Clinical Case of a Successful Endovascular Management of Pulmonary Bleeding

E.R. Khayrutdinov[1], A.V. Arablinsky, V.N. Yakovlev.
Botkin City Clinical Hospital of Moscow Healthcare Department, Chair of therapy and adolescent medicine of Russian Medical Academy of post-graduate education, Moscow, Russia

The treatment of pulmonary bleedings is a complex and thrilling problem of modern surgery. The development of endovascular surgery allowed for the introduction of new methods for minimally invasive management of this pathology. The right choice of embolization technique, embolizing material, as well as the knowledge of anatomical particularities of pulmonary blood supply form the basis of successful management of these severely ill patients. This review gives an example of successful endovascular embolization of the left bronchial artery with polyvinyl alcohol particles in a patient with massive pulmonary bleeding.
Keywords: *pulmonary bleeding, bronchial artery, polyvinyl alcohol particles.*

Massive pulmonary bleeding is a serious medical problem associated with high mortality. Depending on the etiological cause, pulmonary bleeding -related mortality varies from 35 to 85%. The death from pulmonary bleeding is rarely caused by blood loss, in most cases it is related to blood asphyxia. Pulmonary bleeding is considered massive if 24-hours blood loss exceeds 300 ml (1-3). In the absence of etiotropic therapy pulmonary bleeding has recurrent character and is associated by 50% mortality within 6 months (4). The results of surgical treatment of this pathology remain unsatisfactory, in case of urgent surgery the mortality is as high as 40%. We present a case of successful endovascular management of pulmonary bleeding.

Patient B., male, aged 25, was admitted to Botkin City Clinical Hospital on October 18, 2008, with hemoptysis. Chest X-ray examination revealed foci-like shadows in the lower lobe of the left lung. Clinical picture and chest X-ray data gave the basis for differential diagnosis between tuberculosis and pneumonia of unclear etiology. Fiberoptic bronchoscopy (FBS) performed on the same day because of repeated pulmonary bleeding revealed a hemorrhage from the lumen of the left lower lobe bronchus. The bleeding was stopped by bronchus irrigation with aminocaproic acid and Etamsylate solution. However, in several hours the patient had recurrent pulmonary bleeding. Control FBS showed recidivating bleeding from the left lower lobe bronchus; repeated attempts of bronchus irrigation with hemostatic solutions were unsuccessful, and for this reason bronchus tamponade has been performed. The patient was transferred to the intensive care unit and mechanical lung ventilation (MLV), antibacterial and infusion therapies were initiated. General blood count revealed a decrease of hemoglobin concentration to 79 g/l, and in this connection erythrocyte mass transfusion was started. During the next three days the patient had several episodes of recurrent pulmonary bleeding, which required FBS and endoscopic hemostasis. Control chest X-ray revealed single foci-like shadows in both lungs. Computed tomography (CT) of thoracic organs revealed homogenous infiltration of both lungs' lower lobes. The diagnosis of bilateral aspiration pneumonia was made and antibiotic therapy with Tienam and Ciprofloxacin was started. Taking into account recurrent character and unclear etiology of pulmonary bleeding, as well as short-time effect of endoscopic hemostasis during FBS, it was decided to perform angiopulmonography and angiography of the bronchial arteries in order to find the source of bleeding and decide on the method of its embolization.

During angiopulmonography there were no evidences of contrast medium extravasation into the lung parenchyma (Fig. 1). Angiography of the descending thoracic aorta revealed a pathological arterial network from the left bronchial artery (Fig. 2).

Selective angiography of the left bronchial artery showed the increase of its diameter, with hypervascularized area and contrast medium extravasation into the parenchyma of the left lung's lower lobe (Fig. 3).

The left bronchial artery was embolized with polyvinyl alcohol (PVA) particles (500 μc). Control angiogram did not reveal signs of contrast medium extravasation, total occlusion of the left bronchial artery was achieved (Fig. 4).

After the procedure the patient remained severely ill because of respiratory failure against the background of bilateral pneumonia, but pulmonary bleeding did not recur. FBS did not reveal signs of continuing bleeding. The results of laboratory examinations allowed to exclude pulmonary tuberculosis, however, the discovery of worms in patient's feces did not allow to exclude parasitic etiology of his pneumonia. Scatology revealed the presence of Ascaris lubricoides eggs. Antibiotic therapy with Tienam and Ciprofloxacin was suggested. Taking into account the revealed ascariasis, the therapy was supplemented

[1] Address for correspondence:
Dr. Evgueny Khayrutdinov,
Russia, 117574, Moscow, proezd Odoevskogo, 7, bld.1, apt.12.
Tel. +7 916 830 49 64
e-mail: eugkh@yandex.ru
Manuscript received on August 9, 2011.
Accepted for publication on September 5, 2011.

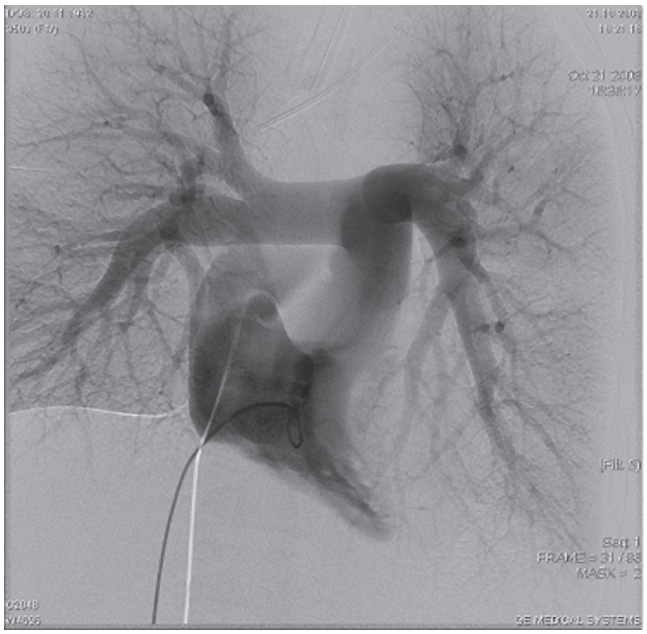

Figure 1. Angiopulmonography

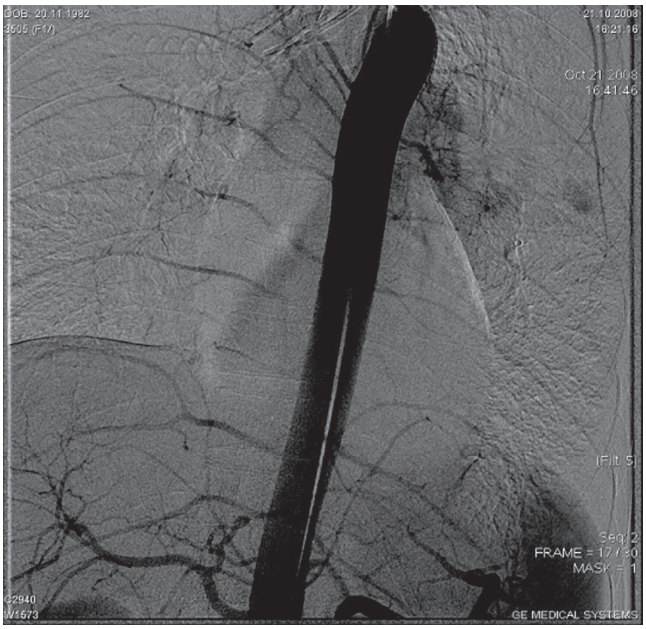

Figure 2. Angiography of the descending thoracic aorta

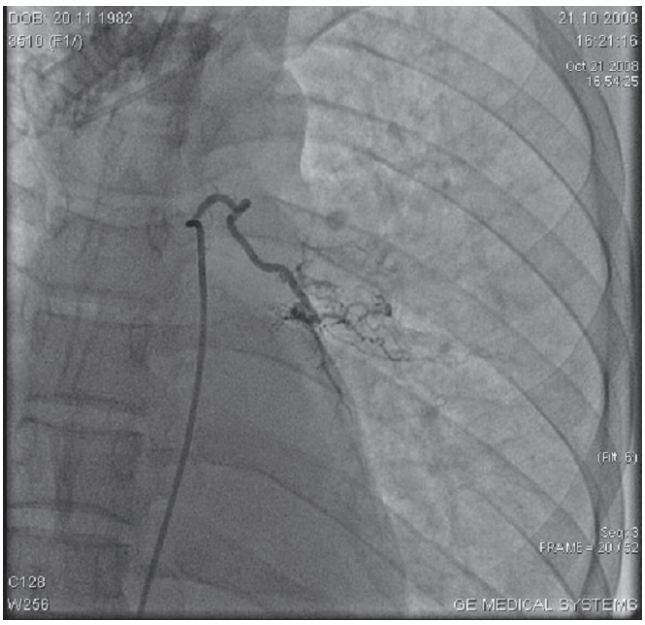

Figure 3. Angiography of the left bronchial artery

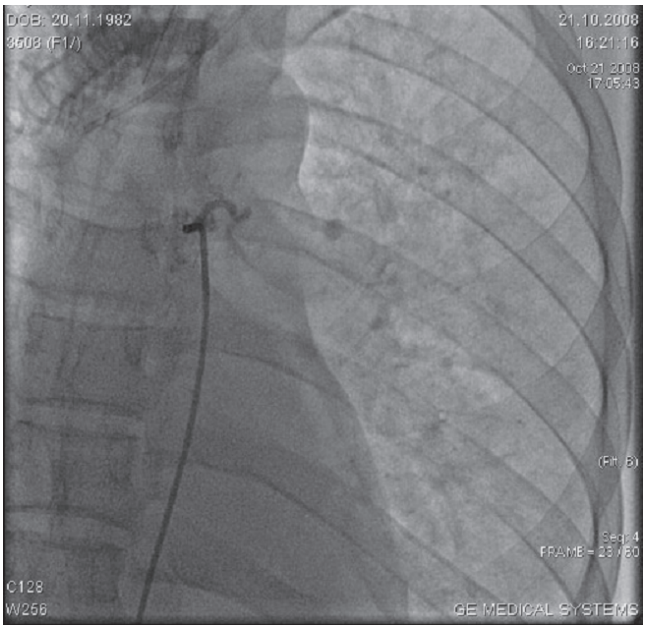

Figure 4. Total embolization of the left bronchial artery with PVA particles.

by anti-worm agent Mebendazol. This therapy led to the stabilization of patient's condition. In 5 days after the embolization of the left bronchial artery he was extubated, pulmonary bleeding did not recur. Chest X-ray examination performed in 2 weeks after the embolization revealed the resolution of bilateral pneumonia. The patient was discharged in a satisfactory condition.

We present a case of successful endovascular treatment of pulmonary bleeding. Bronchial arteries are the source of pulmonary bleeding in more than 90% of cases. The bleeding from the pulmonary arterial system (e.g., pulmonary arteriovenous malformation, pulmonary endometriosis, pulmonary arterial aneurysm, etc.) is rare and occurs in approximately 5%. In the remaining 5% of cases the source of bleeding is not found in bronchial systemic collateral arteries. It can be located in the internal thoracic artery, the thyrocervical trunk of the subclavian artery, the lateral branches of the subclavian and axillary arteries, the intercostal arteries and the inferior diaphragmatic artery (5, 6). In most cases pulmonary bleeding is caused by acute or chronic inflammatory lung disease. Etiological causes of pulmonary bleedings are presented in Table 1.

Pulmonary blood flow in patients with acute or chronic pulmonary diseases is decreased due to hypoxia-caused vasoconstriction, thrombosis and

vasculitis at the level of pulmonary arterioles. This leads to the growth and the enlargement of bronchial arteries aimed at the compensation of decreased pulmonary blood flow. Bronchial arterial blood flow in patients with bronchoectatic pulmonary disease can reach up to 30% of the cardiac output (7). The impact of increased blood pressure and bacterial agents on the bronchial arteries contributes to their rupture and subsequent pulmonary bleeding (2, 8).

Chest X-ray, FBS and CT are the main methods for the diagnostics of pulmonary bleeding. In most cases chest X-ray examination allows to reveal some pulmonary disease, but does not detect the source of bleeding. FBS is the main diagnostic procedure in patients with pulmonary bleeding. It allows to find the source of bleeding in 93% of cases. However, the diagnostic value of FBS in patients without any pathology revealed by chest X-ray is significantly reduced (0-30%). The advantage of bronchoscopy consists in the feasibility of local application of hemostatic agents to stop the bleeding. The examination with CT allows to reveal simultaneously bronchopulmonary and vascular pathology, thus CT is the method of choice for the diagnostics of pulmonary bleeding. It allows to detect the source of bleeding in 63-100% of cases (1, 9).

Angiography of the bronchial arteries is the final step in the diagnostics of the source of pulmonary bleeding prior to embolization. The main distinctive angiographic features of bronchial arterial pathology in pulmonary bleeding are: the enlargement of the main trunk of the bronchial artery (>3 mm), the hypervascularization of the pathological focus area, the impregnation of parenchyma with contrast medium and the presence of bronchopulmonary shunts.

Virtually in all cases bronchial arteries arise from the thoracic aorta at the level of T4-T7 vertebrae (10, 11), in 90% of cases their origin is located at the level of the intervebral disc between the T5 and T6 vertebrae. Bronchial arteries supply the trachea, the bronchi, regional lymphatic nodes, the pleura and the esophagus.

There are 4 main types of bronchial arteries origin (2):

• Type 1: two bronchial arteries arise to the left, and one — to the right of the aorta (intercostal bronchial trunk) — is seen in 40% of cases.

Table 1.

Etiological causes of pulmonary bleeding

Infection: • Bronchoectatic disease • Pneumonia • Chronic bronchitis • Lung abscess • Aspergillosis, mycetoma • Ascariasis • Tuberculosis • Cystic fibrosis
Tumors: • Adenocarcinoma • Bronchus adenoma • Bronchus carcinoid • Endometriosis • Metastases in lungs
Cardiovascular diseases: • Severe left ventricular failure • Mitral stenosis • Pulmonary arterial thromboembolism • Aortic aneurysm • Pulmonary arterial aneurysm • Arteriovenous malformation • Yatrogenic causes (e.g., damage by Swan-Ganz catheter)
Vasculites: • Wegener's disease • Systemic lupus erythematosis • Goodpasture's syndrome
Idiopathic pulmonary hemosiderosis
Aspiration of a foreign body
Lung trauma (contusion)
Use of anticoagulant agents, thrombolythic therapy

• Type 2: one bronchial artery arises to the left, and one intercostal bronchial artery — to the right of the aorta — in 20% of cases.

• Type 3: two bronchial arteries arise to the left, and one bronchial and one intercostal bronchial artery — to the right of the aorta — in 20% of cases..

• Type 4: one bronchial artery arises to the left, and и one bronchial and one intercostal bronchial artery — to the right of the aorta — in 10% of cases.

However there are many variants of bronchial arteries origin. They can arise from the aortic arch, the internal thoracic artery, the thyrocervical trunk, the left subclavian artery, the inferior thyroid artery and the abdominal aorta (11). Bronchial arteries have a lot of collaterals with other anatomic areas, which has to be taken into consideration while performing the embolization. The most important are the collaterals to the anterior cerebral artery supplying the spinal cord, the right and the left subclavian arteries and the right coronary artery.

The embolization of a bronchial artery was first described by Remy (12) in 1970, and with the course of time became the generally adopted method for the treatment of massive pulmonary bleeding (13-16). Technical improvements in catheters' design and production methods, as well as in embolizing materials have contributed to the enhancement of safety and availability of this procedure. The search of the source of pulmonary bleeding during angiographic examination should be started with thoracic angiography. At the next stage selective catheterization of bronchial arteries is performed. It can be done with the use of catheters like Cobra, Simmons, Mammary, Multi-purpose, as well as of special catheters for bronchial arteries. If lateral branches arising from the bronchial artery supply other anatomical areas, superselective embolization using microcatheter is performed, because the embolization of these branches can lead to complications.

Hemostatic sponge, microspheres and coils can be used as embolization material. The main advantage of a hemostatic sponge consists in its availability and low cost. However with the course of time the sponge resolves which can lead to recanalization of the embolized vessel and recurrent bleeding. Thus, hemostatic sponge can be used only for temporary bleeding control. The most frequently used embolizing material are PVA particles. Being biocompatible and non-biodegradable they provide long-term hemostasis (17). Recently it was suggested to use for this purpose the embospheres produced on the basis of triacryl gelatine, however the experience with the use of this material for bronchial arteries embolization is still limited. The main advantage of embospheres over the PVA particles consists in their better penetrating capacity and the lack of propensity for clots formation due to particles' glueing, which is especially important with the use of microcatheters. As a rule, bronchial embolization is performed using particles of 350 — 700 μc; the use of smaller particles is undesirable as it can lead to the embolization of branches supplying healthy tissues. Metallic and plastic coils are seldom used as primary material for bronchial arteries embolization. It is related to the fact that they cause proximal occlusion of the vessel with subsequent development of collaterals to the damaged area and recurrent bleeding. The presence of bronchial arterial aneurysms is main indication for the use of coils (18, 19).

Embolization of bronchial arteries is a high-effective procedure for the treatment of acute pulmonary bleeding. Its one-month effectiveness is 73 to 98% (12, 20, 21). The rate of late pulmonary bleeding recurrence can reach 52%, however, with the use of repeated embolizations and the treatment of the underlying disease the success rate is close to 100%. The most frequent causes of pulmonary bleeding recurrence are recanalization of the embolized vessel, incomplete primary embolization of the sick vessel, the development of new collaterals and the progressing of the underlying disease (22). The frequency of recurrent pulmonary bleeding also depends on its etiological cause, most frequently they occur in patients with cancer and chronic tuberculosis.

The most frequent (24-91%) complication of bronchial arteries embolization is chest pain related to the ischemia of the embolized branches of the bronchial artery. However, it can be more pronounced after embolization of the intercostal arteries' branches. The second most frequent complication, occurring in 0,7 — 18,2% of cases, is dysphagia related to the embolization of esophagus-supplying branches (23). As a rule, the symptoms resolve spontaneously within several days. Spinal cord ischemia occurring in 1,4 — 6,5% of cases is the most severe complication of embolization of the bronchial arteries. There are reports of rare complications, such as bronchus necrosis, unilateral phrenoplegia, bronchus stenosis, infarction lung pneumonia. Eventual ways for the decrease of the risk such complications consist in the use of superselective embolization technique with microcatheters and the due choice of embolization materials.

Thus, embolization of the bronchial arteries is the method of choice for the treatment of patients with acute pulmonary bleeding. The knowledge of anatomical particularities of the bronchial arteries and their collaterals, the due choice of the technique and the material for embolization form the basis for successful embolization in patients with pulmonary bleeding.

References

1. Hirshberg B., Biran I., Glazer M., Kramer M.R. Hemoptysis: etiology, evaluation, and outcome in a tertiary referral hospital. Chest, 1997, 112, 440-4.

2. Yoon W., Kim J.K., KimY.H. et al. Bronchial and nonbronchial systemic artery embolization for life-threatening hemoptysis: a comprehensive review. Radiographics, 2002, 22, 1395-409.

3. Wong M.L., Szkup P., Hopley M.J. Percutaneous embolotherapy for life-threatening hemoptysis. Chest, 2002, 121, 95-102.

4. Knott-Craig C.J., Oostuizen J.G., Rossouw G. et al. Management and prognosis of massive hemoptysis. Recent experience with 120 patients. J. Thorac. Cardiovasc. Surg., 1993, 105, 394-7.

5. Foster D.C., Stern J.L., Buscema J. et al. Pleural and parenchymal pulmonary endometriosis. Obstet. Gynecol., 1981, 58, 552-6.

6. DeLima L.G., Wynands J.E., Bourke M.E. et al. Catheter-induced pulmonary artery false aneurysm and rupture: case report and review. J. Cardiothorac. Vasc. Anesth., 1994, 8, 70-5.

7. Do K.H., Goo J.M., Im J.G. et al. Systemic arterial supply to the lungs in adults: spiral CT findings. Radiographics, 2001, 21, 387-402.

8. Chun H.J., Byun J.Y., Yoo S.S. et al. Added benefit of thoracic aortography after transarterial embolization in patients with hemoptysis. Am. J. Roentgenol., 2003, 180, 1577-81.

9. Hsiao E.I., Kirsch C.M., Kagawa F.T. et al. Utility of fiberoptic bronchoscopy before bronchial artery embolization for massive hemoptysis. Am. J. Roentgenol., 2001, 177, 861-7.

10. Won J.H., Park S.I., Park K.J. et al. Microcatheter placement through a side hole created in a 5-F catheter into proximal subclavian arterial branches causing hemoptysis. J. Vasc. Interv. Radiol., 2004, 15, 881-4.

11. Sancho C., Escalante E., Dominguez J. et al. Embolization of bronchial arteries of anomalous origin. Cardiovasc. Intervent. Radiol., 1998, 21, 300-4.

12. Remy J., Arnaud A., Fardou H. et al. Treatment of hemoptysis by embolization of bronchial arteries. Radiology, 1977, 122, 33-7.

13. Haponik E.F., Fein A., Chin R. Managing life-threatening hemoptysis: has anything really changed? Chest, 2000, 118, 1431-5.

14. Johnson J.L. Manifestations of hemoptysis. How to manage minor, moderate, and massive bleeding? Postgrad. Med., 2002, 112, 101-9.

15. Jougon J., Ballester M., Delcambre F. et al. Massive hemoptysis: what place for medical and surgical treatment. Eur. J. Cardiothorac. Surg., 2002, 22, 345-51.

16. Marshall T.J., Flower C.D., Jackson J.E. The role of radiology in the investigation and management of patients with haemoptysis. Clin. Radiol., 1996, 51, 391-400.

17. White R.I. Bronchial artery embolotherapy for control of acute hemoptysis: analysis of outcome. Chest, 1999, 115, 912-5.

18. Barben J., Robertson D., Olinsky A. et al. Bronchial artery embolization for hemoptysis in young patients with cystic fibrosis. Radiology, 2002, 224, 124-30.

19. Saluja S., Henderson K.J., White R.I. Embolotherapy in the bronchial and pulmonary circulations. Radiol. Clin. North Am., 2000, 38, 425-48.

20. Uflacker R., Kaemmerer A., Picon P.D. et al. Bronchial artery embolization in the management of hemoptysis: technical aspects and long-term results. Radiology, 1985, 157, 637-44.

21. Lampmann L.E., Tjan T.G. Embolization therapy in haemoptysis. Eur. J. Radiol., 1994, 18, 15-9.

22. Marshall T.J., Jackson J.E. Vascular intervention in the thorax: bronchial artery embolization for haemoptysis. Eur. Radiol., 1997, 7, 1221-7.

23. Ramakantan R., Bandekar V.G., Gandhi M.S. et al. Massive hemoptysis due to pulmonary tuberculosis: control with bronchial artery embolization. Radiology, 1996, 200, 691-94.