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Bronchial artery embolization in China

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Prior to bronchial artery embolization (BAE), the number and origin sites of bronchial arteries from the aorta should be carefully evaluated to determine the optimal angiographic approach. This can be accomplished with a preliminary descending thoracic aortogram. Abnormal bronchial arteries are visualized on an initial thoracic aortogram in the majority of affected patients. A descending thoracic aortogram is also useful in the detection of nonbronchial systemic arteries that supply parenchymal lesions. Although cobra-type curved catheters are most commonly used for catheterization of the bronchial artery, several different types of catheters for example Simmons-1, RLG, and Yashiro-type, should be prepared for optimal selection of bronchial arteries. The usefulness of a microcatheter for selective BAE has been emphasized in many recent articles.[1-5] This superselective catheterization permits stabilization of the catheter position within the bronchial artery and safe positioning in the bronchial circulation beyond the origin of spinal cord branches, which prevents severe complications. After catheterization of the bronchial artery, bronchial angiography is performed with manual injection of contrast medium.

Bronchial arteries that originate outside the area between the T5 and T6 vertebrae at the level of the major bronchi are considered to be anomalous. The reported prevalence of bronchial arteries with an anomalous origin ranges from 8.3-35%. These aberrant bronchial arteries may originate from the aortic arch, internal mammary artery, thyrocervical trunk, subclavian artery, costocervical trunk, brachiocephalic artery, pericardiacophrenic artery, inferior phrenic artery, or abdominal aorta. Aberrant bronchial arteries can be distinguished anatomically and angiographically from nonbronchial systemic collateral vessels in that they extend along the course of the major bronchi. In contrast, nonbronchial systemic collateral vessels enter the pulmonary parenchyma through the adherent pleura or via the pulmonary ligament, and their course is not parallel to that of the bronchi. The majority of aberrant bronchial arteries originate from the aortic arch. The prevalence of bronchial arteries with origins outside the aorta is unknown. Interventional radiologists should be aware of the possible presence of aberrant bronchial arteries, especially when a significant bronchial arterial supply to areas of abnormal pulmonary parenchyma is not demonstrated during a catheter search or at descending thoracic aortography. In addition, bronchial arteries of anomalous origin should be suspected and investigated angiographically in patients who present with recurrent hemoptysis despite successful embolization and in those in whom the source of bleeding has not been detected.[2,3]

Angiographic findings in massive hemoptysis include hypertrophic and tortuous bronchial arteries, neovascularity, hypervascularity, shunting into the pulmonary artery or vein, extravasation of contrast medium, and bronchial artery aneurysm. Although extravasation of contrast medium is considered a specific sign of bronchial bleeding, this finding is rarely seen, and its reported prevalence ranges from 3.6-10.7%.[3] Thus, the determination of which arteries are to be embolized should be based on a combination of computerized tomography (CT), bronchoscopic, and angiographic findings with clinical correlation. All angiograms, including intercostal arteriograms, must be carefully scrutinized for opacification of spinal arteries to avoid inadvertent embolization.

A variety of embolic materials are used for BAE. Absorbable gelatin sponge is widely used because it is inexpensive, easy to handle, and has a controllable embolic size. However, disadvantages

of absorbable gelatin sponge are its resolvability and lack of radiopacity. Its use may lead to recanalization of the embolized artery and may sometimes be responsible for recurrent bleeding. Polyvinyl alcohol particles are nonabsorbable embolic materials, and particles 350–500 μm in diameter are the most frequently used worldwide. Their use may prevent the early recurrence of hemoptysis due to recanalization of the embolized artery, as might be anticipated with absorbable gelatin sponge.[3-5]

It is essential to avoid the use of embolic materials that can pass through the bronchopulmonary anastomosis. Experimental study has demonstrated a bronchopulmonary anastomosis of 325 μm in the human lung.[2] Pulmonary infarction via bronchial artery–pulmonary artery shunts or systemic artery embolization via bronchial artery–pulmonary vein shunts may occur when embolic agents less than 325 μm in diameter are used. In addition, it is important to avoid using embolic agents that produce distal occlusion to such an extent that normal peripheral branches that supply the bronchi, esophagus, or vasa vasorum of the pulmonary artery or aorta become occluded, possibly leading to disastrous complications (for example bronchial, esophageal, pulmonary arterial, or aortic wall necrosis). To avoid the complications indicated earlier, we recommend the use of polyvinyl alcohol particles with a diameter of 350–500 μm for BAE.

Bronchopulmonary fistula is a common finding at bronchial angiography in patients with massive hemoptysis. Regardless of whether a bronchopulmonary fistula is demonstrated at bronchial angiography, we perform BAE with the same technique and the same size of embolic materials (polyvinyl alcohol particles over 350 μm in diameter or absorbable gelatin sponge), and we have not encountered any clinical problems related to pulmonary infarction or systemic embolization. Thus, we recommend the use of the same strategy even when a bronchopulmonary fistula is visualized at bronchial angiography.

Liquid embolic agents (for example isobutyl-2 cyanoacrylate, absolute ethanol) are not currently used because of the high risk of severe complications such as tissue necrosis. Stainless steel platinum coils are generally not used for BAE because they tend to occlude more proximal vessels and may preclude repeat embolization if hemoptysis recurs. However, they may be used to occlude a pulmonary artery aneurysm and may occasionally be used in the internal mammary artery to prevent embolization of a normal vascular territory and development of collateral vessels

Previous studies[2-5] have shown that BAE is very effective in controlling acute massive hemoptysis. In our group wit h 50 patients underwent bronchial arteriography, 72 embolization sessions were performed with a total of 111 arteries embolized, and the average number of arteries embolized per patient was 2.5. Control of hemoptysis was observed in 46 patients (85%) at one month. rebleeding occurred within 30 days after the procedure. The initial nonrecurrence rates for BAE have been reported to be 73-98%, with a mean follow-up period ranging from one day to one month. Immediate success rates have increased recently because of the introduction of superselective embolization and the refinement of embolic agents and techniques. However, the long-term success rate of BAE in hemoptysis is unfavorable. Long-term recurrence rates have been reported to be 10–52%, with a mean follow-up period ranging from one to 46 months.[5] However, the long-term success rate can be improved with repeat BAE. Hemoptysis may recur after successful BAE if the disease process is not controlled with drug therapy or surgery because embolization does not address the underlying disease but rather treats the symptom. In this sense, BAE is a palliative procedure that prepares the patient for elective surgery for localized disease or continued antimicrobial therapy.

Recurrent bleeding may be caused by recanalization of embolized vessels, incomplete embolization, revascularization by the collateral circulation, inadequate treatment of the underlying disease, progression of basic lung disease, or nonbronchial systemic arterial supply. Recurrence rate may also be influenced by the cause of the hemoptysis. Recurrent bleeding is more common in patients with chronic tuberculosis, aspergilloma, or neoplasm. In one study[5] of 103 patients who underwent BAE, 16 patients (15.5%) required repeat embolization; all 16 had hemoptysis due to chronic tuberculosis. It is believed that this was due mainly to hypertrophy of the collateral nonbronchial systemic arteries. In a series by Katoh et al,[6] 75% of patients with aspergilloma experienced recurrence of hemoptysis after undergoing initial embolization. Hakanson et al[2] reported that BAE failed within one month in 42% of patients with neoplasm. A neoplasm receives its blood supply from multiple feeder vessels other than the bronchial artery and invades the vascular structure aggressively.

Several complications of BAE have been reported in the literature.[1,3,5] Chest pain is the most common complication, with a reported prevalence of 24–91%. Chest pain is likely related to an ischemic phenomenon caused by embolization and is usually transient. In addition, dysphagia due to embolization of esophageal branches may be encountered, with a reported prevalence of 0.7–18.2%. Dysphagia also regresses spontaneously. Subintimal dissection of the aorta or the bronchial artery during BAE is the other minor complication, with a reported

prevalence of 1–6.3%. There are usually no symptoms or problems related to the subintimal dissection.

The most disastrous complication of BAE is spinal cord ischemia due to the inadvertent occlusion of spinal arteries. The prevalence of spinal cord ischemia after BAE is reported to be 1.4–6.5%. As discussed earlier, the visualization of radicular branches on bronchial or intercostal angiograms is not an absolute contraindication for BAE. However, when the anterior medullary artery (artery of Adamkiewicz) is visualized at angiography, embolization should not be performed. Other rare complications that have been reported in the literature include aortic and bronchial necrosis, bronchoesophageal fistula, non–target organ embolization (for example ischemic colitis), pulmonary infarction, referred pain to the ipsilateral forehead and orbit, and transient cortical blindness. It is hypothesized that cortical blindness develops because of embolism to the occipital cortex, either via a bronchial artery–pulmonary vein shunt or via collateral vessels between the bronchial and vertebral arteries. Nonbronchial systemic arteries can be a significant source of massive hemoptysis, especially in patients with pleural involvement caused by an underlying disease. Missing the nonbronchial systemic arteries at initial angiography may result in early recurrent bleeding after successful embolization of the bronchial artery. Many investigators have documented that a concerted search for nonbronchial systemic arterial supply should be made. In the presence of pleural thickening, nonbronchial systemic feeder vessels that originate from various arteries for example intercostal artery, branches of the subclavian and axillary arteries, internal mammary artery, inferior phrenic artery may develop along the pleural surface and become enlarged as a result of the inflammatory process. Pleural thickening that is noted at chest radiography negatively influences the long-term success rate of BAE. Computerized tomography may help predict the presence of nonbronchial systemic collateral vessels as a source of bleeding in patients with massive hemoptysis. In our experience, pleural thickening of more than 3 mm and tortuous enhancing vascular structures within hypertrophic extrapleural fat seen at contrast-enhanced CT are signs of nonbronchial systemic arterial supply in patients with massive hemoptysis. Use of CT to predict the presence of nonbronchial systemic vessels that supply a parenchymal lesion is important prior to BAE because it helps in localizing the site of bleeding and in selecting systemic vessels for the interventional approach.

In summary, the current management of massive hemoptysis is initial treatment with BAE followed by medical or surgical therapy of the underlying disease. Bronchial arterial catheterization in humans via a percutaneous approach has been practiced for 33 years,[3] initially for direct chemotherapy treatment for bronchial malignancies and then for the embolization of patients with severe hemoptysis. The safety issues that have arisen during these procedures include inadvertent occlusion or embolization into the anterior spinal artery which in a small percentage (highest 5%) of humans arises from one of the branches of the bronchial arteries. Finally, the issues of edema due to arterial engorgement and immune response to the vectors must be quantified at various dosages and volumes by histological examination. In addition, CT may be helpful in predicting the presence of nonbronchial systemic collateral vessels, which can be a significant source of recurrent hemoptysis after successful BAE.

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Histopathological audit of appendicectomy specimens

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Acute appendicitis is a common abdominal emergency requiring hospital admission and surgery. The risk of developing appendicitis is