Original Article

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TANAFFOS

Bronchial Angioembolization for Management of Hemoptysis Due to Pulmonary Tuberculosis

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Background: The study aimed to evaluate the effectiveness and safety of BAE in TB patient with massive hemoptysis and evaluate the recurrence rate of hemoptysis after BAE.

Materials and Methods: In this prospective study, 68 patients with moderate and severe hemoptysis due to active or old tuberculosis who underwent bronchial arteriography were included. CXR and CT scan were performed in all patients. Selective and nonselective bronchial artery angiography was performed in all patient and 62 patients underwent embolization.

Results: Thirty-two patients (47.1%) had active TB and 36 patients (52.9%) had inactive TB (post-tuberculosis sequelae). Abnormality was detected in a single vessel in 30 (44.1%) patients, in two vessels in 23 (33.8%) and in more than two vessels in 13 (19.1%) patients. Embolization was performed in 62 patients and overall 95 abnormal arteries were embolized. Hemoptysis control rate was 82.3% at one month, 73.5% at three months, 69.1 % at 6 months, 63.2% at one year and 60.3% after two years.

Conclusion: No major complication occurred as a result of BAE procedures. BAE is a safe and effective method for the management of hemoptysis in patient with tuberculosis. Only 20.6% of the patients need to repeat BAE during 2 years of follow up.

Key words: Embolization; Bronchial artery; Tuberculosis; Hemoptysis

INTRODUCTION

Massive Hemoptysis, an expectoration of greater than 200-600 ml of blood per day (1), is a potentially life-threatening medical condition, requiring prompt diagnosis and treatment. Pulmonary tuberculosis is the leading cause of massive hemoptysis in developing countries (2-4). Chronic lung inflammation in TB can lead to dilation and engorgement of bronchial vessels, leading to anastomoses between pulmonary and bronchial circulations. Subsequent erosion and rupture of pulmonary or bronchial arteries cause hemoptysis which can be massive. Moreover, necrosis of pulmonary parenchyma and bronchial mucosal invasion by the infection could also be the source of bleeding in tuberculosis. Another rare cause of hemoptysis in TB is the rupture of an abnormal bronchial artery in the wall of a tuberculous cavity (known as Rasmussen's aneurysm) (5).

Both conservative and surgical management of massive hemoptysis carry a high mortality rate (6,7). Bronchial artery embolization (BAE), a minimally-invasive procedure

for the management of hemoptysis, was first described by Remy et al. in 1974 (8). In 1990s, with the use of microcatheters in selective techniques, which allowed securing the origin of spinal artery during embolization sessions, BAE became the method of choice in the management of hemoptysis secondary to a wide variety of causes, including tuberculosis (9,10).

In a recently published systematic review including 22 studies regarding bronchial artery embolization in patients with hemoptysis, immediate success rate for cessation of bleeding was high, ranging from 70 to 99%. However, recurrences were not uncommon, and the reported recurrence rate was as high as 9.8−57.5% in those studies (11).

This study aimed to evaluate the effectiveness and safety of BAE performed in a referral center for pulmonary diseases and to investigate the relationship between clinical characteristics of the patients with pulmonary tuberculosis and the recurrence rate of hemoptysis after BAE.

MATERIALS AND METHODS

This is a prospective study conducted in the Department of Cardiovascular Diseases of "National Research Institute of Tuberculosis and Lung Diseases, Masih Daneshvari Hospital",Tehran, Iran, a tertiary and WHO Collaborating Center for Tuberculosis Education in Eastern Mediterranean Region.

From April 2013 to November 2016, all patients with moderate and severe hemoptysis due to active or old tuberculosis who underwent bronchial arteriography were included in the study. Moderate hemoptysis was defined as hemoptysis of 100-300 ml per day or more than 300 ml per week. Severe hemoptysis referred to hemoptysis more than 300 ml/day, any hemoptysis causing a drop in hemoglobin (1g/dl or more) or hematocrit (5% or more), hypotension (systolic blood pressure less than 90 mmHg), or decreased arterial oxygen saturation ($SPaO_2$ less than 60%) (11). Patients with abnormal coagulation test results were excluded. Chest X-ray and spiral Chest Computerized Tomography (CT) scan were performed in all patients. Active tuberculosis was diagnosed on the basis of systemic symptoms, presence of radiological features, and positive sputum acid-fast bacilli (AFB) smear or culture. Post-tuberculosis sequelae was diagnosed based on a previous history of tuberculosis and/or anti-tuberculosis treatment, and the presence of radiographic features such as bronchiectasis, fibrosis, and calcified nodules (12,13).

All patients received appropriate medical treatment including administration of oxygen, intravenous fluids, vasopressin, and transfusion of blood products as needed. In patients with active TB, standard anti-tuberculosis regimen was started, if not given previously.

Selective and nonselective bronchial angiographies were performed in all patients. All procedures were performed by experienced cardiologists. Trans-femoral catheterization was done under local anesthesia. First a non-selective Digital Subtraction Angiography (DSA) was performed. Vessels were considered abnormal if tortuosity, enlargement more than 3 mm, parenchymal blush and hypervascularity, active contrast extravasation and systemic to pulmonary shunting were present. Then, the abnormal vessels were selectively catheterized. Visualization of the spinal artery at the origin of culprit artery was an absolute contraindication to embolization, if performing the embolization through a microcatheter was not technically possible. Polyvinyl alcohol (PVA) particles (Contour, Boston Scientific, Place Natick, MA, USA) with a size commonly ranging from 300 to 500 µm were used for embolization. Coil (Merit Medical systems, Utah, USA) was used if embolization with PVA particles could was not possible.

The patients were prospectively followed for a median of 20 months.

Immediate control of the bleeding was defined as complete cessation of hemoptysis or having only blood-tinged sputum within the first 24 hours. Recurrence was referred to any significant hemoptysis requiring hospitalization, medical treatment or intervention. Mild

recurrent hemoptysis was managed conservatively. Indications for repeat BAE in patients with moderate and severe recurrent hemoptysis were similar to the first BAE.

The study protocol was approved by the Institutional Ethics Committee of the "National Research Institute of the Tuberculosis and Lung diseases". Written informed consent was obtained from all participants.

RESULTS

A total of 68 patients, including 43 (63.2%) males and 25 (36.8%) females with moderate to severe hemoptysis secondary to tuberculosis or post-tuberculosis sequelae were recruited. The mean age was 56.59 ±13.9, ranging from 18 to 88 years. Hemoptysis was moderate in 29 patients (42.6%) and 39 patients (57.4%) had severe hemoptysis. Thirty two patients (47.1%) had active TB and 36 patients (52.9%) had inactive TB (post-tuberculosis sequelae). Twelve patients (17.6%) had concurrent aspergilloma. Chest radiograph and CT scan were abnormal in all patients. Radiographic and CT findings are presented in Table 1.

Table 1. CT scan findings of the patients with pulmonary tuberculosis presenting with moderate and severe hemoptysis

Chest CT scan findings	N(%)
Consolidation	19 (27.9)
Collapse	1 (1.5)
Reticular infiltration	5 (7.4)
Ground-glass infiltration	22 (32.4)
Cavity	30 (44.1)
Nodule	34 (50)
Pleural effusion	3 (4.4)
Pleural thickening	32 (47.1)
Bronchiectasis	33 (48.5)
Fungus ball	12 (17.6)

Bronchoscopy was performed in 40 (58.8%) patients and abnormal findings were observed in 30 patients. Table 2 summarizes bronchoscopic abnormalities and the observed location for the bleeding during the bronchoscopy.

Table 2 . Bronchoscopic findings in the patients with pulmonary tuberculosis presenting with moderate and severe hemoptysis

Bronchoscopic abnormalities	N (%)
Endobronchial lesion	2(5)
Anthracosis	8 (20)
Mucosal lesion	2 (5)
Bronchial deformity	0
Location of hemoptysis in bronchoscopy	
RUL	4 (10)
RML	8 (20)
RLL	4 (10)
LUL	2 (5)
Lingula	6 (15)
LLL	4 (10)

DSA angiography was performed in all patients and it was abnormal in 48 (70.6%) patients. Selective bronchial artery angiography showed abnormalities in 66 (97%) patients. Abnormality was detected in a single vessel in 30 (44.1%) patients, in two vessels in 23 (33.8%) patients and in more than two vessels in 13 (19.1%) patients. The observed angiographic abnormalities are presented in Table 3. The total number of embolized vessels in patients is summarized in table 4.

Table 3. Angiographic abnormalities of the patients with pulmonary tuberculosis presenting with moderate and severe hemoptysis

Angiographic abnormalities	N (%)
Tortuosity and hypertrophy	58 (85.3)
Shunting to pulmonary artery or vein	37 (57.5)
Parenchymal blush and hypervascularity	18 (26.5)
Active contrast extravasation	13 (19.1)
Aneurysm	10 (14.7)

Table 4. Total number of abnormal and embolized vessels in BAE procedures performed in patients with pulmonary tuberculosis

Involved vessels	Total	No embolization	One embolized vessel	Two embolized vessel	More than two embolized vessel
No abnormal vessel	2	2	0	0	0
Single abnormal vessel	30	1	29	0	0
Two abnormal vessels	23	1	3	19	0
More than two abnormal vessels	13	0	2	1	10

Embolization was performed in 62 patients and overall 95 abnormal arteries were embolized. Forty five left bronchial arteries, 33 right bronchial arteries, 3 left intercostal arteries, 2 right intercostal arteries, and 2 left internal mammary arteries (LIMA) was abnormal and were embolized subsequently (Figure 1 A, B).

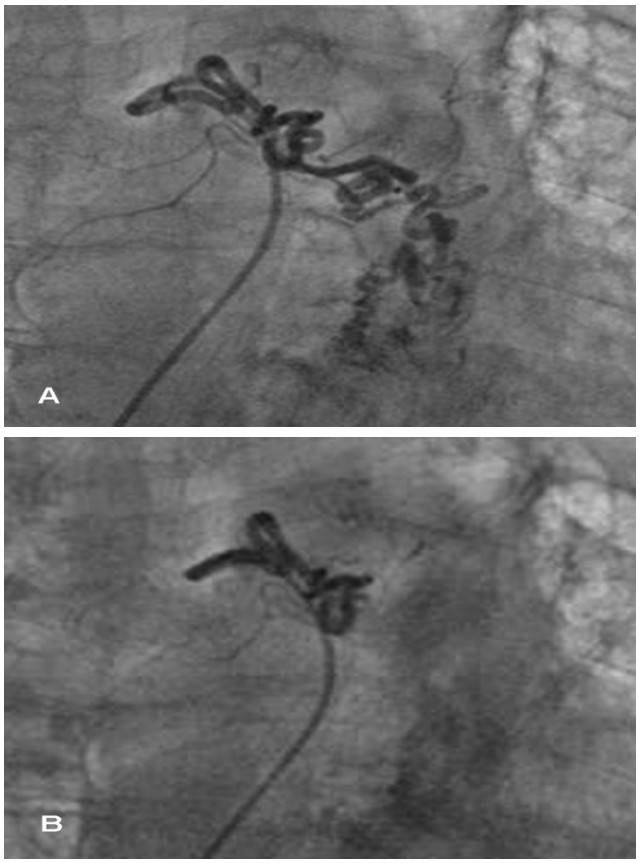

Figure 1(A, B). Bronchial angiogram A) left abnormal bronchial artery with enlargement and tortusity, B) Successful post BAE with PVA particle injection in the main trunk.

Coils were used in two patients in whom angiography showed anastomoses to vertebral arteries, which made the injection of PVA impossible.

Immediate control of the bleeding was observed in 65 patients (95.6%). Three patients had recurrent hemoptysis within the first 24 hours after the procedure. However, only one of them required repeat BAE to control the bleeding (Table 5).

Table 5. Cumulative recurrence rate, hemoptysis control rate and need to repeat BAE during the follow up of the patients

	Recurrence of hemoptysis rate (%)	Hemoptysis control rate (%)	Need to repeat BAE (%)
24 hour	4.4	95.6	1.47
1 week	10.2	89.7	2.94
1 month	17.6	82.3	4.41
3 months	26.4	73.5	10.2
6 months	30.8	69.1	13.2
1 year	36.7	63.2	17.6
≥2 years	39.7	60.3	20.5

Minor procedure-related complications occurred in 20 (29.4%) patients and no major complications were encountered in the patients. The median follow-up was 20 months. There were no lost to follow-up cases. Overall eight patients (11.8%) died which only one of them died due to hemoptysis.

In 27 patients (39.7%) hemoptysis recurred and 14 needed to repeat BAE (20.6%). Table 5 shows the cumulative recurrence rate and repeat BAE during the follow up period. The causes of re-bleeding were insufficient procedure in the first session in 4 patients (14.8%), presence of bronchial collaterals in 9 patients (33.4%), the progression of underlying disease in 7 patients (25.9%), non-bronchial vessels in 2 patients (7.4%) and multiple vessels involvement in 5 patients (18.5%).

Age more than 50 years and the presence of bronchiectasis were significantly associated with recurrence of hemoptysis (P<0.001 and P=0.01, respectively). The recurrence of hemoptysis was not significantly associated with gender (P=0.581), and the number of embolized arteries (P=0.377). There was no significant difference in the recurrence of hemoptysis among patients with active tuberculosis compared to those with post-tuberculosis sequelae (P=0.726).

DISCUSSION

Embolization is an established treatment for massive hemoptysis (11). BAE is considered the best modality in high risk and inoperable patients. It is also the first-line treatment in operable patients, allowing the surgery to be

performed in an elective rather than emergency setting (14,15).

The use of BAE in the management of hemoptysis in patients with TB has been reported previously in several reports (12, 13, 16-19). In our center, as a referral center for hemoptysis due to pulmonary tuberculosis, BAE is used for the management of hemoptysis.

In current study, immediate control of the bleeding was achieved in 66 patients (97.1%). The immediate success rate was higher than the results of van den Heuvel et al. (67%), (18) Yu-Tang Goh et al. (81.5%), (19) and Pei et al. studies (86.6%) (12). However, similar rates were reported by shin et al (96.4%) (13) and Anuradha et al (93.1%) (16).

Despite high immediate clinical success, hemoptysis recurred in 27 out of 68 patients (39.7%) during two years of follow up. Reported recurrence rate is TB patients were 27% to 55% in previous studies (16,17).

Anuradha et al. performed BAE for 58 patients with hemoptysis due to TB. Immediate success rate was 93.1% in their patients. However, recurrence rate was 55%. In their study, hemoptysis control rate was 85.7% at the end of one month, 79.5% at 90 days, 63.2% at 6 months, 51% at one year and 38.7% at the end of two years (16). Similar trend was observed in the present study. Hemoptysis control rate was 82.3% at one month, 73.5% at three months, 69.1 % at 6 months, 63.2% at one year and 60.3% after two years.

Recurrence of hemoptysis during the first few weeks is usually due to non-bronchial systemic artery collaterals and multiple vessels involvement which are not sufficiently embolized during the procedure. Inadequate embolization may also be due to visualization of origin of spinal arteries during angiography when we were unable to use a microcatheter technically, which restrained us from performing the procedure completely. Rebleeding occurring later in the follow-up is mainly caused by the progressive nature of the underlying disease, which leads to chronic inflammation and neovascularization in the destructed lung parenchyma or recanalization of the previously embolized vessels.

The presence of bronchiectasis was significantly associated with higher recurrence rate. It reinforces the fact that BAE is rather a palliative therapy which is not curative and medical or surgical treatment of the underlying pathology is needed to achieve better outcomes.

There are inconsistent reports regarding the association between disease activity and the recurrence rate after BAE. Active TB was shown to be a protective factor in the recurrence of hemoptysis in Pei et al. and Van Den Heuvel et al. studies (12,18). In the study by Lee et al. (20), active TB was significantly associated with higher recurrence rate. However, in our study there was no significant difference in the recurrence of hemoptysis among patients with active TB compared to post-tuberculosis sequelae. This result is in agreement with the results of Anuradha et al. study (16).

The most common complications after BAE are transient chest or back pain and dysphagia (13,16,17,21,22). The reported major complications include vascular dissection or perforation with catheters or guidewires, mediastinal structure infarction and necrosis, broncho-esophageal fistula, ischemic colitis, and neurological complications such as transverse myelitis, cortical blindness and stroke (11-15). In present study, the only observed procedure-related complications were transient chest pain and dysphasia. We did not experience any major complications. Visualization of origin of spinal artery during angiography was absolute contraindication to perform the procedure when we were unable to use a microcatheter technically.

Death due to recurrent hemoptysis was observed in one patient (1.5%). Further studies with larger sample size are needed to evaluate the factors that may influence the mortality.

CONCLUSION

In conclusion, no major complication occurred as a result of BAE procedures and it can control the bleeding in most of the patients. Overall minor complication rate were low and transient. Therefore, BAE is a safe and effective method for the management of hemoptysis in patient with

tuberculosis and only 20.6% of the patients need to repeat BAE during 2 years of follow up. There was no significant difference in the recurrence of hemoptysis among patients with active tuberculosis compared to those with post-tuberculosis sequelae.

REFERENCES

1. Longo DL, Fauci AS, Kasper DL, Hauser SL, Jameson JL, Loscalzo J. Harrison's Principles of Internal Medicine. In: Kritek P, Fanta C, eds. Cough and Hemoptysis. 18th ed McGraw Hill Professional, 2012.
2. Shao H, Wu J, Wu Q, Sun X, Li L, Xing Z, Sun H. Bronchial artery embolization for hemoptysis: a retrospective observational study of 344 patients. ***Chin Med J (Engl)*** 2015;128(1):58-62.
3. Ashraf O. Hemoptysis, a developing world perspective. ***BMC Pulm Med*** 2006;6:1.
4. Bhalla A, Pannu AK, Suri V. Etiology and outcome of moderate-to-massive hemoptysis: Experience from a tertiary care center of North India. ***Int J Mycobacteriol*** 2017;6(3):307-310.
5. Walker HK, Hall WD, Hurst JW, editors. Clinical Methods: The History, Physical, and Laboratory Examinations. In: Corey R. Hemoptysis, Boston: Butterworths, 1990: pp211-13.
6. Burke CT, Mauro MA. Bronchial artery embolization. ***Semin Intervent Radiol*** 2004;21(1):43-48.
7. Fernando HC, Stein M, Benfield JR, Link DP. Role of bronchial artery embolization in the management of hemoptysis. ***Arch Surg*** 1998;133(8):862-866.
8. Rémy J, Voisin C, Dupuis C, Beguery P, Tonnel AB, Denies JL, Douay B. Treatment of hemoptysis by embolization of the systemic circulation. ***Ann Radiol (Paris)*** 1974;17(1):5-16.
9. Tanaka N, Yamakado K, Murashima S, Takeda K, Matsumura K, Nakagawa T, et al. Superselective bronchial artery embolization for hemoptysis with a coaxial microcatheter system. ***J Vasc Interv Radiol*** 1997;8(1 Pt 1):65-70.
10. Chun JY, Morgan R, Belli AM. Radiological management of hemoptysis: a comprehensive review of diagnostic imaging and bronchial arterial embolization. ***Cardiovasc Intervent Radiol*** 2010;33(2):240-250.
11. Panda A, Bhalla AS, Goyal A. Bronchial artery embolization in hemoptysis: a systematic review. ***Diagn Interv Radiol*** 2017;23(4):307-317.
12. Pei R, Zhou Y, Wang G, Wang H, Huang X, Yan X, Yang X. Outcomes of bronchial artery embolization for life-threatening hemoptysis secondary to tuberculosis. ***PLoS One*** 2014;9(12):e115956.
13. Shin BS, Jeon GS, Lee SA, Park MH. Bronchial artery embolisation for the management of haemoptysis in patients with pulmonary tuberculosis. ***Int J Tuberc Lung Dis*** 2011;15(8):1093-1098.
14. Haponik EF, Fein A, Chin R. Managing life-threatening hemoptysis: has anything really changed? ***Chest*** 2000;118(5):1431-1435.
15. Yoon W, Kim JK, Kim YH, Chung TW, Kang HK. Bronchial and nonbronchial systemic artery embolization for life-threatening hemoptysis: a comprehensive review. ***Radiographics*** 2002;22(6):1395-1409.
16. Anuradha C, Shyamkumar NK, Vinu M, Babu NR, Christopher DJ. Outcomes of bronchial artery embolization for life-threatening hemoptysis due to tuberculosis and post-tuberculosis sequelae. ***Diagn Interv Radiol*** 2012;18(1):96-101.
17. Ramakantan R, Bandekar VG, Gandhi MS, Aulakh BG, Deshmukh HL. Massive hemoptysis due to pulmonary tuberculosis: control with bronchial artery embolization. ***Radiology*** 1996;200(3):691-694.
18. van den Heuvel MM, Els Z, Koegelenberg CF, Naidu KM, Bolliger CT, Diacon AH. Risk factors for recurrence of haemoptysis following bronchial artery embolisation for life-threatening haemoptysis. ***Int J Tuberc Lung Dis*** 2007;11(8):909-914.
19. Yu-Tang Goh P, Lin M, Teo N, En Shen Wong D. Embolization for hemoptysis: a six -year review. ***Cardiovasc Intervent Radiol*** 2002;25(1):17-25.
20. Lee S, Chan JW, Chan SC, Chan YH, Kwan TL, Chan MK, et al. Bronchial artery embolisation can be equally safe and effective in the management of chronic recurrent haemoptysis. ***Hong Kong Med J*** 2008;14(1):14-20.
21. Dabó H, Gomes R, Marinho A, Madureira M, Paquete J, Morgado P. Bronchial artery embolisation in management of hemoptysis--A retrospective analysis in a tertiary university hospital. ***Rev Port Pneumol (2006)*** 2016;22(1):34-38.
22. Chun JY, Belli AM. Immediate and long-term outcomes of bronchial and non-bronchial systemic artery embolisation for the management of haemoptysis. ***Eur Radiol*** 2010;20(3):558-565.