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ORIGINAL INVESTIGATION

Management of Massive Hemoptysis: Analyses of 58 Patients

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Abstract

OBJECTIVES: The objective was to describe changing patterns of etiological factors and treatment modalities for massive hemoptysis.

MATERIAL AND METHODS: From January 2008-December 2012, the medical records of 58 massive hemoptysis patients were reviewed.

RESULTS: Fifty-eight patients, 44 were men (75.9%) and 14 were women (24.1%), with a mean age of 51.4 years (range= 19-84 years), were divided into three groups; surgical management (n= 37, 63.8%), conservative management (n= 14, 24.1%) and bronchial artery embolization (n= 6, 10.4%). One case (1.7%) had combined treatment modality; bronchial artery embolization was followed by surgical resection. Anatomical lung resections were the most preferred resection type in the surgical management group (n= 34, 91.9%). The most common etiological factor was bronchiectasis (n= 19, 32.8%); followed by bronchial cancer (n= 14, 24.1%). The duration of hospitalization in the surgical management group was 11.4 days (range= 4-24); whereas in the bronchial artery embolization group, hospitalization was only four days (range= 2-7) ($p< 0.01$). Prolonged air leak (n= 7; 18.9%) was the most common complication in the surgical management group.

CONCLUSION: We emphasize that bronchiectasis was leading cause of massive hemoptysis. Surgical treatment remains the definitive therapy in the management of massive hemoptysis with decreased mortality rates over decades; whereas bronchial artery embolization is an effective therapeutic tool.

KEYWORDS: Hemoptysis, bronchiectasis, tuberculosis, surgical management

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INTRODUCTION

Hemoptysis is phtisis of blood due to various kinds of lung pathologies or systemic diseases and syndromes [1]. Massive bleeding in the airway is potentially a serious and life-threatening condition because of asphyxiation by blood and can cause sudden airway obstruction and hemodynamic instability [2]. Death due to bleeding is a rare cause of mortality. Massive hemoptysis has a mortality rate of 25-50% in patients who are not treated adequately [2,3]. The anatomical dead space of the tracheobronchial tree is only 200 mL or less. Therefore, expectoration of 200 mL or more of blood over a 24-hour period or bronchial blood loss causing hemodynamic or respiratory compromise can be defined as massive or major hemoptysis [4].

Treatment modalities published for massive hemoptysis include conservative medical therapy, surgical therapy (pulmonary resection), endobronchial control measures (balloon tamponade, endobronchial iced saline lavage) and bronchial artery embolization [2,3]. In the late 1970s and at the beginning of 1980s, the most common etiological factor for massive hemoptysis was tuberculosis and surgical management was the prime therapeutic approach with a mortality rate of over 18% [5,6]. However, over decades, conservative treatment modalities play a major role in the management of hemoptysis [1,3]. The objectives of this study are to determine the changing patterns of etiological factors of massive hemoptysis and evaluate the effectiveness of treatment modalities and outcomes.

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MATERIAL AND METHODS

Selection of Patients

From January 2008 to December 2012, 471 patients [302 male (64.1%); 169 female (35.9%)] were admitted to the emergency department of Ataturk Chest Disease and Thoracic Surgery Training and Research Hospital with a complaint of different degrees of hemoptysis. We considered the hemoptysis minor if there was expectoration of blood less than 200 mL per 24 hours; massive if there was expectoration of blood over 200 mL per 24 hours. As anatomical death space of the tracheobronchial tree is only 200 mL and most patients have mortality due to asphyxiation rather than exsanguinations, evaluating the upper bleeding limit as 200 mL for massive hemoptysis is a better approach.

Of those 471 patients, 37 (7.9%) had a previous lung resection and were excluded from the study. 18 patients (3.8%) all of whom had hemoptysis less than 200 mL, refused further treatment modalities after cessation of the hemoptysis with basic treatment modalities; nevertheless, they were also excluded from the study. Out of the 471 patients, 413 (87.7%) had minor hemoptysis and were excluded from the study. There were 58 patients (12.3%) who had an expectoration of blood over 200 mL per day and consequently, were included in the study.

All of the patients who had expectoration of blood over 200 mL per day and did not refuse further treatment were admitted to the intensive care unit (ICU) of the Thoracic Surgery Department and received basic management modalities include strict bed rest, lateral decubitus toward the bleeding site if known, monitoring vital signs and nasal oxygen inhalation. After insertion of intravenous line, appropriate broad-spectrum antibiotics, coagulants (K vitamin), cough suppressants and sedative drugs (diazepam) were given to all patients. Baseline hematological, biochemistry, clotting tests and analysis of blood type were performed and a chest X-Ray was subsequently performed.

All patients underwent either flexible and/or rigid bronchoscopy as soon as possible, for identification of bleeding source, airway toilet and performing possible endobronchial interventions such as adrenaline flush, cold-saline lavage and balloon tamponade. Postero-anterior chest X-Ray and computed tomography of the thorax was performed for the patients who were hemodynamically stable. Pulmonary isolation with a double-lumen endobronchial tube was used as the last choice in refractory massive hemoptysis cases.

Statistical Analysis

Data were analyzed using SPSS (version 17.0, Chicago, IL, USA with the help of a statistician. Differences were considered significant when the probability value of Fisher's Exact Test was less than 0.05.

RESULTS

58 patients were divided into three groups due to the management of a massive hemoptysis, which can be classified as surgical management (n= 37, 63.8%), conservative management (n= 14; 24.1%) and bronchial artery embolization (BAE) (n= 6; 10.4%). The final case had a combined treatment modality; BAE was followed by surgical resection (n= 1; 1.7%). Surgical treatment option has been performed to patients whom had a definitive prior pathology such as lung cancer (including stage, status of metastasis, and resectability), bronchiectasis, arteriovenous malformations and tuberculosis. The patients who had an insufficient general condition, hemodynamic instability, and definitive decision of inoperability for lung tumors have been managed with conservative treatment modalities. BAE was a new approach in our center; patients who managed via BAE has been selected through hemodynamic stability, patients acceptance, and for selected cases only.

Age and Gender

Of the 58 patients who had an expectoration of blood over 200 mL per day, 44 were male (75.9%) and 14 were female (24.1%) with a mean age of 51.4 years (range= 19-84 years). The surgical management group (n= 37) included 28 males (75.7%) and nine females (24.3%) with a mean age of 49.7 years (range= 29-67 years), the conservative management group (n= 14) included 11 males (78.6%) and three females (21.4%) with a mean age of 53.5 years (range= 19-84 years), and the BAE group (n= 6) included four males (66.7%) and two females (33.3%) with a mean age of 55.3 years (range= 35-78 years).

Management

Of those 58 patients, 37 (63.8%) were treated with surgical management, 14 patients (24.1%) were managed with conservative treatment modalities, six patients (10.4%) underwent endovascular control of bleeding with BAE, and one patient (1.7%) was treated by a combination of both BAE and surgical management.

Surgical Management

A total of 37 patients (63.8%) had surgical management for hemoptysis. Of those 37 patients 19 patients (51.3%) underwent lobectomy, three patients (8.1%) underwent pneumonectomy, one patient (2.7%) underwent inferior bilobectomy, three patients (8.1%) underwent lobectomy including another anatomical resection such as segmentectomy (n= 1) or lingulectomy (n= 2), three patients (8.1%) underwent lobectomy including non-anatomical wedge resection and five patients (13.5%) underwent anatomical sublobar resection (lingulectomy n= 4; 10.8% and segmentectomy n= 1; 2.7%). Only three patients (8.1%) underwent wedge resection (Table 1). All resections were performed via thoracotomy; 18 patients (48.6%) were approached by right thoracotomy and 19 patients (51.4%) were approached by left thoracotomy. Chest tube removal time changed between 3-19 days with a mean of 6.6 days (median= 6 days).

For massive hemoptysis cases, during the period of preparing the case for surgical resection, routine blood sample analyses such as complete blood counting (CBC), basic biochemical

Table 1. Surgical management procedures for massive hemoptysis

Surgery	n	%
Lobectomy	19	51.3
Pneumonectomy	3	8.1
Bilobectomy inferior	1	2.7
Lobectomy + sublobar resection	3	8.1
Lobectomy + non-anatomical resection	3	8.1
Sublobar resection	5	13.5
Wedge resection	3	8.1
Total	37	100

examinations, bleeding parameters, and confirmation of blood type were standard basic laboratory tests. Subsequently, an immediate cross-match of blood for a possible transfusion and basic radio-diagnostic evaluations were necessary. The radio-diagnostic techniques included a portable postero-anterior chest X-Ray, and computed tomography of thorax (CT) dependent onto hemodynamic stability of the patient. The pathological changes of the lungs were carefully evaluated by help of a radiologist. After radiological techniques, a bronchoscopy was the accepted diagnostic tool for confirmation of thoracic CT and planning of surgery. After bronchoscopic confirmation of bleeding lobe or segment, a surgical treatment was the preferred treatment option for operable lung diseases.

Every lung cancer patients (n= 4, 10.8%), who had surgical resection in the series had a previously diagnosed lung cancer pathology. Their pathological diagnosis, status of metastasis, TNM classification, bronchoscopic evaluation and scanning tests were all known. Those patients either had a rendezvous for a surgery or has been referred to a thoracic surgery department.

After the operation, all of the patients extubated immediately after the operation and have been welcomed to thoracic surgery intensive care unit (ICU). During the post-operative care of hemoptysis patients, same protocols as other operated patients were followed. These management strategies included routinely control of CBC, and biochemical parameters, appropriate replacements of declining parameters, pain control with analgesics and following-up of drainage from chest tubes. Pulmonary rehabilitation after the operation was our indispensable. After ICU period, patients were followed-up in wards and routine protocols were administered till discharge.

Conservative Management

A total of 14 patients (24.1%) received conservative management for hemoptysis. Conservative management administered high-stage and inoperable lung cancer patients (n= 8, 57.1%), antiphospolipid antibody syndrome patients (n= 2, 14.3%) and patients whom refused surgical management (n= 4, 28.6%). Conservative management includes strict bed rest, lateral decubitus toward the bleeding site if known and nasal oxygen inhalation. Pulmonary isolation with a double-lumen endobronchial tube was used in five patients (35.7%), as the last choice for refractory massive hemoptysis. Other conservative management procedures included rigid bronchoscopy and balloon tamponade (n= 3, 21.4%) and fiberoptic bronchoscopy (n= 6, 42.9%). Both bronchoscopic procedures include airway toilet and performing endobronchial interventions such as adrenaline flush and cold-saline lavage.

Endovascular Management

Of the patients, six patients (10.4%) underwent BAE; 1 patient (1.7%) was treated with BAE followed by lung resection (right lower lobectomy).

Etiological Factors

Of all 58 patients bronchiectasis was the most common pathology (n= 19, 32.8%), followed by bronchial cancer (n= 14, 24.2%), arteriovenous malformation (n= 10, 17.32%) and aspergillosis (n= 5, 8, 6%). Only three patients (5.2%) had hemoptysis due to tuberculosis.

Bronchiectasis was also the most common etiological factor for surgical managed patients (n= 14, 37.8%), followed by arteriovenous malformation (n= 10, 27.0%), aspergillosis (n= 4, 10.8%) and lung cancer (n= 4, 10.8%). In the conservative management group, lung cancers were the most common etiological factor (n= 8, 57.1%), followed by bronchiectasis (n= 2, 14.3%) and antiphospolipid antibody syndrome (n= 2, 14.3%). In BAE group bronchiectasis (n= 2, 33.3%), lung cancer (n= 2, 33.3%) and tuberculosis (n= 2, 33.3%) were the etiological pathologies.

Other etiological factors for massive hemoptysis included actinomycosis (n= 1, 1.7%), pulmonary tromboembolism (n= 1, 1.7%), trauma (n= 1, 1.7%), benign cavity (n= 1, 1.7%), aortic aneurism (n= 1, 1.7%), pneumonia (n= 1, 1.7%) and, idiopathic pulmonary hemoptysis (n= 1, 1.7%) (Table 2).

Hospitalization

The duration of hospitalization ranged between 2 and 29 days (median: 8 days; mean: 9.43 days). Mean hospitalization time for the surgical management group was 11.4 days (range: 4-24; median: 11 days), for the conservative management group was 6.2 days (range: 2-29; median: 4 days); whereas, for the BAE group was 4 days (range: 2-7; median: 3.5 days). The duration difference of hospitalization between the surgical management group and the BAE group was considered as statistically significant by Fisher's Exact Test ($p< 0.01$).

Table 2. Etiological factors of massive hemoptysis

Etiology	n	%
Bronchiectasis	19	32.8
Neoplasm	14	24.2
Arteriovenous malformation	10	17.3
Aspergillosis	5	8.6
Tuberculosis	3	5.2
Other	7	11.9
Total	58	100

Morbidity

In the surgical management group, prolonged air leak more than seven days was the most common complication (n= 7, 18.9%) followed by empyema due to bronchopleural fistula (n= 2, 5.4%). Bronchopleural fistula cases underwent a second operation using the re-thoracotomy approach. The preferred surgical procedure for both cases was bronchopleural fistula repair with myoplasty. In the conservative management group, prolonged mechanical ventilation more than seven days was the most common complication (n= 6, 42.9%). A total of seven cases underwent BAE; however, re-bleeding after BAE was observed in one patient (14.2%) and he underwent surgical resection of the right lower lobectomy.

Mortality

Mortality was seen in three patients (8.1%) in the surgical management group (n= 37), and in 5 patients (35.7%) in the conservative management group (n= 14). Of the 58 patients, a total of eight patients died and mortality of the study was calculated as 13.8%. The mortality difference between the surgical management group and the conservative management group was considered as statistically significant by Fisher's Exact Test ($p< 0.05$).

DISCUSSION

The definition of massive hemoptysis varies widely in the literature (over 200 or 600 mL per day); however, hemoptysis should be evaluated not in terms of the volume of bleeding but from the standpoint of life-threatening airway obstruction and asphyxiation [1,4]. The amount of the bleeding is a significant criteria. But it is also important how long the blood loss continued. Patient may lose 600 mL or more of blood. If such a blood loss occurs gradually and the replacement treatments that the patients need are applied in a timely fashion, blood loss should not generally lead to death. However, if the patient loses 200 mL in an instant, this can lead to death due to acute asphyxia, as anatomical death space of the tracheobronchial tree is only 200 mL. Asphyxiation is the leading cause of mortality, evaluating the upper bleeding limit as 200 mL would be a better approach.

Endo et al. defined massive hemoptysis by one or more of the following: bleeding of over 200 mL per day, bronchial blood loss causing hemodynamic or respiratory compromise, or bleeding resulting in a hematocrit of less than 30% [4]. Hemoptysis patients generally have poor respiratory functions due to underlying lung pathologies [7]. Bleeding and aspiration pneumonia due to clots (even minimal amount) can compromise the pulmonary reserve [4,8]. As the anatomical death space of tracheobronchial tree is only 200 mL, and most of the patients had mortality due to asphyxiation, taking the upper bleeding limit as 200 mL for massive hemoptysis is appropriate.

Etiological factors of hemoptysis changed over decades. In the late 1970s and early 1980s, the most common etiological factors of massive hemoptysis were tuberculosis. Garzon et al. published their ten year experiences about massive hemoptysis in 1977, and showed that tuberculosis was the most common etiological factor (70.5%) followed by bronchiectasis (11%) [5]. In their series both Conlan et al. and Knott-Craig et al. mentioned tuberculosis was still most common etiological factor by 38% and 73.3% respectively [6,9]. However, during the 2000s, tuberculosis was not leading etiological factor in the literature. In their retrospective review, Lee et al. mentioned that bronchiectasis was the common etiological factor (57.4%) followed by tuberculosis (16.7%) [10]. Joughon et al. published a retrospective review of 43 massive hemoptysis cases with bronchiectasis and neoplasms as the primary pathology for massive hemoptysis (both n= 12, 27.9%) followed by tuberculosis (n= 4, 9.3%) [1]. Ong et al. and Ayed et al. also found similar results in which bronchiectasis was the primary etiological factor (65.5% and 58.5% respectively) [2,11]. In our series it has been documented that tuberculosis was neither first, second nor the third pathology for massive hemoptysis. Bronchiectasis was the most common pathology but tuberculosis was the fifth most common pathology for the reasons causing a massive hemoptysis.

Other common etiological factors for massive hemoptysis are arteriovenous malformations and aspergillosis. Aspergillosis is caused by a fungus, *Aspergillus fumigatus*, which is inhaled routinely from atmosphere. The majority of cases occur in people with underlying illness such as tuberculosis, but also with healthy immune systems. Signs and severity vary greatly; hemoptysis due to necrotizing destruction of fungal toxins, is uncommon and surgical resection is treatment option for patients whom had massive hemoptysis.

Surgical treatment remains the definitive therapy in the management of massive hemoptysis when the pathology is localized by bronchoscopy or radiological diagnostic techniques [2]. Garzon et al. reported 90% of surgical manipulation with only 10% of conservative approaches [5]. For decades, the surgical management ratios decreased with an improvement of conservative management and BAE. Conlan et al. published the surgical management rate for massive hemoptysis as 27.6% [6]. Knott-Craig et al. and Joughon et al. published similar ratios for surgical management as 35% and 37.2% respectively [1,9]. However, Ong et al. revealed a rate of surgical management of only 12.9%; yet a BAE rate of 74.2% [11]. In our series most of the patients were treated by surgical procedures; however, non-surgical management procedures play an important role and 34.5% of our series were managed with non-surgical protocols.

A major surgical procedure is an anatomical resection procedure that includes lobectomies, bilobectomies, pneumonectomies and segmentectomies. Metin et al. surgically treated more than 96% of their massive hemoptysis patients with anatomical lung resections [12]. Non-anatomical wedge resections could be performed due to insufficient respiratory functions. In our series we also preferred anatomical resections. We performed anatomical resections to 91.9% of cases; however, 8.1% of cases surgically treated by non-anatomical resections due to their insufficient respiratory functions.

After the surgical procedures, significant postoperative complications such as bronchopleural fistula and empyema,

respiratory insufficiency due to poor respiratory functions, wound infection and postoperative hemorrhage could be seen [2]. Ayed et al.mentioned surgical complications after resection for massive hemoptysis and calculated this as 24.5% [2]. The surgical morbidity in our series was calculated as 24.3% and is very similar to Ayed and colleagues' published series. The most common morbidity in our series was prolonged air leak (n= 7, 18, 9%), which was followed by a bronchopleural fistula (n= 2, 5.4%).

Nevertheless, lung resection due to massive hemoptysis is associated with a high mortality rate. Garzon et al. and Conlan et al. treated massive hemoptysis by surgical management with a mortality rate of 17.6% [5,6]. Knott-Craig et al. published mortality rates as 7.1% in a surgical management group; whereas Joughon et al. mentioned mortality rate as 19% [1,9]. Lee et al. published an in-hospital mortality rate of 15% after various kinds of anatomical lung resections [10]. In our series, the mortality rate in surgical management group was lower than most of the published series. Our surgical mortality rate was 8.1%; a little higher than the rate mentioned by Knott-Craig et al.

Bronchial artery embolization (BAE) has entered the paradigm for treatment of massive hemoptysis and has played an increasingly important role in controlling life-threatening hemoptysis, which was first introduced in 1974 by Remy et al [2,11,13]. The English literature revealed a significant increase in the percentage of BAE with a great success [11]. Ong et al. managed massive hemoptysis mostly with BAE (74.2% of their patients) with a success rate of 77% [11]. Swanson et al. published the effectiveness of BAE and immediate termination of bleeding was achieved with embolization with a success rate of 85.1% [14]. Similarly, Mal et al. discussed the results of 56 massive hemoptysis patients who had been embolized and revealed that immediate control was successful in 43 patients (76.8%) [15]. We performed BAE with a success rate of 85.7%; similar to the above mentioned series.

BAE is associated with low duration hospitalization. Samara et al. prepared a case report in which three cases were presented [16]. All three patients were discharged three to four days after embolization [16]. In our series, the mean duration of hospitalization for the surgical management group was calculated as 11.4 days; whereas in BAE group it was only four days. The difference was considered as statistically significant ($p< 0.01$). Thus, it was concluded that BAE is associated with low morbidity and hospitalization.

CONCLUSION

Bronchiectasis was the leading cause of massive hemoptysis; whereas, tuberculosis, the leading cause in the 1970s and 1980s, was the fifth common pathology. Surgical management remains the definitive therapy for patients with massive hemoptysis with acceptable morbidity and mortality rates. Preferable surgical procedures were anatomical resections for the patients with sufficient pulmonary reserve. Bronchial artery embolization is an effective therapeutic tool and plays an important role in the management of massive hemoptysis with low complication and mortality rates; this procedure also decreases hospitalization duration.

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