

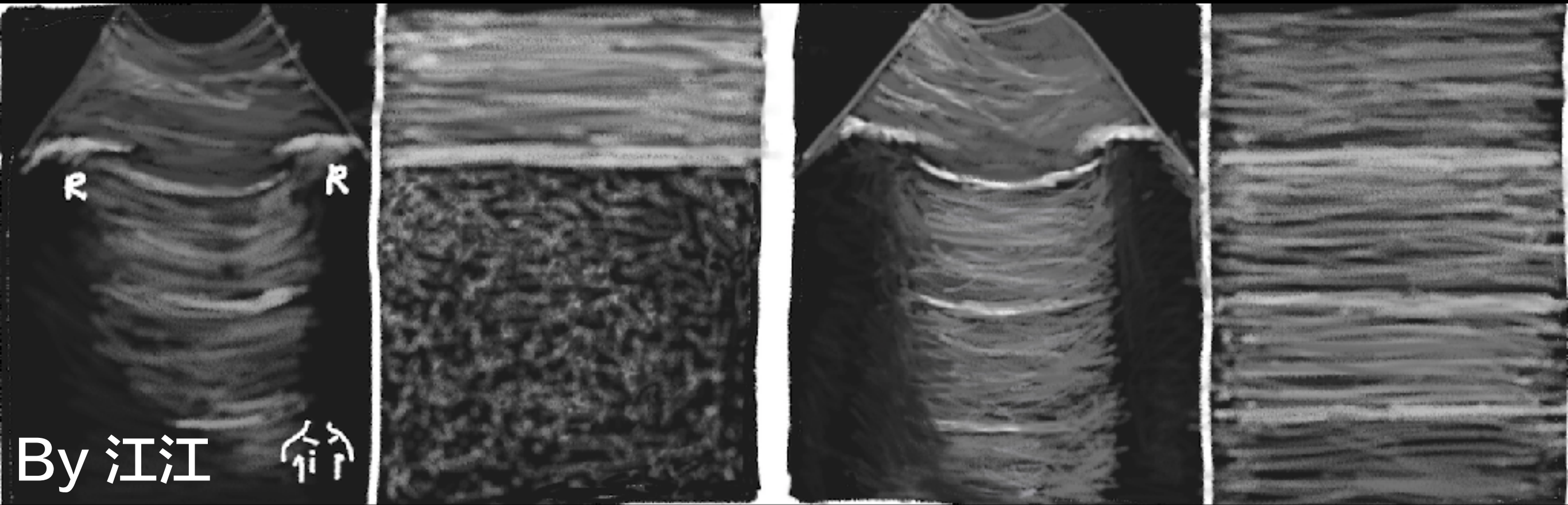


臺中榮民總醫院

POCUS 訓練工作坊

呼吸急症超音波介紹

Lung ultrasound



Resuscitative

Diagnostic

Procedural Guidance

Symptom- or Sign-
Based

Therapeutic

Core Applications

Trauma

Intrauterine Pregnancy

AAA

Cardiac/HD Assessment

Biliary

Urinary Tract

DVT

Soft-tissue/Musculoskeletal

Thoracic/Airway

Ocular

Bowel

Procedural Guidance

ACEP
2016

12

F.O.R.E.S.I.G.H.T. Comprehensive Perioperative Ultrasound Examination

Focused
Peri**O**perative
Risk
Evaluation
Sonography
Involving
Gastro-Abdominal
Hemodynamic, and
Trans-Thoracic Ultrasound

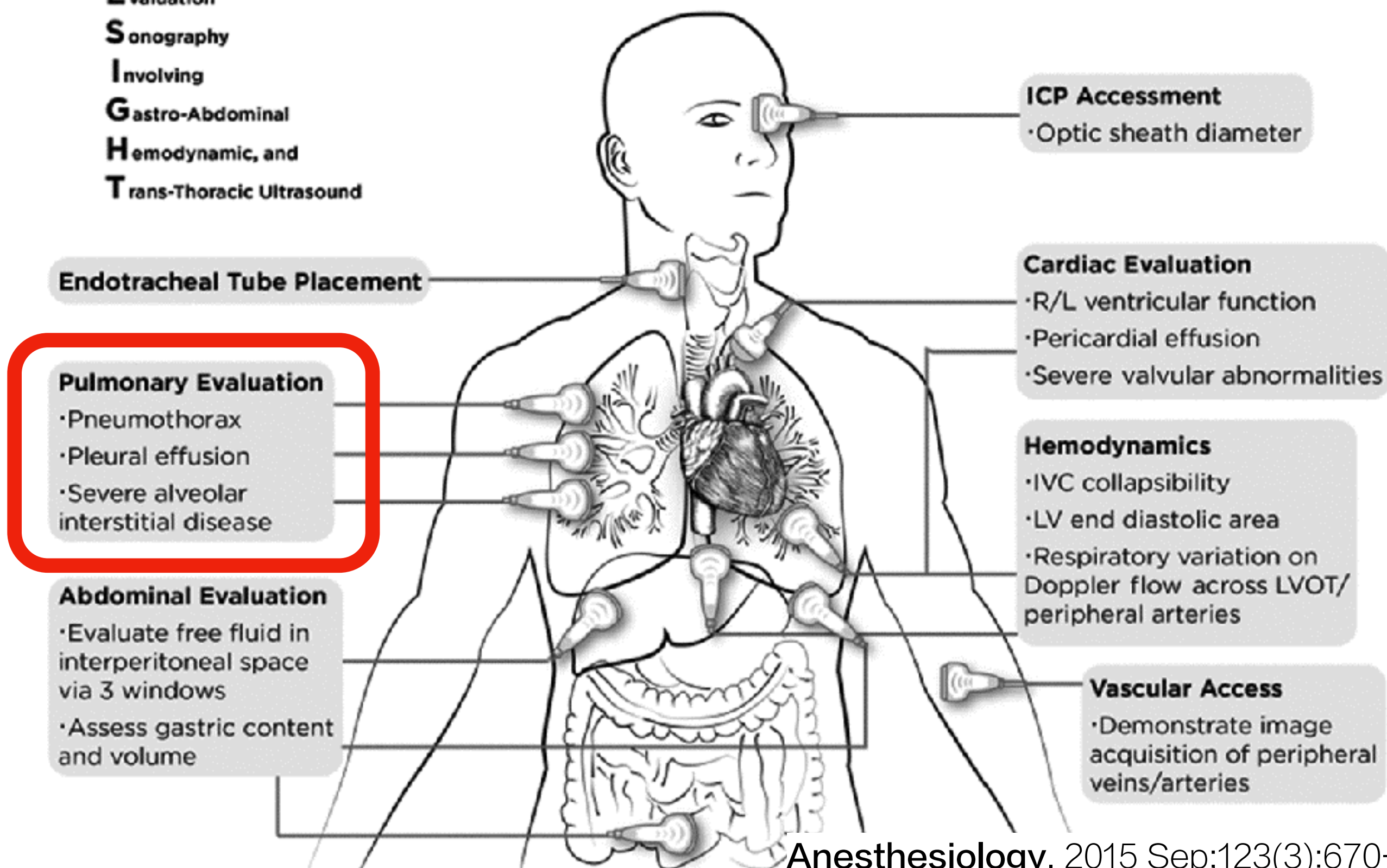
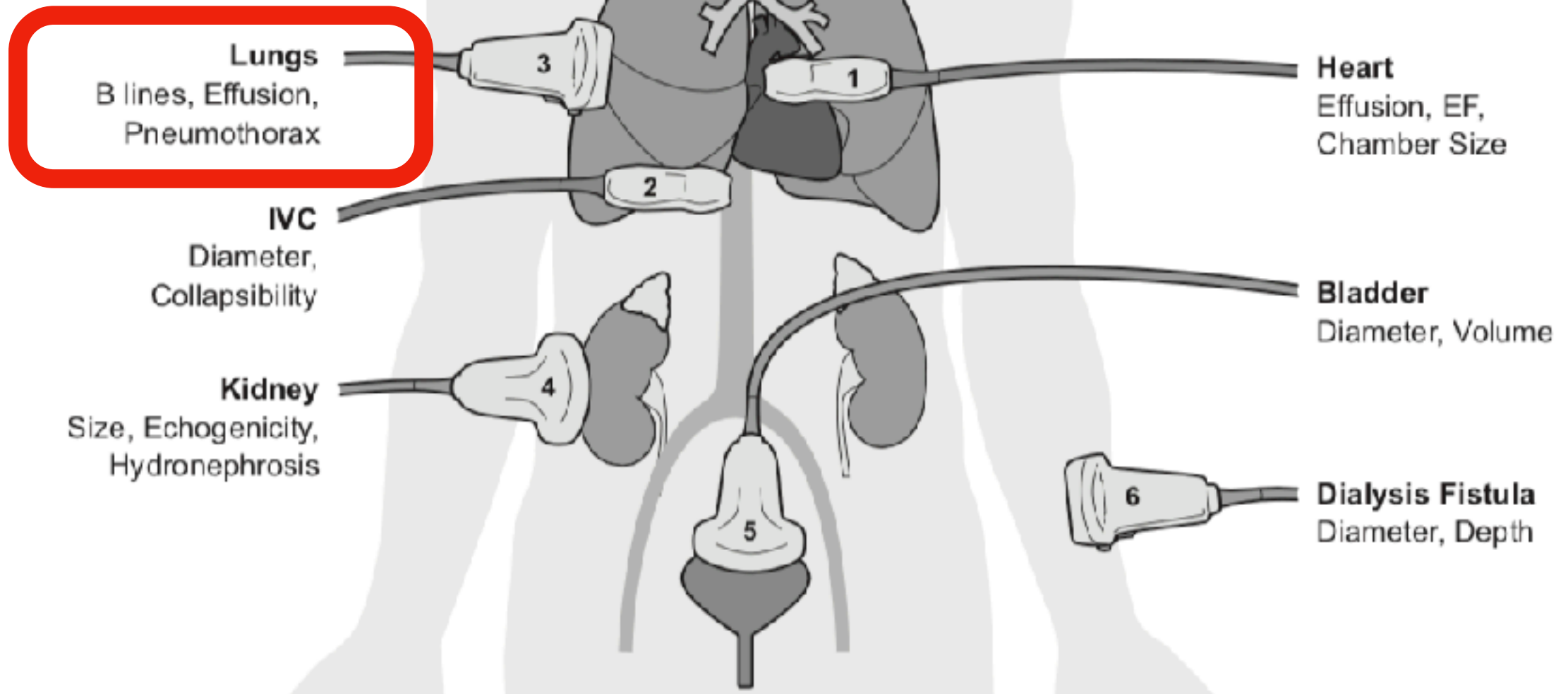


	IMAGE AREA	IMAGE ACQUISITION	PROBE
1	Heart	Parasternal Long Axis (PLAX)	Phased
2	Inferior Vena Cava	Subcostal	Phased
3	Lung	Anterior, Lateral, Posterior	Linear
4	Kidney	Longitudinal, Transverse	Curved
5	Bladder	Suprapubic	Curved
6	Dialysis Fistula	Longitudinal and Transverse	Linear

Johns Hopkins **Nephrology** fellowship
POCUS curriculum



Do you know all ?

Sign	Images	Description	Pathology
Sliding sign	Figure 2	Movement between the two layers of the pleura during normal respiration	Normal
A-lines	Figure 6	Hyperechoic horizontal lines parallel to pleural line occurring at regular intervals below the pleura Artefacts from reverberations between probe and pleura	Seen in normal lungs as well as pneumothorax and emphysematous lungs
B-lines	Figure 1	Hyperechoic artefacts that originate at the pleural line and extend from the probe to the edge of the screen, without fading and perpendicular to the pleural line Artefacts that occur when the interstitium and alveoli are thickened predominantly from becoming oedematous with fluid	Presence of three or more B-lines per intercostal space is evidence of interstitial fluid. If seen diffusely in two or more zones bilaterally is usually indicative of pulmonary oedema
Z-lines	-	Hyperechoic artefact that originates at and perpendicular to the pleural line but does not extend to the edge of the ultrasound window and are shorter, wider and less defined than B-lines	Normal or pneumothorax
V-lines (spine sign)	-	Fluid acts as an acoustic window to enable visualisation of the V-line of vertebral bodies and the posterior thoracic wall in a supine patient	Pleural fluid
E-lines	-	Comet tail artefacts that are superficial to the pleural line	Echogenic foreign bodies or subcutaneous emphysema
Stratosphere sign	Figure 2	The loss of lung sliding beneath the pleura	Pneumothorax
Liver sign (mirror sign)	Figure 4	Tissue similar in consistency to liver tissue seen on US	Lung consolidation absent in pleural effusion
Sea shore sign (M mode)	Figure 2	Pleura appears as horizontal lines and the underlying lung as grainy, making up the sea and sandy shore, respectively	Normal M mode appearance of lung
Bar code sign (M mode)	Figure 3	Bar code-like appearance throughout M mode	Pneumothorax

I-AIM

Indication



Acquisition



Interpretation



Making
decision

I-AIM

Indication



Acquisition

Transducers



Linear

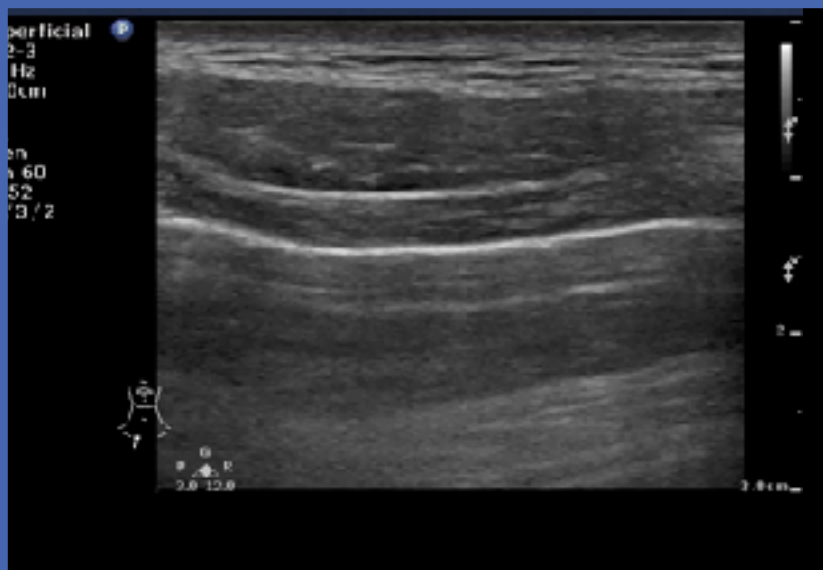


Curve



Sector

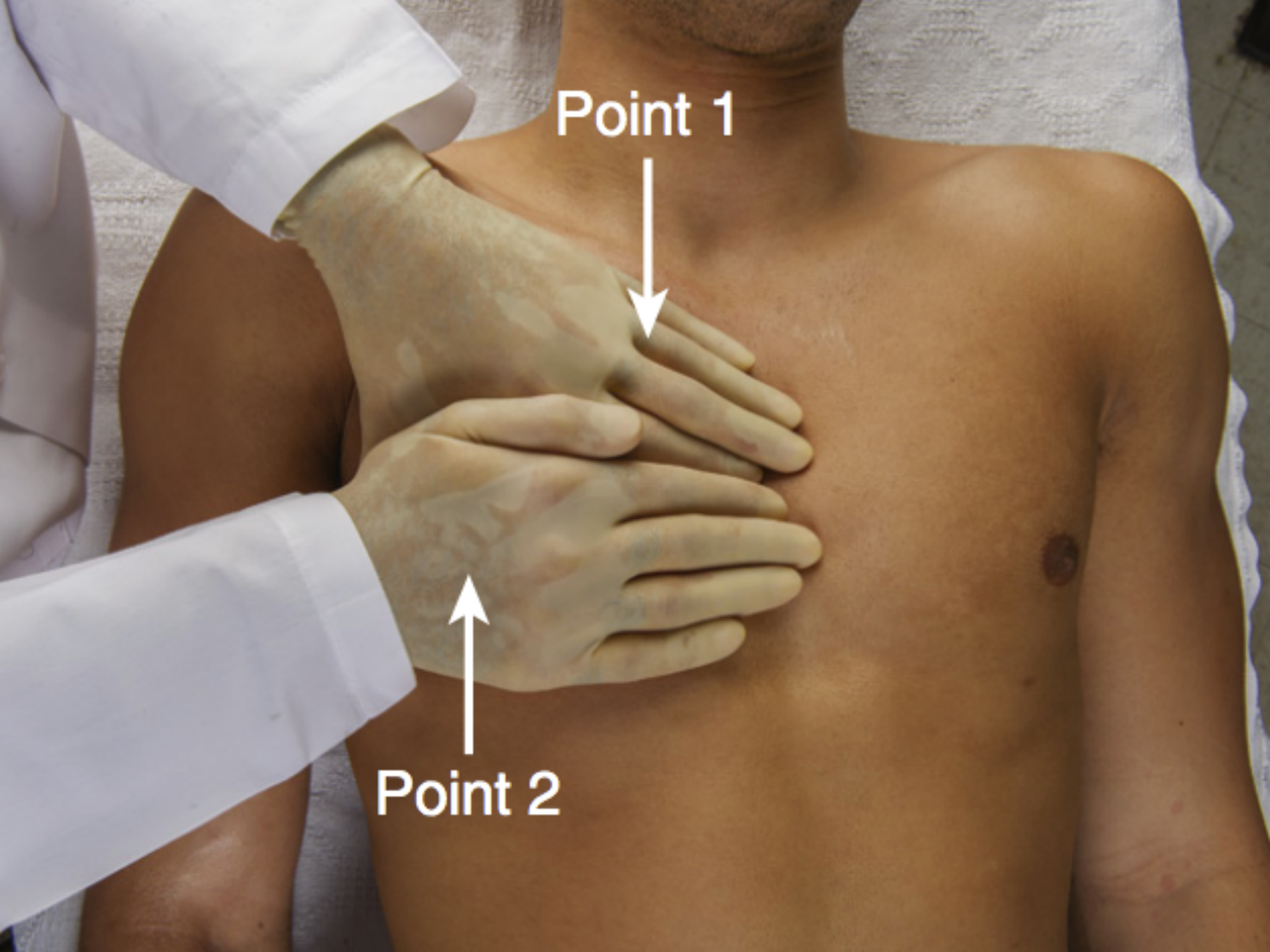
Best for PTX ?

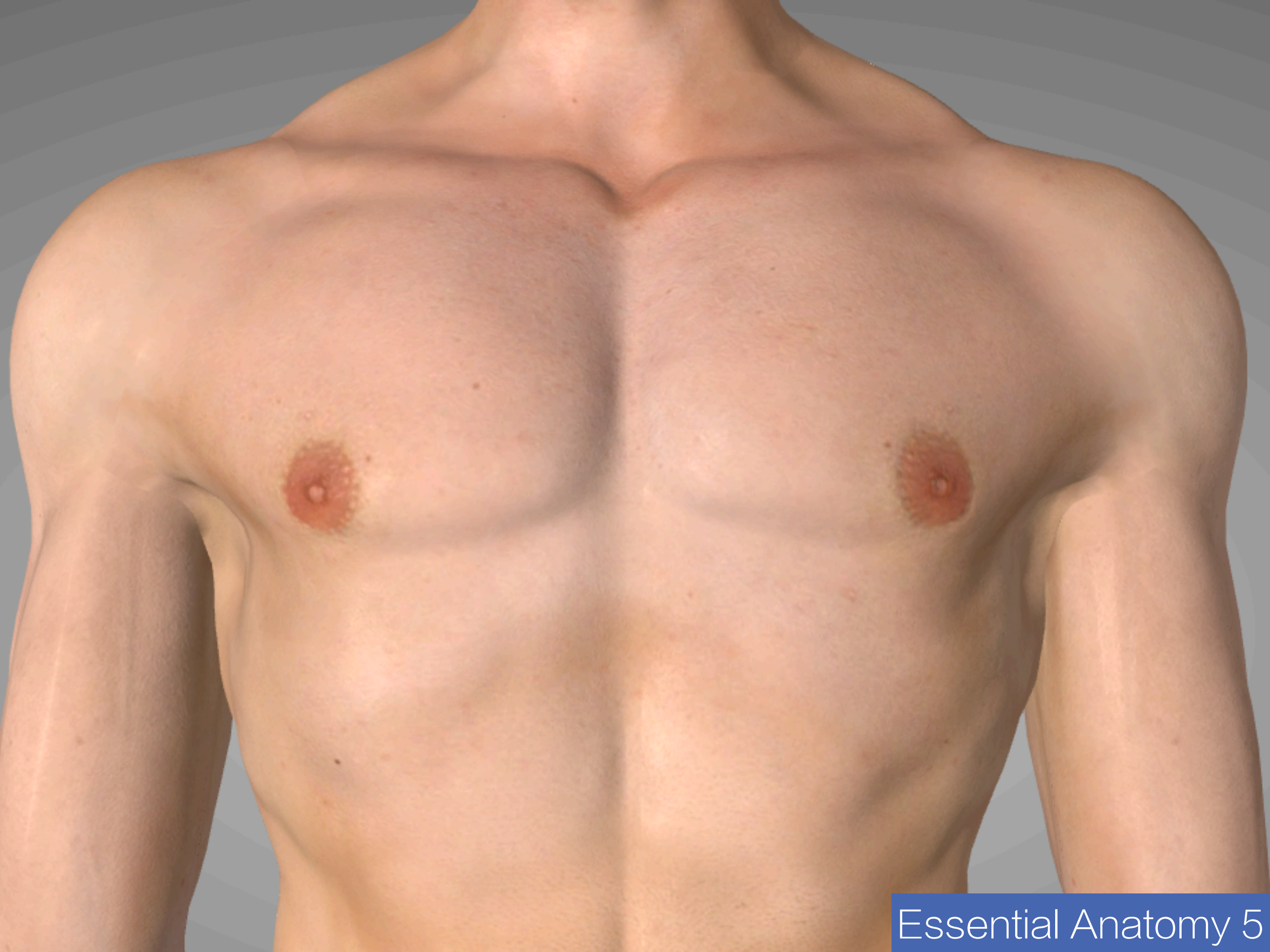


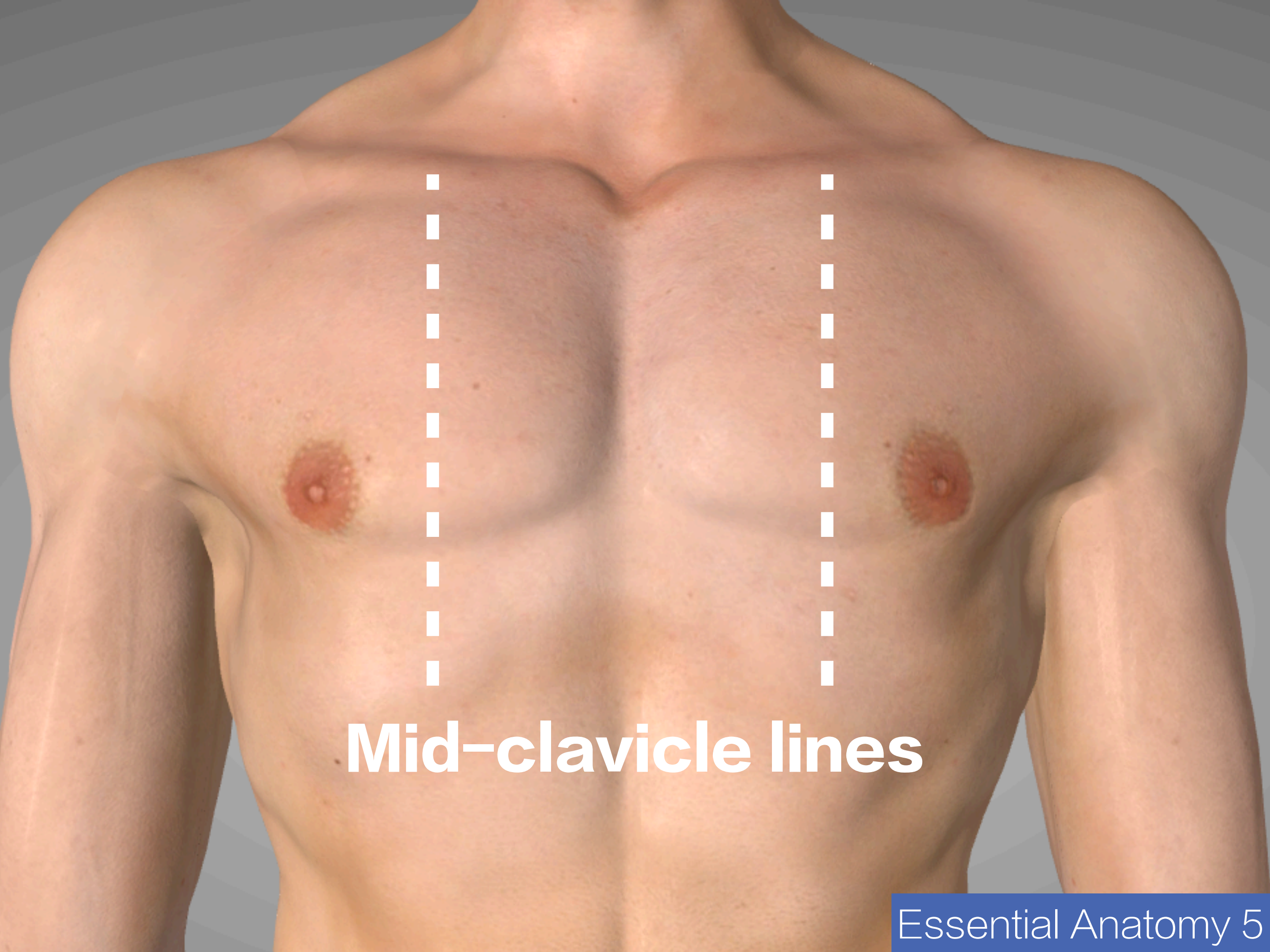
Point 1



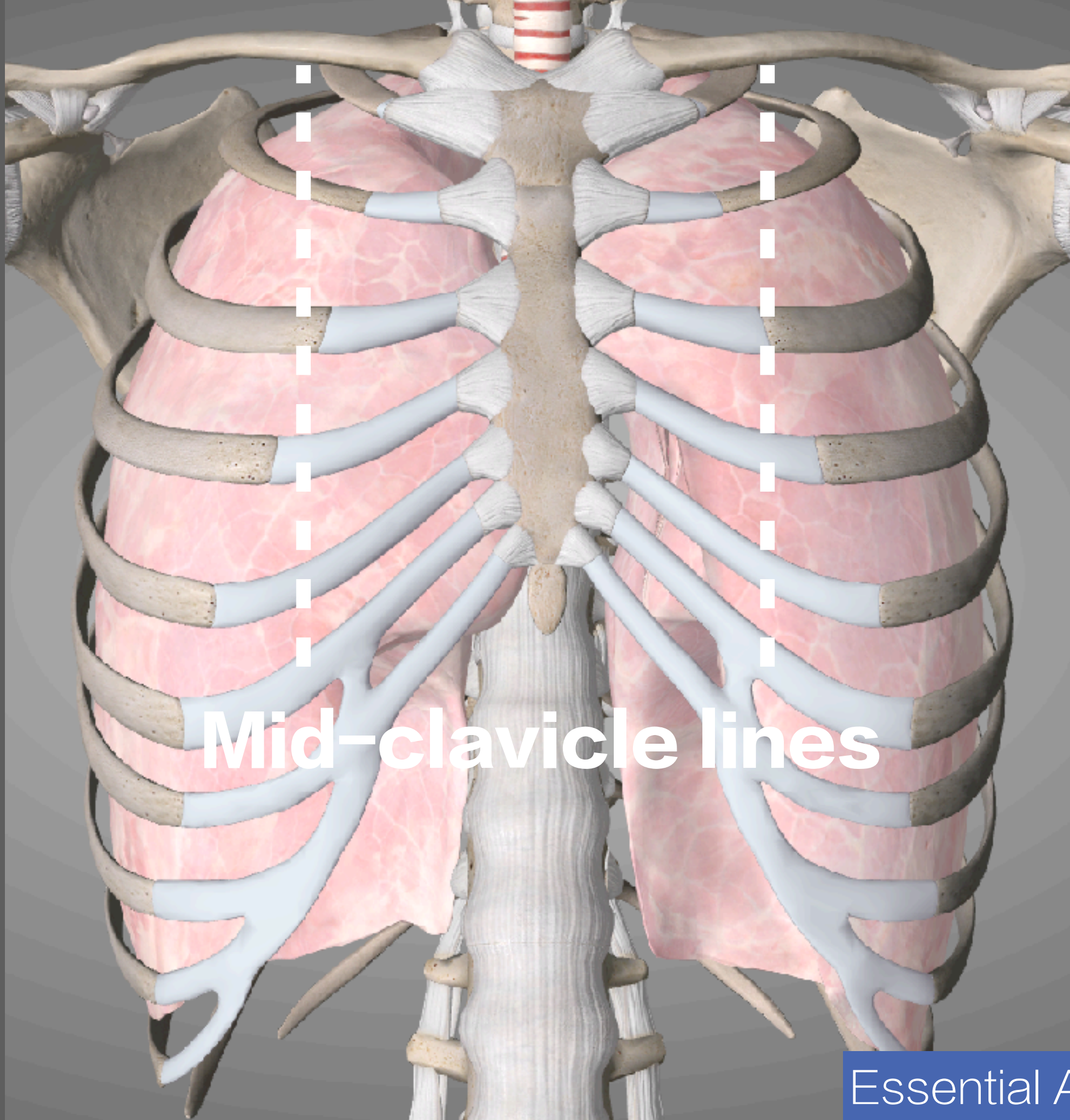
Point 2



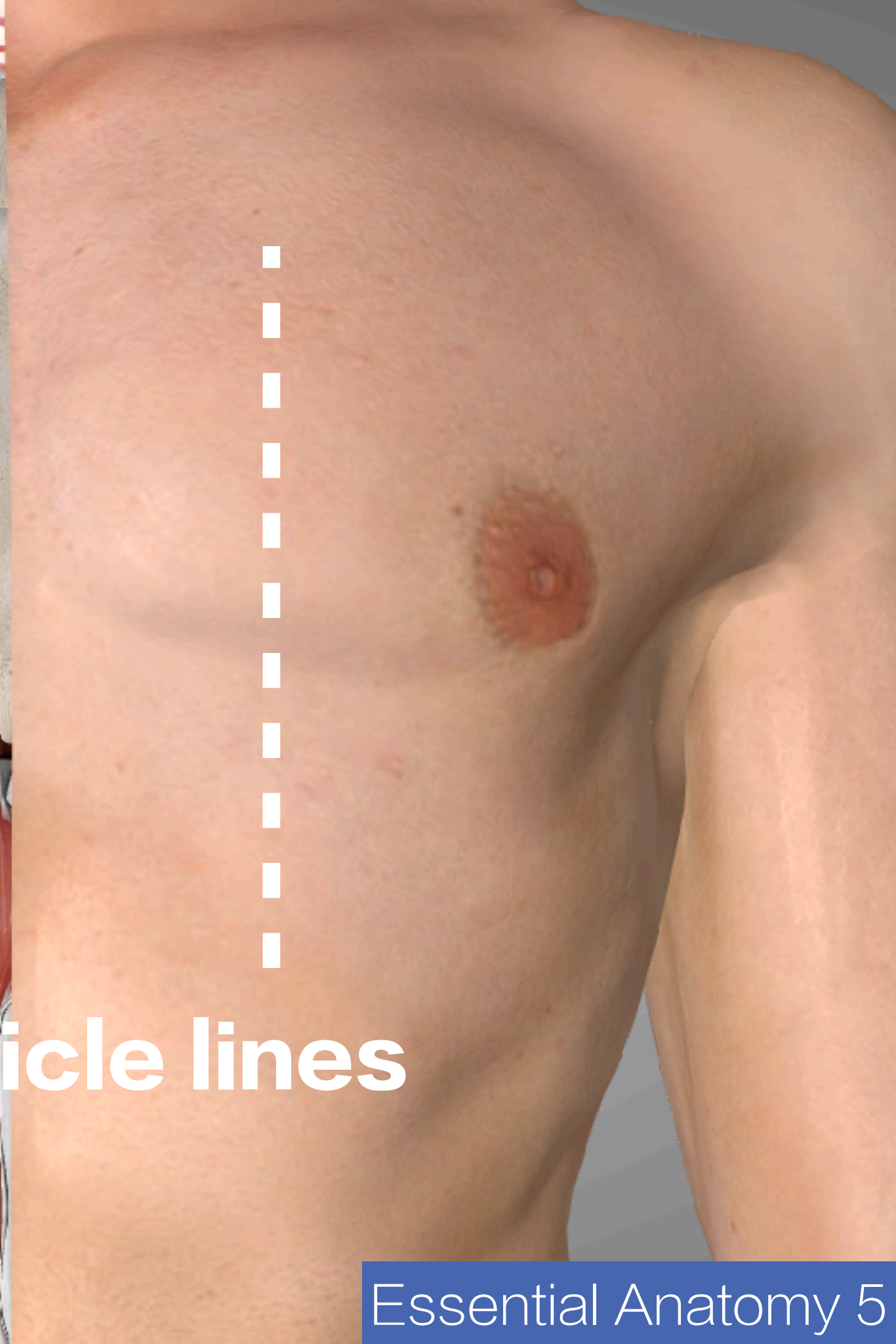
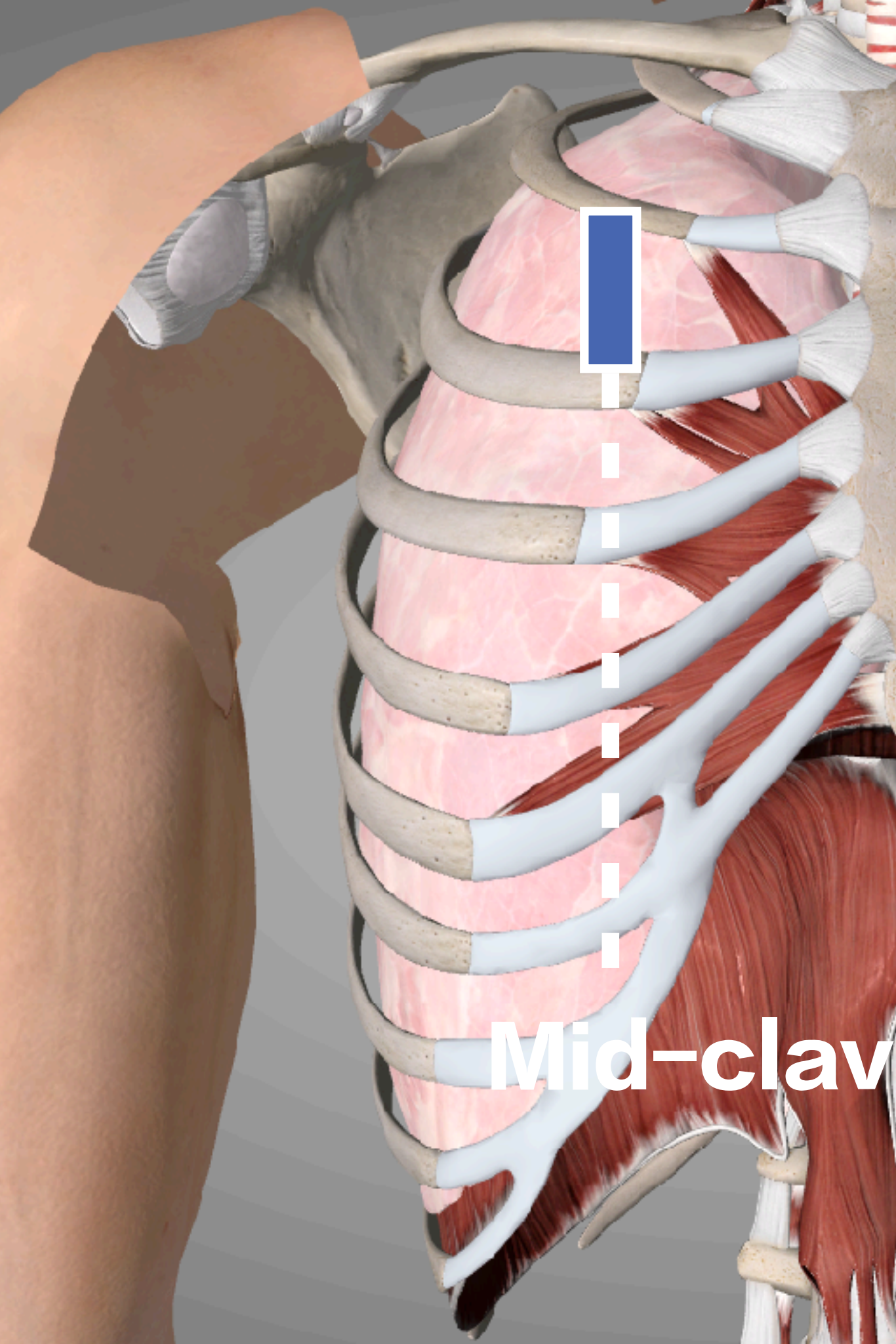




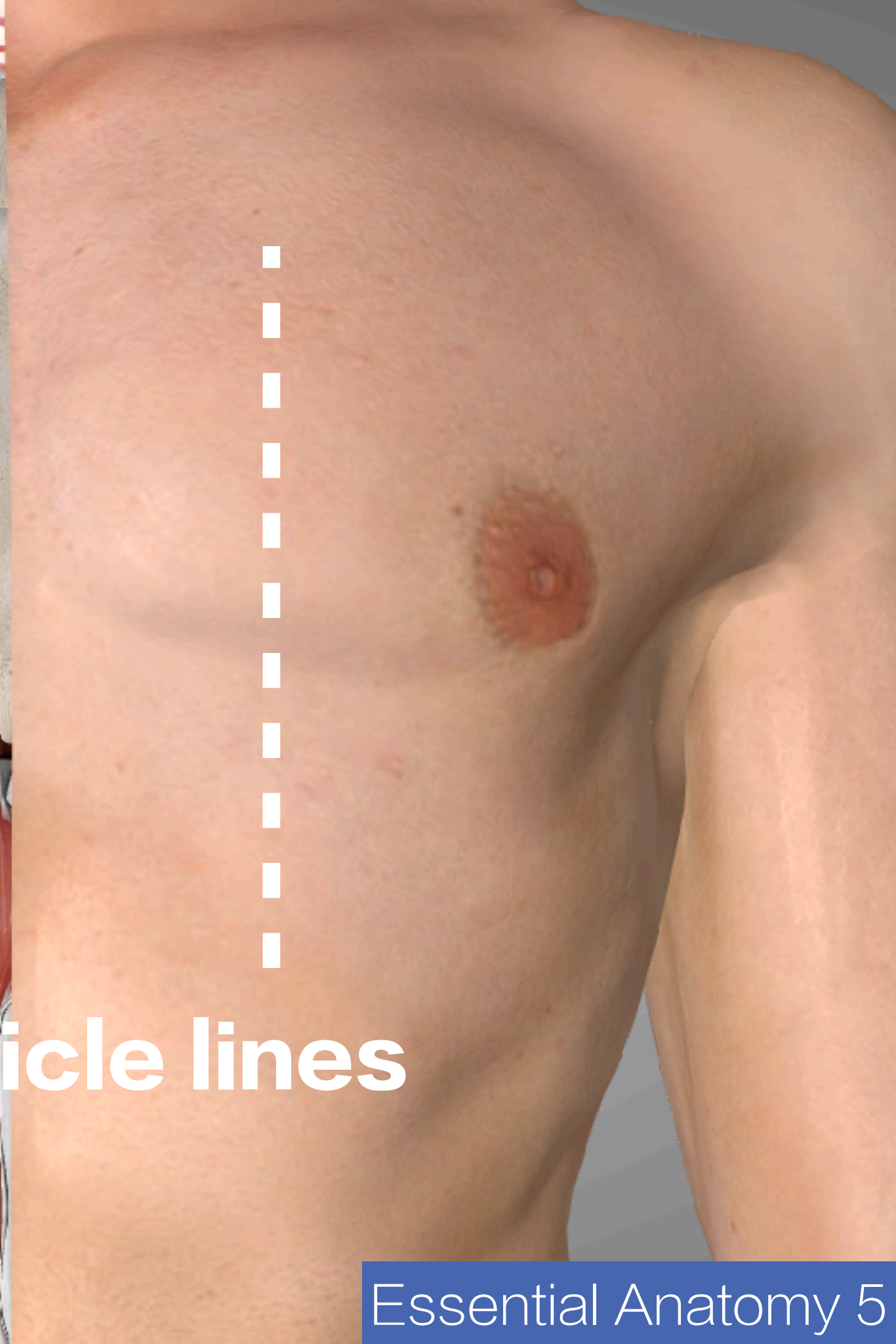
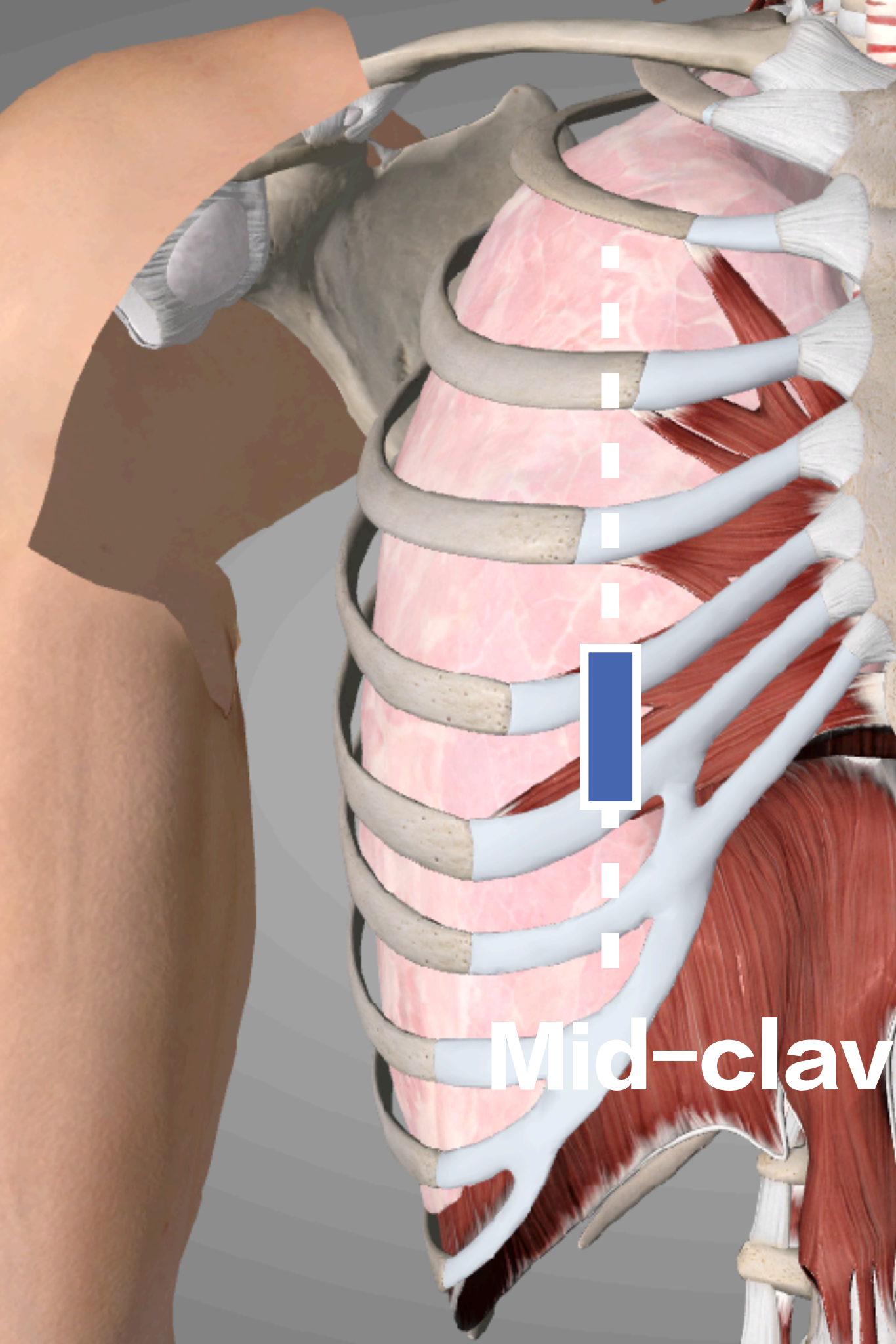
Mid-clavicle lines



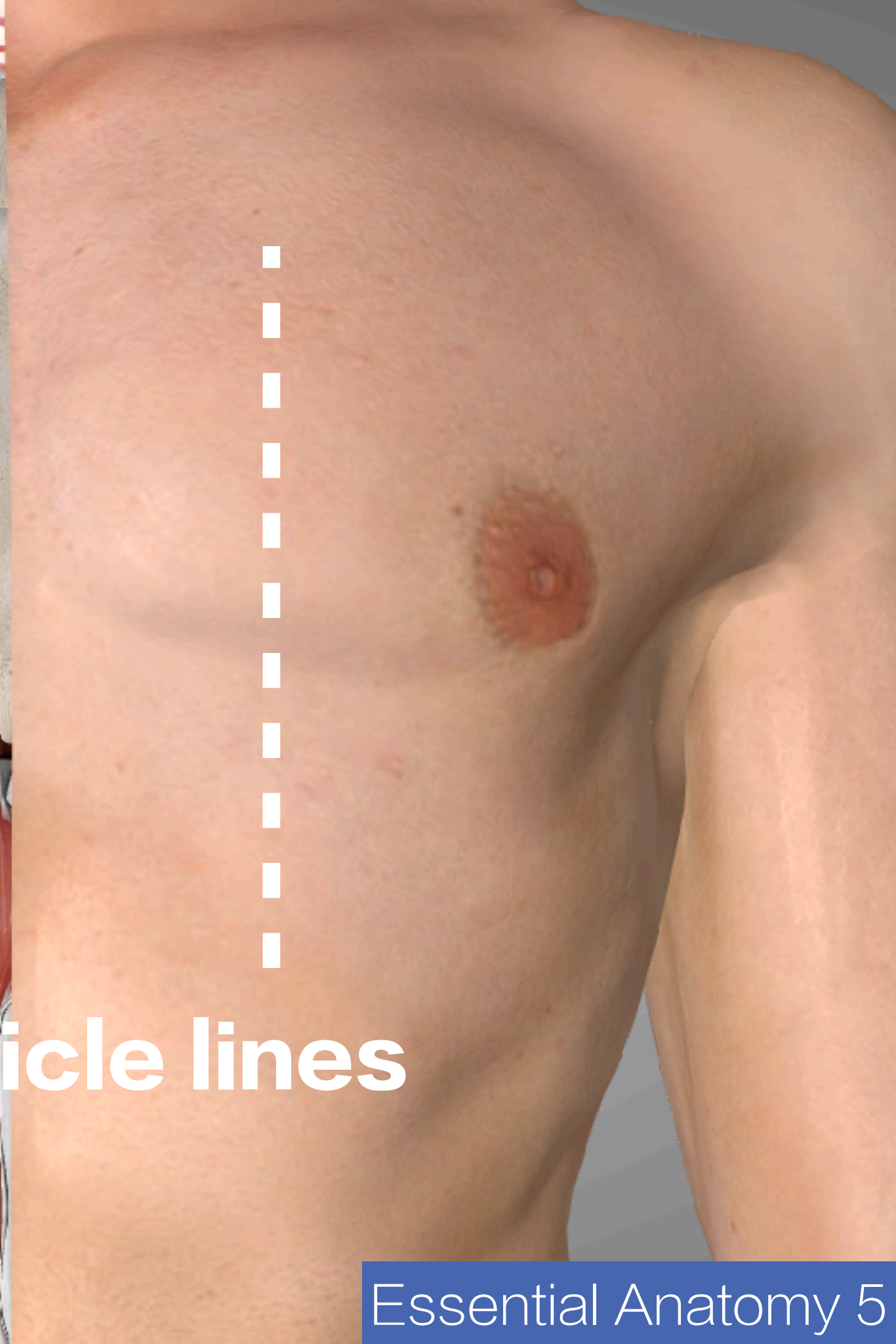
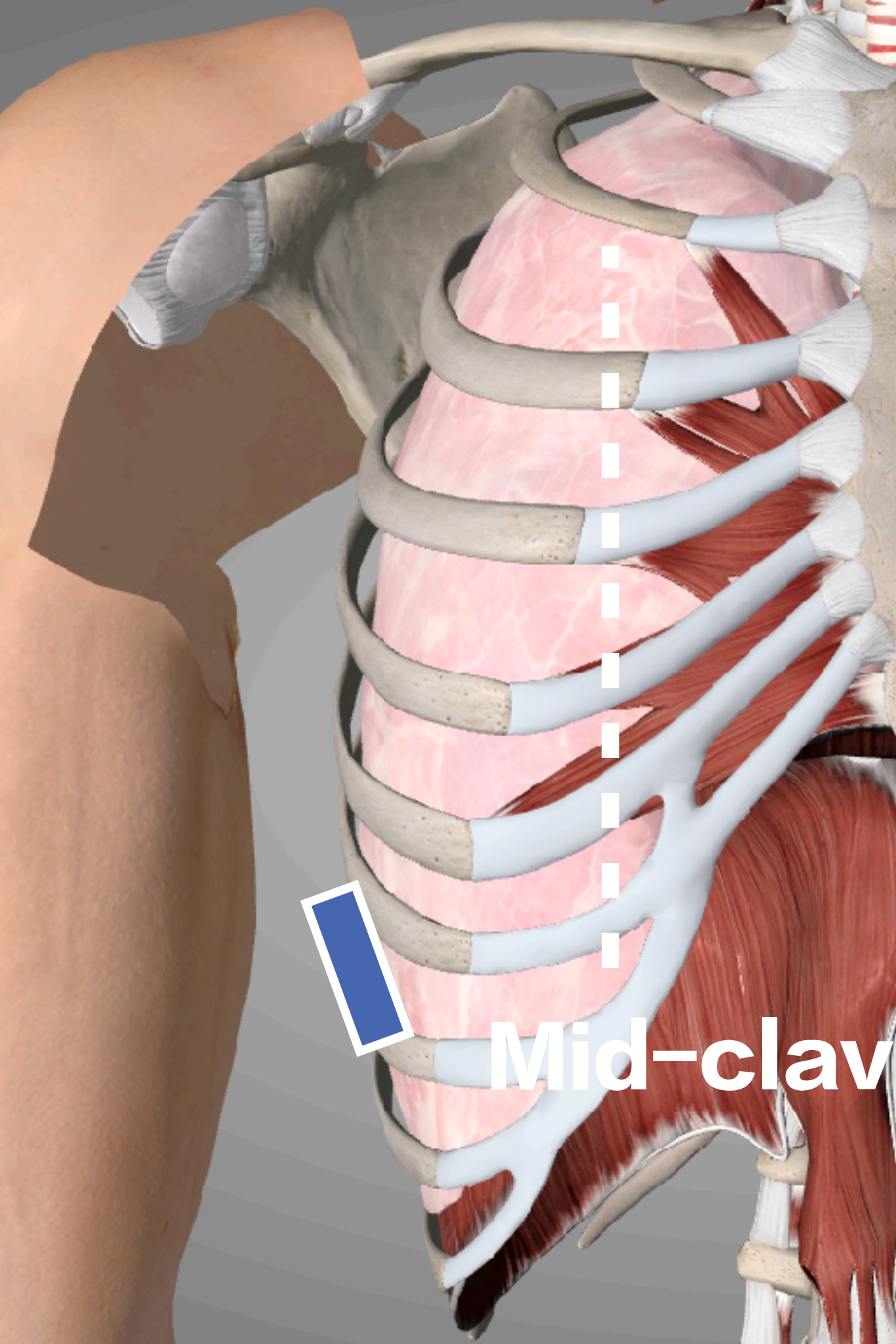
Mid-clavicle lines



Mid-clavicle lines

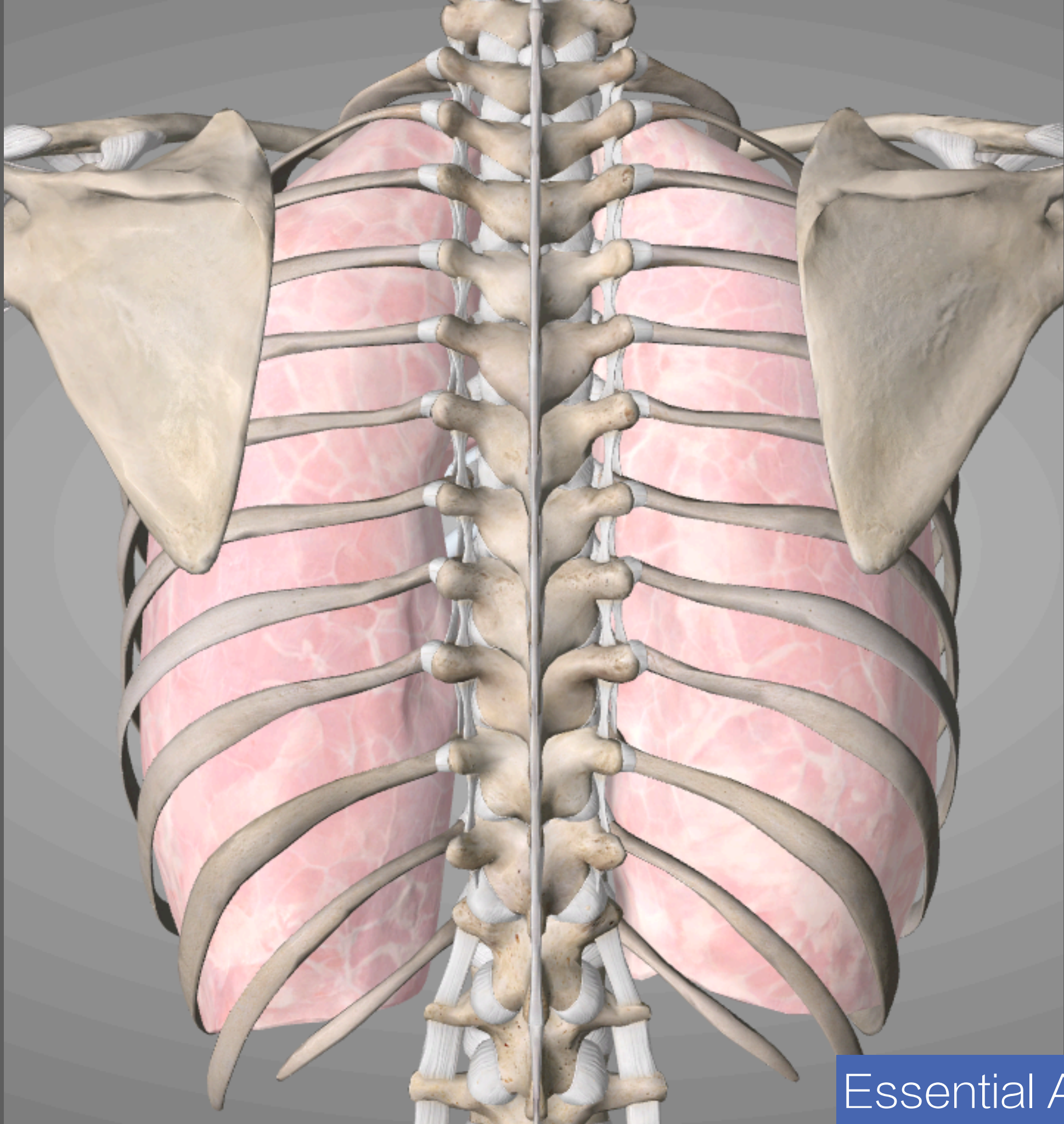


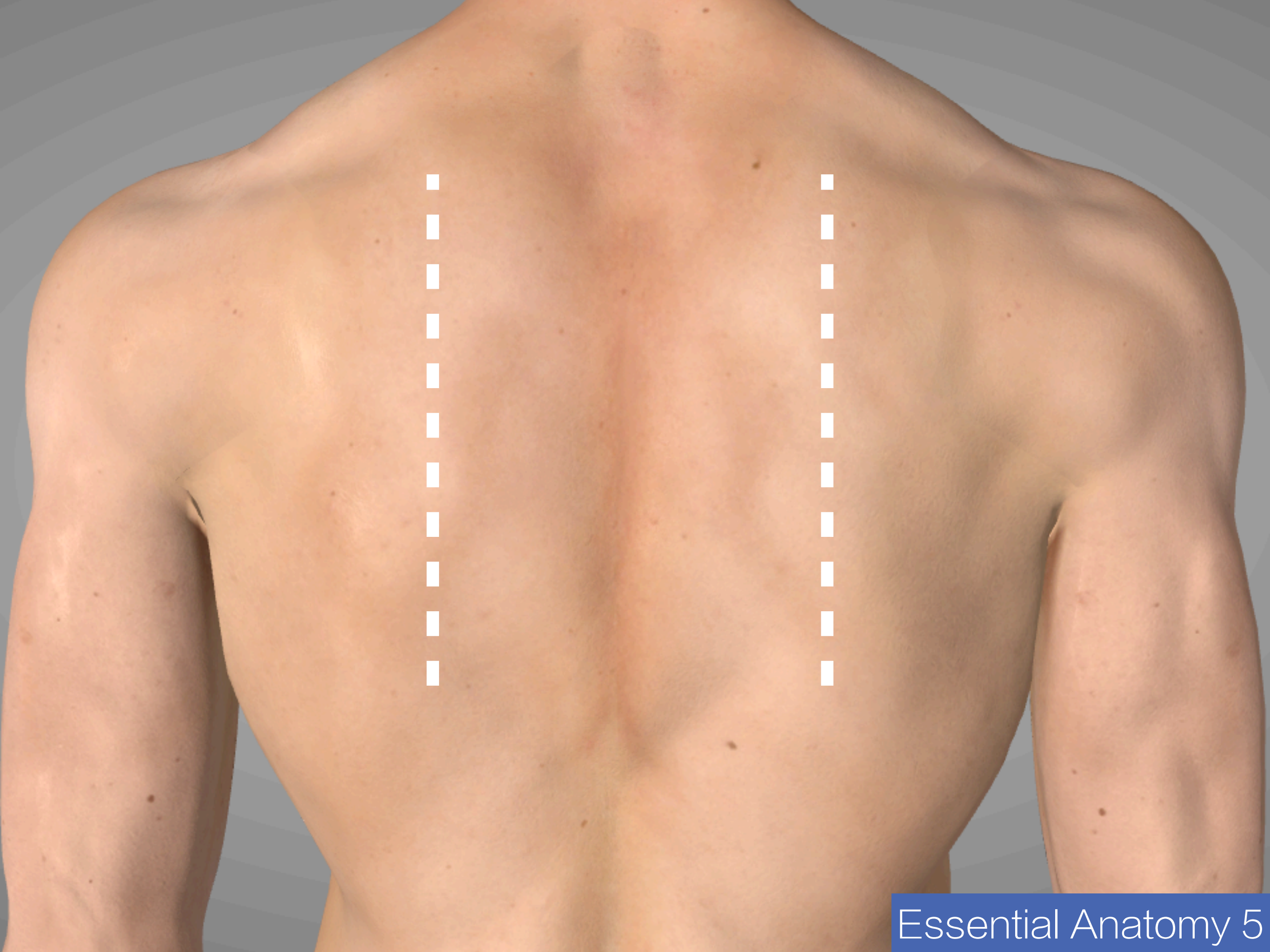
Mid-clavicle lines

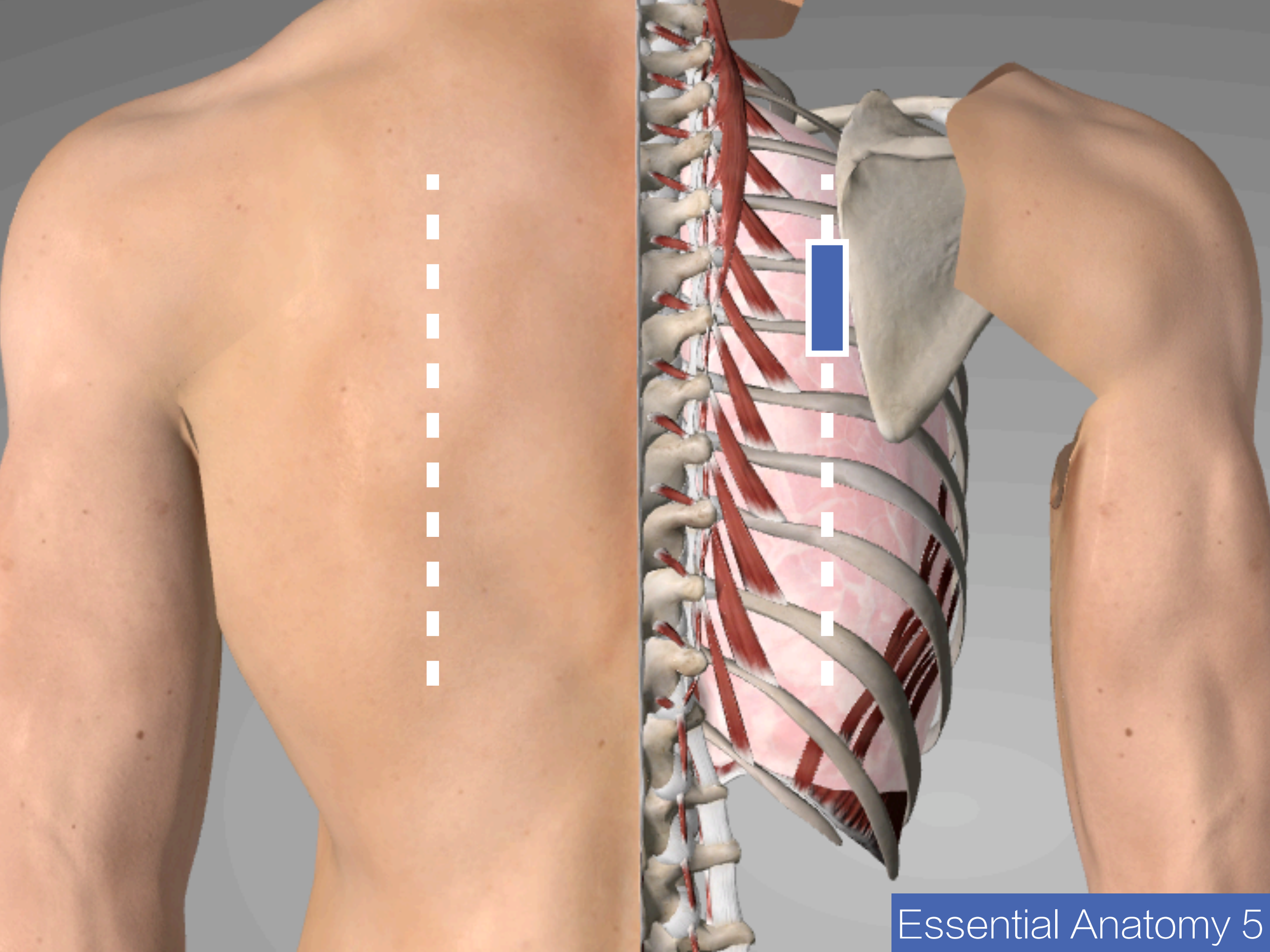


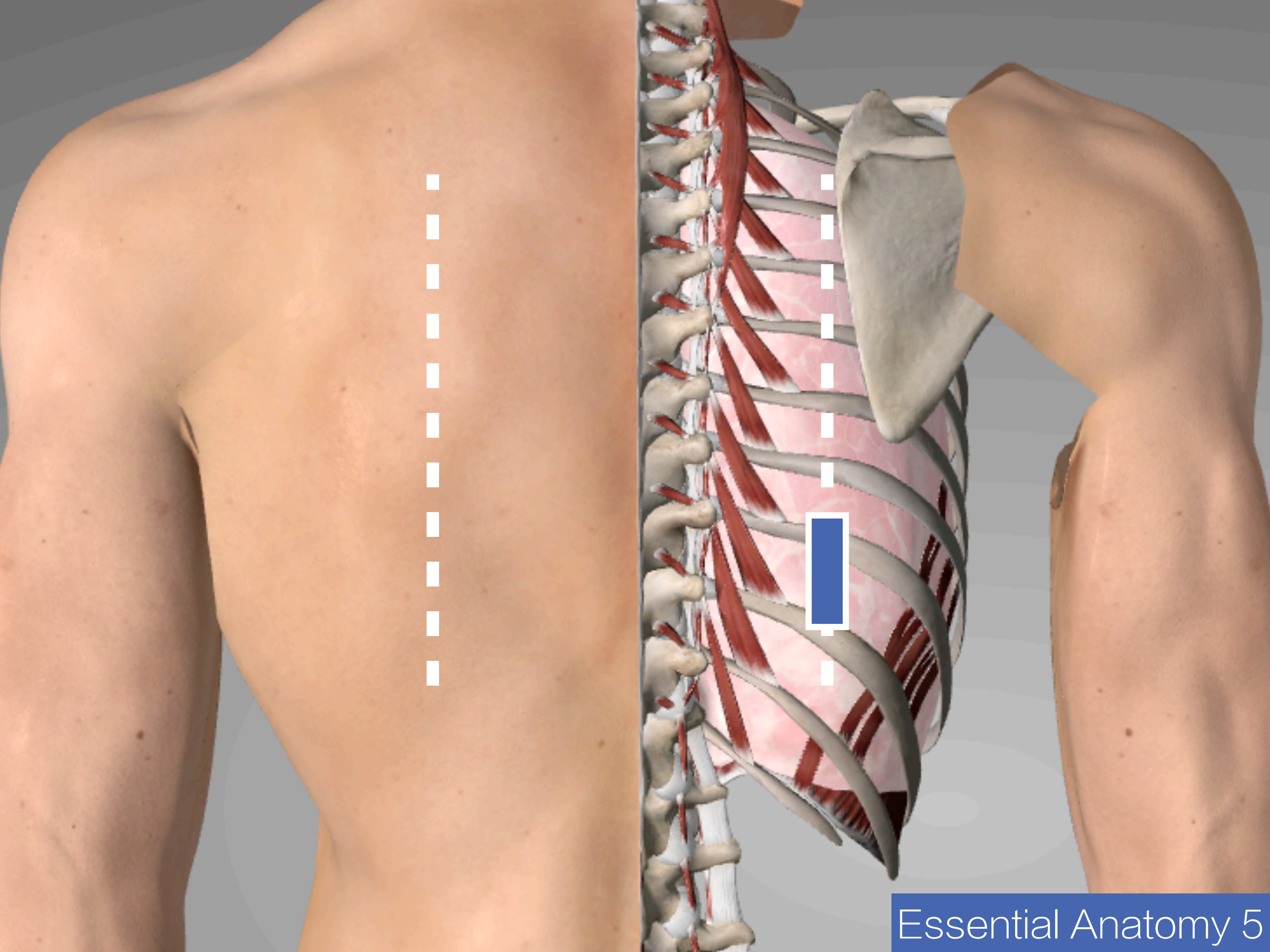
Mid-clavicle lines

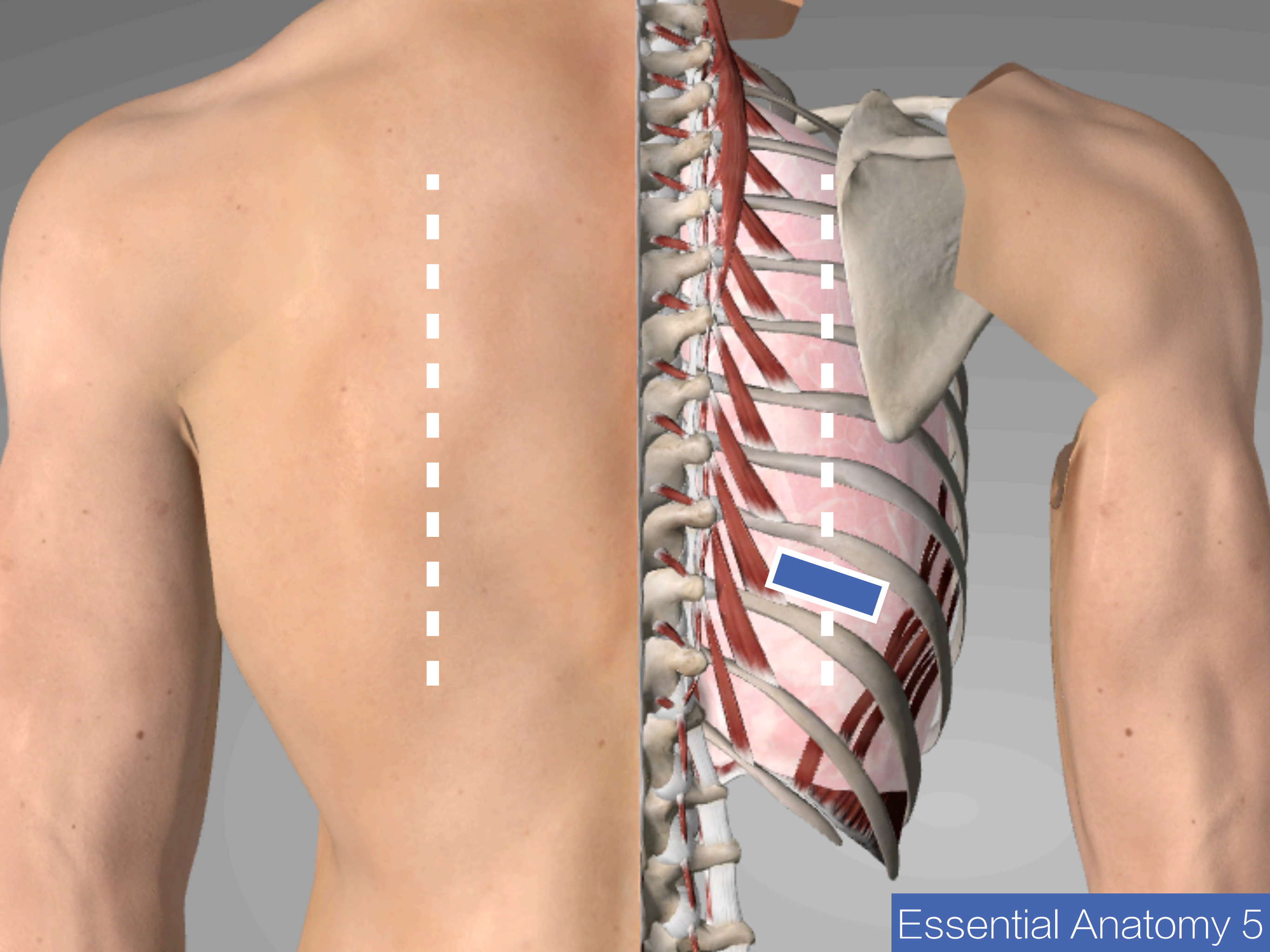


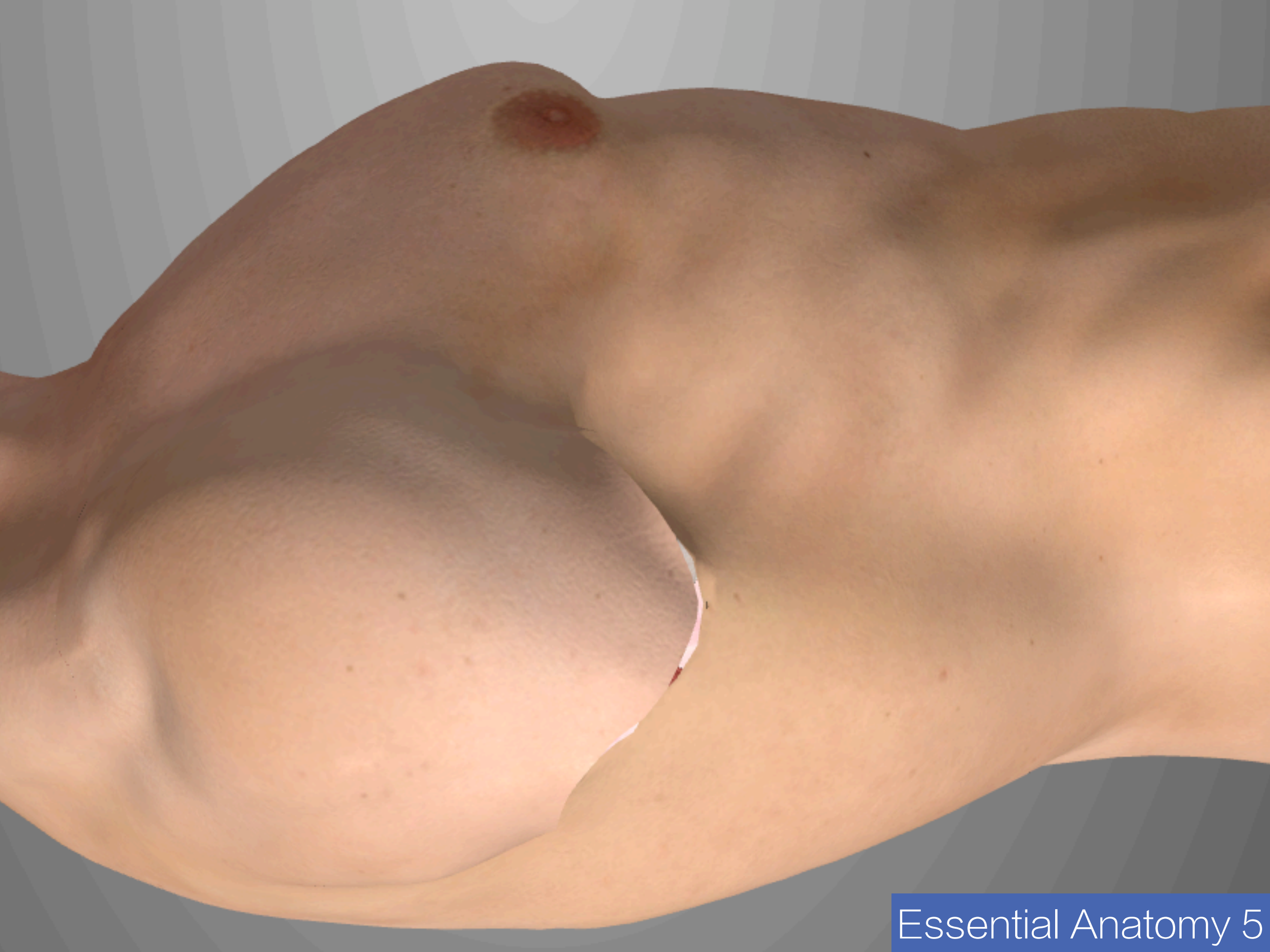












An anatomical illustration of a female torso from the chest to the waist. A dashed white line is drawn horizontally across the upper chest area, passing through the highest point of the breast. The text "Highest point" is written in white, bold font, centered over the dashed line. The background is a light blue gradient with a subtle pattern of white dashed lines.

Highest point



Highest point

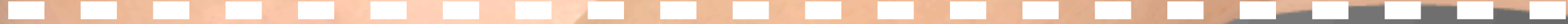
This anatomical illustration shows a lateral view of the human rib cage. The ribs are depicted as curved, light-colored structures. A dashed white line is drawn horizontally across the top of the rib cage, indicating the highest point of the ribs. The text "Highest point" is overlaid in white on the ribs. The background is a light gray with a subtle grid pattern.

An anatomical illustration of a female torso from the chest to the waist. A horizontal dashed white line is drawn across the upper chest. A blue rectangular box highlights the highest point of the breast, which is the point of maximum projection. The text "Highest point" is written in white, bold font over the breast area.

Highest point

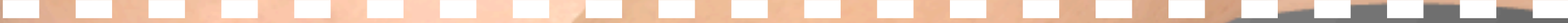


Highest point





Highest point

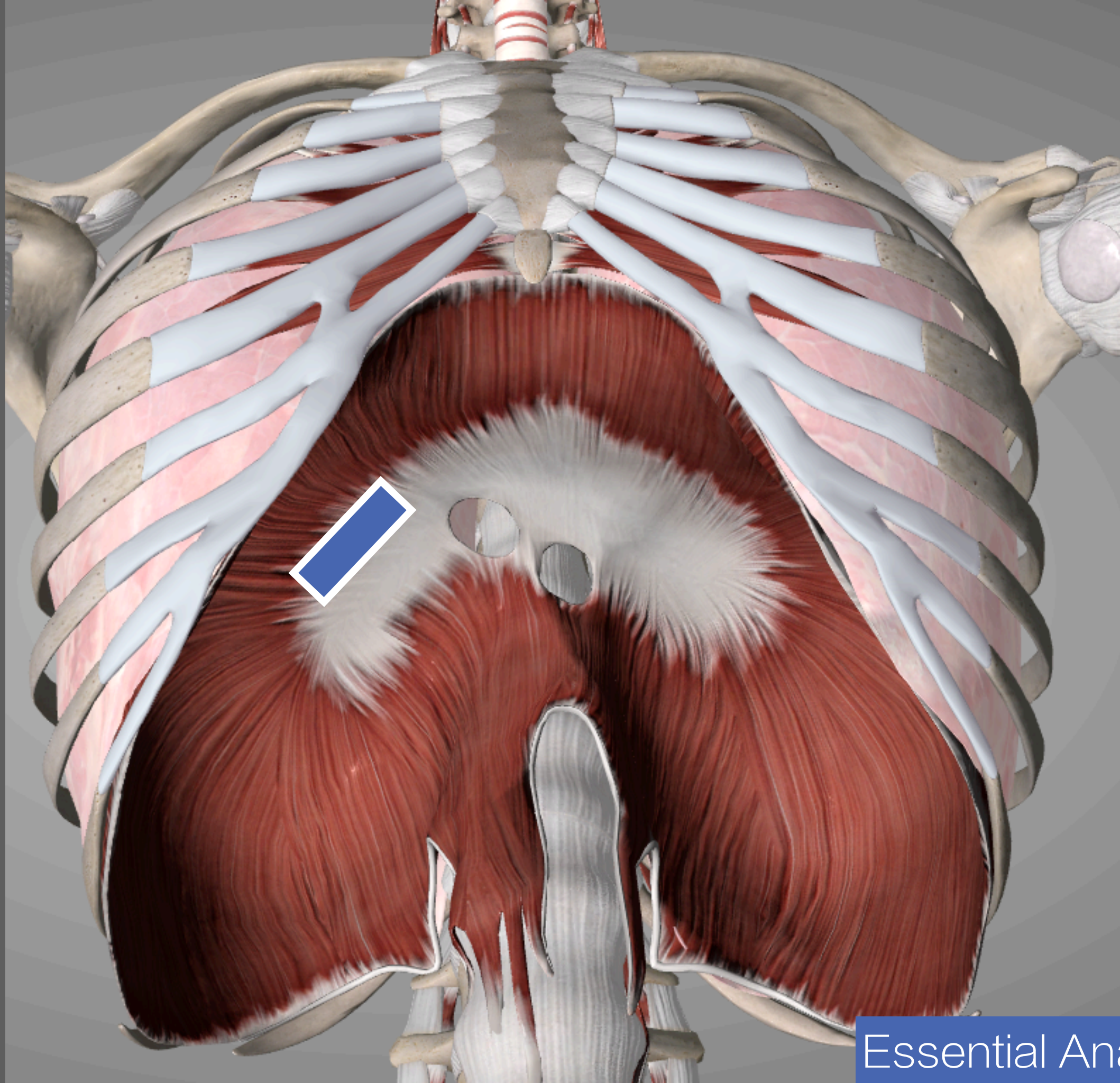




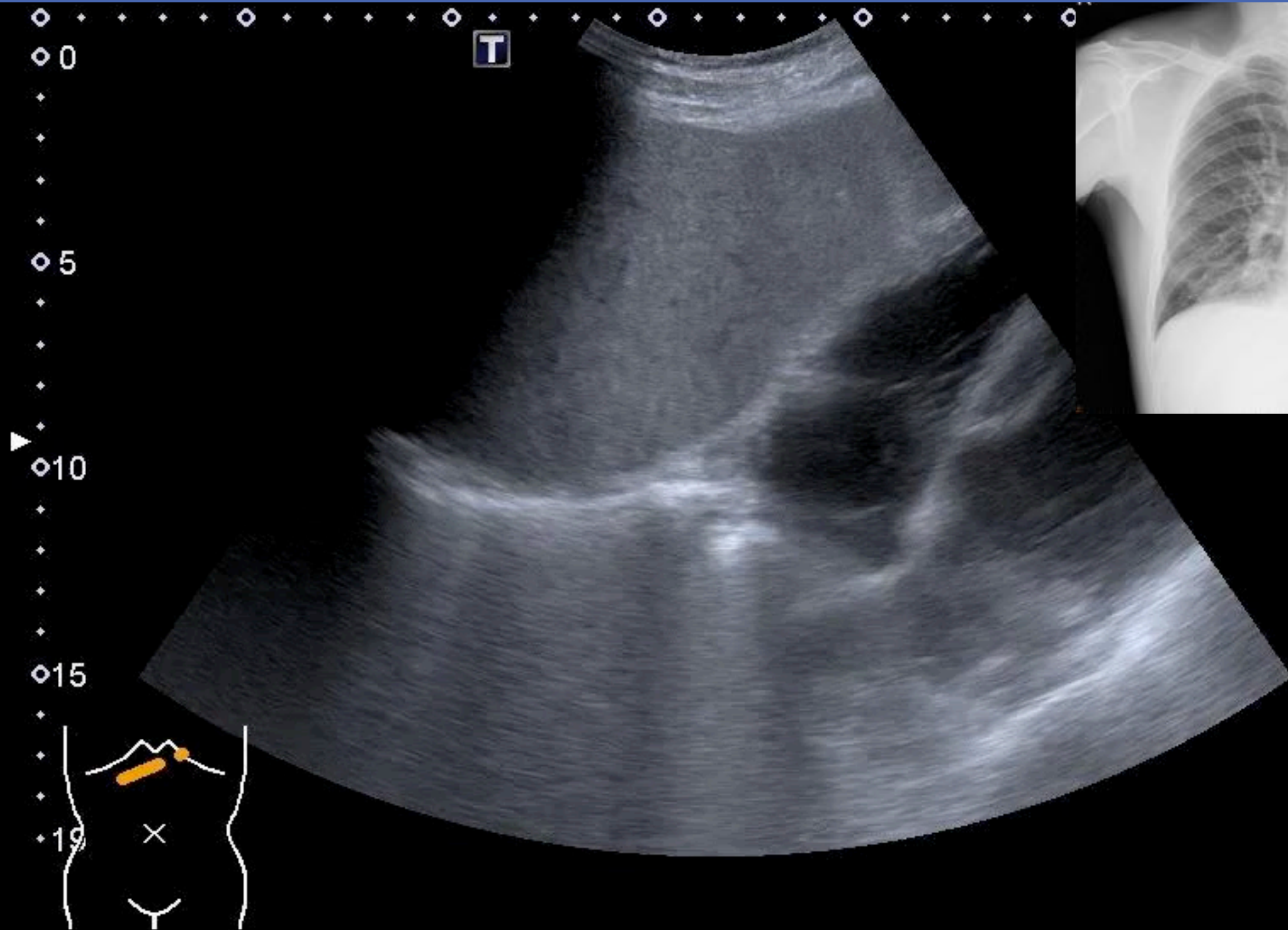
Highest point



Highest point



51M, Epigastric pain & CPR 8.5



I-AIM

Indication

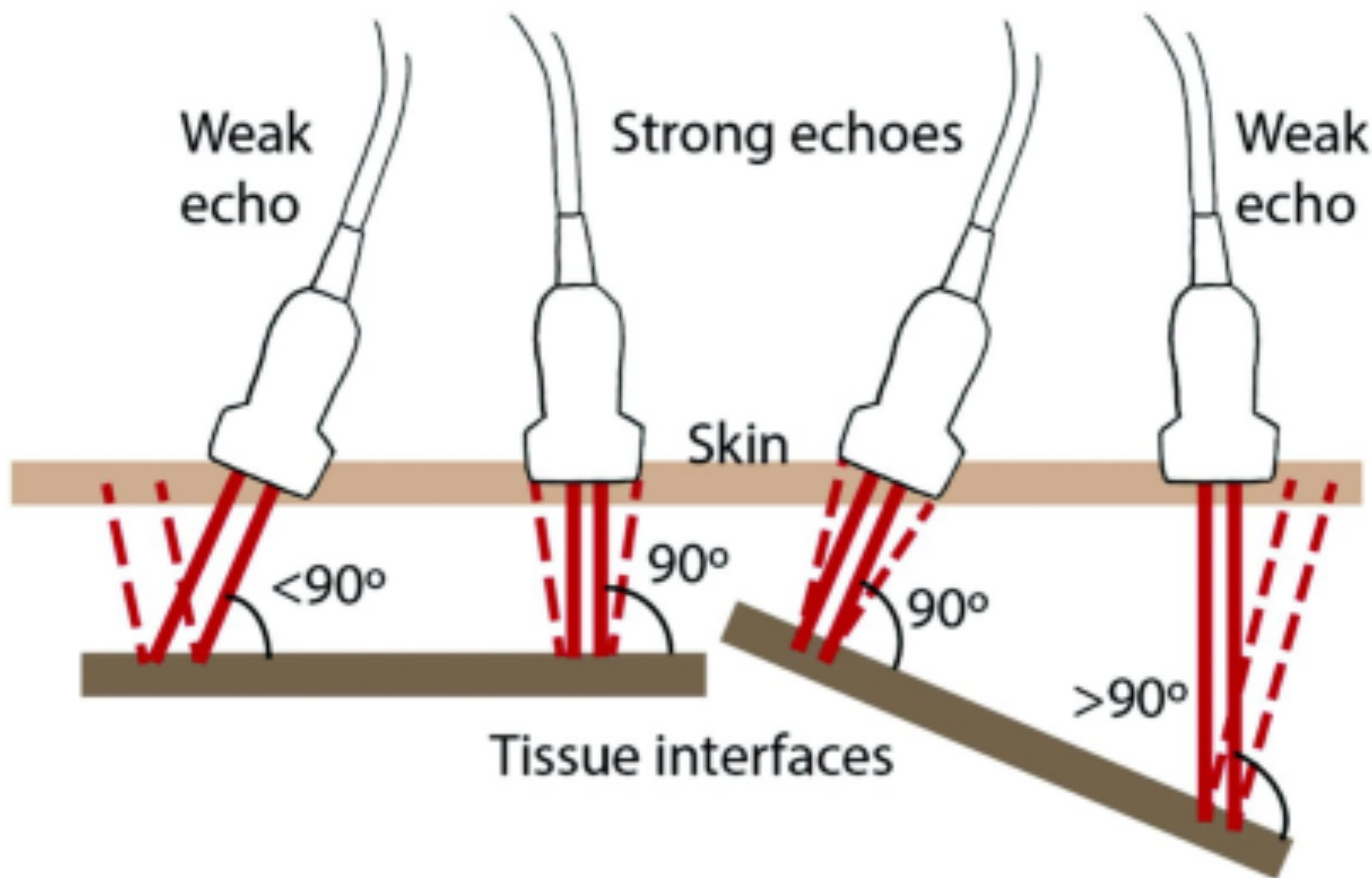


Acquisition



Interpretation

基本原則：垂直



基本原則：氣/水

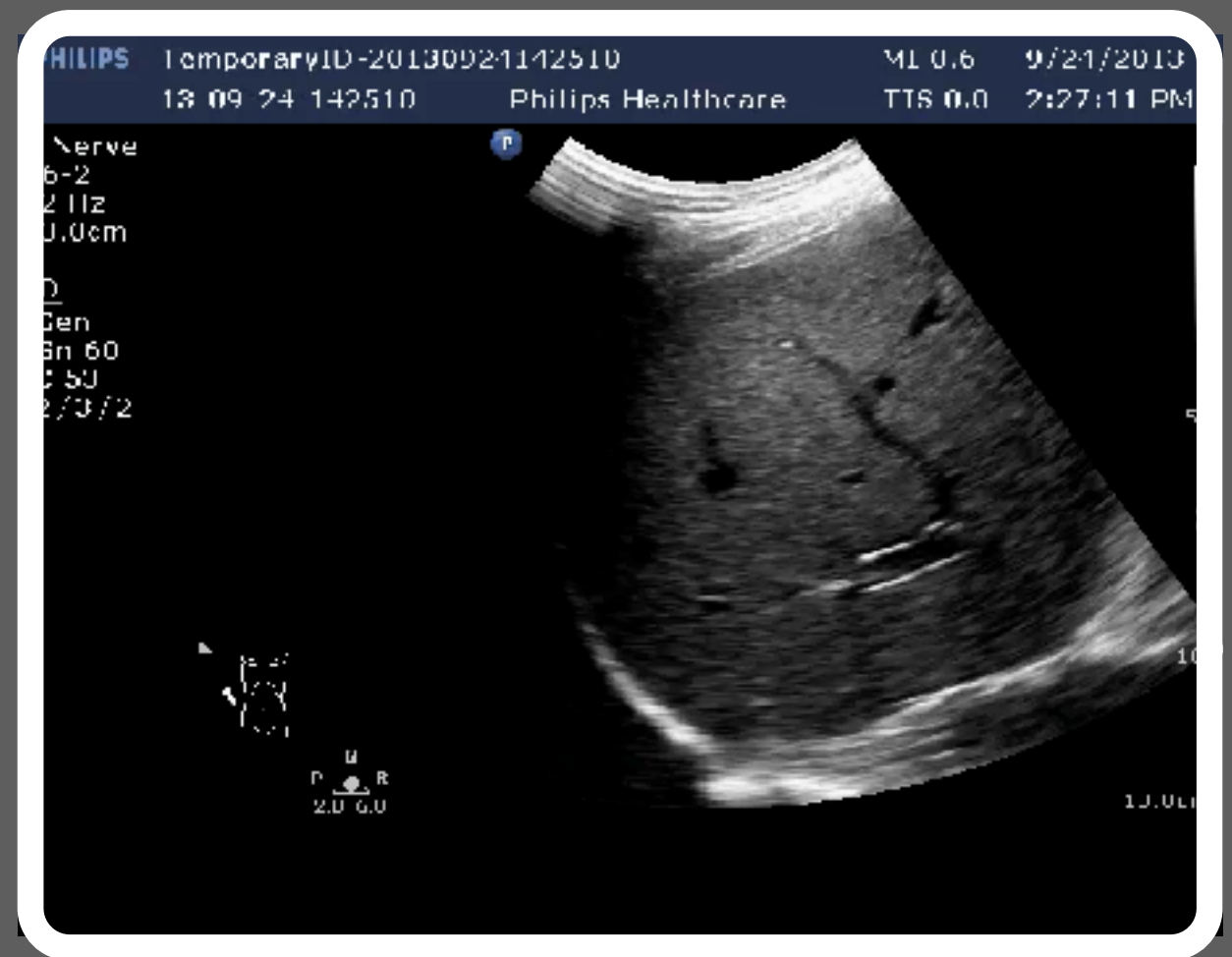
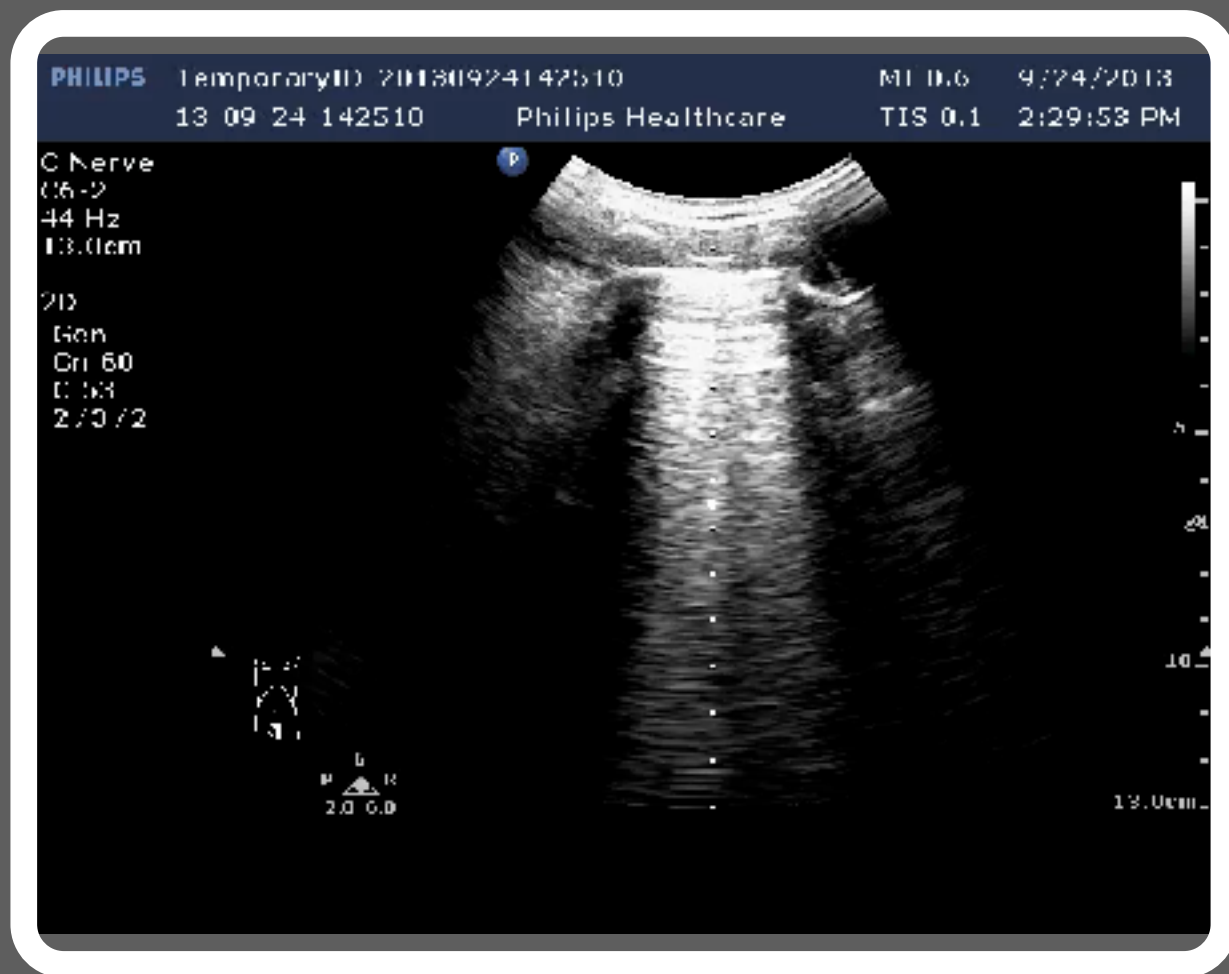
Air

Fluid

基本原則：氣/水

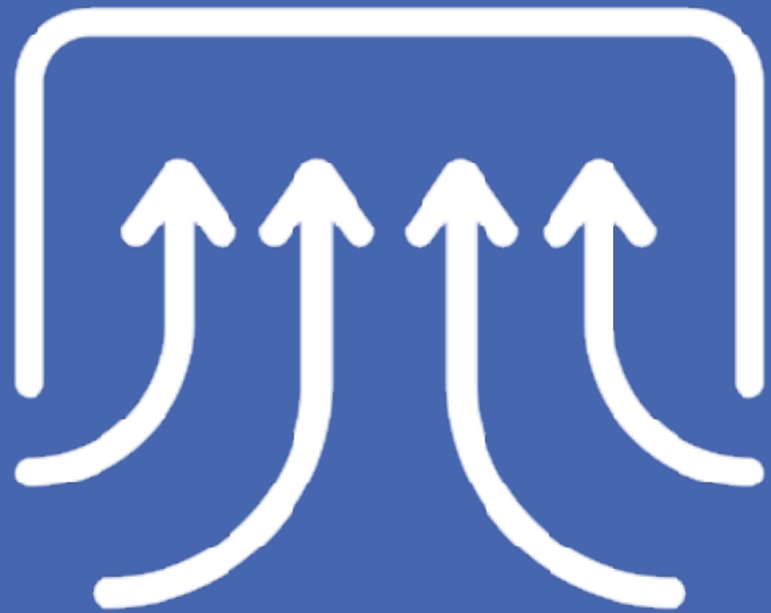
Air

Fluid



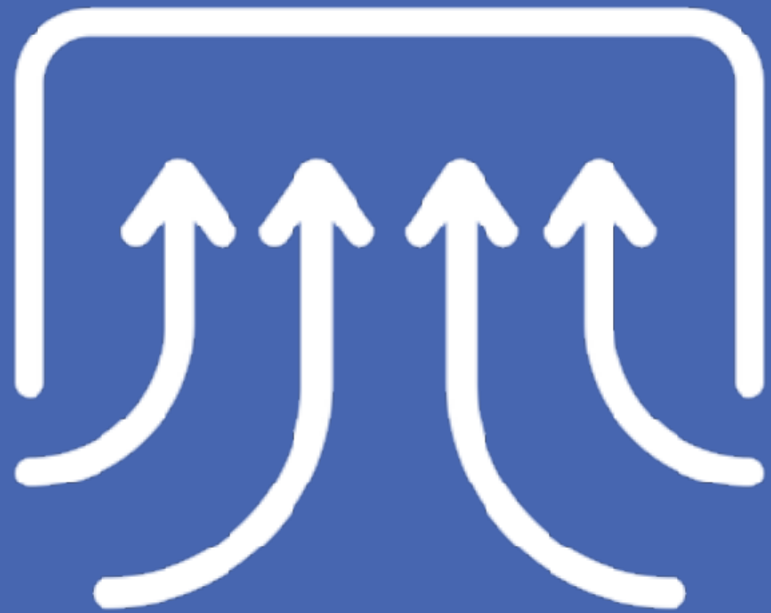
基本原則：氣/水

Air 100%



基本原則：氣/水

Air 100%

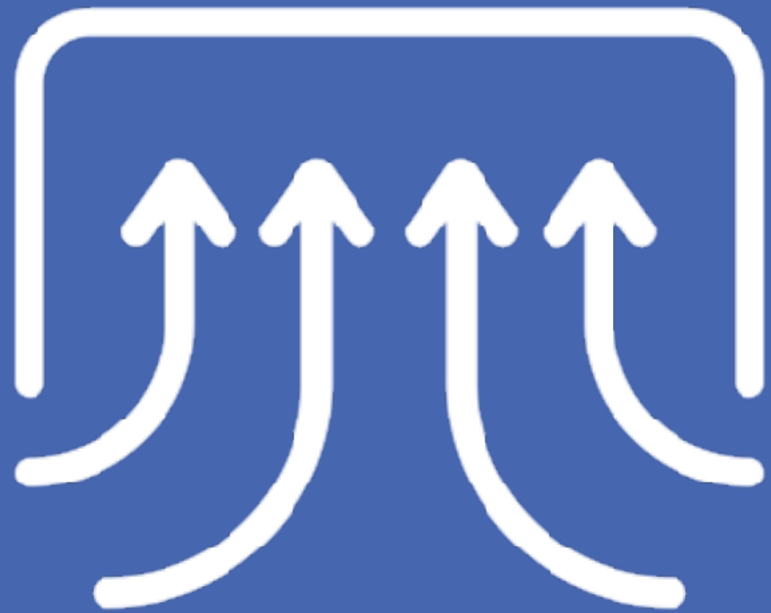


Pneumothorax

基本原則：氣/水

Air 100%

Fluid 100%

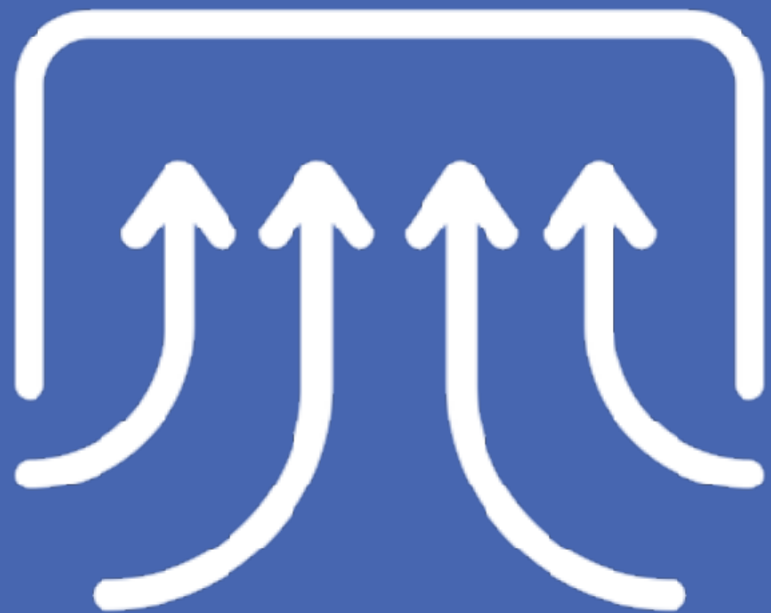


Pneumothorax

基本原則：氣/水

Air 100%

Fluid 100%



Pneumothorax

Pleural effusion

基本原則：真/假

True

Artifact

基本原則：真/假

True

Artifact

Pneumonia
Pleural effusion
Pleural mass

基本原則：真/假

True

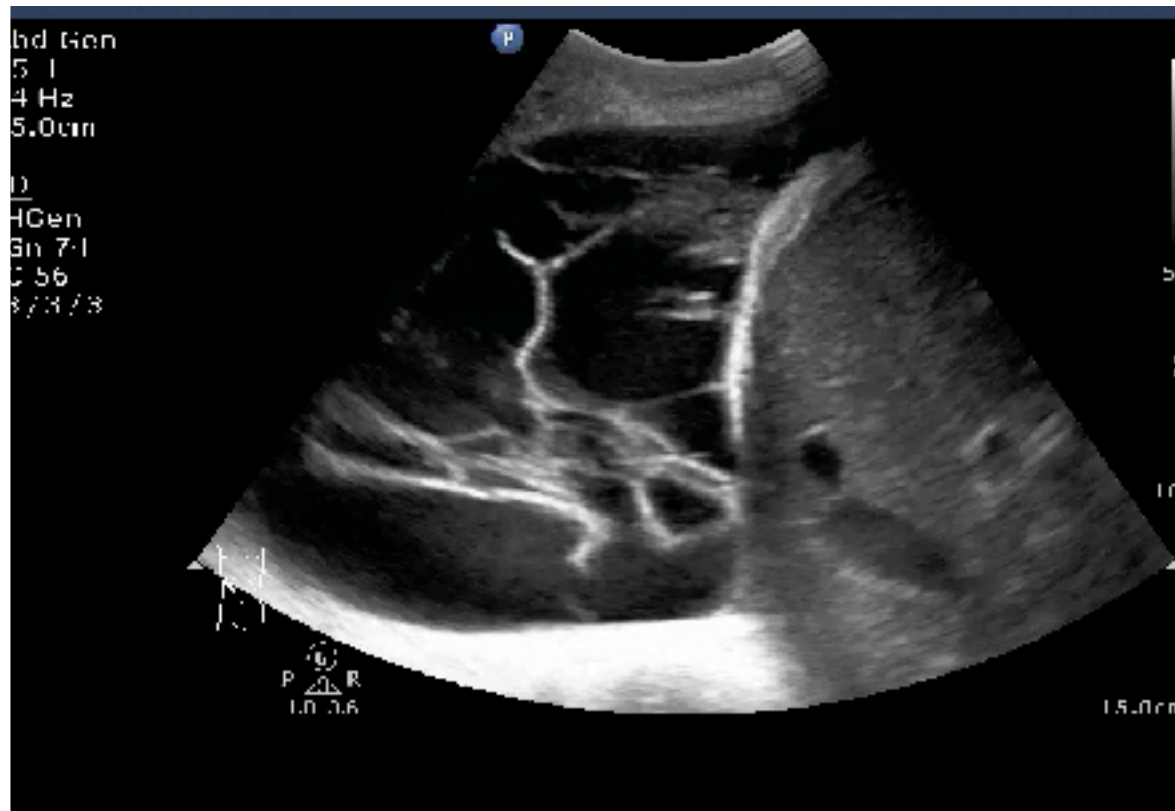
Pneumonia
Pleural effusion
Pleural mass

Artifact

Normal lung
Pneumothorax
AIS

基本原則：真/假

True



基本原則：真/假

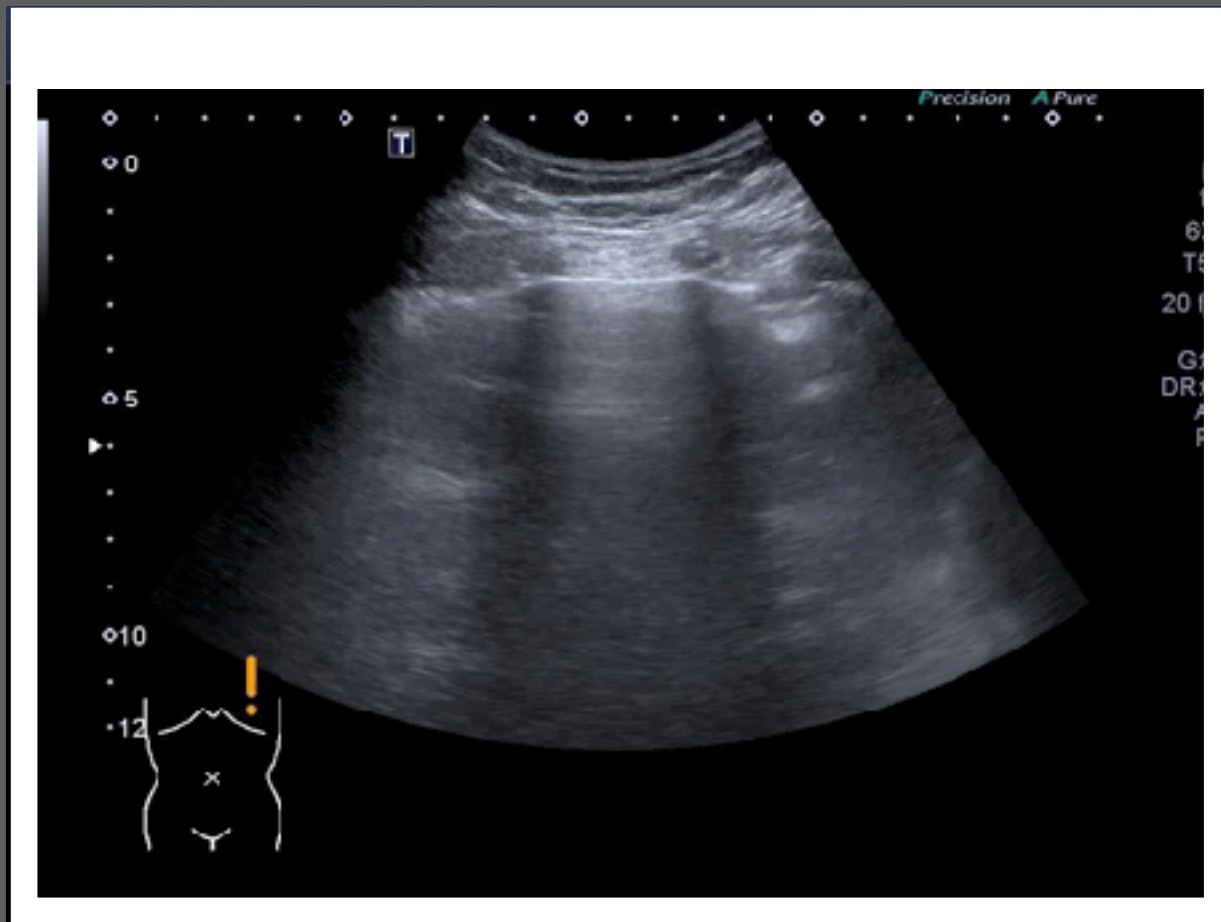
True

Artifact



基本假影：A lines

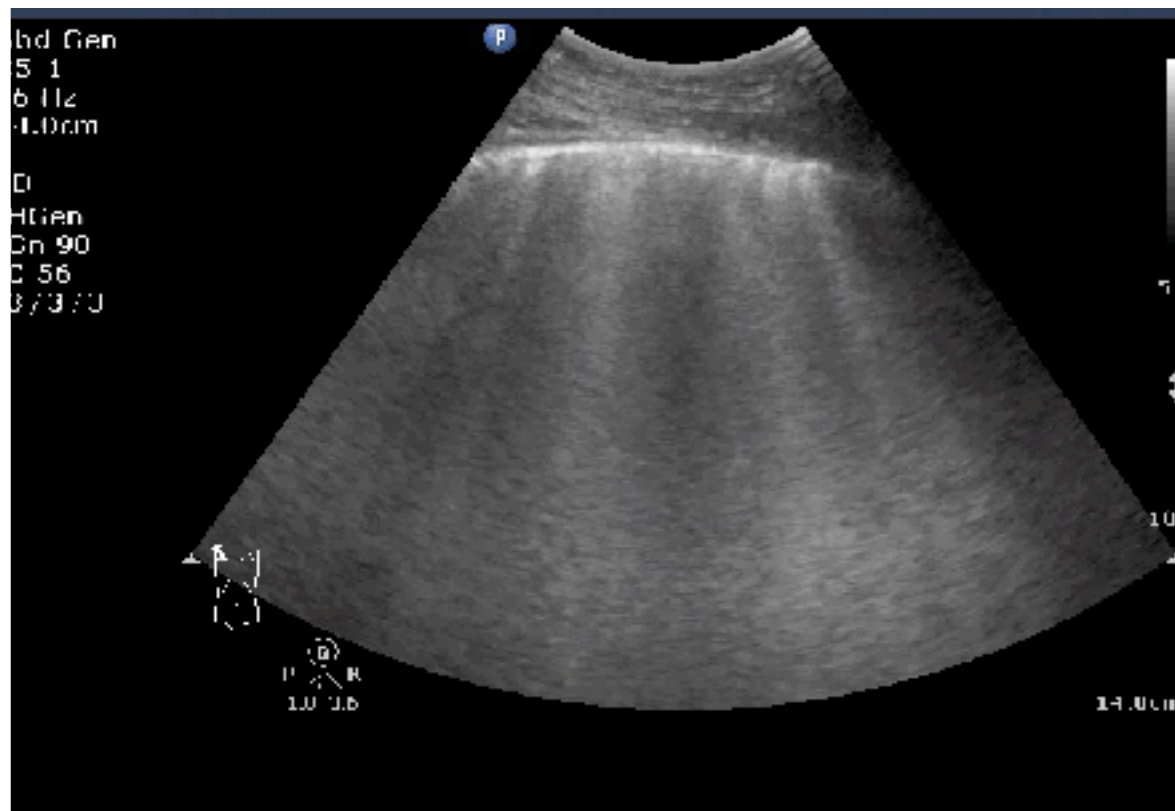
A lines



Pleural
Equal
Horizontal

基本假影 : B lines

B lines



Pleural
Vertical
> 3 in ICS

D. Lichtenstein
G. Mezière
P. Biderman
A. Gepner

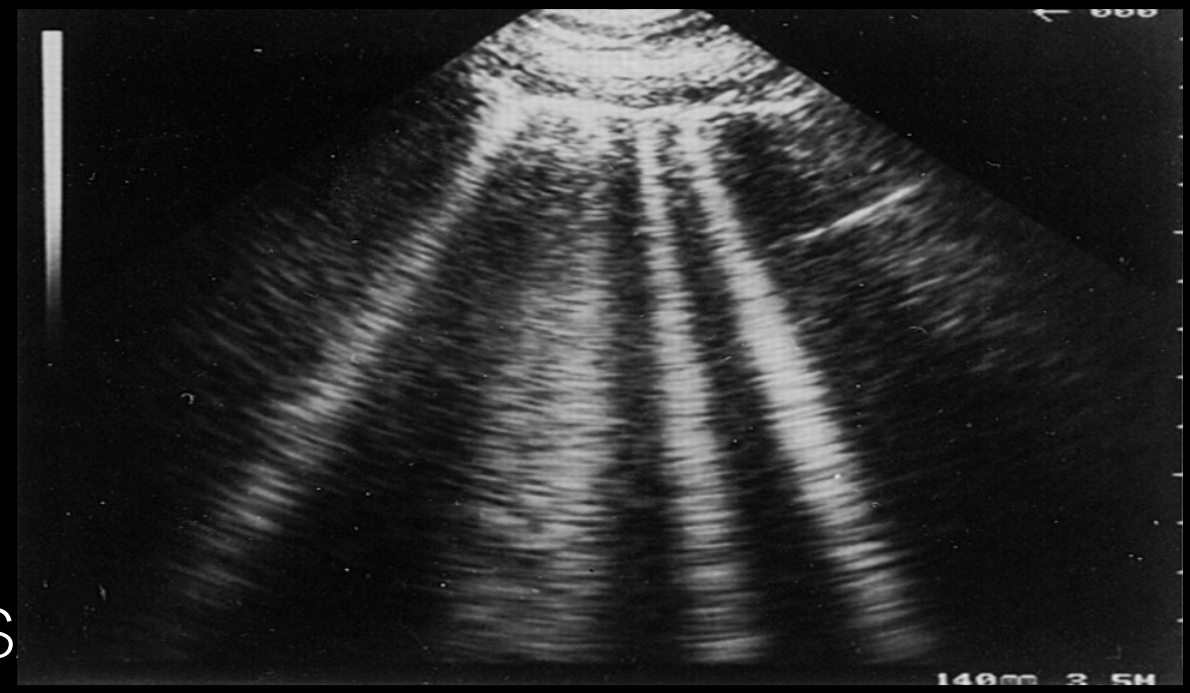
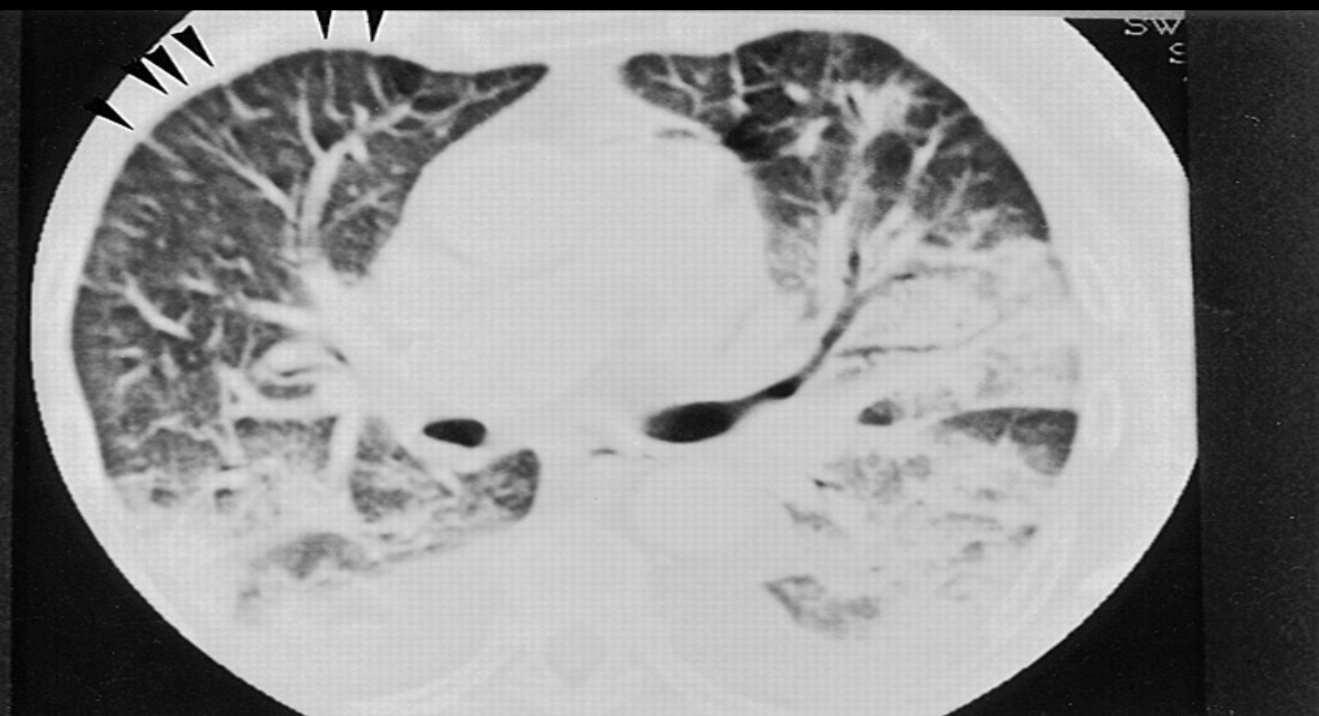
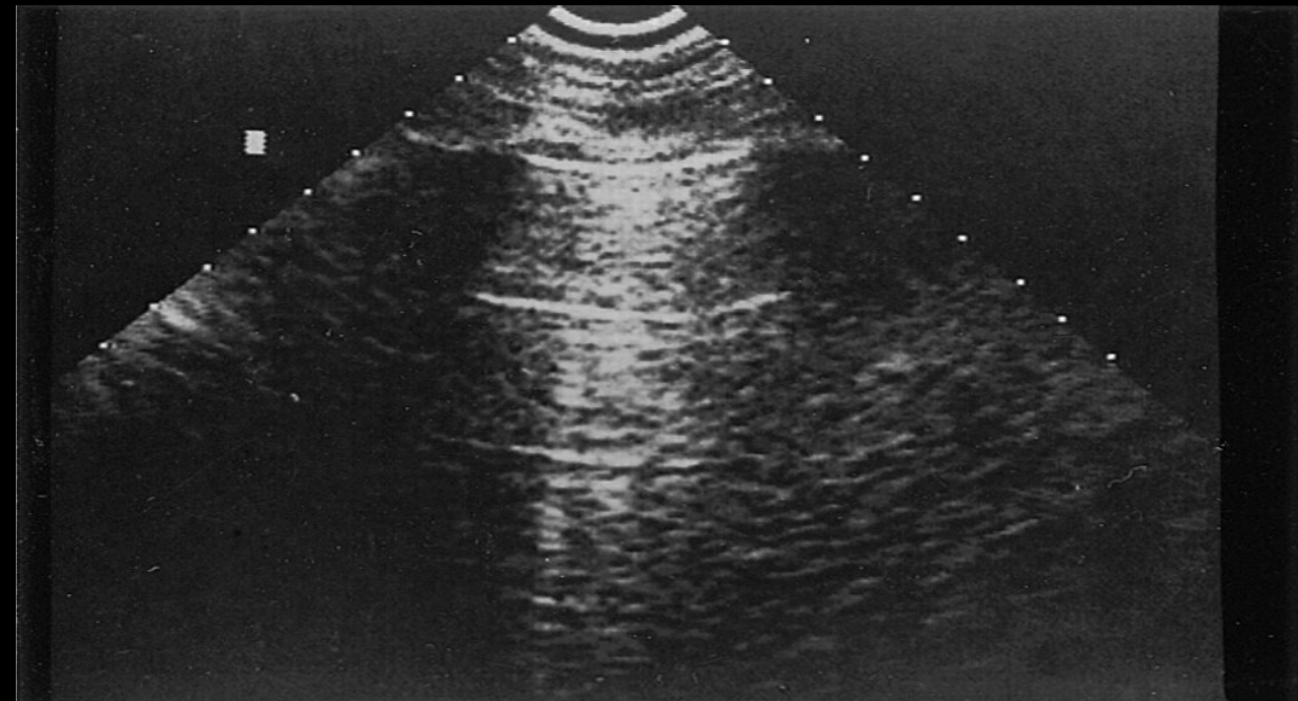
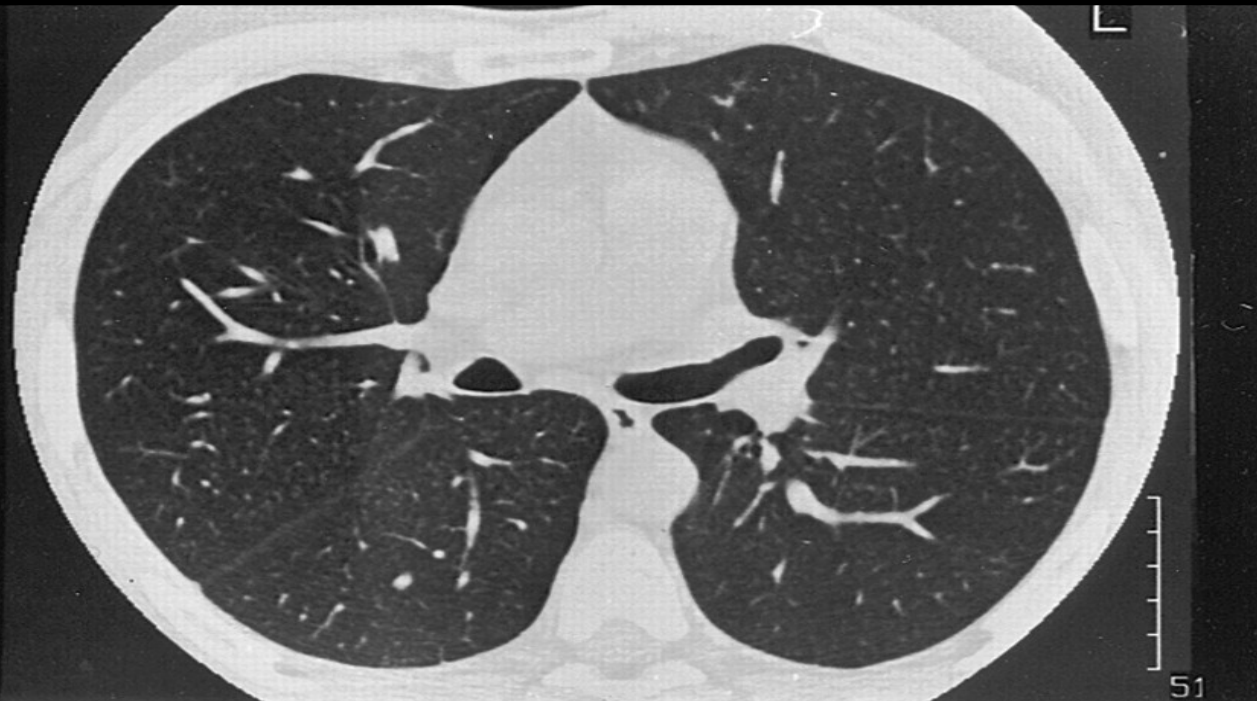
The comet-tail artifact: an ultrasound sign ruling out pneumothorax

B line

A B-mode ultrasound image of a lung. The image shows a vertical, bright, comet-tail artifact (B line) extending from the pleural line to the bottom of the frame. The pleural line is visible as a bright, curved line at the top of the image. The background shows the typical speckled texture of lung tissue.

基本假影：A / B

US B lines ~ Kerley B lines

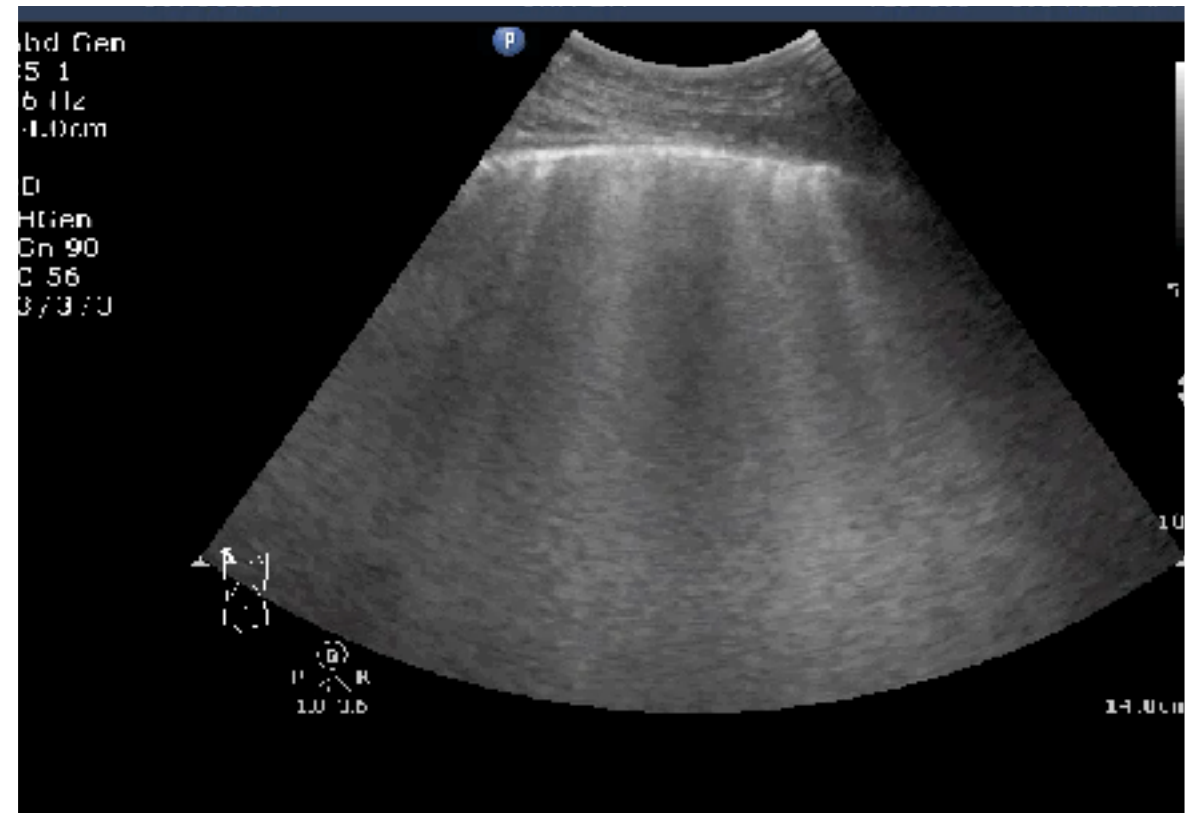
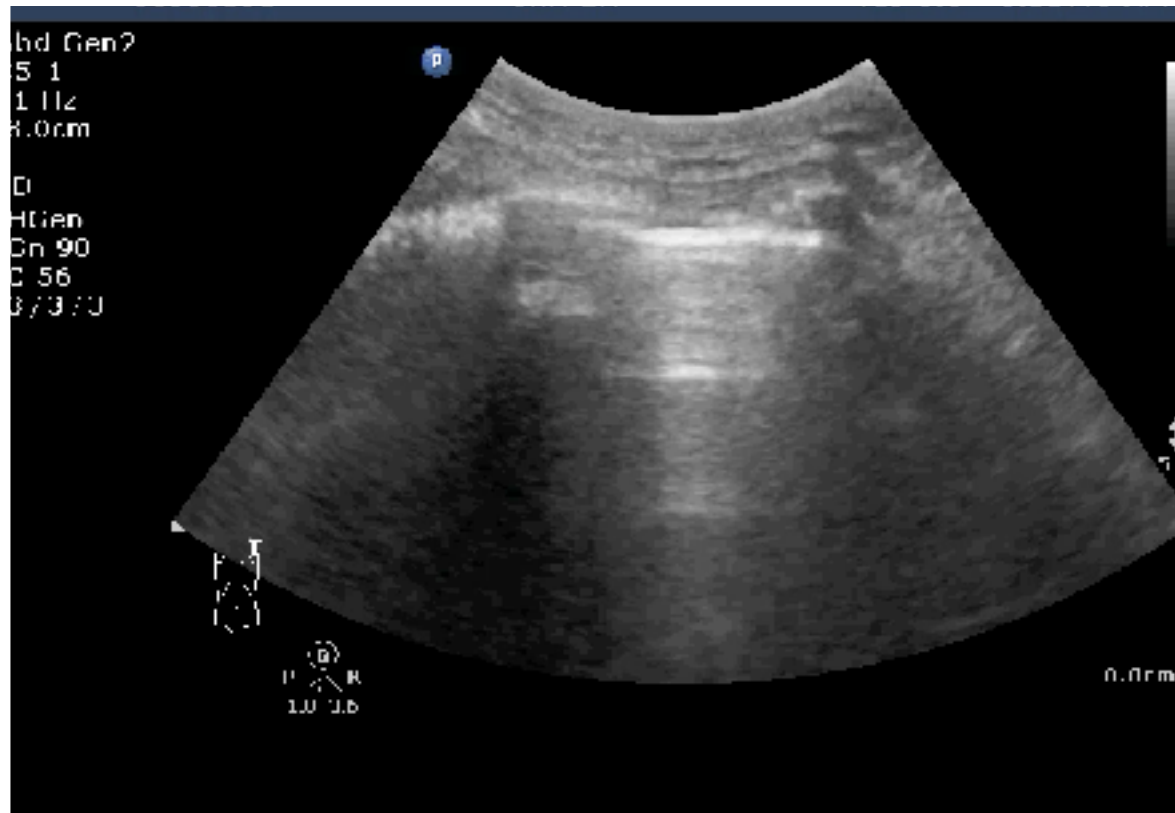


OCUS

基本假影：A / B

A

B



那一個影片有問題??

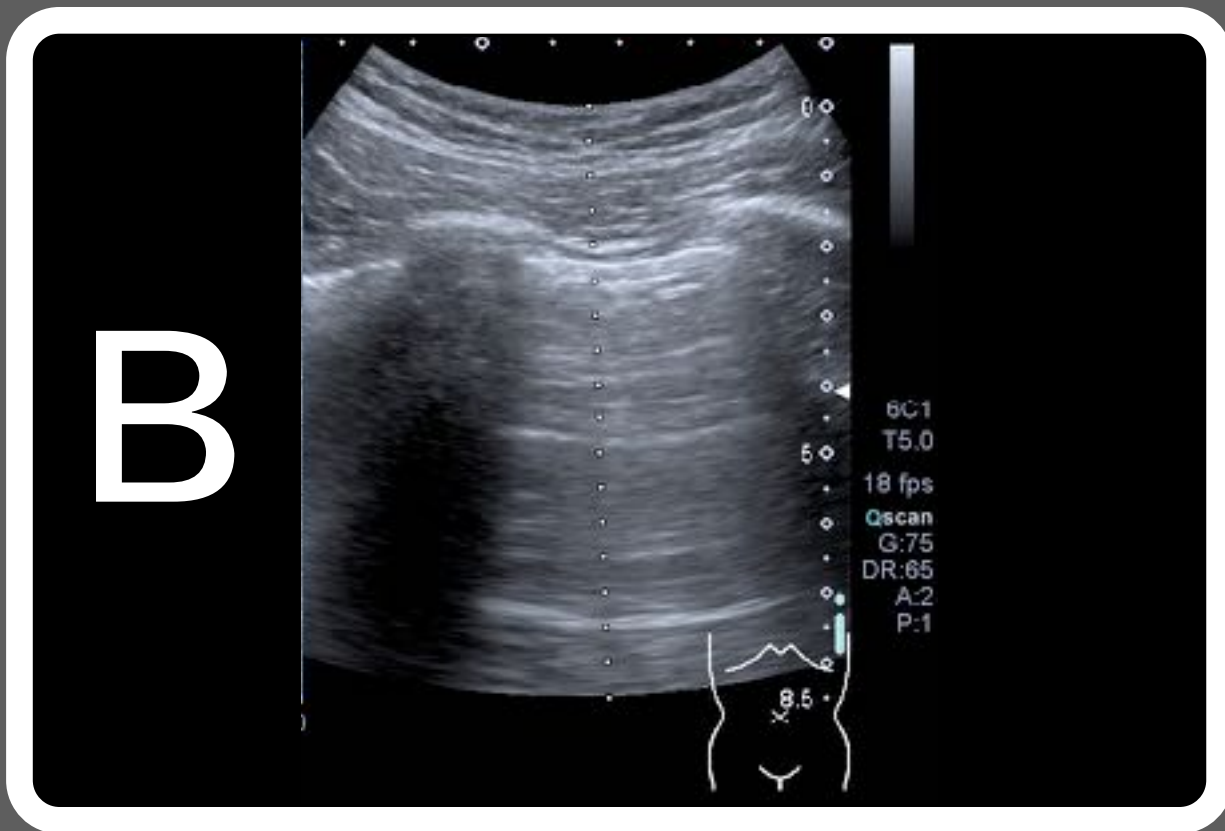
基本分析：動／靜

Static

Dynamic

基本分析：動/靜

Static



基本分析：動/靜

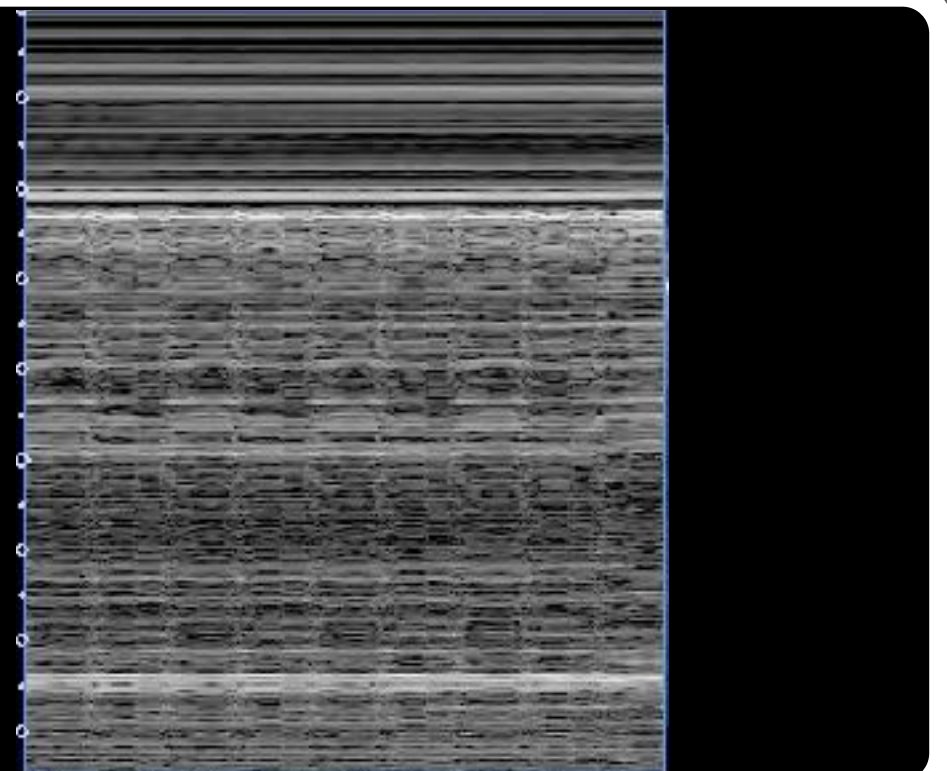
Static

Dynamic

B



M



正常肺部的動與靜



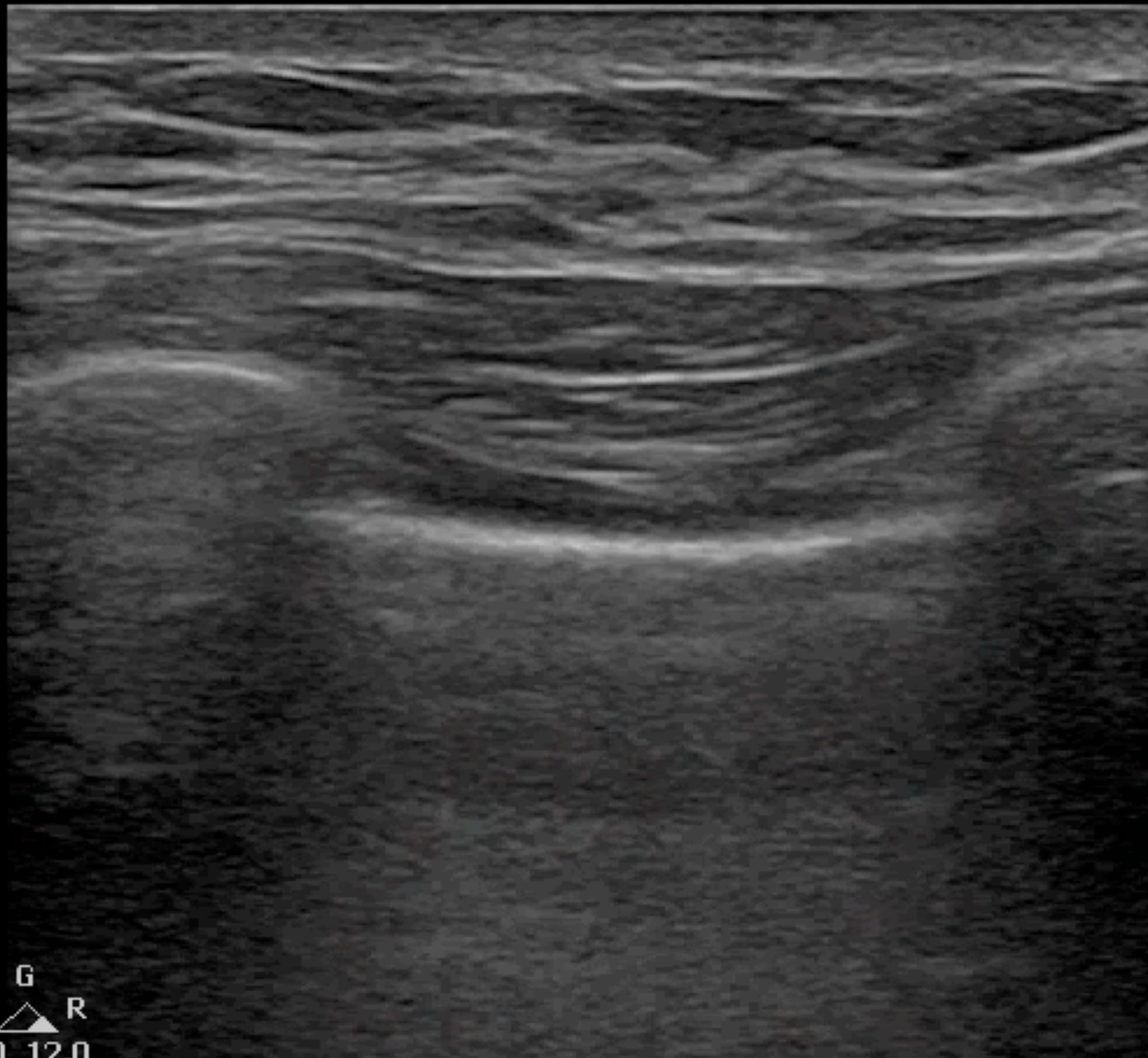
Bat sign & Pleura

Superficial
L12-3
46 Hz
3.5cm

2D

Res
Gn 60
C 56
3 / 2 / 1

P



G
P R
3.0 12.0

2

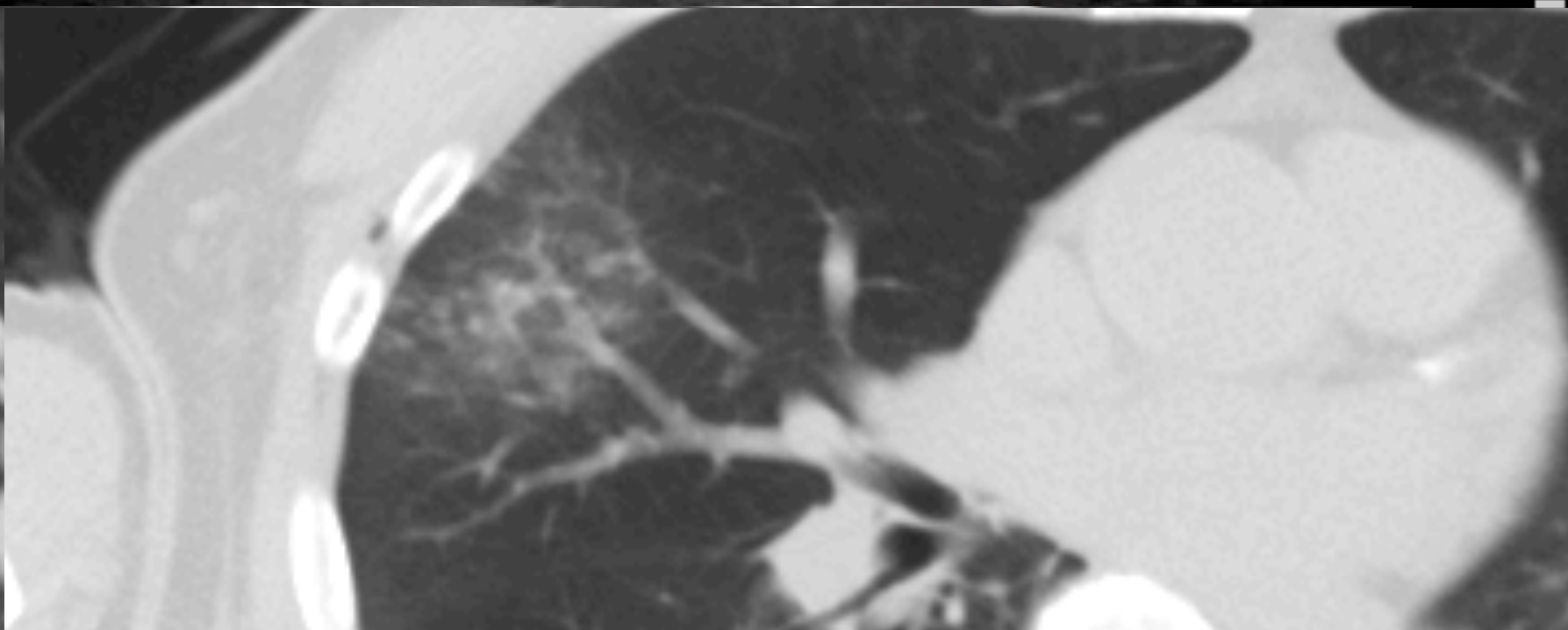
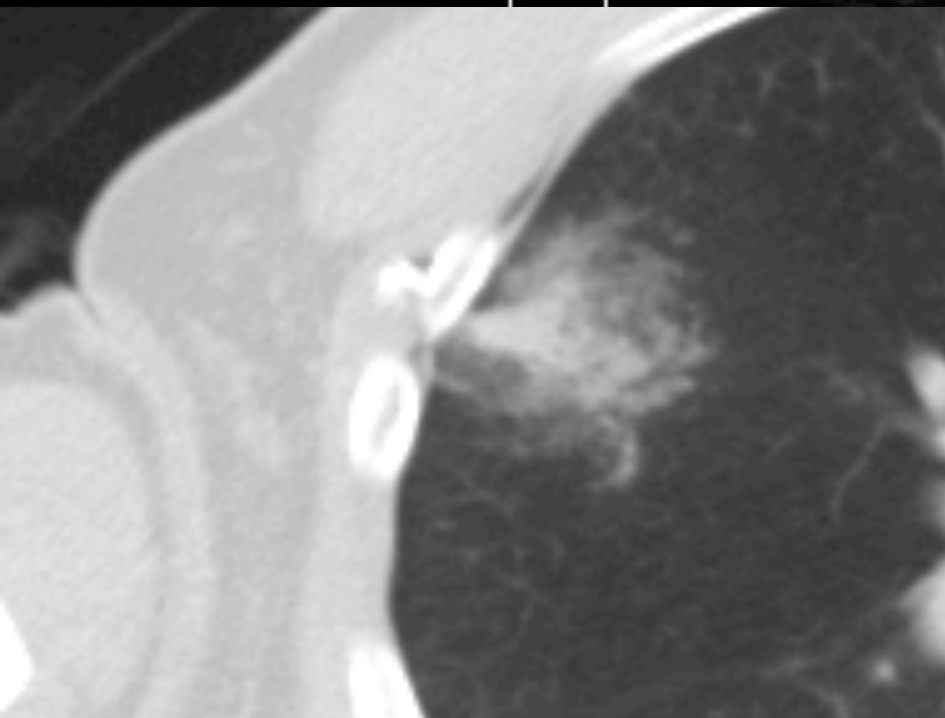
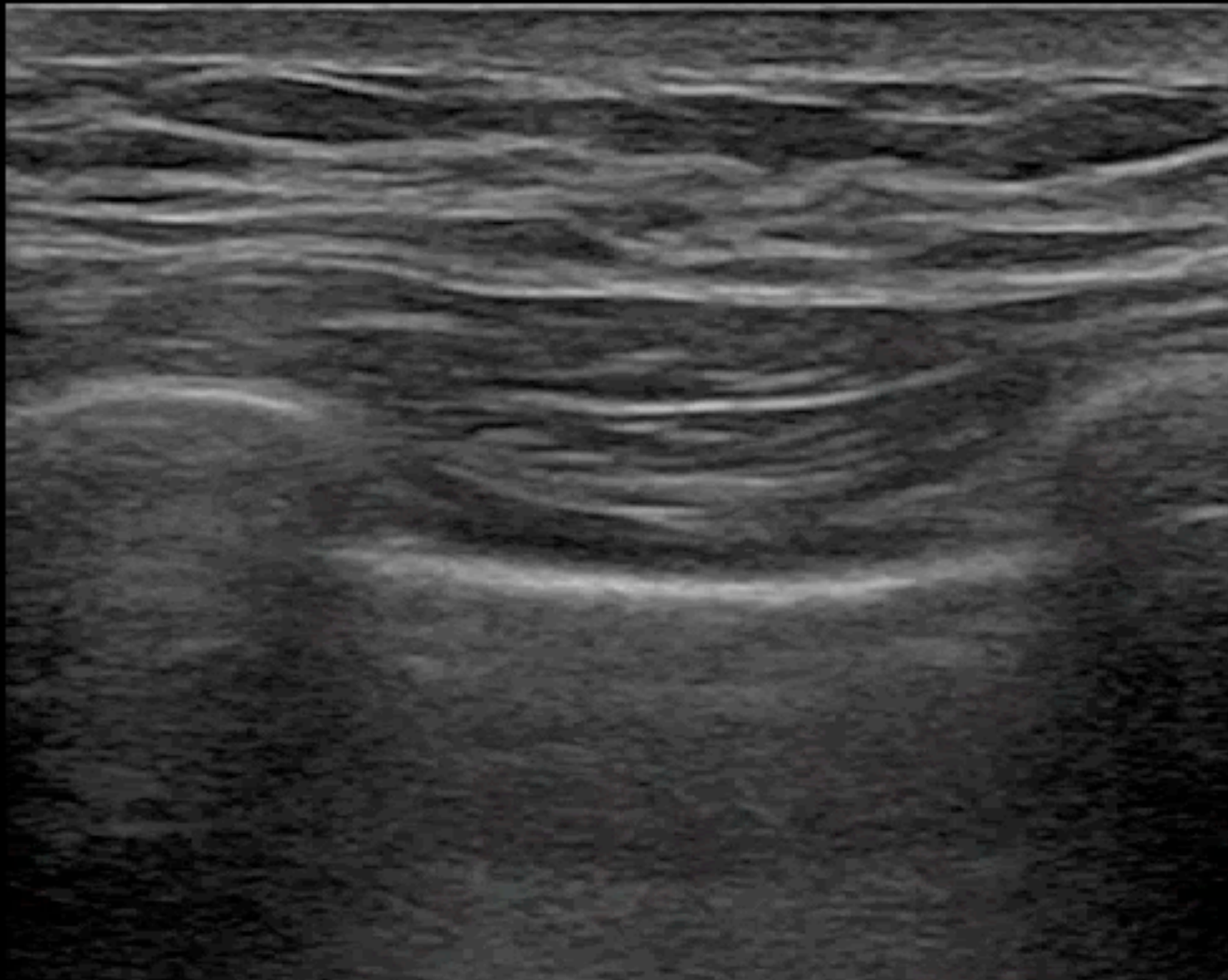
3.5cm

Superficial
L12-3
46 Hz
3.5cm

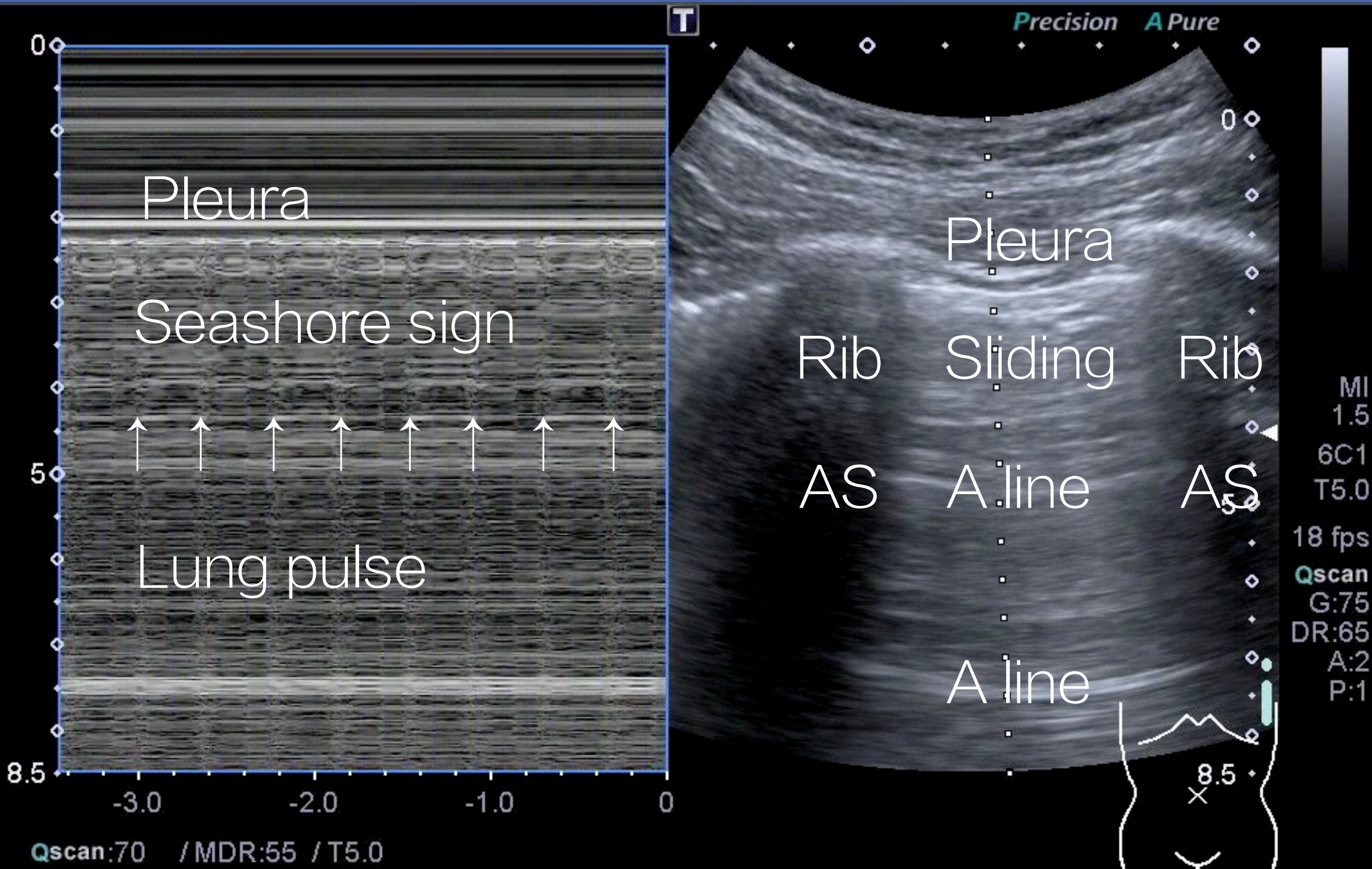
P

2D

Res
Gn 60
C 56
3 / 2 / 1



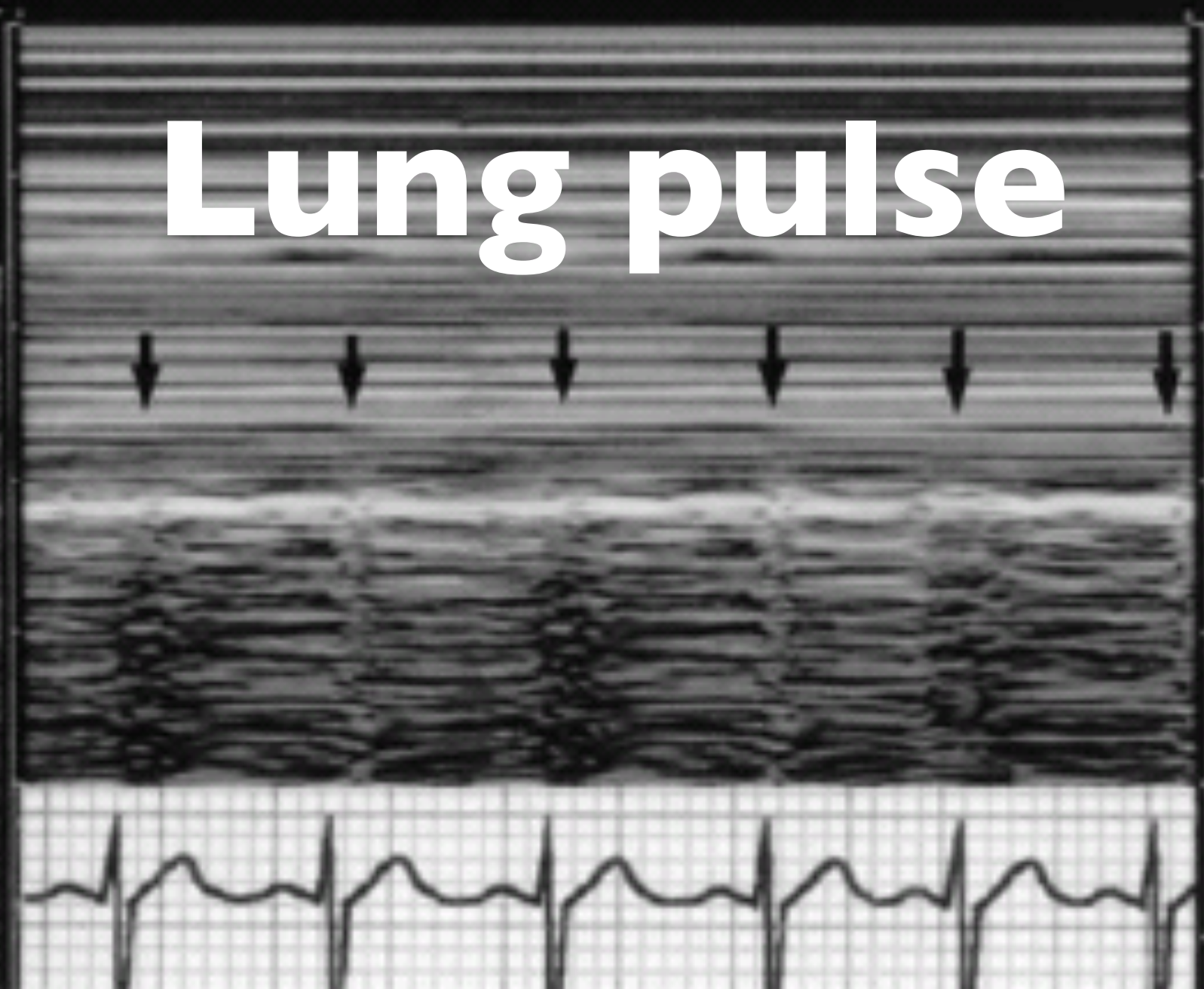
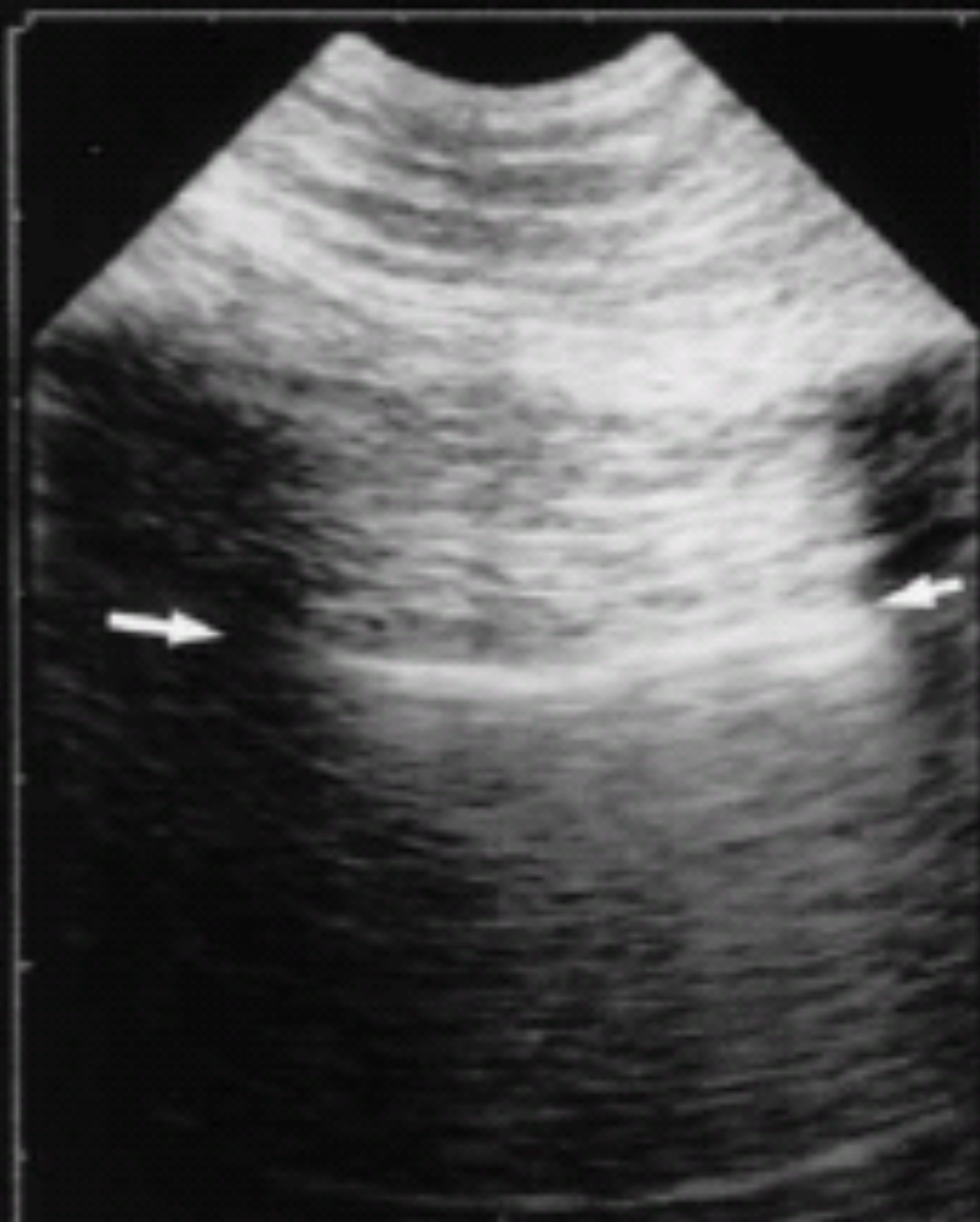
正常肺部的動與靜



Daniel A. Lichtenstein
Nathalie Lascols
Sébastien Prin
Gilbert Mezière

The “lung pulse”: an early ultrasound sign of complete atelectasis

15-NOV-01



LUS的建議：四原則

氣
水

真
假

A
B

動
靜

LUS 醫療決策



Snot: 安心地排除吧

Spin: 有看到很可信

好用的Rule out



Sliding

B lines

Lung pulse

LUS for SABE



Sliding

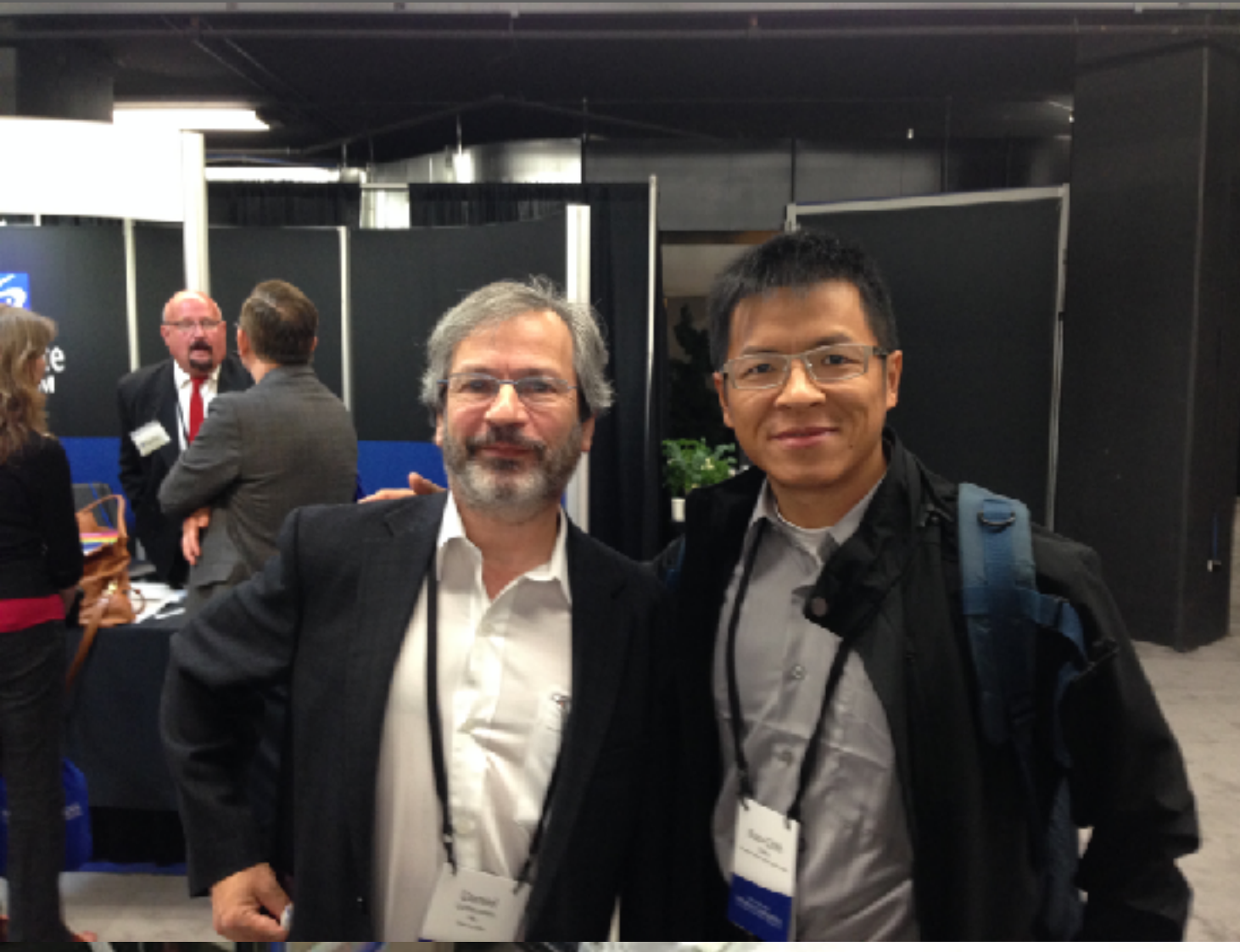
A line

B line

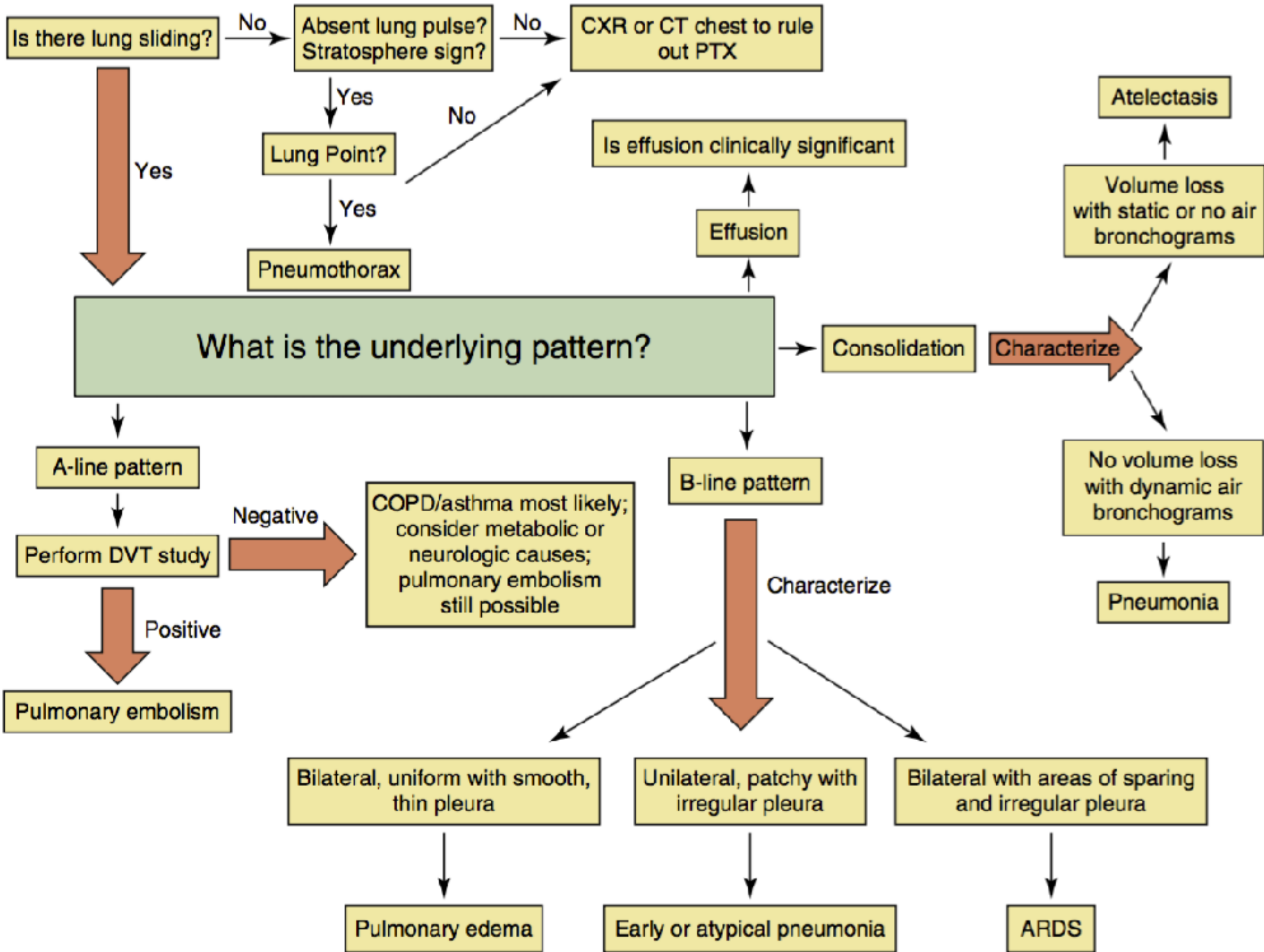
Effusion

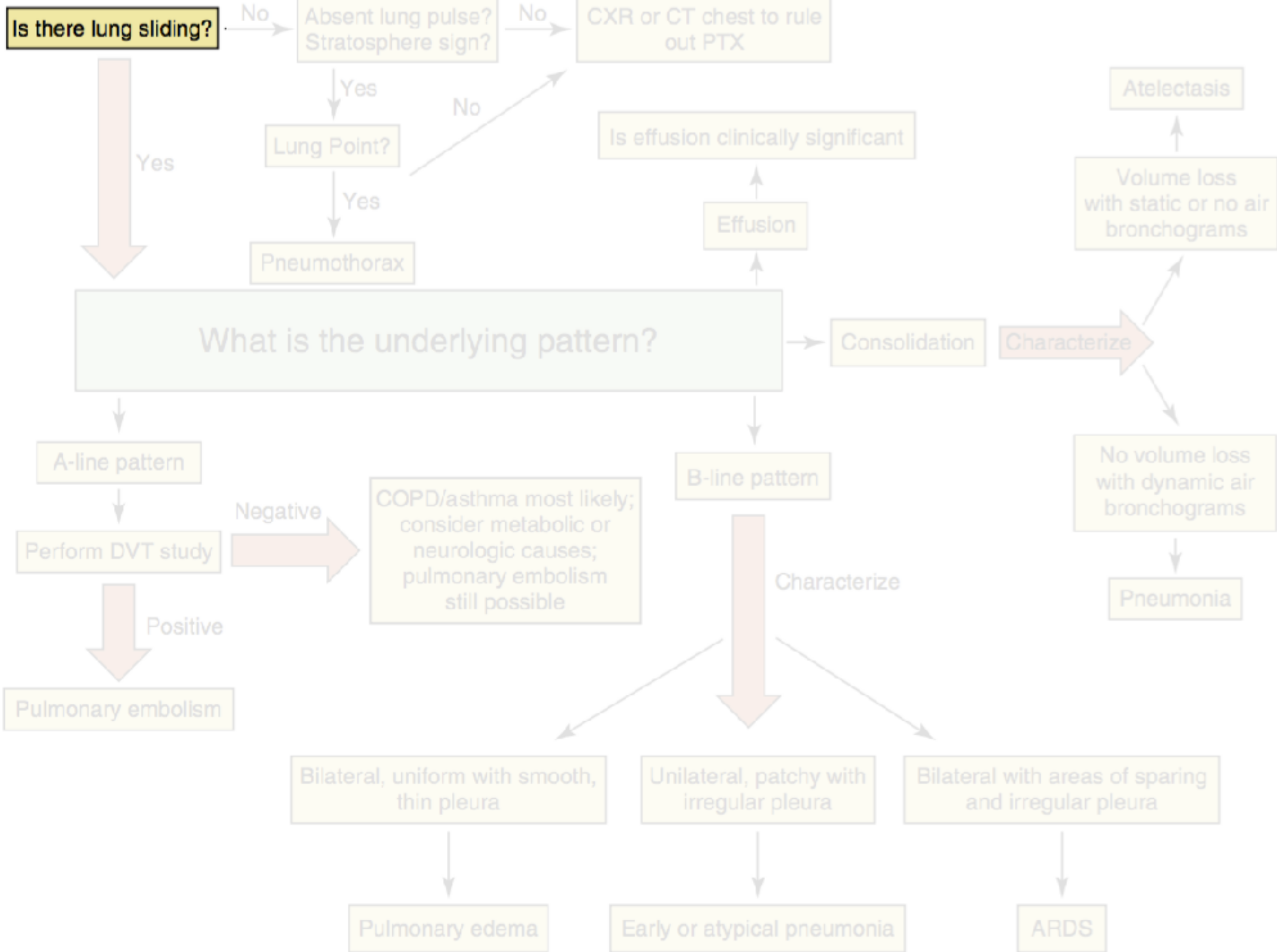
BLUE Protocol

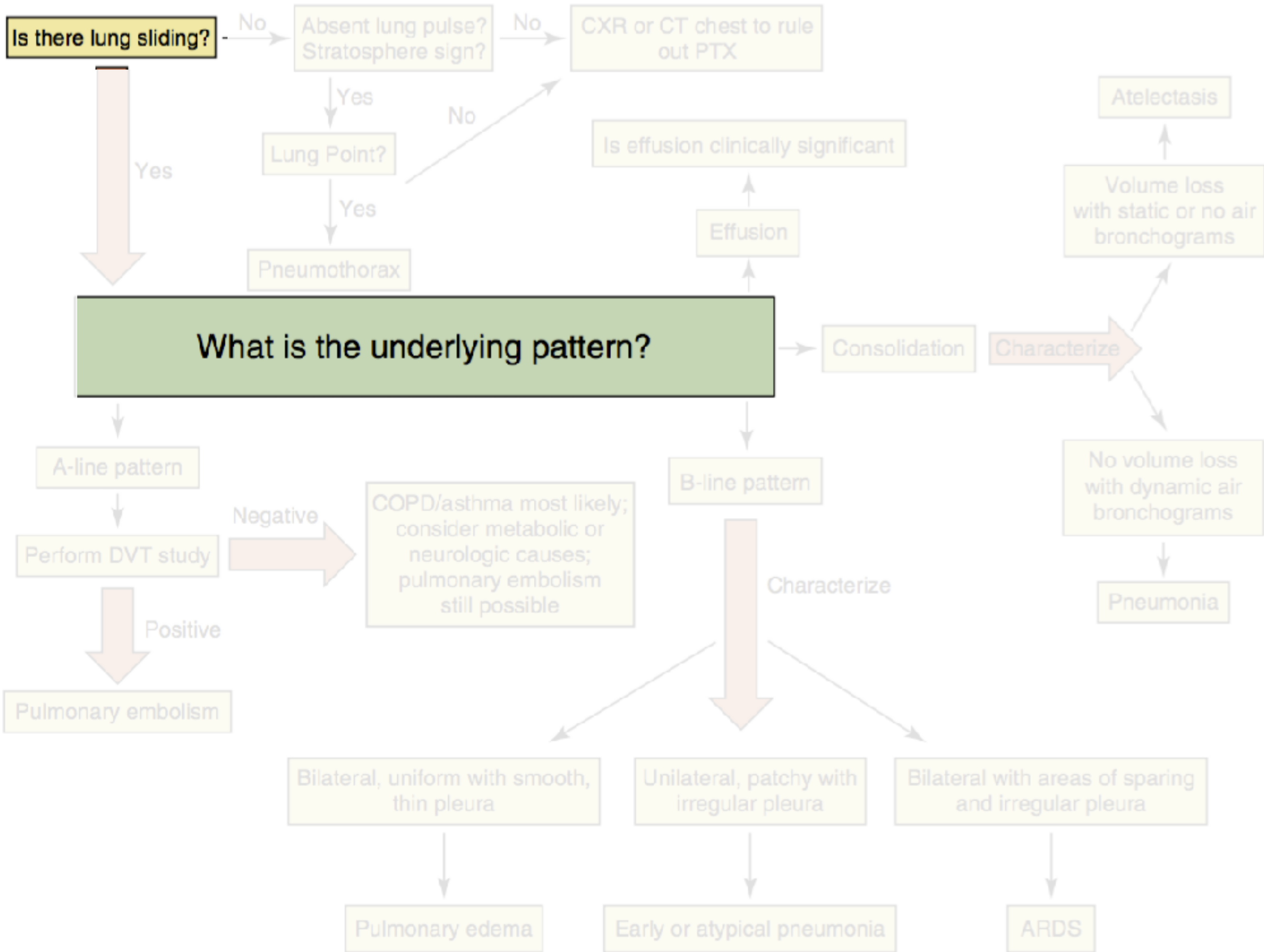
(Bedside Lung Ultrasound in Emergency Protocol)



Daniel Lichtenstein







BLUE Exam Points



Point 1



Point 2



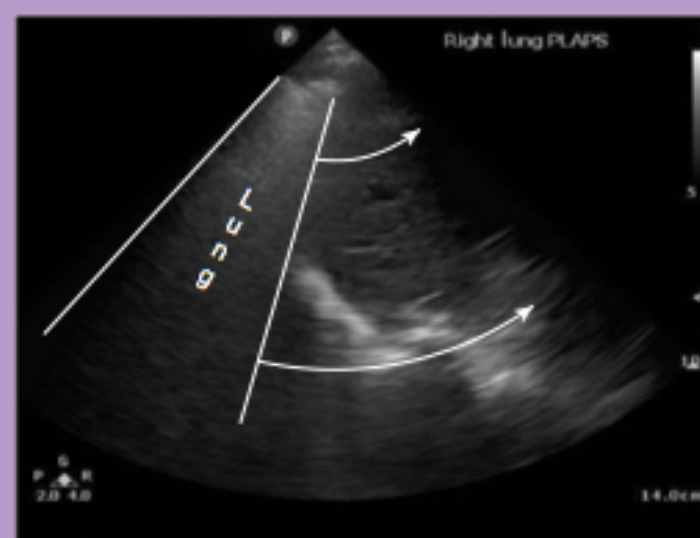
Point 3



Point 4

Sliding

A profiles



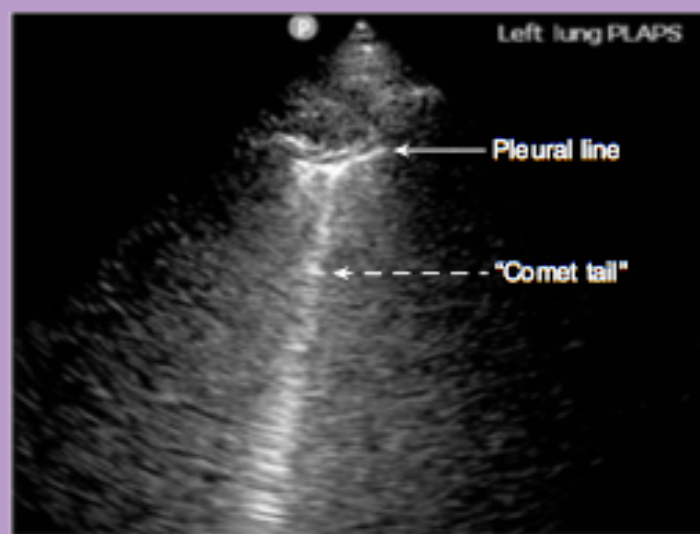
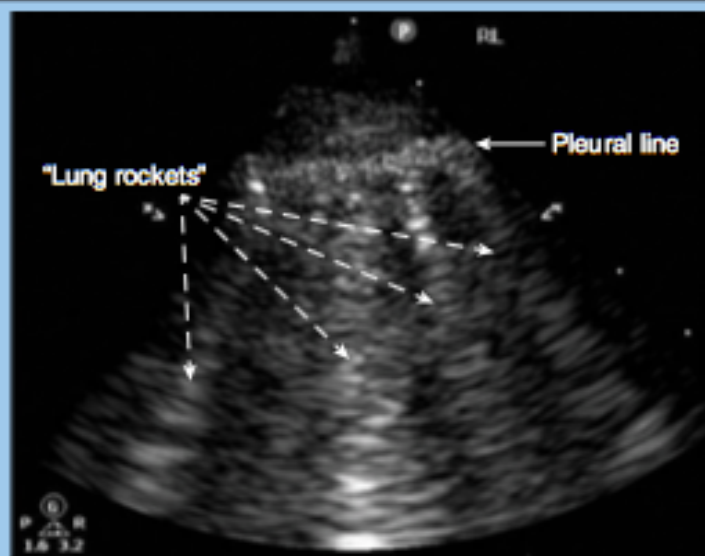
A profile = A-lines + sliding

- Normal
- If symptomatic, consider:
 - Pulmonary embolism
 - COPD, asthma
 - Nonpulmonary conditions

A' profile = A-lines + no sliding

- **Pneumothorax**
- Pleurodesis (*chemical, infection/inflammatory, fibrosis*)
- Lung volume loss (*complete atelectasis, mainstem intubation, mucous plug, pneumonectomy*)

B profiles



B profile = Bilateral B-lines + sliding

- **Pulmonary edema**
- ARDS (*diffuse*)

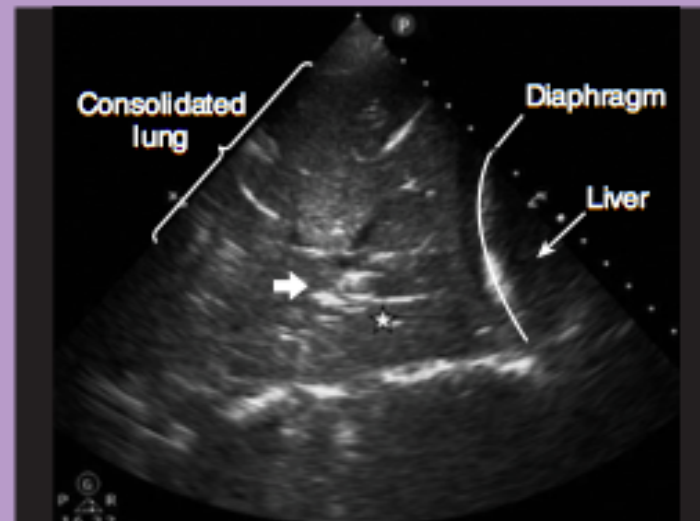
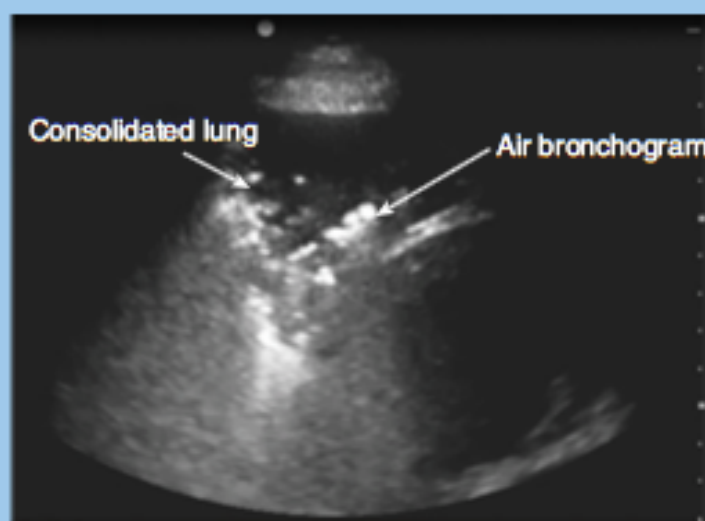
A/B profile = Unilateral B-lines + sliding

- Pneumonia (*mild*)
- ARDS (*focal*)
- Scarring

B' profile = Bilateral B-lines + no sliding

- Pneumonia (*severe*)

C profile



C profile = Consolidation pattern

- **Pneumonia**
- Atelectasis
 - Resorptive
 - Compressive

BLUE 4 points

Point 1



Point 2



Head <<<<< **Sagittal view** >>>>> Toe

Point 3



Point 4



LUS for PAP

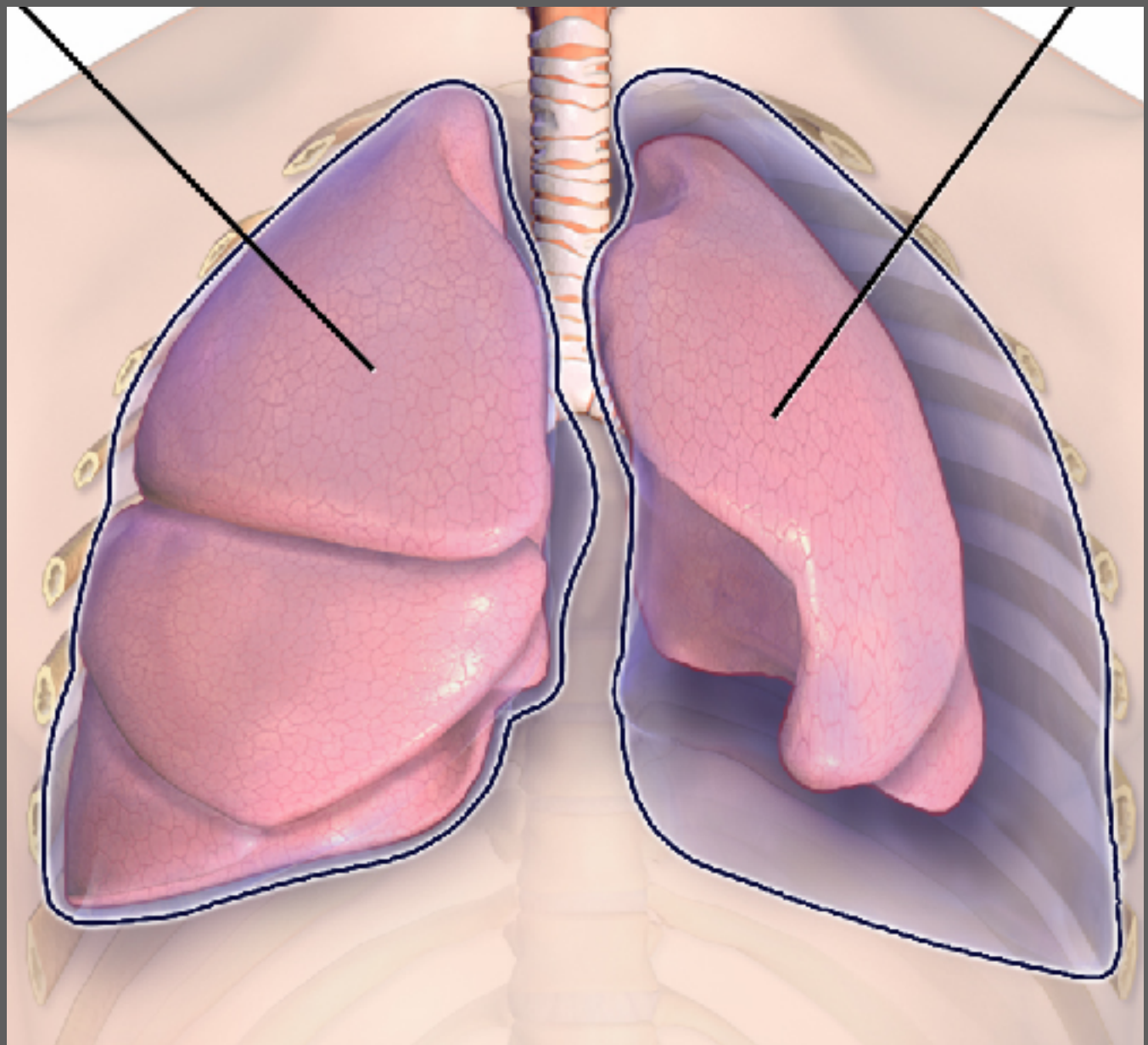
PTX

AIS

PLE

LUS for PAX

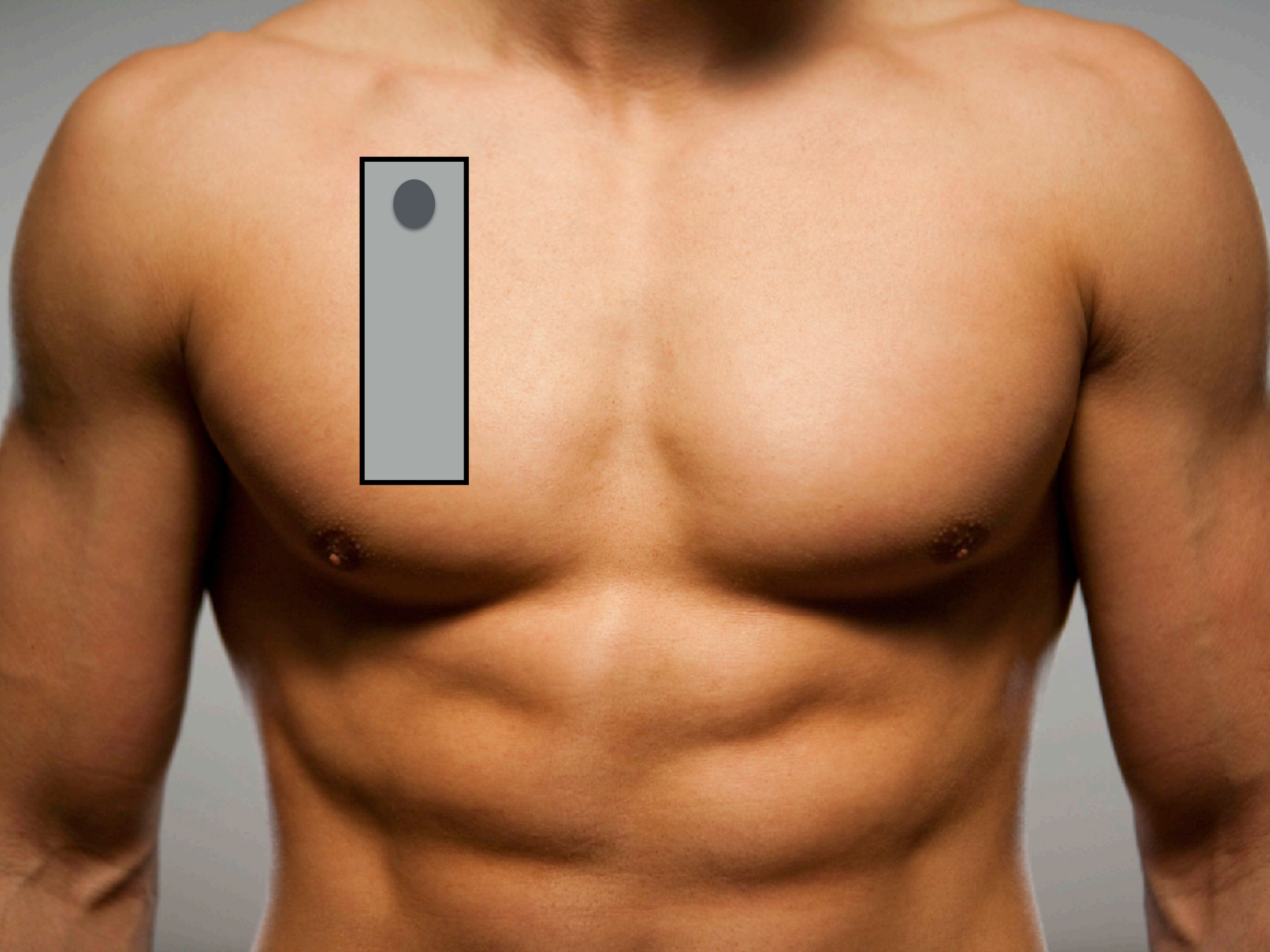
PTX

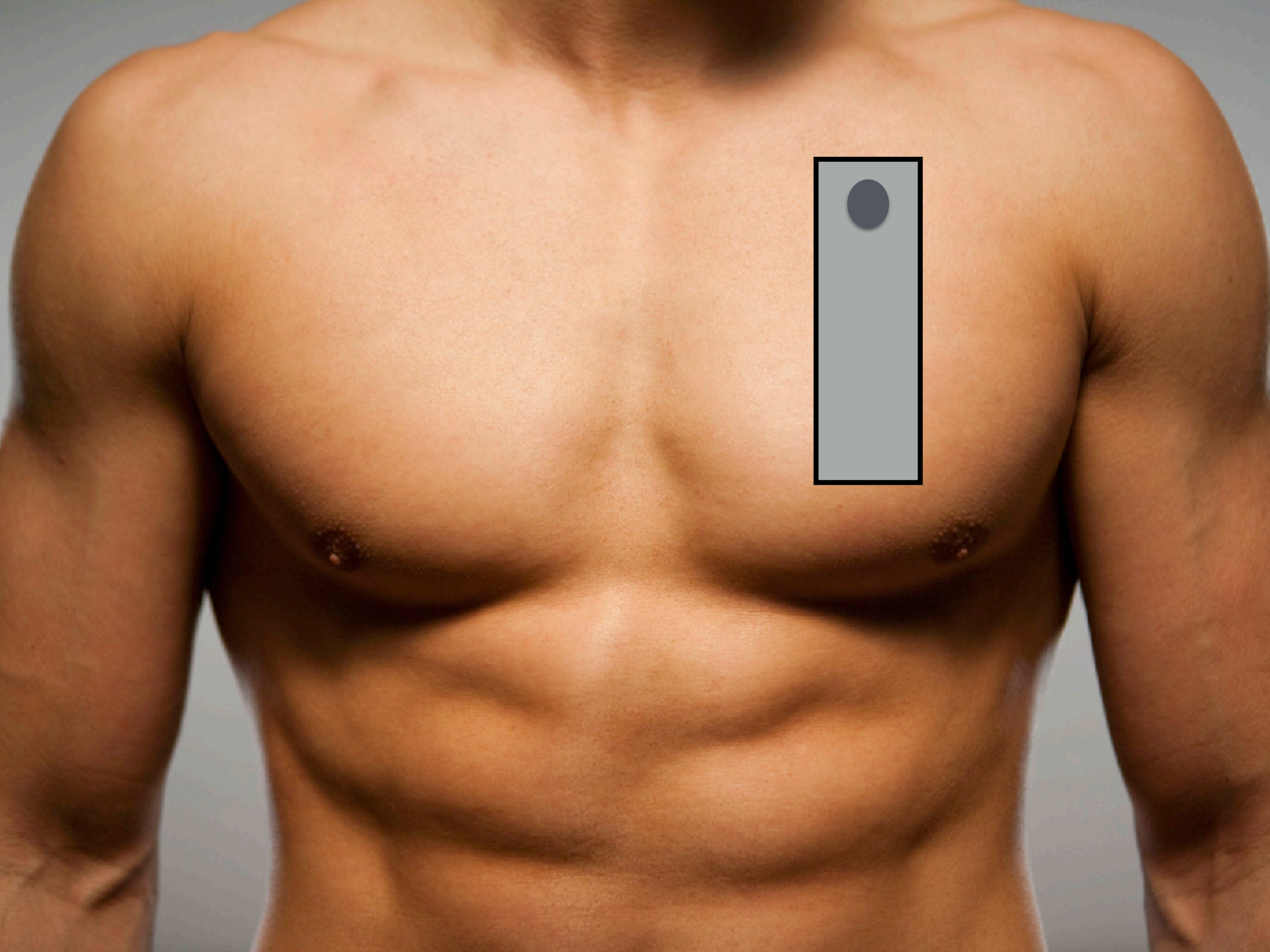


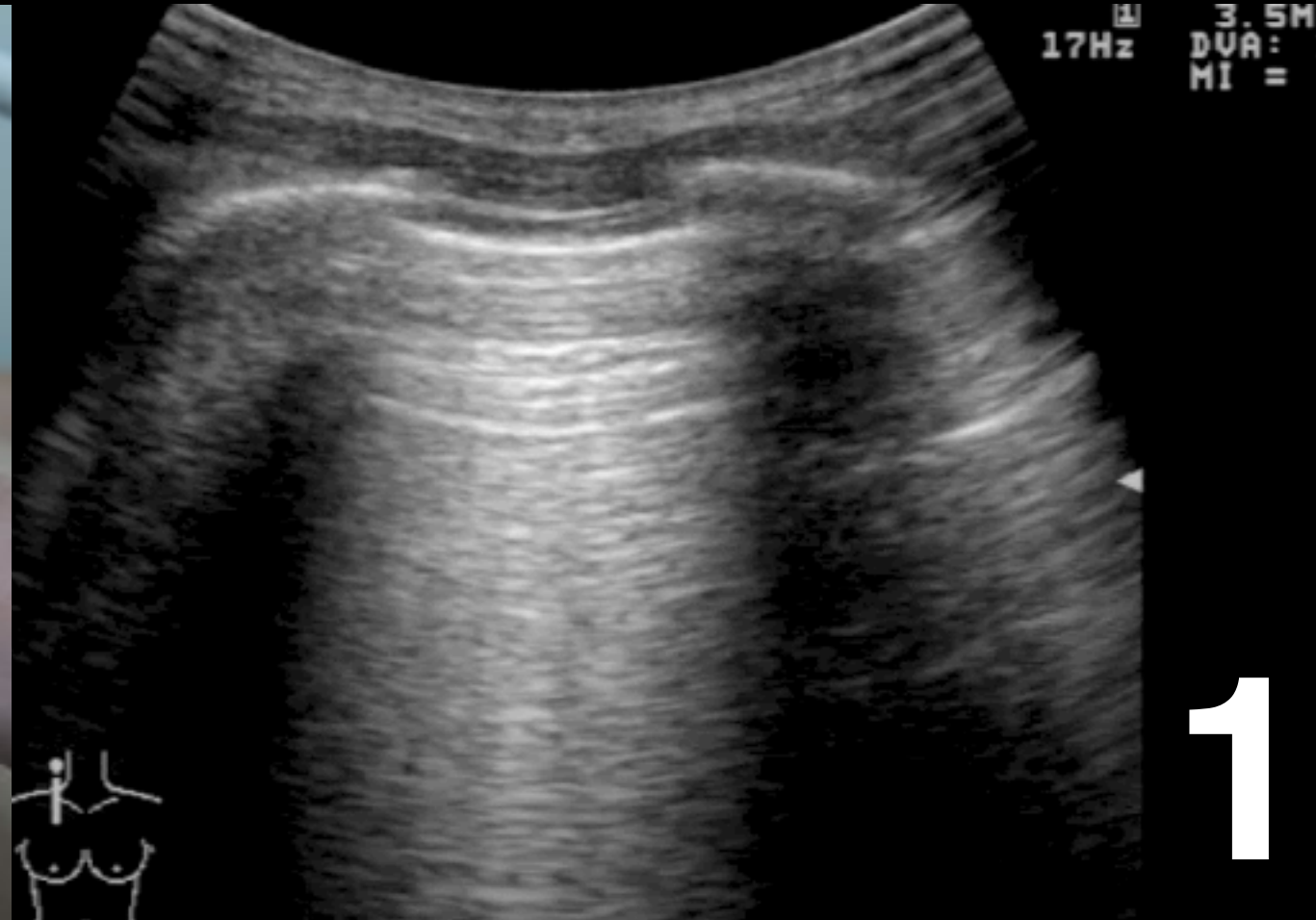
LUS for PTX

Table 2 Lung ultrasound in the diagnosis of pneumothorax

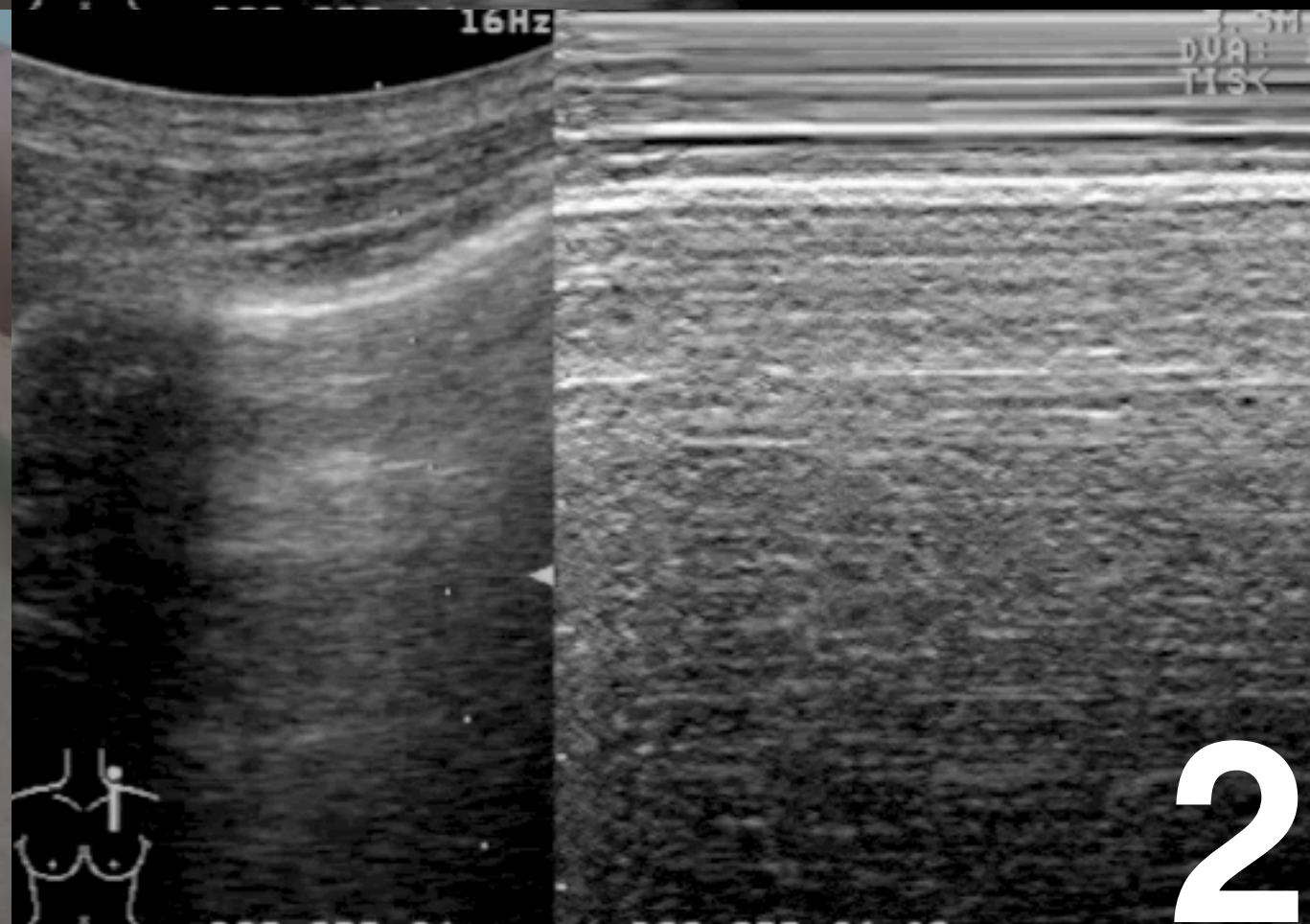
Study (first author) n	Sensitivity (%)	Specificity (%)	Ultrasound LR+/LR-	Gold standard	Sonographer type
Kirkpatrick ⁵⁴ 225	US 49 CXR 21	US 100 CXR 99	Undefined/0.51	CT	Novice trauma surgeons
Knudtson ⁶⁵ 328	US 92	US 99	92/0.081	CXR	Trauma surgeons
Chung ³³ 97	US 80 CXR 47	US 94 CXR 94	13/0.21	CT	Experienced radiologists
Lichtenstein ⁶⁶ 200	US 95	US 94	16/0.053	CT	Intensivists
Zhang ¹⁰ 135	US 86 CXR 27	US 97 CXR 100	29/0.14	CT and chest drain	EP
Sartori ⁶⁷ 285	US 100 CXR 87	US 100 CXR 100	Undefined/0	CT	Experienced physicians not otherwise specified
Lichtenstein ⁶ 260	US 81	US 100	Undefined/0.19	Final clinical diagnosis	Experienced intensivists
Nagarsheth ³⁴ 79	US 81 CXR 31	US 100 CXR 100	Undefined/0.19	CT	Novice surgeon
Ding ⁶⁸ 7569	US 88 CR 52	US 99 CR 100	88/0.12	CT or air escape (meta-analysis)	Meta-analysis varied
Alrajhi ⁶⁹ 1048	US 91 CXR 50	US 98 CXR 99	46/0.092	CT or air escape (meta-analysis)	Meta-analysis varied
Xirouchaki ²² 84	US 75 CXR 0	US 93 CXR 99	11/0.27	CT	Experienced intensivist







1



2

R08 G55 C4

R08 G55 C6 A3

LUS for PTX: When ?

An anatomical illustration of the human thorax, showing the lungs, heart, and rib cage. The lungs are depicted in a light pinkish-red color, and the heart is shown in a darker red. The rib cage is outlined in a light blue color. The background is a light, semi-transparent skin tone.

- **When suspect pneumothorax**
- **Cardiac arrest/ unstable patient**
- **Radio-occult pneumothorax**
- **Limited-resource areas**
- More accurately rules in PTX than supine CXR

Normal ??

Superficial
L12-3
31 Hz
3.0cm

P

2D

Gen
Gn 60
C 52
4/3/2



G
P R
3.0 12.0

2

3.0cm

Normal ??

Superficial
L12-3
31 Hz
3.0cm

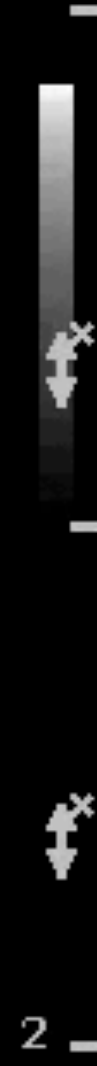
P

2D
Gen
Gn 60
C 52
4/3/2



P G R
3.0 12.0

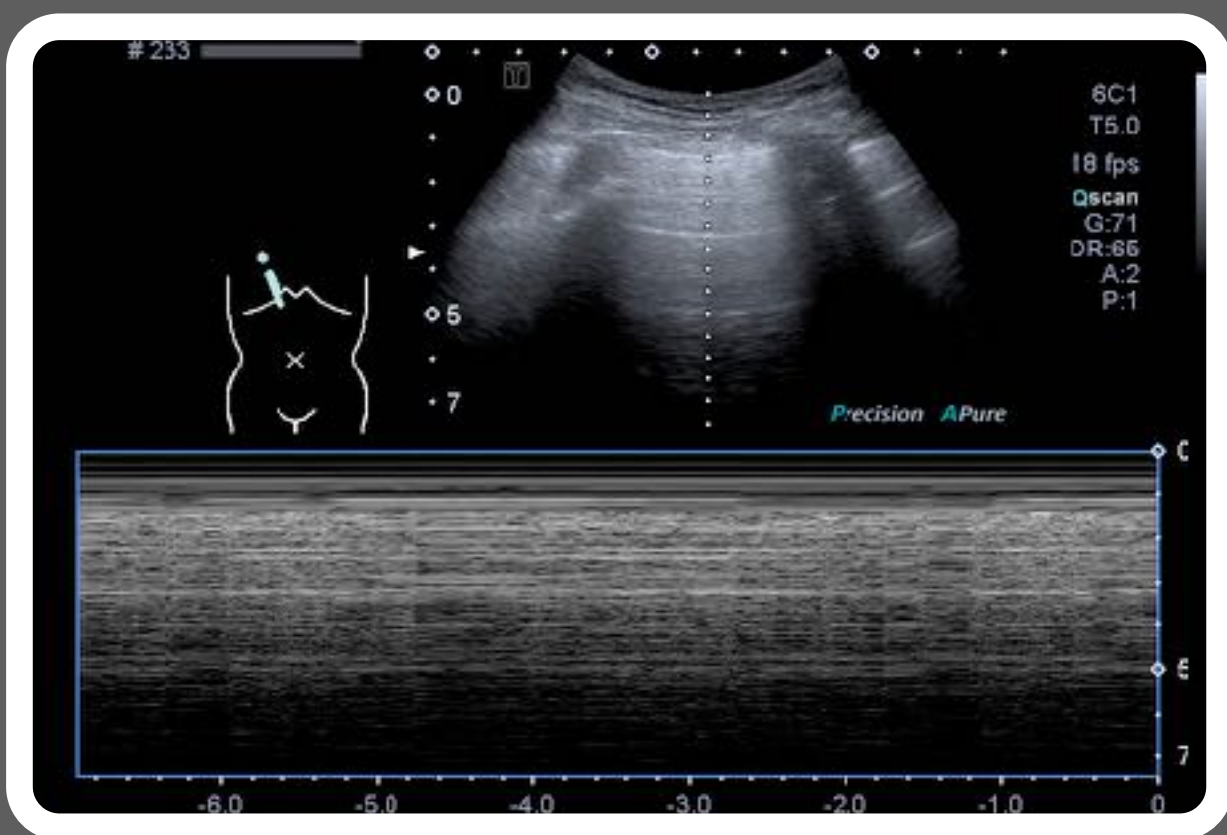
3.0cm



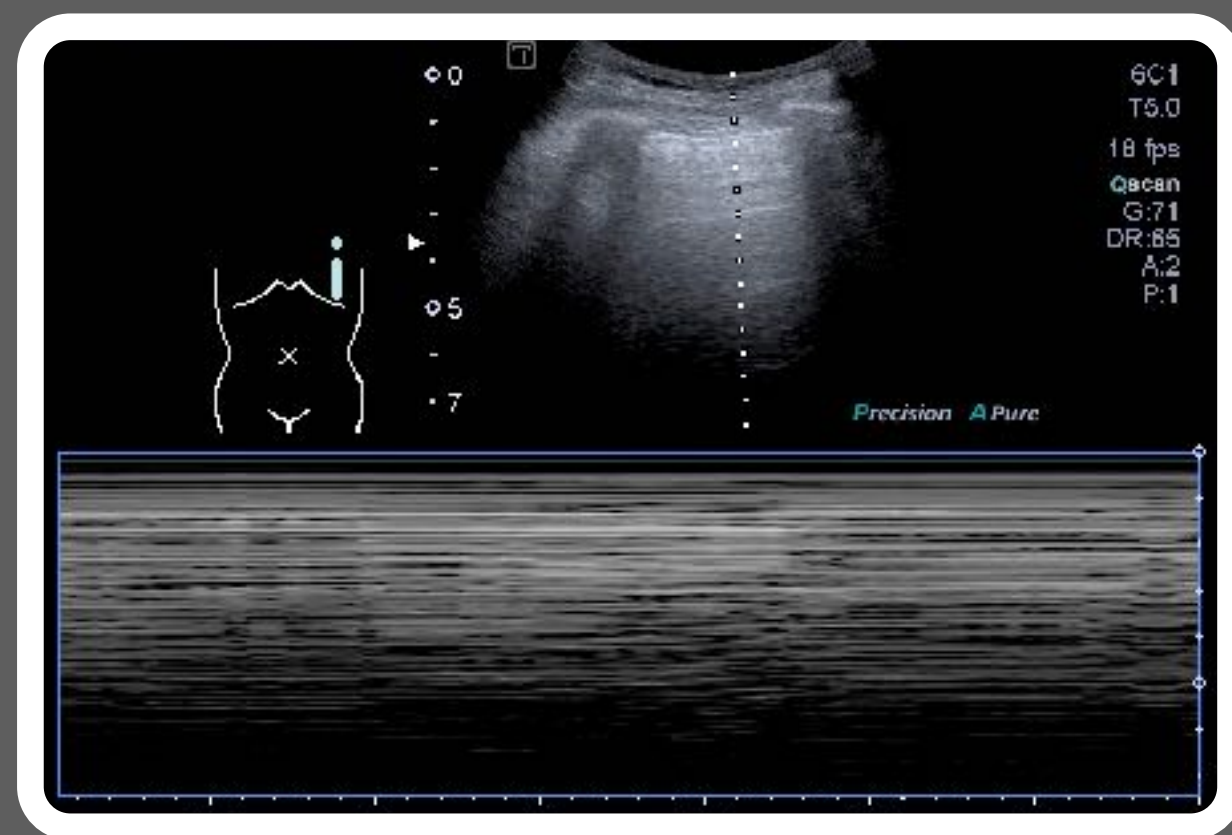
Pneumothorax

Normal

Pneumothorax



Seashore sign

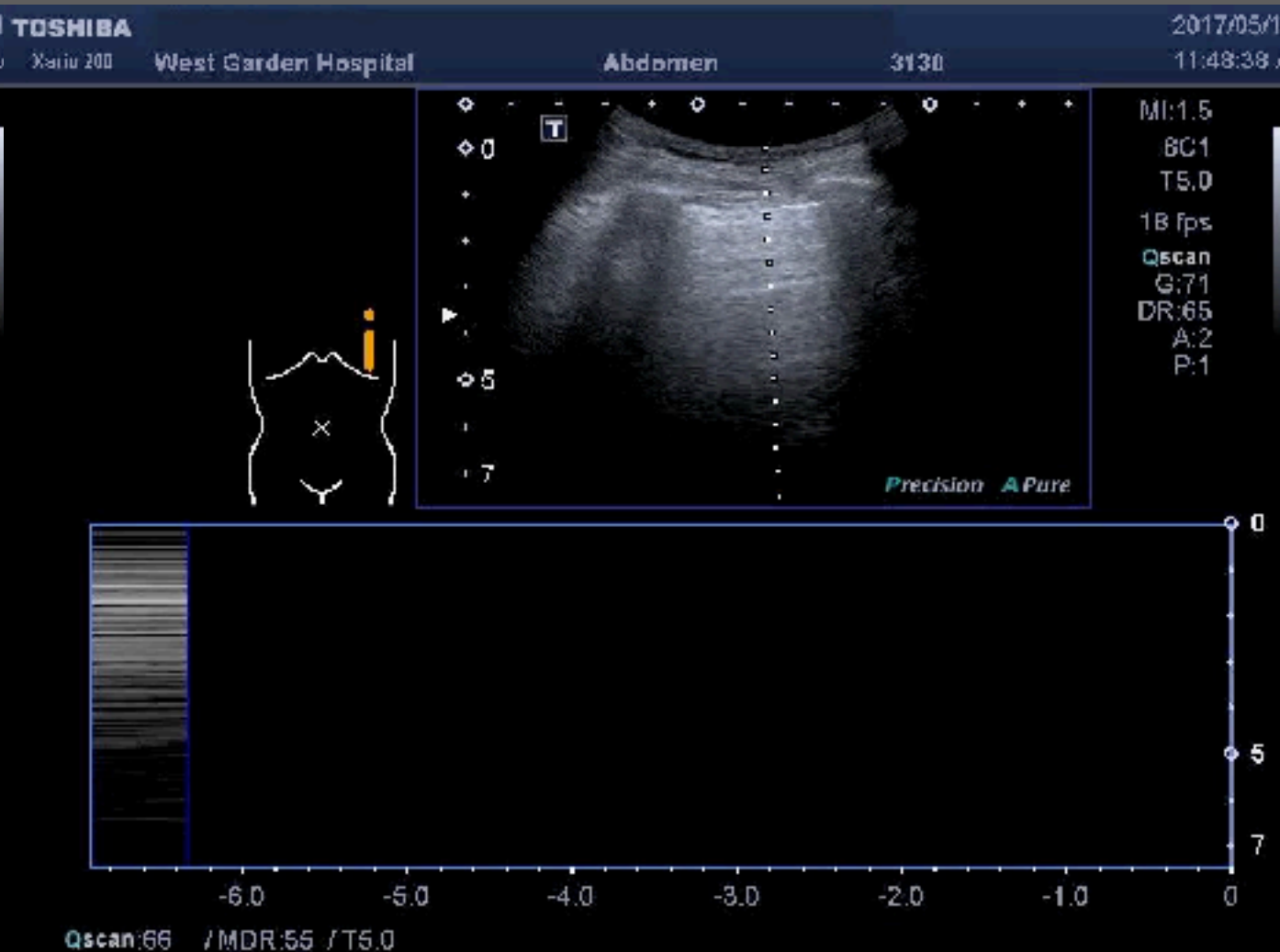
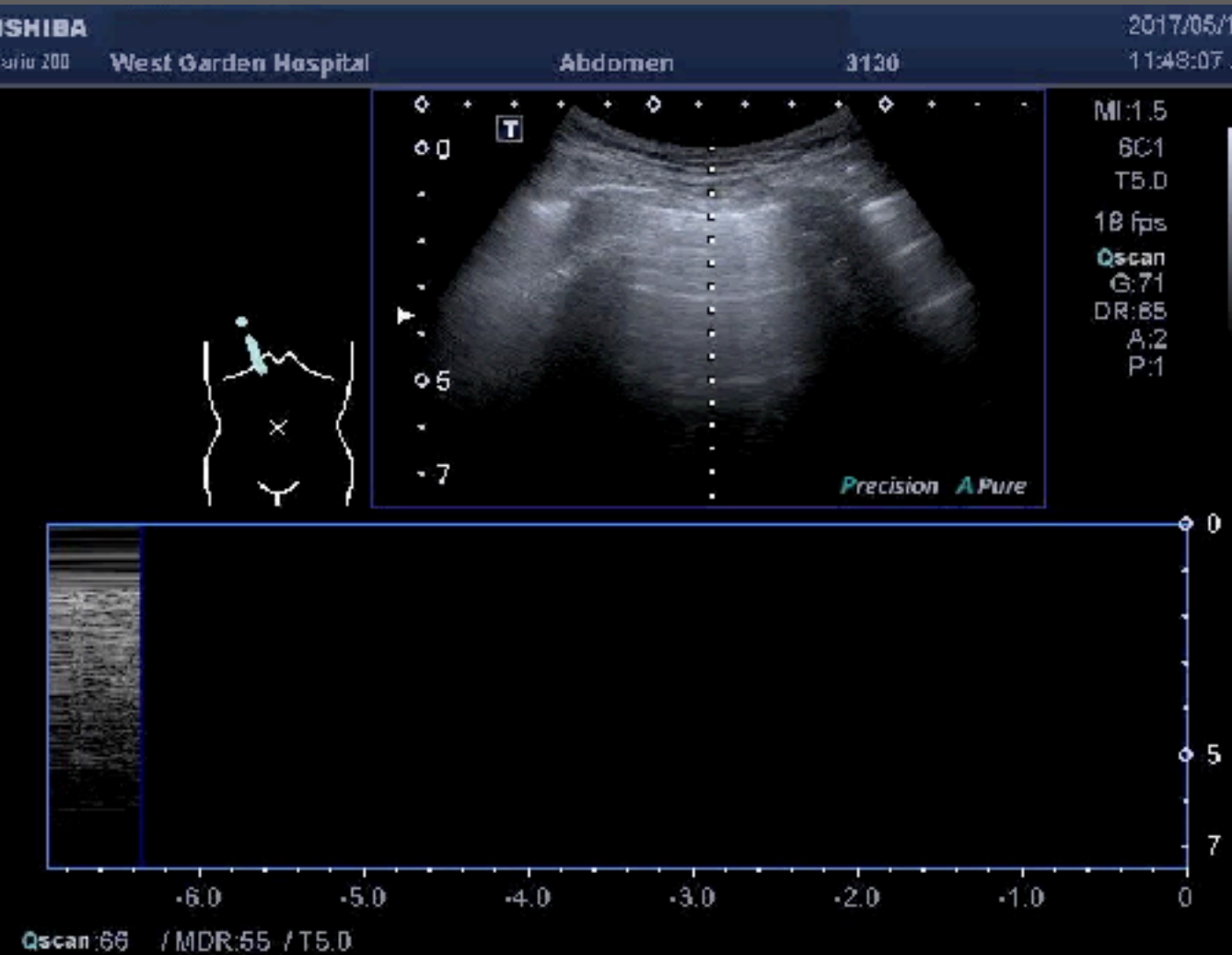


Stratosphere sign

Pneumothorax

Normal

Pneumothorax



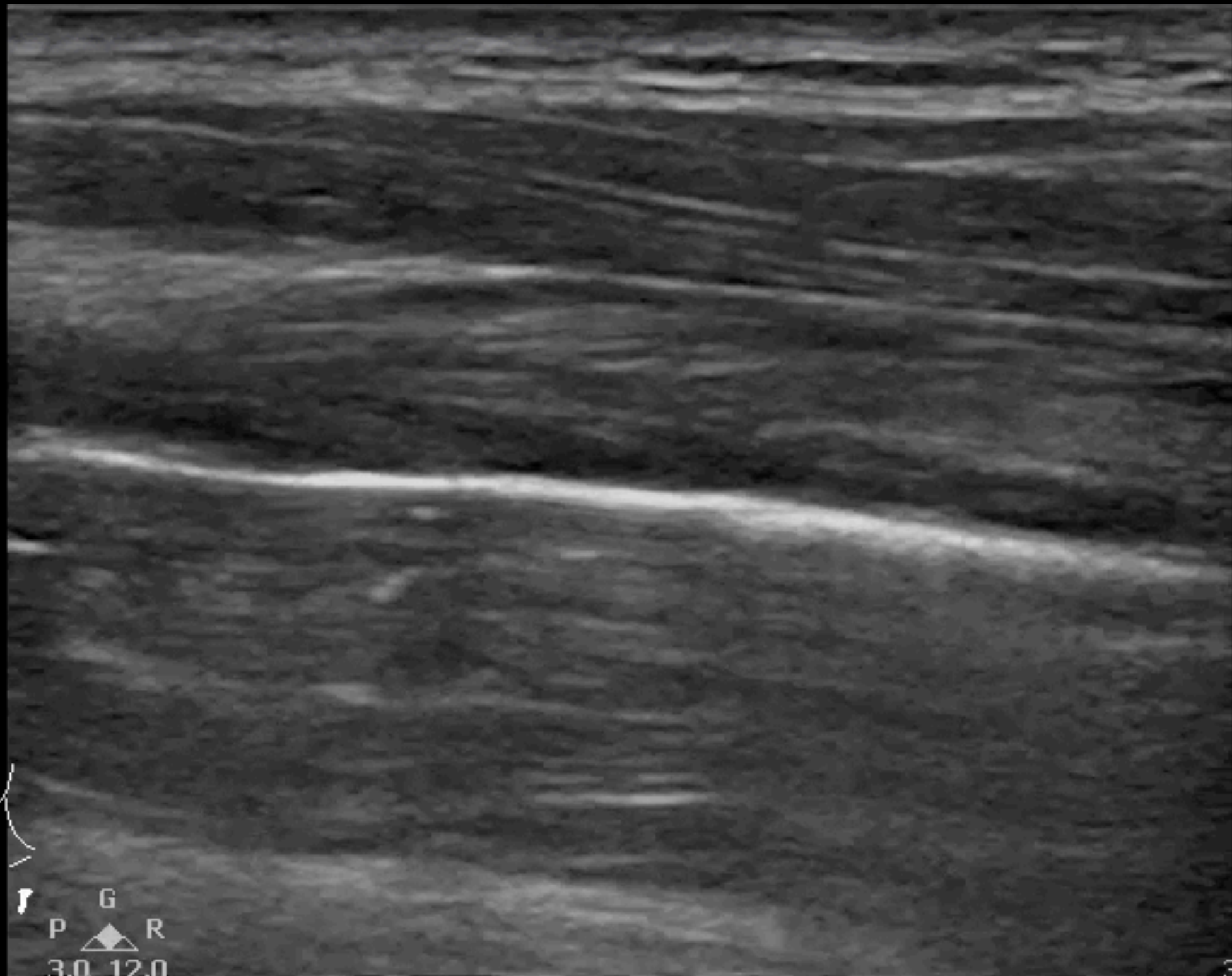
Specificity 100%

Superficial
L12-3
31 Hz
3.0cm

P

2D

Gen
Gn 60
C 52
4/3/2



P G R
3.0 12.0

3.0cm



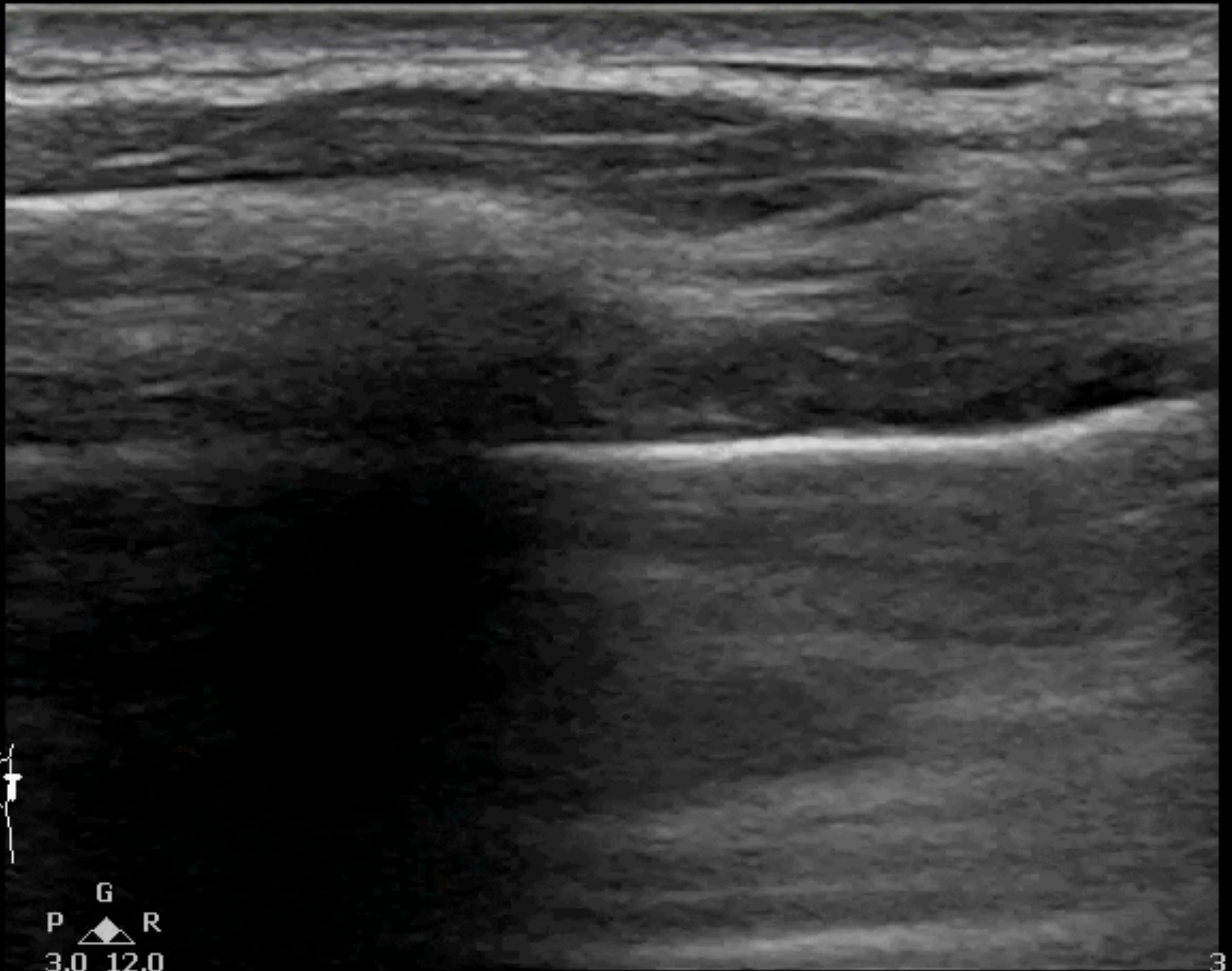
Summary

Superficial
L12-3
31 Hz
3.0cm

P

2D

Gen
Gn 91
C 52
4/3/2

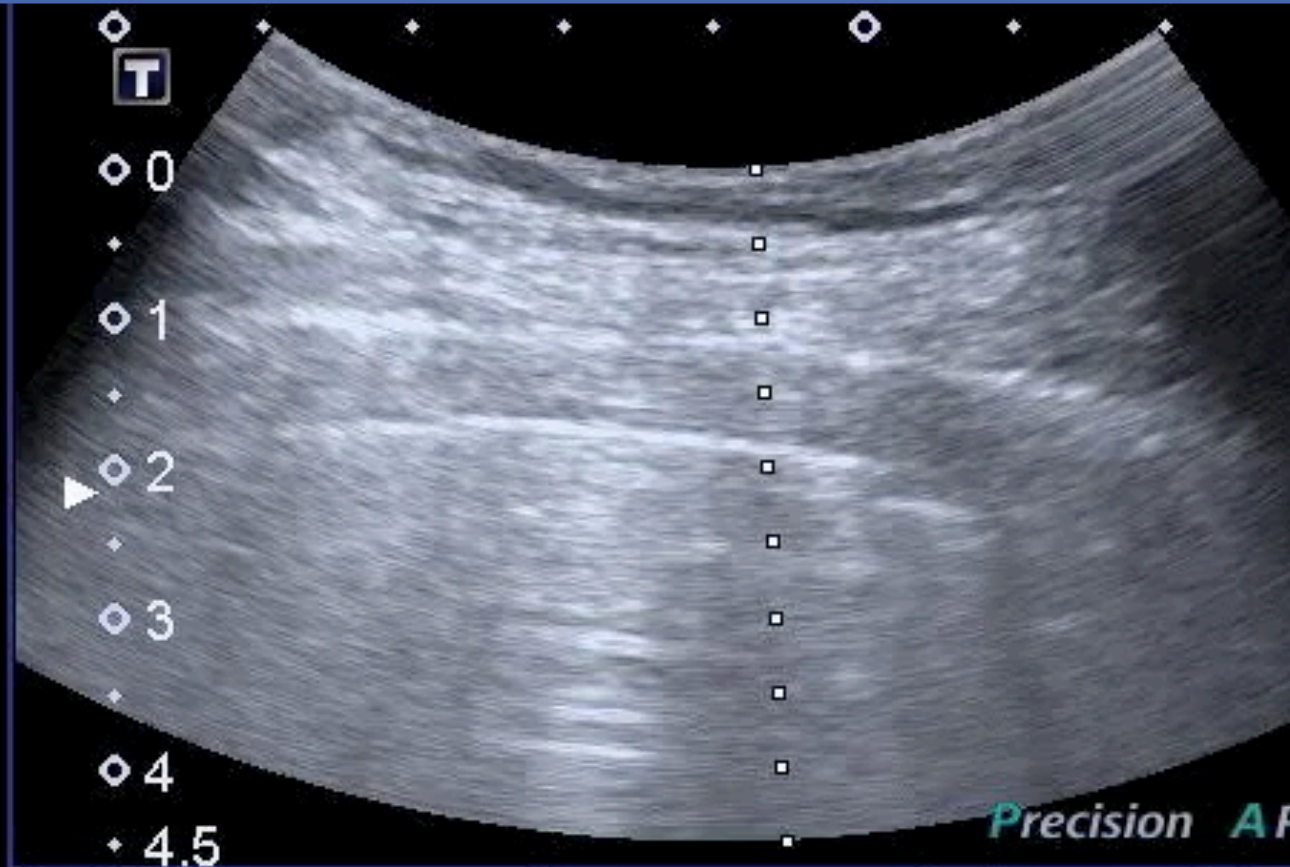


G
P R
3.0 12.0

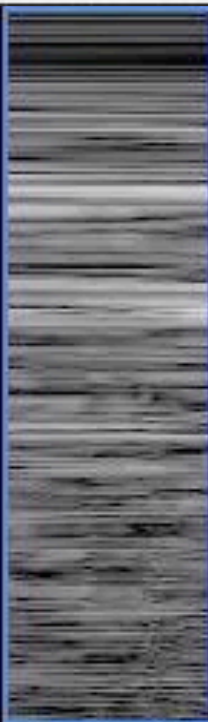
3.0cm

Lung point

A



B



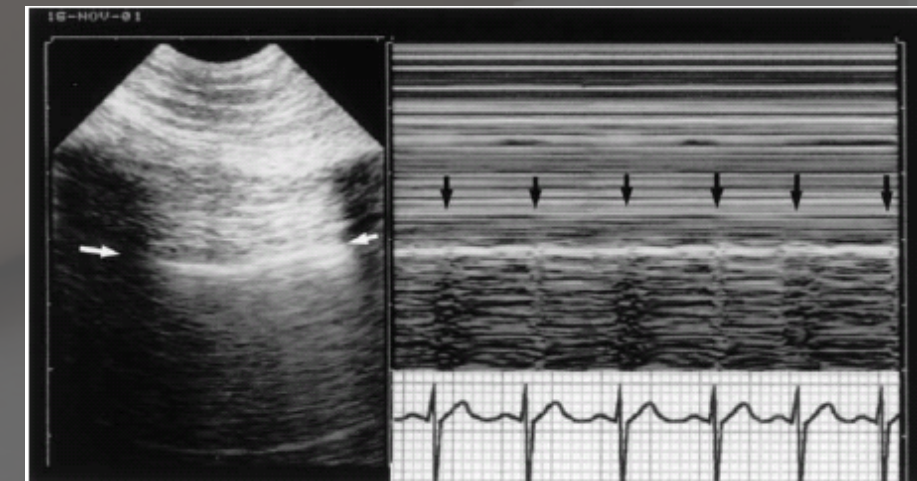
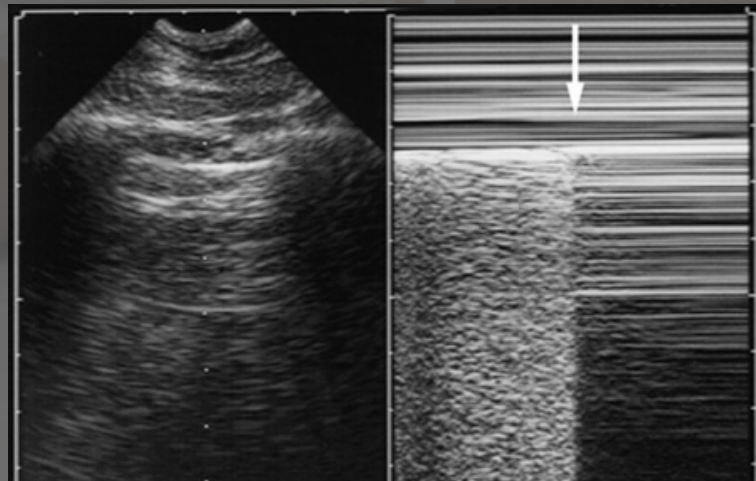
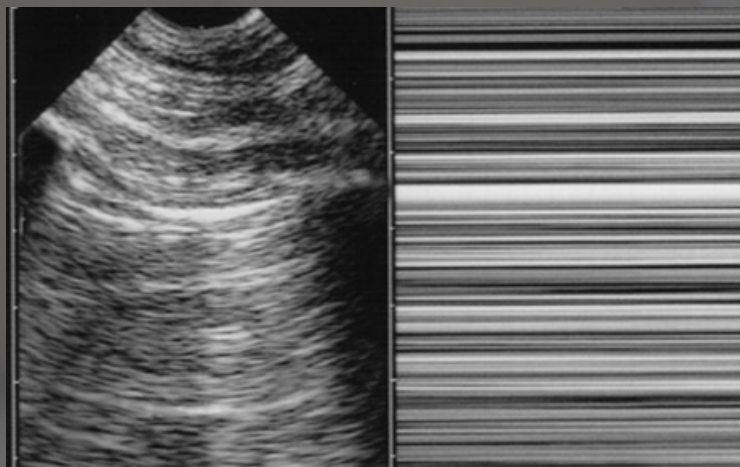
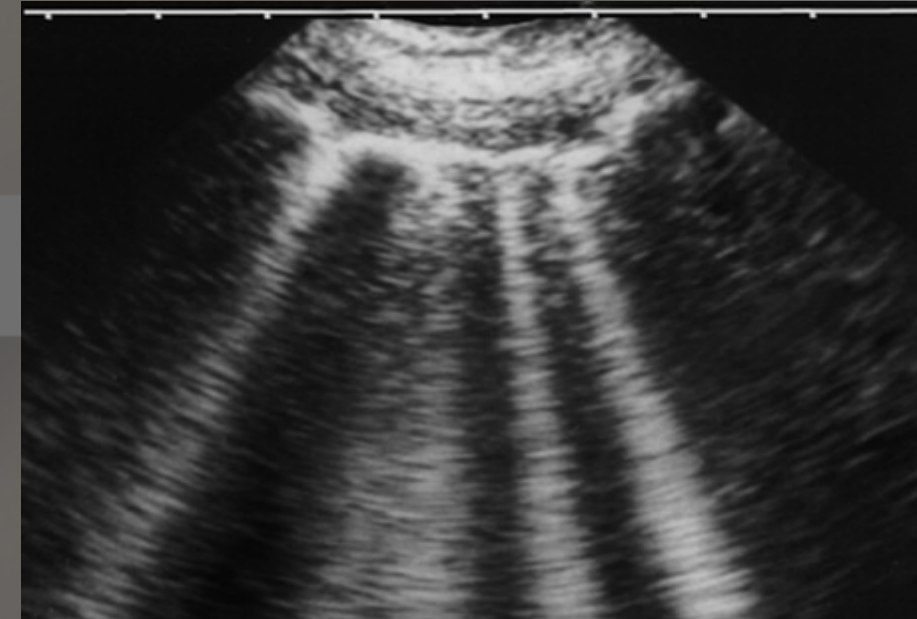
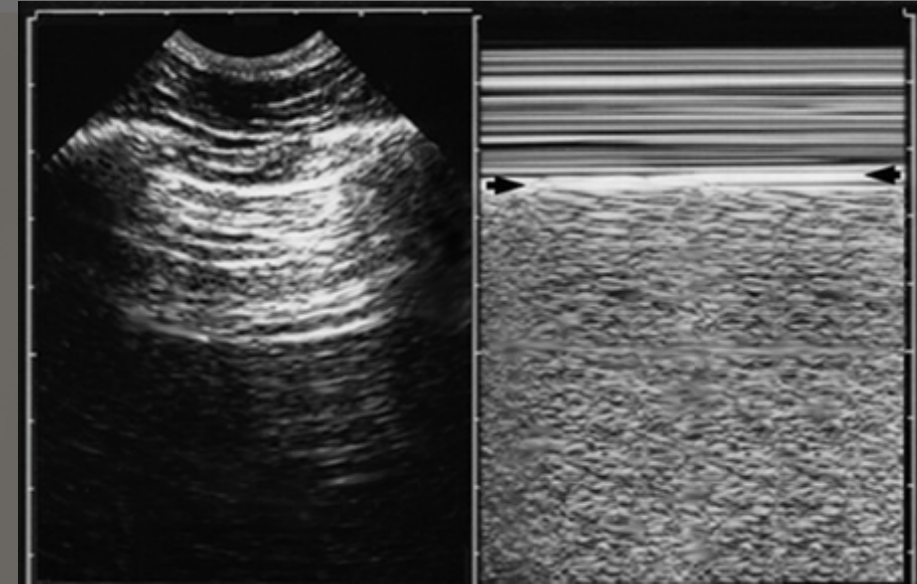
Point 1

PTX

BLUE 4 points

Highest

Point 2



emy

PTX

SBP Point

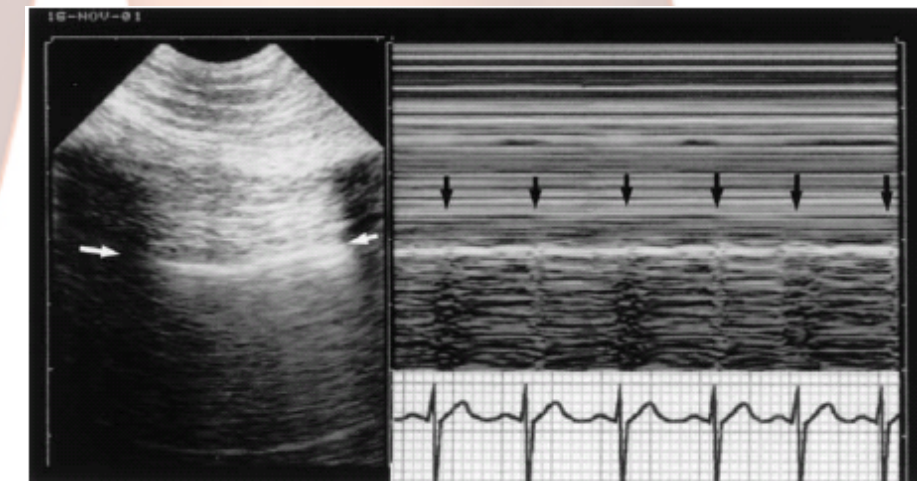
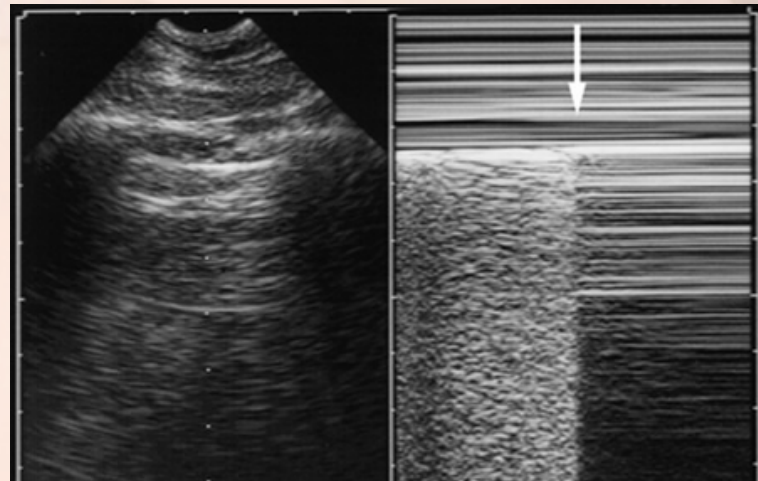
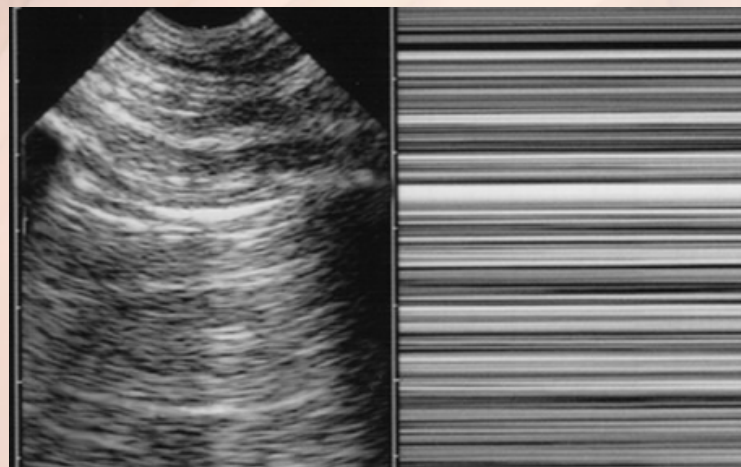
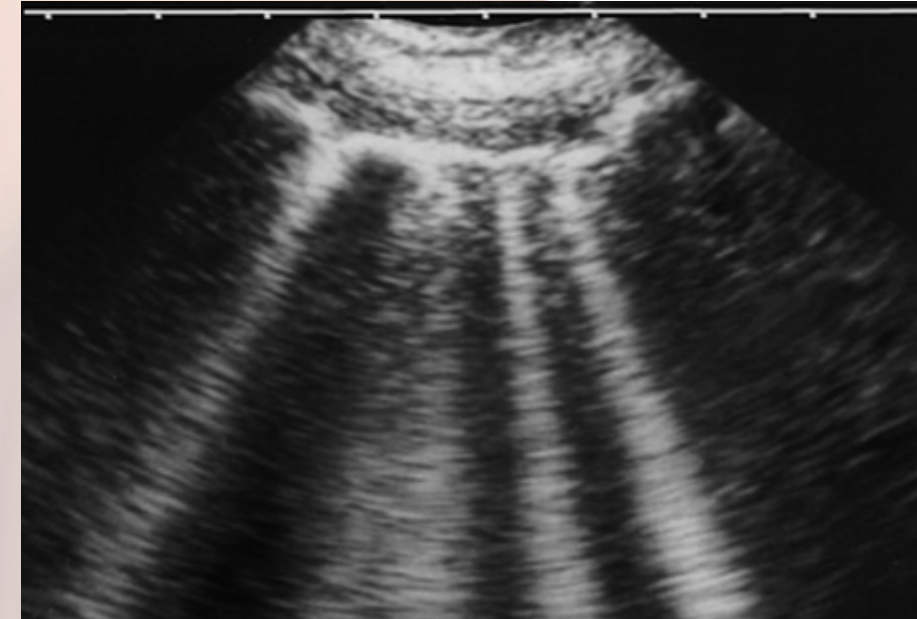
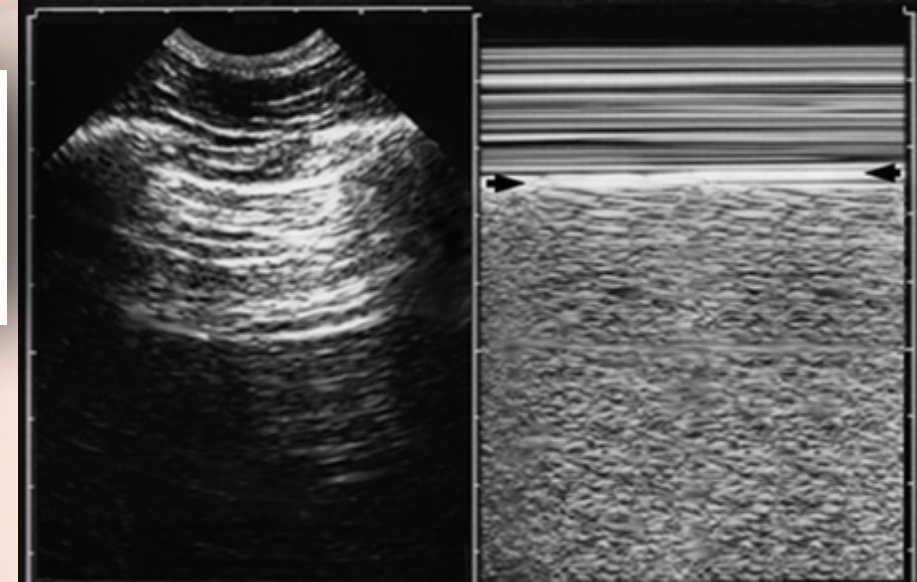
No sliding

No B lines

No pulse

Lung point

4



PLUS for PAP

PTX

AIS

3

2

3

Point 1



Point 2

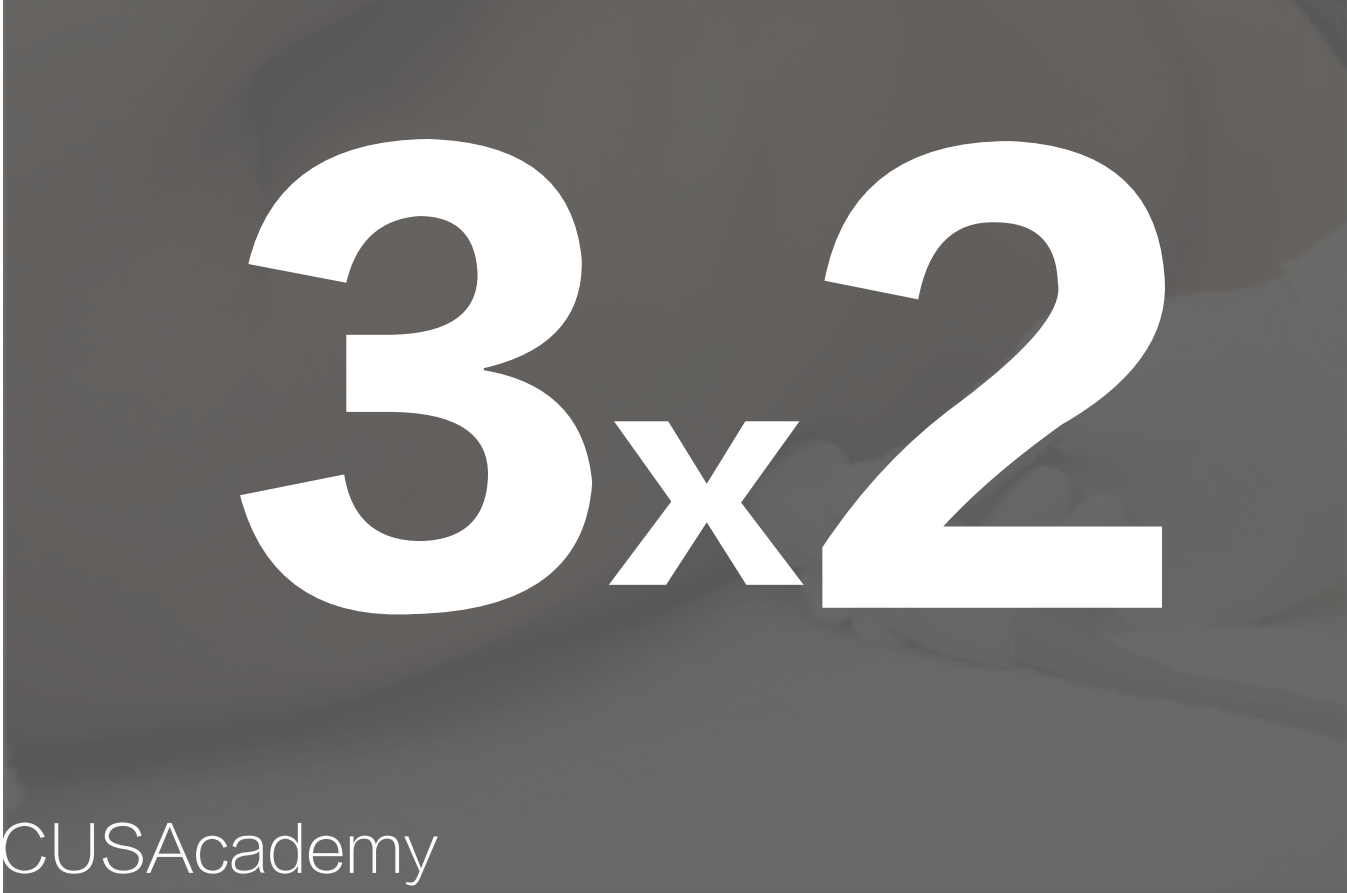


BLUE 4 points

Point 3



Point 4





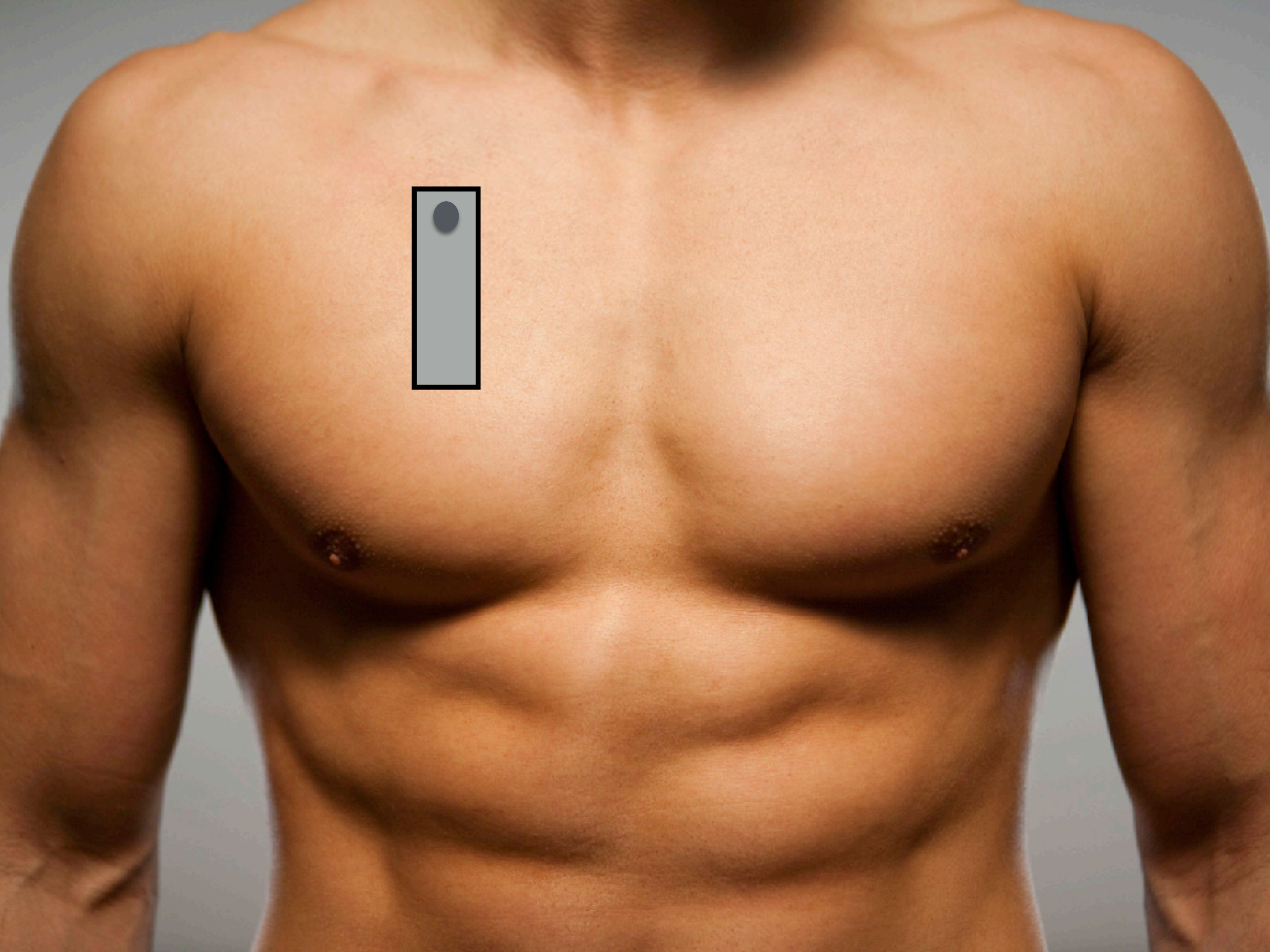
3

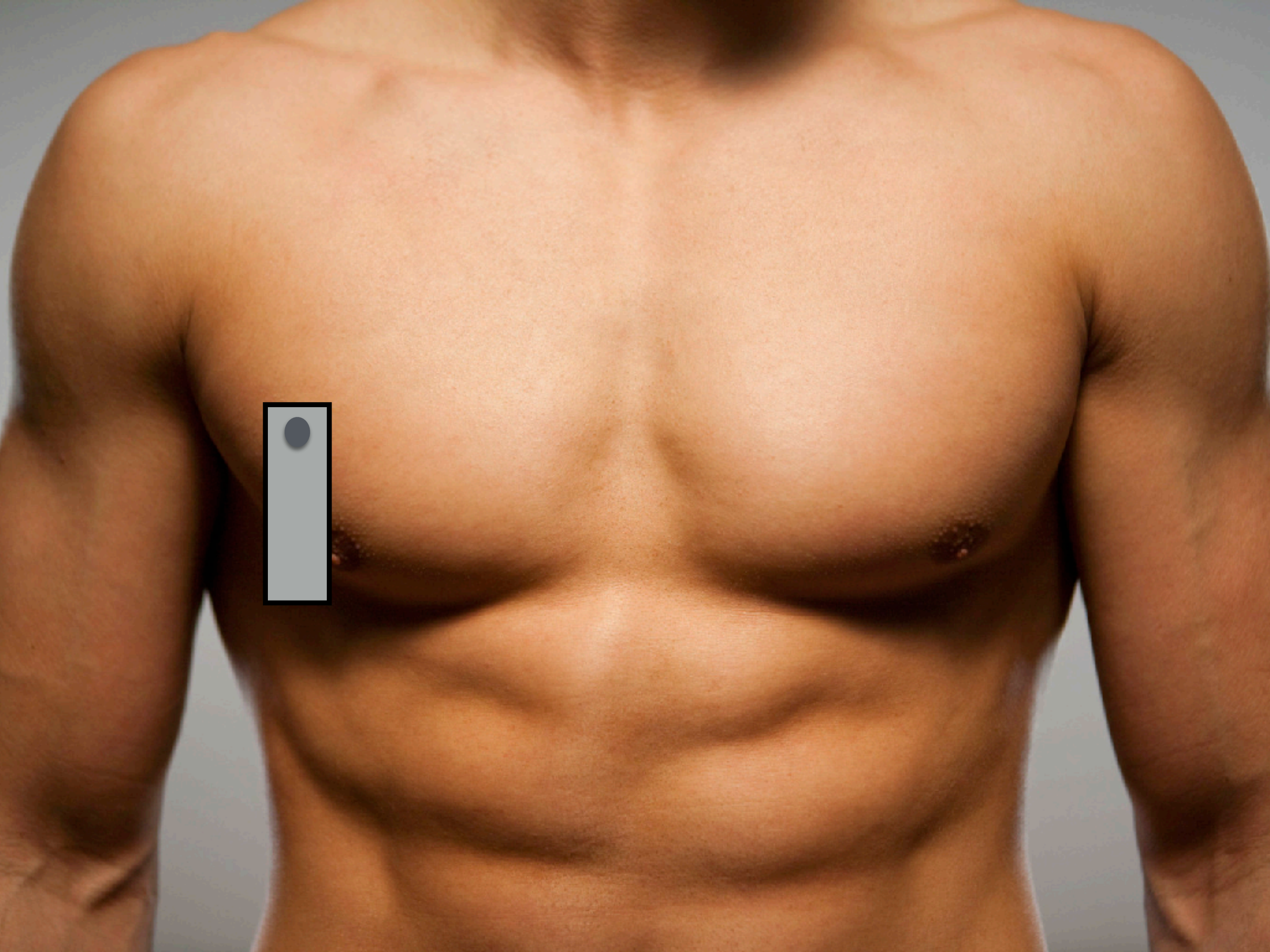
15.12

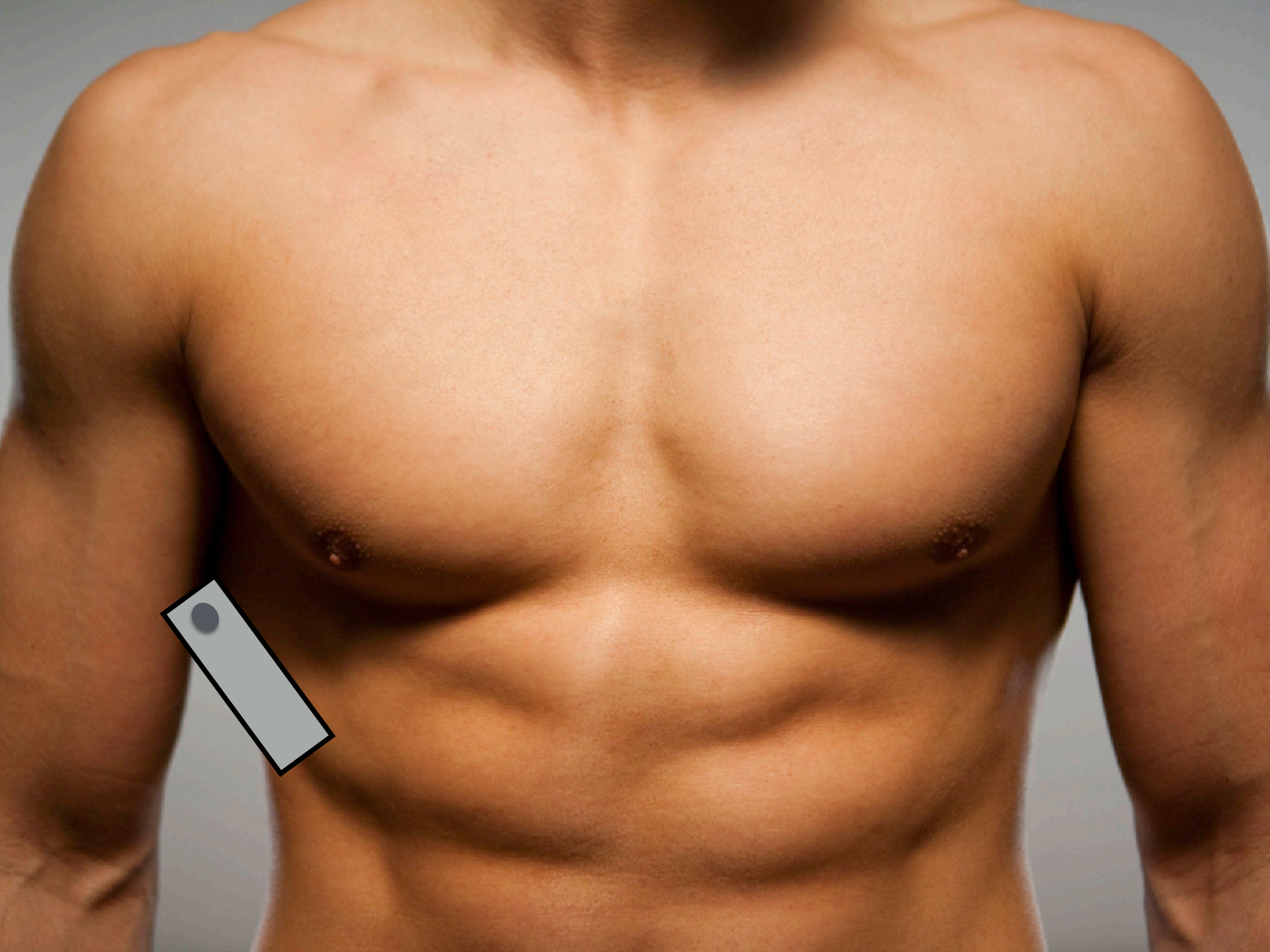
LUS for lung

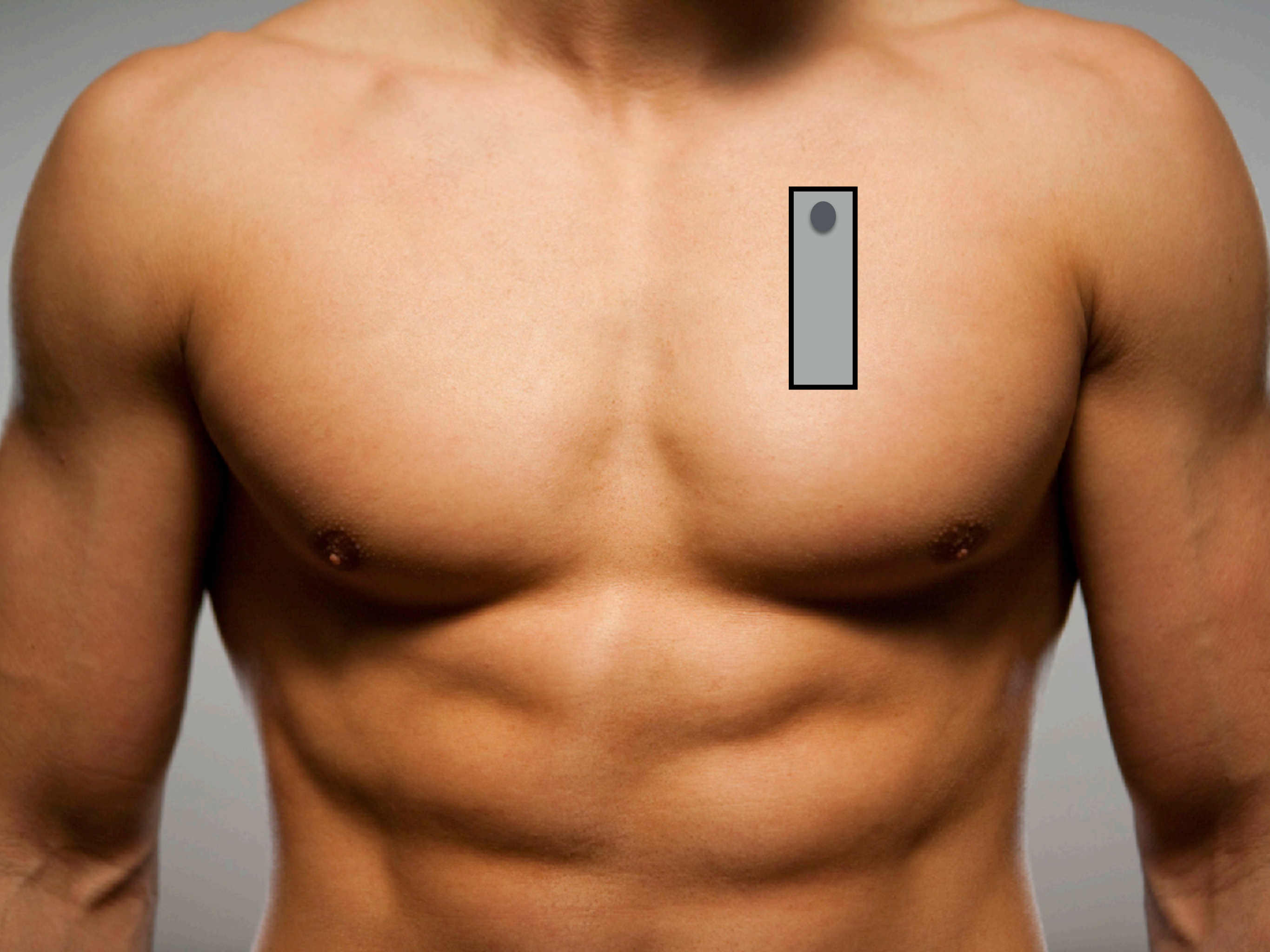
Table 1 Lung ultrasound in the diagnosis of cardiogenic pulmonary oedema

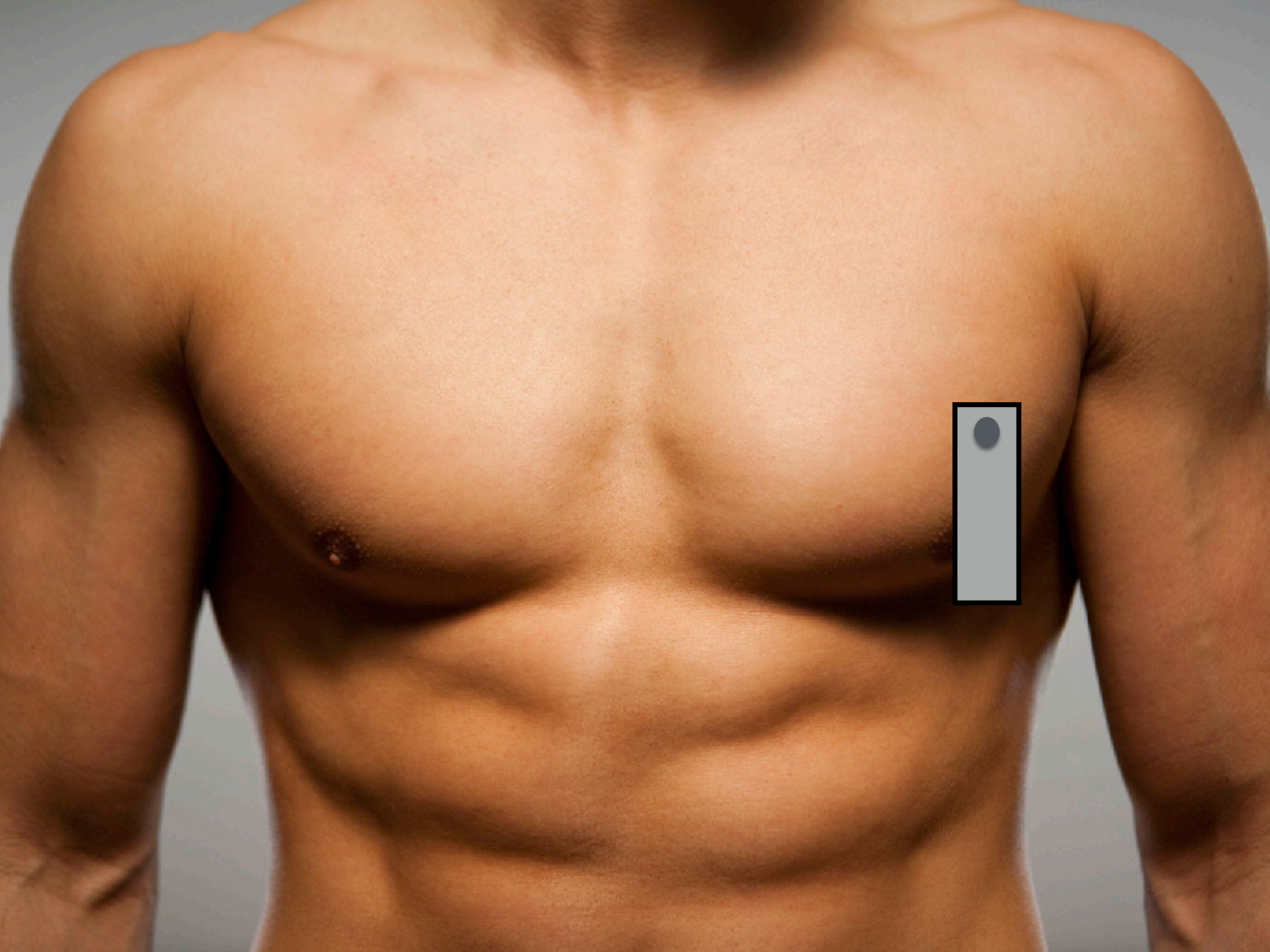
Study (first author)	n	US sensitivity/specificity	US LR+/LR-	Gold standard	Sonographer type
Lichtenstein ⁵	250	93.4/93	13/0.071	CXR	Experienced intensivist
Lichtenstein ¹⁵	146	100/92	13/0	CXR	Experienced intensivist
Agricola ¹⁶	20	90/86	6.4/0.12	CXR/PiCCO/Echo	Cardiologist
Volpicelli ²⁰	300	85/98	43/0.15	CXR/CT/Final diagnosis	EP or radiologist
Gargani ²⁴	149	81/85	5.4/0.22	NT-proBNP	Sonographer not otherwise specified
Lichtenstein ⁶	301	97/95	19/0.032	Final clinical diagnosis	Experienced intensivists
Liteplo ²	100	58/85	3.9/0.49	Final clinical diagnosis	EP or LU- trained student
Maines ¹⁹	23	83/91	9.2/0.19	ICD measure	Experienced physicians not otherwise specified
Vitturi ⁶¹	152	97/79	4.6/0.038	Final clinical diagnosis	Not specified
Prosen ⁶²	248	100/95	20/0	Final clinical diagnosis	EP
Xirouchaki ²²	42	46/80	2.3/0.68	CT	Experienced intensivist
Cibine ⁶³	56	93.6/84	5.9/0.076	Final clinical diagnosis	EP
Al Deeb ²³	1075	94.1/92.4	12/0.064	Meta-analysis	Meta-analysis- physicians or medical students
Chiem ²⁷	380	87/49 (one positive lung zone)	1.7/0.3	Final clinical diagnosis	Novice EP
Pivetta ⁶⁴	1005	97/97.4	37/0.031	Final clinical diagnosis	EP

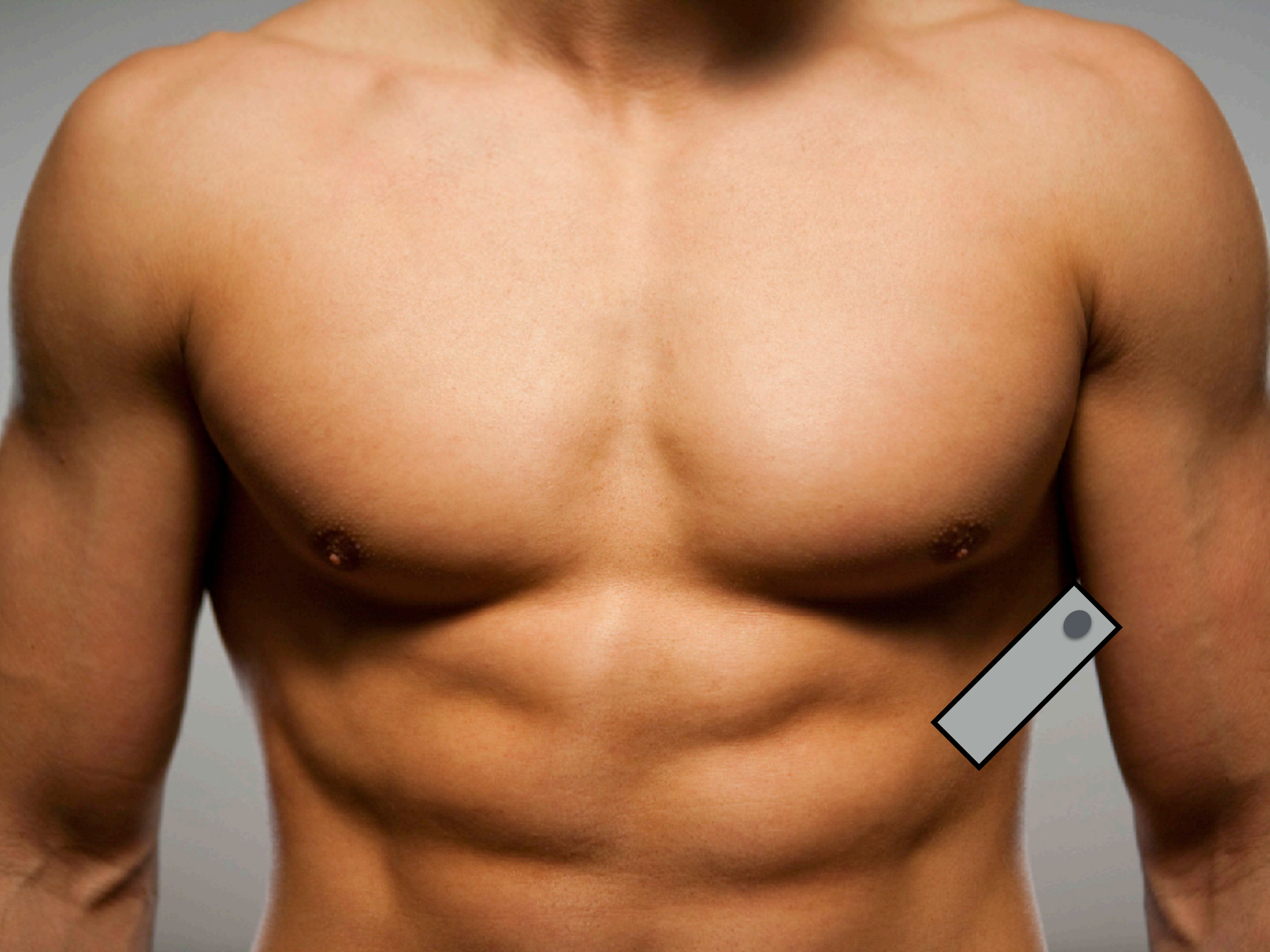










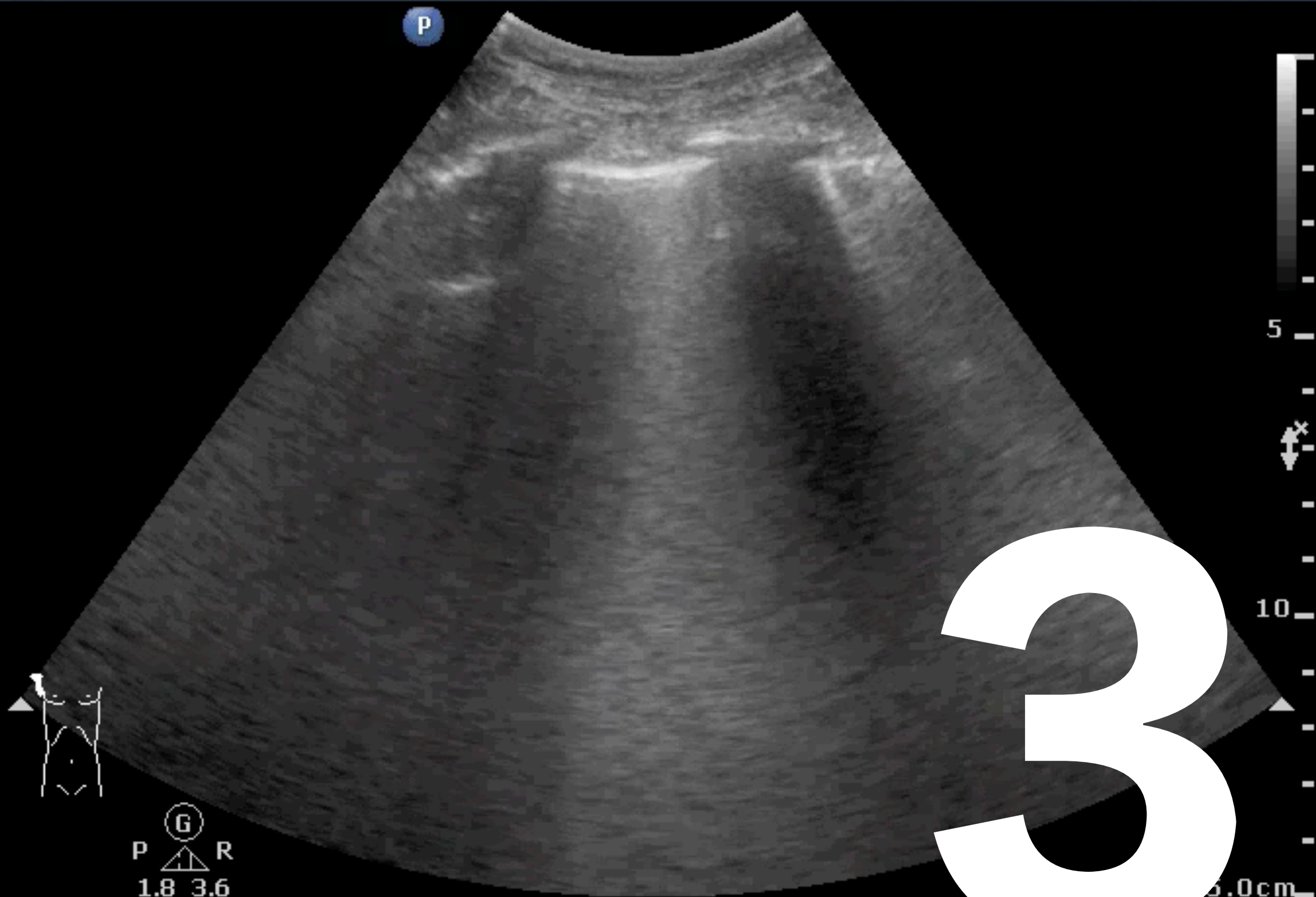


B lines/ Lung rockets

Abd Gen
C5-1
34 Hz
15.0cm

2D

HGen
Gn 90
C 56
3/3/3



3

P (G) R
1.8 3.6

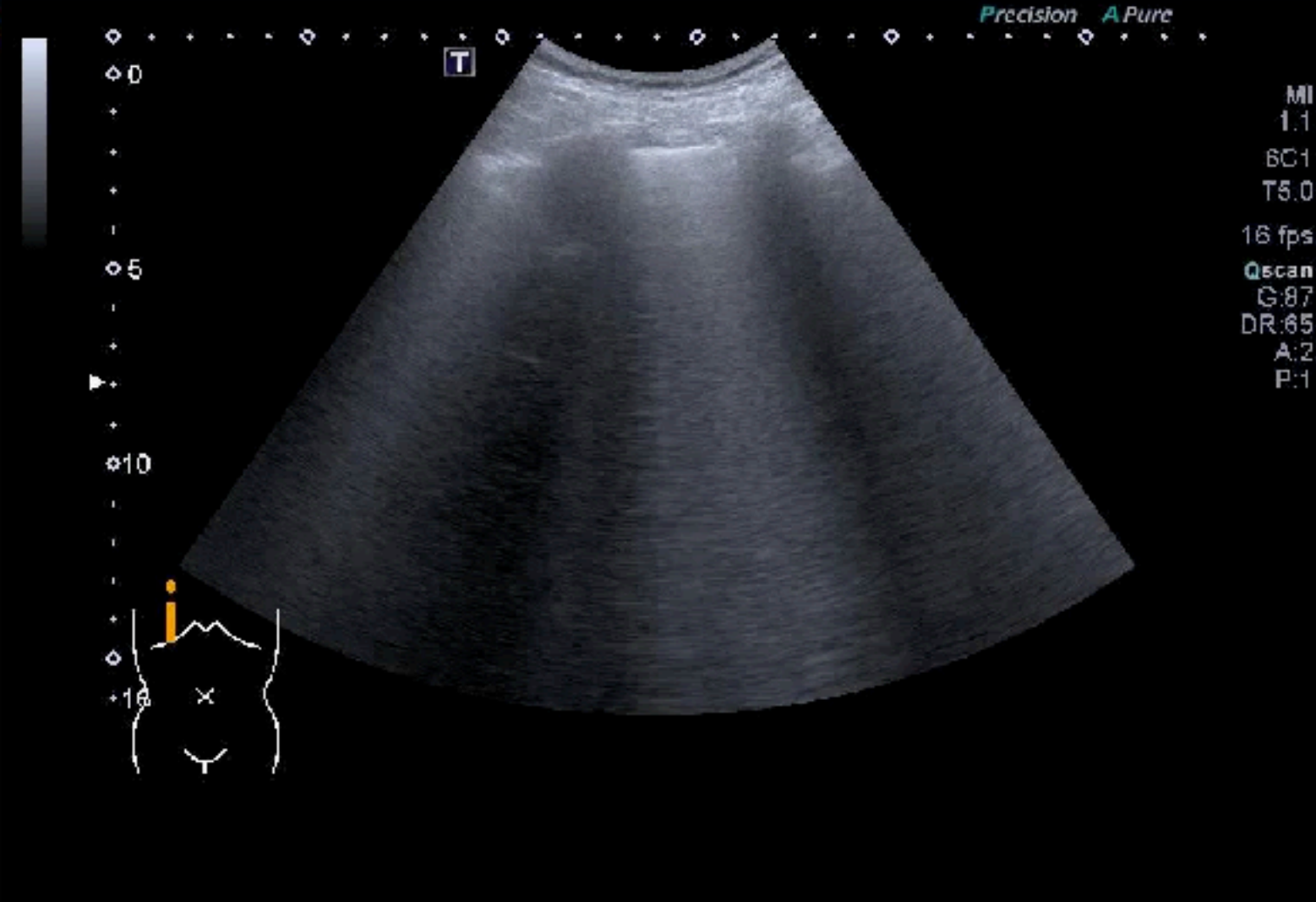
15.0cm

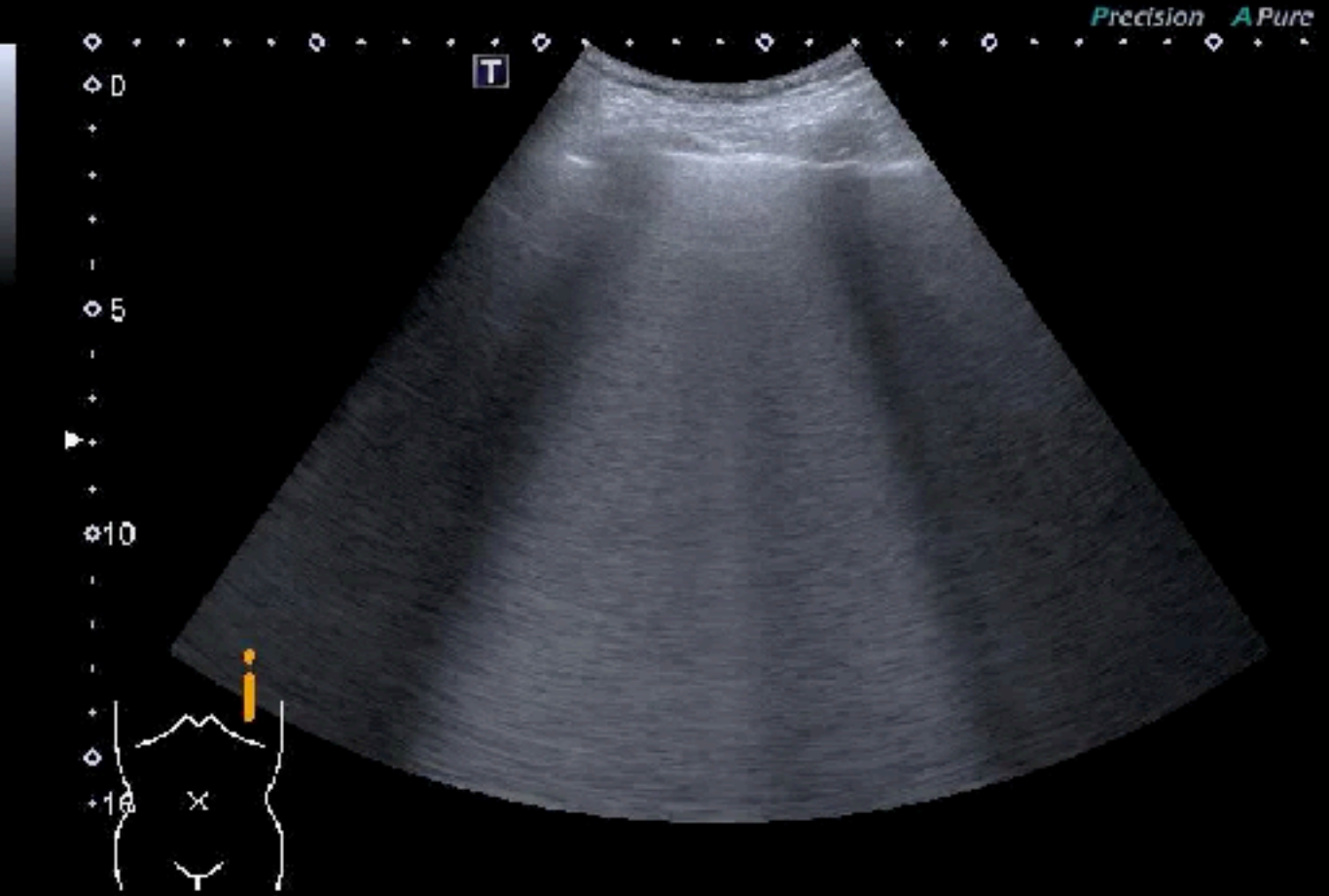
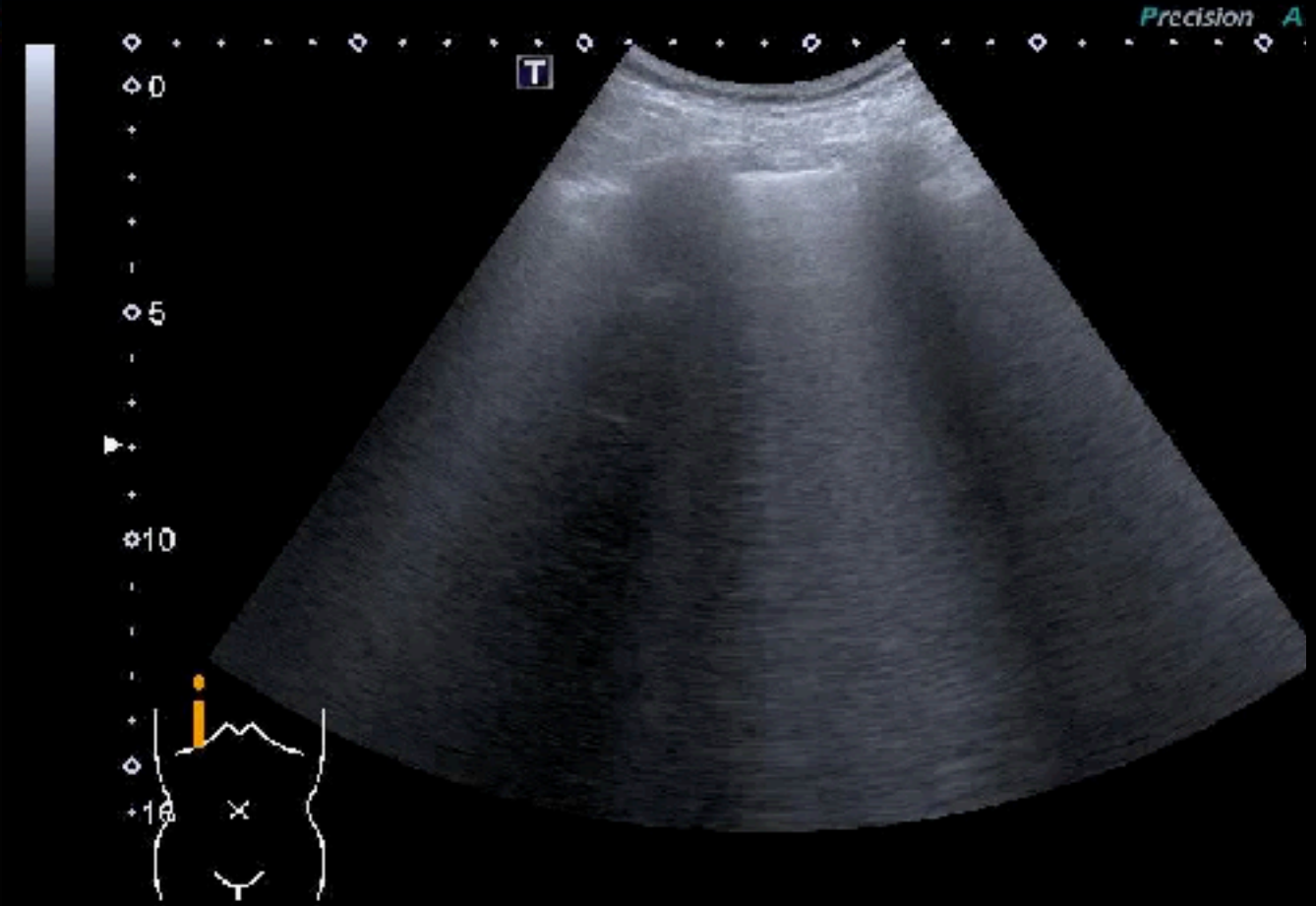


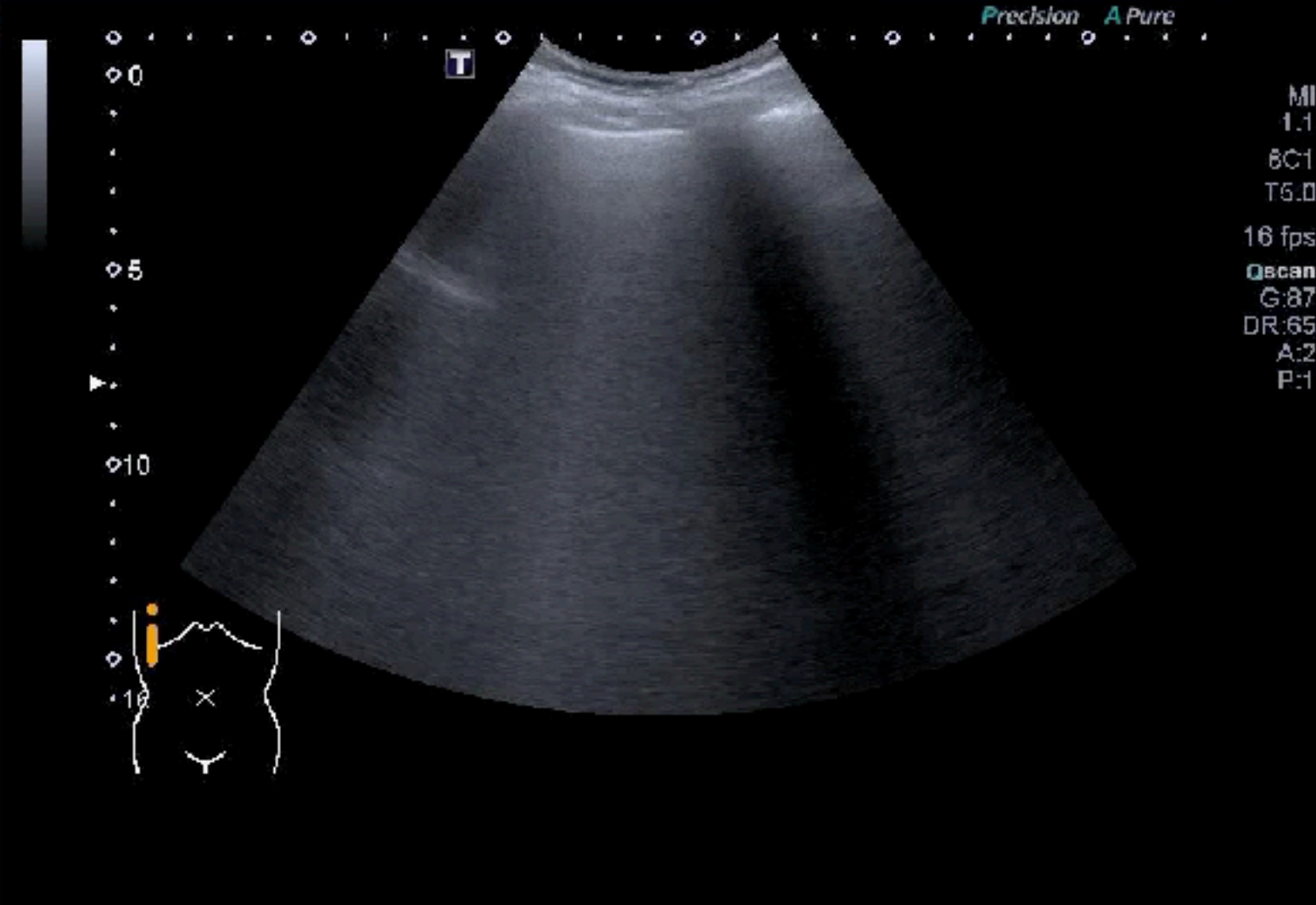
077
M

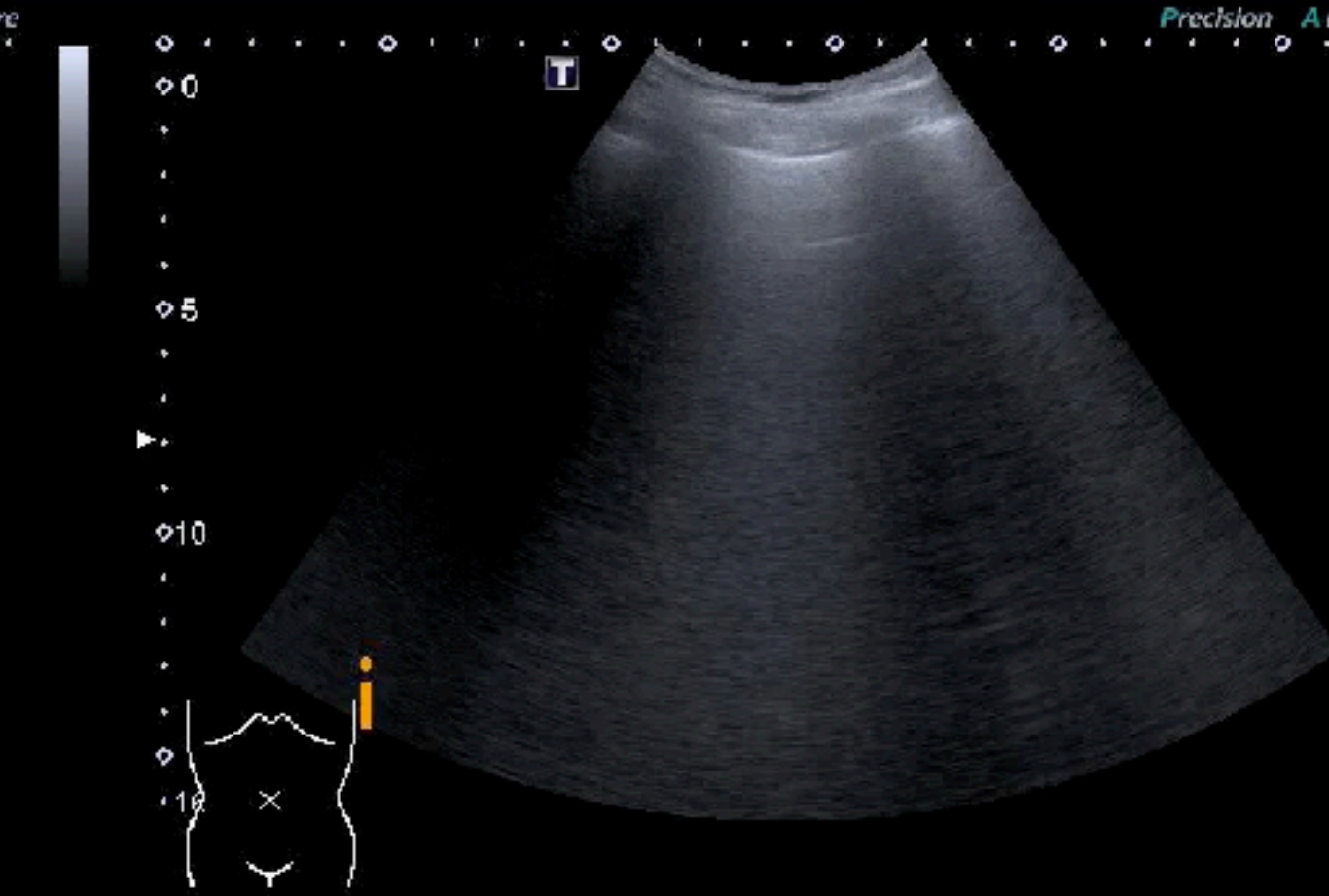
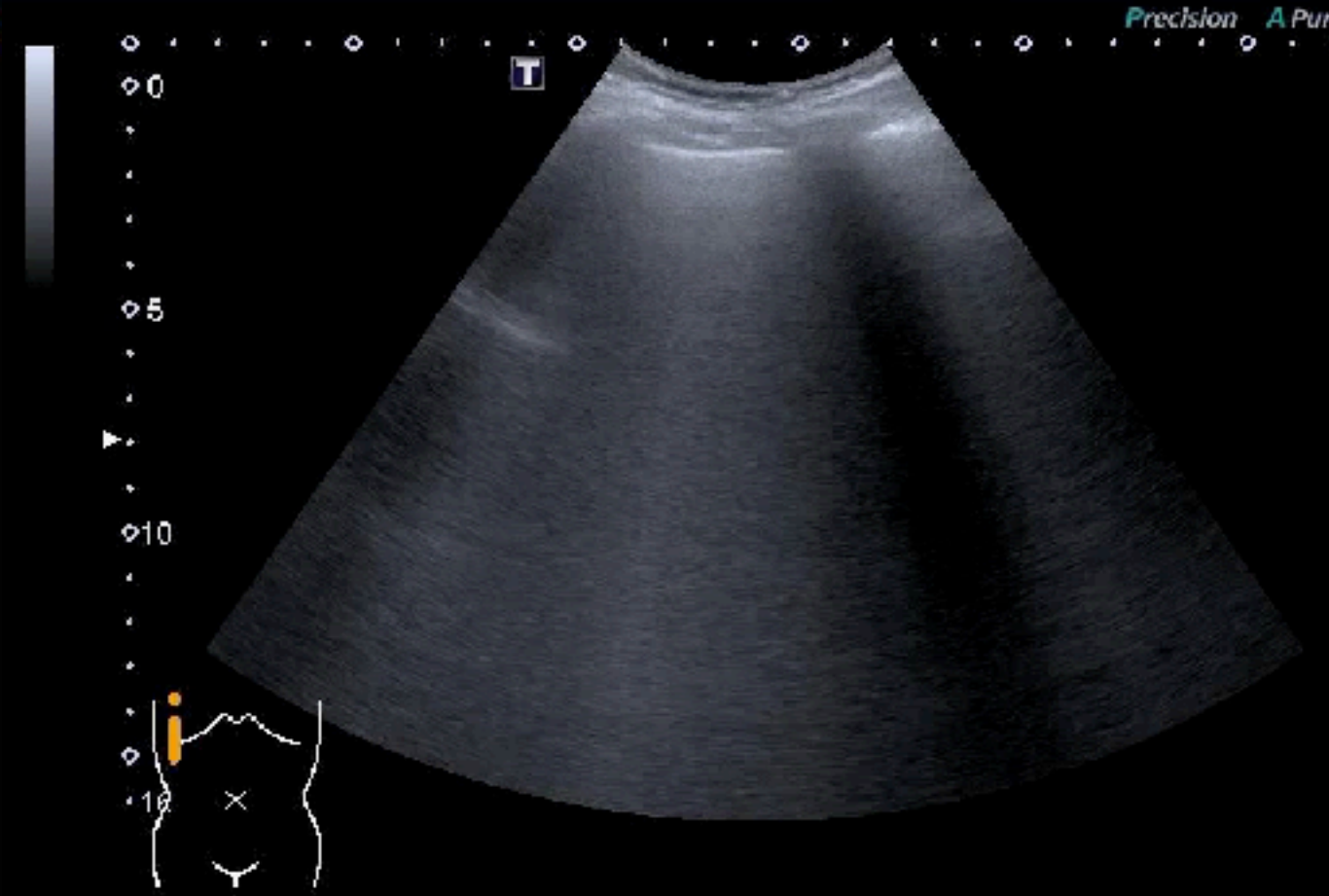
sit

I

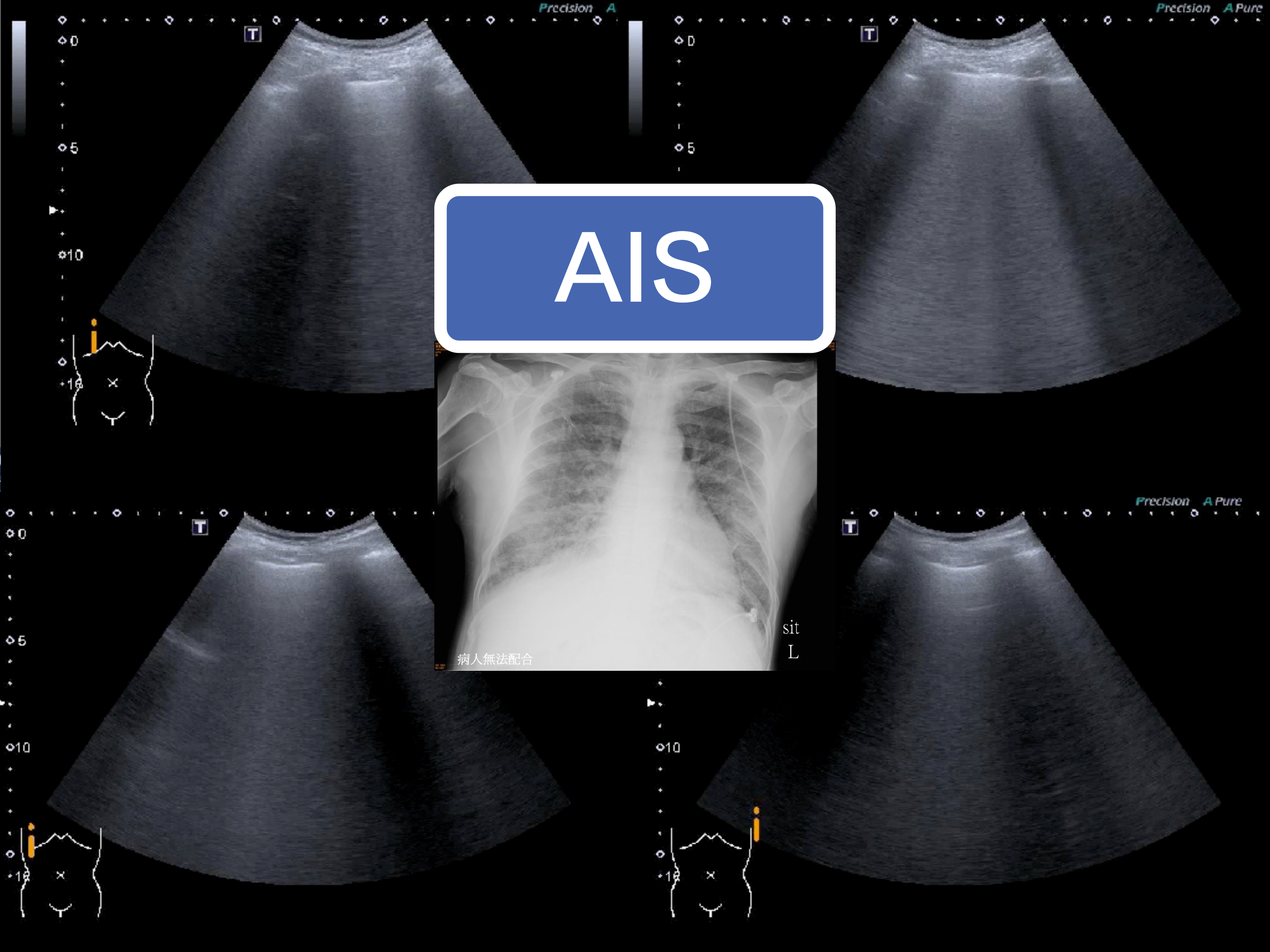
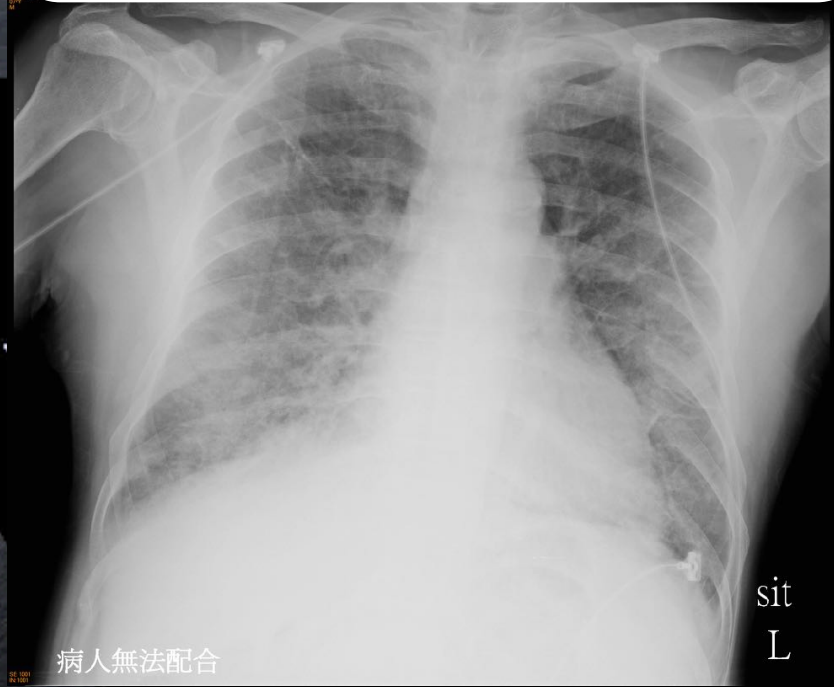








AIS

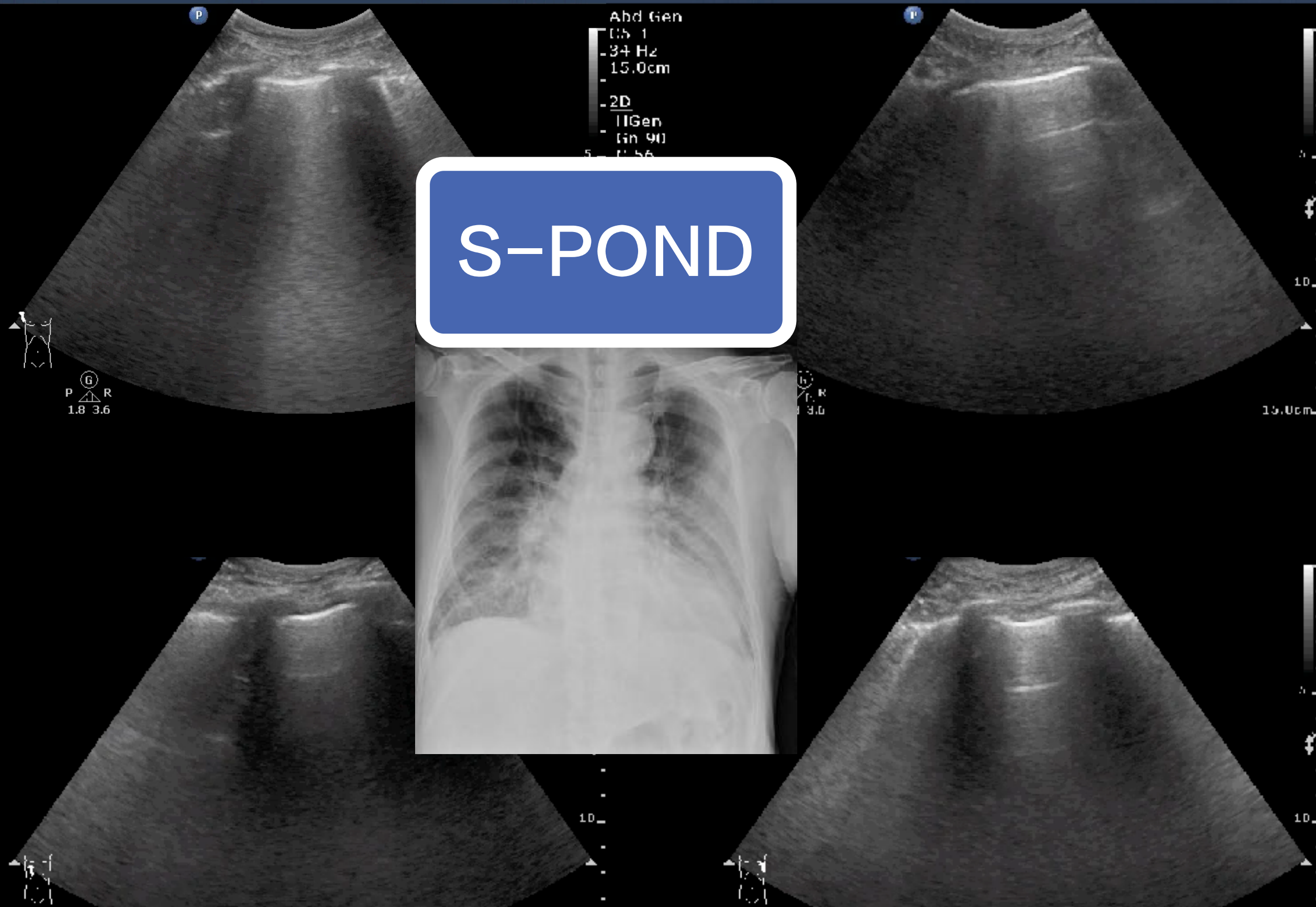


AIS: Bilateral & Diffuse

Abd Gen
C5-1
34 Hz
15.0cm
2D
HGen
Gn 90
C 56
3/3/3

Abd Gen
C5-1
34 Hz
15.0cm
2D
HGen
Gn 90
C 56
3/3/3

S-POND

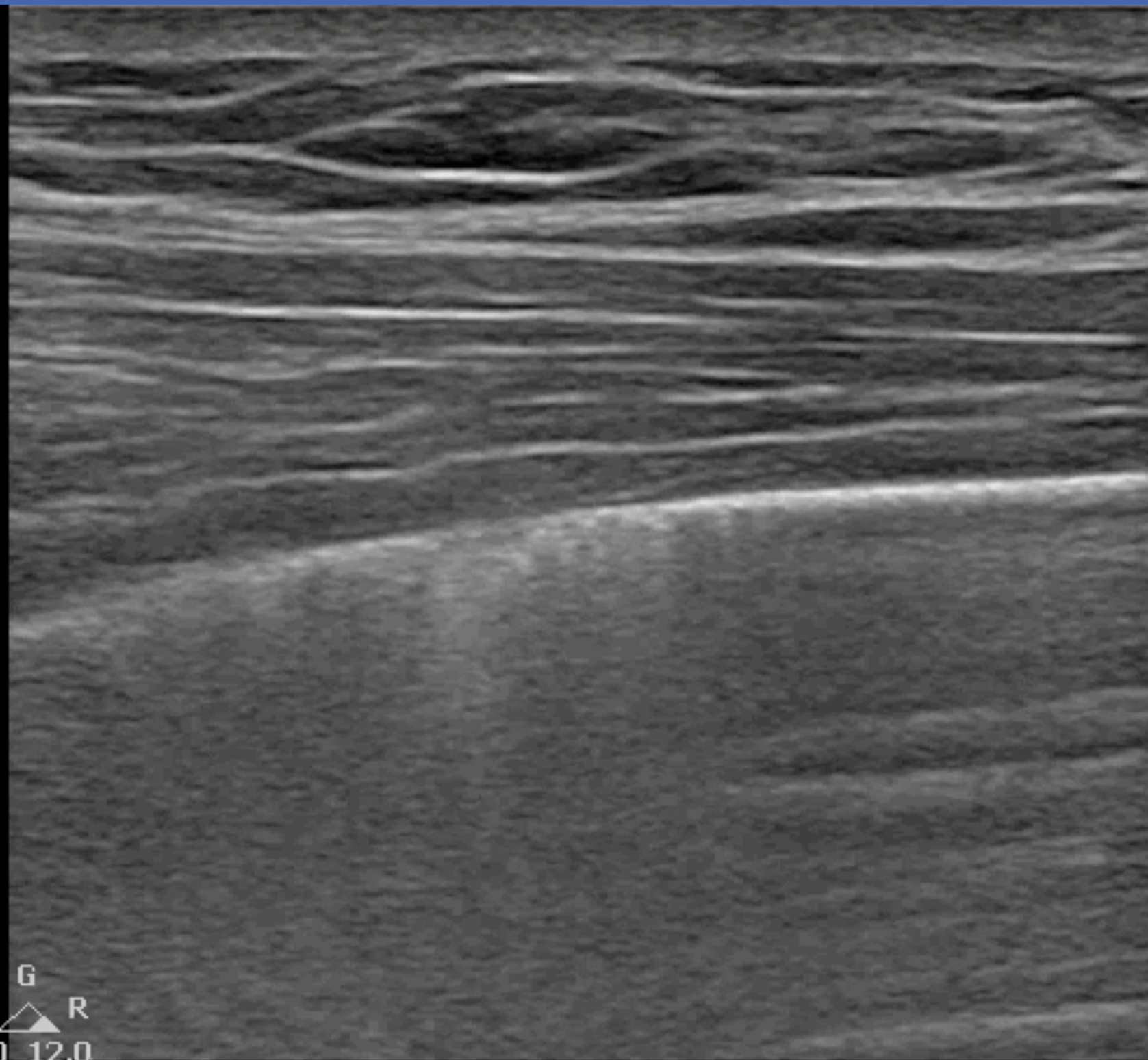


C5-1
34 Hz
15.0cm
2D
HGen
Gn 90
C 56
3/3/3

15.0cm

10

AIS: Localized



Pneumonia

Pneumonitis

Atelectasis

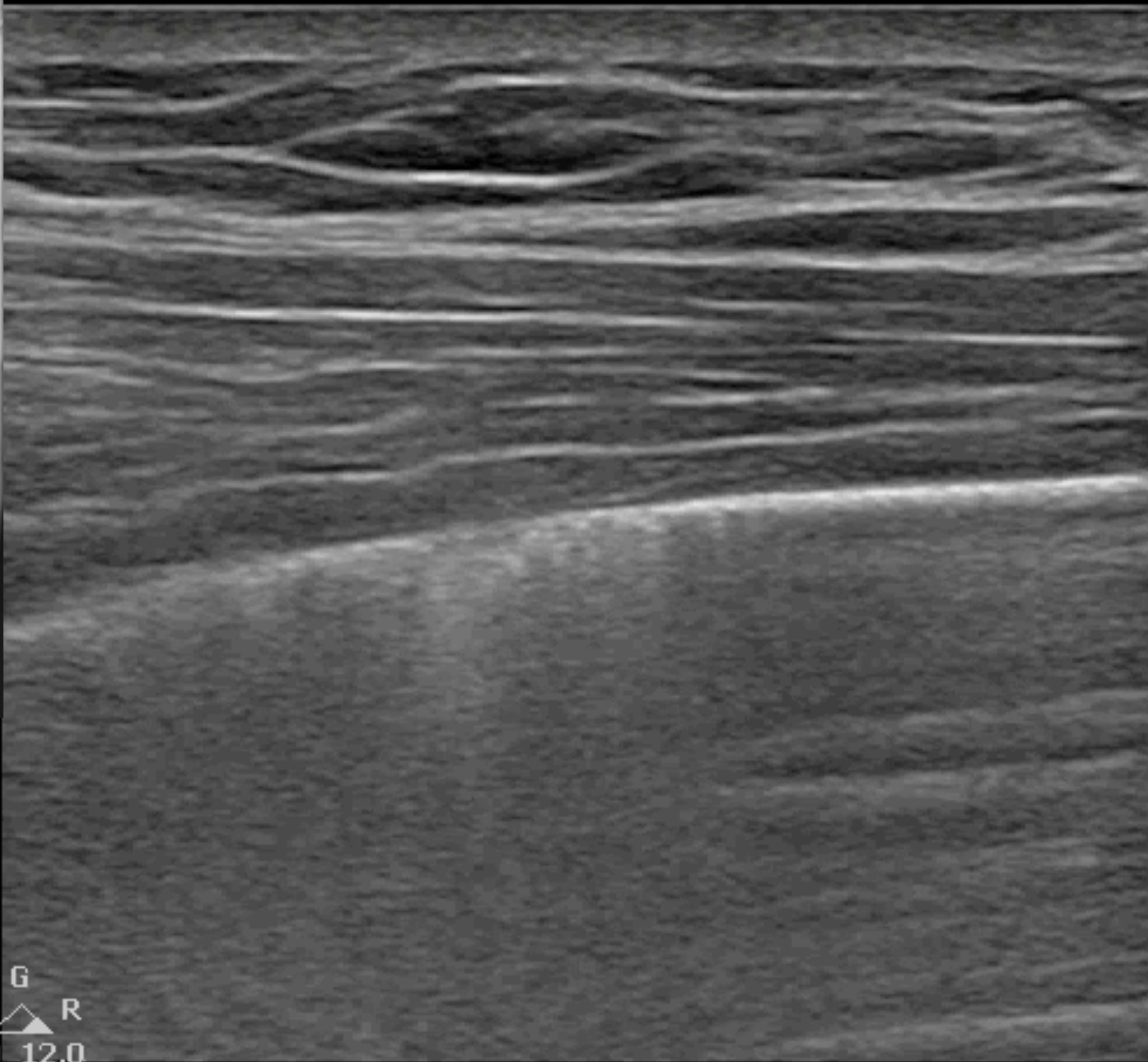
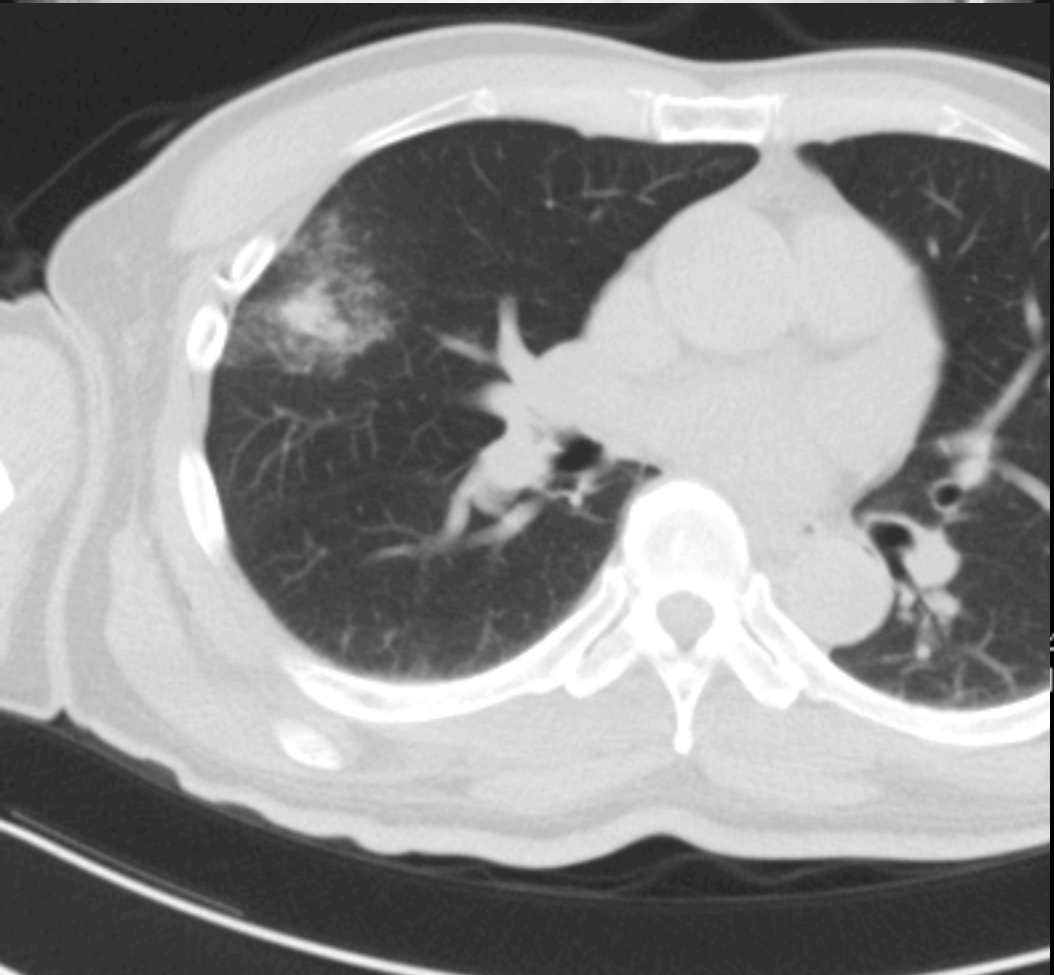
Contusion

Infarction

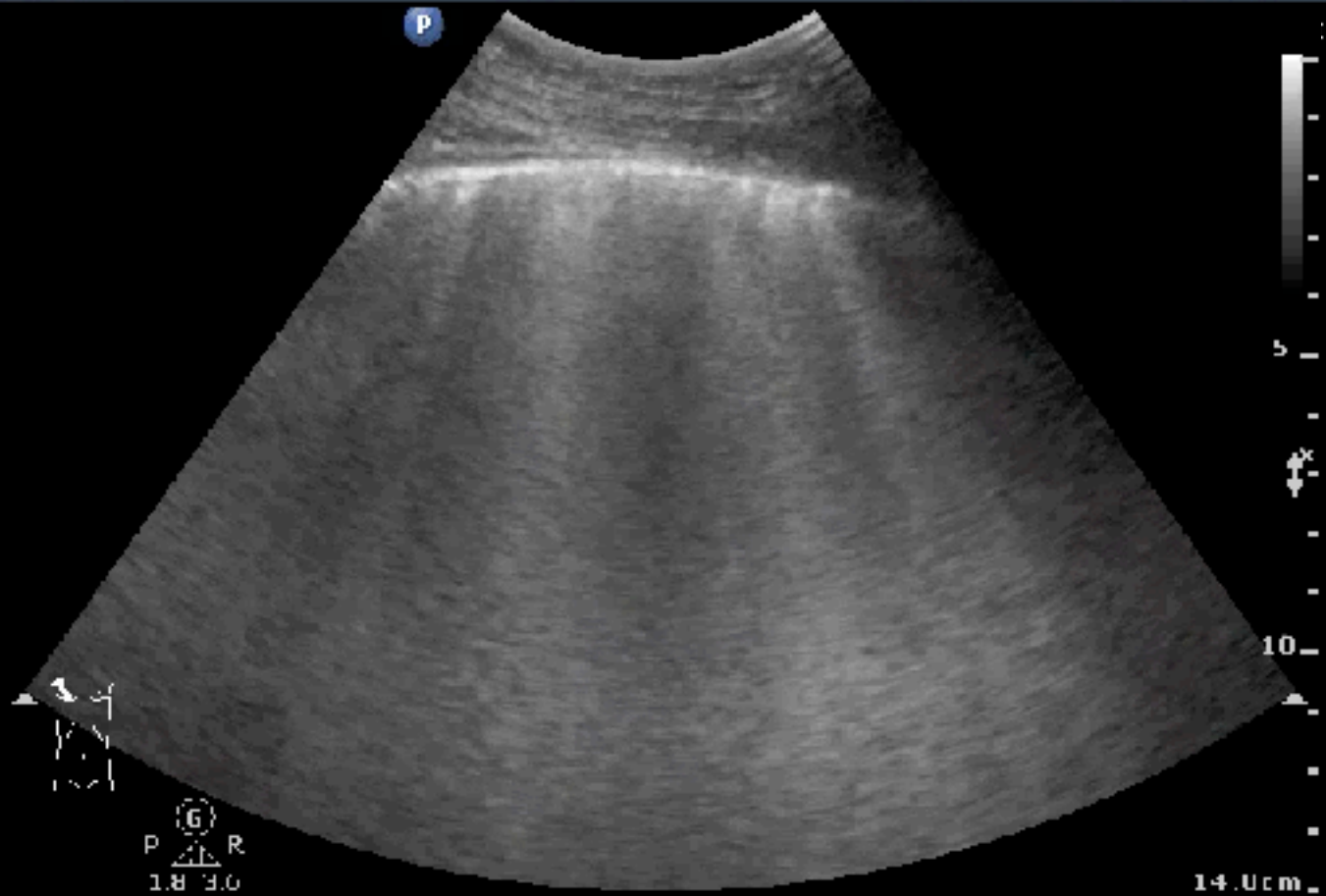
Pleural disease

Neoplasia

Normal lung



Better one ?



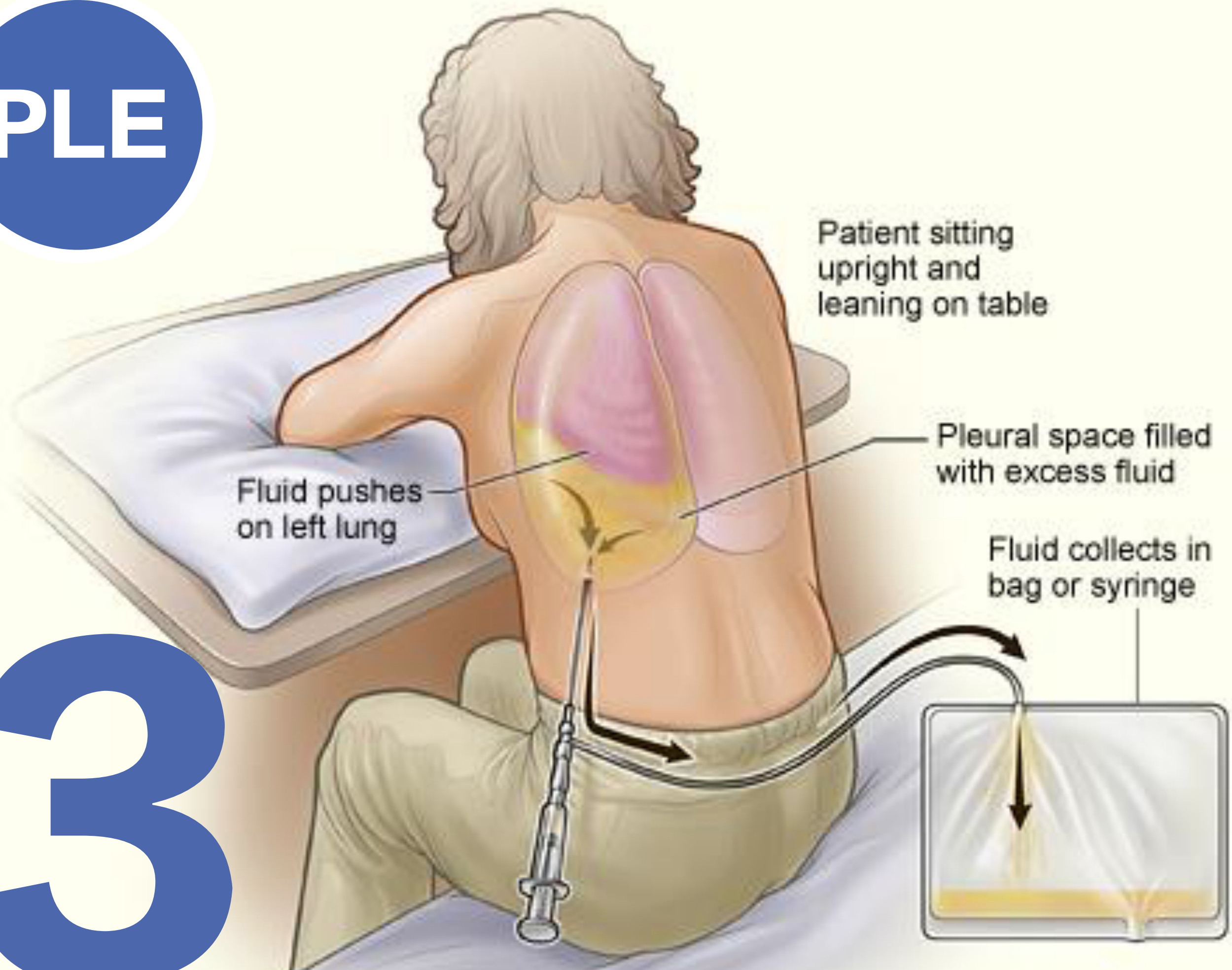
LUS for PAP

PTX

AIS

PLE

PLE



3

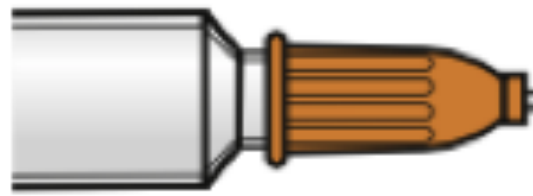
PLE

Rib

vein,
nerve

External
intercostal muscle

Internal
intercostal muscle



Rib-pleura
distance 0.5 cm

Diaphragm

Soft tissue

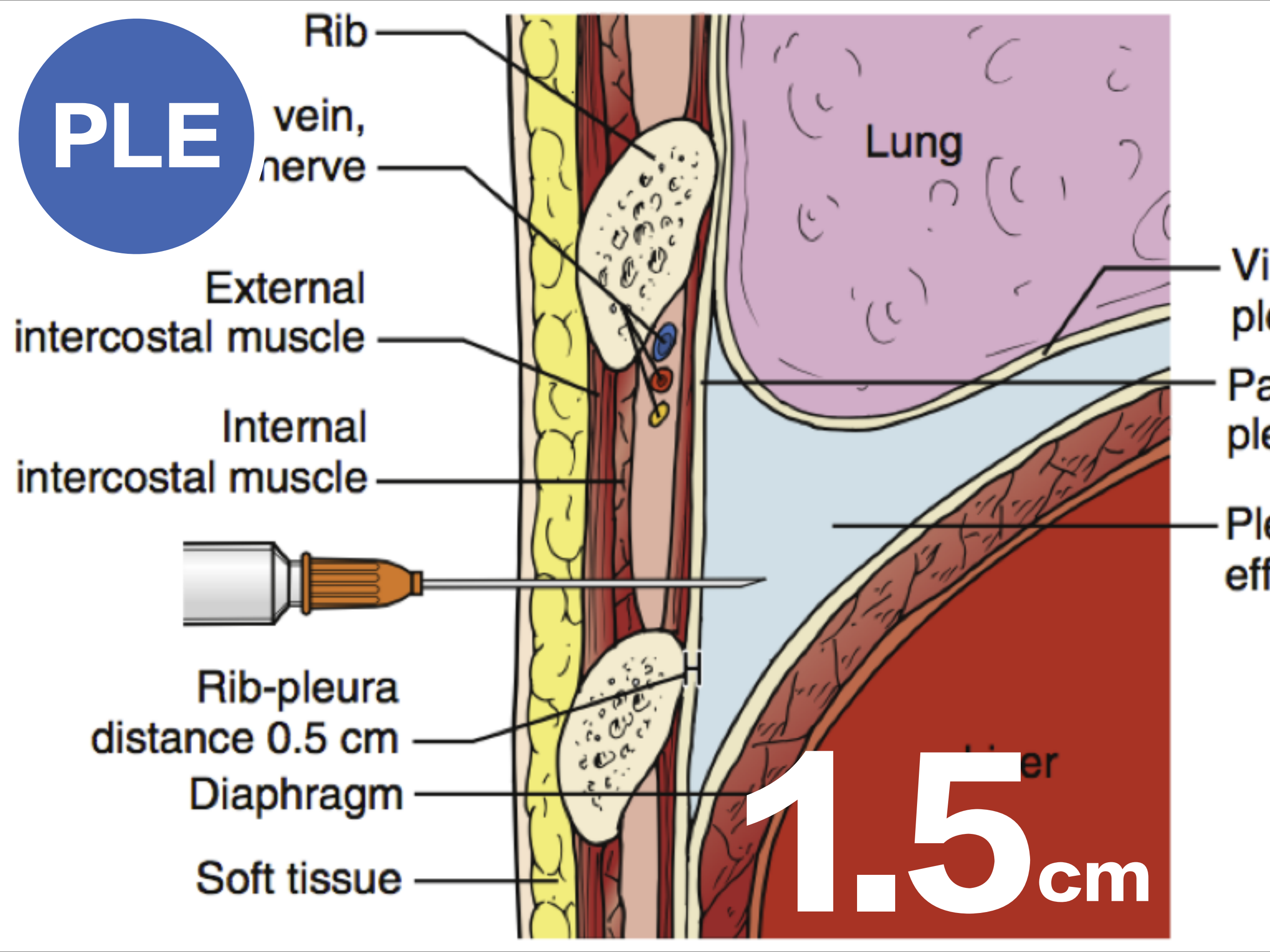
Lung

Visceral
pleura

Parietal
pleura

Pleural
effusion

1.5 cm



LUS for PLE

Table 4 Lung ultrasound in the diagnosis of pleural effusion

Study (first author)	n	Sensitivity (%)	Specificity (%)	Ultrasound LR+/LR-	Gold standard	Sonographer type
Ma ²²	240	US 96	US 100	Undefined/0.04	CT	EP
Rozycki ²³	47	US 84	US 100	Undefined/0.16	CT	Surgeons
Abboud ²⁴	142	US 12	US 98	6/0.9	CT	Experienced EP
Lichenstein ³	32	US 92	US 93	13/0.086	CT	Experienced intensivist
Brooks ²⁵	61	US 92	US 100	Undefined/0.08	Composite gold standard	Experienced EP or surgeon
Xirouchaki ²⁷	42	US 100 CXR 65	US 100 CXR 81	Undefined/0	CT	Experienced intensivist
Schleder ²⁶	24	Hand US 91 CXR 74	Hand US 100 CXR 31	Undefined/0.09	High-end US	Intensivist

Point 1

PLE

BLUE points

Point 3

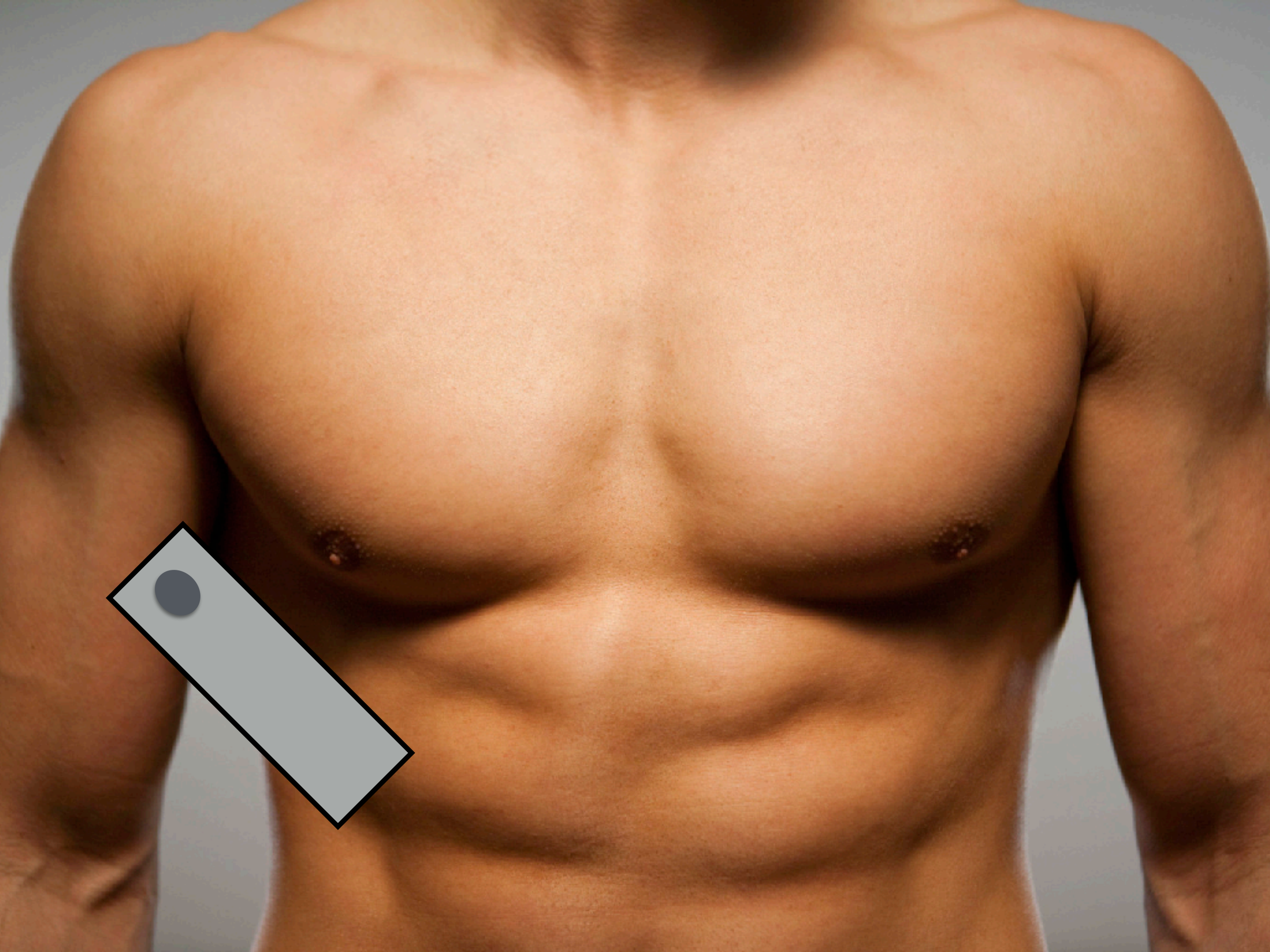


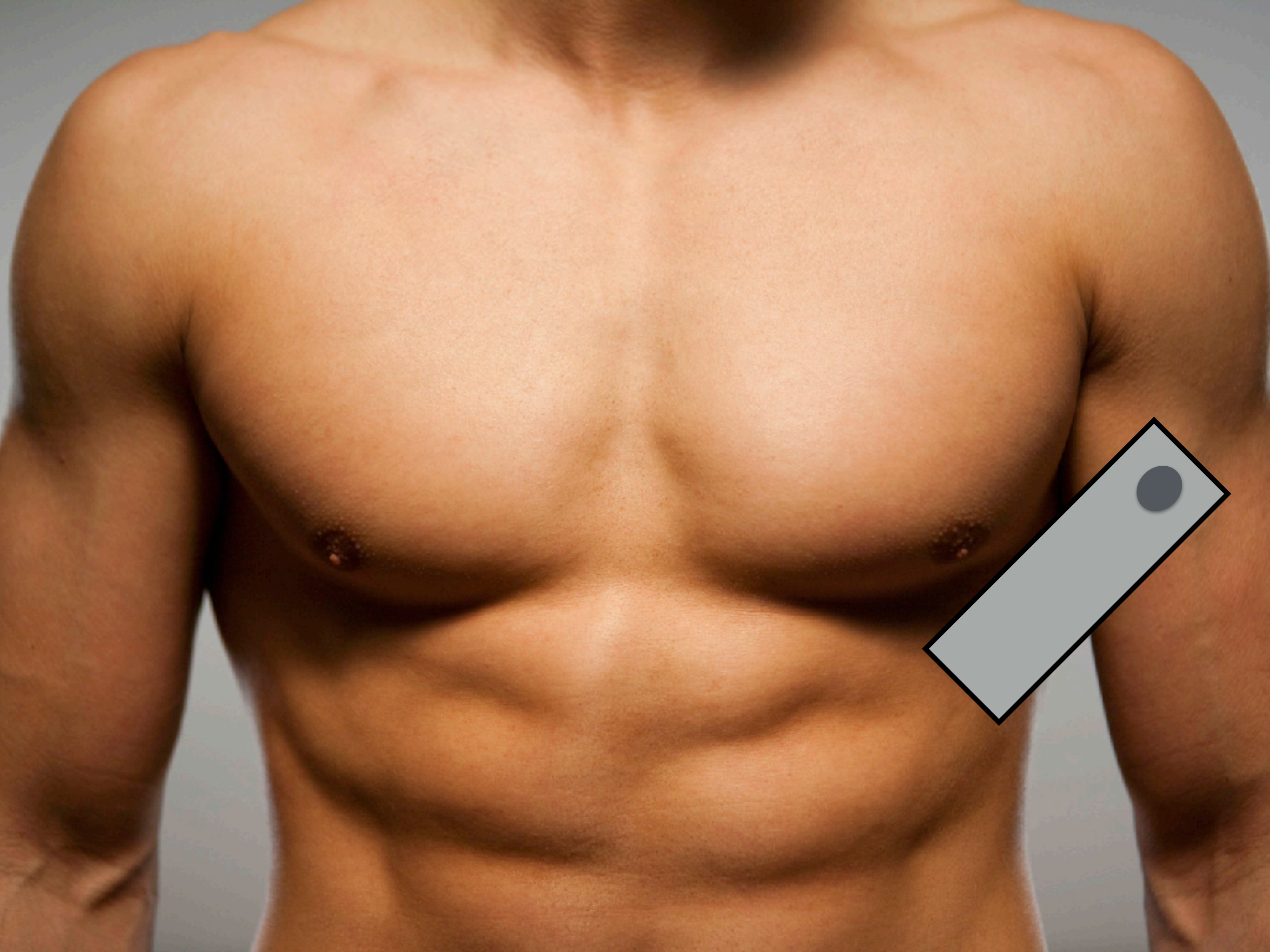
Point 2

**Anechoic
Sharp sign
Sinusoid sign**

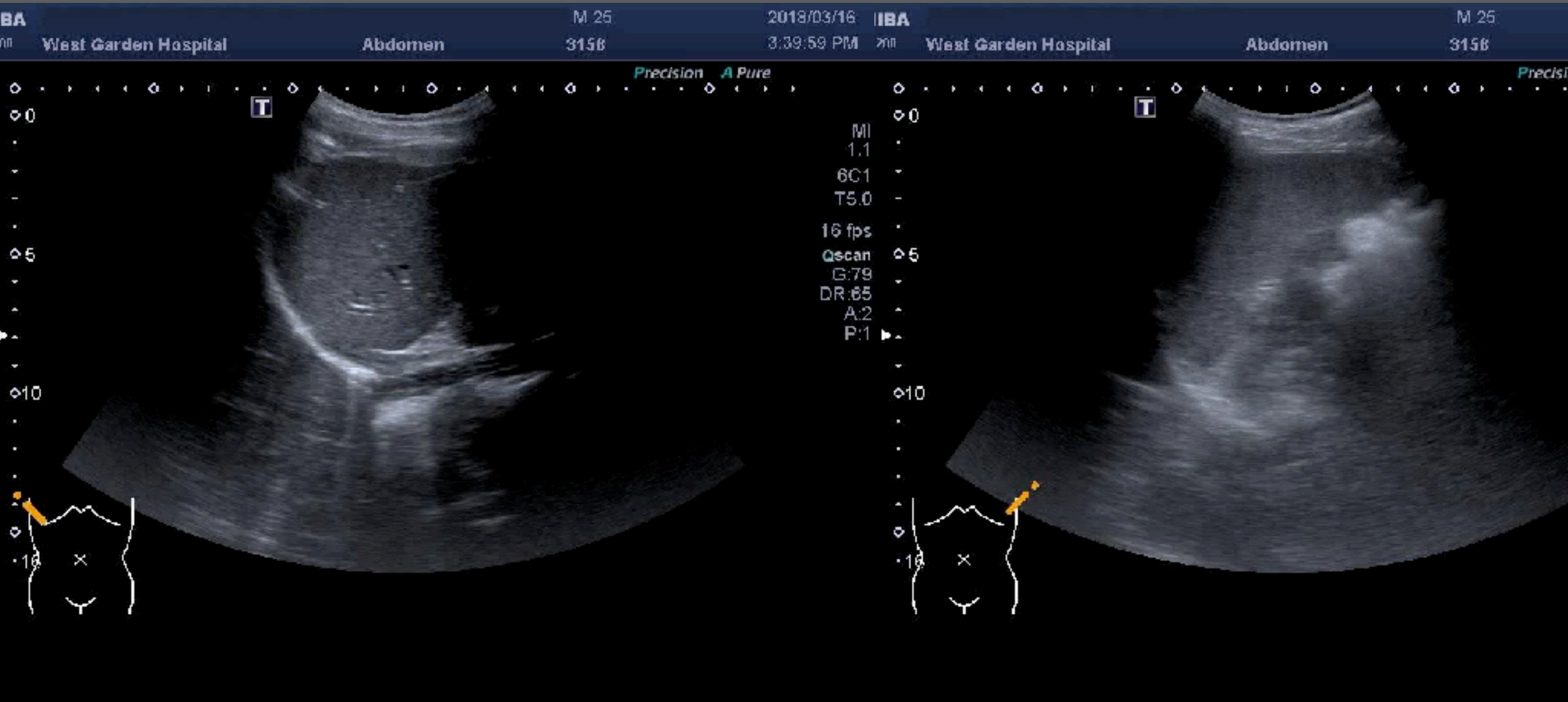
Point 4

Diaphragm





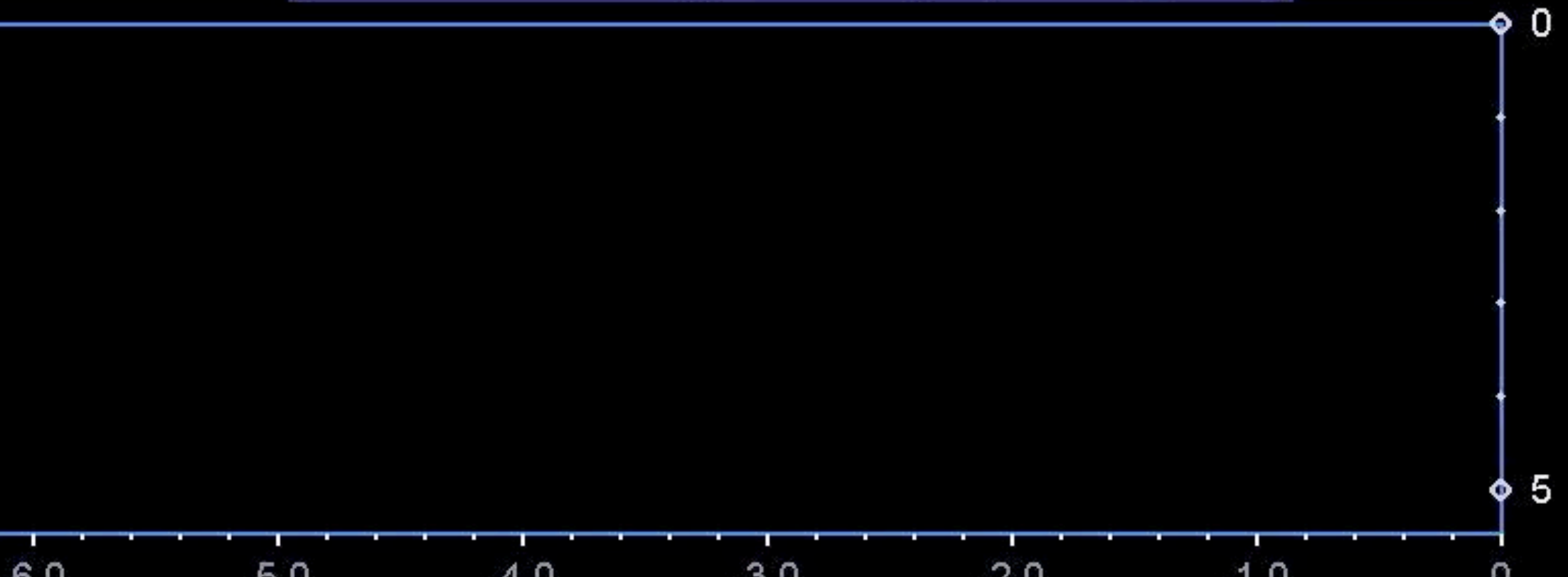
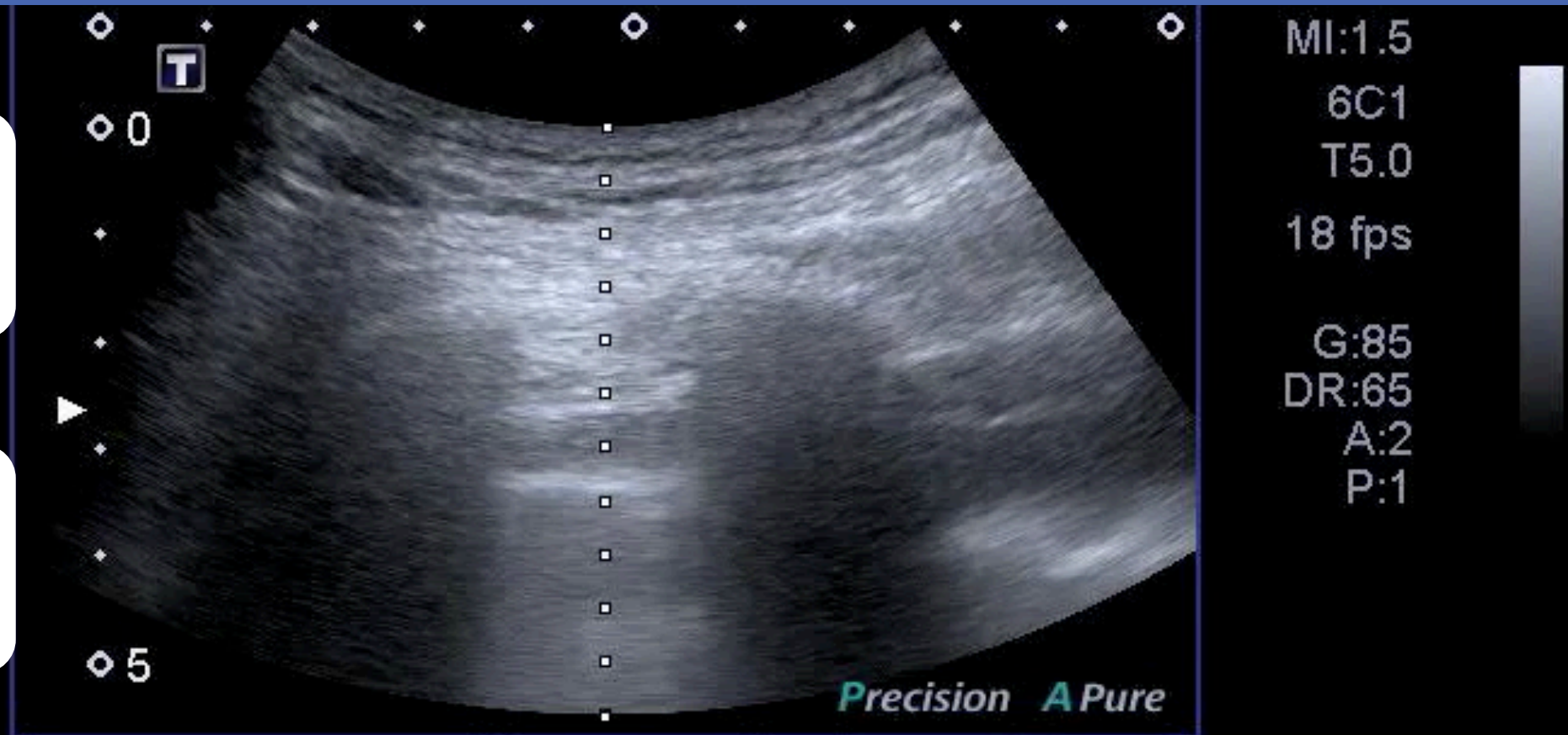
Diaphragm



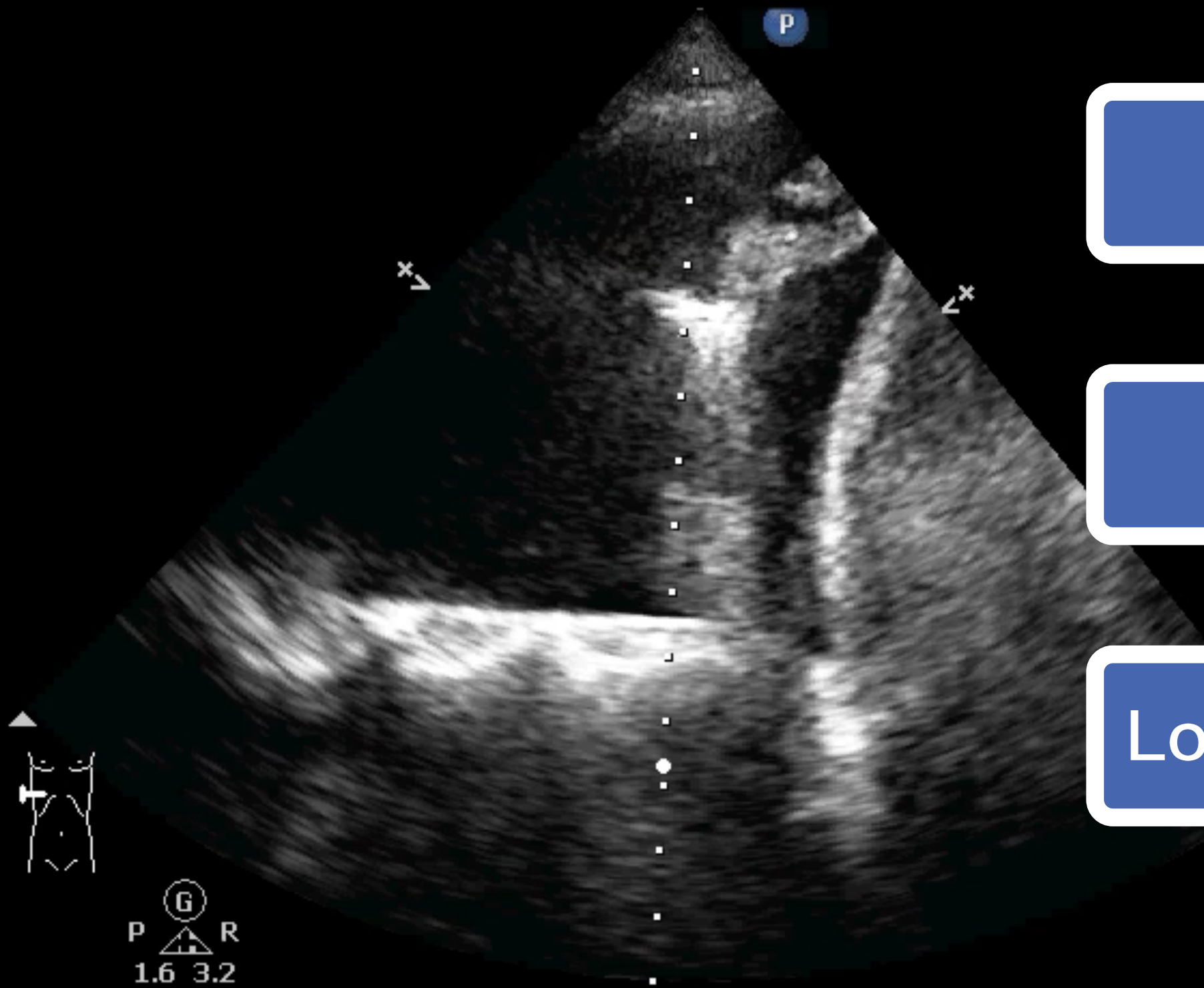
Diaphragm

Sharp sign

Sinusoid sign



SKH-EUTC©ChenKC



Jellyfish sign

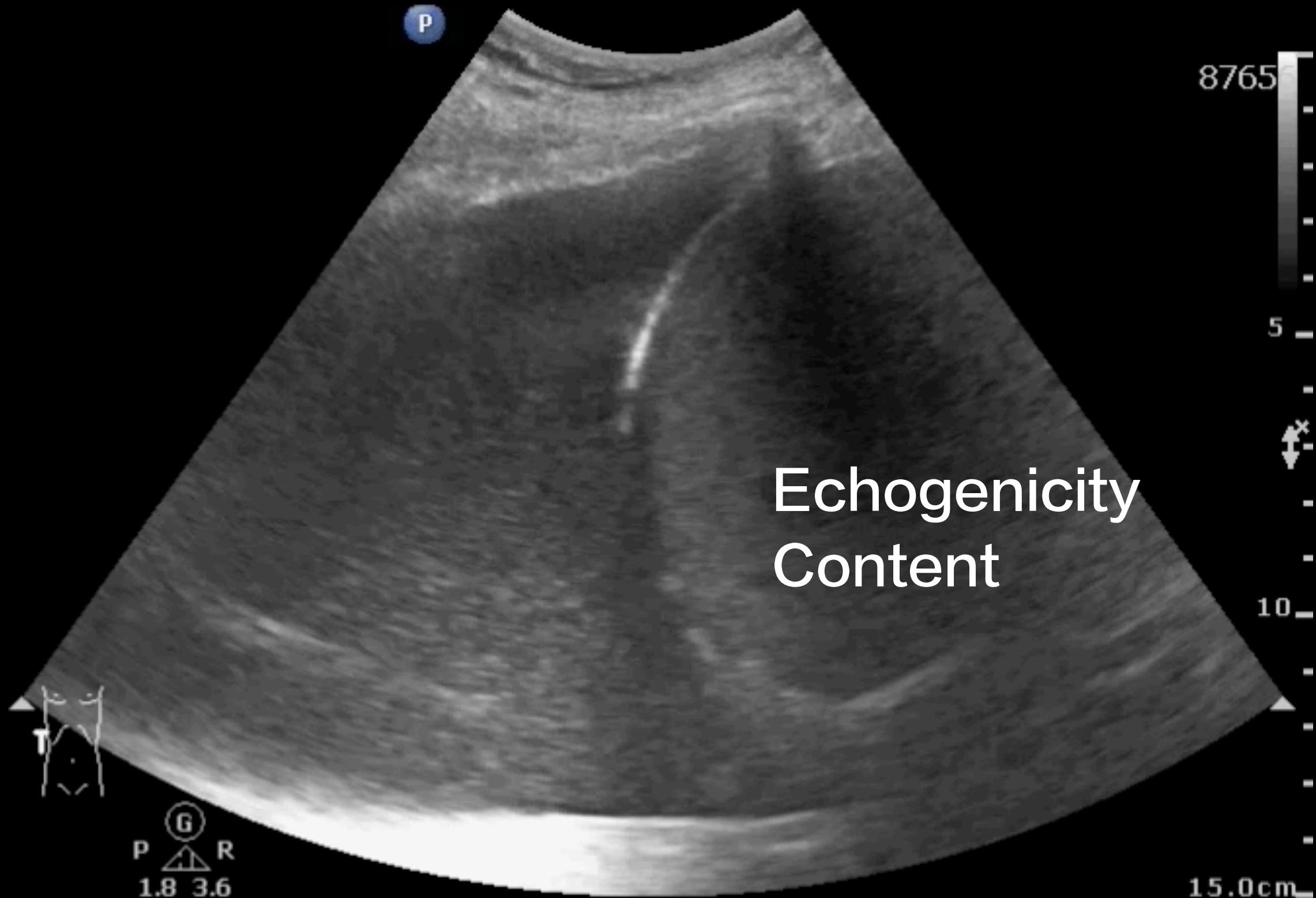
Spine sign

Loss of curtain sign

Plankton sign

Abd Gen2
C5-1
34 Hz
15.0cm

2D
HGen
Gn 100
C 56
3/3/3





102



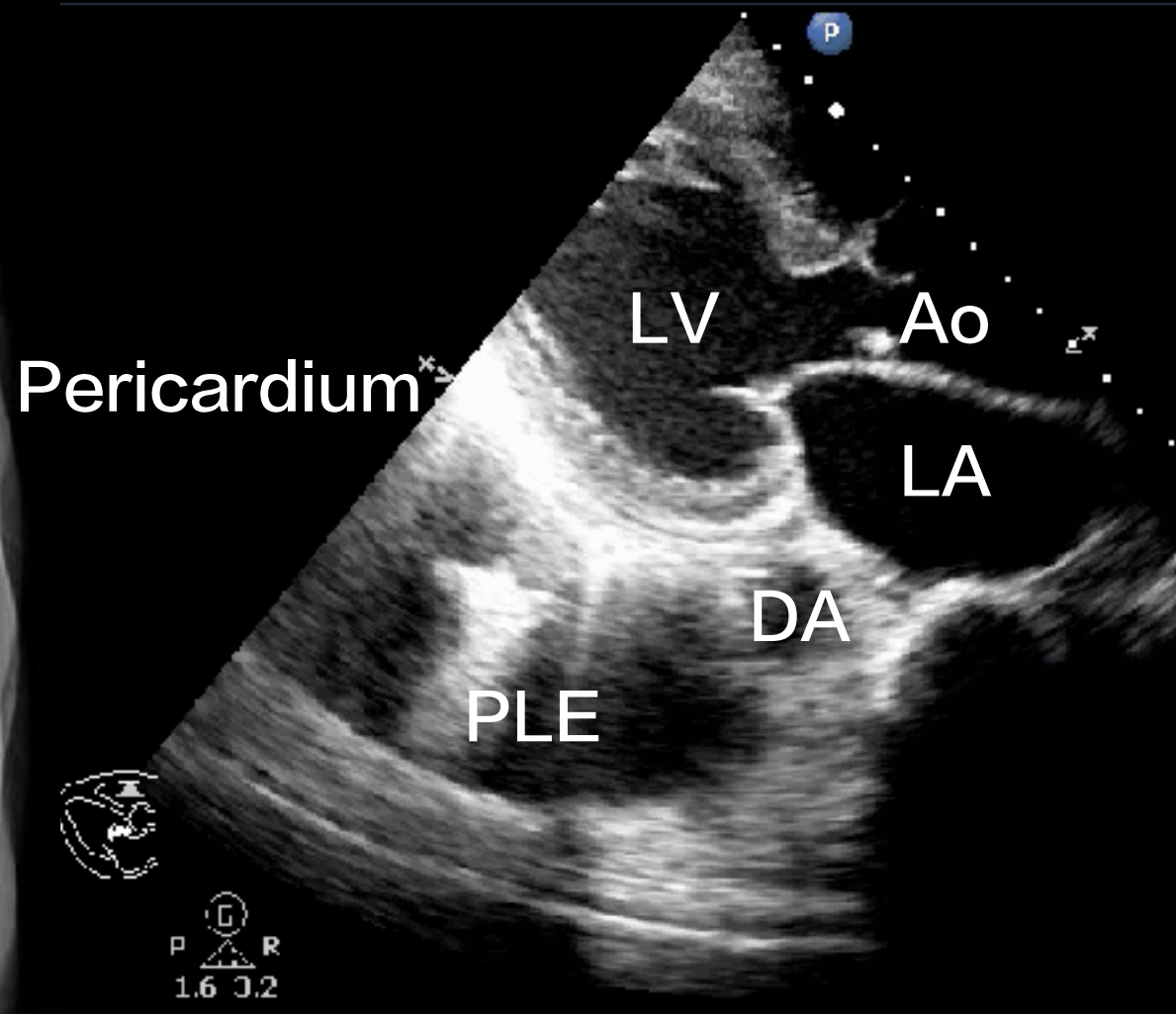
102





D aorta

Pericardial vs Pleural

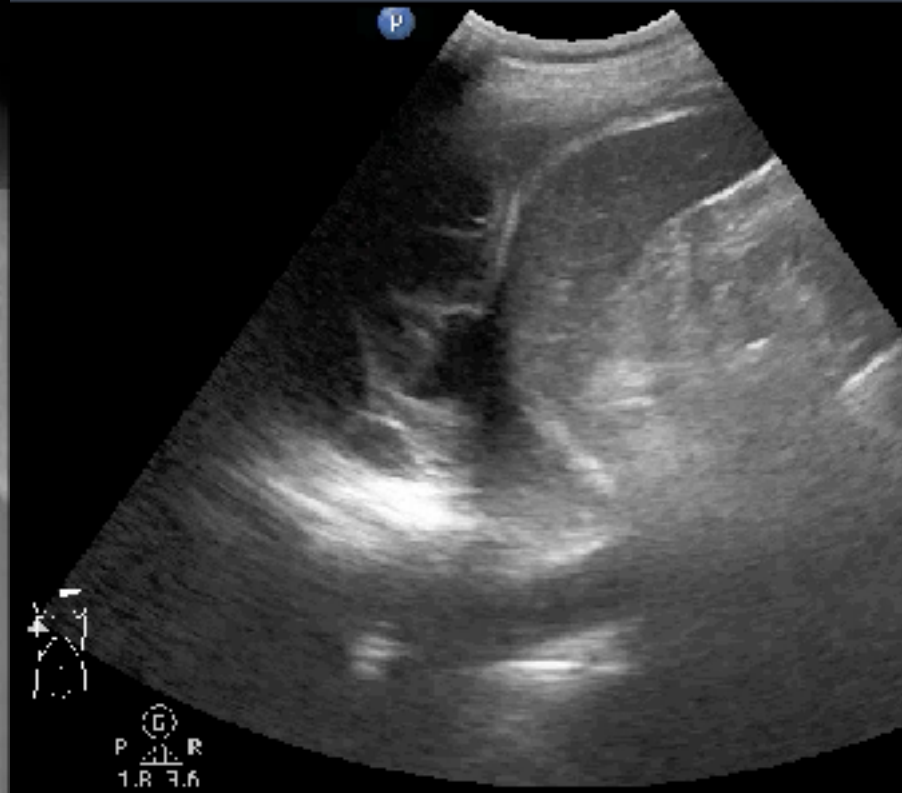


50M, F & Cough



Parapneumonic Effusion





Empyema

**Septation
Fibrin
Particles**

73M, F & Dyspnea



Empyema



What do you see ?

Abd Gen
C5-1
31 Hz
17.0cm

2D

HGen
Gn 90
C 56
3 / 3 / 3



G
P R
1.8 3.6

17.0cm





US for PLE

Detection

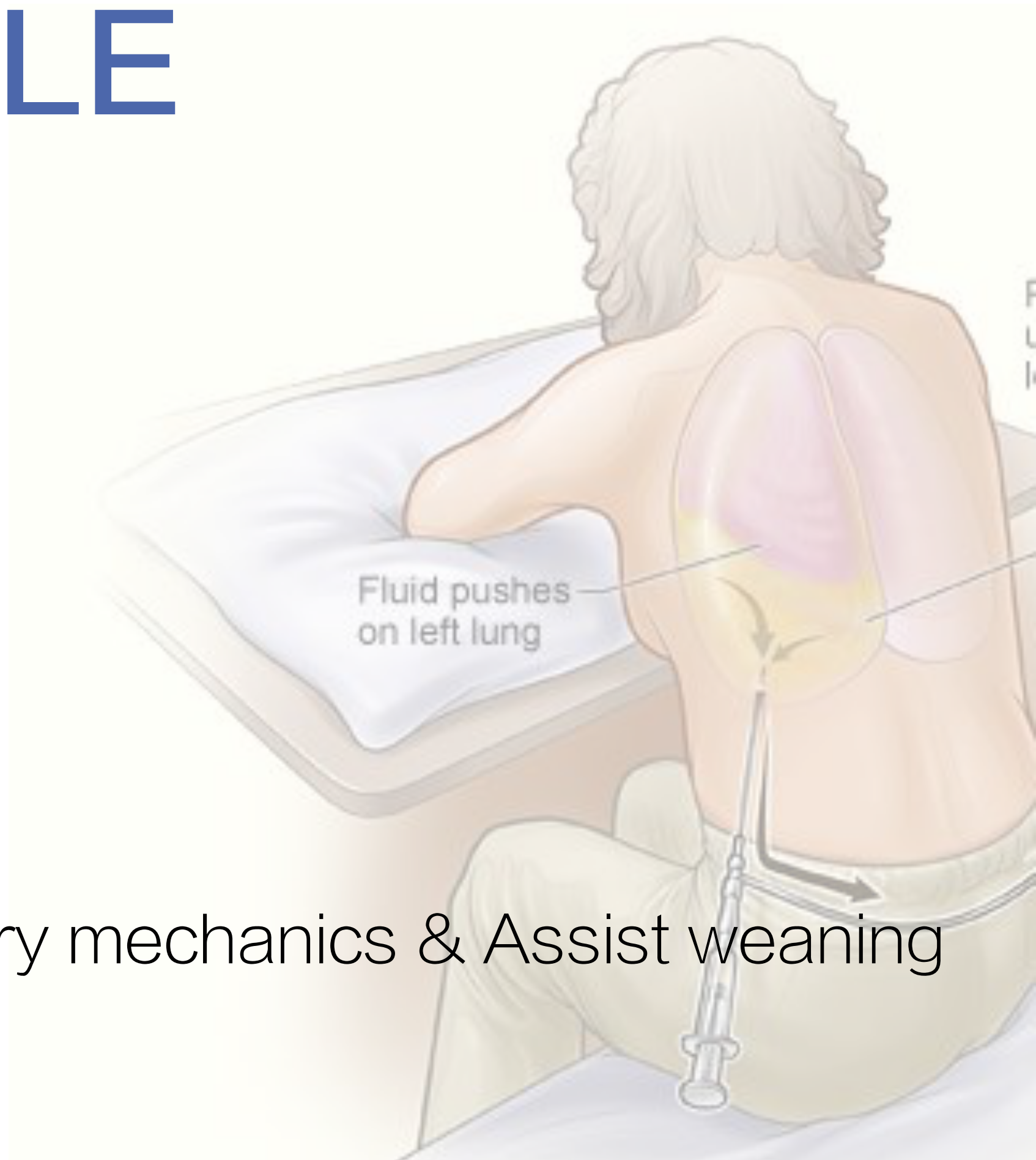
Volume

Nature

Safety

Drainage

Improve ventilatory mechanics & Assist weaning



28F, 來抽肋膜積液吧 !?

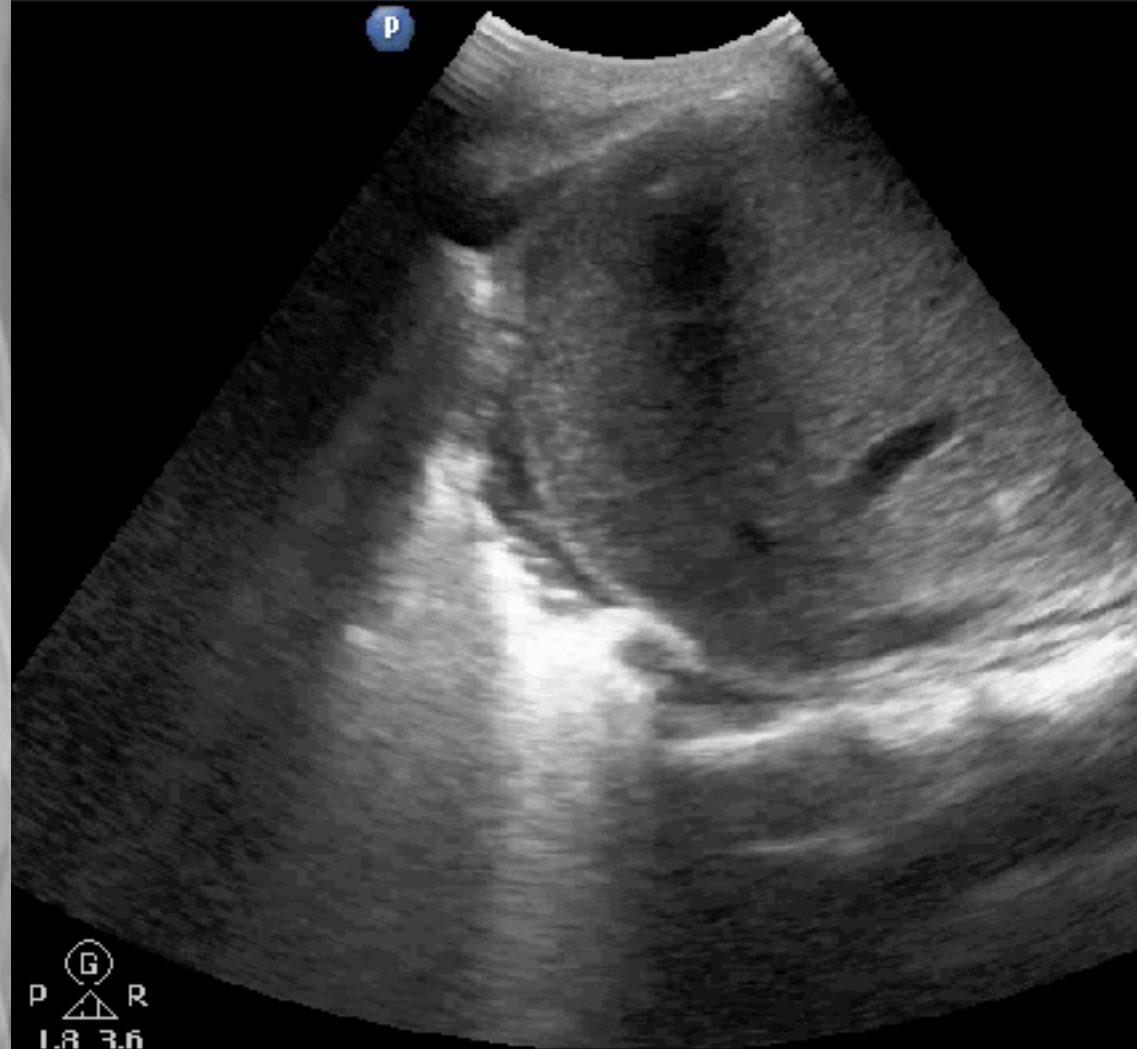
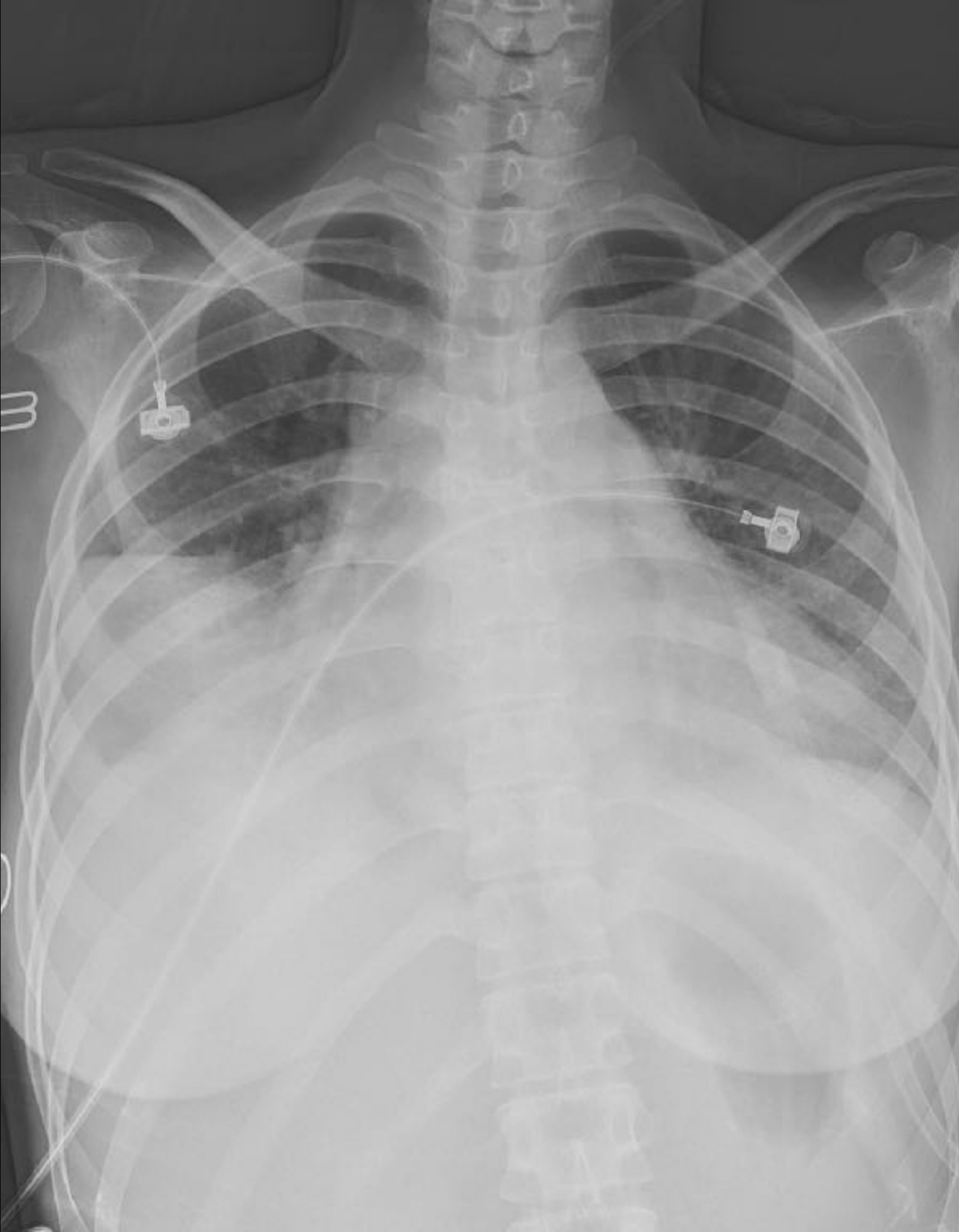


16 個月前

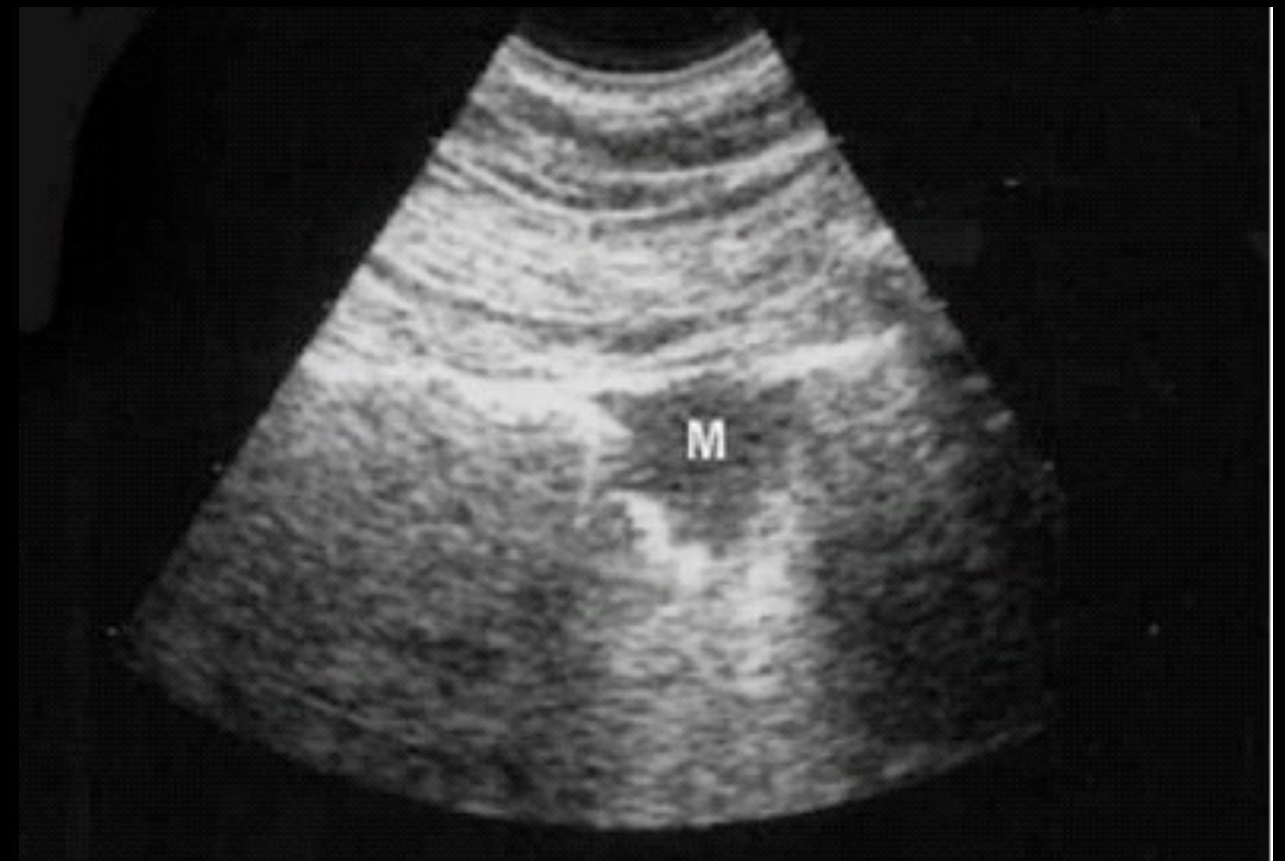
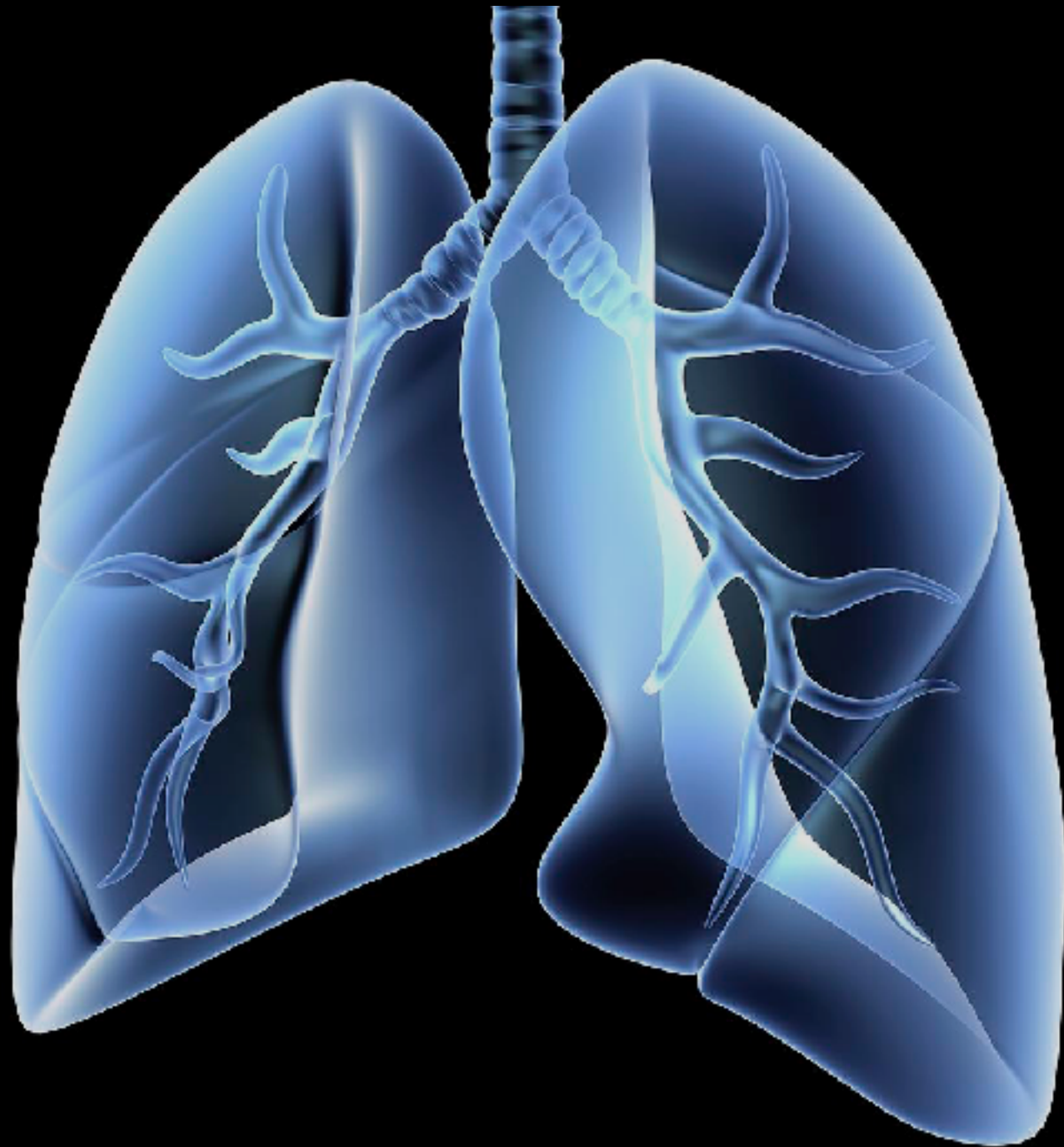


Pneumonia

Consolidation
Air-bronchogram



Consolidation

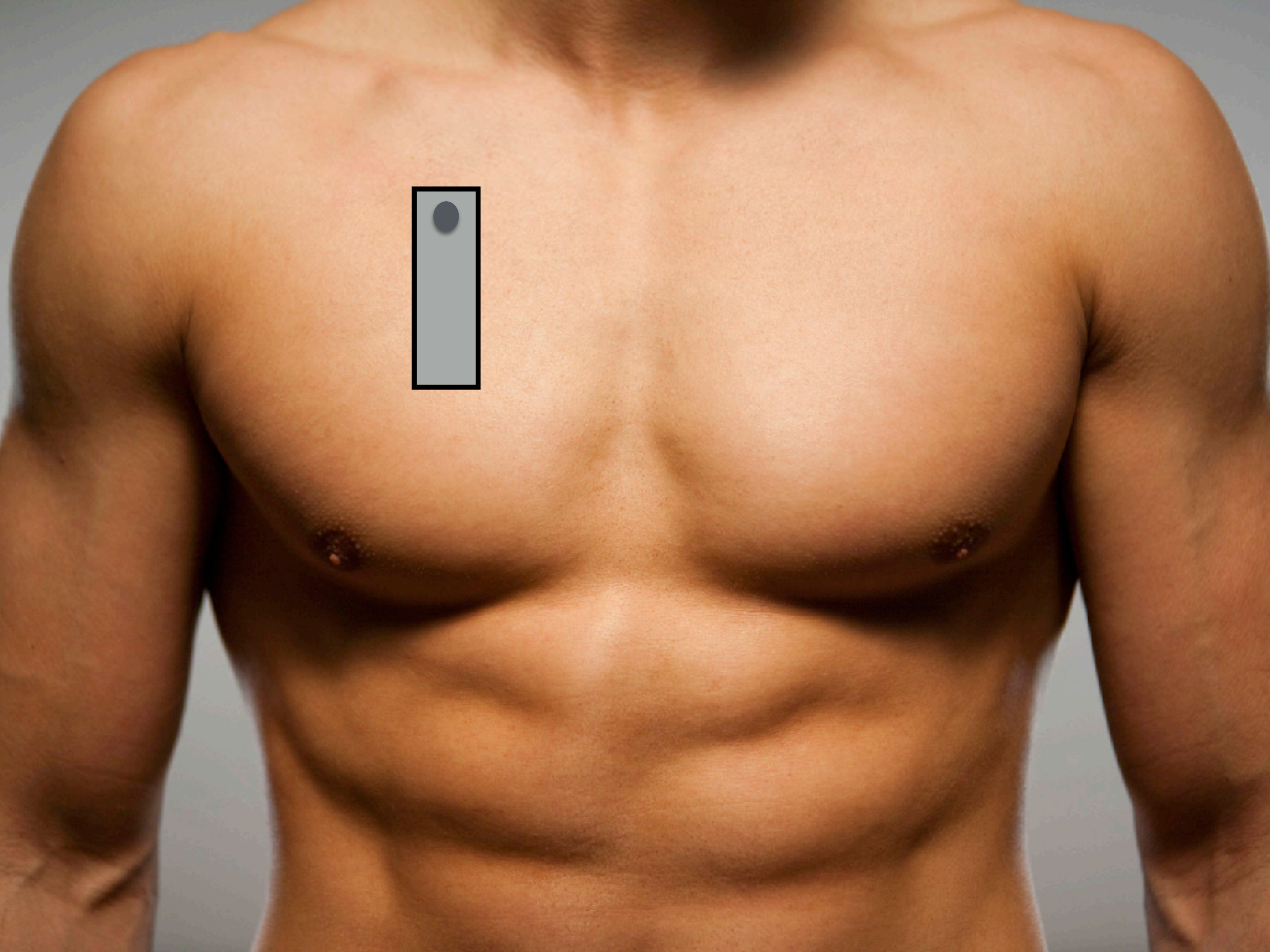


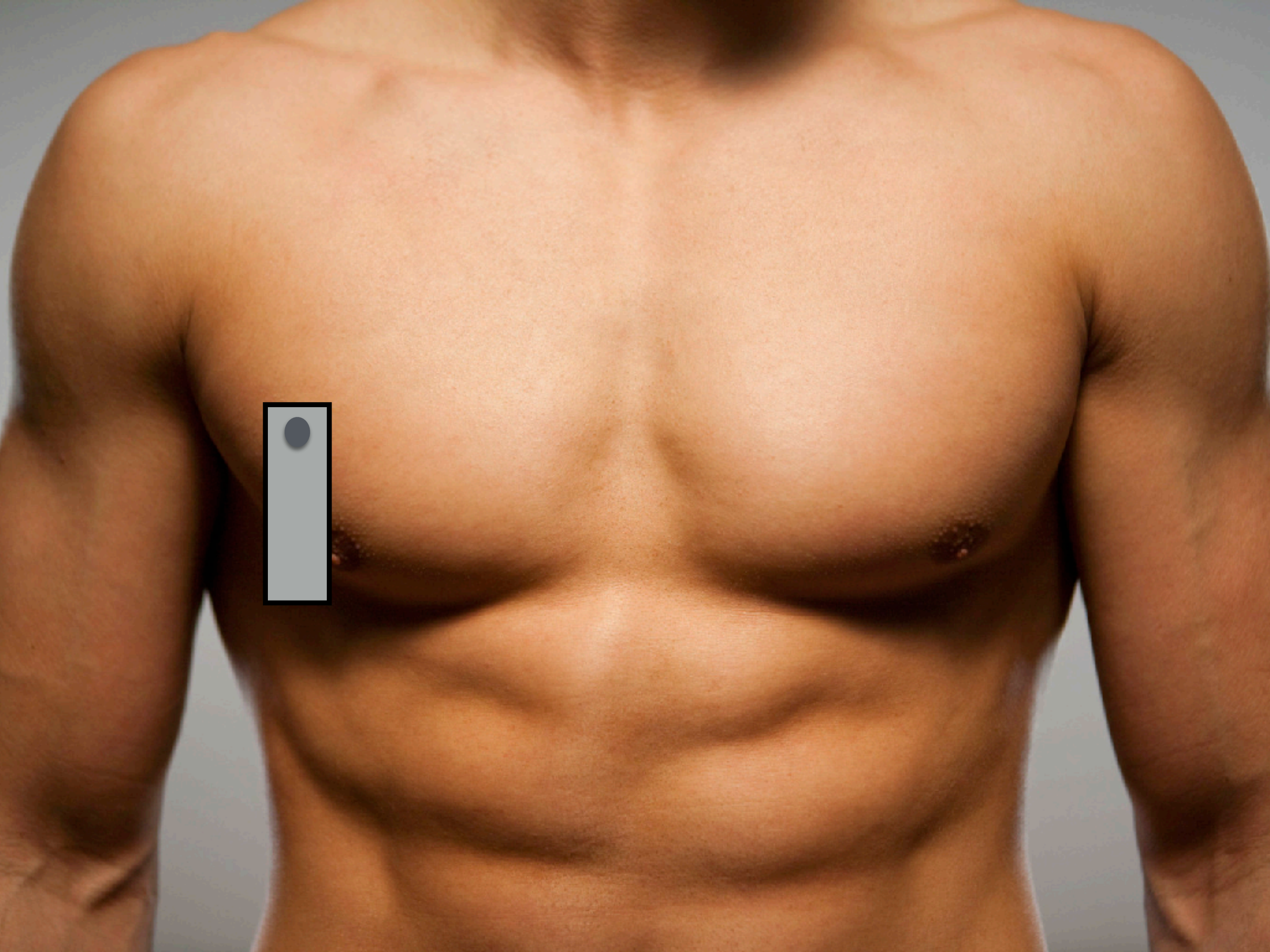
98.5% about the pleura
Sensitivity 90%
Specificity 98%

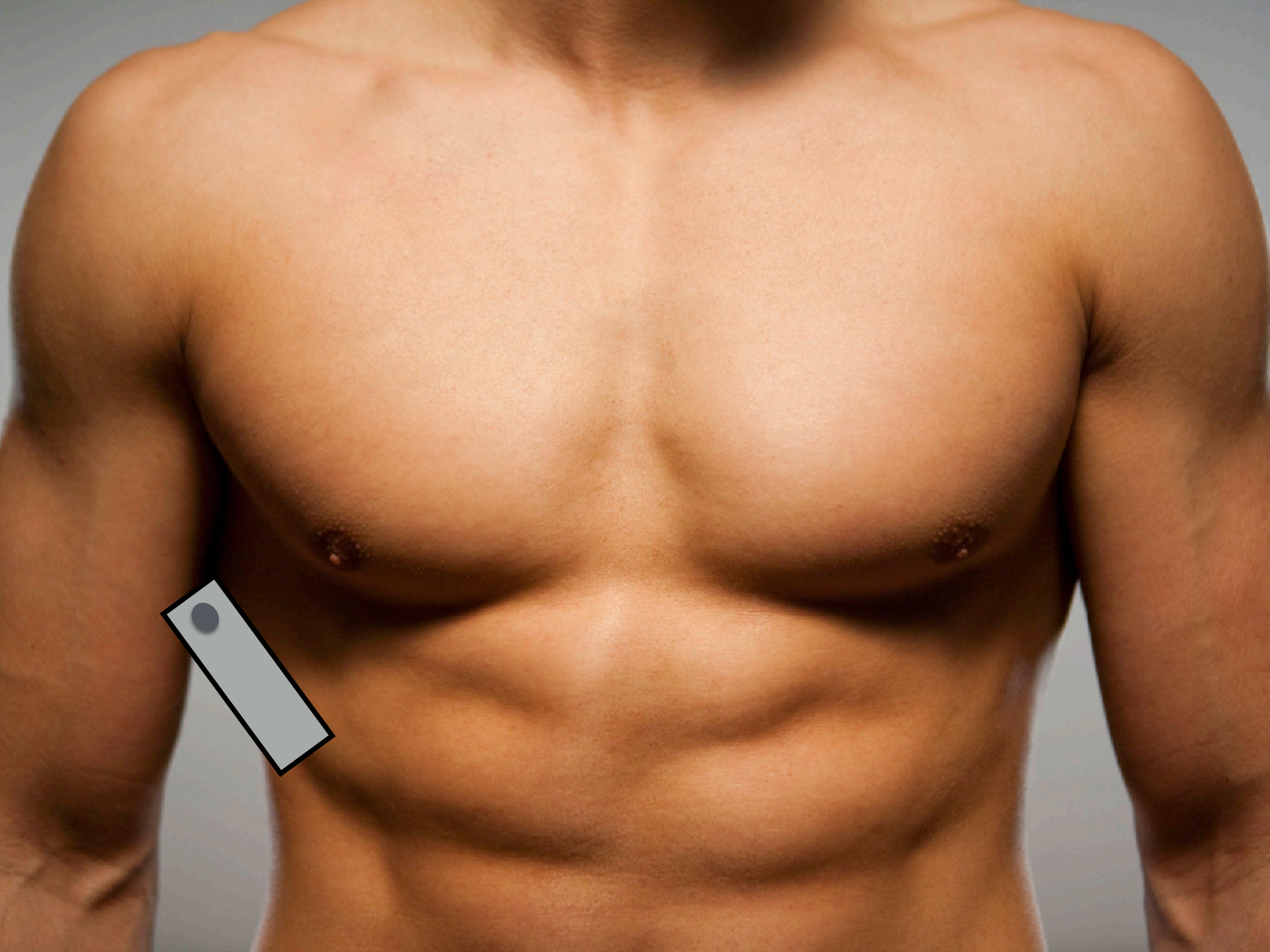
LUS for Consolidation

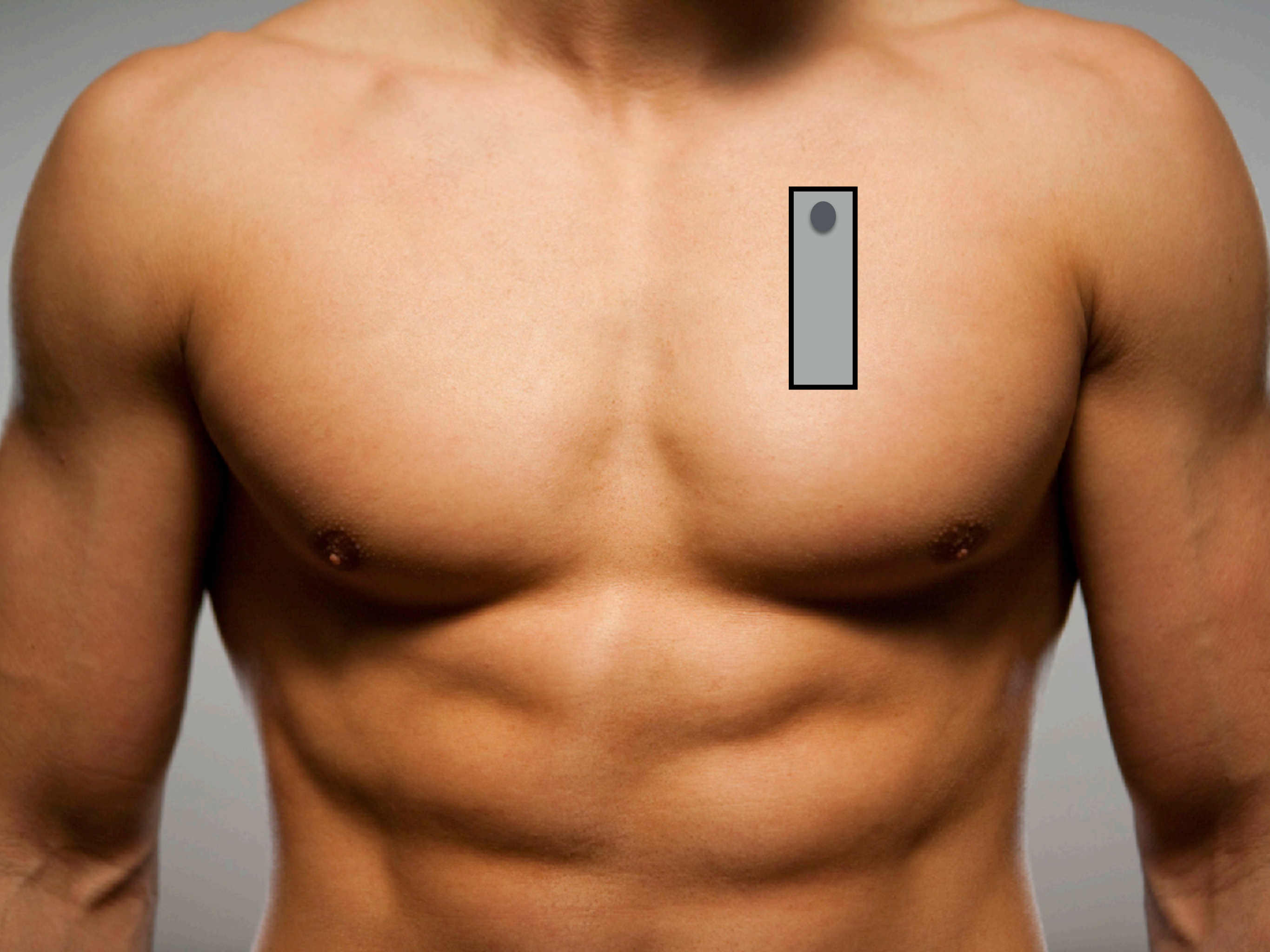
Table 3 Lung ultrasound in the diagnosis of lung consolidation

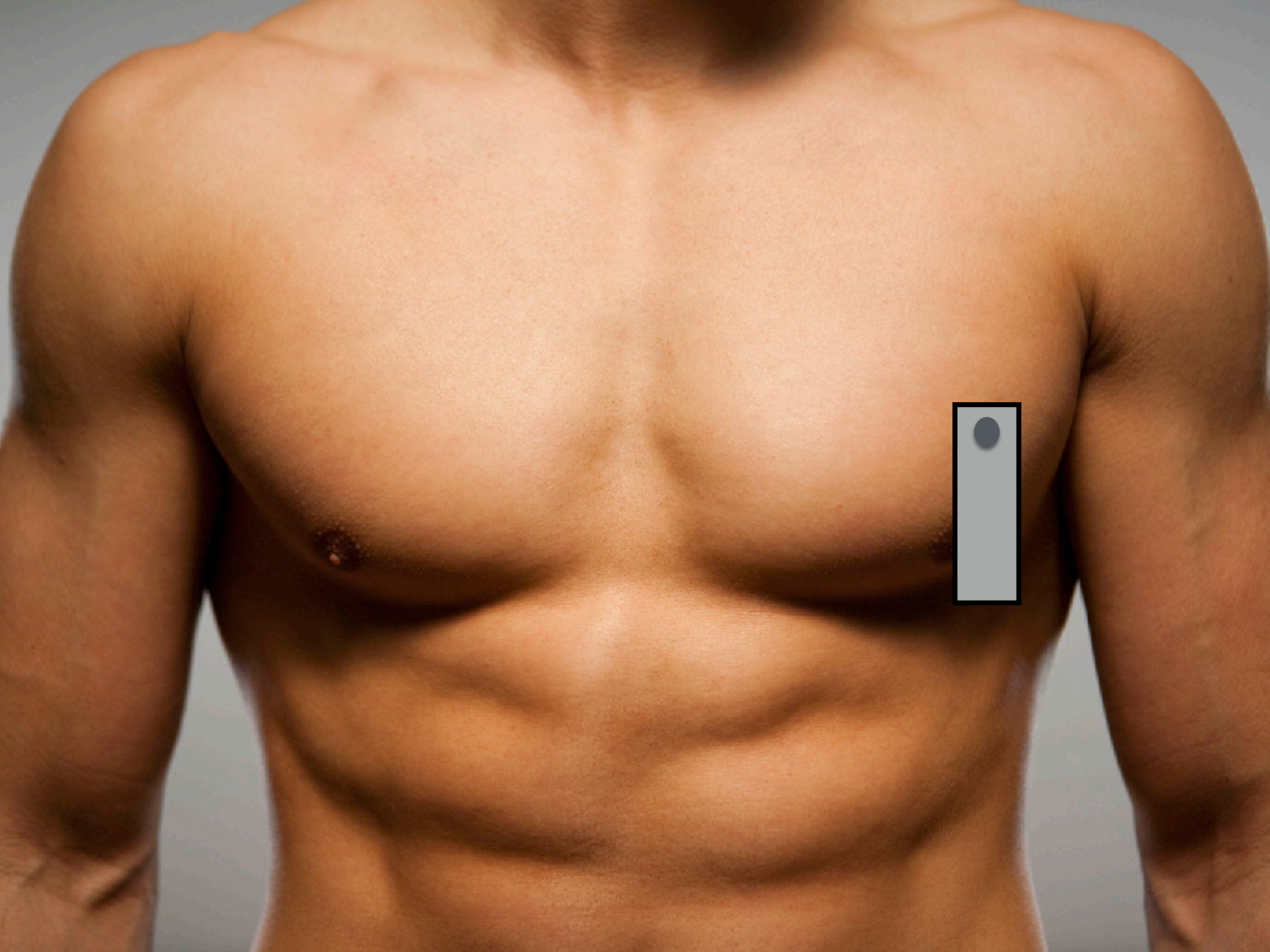
Study (first author)	n	US sensitivity/specificity (%)	Ultrasound LR+/LR-	Gold standard	Sonographer type
Lichtenstein ³	32	93/100	Undefined/0.07	CT	Experienced intensivist
Lichtenstein ⁷	118	90/98	45/0.1	CT	Experienced intensivists
Lichtenstein ⁶	260	89/94	15/0.12	Final clinical diagnosis	Experienced intensivists
Xirouchaki ²²	42	100/78	4.5/0	CT	Experienced intensivist
Cortarello ⁴	81 (pneumonia)	98/95	20/0.021	Final clinical diagnosis	Experienced EP
Chavez ⁷⁰	1172 (pneumonia)	94/96	24/0.063	CXR, CT or clinical criteria (meta-analysis)	Meta-analysis varied
Nazerian ⁷¹	285	83/96	21/0.18	CT	Experienced EP or internist
Llamas-Álvarez ⁴¹	2359	80–90/70–90	Not calculated	Meta-analysis	Meta-analysis varied

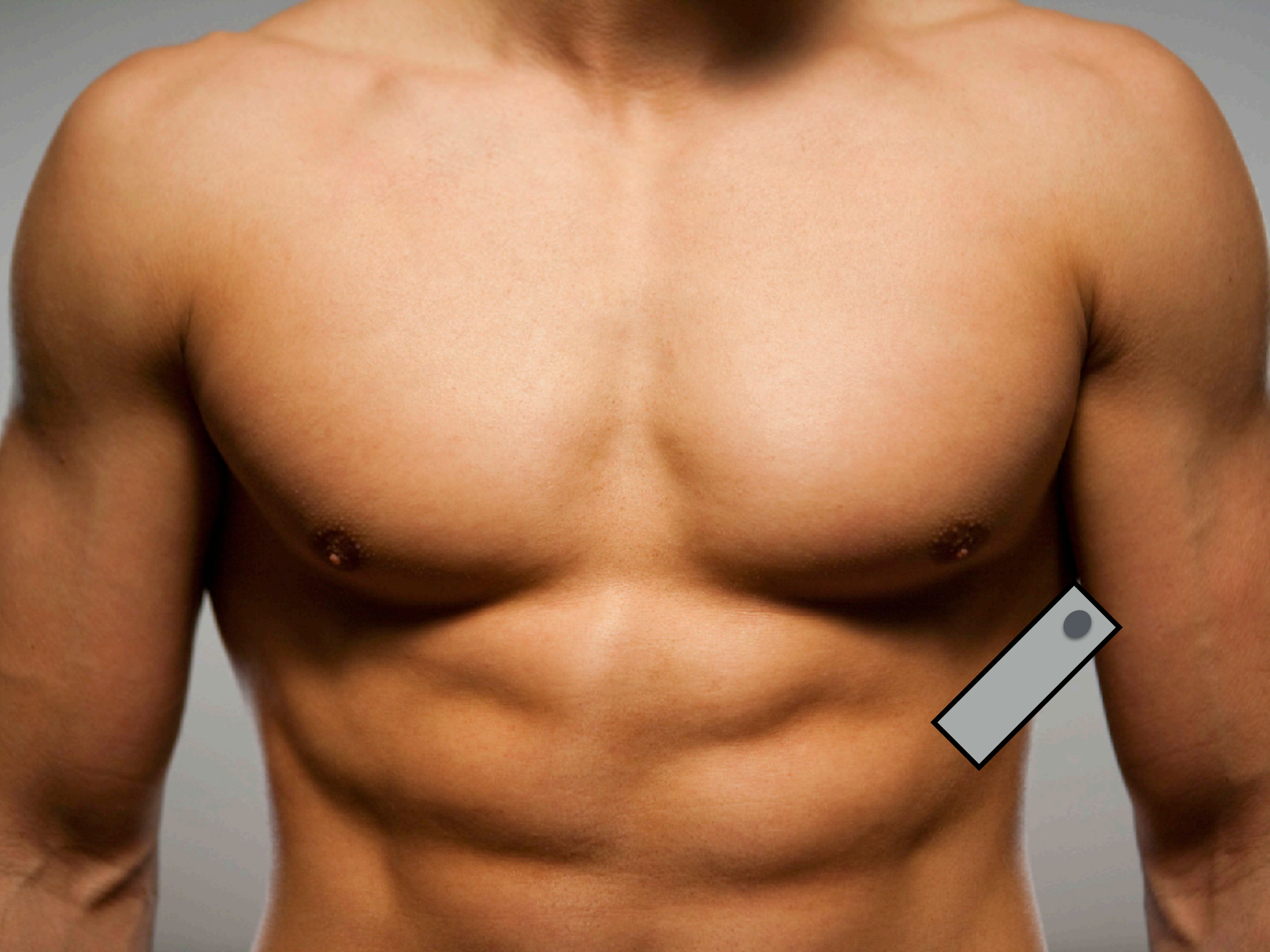






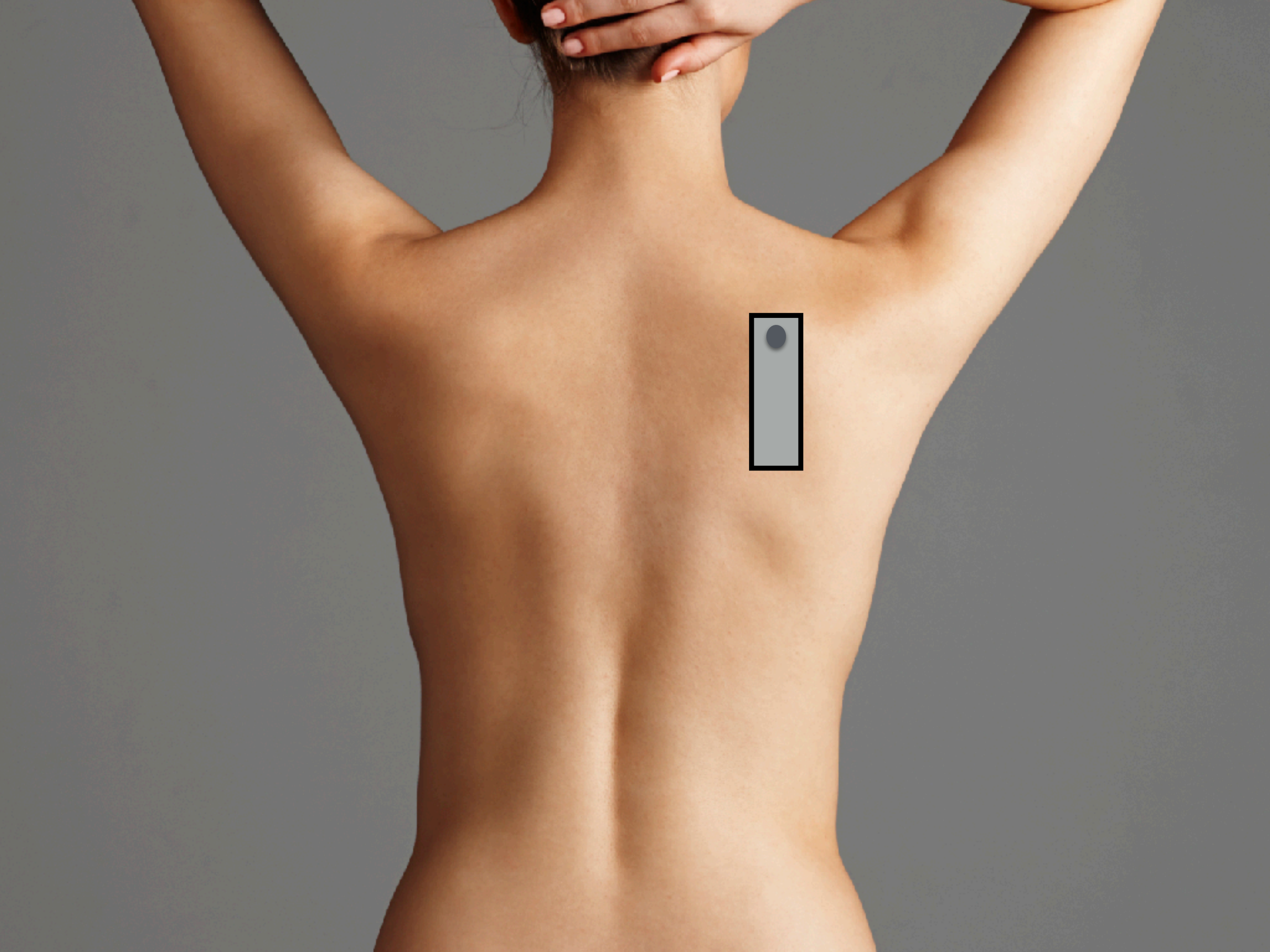


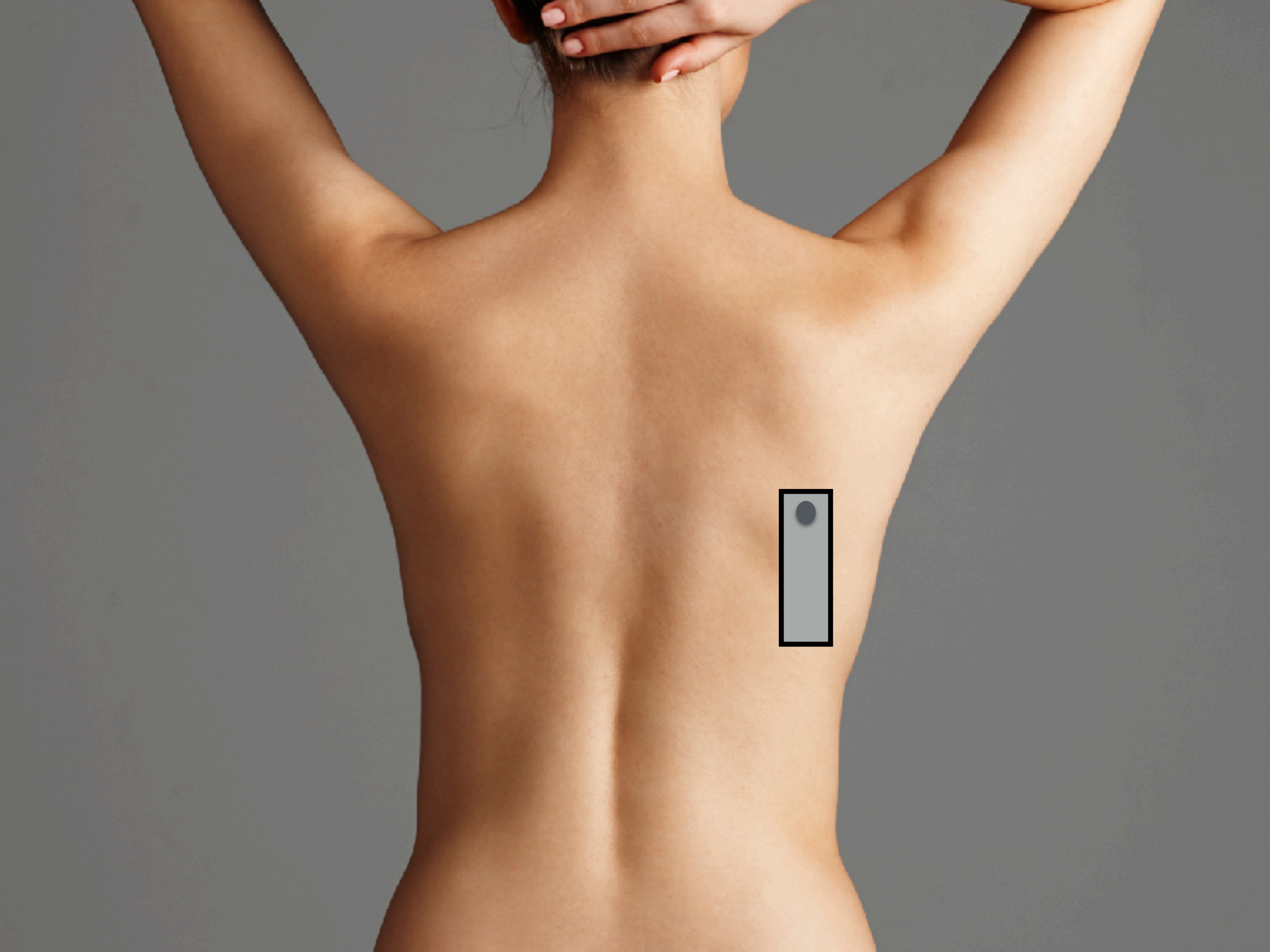












C profile

Abd Gen
C5-1
45 Hz
10.0cm

2D

HGen
Gn 85
C 56
3 / 3 / 3

P

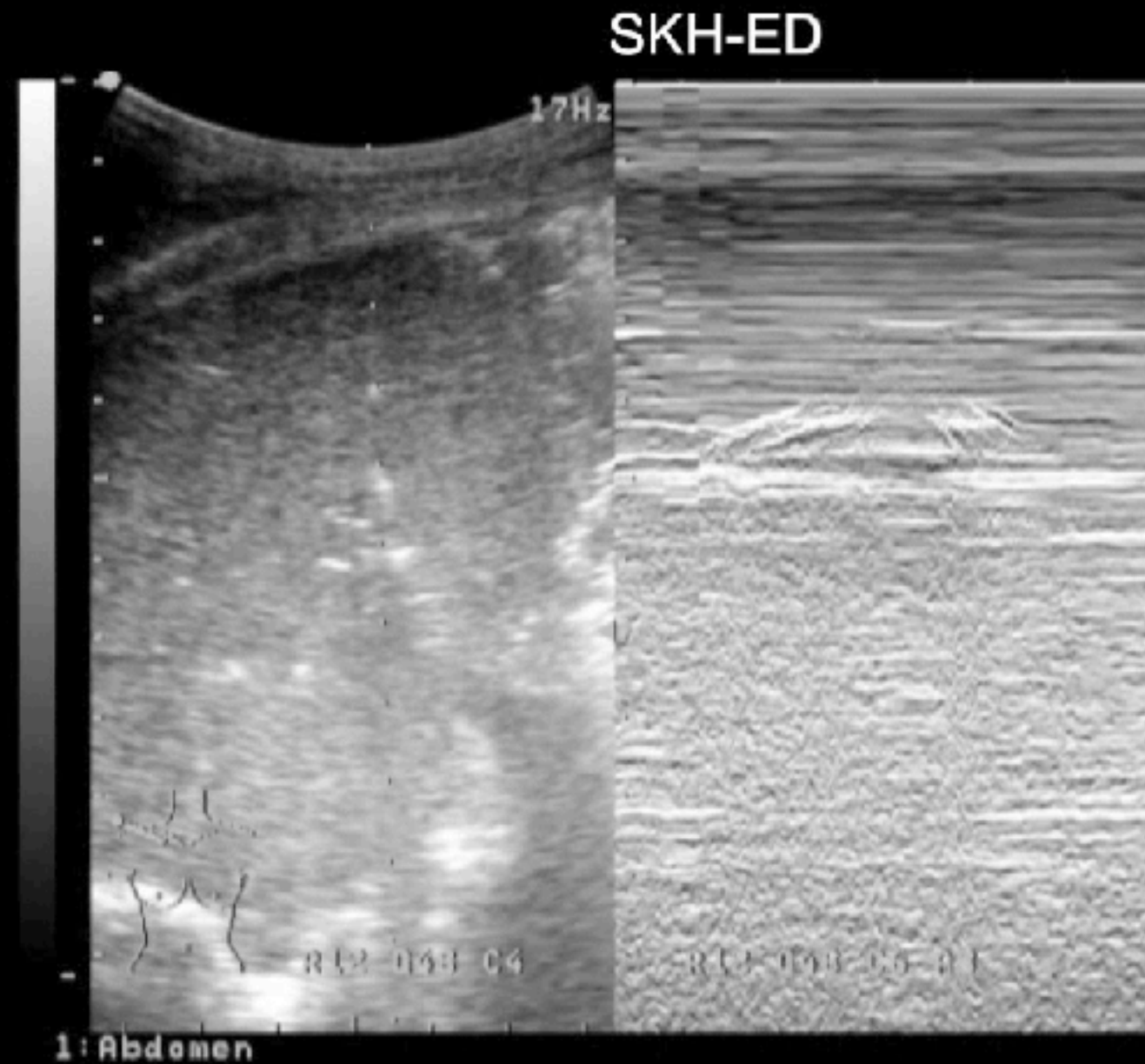
Tissue-like

Air-bronchogram

10.0cm

5

Dynamic air-bronchogram



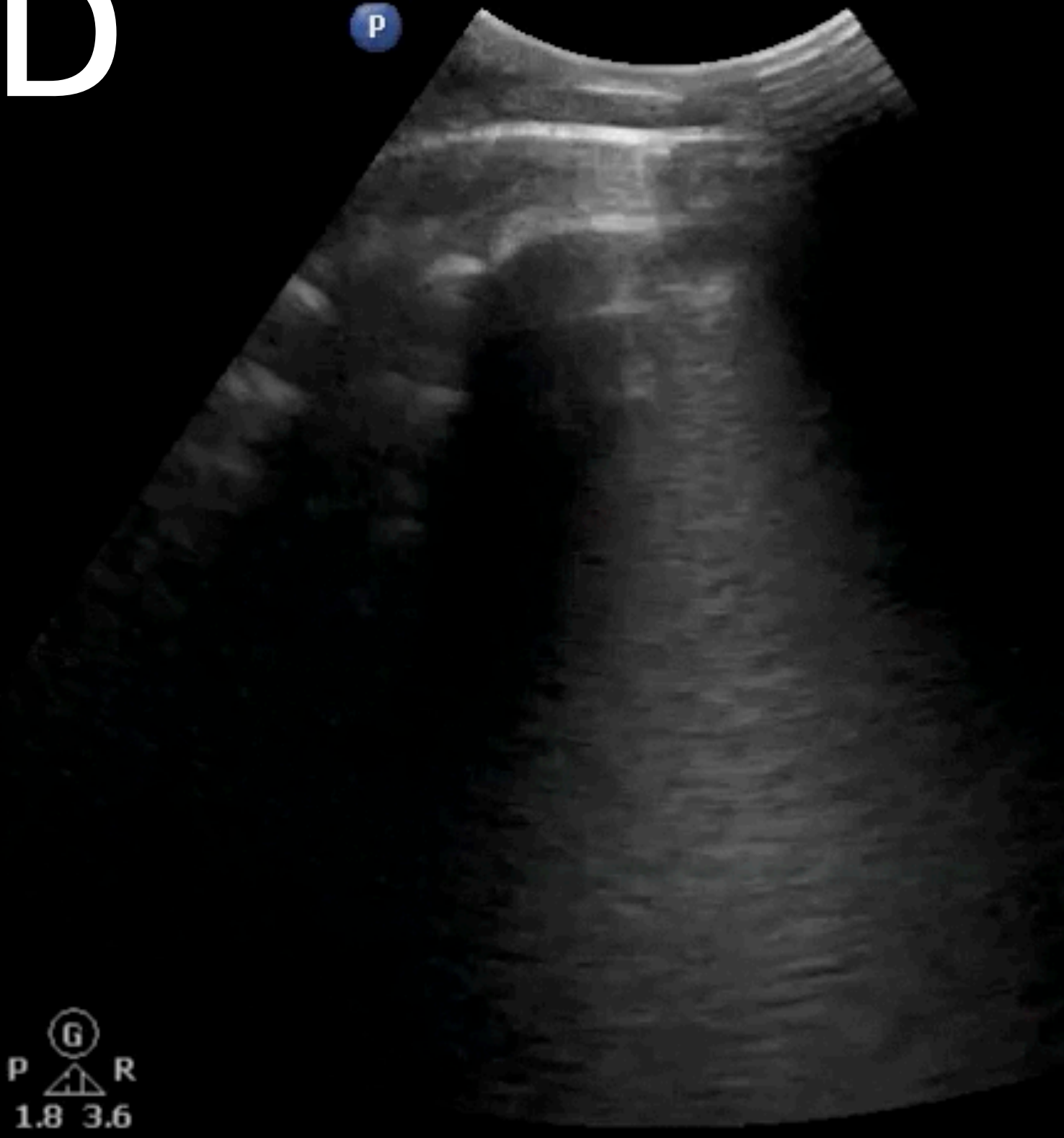
ABCD

Abd Gen
C5-1
34 Hz
15.0cm

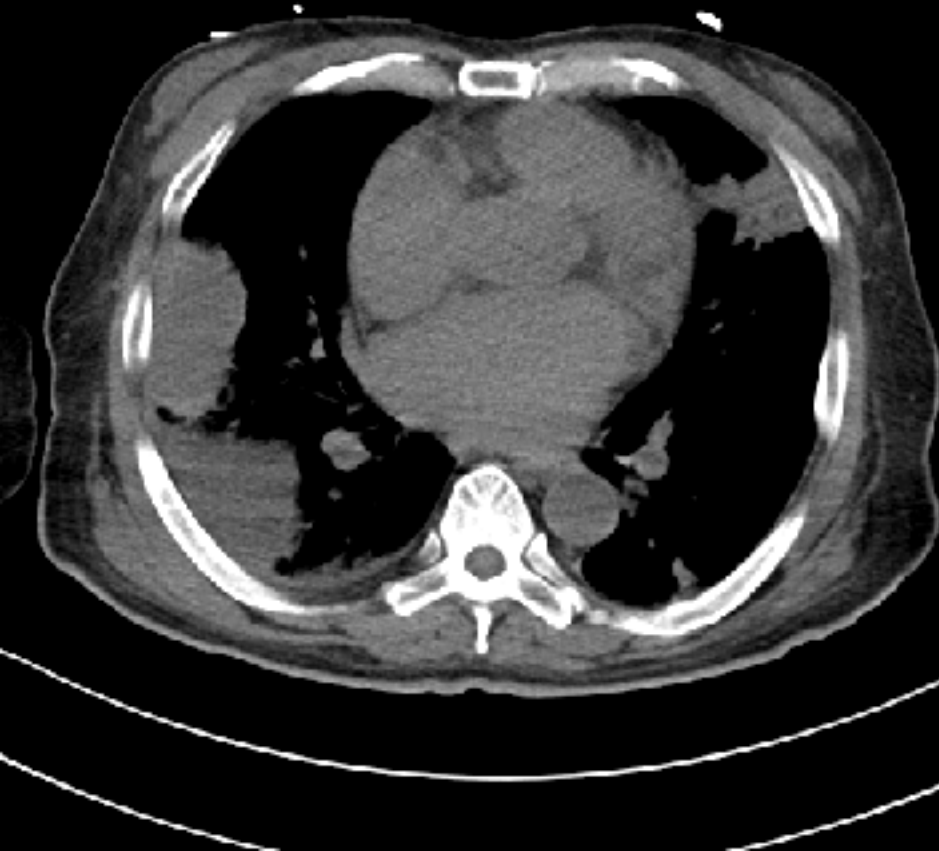
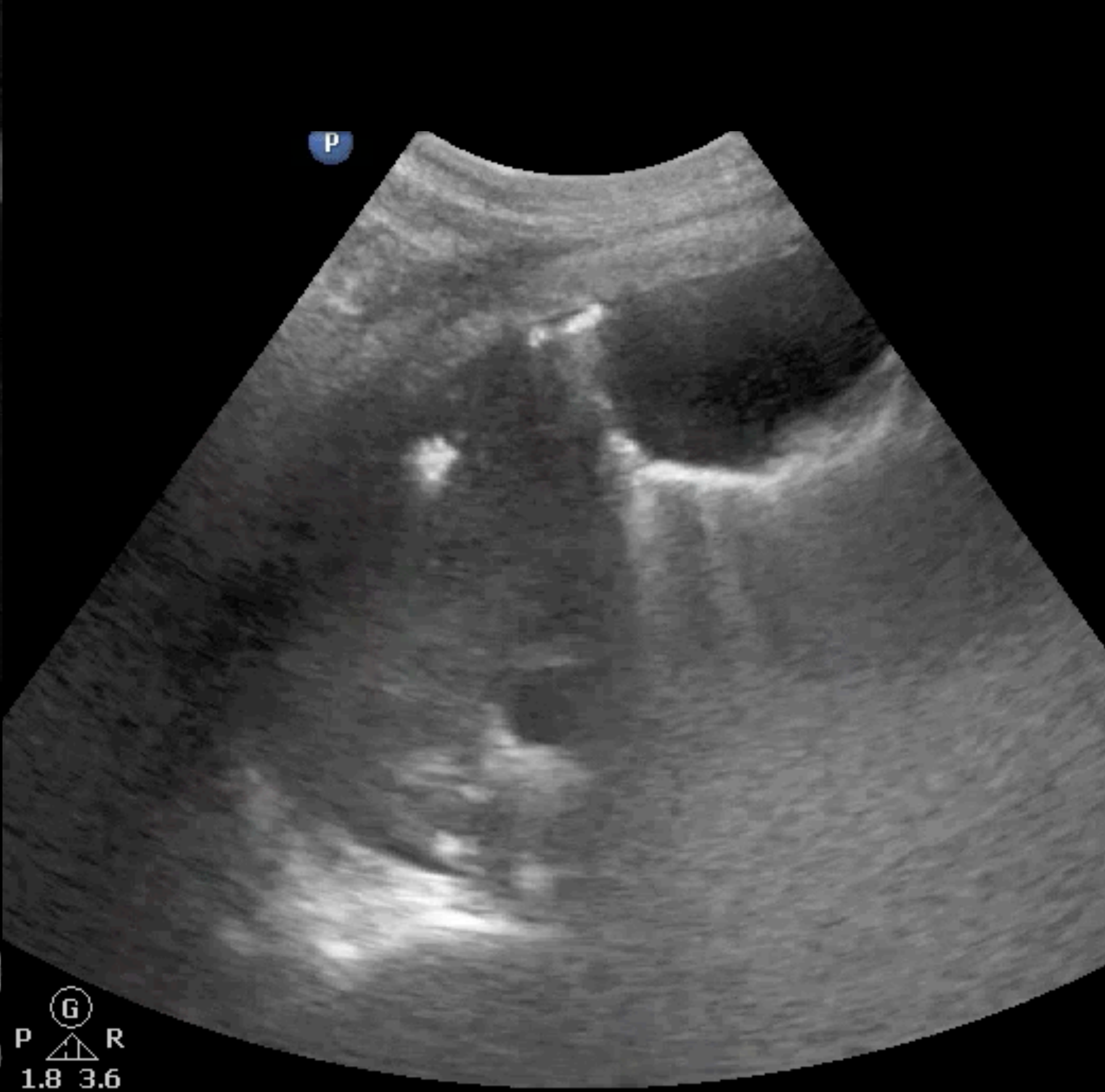
P

SKHER

2D
HGen
Gn 89
C 56
3/3/3



15.0cm



Ⓞ
P ▲ R
1.8 3.6

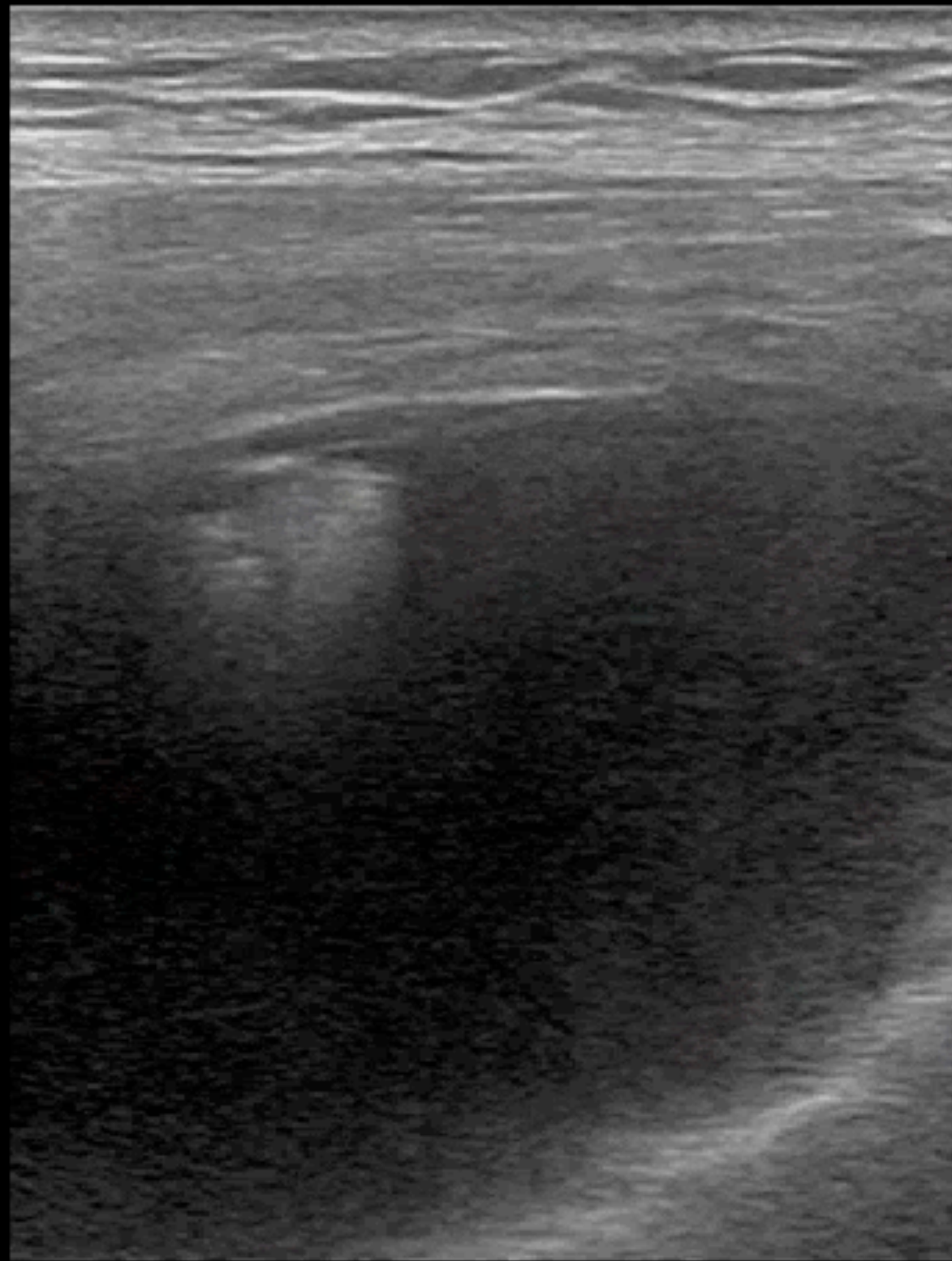
Superficial
L12-3
41 Hz
5.0cm

P

2D
Res
Gn 100
C 56
3/2/1



G
P R
3.0 12.0



2

4

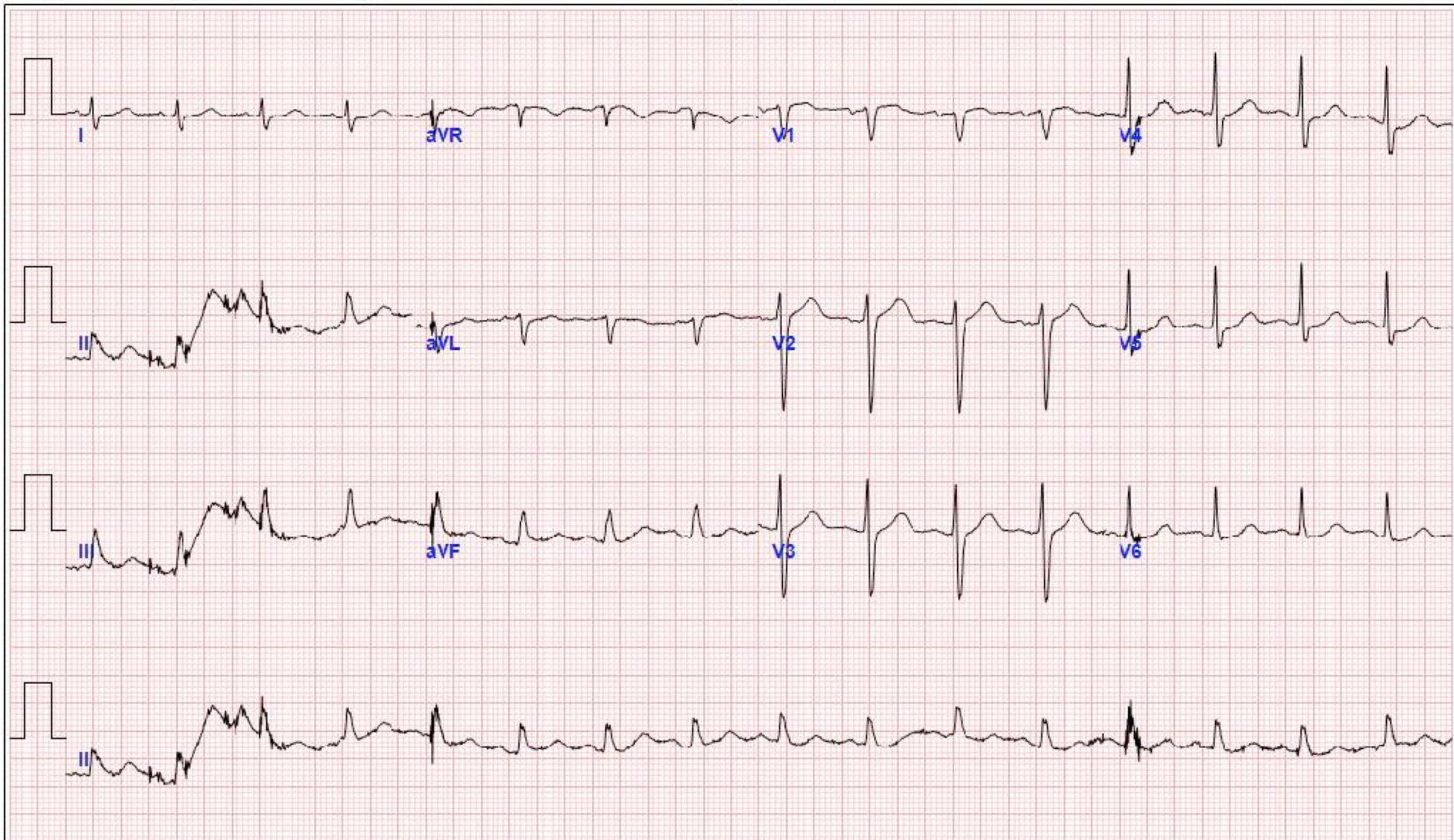
5.0cm

76M, Dyspnea & desaturation



76M, Dyspnea & desaturation

Sex	M	QT/QTc	380/400 ms	Prolonged QT.
Study Date	2017/10/15 22:12:14	P-R-T axes	19,93,51	Abnormal ECG.



25 mm/sec 10 mm/mv

76M, Dyspnea & desaturation

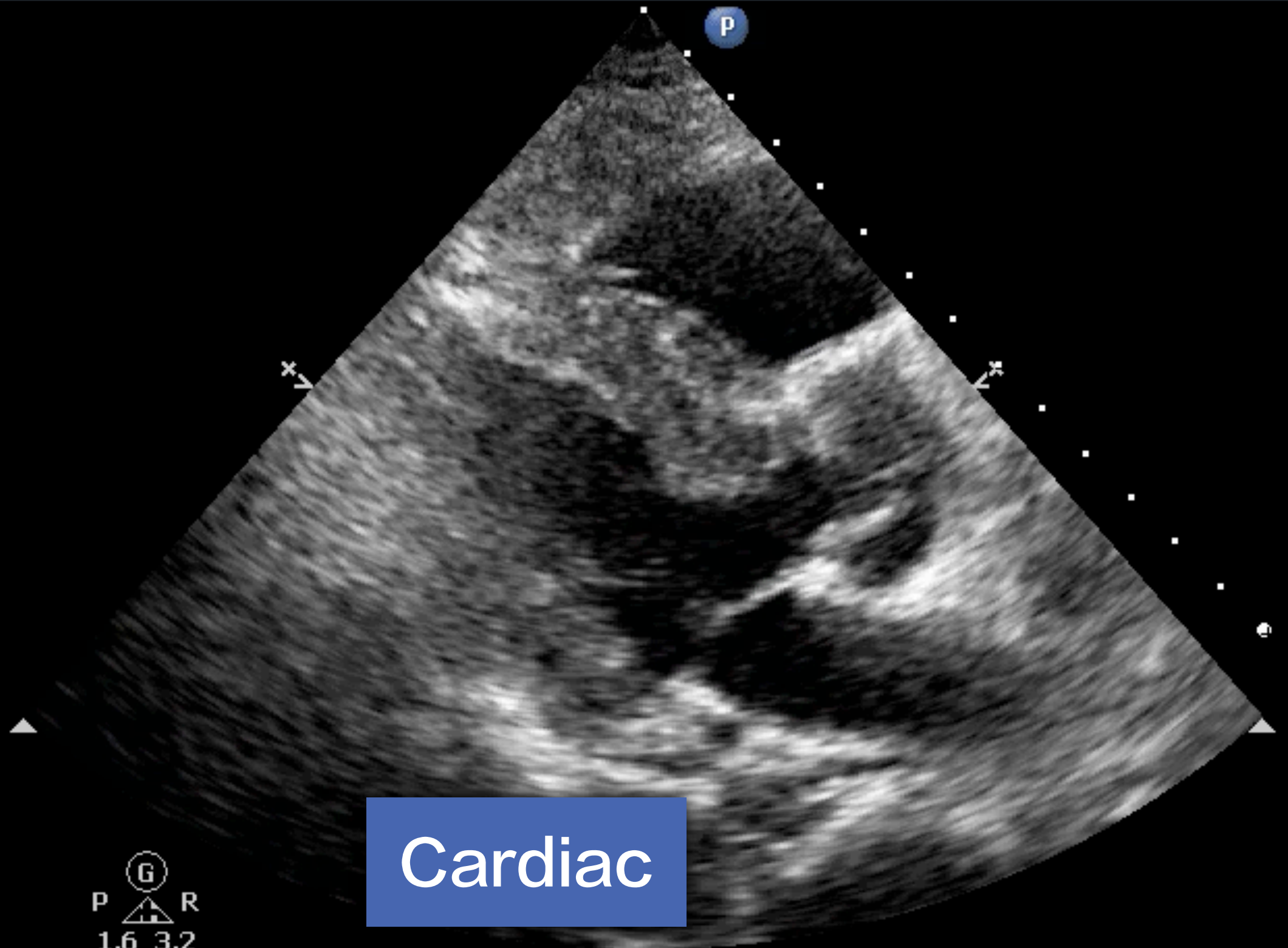


Lung

76M, Dyspnea & desaturation

Adult Echo2
S5-1
34 Hz
15.0cm

2D
HGen
Gn 9
C 50
3/2/0



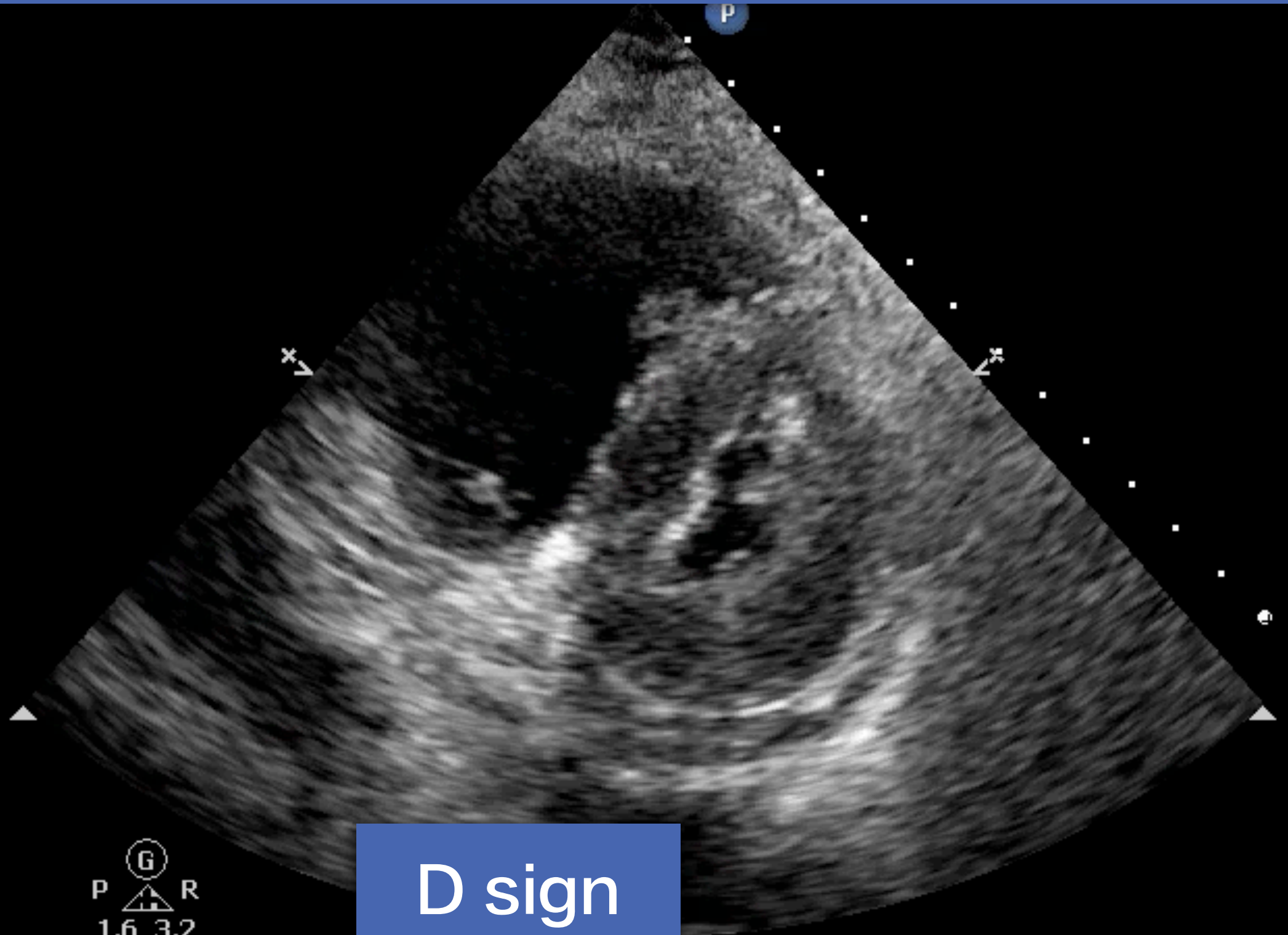
Cardiac

G
P R
1.6 3.2

76M, Dyspnea & desaturation

Adult Echo2
S5-1
34 Hz
15.0cm

2D
HGen
Gn 9
C 50
3/2/0



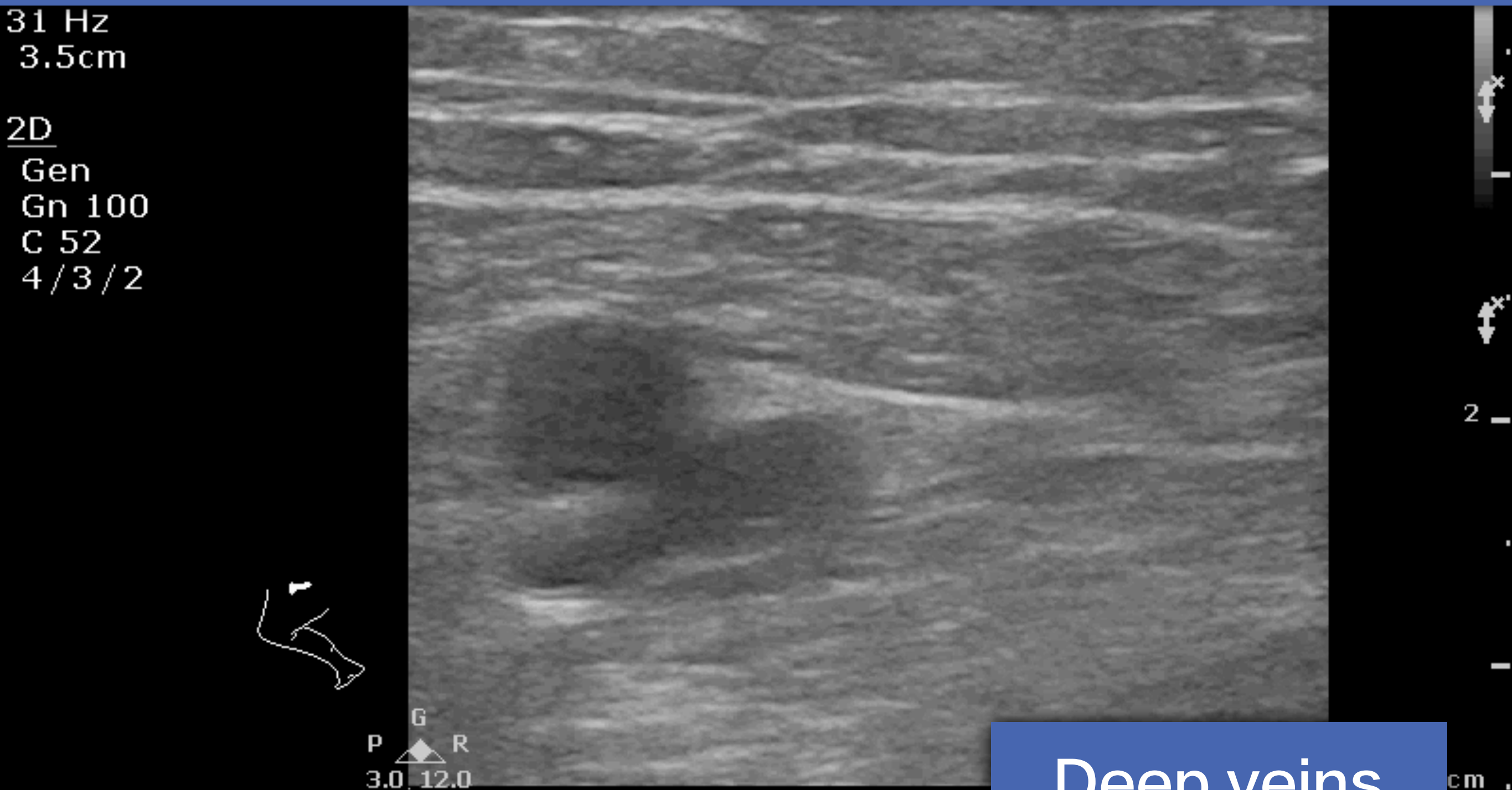
D sign

G
P R
1.6 3.2

Pulmonary embolism



Pulmonary embolism



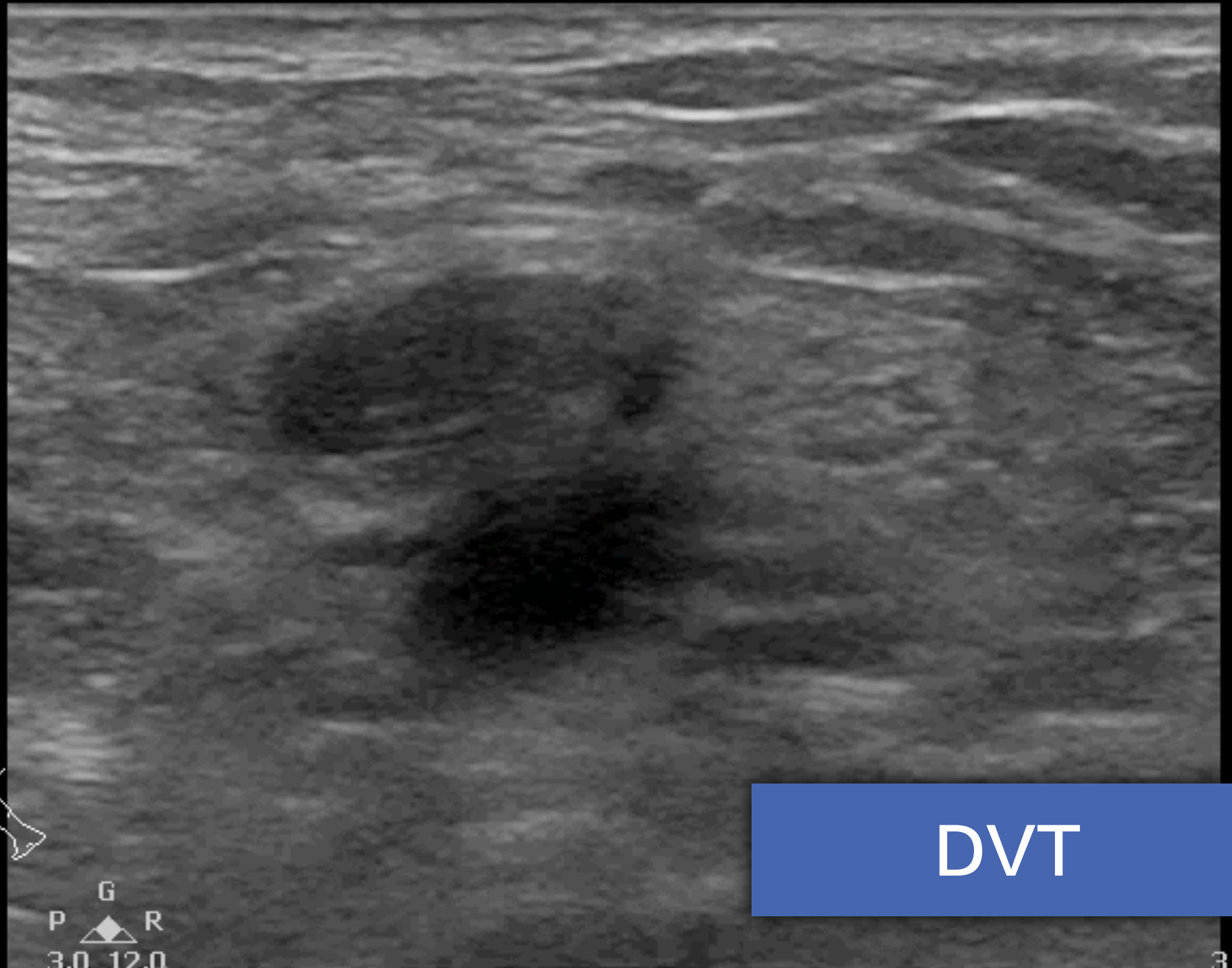
Pulmonary embolism

Superficial
L12-3
31 Hz
3.0cm

P

2D

Gen
Gn 88
C 52
4/3/2



2



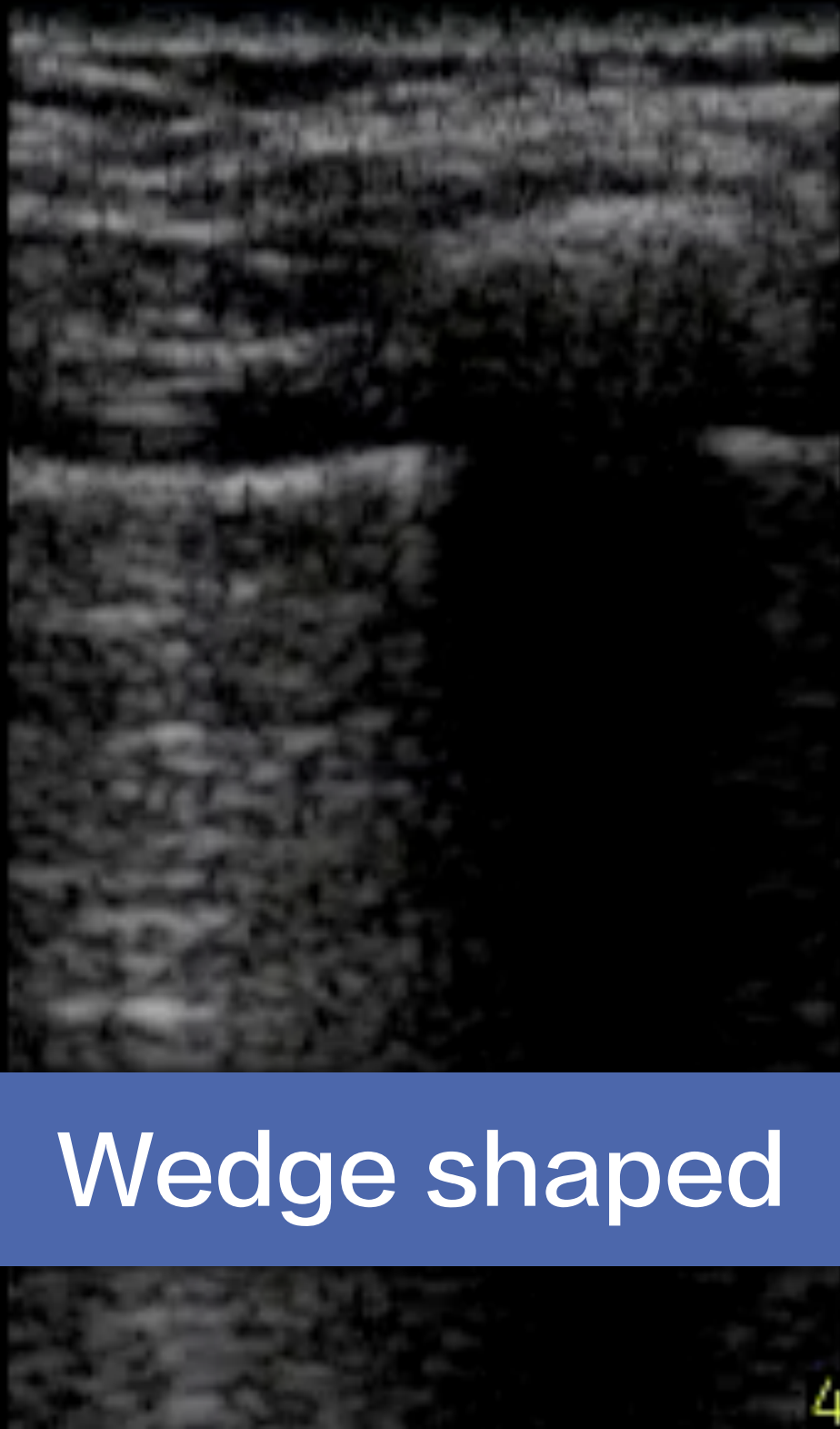
P G R
3.0 12.0

DVT

3.0cm

Pulmonary infarction

#: 38 2:52:50 PM
MI: 0.6 TI: 0.2 28/Mar/2015



4.9cm

#: 38 2:51:43 PM
MI: 0.6 TI: 0.2 28/Mar/2015



4.9cm

Wedge shaped

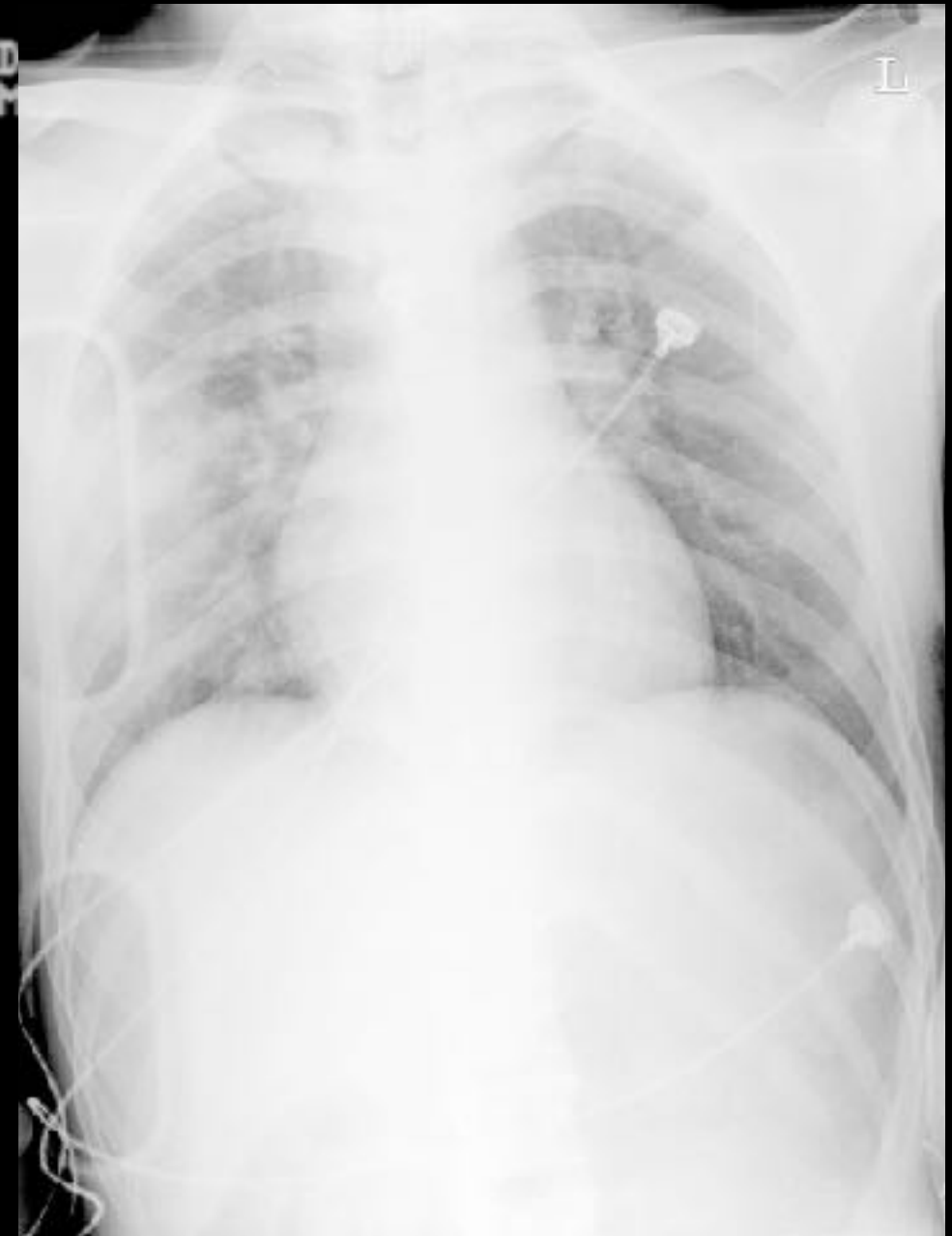
過來人的建議



呼吸喘看肺—心—靜

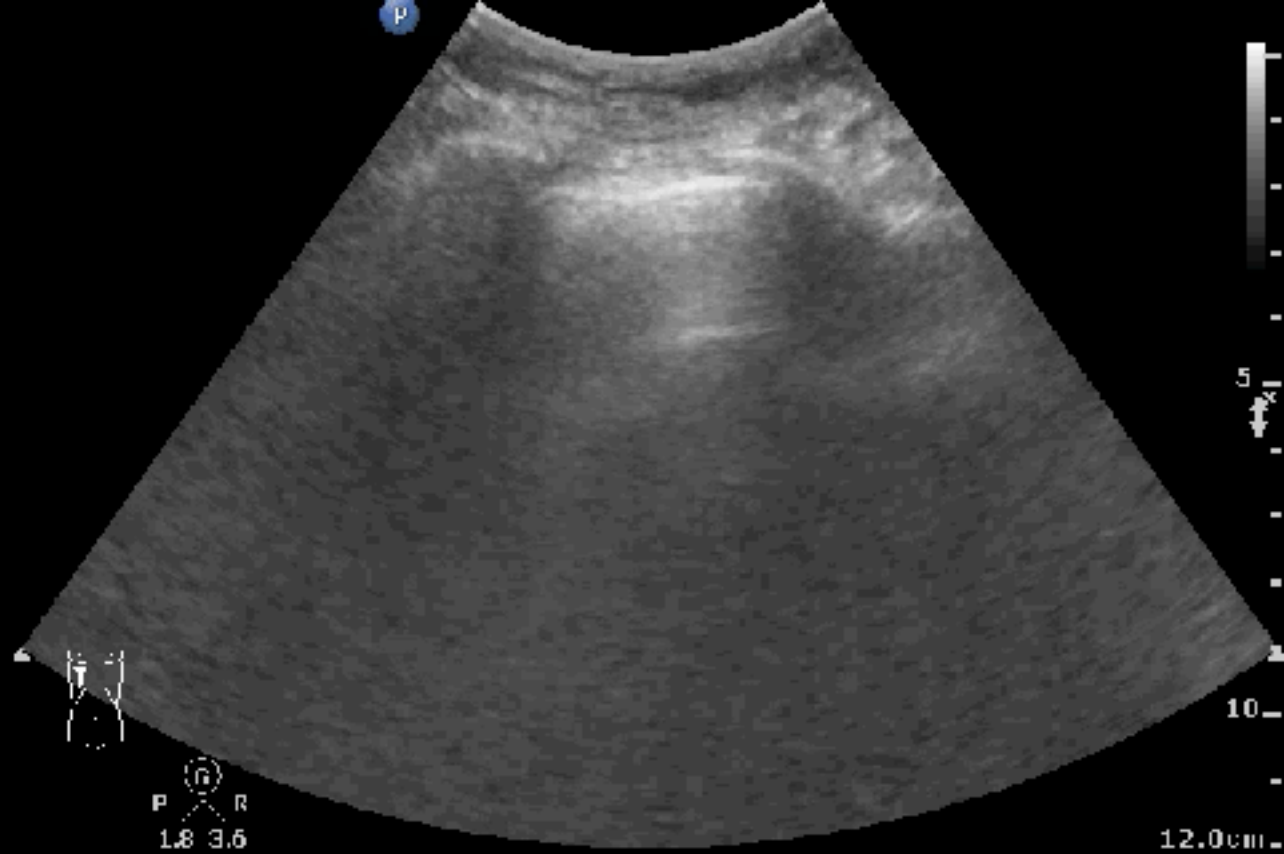
肺栓塞看靜—心—肺

18M, MBA Victim

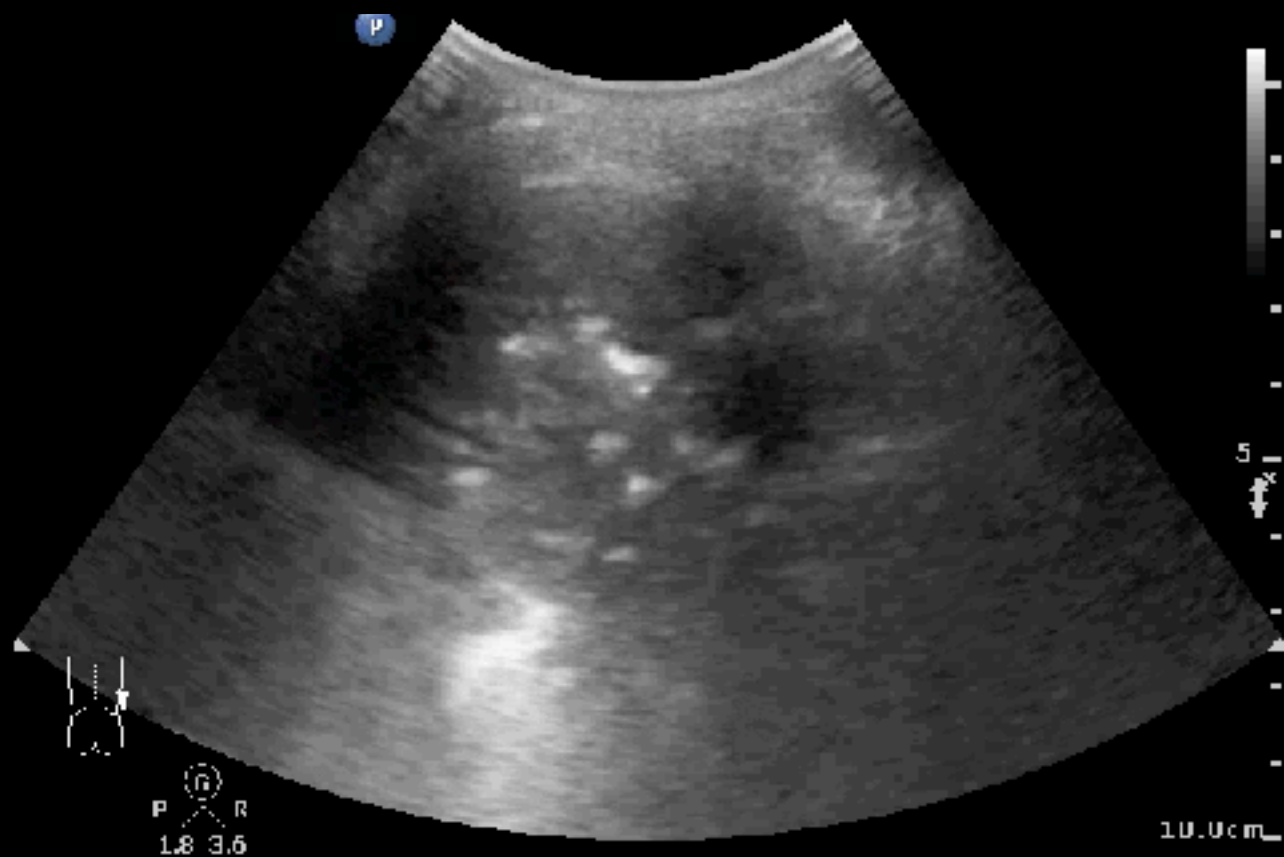


Back !!!

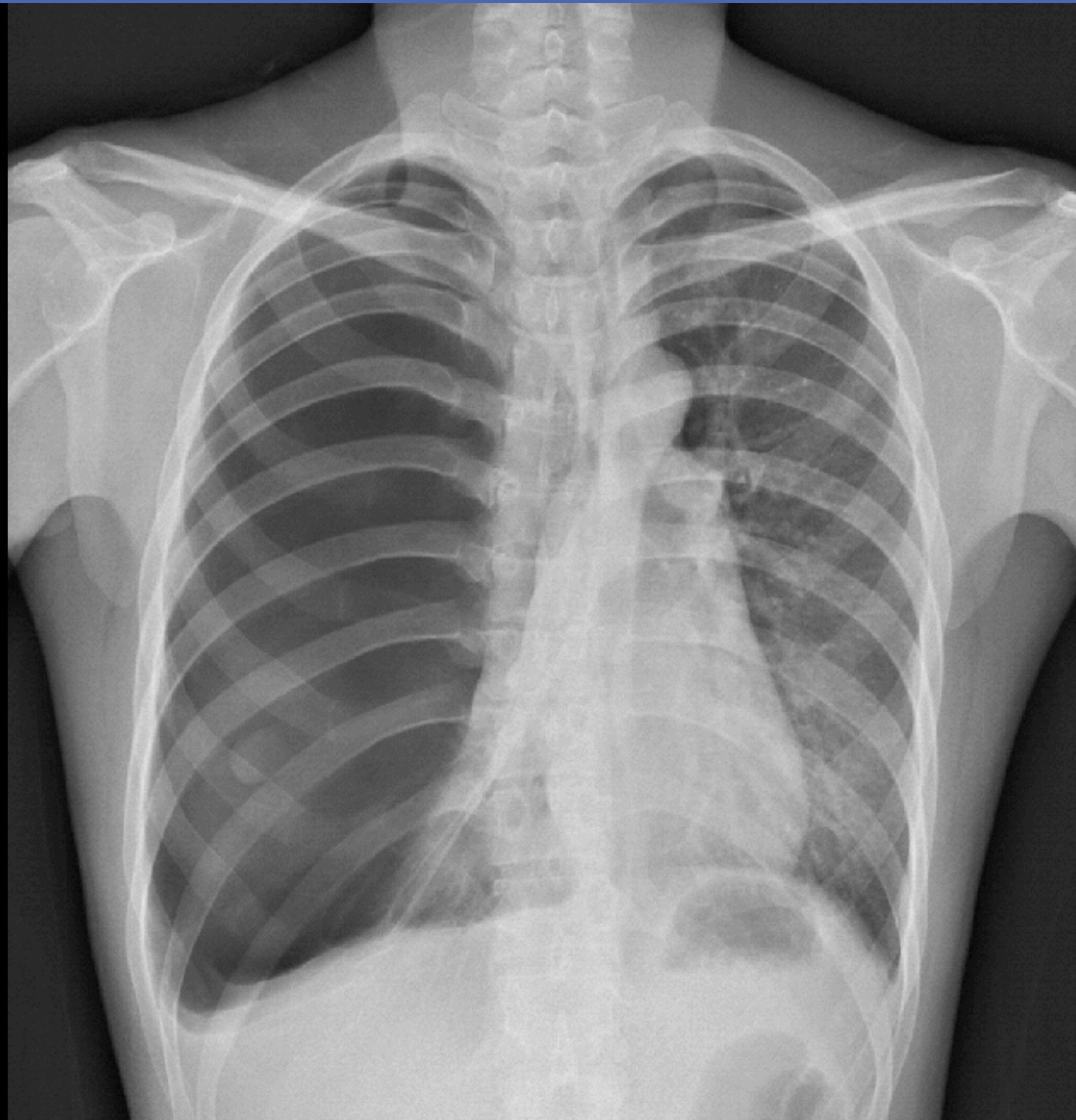
Abd Gen2
C5-1
39 Hz
12.0cm
2D
HGen
Gn 100
C 56
3/3/3

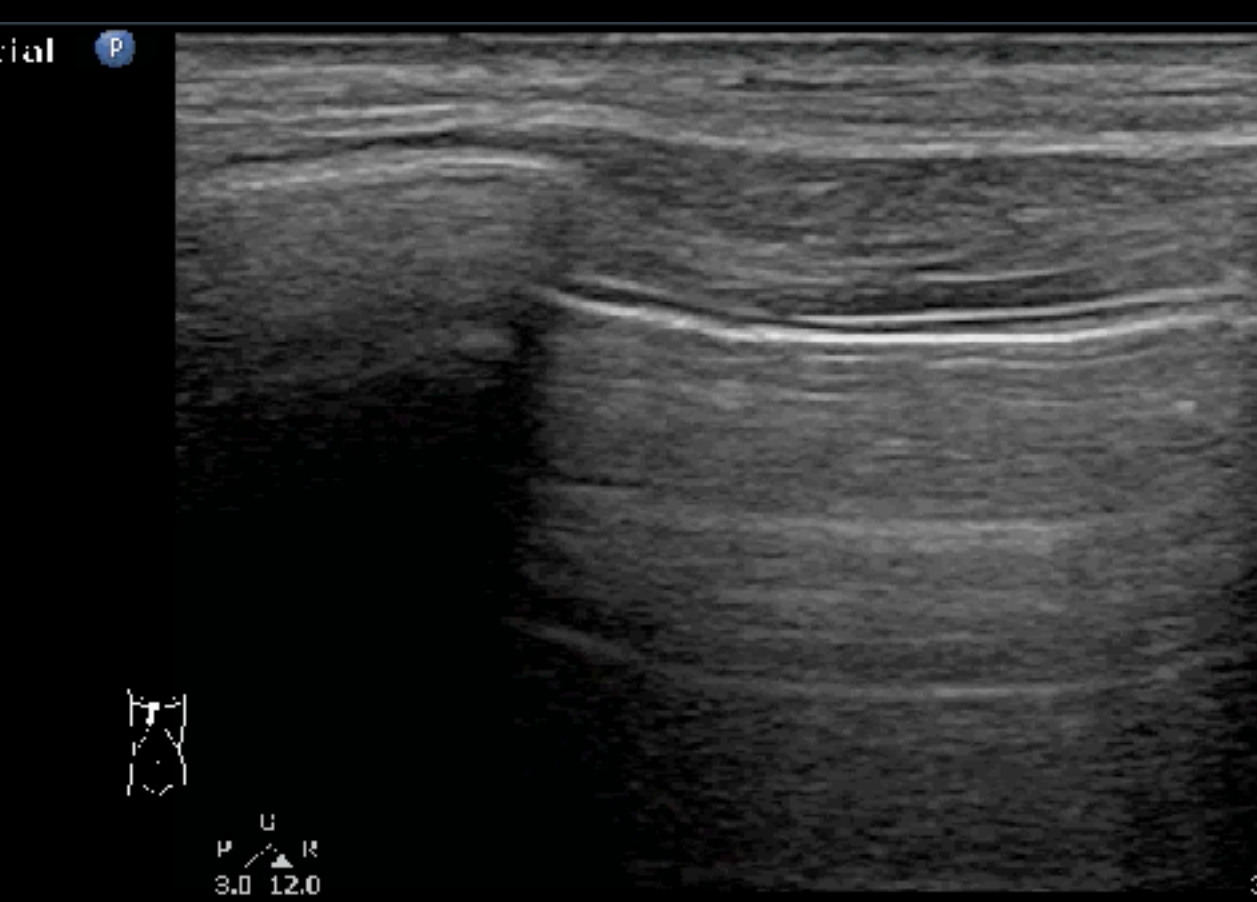
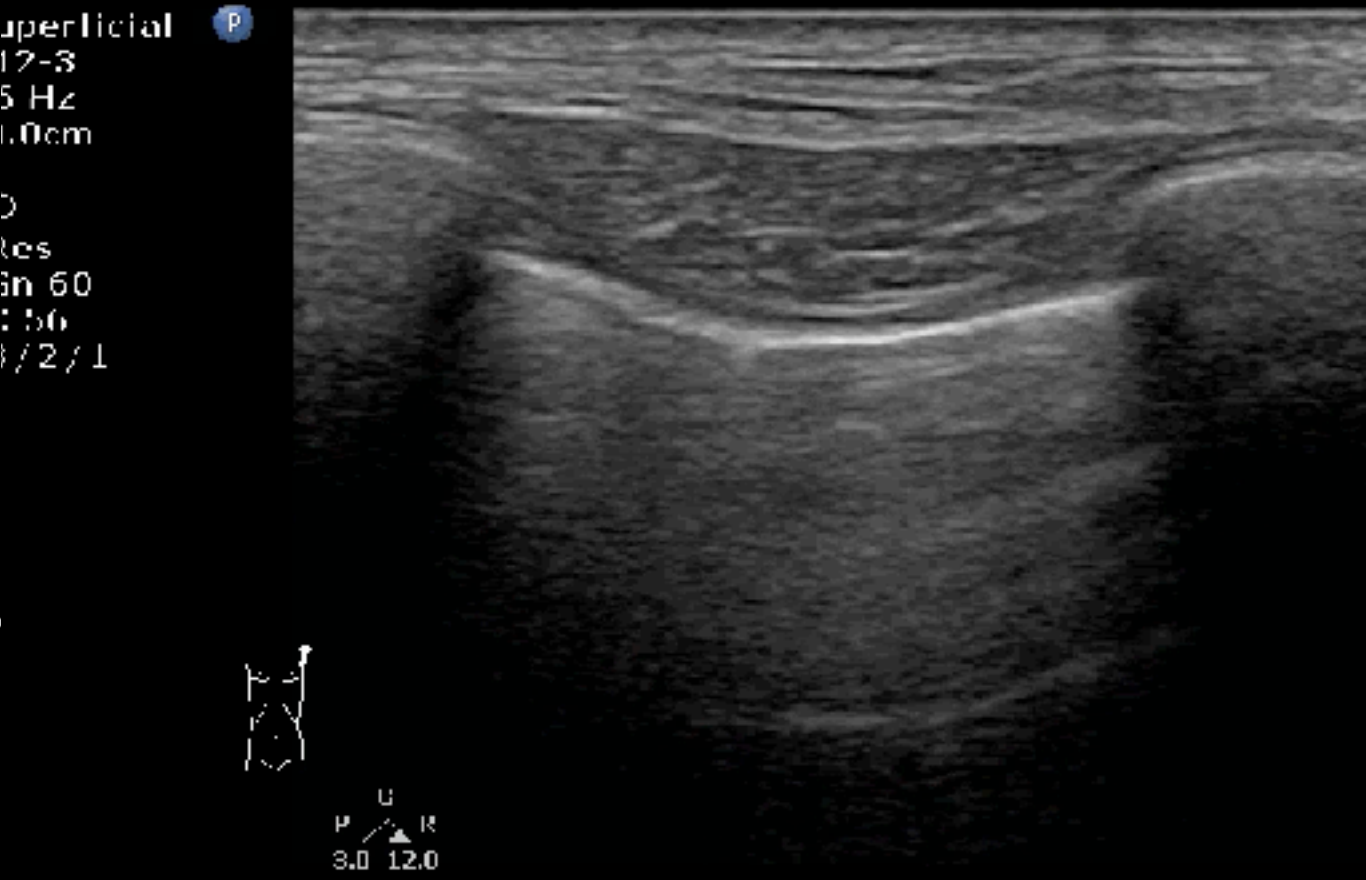
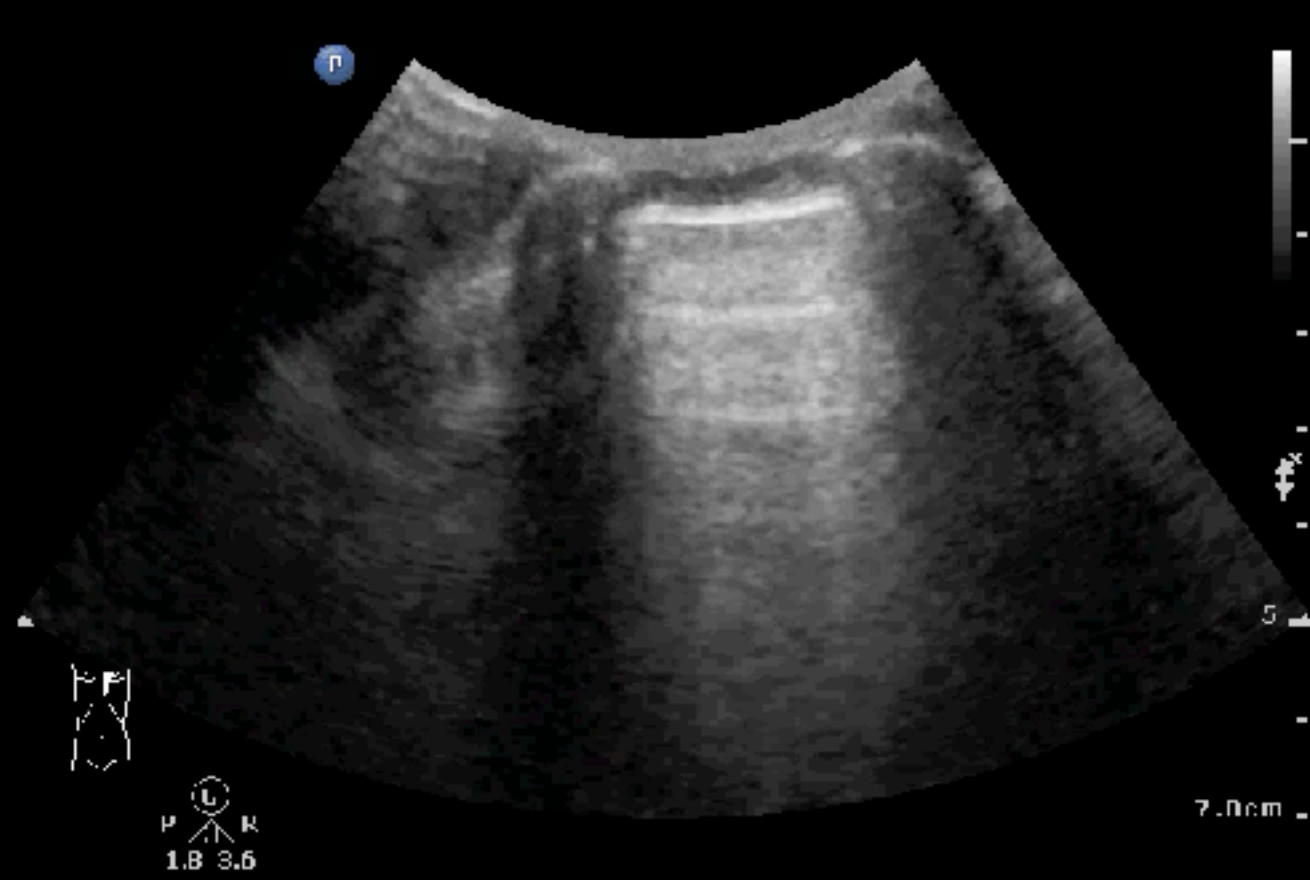


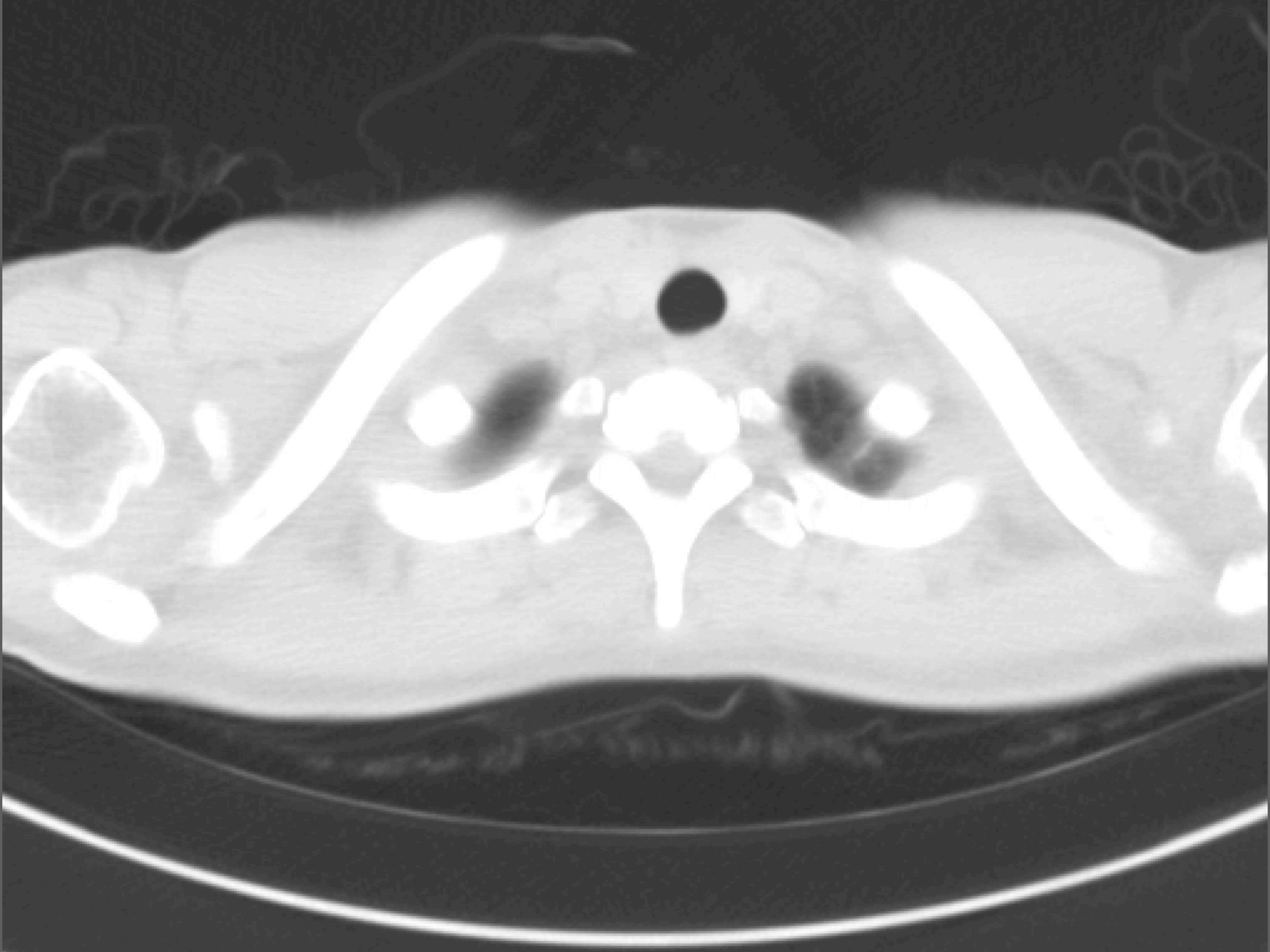
Abd Gen2
C5-1
39 Hz
12.0cm
2D
HGen
Gn 100
C 56
3/3/3



30F, CS referred for pigtail



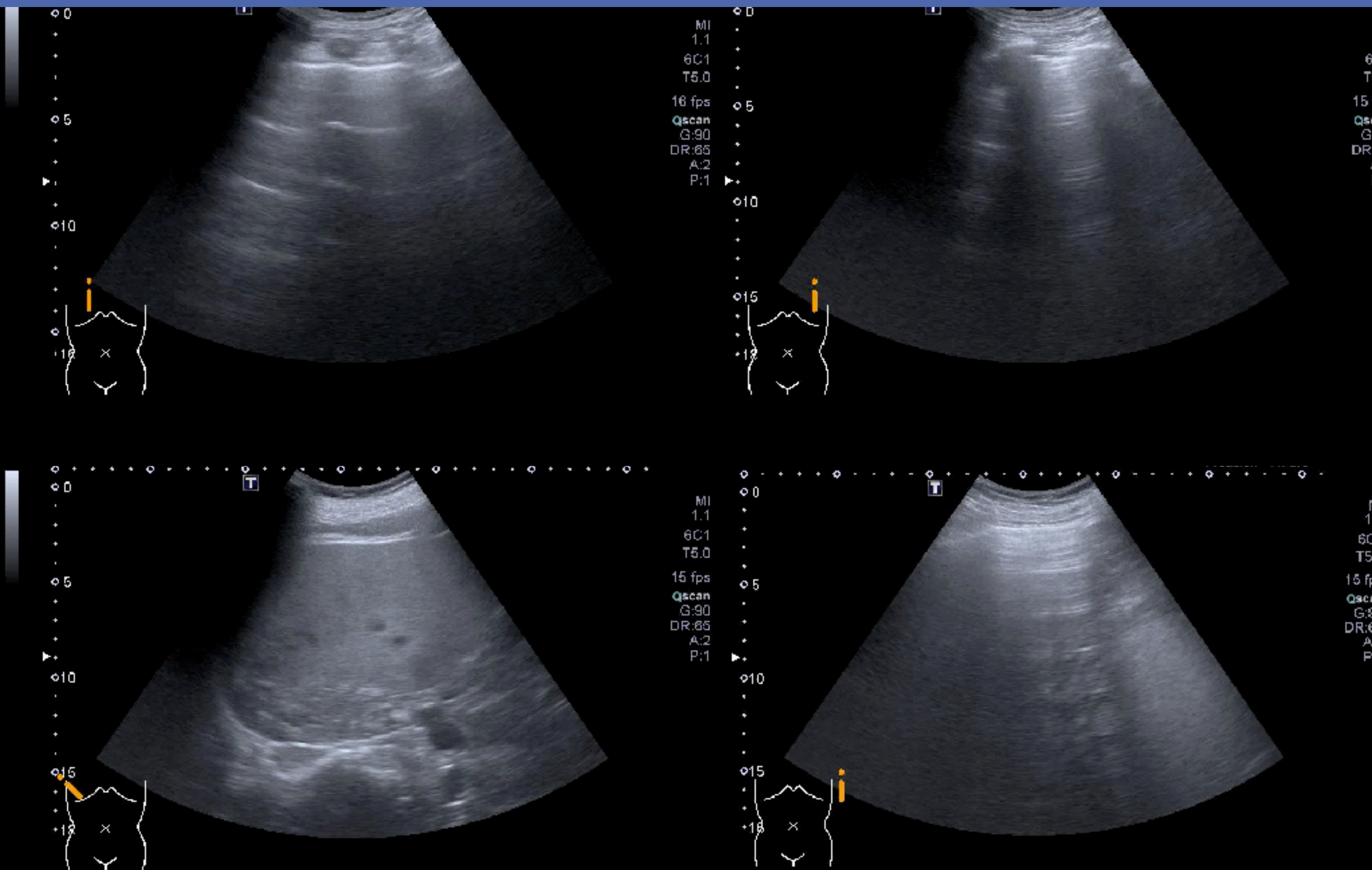




67M, left upper chest pain



54M, COPD & CHF, Dyspnea



Indication

- Respiratory symptoms and/or signs
- Unclear chest radiograph findings
- Monitoring and prognosis

- History
- Physical examination
- ABG
- ECG

← Pretest probability

Acquisition

DIAGNOSTIC HYPOTHESIS			
	Pleural effusion suspected	PTX suspected	Increased lung density suspected
Patient position Probe selection & orientation Protocol selection Picture optimization	<ul style="list-style-type: none"> • Semisitting (or supine) • Low-frequency probe • Maintain postprocessing artifacts reduction algorithms • Start examination from lung bases; identify diaphragm and spine 	<ul style="list-style-type: none"> • Ideally supine • If possible, high-frequency probe • Consider M-mode and Power Doppler • Identify least dependent zone 	<ul style="list-style-type: none"> • Semisitting or supine • Low-frequency and high-frequency probes • If B-line pattern analysis, deactivate post-processing artifacts reduction algorithms • Complete lung examination (anterior, lateral, and posterior surfaces, bilaterally)

Interpretation

PLEURAL LINE INTERFACE

Fluid

Pleural effusion/Hemothorax

- Size
- Fluid characteristics

A-line Pattern

Lung sliding? YES

Lung pulse? YES

Vertical artifact? YES

PTX likely

Lung point? YES

PTX highly likely

Normal lung density at pleural line

Consider:

- PEEP effect/lung overinflation
- Lung pathology not reaching pleural line
- Early stages of lung pathology
- Performance of further tests

Diagnostic Nondiagnostic

Increased Lung Density

- Increased lung weight (water, cells, pus, blood, proteins, connective tissue, lipids) and/or
- Lung deflation

B-line Pattern

Diffuse	Focal
Sonographic findings that may help in differential diagnosis	
<ul style="list-style-type: none"> • B-lines distribution (homogeneous/nonhomogeneous distribution) • B-lines "density" (B1 pattern; B2 pattern) • Decreased lung sliding • Decreased/increased lung pulse • Gravity-dependent or -independent pattern • Presence/absence of pleural line abnormalities • Presence/absence of subpleural abnormalities (e.g., focal consolidations) 	

Solid

Large area of lung consolidation	Small subpleural consolidation
Sonographic findings that may help in differential diagnosis	
<ul style="list-style-type: none"> • Distribution • Detection of air bronchogram(s) • Detection of fluid bronchogram(s) • Vascular pattern within the consolidation 	

Interpretation

PLEURAL LINE INTERFACE

Fluid
Pleural effusion/ Hemothorax
 • Size
 • Fluid characteristics

A-line Pattern

Lung sliding? YES
 NO
 Lung pulse? YES
 NO
 Vertical artifact? YES
 NO

PTX likely
 Lung point? YES
 PTX highly likely

Normal lung density at pleural line
Consider:
 • PEEP effect/lung overinflation
 • Lung pathology not reaching pleural line
 • Early stages of lung pathology
 • Performance of further tests

Diagnostic Nondiagnostic

Increased Lung Density
 • Increased lung weight (water, cells, pus, blood, proteins, connective tissue, lipids) and/or
 • Lung deflation

B-line Pattern

Diffuse	Focal
Sonographic findings that may help in differential diagnosis • B-lines distribution (homogeneous/nonhomogeneous distribution) • B-lines "density" (B1 pattern; B2 pattern) • Decreased lung sliding • Decreased/increased lung pulse • Gravity-dependent or -independent pattern • Presence/absence of pleural line abnormalities • Presence/absence of subpleural abnormalities (e.g., focal consolidations)	

Solid

Large area of lung consolidation	Small subpleural consolidation
Sonographic findings that may help in differential diagnosis • Distribution • Detection of air bronchogram(s) • Detection of fluid bronchogram(s) • Vascular pattern within the consolidation	

Differential diagnosis

• Transudate
 • Exudate
 • Hemothorax
 • Empyema

• PTX
 • Bullous disease
 • Lung overinflation (e.g., COPD, mechanical ventilation)
 • Pleural adhesions
 • Bronchial obstruction

AIR CONTENT ↑

- Asthma exacerbation
- COPD exacerbation
- Pulmonary embolism
- Infectious/neoplastic process without pleural line involvement
- Lung overinflation (e.g., COPD, mechanical ventilation)
- Bronchial obstruction (early)
- Metabolic or neurologic causes

- Cardiogenic (hydrostatic) pulmonary edema
- Nonhydrostatic pulmonary edema (e.g., ARDS)
- Infection
- Pneumonitis
- Idiopathic interstitial pneumonias and other ILDs
- Alveolar hemorrhage
- Alveolar proteinosis
- Normal pattern (if isolated at lung bases)

- Lung consolidation
- Pulmonary infarct
- Pulmonary contusion
- Atelectasis (compression or obstruction)
- Primary lung cancer/tumor or metastasis

LUNG DENSITY →

Medical Decision-making

- Integration with clinical context (pretest probability)
- Consistency or inconsistency of findings with pretest diagnostic hypothesis
- LUS diagnostic or nondiagnostic
- Changes in diagnostic and therapeutic approach

LUS for critically ill patients

ARJCCM 2018

ACUTE RESPIRATORY FAILURE – DIFFERENTIAL DIAGNOSIS

Start with anterior fields examination

A-lines

B-lines[#]

Consolidations

No sliding

Sliding

Focal

Diffuse

Subpleural consolidations

Thin regular pleura
Normal sliding

Subpleural consolidation
Irregular and thickened pleura
Reduced sliding

Move to postero-lateral fields or other point-of-care ultrasound techniques

Lung point

Eventual consolidations

Subpleural consolidations
DVT+

Eventual consolidations

Eventual consolidation &
eventual pleural effusion

Eventual consolidation

Pneumothorax

COPD

Pulmonary
Embolism

Pneumonia

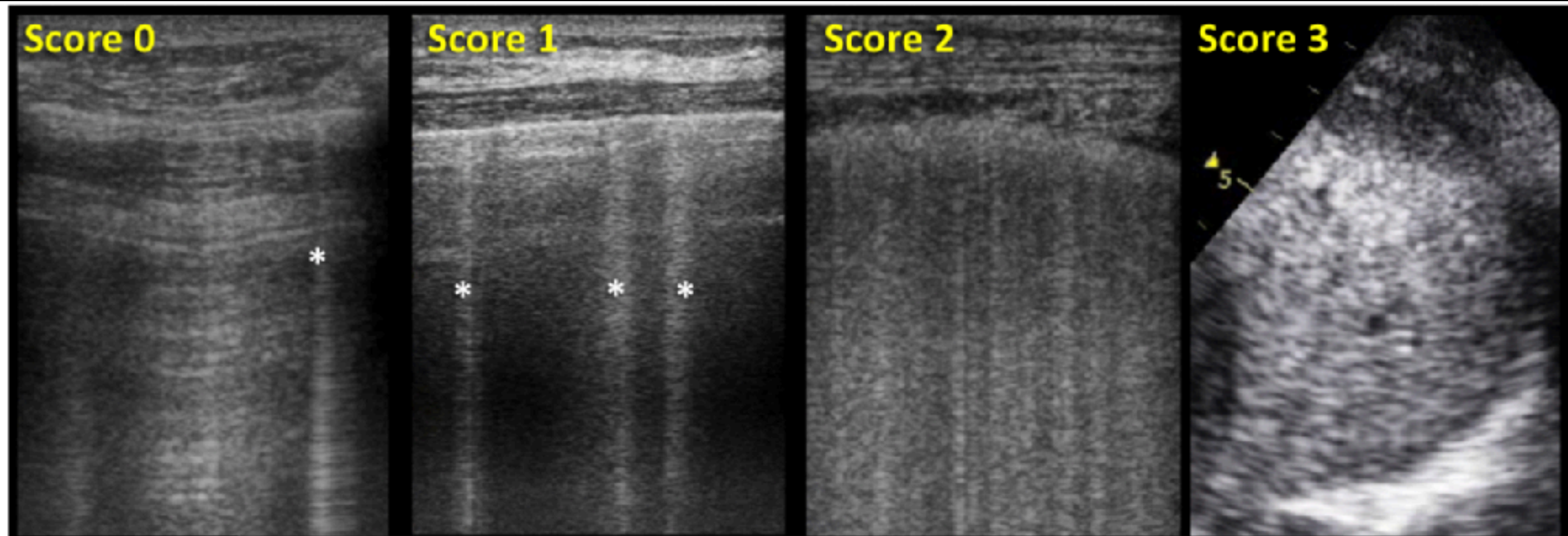
Cardiogenic
edema

Interstitial
disease

ARDS
Pneumonia

Lung Aeration Score

12 regions: 0 ~ 36



Reaeration score	+1	←	←	←
	+3	←	←	←
	+5	←	←	←
	-1	→	→	→
	-3	→	→	→
	-5	→	→	→

Take Home Message

氣
水

真
假

A
B

動
靜

PTX

AIS

PLE

Sliding



A - B - C - D - E