Cryotechnology for Staged Removal of Self-Expandable Metallic Airway Stents

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Self-expandable covered metallic airway stents (SEMAS) deployed for relieving inoperable central airway obstruction frequently develop complications that require removal of the device. Current techniques for SEMAS removal also involve serious complications. We are reporting a novel two-staged endoscopic approach using cryotechnology for removal of SEMAS obstructed by exuberant granulation tissue in two patients. During the first stage, the obstructing intraluminal granulation tissue was removed with cryodebridement and residual extraluminal deposits were lysed with cryotherapy. During the second stage, performed two days later, the SEMAS was liberated by mechanical means and removed in one piece. The staged approach with cryotechnology was successful and without complications.

Case Reports

Patient 1 is a 71-year-old woman with fibrosing mediastinitis and who developed progressive dyspnea and a productive cough. Chest computed tomography (CT) scan revealed an obstruction of the left main stem bronchus with marked distortion of the airway anatomy, precluding the placement of a silicone stent. An Ultraflex covered 14 × 40-mm stent (Boston Scientific, Natick, MA) was inserted without complications. Three months later, flexible bronchoscopy revealed minimal granulation tissue at the distal end of the stent. The patient was lost to follow-up for 14 months; she then returned with intermittent fever, productive cough, wheezing, and dyspnea. The CT scan (Fig 1) and rigid bronchoscopy revealed high-grade obstruction of the stent by granulation tissue (Figs 2, 3). The obstruction was relieved by cryodebridement, cryotherapy, and balloon dilatation during a 90-min intervention. Because of a marginal pulmonary reserve, the patient’s lungs were ventilated mechanically for 2 d, and the stent was separated from the bronchus with a #8 Fr Jackson dilator through a rigid bronchoscope. The device was removed in one piece without complications. The patient was extubated and discharged from the hospital 2 d later. The airway stenosis recurred at 3 months, requiring balloon dilatation and mitomycin C application. Subsequently, the dilatations with mitomycin C application were repeated every 12 months.

Patient 2 is a 55-year-old man with stage IIIA squamous cell lung carcinoma obstructing the left main stem bronchus; he underwent tumor debulking through a rigid bronchoscope. An Ultraflex covered 12 × 30-mm stent (Boston Scientific, Natick, MA) was inserted and followed by a course of chemoradiation. One year later, dyspnea and productive cough developed. A chest CT scan demonstrated obstruction at the distal end of the stent, and rigid bronchoscopy revealed excessive granulation tissue in-growth. Cryodebridement, cryotherapy, and balloon dilatation were performed through a therapeutic flexible bronchoscope. The patient was extubated after the procedure. Two days later, the stent was freed circumferentially with a #8 Fr Jackson dilator and removed in one piece with rigid forceps through a rigid bronchoscope. Minor bleeding was controlled with APC and the...
The patient was discharged from the hospital. Surveillance bronchoscopy 2 months later revealed occlusion of the left main stem bronchus by concentric complex stenosis. Balloon dilatation was performed, and a silicone stent was inserted.

**Technique**

The technique described in this communication can be modified by the demands of the clinical situation and judgment of the operator. The first stage is performed with a flexible bronchoscope (BF type XT 160; Olympus, Tokyo, Japan) inserted inside a rigid barrel (Bryan Dumon Series II; Bryan Corporation, Woburn, MA) to secure the airway and facilitate oxygenation as well as ventilation. A 1.9 mm flexible cryoprobe (ERBOKRYO CA; ERBE, Tubingen, Germany; Fig 4) is introduced into the working channel of the flexible bronchoscope. For cryodebridement, the probe is advanced until its tip reaches the target tissue. Pressurized nitrous oxide is delivered into a closed channel circuit in the probe and the tip is cooled to ~89.5°C according to the Joule–Thompson effect. Contact between cold probe tip and target tissue for 5–10 s freezes up to a 10-mm³ tissue mass that adheres to the cryoprobe. The flexible bronchoscope is withdrawn along with the probe and frozen tissue (Fig 5B). This maneuver is repeated at the 2, 4, 6, 8, 10, and 12-o’clock positions until most of the obstructive tissue is removed. Next, the cold probe is advanced to the residual granulation tissue or tumor between struts for 20–30 s. Spontaneous thawing of the frozen tissue adherent to the tip of the probe promotes cell death of the extraluminal granulation tissue during the next 48 h. The maneuver is repeated circumferentially at the proximal and distal ends of the stent. Care is exercised to avoid contact between the cryoprobe and strut of the stent. Finally, the bronchial lumen is dilated with a balloon inside the stent to its maximal diameter for 30 s to maintain patency and obtain hemostasis.

Fig 1. Three-dimensional reconstruction showing critical narrowing at the distal end of the metallic stent.

Fig 2. Granulation tissue at the proximal end of the stent.

Fig 3. Granulation tissue at the distal end of the stent.

Fig 4. Flexible cryoprobe. Outer diameter, 1.9 mm; length, 90 cm.
A 2-day interval was selected between the first and second stages of the procedure, because tissue necrosis with sloughing takes place during the first three days after cryotherapy for airway obstruction by large tumors.

During the second stage, a rigid bronchoscope is used and residual debris is removed with flexible forceps. A #8 Fr Jackson dilator is inserted between the stent and the airway at the 3, 6, 9, and 12-o’clock positions to liberate the device. The stent is then grasped by a rigid forceps and pulled with a twisting motion into the lumen of the rigid bronchoscope, which is then withdrawn. Balloon dilatation is repeated to maximize airway diameter and promote hemostasis. If bleeding persists, APC was used.

Comment

Current methods for removing SEMAS are technically challenging and are associated with complications that include mucosal tear at times with bleeding, airway obstruction, respiratory failure, tension pneumothorax, retained stent particles, death, and the potential of fire in the airway [1].

Cryotechnology has been used for debriding and recanalizing larger airways, but to our knowledge the method has not been used for the removal of SEMAS. Schuman and colleagues [4] reported on cryodebridement of airways obstructed by malignant and benign tissues in 225 patients. The technique proved simple, easy to perform, and successful in 91.1% of the cases without serious complications. Maiwand and colleagues [5] used cryotherapy successfully in 64 patients for lysing excessive granulation tissue at bronchial anastomoses following lung transplantation. The available experience confirms the safety, efficacy, and relative low cost of cryotechnology. Our clinical experience offers new evidence that cryodebridement combined with cryotherapy could represent improvement over presently used methods for removal of SEMAS. The approach merits further evaluation.

Rigid bronchoscopy is preferred for both stages of the procedure because it provides a secure airway and facilitates oxygenation, ventilation, and hemostasis. It also permits the use of rigid instruments with superior grasping power.

Removal of a SEMAS in a single stage would seem preferable, but at the present state of the art, the procedure is likely to consume an unduly long period that increases the risks of serious complications with extended length of hospitalizations and a high cost.

Although recanalization was achieved in both patients, we elected to remove the SEMAS because in our experience, retention of the device following stent revision experienced an accelerated progression of granulation tissue formation, probably related to local inflammation in the presence of a foreign body.

Current methods for SEMAS removal involve multiple endoscopic procedures, use of expensive equipment, long hospitalizations, and high cost [4]. Our limited experience and available information in the literature suggest that removal of a SEMAS by cryotechnology probably requires fewer interventions with fewer complications, shorter hospitalizations, and lower cost than current methods. Removal of SEMAS using cryotechnology during a two-staged approach merits trial as a first-line technique. Further experience is necessary to confirm this recommendation.

References