What’s Lurking in the Shadows?

A Pictorial Review of Blind Spots on Chest Radiographs

and the Perils of Overlooking Them

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• None
Objectives

• Provide a brief review of perceptual errors in radiology with focus on chest radiography

• Discuss malpractice implications of perceptual errors in chest radiography

• Provide a pictorial review of common “blind spots” on PA (or AP) and lateral chest radiographs (CXR) with emphasis on missed neoplasms
  • Present a series of cases that viewers can take as unknowns
  • Serves as introduction for radiology trainees and refresher for experienced radiologists

• Describe methods for reducing perceptual errors
Interpretive error:
The perils of neglecting blind spots

• Errors in interpretation:
  • Most common cause of malpractice suits against radiologists, far more so than communication errors and others [1, 2]
  • Can result in patient harm, litigation, and distress to both patients and radiologists

• Perceptual errors account for approximately 60 to 80% of interpretive errors [3], many resulting in missed diagnoses therefore potential harm to patients

• Even when errors and malpractice actions do not result in claims, physicians may suffer from significant error related stress [4]:
  • Anxiety about future errors
  • Loss of confidence
  • Sleeping difficulties
  • Loss of job satisfaction
  • Feared harm to reputation
Malpractice in chest radiology: The perils of neglecting blind spots

- Overall, missed breast cancer is most common missed diagnosis resulting in malpractice suits against radiologists, followed by missed fractures, then missed lung cancers [1]

- Majority of malpractice suits in chest radiology relate to missed lung cancers [2] and, in a 1999 study, 90% were due to errors in CXR interpretation [5]

- Despite increased use of cross sectional imaging, CXR remain the most commonly ordered imaging study, therefore radiologists must remain proficient

### Chest specific malpractice claims [2]

<table>
<thead>
<tr>
<th>Condition</th>
<th>Claims</th>
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<tbody>
<tr>
<td>Lung cancer</td>
<td>42.5</td>
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<tr>
<td>Dissection</td>
<td>7.1</td>
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<tr>
<td>Foreign body</td>
<td>6.1</td>
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<td>4.9</td>
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<tr>
<td>Other complication</td>
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<td>Lymphoma</td>
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<tr>
<td>Myocardial infarction</td>
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<tr>
<td>Fracture - rib</td>
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<tr>
<td>Other</td>
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</table>
Perceptual Error and Lesion Detectability

Perceptual Error [3]

- **Recognition**: Failure to recognize object; may occur due to insufficient dwell time
- **Decision Making**: Radiologist dwells on finding but fails to recognize concerning features or dismisses them
- **Satisfaction of Search**: Once radiologist sees one abnormality, becomes satisfied and fails to continue search

Lesion Detectability: Limitations on CXR

- Small lesion size
- Low lesion attenuation
- Ill-defined lesion margins
Common Blind Spots on PA and Lateral Chest Radiographs

Apices
Beneath ribs
Paratracheal regions
Suprahilar regions
Hilar regions
Infralobar regions
Retrocardiac regions
Beneath diaphragms

Upper lobes (posterior and apical)
Over spine
Over heart (particularly superiorly)
The following cases illustrate the most common blind spots, focusing on missed neoplasms in lungs and bones. A comprehensive review of all radiographic blind spots (e.g. mediastinum, trachea, chest wall soft tissues) is beyond the scope of this presentation.

Take them as unknowns and evaluate each image for 6 seconds to determine lesion location – do not click until the lesion is revealed.
Case One

Evaluate the left image for 6 seconds to find the lesion - do not click.
Apical lesions:
- Among most commonly overlooked [6, 7]
- Many overlapping bones
- Common location for lung cancers
- Be sure to focus on apices and compare for symmetry; any asymmetry, particularly in density, should alert to possible lesion

Case One (upper images):
Frontal CXR shows subtle lesion under first right rib (arrow). Spiculated nodule shown on CT. Biopsy showed moderately differentiated adenocarcinoma.

Companion case (lower images):
Beware the missing rib! AP CXR shows absence of third left rib (oval). Corresponding CT shows destructive soft tissue mass in the 3rd left posterior rib as well as asymmetric left apical opacity. Can be more difficult to identify what is missing than what is extra, especially in apices. Metastatic anal carcinoma.
Case Two

Evaluate the left image for 6 seconds to find the lesion – do not click.
Case Two: AP CXR shows faint, peripheral lesion under the overlap point of right anterior 2\textsuperscript{nd} and posterior 5\textsuperscript{th} ribs (arrow). Coronal CT image shows spiculated right upper lobe nodule (arrow). Non-small cell lung carcinoma.

Lesions under bones:
- Bones are a formidable obstacle to lesion detection, which obscured 98% of missed lesions in one series [7]
- Ribs and clavicles are particularly treacherous, especially where they overlap
Case Three

Evaluate the left image for 6 seconds to find the lesion – do not click.
Case Three: PA and lateral CXR shows nodule under right hemidiaphragm (arrow), not visible on lateral projection. No diagnosis. Nodule was present on chest radiograph performed 7 years prior therefore presumed to be benign. Nodule is well demonstrated on corresponding coronal CT image (arrow).

Subdiaphragmatic Lesions:
- Inferior lung bases extend well below the diaphragm
- In one series, 14% of missed nodules were in the inferior lung bases [8]
- Remember to scan beneath the diaphragm
Case Four

Evaluate the left image for 6 seconds to find the lesion – do not click.
Case Four: Several nodules are visible on the PA view (arrows). None was evident on the lateral view (not shown). Axial CT images correspond to three lesions shown on chest radiograph (arrows are color coded). On FDG-PET, only the left lower lobe lesion was FDG-avid and proved to be lung carcinoma.

Chest Wall Hardware:
• Can obscure lesion outright or create distraction, limiting evaluation of immediate surroundings
• Lateral view may be helpful

Satisfaction of search:
• Beware satisfaction of search! Several lesions present in this case, only one FDG-avid on PET
Case Five

Evaluate PA and lateral views for 6 seconds to find the lesion – do not click.
Case Five (upper images): PA and lateral views show right apical lesion (arrows). Spiculated nodule on corresponding axial CT image (arrow) was FDG-avid on PET.

Paratracheal regions:
- Can also obscure lesions arising in regions superimposed upon them, as in this case
- Lymphadenopathy or masses arising in paratracheal lesions can easily evade detection due to lack of contrast with adjacent mediastinum (arrows, companion case)
- Be aware of any paratracheal stripe thickening on the PA view

Companion case (lower images): Beware the paratracheal regions! Lobulated right paratracheal contour (arrow) on PA view corresponded to right suprahilar mass and paratracheal adenopathy on corresponding CT (arrow).
Case Six

Evaluate the left image for 6 seconds to find the lesion – do not click.
Case Six (upper images): 73 year old with brain metastases from unknown primary. Pre-op CXR shows an extra lobulated density overlying the right hilum (arrow) that could be mistaken for vessel. Corresponding CT shows spiculated right lower lobe nodule (arrow), lung carcinoma.

Companion case (lower images): Frontal CXR shows asymmetric left hilar density (arrow). Corresponding CT shows spiculated left lower lobe mass (arrow), lung carcinoma.

Hila:
- A common location for perceptual errors in chest radiography [8]
- The hila are asymmetric in location and, to some extent, in contour.
- Carefully scrutinize the hila and compare for any extra contours and/or asymmetry in density.
Case Seven

Evaluate the left image for 6 seconds to find the lesion – do not click.
Case Seven (upper images): 73 yo F presented with neurologic symptoms, MR showed left frontal lobe mass, NSCLC. Frontal view of the chest shows subtle right infrahilar opacity (arrow). Corresponding CT shows the primary lung carcinoma (arrow). The lesion is strongly FDG-avid on PET.

Companion case (lower images): Retrocardiac lesions also challenging - poor contrast with soft tissue lesions, particularly on portable CXR. Portable AP view (left image) shows subtle retrocardiac mass (arrow), better seen on repeat AP CXR (middle image) and corresponding CT.

Infrahilar Regions:
- Confusing due to hilar vessels and overall busy appearance
- Infrahilar regions should contain lung and vessels; any extra density should prompt meticulous evaluation and, in uncertain cases, cross sectional imaging.
Case Eight

Evaluate the PA and lateral views for 6 seconds to find the lesion – do not click.
Case Eight: Lesion representing hepatocellular carcinoma metastasis (arrows) is better visualized on the lateral view (middle image), easily overlooked on the PA view due to paratracheal location (left image). However, lesions in the posterior upper lobes can also be difficult to visualize even on the lateral view.

Lateral Projection: Upper Lung Zone
- In a small number of cases, lesions may be visible only on the lateral view [6, 7]
- Upper lobe lesions (particularly posterior) can be difficult to visualize on the lateral projection due to extensive overlapping bone (ribs, scapulae, spine).
Case Nine

Evaluate the left image for 6 seconds to find the lesion – do not click.
Case Nine (upper images):
History of T cell lymphoma. Subtle mass in paravertebral region visible only on the lateral view (arrow) represents lymphoma. Corresponding sagittal and axial images show the soft tissue mass (arrows).

Companion case (lower images): Mass is well seen overlying spine on lateral view (arrow), only very faintly visible on PA view, likely in left hilum (arrow ?). The patient is currently scheduled for CT.

Lateral Projection: Spine
- The spine is a notorious blind spot on the lateral projection
- Should decrease in density from superior to inferior; an increase in density may indicate presence of an abnormality (“spine sign”)
Case Ten

Evaluate the left image for 6 seconds to find the lesion – do not click.
Case Ten (upper images): Well defined retrosternal nodule (arrow) is seen on the lateral CXR, not visible on PA view. Corresponding CT shows left upper lobe carcinoma, strongly FDG-avid on PET.

Companion case (lower images): Mass on lateral projection (arrow) overlies retrosternal space, not convincingly seen on PA view. Sagittal CT image (right image) shows left upper lobe soft tissue mass (arrow).

Lateral Projection: Over heart and in retrosternal space
- Retrosternal space should be clear on the lateral projection
- Cardiac silhouette may obscure soft tissue lesions due to its similar density
Case Eleven

Evaluate both frontal radiographs, performed on the same patient 3 years apart.

Chest radiograph performed in 2005

Chest radiograph performed in 2008
Case Eleven: 2005 PA CXR shows mild opacity in the left suprahilar region (arrow), which progresses to extensive left lung consolidation over several years, seen on 2008 PA CXR. Multifocal bronchogenic adenocarcinoma. Corresponding axial CT images (bottom images) demonstrate similar findings as the CXR's, findings which can be mistaken for pneumonia.

Hiding in plain sight:
Beware any nonresolving pulmonary consolidation or ground glass opacity. Adenocarcinoma can masquerade as pneumonia.
Methods for Reducing Perceptual Errors [3, 9]

Practice habits and non-electronic systems approaches

• Employ a systematic search of blind spots on chest radiographs

• Resist satisfaction of search: continue your systematic search, even after an abnormality is detected

• Decrease work load and interpretive speed: average number of images requiring interpretation has increased dramatically and decreases accuracy

• Minimize distractions in reading room when possible: Several studies have shown increase in error rate related to distractions during interpretation time

• Double reading: a known method for reducing error; costly, therefore not routinely performed, but should be utilized in complex cases

• Systematic Feedback: “Missed case” or discrepancy conferences and multidisciplinary conferences

Electronic and IT systems solutions

• Electronic Peer Review: Use of electronic peer review products

• Use of structured report templates: Encourages adherence to systematic search pattern

• Electronic medical record: May contain relevant history not provided by referring provider

• Bone subtraction and computer aided detection software
Conclusions

• Errors in interpretation are the most common cause for malpractice actions against radiologists, and perceptual errors are the most common type of interpretive error, with potential for significant patient harm and radiologist stress.

• Missed lung cancers are the most common cause of malpractice suits related to chest radiology.

• Chest radiographs remain the most commonly ordered imaging study and pose many interpretive challenges, harboring several blind spots.

• The dangers of chest radiographic blind spots can be mitigated through use of a systematic search on both the frontal and lateral views.

• Additional methods exist for decreasing interpretive errors including solutions related to practice habits and systems solutions.
References


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