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## Bronchial artery embolization for the treatment of hemoptysis caused by *Aspergillus fumigatus* infection

### Embolizacja tętnic oskrzelowych w leczeniu krwawień z dróg oddechowych spowodowanych infekcją *Aspergillus fumigatus*

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#### Keywords

embolization, aspergilloma, *Aspergillus fumigatus*, hemoptysis

#### Słowa kluczowe

embolizacja, grzybnia, *Aspergillus fumigatus*, krwiotłucie

#### Summary

**Introduction.** *Aspergillus fumigatus* is one of the most common fungal pathogens to cause lung infection. Typically, it presents in the form of aspergilloma, which is an oval mass consisted of matted mycelium. The first, and often the only symptom is bleeding from the respiratory tract. Hemoptysis is a dangerous complication, without treatment can quickly lead to death. Currently, interventional radiology gives a possibility of non-invasive treatment in hemoptysis caused by aspergilloma infection.

**Aim.** Evaluation the efficacy and safety of endovascular embolization of the bronchial arteries for the treatment of haemoptysis, which is a complication of invasive fungal infection of the lungs.

**Material and methods.** The study was a retrospective analysis of 5 patients treated due to hemoptysis as a complication of pulmonary aspergilloma. In three cases, embolization was performed using hydrogel microspheres, in two cases a tissue glue was used.

**Results.** In one case, due to technical difficulties, complete embolization wasn't possible. Others have been properly closed. Control angiographic examinations showed effective closure of embolized arteries. In the six-month follow-up there was no recurrence of bleeding, there were also no complications related to the embolization procedure.

**Conclusions.** Bronchial artery embolization is a safe and effective treatment of bleeding from the respiratory tract and should always be considered as a treatment option for haemoptysis caused by aspergilloma. The procedure does not interfere with pharmacological therapy, and both methods can be used simultaneously. In special cases, it can also be used as preparation for surgery, significantly reducing the risk of perioperative mortality.

#### Streszczenie

**Wstęp.** *Aspergillus fumigatus* jest jednym z najczęstszych patogenów będących przyczyną grzybiczej infekcji płucnej. Typowo występuje w postaci grzybnia kropidlakowego płuc, będącego owalną masą złożoną ze splecionej grzybni kropidlaka. Często pierwszym i jedynym objawem choroby jest krwawienie z dróg oddechowych. Krwiotłucie jest powikłaniem groźnym i bez leczenia szybko może doprowadzić do zgonu. Obecnie w leczeniu grzybników płuc możliwe jest zastosowanie nieinwazyjnych metod radiologii zabiegowej.

**Cel pracy.** Ocena skuteczności i bezpieczeństwa wewnątrznaczyniowej embolizacji tętnic oskrzelowych w leczeniu krwawień z dróg oddechowych będących powikłaniem inwazyjnej infekcji grzybiczej płuc.

**Materiał i metody.** Retrospektywnej analizie poddano badania 5 chorych leczonych z powodu grzybnia płuc powikłanego krwawieniem z dróg oddechowych. W trzech przypadkach wykonano embolizację przy użyciu mikrosfer hydrożelowych, w dwóch przypadkach wykorzystano klej tkankowy.

**Wyniki.** Z powodu trudności technicznych u jednego chorego nie udało się zamknąć wszystkich naczyń. Pozostałe zostały prawidłowo zamknięte. Kontrolne badania angiograficzne u wszystkich chorych wykazały skuteczne zamknięcie embolizowanych naczyń i przetok. W ciągu sześciomiesięcznej obserwacji nie stwierdzono nawrotów krwawienia. Nie stwierdzono również żadnych powikłań związanych z zabiegiem embolizacji.

#### Conflict of interest Konflikt interesów

None

Brak konfliktu interesów

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**Wnioski.** Embolizacja tętnic oskrzelowych jest bezpiecznym i skutecznym leczeniem krwawień z dróg oddechowych i zawsze powinna być rozważana jako leczenie w krwawieniach z grzybniaków płuc. Nie koliduje ona z leczeniem farmakologicznym i obie metody mogą być stosowane jednocześnie. W szczególnych przypadkach może być również zastosowana jako przygotowanie do zabiegu operacyjnego usunięcia płuc, zmniejszając znacznie ryzyko śmiertelności okołoperacyjnej.

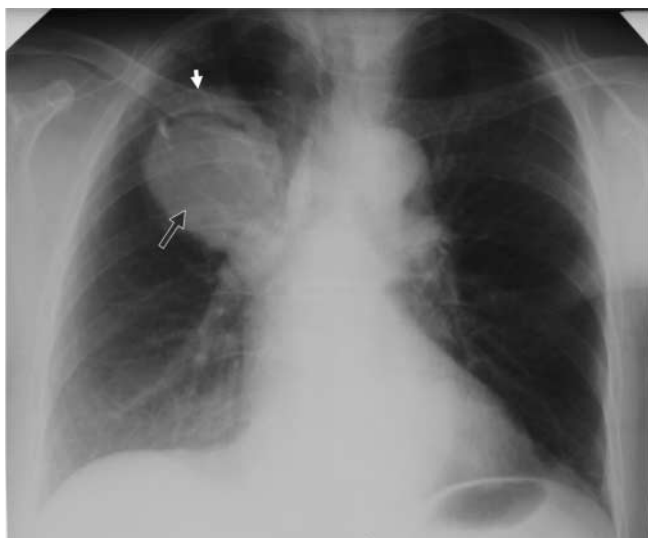
## INTRODUCTION

*Aspergillus fumigatus* is one of the most common fungal pathogens to cause pulmonary infection. The fungal spores can be inhaled to the lungs or moved to the bloodstream with surgical tools and lead to generalized infection of the body (1).

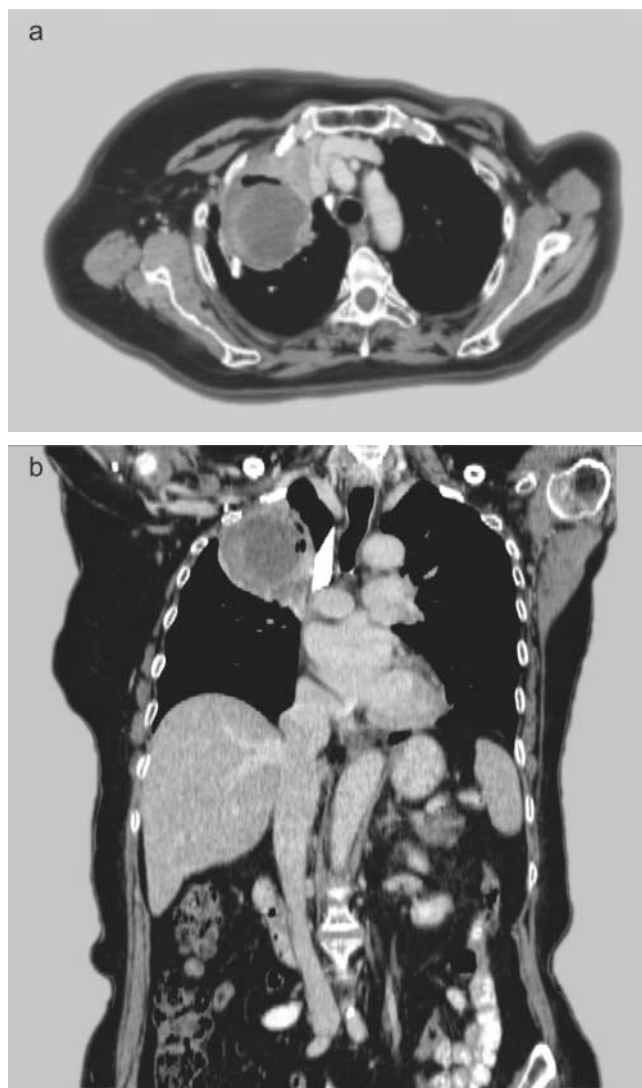
*Aspergillus fumigatus* infection may have different forms, from allergic to invasive pulmonary aspergillosis (2). The most common form of *A. fumigatus* infection is aspergilloma which is an oval mass consisting of tangled mycelium. Mycetoma usually develops in patients with no immune deficiencies. The sole condition of aspergilloma growth is the presence of pulmonary cavities, predominantly post-inflammatory, sarcoidotic or bronchiectatic cavitary lesions (3).

The major radiographic finding in aspergilloma is a characteristic oval shadow in the lung cavity surrounded by air and the cavity wall (fig. 1, 2a, b). To confirm the diagnosis, tests for *A. fumigatus* antibodies can be performed (4, 5).

The most dangerous and often the only symptom of aspergilloma is bleeding from the respiratory tract. Haemoptysis occurs due to congestion and increased pressure in the inflamed vessels, ultimately resulting in rupture of the vessel wall and extravasation. The other damaging factors are proteolytic enzymes produced by the scraps of a growing mycelium. The main cause of death in patients with haemoptysis is asphyxia. Direct consequences in the form of massive haemorrhage are extremely rare (6, 7).



**Fig. 1.** Oval mass (black arrow) with characteristic ring (white arrow) in the upper lobe of the right lung



**Fig. 2a, b.** Aspergilloma in CT

Nowadays, thanks to advances in interventional radiology, dangerous bleedings from the bronchial tree can be treated with percutaneous, minimally invasive bronchial artery embolization (BAE).

## AIM

The aim of this study was to evaluate the efficacy and safety of endovascular embolization of the bronchial arteries for the treatment of haemoptysis, which is a complication of invasive fungal infection of the lungs.

## MATERIAL AND METHODS

In the retrospective study, 5 cases of patients with aspergilloma complicated by bleeding from the airway

treated in the Department of Radiology and Neuro-radiology from September 2011 to September 2016, were analysed. The study group consisted of 20% of women and 80% of men, aged 50-80 years. Four patients were treated previously for tuberculosis, one patient was diagnosed with throat cancer. The diagnosis was based on chest X-ray and computed tomography (CT) scans. Aspergillomas were detected in the form of a tumour growing in the lung cavity, whose boundaries were visible through the gas limbus separating the tumour mass from the lung cavity, called the Monad's sign.

Embolization procedures were performed at the Department of Radiology and Neuroradiology MU in Lublin, using a Siemens Multi Star system. The procedures were performed under local anaesthesia. The Seldinger method was applied to puncture the femoral artery. The vascular 5 French sheath was inserted. Aortography was performed using a Pigtail catheter and a contrast agent Visipaque 320 administered in a volume of 25 ml with the flow rate of 12 ml/sec. Once the presence of pathological vessels was confirmed, embolisation was performed.

## RESULTS

Vessels supplying the mycetomas were intercostal and bronchial arteries as well as branches of the internal mammary artery. Arteries were selectively cannulated. Depending on the anatomical conditions, different catheters were used, most commonly Pigtail, Cobra, Simmonds1, Simmonds2 and Progreat micro-catheters (Terumo).

Each patient underwent embolization. All the embolized tumours were located in the right lung. In three cases, embolization was performed using hydrogel microspheres (Embosphere) 100 to 700  $\mu$ m (fig. 3a-c). In two cases, tissue glue was used. In three procedures with particles, the bronchial arteries, as well as the intercostal branches of the internal mammary artery were closed. Due to technical difficulties, complete embolization was not performed in one patient. Other arteries were properly closed. In one of five patients, a fistula between the branches of bronchial and pulmonary arteries was revealed. Using tissue glue and lipiodol mixture at a concentration of 25%, the shunt was closed. Follow-up angiographies showed effective closure of embolized vessels and fistulas in all patients. The follow-up angiographies performed 6 months later demonstrated no recurrences of bleeding. Moreover, there were no complications related to the embolization procedure.

## DISCUSSION

Fungal infection of the lungs is the most common cause of bleeding from the respiratory tract beside tuberculosis and lung cancer (8). Restrictive surgical procedures have long been the only treatment of aspergilloma in cases of haemoptysis or ineffective medication. Perioperative mortality ranged from 7 to 18% and in-

creased to 50% during life-saving treatments (8). The situation changed since 1973, when Remy first described bronchial artery embolization (9). Since that time, there have been many articles on BAE as the main treatment option for bleeding from the respiratory tract, proving its effectiveness and low risk of complications.

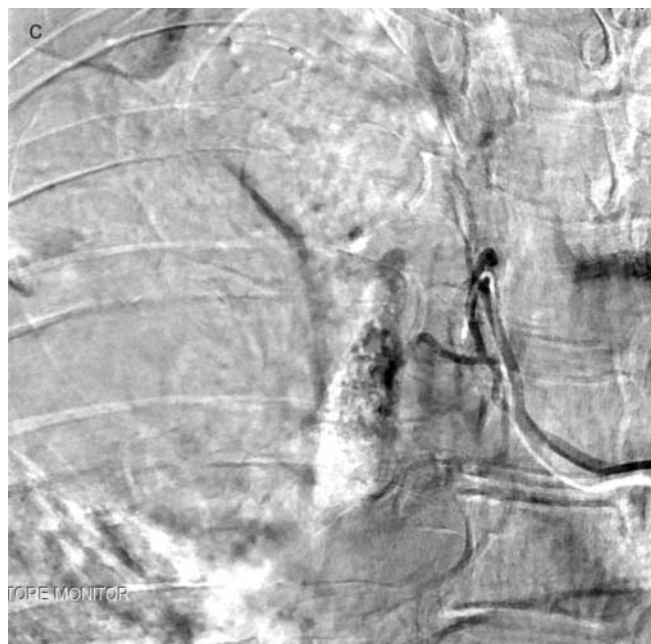
There are different types of embolization materials. Particles of polyvinyl alcohol and hydrogel microspheres are the most popular. They cause permanent vascular occlusion. During the fluoroscopy-guided procedure, the mixture of particles and a contrast agent is administered manually via a catheter inserted into the blood vessels supplying the pathological conglomerate. Skilful use of the



**Fig. 3a.** Selective angiography of the right bronchial artery with a common origin with the intercostal artery is showing pathological arteries supplying an aspergilloma



**Fig. 3b.** Superselective arteriography of the right bronchial artery before embolization. Pathological vessels were closed with the use of microspheres (Embozene 500  $\mu$ m)



**Fig. 3c.** Arteriography after embolization. All pathological vessels are occluded

material by experienced radiologists and selection of a suitable particle size prevent the post-procedure reflux effects. Foam gelatine is seldom used in BAE, mainly due to the risk of recurrent bleeding, as it is capable of being resorbed from the vessel's lumen.

Embolization of the bronchial tree using metal coils allows more proximal vessel occlusion, and it is usually applied in conjunction with other materials (7). Only a few literature reports regard the results of aspergilloma treatment.

Rashad et al. described BAE performed in 47 patients with life-threatening bleeding from the respiratory tract using polyvinyl alcohol and spirals. During the 6-month follow-up, 2 patients had relapsed bleeding. BAE was re-used with satisfactory outcomes. There were no procedure-associated complications (8).

Serasil performed BAE in 20 patients with massive bleeding from the lungs using polyvinyl alcohol, spirals, and microspheres. In 100% of patients, bleeding was stopped. In 30% of patients bleeding recurred within 3 years of observation. Re-embolization was needed and the desired effect was achieved. There were no complications (10).

Ding et al. reported one case of treating massive bleeding from the lungs. Firstly, the patient was treated with antibiotic therapy and transfusion of two units of blood, which appeared ineffective. CT angiography revealed a tumour mass at the top of the right lung surrounded with the limbus gas, of aspergilloma-like appearance. Radiographic diagnosis of aspergilloma was confirmed by serological tests. Further management involved empirical embolization of one bronchial and two intercostal arteries. Voriconazole was given intravenously. Despite the therapy applied, the patient still had episodes of haemoptysis. The repeated CT angiography demonstrated an aneurysm of the pulmonary artery located at the right top of the right lung. The artery was embolized with coils. The course of treatment was uneventful. Follow-up computed tomography confirmed the exclusion of the aneurysm from the circulation (11).

Corr described the treatment of 12 patients with a massive (more than 300 ml/day) bleeding from the respiratory tract due to pulmonary aspergillosis. In 11 cases, the pathological arteries were closed with embolization. During the one-month follow-up, there were no repeated episodes of haemoptysis. In one case, embolization did not stop haemoptysis. The infected lobe had to be removed surgically (12).

The BAE-related side effects are most commonly associated with inadvertent closure of non-planned vessels and passage of the embolization material through the anastomosis to the other organs. Bronchial artery embolization may cause complications, such as dysphagia, oesophageal and broncho-pulmonary fistula or necrosis. The risk of procedure-related complications ranges from 1.4-6.5% (7). In our study, there were no complications associated with the use of BAE.

## CONCLUSIONS

Bronchial artery embolization is a safe and effective treatment of bleeding from the respiratory tract and should always be considered as a treatment option for haemoptysis caused by aspergilloma. The procedure does not interfere with pharmacological therapy, and both methods can be used simultaneously. In special cases, it can also be used as preparation for surgery, significantly reducing the risk of perioperative mortality.

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received/otrzymano: 02.03.2017  
accepted/zaakceptowano: 24.03.2017