

Lung ultrasound in the critically ill

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Lung Ultrasound

- Introduction
- Equipment and Examination Techniques
- Normal Findings
- Pneumothorax
- Pleural Effusion

Lung Ultrasound

- **Introduction**
- Equipment and Examination Techniques
- Normal Findings
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Introduction

- Diagnostic imaging is essential when dealing with a critically ill patient
- CXRs are only performed on patients in the supine position.
- These circumstances may result in diagnostic errors regarding pleural effusions, parenchymal consolidation, and alveolar-interstitial syndrome

Introduction

- CT scan assures accurate diagnosis of pneumothorax (PNX), pleural effusion, lung consolidation.
- The patient need to be transported to a CT unit:
 - Risky
 - Requires cardio-respiratory monitoring
 - Medical assistance.

Why Use Lung Ultrasound?

- Increasingly “standard of care” issue
- Really informative
- Negative findings also important
- Interesting and challenging
- Enjoyable!

Why Use Lung Ultrasound?

- Relatively easy
- Bedside examination
- User-friendly, inexpensive
- Portable equipment
- Offers accurate information that is of therapeutic and diagnostic relevance.

Lung Ultrasound

- Introduction
- **Equipment and Examination Techniques**
- Normal Findings
- Pneumothorax
- Pleural Effusion

Equipment and Examination Techniques

- Convex transducer, 3–5 MHz
 - Deep lung structures
- High-frequency 5–12 MHz linear probe
 - chest wall, pleura, and the lung peripheral parenchyma.

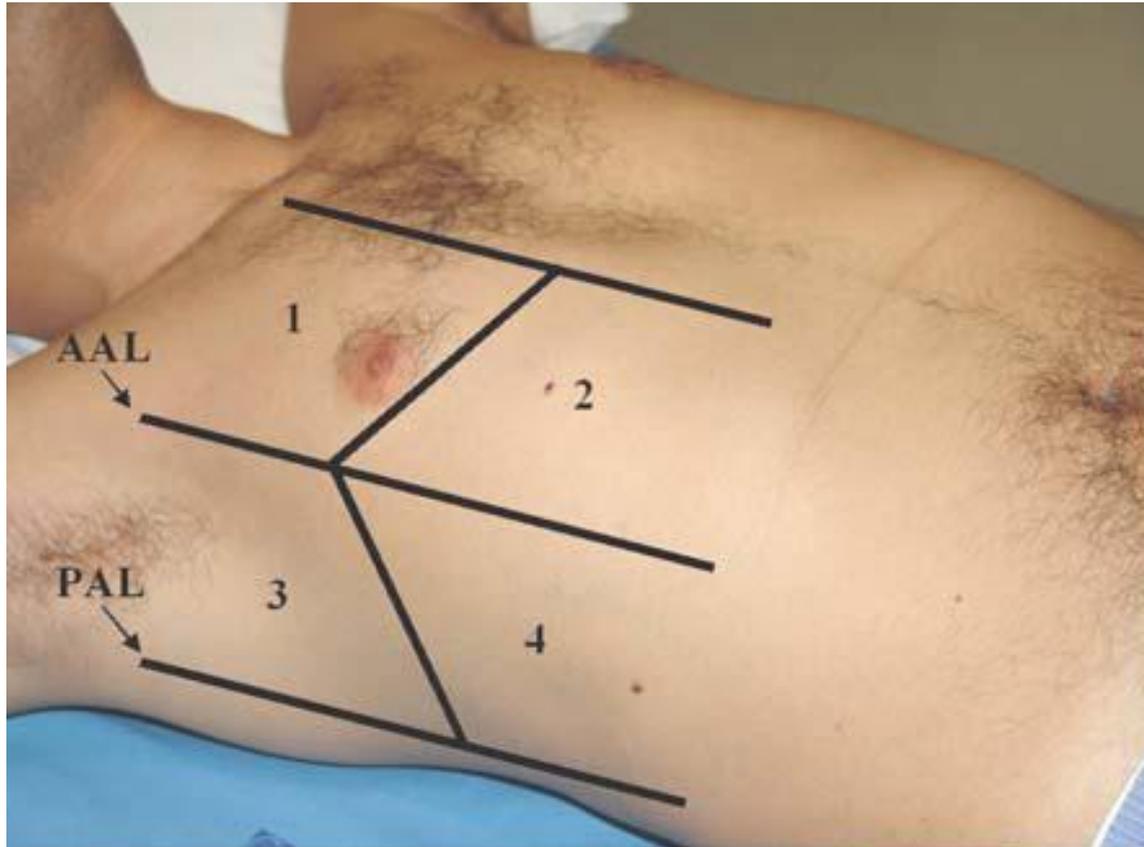


Equipment and Examination Techniques

A complete examination of the chest requires:

- Longitudinal, transversal, and oblique-array probes to be placed along the rib spaces
- Proceeding from top to bottom
- Ventral-dorsal direction
- Along parasternal, medial clavicular, anterior axillary, medial, and posterior lines.

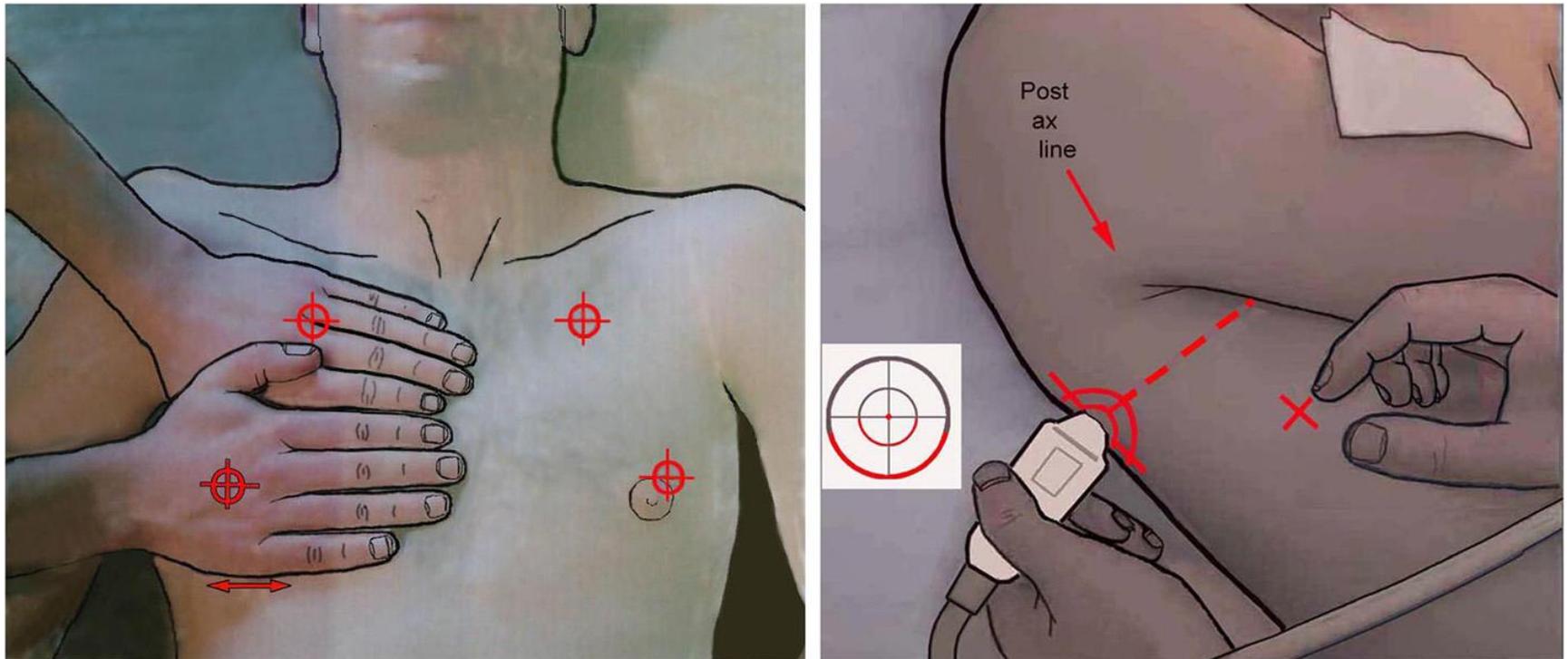
Equipment and Examination Techniques



Scanning Positions

Equipment and Examination Techniques

Areas of investigation and the BLUE-points



Extract from “Whole body ultrasonography in the critically ill” (2010 Ed, Chapter 14)

Normal Findings

Seven principles of lung ultrasound

- 1) LUS performed using simple equipment.
- 2) In the thorax, gas and fluids have opposite locations, generating artifacts.
- 3) The lung is the most voluminous organ. Standardized areas can be defined.

Lichtenstein D, Mezière G: The BLUE-points: three standardized points used in the BLUE-protocol for ultrasound assessment of the lung in acute respiratory failure. Crit Ultrasound J 2011, 3:109–110.

Normal Findings

- 4) All signs arise from the pleural line.
- 5) Static signs are mainly artifactual.
- 6) The signs arising from the pleural line are foremost dynamic.
- 7) Almost all acute life-threatening disorders about the pleural line.

Lichtenstein D: Whole body ultrasonography in the critically ill. 2010th edition. Heidelberg, Berlin, New York: Springer-Verlag.

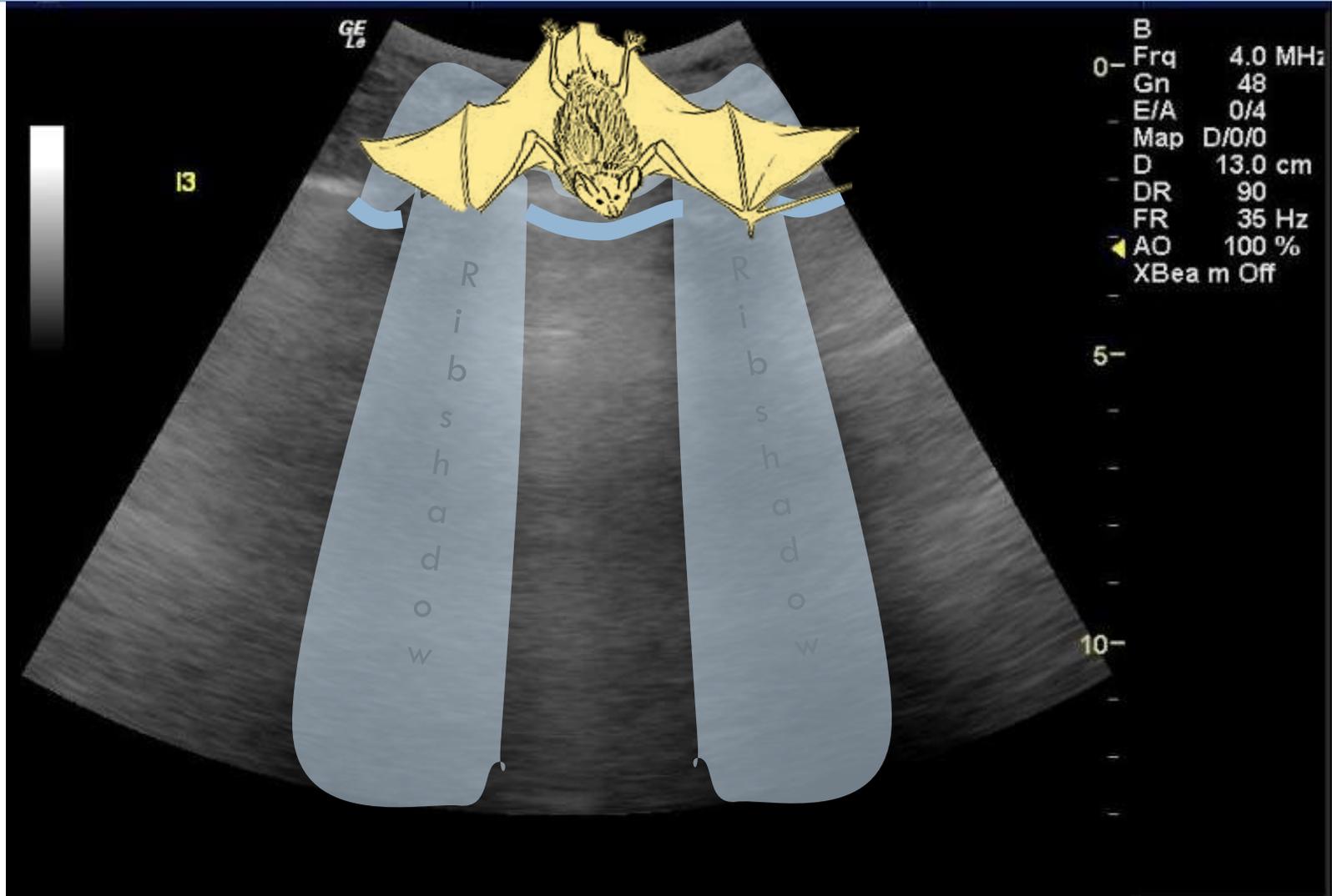
Lichtenstein D: Classification of artifacts. In Whole Body Ultrasonography in the Critically Ill. Edited by. Heidelberg, Berlin, New York: Springer-Verlag; 2010:185–188.

Normal Findings

The pleural line generates the “bat sign” a permanent landmark indicating the parietal pleura



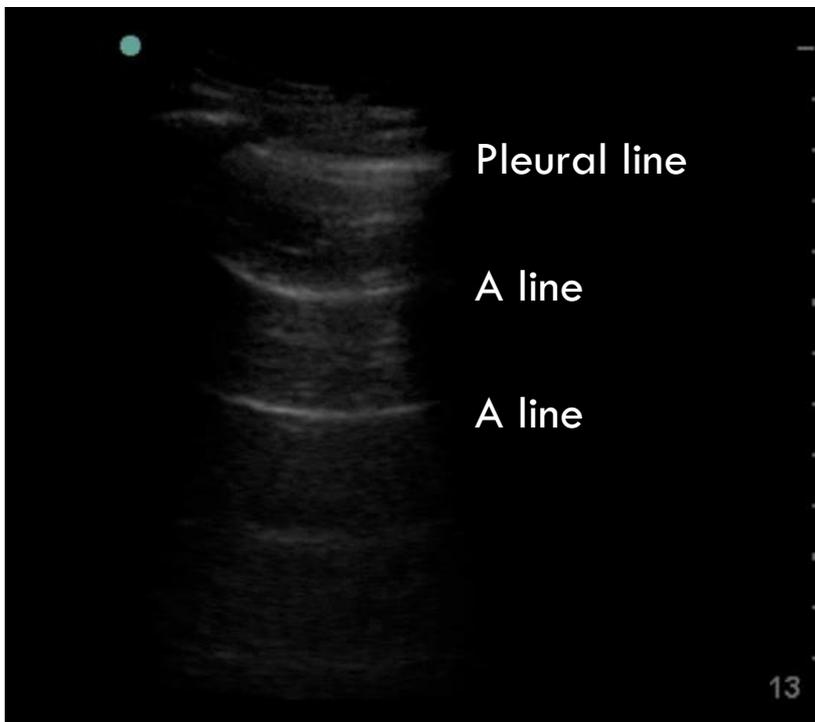
Normal Findings



Normal Findings

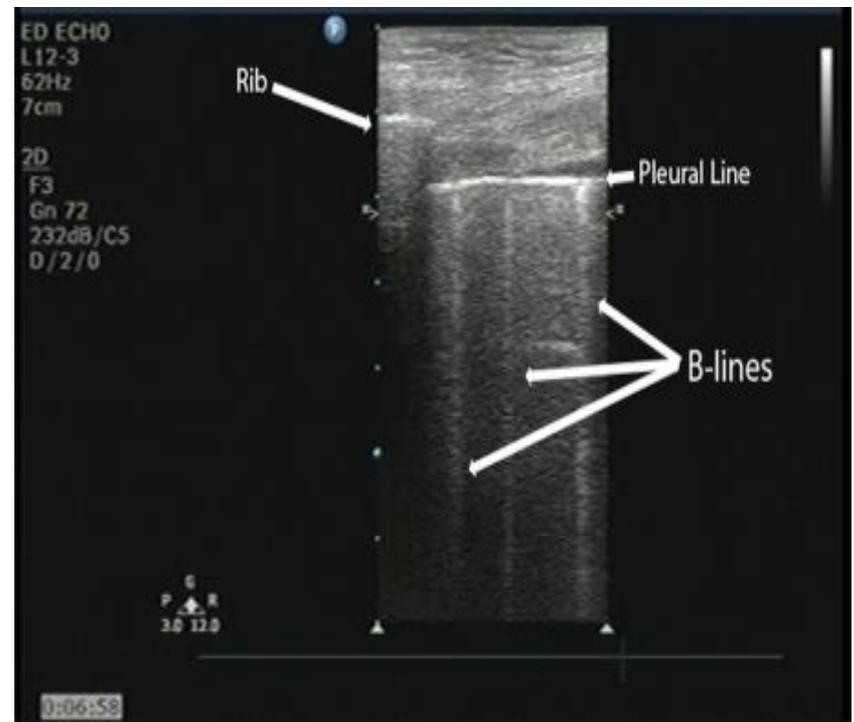
A lines

- Typical reverberation artifacts
- Linear images
- Parallel to the pleural

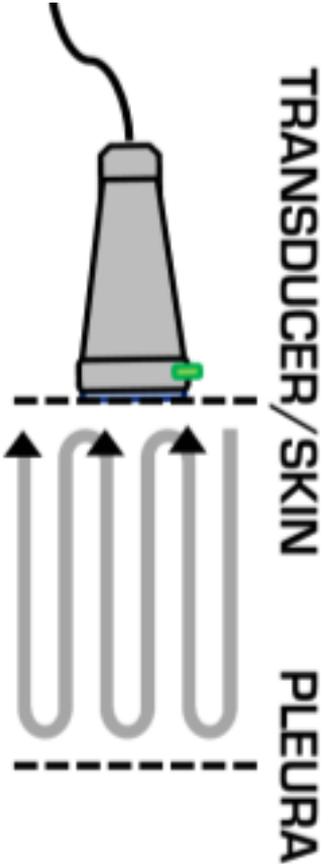


B lines

- Vertical narrow bands from pleural line to edge of screen
- Obliterate the A line



A Lines





Crd
P17



CF
85%
3
40

MI
0.7



10

Time

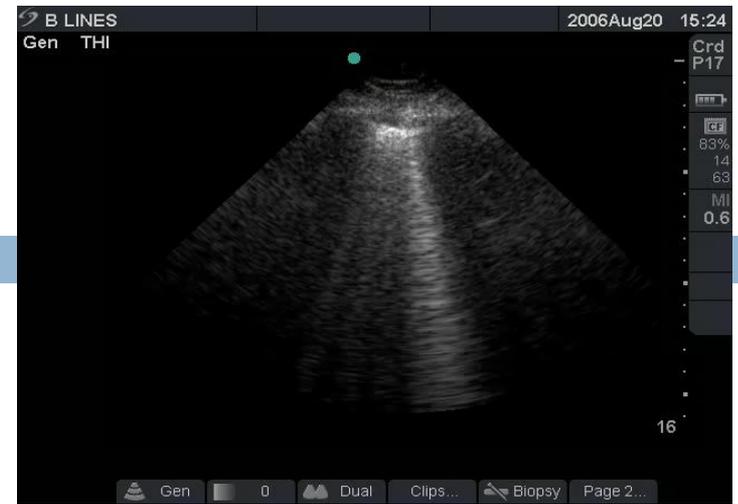
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PrevOff

Pro

Back...

B lines



- Vertical, hyperechoic rays projecting from pleural line (ring down artifact)
- Extend to the bottom of screen
- Reflects fluid in the interlobular septum

B LINES

2006 Aug 20 15:24

Gen THI

Crd
P17



CF

83%

14

63

MI

0.6

16



Gen



0



Dual

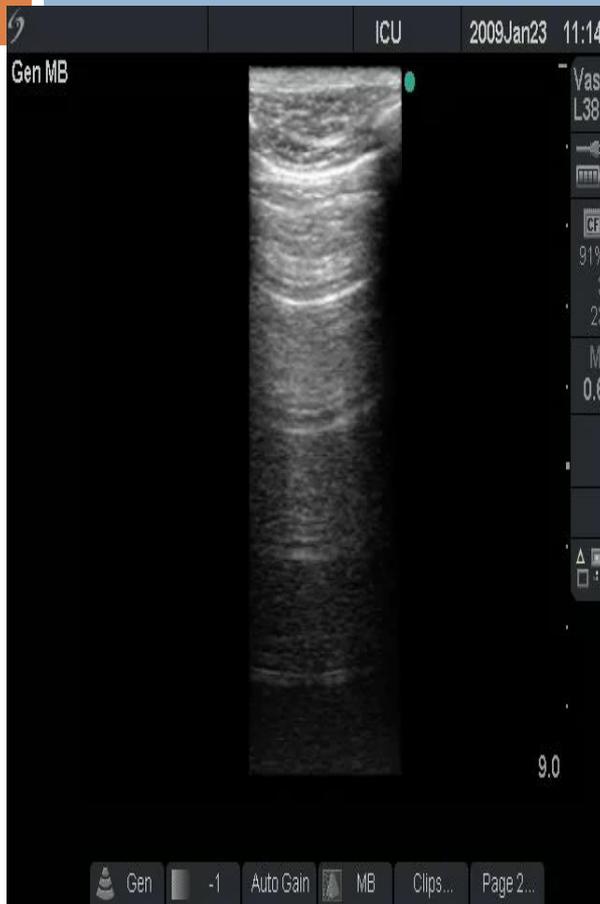
Clips...



Biopsy

Page 2...

A lines vs. B lines



Normal Findings

Pleural sliding (lung sliding sign)

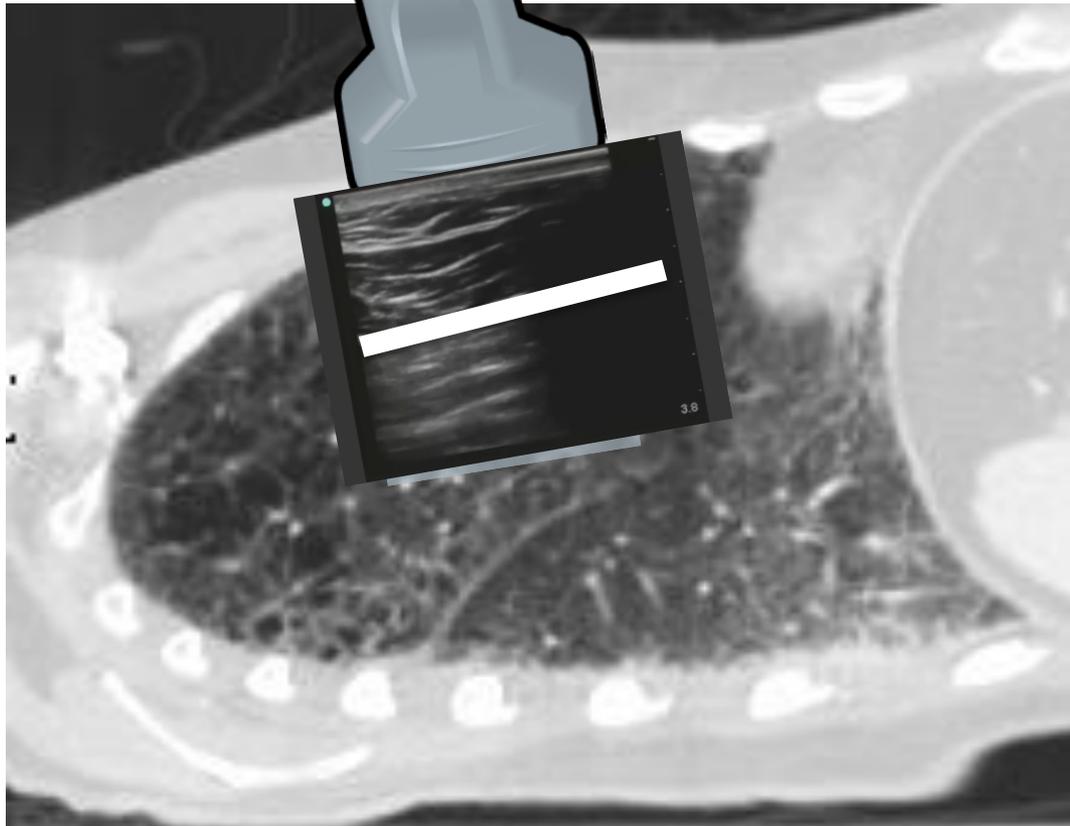
- Indicates that the pleural line contains the visceral pleura
- Greatest in lower thorax (greatest expansion)

M-mode “seashore sign”

- Structures superficial to pleural line are static horizontal lines on M-mode = WAVES
- Motion of pleural line is “reflected” deep to it = SAND

2 layers of pleura

Seen as 1 layer



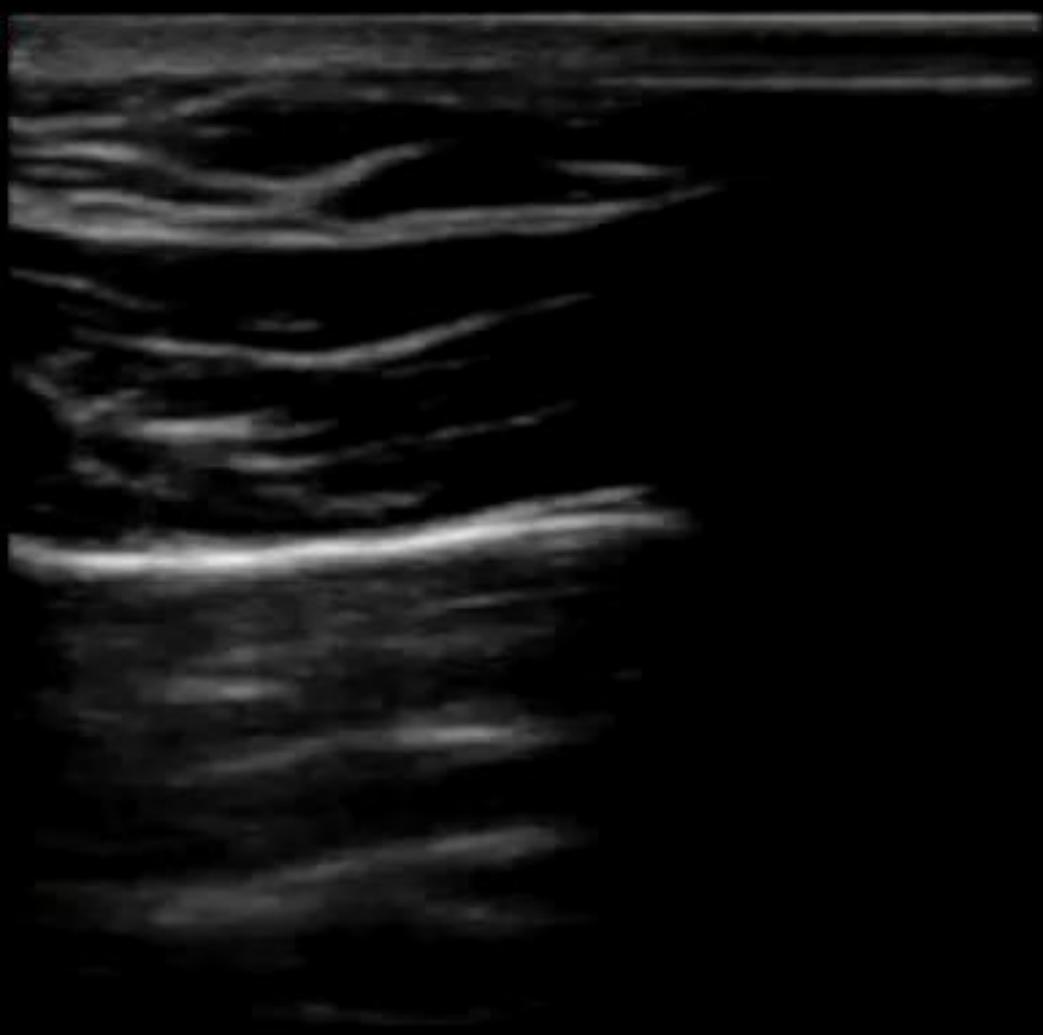
SLIDING





2011Feb15 18:21

Gen
S MB



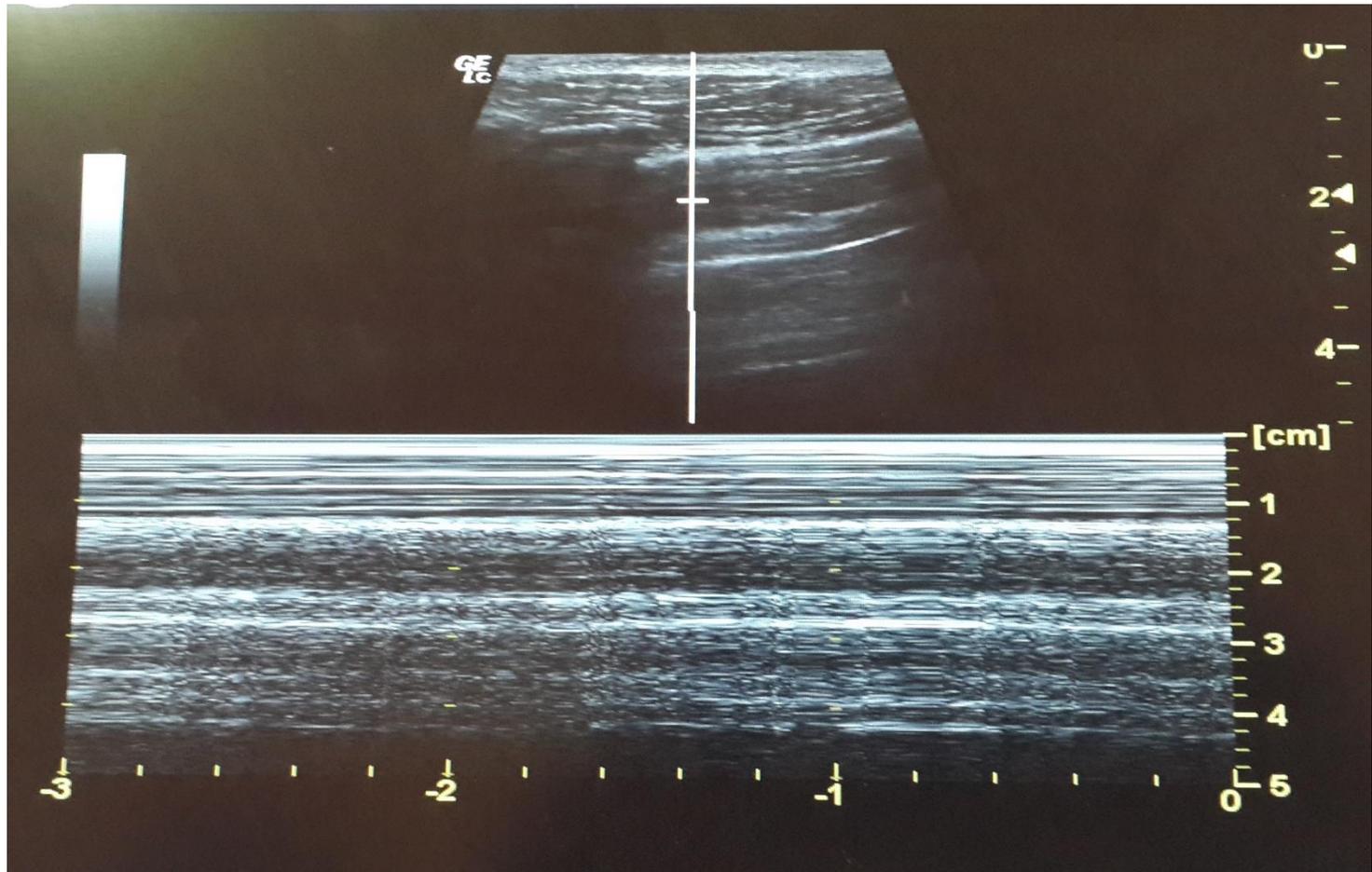
Vas
L38
86%
MI
0.9
TIS
0.2

A
B

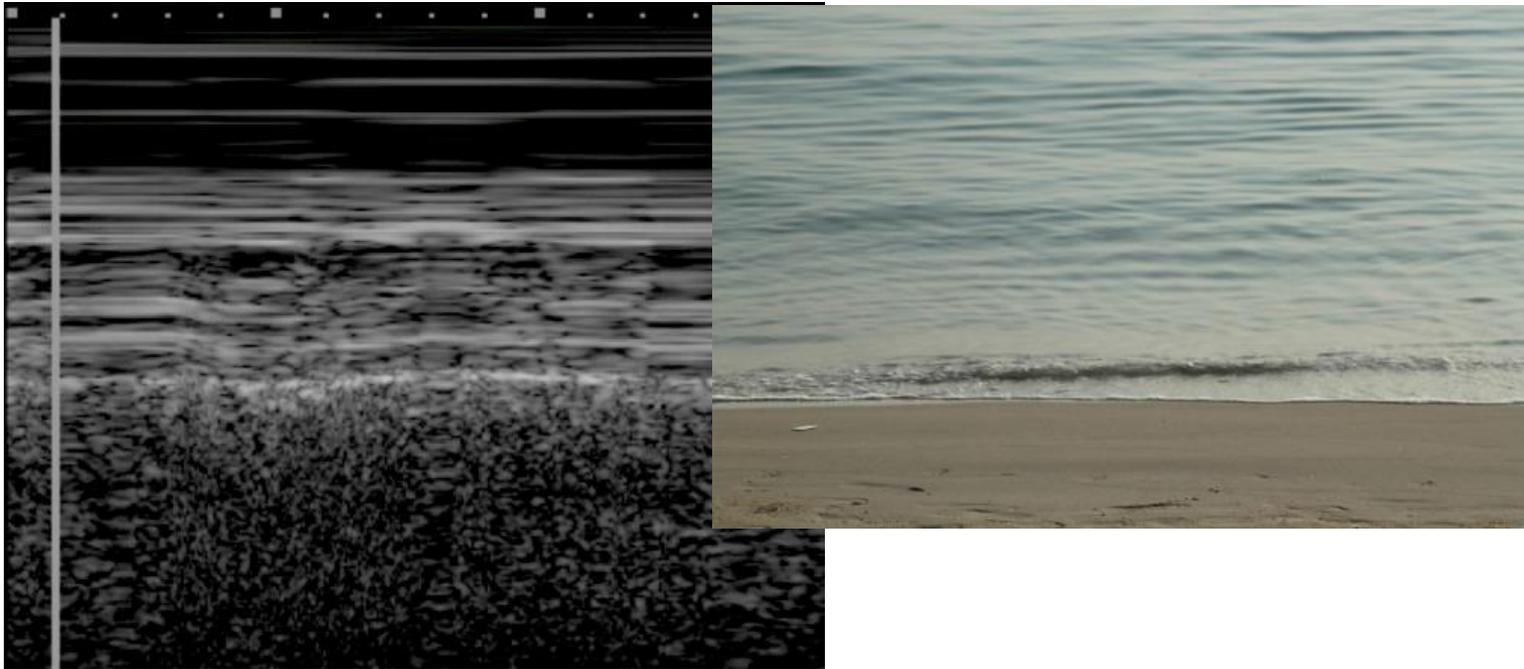
3.8

Normal Findings

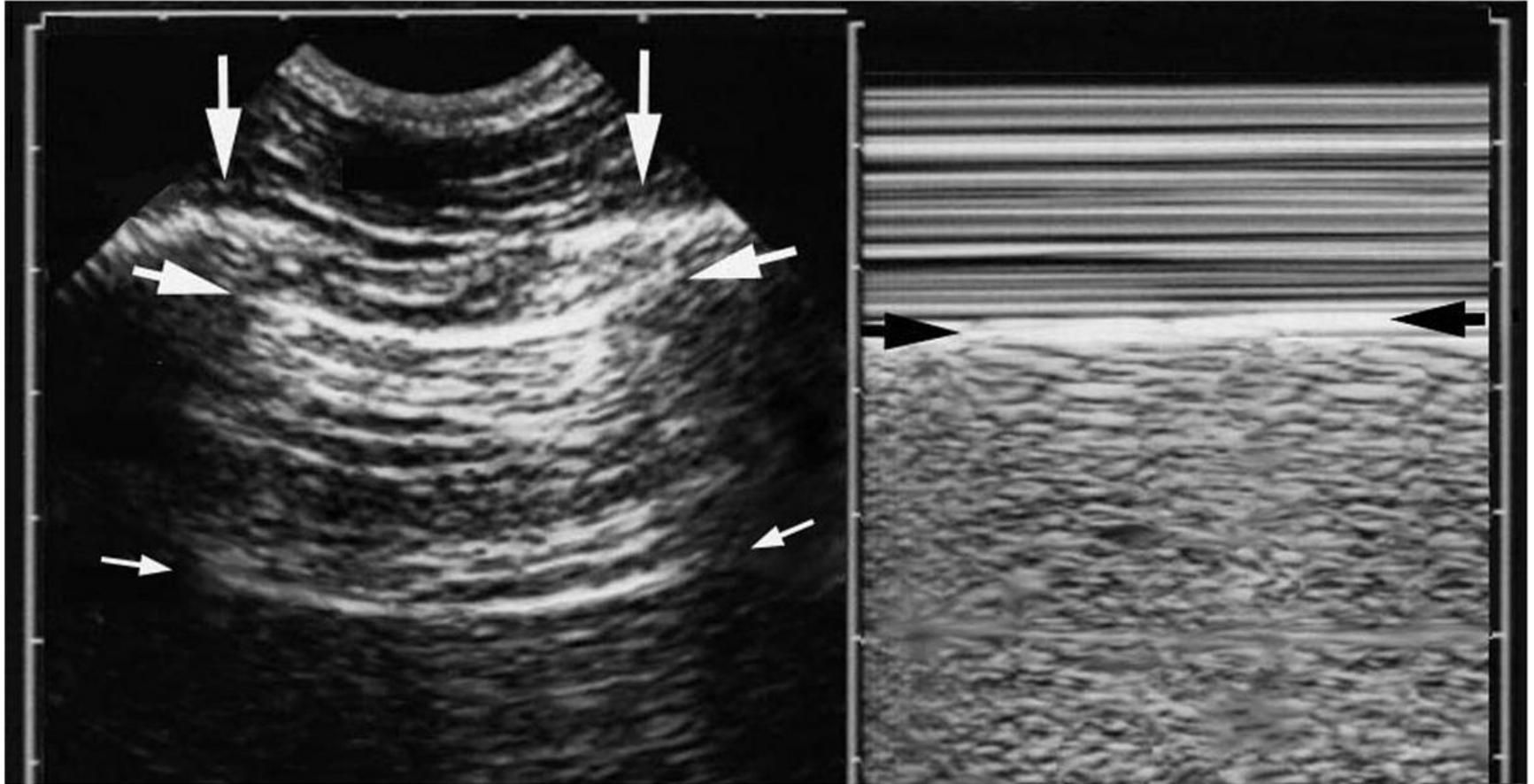
M-mode “seashore sign”



Normal Findings



Normal Findings



Lung Ultrasound

- Introduction
- Equipment and Examination Techniques
- Normal Findings
- **Pneumothorax**
- Pleural Effusion

Pneumothorax

Diagnosis of pneumothorax requires three steps

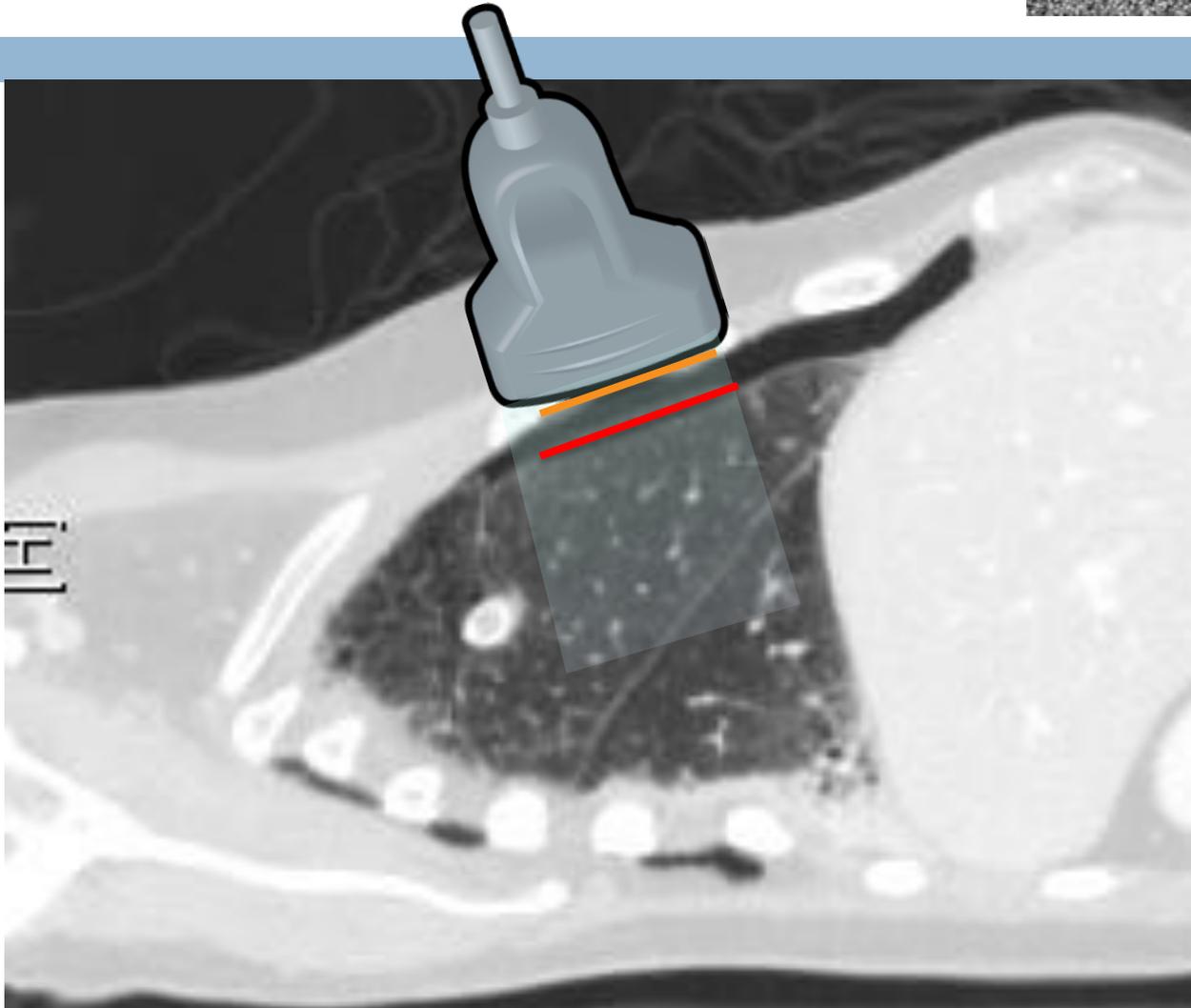
- Abolished lung-sliding
 - 95% sensitivity
 - Pneumothorax generates a completely motionless pleural line using real-time.
 - M-mode shows the stratosphere sign

Pneumothorax

- The A-line sign (i.e., no B-line seen)
 - 60% sensitivity but 100% specificity.
 - One motionless B-line discounts pneumothorax.
 - Abolished lung-sliding plus absence of B-lines, at the anterior area, in supine patients, is called “A'-profile” in the BLUE-protocol

Pneumothorax

- parietal pleura
- visceral pleura
- ▒ intrapleural air



HEMITORAX IZDO

GE
L7



1-
2-
3-
4-



Res
S MB



2012Aug20 19:59

Sup
L25



51%

MI

0.6

TIS

0.2

A

B



4.3



Hide



1/10

U/L

Done

Pneumothorax

- The lung point

- Pathognomonic.

- It shows in patients with an A'-profile, at a precise location, lung signs suddenly appearing with respiration: transient B-lines, lung-sliding

- Explained by the inspiratory increase of parietal contact of the collapsed lung

Lung Point



S

MB



L38



92%

MI

0.9



3.8



8



U/L



Biopsy

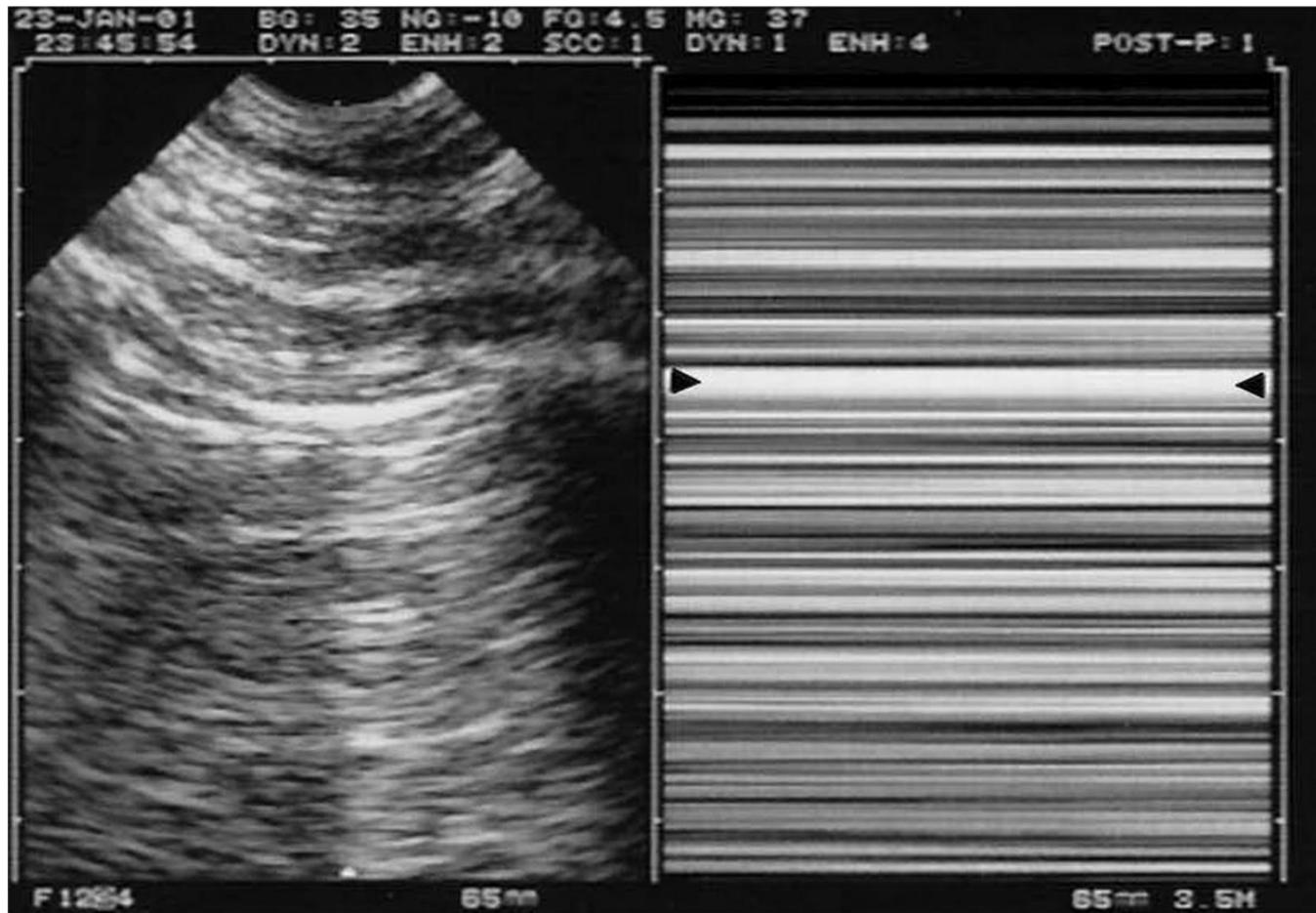
Clips...

Page 2/2

Pneumothorax

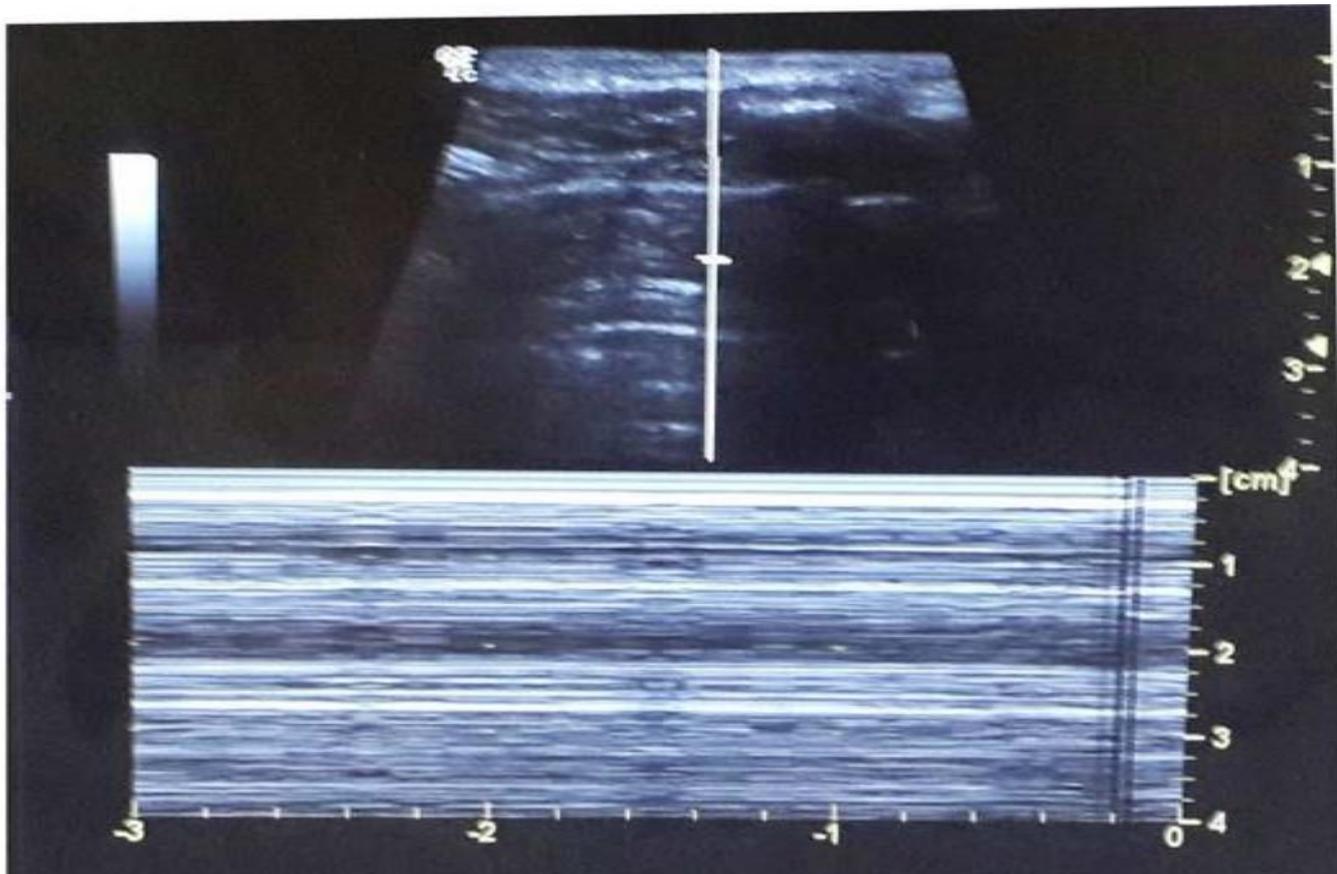
- Seconds are required for well-trained physicians to determine lung-sliding, B-lines, or their absence
- Less than 1 minute to detect a lung-point

Pneumothorax



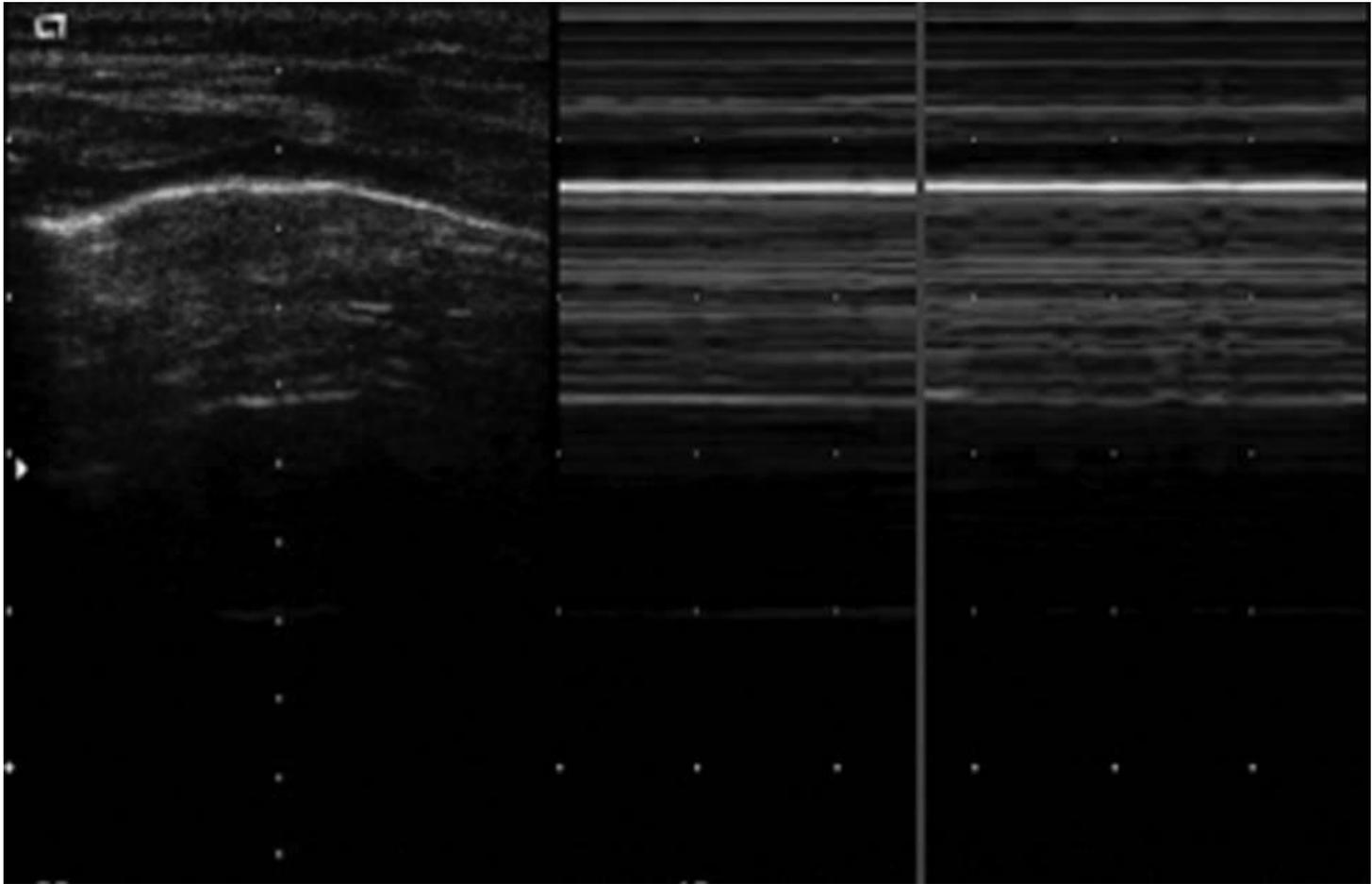
Pneumothorax and the stratosphere sign

Pneumothorax



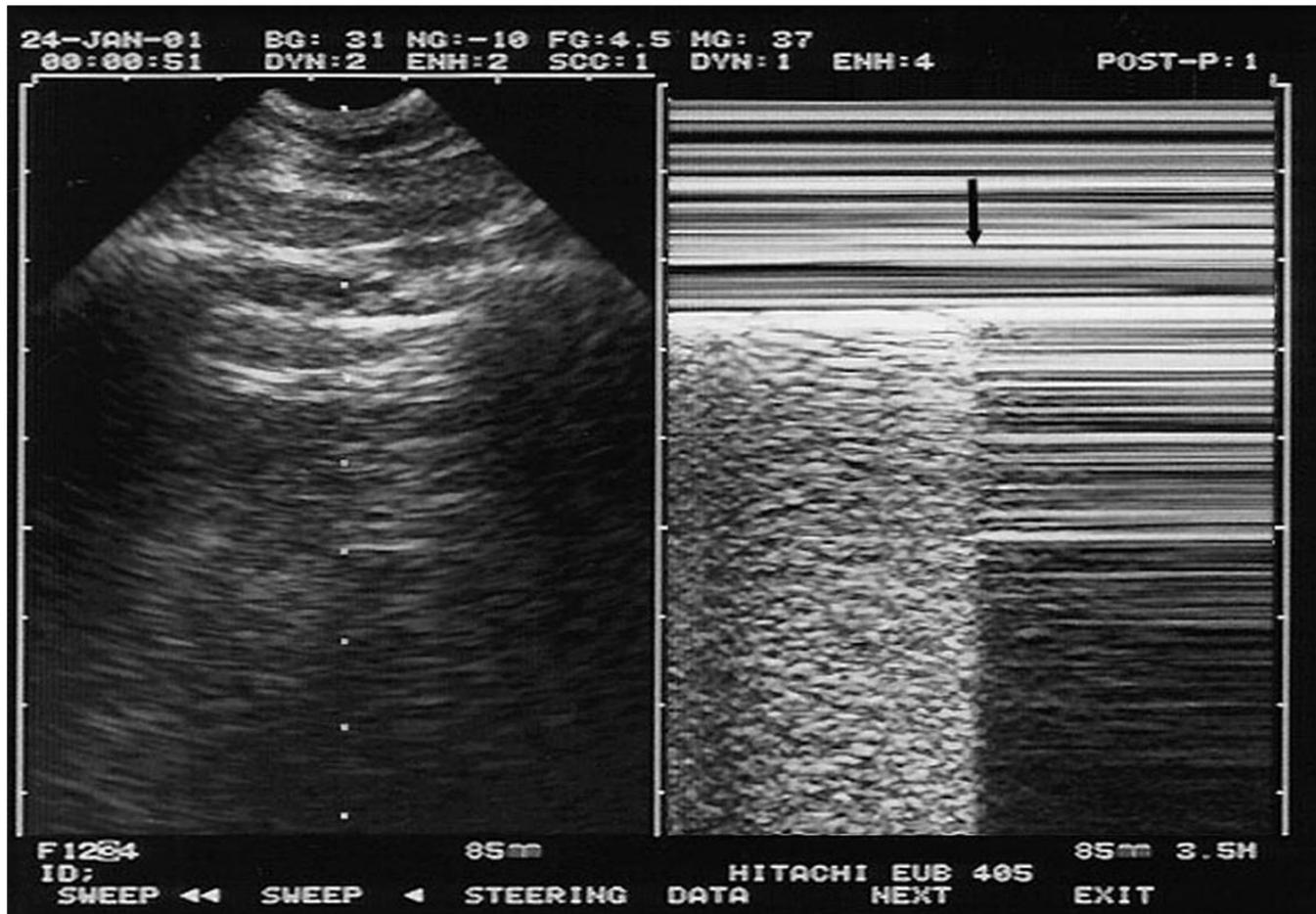
Pneumothorax and the stratosphere sign

Pneumothorax



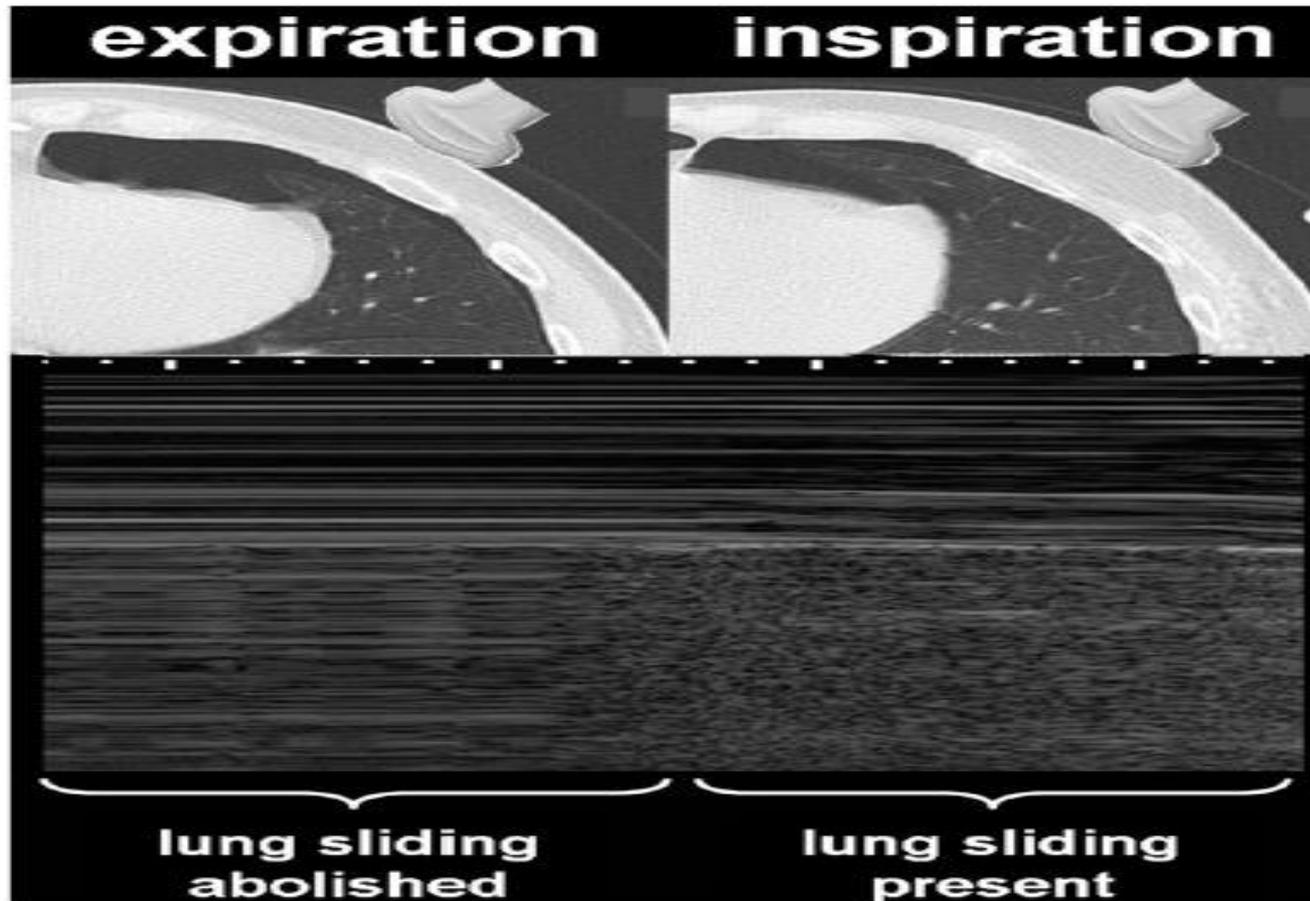
Pneumothorax and the stratosphere sign

Pneumothorax



Pneumothorax and the lung point

Pneumothorax

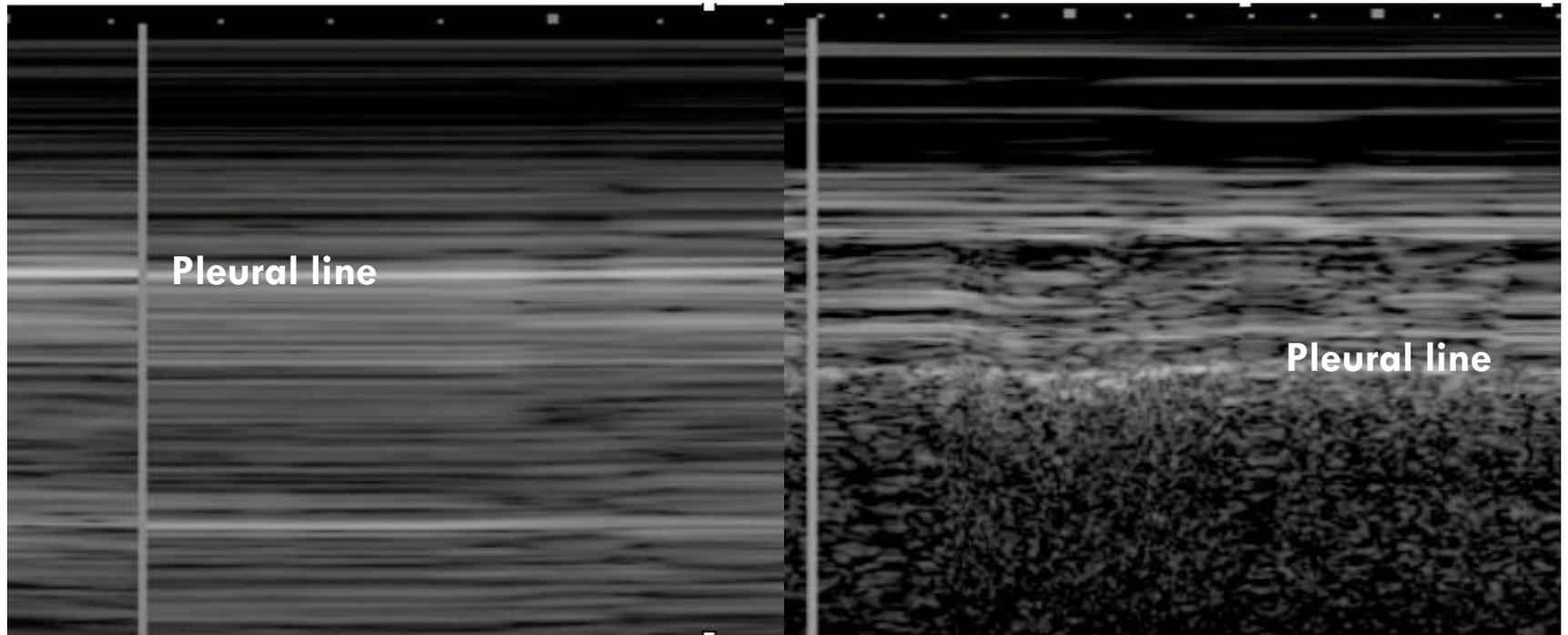


Pneumothorax and the lung point

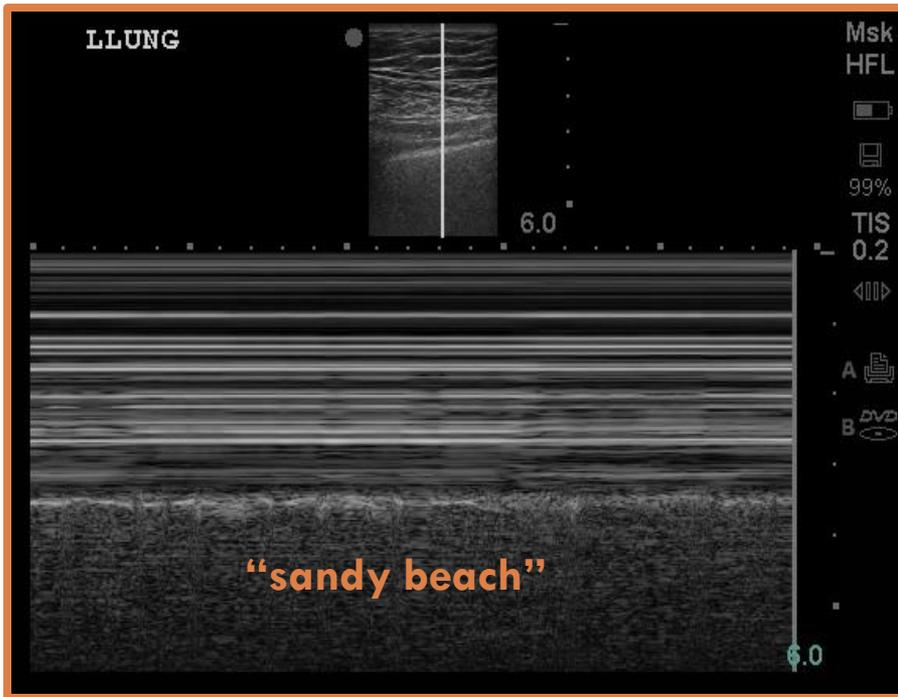
Pneumothorax

stratosphere sign.

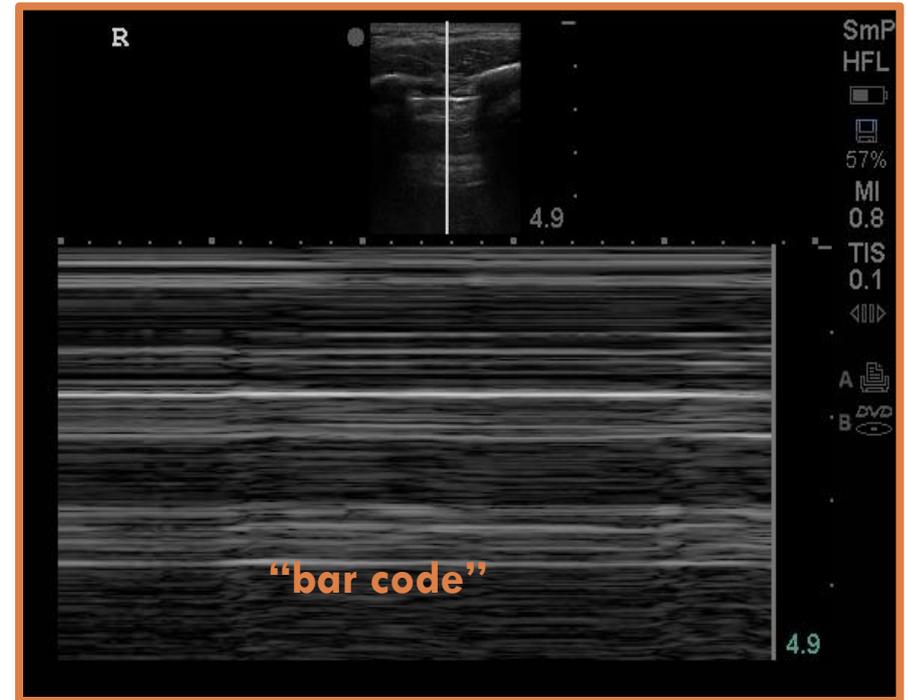
Seashore sign.



Pneumothorax



Normal



Pneumothorax

Lung Ultrasound

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- Pneumothorax
- **Pleural Effusion**

Pleural Effusion

- Ultrasound is more efficient than:
 - Normal physical examination
 - CXR in pleural effusion diagnosis.
- Even minimal effusion (about 5 mL), can be detected
- LUS can detect the nature of a hemithorax opacity, differentiating liquid and solid components of the opacity

Pleural Effusion

- Transudates → Anechoic
- Exudates → Corpuscular
- Hydropneumothorax → Hyper-reflectant air bubbles in effusion
- LUS is accurate in indicating the Organized or Septate effusion

Pleural Effusion

- More sensitive and specific than a CT in indicating the presence of Septae in pleural effusion
- More accurate in quantifying pleural effusion than a CXR.

Pleural Effusion-technique I

- Place the probe in a coronal plane.
- Look to get the liver or spleen, the kidney and the diaphragm.
- Focus on the diaphragm and look for the mirror image on the cranial side.
- If this mirror is absent, then there is fluid in the pleural space.



2013Mar24 12:39

Gen
S MB

L.AAXL

Abd
P21



70%

MI

1.0

TIS

0.4

A

B



19



Gen



0



Guide

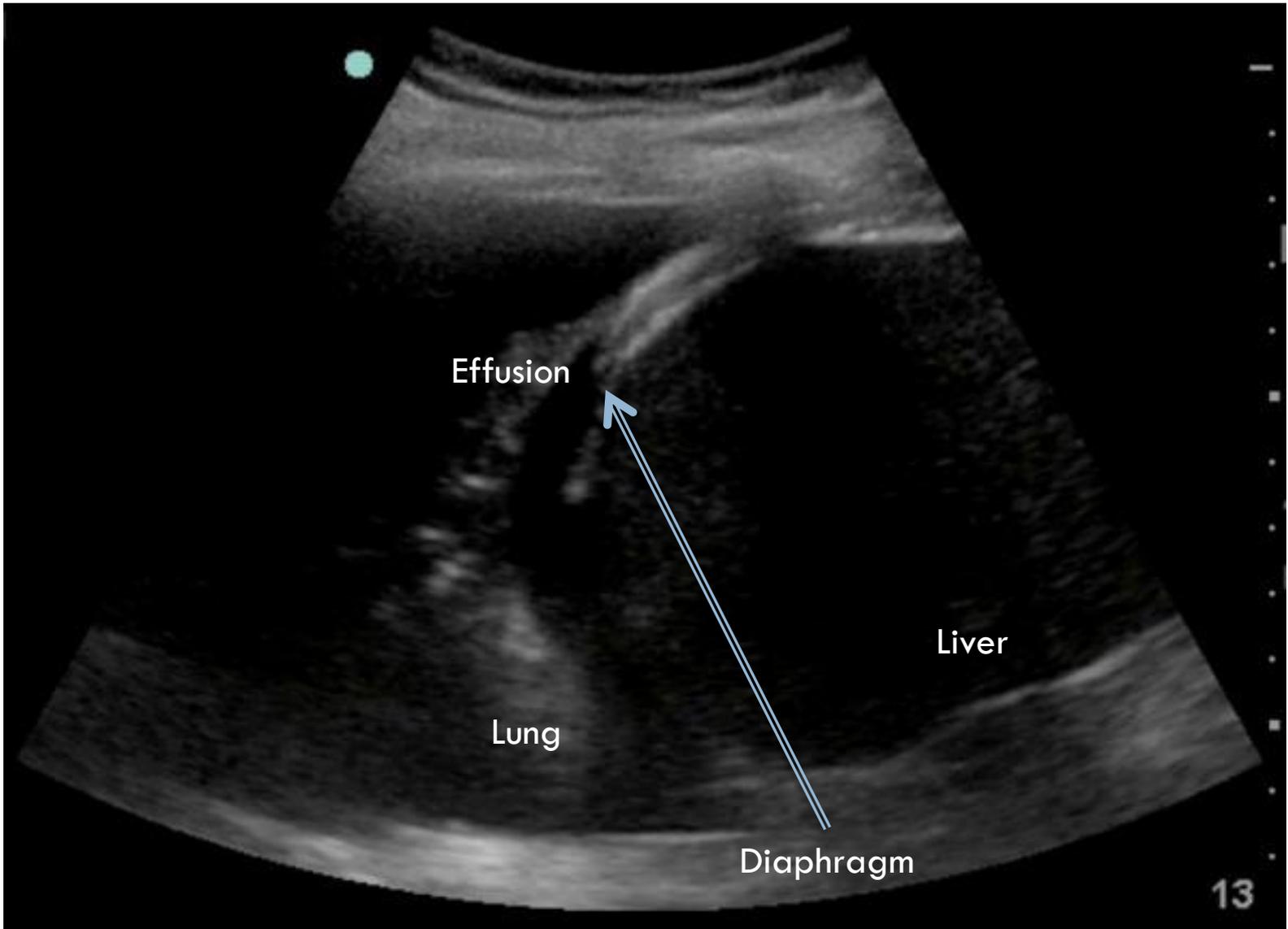


MB On



Off

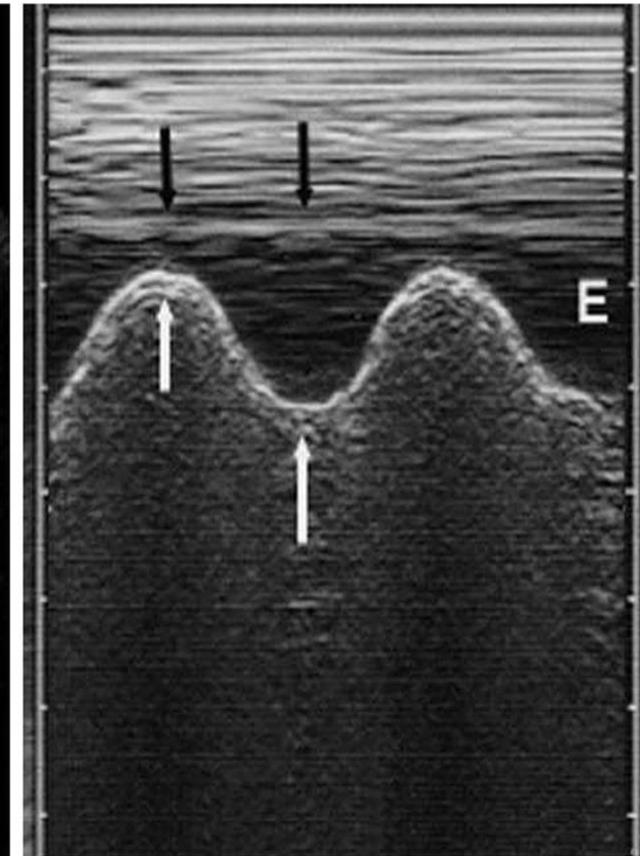
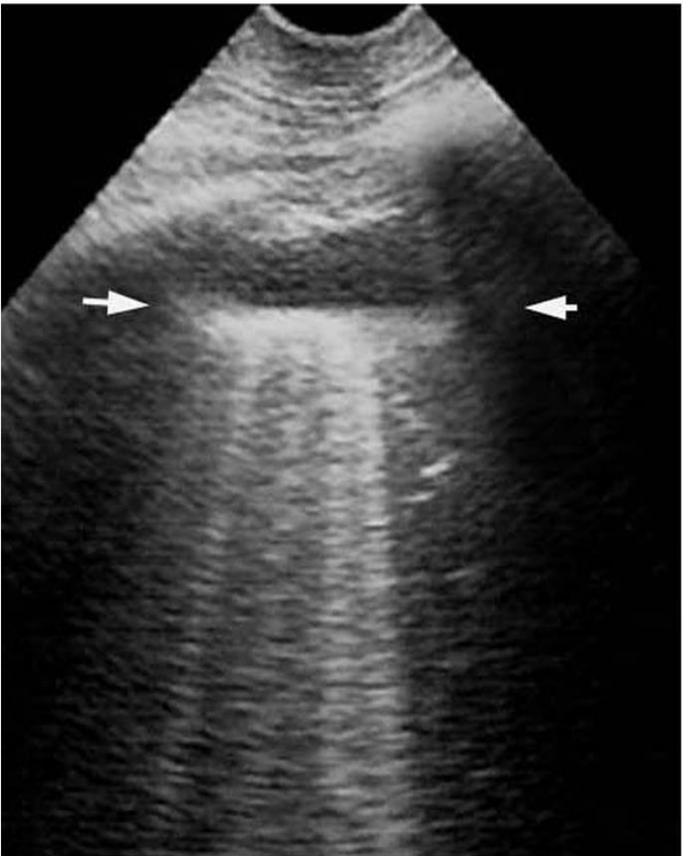
Page 1/2



Pleural Effusion-technique II

- Short probe is applied at the PLAPS-point.
- Locating all free effusions, regardless their volume
- Quad sign
 - Below the pleural line, a parallel line can be seen: the lung line, indicating the visceral pleura.
 - This line, together with the pleural line and the shadow of the ribs, display a kind of quad

Sinusoid sign M-mode



Minimal pleural effusion; Quad and Sinusoid sign

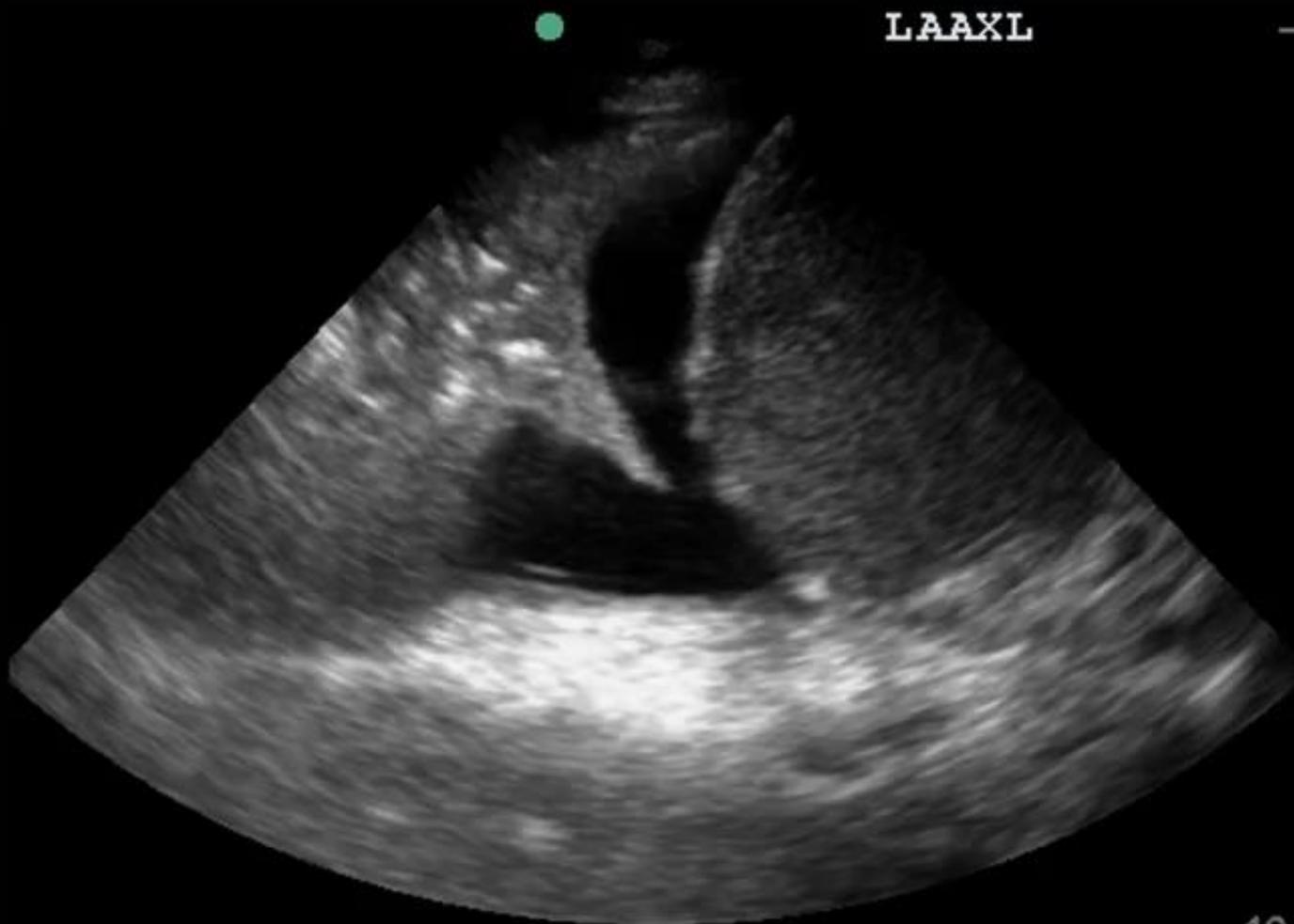


2013Mar24 12:39

Gen
S MB

L.AAXL

Abd
P21



70%

MI

1.0

TIS

0.4

A

B



19



Gen



0



Guide



MB On



Off

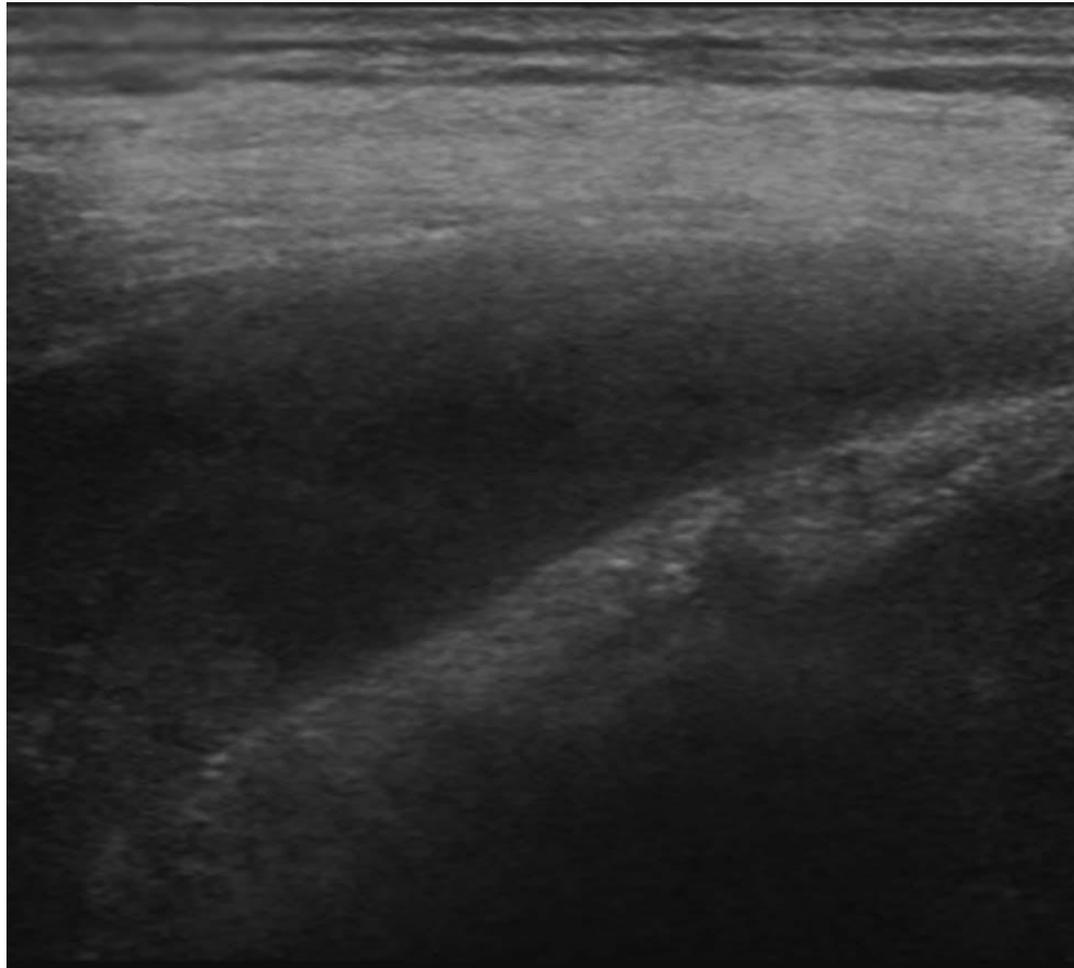
Page 1/2

Pleural Effusion



Transudate-anechoic

Pleural Effusion



Corpusculated exudate

Complex Pleural Effusion



Pleural Effusion



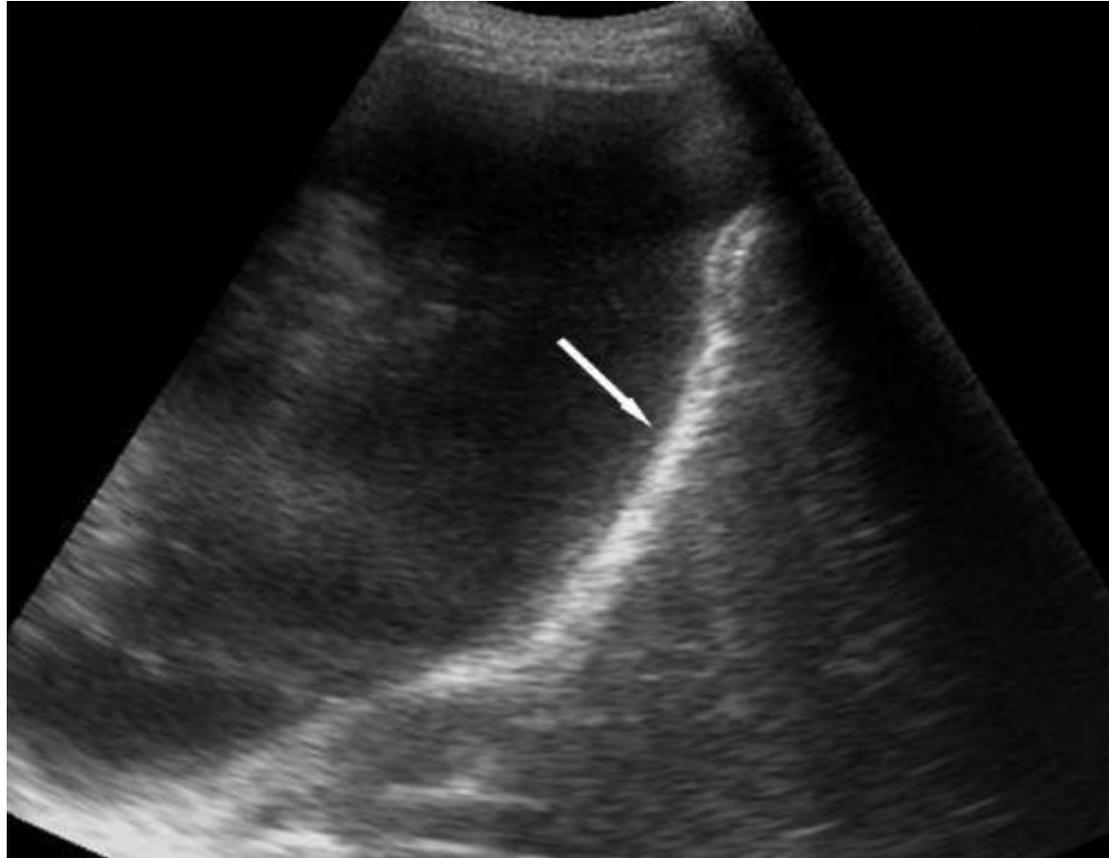
Complex, non-septated

Pleural Effusion



Complex, septated

Pleural Effusion



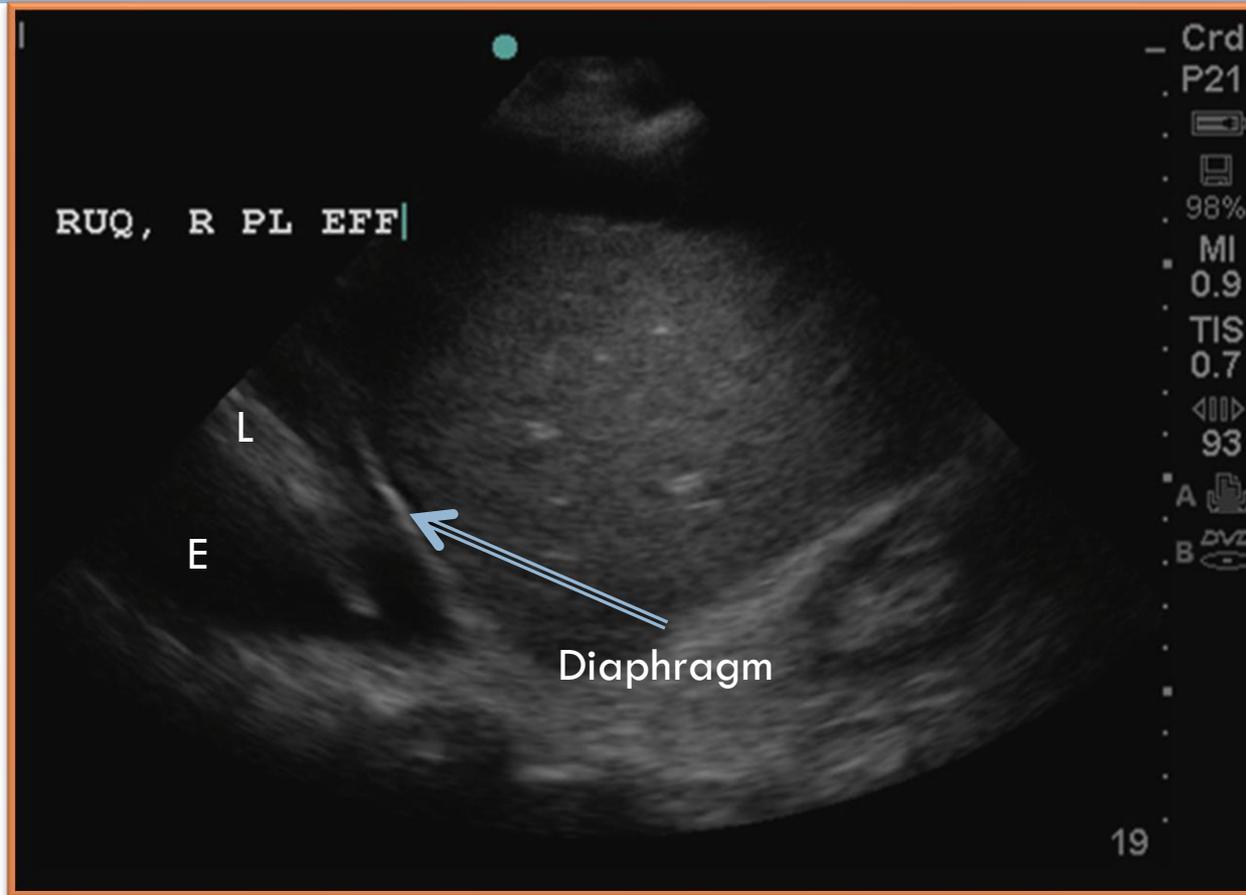
Inverted diaphragm

Pleural Effusion



Effusion with atelectasis

Pleural Effusion



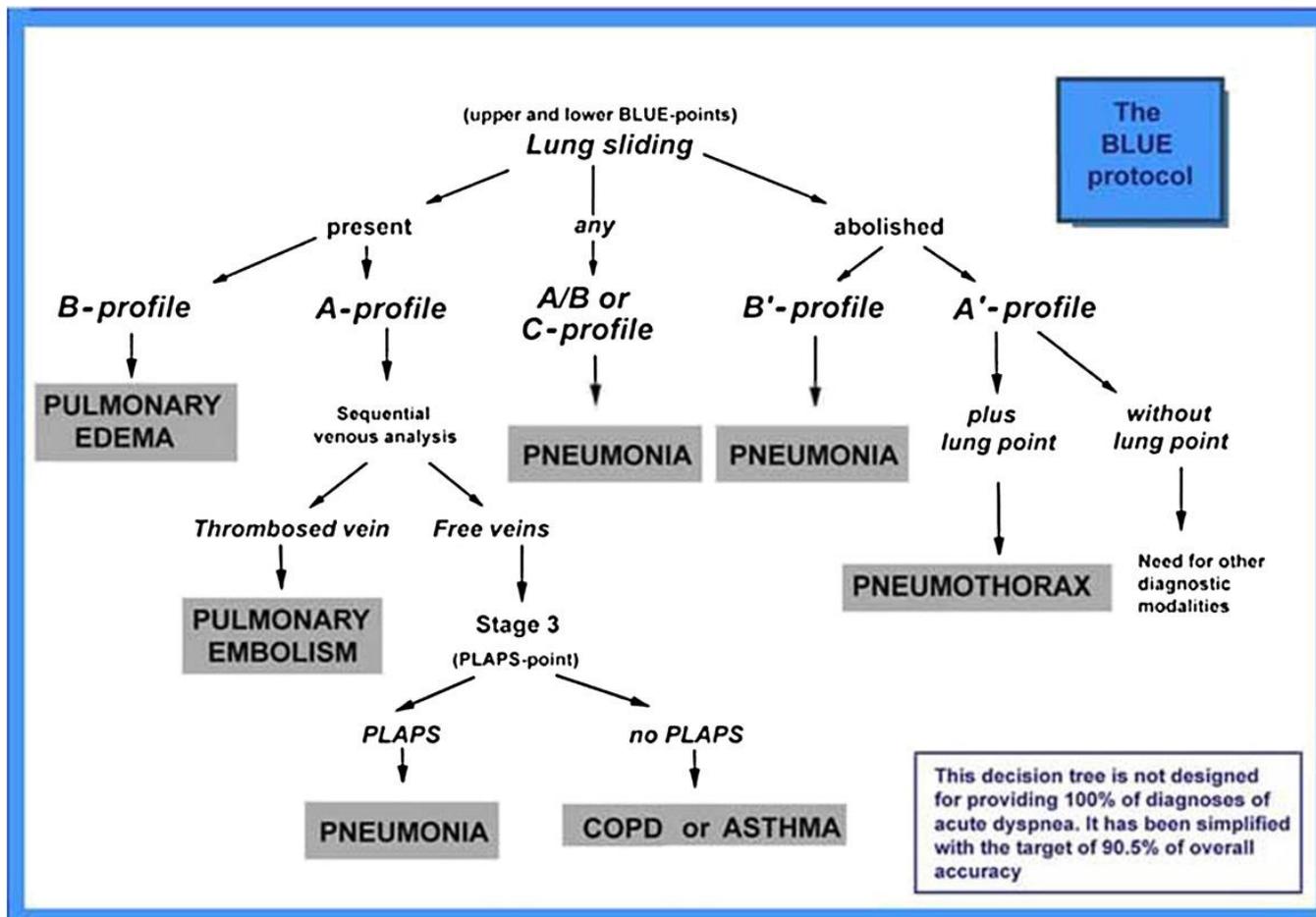
Anatomic Boundaries



Is this a pleural effusion?



Lung Ultrasound



THANK YOU