Supraselective bronchial artery embolization in patients with massive hemoptysis.

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Learning objectives

To understand general principles of patient's selection for bronchial artery embolization based on clinic and imaging criteria.

To become familiar with main steps of procedure and imaging interpretation.

To learn about treatment results and complications risks.
Background

Hemoptysis is expectoration of blood or blood-streaked sputum from bronchi or lungs. Source of bleeding are hypertrophied, fragile bronchial arteries in patients with chronic inflammatory lung diseases: tuberculosis, cystic fibrosis, sarcoidosis. Massive hemoptysis is potentially fatal complication leading up to 85% mortality when treated conservatively.

There are several possibilities of hemoptysis treatment - conservative, operation and mini invasive interventional procedures. Most patients with diffuse lung disease and hemoptysis have limited pulmonary reserves, therefore are unacceptable for surgery. Conservative therapy is usually unsuccessful because of chronic nature of disease, collaboration problems with patients etc. Recently catheterization of bronchial arteries feeding affected areas followed by particulate embolization is elaborated and recognized as effective alternative emergency treatment for bleeding control.

Clinical indications for bronchial artery embolization (BAE) are formulated currently as following:

1) Hemoptysis that can't be stopped by bronchoscopy or conservative treatment.
2) Massive hemoptysis - 300 ml or more in 24 hrs.
3) Mild often hemoptysis - 3 episodes of hemoptysis during one week with 100 ml of blood.
4) Light chronic hemoptysis with accelerating nature.

Anatomically bronchial arteries arise from the descending thoracic aorta between the upper T5 to the lower T6 vertebral bodies in 70% of population. Another 10% remain a first-order branch of the thoracic aorta or arch, but outside of the T5-T6 confines. The remaining 20% originate from a variety of structures including the thoracic (brachiocephalic, subclavian, internal mammary, pericardiophrenic, or thyrocervical) and abdominal (aorta, inferior phrenic, celiac) branches. A thorough understanding of the various anatomic permutations and their associated potential clinical significance is obviously necessary when considering bronchial artery embolization. Hence non bronchial systemic collaterals should be investigated and treated concurrently with the hypertrophied bronchial arteries at the time of initial arteriogram when possible.

There are different materials for bronchial embolization - vascular plugs, coils and liquid particle embolization substances. Each material has its advantages and disadvantages - rapidity and completeness vessel occlusion, control of embolizing material spread into vessel, time window for procedure etc. The goal of treatment is selective closure of
bronchial artery or its branches and collaterals, in way where used materials stay at the planned site. If the treatment is successful hemoptysis stops at the end of procedure.

Complications associated with BAE usually can be divided between those which are caused by angiography (nephropathy or allergic caused by contrast medium) and complications caused by unintentional non target embolization. Non target embolization can cause severe conditions like transverse myelitis due to spinal cord ischemia and embolization of mediastinal structures through collaterals, fortunately these conditions are rare. Usually patients develop post embolization syndrome: raised temperature, burning sensation and pain in chest, dysphagia but these symptoms usually disappear in time window from 48 hrs to 2-3 weeks.
Findings and procedure details

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We demonstrate our experience of successful interventional treatment in two patients of chronic inflammatory lung diseases and acute hemoptysis.

Case Nr 1.

Male patient, 49 years old, was brought into emergency with acute chest pain and hemoptysis. The patient had medical history of thoracic surgery in the last decade due to massive spread of tuberculosis. As a temporary treatment emergency bronchoscopic obturation of bleeding lung segment with porolon plug was performed what gave a time for subsequent clinical and radiological examination.

Chest x-ray and CTA were performed to identify acute radiographic changes in the lungs: bronchiectasis, new infiltrate and discover causes of bleeding.

CTA showed perifocal bleeding in postoperative segments, hypertrophy of the right bronchial artery, and intensified vascularity in postoperative lung segments (Fig.1.A, B).

Bronchial artery embolization [BAE] (Fig.2.A, B, C): Transfemoral access with Seldingers technique provided route to position guide catheter in thoracic aorta at the level of fifth to sixth thoracic vertebrae. After inserting 5F guide catheter into target bronchial artery and injecting contrast medium evaluation of bleeding site was available. Using 2.7 F micro catheter coaxially super selective artery catheterization was performed. Position of catheter at the place of embolization was confirmed by injecting small doses of contrast. Liquid embolization particles were injected into targeted artery in slow and steady fashion. It is necessary to emphasize that at this stage of procedure is highly important to make sure that particles are embolizing the correct artery and that micro catheter doesn't stick to artery wall. After embolization procedure both micro and guide catheter were removed.

In the first post intervention days patient developed post embolizing syndrome - elevated temperature and chest pain which ceased within 3 days. Few days after BAE follow up bronchoscopy with porolon plug removal was done. No signs of bleeding from bronchi wall were found.

Control X-ray (Fig.3) demonstrated embolization cast in the right bronchial artery.

Case Nr 2.
Male patient, 71 years old, suffering from chronic interstitial inflammatory lung disease and recent episode of pleuropneumonia, was delivered to emergency with massive hemoptysis lasting for 4 days.

During bronchoscopic procedure tiny blood clots in the first, third, eighth, tenth and lingular segments of the left lung were visualized. Chest x-ray and CTA were performed to identify acute radiographic changes in the lungs. CTA showed hipervascularity of the left bronchial arteries and lung architecture deformations, manly expressed in the left lower segments (Fig.4, A, B).

Bronchial artery embolization [BAE] (Fig.5.A, B, C) was performed using transfemoral access with Seldingers technique. At first, visualization of bronchial arteries was difficult due to anatomical variation of bronchial arteries course, breathing motions and pulsations from heart and aorta. After inserting 5F guide catheter into target bronchial artery and injecting contrast medium visualization of bleeding site was available. Using 2.7 F micro catheter coaxially super selective catheterization of artery was done. Position of catheter at place of embolization was confirmed by injecting small doses of contrast. Embolization particles were injected into targeted artery in slow and steady fashion.

On follow up bronchoscopy performed three days after BAE porolon plug was removed. No signs of bleeding from bronchi wall were found.

Control X-ray (Fig.6) showed embolization cast in the right bronchial artery.
Images for this section:

**Fig. 1:** Case Nr 1. Preoperative CTA : A. CTA MIP. Perifocal bleeding in postoperative segments; B. CTA VR. Hypertrophy of the right bronchial artery, intensified vascularity in postoperative lung segments

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**Fig. 2:** Case Nr.1. DSA A, B and C. Steps of BAE. From the left to the right: A. DSA shows multiple shunts between hypertrophic right bronchial arteries and right pulmonal veins B. Selective catheterization of the right bronchial artery C. Super selective catheterization of the descending branch of right bronchial artery during the process of embolization.

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**Fig. 3:** Case Nr 1. Control X-ray locating embolization cast in the right bronchial artery

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**Fig. 4:** Case Nr 2. Preoperative CTA: A. CTA MIP saggital. Hipervascularity of left bronchial arteries; B. CTA MIP coronal. Lung architecture deformations, manly expressed in the left lower segments
Fig. 5: Case Nr.2. DSA A, B and C. Steps of BAE. From the left to the right: A. DSA shows explicit hypertrophy with "sponge" like vascular appearance at the peripheral branches of the left bronchial artery B. Selective catheterization of the left bronchial artery C. Super selective catheterization of the left bronchial artery during the process of embolization.
**Fig. 6:** Case Nr 2. Control X-ray locating embolization cast in the left bronchial artery. Revealing of the anatomic configuration of accessory branch which curves into right direction.

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Conclusion

Conclusions

1. Supralselective bronchial artery embolization in major hemoptysis is effective and potentially safe emergency treatment for patients with chronic diffuse inflammatory lung diseases.

2. Precise radiologic diagnostic of the individual anatomical varieties of bronchial arteries and bleeding source, understanding of bleeding mechanism, selection of appropriate treatment materials and technique, as well as sufficient interventional treatment skills of operators are essential for successful treatment and achieving of optimal result.
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