Lobar Atelectasis: Typical and Atypical Radiographic and CT Findings

Kyung Soo Lee, M.D., Joong Mo Ahn, M.D., Jung-Gi Im, M.D., Nestor L. Müller, M.D., PhD.

The characteristic radiographic and CT findings of lobar atelectasis are well known. However, lobar atelectasis is a dynamic process, and atypical presentations may occur due to a number of different causes. Familiarity with the various typical and atypical radiographic findings of lobar atelectasis is important for correct diagnosis. The aim of this manuscript is to illustrate the spectrum of radiographic findings of lobar atelectasis and to correlate the radiographic findings with the CT findings. The review will illustrate examples of typical and atypical lobar atelectasis, including combined lobar atelectasis, peripheral lobar atelectasis, migrating lobar atelectasis, rounded atelectasis involving the entire lobe and lobar atelectasis mimicking paravertebral and mediastinal masses.

Index Words: Lung, collapse Lung, CT Lung, radiography

INTRODUCTION

Volume loss leads to anatomic alterations within the atelectatic lobe as well as compensatory changes in adjacent structures as they attempt to occupy the space left by the atelectatic lobe (1-3). Considerable volume loss is required in order to increase the opacity of the lung. More sensitive findings of atelectasis include displacement of the interlobar fissures, hila, mediastinum and bronchi. The presence and conspicuity of the various findings is influenced by the severity of atelectasis, type of atelectasis, condition of the underlying lung, as well as the presence of extrapulmonary abnormalities such as pleural thickening. Awareness of the various direct and indirect signs of lobar atelectasis and of atypical presentations is important in order to make the correct diagnosis.

The diagnosis of lobar atelectasis can usually be made based on findings of the chest radiograph. Computed tomography (CT) can be helpful in the assessment of patients with lobar atelectasis, particularly when the radiographic findings are atypical (4-7). CT is also often performed in order to determine the underlying cause for the atelectasis.

The aims of this manuscript are to illustrate the various forms of typical and atypical lobar atelectasis on chest radiographs and to correlate the radiographic findings of lobar atelectasis with those seen on CT.

Right Upper Lobar Atelectasis

Right upper lobe (RUL) atelectasis results in overinflation of the right middle lobe and shift of the minor fissure superiorly and medially (Table 1). It also results in compensatory overinflation of the right lower lobe (RLL) with shift of the major fissure anteriorly, superiorly and medially (Fig. 1). The Golden's S sign denotes a centrally located mass with associated lobar atelectasis. The mass should be large enough to be borderforming with the adjacent hyperexpanded lung (Fig. 1). With complete atelectasis, the RUL is either pancaked medially, simulating mediastinal widening or a mediastinal mass (Fig. 2), or superiorly simulating an apical pleural cap.

On the lateral chest radiograph, an ill-defined opacity anterior to the trachea and obliteration of the anterior margin of the ascending aorta may sometimes be the only findings (1-3).
The minor fissure changes its position more dramatically than does the major fissure. With elevation of the minor fissure, the middle lobe shifts up laterally alongside the atelectatic upper lobe. At CT the middle and upper lobes can be seen side-by-side anterior to the major fissure with the superior segment of the lower lobe posterior to the fissure (Fig. 1). The major fissure maintains its previous contour, whether straight, concave, or convex (4-7).

**Left Upper Lobar Atelectasis**

With LUL atelectasis, the direction of movement is anterosuperior rather than directly superior as in RUL atelectasis (Table 2). The left pulmonary artery, which courses over the left main bronchus, restrains the bronchus and limits the superior migration of the

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**Fig. 1. Typical right upper lobar atelectasis.**

a. Chest radiograph shows right upper lung zone opacity margined laterally by the elevated right minor fissure.

b. Conventional (10 mm collimation) CT scan demonstrates atelectatic right upper lobe marginated laterally by right minor fissure (arrowheads) and posteriorly by right major fissure (arrow). Due to central mass, the medial major fissure shows convex border (Golden’s S sign).

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**Fig. 2. Right upper lobar atelectasis simulating right superior mediastinal mass.**

a. Chest radiograph shows semilunar opacity abutting right superior mediastinum.

b. Conventional (10 mm collimation) enhanced CT scan at level of distal trachea shows atelectatic right upper lobe with mucoid impaction in dilated bronchi. Atelectatic upper lobe is sharply marginated laterally by the minor fissure.
atelectatic lobe (8). For this reason, the superior segment of the LLL expands upward toward the apex of the left hemithorax. Therefore atelectasis of the left upper lobe is associated with increased opacity in the suprahilar region on the PA radiograph. As atelectasis progresses, it leads to increased opacity with poorly defined margins in the perihilar region (Fig. 3a).

On the lateral radiograph, the lateral portion of the major fissure is displaced forward and is placed tangentially resulting in a sharp interface (Fig. 3b).

On CT scans, the atelectatic LUL forms a homogeneous opacity based on the anterior chest wall and the mediastinum. The posterior margin has a V-shaped contour from the lung apex to the hilum, where the apex of the V merges with the hilar vessels and bronchi. It is these hilar structures, which are relatively fixed in position, that tether the major fissure into the V-shape (Fig. 3c). The superior segment of the LLL is pulled forward along both the medial and lateral limbs of the V. The part of the superior segment that follows

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Fig. 3. Typical left upper lobar atelectasis.
a. Chest radiograph shows ill-defined opacity in left hilar area. The hyperexpanded superior segment of the left lower lobe leads to a lucency between the mediastinum and atelectatic left upper lobe, the so-called Luftsichel (air-crescent) (arrows).
b. Lateral radiograph shows anterior displacement of left major fissure. Anterior border of ascending aorta (arrows) is well visualized.
c. Conventional (10 mm collimation) CT scan at level of aortic arch shows V-shaped posterior margin of atelectatic left upper lobe. Superior segment of left lower lobe is pulled forward along both medial and lateral limbs of V.
the medial limb forms a tongue of lung between the mediastinum and the atelectatic LUL. This tongue is visible on PA radiographs and has been called the Luftschel (air-crescent) or periaortic lucency (7) (Fig. 3c). Less commonly, the major fissure may have a straight border rather than a V-shaped contour (Fig. 4).

Occasionally the atelectatic lobe may have sharp margins on the PA radiograph simulating a hilar mass (Fig. 4, 5). With marked LUL atelectasis, the contour of the major fissure interface may appear continuous with that of the normal epicardial fat on the lateral radiograph (Fig. 5).

FIG. 4. Complete atelectasis of left upper lobe.
a. Chest radiograph shows mass-like lesion in left hilar area.
b. Thin-section (1.5 collimation) CT scan obtained at level of carina shows atelectatic left upper lobe. Left upper lobe, being replaced only by dilated bronchi, is margined posteriorly by major fissure.

FIG. 5. Complete atelectasis of left upper lobe simulating left hilar mass.
a. Chest radiograph shows mass-like lesion in left hilar area. Ill-defined opacity is also shown superior to mass-like lesion.
b. Lateral radiograph shows anteriorly displaced left major fissure, inferior aspect of which is continuous with normal epicardial fat (arrows).

FIG. 6. Typical right middle lobar atelectasis.
a. Posteroanterior chest radiograph shows triangular shaped opacity in right lower lung zone with obliteration of right lower cardiac border.
b. Lateral radiograph shows triangular opacity in anterior aspect of thorax overlapped with cardiac silhouette with its apex toward hilum.
**Right Middle Lobar Atelectasis**

As the RML loses volume, the minor and major fissures move toward each other in an inferomedial and superomedial direction, respectively (Table 3). The RML thus assumes an oblique orientation and on the PA radiograph results in a poorly defined increased opacity which obscures the right heart border (Fig. 6). In general, the greater the atelectasis and the greater the reorientation of the RML, the more difficult it is to recognize the atelectasis on PA radiograph (Fig. 7). On the lateral view, RML atelectasis is seen as a triangular opacity margined superiorly by the minor fis-

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**Table 3. Ancillary Radiographic Findings of Atelectasis of Right Middle Lobe**

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<th>Findings</th>
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<tr>
<td>Fissural reorientation</td>
<td>Inferomedial and superomedial displacement of minor and major fissures respectively</td>
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<tr>
<td>Hilum</td>
<td>No change in size and position</td>
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<td>Mediastinum</td>
<td>Lack of major mediastinal shift</td>
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<td>Diaphragm</td>
<td>Elevated anteriorly</td>
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<td>Bronchus</td>
<td>Air bronchogram of RML bronchi on PA and lateral view</td>
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**Fig. 7. Complete atelectasis of right middle lobe.**

- a. Chest radiograph shows focal area of discontinuity in right lower cardiac border.
- b. Thin-section (1.5 mm collimation) CT scan obtained at level of inferior pulmonary vein shows triangular shaped atelectatic right middle lobe replaced by dilated bronchi, margined anteriorly by right minor fissure and laterally by right major fissure.

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**Fig. 8. Atelectasis of right lower lobe.**

- a. Chest radiograph shows atelectatic right lower lobe margined by right major fissure (arrows). Central mass caused outward bulging of lateral margin of atelectatic right lower lobe.
- b. Conventional (10 mm collimation) CT scan obtained at subcarinal level shows central mass (arrowheads) and atelectatic right lower lobe (arrows), margined by right major fissure.
sure and inferiorly by the major fissure (Fig. 6b). The apex of the triangle is in the hilar area, and the base is located peripherally.

On CT scans, the RML is triangular or trapezoidal (Fig. 6, 7). Its posterior border, demarcated by the major fissure, is usually well defined because the major fissure crosses the scan plane almost perpendicularly. On the other hand, the interface between RML and RUL is often less distinct because of the dome-shaped contour of the minor fissure.

### Lower Lobar Atelectasis

As the lower lobes become atelectatic, the lateral portion of the major fissure moves posteriorly toward the costophrenic angle and may be well delineated on the lateral radiograph (Table 4). The medial portion of the major fissure relates to the mediastinal wedge of pulmonary attachment. The wedge is frequently difficult to detect on the lateral radiograph except for a slight area of increased opacity extending from the posterior costophrenic angle toward the hilum. On PA

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![Fig. 9. Complete atelectasis of right lower lobe.](image)

**a.** Chest radiograph shows a line shadow suggesting lateral margin of right major fissure in right retrocardiac area. Note oligemic hilar vessels.

**b.** Thin-section (1.0 mm collimation) CT scan obtained at level of distal bronchus intermedius shows posteriorly displaced right minor fissure and atelectatic right lower lobe (arrow) marginated by right major fissure.

**c.** CT scan obtained 10 mm distal to (b) shows a branch (arrow) of right middle lobar bronchus, oriented posteriorly and superiorly.
radiographs, the lateral margin of the lobe may be ill defined or well defined, depending on whether or not the adjacent hyperexpanded lung has placed the fissural edge of the lower lobe tangential to the X-ray beam (Fig. 8).

On CT scans, the lower lobes lose volume in a posteromedial direction, pulling down the major fissure (Fig. 8). The lateral portion of this fissure demonstrates a greater degree of mobility, because the medial portion is fixed to the mediastinum by the hilar structures and the inferior pulmonary ligament.

If marked atelectasis of the RLL has occurred, the triangular-shaped opacity may be difficult to detect through the mediastinum because of its small size (Fig. 9). In LLL atelectasis, the involved lobe may appear as a left paraspinal mass instead of the more characteristic triangular shape with the apex at the hilum and the base at the left hemidiaphragm (Fig. 10). The appearance of lower lobar atelectasis as a paraspinal mass is believed to result from incomplete attachment of the inferior pulmonary ligament to the hemidiaphragm (9).

**Combined Lobar Atelectasis**

Combined lobar atelectasis refers to the condition in which the volumes of two lobes of the lung are decreased simultaneously (1, 3, 10). Because the right

![Fig. 10. Atypical atelectasis of left lower lobe simulating left paraspinal mass.](image1)

*a*. Chest radiographs shows left hilar prominence and unusual branching pattern of hilar vessels. Margin of descending aorta is interrupted distally (arrow), suggesting possible left paraspinal mass. Note shift of upper mediastinum to the left.

*b*. Conventional (10 mm collimation) CT scan obtained at ventricular level shows atelectatic left lower lobe, posteriorly in paraspinal area.

![Fig. 11. Combined atelectasis of right middle and lower lobes due to mucus impaction in bronchus intermedius.](image2)

*a*. Chest radiograph shows opacity in right lower lung zone obscuring right atrium and right hemidiaphragm. Inferior displacement of major (arrows) and minor (arrowheads) fissures is present. Also note inferior displacement of right hilum and hyperexpansion of right upper lobe.

*b*. Lateral radiograph shows opacification throughout right lower lung zone obscuring right hemidiaphragm. Upper border of opacity is bordered anteriorly by minor fissure and posteriorly by major fissure.
Fig. 12. Combined atelectasis of right upper and middle lobes due to metastatic endobronchial tumor.

a. Chest radiograph shows opacity in right upper and middle lung zones. Cephalad displacement and rotation of hilar vessels are observed. Right hemidiaphragmatic tenting is associated. Also noted are metastatic nodules and mass in left lung.

b. Lateral radiograph shows anterior displacement of right major fissure (arrows).

Fig. 13. Combined atelectasis of right upper and lower lobes due to mucus plug. Chest radiograph following general anesthesia shows opacities in right upper and lower lung zones, sharply marginated by elevated right minor fissure (arrowheads) and depressed right major fissure (arrows) respectively. Right middle lobe is overexpanded.

Combined Atelectasis of the Right Middle and Lower Lobes

Because the bronchus intermedius is the common pathway to the right middle and lower lobes, a single localized lesion involving the bronchus intermedius gives rise to combined atelectasis of these lobes. The bronchial obstruction can be caused by a tumor, a foreign body, a mucous plug, or an inflammatory stricture (10).

On the PA radiograph, the atelectatic RLL obscures the right hemidiaphragm, whereas the atelectatic right middle lobe obscures the right cardiac border (Fig. 11). Depression of both the major and minor fissures is present, the depression being most marked laterally (Fig. 11a). Other signs of combined atelectasis of the right middle and lower lobes include a small and depressed right hilum and decreased vascularity of a hyperexpanded RUL compared with the normal left lung. On the lateral view, increased opacity is present throughout the lower part of the chest.

On CT scans, the atelectatic RML and RLL occupy the lower hemithorax and abut the right cardiac border medially and the right hemidiaphragm inferiorly. The right major and minor fissures border the lateral and anteromedial margins of the atelectatic lobes, respectively (Fig. 11). Complete combined RML and RLL atelectasis can be difficult to detect on PA and lateral radiographs. The diagnosis should be suspected in patients with a small right hilum and an apparently oligemic right lung which represents the hyperex-
panded RUL.

**Combined Atelectasis of the Right Upper and Middle Lobes**

For combined atelectasis of the RUL and RML to occur, the bronchi of both lobes must be narrowed or occluded by a single or two separate lesions while the bronchus intermedius remains patent, thus allowing the RLL to remain expanded. Combined atelectasis of the RUL and RML can occur with bronchogenic carcinoma, metastatic tumor, carcinoid tumor, mucous plug, and bronchial inflammation. In bronchogenic carcinoma, the primary tumor can obstruct one bronchus and cause the other bronchus to be obstructed by direct extension through the lung parenchyma or peribronchial sheath or by lymphadenopathy.

On the PA radiograph, the atelectatic RUL and RML form an opacity that obscures the outline of the mediastinum and fades laterally. Combined atelectasis of the RUL and RML can lead to cephalad and lateral displacement and rotation of the hilar vessels. The silhouettes of the ascending aorta and the right atrium are usually obscured (Fig. 12). On the lateral view, the major fissure can be seen to be displaced anteriorly.

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**Fig. 14.** Peripheral atelectasis of combined right upper and middle lobe caused by bronchogenic carcinoma.

a. Chest radiograph shows poorly defined opacity in right upper and middle lung zones laterally, suggesting localized pleural effusion. This opacity is sharply margined medially by radiolucent lung (arrows). Also noted are cephalad and lateral displacement and rotation of hilar vessels and shift of mediastinum to the right.

b. Conventional (10 mm collimation) CT scan shows atelectatic upper lobe (arrows) margined medially by hyperexpanded superior segment of right lower lobe. Also note small right pleural effusion. (Reprinted, with permission, from reference 10)

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**Fig. 15.** Migrating right upper lobe atelectasis.

a. Anteroposterior radiograph shows opacity in right upper lung zone simulating right superior mediastinal mass or apical pleural cap. Inferomedial portion of opacity shows Golden’s S sign (arrows), suggesting central mass lesion.

b. Posteroanterior radiograph shows migrating nature of atelectatic lobe. Atelectatic right upper lobe migrated to right hilar area (arrows). Lateral displacement of right interlobar pulmonary artery and its branches and oligemic right lung are the only findings that suggest lobar atelectasis.
The relative proximity of the major fissure to the anterior chest wall is dependent on the degree of atelectasis of the RUL and RML. Retrosternal radiolucency, caused by herniation of the left lung into the retrosternal space, and the accentuated main pulmonary artery segment also can be seen on the lateral view (Fig. 12). The radiographic findings of combined atelectasis of the RUL and RML are similar to those of LUL atelectasis (10).

On CT scan, the atelectatic RUL and RML cause a wedge-shaped area of soft-tissue attenuation abutting the chest wall anteriorly and the ascending aorta and right cardiac border medially. This wedge-shaped opacification extends inferiorly to the level of the right atrium. The major fissure is displaced anteriorly, and the hyperexpanded lower lobe fills most of the right hemithorax.

**Combined Atelectasis of the Right Upper and Lower Lobes**

Combined atelectasis of the RUL and RLL is rare. It may be due to mucous plugs occurring simultaneously in the bronchi of the RUL and RLL. The radiographic findings of combined atelectasis of RUL and RLL are similar to those of isolated atelectasis of either lobe. Upper lobe atelectasis leads to elevation of the minor fissure, whereas lower lobe atelectasis leads to downward and medial shift of the major fissure (Fig. 13). On CT scans, the minor fissure if higher than normal because of the atelectasis of the RUL and more posterior than normal because of the atelectasis of the RLL. The middle lobe is overinflated.

**Peripheral Lobar Atelectasis**

Franken and Klatte (11) described the radiographic findings of what they called "atypical (peripheral) right upper lobe atelectasis", mimicking apical pleural effusion. In this type of atelectasis of the RUL, the atelectatic lobe continues to lie adjacent to the lateral chest wall. The dense lateral portion of the atelectatic lobe is sharply marginated medially. On CT in this form of atelectasis, the RML expands upward in front of the atelectatic RUL with the minor fissure adopting an almost coronal orientation. The superior segment of the RLL herniates upward posterior and medial to the atelectatic RUL with the major fissure being repositioned to a more parasagittal orientation superiorly, presenting itself as a radiographic interface on the PA projection (11-13). The herniated superior segment of RLL forms the so called Luftschel (air crescent) medial to the atelectatic lobe. Recently two cases of peripheral atelectasis of left upper lobe, caused by bronchogenic carcinoma, have also been reported (13). We have seen a case of peripheral atelectasis of the combined RUL and RML in a patient with bronchogenic carcinoma (Fig. 14).

**Migrating Lobar Atelectasis**

A very heavy lobe, filled with fluid, chronic pneumonia, or a tumor, may migrate in the hemithorax with change in body position adopting a dependent position. Heavy lobes and pedunculated pleural mesotheliomas are the two likely causes of a large migrating chest density (10, 14). Migrating atelectasis usually involves a single lobe (Fig. 15) but it has also been described with combined RUL and RML atelectasis. Migratory lobar atelectasis should be distinguished from lung torsion. Radiographic findings of lung torsion include atypical orientation of the fissures as well as abnormal position and orientation of the pulmonary vessels within the atelectatic lobe (15).

**Rounded Atelectasis**

Rounded atelectasis is a form of peripheral pulmonary volume loss. Rounded atelectasis is hypothesized to be due to contraction of a focus of visceral pleural fibrosis that results in buckling of the pleura and atelectasis of underlying lung parenchyma (16). It usually results in volume loss of part of a lobe unrelated to the segmental anatomy. Rounded atelectasis usually pre-
sents as a mass that may simulate a pulmonary neo-
plasm on chest radiograph. The CT criteria for the diag-
nosis of rounded atelectasis include (1) a rounded or
ovar mass abutting a pleural surface, (2) vessels and
bronchi curving into the mass, and (3) associated
pleural thickening with or without calcification (17).
Although rounded atelectasis is usually confined to a
small portion of lung, occasionally it may involve the
entire lobe and simulate a large mass (Fig. 16).

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