Emergency in CVT Surgery: Massive hemoptysis

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Massive hemoptysis

• Definition: varies
  – > 600 ml in 24 hours
  – > 150 ml bolus
## Etiology

<table>
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<th>Study</th>
<th>Year</th>
<th>Country</th>
<th>Patients</th>
<th>Underlying cause of hemoptysis, %</th>
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Case I

- A 63-year-old man with HT, HL, DM, and smoking
- Admitted because of massive hemoptysis (600 ml in 24 Hr)
- VS- stable. O2 sat 99-100%
- No coagulopathy or thrombocytopenia.
- CXR - radiodensity in the medial aspect of Rt middle lung zone.
- CT scan - a 4-cm spiculated cavitary mass in the superior segment RLL with several subcentimeter nodules inferior to the lesion.
• There is no consensus on the optimal diagnostic approach to massive hemoptysis.

• CXR can identify the site of bleeding in 33–82%.

• CT in 70–88.5%.
  – CT is much more efficient than bronchoscopy for determining the cause of bleeding (60–77 vs. 2.5–8%).
  – CT can replace bronchoscopy as a first-line investigational approach because of its higher diagnostic yield.
What would you do?
• Diagnostic workup for massive hemoptysis should be undertaken as soon as airway protection and hemodynamic status are assessed and stabilized.
• FOB identifies the site of bleeding in 73–93%  
  – Significantly lower in cases of mild or moderate hemoptysis  
  – Limitations of FOB in massive, life-threatening hemoptysis.  
  → Interventional pulmonologists should not rely on FOB in such situations
• Rigid bronchoscopy is more efficient at safeguarding airway patency, preserving ventilation, and allowing better clearance of the airways, therefore improving visualization
• FOB can be introduced through the rigid scope as it provides easier access to the upper lobes and peripheral bronchi
LLL cavitary mass

• FOB was done. There was blood clot at the orifice of RLL bronchus

• The FOB was advanced into the cavity. Forceps biopsies led to bleeding from the orifice of the superior segment.

• What is your initial action?
Aware of basic strategies to manage procedure-induced bleeding

- Biopsies in dependent areas of the lung
- Suctioning and frequent scope repositioning should be kept to a minimum
- If massive bleeding is encountered, → rigid bronchoscopy
Rigid bronchoscopy

- securing airway patency and safeguarding ventilation, thereby preventing asphyxia.
- better suction of blood clots and secretions through its large working channel, and improved visualization of the airways
Bronchoscopic Treatment

• When expertise is available, bronchoscopic treatment strategies ensure adequate control of bleeding, therefore contributing to stabilization of the patient’s hemodynamic status and respiratory parameters.

• They are most often temporary measures for early management
Bronchial blocking using devices and endobronchial treatment

- *Cold-Saline Lavage*

- *Topical Vasoconstrictive Agents*
  - Topical epinephrine (1: 20,000)
  - Topical antidiuretic hormone derivatives

- *Tranexamic Acid* (500–1,000 mg)

- *Fibrinogen/Thrombin*

- *Balloon Tamponade*

- *Endobronchial Covered Stent Tamponade*
Endobronchial Airway Blockade

• Silicone Spigot (~6 mm)

• Bronchoscopy-Guided Topical Hemostatic Tamponade

• Endobronchial Sealing with Biocompatible Glue (n-butyl cyanoacrylate)
• Laser Photocoagulation

• Argon Plasma Coagulation

• Electrocautery

• Other Treatments: Cryotherapy and Brachytherapy
Laser
The initial action done
• Bleeding was initially controlled using a combination of recombinant thrombin and balloon bronchoplasty with a 4-Fr Fogarty balloon.
• Two pieces of oxidized regenerated cellulose (Surgicell) approximately 15x15 mm were folded and placed into the jaws of a flexible biopsy forceps.

• The forceps were then withdrawn into the operating channel of the bronchoscope, and the scope was reinserted into the airways.

• The forceps were inserted into the cavity, and the ORC was deployed.

• The bleeding stopped.
• The pathology on the forceps biopsy was consistent with inflammatory changes
What to do next?
• He then underwent thoracotomy 1 week later due to a continued concern for a malignancy.
Case II

- 21 years old woman
- Massive hemoptysis - 600 ml in 2 hr
- Hypovolemic shock
- What is your initial management?
• The initial approach for management of massive hemoptysis involves protection of the airways and volume resuscitation

• If the bleeding side is known, the patient should be placed in a lateral decubitus position, with the *bleeding side down* in order to prevent aspiration into the unaffected lung.
• → resuscitation + Bl transfusion

• How to deal with bleeding?
• Single –lumen intubation to secure airway and remove clot → bleeding decreased
• Intubated with a large-caliber ETT (No 8 or more), and FOB should be immediately performed, to suction blood clots and secretions.

• Alternatively, once the airways are cleared, unilateral intubation can be performed to
  – protect the non-bleeding lung from aspiration
  – and to allow effective ventilation while awaiting definitive treatment strategies.
• Unstable hemodynamic or respiratory status → urgent rigid bronchoscopy (by a skilled physician),
  – most efficient to clear airways from clots/secretions,
  – ensuring effective tamponade of the bleeding airway
  – safe isolation of the non-affected lung,
  – thereby preventing asphyxia and preserving ventilation.
• Lt lung bleeding → Don’t selectively intubate the right main bronchus
• as this procedure would occlude the right upper lobe bronchus, further compromising gas exchange.
• Instead, tracheal intubation can be performed, followed by insertion of a balloon catheter besides ETT through the vocal cords, with subsequent introduction into the left main bronchus under bronchoscopic visualization.
Figure 4  Selective intubation of left main bronchus in a case of right sided massive haemoptysis.

Figure 5  Control of left sided massive haemoptysis by tracheal intubation, placement, and inflation of a Fogarty catheter in the left main bronchus.
• Although double-lumen intubation also allows isolation of the bleeding lung while preventing aspiration into the unaffected lung,

• this procedure requires highly trained medical personnel, and should only be performed after clearing the airways.

• Once hemodynamic and respiratory conditions are stabilized, urgent endovascular therapy should be considered.
Back to case
• CXR and emergency CT show extensive alveolar infiltrates both lung
• Emergency FOB was one
• Emergency FOB → failed to localized bleeding due to flooding of blood

• After resuscitation and stabilization, hemodynamic OK, with O2 sat of 70%

• What to do next?
• Transferred to University Hospital

• Repeat FOB

• Airway could be cleared.

• A slightly elevated bluish structure in the Rt main bronchus → vascular malformation?

With continuous oozing
• Topical treatment with cold saline, epinephrine, transamine
• Systemic treatment with desmopressin and transamine
• Bleeding was markedly reduced, however, not completely stopped
• What to do next?
• If the underlying lesion is endoluminal, whether in the central airways or in more peripheral bronchi within the reach of the rigid scope, the latter allows further management, including
  – Local coagulation therapy (laser, electrocautery, argon plasma coagulation, APC)
Bronchial Artery Embolization
The types of bronchial arterial supply

- Type I, two bronchial arteries on the left and one on the right as an intercostobronchial trunk (ICBT) (40.6%);
- Type II, one on the left and one ICBT on the right (21.3%);
- Type III, two on the left and two on the right (one ICBT and one bronchial artery) (20.6%);
- Type IV, one on the left and two on the right (one ICBT and one bronchial artery) (9.7%).
• Massive hemoptysis usually originates from the high pressure bronchial circulation (90%)
• Less frequently, the aorta (aortobronchial fistula, ruptured aortic aneurysm) or nonbronchial systemic circulation (ICS arteries, coronary arteries, thoracic arteries originating from the axillary and subclavian arteries and the upper and inferior phrenic arteries)
• Selective right internal mammary angiogram shows an aberrant right bronchial artery
• Selective left bronchial angiogram demonstrates a large, hypervascular lesion in the left upper lobe with an aneurysm (arrow). (b) On an angiogram obtained after embolization with polyvinyl alcohol particles, neither the hypervascular lesion nor the aneurysm is visualized.
• a pathologic left bronchial artery (arrow) that originates from the anterior wall of the descending thoracic aorta
Embolic Materials

• Absorbable gelatin sponge
  – widely used
  – inexpensive, easy to handle, and has a controllable embolic size.
  – disadvantages are its resolvability and lack of radiopacity.
• Polyvinyl alcohol particles
  – nonabsorbable embolic materials
  – particles 350–500 μm in diameter
  – may prevent the early recurrence of hemoptysis due to recanalization
• It is essential to avoid the use of embolic materials that can pass through the bronchopulmonary anastomosis (325 μm in the human lung)
• Liquid embolic agents (eg, isobutyl-2 cyanoacrylate, absolute ethanol) are not currently used because of the high risk of severe complications such as tissue necrosis.

• Stainless steel platinum coils are generally not used for BAE because they tend to occlude more proximal vessels and may preclude repeat embolization if hemoptysis recurs.
• The initial success rates - 73%–98%, (F/U 1 d to 1 mo)
• The long-term success rate - unfavorable.
• 10%–52%, with a mean F/U 1 to 46 mo
• Recurrent bleeding is more common in patients with chronic tuberculosis, aspergilloma, or neoplasm.
• 58 patients (January 2000-February 2014)
• 40% had recurrent hemoptysis.
• A Kaplan-Meier analysis revealed an excellent long-term survival that was 85% at 10 years
Bronchial Artery Embolization for Moderate to Massive Hemoptysis

Abstract

Purpose of study: Hemoptysis is a common emergency coming to the pulmonary medicine and general Medicine department. Massive hemoptysis has high mortality even after surgical treatment. Bronchial artery embolization is an effective alternative to surgery for controlling hemoptysis, with high success rate.

Material and methods: 74 consecutive patients coming to our hospital with moderate to severe hemoptysis were subjected to bronchial artery embolization (BAE). Femoral arterial puncture was the commonest approach. Some patients, where the culprit vessel was arising from subclavian artery, were approached from radial artery puncture. All patients were embolized with poly vinyl alcohol particles.

Results: Out of 74 patients, 54 were male and 20 were female. The mean age was 46.67±14.58 yrs. Cause of hemoptysis was tuberculosis in 64 patients, bronchiectasis in two, aspergillosis in two and in six, the cause was not known. Total 192 vessels were embolized, 86 bronchial, 43 from subclavian, 53 intercostal and 20 internal mammary.

Within one year, recurrence occurred in 13 patients three of whom died. In 9 patients, the bleeding was controlled with repeat BAE.

Conclusion: Commonest cause of hemoptysis was pulmonary tuberculosis. BAE had initial success of 100%. Recurrence occurred in 13 (17.56%) patients. Repeat BAE was successful in majority of these. 3 patients died of recurrent hemoptysis.
Back to the case
• Selective angiography of bronchial a., ICS a., IMA, aorta
  – Two small aneurysm and AVMs
• → embolization → completely stop bleeding
• On ETT. No bleeding. Hemodynamic – OK
• Severe hypoxia → ECMO
• No further surgical intervention
Emergency thoracotomy for massive hemoptysis is at high risk. In case of bleeding from the arterial bronchial a., embolization may enable to postpone surgery and operate secondarily.

In case of bleeding from the pulmonary vessels (tumor necrosis), surgical treatment must be immediate.
Surgery

• Emergency surgery has been gradually abandoned because of the high morbidity and mortality ranging between 20 and 30%.

• In addition, surgical resection is not an option for patients with poor functional status, moderate to severe lung function impairment, bilateral pulmonary disease or other comorbidities.
• Currently, surgery is mainly reserved for cases of
  – technical failure of arteriography,
  – early or repeated recurrences
  – in extreme situations where the amount of bleeding or the patient’s cardiopulmonary status are deemed life-threatening and do not allow transfer to an interventional radiology suite or any related delays in management.
• Surgery also remains the strategy of choice for the management of massive hemoptysis caused by diffuse and complex arteriovenous malformations, iatrogenic PA rupture, chest trauma, and mycetoma not responding to other therapeutic strategies, or associated with recurrent life-threatening hemoptysis
Mortality rate

• 71% in patients who lost $\geq 600$ ml of blood in 4 h,
• 22% in patients with 6–600 ml within 4–16 h,
• 5% in those with 600 ml of hemoptysis within 16–48 h.
Surgical issues

• Preop cardiopulmonary assessment is difficult in emergency situation. Use same principle as elective lung resection

• Anatomical resection via conventional posterolateral thoracotomy is recommended

• Positioning may be difficult because of “bleeding side up” position

• Alternative approaches are available
Positioning

• If bleeding side up is not possible, consider “prone position” thoracotomy
Non – anatomical resection

- The intrathoracic pathology may preclude anatomical resection such as severe intrapleural adhesion, destroyed lung with calcified perihilar LN.
- Non-anatomical resection is acceptable.
- Non resection is also acceptable.
Massive hemoptysis controlled with transection of a pulmonary vein and bronchus—a case report

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• A 57-year-old male with bronchiectasis with massive hemoptysis.

• ETT was performed for airway protection.

• CXR showed increasing opacity in the left lower lobe with bronchial dilatation

• Chest CT demonstrated bilateral bronchitis with cystic dilatation in the LLL with numerous small vessels in the left hilar region.
Bronchoscopy revealed a large amount of fresh blood over the lower trachea, and the examination could not be completed. Pulmonary angiography demonstrated a plexus of proliferating vessels around left bronchus artery (Figure 1C).
• embolization of the left brachial artery was performed. However, some proximal collateral vessels which could not be embolized remained.

• After the procedure, persistent hemoptysis was noted, and therefore surgical intervention was taken.
• Enlargement and marked tortuosity of the bronchial arteries were also found, and these vessels were ligated with sutures.

• Pneumonectomy was considered, however, it was not performed in consideration of the high potential mortality.
• The inferior pulmonary vein was transected to allow identification of the left lower lobe bronchus.

• The bronchus of the left lower lobe was then transected to control the hemoptysis, and the pulmonary artery was preserved.
Algorithm
Massive hemoptysis

Acute respiratory failure

- Admit to ICU
- Rigid intubation (airway clearance, bleeding tamponade, and contralateral lung isolation)
- Lateral decubitus if bleeding side known
- Volume resuscitation
- Correction of coagulopathy
- Bedside chest X-ray

No acute respiratory failure

- Admit to ICU for surveillance
- Chest X-ray
  - Ideally, rigid bronchoscopy
  - Lateral decubitus if bleeding side known
  - (flexible bronchoscopy as alternative)

Bleeding localized

- Yes
  - Endoluminal lesion

- No
  - MDCT
Bleeding localized

No

MDCT

Bleeding not localized

Conservative management and close surveillance

Bleeding localized

BAE

Successful

Multiple recurrences

Surgery

Not successful

Surgery

(flexible bronchoscopy as alternative)
Take home messages

• Massive hemoptysis – stable/unstable
• Resuscitation and securing airway are the most important
• Next question - Localized/ Diffuse
• Localization – FOB/ rigid bronchoscopy
• Diffuse - CT
• Investigation to identify the diagnosis and its definitive treatment is crucial.
Treatment

• Endolumional lesion – endobronchial treatment: laser

• Localized + no endoluminal lesion – endobronchial blokade/ hemostatic treatment
Endovascular treatment (Bronchial artery embolization)

• Failed endobronchial treatment for endoluminal lesion

• Follow initial endobronchial treatment for non-endoluminal lesion
Surgery

• High mortality. Aware of poor cardiopulmonary reserve patient

• Indications
  – Failed BAE
  – Recurrence
  – Unstable, unable to do BAE...