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Surgical treatment of life-threatening hemoptysis: 15 years of experience

Oktay Aslaner

Alanya Alaaddin Keykubat University, Faculty of Medicine, Department of Thoracic Surgery, Antalya, Turkey

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Abstract

Hemoptysis is the name of the finding that the bleeding originating from any part of the respiratory system passing through the bronchial system and out through the mouth. While it can often disappear with medical treatment or spontaneously, the term "life-threatening hemoptysis" (LTH) has started to be used when it results in a serious event, such as airway obstruction, impaired gas exchange or hemodynamic instability. In this article, we aimed to share our surgical experiences with LTH, that has developed and changed in the literature in the past 15 years. In the same time we aimed to show the efficiency of surgery in LTH. This study includes a retrospective analysis of 129 patients who applied to our clinic with the complaint of hemoptysis, between 2005 and 2020. We included all patients who applied to our outpatient clinic with hemoptysis complaints and for whom we could access retrospective file information. We considered our patients with sudden onset or airway obstruction, deterioration in oxygenation and hemoptysis of 100 cc or more in 24 hours as life-threatening hemoptysis (LTH), and our other patients as minor hemoptysis. 74 (57.36%) of the patients were female and 55 (42.74%) were male. Those with LTH were 39% (30.23), and those without LTH were 9 (69.77%). Bronchiectasis seen in 35 patients (27.1%) was found to be the most common etiological disease. Lung cancer (26 cases, 20.15%) and tuberculosis (16 cases, 12.4%) were other common etiologies. The approach to hemoptysis should be made by considering every patient to return to the LTH form and should be treated by rapid diagnosis and treatment, with correct history and physical examination methods. Correct treatment, surgical timing in particular, can be lifesaving.

Keywords: Hemoptysis, lobectomy, lung cancer, tuberculosis, bronchiectasis

Introduction

Hemoptysis is the term used to refer to bleeding that originates from the lower respiratory tract out through the mouth. While this condition often disappears with medical treatment or spontaneously, it can sometimes turn into massive hemoptysis and become life threatening [1-4]. There is no consensus in the literature regarding the most effective approach to take with regard to hemoptysis, and each patient must be evaluated individually. A thoracic surgeon should also be part of the team for the diagnosis, differentiation and treatment of hemoptysis, along with a pulmonologist and an interventional radiologist. Cardiovascular surgeons should be on the team when necessary, as it may be found that aortic pathologies are among the causes of the hemoptysis [5]. With this article, we wanted to share our patient experiences that have developed and changed in the past 15 years, in light of the literature on the topic. This study shows that the correct approach with patients with hemoptysis and in particular the correct, timely surgical interventions, can be lifesaving.

***Corresponding Author:** Oktay Aslaner, Alanya Alaaddin Keykubat University, Faculty of Medicine, Department of Thoracic Surgery, Antalya, Turkey
E-mail: oktay.aslaner@alanya.edu.tr

Materials and Methods

This study includes a retrospective analysis of 129 patients who applied to our clinic with symptoms of hemoptysis, between 2005 and 2020. We included all patients who had applied to our outpatient clinic with complaints of hemoptysis and whose retrospective file information was available. Patients whose blood originates from the gastrointestinal system or upper respiratory tract, such as throat-sinuses, were excluded. We also excluded cases whose treatment was not continuing or who were out of follow-up in our hospital.

We categorized patients as having life-threatening hemoptysis (LTH) when they had 100 cc or more blood expectoration in 24 hours or a bleeding in a serious event, including airway obstruction, significant gas exchange alterations or hemodynamic instability. All other patients were categorized has having minor hemoptysis. For practical use, a 100 cc tea glass is easily quantifiable by patients as a criterion for massive hemoptysis, which we used to ask patients if their hemoptysis would fill the 100-cc glass per day. Our emergency surgery application criteria were as follows: firstly, the hemoptysis must be LTH. Secondly, the lesion causing hemoptysis should be resectable. Finally, cardiac and respiratory reserves should be sufficient for surgery. We used

echocardiography to measure cardiac reserve and did not operate if the ejection fraction was under 30%. If the patient's position was convenient to measure respiratory function (RFT), we used the respiratory function test to determine respiratory reserve. If FEV 1 (Forced Expiratory Volume 1st second) volume was larger than 2 liters, we considered the patient suitable for pneumonectomy. If FEV 1 volume was above 1.5 liter, we considered the patient suitable for lobectomy. If patient position was not convenient to perform the RFT, we determined whether the patient's respiratory reserves were suitable for lung resection by looking at the blood gas, the general condition of the patient and the quality of the lung parenchyma in the lung tomography.

Lesions such as tumor, bronchiectasis or mushroom ball that cause or are likely to cause hemoptysis are very close to or adjacent to large vascular structures such as the main pulmonary artery, main pulmonary vein and aorta, which requires primary surgery of the cases. Pulmonary artery aneurysms, which usually develop after vasculitis, are also conditions that require primary surgery.

Approval was obtained for our study from the Clinical Research Ethics Committee of the Alanya Alaaddin Keykubat University Faculty of Medicine, with decision number of 22-10.

Statistical method

The SPPS 25 statistical package program (IBM Corp., released 2017, IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.) was used to evaluate the data. Variables were introduced with percentages and frequency values. Categorical data was analyzed with Fisher's exact test and the chi-square test. In cases where the expected frequencies were less than 20%, an evaluation was made using the Monte Carlo simulation method to include these frequencies in the analysis. For the significance level of the tests, p values of <0.05 and <0.01 were accepted.

Results

In terms of genders, 74 (57.36%) of the patients were female, and 55 (42.74%) were male. We grouped our patients into two categories: Group A - minor hemoptysis 90 (69.77%) and Group B - LTH 39 (30.23%) patients. The patients' demographic features are shown in Table 1.

All patients who described having had hemoptysis had a thorax CT with opaque. We were unable to detect any underlying causes in 32 patients using thoracic tomography. A fiberoptic bronchoscopy (FOB) was performed for the evaluation and diagnosis for 64 patients.

Bronchiectasis was detected in 35 patients who described having had hemoptysis: this affected a single lobe in 15 patients and more than one lobe in 20 patients. Surgery was recommended for 15 of these: five patients accepted surgery and their hemoptysis complaints disappeared postoperatively. Medical treatment was started for the other patients and findings from a retrospective investigation showed that of the 10 patients who had surgery in other center, four no longer had any complaints of hemoptysis. Three of the six remaining patients who had applied to our clinic were interviewed after one year, on average; we learned that the hemoptysis of these patients had stopped following treatment, but had resumed after a period of time following the discontinuation of medical treatment, and this situation was repeated several times.

We detected lung cancer in 26 of our cases, 16 of which had previously been diagnosed. Additionally, 16 of these 26 patients were in the category of minor hemoptysis. Medical treatment was started in the 16 patients who were under medical oncology follow-up: the hemoptysis in 10 of these was stopped within two to five days, and they were referred to medical oncology for the continuation of their treatments. We performed rigid bronchoscopy for cauterization of endobronchial lesions to the 6 remaining patients, which was subsequently stopped following this intervention. Out of 7 patients who had been diagnosed with lung cancer for the first time, endobronchial lesions were detected in 4 of them and cauterized by rigid bronchoscopy. While bleeding was controlled in 3 patients, the bleeding increased after cauterization in 1 patient. This particular patient was given a lobectomy and her hemoptysis subsequently disappeared.

Tuberculosis was detected in 16 patients and FOB was performed in all of them. Lavage was then performed and the diagnoses were made from this intervention. 6 patients had operations because of massive hemoptysis and right upper lobectomies were performed. One of these patients died during the postoperative period and 10 of the 16 were in the category of non-massive hemoptysis. Treatment for tuberculosis was initiated after referrals to the relevant centers and the patients' hemoptysis disappeared after an average of one year.

One of our patients had a massive hemoptysis two months after an operation because of a fungal ball in his lung resulting from Behçet's disease, and he then presented with hemoptysis. Another patient had aneurysms in multiple pulmonary artery branches that were detected through a pulmonary angiography. Lobectomy was performed, and her hemoptysis disappeared. In addition, a massive pulmonary embolism developed during the follow-up period of one of our patients who had breast cancer, and an emergency embolectomy was performed. One of our patients received surgery to treat a massive hemoptysis that was due to chronic inflammation in the right main bronchus, and massive hemoptysis developed in five of our patients while they were being followed up for diagnoses of congestive heart failure. All the study data was analyzed statistically (Table 2).

The patient to whom we applied the pulmonary embolectomy died one week later due to complications related to breast cancer. When we analyzed the files retrospectively, we found that all our patients who underwent resection due to hemoptysis, saw their hemoptysis complaints disappear after six months and continued to survive.

Table 1. Demographic features of patients

	GROUP A MINOR HEMOPTYSIS	GROUP B LTH	TOTAL
FEMALE/MALE	53/37	21/18	129 (%100)
TOTAL	90 (69.77%)	39 (30.23%)	129 (%100)

Table 2. Diagnostic features of patients

	LTH (n)	%	Minor (n)	%	p
Bronchiectasis	9	23.08	26	28.89	>0.05
Lung cancer	10	25.64	16	17.78	>0.05
Tuberculosis	6	15.38	10	11.11	<0.05
Thoracic trauma	3	7.69	0	0.00	<0.05
Congestive heart failure	5	12.82	0	0.00	<0.05
Others	4	10.26	3	3.33	<0.05
Undiagnosed	2	5.13	35	38.89	>0.05
Total	39	100	90	100	

Table 3. Treatment options of hemoptysis patients

	LTH (n)	%	Minor (n)	%	p
Lobectomy/Bilobectomy	17	43.6	0	0	<0.05
Pneumonectomy	2	5.1	0	0	>0.05
Interventional bronchoscopy	3	7.6	0	0	>0.05
Pulmonary embolectomy	1	2.6	0	0	>0.05
Medical treatment	16	41.1	90	100	<0.05
Total	39	100	90	100	

Seven out of 26 lung cancer patients were diagnosed for the first time. Twelve of 35 bronchiectasis patients were diagnosed for the first time. Six out of 16 tuberculosis patients were diagnosed for first time. Thus, 25 of all hemoptysis patients were diagnosed for the first time. Thirty seven patients could not be diagnosed. Sixty seven patients were previously diagnosed.

Discussion

The main result of this study is that timely correct surgical interventions in Life-threatening hemoptysis (LTH) patients are life-saving.

LTH is expectoration of a large amount of blood or a rapid rate of bleeding, from lower respiratory tract. This condition used to be referred to as massive hemoptysis, but amounts and definition issues remained quite controversial. If a bleeding refers to a life-threatening event, including airway obstruction, significant gas exchange alterations, or hemodynamic instability, we generally prefer to use the term LTH. Criteria based solely on the volume of blood cannot be used precisely since quantifying the amount of blood that a patient has expectorated is challenging [1-4].

The main cause of death in LTH is hypoxia that develops as a result of obstruction of the airways with bleeding. There are publications showing the cause of death in accompanying hypotension and blood loss. In our clinical practice, more than 100 mL is quantifiable by patients as roughly a tea glass of blood, in 24 hours [6].

Causes of hemoptysis are grouped under 5 main headings in the literature. These are infective, neoplastic, vascular, autoimmune and drug dependent causes Inflammatory causes, such as bronchiectasis, lung abscess and tuberculosis, initiate neovascularization in bronchial arteries and lead to the formation of many new bronchial arteries, as well as enlargement of existing bronchial arteries [7-9].

Although hemoptysis is not clinically seen, it should be considered that hemoptysis may develop in the following pathologies; congenital heart disease, congestive heart failure, mitral stenosis, aortobronchial fistula from erosion of an aortic graft or aneurysm, endobronchial brachytherapy, erosion of airway stent, lung transplantation, mediastinal or lung radiation therapy, pulmonary artery rupture from right-sided heart catheterization,pulmonary laceration from chest tube placement or thoracentesis, pulmonary vein stenosis after radiofrequency ablation, thrombolytic therapy, tracheoinnominate artery fistula after tracheostomy, transbronchial lung biopsy or cryobiopsy, transthoracic needle aspiration, aspergillosis and other mycetomas, bacterial and viral bronchitis and pneumonia, lung flukes and parasites, necrotizing pneumonia and lung abscess, anticoagulants (ie, heparin, warfarin, dabigatran, enoxaparin, apixaban), antiplatelets (ie, clopidogrel, ticagrelor, prasugrel), blast injury, cocaine abuse, foreign body aspiration, trauma, pulmonary embolism and infarction, diffuse alveolar hemorrhage from vasculitis: granulomatous polyangiitis, Goodpasture syndrome, Behçet disease, systemic lupus erythematosus, cryoglobulinemia, arteriovenous malformations, including hereditary hemorrhagic telangiectasia, pulmonary artery aneurysm, ruptured thoracic aneurysm. As in all bleedings, the use of anticoagulant drugs in hemoptysis, increases the amount of bleeding. This can lead to life threatening hemoptysis [10].

Bleeding and hemoptysis occur as a result of the destruction of the existing lesions in the lung parenchyma, in the bronchial artery wall [11, 12]. In our series, they were generally gathered under these 5 titles. Other than these 5 main headings, congestive heart failure, massive pulmonary embolism in main pulmonary artery, main bronchus stricture and improper blood transfusion, were additional causes of hemoptysis.

When hemoptysis is suspected, the primary concern is to determine the severity and cause of hemoptysis. Before diagnosis, anamnesis and physical examination take place: the patient's history often

guides us to the underlying disease. Thoracic tomography and fiberoptic bronchoscopy are then required [13]. There are 3 regions to be targeted in the imaging performed in terms of determination of the localization in hemoptysis, which are lung parenchyma, airways and pulmonary vessels [14]. They provide very valuable information about the localization of the bleeding and whether it is massive or even there is a possibility of recurrence of a previously stopped bleeding. Detection of the localization of the bleeding by the FOB was found to be 93% and CT gives valuable results in determining the etiology of hemoptysis. Our rate of determining the etiology and localization of hemoptysis in our patients who accepted tomography and FOB was 95%, a rate that is compatible with the literature [11].

Bleeding from the mouth does not always mean hemoptysis. Pathologies such as epistaxis, hematemesis, gingival bleeding and tumors or infections that may cause bleeding in the mouth can be confused with hemoptysis [10].

It is possible to diagnose underlying diseases without hemoptysis in patients presenting with hemoptysis. Cardiovascular and respiratory screening tests, such as echocardiography, computed tomography, x-ray, and/or even simply respiratory functioning tests, can be useful to diagnose underlying diseases incidentally. These tests can present preliminary findings or main diagnostic data for inflammatory diseases of the airways, including tuberculosis and aspergillosis, bronchial carcinoma and metastases, bronchiectasis, as well as cardiovascular causes such as pulmonary edema/mitral stenosis and pulmonary artery embolism. However, these tests are usually not used for general community screening in the absence of complaints or without any predisposing risk [15].

There are two types of circulation in the lung: bronchial and pulmonary. Although the bronchial artery circulation is responsible for only 2 percent of the total vascular supply to the lung, bleeding from a bronchial artery is the cause of LTH in more than 90% of cases, while the remaining 5% are ruptured aortic aneurysm, aortic origin such as aorto-bronchial fistula, coronary arteries, intercostal arteries, subclavian artery and axillary artery [5]. The pressure of the pulmonary circulation is low and it is in contact with the respiratory system at the level of the alveoli and terminal bronchi. Therefore, it is responsible for 5% of massive hemoptysis [5].

In our cases, there were only 2 (1.5%) LTH cases that we could be determined to be due to the pulmonary artery, which is consistent with the literature.

LTH rate is reported as 5% among all hemoptysis in the literature [16]. In this retrospective study, we evaluated only patients with hemoptysis who applied to thoracic surgery, therefore the rate of patients with LTH in our patient group was found to be 27.9%. This ratio was well above that which is found in the literature since our department is a surgical clinic that serves selected patients referred from other departments, mostly emergency services or chest diseases, who requires urgent intervention.

In severe hemoptysis, the priority is to guarantee ventilation of the healthy side by double lumen intubation or single lumen intubation of the non-bleeding side [17]. The key to success in the treatment of massive hemoptysis is the accurate assessment of the patient, rapid and accurate determination of the location of the hemoptysis and a congruent multidisciplinary approach between the chest diseases specialist radiologist and the thoracic surgeon. In the literature, a reliable and current approach is Bronchial Artery Embolization (BAE) for LTH and recurrent hemoptysis [18].

Minor hemoptysis limits itself spontaneously in 90% of the patients or with medical treatment [2]. In our cases, minor hemoptysis disappeared with medial therapy in all patients who accepted treatment. Increased prothrombin time value is decreased with fresh frozen plasma (FFP) infusion treatment. In addition to FFP, all patients were given tranexamic acid and vitamin K.

Surgery is still considered as the first choice in bleeding necrotizing tumors, cavitary tuberculosis, refractory aspergilloma, ongoing hemoptysis despite BAE, as well as in traumatic or iatrogenic pulmonary vascular injuries. It is available in extreme cases, in which treatment involves bronchiectasis and also develops dissection in patients with hemoptysis by TEVAR. Bronchial artery embolization (BAE) is the first choice in LTH and success has been achieved in up to 94% in the literature [5-19].

Since the BAE opportunity is not available in our hospital, we prioritized surgical treatment for LTH patients. We performed emergency lung resection in a significant portion of these patients and cauterization to patients with endobronchial lesion, using a rigid bronchoscope. We applied pulmonary embolectomy to one of our patients, and while bronchial artery embolization saves the patient's life without the need for a major surgical procedure with a high risk of complications, it also includes risks such as transverse myelitis due to spinal cord ischemia [20]. Hemoptysis occurs in 10% of those with chronic lung disease. In those with lung cancer disease, it recurs in 0.1% every year. Among the diseases that cause hemoptysis, the rate of bronchiectasis, which can be considered as a chronic lung disease, was 27.13%, and the rate of lung cancer was 17.05% [21].

Hemoptysis disappeared with medical treatment in 4 of the patients who were followed up in the intensive care unit and underwent medical treatment. Aside from these, we had to operate 5 cases urgently. In emergency situations of hemoptysis, mortality decreased from 37-42% to 7-18%. In recent studies, this rate has been found between 4-19% [22]. 4 of the 17 cases we took into surgery were intraoperative exitus, although this rate, which amounted to 23%, is slightly higher than that which is found in the literature. The causes of mortality within our patients were breast cancer, multiple organ failure or operative complications, rather than hemoptysis. Valipour et al. described the topical clot tamponade method to stop bleeding in bronchoscopy. They succeeded by washing with cold saline solution and creating a local clot tamponade with local epinephrine. They also used oxidized regenerated cellulose to generate local clot tamponade and this was 98% successful (56/57 patients). In addition to cold saline vasoconstrictive agents, fibrinolytic agents, oxidized regenerated cellulose, biocompatible glue, laser photocoagulation, argon plasma coagulation and endobronchial stents can be used in the treatment [23].

We applied cold isotonic washing and diluted local epinephrine in all patients with FOB and we achieved a 95% success rate in non-massive patients, a ratio compatible with the literature. It has been stated in the literature that there are arrhythmias at a rate of

1: 1000 as a result of local epinephrine applications, and that these arrhythmias could be overcome with ß-blockers. Steinfort et al. stated that tachycardia or even ventricular fibrillation, may occur as a result of endobronchial epinephrine administration [24]. In our cases, we did not encounter any arrhythmias after diluted local epinephrine applications. In thermal ablation, it is frequently used in conditions that cause endobronchial lesions, and endobronchial tumors in particular.

Surgery is another treatment method for patients who are suffering from LTH, except for BAE. Andrejak et al. divided the cases on whom they performed surgery into three groups, in their surgical series of 111 people. Emergency cases and planned cases were the ones where hemoptysis continued despite other treatments[22]. The main and striking result of this study appears to be that every hemoptysis patient should be taken seriously: the patients' anamnesis, physical examinations should be done earnestly, further evaluation requirement needs should be sought swiftly and surgeries should definitely be considered, in pathologies that requires it. The correct surgical treatment method, applied rapidly to the proper patient, is often lifesaving.

If LTH is treated conservatively, the mortality rate is 50-100%[22]. We approached only 9 of our cases conservatively.

Less than 5% of hemoptysis are LTH in most series. The fact that massive hemoptysis is an LTH which results in mortality up to 80% [25]. Twelve (33%) of 36 LTH cases died in our cases, a rate which is lower than those found in the literature. Corokko et al. found a direct relationship between the amount of bleeding and death: the mortality rate in patients who bleed 600ml in 4 hours is 71%, whereas this rate is 22% in patients who bleed 600ml between 4-16 hours, and 5% with 600cc bleeding between 16-48 hours [26]. In our cases, we did not have the opportunity to make these measurements, however we observed that the mortality of our patients increased in parallel to the amount of hemoptysis they produced. Mortality rates were found to be 35%, 4% and 0%, respectively. Garzon et al. accepted 600ml / 24 hours as massive hemoptysis and reported the mortality rate as 13% in their experience of 74 cases in which they performed surgery in 15 years [27]. Our mortality rate after surgery was 23%, compatible with literature.

We could not find any pathology that could have led to hemoptysis as a result of FOB in these 18 patients, and they were referred to an otolaryngologist. Bleeding in the larynx region was detected by an ear, nose and throat (ENT) doctor in only three of these patients, and cancer of the larynx was diagnosed in one. The cause of the bleeding in the other two patients was attributed to infections.

Limitations

Absence of the BAE equipment/facility in our hospital was the most crucial restriction for this study.

Conclusion

Hemoptysis is a condition that is seen in many situations and causes great anxiety in the patients. LTH, previously known as massive hemoptysis, is an emergency with high mortality in which oxygenation is impaired and thus must be diagnosed and treated rapidly. A thorax CT with opaque and FOB are both effective diagnostics in over 90% of the patients. If there is a well-localized disease, carefully performed surgeries would reduce mortality.

Conflict of interests
The authors declare that they have no competing interests.

Financial Disclosure
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Ethical approval
Approval was obtained for our study from the Clinical Research Ethics Committee of the Alanya Alaaddin Keykubat University Faculty of Medicine, with decision number of 22-10.

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