Review areas of chest on frontal radiograph

Poster No.: P-0026
Congress: ESTI 2014
Type: Educational Poster
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Keywords: Plain radiographic studies, Lung, Emergency, Thorax, Diagnostic procedure, Cancer
DOI: 10.1594/esti2014/P-0026

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Learning objectives

To make the trainee radiologists aware of areas in chest radiograph, where the lesions are commonly missed.

In this poster, we will describe commonly missed abnormalities on a chest radiograph.

The aim is to stress on potential error of perception in reporting the chest radiograph.

Background

Despite significant technical advances in radiology, chest radiograph still remains the most commonly used screening tools for emergency departments as well as outpatient clinics. A large proportion of patients visiting their physician get a chest radiograph for one or the other reasons. It is easily available, cheap and cause least discomfort to patient. Above all, the radiation dose is very low compared to CT scan. Most of the screening radiographs are normal. However, interposed within these 'normals' are small number of cases with positive findings that may be clinically very relevant. Radiologists are expected to identify all abnormal radiographs but mistakes are bound to happen. Most of the missed lesions are retrospectively seen on the radiograph. It has been known that radiologists tend to overlook the lesions in 'review areas' on chest radiograph. The purpose of this poster is to make trainee radiologists aware of review areas of chest. These areas include but not limited to lower neck, lung apices, superior mediastinum, hilum, retro cardiac region, retro diaphragmatic region, infra diaphragmatic region and bones Fig. 1 on page .
Fig. 1: Normal chest radiograph marked with review areas: (1) Lower neck, (2) Lung apices, (3) Superior mediastinum, (4) Hilum, (5) Retro cardiac region, (6) Retro diaphragmatic region and (7) Infra diaphragmatic region.

References: Khoo Teck Puat Hospital - Singapore/SG
Imaging findings OR Procedure details

Errors in radiology are attributed to poor technique, failures of perception, lack of knowledge and poor judgments\(^1\). Earlier studies have reported that 90% of peripheral neoplasms and 70% of central neoplasms can be seen in retrospective analysis\(^2\). The smaller the size of the lesion, the more likelihood it to be missed on chest radiograph\(^3\). Mean diameter of missed lesion has been reported to be around 1.6 cm\(^3,4\). Though, human eye is capable of detecting nodule as small as 3 mm, approximately 50% of lung nodules less than 5 mm can be missed by radiologists\(^5\). Quekel \textit{eta al} reported that the majority (55%) of missed lung cancers are superimposed by bones, mediastinal structures or diaphragm\(^3\). The superimposed structures contribute to the error of perception. Many studies have reported an extreme upper lobe predominance of missed lung cancers ranging from 60% to 81\(^%\)\(^4,6,7\). On a frontal chest radiograph, 26.4% of the lung volume and 43% of the lung area are obscured by heart, mediastinum and diaphragm\(^8\). As high as 65% of the hilar cancers can be missed on a frontal radiograph\(^2\). Centrally located lesions that are missed are larger than peripherally located lesions\(^3\). Unsharpness of the lesion is another important factor that is associated with false negative results on a radiograph\(^3,4,9\).

Introduction of digital imaging techniques have increased the sensitivity of chest radiograph but there is always a human factor involved in reading the radiographs. Hoop \textit{et al} concluded that if rely on chest radiography alone, 22%-63% of the lung cancers would be missed at a stage of disease at which they could be detected with CT\(^10\). The diagnostic delay due to missed lesions changes the outcome of the management. Similarly, delay or failure to identify nonmalignant abnormalities like pneumomediastinum can lead to increase morbidity and mortality. There is agreement that certain areas in chest radiograph need more attention than other to minimize or avoid missing the lesions. These areas include but not limited to lower neck, lung apices, superior mediastinum, hilum, retro cardiac region, retro diaphragmatic region, infra diaphragmatic region and bones.

1. Lower neck: It is essential to evaluate the lower part of neck included in a chest radiograph. Most common neck mass that projects on chest radiograph is an enlarged thyroid. Presence of tracheal deviation can be a clue to diagnosis. Ultrasound neck can confirm the thyroid lesion noninvasively. Prevertebral soft tissues associated with lower cervical spine lesions can also be visualized on chest radiograph Fig. 2 on page .
**Fig. 2**: 63-years-old man with neck pain and cough. (a) Chest radiograph shows a 'V' shaped soft tissue extending on both side of lower neck. Note, that there is only mild mass effect on trachea. (b) Coronal reconstruction of contrast CT chest confirms that there is destructive prevertebral soft tissue (white arrow). This was subsequently proven to be a cervical spine myeloma.

**References**: Khoo Teck Puat Hospital - Singapore/SG

2. **Lung apices**: This is the commonest location for missed lung cancer. This region is crowded with bones and it is further complicated by irregular, often asymmetric calcification of the first costal cartilage. A lordotic view is helpful in many cases **Fig. 3** on page __________.

**Fig. 3**: Right upper lobe mass in a screening chest radiograph. (a) Initial chest radiograph shows asymmetric fullness in right upper zone, presumed to be due to calcification of first costal cartilage. (b) A lordotic view shows a soft tissue opacity in
right upper zone (black arrow). (c) Coronal CT image confirms the presence of mass in same location (white arrow).

References: Khoo Teck Puat Hospital - Singapore/SG

Often, clinical history prompts the reader to look for apical lesion Fig. 4 on page . Patients with pancoast tumor, a lung cancer arising in apex usually presents with shoulder pain and brachial plexopathy.

Fig. 4: Pancoast tumor in a 65-years-old man. (a) Chest radiograph shows soft tissue opacity in the left lung apex. This mass was missed on initial read but was identified on review of images at the request of referring physician as the patient was constantly complaining of unexplained left shoulder pain. (b) Coronal reconstruction of contrast CT chest confirms a pancoast tumor in left lung apex (black arrow).

References: Khoo Teck Puat Hospital - Singapore/SG

3. Superior mediastinum: Tracheal and paratracheal region also need extra attention while reading the radiograph. Right paratracheal stripe is the most commonly seen line on a posterior-anterior chest radiograph. Focal or diffuse thickening of right paratracheal strip can be due to tortuous vessels, lymph nodes, thyroid mass or a bronchogenic cyst Fig. 5 on page . Diffuse smooth thickening of paratracheal strip is usually due tortuous vessels while focal and / or lobular thickening is due to mass or lymphadenopathy.
Fig. 5: A paratracheal bronchogenic cyst in an asymptomatic 25-years-old man, not described in few other prior radiographs. (a) Chest radiograph shows focal bulge in the right paratracheal stripe in a 25 yr old asymptomatic man. (b) Coronal reconstruction of contrast CT chest revealed a paratracheal cystic mass projecting in trachea (white arrow). Thoracotomy confirmed it to be a bronchogenic cyst.

References: Khoo Teck Puat Hospital - Singapore/SG

Apart from opacities, lucencies in central superior mediastinum should also be carefully scrutinized for presence of air-fluid level (Fig. 6 on page ) and paratracheal pneumomediastinum Fig. 7 on page .

Fig. 6: (a) Normal appearing chest radiograph of a young man presenting to emergency department with chest pain. Note the prominent lucent area projecting over
and beyond tracheal lucency with air-fluid level. (b) Axial slice of contrast CT chest revealed dilated upper esophagus. The lower slices showed achalasia cardia.

References: Khoo Teck Puat Hospital - Singapore/SG

**Fig. 7:** A 17-years-old boy with sudden onset of chest pain and shortness of breath. (a) Magnified chest radiograph shows bilateral paratracheal lucencies, that were missed on initial read. Coronal CT image demonstrates pneumomediastinum. The final diagnosis was spontaneous pneumomediastinum.

References: Khoo Teck Puat Hospital - Singapore/SG

4. Hilum: Hilar and perihilar region is the most important review area in a chest radiograph as it is the common location for missed lung cancer. The appearance of hilar borders and densities is variable, limiting the detection of small hilar / perihilar nodules. Hilar contour is distorted by lymphadenopathy and central lung cancers [Fig. 8 on page]. Felson’s hilum overlay sign and hilum convergence sign are still relevant for evaluation of large hilar masses [Fig. 9 on page].
**Fig. 8:** (a) Chest radiograph shows increased lung volumes in an elderly man. No obvious mass was seen on first look but careful scrutiny of right perihilar region depicts a horizontally oriented opacity partially overlying the more vertically oriented right lobar pulmonary artery (hilum overlay sign). This opacity is better appreciated on magnified image(b). (c) Coronal CT image confirms that the opacity corresponds to a mass (black arrow) in right lower lobe. Bilateral emphysematous bullae are also shown on CT.

**References:** Khoo Teck Puat Hospital - Singapore/SG

**Fig. 9:** (a) Chest radiograph shows a subtle opacity causing bulge in left perihilar region. This opacity is overlapping the left pulmonary artery in an elderly man. The lower lobe vessels are converging inferior to the opacity, giving a clue that this opacity is not a dilated pulmonary artery (hilum convergence sign). (b,c) Axial and Coronal CT images prove that the opacity corresponds to a left perihilar mass (black arrow).

**References:** Khoo Teck Puat Hospital - Singapore/SG

**5. Retro cardiac region:** A substantial portion of left lower lung lies behind the heart. Underexposed or enlarged heart can hide lesions in left lower lung and posterior mediastinum **Fig. 10** on page . A lateral radiograph can be complimentary in such cases but it is not regularly performed in all institutions. Manipulating the contrast in digital radiograph is also very helpful in identifying retro cardiac lesions.
**Fig. 10:** Esophageal gastrointestinal stromal tumor in a 30-years-old man with mild chest discomfort. (a) Chest radiograph shows a subtle rounded opacity overlapping the heart. (b) Coronal CT image reveals a mass (white arrow) arising from the esophagus.

**References:** Khoo Teck Puat Hospital - Singapore/SG

6. **Retro diaphragmatic region:** Small lesions behind the diaphragm can be overlooked. A lateral radiograph is considered very useful for evaluation of suspected lesion in posterior costophrenic sulcus.
**Fig. 11:** 55-years-old chronic alcoholic man with cough and fever. (a) Chest radiograph shows a subtle opacity in the right lower lobe partially hidden behind the diaphragm. (b) Axial CT image reveals a patch of consolidation in right costophrenic sulcus (black arrow), presumed to be aspiration pneumonitis.

*References:* Khoo Teck Puat Hospital - Singapore/SG

**Fig. 12:** (a) Pre employment screening radiograph in a 43-year-old woman shows a small well circumscribed round opacity in the right retro diaphragmatic region. (b) Lateral radiograph localized the opacity in posterior costophrenic sulcus (black arrow). (c) A CT later done shows it to be a fat containing hamartoma (white arrow).

*References:* Khoo Teck Puat Hospital - Singapore/SG
7. **Infra diaphragmatic region:** A chest radiograph also includes a portion of upper abdomen. Lucencies under diaphragm are more important than opacities. Free air from hollow viscus perforation and abscesses (Fig. 13 on page ) should be kept in mind while reviewing this region. A chilaiditi variant can be easily distinguished from a hepatic abscess or pneumoperitoneum.

![Fig. 13: 73-year-old man presented to emergency department with septic shock. (a) Chest radiograph shows a air-fluid level in right upper quadrant of abdomen without any abnormality in lungs. (b) Unenhanced coronal CT image of abdomen demonstrates a large air containing liver abscess.](image)

**References:** Khoo Teck Puat Hospital - Singapore/SG

8. **Bones:** The large bony thorax poses a huge challenge to radiologist. Clinical information about trauma, tenderness or focal swelling is very helpful for a reader to focus on the area of interest.

**Conclusion**

The radiologists should be aware of areas, where the pathologies are commonly missed on chest radiograph. This can help in early identification of malignant lung lesions which improve the prognosis of lung cancer. Accurate identification of benign lesions also helps in cost cutting and saving discomfort to patients from unnecessary investigations.
Fig. 1: Normal chest radiograph marked with review areas: (1) Lower neck, (2) Lung apices, (3) Superior mediastinum, (4) Hilum, (5) Retro cardiac region, (6) Retro disphragmatic region and (7) Infra diaphragmatic region.
References


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