

Chapter 49

Bronchial Artery Embolization



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Evaluating the Patient

What are important aspects of the clinical history during patient evaluation?	Frequency and severity of hemoptysis, any evidence of airway compromise, and information or history that may help determine the underlying etiology.
What are important components of the physical exam during patient evaluation?	Evaluate for signs of respiratory distress (tachypnea, tachycardia, auscultation of lungs for wheezing or decreased breath sounds) and hemodynamic instability (pulse, BP).
What are important laboratory values to consider during patient evaluation?	Hemoglobin/hematocrit to evaluate for degree of anemia WBC and cultures to evaluate for infection Coagulation profile and renal function before arteriogram and embolization

(continued)

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<p>What is the best noninvasive imaging modality for the evaluation of massive hemoptysis?</p>	<p>CT angiography – Can identify the etiology of hemoptysis and demonstrate bronchial artery anatomy, assisting in pre-procedural planning.</p>
<p>Can CTA usually confirm the site of bleeding and evaluate for laterality of involvement? Which invasive diagnostic studies can help evaluate for bleeding site and also be therapeutic?</p>	<p>CTA does not usually locate the exact site of bleeding, but it can lateralize the site of bleeding when the source is unilateral. Fiber-optic bronchoscopy – Can help confirm bronchial etiology for hemoptysis and identify the laterality of involvement in up to 95% of cases. It can also treat the source of hemoptysis in some cases. Arteriography and embolization – Both diagnostic and therapeutic; first-line therapy for most cases of massive hemoptysis; also indicated when bronchoscopy cannot adequately control ongoing bleeding.</p>
<p>What is the typical appearance of abnormal bronchial arteries that may suggest sites of bleeding?</p>	<p>One or more enlarged, hypertrophied, and tortuous vessel extending along the tracheobronchial tree into an extensive area of patchy hypervascularity; AV shunting or pseudoaneurysms may also be seen. Active contrast extravasation is not commonly seen.</p>

High Yield History

<p>Define massive hemoptysis.</p>	<p>Hemoptysis > 250 ml in volume within 24 hours.</p>
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Define a major hemorrhagic hemoptysis event.	Three or more days of hemoptysis in a week, with each day totaling greater than or equal to 100 ml in volume.
What are the potential clinical results of continuing hemorrhage into the airways? What is the mortality rate with conservative management?	Hypovolemia and asphyxiation; this can lead to a mortality of 50–85% with conservative management.
What are common etiologies for massive hemoptysis?	Infections (Tb, Aspergillosis, chronic bacterial pneumonia) Chronic lung diseases (CF, sarcoidosis, COPD, interstitial pneumonias) Malignancy Trauma
Massive hemoptysis is most commonly associated with the abnormality of which circulation of the lungs (bronchial or pulmonary)?	Systemic arteries that supply the bronchial tree – bronchial arteries, although pulmonary arterial system can cause massive hemoptysis, this is rare.
What characteristic of the bronchial airway system makes bronchial artery embolization an effective and safe intervention for controlling hemoptysis?	Occlusion of targeted bronchial arteries causes little or no ischemia of the bronchial airways while having a high success rate of stopping hemoptysis. This is because up to 95% of massive hemoptysis cases originate from the bronchial artery system, yet the bronchial system supplies less than 1% of blood flow to the lungs. More than 99% of the blood flow to the lungs is supplied by the pulmonary system.

Indications/Contraindications

What is the gold standard or first-line therapy for massive hemoptysis?	Bronchial arteriogram with embolization is now considered the gold standard treatment for massive hemoptysis, as most massive hemoptysis cases originate from the bronchial arterial system. However, most patients will have first undergone bronchoscopy given its benefits of obtaining an airway for oxygenation and its ability to both localize and treat the source of bleeding.
What are contraindications to bronchial artery embolization?	Non-bronchial artery source for bleeding, i.e., pulmonary artery Contrast allergy Inability to perform general endotracheal anesthesia (GETA)
Is shunting between the bronchial arteries and the pulmonary veins or arteries an absolute contraindication to embolization?	Shunting may be seen during angiography and is not an absolute contraindication, though it may require adjustment of technique.

Relevant Anatomy

The bronchial arteries most commonly arise from which levels of the thoracic aorta?	T3-T8 levels, with most arising from T5-T6 levels. The left bronchial arteries (typically two) most commonly arise from the descending thoracic aorta.
What structures do the bronchial arteries supply?	The trachea and major bronchial airways, esophagus, vagus nerve, visceral pleura, mediastinal lymph nodes, vasa vasorum of thoracic aorta, and pulmonary arteries

Define orthotopic vs ectopic origins of the bronchial arteries. What are possible ectopic sites?	Orthotopic describes normal origins of the bronchial arteries from the descending thoracic aorta, while ectopic describes variant origins of the bronchial arteries. In at least 20% of patients, at least one of the bronchial arteries can arise from the subclavian artery, internal mammary artery, thyrocervical trunk, superior intercostals, pericardiophrenic and inferior phrenic arteries, abdominal aorta, or coronary arteries.
Which collateral arteries may hypertrophy and parasitize sites of bronchial arterial bleeding?	In the setting of prior embolization or chronic lung disease, parasitizing vessels may originate from the intercostal, inferior phrenic, internal thoracic arteries, or the costocervical and thyrocervical trunks.
Describe the Caldwell variations of the bronchial artery branching pattern.	Type I – Most common (40% of pts), single right intercostobronchial trunk and two left bronchial arteries with separate origins Type II – 20%, single right intercostobronchial trunk and only one left bronchial artery Type III – 20%, right intercostobronchial trunk with additional right bronchial artery having separate origin, and two left bronchial arteries Type IV – 10%, right intercostobronchial trunk with additional right bronchial artery having separate origin, and one left bronchial artery
Can the bronchial arteries supply an anterior spinal artery? Why is this important?	Yes, the right intercostobronchial trunk (which gives rise to right-sided bronchial artery branches) can give rise to an anterior medullary artery that supplies the spinal cord through an anterior spinal artery. The anterior medullary branch characteristically forms a hairpin turn on angiogram. It is important to identify any spinal artery supply from the bronchial arteries to prevent inadvertent nontarget embolization of the anterior spinal artery, which can lead to paraplegia.

Relevant Materials

What is the key prerequisite for determining the use of general anesthesia versus conscious sedation when performing bronchial artery embolization?

Airway patency is vital; in some cases, a unilateral selective main stem bronchial intubation may be required.

Describe how an endobronchial blocker can be used to achieve selective unilateral bronchial intubation.

The endobronchial blocker is a device that can be inserted coaxially down the tracheal tube after tracheal intubation and into either the left or right mainstem bronchus. The balloon attached to the blocker is then insufflated, effectively blocking that bronchus and achieving unilateral intubation of the contralateral side.

What sized catheters are used to selectively catheterize bronchial arteries?

Selective catheterization of abnormal vessels is performed with 4-Fr or 5-Fr catheters. Superselective catheterization can be performed using 3-Fr or smaller microcatheters to select smaller, more distal, or tortuous bronchial arteries.

Discuss the embolic agent(s) typically used for bronchial artery embolization.

Polyvinyl alcohol (PVA) particles and solid (tris-acryl gelatin, TAGM) microspheres are the most commonly used agents; coils provide more proximal occlusion compared to PVA or liquid embolizing agents and are thus used in cases of aneurysm/pseudoaneurysm, arteriovenous malformations, or to occlude non-bronchial collateral vessels. Although liquid embolic agents such as n-Butyl-2-cyanoacrylate (NBCA) were less preferred in the past due to fear of distal embolization causing pulmonary ischemia/infarction, more recent studies have shown similar safety and efficacy of using such liquid agents compared to PVA particles. NBCA have also been shown to achieve better hemoptysis control rates and higher long-term hemoptysis-free survival rates when compared to PVA in patients with bronchiectasis.

When using particles to perform bronchial artery embolization, what embolic and which particle sizes should be avoided and why?

Gelfoam is not desirable as it can lead to early recanalization and rebleeding. PVA particles and microspheres smaller than 300 μm should be avoided, as these particles can pass through broncho-pulmonary anastomoses which have a mean diameter of 325 μm , thus increasing the risk for pulmonary ischemia or infarct. If smaller embolic sizes are used, embolization should be performed super-selectively using 3 Fr or smaller microcatheters.

General Step by Step

What are the options for arterial access in bronchial artery angiography and embolization?	Femoral artery access is the preferred route for bronchial artery embolization due to better angulation. In cases with more complex anatomy that preclude femoral access, such as tortuosity of aorta, radial access, and even transaxillary routes have been reported.
What is the typical angiographic appearance of bronchial arteries contributing to hemoptysis?	Hypertrophied and tortuous. Dense networks of neovascularity and hypervascularity are often seen.
What should always be done after the occlusion of vascular injury to rule out continued bleeding from collateral blood supply?	After embolization, performing a post-procedural aortic angiogram is vital to ensure adequate arterial occlusion and to evaluate for any collateral branches not previously visible that require embolization.
How can one evaluate for successful bronchial artery embolization?	Clinical cessation of bloody sputum expectoration.
What is the reported short-term recurrence rate of hemoptysis at one-month post embolization?	2–27%.
What is the reported long-term recurrence rate of hemoptysis at 46-month post embolization?	10–52%.

Should embolization be performed in the setting of massive hemoptysis and absence of angiographic visualization of bleeding?	Yes. Active bleeding on angiography is often not seen.
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Complications

What are the common causes of recurrent hemoptysis after bronchial artery embolization?	Though not considered complications, incomplete embolization of the target vessel, failure to find and embolize all affected bronchial vessels, failure to find and embolize collateral vessels from outside of the bronchial system, collateralization after embolization, and recanalization of the embolized bronchial artery are all possible causes of continued or re-bleeding after the procedure.
What are the most common side effects of bronchial artery embolization?	Transient chest pain and/or dysphagia from the occlusion of intercostal or esophageal arterial branches supplied by the bronchial arteries.
How are these side effects managed?	These symptoms are usually self-limited and can be treated with analgesics.
What is the most feared complication of bronchial artery embolization?	Anterior spinal cord syndrome from spinal cord ischemia.
What is the reported incidence of spinal cord ischemia?	About 1%.

Landmark Research

Tom LM, Palevsky HI, Holsclaw DS, Trerotola SO, Dagli M, Mondschein JI, et al. Recurrent Bleeding, Survival, and Longitudinal Pulmonary Function following Bronchial Artery Embolization for Hemoptysis in a U.S. Adult Population. *Journal of vascular and interventional radiology: JVIR*. 2015;26(12):1806-13.e1.

- Technical success rate of bronchial artery embolization for hemoptysis is 90%; technical failures included no bronchial or extrabronchial collateral vessel causing hemoptysis identified (3%), unsuccessful catheterization due to vessel tortuosity, vasospasm, or dissection (5%), and case termination due to major complication (2%).
- Of the technically successful cases, clinical success rates at 24 hrs and 30 days were 82% and 68%, respectively; 15% of patients required two embolization procedures while 9% required three or more embolizations; recurrent bleeding and mortality were increased in patients with sarcoidosis.
- 51% of embolization cases were preceded by bronchoscopy, of which 86% localized the bleeding.

Common Questions

What should be the initial management in a patient with massive hemoptysis?

Place the patient in dependent positioning of the bleeding lung.

Is massive hemoptysis more commonly associated with abnormalities of the bronchial arteries or pulmonary arteries?

Bronchial arteries.

<p>What is a Rasmussen's Aneurysm? Why is it important with respect to hemoptysis?</p>	<p>Rasmussen's aneurysm is a post-inflammatory aneurysm or pseudoaneurysm that arise from a pulmonary artery branch adjacent to or within a tuberculous cavity. Massive hemoptysis from rupture of a Rasmussen's aneurysm is a rare but potentially fatal complication of cavitary tuberculosis.</p>
<p>What does the Artery of Adamkiewicz arise from? What is the most common level for the Artery of Adamkiewicz to arise from?</p>	<p>The artery arises from the anterior radicular branch of the spinal branch of the posterior intercostal artery. The artery most commonly level originates on the left, at the T8-L1 levels, though has been reported to arise from either side from the T3-L4 levels.</p>

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