Endovascular treatment of haemoptysis: Medium and long-term assessment

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KEYWORDS
Haemoptysis;
Angiography;
Bronchial artery embolisation;
Aspergilloma;
Bronchial arteries

Abstract
Purpose: To assess the short, medium and long-term results of bronchial artery embolisation (BAE) and identify the factors favouring the recurrence of haemoptysis.
Patients and methods: This is a retrospective study, between January 2001 and June 2010, comprising 53 consecutive patients with BAE. The mean age was 53.8 years. There were 15 women (28.30%) and 38 men (71.69%).
Results: The aetiologies of haemoptysis were dominated by the residual signs of pulmonary tuberculosis: 18 cases (33.96%), bronchial dilations: 12 cases (22.64%) and aspergilloma: five cases (9.43%). The bronchial arteriography showed signs of bronchial hypervascularisation in 92.45% of the cases. Forty-six patients had a first embolisation (86.79%) with immediate efficacy in 84.90% of the cases (n = 45). This efficacy was noted after more than 3 years in 60.08% of the cases. Short (< 30 days) and medium-term (> 30 days and < 3 years) recurrence of haemoptysis were noted in 17.39% and 8.69% of the cases respectively. A statistically significant correlation between aspergilloma and the immediate recurrence was found (P = 0.013). The risk of medium and long-term recurrence (> 3 years) was correlated with age. The survival without recurrence was statistically higher when the age was less than 60 years (P = 0.0041).
Conclusion: BAE is an effective treatment. Aspergilloma is a major risk factor in the recurrence of haemoptysis. Repeated embolisation may be proposed for these patients.
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Haemoptysis accounts for 10 to 15% of all admissions in pneumology [1]. It requires emergency care in a specialised environment. In fact, in spite of this care, death due to major haemoptysis ranges from 50 to 100% even after surgical haemostasis [2,3]. Bronchial artery embolisation (BAE), first described by J. Rémy in 1973, achieves emergency haemostasis by reducing systemic hypervascularisation [4]. Interventional radiology is currently an alternative treatment to control haemoptysis. In fact, BAE is the only treatment for inoperable patients. In most cases, BAE can immediately control the haemoptysis although medium and long-term recurrences may occur. The purpose of this paper is to assess the short, medium and long-term results of BAE and identify the factors favouring the recurrence of haemoptysis, especially in our country, still a country with endemic tuberculosis.

Patients and methods

This retrospective study, carried out from January 2001 to June 2010, included 53 patients referred by different pneumology departments in Greater Tunis. All of the BAE were carried out by the same radiologist, in the interventional radiology unit at Hôpital Charles-Nicoll in Tunisia, equipped with a digital angiograph (Philips Integris V 3000) comprising of a rotary arc. The haemoptysis was considered to be mild if under 100 mL/24 h, moderate if between 100 and 400 mL/24 h and major if over 400 mL/24 h. All of the patients benefited from bronchial fibroscopy and a chest CT with injection of contrast product in order to determine the source of the bleeding as well as the underlying disease. Thirty-six patients had a single-slice spiral CT (67.92%) and 17 patients (32.07%) had a multi-slice thoracic angio-CT (ATMC) (16 slices). The ATMC protocol included the acquisition at aortic time with an output of 4 mL/s. The acquisition was 16 × 1.25 mm with an interval of 0.625 min followed by vascular MIP, MPR and curvilinear reconstructions.

The embolisation was carried out under local anaesthetic. The arterial approach involved a puncture of the right common femoral artery, followed by the placement of a 5-French introducer according to the Seldinger technique. The arteriography prior to the embolisation was carried out using a 5-French Pigtail catheter. The selective catheterisation of the bronchial arteries was carried out with a 5-French Cobra catheter and a Terumo® hydrophilic guidewire. In certain cases, hyper-selective catheterisation was necessary with a 3F micro-catheter assembled through a catheter guide. At the end of the diagnostic stage, a decision for embolisation was made on the basis of the signs indicating systemic bronchial or non-bronchial hypervascularisation (Boxed text 1), or oriented by thoracic angio-CT specifying the topography and/or the cause of the bleeding. The angiograph is used to detect the anterior spinal artery that requires special care. This was identified in only one of our patients, since hyper-selective catheterisation beyond the origin of the spinal artery was technically difficult in this case. The embolic agent was chosen according to the vascular lesion and the availability of the vascular occlusion agent. We used three types:

Boxed text 1 Signs of bronchial hypervascularisation in the bronchial arteriography.
- Hypertrophy of the arterial branch: this may occur by an increase in the diameter of the artery, a twisted appearance or excessively good distal visualisation.
- An excessive parenchymograph or parenchymatous blush attesting to hypervascularisation.
- A systemo-pulmonary or systemo-systemic shunt.
- Aneurisms, or extravasation of contrast product in the bronchial lumen.

- gelatine (Curaspon® or Spongell®) that are solid absorbable particles;
- embospheres that are 500 to 1200 μm solid non-absorbable particles;
- metal spires (or coils).

The results were immediately estimated after the arteriography, on a short-term basis until 30 days after the embolisation, on a medium-term basis (> 1 month and < 3 years) and on a long-term basis (≥ to 3 years). For the statistical study, the means were compared using Student’s t-test and the percentages with Pearson’s Chi² test or Fisher’s exact test. A single and multivariate study was used to calculate the factors of risk.

Results

The mean age of the patients was 53.8 years (20 to 79 years). There were 15 women (28.30%) and 38 men (71.69%). Only one patient suffered from mild haemoptysis although it was recurrent. The haemoptysis was moderate in 41 patients (77.35% of the cases) and major in 11 patients (20.75% of the cases). The aetiologies of the haemoptysis are presented in Table 1. They are dominated by the residual signs of pulmonary tuberculosis: 18 cases (33.96%), bronchial dilatation: 12 cases (22.64%) and aspergilloma: five cases (9.43%). The thoracic tomodensitometry detected unpolished glass images in 10 cases (18.86%) and parenchymatous condensation in 12 cases (22.64%), attesting to local bleeding in the pulmonary parenchyma and signs related to the underlying disease in 17 cases (32.07%).

Study of the systemic and non-systemic arterial vasculatisation was inadequate by the single-slice CT. In the 17 patients with ATMC, we detected hypertrophic and dilated bronchial and non-bronchial systemic arteries in 14 cases (82.35%) (Fig. 1). The thoracic CT helped determine the cause of the haemoptysis in 92% of the cases. It was not helpful in five patients (9%). In these patients, the arteriography revealed the existence of a parenchymatous blush and hypertrophy of an arterial segment in four patients. The bronchial arteriography revealed signs of bronchial hypervascularisation in 49 patients (92.45% of the cases). The association of arterial hypertrophy and parenchymatous blush was noted in 41 patients (77.35%). Isolated parenchymatous blush was found in eight cases (15.09%). Systemo-pulmonary shunting was observed in four cases (7.54%), in all cases consisting of counter-current shunting. Associated extravasation of the contrast
product was described in two cases (3.77%). The arteriography was normal in four patients. One patient had dilation lesions of the cylindrical segmental bronchi, two patients had residual signs of minor localised tuberculosis and one patient had primary bronchopulmonary cancer. The haemoptysis was moderate in these four cases. On the anatomic level, 64 arteries were responsible for the haemoptysis. In decreasing order of occurrence they involved:

- the right bronchial artery in 30.18% of the cases (16 patients);
- the left bronchial artery in 28.30% of the cases (15 patients);
- the non-bronchial systemic arteries in 24.52% of the cases (13 patients): the intercostal arteries in 12 patients (Fig. 2) and a collateral branch of the left scapular artery (Fig. 3), the thyro-bicervico-scapular trunk in another patient (Fig. 4);
- the right broncho-intercostal trunk in 18.86% of the cases (10 patients);
- the right-left common trunk in 16.98% of the cases (nine patients);
- one patient had a left superior bronchial artery that arose from the left internal mammary artery (Fig. 5).

Forty-six patients had a first embolisation (86.79%). Six of them had two embolisations and one had three embolisations. Our statistical study only took the first embolisation into account. Complete stagnation of the contrast product was obtained in 45 of the 46 patients that had a first embolisation (84.90%). We noted eight failures (15.09%) in embolisation. In one case, the bleeding did not completely stop with incomplete stagnation of the contrast product. The failure was technical in the seven other cases (13%):

- four patients had a normal arteriography;
- one patient, in whom we detected an anterior spinal artery arising form the TBICD, required surgery (right superior lobectomy for dilation of the bronchi);
- in two cases, the failure was due to the impossibility of catheterisation of the bronchial artery responsible for the bleeding. One patient required surgery and another evolved well with medical treatment.

The first embolisation was carried out with Curaspon® particles in 38 cases (82.60% of the cases), embospheres in six cases (13.04% of the cases), the association of embospheres and coil in one case and Curaspon® and coils in one case. A micro-catheter was used in 30.43% of the cases (14 patients). Only one complication was noted: it consisted of
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Figure 2. Major haemoptysis in a 50-year-old man with a past history of tuberculosis. Global aortography revealing hypertrophy of the fourth right intercostal artery (arrow) and the right broncho-intercostal trunk (head of arrow).

Figure 3. Recurrent haemoptysis in a 65-year-old man with a past history of pulmonary tuberculosis. Selective catheterisation of the left subclavian artery revealing a collateral branch of the left scapular artery feeding a vascular blush (arrow).

Figure 4. Systemic hypervascularisation of the right pulmonary apex fed by the branches arising from the right thyro-bicervico-scapular trunk (arrow).

Figure 5. Origin of the upper left bronchial artery from the left internal mammary artery with transpleural route (arrows).

left brain ischemia forming 7 days after embolisation in a 65-year-old smoker. In view of this delay, it is not certain that it may be attributed to the endovascular procedure. A long-term recurrence was not noted in 28 of the 46 patients benefiting from embolisation (60.08%) after more than 3 years. Four patients dropped-out 10, 12, 18 and 20 months after the embolisation without a recurrence of the haemoptysis during this period. Two patients died after 12 and 18 months from the underlying disease. Twelve patients presented a recurrence of haemoptysis:

• eight patients (17.39%) who had a short-term recurrence of the haemoptysis (≤ 1 month), including one death 10 hours after the embolisation in a picture of severe respiratory failure by alveolar flooding. Half of these early recurrences occurred in patients presenting aspergilloma;
• four patients (8.69%) had a medium-term recurrence.

The results of the embolisation according to the aetiology of the haemoptysis are reported in Table 2. The evolution after the recurrence of the haemoptysis is detailed in Table 3. There is a statistically significant relationship between aspergilloma and short-term recurrence.
Table 2  Result of the embolisation according to the underlying disease.

<table>
<thead>
<tr>
<th>Underlying disease</th>
<th>BAE (n = 46)</th>
<th>No recurrence (n = 34)* (%)</th>
<th>Recurrence (n = 12) (%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual signs of tuberculosis (excluding aspergilloma graft)</td>
<td>16</td>
<td>13 (81.25)</td>
<td>3 (18.7)</td>
<td>0.3</td>
</tr>
<tr>
<td>Bronchial dilation</td>
<td>8</td>
<td>8 (100)</td>
<td>0</td>
<td>0.07</td>
</tr>
<tr>
<td>Non-operable bronchopulmonary cancer</td>
<td>4</td>
<td>3 (75)</td>
<td>1 (25)</td>
<td>0.7</td>
</tr>
<tr>
<td>Aspergilloma</td>
<td>5</td>
<td>1 (20)</td>
<td>4 (80)</td>
<td>0.013</td>
</tr>
<tr>
<td>Active pulmonary tuberculosis</td>
<td>5</td>
<td>4 (80)</td>
<td>1 (20)</td>
<td>0.6</td>
</tr>
<tr>
<td>Non-specific infectious pneumopathy</td>
<td>3</td>
<td>2 (66.67)</td>
<td>1 (33.34)</td>
<td>0.6</td>
</tr>
<tr>
<td>Arteriovenous malformation</td>
<td>1</td>
<td>1 (100)</td>
<td>0</td>
<td>0.7</td>
</tr>
<tr>
<td>Bronchogenic cyst</td>
<td>1</td>
<td>100</td>
<td></td>
<td>0.2</td>
</tr>
<tr>
<td>Idiopathic</td>
<td>3</td>
<td>2 (66.67)</td>
<td>1 (33.34)</td>
<td>0.6</td>
</tr>
</tbody>
</table>

BAE: bronchial artery embolisation.
* Including four drop-outs between 10 and 20 months and two deaths at 12 and 18 months.

Table 3  Evolution after first recurrence of the haemoptysis.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>n = 12</th>
<th>Date of recurrence</th>
<th>Treatment of the recurrence</th>
<th>Evolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual signs of tuberculosis</td>
<td>1st patient</td>
<td>D4</td>
<td>2nd BAE (D4)</td>
<td>No recurrence</td>
</tr>
<tr>
<td></td>
<td>2nd patient</td>
<td>D 2 years after 2nd BAE</td>
<td>3rd BAE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3rd patient</td>
<td>D 2 months</td>
<td>Surgery</td>
<td>No recurrence</td>
</tr>
<tr>
<td>Bronchopulmonary cancer</td>
<td>1 patient</td>
<td>D2</td>
<td>Medical treatment</td>
<td>Died on D10 due to neoplastic disease</td>
</tr>
<tr>
<td>Aspergilloma</td>
<td>1st patient</td>
<td>D0</td>
<td>—</td>
<td>Died by haemoptysis</td>
</tr>
<tr>
<td></td>
<td>2nd patient</td>
<td>D9</td>
<td>2nd embolisation surgery</td>
<td>No recurrence</td>
</tr>
<tr>
<td></td>
<td>3rd patient</td>
<td>D18</td>
<td>2nd embolisation</td>
<td>No recurrence</td>
</tr>
<tr>
<td></td>
<td>4th patient</td>
<td>D30</td>
<td>2nd embolisation</td>
<td>Recurrence of haemoptysis</td>
</tr>
<tr>
<td>Active pulmonary tuberculosis</td>
<td>1 patient</td>
<td>D 2 months</td>
<td>2nd embolisation</td>
<td>No recurrence</td>
</tr>
<tr>
<td>Infectious pneumopathy</td>
<td>1 patient</td>
<td>D2</td>
<td>Surgery</td>
<td>No recurrence</td>
</tr>
<tr>
<td>Bronchogenic cyst</td>
<td>1 patient</td>
<td>D30</td>
<td>Surgery</td>
<td>No recurrence</td>
</tr>
<tr>
<td>Idiopathic</td>
<td>1 patient</td>
<td>D 13 months</td>
<td>2nd embolisation</td>
<td>No recurrence</td>
</tr>
</tbody>
</table>

BAE: bronchial artery embolisation.

We calculated the cumulate survival without recurrence using the Kaplan-Meier method in the patients that did not have a recurrence more than 30 days after the embolisation. The mean survival without recurrence is 43 months. The risk of medium and long-term recurrence was multiplied by 8.2 when the age was more than or equal to 60 years. There is a significant difference in the survival curves without recurrence (P = 0.0041). The survival without recurrence was statistically better when the age was less than 60 years (Fig. 6).

Discussion

The treatment of haemoptysis, in particular by BAE, depends on the aetiology, abundance and tolerance. The aetiologies

Figure 6. Cumulate survival curves without recurrence as a function of age.
of haemoptysis are numerous in the series by Crema
sch [5], Zhang [6] and Karen [7]. Bronchial dilation is the
leading cause of haemoptysis, followed by tuberculosis. Ne-
evertheless, in our series, tuberculosis is the leading cause
of haemoptysis, given that tuberculosis is still endemic in
Tunisia.

Certain complementary examinations are indispensable
when faced with haemoptysis. The association of bronchial
fibroscopy and ATMC, in most cases, provides a topographic
diagnosis and the aetiology of the haemoptysis [8,9]. How-
ever, the role of bronchial fibroscopy is currently highly
debated, in particular since the arrival of the multi-slice
angio-CT (ATMC). The ATMC provides a pulmonary vascu-
lar map as well as an exhaustive study of the mediastinum
and the parenchyma during the same acquisition [10]. The
ATMC identifies all of the catheterisable bronchial arter-
ies in angiography that are the source of the bleeding, as
well as detects pulmonary arterial anomalies and therefore,
avoids useless bronchial angiographies and correctly in-
dicates the therapeutic attitude [11,12]. Nevertheless, the
ATMC does not identify certain collateral bronchial arteries,
in particular the anterior median spinal artery. Only the
anterior lumbar spinal artery can be detected at this time
[12]. In our series, the ATMC detects the dilated bronchial
and non-bronchial systemic arteries, attesting to hypervas-
cularisation in 82.35% of the cases. However, it is difficult to
determine reliable criteria, through an analysis of the liter-
ature, in order to assess the efficacy of embolisation. There
are two reasons for this:

• on the one hand, the heterogeneity of the different series
in the literature in terms of abundance of the haemopty-
sis, does not always allow for reliable comparison;

• on the other hand, the criteria selected in the differ-
ent series in the literature vary: immediate arrest of
the haemoptysis (active haemoptysis), a satisfactory post-
embolisation arteriographic aspect, or even the absence
of short and long-term recurrence. This most often
accounts for the difficulty in data gathering.

In our series, the immediate efficacy was 84.90%. Our
results are similar to those presented in the literature.
In fact, a very high immediate efficacy has always been
reported in the different series, oscillating between 73% and
99% [13–19]. BAE is an effective procedure to stabilise
many patients and definitively treat others [7,10]. Ne-
evertheless, its short-term efficacy (< 30 days) is reported less
often. Several studies have reported a risk of recurrence
ranging from 10 to 29% during the first month after emboli-
sation [14,16,19]. In our series, the short-term recurrence
was noted in 15.21% of the cases.

The short-term recurrence depends on the aetiology. A
favourable evolution was noted in case of active pulmonary
tuberculosis after antituberculous therapy and embolisation
with a high rate of immediate success and a low rate of
recurrence [19,20]. An unfavourable prognosis was noted
in patients presenting aspergilloma [17,19,21–24]. A recent
study reports a recurrence in 100% of the cases in these
patients. Most of the recurrences occur within 2 weeks
after embolisation with a mortality of up to 50% during the
first month [19]. Aspergilloma is therefore correlated with a
statistically significant risk of haemoptoic recurrence both
in the literature and in our series [23] requiring repeated
embolisation at best associated with surgery.

In our series, 50% of the short-term recurrences were
related to aspergilloma and 80% of the patients with
aspergilloma presented a short-term recurrence. Neoplastic
pulmonary disease is also the cause of the immediate and
long-term recurrence of haemoptysis (which was not found
in our series) and is associated with a mortality related to
the progressive nature of the underlying disease [15,17].
The long-term recurrence of haemoptysis is secondary to
re-canalisation of the previously embolised vessel or the
revascularisation of the collaterals as related to the pro-
gression of the underlying pulmonary disease, in particular
aspergilloma [14,15,19,20]. This recurrence may occur after
a period of 2 to 5 years [19,20]. Therefore, it is important
to identify and embolise all vessels that may contribute to
an abnormal vascular replacement. Repeated embolisations
may thereby help improve the prognosis in case of the recur-
rence of haemoptysis after a first embolisation. A second
embolisation was carried out in seven patients, including
three for aspergilloma graft. One patient had BAE on three
occasions.

In our study, we noted that age may also be a factor in
the prognosis.

In addition to predisposition-related factors, the efficacy
of embolisation also depends on the material used. Gelatine
is cheap, easy to use and the size of the particles can be
controlled. However, due to its non-absorbable nature, cer-
tain authors think that it may foster medium and long-term
recurrence [15,25]. In our study, gelatine seems to be as
effective as the other embolisation agents. In fact, the dif-
ference in the cumulative survival without recurrence in the
patients treated with Curaspon® and in those treated with
emphospheres is not statistically significant. A recent study
has demonstrated the possibility of using the ethylene-vinyl
alcohol copolymer, which seems to be beneficial in patients
presenting recurrent haemoptysis [26].

Conclusion

Our study confirms the safety and value of BAE in the treat-
ment of haemoptysis. The nature of the underlying disease
and the underlying predisposition, in particular age, are
important factors to take into account in the therapeutic
decision. We noted that aspergilloma is the major factor of
risk at the origin of haemoptoic recurrences after emboli-
sation. Another embolisation may be proposed for these
patients.

Disclosure of interest

The authors declare that they have no conflicts of interest
concerning this article.

References

[1] Alaoui AY, Barial M, Boutahiri A. Clinical characteristics and
etiology in hemoptysis in a pneumology service: 291 cases. Rev