EGFR mutations [5, 7]. According to guidelines outlined by the College of American Pathologists, the International Association for the Study of Lung Cancer, and the Association for Molecular Pathology, EGFR and ALK tests are recommended for adenocarcinomas and mixed lung cancers presenting an adenocarcinoma component [8]. In this case of mixed lung cancer, we identified sensitive EGFR mutations, which is in line with the criteria proposed by the College of American Pathologists and supports the use of TKI for this patient in the event of distant metastasis or tumor recurrence.

References

A Novel Approach to Endobronchial Closure of a Bronchial Pleural Fistula
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Bronchopleural fistula presents an important and challenging management problem after lung parenchymal resection. The mainstay of treatment has been surgical revision of the bronchial stump, however increasingly endobronchial therapies are being employed. We report the novel use of a liquid embolic agent with an Amplatzer vascular plug to seal a chronic bronchopleural fistula. Using rigid bronchoscopy, fluoroscopy, radio opaque liquid embolic agent, and the Amplatzer vascular plug, we were able to demonstrate not only feasibility but also safety and a marked reduction in symptoms consistent with successful closure of the bronchopleural fistula.

Bronchopleural fistula (BPF) is a communication between the pleural space and the bronchial tree. The majority of cases occur after pneumonectomy, with subsequent infection, chemotherapy, radiotherapy, and persistent spontaneous pneumothorax [1]. The reported incidence of BPF ranges from 0.5% to 20% and has been shown to be associated with the underlying etiology, surgical technique, and experience of the surgeon [1].

Complications associated with BPF are due to a loss of pleural space sterility after the establishment of direct communication with the airway. These complications include but are not limited to empyema, aspiration pneumonia, adult respiratory distress syndrome, and death [2]. The diagnosis and treatment of BPF represents a challenging problem and an important source of postoperative morbidity and mortality.

We report the first case in the literature utilizing a fluoroscopically visualizable liquid embolic agent in conjunction with the Amplatzer Vascular Plug II (AVP [St. Jude Medical, St. Paul, MN]) to endobronchially seal a BPF and cement the AVP in place using rigid bronchoscopy and fluoroscopy.

A 66-year-old man with a history of adenocarcinoma of the lung who had undergone right pneumonectomy with stump breakdown and recurrent empyema. He was treated with tube thoracostomy and antibiotics, followed by several failed attempts at endobronchial closures. Finally, an Eloesser flap with window was created. After several years with an improvement in symptoms and an exhaustive assessment for stump healing and closure including V/Q scan, bronchoscopies with direct visual inspection, Omnipaque (GE Healthcare, Waukesha, WI) fluoroscopic evaluation, contrast chest computed tomography, and negative cultures of both bronchial stump and pleural space, the flap was surgically reversed.

Three months after Eloesser flap closure, the patient began to have recurrent episodes of pleural sepsis due to recurrence of the BPF. Because of his poor surgical candidacy and based on prior reports of success [3, 4], an endobronchial closure using an AVP was attempted. Under rigid bronchoscopic guidance, the AVP was placed through a guide sheath into the right main bronchus, intentionally obstructing the stump. After this, 0.9 mL cyanoacrylate glue was injected into the space between the
bronchial wall and AVP. Four weeks later, the patient had recurrent empyema prompting repeat bronchoscopy, which revealed rotation of the AVP 90 degrees, leading to its removal. A second attempt at AVP placement involved the novel use of Onyx-34 liquid embolic (Covidien, Irvine, CA) injected behind and next to the AVP in an effort to create a plug that would conform to the shape of the bronchial stump and stabilize the position of the AVP while achieving a seal of the BPF. The risks and benefits of the off-label use of AVP and Onyx-34 in BPF closure were explained to the patient, who consented to the procedure, and an Institutional Review Board waiver was granted.

**Procedure Details**

After securing the patient’s airway using a 13-mm rigid bronchoscope (Bryan Corp, Woburn, MA), a 7F, 55 cm Raabe sheath (Cook, Bloomington, IN) was advanced into the distal terminus of the right main bronchial stump. Parallel to this sheath, an Echelon-14 microcatheter (Covidien) was advanced through a Kumpe catheter (Cook) and coiled within the distal stump. Under bronchoscopic and fluoroscopic guidance, an 18-mm AVP II (St. Jude Medical, Plymouth, MN) was advanced through the sheath and deployed in the distal bronchial stump (Fig 1). Again under both bronchoscopic and fluoroscopic control, the stump was embolized with Onyx-34 liquid embolic through the microcatheter, with care to avoid liquid embolic extension above the plug (Fig 2). Once a cast of the bronchial stump was formed on fluoroscopy, the microcatheter was withdrawn into the Kumpe catheter, and both were removed as a unit. The left main stem bronchus was interrogated to confirm absence of nontarget liquid embolization. After the procedure, the patient reported a marked reduction in purulent secretions and cough consistent with successful closure of the BPF, and he continues to show improved clinical symptoms while being longitudinally monitored.

**Comment**

Treatment of BPF has historically involved repeat surgical procedures aimed at reinforcing the bronchial stump after breakdown. The success rate of surgical closure of BPF has been reported between 80% and 95% but is associated with the risk of open thoracotomy [5]. More recently, endobronchial approaches have been as the means of nonsurgical therapy. Success has been variable, and the lack of consensus suggests that no optimal therapy is available; rather, the current interventions seem to be complementary and indicate that treatment should be individualized [6].

We present the first case of combination therapy involving rigid bronchoscopy, fluoroscopy, AVP placement, and liquid embolic agent aimed at occluding a chronic BPF. Our patient underwent several attempts at BPF occlusion complicated by recurrent empyema, necessitating eventual Eloesser flap placement. Owing to his poor surgical candidacy, we planned and successfully undertook a rigid bronchoscopic approach using an AVP in conjunction with fluoroscopy and a liquid embolic agent to seal the BPF.

Onyx-34 is used to embolize central nervous arteriovenous malformations but has been applied in the peripheral circulation [7, 8]. It has until now never been reported to have been used outside of the vascular tree. Onyx-34 is a nonadhesive liquid embolic agent consisting of ethylene vinyl alcohol copolymer dissolved in dimethyl sulfoxide and suspended micronized tantalum powder to provide contrast for fluoroscopic visualization. Onyx-34 was chosen for its increased viscosity over Onyx-18 as there was concern for leakage out of the stump and into the pleural space. The...
addition of a fluoroscopically visible liquid embolic agent is novel in that it acts to cement the AVP in place while allowing visualized filling of the bronchial stump defects distal to the AVP.

The AVP has traditionally been deployed within the vascular tree; however, extravascular use has been shown to be feasible [3, 4]. The size and deployment characteristics make the AVP an excellent choice in the occlusion of bronchial stump not amenable to surgery. Three previous endoscopic techniques using an AVP to occlude a BPF have been reported [3, 4]. This report demonstrates not only its feasibility but also its safety; however, one limitation is that so far long-term follow-up is lacking.

In conclusion, the use of rigid bronchoscopy, fluoroscopy, AVP placement, and use of Onyx-34 is a novel approach to occlusion of chronic BPF in patients who are unable to undergo surgical closure.

References


High Tracheal Bifurcation: An Unusual Cause of Left Bronchial Obstruction

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Congenitally short trachea is an uncommon abnormality. It is characterized by a reduced number of tracheal cartilage rings. As a result, the carina is situated at a higher level than usual. That causes the left main bronchus to course abnormally behind the arch of the aorta, rendering it prone to compression. We report the case of an infant who underwent successful aortopexy of the aortic arch for this condition.


Extrinsic left main bronchial compression is generally seen secondary to aneurysmal pulmonary artery, vascular ring, or bronchogenic/mediastinal cysts. In this report, we describe an unusual anatomic entity wherein the left main bronchus arising from a congenital short trachea coursed behind the aortic arch and was compressed by it.

An 8-week-old infant was referred to us with a history of respiratory distress since birth. The distress was severe enough to require continuous noninvasive positive pressure ventilatory support. Serial chest radiographs showed progressive hyperinflation of the left lung suggestive of air trapping (Fig 1A). The child was transferred to our center intubated and ventilated. Subsequently, we were not able to wean the child from the ventilator. Computed tomography of the chest confirmed a high tracheal bifurcation at the level of the second thoracic vertebra and narrowing of the proximal left main bronchus behind the mid third of the arch of the aorta. A simultaneous bronchogram and aortogram was planned to demonstrate dynamic compression of the left bronchus with a view to proceed to an aortopexy immediately. The entire procedure was done in the cardiac catheter laboratory. The child was anesthetized, and flexible bronchoscopy was performed. There was pulsatile anterior compression of the distal trachea and anteroposterior narrowing of the left main bronchus (Fig 2A; Video 1). The bronchoscope could not be passed beyond the narrowed segment of the left bronchus. A simultaneous bronchogram and aortogram was then performed. Although dynamic compression at the narrowed bronchial segment could not be demonstrated, the spatial relationship between the distal arch and left main bronchus could be defined (Fig 3). The distal left main bronchus beyond the retroaortic segment had a normal caliber with no malacia. A sternotomy was then done. The pericardium was opened. The thymus was subtotally excised. The ascending aorta, arch, proximal portions of the arch branches, and the proximal descending aorta were completely mobilized. The ligamentum arteriosum was

The Videos can be viewed in the online version of this article [http://dx.doi.org/10.1016/j.athoracsur.2013.09.072] on http://www.annalsthoracicsurgery.org.