Radiological signs of lobar collapse. Chest radiographic findings and CT imaging correlation.

Poster No.: C-1379
Congress: ECR 2011
Type: Educational Exhibit
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Keywords: Atelectasis, CT, Conventional radiography, Thorax, Lung
DOI: 10.1594/ecr2011/C-1379

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Learning objectives

To illustrate the signs of atelectasis of the different lobes on chest radiographs.

To show the correlation of chest radiographic findings of atelectasis with CT images.

To review the major mechanisms and ethiologies of lung and lobar atelectasis.
**Background**

Atelectasis of the lung refers to collapse or loss of lung volume.

Recognizing signs of collapse on chest radiographs is important in the diagnosis of lung disease because bronchogenic carcinoma is a frequent cause of postobstructive collapse.

In some cases a confident diagnosis can be made based on typical radiographic signs whereas other cases have a more non-specific appearance.

In this exhibit we will illustrate typical appearances and some unusual signs of the various types of atelectasis on chest radiographs and on CT images.
Imaging findings OR Procedure details

Atelectasis can be classified either by its pathophysiology or by the region and extent of lung involved.

Direct and indirect signs of atelectasis affecting the different lobes or combined lobes are listed in Fig. 1 and are illustrated in Figs. 2, 3 and 4.

An overview of the mechanisms of atelectasis including obstructive and nonobstructive causes is presented in Fig. 5.

Cases 1 to 28 (Figs. 6-33) show a wide spectrum of radiographic and CT findings of lung and lobar atelectasis.

These cases include lobar atelectasis, combined lobar atelectasis, complete lung collapse, segmental, subsegmental and rounded atelectases. The type of atelectasis and its specific cause is explained for each case.

Additional radiographic signs that may suggest the underlying pathology are discussed by correlating chest radiographic findings with the corresponding CT images.

1- Right Upper Lobe (RUL) Atelectasis:

• RUL tends to collapse medially and superiorly, with superomedial shift of the minor fissure and anteromedial shift of the major fissure.
• If due to a central mass, the minor fissure retracts cranially with a superolateral convexity and an inferomedial convexity (Golden S- sign).
• The trachea is deviated toward the right. The right hilum and hemidiaphragm are elevated.
• Tenting of the diaphragmatic pleura, called the juxtaphrenic peak sign, may also be seen in RUL atelectasis.

Examples of RUL atelectasis are illustrated in figs. 6 to 10 (cases 1 to 5).

2- Right Middle Lobe (RML) Atelectasis:

• The RML accounts only for 10% of total lung volume.
• It has a greater tendency to collapse than other lobes.
• Radiographic findings can be subtle: a) Vague density over the right lower lung. b) Obscured right heart border. c) Lateral view: obliquely oriented
triangular opacity with apex pointed toward hilum (anterosuperior shift of the major fissure and posteroinferior shift of the minor fissure).

Examples of RML atelectasis are illustrated in figs. 11 and 12 (cases 6 and 7).

3- Right Lower Lobe (RLL) Atelectasis:

- The atelectatic RLL retracts posteromedially and inferiorly.
- The major fissure is shifted downward and becomes visible.
- As RLL collapses, it forms a triangular opacity which obscures the right interlobar pulmonary artery and hemidiaphragm, and eventually forms a right paraspinal mass that projects behind the right atrium.
- On the lateral view, the posterior third of the right diaphragm is obscured by the collapsed RLL. A vague triangular opacity with its apex at the hilum and its based over the right hemidiaphragm and posterior costophrenic sulcus may be seen.

Examples of RLL atelectasis are illustrated in figs. 13 to 15 (cases 8 to 10).

4- Left Upper Lobe (LUL) Atelectasis:

- LUL atelectasis has a different appearance from RUL atelectasis because of lack of a minor fissure.
- Faint, hazy opacity in left upper hemithorax. Leftward tracheal displacement, right hiliar and diaphragm elevation. Main pulmonary trunk and upper contour of left pulmonary artery obliteration.
- On the frontal view, the lobe collapses medially, but there is often lung from the lower lobe between the collapsed upper lobe and the mediastinum (Luftsichel sign).
- On the lateral view, the major fissure shifts anteriorly and is seen marginating a long, narrow band of increased opacity paralleling the anterior chest wall.

Examples of LUL atelectasis are illustrated in figs. 16 to 21 (cases 11 to 16).

5- Left Lower Lobe (LLL) Atelectasis:

- Common after cardiac surgery.
- Radiographic findings may include: a) Increased retrocardiac opacity. b) Obscuring of the left lower lobe vessels and left hemidiaphragm. c) Caudal displacement of left hilum. d) Levorotation of cardiac silhouette with flattening of cardiac waist. e) Mediastinal shift can cause partial obliteration of aortic arch. f) The left major fissure can parallel the left cardiac border, and the completely atelectatic lobe can mimic a left paraspinal mass.
An example of LLL atelectasis is illustrated in fig. 22 (case 17).

6- **Combined Lobes Atelectasis**: cases 18 to 20 are illustrated in figs. 23 to 25.

7- **Complete Lung Collapse**: cases 21 to 23 are illustrated in figs. 26 to 28.

8- **Segmental and subsegmental atelectases**: cases 24 to 26 are illustrated in figs. 29 to 31.

9- **Rounded atelectasis**: cases 27 and 28 are illustrated in figs. 32 and 33.
Radiographic Signs in Lobar Atelectasis

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<th>Indirect Signs</th>
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<td>Bronchovascular crowding</td>
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**Fig. 0:** Radiographic Signs in Lobar Atelectasis

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**Fig. 0:** Radiographic Signs in Lobar atelectasis

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Radiographic Signs in Lobar Atelectasis

Fig. 0: Radiographic Signs in Lobar atelectasis

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### Types of pulmonary atelectasis

<table>
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<th>TYPE</th>
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<td>Foreign bodies</td>
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<td>Radiation fibrosis</td>
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<tr>
<td>Adhesive</td>
<td>Surfactant dysfunction (respiratory distress syndrome; pulmonary embolism; radiation pneumonitis, lung contusion...)</td>
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</tbody>
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**Fig. 0:** Types of pulmonary atelectasis

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Right Upper Lobe Atelectasis

**PA Radiograph:** Atelectatic RUL produces a triangular apical opacity. The right minor fissure is retracted cranially and has an inverted S-shaped configuration (Golden S sign) beginning at the superior part of the atelectatic lobe and curving down around the hilar mass.

**CT:** CT demonstrates the hilar mass (M) obliterating the right superior bronchus. The atelectatic lobe (A) is defined laterally by the minor fissure and posteriorly by the right major fissure.

**Fig. 0:** Case 1. Right Upper Lobe Atelectasis

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Right Upper Lobe Atelectasis

Fig. 0: Case 2. Right Upper Lobe Atelectasis

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Right Upper Lobe Atelectasis

**PA Radiograph:** Right upper paramediastinal opacity with ipsilateral tracheal displacement and elevation of the right hilum. A juxtaephrenic peak (arrow) is present indicating loss of volume in the upper lobe.

**Lateral Radiograph:** Anterosuperior density produced by the atelectatic lobe.

**CT:** Atelectasic lobe plastered medially against the mediastium (A). Difussed calcified tracheobronchial wall due to amiloidosis. Wall thickening and narrowing of the right main bronchus (arrow).

**Fig. 0:** Case 3. Right Upper Lobe Atelectasis

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Right Upper Lobe Atelectasis

**Type:** cicatricial  
**Cause:** tuberculosis

**PA Radiograph:** Increased density of the RUL due to fibrosis and calcification, characteristic of postprimary tuberculosis. Marked volume loss of the right hemithorax with ipsilateral deviation of the trachea and elevation of the right hilum.

**Lateral Radiograph:** The atelectatic lobe produces a hazy anterosuperior opacity.

**CT:** CT shows RUL pleuropulmonary fibrotic bands with anterosuperior displacement of the major fissure around the area of atelectasis. Multiple scattered calcified granulomas are also noted (arrows).

**Fig. 0:** Case 4. Right Upper Lobe Atelectasis

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Right Upper Lobe Atelectasis

**PA Radiograph:** A faint area of increased opacity within the radiation portal can be seen in the RUL. Surgical clips due to axilar lymphadenectomy changes are also noted (arrow).

**CT:**  
a) CT shows a subpleural area of increased attenuation with air bronchograms consistent with radiation fibrosis.  
b) Vascular crowding towards the subpleural opacity indicates volume loss.

**Fig. 0:** Case 5. Right Upper Lobe Atelectasis

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**Right Middle Lobe Atelectasis**

**Fig. 0: Case 6. Right Middle Lobe Atelectasis**

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Case 7. Right Middle Lobe Atelectasis

**Type:** cicatricial  
**Cause:** bronchiectasis

**Fig. 0:** Case 7. Right Middle Lobe Atelectasis

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**PA Radiograph:** A faint increase in opacity in the right lower lung can be seen.

**Lateral Radiograph:** The lateral view shows a triangular opacity overlying the heart because the major fissure shifts upward and the minor fissure shifts downward.

**CT:** a) CT demonstrates bronchial narrowing and wall thickening of a segment. b) Distal varicose bronchiectasis can be seen.
Right Lower Lobe Atelectasis

**PA Radiograph:** Triangular opacity in the right lower paramediastinal region, with loss of the medial retrocardiac diaphragmatic outline. The major fissure, normally not visible on a PA radiograph, is evident with an RLL collapse. **Lateral Radiograph:** The collapsed RLL projects as a vague triangular opacity over the normally lucent area, with its apex at the hilum and its base over the posterior portion of the right hemidiaphragm.

**CT:** The atelectatic RLL can be seen in the right lower paramediastinal region as a triangular opacity with mucous bronchogram. The atelectasis resolved after respiratory physiotherapy, indicating mucous plug as the obstructing cause.

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**Fig. 0:** Case 8. Right Lower Lobe Atelectasis

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Right Lower Lobe Atelectasis

**Plain Radiograph:** Faint area of increased opacity in the RLL with associated bronchovascular crowding and discrete hyperinsufflation of the adjacent lateral parenchyma. On the lateral view the posterior aspect of the right hemidiaphragm is obscured.

**CT:** a) hypervascular mass within the RLL bronchus (arrow). Bronchoscopy showed endobronchial carcinoid tumor. b) the atelectatic segment can be seen as an area of consolidation with air bronchograms and retraction of minor and major fissures (arrows).

**Fig. 0:** Case 9. Right Lower Lobe Atelectasis

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Right Lower Lobe Atelectasis

PA Radiograph: Right apicoposterior pneumothorax. The RLL shows increased attenuation due to passive atelectasis. The pneumothorax is bounded by the outline of the atelectatic lower lobe (arrows).

CT shows the right pneumothorax causing partial atelectasis of the ipsilateral lower lobe and mediastinal shift toward the left. An area of consolidation with air bronchograms can be seen over the posterior segment of the atelectatic RLL lobe.

Fig. 0: Case 10. Right Lower Lobe Atelectasis

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CASE 11

Left Upper Lobe Atelectasis

Type: cicatricial
Cause: fibrothorax

**PA Radiograph:** shows an extensive area of residual pleural thickening and calcification over the LUL. The trachea is deviated toward the left, and the left hilum and hemidiaphragm are elevated indicating marked volume loss. Compensatory hyperinflation of the right lung indicates chronic atelectasis. A vertical lucency separates the aortic arch from the medial margin of the atelectatic lobe and forms an air crescent (Luftschel sign).

**Lateral Radiograph:** the collapsed LUL is displaced anteriorly and delineated by the major fissure (arrow). The left hemithorax is occupied mostly by the hyperexpanded LLL.

**Fig. 0:** Case 11. Left Upper Lobe Atelectasis

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Left Upper Lobe Atelectasis

**PA Radiograph:** Increased opacity over the left upper thorax. A crescent of air (Lujetschel sign) between the aortic arch and the atelectatic LUL can be seen (aired out lower lobe). Hyperinflation of right lung.

**Lateral Radiograph:** the major fissure shifts anteriorly and is seen marginating a long, narrow band of increase opacity paralleling the anterior chest wall.

**CT:** a left hilar mass obliterates the superior bronchus causing complete LUL atelectasis.

**Fig. 0:** Case 12. Left Upper Lobe Atelectasis

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**Left Upper Lobe Atelectasis**

**PA Radiograph:** LUL fibrosis with ipsilateral mediastinal shift and elevation of the left hilum and hemidiafragm. There is marked reduction of the overall left lung volume when compared to the right lung. Compensatory hyperinflation of the right lung indicates chronic atelectasis.

**Lateral Radiograph:** the hyperexpanded right lung herniates across the anterior mediastinum into the left hemithorax accounting for the retrosternal lucency (arrow) and for the sharp outline of the anterior contour of the ascending aorta.

**Fig. 0:** Case 13. Left Upper Lobe Atelectasis

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Left Upper Lobe Atelectasis

**PA Radiograph:** apical consolidation and marked fibrotic changes in LUL with retraction of the hilum, obliteration of the cardiac border, compensatory hyperinsuflation of the right lung and mediastinal leftward shift. The fibrotic lung shows apical pleural thickening and calcified granulomas.

**Lateral Radiograph:** The major fissure is displaced anteriorly and delineates de collapsed LUL.

**CT:** Mediastinal shift toward the left. The atelectatic LUL produces a triangular opacity with presence of varicose bronchiectasis within the atelectatic parenchyma.

**Fig. 0:** Case 14. Left Upper Lobe Atelectasis

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Lingular Atelectasis

**Radiograph:** A faint opacity obscures the left cardiac silhouette. On the lateral view the major fissure is displaced anteriorly and delineates the posterior border of the atelectatic lingula (arrow).

**CT:** CT shows partial obstruction of the lingular bronchus by a mass (arrows). Bronchoscopy demonstrated a blood clot as the obstructive cause. The atelectatic lingula can be seen as a triangular faint opacity with its medial contour apposed against the left heart border.

**Fig. 0:** Case 15. Lingular Atelectasis

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Case 16. Lingular Atelectasis

**Type:** adhesive  
**Cause:** pulmonary embolism

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**CT mediastinal window:** Contrast enhanced CT shows intraluminal filling defects within the left lower lobe pulmonary artery and within a lingular branch of the right upper lobe pulmonary artery, representing pulmonary emboli (arrows).

**CT parenchymal window:** shows bilateral linear opacities coursing perpendicular to the costal pleura in the lingula and right middle lobe, representing areas of subsegmental atelectasis (arrows).

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**Fig. 0:** Case 16. Lingular Atelectasis

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**Left Lower Lobe atelectasis**

**Plain Radiograph:** the PA view shows increased retrocardiac opacity secondary to a mass. The lateral view demonstrates the LLL location of the mass and shows subtle elevation of the left hemidiaphragm.

**CT:** 
- a) Large mass (M) with central necrosis and polilobulated borders located in the inferomedial segment of the LLL. The fat plain between the mass and the aorta is obliterated. 
- b) Compressive atelectasis of the adjacent posteroinferior LLL parenchyma (arrow).

**Fig. 0:** Case 17. Left Lower Lobe Atelectasis

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**Combined Lobar Atelectasis**

**Fig. 0:** Case 18. Combined Lobar Atelectasis

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**CASE 19**

**Combined Lobar Atelectasis**

**Type:** obstructive  
**Cause:** foreign body

**PA Radiograph:** The right hemidiaphragm and the right heart border are partially obscured. The minor fissure forms an interface with the RUL. The right major fissure shifts inferomedially and the RLL obscures the right descending pulmonary artery. The right hilar structures are displaced caudally.

**CT:** a) An obstructing high-density foreign body (arrow) located within the bronchus intermedius affects the aireation of the RML and RLL (fragment of sea shell found at bronchoscopy). b) shows alveolar consolidation with air bronchograms over the RML and RLL secondary to atelectasis. Cavitations and pleural effusion suggest over infection.

**Fig. 0:** Case 19. Combined Lobar Atelectasis

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**Combined Lobar Atelectasis**

**Radiograph:** The minor fissure is caudally displaced and the interface that forms with the RUL can mimic an elevated hemidiaphragm or a subpulmonic pleural effusion. The descending right pulmonary artery, right heart border and right hemidiaphragm are obscured.

**CT:** 
- **a)** a right hilar mass obliterates the pulmonary veins, producing complete obstruction of the bronchus intermedius (arrow).
- **b)** the atelectatic RML and RLL lie adjacent to the mediastinum. Obliteration of the right pulmonary vein by the mass can be seen (arrow).

**Mucous bronchograms within the atelectatic lung.**

**Fig. 0:** Case 20. Combined Lobar Atelectasis

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Fig. 0: Case 21. Complete Lung Collapse

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**Complete Lung collapse**

**PA Radiograph** shows complete opacification of the right hemithorax with marked cardiomeediastinal shift to the right side due to complete atelectasis of the right lung.

**CT** demonstrates an heterogeneous mass extending along the RUL (M) with cutoff of the main right bronchus (arrow), indicating obstructive tumor as the cause of atelectasis. Main right pulmonary artery is obliterated. A small pleural effusion surrounds the atelectatic lung entering the minor fissure (asterisk).

**Fig. 0:** Case 22. Complete Lung Collapse

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Complete Lung collapse

**PA Radiograph:** shows complete opacification of the entire left hemithorax and rightward mediastinal shift, due to pleural effusion.

**CT:** 
- **a)** demonstrates complete collapse of the left lung (arrow), plastered medially against the mediastium and surrounded by a large pleural effusion. There was no evidence of central hilar mass or of bronchial narrowing or occlusion, being pleural effusion the cause of the passive collapse. 
- **b)** Underlying pleural mass (M) in the lower left hemithorax (pleural metastases from liposarcoma) suggested the malignant nature of the pleural effusion.

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**Fig. 0:** Case 23. Complete Lung Collapse

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Segmental Atelectasis

Plain Radiograph: shows a band-like opacity with well-defined borders, perpendicular to the costal surface, located in the LUL.

CT: The segmental atelectasis is located within the anterior segment of the LUL. Bronchial wall thickening with partial narrowing of the left upper bronchus and adjacent bullae indicates the compressive nature of the atelectasis.

Fig. 0: Case 24. Segmental Atelectasis

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Subsegmental Atelectasis

Plain Radiograph shows a well-defined band-like opacity adjacent to the minor fissure and perpendicular to the costal surface. There is discrete hyperinflation of the right lower lobe.

CT confirms the location of the laminar atelectasis within the anterior segment of the RUL. The adjacent minor fissure is anterosuperiorly displaced.

Fig. 0: Case 25. Subsegmental Atelectasis
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Subsegmental Atelectasis

PA Radiograph: shows a thin linear opacity in the right lower paramediastinal region taking a perpendicular disposition toward the costal pleural surface.

Lateral Radiograph: demonstrates the posterior location of the laminar atelectasis within the posterior segment of the RLL, coursing posteroanteriorly and parallel to the superior border of the right hemidiaphragm (arrow).

Fig. 0: Case 26. Subsegmental Atelectasis

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Rounded Atelectasis

Plain Radiograph: well-defined pleural-based opacity in the LLL along the posterior costal surface (arrows).

CT: The round-shaped mass forms an acute angle with the pleura and is seen adjacent to an area of pleural thickening. The “comet tail” of vessels and bronchi is seen curving between the hilum and the apex of the mass.

Fig. 0: Case 27. Rounded Atelectasis

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Plain Radiograph: an ill-defined opacity can be seen in the RLL along the posterior costal surface (arrows).

CT: Adjacent to an area of pleural thickening and calcification, the round-shaped mass forms an acute angle with the posterior pleura. The “comet tail” of vessels and bronchi is seen as tentacle-like extensions towards the hilum.

Fig. 0: Case 28. Rounded Atelectasis

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Conclusion

Recognition of the typical patterns of lobar collapse on chest radiographs is essential to develop an appropriate diagnosis and therefore avoid delays in patient management.

Appreciation of the mechanisms and CT features of atelectasis increases diagnostic accuracy.
References