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Bronchial Artery Embolization for Massive Hemoptysis: A Retrospective Study

Ali Fani [1], Masoumeh Sinkaee [2*], Azar Fani Pakdel [3], Davood Attaran [4], Leila Ghofraniha [4]

[1] Radiologist, RazaviHospital, Mashhad, Iran.
[2*] Student of Radiologic Technology, School Of Paramedical Sciences, Mashhad University of Medical Sciences, Mashhad, Iran.
[3] Radiotherapist,Cancer Research Center, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.
[4] Pulmonologist, Lung disease COPD TB Research Center, Mashhad University of Medical Sciences, Mashhad, Iran.

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ABSTRACT

Introduction: To assess the efficacy and safety of bronchial artery embolization in the treatment of massive hemoptysis.
Materials and Methods: A retrospective study on 46 patients (26 males and 20 females) who were referred to the Razavi Hospital from April 2009 to May 2012 with massive hemoptysis and had bronchial artery embolization procedures. General characteristics of the patients including age, gender, etiology, and thorax computed tomograms, findings of bronchial angiographic, results of the embolization, complications related to bronchial artery embolization and clinical outcome during follow-up were reviewed.
Results: The etiology included previous pulmonary tuberculosis in 20 cases, previous tuberculosis with bronchiectasis in 16 cases, bronchiectasis in 6 cases, and active pulmonary tuberculosis in one case. No identifiable causes could be detected in three patients. Moreover, massive hemoptysis was successfully and immediately controlled following the embolization procedure in all patients.
One patient developed recurrent hemoptysis during one month following the procedure and was treated by re-embolization.
No major procedure–related complication such as bronchial infarction was identified However none of the patientsexperienced neurological complications.
Conclusion: Bronchial artery embolization is a safe and effective means of controlling massive hemoptysis and should be regarded as the first-line treatment for this condition.

Introduction

Massive hemoptysis is a life-threatening respiratory emergency. The condition has been widely defined as a blood loss of 300 to 600mL during a period of 24 hours (1).

However, the volume of blood that is lost is usually underestimated because a considerable amount of blood may not be expectorated and remains within the lungs.

Conservative management of massive hemoptysis caries a mortality of 50-100 % (2).

The reported mortality for surgical treatment ranged from 7. 1-18.2 % (3).

Mortality increases significantly, up to about 40 %, when the surgery is underwent as an emergency procedure (4,5). Because of poor pulmonary reserve, most patients with massive hemoptysis are not fit for surgical treatment.

Bronchial artery embolization was first described by Remy et al in 1973 (6). It has now been generally accepted as a first-line treatment for massive hemoptysis (7).

Bronchial artery embolization is also an efficient procedure in preparing patients for elective rather than high risk emergency surgeries (4). This retrospective study aimed to assess the efficacy and safety of bronchial artery embolization in the management of massive hemoptysis.

* *Corresponding author:* MasoumehSinkaee, Student of Radiologic Technology, School Of Paramedical Sciences, Mashhad University of Medical Sciences, Mashhad, Iran, Fax.:+985118402972, Mobile: +98 914 353 3600, *E-mail:* sinkaeem891@mums.ac.ir

Materials and Methods

From April 2009 to May 2012, the bronchial artery embolization was performed for 46 patients who presented with massive hemoptysis to the department of radiology of Razavi Hospital, Mashhad, Iran. All procedures were performed on an emergency basis. The clinical records of all patients were reviewed. All information including age, gender, etiology, the findings from computed tomography (CT) of the thorax and bronchial angiography, complications related to bronchial artery embolization and outcomes of bronchial artery embolization during follow-up were studied.

In all procedures, vascular access was achieved through the femoral approach. Flush-descending thoracic aortography was performed using 5-French catheters with multiple side holes (Figure 1). Abnormally dilated, hypertrophic and tortuous bronchial arteries were identified and selectively cannulated with the use of 0.035-inch angled tip hydrophilic guide-wires and 5-F catheters, such as Simmons or Cobra catheters. Digital subtraction selective bronchial angiography was subsequently performed (Figure 2). Embolic agents were subsequently injected until the blood flow inside the affected vessels became sluggish (Figure 3). The contrast medium was the non-ionic agent visipaque, which was mixed with normal saline in a ratio of 1:1. Polyvenyl alcohol, an embolic material, was utilized as the particles. The particle size ranged from 300- 700 μm.

Figure 1. Descending thoracic aortogram-LAO (Pigtail catheter).Demonstrate bronchial artery anatomy.Identify other systemic collateral vessels.Contrast-agent:20-30 ml.Flow:15 ml/sec.Image frequency:2/sec

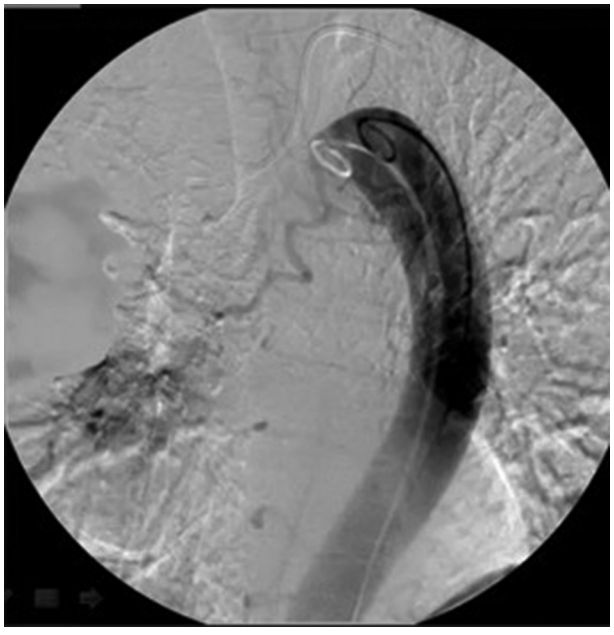

Figure 2. Selective catheterization of bronchial artery of affected side. Angiographic findings: hypertropic & tortuous bronchial arteries, areas of hypervascularity & neovascularity, shunting of blood into pulmonary artery or vein.

Figure 3. A-nonselective angiogram, B-selective angiogram, C-post PVA

Results

The 46 patients underwent bronchial artery embolization for acute massive hemoptysis comprised of 26 males and 20femaleswhose mean age was 60years (range: 20-86 years).

The etiology included previous pulmonary tuberculosis in 20 cases, previous tuberculosis with bronchiectasis in 16 cases, bronchiectasis in 6 cases, and active pulmonary tuberculosis in one case.

No identifiable causes were detected in 3 patients.

A total of 46 bronchial artery embolizations had been performed (Table 1). Flush-descending thoracic aortograms were obtained prior to selective bronchial angiography during the procedures. Abnormal bronchial arteries had been visualized in 35 of these 46aortograms.

Table 1. Number of arteries embolized during bronchial artery embolization.

Artery embolized	N o	Percent
Right bronchial artery	23	37.1%
Left bronchial artery	17	27.42%
Combined right and left bronchial trunk	6	9.68%
System collateral	16	25.80%

Massive hemoptysis was successfully controlled immediately following the procedure in all patients.

Abnormal non-bronchial systemic collateral supply was noted in 14 (41%) cases (Table 2). The abnormal systemic collateral arteries included an internal mammary artery (n=7), an intercostals artery (n=4), and a costocervical trunk (n=3). Four patients had multiple systemic collateral vessels. Procedures were repeated in one patient because of recurrent symptoms. The patient who suffered from tuberculosis developed recurrent heamoptysis during the month followingthe procedure and was treated by reembolization.

Table 2. Number of non-bronchial system collateral arteries embolized during bronchial artery embolization

Non-bronchial system collateral artery	N o	Percent
Internal mammary artery	7	31.82%
Intercostal artery	4	18.18%
Costocervical trunk	3	13.64%
Lateral thoracic artery	2	9.09%
Inferior phrenic artery	2	9.09%
Subclavian artery	2	9.09%
Superior thoracic artery	2	9.09%

Discussion

Massive or life-threatening hemoptysis may have numerous causes and the etiology varies in different parts of the world. In eastern countries, pulmonary tuberculosis and bronchiectasis are the most frequent causes (8). In our series, 37 cases of massive hemoptysis were associated with former pulmonary tuberculosis (20 with previous pulmonary tuberculosis and 16 with previous tuberculosis and bronchiectasis).In apatient, the massive hemoptysis was related to active pulmonary tuberculosis however in the Western countries bronchogenic carcinoma, cystic fibrosis and aspergillosis are the most prevalent causes (2,3,6). Other causes include lung abscess, pneumonia,chronic bronchiectasis, pulmonary-interstitial fibrosis, pneumoconiosis, pulmonary artery aneurysm (Rasmussen's aneurysm), congenital cardiac or pulmonary vascular anomalies, aortobronchial fistula, ruptured aortic aneurysm, and ruptured bronchial artery aneurysm (9).

Hypertrophied and tortuous bronchial arteries or collateral vessels, an unfolded aorta in elderly patients with diffuse atherosclerotic disease, and abnormal take-off of the vessels usually make stable cannulation difficult and embolization unsafe (10). We used microcatheters in some cases to achieve a more stable and distal cannulation of abnormal vessels, in order to bypass the spinal artery and to prevent reflux of embolic agents into the aorta and therefore to other non-target sites of the patients in our study experienced complications of stroke or organ infarction due to non-target embolization. Two different groups of spinal arteries may be encountered during bronchial angiography. The dorsal and ventral arteries are frequently identified as small and curvilinear vessels that extended towards the midline and supply the dorsal and ventral nerve roots.The anterior medullary arteries, which are rarely observed, run supra-medially to join with the anterior spinal arteries, thereby forming characteristic hairpin loops (10). It has been stated that the presence of the radicular arteries should not be considered as a contraindication of bronchial artery embolization (10-12). On the other hand, researchers believe that embolization or repeated angiography should be avoided in the presence of anterior medullary arteries because of the spinal cord ischemia (9). The use of embolic particles larger than 200-250 μm has been postulated to be safe because the particles are supposed to be too large to enter the spinal arteries (1). We believe that bronchial artery embolization can be performed safely by using large particles (>300 μm) and with the catheter tip well beyond the origin of anterior medullary arteries. Bronchiopulmonary shunts are occasionally encountered during bronchial angiography (2).

Pulmonary infarction or systemic arterial embolization might occur if embolic agents pass through the bronchial artery-pulmonary artery shunt or the bronchial artery-pulmonary vein shunt, respectively. Therefore, it is important not to use particles that can easily pass through the shunts (1,2).

An experimental study has established that bronchiopulmonary anastomosis measures about 325μm in human lungs(10). Some authors have suggested that bronchial artery embolization can be safely performed in the presence of bronchiopulmonary shunt, that the size of the embolic agents exceeds 350μm. Embolization by metallic coils will block the proximal parent arteries (1,6). Any rebreeding caused by distal collateralization with mean that further access to these collaterals may be lost, because proximal arteries are occluded. We therefore used particles ranging from 300-700 μm for bronchial artery embolizationtherefore we could embolize only at the arteriole and capillary levels, while keeping the proximal parent arteries patent.

Furthermore, these particles were unlikely to pass through the anterior medullary artery or bronchiopul-

monary shunt (1).

We performed flush-descending thoracic aortography for most patients to locate the abnormally hypertrophied bronchial arteries.

A normal thoracic angiogram, however, should not preclude the explore for an abnormal bronchial artery Therefore selective search for abnormal non-bronchial systemic collateral arteries should be performed (1,7). Of particular importance are the subclavian artery and its branches (most commonly, the internal mammary artery) for upper lobe lesions, and the inferior phrenic artery for lower lobe lesions (13).

Radiological investigation for massive hemoptysis usually includes chest radiography, CTand bronchoscopy; which aim at determining the causes as well as the sources of bleeding (14).

Conventional chest radiography is a simple, fast, cheap, non –invasive and readily available procedure(14). Fiberoptic bronchoscopy has also been used to investigate hemoptysis. However with this technique, it is usually difficult to locate the bleeding site in case of massive hemoptysis in which most of the bronchi are flooded. The potential risks of bronchoscopy include sedation, hypoxemia, aspiration and a delay in definitive treatment (14). Although vasoactive drugs can be infused locally during bronchoscopy to stop bleeding, endoscopic therapy is usually not effective in most cases of massive hemoptysis(5). Finally, CT of the thorax may demonstrate and locate most lung lesions, including pulmonary tuberculosis changes, bronchiectasis, bronchogenic tumors, and aspergillosis(14). The technique is fast, non-invasive and readily available. Moreover, CTscan helps to locate the site of bleeding in 63-100 % of patients with hemoptysis (8).

Conclusion

In our cases of massive hemoptysis, CT of the thorax was useful in locating the site of bleeding. Our overall success rate in the control of bleeding immediately following the procedure was 97 %.

Bronchial artery embolization is a safe and effective means of controlling bleeding and should be considered as the first-line treatment for massive hemoptysis.

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Conflict of Interest

The authors declare no conflict of interest.

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