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Percutaneous Embolotherapy in Life-Threatening Hemoptysis

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Abstract. Percutaneous embolization of the bronchial arteries to control massive or recurrent hemoptysis has become an accepted procedure, especially in treating patients with chronic pulmonary disease who are poor candidates for lung resection. Nonbronchial systemic collateral arteries and pulmonary arteries may contribute significantly to pulmonary hemorrhage, but embolization of these vessels has not been stressed in recent literature. When embolization of the bronchial artery fails to control hemoptysis, nonbronchial systemic collateral arteries should be embolized. If no systemic collaterals are present, then embolization of segmental pulmonary arteries may prove helpful.

Key words: Hemoptysis—Bronchial artery—Embolization—Pulmonary artery—Nonbronchial systemic collateral artery—Systemic-pulmonary shunt

Hemoptysis is a nonspecific symptom that may occur with a variety of respiratory conditions. The clinical spectrum ranges from occasional blood-streaked sputum to sudden fatal hemorrhage. Life-threatening hemoptysis is defined as a pulmonary hemorrhage of 300 ml within 24 h [1]. Approximately 75% of patients with this severe hemoptysis will die if they are managed conservatively [2]. An aggressive surgical approach has greatly improved the patient's chance of survival; in two studies it resulted in mortalities of only 9 and 17%, respectively [2, 3]. Patients who are not surgical candidates (e.g., those with bilateral chronic lung disease, nonresectable bronchogenic carcinoma, low vital capacity, or recurrent hemoptysis following surgery) have been difficult to treat. Angiography and embolization, however, can effectively treat these patients [4–6]. In patients with cystic fibrosis, bronchial artery embolization has been suggested as the treatment of choice [7].

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Patients and Methods

Three patients with life-threatening hemoptysis were treated by percutaneous embolotherapy during active hemorrhage, using transcatheter embolization. Bronchoscopy and chest radiographs were performed to determine whether bleeding was from the right or left lung. Arteriograms, performed via the femoral approach, were then tailored to the findings on the chest radiograph and bronchoscopy. A thoracic aortogram was performed to evaluate the number, location, and degree of enlargement of pathologic vessels. Next, a catheter was introduced into the individual blood vessel branches supplying the abnormal lung and nonionic contrast material (Omnipaque 350) was selectively injected.

Extravasation of contrast material, the only direct sign of hemorrhage, is rarely seen during bronchial artery angiography and was not visible in any of our patients. We used reliable secondary signs of pulmonary hemorrhage to identify the vessels responsible for pulmonary bleeding. These signs include hypervascularity of the involved area of lung, hypertrophy of supplying arteries, and shunting of contrast material into pulmonary arterial or venous branches. Both bronchial and nonbronchial collateral arteriograms revealed the secondary signs.

Case 1

A 65-year-old man presented with life-threatening hemoptysis of several days' duration. He had chronic pulmonary interstitial fibrosis with upper zone predominence associated with ankylosing spondylitis. Bronchoscopy showed bleeding from the right upper lobe. During angiography, selective injection of the right bronchial artery revealed an area of hyperemia in the fibrotic lung tissue of the right upper lobe. Embolization with Gelfoam particles stopped the bleeding, and the patient was discharged 6 days later. There has been no recurrence of hemoptysis during 14 months of follow-up.

Case 2

A 71-year-old woman presented with a 2-year history of hemoptysis that had become progressively worse until massive hemoptysis developed 2 days before angiography. She had chronic lung disease with severe bronchiectasis resulting from previous tuber-

Fig. 1. Selective injection of the left bronchial artery shows a dilated, tortuous vessel with many branches. Note the retrograde filling of the left pulmonary artery (arrows).

culosis. Bronchoscopy showed bleeding from the left lung. During angiography, selective injection of the left bronchial artery revealed a dilated, tortuous vessel; later films showing the left pulmonary artery (Fig. 1) indicated a systemic-pulmonary shunt. This bronchial artery was selectively embolized with Gelfoam particles. Following the procedure, the patient's hemoptysis slowed but did not stop. Angiography was repeated 3 days later. A selective injection of the left subclavian artery showed enlarged collaterals from the chest wall to the left lung with subsequent visualization of the left pulmonary artery (Fig. 2). Two of these collateral channels were selectively injected and embolized. The patient did well following this procedure and at follow-up 12 months later, she had no recurrence of hemoptysis.

Case 3

A 57-year-old physician presented with sudden onset of massive hemoptysis. He had a carcinoma of the right upper lobe which had been irradiated 1 year before. Examination showed obstruction of the superior vena cava from recurrent tumor. Bronchoscopy revealed bleeding from the right lung. During angiography, selective injection of a right bronchial artery showed a small vessel to the right upper lobe. Selective injection of the right subclavian artery failed to reveal any collaterals. Even though there were no secondary signs to indicate hemorrhage from the right bronchial artery, it was embolized with Gelfoam particles in

Fig. 2. Selective injection of the left subclavian artery shows many chest-wall collaterals; these fill the left pulmonary artery in a retrograde fashion indicative of systemic-pulmonary shunting. The lateral thoracic artery (open arrow) and the highest thoracic artery (black arrow) were embolized.

an attempt to control the patient's hemoptysis. He continued to bleed and 4 days later the pulmonary artery to the right upper lobe was selectively catheterized and embolized (Fig. 3) with Gelfoam particles and a small coil. The patient stopped bleeding and was discharged 10 days later. He has had no recurrence of hemoptysis during 3 months of follow-up.

Discussion

Percutaneous embolization of the bronchial arteries to control massive or recurrent hemoptysis has become an accepted procedure, especially for patients with chronic pulmonary disease who are poor candidates for lung resection. In the vast majority of patients hemoptysis originates from systemic rather than pulmonary arteries, usually from the bronchial arteries. The literature has emphasized embolization of the bronchial artery supplying that portion of lung that is bleeding [1–9], but this vessel is not always the source of the hemorrhage. If bleeding persists, nonbronchial systemic collaterals [10], or even the pulmonary artery itself [6], may be successfully embolized.

There is some risk of recurrent hemoptysis after embolization of the bronchial artery, but the amount of bleeding is minor in most cases [9]. The reported incidence of recurrent massive hemoptysis after embolization varies from 10 to 21% [4–6]. Recurrent bleeding may be due to recanalization of embolized vessels, enlargement of systemic collaterals, or the progression of underlying disease.

Fig. 3. Selective injection of the right pulmonary artery; the origin of the right upper lobe branch arises posteriorly and is obscured by the main pulmonary artery. Note the deformity of two branches of the right upper lobe pulmonary artery (black arrows) and narrowing of the main right pulmonary artery (open arrows) caused by recurrent tumor. The branch to the right upper lobe was selectively catheterized and embolized.

Knowledge of the anatomy, not only of the bronchial arteries but of the nonbronchial systemic collaterals and anterior spinal artery, is essential for embolization to be successful. The position and distribution of the bronchial arteries vary with the individual. Using angiographic data from 72 patients, Uflacker et al. (5) described 10 different patterns: variations of a right intercostobronchial trunk arising laterally or dorsally, single right or left bronchial arteries, and common bronchial trunks arising from the ventral aspect of the aorta. Arteries supplying the midthoracic spinal cord originate from the intercostal arteries. Occasionally a spinal artery shares a common origin with the right bronchial artery. Most authors consider this configuration an absolute contraindication to embolization because of the risk of paralysis. This configuration did not occur in any of our patients.

The importance of nonbronchial systemic collateral arteries has not been stressed in the literature until a recent article by Keller et al. [10]. In the 20 patients they examined, nonbronchial systemic collateral arteries contributed significantly to hemorrhage in 45% of patients. Bronchial arteries were embolized in all but 1 patient, but nonbronchial systemic collaterals accounted for 59.9% of the total number of arteries embolized. These collaterals can originate from phrenic, intercostal, internal mammary, thyrocervical, and other branches of the subclavian and axillary arteries.

Complications related to bronchial artery embolization have been thoroughly described in the literature [4, 5]. The most serious potential complications are spinal cord injury and distal embolization. To date, there have been no reports of spinal cord injury occurring during bronchial artery embolization; however, paralysis has occurred as a consequence of bronchial arteriography [11]. Presumably, paralysis was related to the toxic effects of ionic contrast material and/or to ischemia caused by the catheter wedging within the bronchial artery [9]. One case of bowel infarction related to distal embolization of the upper abdominal viscera has been reported [4]. We encountered no complications in our series except for transient chest-wall pain in Case 2. Embolization should always be carried out with Gelfoam or other particles. Microdispersion suspensions (Gelfoam powder), liquid sclerosing agents, and ethanol [4, 6, 8, 10] should not be used because of the risk of tissue necrosis.

If hemoptysis persists after the embolization of systemic arteries, then it may be expedient to embolize the pulmonary artery supplying the bleeding segment of lung. Embolization of the pulmonary artery in the control of massive hemoptysis has been described in 2 patients by Rabkin et al. [6] and in 5 patients by Remy et al. [12]. In 1 of our patients, it worked well without adverse effects.

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