Chest Ultrasound:
Pneumothorax

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Outline

- Probe positioning/scanning
- Normal findings
- Ultrasound diagnosis of pneumothorax
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Lung Ultrasound
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Important landmarks: the INTERCOSTAL SPACE

LONGITUDINAL SCAN

If you consider the orientation of the ribs and the need to have the probe in the intercostal space, longitudinal scans will actually be orthogonal to the intercostal space.
Important landmarks: the INTERCOSTAL SPACE

What to look at: first of all identify the intercostal space. With a longitudinal scan, it appears delimited by the ribs and their shadows. This is named (by the phantasy of Dr. Lichtenstein) as “bat sign”.

- The bat sign indicates appropriate probe positioning:
  - upper rib
  - lower rib
  - intercostal space
Normal findings

- Pleural Line
- Pleural Sliding
- A lines
- B line (artifact)

Normal semiology of the healthy lung is represented exclusively by artifacts. These are 3:

1. A transversal hyperechoic line in the intercostal space, placed 1 or half centimeter below the outer surface of the ribs, the so called **pleural line** (this is the physical site of the tissue-air interface, represented by the parietal and visceral pleura in touch)
2. The motion of this line with respiration, seen as a sort of glittering. This is called **pleural sliding or gliding** (it derives from the continual coming and going of the visceral pleura with the tide of lung inflation and deflation)
3. Transversal hyperechoic artifacts, parallel to the pleural line and placed at a regular distance which is a multiple of the distance between the probe footprint and the pleural line itself. This are called **A lines**.

Pleural sliding when minimal can be anyway appreciated with M-Mode. If we hold steadily the probe on the chest, pre-pleural tissues are viewed with M-Mode as steady dots always at the same depth, appearing on the time scale as straight lines. The moving visceral pleura, with its natural irregularity, viceversa generates non aligned artifactual dots, represented on the time scale as irregular lines.
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The Pleural Line

- **Probe**
  - High frequency (vascular)
  - Microconvex probe
- **Probe position** – longitudinal scan, **perpendicular** to ribs (up/down chest)
- **Pleural line:**
  - Hyperechoic (white)
  - Slightly horizontal
    - ≈ 0.5 cm below rib line
    - Reflects soft tissue/lung tissue interface
    - Lung/chest wall interface

Probe: commonly the vascular probe is used, however, a small footprint microconvex or high frequency convex probes are very good as well.
THE PLEURAL LINE

Rib shadow

Rib shadow
THE PLEURAL LINE

Rib shadow

Pleural line

Rib shadow
Sliding Sign

- Sliding of visceral pleura against the parietal pleura
- To-and-fro movement visible at pleural line
- Caused by inspiratory excursion of the lung toward the abdomen
- Observed in ventilated or healthy patients regardless of age and body habitus
- May be absent in Apex
Sliding Sign
Sliding Sign
Seashore Sign
Seashore Sign

Pleural line
A line (artifact)

- An artifact observed in
  - Normal lungs
  - Certain diseased lungs
  - Pneumothorax

- Roughly horizontal, hyperechoic line

- Parallel to the pleural line and arising below it

- Arising at a distance equal to the distance between the skin and the pleural line
B line (artifact)

- Seen in diseased lungs
- Roughly vertical, comet-tail artifact
  - Arises from the pleural line
  - Well-defined (laser-beam-like)
  - Spread to the edge of the screen without fading
  - Erase A lines
  - Moves with lung sliding

- Lung rockets: several simultaneously visible B lines
B line (artifact)

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B line (artifact)
Pneumothorax
Pneumothorax

- Daily concern in the ICU – estimated rate of 6%\[^1\]
- Missed pneumothorax – high risk for complications
- Excessive search for pneumothorax
  - ↑ irradiation
  - ↑ cost
  - Delays in management
- Diagnosis
  - CT – gold standard (expense, ICU logistics)
  - CXR – 30% missing rate in initial radiography\[^2\]
    - ½ will develop to tension pneumothorax\[^3\]
    - Tension pneumothorax – radioccult in a bedside CXR\[^4\]

3. Am J Roentgenol 1985;144:901
4. Radiology 1982;142:15
Pneumothorax

- **U/S** – the new modality for diagnosis of pneumothorax
  - Availability
  - Bedside
  - Cost

- Superior to bedside CXR for detection of pneumothorax

5. Radiology 2002;225:210
6. J Trauma 2001;50:750
step 1: absent sliding sign

Pleural line
step 1: absent sliding sign

Pleural line
step 1: absent sliding sign

Pleural line
Stratosphere Sign (bar code sign)
Lung Sliding - Significance

- Lung sliding present – NO PNEUMOTHORAX (100%!!)
  - Negative predictive value – 100%

- False positive: disease process preventing lung sliding
  - ARDS
  - Significant pneumonia
  - Pulmonary fibrosis
  - Pleurodesis (acute, chronic)
  - Acute asthma

*Chest 1995;108:1345*
Lung Sliding – Caution

- Can only comment on level scanned
- Need to scan entire chest (anterior in supine position)
Step 2: Look for other artifacts

- **B lines**
  - **Present:** no pneumothorax (visceral pleura in contact with chest wall)
  - **Not present:** look for other signs (lung point)

- **A lines**
  - present in normal lung
  - Pneumothorax
Step 2: look for other artifacts

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- **A lines**
  - present in normal lung
  - Pneumothorax
    - Not useful
lungs point

- All or none phenomenon

- Characteristics
  - Precise moment of respiration (usually inspiration)
  - Findings of signs (lung sliding, rockets, B lines) in an area previously observed with no lung sliding
  - Sensitivity – 66%, specificity – 100%*

- Etiology: Re-appearance of artifacts at the boundary area

*Intensive Care Med 26;1434
lung point
lung point
the “blue” protocol
Take Home Points

- Lung sliding rules out pneumothorax or effusion at that area
- B lines (comet tail, rockets) rules out pneumothorax
- Addition of M mode can help when lung sliding and B lines are hard to see
- Absence of sliding and B lines could be anything that blocks pleural interaction
Questions