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*Original Article*

# Long term follow up of a series of patients with massive hemoptysis treated using bronchial artery embolization

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**Abstract.** Massive hemoptysis is an important medical emergency which needs immediate managements. There are different managements offered for this event but there is no universal accordance on management of massive hemoptysis. Available database is not adequate in this field. Here we aimed to present a series of Iranian patients with massive hemoptysis managed in Yazd. We entered 33 referred patients into our study with their own informed consent. The patients had already been diagnosed with their pathology. Except 5 patients, they all underwent embolization intervention. Tuberculosis and bronchiectasis were the most common causes of hemoptysis detected in 11 (39%) and 10 (35%) patients respectively. Other causes of hemoptysis in studied patients were primary pulmonary hypertension, Eisenmenger's syndrome, lung tumor and cystic fibrosis. All patients underwent angiography and were treated using bronchial artery embolization technique. Five patients involved recurrent hemoptysis, accounting for 17% of the patients. Two patients involved unwanted complications of embolization therapy. Unfortunately, we recorded two related mortalities in our follow up. Our study showed that embolization technique is followed by a low rate of mortality and recurrence and remains as one of the most effective procedures for management of hemoptysis.

**Keywords**: Hemoptysis, embolization, angiography, intervention

## Introduction

Hemoptysis is defined as expectoration of blood originated from lung parenchyma or lower respiratory airways. In this definition upper respiratory tract bleedings are not considered as hemoptysis [1]. Hemoptysis is categorized into massive and non-massive groups [2]. Massive hemoptysis stands a low portion of total hemoptysis but if happens it will lead to high rate of mortality [3, 4]. Despite high risk of mortality still there are not adequate researches performed about management of hemoptysis. The number of case series and their follow ups and outcome reports are also limited [5]. Etiologies leading to hemoptysis have changed during time. Recent statistics indicate bronchiectasis, TB, necrotizing pneumonia and bronchogenic carcinoma as the most common etiologies of massive hemoptysis [6]. Hemoptysis can be managed using medical, surgical or embolization approaches but up to dated investigations consider embolization technique as the most effective treatment with better outcomes and lower risk of mortality [3, 7]. Available database about embolization management in patients with massive hemoptysis is limited either in the world or in our region, Iran. Embolization and angiographic intervention techniques are well developed in Iran and are being used with similar outcomes as other countries. In this paper we present a series of patients with hemoptysis managed via transcatheteral bronchial artery embolization in Yazd, Iran.

## Patients and Methods

We are about to present a series of 33 patients referred to Shahid Sadoughi hospital during 6 months since February 2013 till August 2013 with massive hemoptysis. All referred patients had already been diagnosed and bleeding sites were determined using bronchoscopy, chest X-ray (CXR) or computed tomography (CT-scan). All referred patients who entered our study were informed about all details while signing their informed consent and our study was carried out with institutional review board approval. They first underwent bronchial angiography via 5F Cobra catheters for primary imaging and evaluation. Of the patients, 28 were treated via embolization method. Immediate success rate was 100% and hemoptysis stopped in all patients after embolization. All procedures were done by one of Shahid Sadoughi staffs personally, this provided equal operator depended factors for all patients. As suggested by M.C O'Dell et al., we followed our patients to check persistent hemoptysis, non-target embolization and unstable hemodynamics for 2 years [8]. Five cases that

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TABLE 1
SUMMED UP RESULTS

| Condition | No. of patients | | | |
|---|---|---|---|---|
| | Embolization | Recurrence | Complication | Mortality |
| TB | 11 | 2 | 2 | 1 |
| Bronchiectasis | 10 | 1 | - | - |
| PPH | 2 | 1 | - | 1 |
| ES | 2 | 1 | - | - |
| Lung tumor | 2 | - | - | - |
| CF | 1 | - | - | - |
| Total No. | 28 | 5 | 2 | 2 |

TB: tuberclosis, PPH: primary pulmonary hypertension, ES: Eisenmenger's syndrome, CF: cystic fibrosis.

were not candidate for embolization treatment were as below:

1. Patient with evidences of a large pulmonary artery aneurysm as the cause of hemoptysis.
2. Young patient diagnosed as bronchiolitis obliterans organizing pneumonia (BOOP) syndrome.
3. High risk case of lung tumor for embolization which was suggested for conservative treatment.
4. Known bronchiectasis case that was candidate for other treatment options.
5. A case which was referred back for a more comprehensive diagnostic work up.

Other patients were treated using embolization via "Merit medical" polyvinyl alcohol (PVA) 355-500 or 500-710 micron particles. The average hospitalization ranged from 1 to 3 days.

Five patients involved recurrence among those who were treated using embolization technique (17.85%): Three of them were treated using repeated embolization. One was observed in hospital without angiographic intervention and was discharged with stable hemodynamics. The last one was a known case of TB that her second hemoptysis led to death. Two patients developed treatment complications including self-limiting thoracic aorta dissection and inevitable dysphagia.

Here is the list of recurrent hemoptysis cases after first time embolization:

1. A 53 years old man with history of bronchiectasis treated with embolization technique and discharged with stable hemodynamics. He was re-admitted 3 months later with complaint of massive hemoptysis, respiratory arrest and unstable hemodynamics. The patient was intubated and treated using common bronchial artery embolization. There was no more complaint of hemoptysis during our follow up.
2. This case was a 27 years old man and known case of ES with hemoptysis and anemia. He was treated using right inter costobronchial artery embolization. He was readmitted after 1 month with evidences of bleeding from major aortopulmonary collateral artery (MAPCA) and was successfully treated using MAPCA embolization.
3. The next case was a 65 years old woman with history of TB and hemoptysis. She was treated with right bronchial artery embolization for the first time but she was readmitted with pervious symptoms. During investigations a non-bronchial artery branched from intercostal arteries was claimed to be responsible f or hemoptysis. Patient's symptoms disappeared after second embolization of non-bronchial artery. This non-bronchial artery was also one of the esophagus supply sources thus she faced unavoidable dysphagia after embolization. Dysphagia recovered completely after 2 or 3 days.
4. The other case was a 64 years old man diagnosed with PPH and poor unstable hemodynamic conditions so was too risky for a second embolization therapy. He was transferred to intensive care unit (ICU) for conservative care. After one month his hemodynamic condition became stable and his hemoptysis stopped without any interventional therapy.
5. The last case was a 73 years old woman with hemoptysis due to TB infection which was treated successfully for the first time. Unfortunately, she passed away at home due to second massive hemoptysis.

Two mortality cases are also recorded. One of them was the fifth case mentioned above who passed away at home due to massive hemoptysis. The other one was a patient with complicated heart disease who passed away before cardiac surgery because of two vessel disease (2VD) and severe mitral regurgitation (MR).

## Results

The average age of massive hemoptysis cases was 51 years varied from 20 to 86 years old. Twenty cases were female and only 8 of them were male. Majority of patients were known cases of TB (39.28%) which active TB infection was detected in one of them. Other cases included bronchiectasis (35.71%), primary pulmonary hypertension (PPH) (7.14%), lung tumor (7.14%), Eisenmenger's syndrome (ES) (7.14%) and cystic fibrosis (CF) (3.57%) respectively. TB patients were the ones with highest rate of recurrence and complication. They accounted for 40% of recurrence cases and 100% of complicated patients.

## Discussion

Hemoptysis is not a rare clinical manifestation. It is defined as coughing up blood that is originated from lung parenchyma or lower airways, trachea, pharynx and bronchi [1]. Hemoptysis incidence is 1 out of each 1000 outpatients per year. It makes 6.8% of outpatient pulmonary clinic visits so each first line physician will encounter hemoptysis cases 4 or 5 times a year [2, 6].

Although hemoptysis can be self-limiting in many cases but it may need ICU admittance and can even lead to death [9]. Hemoptysis is categorized into 2 broad groups traditionally, massive or severe and non-massive or so called mild or moderate. Massive hemoptysis has an incidence of less than 5% of total hemoptysis [3]. It is low, but its mortality rate is more than 50% which is much higher than non-massive hemoptysis. For this reason, Ibrahim et al. suggested that "life threatening hemoptysis" expression should be used instead of massive hemoptysis [10]. Based on this it is mandatory for any medical doctor to be able to manage patients with chief compliant of massive or non-massive hemoptysis [2]. Massive hemoptysis is defined by bleeding amount of 200 to 1000 milliliter (ml) during 24 hours but the most frequent

amount used in literature is ranged between 300 and 600 ml during 24 hours. Other terms are also seen to be used for describing amount and severity of hemoptysis such as major (>200 ml/24 hours), severe (>150 ml/12 hours) and exsanguinating (>1000 ml total) [11]. An amount of 400 ml of blood within the lung parenchyma is enough for respiratory failure and may be followed by asphyxia and exsanguination as the most common causes of death due to hemoptysis [1]. Massive hemoptysis in pediatrics means bleeding more than 8ml/kg during 24 hours or 200ml during 24 hours [12].

The main etiologies for hemoptysis are categorized under 3 main groups: airway diseases, parenchymal diseases and vascular diseases [1]. Hemoptysis etiologies have changed during time and vary in different geographic zones. At the 1960s, common etiologies were mostly TB, bronchiectasis and lung abscess. Other etiologies including bronchiectasis, lung cancer and pneumonia were less common etiologies respectively [6, 13]. TB still stays the main reason of hemoptysis worldwide. The differential prevalence varies in different regions. In developing countries statistics show that the most common etiologies are still infections but in the USA and other developed countries the main etiology has changed to bronchiectasis and lung cancer [14]. Other uncommon reasons for hemoptysis are bronchial adenoma, systemic hypertension, vasculitis, lipoid pneumonia and radiation pneumonitis or even bronchial artery aneurysm (BAA) in only 1% of intermittent hemoptysis patients [13, 15]. In children etiologies are different. The most common causes of hemoptysis in children are foreign body aspiration, infection, bronchiectasis, CF, pulmonary TB and less commonly trauma and cardiovascular abnormalities or even disseminated intravascular coagulation (DIC) [16]. Hemoptysis happens in 9.1% of CF patients and is usually associated with comorbid diseases. Massive hemoptysis happens in 4.1% of CF patients [17]. In this study we concluded that bronchiectasis and TB are the most common etiologies for hemoptysis as H. Dabó et al also did.

Lung is supplied by 2 main arterial systems: bronchial arteries and pulmonary arteries [18]. Bronchial arteries receive 1% of cardiac output and supply airways and pulmonary arteries as vasa vasorum. Pulmonary arteries are responsible for 99% of lung oxygenation and gas exchange and also supply trachea, bronchi, esophagus and visceral pleura [1, 19]. Bronchial artery is responsible for 90% of hemoptysis and the rest 10% is divided between pulmonary and other lung supplying arteries equally [3, 4]. There are a lot of different variations in anatomy of these arteries but the most common variation of bronchial artery pattern was reported by Battal et al. using multi-detector computed tomography (MDCT) angiography. This pattern is one bronchial artery on each side which is divided into two arteries on right side and one on the left side. Normal diameter of bronchial artery is reported to be median 3 millimeter (mm) by the same team but again the diameters are reported to be different in different researches. This points out to the big controversy on bronchial artery anatomy [20]. Bronchial arteries typically branch from proximal descending thoracic aorta. They are called as orthotopic when they are originated at T5-T6 vertebral level and ectopic if they are originated elsewhere. 64% of general population show orthotopic pattern in imaging. Ectopic bronchial arteries are possible to be originated from aorta directly, subclavian artery, brachiocephalic, thyrocervical and even coronary arteries but the most common site is undersurface of the aortic arch [19]. Ectopic bronchial artery pattern is more common in men [21].

Patients with massive hemoptysis admitted to emergency room need immediate care since untreated massive hemoptysis can have up to 85% mortality rate [22]. Management of these patients mostly needs a team including intensivist, interventionist and thoracic surgeon [11]. The first step of management for these patients is to enhance the patient's general condition using effective stabilization. The most important step of management is to establish a functional supportive air way and the most available and easy way is intubation using a single lumen endotracheal tube. The next step is to determine the site of bleeding and thus a bronchoscopy is suggested mostly, because it is said to be useful in 2 ways: 1) clearing the airways and 2) establishing an appropriate vision to the bleeding site [6]. It is discussed in different researches that bronchoscopy can also offer useful treatment options in the first steps of management before target therapy or diagnostic work up such as selective intubation, cold saline lavage and applying bleeding control agents. Diagnostic work ups are different in massive and non-massive hemoptysis patients and their unit goal is to identify etiology and locate the site of active bleeding. The routine available diagnostic tools are chest X-Ray, chest CT scan, bronchoscopy, and laboratory tests [11]. Chest radiography is the best diagnostic test for the first step in patients with stable hemodynamics [2]. A descending aortogram is suggested if there is a possibility of bleeding from non-bronchial vessels [11].

Conservative therapy for hemoptysis mostly consist of controlling coagulopathy state, cardiovascular support and airway protection, the latter is considered as the most important one [14]. Conservative therapy for massive hemoptysis is followed by 50-100% of mortality thus after successful stabilization the patient is candidate for definite target therapy which can be achieved within 3 protocols: endovascular intervention (BAE), surgical treatment and medical treatment [7, 23]. Hemoptysis was not considered to be curable until 1940 and up to approximately 20 years ago surgery was the treatment of choice for massive hemoptysis [1, 16]. Since 1973 that BAE was first performed by Remy et al this endovascular intervention became the treatment of choice in most of acute hemoptysis cases because of both diagnostic and curative benefits [8, 24]. Among these options, medical treatment led to 45% mortality, surgical resection led to 7-18% of mortality in selective cases and 40% of mortality in emergency cases [1, 23].

Available medical treatment for hemoptysis are not suitable nowadays but Tranexamic acid is reported to be useful in controlling patients with bronchiectasis due to CF

in limited articles. Medical treatment using anticoagulants should be in mind only for some pulmonary renal cases such as Goodpasture or granulomatosis with polyangitis (GPA). Other medical treatments such as anti TB treatment, antifungal or antibiotic agents are not enough and the best results are achieved if they are prescribed along with bronchial artery embolization (BAE) or surgical treatments [7].

Surgical options for massive hemoptysis is resection which can be done as segmentectomy, lobectomy and pneumonectomy [14]. Each of these operations can be done in 3 approaches depending on the time passed since definite hemoptysis diagnosis: emergency, scheduled (is done when bleeding is controlled) and planned (is done in a second admission after discharge) [6]. Nowadays surgery remains treatment of choice only in limited cases such as iatrogenic pulmonary artery rupture, chest trauma and aspergilloma except those who cannot survive surgery because of comorbid diseases or emergency conditions [1, 6]. Surgery is also useful in patients with lung cancer and idiopathic bronchiectasis after stabilization via BAE [14]. Immediate success rate of BAE method was reported in a range of 80% up to 98.5% [18]. In a study done in 2014, G.R. Alexander tried to show that BAE can also be used as a temporizing method before surgery rather than main treatment of hemoptysis. But the results demonstrate that although BAE is helpful for immediate control of bleeding but recurrence rate in patients with BAE as temporizing measure was significantly higher in comparison to patient who underwent surgery without any endovascular intervention (75% compared to 2%) [23]. Hemoptysis arising from malignant etiologies are the most failed cases for performing BAE and they had the worst long term outcomes [18]. This indicates that maybe in these cases BAE is better to be done only for immediate control of bleeding and then the cases can be candidate for surgical resection [14]. Some studies indicate that recurrence rate of BAE is about 29.8% as an average and some others reported the average recurrence of hemoptysis as 23% in 5 years depending on etiology [3, 18]. Our study ended up with a recurrence rate of 17.85% but one of the highest recurrence rates was reported by Fruchter et al. which was 57.7% [14]. High recurrence rates of hemoptysis controlled using BAE was reported to be related to the underlying lung diseases such as aspergillosis, TB and bronchial carcinoma [25].

In our study the highest recurrence rate was among TB infected patients. A Spanish study involving 317 patients revealed that in TB related massive hemoptysis, endovascular treatment had a success rate of 91% and the recurrence rate was 22% and need to second embolization was recorded in only 7% of patients [26]. Another study performed about TB associated hemoptysis showed that average age of diagnosis of active TB was 36 years and 25% of patients experience recurrent hemoptysis after the first time of BAE. Destructed lung tissue, fungal ball and Chest CT consolidations were reported as recurrence risk factors in TB infected patients by Ryu et al. [27]. There are no certain contraindications to perform BAE except 2 relative contraindications including coagulopathy and renal failure or contrast allergy [8]. The most common embolic materials used in the procedures are PVA and gelatin sponge and particles larger than 300 microns are mostly used [25]. The most common complications of BAE seem to be sub intimal dissection, fever, chest pain, dyspnea, dysphagia headache and etc. [4]. We faced sub intimal dissection and dysphagia in our study. Spinal artery ischemia, the most frightening complication of BAE that can cause paraplegia is reported to happen in a range of 1.4% up to 6.5% [18, 25]. This complication can be prohibited by using particles larger than 300 microns [25]. We also used large particles in our procedures and thus we didn't face spinal ischemia.

**Conflict of interest**

The authors declare no conflicts of interest and no financial support.

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