Pictorial essay of unusual radiologic manifestations of pulmonary and airway metastasis at initial presentation of lung cancer

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Learning objectives

1. To understand various mechanisms of pulmonary and airway metastasis in patients with lung cancer.

2. To learn unusual radiographic and CT findings of pulmonary and airway metastasis of lung cancer.
Background

1. Pulmonary and airway metastasis in patients with lung cancer may present with variable radiologic manifestations according to the mechanism of disease spread.

2. Unusual radiologic manifestation of pulmonary metastasis in initial presentation of lung cancer may simulate diffuse interstitial lung disease or pulmonary infection.
Imaging findings OR Procedure details

1. Unilateral increase in pulmonary interstitial markings: Lung cancer with pulmonary lymphangitic carcinomatosis

Unilateral diffuse increase in pulmonary interstitial markings may be initial manifestation in lung cancer with pulmonary lymphangitic carcinomatosis. Lung cancer commonly spread via the lymphatic system. Pulmonary lymphangitic carcinomatosis refers to tumor growth in the lymphatic system of the lungs, and it may results from lymphatic spread of tumor from mediastinal and hilar lymph nodes.

Chest radiograph: Unilateral diffuse reticular or reticulonodular opacities and septal lines mimicking sarcoidosis or pulmonary interstitial edema (Fig. 1A, 2A).

Differential points on CT scan from other interstitial lung diseases: Unilateral or asymmetrical increase in pulmonary interstitial markings; nodular thickening of pulmonary interstitium (Fig. 1B, 1C, 2B, 2C); presence of primary mass which is usually small and difficult to be found on initial chest radiograph (Fig. 1B); associated hilar node or mediastinal lymph node enlargement.

2. Miliary nodules: Lung cancer with miliary hematogeneous pulmonary metastasis

Most patients with hematogeneous pulmonary metastases have multiple, sharply marginated lung nodules. In some patients, however, widespread hematogeneous metastases occur with numerous small nodules, and rarely with miliary nodules. There has been a report that lung adenocarcinoma with epidermal growth factor receptor gene (EGFR) mutations developed miliary metastasis, while such metastases were much less common in patients with lung adenocarcinoma with wild-type EGFR (Toqashi Y, et al.)

Chest radiograph: Miliary nodules mimicking miliary tuberculosis (Fig. 3A, 4A)

Differential points on CT scan from military tuberculosis: Nodules are usually larger and variable in sizes (Fig. 3-5); cavitation of nodules (Fig. 4B, 4C), presence of primary mass which is usually small and difficult to be found on initial chest radiograph (Fig. 3B, 5C).

3. Poorly-defined nodules mimicking airspace nodules: Lung cancer with intravascular pulmonary metastasis

Although direct lymphovascular tumor spread from primary mass is often seen, intravascular pulmonary metastasis is rare in primary lung cancer. The incidence of intravascular metastasis in nonpulmonary malignancy is known to vary, ranging from
approximately 2% to 26%, according to how they are defined. There are four basic types of pulmonary vascular involvement by tumor emboli: (a) Large tumor emboli may produce a syndrome of acute pulmonary hypertension by occluding the main pulmonary artery or large lobar branches. (b) Smaller tumor emboli may occlude small arteries and arterioles leading to progressive dyspnea and subacute pulmonary hypertension. (c) Pulmonary microvascular occlusion may be part of generalized lymphatic involvement. (d) There may be a combination of the above types.

**Chest radiograph:** poorly-defined nodules mimicking pulmonary infection with airspace nodules such as pulmonary tuberculosis or other infectious bronchiolitis (Fig. 6A).

**Differential points on CT scan from other diseases with airspace nodules:** Multifocal dilatation and beading of peripheral pulmonary arteries (tree-in-bud appearance with somewhat larger and more uneven in sizes than that in airspace nodules, Fig. 6B, 6C), findings of lung cancer including presence of primary mass and lymph node metastasis (Fig. 6C).

### 4. Lung cancer of consolidation pattern

Adenocarcinoma with bronchioloalveolar carcinoma (BAC) pattern may present with lobar or diffuse pulmonary consolidation, which is usually indistinguishable from pneumonia on plain radiograph.

**Chest radiograph:** Single or multilobar pulmonary consolidation mimicking pneumonia (Fig. 7A).

**Differential points on CT scan from pulmonary infection:** Long-standing consolidation with no response to antibiotics or antituberculous treatment, slower progression on serial follow-up, sometimes non-anatomical distribution of consolidation (Fig. 7C), sometimes associated small nodules or mass, expectoration of mucin (bronchorrhea) may show slight "interval improvement" of consolidation on follow-up radiograph and make confusion in diagnosis of lung cancer in mucin producing adenocarcinoma, enhancing pulmonary vessels within areas of low-density consolidation due to mucin ("CT angiogram sign"; This sign cannot be used for CT scans obtained with rapid contrast infusion.)

### 5. Endotracheal and endobronchial metastasis in lung cancer

Metastasis to large airways including the trachea and central bronchi is extremely rare, although direct involvement by primary lung cancer is often seen. Tracheal tumor cells may originate from the primary site via submucosal lymphatic or blood vessels (Heitmiller RF, et al.). The incidence of endotracheal or endobronchial metastasis of nonpulmonary malignancies is known to vary, ranging from approximately 2% to 50%, according to how they are defined. In a study with six patients with tracheal metastasis of primary lung
cancer, the overall incidence of tracheal metastasis was 0.44% (6/1,372) in surgically resected non-small cell lung cancer (0.77% in squamous cell carcinomas and 0.18% in adenocarcinomas), and the incidence of tracheal metastasis was lower in primary lung cancers than in nonpulmonary malignancies (Chong S, et al.).

**Chest radiograph and CT:** Endotracheal or endobronchial nodule or eccentric wall thickening of the trachea or central bronchi in patients with lung cancer (Fig. 8).
Fig. 1: A 48-year-old man with lung cancer in RUL with pulmonary lymphangitic carcinomatosis. A. Initial chest radiograph shows diffuse peribronchovascular interstitial thickenings in the right lung. B, C. HRCT scans show primary mass in RUL (arrow). Diffuse interlobular septal and peribronchovascular interstitial thickenings in the right lung. PCNA of RUL nodule revealed moderately differentiated adenocarcinoma.

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Fig. 2: A 58-year-old woman with lung cancer in RML and pulmonary lymphangitic carcinomatosis in the right lung and diffuse osteoblastic bone metastasis A. Initial chest radiograph shows diffusely increased pulmonary interstitial markings in the right lung. Also noted are focal consolidation in right middle lobe, small right pleural effusion, and diffuse osteoblastic change in bony thorax. B, C. CT scans (3-mm slice thickness, bone algorithm reconstruction, lung window images) show primary mass in RML (arrow, B) and diffuse interlobular septal and peribronchovascular interstitial thickenings in the right lung. Adenocarcinoma was confirmed by percutaneous transthoracic needle biopsy of RML mass.

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Fig. 3: A 74-year-old man with lung cancer in RLL with miliary metastasis A. Initial chest radiograph shows miliary nodules through entire both lungs. B, C. CT scans (3-mm slice thickness, bone algorithm reconstruction, lung window images) show a nodule in RLL superior segment (arrow), which was obscured by right hilar shadow on chest radiograph. Also noted are numerous tiny metastatic nodules are noted in both lungs. The tiny nodules are slightly different in sizes. Adenocarcinoma was confirmed by PCNA of RLL nodule.

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Fig. 4: A 43-year-old woman with lung cancer in LLL with miliary metastasis. A. Initial chest radiograph shows diffuse fine nodules in entire both lungs. B. CT scan (3-mm slice CT, bone algorithm reconstruction) shows a cavitary mass in LLL and miliary metastatic nodules in both lungs. Some of miliary nodules show cavitation (arrows). Squamous cell carcinoma was confirmed by PCNA of LLL mass.

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**Fig. 5:** A 54-year-old man with lung cancer in RML with hematogeneous pulmonary metastasis. A. Initial chest radiograph shows numerous small nodules through entire both lungs. B, C. HRCT scans show numerous micronodules in entire both lungs. Nodules are variable in sizes. A poorly-defined mass, which is suggestive of primary mass, is noted in RML (arrow). PCNA of RML mass revealed adenocarcinoma.

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Fig. 6: A 41-year-old man with lung cancer in LLL with diffuse intravascular pulmonary metastasis. A. Initial chest radiograph show a poorly-defined mass in infrahilar area (arrow) and poorly-defined nodules in the right lung. B, C. CT scans (3-mm slice thickness, bone algorithm reconstruction) show a poorly-defined mass in left hilar area. Also noted are nodular enlargements of peripheral pulmonary vessels (arrows), suggestive of intravascular metastasis. PCNA of LLL mass revealewd poorly differentiated squamous cell carcinoma.

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Fig. 7: A 58-year-old man with lung cancer of consolidation pattern. A. Initial chest radiograph shows consolidations in both lower lung zones. Ill-defined mass or mass-like consolidation is noted in left perihilar lung. B, C. CT scans (3-mm slice thickness, bone algorithm reconstruction) show multiple mixed areas of consolidation and ground-glass opacities in both lungs. Consolidation in RLL shows non-segmental distribution. PCNA of LLL consolidation demonstrated adenocarcinoma with mucinous feature.

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Fig. 8: A 63-year-old man with squamous cell carcinoma of the lung. A. Patient was diagnosed to have lung cancer in LUL 1 year ago. Follow-up chest radiograph shows nodular protrusion in proximal left main bronchus (arrow) as well as large primary mass in LUL. B. CT scan shows enhancing bronchial mass at the level of carina. Also noted are primary mass in LUL and left pleural effusion. The bronchial nodule showed size changes after cancer treatment.

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Conclusion

It is important to be familiar with unusual radiographic and CT findings of pulmonary and airway metastasis of lung cancer to avoid delays in diagnosis and treatment.
References


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