Study objectives: Massive hemoptysis is a life-threatening condition. Therapeutic strategies such as interventional angiography, surgery, and/or bronchoscopy have been applied in the clinical setting with variable results. We investigated the efficacy of bronchoscopy-guided topical hemostatic tamponade therapy (THT) using oxidized regenerated cellulose (ORC) mesh in the management of life-threatening hemoptysis.

Design: Seventy-six consecutive patients underwent emergency bronchoscopy for massive hemoptysis. Fifty-seven patients (75%) had persistent endobronchial bleeding despite bronchoscopic wedging technique, cold saline solution lavage, and instillation of regional vasoconstrictors. These patients subsequently underwent THT according to the same procedure.

Setting: Teaching hospital, bronchoscopy unit of a 300-bed tertiary pulmonary referral center.

Results: THT with ORC was successfully performed on 56 of 57 patients (98%) with an immediate arrest of hemoptysis. All patients successfully treated with THT remained free of hemoptysis for the first 48 h. None required intensive care support or immediate surgery. Mean procedure time (± SD) of THT was 11.5 ± 4.2 min. Recurrence of hemoptysis that was characterized as being mild (< 30 mL) to moderate (30 to 100 mL) developed in six patients (10.5%) 3 to 6 days after THT. Postobstructive pneumonia developed in five subjects (9%) after endoscopic THT. A subgroup of patients (n = 14) underwent bronchoscopic follow-up 4 weeks after discharge. The ORC mesh was absorbed in all of these patients without signs of foreign body reaction.

Conclusions: Endobronchial THT using ORC is a safe and practicable technique in the management of life-threatening hemoptysis with a high success and a relatively low complication rate.

Key words: bronchoscopy; hemoptysis; hemostatic therapy; oxidized regenerated cellulose; tamponade

Abbreviations: BAE = bronchial artery embolization; ORC = oxidized regenerated cellulose; THT = topical hemostatic tamponade therapy

Acutely massive hemoptysis is a life-threatening condition associated with a high mortality rate ranging from 23 to 85%.1 The main threat in the acute phase remains asphyxiation resulting from flooding of the airways and alveoli with blood. Maintenance of airway patency and control of bleeding are therefore the primary goals, followed by identifying the site and the underlying cause of bleeding. Correctly inserted double-lumen endotracheal tubes may achieve some of these goals through isolation of the affected lung and adequate ventilation of the nonaffected lung. However, these tubes carry significant risks2,3 and are difficult to place properly.4 In a survey,5 the majority of responding chest physicians acknowledged a lack of proficiency with placement of the double-lumen tubes. Other therapeutic techniques in the management of massive hemoptysis are early endoscopy, bronchial artery embolization (BAE), and/or surgery.

*From the Department of Respiratory and Critical Care Medicine and the Ludwig-Boltzmann Institute for COPD, Otto-Wagner-Hospital, Vienna, Austria.

Manuscript received May 18, 2004; revision accepted December 7, 2004.

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Correspondence to: Arschang Valipour, MD, Department of Respiratory and Critical Care Medicine, Otto-Wagner-Spital, Sanatoriumstr. 2, 1140 Wien, Vienna, Austria; e-mail: arschang.valipour@wienkav.at

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Temporary control of hemoptysis using bronchoscopy may be achieved with cold saline solution lavage, instillation of topical vasoconstrictive agents, and/or balloon tamponade therapy. Although regional instillation of vasoconstrictors is useful in cases of less severe bleeding, its role in massive hemoptysis is uncertain. Endobronchial blocking techniques using a Fogarty balloon catheter enable the physician to occlude the bleeding bronchus on a segmental level, thus providing more lung tissue for gas exchange. Difficulties in positioning the catheter and problems with removal of the bronchoscope over the Fogarty, however, might discourage its use in clinical practice.

We have developed a method that overcomes most of the problems mentioned above. Our experience with this bronchoscopy-guided topical hemostatic tamponade therapy (THT) in patients with life-threatening hemoptysis is outlined below.

**Materials and Methods**

**Setting**

Interventional bronchoscopy unit of a 300-bed respiratory and critical care medicine referral center in Vienna with an average of 2,200 bronchoscopic procedures per year over the past 3 years.

**Patients**

From January 2000 to January 2004, 486 patients underwent bronchoscopy for hemoptysis at our institution. Of these, 76 patients (15%) required emergency bronchoscopy for massive hemoptysis. The definition of massive hemoptysis was based on a bleeding rate > 150 mL of expectorated blood per hour, or a documentation of at least 150 mL of expectorated blood on one occasion, plus clinical consequences such as impaired respiratory function with a PaO₂ < 60 mm Hg (≈ 8 kPa). Blood was drawn for a CBC count, arterial blood gas, coagulation profile, electrolytes, blood typing, and cross-match for each patient. Patients were monitored using heart rate, arterial oxygen saturation, and BP. If a physical examination and/or a chest radiograph were able to lateralize the site of bleeding, the patient was positioned on their bleeding side until bronchoscopy. Every patient received supplemental oxygen, IV access for fluid resuscitation, antibiotics (in case of documented or suspected bacterial infection), and/or tuberculostatic treatment for those with active tuberculosis. The study was approved by the institutional ethics committee.

**Bronchoscopy**

The procedure was performed under total IV anesthesia. A rigid bronchoscope was inserted in the standard manner, and ventilation commenced using high-frequency jet ventilation through a side port of the bronchoscope. The central airways were cleared of blood with a large-bore suction catheter, and large forceps were used to facilitate blood clot debridement if present. Once the bleeding side was identified, the patient was tilted head down (approximately 10°) and toward the bleeding side to maximize protection of the contralateral side. A flexible bronchoscope with an aspiration channel of 2.2 mm (Olympus; BF-P40; Vienna, Austria) was inserted through the rigid bronchoscope to confirm the hemorrhaging site and clear the peripheral airways from blood. Once the exact bleeding location was determined, the bronchoscope was placed into a wedge position in the bleeding bronchus, and a cold saline solution lavage was started, followed by the instillation of a 1:20,000 epinephrine solution. Patients who were successfully treated following this procedure were excluded from the study. In addition, we excluded those patients who had no evidence of current endobronchial bleeding on bronchoscopy.

All endoscopically visible abnormalities were sampled for diagnostic examination, brushed, or lavaged for adequate specimens. Bronchoscopically nonvisible but radiologically suspected abnormalities were sampled or brushed only when the subsegmental bronchus leading to the pathology was an actively bleeding subsegment.

**Bronchoscopic THT**

THT was performed on patients with persistent endobronchial bleeding despite wedging, cold saline solution lavage, and regional instillation of epinephrine. The hemostatic agent used was oxidized regenerated cellulose (ORC) [Surgicel; Ethicon; Somerville, NJ]. ORC is a sterile, knitted fabric. After it has been saturated with blood, it swells into a brownish or black gelatinous mass that aids in the formation of a clot, thereby serving as a hemostatic adjunct in the control of bleeding.

The ORC mesh is supplied as a knitted fabric strip that can easily be trimmed to custom sizes for use in endoscopic procedures. After it has been cut to the appropriate size, the hemostat is grasped with biopsy forceps at one end and then pulled back into the operating channel with a steady backward motion until it is enclosed in the end of the flexible bronchoscope (Fig 1). The maximum size of hemostat that can be pulled into the 2.2 channel of the bronchoscope is approximately 30 × 40 mm. After identification of the bleeding site, the ORC is placed selectively into the bleeding bronchus as far as peripherally possible but within the bronchoscopists endobronchial view. The ORC mesh conforms and adheres readily to irregular surfaces and crevices, allowing endobronchial tamponade from the subsegmental to the lobar bronchus level, even in the presence of carcinomatous infiltration of the bronchial lumen. Depending on bleeding severity and/or bronchus diameter, between 4 and 10 layers of the mesh were used to provide a tight blockade of the bronchus.

**Effectiveness of Therapy**

THT was considered successful when massive hemoptysis was controlled and patients remained free of hemoptysis for at least 48 h. A record was made of the peri-interventional and postinterventional complication rate, duration of hospitalization, necessity of BAE or repeat bronchoscopy, need for intensive care support, and/or surgery. Patients were monitored over an additional 1-year period.

**Bronchoscopic Follow-up Study**

A randomly selected subgroup of patients (n = 14) underwent repeat bronchoscopy after 3 to 4 weeks to determine absorption characteristics of endobronchial ORC placement. Endobronchial mucosa biopsies were performed at the site of original ORC placement to assess histologic tissue reaction.
Results

Patient Characteristics

Of the initial 76 patients, 6 were excluded because of a failure to visualize recent endobronchial bleeding, and an additional 13 patients were excluded because they responded well to topical instillation of vasoconstrictive agents and/or iced saline solution lavage. Data reported is on the remaining 57 patients (40 were male and 17 were female; mean age [± SD], 56 ± 17 years).

Underlying Diagnosis of Life-Threatening Hemoptysis

The underlying diagnoses of life-threatening hemoptysis and the respective bleeding sites are presented in Table 1. Lung cancer (35%) and tuberculosis (23%) were the most common diagnoses. Other etiologies were endobronchial metastatic disease, bronchiectasis, and vascular malformation. No specific cause could be identified in nine patients (16%), despite a thorough investigation including spiral CT scan, echocardiography, microbiological analysis of airway secretions, laboratory markers of vasculitis, and systemic bleeding disorders.

Bronchoscopy-Guided THT

Before THT, there was evidence of ipsilateral or bilateral blood aspiration in all study patients. The site of active bleeding was localized at the subsegmental (n = 18), segmental (n = 29), and stem bronchus level (n = 10). Figure 2 shows a bleeding (subsegmental) bronchus prior to and throughout THT. Overall, the procedure was successfully performed in 56 of 57 patients (98%) with an immediate arrest of hemoptysis. Endobronchial bleeding was not controlled in one patient with a large vessel bleed. This patient was intubated and underwent surgical (lobar) resection to control hemoptysis.

Mean procedure time of THT alone was 11.5 ± 4.2 min. Mean procedure time of bronchoscopy including THT was 37.2 ± 14.9 min. None of the patients required intensive care support or immediate surgery. All 56 patients successfully treated with THT remained free of hemoptysis for the first 48 h. However, recurrent hemoptysis that was characterized as being mild (<30 mL expectorated blood) to moderate (30 to 100 mL expectorated blood) developed in six subjects (10.5%) between 3 and 6 days after THT. These patients underwent BAE, which was successfully carried out in four patients but failed to stop the bleeding in two patients. These two patients underwent repeated bronchoscopy with THT to control hemoptysis.
Complications, Morbidity, and Mortality

There were no procedure-related deaths or serious complications associated with THT. Clinical signs and/or radiologic evidence of postobstructive pneumonia developed in five patients (9%) within 6 days. Postobstructive pneumonia was more frequent in patients who underwent hemostatic tamponade of a lobar bronchus (n = 4) than in those with tamponade of a segmental (n = 1) or subsegmental bronchus. These patients underwent repeated bronchoscopy to remove residual ORC fragments, blood clots, and mucus, if present. In addition, they received a short course of antibiotic therapy, which resolved clinical and radiologic signs of pneumonia.

Mean duration of hospitalization was 15.3 ± 10.1 days. Fifty-five patients (96%) survived the hospital stay and were discharged free of hemoptysis. Two patients died during the hospital stay due to underlying metastatic cancer. The mean follow-up time was 10.1 ± 3.2 months. The overall 1-year survival rate was 70%. Eleven patients succumbed due to advanced primary lung cancer, three patients died from nonrespiratory-related diseases, and one patient died from multidrug-resistant tuberculosis. None of these patients died from recurrence of hemoptysis.

Bronchoscopic Follow-up Studies (n = 14)

None of the patients who underwent repeated bronchoscopy had a recurrence of hemoptysis. There was no evidence of endobronchial bleeding on control bronchoscopy. The material used for THT was absorbed in all of these patients without significant signs of visible foreign body reaction. Histologic examination of endobronchial biopsies at the site of original ORC placement revealed no evidence of foreign body tissue reaction.

Discussion

In patients with life-threatening hemoptysis, bronchoscopy-guided THT using ORC was able to achieve immediate control of hemoptysis in 98% of patients. Only 6 of the 56 patients studied had recurrence of mild-to-moderate hemoptysis within the first week of hospitalization, which was successfully treated with BAE in most instances. Despite a few cases of uncomplicated pneumonia, there were no other significant peri-interventional complications.

Life-threatening hemoptysis remains an important clinical concern of chest physicians. In a survey,5

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Table 1—Diagnoses of Life-Threatening Hemoptysis

<table>
<thead>
<tr>
<th>Etiology of Hemoptysis</th>
<th>Right/Left Upper Lobe</th>
<th>Middle Lobe/Lingula</th>
<th>Right/Left Lower Lobe</th>
<th>Right/Left Ratio</th>
<th>No. (% of Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung cancer</td>
<td>8/3</td>
<td>3/1</td>
<td>4/1</td>
<td>15/5</td>
<td>30 (52)</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>6/3</td>
<td>0/1</td>
<td>2/1</td>
<td>8/5</td>
<td>14 (25)</td>
</tr>
<tr>
<td>Metastatic disease</td>
<td>1/0</td>
<td>1/1</td>
<td>2/1</td>
<td>4/2</td>
<td>6 (10.5)</td>
</tr>
<tr>
<td>Bronchiectasis</td>
<td>0/0</td>
<td>2/0</td>
<td>2/1</td>
<td>4/1</td>
<td>5 (8.5)</td>
</tr>
<tr>
<td>Vascular malformation</td>
<td>1/1</td>
<td>0/1</td>
<td>1/0</td>
<td>2/2</td>
<td>4 (7)</td>
</tr>
<tr>
<td>Unknown</td>
<td>1/1</td>
<td>2/2</td>
<td>2/1</td>
<td>5/4</td>
<td>9 (16)</td>
</tr>
<tr>
<td>Total No.</td>
<td>17/8</td>
<td>8/6</td>
<td>13/5</td>
<td>38/19</td>
<td>57</td>
</tr>
<tr>
<td>% of total</td>
<td>30/14</td>
<td>14/10.5</td>
<td>23/8.5</td>
<td>67/33</td>
<td>100</td>
</tr>
</tbody>
</table>

FIGURE 2. Endobronchial view of a bleeding subsegmental bronchus (right B1b) before (top) and during bronchoscopy-guided THT (bottom).
86% of responding chest physicians had treated patients with massive hemoptysis during the previous year, and 28% had a patient die from pulmonary hemorrhage. In cases of severe endobronchial bleeding, immediate control of the airways is imperative and may be achieved by insertion of a double-lumen tube to isolate and ventilate the lungs separately. However, these tubes may be difficult to place properly, and displacement may result in aspiration and death. Another disadvantage is that they are easily obstructed by clots and do not permit passage of bronchoscopes of adequate size to allow toilet under unobstructed vision. Hemoptysis control can also be obtained by using either iced saline solution lavage or regional instillation of vasoconstrictive agents. Although this approach might be useful in mild-to-moderate hemoptysis, it is insufficient for massive active bleeding where the agent is diluted and flushed away.

In our study, 13 of 76 patients were probably due to the inability of mucus clearing behind the obstructed airway, rather than a propagated infection as a result of foreign tissue reaction. Laboratory and clinical data show absorption times of ORC products between 7 days and 20 days, usually without evidence of foreign body reaction. This is in accordance with our findings.

The principle of bronchoscopy-guided THT is similar to other endobronchial blocking techniques. The lack of a control group, therefore, remains the major limitation in this report, and potential advantages of THT over other bronchoscopic or nonscopic techniques need to be assessed in future studies.

The primary aim is to prevent spillage of blood to nonaffect, functionally intact alveolar areas of the lung. This can also be accomplished using a Fogarty catheter. Removal of the bronchoscope over the Fogarty, however, is difficult because the valve is part of the device. In an uncontrolled trial, Freitag et al have tested a double-lumen bronchus-blocking catheter with superior handling qualities to the Fogarty. Twenty-six of the 27 patients with hemoptysis were successfully treated using that device. The authors, however, reported one death in a patient who pulled out the catheter himself and a few complications such as balloon dislocations and poststenotic pneumonia. Temporary bleeding control can also be achieved by using endoscopic instillation of a fibrinogen-thrombin solution. The relapse rate with this technique, however, is relatively high.

Should the bleeding resume despite bronchoscopic interventions, other therapeutic options such as interventional angiography and/or surgery should be considered. BAÉ has become increasingly popular among chest physicians. With BAÉ, initial control of bleeding can be achieved in 60 to 95% of subjects. In a retrospective analysis, Mal et al reported on 56 consecutive patients on whom they attempted BAÉ. The procedure was not successful in managing hemoptysis in 23% of the subjects, which was predominantly due to a technical failure or due to collaterals arising from the bronchial circulation that feed the spinal column. High recurrence rates and serious complications such as paraparesis and paraplegia should be considered when offering this treatment.

Finally, there is also a surgical approach in the management of hemoptysis. Although it may be needed for a specific, large-vessel bleed, or if there is a parenchymal source that is resectable, surgery is associated with a high risk of morbidity and mortality during the acute episode.

In conclusion, endobronchial THT using ORC is a safe and practicable technique in the management of life-threatening hemoptysis with a high success and a relatively low complication rate. Future studies shall focus on new indications, such as persistent postbiopptic hemoptysis.
ACKNOWLEDGMENT: The authors are grateful to the nursing staff of the bronchoscopy unit, and Afruz Valipour and Mehrunnissa Mehdi for their assistance in preparing the article.

REFERENCES
12 Conlan AA, Hurwitz SS. Management of massive hemoptysis with the rigid bronchoscope and cold saline lavage. Thorax 1980; 35:901–904