VIA MEDICA

ORIGINAL RESEARCH

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The effectiveness of bronchial artery embolisation in patients with haemoptysis

Abstract

Introduction: Bronchial artery embolisation (BAE) is one of the methods used in massive and recurring haemoptysis. The aim of the study is to determine the effectiveness and complications of bronchial artery embolisation in recurring haemoptysis.

Material and methods: The analysis included 47 embolisation procedures performed on 30 patients treated between 2011 and 2017 in the Department of Respiratory Medicine, Allergology and Pulmonary Oncology due to haemoptysis. The patient's age ranged between 18 and 71 years, while mean age at the time of BAE was 33.5 years. Patients with tuberculosis constituted 73.33% (n = 22) of the sample and underwent 31 embolisation procedures in total. The remaining part of the sample (n = 8) collectively underwent 16 BAEs. The analysis was conducted by verifying the medical documentation, as well as carrying face-to-face and phone conversations.

Results: Immediate control due to the inhibition of bleeding was obtained in 95.75% of cases. Recurrence within 3 days of BAE was reported in 5 patients (10.63%), and 4 re-embolisation procedures were conducted. In 10 patients (33.33%), recurrence was observed during the first year post-BAE, while it was reported in 17 cases during the whole observation period (56.66% of patients). The subjects who underwent re-embolisation demonstrated recurrence-free periods lasting from 2 days to 63 months. In patients with recurrence but no re-embolisation, the shortest and longest haemoptysis-free time was 2 and 35 months, respectively. Eleven patients (36.66%) required several embolisation procedures during the whole observation period.

Conclusions: BAE is a highly successful procedure in treating haemoptysis. The risk of complications is low.

Key words: embolisation, haemoptysis, cystic fibrosis, lung disease

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Introduction

Haemoptysis stands for coughing up of blood or bloody sputum from the lower parts of the respiratory tract, i.e. from the trachea or bronchi. The loss of < 200 ml during 24 h does not require surgical intervention. However, coughing up more than 200 ml daily means massive haemoptysis and can be directly life-threatening, which calls for endovascular treatment [1, 2].

Bronchial artery embolisation (BAE) is one of the methods used in massive haemoptysis [3–5]. Vascular haemorrhage is a common complication in chronic lung diseases [6]. It can be triggered by: cystic fibrosis [2], lung cancer [7], tuberculosis [4], bronchial and lung inflammations, mycotic infections, as well as congenital defects of pulmonary and cardiac vessels [8]. In the majority of patients, haemoptysis is a complication of destructive changes occurring in bronchial vessels as a result of chronic inflammation in the course of diseases listed above [1, 2]. This leads to arterial widening and the development of collateral circulation, characterised by fragile, sinuous vessels that can break easily [9].

The aim of the paper is to present the results of a retrospective analysis of the effectiveness of bronchial artery embolisation (taking complications into account) in the Department of Respiratory Medicine, Allergology and Pulmonary Oncology, during the period from 2011 to 2017.

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Material and methods

30 patients were treated in the Department by means of endovascular embolisation between 2011 and 2017. BAE was conducted due to massive and/or recurring haemoptysis. Most of the patients were previously treated by means of other methods, including pharmacological treatment, which failed to stop haemoptysis.

In the paper, we report on the analysis of embolisation conducted on different patients, irrespective of haemoptysis aetiology. Patients with cystic fibrosis constituted 73.33% (n = 22) of the sample, and collectively underwent 31 embolisation procedures. The remaining part of the sample (n = 8, 26.7%) was composed of patients with: pulmonary aspergillosis (n = 3), silicosis (n = 1), right lung hypoplasia (n = 1), lung fibrosis subsequent to mediastinal seminoma radiotherapy (n = 1), pulmonary mycobacteriosis (n = 1) and bronchiectasis (n = 1). Sixteen embolisation procedures were performed.

The patients underwent embolisation at the Department of Respiratory Medicine, Allergology and Pulmonary Oncology, following diligent clinical assessment. The planned angiographic procedure was preceded by CT angiography scan (CT-angio scan), in order to assess pulmonary parenchyma, especially the number, anatomy and anatomical variety of bronchial arteries. Due to its high sensitivity and specificity, CT angiography is a method of choice in diagnosis of heamoptisis. It's helpful in diagnosis of bleeding localisation and its cause, and has a significant impact on deciding further therapeutic options. Efficacy in determining bleeding site is estimated at 63–100%. Given CT angiography short duration, it may be only diagnostic possibility in urgent emergency, which massive haemoptysis often is [10–12].

Individuals with cystic-fibrosis-induced haemoptysis had all bronchial arteries that could be subject to embolised catheterisation . In the rest of patients, embolisation was conducted for only those arteries which led to the area suspected to be the source of haemorrhage, based on bronchoscopy and CT-angio scan.

Common femoral artery access was used as the route in BAE procedures. Pathologically changed vessels were identified by means of digital subtraction angiography (DSA), conducting a preliminary descending aorta aortogram (Fig. 1). Subsequently, bronchial branches were selectively catheterised by means of 4F or 5F catheters. Embolisation was conducted using polyvinyl alcohol (PVA) embolisation particles

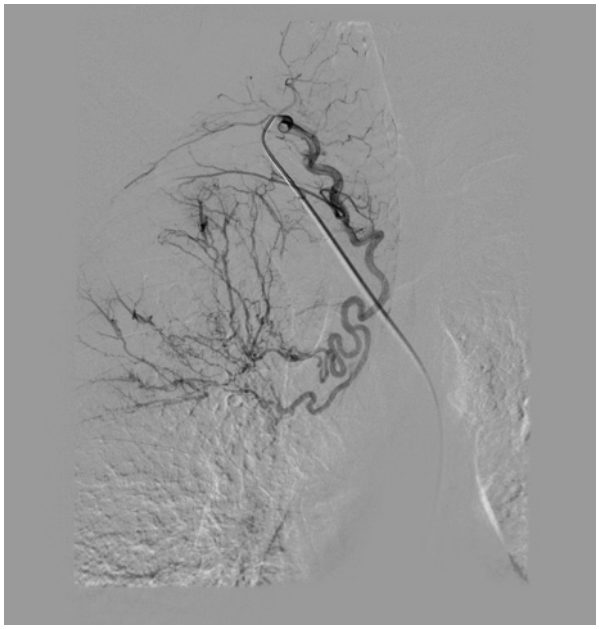

Figure 1. Pathologically changed vessels identified by means of digital subtraction angiography (DSA), conducting a preliminary descending aorta aortogram

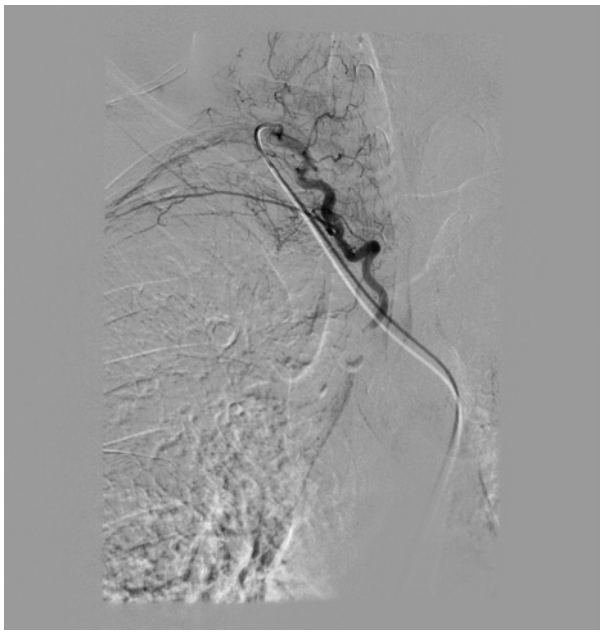

Figure 2. Embolisation conducted using polyvinyl alcohol (PVA) embolisation particles (Cook) whose size was 300 to 2000 μm

(Cook) whose size was 300 to 2000 μm (Fig. 2). In addition, a microcatheter was introduced in the case the regular catheter was unstable, or when embolisation liquids (Squid) or detachable spirals were used.

The number of patients who underwent embolisation by means of PVA was equal to 28

(mean age: 33 yo, range: 18–71 yo). In addition, there was 1 patient (26 yo) in whom embolisation spirals were used. Finally, also 1 patient (36 yo) was subjected to different BAE methods: first, a procedure with detachable spirals and Squid , which was followed 6 days later by PVA embolisation.

Results

Thirty patients with recurring and/or massive haemoptysis required bronchial artery embolisation. The average time of observation was 22.8 months, and ranged from 5 days to 84 months. Contact with 3 patients was lost immediately after hospitalisation during which embolisation was conducted. Another 5 patients discontinued the contact during the observation period (mean time from BAE to contact loss: 23 months, ranging from 5 to 52 months).

Immediate haemorrhage inhibition during the first 24 hours post-embolisation was achieved in 95.75% of patients (haemoptysis recurred within several hours in two patients). Haemoptysis recurrence within 3 days post-BAE was observed in 5 patients (10.63%). Four re-embolisation procedures were conducted during the same hospital stay. Haemoptysis recurred within the first year post-embolisation in 10 patients (33.33%), and in 17 patients (56.66%) during the total period of observation.

Eleven out of 17 patients (64.71%) with recurring haemoptysis required another endovascular bronchial artery embolisation procedure. Eight of those patients had two embolisation procedures, 1 patient — three, 1 patient — four, and another 1 patient — five embolisation procedures performed. In total, 28 BAEs (17 re-embolisation procedures) were conducted in those patients. The remaining 6 patients experienced minor haemoptysis which stopped following conservative treatment.

Three patients underwent lung transplant surgery during the observation period. The average time between the last BAE and lung transplant was 15 months, ranging from 3 to 28 months.

Pneumonectomy of the right lung was performed in one patient 2 months following the last BAE.

Six patients died during the observation, including 5 patients with cystic fibrosis and 1 patient with pulmonary mycetoma. The average time between the last BAE and patient's death was 16.5 months, ranging from 3 to 38 months.

The number of embolisation procedures goes as follows for different methods: 45 (95.74%) embolisation procedures with PVA particles, 1 (2.13%) spiral embolisation and 1 (2.13%) spiral + Squid embolisation. The vast majority of BAEs (45 out of 47) was conducted by means of PVA particles, and therefore comparing this method to the other ones (2 out of 47 BAEs) would be inconclusive.

In order to determine the shortest and the longest haemoptysis-free period, patients were divided into three groups. The first group was composed of individuals in whom re-embolisation was performed due to massive haemoptysis (Table 1); the second group included patients with minor haemoptysis (blood-tinged sputum, coughing up single blood lines) who did not require any surgical intervention; in turn, the third group was composed of patients with no recurrence.

11 individuals were present in the first group. The shortest bleeding-free interval was several hours while the longest one lasted 63 months. The shortest recurrence-free period between the first and second BAE (11 procedures, average time: 13 months) was equal to 2 days, while the longest one was 63 months. The shortest recurrence-free period between the second and third BAE (3 procedures, average

Table 1. Time between consecutive embolizations in patients with recurrent hemoptysis

BAE/PT	Pt 2	Pt 3	Pt 6	Pt 7	Pt 8	Pt 12	Pt 14	Pt 16	Pt 17	Pt 25	Pt 28
1–2	3 months	63 months	22 months	2 days	13 months	10 months	14 months	10 months	5 days	4 months	11 days
2–3	8 months		17 months							11 days	
3–4	16 months		13 months								
4–5	5 days										

BAE: bronchial artery embolization; Pt: patient

time: 8 months) lasted 11 days, and the longest: 17 months. The shortest recurrence-free period between the third and fourth BAE (2 procedures, average time: 15 months) was 13 months, while the longest one lasted 16 months. Finally, in one patient, a fifth BAE was performed five days after the fourth one.

Six patients were included in the second group. The shortest recurrence-free period was 2 months, and the longest one: 35 months.

Patients in whom recurrence did not occur were under observation from 5 to 38 months.

In general, haemoptysis-free time averaged for all 30 patients was equal to 15.8 months.

Minor post-BAE complications reported by the patients included haematoma at the site of microcatheter insertion (n = 1), fever (n = 1) and vomiting (n = 2).

The patients' data, information on embolisation, haemoptysis-free period, other medical incidents and the death of observed patients are presented in Table 2.

Discussion

While all the procedures were effective, recurrence was observed in two patients as soon as several hours post-BAE. Bleeding control during the first 24 hours post-BAE reached the level of 95.74%. In the course of the long-term observation, haemoptysis recurrence was reported in 33.33% of patients. In general, recurrence was observed in 56.66% of the subjects. These results are in accordance with the outcomes obtained in other centres [13–17].

Tape *et al.* [13] conducted an observation on 15 patients with cystic fibrosis in whom 33 BAEs were performed. The mean time of observation was 72 months, ranging from 3 to 168 months. The procedures resulted in 100% of haemoptysis inhibition, while recurrence was reported in 60% of patients during the whole time of observation.

In turn, Shin *et al.* [14] described a group of 398 patients with tuberculosis who underwent BAE. The reported effectiveness of BAE during the first 24 hours was 96.4%, while recurrence was observed in 48.6% of patients post-BAE.

Rashad *et al.* [15] embarked on a study on 47 patients with massive haemoptysis, who were observed for 6 months post-embolisation. Re-embolisation was conducted in 2 patients due to bleeding recurrence. The following causes of haemoptysis were reported: active tuberculosis, post-tuberculosis changes in pulmonary parenchyma and bronchiectasis.

Endovascular embolisation is also effective in aspergillosis. Corr *et al.* [16] conducted an observation on 12 patients with aspergillosis and reported 1 haemoptysis recurrence within 4 weeks post-BAE.

The effectiveness of endovascular embolisation is high. That notwithstanding, the risk of death, lung transplant or pneumonectomy is increased in the group of patients who once suffered from haemoptysis, even if they were successfully treated with embolization [17].

Vidal *et al.* [17] compared 30 patients with tuberculosis, in whom massive haemoptysis was treated with embolisation (42 procedures were conducted) to a control group including 27 healthy patients, matched for sex, age and FEV_1 value in spirometry. Among patients undergoing BAE, haemoptysis was inhibited during the first 24 hours in 96.6% (n = 29) of cases. A 5-year-long observation showed that 9 patients underwent transplantation, in comparison to 1 patient in the control group. Patients undergoing embolisation due to arterial bleeding are under increased risk of lung function deterioration, the need to have a lung transplant, or death.

3 out of 30 patients observed in our Department required lung transplant (patients with tuberculosis), while 1 was in need for right lung pneumonectomy (patient with aspergillosis).

Conclusions

Bronchial artery embolisation was highly successful shortly after the procedure (95.74% during the first 24 hours). Recurrence occurred within 1 year in 33.33% of patients, while a single re-embolisation was successful in half of the sample in the long perspective.

BAE is burdened with a low level of complications. It can be repeated if needed, including once-treated vessels where recanalisation occurred [18].

Conflict of interest

The authors declare no conflict of interest.

Table 2. Bronchial artery embolization (BAE) during the period from 2011 to 2017

No	Sex (M/F)	Diagnosis	No of BAE	Age during BAE	Coil (C) or PVA, (year of BAE)	Recurrent haemoptysis	Recurrent required BAE	Observation time until first BAE	Haemoptysis free time	Death (time from last BAE)	Other medical events
Pt 1	M	CF	1	31	PVA (2011)	No	–	30 months	30 months	30 months	
Pt 2	M	Bronchiecta-sis, COPD	5	57, 58, 60	PVA (2011, 2011, 2012, 2013,2013)	Yes	Yes	28 months, then lost track	2 days: shortest 16 months: longest		
Pt 3	M	CF	2	29, 34	PVA (2011, 2016)	Yes	Yes	84 months	62 months		
Pt 4	F	CF	1	20	PVA (2011)	No	–	38 months	38 months	38 months	
Pt 5	M	CF	1	20	PVA (2012)	No	–	17 months	17 months, till death	17 months	
Pt 6	F	CF	4	19, 20, 22, 23	PVA (2012, 2014, 2016, 2017)	Yes	Yes	52 months, then lost track	13 months: shortest, 22 months: longest		
Pt 7	M	CF	2	30,30	PVA (2013, 2013)	Yes	Yes	59 months	2 days: shortest 59 months: longest		Lung transplant Sep 2015
Pt 8	F	CF	2	29, 30	PVA (2013, 2014)	Yes	Yes	12 months, then lost track	12 months		
Pt 9	M	Pulmonary hypoplasia	1	26	C (2014)	Yes	No	51 months	35 months		
Pt 10	M	Pulmonary fibrosis, COPD	1	53	PVA (2014)	No	–	After hospitalization lost track	After hospitalization lost track		
Pt 11	F	CF	1	22	PVA (2014)	Yes	No	43 months	13 months: shortest 30 months: longest		Lung transplant Oct 2015
Pt 12	M	Pneumo-coniosis	2	70, 71	PVA (2014, 2015)	Yes	Yes	42 months	8 months: shortest 32 months: longest		
Pt 13	F	CF	1	21	PVA (2015)	No	-	5 months	5 months, till death	5 months	
Pt 14	F	CF	2	25, 26	PVA (2015, 2016)	Yes	Yes	34 months	14 months: shortest 20 months: longest		
Pt 15	F	CF	1	19	PVA (2015)	No	–	21 months, Then lost track	21 months		
Pt 16	M	CF	2	25,26	PVA (2015, 2016)	Yes	Yes	28 months	10 months: shortest 15 months: longest	3 months	BAE Jan 2018 Lung transplant Mar 2018

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Table 2 cont. Bronchial artery embolization (BAE) during the period from 2011 to 2017

No	Sex (M/F)	Diagnosis	No of BAE	Age during BAE	Coil (C) or PVA, (year of BAE)	Recurrent haemoptysis	Recurrent required BAE	Observation time until first BAE	Haemoptysis free time	Death (time from last BAE)	Other medical events
Pt 17	F	CF	2	24	PVA (2015, 2015)	Yes	Yes	After hospitalization lost track	5 days		
Pt 18	F	CF	1	20	PVA (2016)	No	–	After hospitalization lost track	5 days		
Pt 19	F	Aspergillosis	1	68	PVA (2016)	Yes	No	22 months	6 months: shortest 16 months: longest		
Pt 20	F	CF	1	28	PVA (2016)	Yes	No	20 months	4 months: shortest 16 months: longest		
Pt 21	F	CF	1	30	PVA (2016)	No	–	17 months	17 months		
Pt 22	F	CF	1	21	PVA (2016)	No	–	13 months	13 months		
Pt 23	F	CF	1	21	PVA (2017)	Yes	No	8 months	2 months: shortest 3 months: longest		
Pt 24	M	CF	1	18	PVA (2017)	No	–	5 months, Then lost track	5 months		
Pt 25	M	Aspergillosis	3	48	PVA (2017, 2017, 2017)	Yes	Yes	10 months	3 days: shortest 5 months: longest		
Pt 26	F	CF	1	25	PVA (2017)	No	–	12 months	12 months		
Pt 27	M	Aspergillosis	1	68	PVA (2017)	Yes	No	6 months	2 months: shortest 4 months: longest	6 months	
Pt 28	F	Mycobacte-riosis	2	53	PVA (2017), C + Squid (2017)	Yes	Yes	11 months	6 days: shortest 8 months: longest		Right lung pneumo-nectomy Aug 2017
Pt 29	M	CF	1	33	PVA (2017)	No	–	10 months	10 months		
Pt 30	M	CF	1	21	PVA (2017)	No	–	6 months	6 months		

Pt: patient; CF: cystic fibrosis; COPD: chronic obstructive pulmonary disease; PVA: polyvinyl alcohol

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