 2.4% and good or excellent results were achieved in 94% patients, including patients with advanced emphysema and heart failure and 18 patients who had previously undergone resection. In light of our experience, an enthusiastic attitude toward endoluminal stents is unfounded and a preference for stents over surgical repair in the absence of true contraindications is not supported by evidence. Tracheal strictures should not be declared unresectable unless evaluated by a surgeon experienced in tracheal reconstruction.

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