R.M. MROZ\textsuperscript{1}, K. KORDECKI\textsuperscript{2}, M.D. KOZLOWSKI\textsuperscript{3}, A. BANIUKEWICZ\textsuperscript{4}, A. LEWSZUK\textsuperscript{2}, Z. BONDYRA\textsuperscript{2}, J. LAUDANSKI\textsuperscript{3}, A. DABROWSKI\textsuperscript{4}, E. CHYCZEWSKA\textsuperscript{1}

SEVERE RESPIRATORY DISTRESS CAUSED BY CENTRAL AIRWAY OBSTRUCTION TREATED WITH SELF-EXPANDABLE METALLIC STENTS

\textsuperscript{1}Department of Pneumology, \textsuperscript{2}Department of Radiology, \textsuperscript{3}Department of Thoracic Surgery, and \textsuperscript{4}Department of Gastroenterology and Internal Medicine, Bialystok Medical University, Bialystok, Poland

We investigate retrospectively the efficacy of self-expandable metallic stents (SEMS) for severe respiratory distress (SRD) in patients with central airway obstruction (CAO). Thirty three patients with CAO were treated with SEMS using fiberoptic bronchoscopy method. We found an intraluminal obstruction present in 7, extraluminal compression in 10, and combined stenosis in 16 cases. Tumor infiltration occupied more than 90\% of the endoluminal diameter in 21, 70\% in 9, and 50\% in 3 cases. Obstruction was caused by primary cancer of lung in 23, thyroid in 5, and esophagus in 5 patients. Up to 3 stents per patient were placed. Double stenting (esophagus and trachea) was required in five patients. All patients exhibited symptomatic and arterial blood gas improvement. The mean follow-up was 65 (5 to 752) days. SEMS are useful for the treatment of SRD caused by CAO. The overall effect is related to the degree of tumor progression itself.

\textbf{Key words}: central airway obstruction, expandable metallic stents

INTRODUCTION

Significant airway obstruction leading to severe respiratory distress requires immediate action to promptly regain the airway passage (1). Obstruction is caused by intraluminal tumor growth, extraluminal tumor compression or its combination (Fig. 1). In addition, severe respiratory distress and poor physical condition may provide little room for timely and safe intervention, so immediate action is
warranted. The most common etiology for a central airway obstruction (CAO) is a primary or metastatic carcinoma of the lung, direct infiltration of esophageal carcinoma, tumors of thyroid gland or mediastinal lymph node metastasis from other primary tumors. CAO leads to morbidity with life-threatening symptoms. Various treatment modalities have been developed for the management of an inoperable malignant stricture in the central airways. In the palliative setting of alleviating central airway obstruction, laser resection, electrocautery, argon plasma coagulation, and stenting are techniques that can provide immediate relief, in contrast to cryotherapy, brachytherapy, and photodynamic therapy with delayed effects (2-4). Recently, stents initially developed for the treatment of vascular stenosis have been adapted for use in the tracheobronchial tree (5-8). Here, we describe our experience using expandable metallic stents (SEMS) in patients with tracheobronchial strictures caused by various diseases.

MATERIAL AND METHODS

Expandable Metallic Stents

The SEMS used were cylindrical structures made of stainless-steel wire. The stents were available in lengths of 20 mm up to 90 mm and were constructed of 0.45 mm stainless-steel wire. The wires were shaped into cylinder (Boston Scientific Wallstent, USA). The complete implantation kit included a flexible insertion guide wire, and introducer sheath.

Technique

The stent was inserted in its compressed form into the introducer sheath using the stent pusher. Bronchoscopy was performed under local or intravenous anesthesia to inspect the stricture and clear the airway of any secretions. The tip of the bronchoscope was then positioned immediately above the stricture. The flexible guide wire was passed through the stricture under fluoroscopic control. Two radio-opaque markers were placed on the skin of the chest to outline the extent of the stricture. Once the guide wire was in place across the stricture, the bronchoscope was withdrawn and again inserted to allow visualization. Then the sheath was inserted over the guide wire. The stent was pushed down and held in position then the sheath was withdrawn, allowing the stent to be released across the stricture. Additional stents were applied for longer strictures. The stent position was assessed using fluoroscopy and bronchoscopy. Finally, chest radiographs were obtained to confirm the position of the stent.

Pre-stenting studies

Initially, the stricture, the level and the length of obstruction were assessed using chest radiographs and computer tomography. Careful endoscopic examination of the airway was carried out to verify the site and extent of the lesion.

Patients

The study was approved by a local Ethics Committee. The stenting procedure is part of a recognized clinical treatment. There were 33 patients, 28 men and 5 women, ranging in age from 47 to 72 years (mean 60, 8 years) who underwent stenting between October 2001 and December 2006.
The etiology of the obstruction included a primary lung carcinoma (n=23), an esophageal carcinoma (n=5), and thyroid carcinoma (n=5). The stented stenotic segment involved both main-stem bronchi (n=1), the trachea alone (n=11), the trachea and one main-stem bronchus (n=11), the trachea and both main-stem bronchi (n=6), the trachea and esophagus (n=4). The cause of the airway stenosis was extraluminal compression (n=10), intraluminal obstruction (n= 7), or combined stenosis (extraluminal compression and intraluminal obstruction) in 16 cases (Table 1). All the patients with intraluminal obstruction had squamous cell lung carcinoma. Of the ten patients with extraluminal compression, there were five with thyroid carcinoma, four with thyroid carcinoma and one with esophageal carcinoma. Of the sixteen patients with combined stenosis, there were ten with squamous cell lung cancer, two with small cell lung cancer, and four with esophageal carcinoma. The number of stents used per patient ranged from one to three. Stents were inserted at one procedure in all patients.

None of the patients received additional endobronchial therapy. The patients were evaluated by clinical response and by improvement in blood oxygenation measured by oxygen saturation (SaO₂) and oxygen partial pressure (PaO₂).

RESULTS

Placement of the stents was relatively simple. Stenting was performed successfully in all 33 patients. No migration of the SEMS occurred and none of the patients complained of post-operative respiratory symptoms, such as coughing, discomfort, or other evidence of tracheobronchial irritation. All of the patients received SEMS during one procedure. All patients showed relief from distress and were followed for 5-752 days (Table 1). The mean follow-up period

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was 65 days (December 31st, 2007). Relief from stridor was dramatic and occurred within hours soon after the procedure.

All patients were improved in symptoms, PaO$_2$, and SaO$_2$ after insertion of the SEMS (Fig. 1). Follow-up examinations were performed in our institution. The tumor occupied more than 90% of the endoluminal circumference in 21 patients, more than 70% in nine patients, and more than 50% in three patients. Death in the late post-operative period occurred as a result of progression of the primary disease without evidence of central airway obstruction.

**DISCUSSION**

Endoluminal implantation of stents has evolved as a nonsurgical, minimally invasive treatment option of stenosis of the upper airway tract as a valuable
adjunct to other therapeutic bronchoscopy techniques to relieve airway obstruction (8, 9). Rigid bronchoscopy secures a stable airway, permits better endoscopic visualization, allows much more room for maneuver and adjustment within the airway conduit, and all types of stents can be inserted. Flexible bronchoscopy alone or through an orotracheal tube can be used to insert only self-expandable stents, although fluoroscopy control is often necessary to ensure optimal placement. The indications of stent placement are listed in Table 2 (10). Over 80% of patients with tumor-related stenosis who were treated by therapeutic bronchoscopy and airway stenting presented immediate symptom improvement in recent series (11). Dramatic relief in stridor has been observed after stenting, and cumulative evidence suggests beneficial effects of stent placement in selected patients (12-14). Similar for our observation in malignant esophageal/tracheobronchial stricture cases, dyspnea and dysphagia were also significantly decreased after parallel placement of covered expandable nitinol esophageal and airway stents (15). The improvement in functional tests after stent placement has been described (16).

An ideal stent should have the following properties: be easy to insert and remove, should not migrate, be made of a biocompatible material, should not cause obstruction of segmental openings, should not impair mucociliary clearance, adapt to the varying dimensions of the airways during respiration and coughing, and should be visible on an ordinary radiograph. The SEMS include all of above mentioned excluding its removability (17). It is well tolerated, requiring only a flexible bronchoscope procedure. All of the patients exhibited dramatic improvement in their respiratory symptoms after stenting, despite the nature of the stenosis. We did not observe migration, stent fracture or perforation of the airway wall in our series. Granulation tissue formation and mucus plugging, which is commonly reported had minor impact on the final outcome of our patients. This excessive reaction, resembling a foreign body reaction may lead to formation of webs and recurrent stenosis (18). Sawada et al (19) have reported the emplacement of Gianturco stents in the trachea of dogs. Their histological examination confirmed that endothelialization over the stent takes place by 3 weeks with the formation of ciliated columnar epithelium on the luminal surface and the stent does not appear to penetrate beyond the cartilage. Notably, some investigators recommends these stents should not be placed in the airways due to association with fatal complications (1). A disadvantage of the Wallstent is the propensity to form granulation tissue at its proximal and distal ends due to the irritation from the uncovered end fibers (1). Because of the relatively short period of the observation we did not observed such complications. Covered stents offer a barrier effect, but sputum retention is a problem as for silicone. Respiratory secretions are capable of damaging polyurethane membranes and degradation has been reported when such stents were inserted in the airway for long periods. In our series we did not performed complementary endoluminal therapy. The use of SEMS has been reported for the treatment of benign and malignant
tracheobronchial stenosis (1, 2, 7-12). Miyazawa et al (20) have reported that the uncovered Ultraflex stent can be used in all locations and in certain complicated situations, such as: long stenosis of varying diameters, narrow stenosis, hourglass stenosis, curvilinear stenosis, and bilateral main-stem bronchi stenosis. Stenting should be undertaken with caution and only after careful consideration in patients with elevated bleeding times or coagulopathies, and a tumor stricture adjacent to a major vessel (18). Stent insertion is contraindicated in patients for whom bronchoscopic procedures are contraindicated (18). The results of airway stenting, although generally positive, are varied. Follow-up after stenting is often inadequate, and several different clinical endpoints may be used to evaluate success. In our series we found overall improvement in blood oxygenation. Measurements of pulmonary function seem to be a more accurate alternative, even though it provides variable results (21, 22).

Malignant central airway obstruction is difficult to manage and is associated with poor outcome, ranging between 3.4 and 8.2 months of post stenting survival time (14, 23). Stenting may function as a bridge until further curative treatment can be used (14). Added benefits of adjuvant therapy in those patients who received radiation therapy after airway stenting have recently been reported (14). In patients with advanced cancer and malignant airway obstruction, therapeutic bronchoscopy and airway stenting might improve survival (23). Shaffer at al (24) have described the use of SEEMS to facilitate extubation in CAO patients. As other authors, we found the following advantages of Wallstents: migration of the stent is uncommon, neoeptithelialization helps preserve mucociliary action, and stent exhibits a certain degree of dynamic compression with coughing and respiration, ease of insertion (1, 14). In addition it may easily be used in patients with mechanical ventilation; patients can be easily intubated through the tracheal stent (1). We conclude that SEEMS are useful for the treatment of severe respiratory distress caused by extraluminal and intraluminal stricture in the central airways, providing efficient palliation of symptoms, and the overall effect of SEEMS for stenosis is related to the degree of infiltration and of tumor progression itself.

Conflicts of interest: The authors had no conflicts of interest to declare in relation to this article.

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Author’s address: Robert M. Mroz, Department of Pneumology, Bialystok Medical University, Zurawia 14 St., 15-540 Bialystok, Poland; e-mail: robmroz@wp.pl