Sight beyond Sight: Using Endobronchial Ultrasonography to Reestablish a Completely Occluded Airway

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Case Vignette

A 58-year-old man with a history of severe chronic obstructive pulmonary disease underwent bilateral lung transplantation. His course was complicated with severe left main stem bronchi (LMSB) stenosis requiring stent placement and subsequent removal. Weeks after, the patient had recurrence of the severe stenosis, undergoing multiple unsuccessful attempts of flexible and rigid bronchoscopic recanalization that led to two perforations of the LMSB proximal to the area of stenosis.

A multidisciplinary team that included interventional pulmonology, interventional radiology, and thoracic surgery was created for a last attempt of recanalization. A flexible bronchoscopy demonstrated persistent LMSB complete occlusion with two lateral bronchial defects from prior dilation attempts (Figure 1). An endobronchial ultrasound (EBUS) bronchoscope (BF-UC180F; Olympus) was used to identify and differentiate the distal LMSB from pulmonary vasculature and parenchyma. A circular hypoechoic rim with an internal homogenous isoechoic area was visualized, resembling both the short axis view of the bronchus and distal secretions, respectively (Figure 2). Doppler evaluation of this structure showed no flow, which helped to differentiate it from other adjacent vascular structures. A 21G EBUS needle (21G ViziShot; Olympus) was advanced toward the target bronchi under direct ultrasonographic guidance. Following this, aliquots of 10 ml of a 50/50 mixture of Iovue 300 (Iopamidol Injection 61%; Bracco Laboratories) with normal saline were injected under fluoroscopic visualization. This confirmed...
The recanalized airway was inspected with a pediatric scope (BF-P190; Olympus). The Glidecath 4Fr, 100 cm length, straight tip; Terumo) that was previously loaded in a 19G) that was used and advanced blindly was unable to traverse the obstruction. Bronchial dilation using a Jackson dilator and contrast bronchography guided by fluoroscopy were both attempted previously and led to two initial bronchial perforations. Endobronchial ultrasonography has been used in the past to identify normal and tumor-invaded bronchial rings. The cartilage of the bronchi is observed as a hypoechoic circular rim (white circle). There is mucus intraluminally (isoechoic area, white arrowhead). Note the fibrous tissue. A vascular structure (PA) is seen as an anechoic area. Flow was confirmed with color Doppler. (D) Fluoroscopic view during contrast-bronchography with EBUS scope needle. The contrast enhancement of the bronchial tree does not fade away, in contrast to vascular structures. *The radiopaque area inferior to the scope represents a collection of contrast in the mediastinal pocket that leaked before the contrast-bronchography EBUS injection.

First, EBUS was used to identify distal bronchi and guide a 21G needle to traverse a patent bronchial tree. After this key step and under fluoroscopic guidance, a 0.018” guidewire was inserted into the lumen of the 21G needle, and both EBUS scope and needle were removed en-bloc leaving the guidewire. The distal end of the guidewire was introduced into a 4Fr catheter (Glidecath 4Fr, 100 cm length, straight tip; Terumo) that was previously loaded in a pediatric scope (BF-P190; Olympus). The scope and catheter were subsequently advanced following the guidewire under fluoroscopy. The 0.018” guidewire was then removed, and contrast bronchography was repeated, confirming the correct localization of the tip of the 4Fr catheter.

A new 0.035” guidewire was inserted, allowing sequential balloon dilation of the new airway (3, 4, 6, 8, 9, and finally 10 mm). The recanalized airway was inspected with the bronchoscope, revealing the distal end of the left secondary carina. After this, a 10 × 40 mm self-expanding metallic stent was deployed, and the patient was extubated (Figure 3).

**Discussion**

Airway complication rates following lung transplantation vary considerably with cited ranges from single digits up to a third of patients. The generally accepted complication rate is around 15%. The largest contributor to these complications is thought to be ischemia, which is caused by the unique post-transplant lung circulation in addition to pre- and intraoperative ischemia. As the bronchial artery circulation is not usually reestablished, perfusion is dependent on retrograde collaterals from the pulmonary artery. It can take weeks for this circulation to be fully reestablished through collaterals. Other cited contributory factors include rejection, immunosuppressant therapy, infection, and inadequate organ preservation.

Of these airway complications, bronchial stenosis is the most common and has been shown to be an independent risk factor for death. Bronchial stenosis is most often treated with a combination of balloon dilation, argon plasma coagulation, or stenting. Silicone stents were first to be used, but their tendency to migrate and mucous plug has made self-expanding metal stents the current preferred option. Unfortunately, self-expanding metal stents have an increased propensity to form granulation tissue requiring close follow-up and removal. Emerging research is being done with self-expanding silicone stents that may be able to combine the benefits of both types of stents.

Complete occlusion of the bronchus is a rare occurrence, and few options for management have been described. Open surgical bronchoplasty is an option, though with significant morbidity. Another strategy is to blindly tunnel (for example, using cautery knife or Jackson dilator during rigid bronchoscopy); however, there is a significant risk for airway tear or injury to vasculature, especially given disruption of normal anatomy. Alraiyes and colleagues have reported successfully utilizing contrast bronchography via Wang needle or Fogarty balloon catheter to determine airway patency beyond occlusion with subsequent successful dilation.

In our patient’s case, we had trialed unsuccessfully both blind tunneling and contrast bronchography. The fibrous tissue was so dense that the initial needle (19G) that was used and advanced blindly with a bronchoscope to administer contrast was unable to traverse the obstruction. Bronchial dilation using a Jackson dilator and contrast bronchography guided by fluoroscopy were both attempted previously and led to two initial bronchial perforations. Endobronchial ultrasonography has been used in the past to identify normal and tumor-invaded bronchial rings. The cartilaginous portion of the bronchi are observed on ultrasound as hypoechoic oval structures. When faced with this unique situation, we opted to use EBUS for a novel purpose: to see beyond the obstruction to access the distal airway.

Our case had several novel elements. First, EBUS was used to identify distal bronchi and guide a 21G needle to traverse a...
complete bronchial occlusion into the targeted airway. Second, we used Doppler to confirm the absence of blood flow within the bronchi. Third, we inserted a 0.018” guidewire through the thin 21G EBUS needle to allow removal of the EBUS scope and needle. Fourth, we employed a 4Fr catheter through a pediatric bronchoscope that allowed the following: guidewire exchange, repeat contrast bronchography, and subsequent balloon dilations. Once the tract was established and bronchus patency confirmed, a 10 × 40 mm self-expanding metallic stent was placed.

When faced with similar patients with complete bronchial occlusion, endobronchial ultrasound could be used as an adjunct to contrast bronchography to help avoid large vasculature in attempts to reestablish airway patency. Importantly, the operator must be familiar with the EBUS characteristics of the bronchi, as the lack of familiarity might limit the applicability of this technique.

Follow-Up

Postintervention chest computed tomography confirmed full reexpansion of left lung with minimal atelectasis,
although both left upper and lingular lobes were occluded at the end of the initial stent placement (Figure 4). This stent was repositioned successfully 1 week after, achieving patency of all lobes. Surveillance bronchoscopy 4 weeks after showed development of granulation tissue in the distal end of stent, which was treated with stent replacement, cryotherapy, and mitomycin C. The prior two bronchial defects along the LMSB were no longer apparent. Four months after stent placement, the patient died suddenly at home from presumed pulmonary embolism given he had acute bilateral deep venous thrombosis.

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