Chest radiography and Computed Tomography in the evaluation of patients with hemoptysis.

Poster No.: C-1584
Congress: ECR 2011
Type: Educational Exhibit
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Keywords: Diagnostic procedure, Digital radiography, CT-High Resolution, CT, Thorax, Respiratory system
DOI: 10.1594/ecr2011/C-1584

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Learning objectives

1. Definition of hemoptysis
2. Present the chest radiography and the Computed Tomography (CT) findings in patients presenting hemoptysis.
3. Present the different causes of hemoptysis.
4. Evaluate the role of chest radiography and CT
5. Present the diagnostic approach of a patient with hemoptysis.

Background

Hemoptysis is defined as the expectoration of blood originating from the lower respiratory tract. It is a common symptom in clinical practice and it represents a diagnostic challenge to the contemporary radiologist.

The severity of hemoptysis has various definitions, ranging from 100 mL to 1 L of blood expectorated in 24 hours. Massive hemoptysis may be defined as bleeding of >300 mL in 24 hours.

Imaging findings OR Procedure details

Radiological findings of hemoptysis

The detection of the bleeding site as well as the underline disorder is very important for the appropriate management of the patients presenting hemoptysis. The common diagnostic evaluation usually consists of a plain chest radiograph, a CT of the chest, and a fiberoptic bronchoscopy.

The conventional radiograph and CT of the chest are the two first line imaging modalities for the evaluation of hemoptysis, which supplement one another. The radiological findings depend on the underline causes, their location and their severity. Therefore, in relation to the most common causes of hemoptysis the radiological findings include: bronchial dilatation and bronchiectasies, parenchymal infiltrates, masses of the pulmonary parenchyma and/or the hilum and nodules.
In patients with extensive bilateral disease or equivalent findings on the plain chest radiograph, the site of hemorrhage can usually be localized on CT on the basis of the presence of liquified material in segmental and lobar bronchi and hazy consolidation or ground-glass infiltrates in the lung parenchyma, findings that represent intraalveolar hemorrhage.

**Differential Diagnosis**

The etiology for hemoptysis varies among different series according to the geographic location, the prevalence of tuberculosis and the diagnostic tests employed.

The recent literature indicates that in order of importance the main causes of hemoptysis are:

- bronchiectasis (Fig.1)
- bronchitis (chronic and acute)
- lung cancer, (Fig.2-4)

The finding of bronchiectasis as a main cause for hemoptysis is probably secondary to remote nonactive infection by tuberculosis or other infections. Indeed, for centuries, hemoptysis was considered pathognomonic of pulmonary tuberculosis. It should be expected that owing to the decreased incidence of tuberculosis in the Western countries and effective antibiotic therapy, there will be a decline in bronchiectasis as a cause of hemoptysis.

Lung tumor must be always included in the differential diagnosis of hemoptysis. Primary bronchogenic carcinoma with central location is the most commonly associated malignancy.

Other minor causes of hemoptysis are listed below:

- Infection (tuberculosis) (Fig.5,6), pneumonia
- Interstitial lung disease (Fig.7-9)
- Congestive heart failure
- Diffuse alveolar hemorrhage (Goodpasture syndrome), (Fig.10-12)
- Idiopathic hemosiderosis
- Pulmonary embolism
- Iatrogenic causes (pulmonary artery inflation devices, anticoagulants, trauma) (Fig. 13)
• Vasculitis (Behcet disease, Takayasu arteritis)

• Congenital disorders (pulmonary sequestration, pulmonary artery atresia or stenosis, pulmonary arteriovenous malformation), (Fig. 14-16)

• Bronchial artery aneurysm, Rasmussen aneurysm

• Pseudosequestration

The majority of patients will have an identifiable source and etiology for bleeding at the time of initial diagnosis. However, despite the currently available diagnostic tools, some cases of hemoptysis remain without identified etiology, whatever the severity of the bleeding. This has been attributed as "cryptogenic" hemoptysis and is responsible for 7 to 25% of episodes of hemoptysis, particularly in smokers, where the ratio rises up to 3 to 34%. Cryptogenic hemoptysis is a diagnosis of exclusion and might be expected to decrease in prevalence with more systematic use of Computed Tomography (CT).

**Evaluation of chest radiography and chest CT**

Radiography can help lateralize the bleeding with a high degree of certainty and can often help detect underlying parenchymal and pleural abnormalities. However, although radiography is a useful initial examination, it needs to be complemented with more detailed evaluation.

Further evaluation of hemoptysis should include a chest CT, which significantly improves the roentgenographic diagnostic yield. Chest CT and contrast material-enhanced chest CT has the advantage of allowing acquisition of images of the entire thorax in a rapid, safe, and noninvasive manner. Published studies on the efficacy of CT have already demonstrated the capacity of this imaging technique to help predict the site of bleeding as accurately as bronchoscopy and to help detect underlying disease with high sensitivity.

A lot of studies attempt to correlate the efficacy of plain chest radiography, chest CT and bronchoscopy in the diagnostic yield. Many of them point the value of CT in the recognition of the etiology of hemoptysis.

- Revel et al. stated that in 80 patients presenting hemoptysis, CT revealed in 77% of the cases the cause of hemoptysis and in another 70% of the cases the site of bleeding, versus 35% and 46% respectively with the appliance of plain chest film. Also, in 13% of the patients with hemoptysis and normal chest radiograph, CT demonstrated the presence of bronchiectasies in 70% of them. In the same study, CT outbalances bronchoscopy in the detection of the cause of bleeding (77% vs 8%) but not in the localization of the bleeding site.
- In another study, Millar et al. stated the value of chest CT in 40 patients with negative chest radiograph. In 50% of them, CT revealed the etiology of hemoptysis and specifically bronchiectasies (18%), malignancy (10%) and consolidation (10%).

- More specific studies with patients at high risk for malignancy (>40 y old, >40 pack-year smoking history) state the superiority of CT in the recognition of the underline tumor, while bronchoscopy is nondiagnostic in many cases.

To conclude, the last appropriateness criteria of hemoptysis demonstrated by the American College of Radiology (ACR) are the following:

- Initial evaluation of patients with hemoptysis should include a chest radiograph.

- In contrast, in patients at high risk for malignancy, CT is suggested for initial evaluation. CT should also be considered in patients who are active or exsmokers, despite a negative chest radiograph.

- Patients at high risk for malignancy with negative chest radiograph, CT scan and bronchoscopy can be followed with observation for the following 3 years. Radiography and CT are recommended imaging modalities for follow-up.

**Suggested algorithm for diagnostic evaluation of patients with hemoptysis.**
Fig.: Suggested algorithm for diagnostic evaluation of patients with hemoptysis.

References: K. Stefanidis; CT and MRI Department, Evangelismos Hospital, ATHENS, GREECE

Images for this section:
Fig. 1: Hyper IgE syndrome in a patient with a history of recurrent infections of the lower respiratory tract. Axial CT image depicts the presence of numerous cylindric bronchiectasis with perivascular thickening and presence of areas of ground glass.
Fig. 2: Axial CT image shows a centrally located bronchial carcinoma and area of ground glass opacity.
Fig. 3: Contrast-enhanced CT on lung window. CT shows a large mass in the left hilum, surrounded by a zone of ground glass attenuation.
Fig. 4: Contrast-enhanced CT in soft tissue window in the same patient showing a bronchial carcinoma extension into the left pulmonary artery.
Fig. 5: A male patient with active tuberculosis presenting hemoptysis. Axial CT image shows bronchial dilatation with the presence of a spiculated nodule in the right lung and the presence of a small number of peripheral cysts in the left lung.
**Fig. 6:** Invasive aspergillosis in an immunocompromised patient. CT scan shows consolidation with air bronchogram and ground glass attenuation (halo sign) at the right upper lobe.
Fig. 7: HRCT appearance of idiopathic pulmonary fibrosis in a patient presenting hemoptysis. A subleural reticular pattern with dilatation of the bronchi is noted.
**Fig. 8:** Cryptogenic organizing pneumonia (COP) in a 54-year-old woman. Rx shows bilaterally consolidation extending to the periphery.
Fig. 9: In the same patient, CT scan shows bilateral peribronchovascular areas of consolidation with air-bronchograms and ground glass attenuation at the periphery.
**Fig. 10:** A 62 years old patient with Goodpasture syndrome. Rx shows consolidation of the entire right lung with presence of air-broncogramms. Consolidation can also be seen in the periphery of the upper left lung and in the left lower lung due to haemorrhage.
**Fig. 11:** CT axial image in the same patient with Goodpasture syndrome confirm the complete consolidation of the right lung and the left upper lung with presence of air-bronchograms.
Fig. 12: Rx of the same patient after administration of corticosteroids shows improvement of the radiological findings.
Fig. 13: Alveolar hemorrhage of the left upper lung after trauma
**Fig. 14:** Chest radiography shows abnormal opacity in the right lower lung in a young patient with hemoptysis.
Fig. 15: 33 years old patient with intralobar pulmonary sequestration. Axial CT in lower sections in reveals cystic components in the abnormal area with ground glass opacity.
Fig. 16: Coronal reconstruction CT with iv contrast in the same patient demonstrates the aberrant artery arising from the thoracic aorta supplying the lesion.
Fig. 17: Suggested algorithm for diagnostic evaluation of patients with hemoptysis.
Conclusion

Diagnosis of the etiology of hemoptysis is based on both clinical examination and imaging procedures. The role of CT can be considered essential as a quick and non-invasive tool in the diagnosis and management of hemoptysis.

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References