Therapeutic Bronchoscopic Intervention With Resector Balloon

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Abstract: In this study a novel therapeutic bronchoscopic technique, balloon bronchoplasty with resector balloon, was used in 128 procedures for 112 consecutive patients with airway obstruction from lung cancer or granulation tissue. All procedures, except 4, were performed with a rigid bronchoscope under general anesthesia. The remainder were performed with a flexible bronchoscope under local anesthesia. In all procedures, balloon bronchoplasty was the primary method and we achieved 100% success with no major immediate or long-term complications. The technique also facilitated submucosal and distal tumor resection. We found balloon bronchoplasty using resector balloon to be a safe, effective, fast, easy, and potentially cost-effective method in the management of airway obstruction from endobronchial submucosal lesions.

Key Words: bronchoscopy, airway obstructions, endoluminal airway tumors

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Various endobronchial techniques, such as laser photoresection, endobronchial electrosurgery, argon plasma coagulation, cryotherapy, stent placement, and balloon bronchoplasty are used either singly or in combination, on the basis of location and type of lesion, either through a rigid or a flexible bronchoscope.[1–6] A newly proposed endobronchial method using a resector balloon can also be used for this purpose, which has some advantages over the above methods. It can be performed more easily and effectively even in distal airways, with an acceptable rate of complication. This method also is effective when dealing with submucosal concentric obstruction.[7]

We used a resector balloon in 128 interventions for endoluminal and submucosal obstruction of the trachea, main lobar, and segmental bronchi. In all interventions, endoluminal lesions were completely resected by resector balloon alone. This article describes our experience with the resector balloon in detail (Figs. 1 and 2).

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PATIENTS AND METHODS

Informed consent was obtained from each patient before the procedure. This study was approved by our Institutional Ethics Committee.

"Resector balloon" is composed of a 120-cm-long single lumen polyethylene tube of 2 mm outer diameter. On its distal end a latex balloon is mounted. The length of the balloon varies between 10 and 40 mm, depending upon the length and location of the lesion (10, 15, 20, and 40 mm). The maximum inflated diameter of the balloon also varies (10 mm, 15 mm, and 20 mm). The balloon is covered with a hexagonal mesh structure made of 0.3-mm-thick polyurethane fibers. When the balloon is inflated just at the level of endoluminal tumor, the polyurethane fibers around the balloon cut and destroy the tumoral tissue. At the same time the balloon tamponades the tumor tissue to minimize bleeding. Thus, the resector balloon when inflated endoluminally can be used for mechanical destruction and removal of the endobronchial lesions without significant bleeding.[7]

Before the operation, all patients were evaluated by a cardiologist and an anesthesiologist, premedicated

FIGURE 1. Resector balloon passed through the flexible bronchoscope. a+

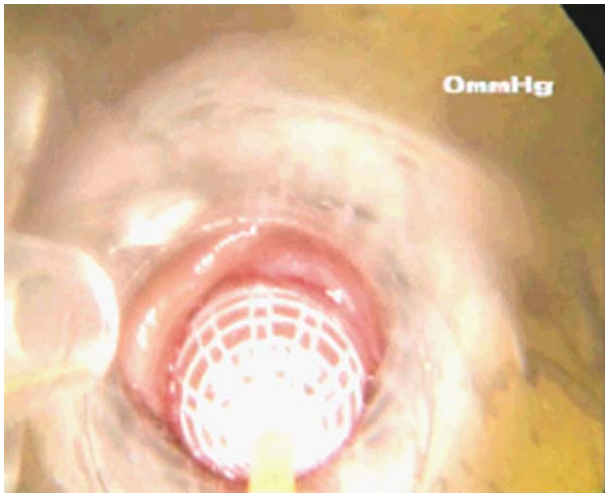

FIGURE 2. Interventional bronchoscopy session with resector balloon. *a+*

and given antibiotics. Except for 4 interventions, all interventions were performed under general anesthesia via rigid and flexible bronchoscopes. In 4 interventions, midozolam (0.05 mg/kg) and lidocaine were used for local anesthesia. We used Dumon-Harrel Rigid Bronchoscope and Olympus Therapeutic Bronchoscope BF-XT, which has a 3.2 mm channel diameter. We used the resector balloon in all cases that had endoluminal and submucosal lesions according to the procedure described earlier.[7]

RESULTS

Between April 2006 and September 2007, 112 patients (92 men and 20 women; age range, 19 to 90 y; mean age 55.1 y) with tracheobronchial obstruction due to malignancy (n = 110) and granulation tissue (n = 2) were admitted to our clinic. The symptoms included dyspnea, stridor, fever, respiratory insufficiency, and hemoptysis, in combination with hypoalbuminemia, rise of white blood cell count, and C-reactive protein due to postobstructive pneumonia. Diagnoses were established by reviewing the patient's history, computerized tomography (three-dimensional reconstructions), and bronchoscopy. Except for 2 male patients with postintubation tracheal stenosis and 10 newly diagnosed cases, previous chemotherapy and radiotherapy had been given in all of malignant cases. Patient demographics are summarized in Table 1.

Lesions were in the proximal trachea in 3, distal trachea in 1, carina and bilateral main bronchi in 13, left main bronchus in 11, left main upper and lower lobe bronchi in 13, left upper bronchus in 2, left lower lobe bronchus in 3, right main bronchus in 16, right main—intermediate and lower lobe bronchi in 19, right intermediate—middle and lower lobe bronchi in 19, right upper lobe bronchus in 4, and right lower lobe bronchus in 8 cases. Some patients had more than 1 lesion. In all interventions, endoluminal and submucosal lesions were completely resected by resector balloon alone. We inserted a silicone stent at the tracheal location in 2 cases who had postintubation tracheal stenoses, straight silicone stent in trachea in a patient with tracheal adenoid cystic carcinoma, a Y-silicone stent at the left secondary carinal level in 2 cases with nonsmall cell carcinoma, and a straight silicone stent at the right main bronchus (3), right intermediate bronchus (3), and left main bronchus (2) in 8 cases with nonsmall cell carcinoma.

Resector balloon was used in 128 interventions. Endoluminal and submucosal lesions were completely resected by resector balloon alone and no other additional resection technique was necessary. The airway patency was maintained in all cases. Complications such as bleeding, perforation, or

TABLE 1. Patient Demographics

Variable	Value
Patients	112
Age (y)	19-90 (55.1)
Male/female	92/20
Symptoms	
Dyspnea	109
Fever	106
Hemoptysis	57
Cough	110
Stridor	59
Respiratory insufficiency (NIMV)	33
Respiratory insufficiency (MV)	11
Diagnosis	
Nonsmall cell lung cancer	85
Small cell lung cancer	17
Adenoid cystic carcinoma	1
Metastatic lung cancer	7
Granulation tissue (postintubation tracheal stenosis)	2
Location of lesion	
Trachea	4
Carina-bilateral main bronchi	13
Left main bronchus	11
Left main bronchus—left upper and lower lobes	13
Left upper lobe bronchus	2
Left lower lobe bronchus	3
Right main bronchus	16
Right main—intermediate-lower lobe bronchus	19
Right intermediate—middle-lower lobe bronchus	19
Right lower lobe bronchus	8
Right upper lobe bronchus	4
Previous treatment	
Chemotherapy	88
Radiotherapy	34
Therapeutic bronchoscopy	9

MV indicates mechanical ventilation, NIMV, noninvasive mechanical ventilation.

decreased oxygen saturation were not observed during the procedures. Stenting was also performed for external compression in 13 interventions.

Durations of the interventions ranged from 17 to 98 minutes. The mean intervention period was 38 minutes.

Except for 1 female patient, all patients were extubated in the operating room. All patients reported significant improvement in their respiratory symptoms. Respiratory distress was relieved in 43 patients who required mechanical or noninvasive mechanical ventilation. During the follow-ups, the day after the procedure, complete airway patencies were confirmed by three-dimensional thoracic computed tomography in all patients.

Despite initial complete endoluminal resections, a repeat session was necessary in 3 cases because of tumor relapse in a 3-month period. In one case, therapeutic bronchoscopic intervention was applied in 5 different sessions. The patient had a metastatic pancreatic tumor and nearly all of the segmental bronchi were obstructed with endoluminal tumor and her general status was very poor. She was intubated because of respiratory insufficiency. After maintaining bilateral main bronchial lumen patency by the first therapeutic intervention, it was observed that left upper and lower lobe segment bronchi, and right lower and middle lobe segment bronchi were obstructed by tumoral masses. Because of her general status (World Health Organization performance scale 4), individual sessions were applied for each different location. For the upper lobar and segmental lesions, resector balloon was used via flexible bronchoscope placed through a rigid bronchoscope. She died 1 month later in intensive care unit due to *Pseudomonas aeruginosa* sepsis. One male patient died 5 days after intervention because of acute pulmonary embolism from acute deep venous thromboembolism involving the right leg.

DISCUSSION

Owing to factors limiting outcomes from endobronchial therapy, such as the location of the tumor, the type of its invasion, complication risk of a specific resection method, and required procedure time, the search continues for a more efficient modality. Although it is easy to perform therapies, such as laser photoresection, electrosurgery, and cryotherapy, in large airways, risk of complication increases when the tumor is located more distally.[4,5,8] Resector balloon introduced through a flexible bronchoscope can be easily used to open up upper lobar and distal airways. In addition, dilatation and bleeding control can be carried out simultaneously.[7] Balloon bronchoplasty is easy to perform, besides being a cylindrical resector device, and it treats the lesions in 360-degree circumference.

Resection of submucosal tumors is difficult because of a risk of perforation. Laser photoresection, electrosurgery, or cryotherapy cannot be performed in concentric submucosal lesions. The tip of the rigid bronchoscope can cause complications such as bleeding and destruction of normal bronchial cartilage when used for mechanical resection.[6] Although stent placement facilitates submucosal concentric lesions, it is not without complications. Brachytherapy and photodynamic therapy are performed for submucosal lesions for their delayed effect, yet their long-term complications, which include necrosis and massive hemoptysis, could be fatal.[9] We believe that submucosal lesions can be resected without destroying the normal bronchial wall using the resector balloon.

It was further demonstrated that the duration of intervention was also very short. The procedure time was less than 40 minutes, potentially reducing duration-related complications.

Use of resector balloon tamponade technique eliminates laser photocoagulation, argon plasma coagulation, and related complications.

Resector balloon is gentle and only removes the endoluminal lesions. Complications such as heavy bleeding, cartilage destruction, and perforation are not observed. The procedure can be performed under local anesthesia.

In conclusion, we believe that resector balloon can be used as a unique tool in the management of airway obstructions from endobronchial and submucosal lesions.

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