Audit of bronchial artery embolisation in a specialist respiratory centre

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Abstract
Objective — To audit the use of bronchial arteriography and embolisation for controlling haemoptysis.
Design — Retrospective review of radiological and clinical data.
Setting — Brompton and National Heart Hospitals.
Patients — 35 patients with severe pulmonary disease in whom 58 bronchial arteriograms were obtained between 1 January 1984 and 31 December 1989 with the intention of bronchial artery embolisation for controlling haemoptysis.

Main measures — Rate of technical success and cessation of haemoptysis; detailed evaluation of patients, particularly those with major haemoptysis (>100 ml expectorated blood); and retrospective assessment of the appropriateness of the procedure in each.

Results — 58 procedures were performed, nine of which were unsuitable for detailed analysis. Nine procedures were for minor haemoptysis, which subsequently recurred, and 40 for recent major haemoptysis in 26 patients with cystic fibrosis (16) aspergilloma (six), bronchiectasis (three), and an unknown diagnosis (one). The median total volume of haemoptysis in the episode before the procedure was 680 ml (range 270–2200 ml). Embolisation was technically successful in 33/40 procedures, in 17 of which, however, major haemoptysis recurred within 10 days of the procedure, leaving 16 clinically and technically successful procedures in 15 patients. Five patients (three with aspergilloma, two with cystic fibrosis) died of haemoptysis despite attempted embolisation.

Conclusion — Success rate of bronchial artery embolisation was 40%/4(16/40).

Implications — Bronchial artery embolisation is probably not justified for minor haemoptysis or when performed more than one week after a major haemoptysis. Repeat arteriograms during a single period of haemoptysis are seldom useful. With these criteria 43% fewer procedures would have been performed with no loss of clinical benefit.

Introduction
In patients with troublesome haemoptysis bronchial artery embolisation is sometimes undertaken with the objective of stopping the haemorrhage. There is no defined list of the indications for embolisation, although most patients treated in published series have experienced recurrent haemoptyses in excess of 100 ml per episode. Recent editorials1,2 and a topical review3 highlighted success rates of 75–90% for bronchial artery embolisation in controlling haemoptysis, based on three large studies in the world literature.4,5,6 The populations studied are very different, in 16 of 49 patients from France1 and 70 of 75 patients from Brazil5 the underlying diagnosis was tuberculosis. Abscess or pneumonia was the underlying disease in 118 of 306 patients from the former Soviet Union.8 Our two hospitals receive many tertiary referrals, and the patients have a different range of disease. In particular, Brompton Hospital has a large population of between 400 and 500 adult patients with cystic fibrosis. The aims of our study were to ascertain the characteristics of our population and the success rate of bronchial artery embolisation in this population and to assess the appropriateness of each procedure.

Patients and methods

PATIENTS
We undertook a retrospective search of the radiological records of patients at the Royal Brompton and Heart Hospitals between 1 January 1984 and 31 December 1989 to identify bronchial arteriography performed with the intention of embolisation to stop haemoptysis. The arteriograms were reviewed with reference to the clinical data obtained from the patients’ medical records.

Major haemoptysis was defined in this study as an episode during which at least 100 ml of blood was expectorated during a single bout of coughing. Otherwise the episode was defined as a minor haemoptysis. Assessment of the size of each haemoptysis was based primarily on the volumes of expectorated blood recorded by the nursing staff.

BRONCHIAL ARTERY EMBOLISATION

All patients were catheterised through a transfemoral approach using an end hole preformed catheter. As the bronchial arteries normally arise from the descending aorta a search was made between the fourth and sixth thoracic vertebrae, using the air in the left main bronchus as an anatomical landmark. There is a wide variation in the pattern of bronchial artery distribution, at least 10 different types being described in published...
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Embolisation of the bronchial arteries was undertaken if selective angiography showed one or more of the following: (a) blush or extravasation of contrast medium, (b) enlarged and tortuous vessels, (c) diffuse or pericavitary increased vascularity, and (d) systemic to pulmonary anastomoses. Embolisation was not performed if the catheter position could not be stabilised. The embolisation material consisted of a suspension of gelatin (Sterispon, Allen and Hanburys) in contrast medium. This enables the material to be visualised as it is injected into the artery. Any spillage into the aorta can also be identified. Material was injected until the flow was arrested and the artery occluded. Usually, all abnormal bronchial arteries originating from the aorta and identified during the procedure were embolised, if safe to do so. A particularly detailed search was made for arteries supplying the lobe suspected as the source of the haemoptysis at bronchoscopy. All procedures were performed by a consultant radiologist or under his direct supervision.

A technically successful embolisation was defined as angiographic demonstration of complete arterial occlusion. The procedures were divided into two groups for analysis; those performed within one week of (recent) major haemoptysis and the remainder. Clinical success was arbitrarily defined as cessation of major haemoptysis for at least 10 days after attempted embolisation. If major haemoptysis recurred after this interval it was arbitrarily defined as a new problem.

Results

During the study period 58 bronchial arteriograms were obtained in 35 patients, with the intention of embolising abnormal vessels. Twenty five patients had one arteriogram, seven had two, one had three, one had four and two had six arteriograms in the study period.

PROCEDURES FOR RECENT MAJOR HAEMOPTYSIS

In the main group forty procedures in 26 patients were performed within one week of major haemoptysis. Tables 1 and 2 show the clinical characteristics and initial severity of the recent major haemoptysis for these 26 patients. Most had chronic bronchial sepsis and received antibiotics. Although it was not possible to obtain details of the physiotherapy given during each episode of haemoptysis, it was clear that most patients were referred for this treatment. Fibreoptic bronchoscopy had been undertaken before 37 of these 40 arteriograms and had localised the site of bleeding to a specific lobe in 33 and to one lung in two but had failed to localise the site of bleeding on two occasions.

Technical success – Embolisation was technically successful in 33 of the 40 procedures (24/26 patients). Among these technically successful embolisations, major haemoptysis recurred within 10 days in 17 (median blood loss 500 ml, range 150 – > 2600 ml). Embolisation was not possible on seven occasions. In five procedures no abnormal vessels were shown, four of which were undertaken for recurrence of major haemoptysis within 10 days of a technically successful procedure. The catheter position could not be stabilised on two occasions.

Combined clinical and technical success – Cessation of major haemoptysis for at least 10 days (clinical success) and technical success were achieved in only 16 of the 40 procedures. The combined success rate was similar in the different disease categories (cystic fibrosis 10/23 procedures, aspergilloma 4/12, bronchiectasis 2/4, and cause unknown 0/1). Fourteen of 31 first attempts were successful. However, only two of nine repeat procedures were successful. Six of the seven technically unsuccessful procedures were clinically successful. In other words, major haemoptysis ceased after arteriography without embolisation in six of seven patients.

Outcome – Five of the 26 patients (three with cystic fibrosis, two with aspergilloma) died as a result of haemoptysis despite embolisation and subsequent surgery (cavernostomy, bronchial artery ligation or pulmonary resection, or both) and mechanical ventilatory support, plus radiotherapy in one patient. Eight other patients died within one year of the procedure: five of their underlying respiratory disease, one of recurrence of haemoptysis (cause unknown), and two of unrelated reasons. The thirteen survivors have subsequently been followed up for a median of 21 months (range 12–60 months).

Complications – There were no major complications as a result of the arteriography and embolisation. Minor complications recorded were small groin haematomas in two patients and transient episodes of chest pain.

Table 1: Clinical details of 26 patients with recent major haemoptysis undergoing bronchial arteriography to embolise abnormal vessels

<table>
<thead>
<tr>
<th>No of patients</th>
<th>Medium (range) age (years)</th>
</tr>
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<tbody>
<tr>
<td>Male/female</td>
<td>16/10</td>
</tr>
<tr>
<td>With chronic bronchial sepsis</td>
<td>22</td>
</tr>
<tr>
<td>Receiving antibiotic treatment</td>
<td>23</td>
</tr>
<tr>
<td>Diagnoses:</td>
<td></td>
</tr>
<tr>
<td>Cystic fibrosis*</td>
<td>16  24(15–33)</td>
</tr>
<tr>
<td>Aspergilloma</td>
<td>6</td>
</tr>
<tr>
<td>Bronchiectasis</td>
<td>3</td>
</tr>
<tr>
<td>Unknown</td>
<td>1</td>
</tr>
<tr>
<td>Median FEV₁ (range) 35(13–96)%</td>
<td>* predicted value.</td>
</tr>
</tbody>
</table>

*Prothrombin ratio prolonged (>1.2–1.5) in five patients, one patient also had a low platelet count (45 x 10⁷/μl).
†Only three patients (two with cystic fibrosis, one with aspergilloma) had FEV₁ above 60% predicted value.

Table 2: Severity of haemoptysis before bronchial arteriography in 26 patients with recent major haemoptysis

<table>
<thead>
<tr>
<th>Measure</th>
<th>Median (range) expected volume</th>
<th>No of patients</th>
<th>No of patients receiving blood transfusion (&gt; 2 units)</th>
<th>No of patients receiving mechanical ventilatory support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median (range) expected volume</td>
<td>680(270–2200)</td>
<td>10</td>
<td>4</td>
<td>4</td>
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abdominal pain, and femoral nerve paresis, each in one patient.

PROCEEDURES NOT INCLUDED IN MAIN ANALYSIS
Of the original 58 procedures, 18 were not considered in the main analysis. Nine procedures in eight patients followed episodes of minor haemoptysis, and all of these patients subsequently rebled. Seven procedures for major haemoptysis in four patients were undertaken more than one week after the episode of major haemoptysis. No further major haemoptysis occurred in the 10 days after these procedures. However, it is impossible to determine whether cessation of the haemoptysis was the result of the embolisation or not.

In one patient embolisation was successful for a major haemoptysis which followed laser treatment for carcinoma of the bronchus. Inadequate clinical data were available to allow evaluation of one procedure.

Discussion
There are no agreed rules for deciding whether bronchial artery embolisation is an appropriate treatment intervention in individual cases. As a result we decided in our audit to use the results of our retrospective analysis, itself, and the published series to evaluate the appropriateness of the procedure on each occasion and to develop guidelines for the future.

The success rate of the procedure for the control of major recent haemoptysis was 40% (16/40). This result is similar to that of 53% (8/15) in a study of patients with cystic fibrosis. However, it seems to compare unfavourably with the large series previously reported and two recent studies in the United States (of 20 and 25 patients respectively with cystic fibrosis) which reported 95% and 84% success rates respectively for control of haemoptysis.

There are several important reasons for the apparent differences in success rate. Firstly, our success rate (16/40) is based on the evaluation of a rigorously defined subgroup of patients in whom recent major haemoptysis was clearly recorded. In the recent study by Cohen et al, patients with cystic fibrosis with smaller amounts of haemoptysis were included in the calculation of success rate. In that study patients with chronic or slowly increasing haemoptysis interfering with lifestyle and with haemoptysis preventing postural drainage or home management were selected for angiography; these patients may have stopped bleeding spontaneously and are, therefore, more difficult to evaluate objectively. Secondly, the range and severity of underlying disease in our patients are different from those in other series. Our patients had severe cystic fibrosis, bronchiectasis, or aspergillosis with chronic bronchial sepsis. These conditions are associated with the presence of large, multiple bronchopulmonary vascular anastomoses. The poor prognosis for patients who experience massive haemoptysis with underlying cystic fibrosis or with mycetomas is known. Thirdly, other studies have also embolised systemic to pulmonary anastomoses from intercostal, subclavian, axillary, or internal mammary arteries. In one of these studies most of the patients required parenteral narcotic analgesia. Embolisation had to be confined to the bronchial arteries in our patients because the poor respiratory reserve (forced expiratory volume in one second 35% of predicted) necessitated a short procedure and contraindicated the use of narcotic analgesia.

In the light of the limited success in our patients with recent major haemoptysis we suggest that embolisation is unlikely to be worthwhile in patients with recurrent small haemoptyses, and we doubt its value in patients whose major haemoptysis occurred more than one week before the procedure. In addition, there is little evidence of benefit from repeat procedures for a single period of recurrent haemoptyses. It is interesting to speculate why patients with small or past major haemoptyses were referred for embolisation, as an understanding of the possible reasons may help to prevent inappropriate referrals in the future. Haemoptysis is a particularly distressing symptom for patients and carers, and “a little blood goes a long way.” The published success rate for massive haemoptysis is very encouraging, and it is not surprising that without local audit data, the multiple pressures for invasive treatment led to procedures being undertaken which, with hindsight, seem inappropriate. The availability in a hospital of a complex invasive procedure is likely to encourage referrals.

Bronchial artery embolisation will reduce blood pressure and blood flow at the site of haemorrhage, but alone it will not abolish haemorrhage. Cessation of haemorrhage also requires blood clotting and repair of blood vessels. Inflammation, for example in chronic bronchial sepsis, is difficult to abolish in patients with severe disease and probably impairs repair of vessels. The low efficacy of bronchial artery embolisation in our patients highlights the need to try to stop haemorrhage by intensive antibiotic treatment and judicious use of physiotherapy. Botenga proposed that successful treatment of the inflammatory process may lead to the disappearance of bronchopulmonary anastomoses. The prolongation of prothrombin time recorded in five patients was minor, and vitamin K was administered.

As a consequence of this audit our radiologists limit the use of bronchial arteriography and embolisation to patients with recent major haemoptysis. The procedure now is no longer undertaken for minor haemoptysis or past (>1 week) major haemoptysis. Repeat procedures after technically successful embolisation are now only reluctantly undertaken. If these restrictions had been applied to the patient population studied in this audit up to 43% fewer procedures would have been performed with no loss of clinical
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benefit. Bronchial embolisation is safe whereas the alternatives, such as surgery and more extensive arteriography, may be more hazardous in this population of patients. Pleural changes after thoracotomy are a relative contraindication to future lung transplantation. The criteria identified above are now applied when discussing potential embolisations with referring clinicians. In this manner, we aim to avoid inappropriate procedures.

We thank the physicians and radiologists whose patients are included in this audit.