

High Resolution Computed Tomography Evaluation of Adults Presenting with Recurrent Mild Hemoptysis in a Tertiary Care Health Facility

Ankur Ranjan Saikia¹, Rupak Bhuyan², Aniruddha Basu³, Suresh Killing⁴, Anuja Saikia⁵

¹Postgraduate Student, Department of Radiodiagnosis, Jorhat Medical College & Hospital, Jorhat, Assam, India
Corresponding Author Email: [saikiaankur00\[at\]gmail.com](mailto:saikiaankur00[at]gmail.com)

²Head and Professor, Department of Radiodiagnosis, Jorhat Medical College and Hospital, Jorhat, Assam, India

³Associate Professor, Department of Radiodiagnosis, Jorhat Medical College and Hospital, Jorhat, Assam, India

⁴Assistant Professor, Department of Radiodiagnosis, Jorhat Medical College and Hospital, Jorhat, Assam, India

⁵Registrar, Department of Radiodiagnosis, Jorhat Medical College and Hospital, Jorhat, Assam, India

Abstract: Objective: The purpose of the study is to evaluate HRCT imaging patterns in adults presenting with recurrent mild hemoptysis and determine common underlying etiologies based on HRCT imaging findings. Materials and methods: A single centre retrospective cross-sectional study was conducted among 50 adults with the chief complaints of mild recurrent non-life-threatening hemoptysis who presented to the Department of Radiodiagnosis, Jorhat Medical College & Hospital, Jorhat for HRCT imaging of thorax. HRCT were performed using a 128-slice scanner with thin-section axial images and multiplanar reconstructions. HRCT images of the patients were reviewed from the stored datasets on PACS. Results: Out of the 50 patients, HRCT showed positive findings in 38 patients whereas 12 patients showed no remarkable findings. Tuberculosis with its sequelae and complications were identified as the most common etiology. Most common imaging feature of patients in HRCT was presence of post infective cavitory lesions and bronchiectatic changes. Conclusion: The findings of the study extend the diagnostic value of HRCT as primary investigation of choice in mild hemoptysis, where peripheral airway and parenchymal abnormalities predominate.

Keywords: Hemoptysis, Etiology, Adults, High Resolution Computed Tomography, Imaging pattern

1. Introduction

Hemoptysis is defined as the expectoration of blood from the lung alveoli or airways of the lower respiratory tract and accounts for a significant fraction of pulmonary consultations. It must be distinguished clinically from hematemesis and aspirated blood related to nasopharyngeal injury. A variety of clinical classification systems exist for hemoptysis which typically attempt to enumerate criteria defining severe, life-threatening cases of hemoptysis from those with mild, non-life threatening disease. Life-threatening hemoptysis may be defined as any hemoptysis that is > 150 mL in volume in 24 hours or hemoptysis at a rate of 100 mL/h, and hemoptysis that causes airway obstruction/respiratory failure/ hemodynamic instability requiring blood transfusions.(1)

Recurrent mild hemoptysis defined as repeated expectoration of small amounts of blood from the lower respiratory tract, presents a diagnostic challenge in clinical practice. Although life-threatening bleeding is rare in this subgroup, persistent hemoptysis causes anxiety, prompts extensive workup, and may herald underlying unresolved or undetected pathology ranging from bronchiectasis to early neoplasm. Standard chest radiography often fails to detect subtle parenchymal or airway changes in recurrent mild hemoptysis. Flexible bronchoscopy, while essential to exclude central airway lesions, has limited reach and sensitivity for peripheral abnormalities. High-resolution

computed tomography (HRCT) of the chest, with its ability to visualize airway walls, small bronchioles, and parenchymal microarchitecture, offers a noninvasive alternative that can guide further intervention. HRCT offers superior resolution and anatomical detail, making it a valuable modality in evaluating recurrent cases with inconclusive initial workup.

Previous studies have demonstrated HRCT's value in massive hemoptysis and in cases with overt parenchymal disease, but data on its use in mild recurrent hemoptysis cases with normal radiographs are sparse.

Aim: To evaluate the role of high resolution computed tomography of thorax in adult patients presenting with mild recurrent hemoptysis in a tertiary care health facility

Objectives:

- 1) To evaluate HRCT imaging patterns in adults presenting with recurrent mild hemoptysis,
- 2) To determine common underlying etiologies based on HRCT imaging findings

2. Materials and Methods

A single centre retrospective cross-sectional study was conducted among 50 adults with the chief complaints of mild recurrent nonlife threatening hemoptysis who presented to the Department of Radiodiagnosis, Jorhat Medical College & Hospital, Jorhat for HRCT imaging of thorax.

Volume 14 Issue 8, August 2025

Fully Refereed | Open Access | Double Blind Peer Reviewed Journal

www.ijsr.net

Inclusion Criteria

- Adults aged ≥ 18 years.
- ≥ 2 episodes of mild hemoptysis (< 30 mL/day).
- Normal or inconclusive chest X-ray.

Exclusion Criteria

- Massive hemoptysis / Life threatening hemoptysis.
- Coagulopathy or anticoagulant therapy.
- Iatrogenic or traumatic injuries

Imaging Protocol

HRCT chest performed using a United Imaging Healthcare uCT 780 128-slice scanner with thin-section axial images and multiplanar reconstructions. Contrast-enhanced scans were used selectively as necessary to minimize the risk of nephrotoxicity.

3. Results**Image Interpretation**

HRCT images of the patients were reviewed from the stored datasets on PACS. The peculiar imaging findings with relevant clinical history and available laboratory reports were utilized as and when necessary to arrive at a suitable provisional diagnosis. The common HRCT imaging pattern or findings were as follows-

- Large cavitary lesions with or without internal soft tissue attenuation (most common)
- Cylindrical and cystic bronchiectasis (signet ring, tram-track appearance)
- Ground-glass opacities (diffuse/focal)
- Centrilobular nodules ("tree-in-bud")
- Consolidation Fibrotic bands/volume loss
- Bronchial wall thickening/edema
- Bronchial obstruction & resultant atelectasis
- Spiculated or cavitary solitary/multiple pulmonary nodule/ mass
- Multiple well defined bilateral random pulmonary nodules $\pm$ cavitation
- Emphysematous changes
- NSIP pattern
- Lung Abscess
- Vascular anomalies (arteriovenous malformation)
- No significant abnormality

Amongst the provisional diagnoses from the imaging features, chronic tubercular etiology along with its sequelae and complications in the form of cavitary lesions, traction bronchiectatic changes, secondary infections, lung abscess, aspergilloma and parenchymal fibrotic changes constituted the most common etiology. (48%). A considerable proportion of patients showed no remarkable or significant findings in HRCT (22%). Bronchiectasis, malignant lung masses/nodules as well as active tuberculous infection with endobronchial spread in the form of patchy ground glass opacities and 'tree in bud' centrilobular nodules all three together emerged as the 4th most common etiology (6%). Less common causes of mild hemoptysis included emphysema/COPD (4%), bronchitis (2%), ILD (2%), angioinvasive aspergillosis (2%) and pulmonary AVM (2%). (Fig 1)

44-58 years with a higher prevalence in male population. Majority (n=38) of the patients demonstrated positive findings on HRCT (Fig 2 and 3) while 12 patients demonstrated no significant abnormality on HRCT. Smoking history was more prevalent in male population. (Fig 4).

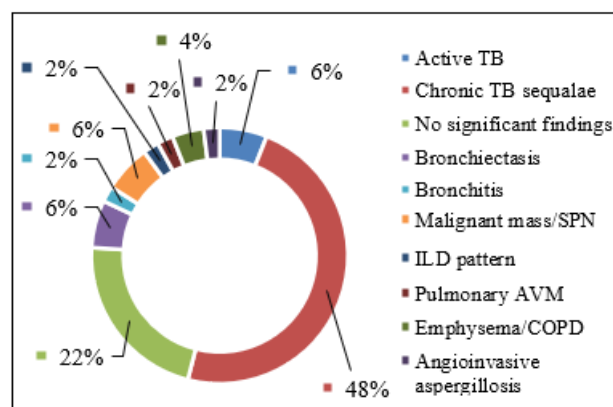


Figure 1: Distribution of etiologies

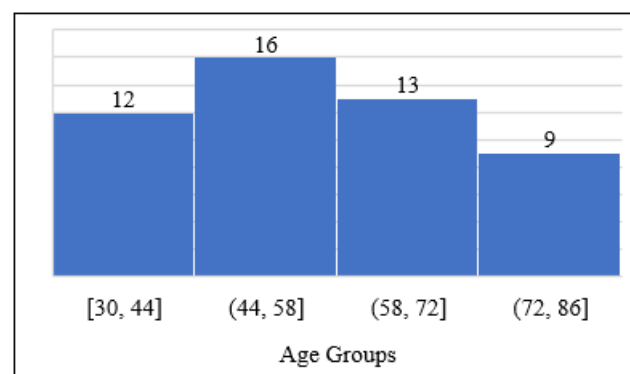


Figure 2: Distribution of patients in age groups

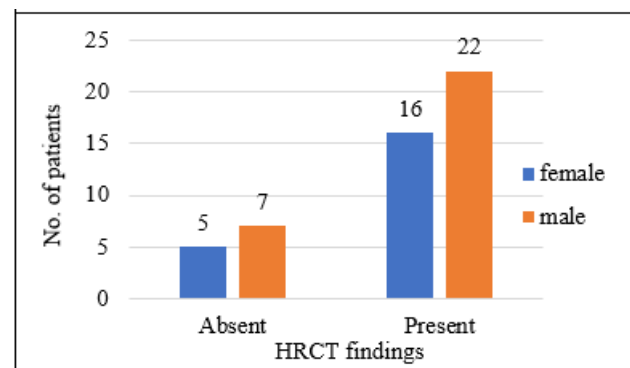


Figure 3: Distribution according to presence of HRCT findings and gender

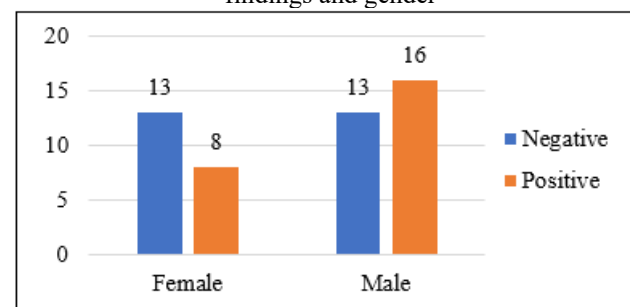


Figure 4: Distribution of patients according to gender and smoking history

Maximum number of patients belonged to the age group of

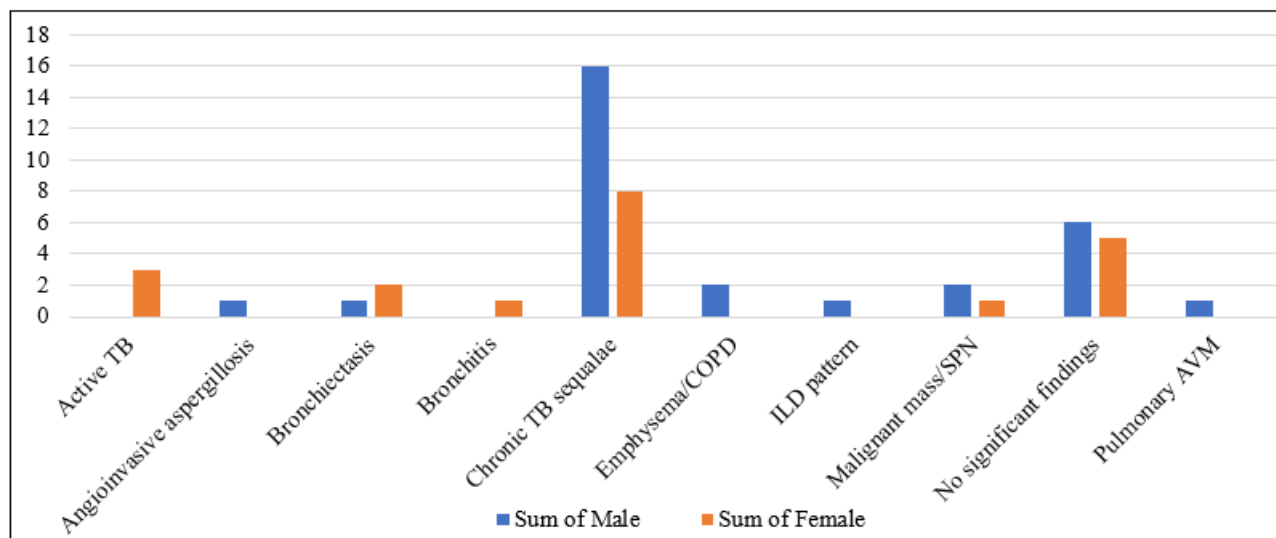
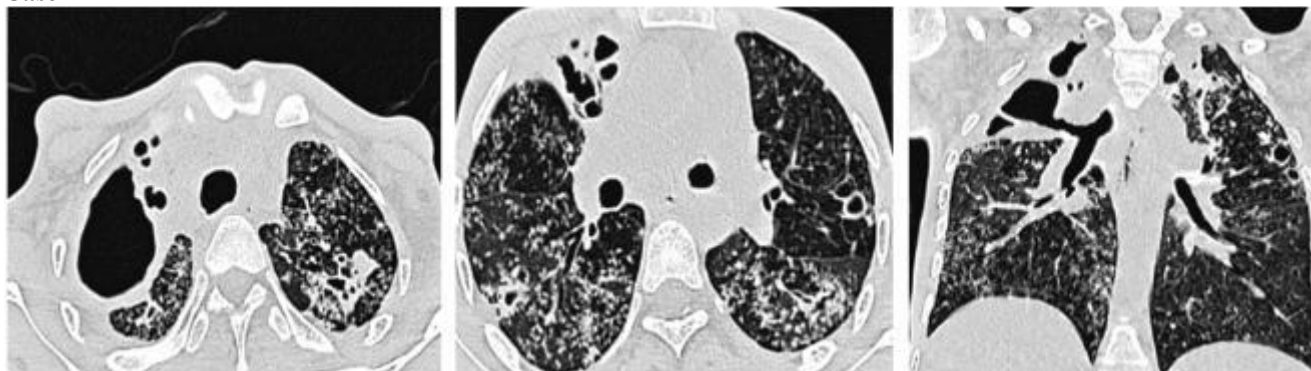


Figure 5: Gender distribution in various etiologies

Cases:

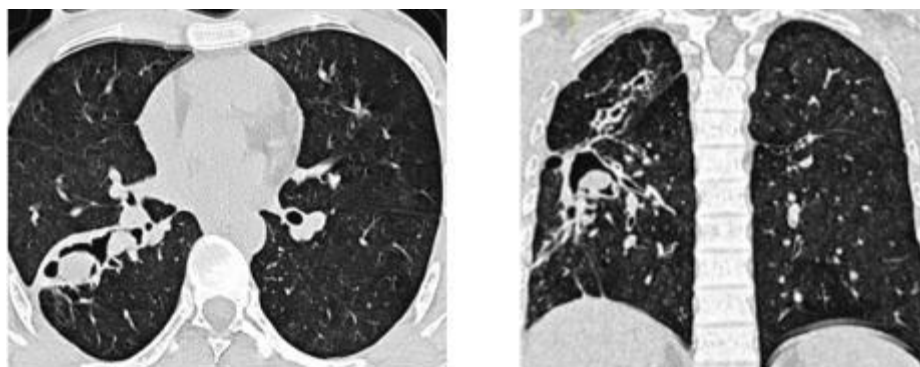
Case 1



A 55 year old female patient with TB contact history presenting with fever, evening rise of temperature, weight loss, cough with expectoration and hemoptysis with imaging findings showing active tuberculous infection in the form of “tree in bud” centrilobular nodular opacities with subtle

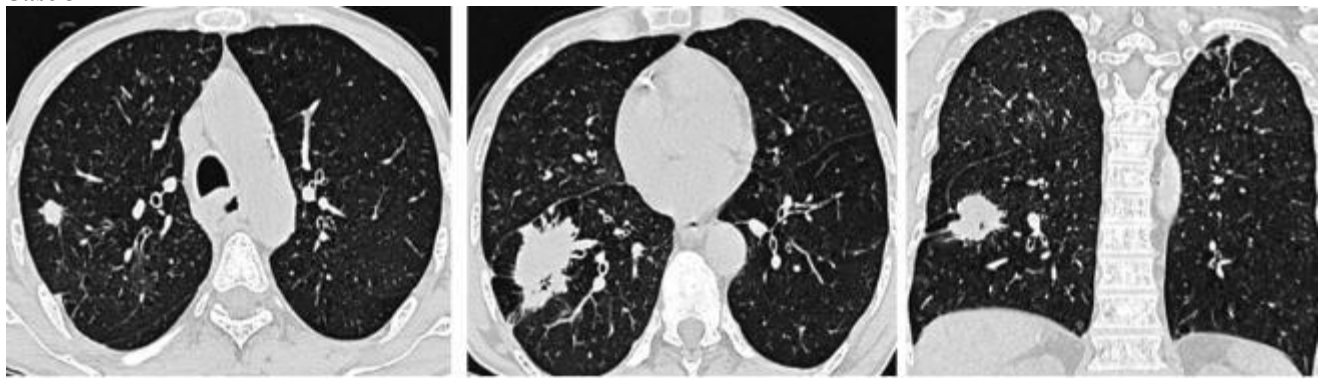
ground glassing in bilateral lung fields as well as sequelae of previous infection in the form of cavitory lesions, post infective bronchiectasis, volume loss predominantly in right upper lobe. There was associated necrotic mediastinal lymphadenopathy.

Case 2



A 46 year old female presented with recurrent episodes of mild hemoptysis and cough along with history of pulmonary tuberculosis with imaging findings consistent with aspergilloma and sequelae of tubercular infection. HRCT showed a thick-walled cavitary lesion in the superior segment of

right lower lobe with an intracavitary round soft tissue attenuation giving an air crescent sign and showing movement with prone and supine positioning. There is associated adjacent traction bronchiectasis and fibrotic changes.

Case 3

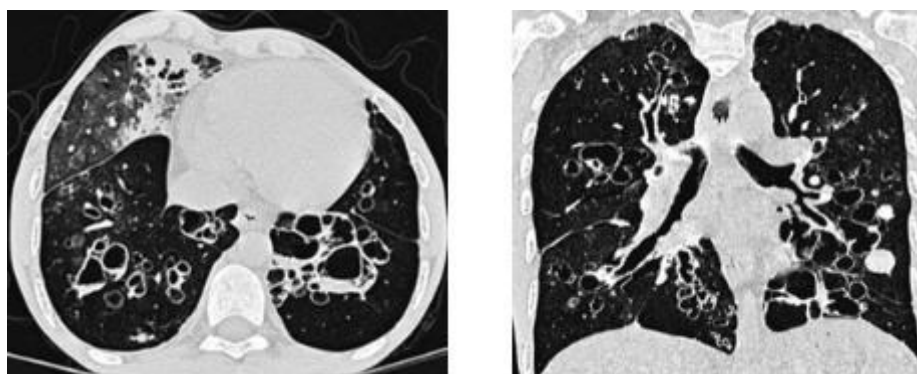
A 60 year old male patient presenting with pleuritic chest pain and occasional hemoptysis with imaging features consistent with malignant pulmonary nodule. Two different

sized irregular shaped nodule with spiculated margins and pleural tail noted in right upper and subfissural location in right lower lobe

Case 4

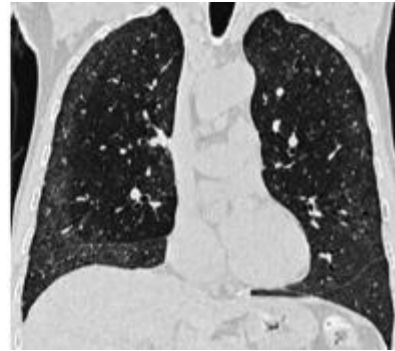
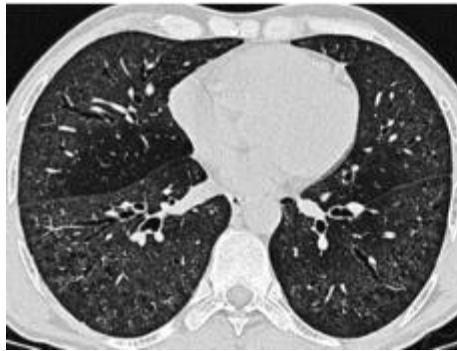
A 73 year old male smoker presenting with dyspnea and recurrent episodes of hemoptysis with imaging findings consistent with primary lung carcinoma (Squamous cell lung carcinoma). There is presence of ill- defined

consolidation and groundglassing in central part of right upper lung lobe extending and infiltrating to hilum with infiltration, cutoff of right upper lobe bronchus. The mass shows heterogenous post contrast enhancement.

Case 5

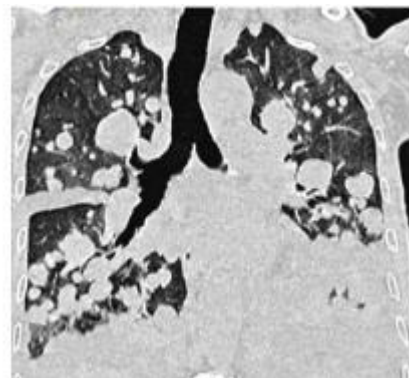
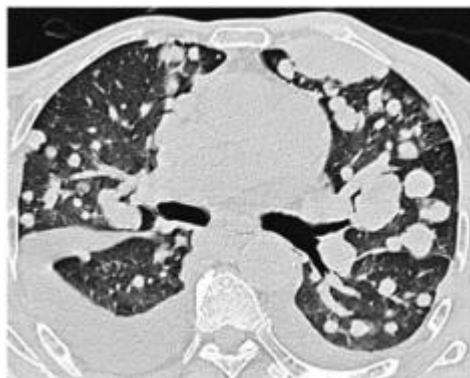
A 63 year old female presenting with recurrent history of LRTI cough and hemoptysis with imaging findings showing cystic as well as cylindrical bronchiectatic changes in bilateral lung lobes along with bronchial wall thickening

giving a 'bunch of grapes', 'tram track' and 'signet ring' appearance along with bilateral areas of air trapping. There is area of consolidation in right middle lobe

Case 6

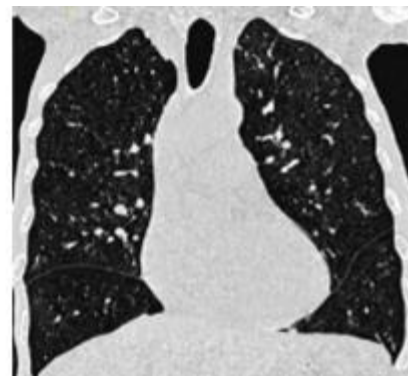
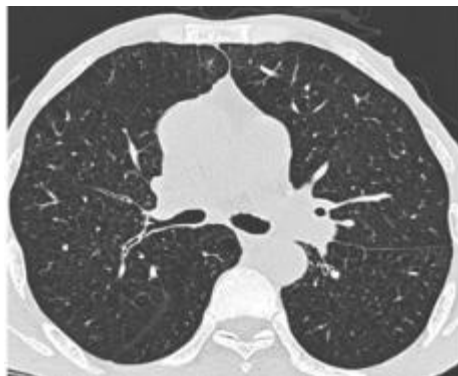
A 45 year old male with history of SLE presenting with insidious onset dry cough, dyspnea as well as mild hemoptysis with imaging findings consistent with cellular NSIP pattern. Bilateral peripheral and basal predominant

ground glass opacities and reticular opacities noted with relative subpleural sparing.

Case 7

A 63 year old male patient with history of colon carcinoma presented with weight loss, recurrent episodes of hemoptysis along with dyspnea with imaging findings

consistent with lung metastases. Numerous variable sized well defined rounded nodules noted in random distribution in bilateral lung fields along with bilateral pleural effusion.

Case 8

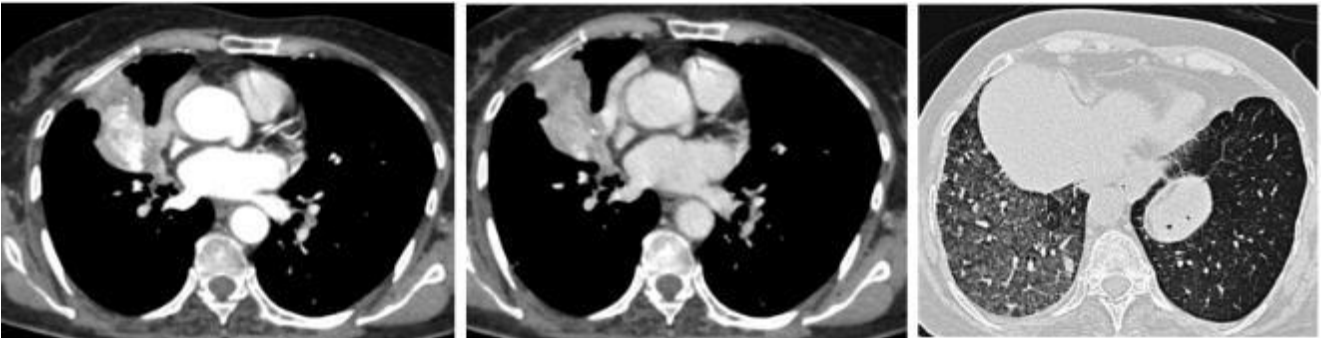
A 65 year old male with smoking history presented with chronic cough and 2nd episode of mild hemoptysis with imaging findings consistent with emphysematous COPD

changes. Diffuse bilateral centrilobular emphysematous changes noted involving all lobes along with few bilateral upper lobe paraseptal emphysematous changes.

Case 9

A 42 year old immunocompromised male patient presenting with recurrent episodes of hemoptysis with imaging features consistent with invasive fungal aspergillosis. HRCT

showed multiple bilateral peripheral variable sized nodules with surrounding groundglass halo along with few nodules showing internal breakdown, few giving 'air crescent sign'

Case 10

A 63 year old female presenting with multiple episodes of hemoptysis with imaging features consistent with pulmonary AVM. An area of consolidation with an avidly enhancing nidus (in venous and arterial phases) noted in right middle lobe. There is presence of ground glassing with septal thickening in right lower lobe s/o possible pulmonary haemorrhage.

CT may detect blood products in large or small airways. Blood products in the bronchial tree may manifest as detectable filling defects. In larger airways, these filling defects show higher attenuation (> 40 HU), which allows them to be distinguished from mucus. Obstruction of larger airways with blood products may also result in atelectasis.(2)

4. Discussion

The pathophysiology for the hemoptysis includes chronic inflammation, hypoxia-induced neoangiogenesis, and fragile vessel formation. There may also be direct injury or invasion of the blood vessel by tumor or infection.(2) The pulmonary arteries and bronchial arteries constitute the dual arterial system of the lungs, of which pulmonary arteries contribute to 90% of arterial supply. Bronchial arteries are responsible for hemoptysis in more than 90% of cases.(2) The source of hemoptysis can be the airway, parenchyma, or vessels.(3) The airway sources include bronchiectasis, neoplasms, bronchitis, foreign body, etc. Parenchymal causes include infections (TB, fungal, and other pneumonias). Vascular causes include pulmonary AVMs, Rasmussen's aneurysm, bronchopulmonary fistula, vasculitis, etc.

In non-contrast HRCT, blood in the alveoli appears as ground-glass opacity or consolidation which may imply as areas of parenchymal hemorrhage in patients presenting with hemoptysis., Septal lines may also be present in subacute hemorrhage as macrophages enter the area and migrate to lymphatic vessels in the interlobular septa to remove the blood products. (4)

A diffuse pattern of pulmonary parenchymal hemorrhage is suggestive of a systemic process often showing a 'crazy paving pattern'.(2)

In contrast, focal findings of parenchymal hemorrhage can be used to localize bleeding to a specific lesion or vascular territory. Both parenchymal and aspirated blood can be nodular, but findings of smaller well-defined clustered tree-in-bud centrilobular nodules favor aspiration from a proximal source, whereas regional or diffuse centrilobular ground-glass opacities are more suggestive of parenchymal bleeding.(4) The severity of hemoptysis may not be proportional to the extent of abnormality detected on imaging. Underlying lesions in the lungs, like bronchiectasis, cavities, active infection, or malignancy, should be looked for.(2)

Blood in distal airways manifests as centrilobular nodules with a tree-in-bud appearance.

Post contrast CT images may reveal the following findings such as- hypertrophic tortuous bronchial arteries (diameter > 2.0 mm) or non bronchial systemic arteries NBSAs including intercostal arteries, branches of internal mammary arteries, inferior phrenic arteries, other

subclavian branches like costo cervical and thoracodorsal arteries.(4)CECT may demonstrate neovascularization or peri bronchial hypervascularity, contrast extravasation., bronchial artery aneurysm/pseudoaneurysm, pulmonary artery aneurysms (PAAs) and AVMs. Systemic to pulmonary vasculature shunting (SPS), especially in multicentric parenchymal lung disease with imaging signs like non-tapering pulmonary artery sign, clustering of vessels significant differential attenuation sign (> 25 HU difference in attenuation between segmental pulmonary arteries of shunting side and normal non-shunting side).(4) Medical reviews from different part of the world revealed that the etiological pattern of hemoptysis has changed in the developed countries, with pulmonary tuberculosis is becoming less important as a cause of bleeding from the lungs. (5)In our country, however, the pattern has not changed. Pulmonary tuberculosis was the most common cause of hemoptysis four decades ago as shown by Rao in his study in 1960 (6) and it is still the leading cause of it as is evident from the present study, in which tuberculosis was found in 48% of patients with hemoptysis. In developing countries like India, pulmonary tuberculosis -both active and chronic along with its sequelae such as cavitary lesions, aspergilloma, secondary infections, lung abscess and post infectious bronchiectatic as well as parenchymal fibrotic changes act as the major etiology of recurrent mild hemoptysis

Few studies have mentioned bronchial neoplasms (primary and secondary) (19–28%) as the most common cause in developed countries, while other studies have mentioned bronchiectasis (31–57%) as the most common cause.(2) The other less common etiologies include fungal infection, non-tubercular mycobacterial infection, chronic lung disease, vascular lesions like pulmonary arteriovenous malformations (AVMs), vasculitis,etc. In some cases, the diagnosis remains cryptogenic.(2)

5. Conclusion

Based on the above study, we came to the following conclusions:

- Most common imaging feature of patients with mild recurrent hemoptysis in HRCT was presence of post infective cavitary lesions, bronchiectatic changes.
- Pulmonary tuberculosis is still the major cause of mild recurrent hemoptysis in adults in developing countries like India.
- Unlike in massive life threatening hemoptysis, primary vascular causes like pulmonary AVM, bronchial artery aneurysms,etc remain a less common cause of mild recurrent hemoptysis
- Majority of patients belonged to middle aged population with male predominance.
- Chronic smoking history was identified as a major associated factor
- HRCT was successful in detecting positive imaging findings in majority of cases and also helped in diagnosing most probable etiology.
- HRCT needs to be complemented further with other invasive imaging modalities like fiberoptic bronchoscopy, conventional angiography for detecting the possible cause of bleeding in HRCT negative cases.

- Our findings extend the diagnostic value of HRCT as primary investigation of choice in mild hemoptysis, where peripheral airway and parenchymal abnormalities predominate.

6. Further Scope

Cryptogenic hemoptysis remains a diagnostic challenge, warranting further molecular and functional imaging studies. Moreover, multicenter studies and larger population needs to be studied to evaluate findings in diverse settings.

References

- [1] Ibrahim WH. Massive haemoptysis: the definition should be revised. *European Respiratory Journal*. 2008;32(4):1131–2.
- [2] Singhal R, KB SB, Naranje P, Kazimi J, Garg PK, Chandra D, et al. Society of chest imaging and interventions consensus guidelines for the interventional radiology management of hemoptysis. *Indian Journal of Radiology and Imaging*. 2023;33(03):361–72.
- [3] Deshwal H, Sinha A, Mehta AC. Life-threatening hemoptysis. In: *Seminars in respiratory and critical care medicine*. Thieme Medical Publishers, Inc.; 2021. p. 145–59.
- [4] Kettenbach J, Ittrich H, Gaubert JY, Gebauer B, Vos JA. CIRSE standards of practice on bronchial artery embolisation. *Cardiovasc Intervent Radiol*. 2022;45(6):721–32.
- [5] Bidwell JL, Pachner RW. Hemoptysis: diagnosis and management. *Am Fam Physician*. 2005;72(7):1253–60.
- [6] Rao PU. Hemoptysis as a symptom in a chest clinic. *Indian J Chest Dis*. 1960;2(8).