May 27th, 2016

Lung Ultrasonography : basic application

Department of Thoracic and Cardiovascular Surgery,

CNUH

Do Wan Kim

Principle

- 5-MHz Microconvex/Linear probe (4 -12 MHz)
  - 1 -17cm range of exploration
- Turn off filters : for artifacts
- Normal lung : invisible
- Air : non transmitter
- Fluid : good mediator
- Pneumothorax : interrupt of visceral pleura
- Pleural effusion : identification of visceral pleura

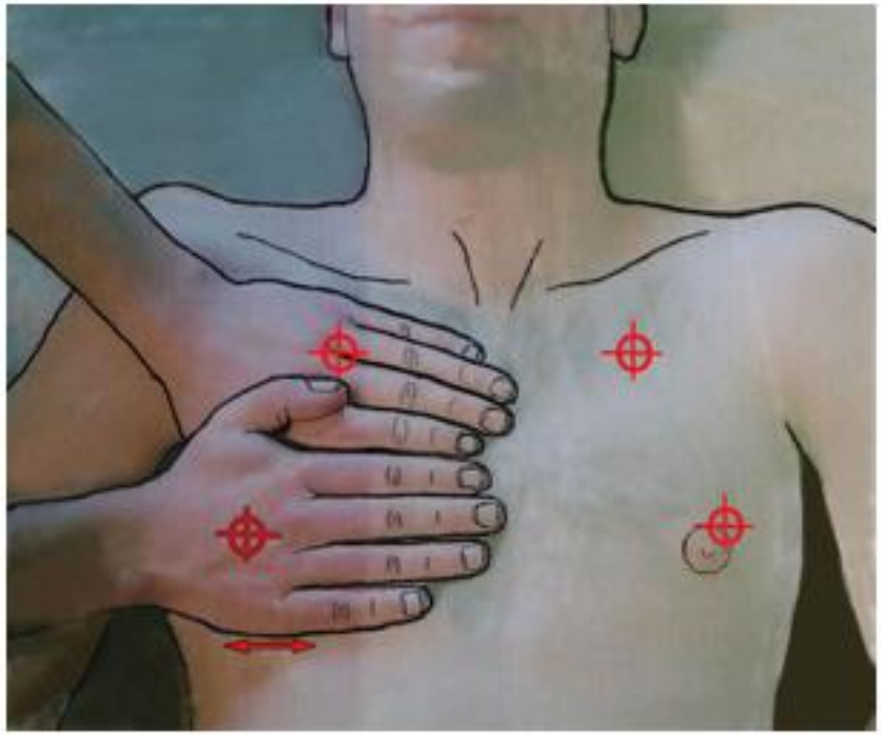
Principle

- High frequency (5 -10 MHz)
  - Greater resolution
  - Less penetration
  - Superficial structure
- Lower frequency (2 – 3.5 MHz)
  - Greater penetration
  - Less resolution
  - Deep structure

Check point

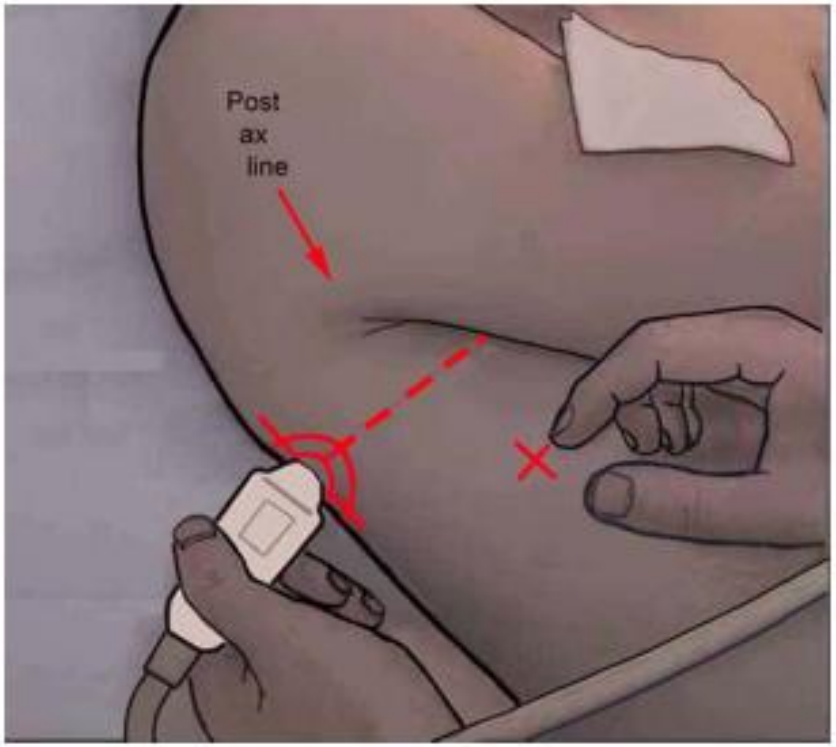
- Boundary
  - Sternum
  - Anterior axillary line
  - Posterior axillary line
- Area
  - Upper BLUE point
  - Lower BLUE point
  - PLAPS (Posterior/ Lateral, Alveolar / Pleural syndrome) point

BLUE point



Lichtenstein DA. **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

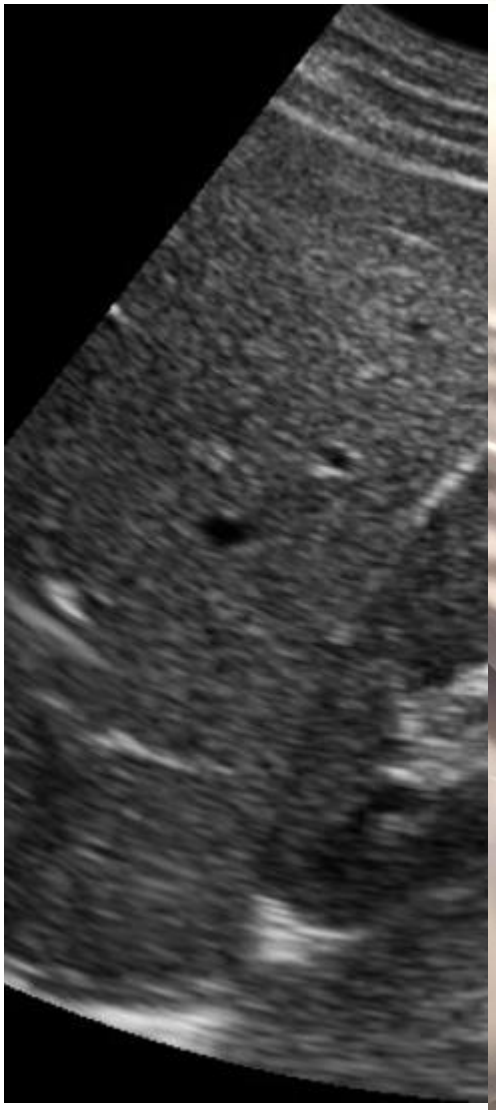
BLUE point



Lichtenstein DA. **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

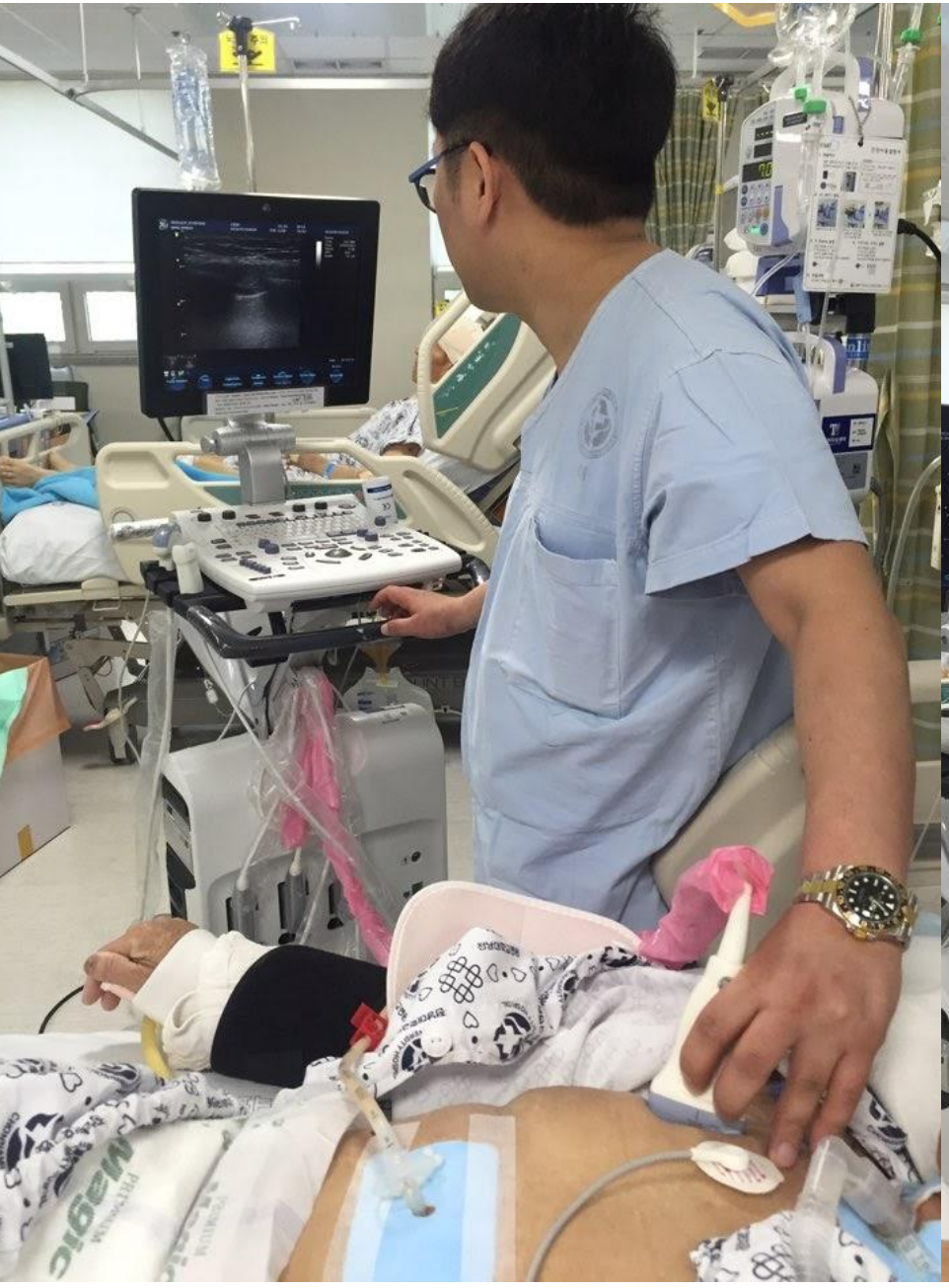
PLAPS-point

- Posterior axillary line + Lower BLUE point
- Alveolar syndrome : consolidation
- Pleural syndrome : pleural fluid
- Milestone of pleural effusion
- The lowest point of the lung
- BLUE protocol : not pulmonary edema but pneumonia

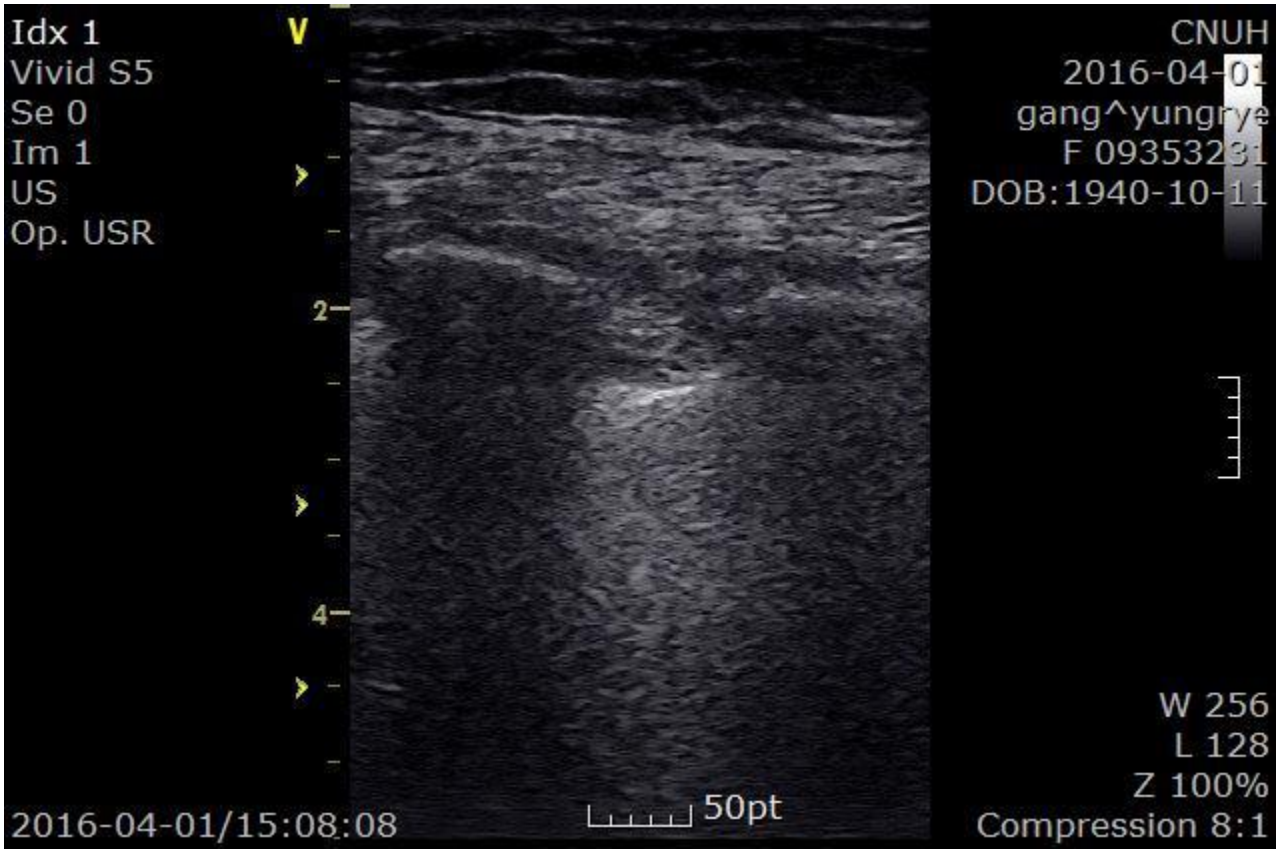


Manipulation

- Correct angle – right angle of pleura
- Carmen maneuver
- Zero pressure
- Pleural line : 0.5 cm below the rib line
- Distance of the ICS : 2 cm
- Neonate : Same as adult



Bat sign ??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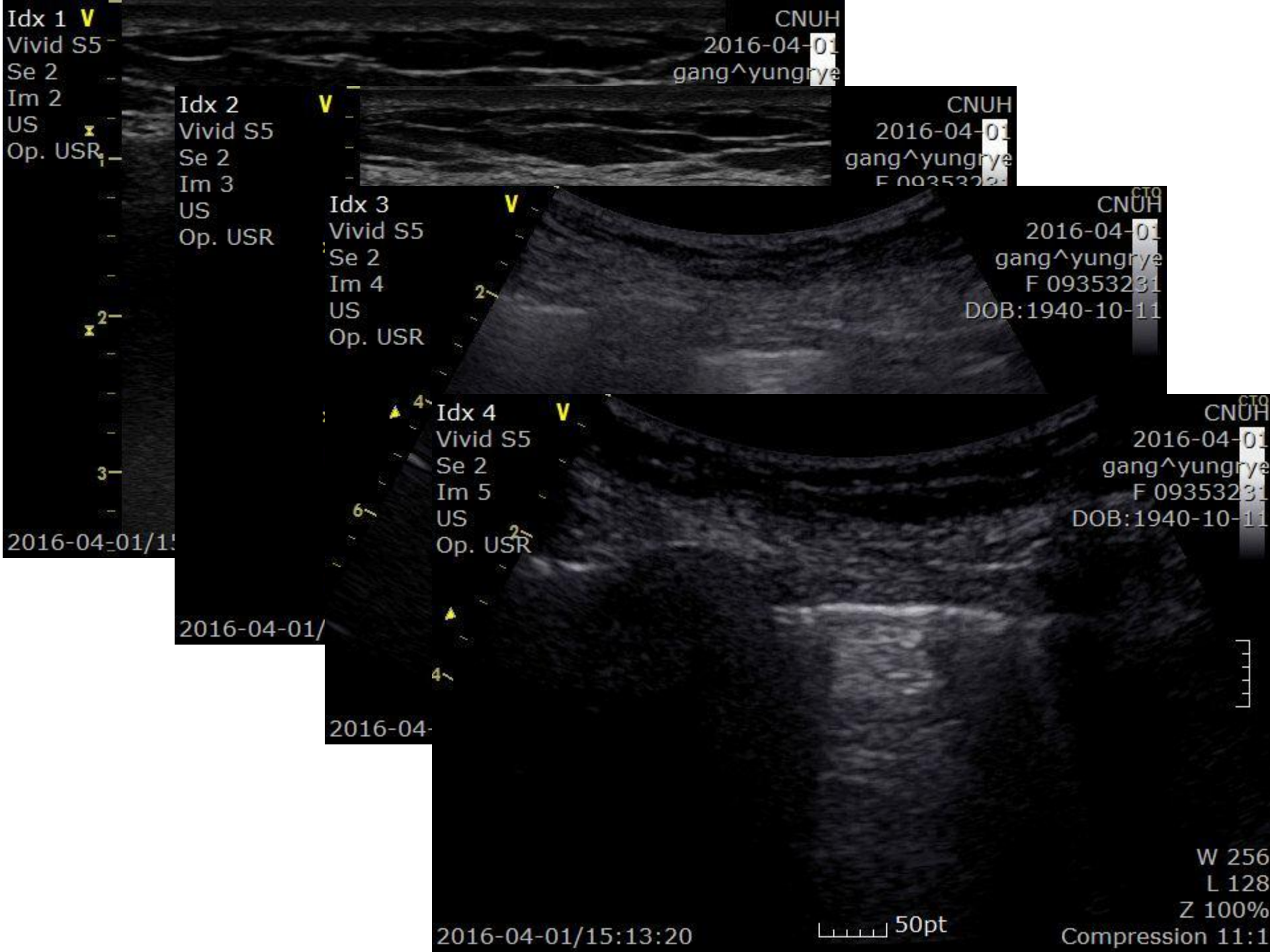
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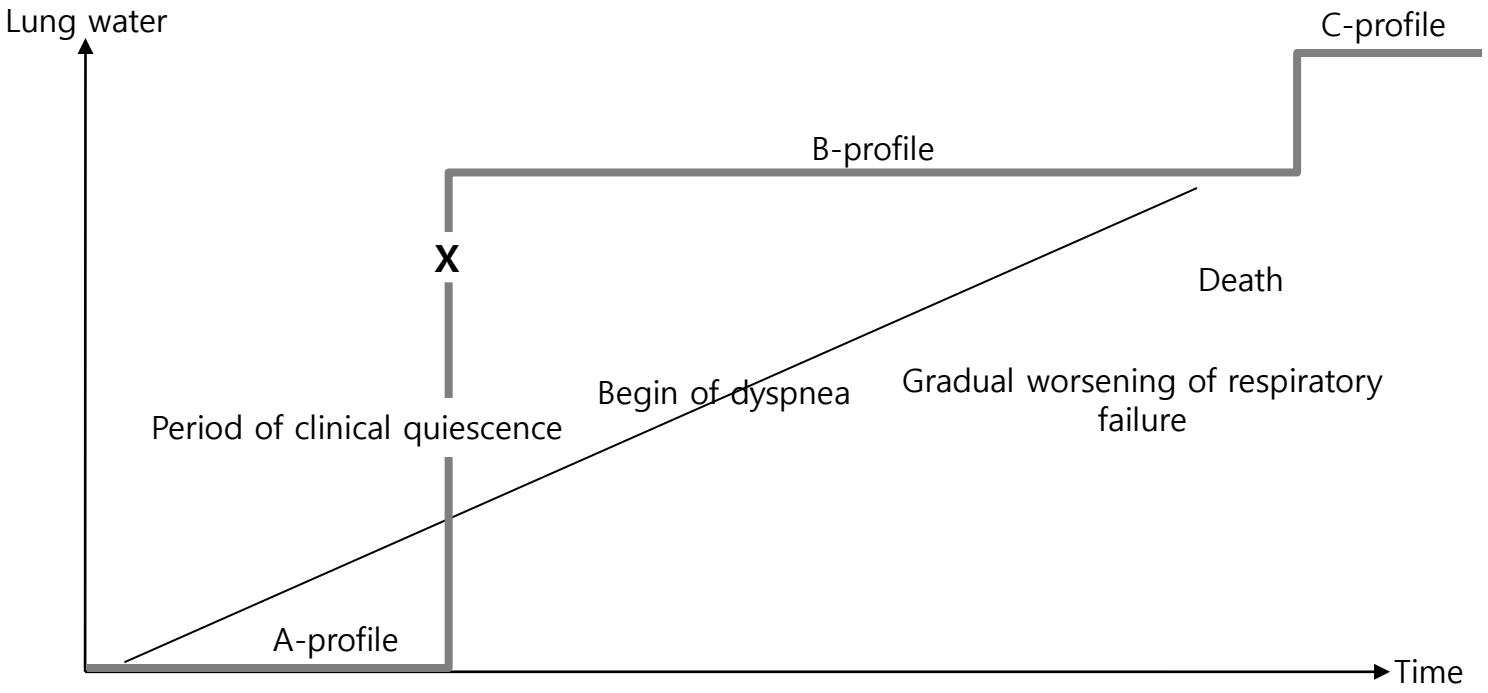
10 signs

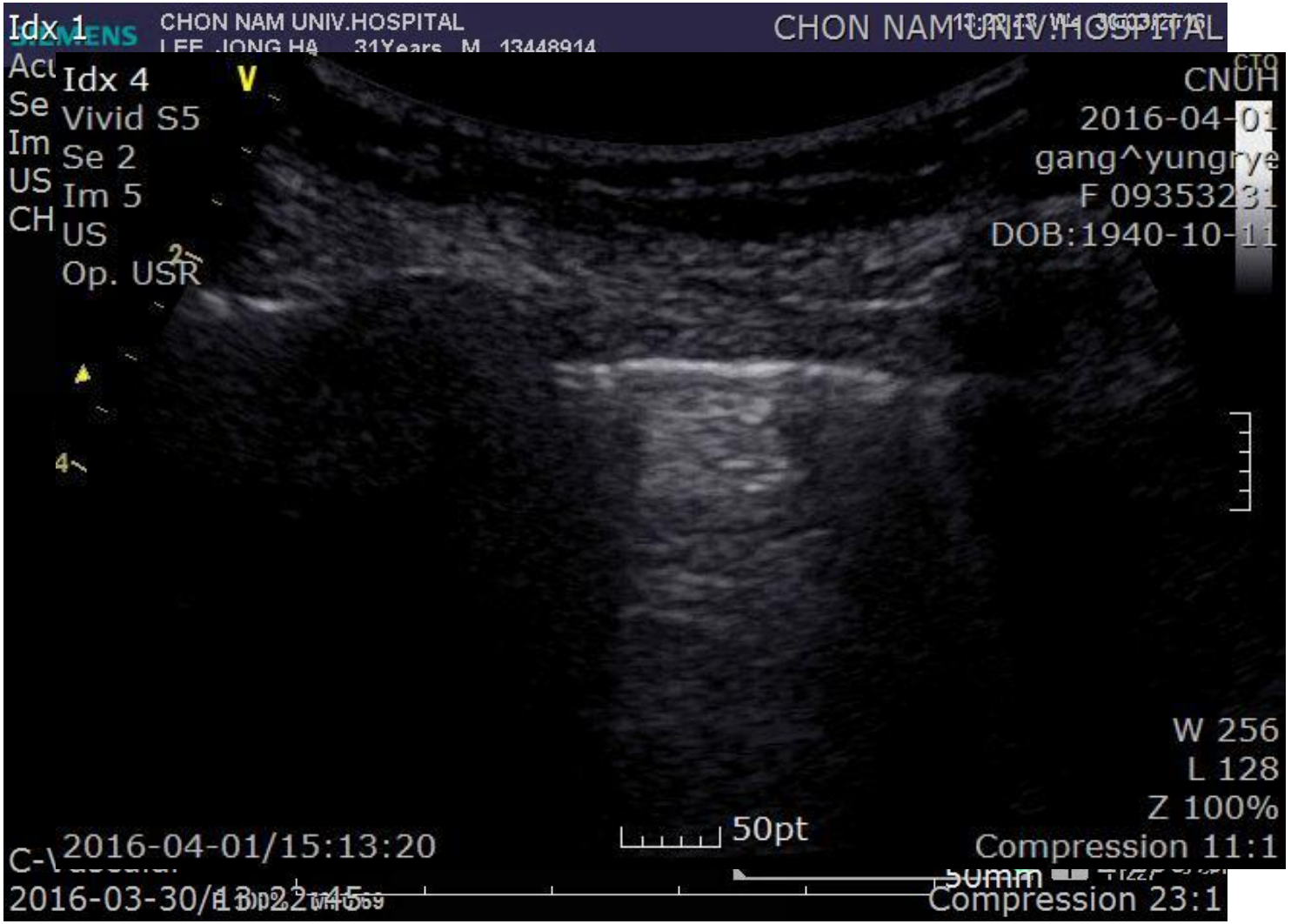
- Bat sign
- A line
- Lung sliding
- Stratosphere sign
- Lung point
- Sinusoid sign
- Quad sign
- Shred sign
- Tissue like sign
- B line


Lung water
C-profile
B-profile
X
Death
Begin of dyspnea
Gradual worsening of respiratory failure
Period of clinical quiescence
A-profile
Time

Bat sign

- Location of the lung – 1st sign, landmark
- Upper rib, lower rib, pleural line
- Pediatrics : same as adult
- Normal : do not distinguish visceral and parietal pleura
- More important indicator than lung sliding sign

Bat sign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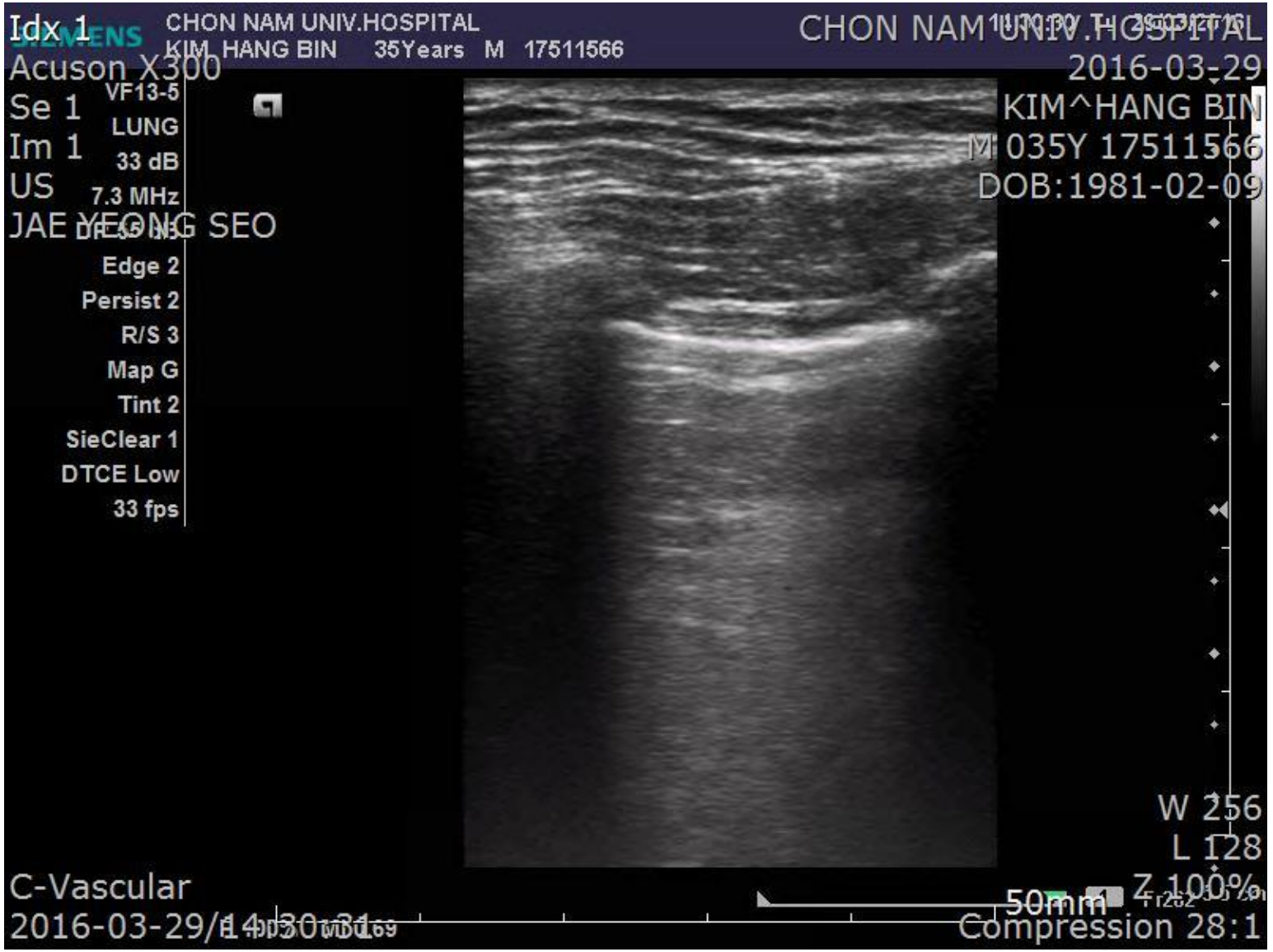
A-lines

- First letter of Alphabet
- Horizontal, Reverberations, Motionless
- Manifestation of air
- Only finding in two third of normal lung
- A-line + lung sliding = A profile
- A-line only without sliding = A’ profile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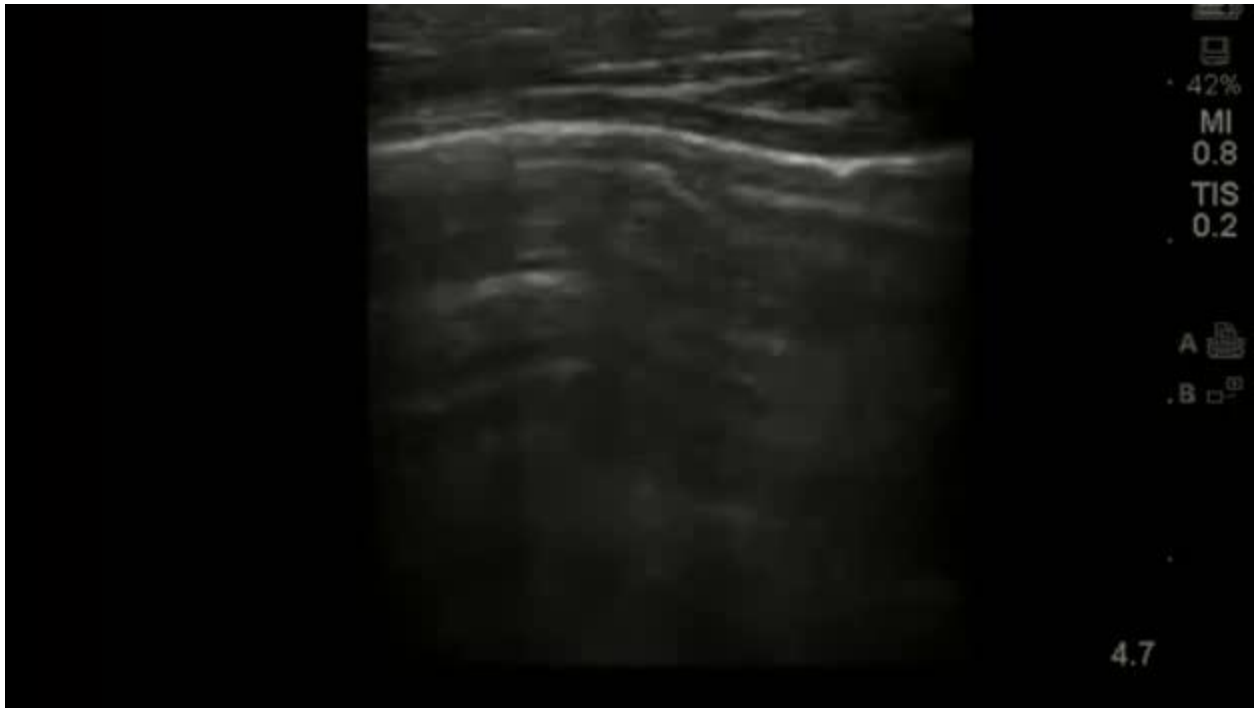
Lung sliding

- Pleural sliding (visceral pleura movement)
- Lung touching chest wall
- Greatest in lower thorax
- Absence : pneumothorax, intrathoracic adhesion, critical parenchymal disease, esophageal intubation
- M-mode : Seashore sign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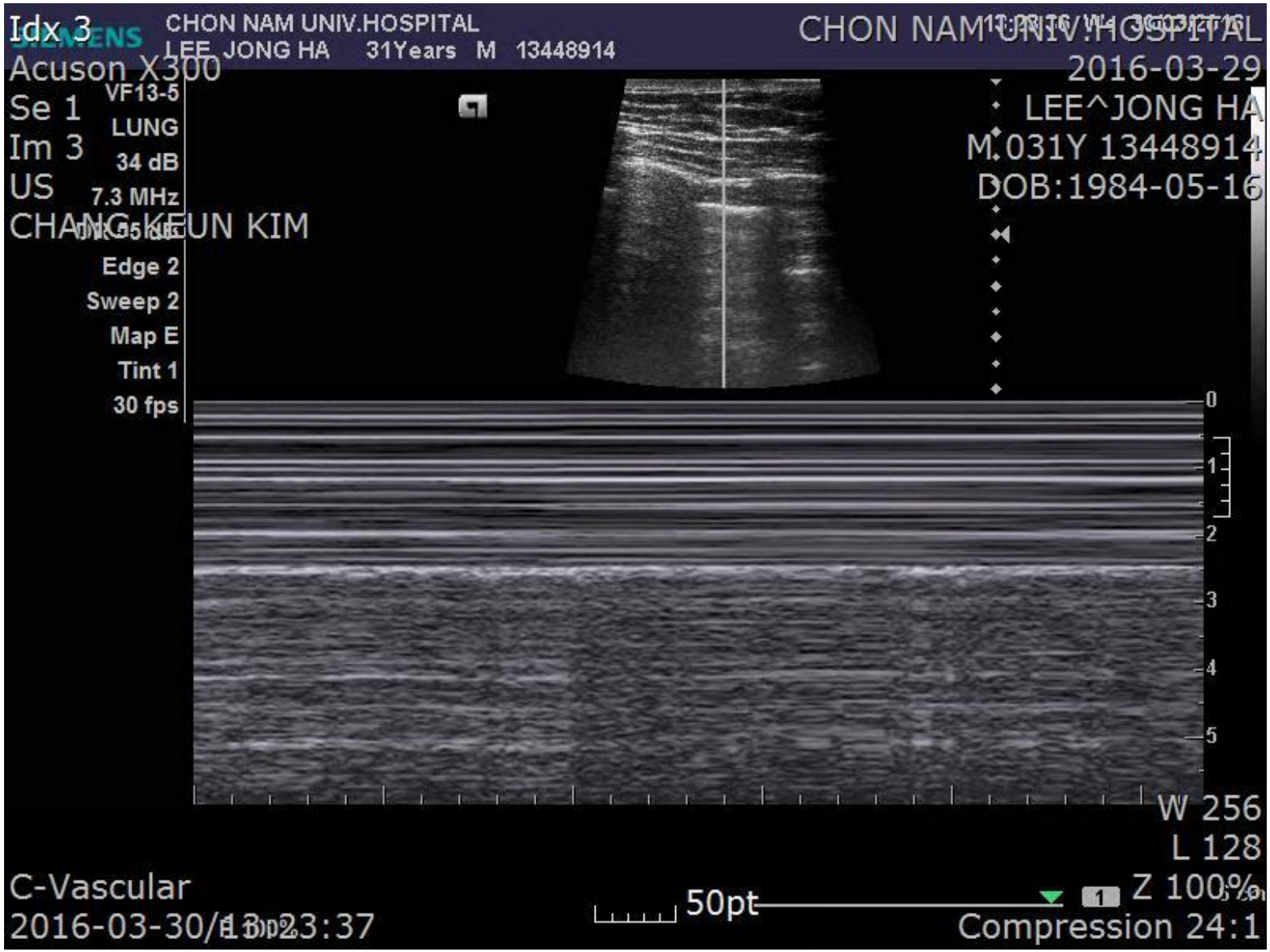
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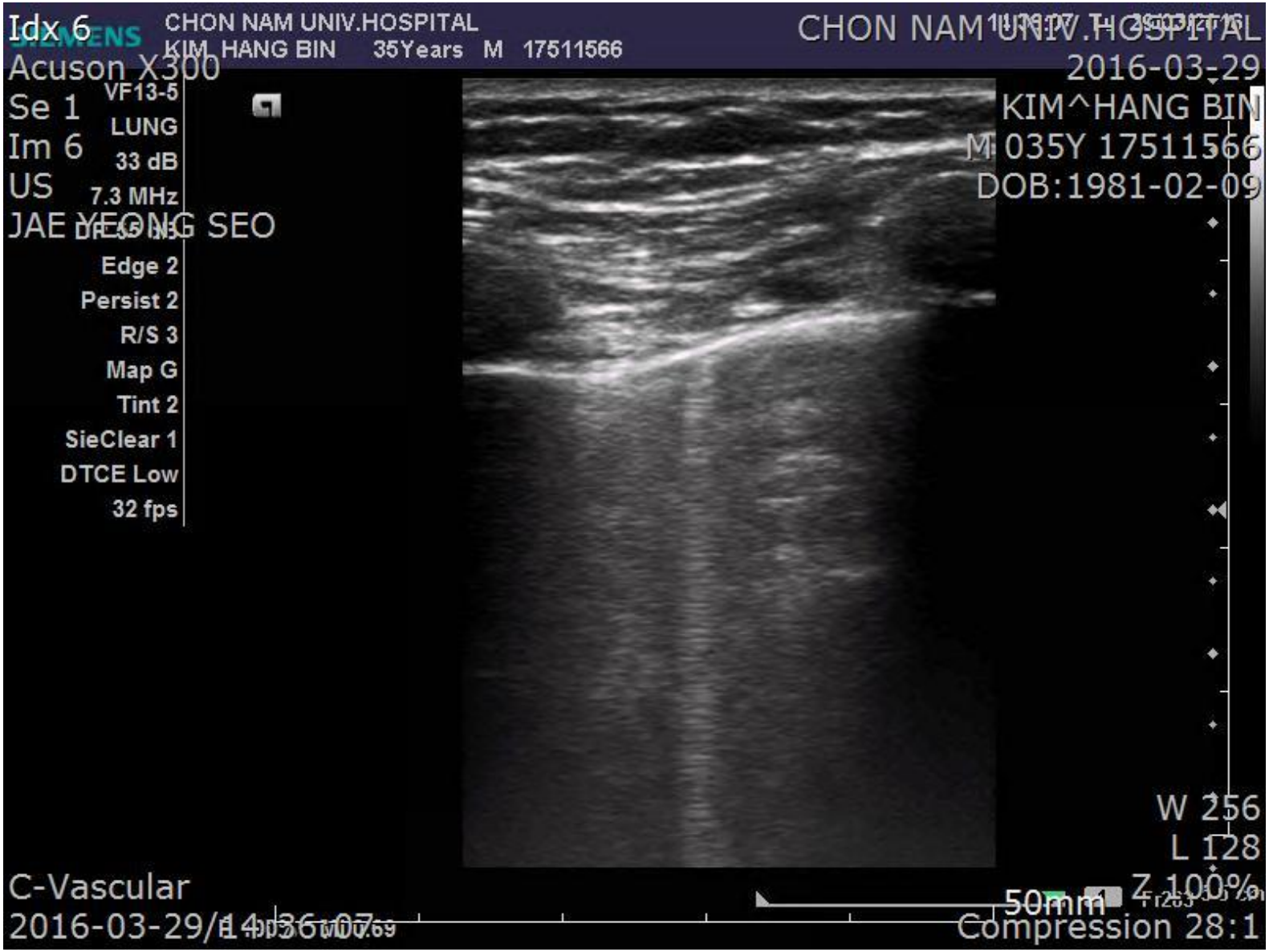
B-lines

- **Comet-tail sign : water contained anatomy**
- **Originates from pleura,** absence of air
- Hyperechoic, vertical narrow bands
- Obliterate A-line, move with lung sliding
- 3 more at once : abnormal interstitial pathology, lesion in alveoli, lung rockets
- Join of B-lines : severity

Lung rockets

- PLAPS point : non specific (d/t gravity)
- Bilateral all fields : cardiogenic edema
- Localized : consolidation (pneumonia, interstitial diseases)
- Lung rockets + lung sliding = B profile
- Lung rockets without sliding = B’ profile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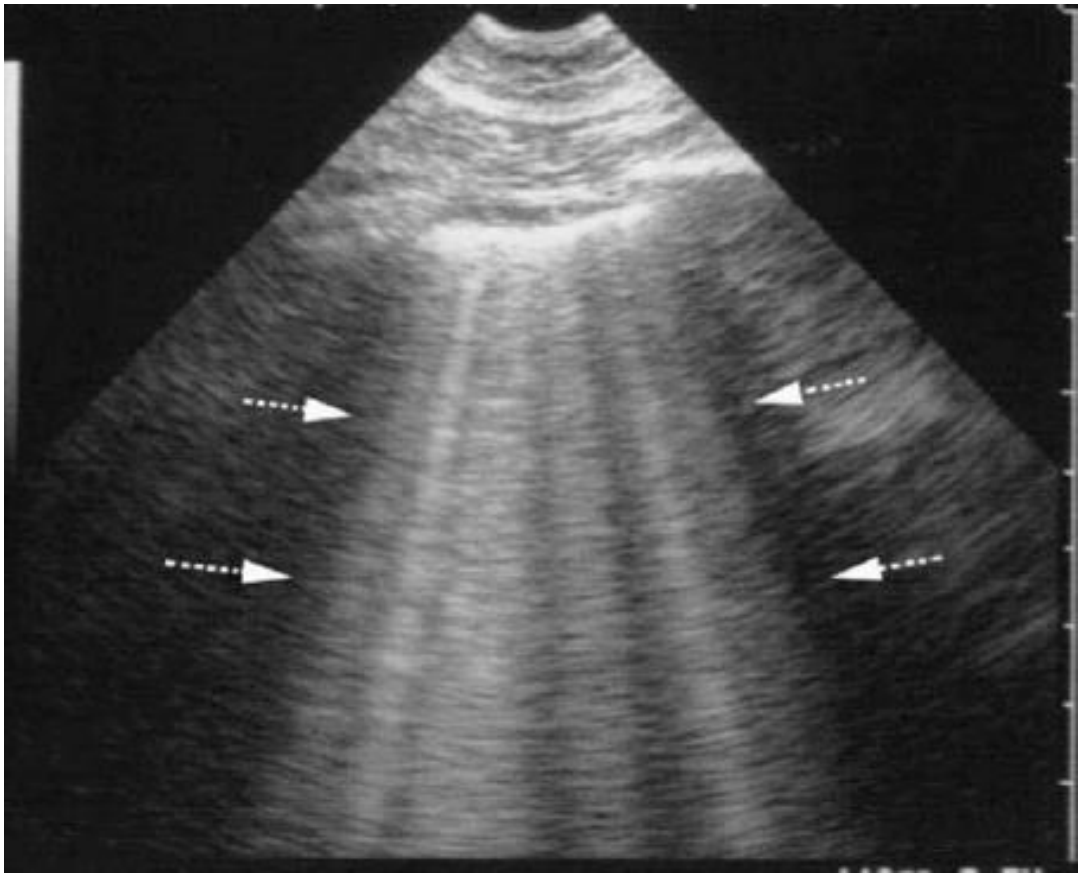
Compression 28:1

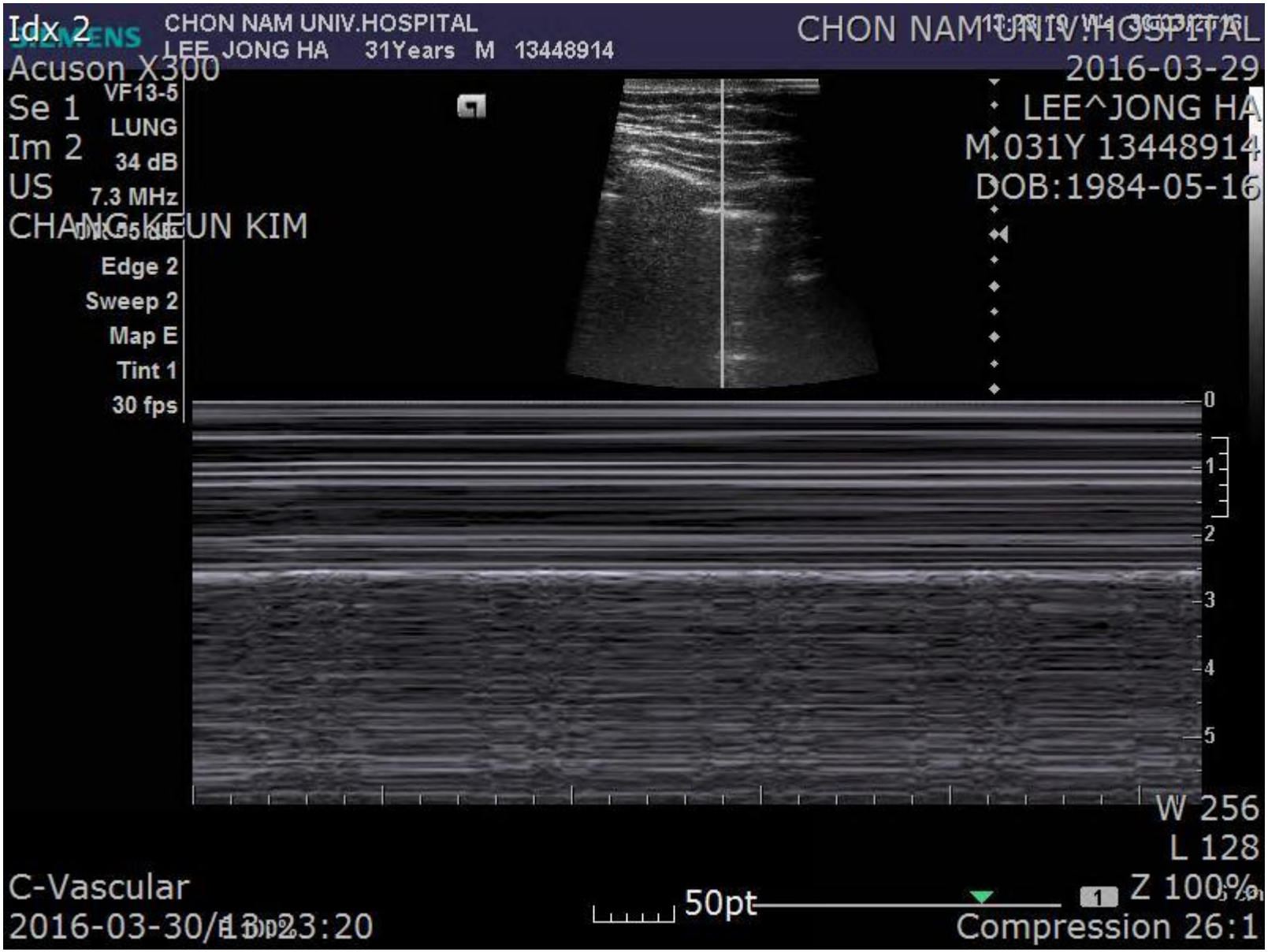
B-lines



Lichtenstein DA. **Relevance of lung ultrasound in the diagnosis of acute respiratory failure: the BLUE protocol.** Chest. 2008 Jul;134(1):117-25.

Stratosphere sign

- Barcode sign
- Absence of lung sliding
- D/D with lung pulse
- Pneumothorax in M mode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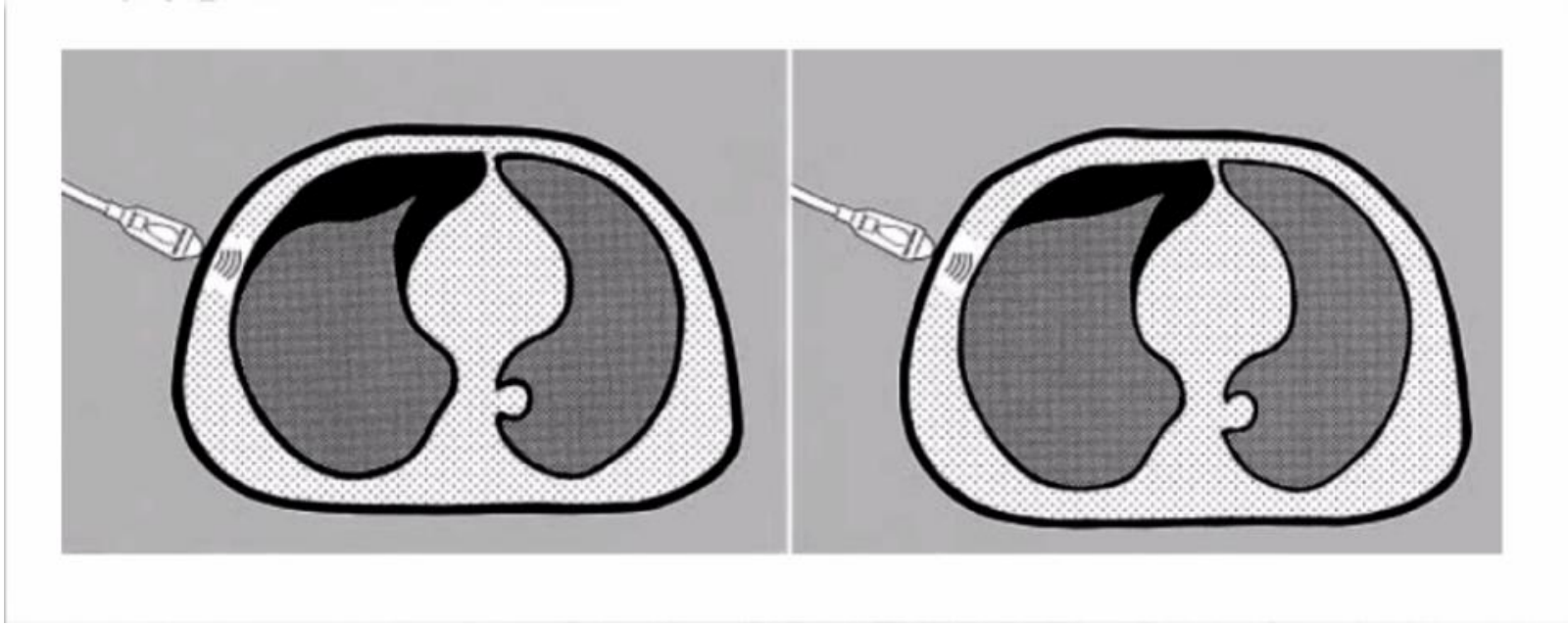
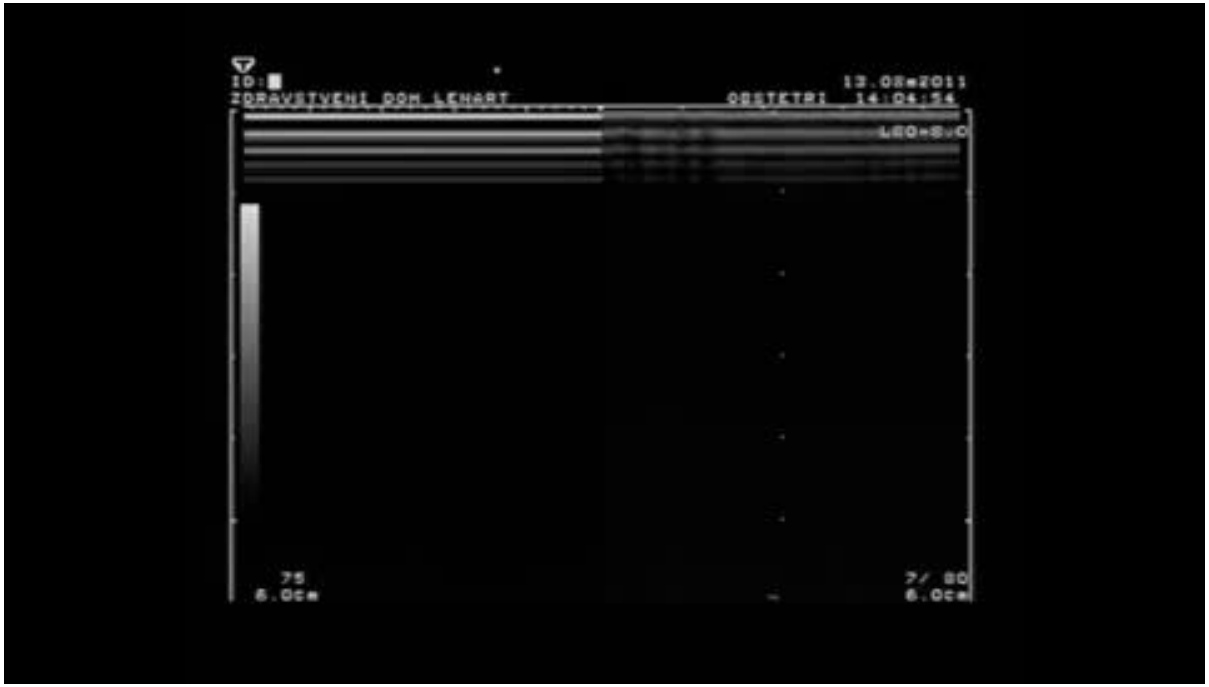
Lung point

- Indicator of pneumothorax
- Abrupt appearance
- Lateral side : Pneumothorax size 
- On one side : lung sliding preserve
- On the other side : lung sliding absent
- Pneumothorax with no lung point : massive pneumothorax (total collapse)

Lung point



Lung point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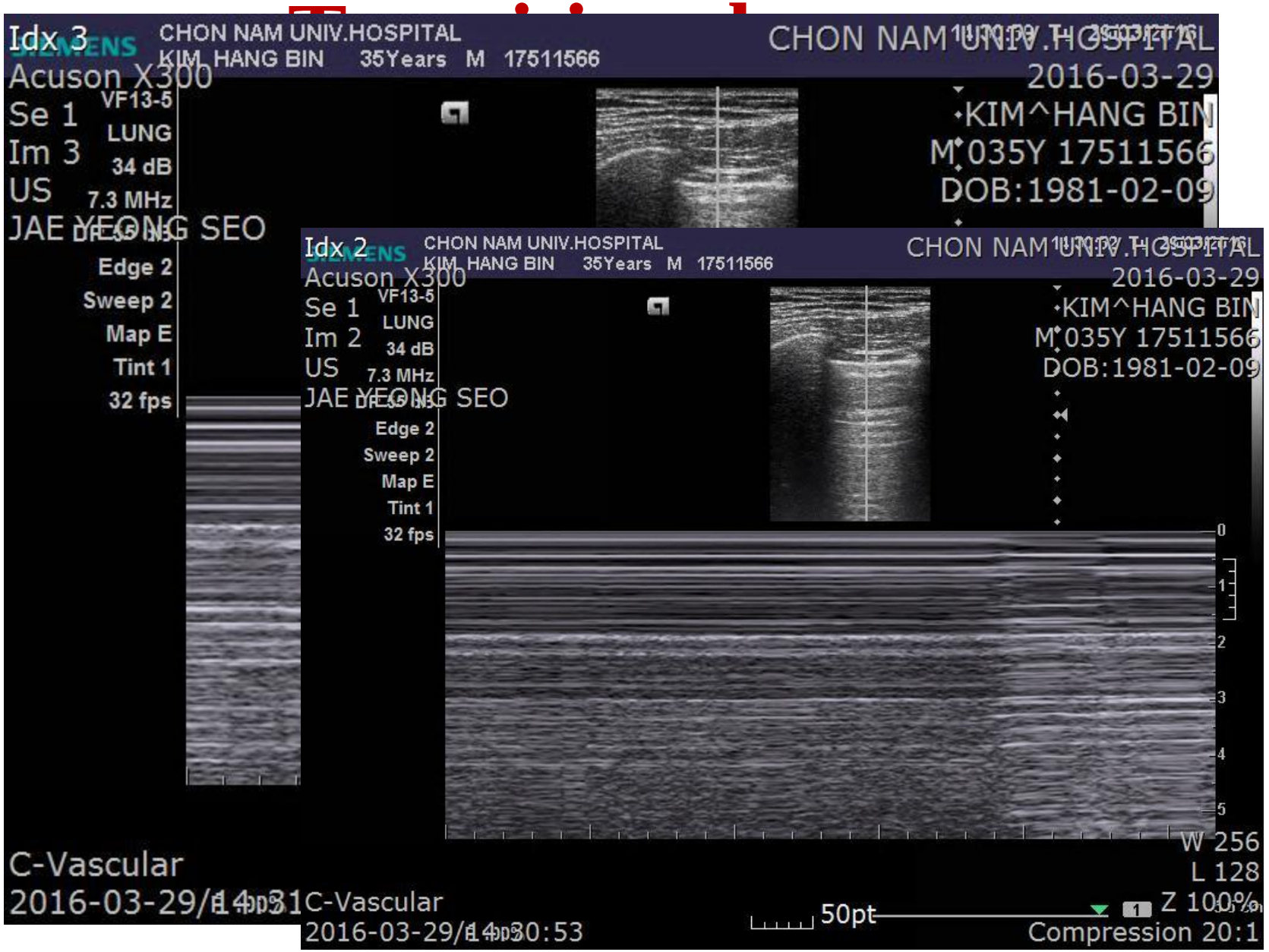
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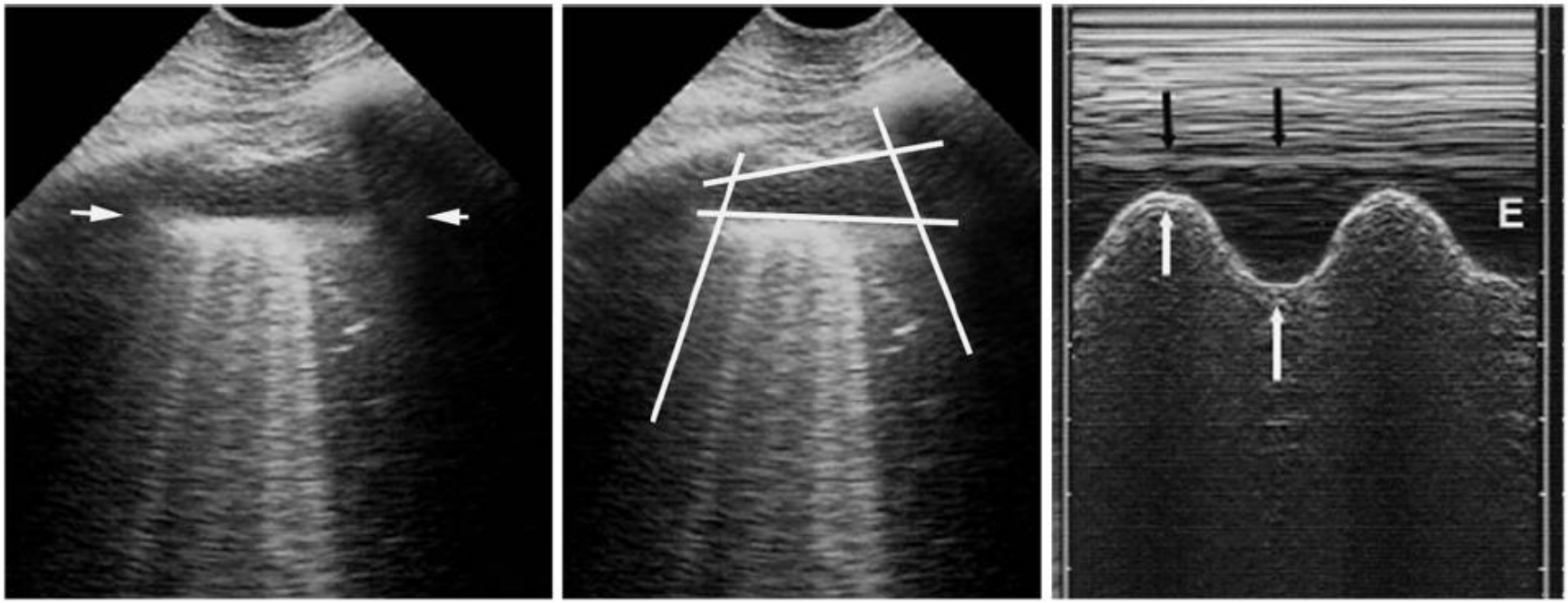
Lung point

- D/D with Mangrove variant
- End expiration or inspiration pause
- Moderate use of M-mode
- Progressive pattern
- Entire lung area



Lichtenstein DA. **Lung ultrasound in the critically ill.** Annals of Intensive Care 2014, 4:1

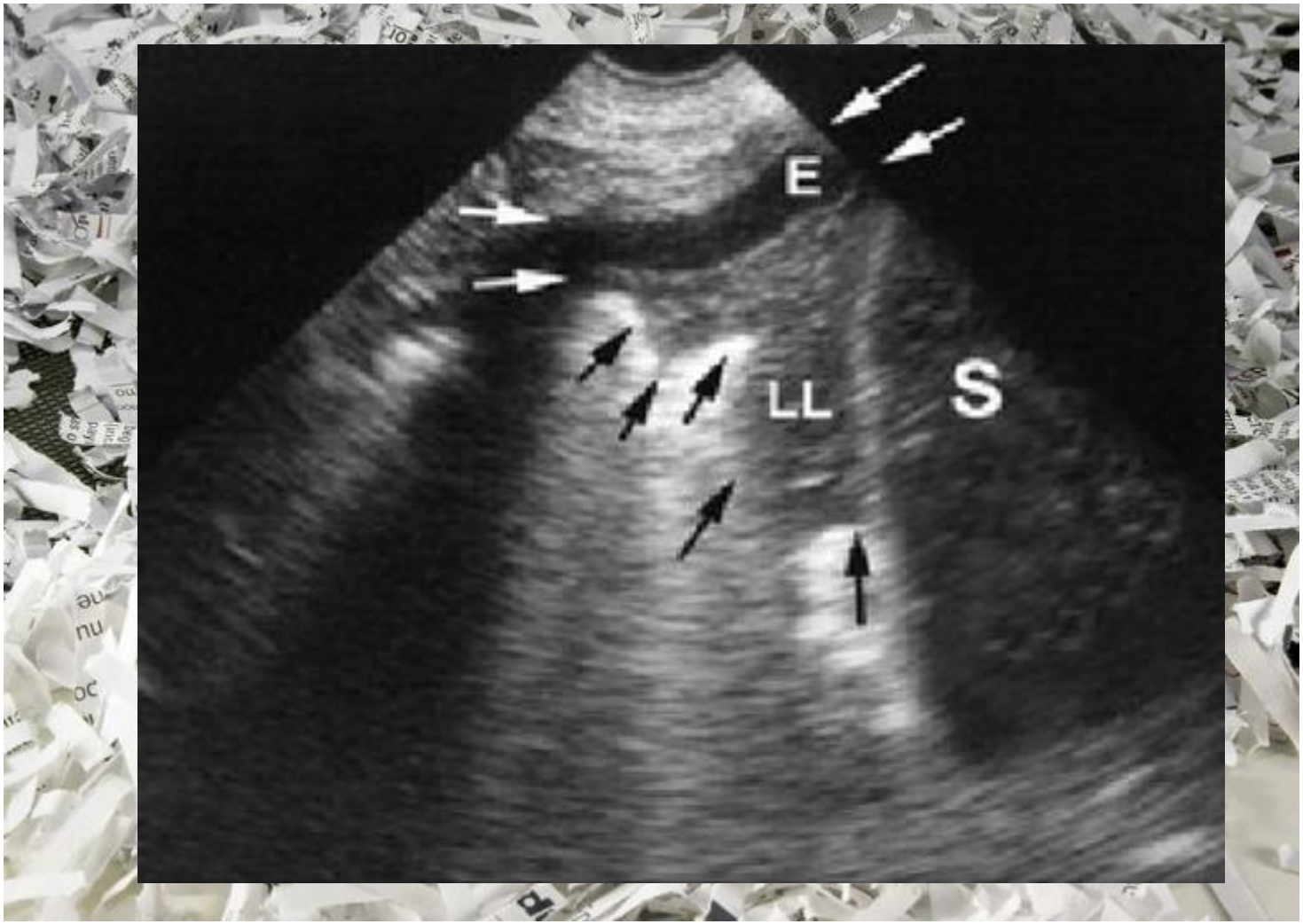
Quad sign

- PLAPS point
- Dependent position
- Static sign, pleural and lung line, rib
- Deep boundary of the collection : regular
- Roughly parallel to the pleural line
- Sub B-lines

Shred sign

- Alveolar consolidation
- More common
- Boundary – pleural line, air-consolidative border
- Fractal line
- The nontranslobar sign of consolidation
- Mixed pattern :aerated lung and consolidation
- Tissular pattern

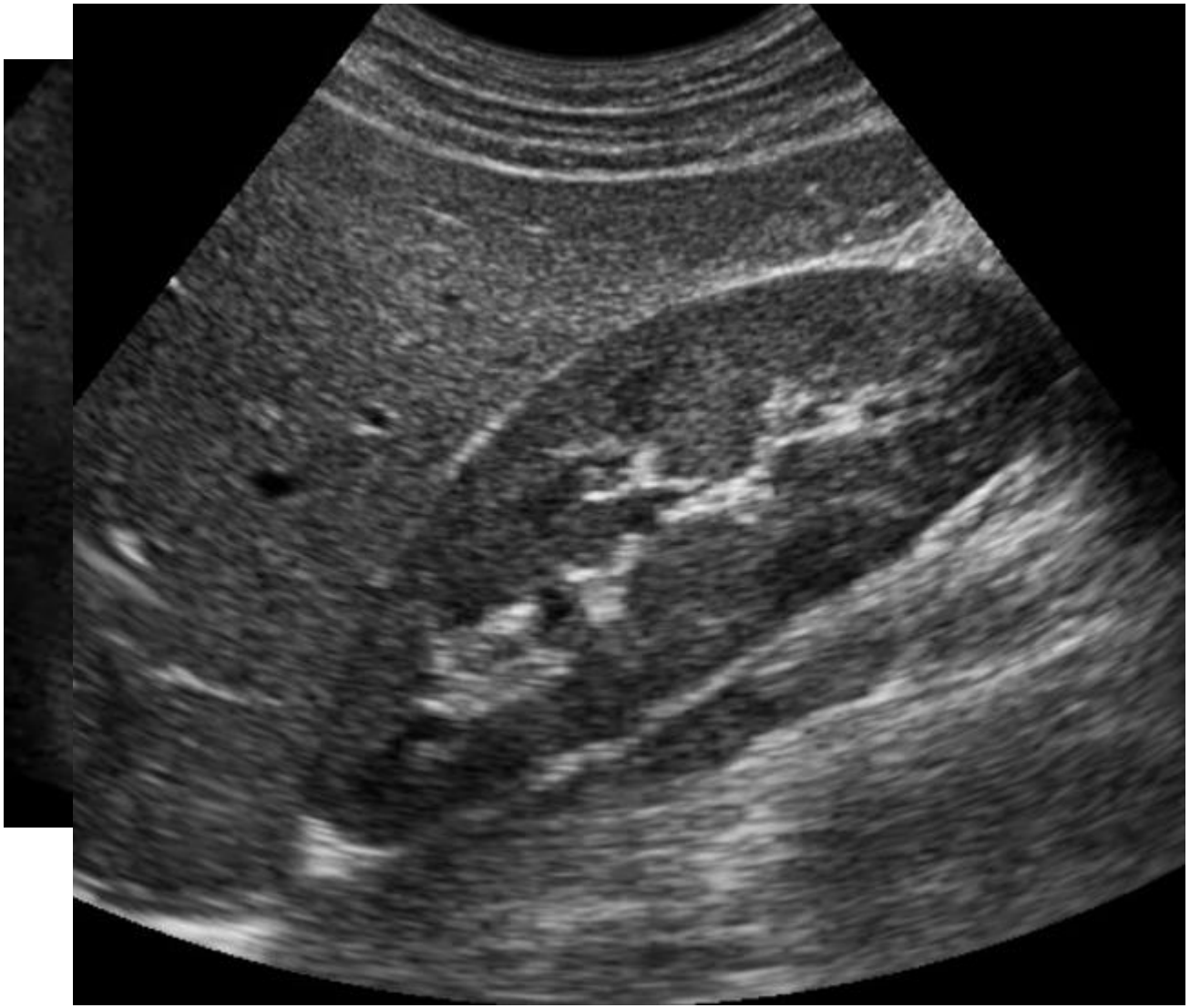
Shred sign



Tissue like sign

- The sign of translobar consolidation
- Hepatization
  - Disorder looking like a solid organ
- No sinusoid sign : a size remains steady
- No fractal line

Tissue like sign



BLUE-protocol

- Acute respiratory failure
- Very fast (< 3 min.)
- Upper point : upper lobe
- Lower point : middle lobe, lingular segment
- PLAPS point : lower lobe

Accuracy

- U/S sensitivity : 98%
- U/S specificity : 95%
- X-ray sensitivity : 67%
- X-ray specificity : 85%

Francesca C, et al. **Lung ultrasound is an accurate diagnostic tool for the diagnosis of pneumonia in the emergency department**.
Emerg Med J 2012;29:19-23

Pneumothorax

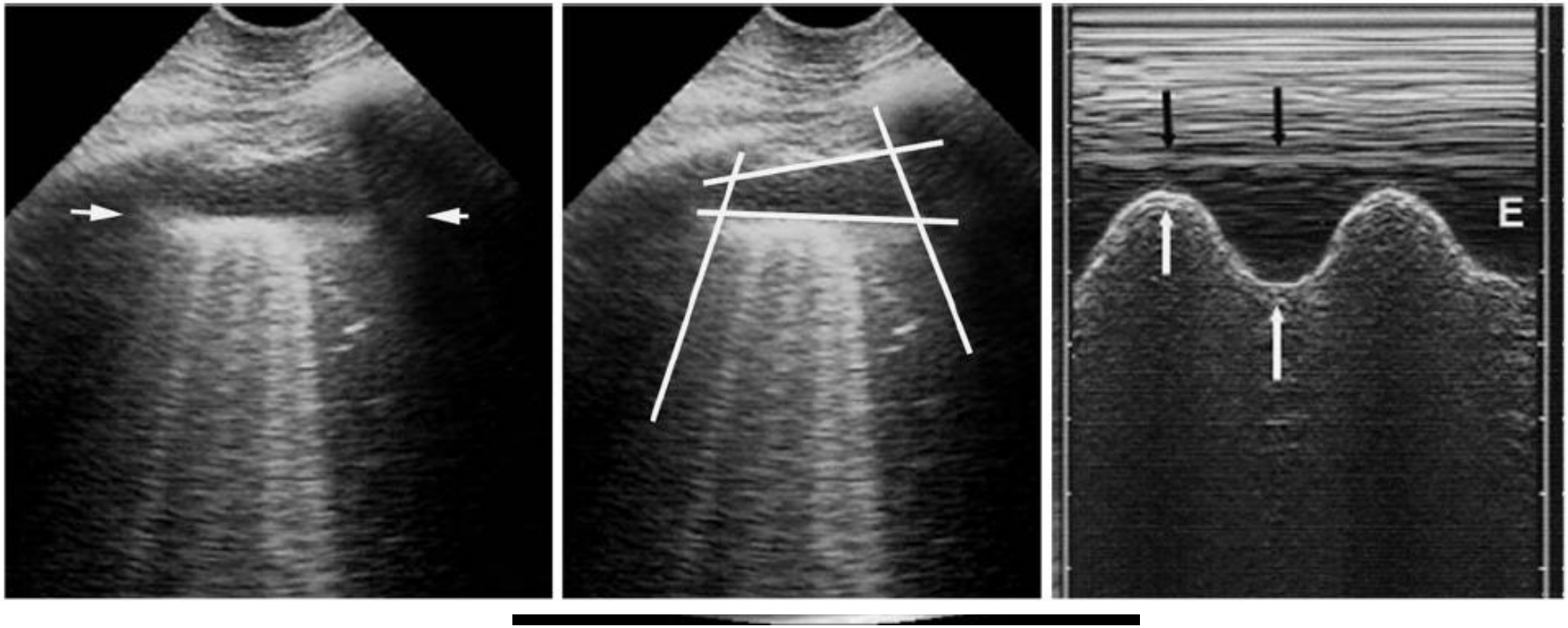
- High frequency probe
- Disappearance of lung sliding
- Presence of lung point
- Evaluation of whole respiratory cycle
- Presence of B-line : r/o pneumothorax
- Supine : lower BLUE point
- Fowler’s : upper BLUE point

Pneumothorax

Pleural effusion

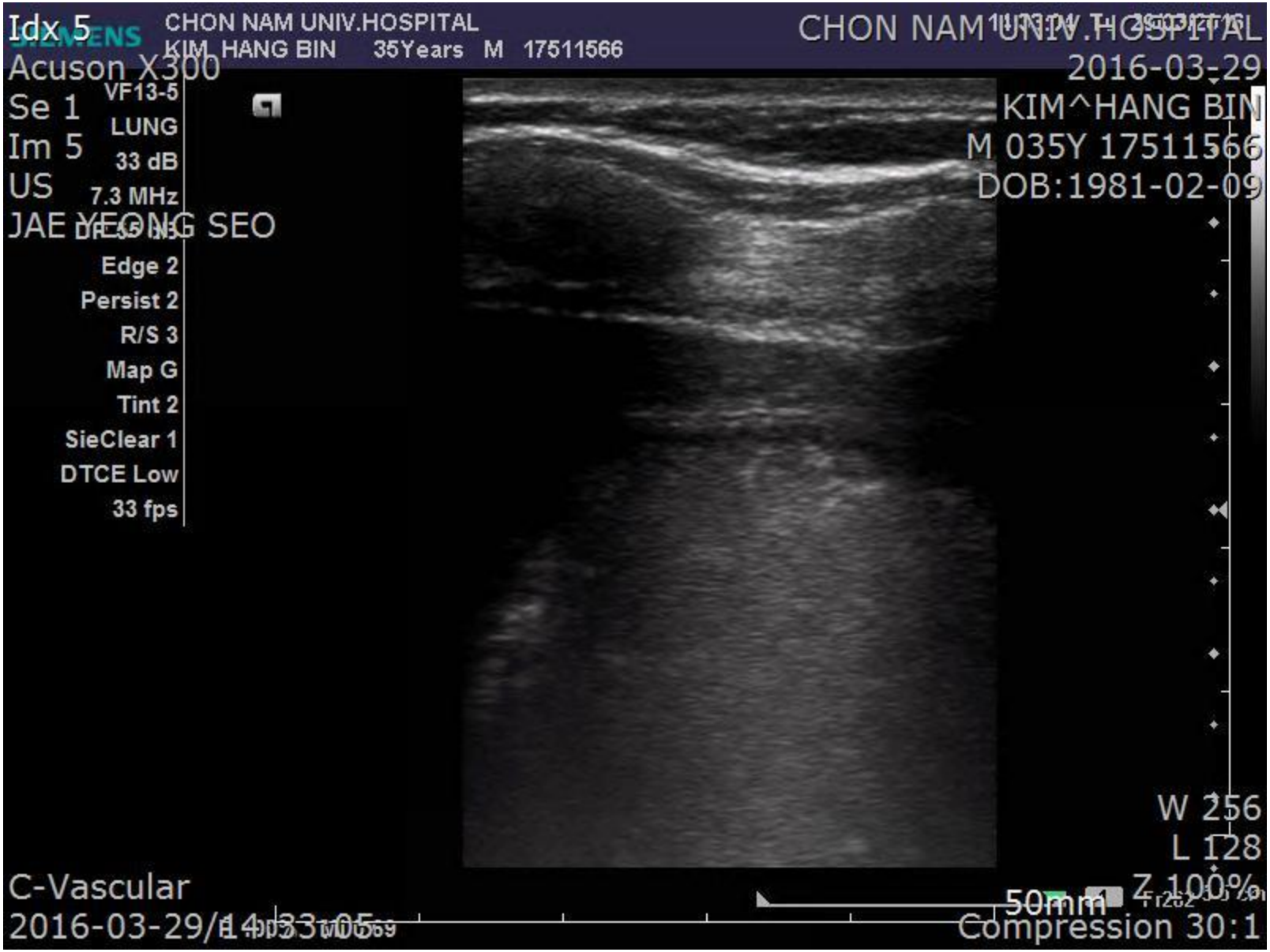
- Amount : > 20ml
- The volume does change with respiration
- Quadrangular shape with a regular lower border
- Useful Indicator of drainage site
- Transudate : anechoic
- Exudate : echogenic feature
- Sub B-line

Pleural effusion



Alveolar syndrome

- Water contained alveoli
- m/c in PLAPS point
- Does not change with respiration
- D/D with abdominal organ (etc liver.)
- Visible state of lung tissue
- Hepatization
  - Consolidated lung looks like liver
  - Air bronchogram indicate parenchymal syndrome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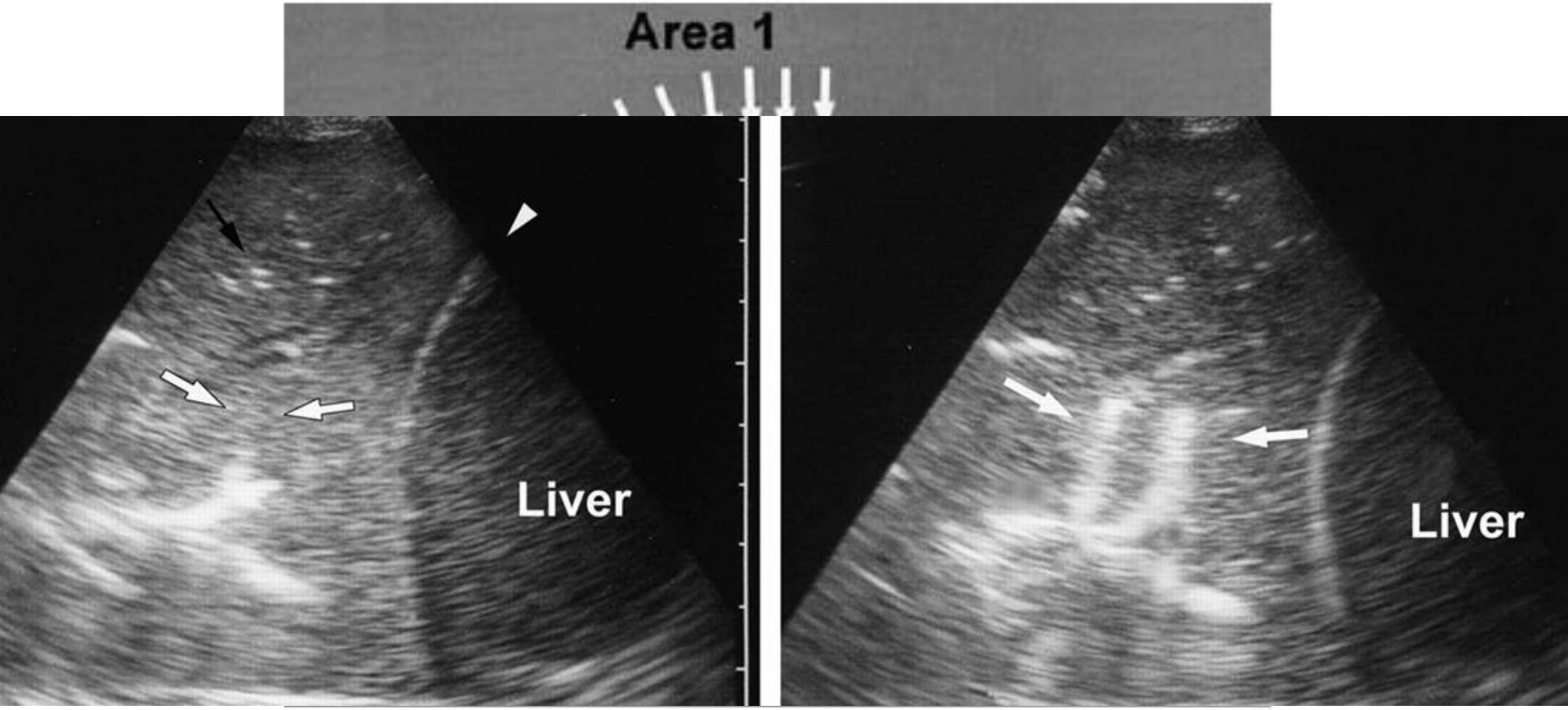
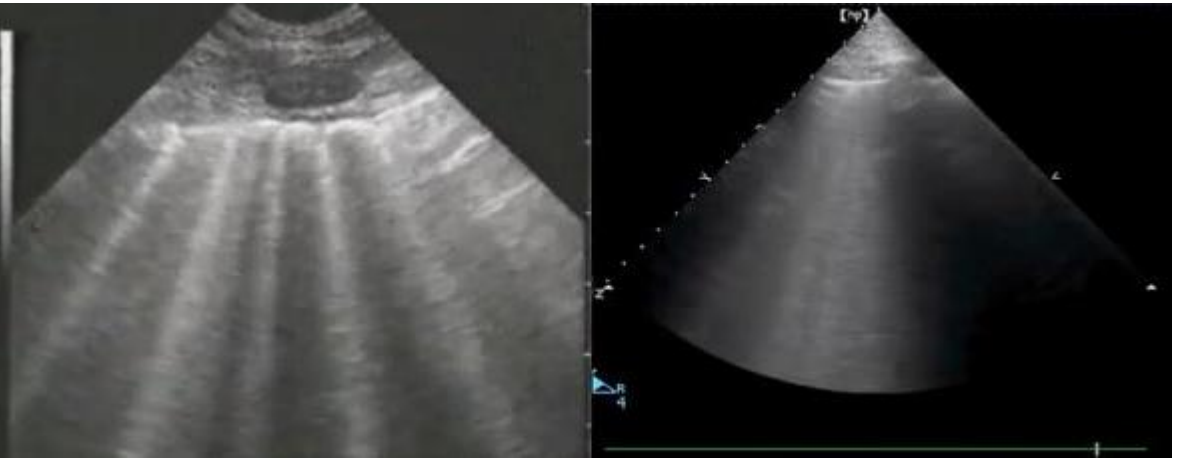
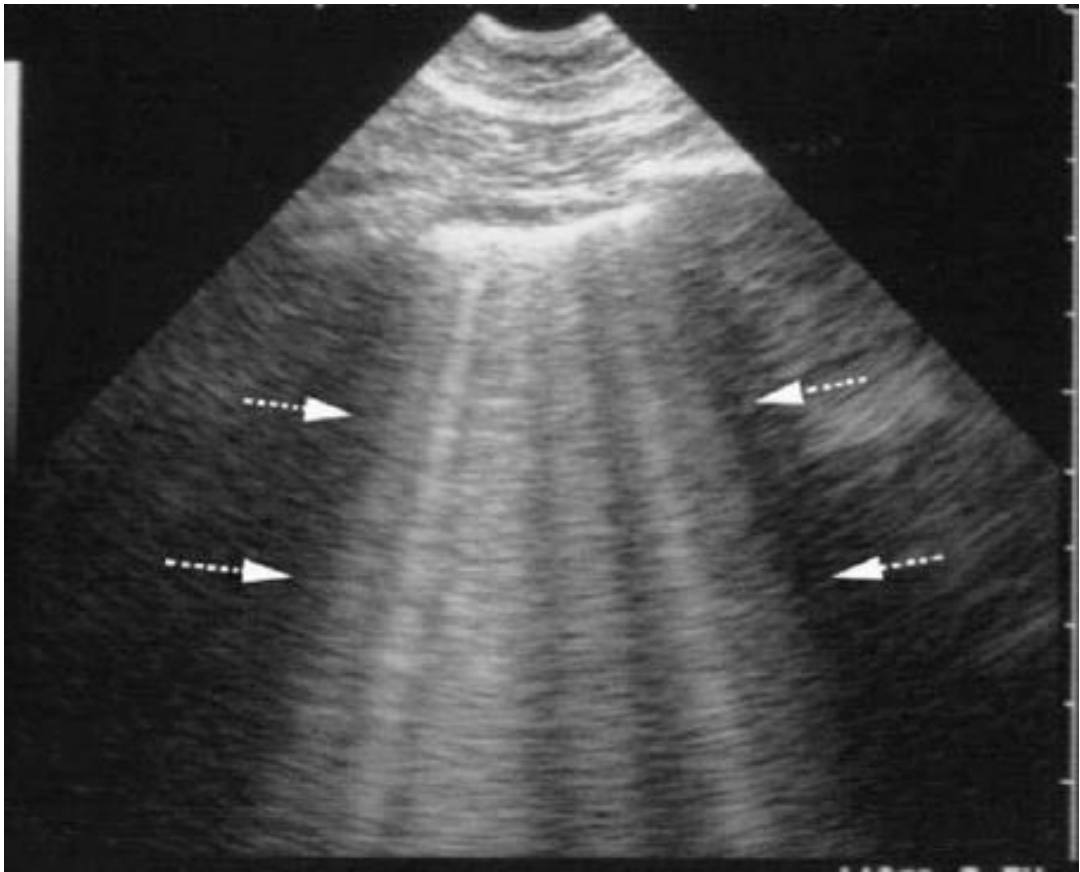


Lichtenstein DA**. Ultrasound diagnosis of alveolar consolidation in the critically ill.** Intensive Care Med (2004) 30:276–281

Interstitial syndrome

- Thickened interlobular septum
- B-lines, Lung rockets sign
- Upper and lower BLUE point
- B1 = 7mm apart (moderate air loss)
- B2 = 3mm apart (severe air loss)
- D/D with Z-line
- PLAPS point : less clinical importance



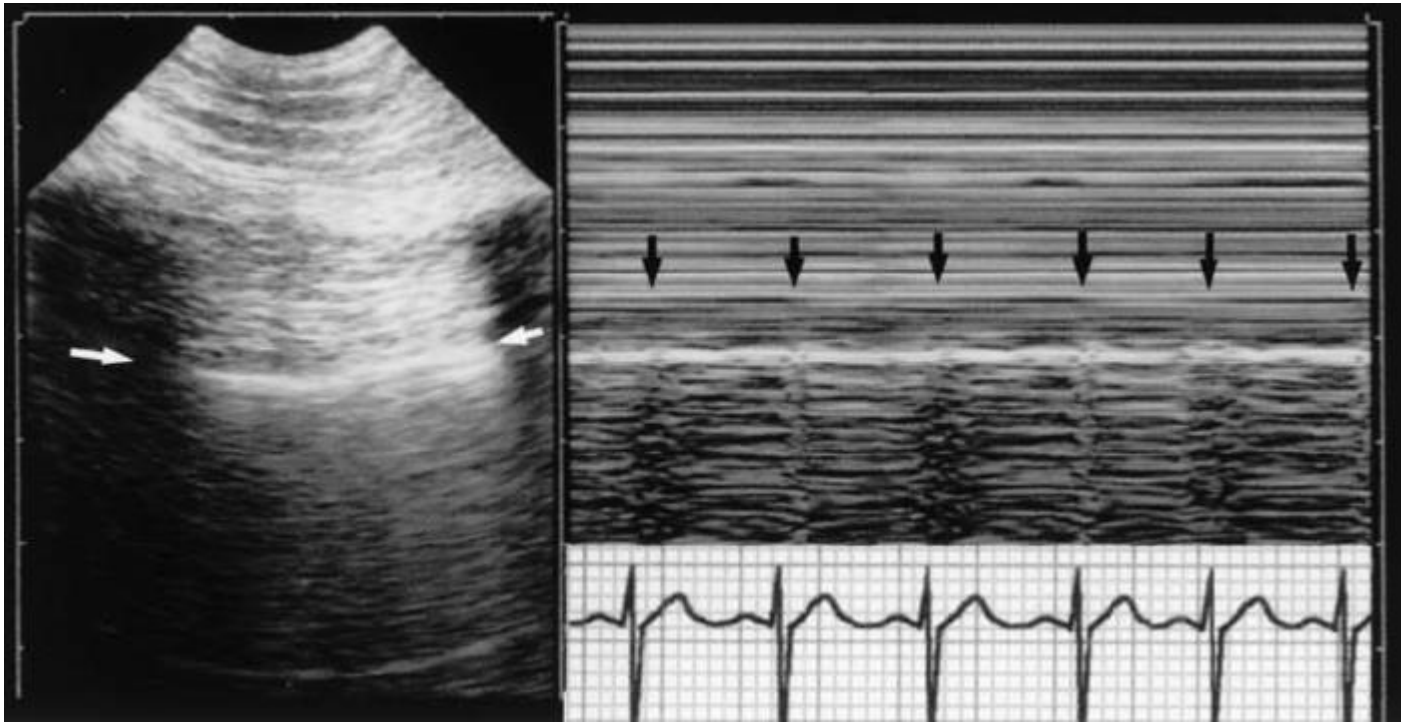


Lung pulse

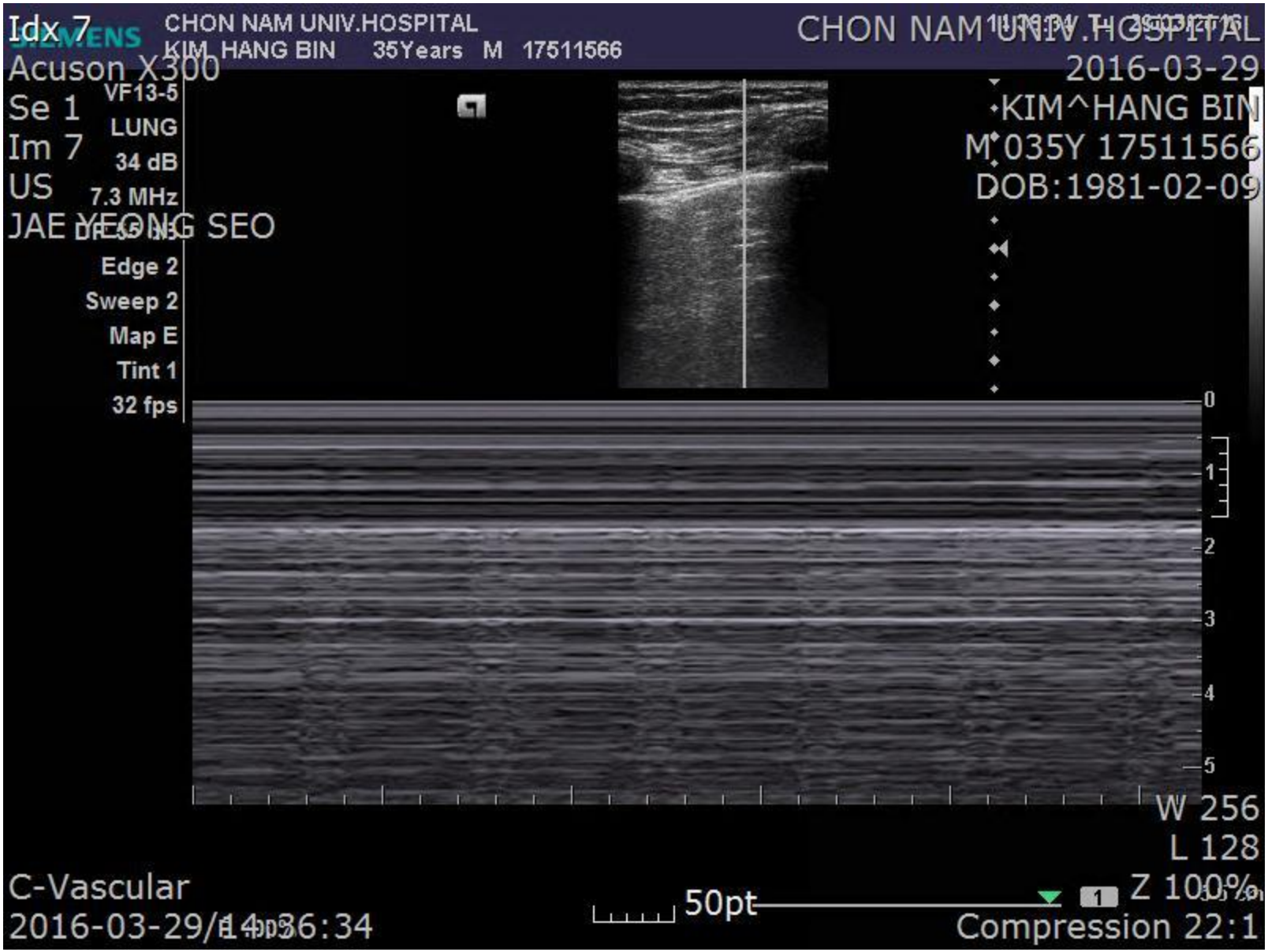
- Disappearance of lung sliding
- Heart beating
- r/o pneumothorax
- D/D pneumothorax : no lung pulse
- Atelectasis : selective intubation, ARDS

Lichtenstein DA, et al. **The "lung pulse": an early ultrasound sign of complete atelectasis.** Intensive Care Med. 2003 Dec;29(12):2187-92.

Lung pulse



Lichtenstein DA, et al. **The “lung pulse”: an early ultrasound sign of complete atelectasis.** Intensive Care Med (2003) 29:2187–2192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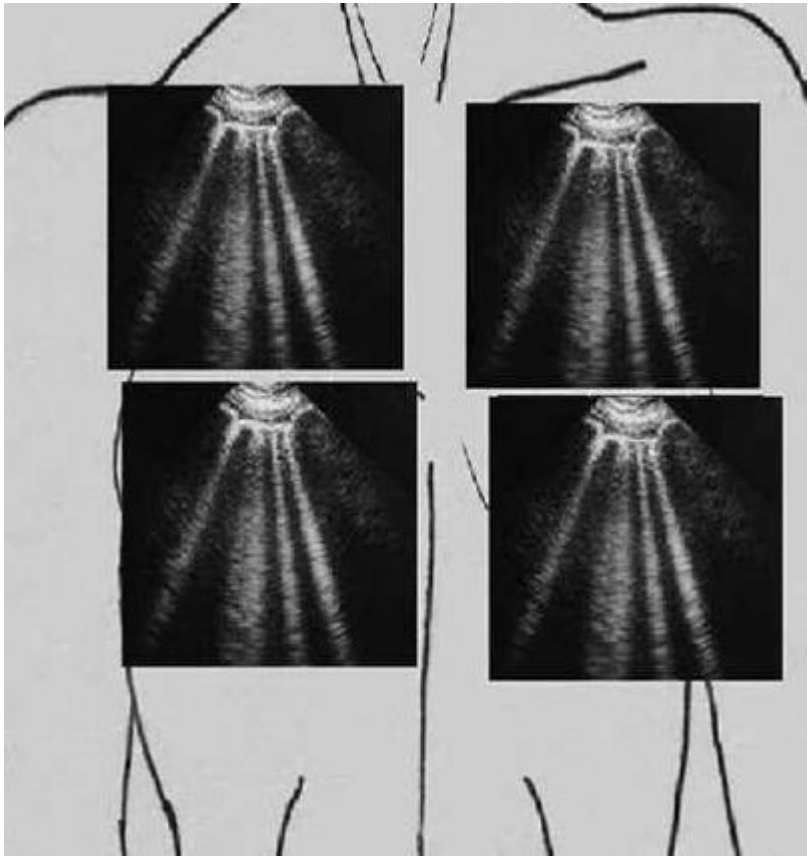
Pulmonary edema

- Anterior-predominant bilateral B line (more > 4)
- Presence of lung sliding
- B-profile
- Smooth pleura
- Abrupt onset of B-line : endpoint of fluid therapy
- Proceed to C-profile

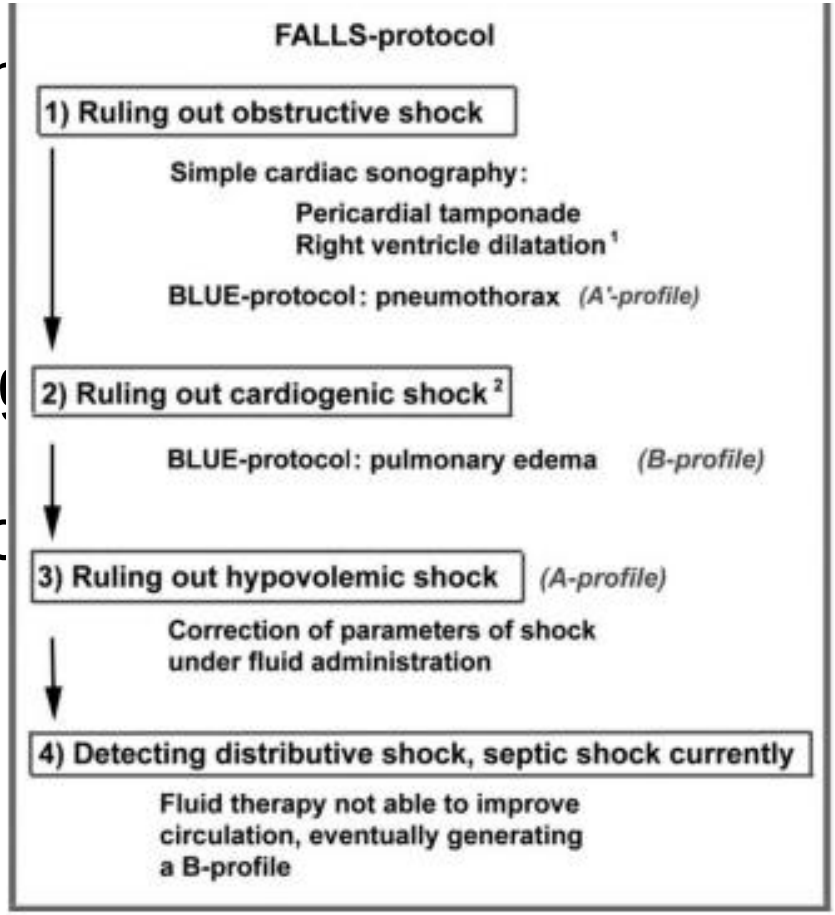
Pulmonary edema



Lichtenstein DA. **Relevance of lung ultrasound in the diagnosis of acute respiratory failure: the BLUE protocol.** Chest. 2008 Jul;134(1):117-25.

FALLS-Protocol

- Not yet supported by clir
- Dichotomy
- Change of A-lines to lun
- Direct biomarker of clinic



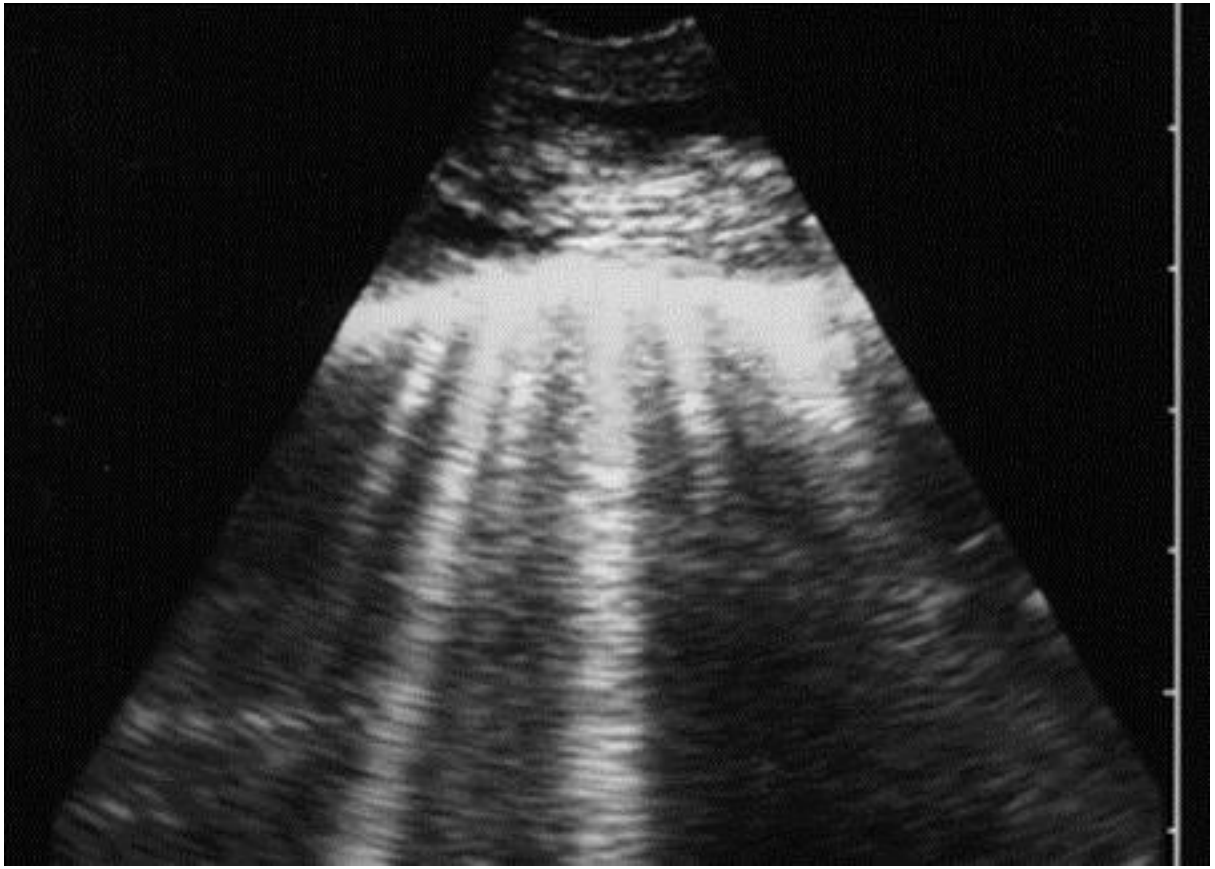
Lichtenstein DA. **BLUE-protocol and FALLS-protocol: two applications of lung ultrasound in the critically ill.** Chest.2015 Jun;147(6):1659-70.

BLUE protocol

- Lung rockets : only anterolateral part
- Pulmonary edema : diffuse B-line + lung sliding
- Pneumothorax : A-line + Lung point + sliding(-)
- Pneumonia : B-pattern + sliding(-), A-profile +PLAPS, A/B profile, C-profile

Limitation

- Do not evaluation of trachea
- Chest tube
- Dressing
- Subcutaneous emphysema
  - No Bat sign
  - E-lines
- Huge bullae
  - finding of lung sliding
  - D/D with pneumothorax




Idx 1
Chonnam University Hospital
2016-04-01
PARK JIN OHK
M 76Y 21634361
DOB:1939-09-08
R
ap
Idx 3
Vivid S5
Se 1
CNUH
2016-04-01
O 21634361
Idx 2
Idx 1
Vivid S5
Se 1
Im 2
Im 1
US
Op. USR
2016-04-01/18:48:08
50pt
W 256
L 128
Z 100%
Compression 9:1
Chest
AP (17X17)
2016-04-01/13:09:52
W 3968
L 2306
Z 100%
Compression 2:1