AFMP
Association Franco-Méditerranéenne de Pneumologie

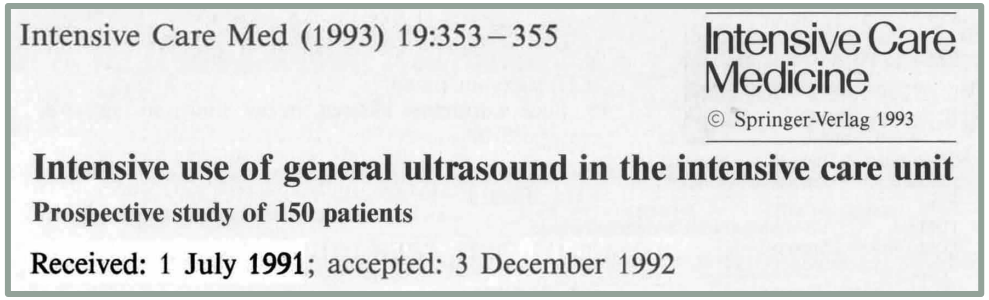
L'échographie pulmonaire

Dr Christian Etel
Service d'Anesthésie et Réanimation
Hôpital Tel Chiha - Zahlé

Le poumon, un exclu de l'échographie ?

"Les poumons représentent un obstacle majeur à l'utilisation de l'échographie au niveau du thorax".

In Harrison PR. Principles of Internal Medicine. 1992:1043



Intensive Care Med (1993) 19:353–355

Intensive Care Medicine

Intensive use of general ultrasound in the intensive care unit

Prospective study of 150 patients

Received: 1 **July 1991**; accepted: 3 December 1992

La définition de l'échographie critique associe :
Le diagnostic
Un geste thérapeutique immédiat.

La définition inclut le rôle du réanimateur en première ligne, et le poumon comme cible prioritaire.

Performances

	Sens./Sp	Source (référence = scanner)
Epanchement pleural	94 / 97	
Consolidation alvéolaire	90/98	
Syndrome interstitiel	100/100*	
Pneumothorax complet	100/91-60	
Pneumothorax occulte	79/100	

* 93/93 dans Abstract si comparé à la radiographie, 100/100 dans Results quand comparé au scanner

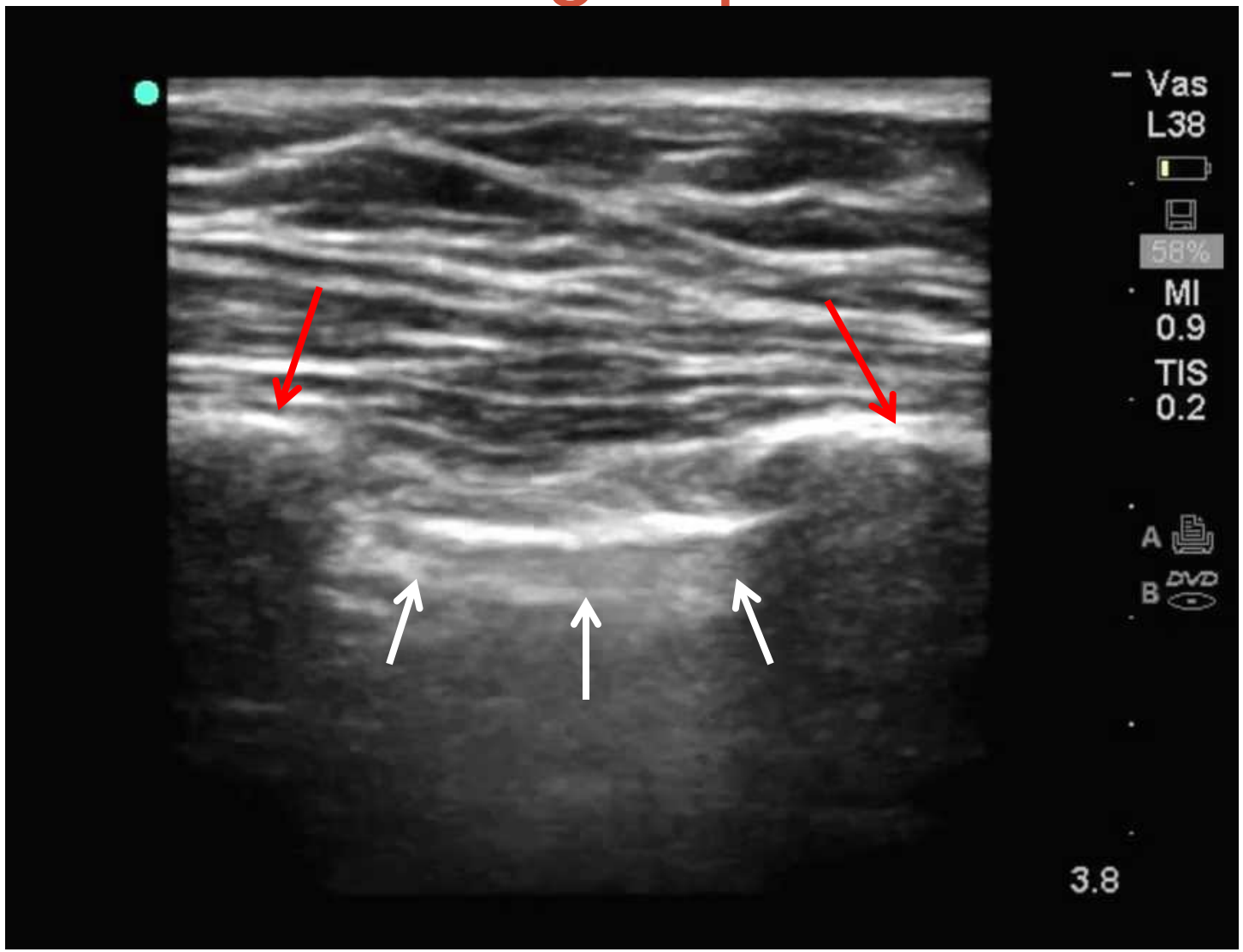
Principes de l'échographie pulmonaire

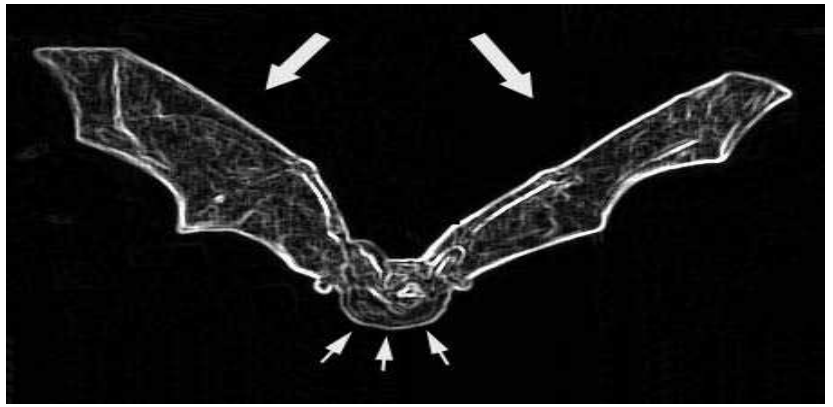
- Machine d'échographie 2D simple
- Liquides et gaz coexistent dans le thorax : Des artéfacts sont créés par le gradient d'impédance élevé entre gaz et liquide
- L'identification des signes sur l'échographie pulmonaire est basée sur l'analyse de ces artéfacts
- Le poumon est un organe vital, large et les signes sont dynamiques en temps rééls
- Presque tous les syndromes aigus sont en relation avec la surface
- Les signes sont tous issus de la ligne pleurale

Les **dix** signes de base

1. La ligne pleurale
2. Le glissement pleural
3. La ligne A
4. La ligne B et les fusées pleurales
5. Le signe de la fractale
6. Le signe pseudo-tissulaire
7. Le signe du dièse
8. Le signe de la sinusoïde
9. Le signe de la stratosphère
10. Le point poumon

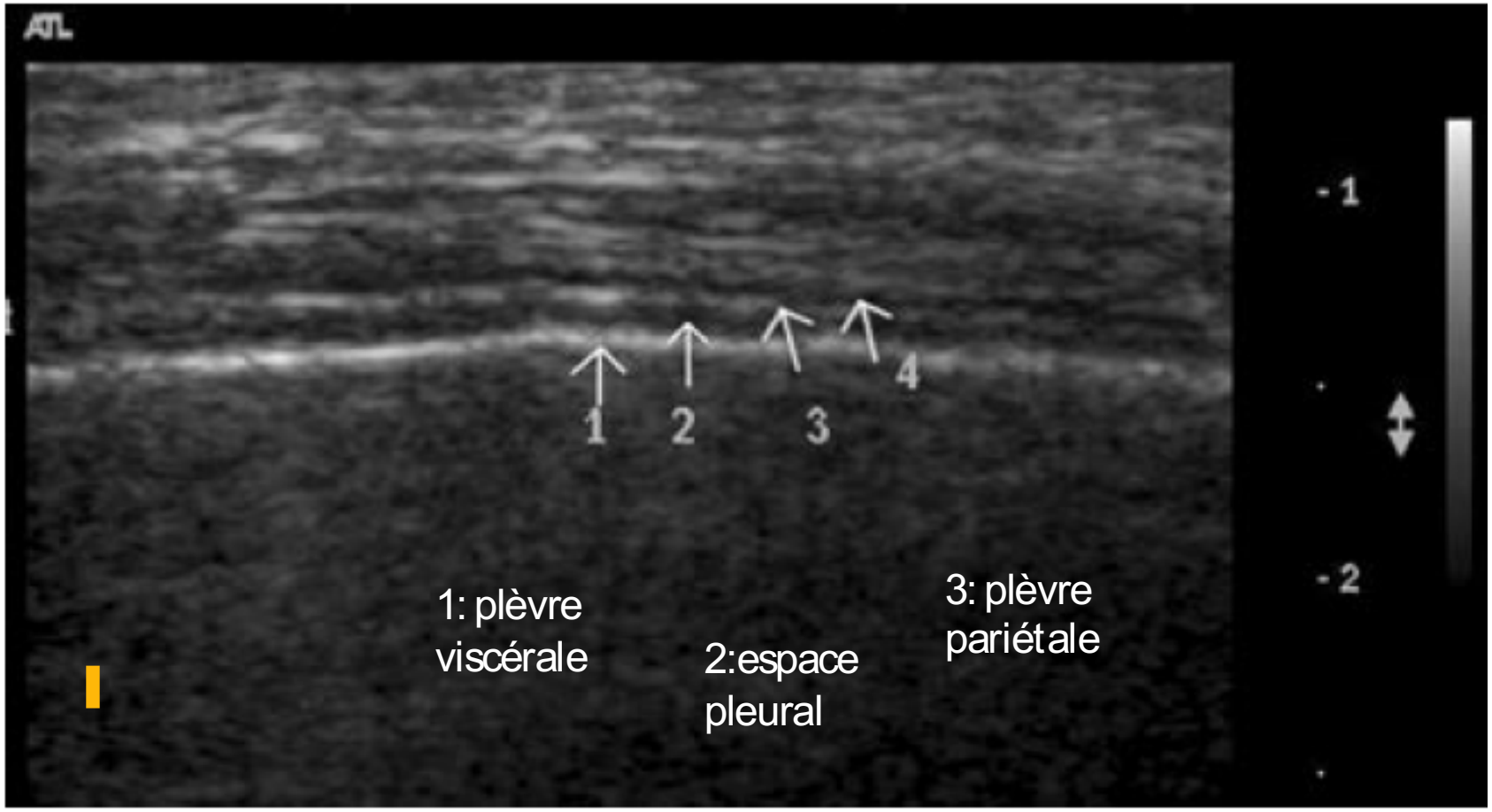
1. La ligne pleurale



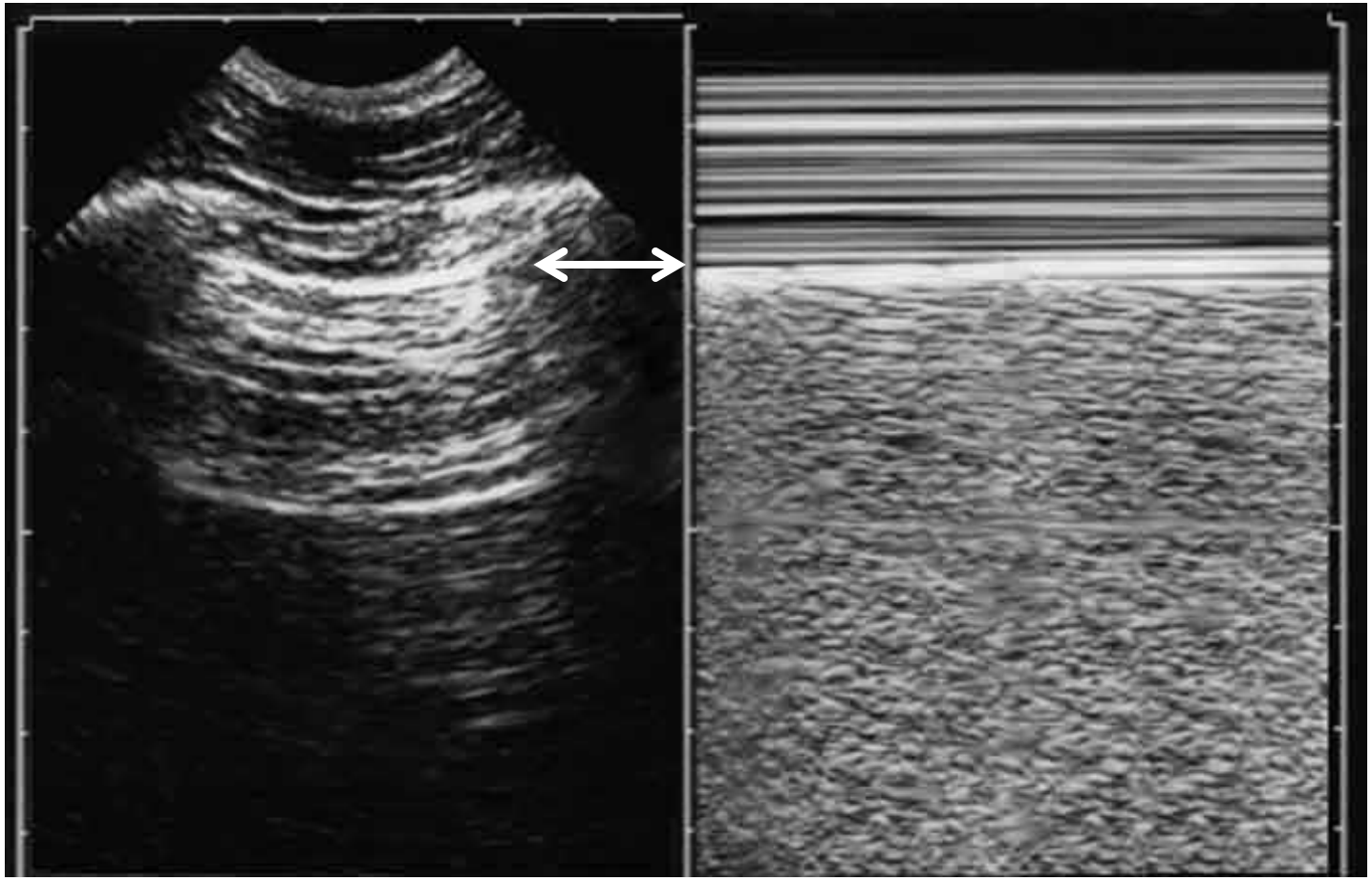


Signe de la chauve-souris

1. La ligne pleurale



2. Le glissement pleural et le signe du bord de la mer



Séparation en deux phases par la ligne pleurale (Mode TM)
Permet d'objectiver le glissement pleural sans Doppler

Le LUS – Lung Ultrasound Score

- Poumon divisé en 6 régions d'explorations
  - Antérieur
  - Latéral
  - Postérieur

  } supérieur et inférieur

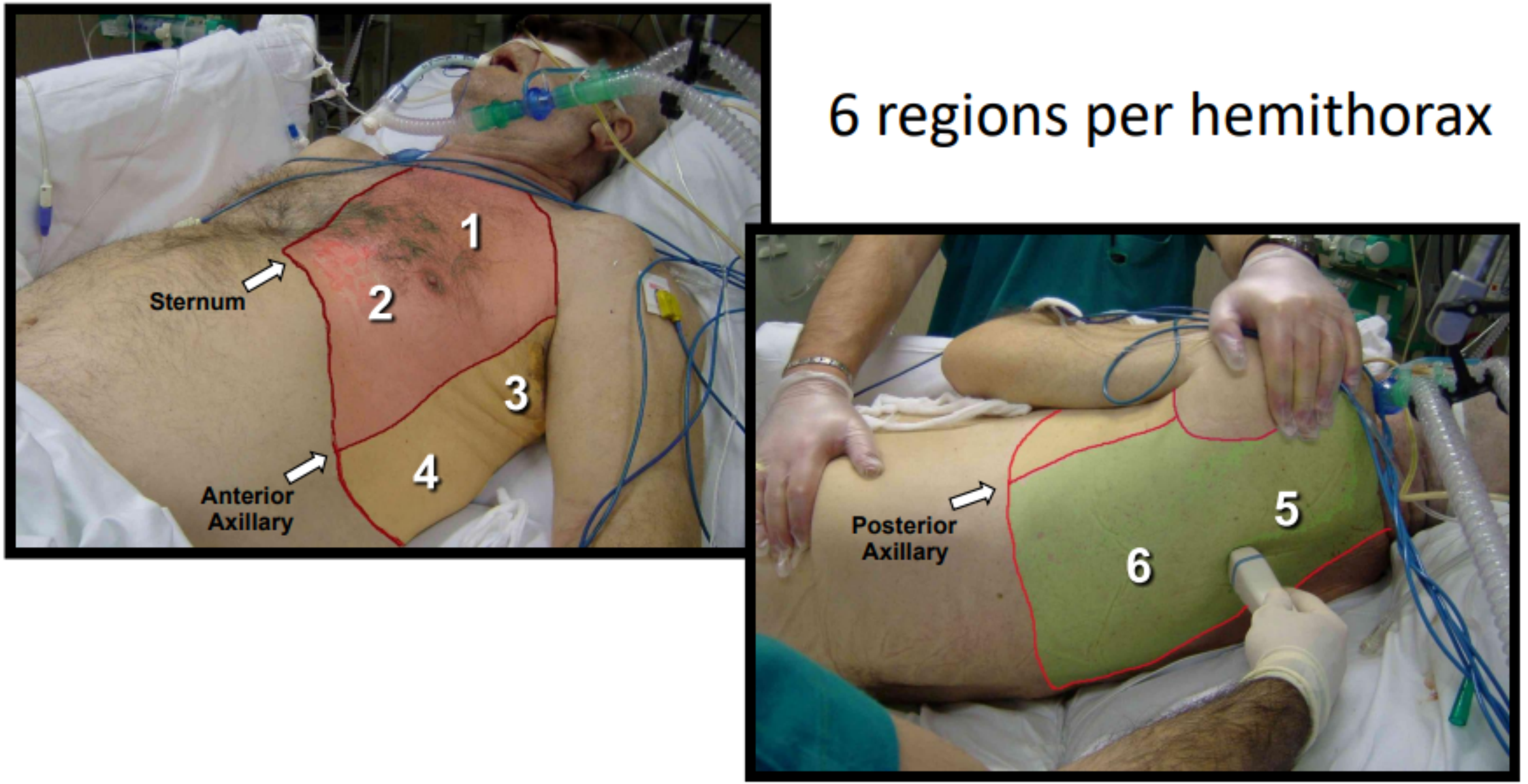
  - **Ou points BLUE et PLAPS**

- Chaque région est conférée un score selon le degré de perte de l'aération
  - **0 1 2 3**

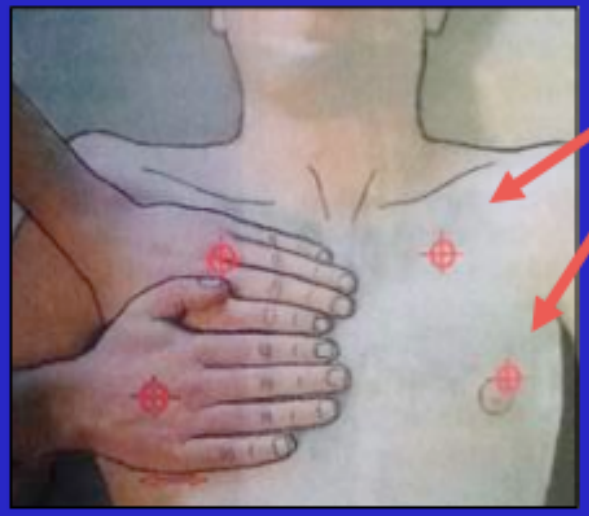
Perte d'aération croissante

- Une lettre est rajoutée pour indiquer le caractère du signe identifié

6 regions per hemithorax



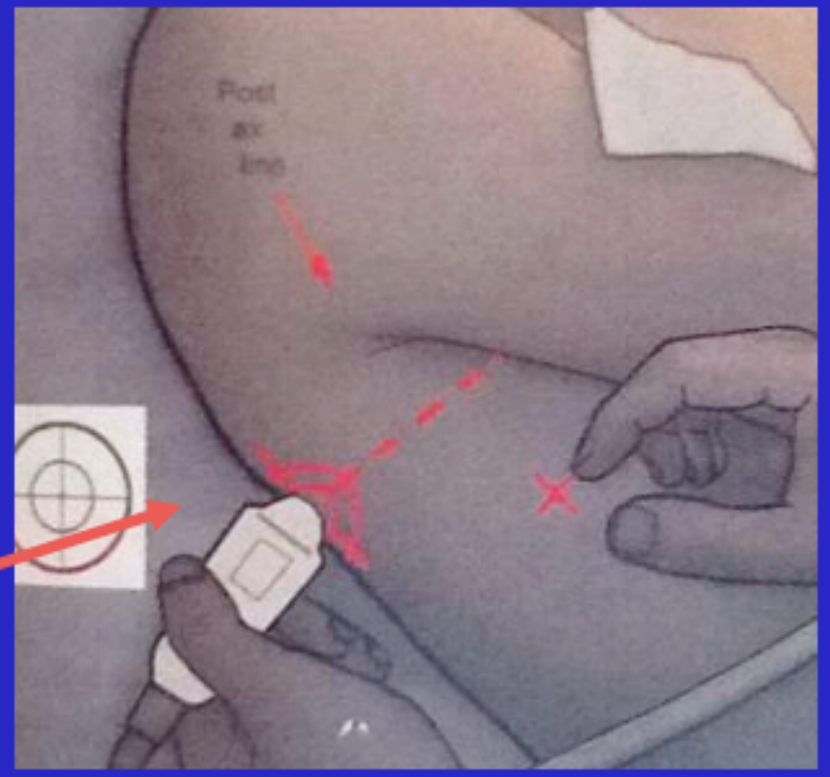
Points BLUE et PLAPS

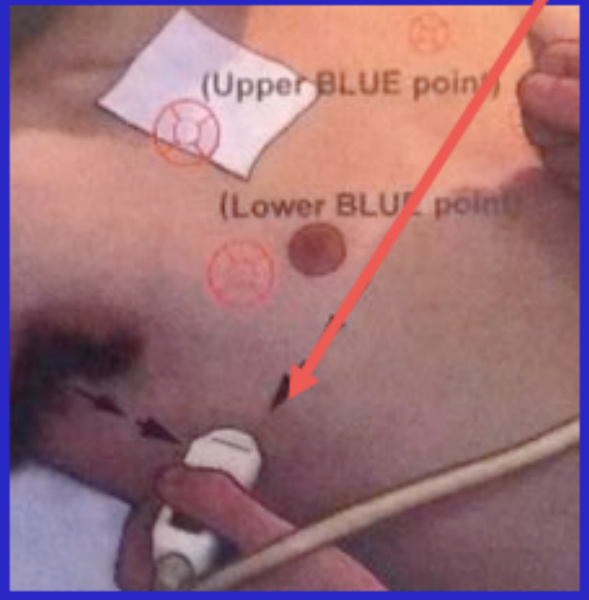


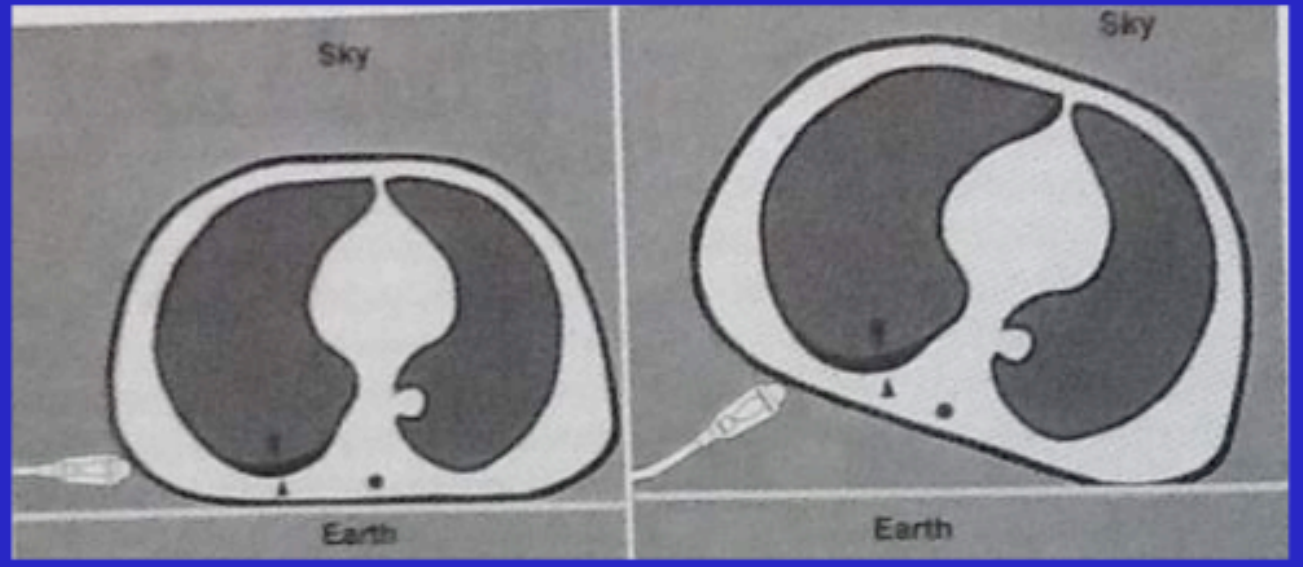
Upper and Lower BLUE points

Phrenic point

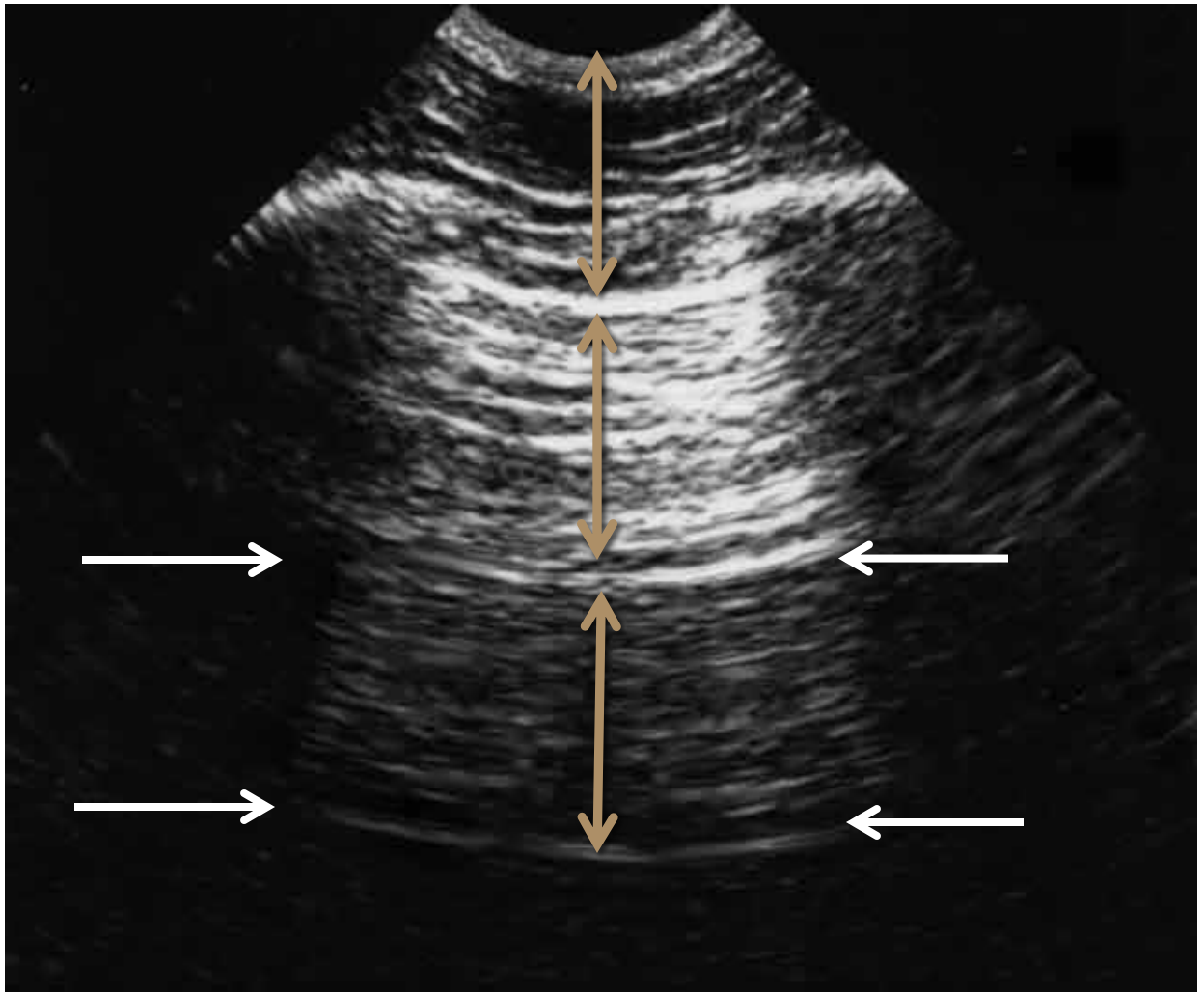
PLAPS point



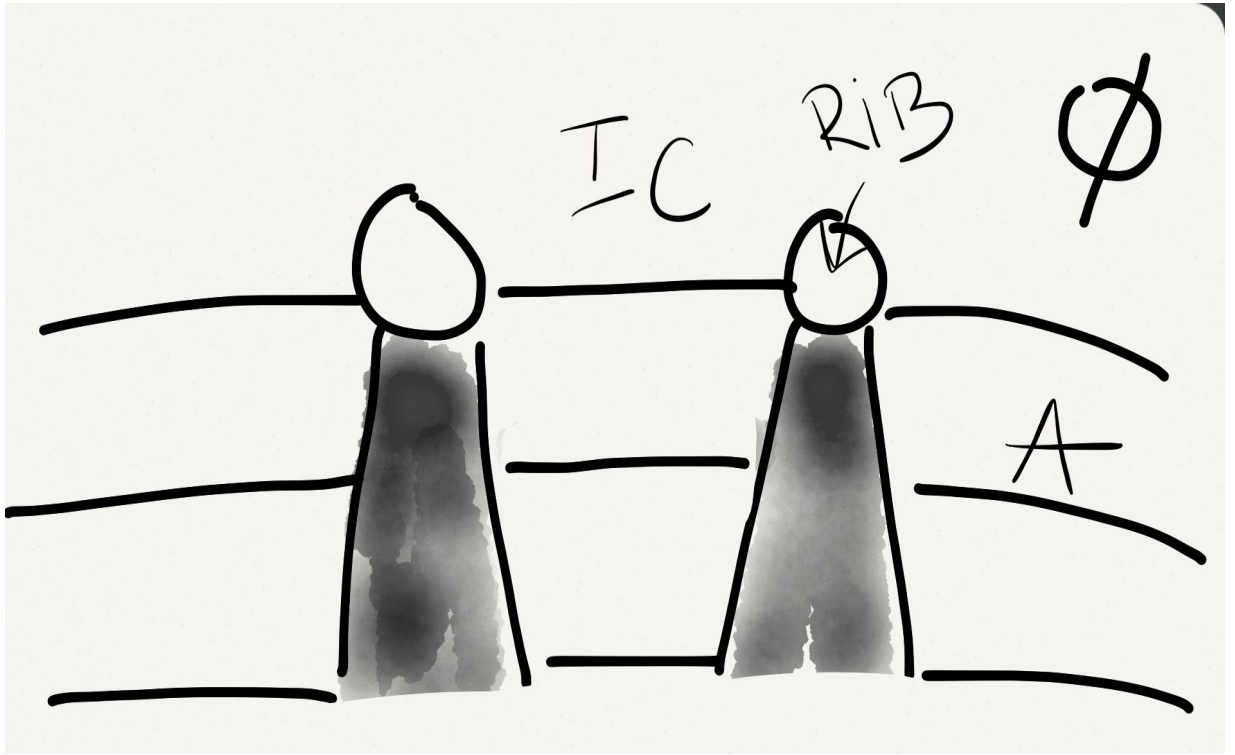




3. Le signe de la ligne A



- La ligne échogène horizontale naissant de la ligne pleurale
- Elle indique une image aérique

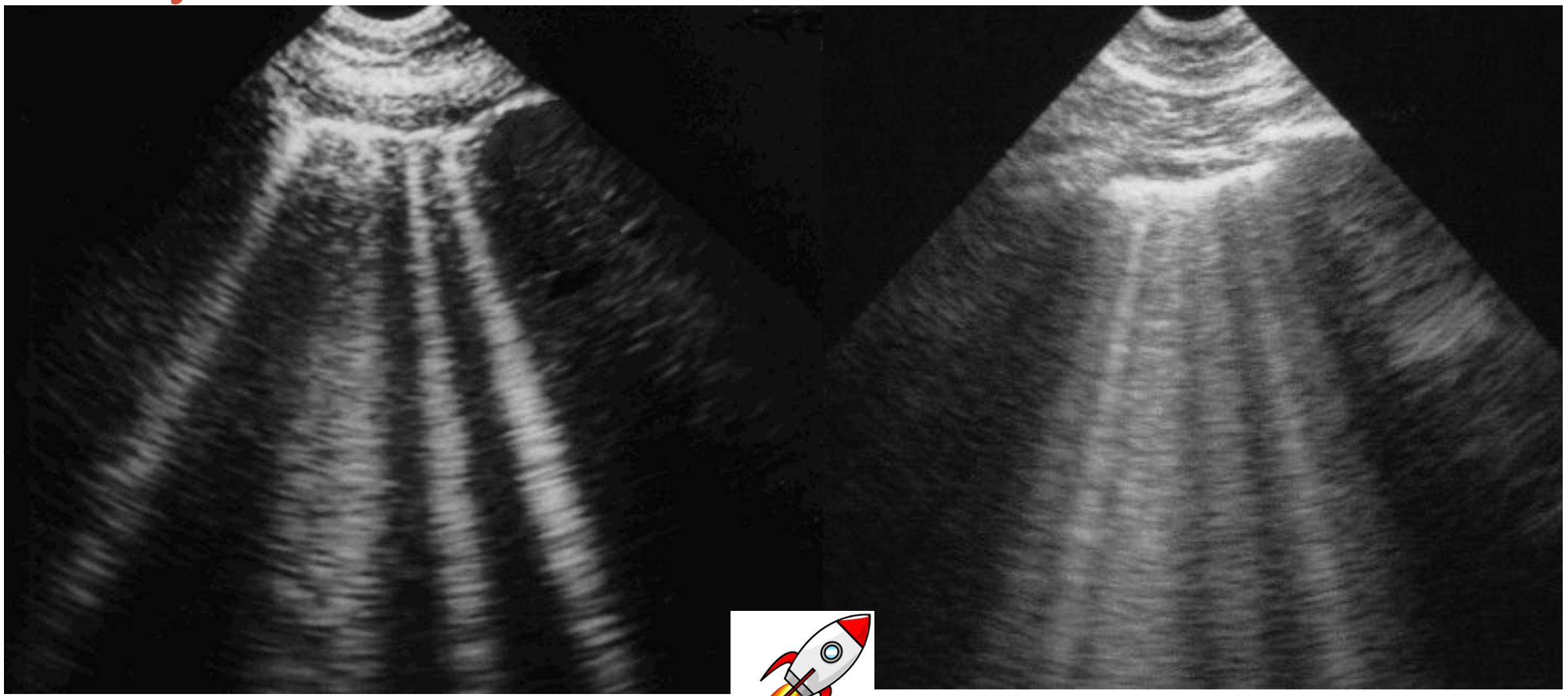


Ligne A -Normal

Cotation ZERO - aération normale

(avec glissement pleural)

4. La ligne B ou fusées pleurales
Syndrome interstitiel



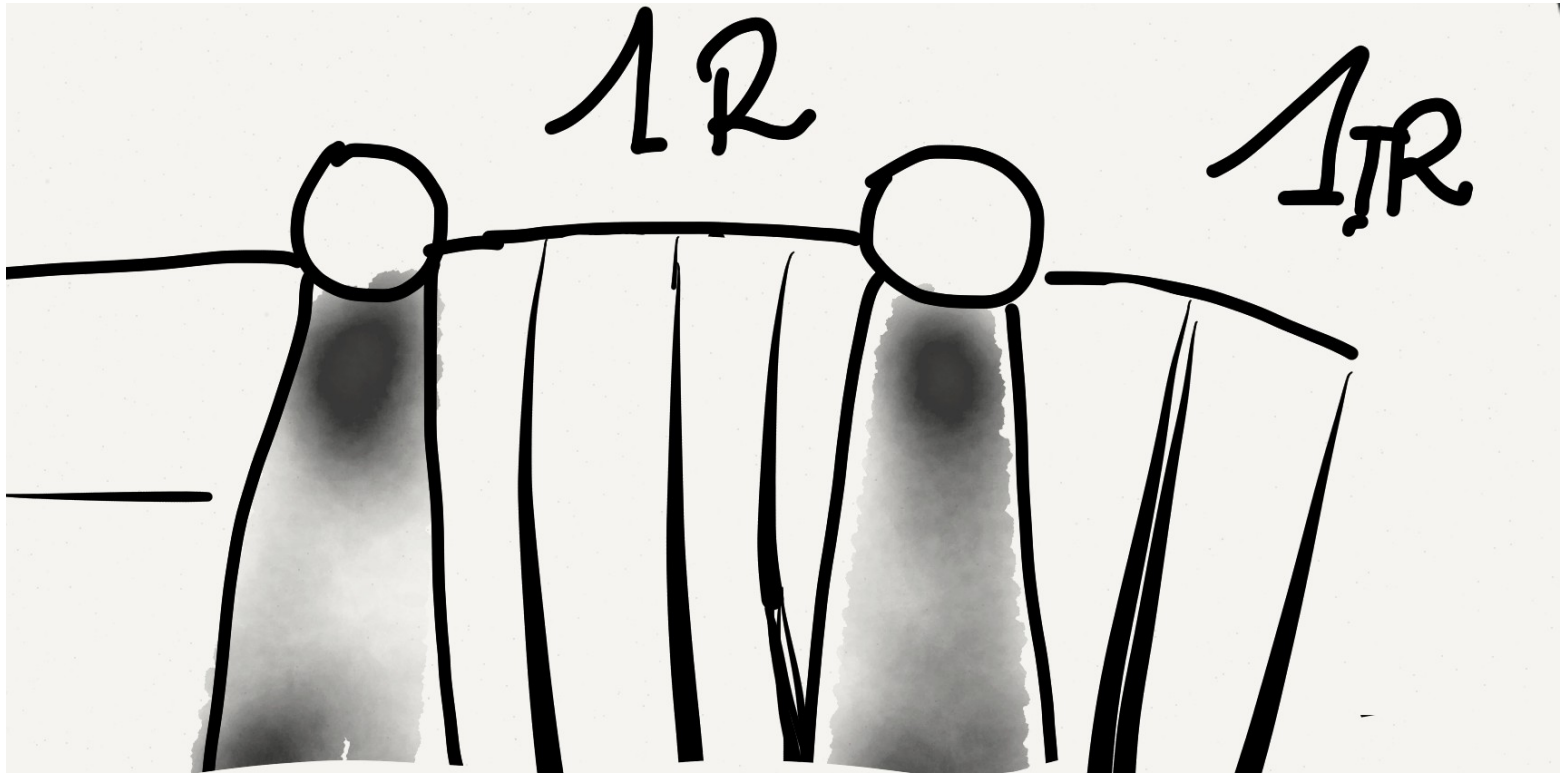
4. La ligne B

Trois critères constants (100%):

- Artéfact en queue de comète
- naissant de la ligne pleurale
- glissant avec le glissement pleural

Quatre critères quasi-constants (93-97%)

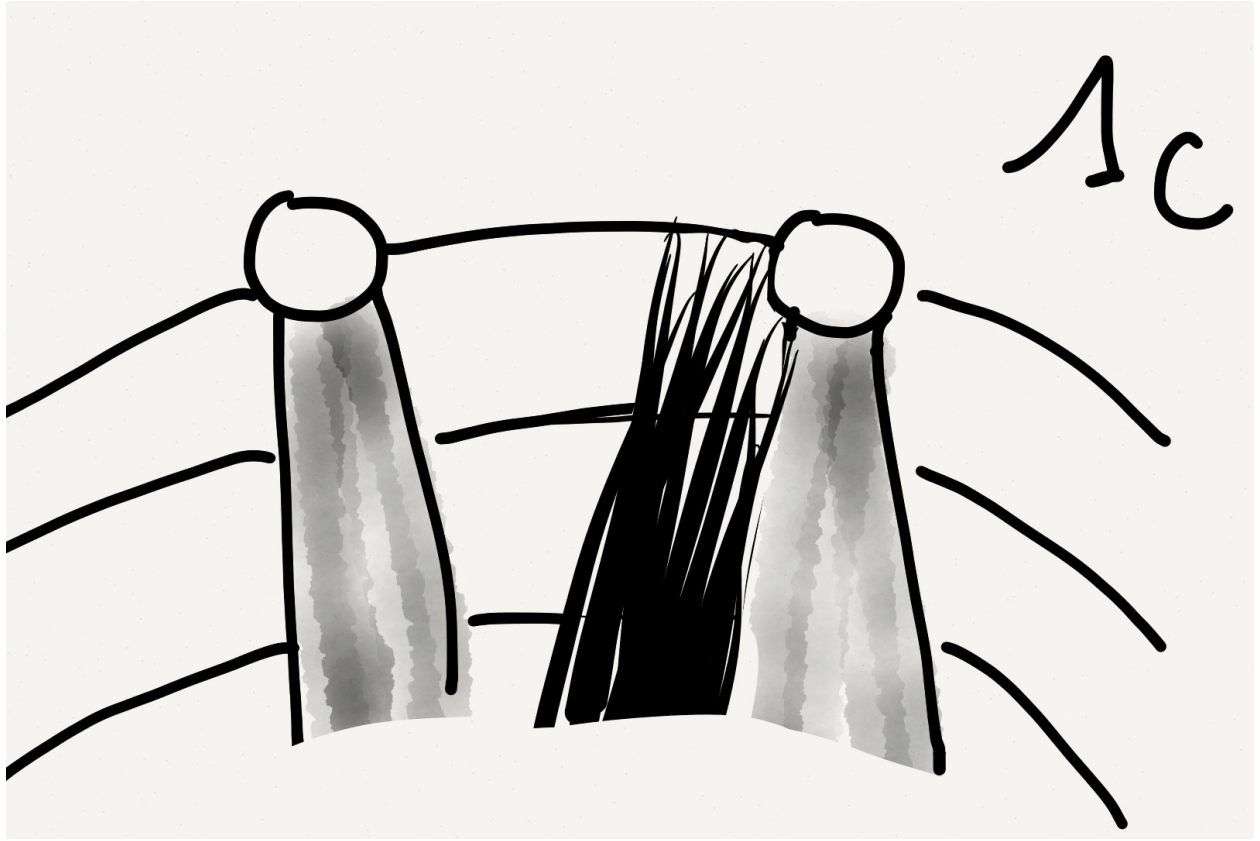
- bien défini tel un rayon laser
- s'étendant sans épuisement
- effaçant les lignes A
- hyperéchogène



Lignes B isolées

perte d'aération modérée

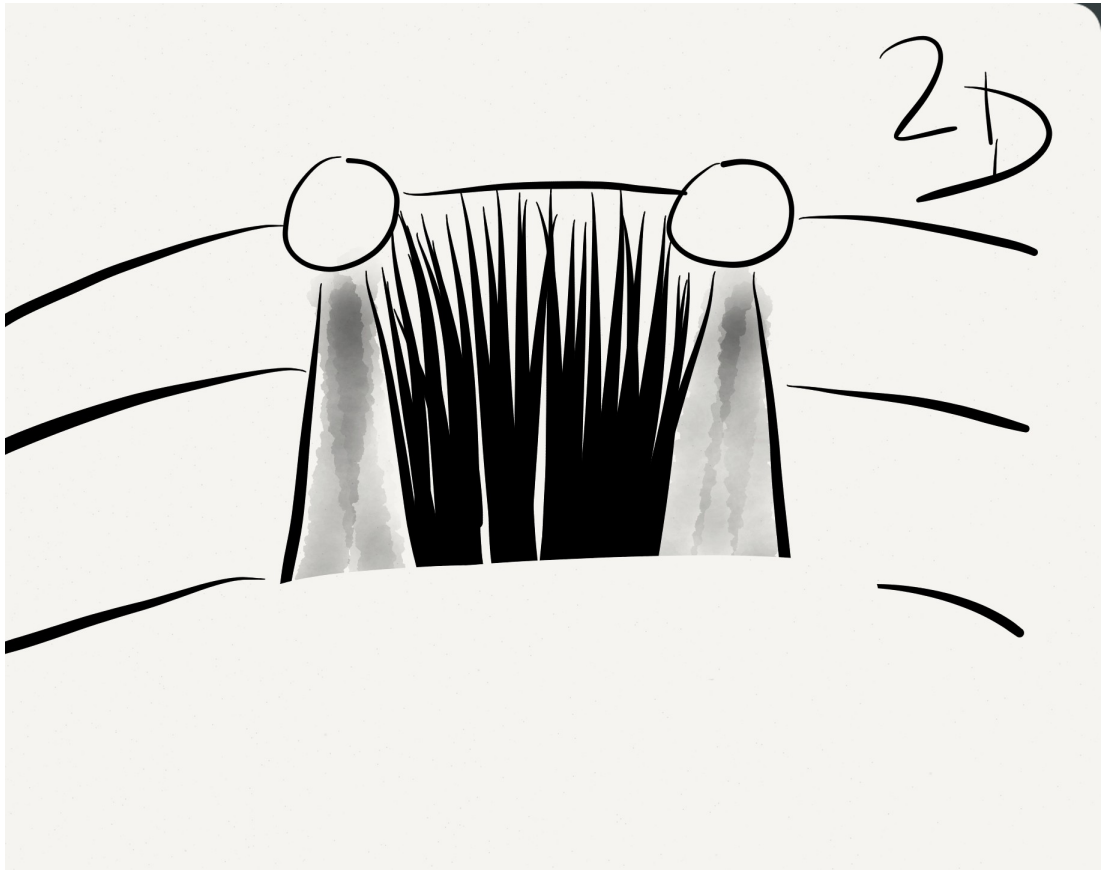
1R - régulièrement espacées et 1IR - irrégulièrement espacées



Lignes B isolées

perte d'aération modérée

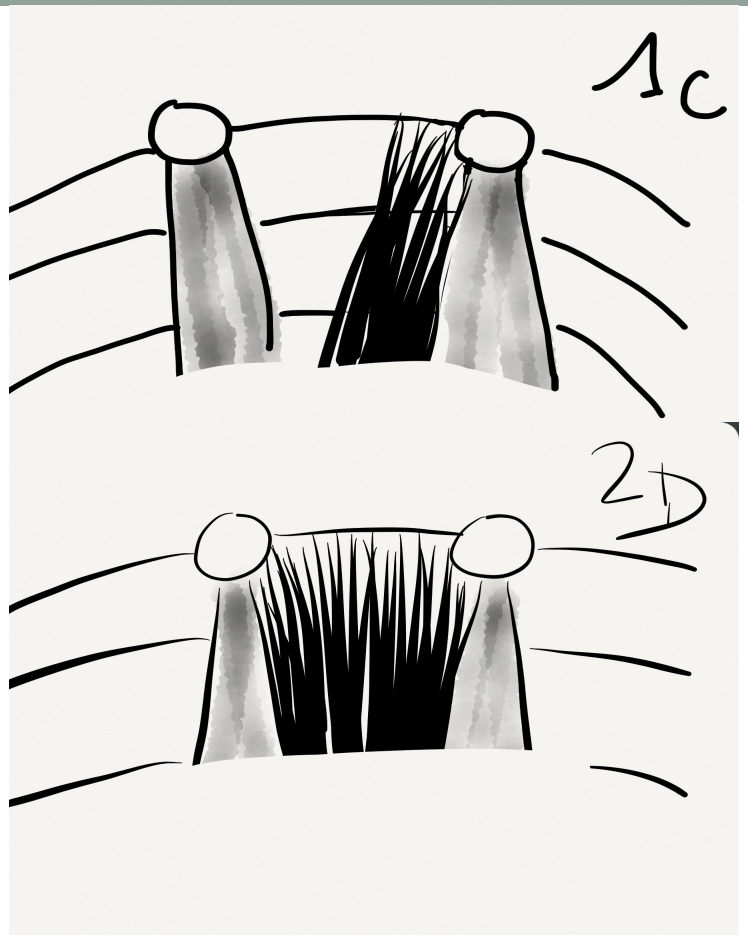
1c - lignes coalescentes n'occupant pas tout l'espace intercostal

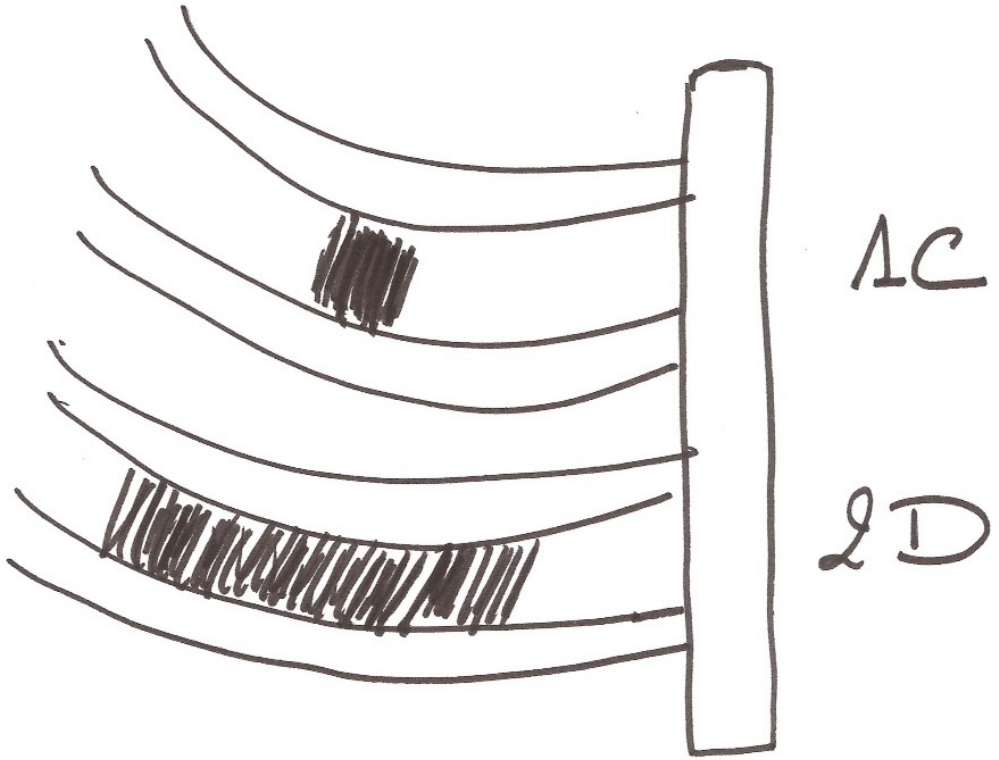


Lignes B confluantes

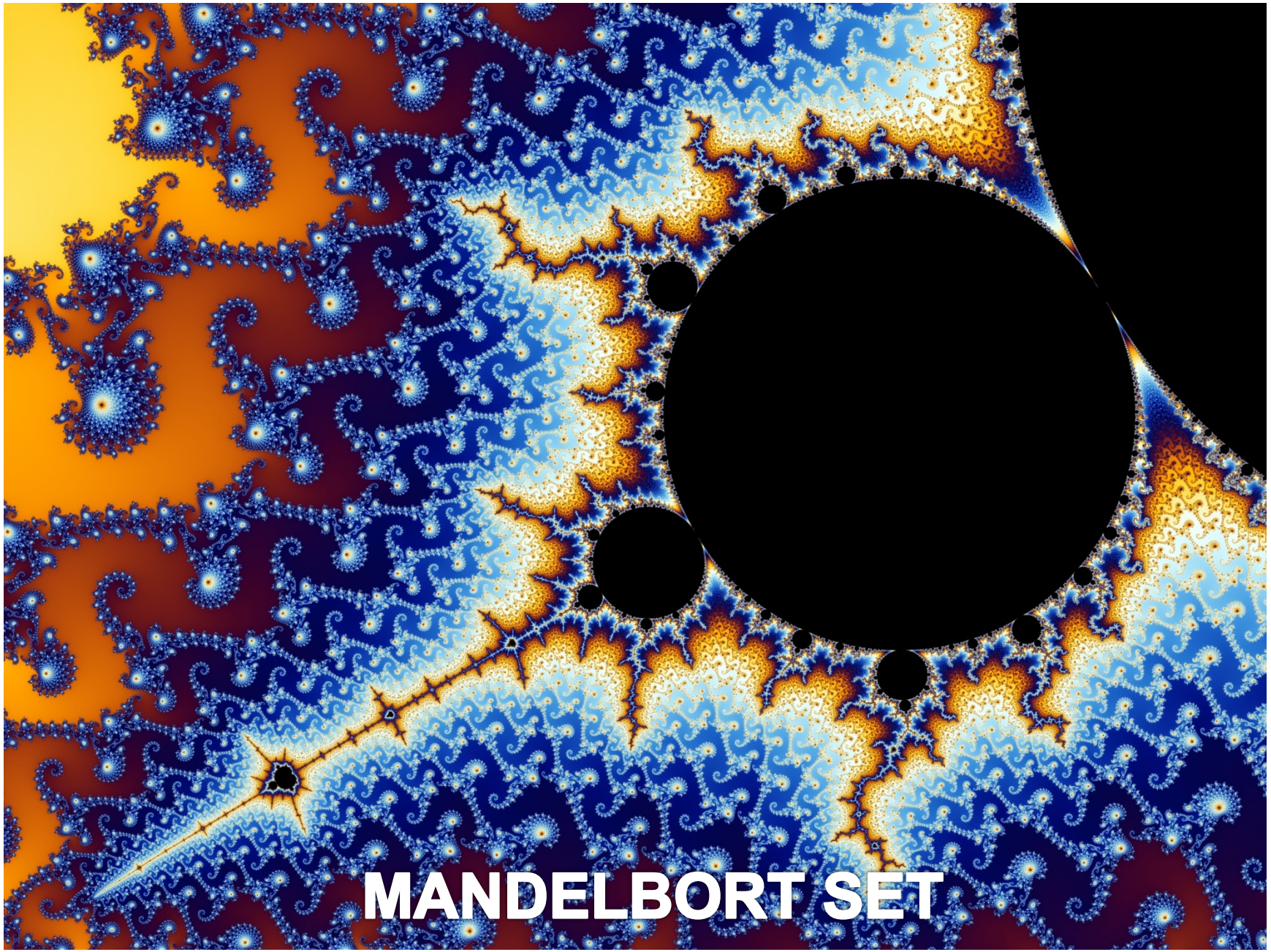
Perte d'aération sévère

2D - lignes confluentes occupant tout l'espace intercostal



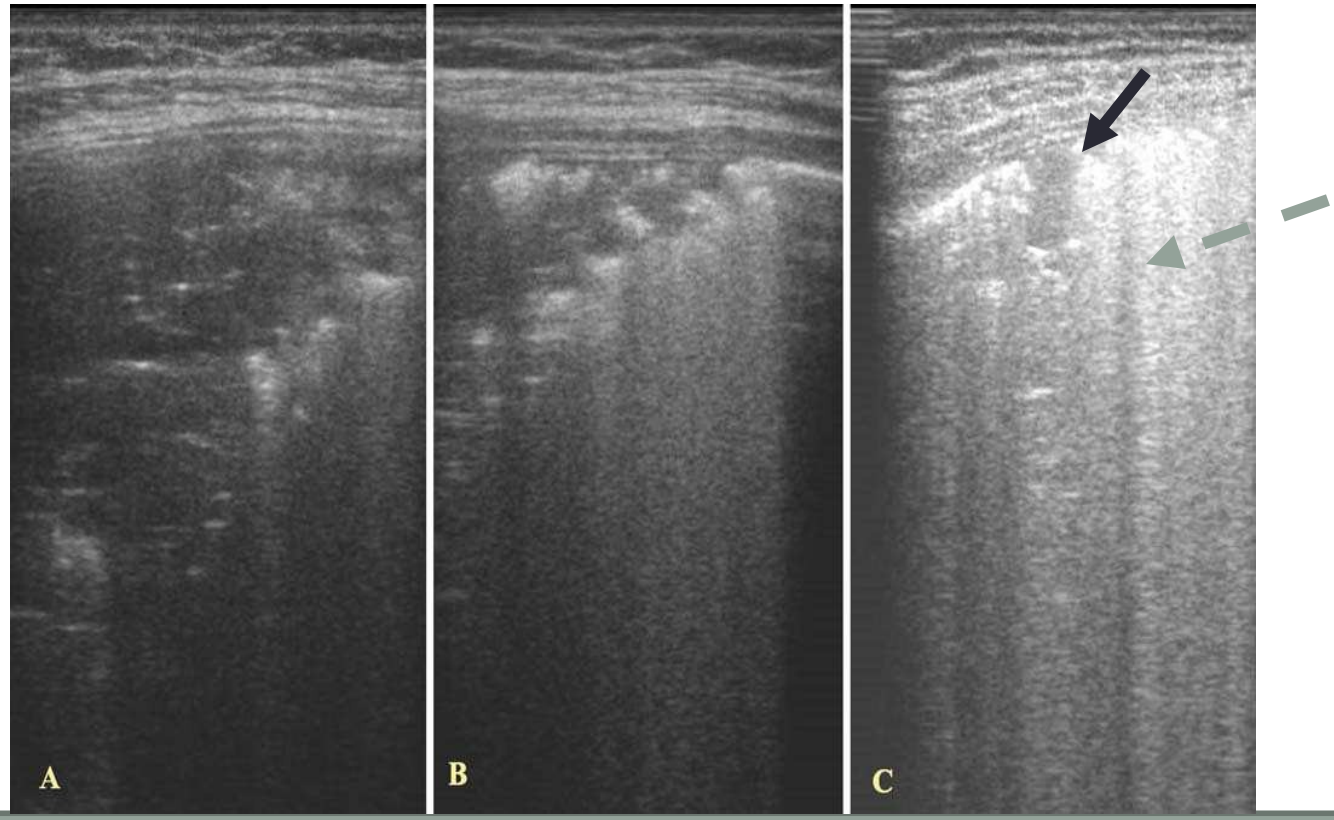


La cotation 2D correspond à une atteinte de l'ensemble de l'espace intercostal contrairement au 1c qui est une atteinte localisée de l'espace intercostal


MANDELBORT SET

5. Syndrome alvéolaire

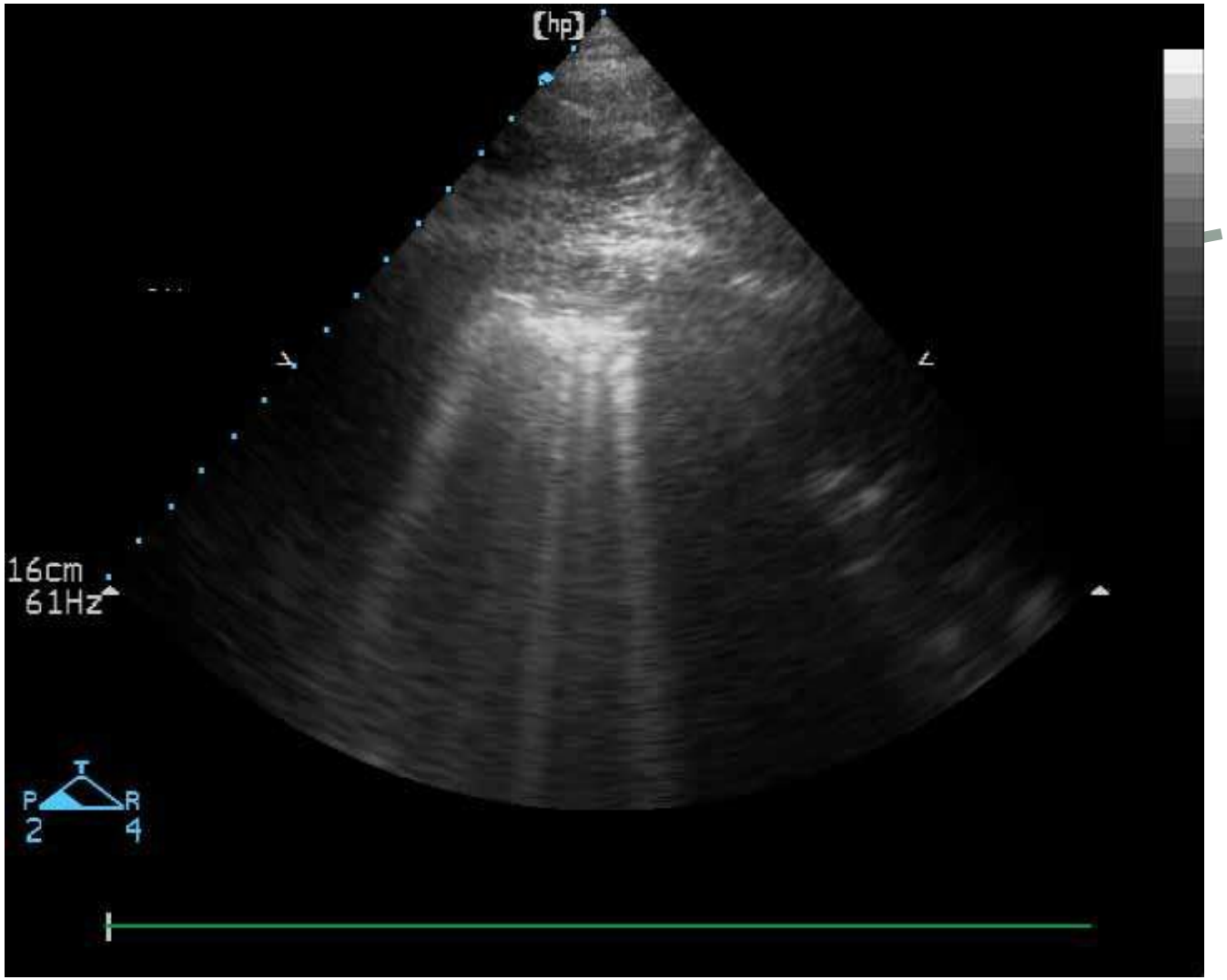
Forme non trans-lobaire : Le signe de la fractale

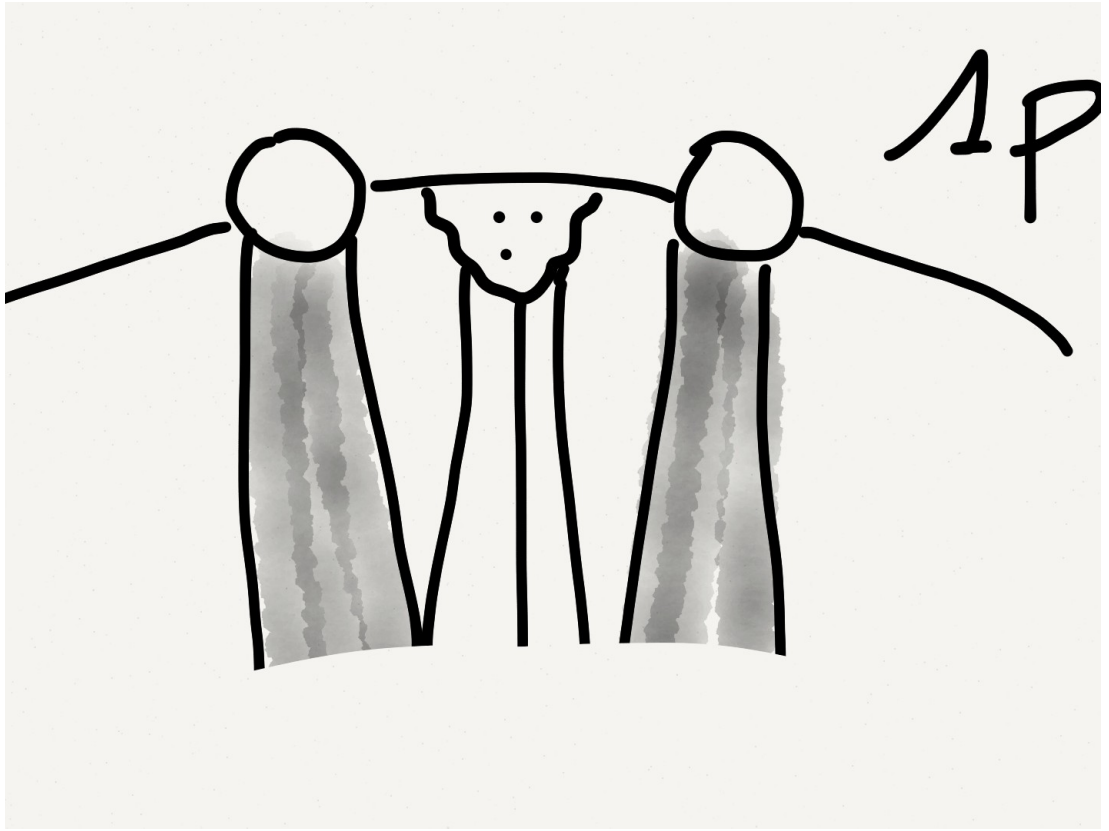


Une ligne déchiquetée, totalement différente de la régulière ligne pulmonaire

5. Syndrome alvéolaire

Forme non trans-lobaire : Le signe de la fractale



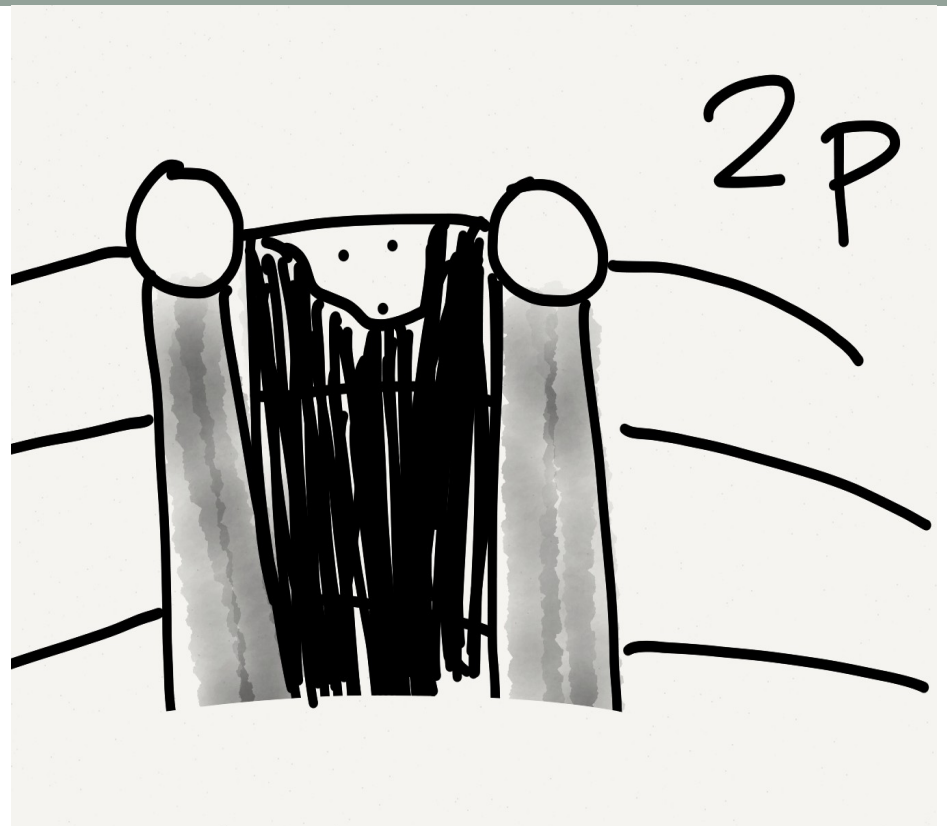


Lignes B isolées

Pertes d'aération modérée

1p - issues de consolidations sous pleurales

(consolidation non translobaire)



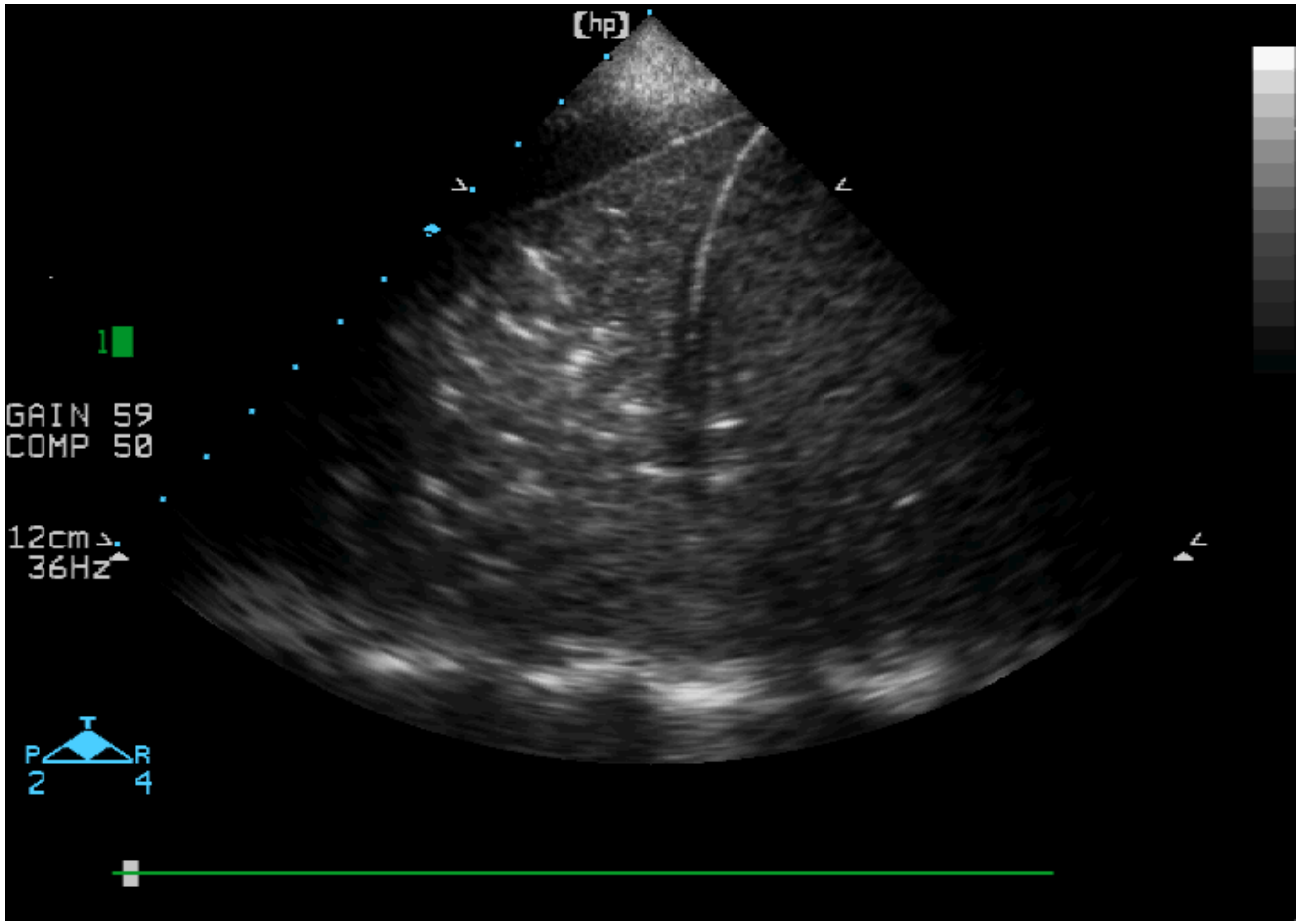
Lignes B confluantes

Perte d'aération sévère

2p - lignes confluentes occupant tout l'espace intercostal issues de consolidations sous pleurales (consolidation non translobaire)

6. Syndrome alvéolaire

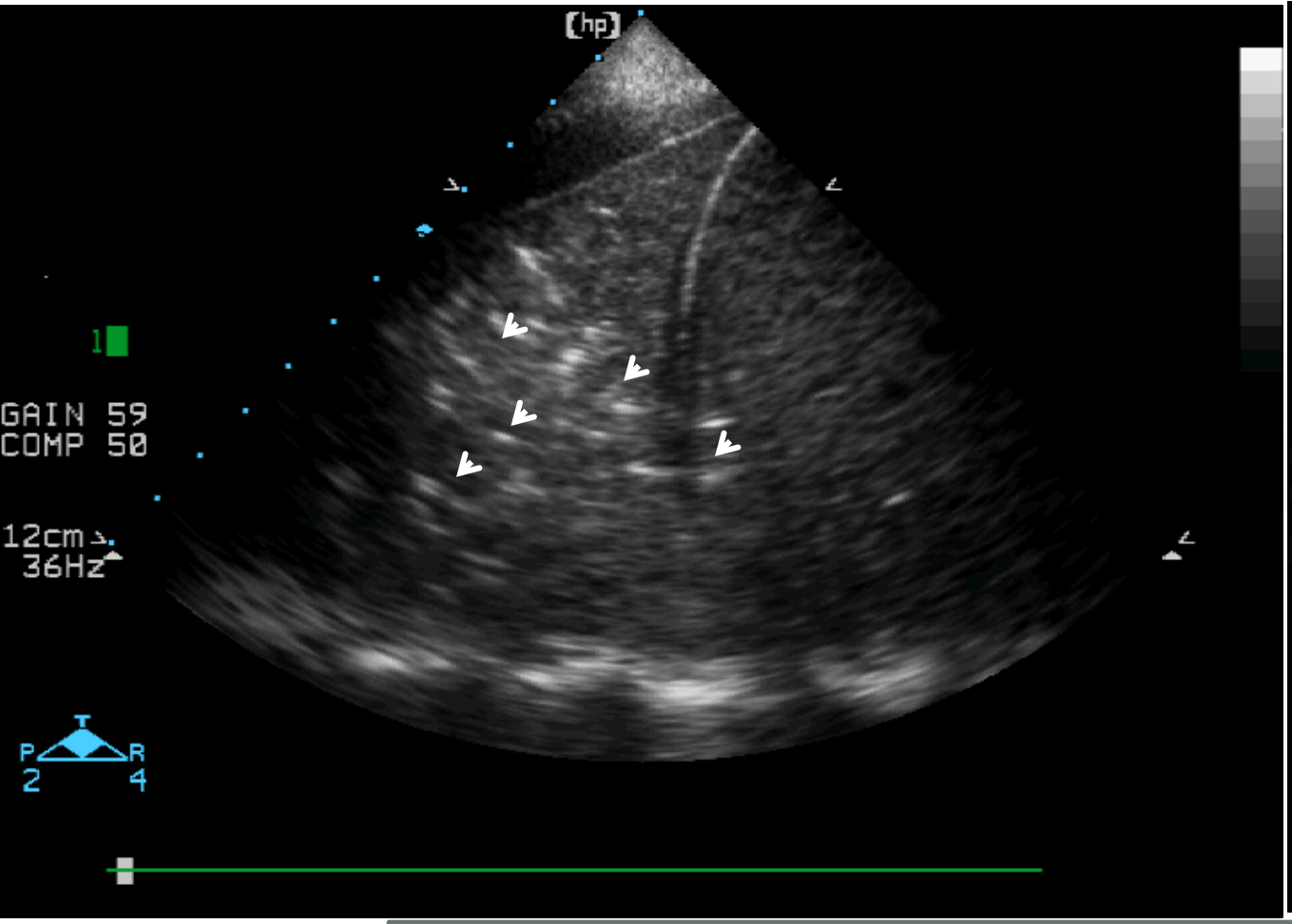
Forme trans-lobaire : Le signe pseudo-tissulaire

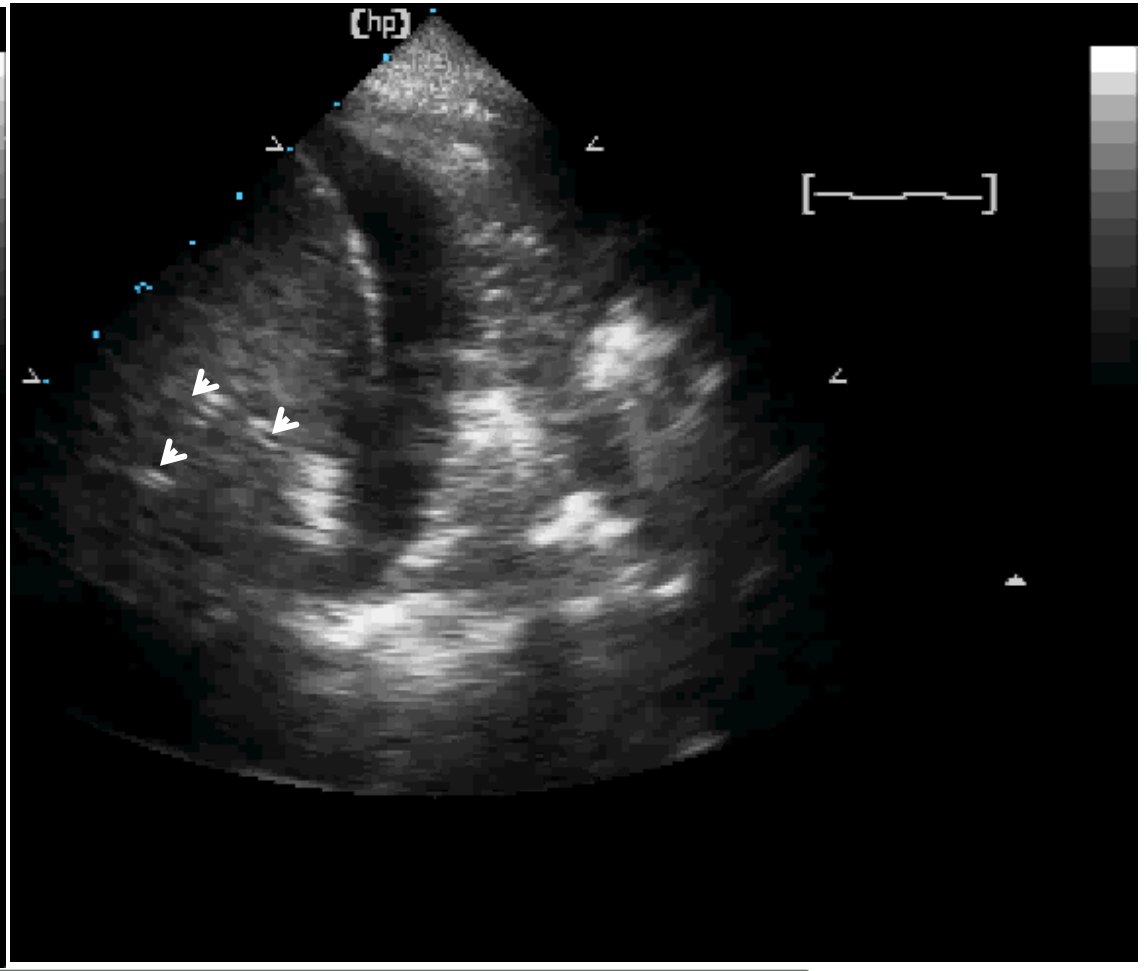


Une perte complète de l'aération : Poumon visible « hépatisé »

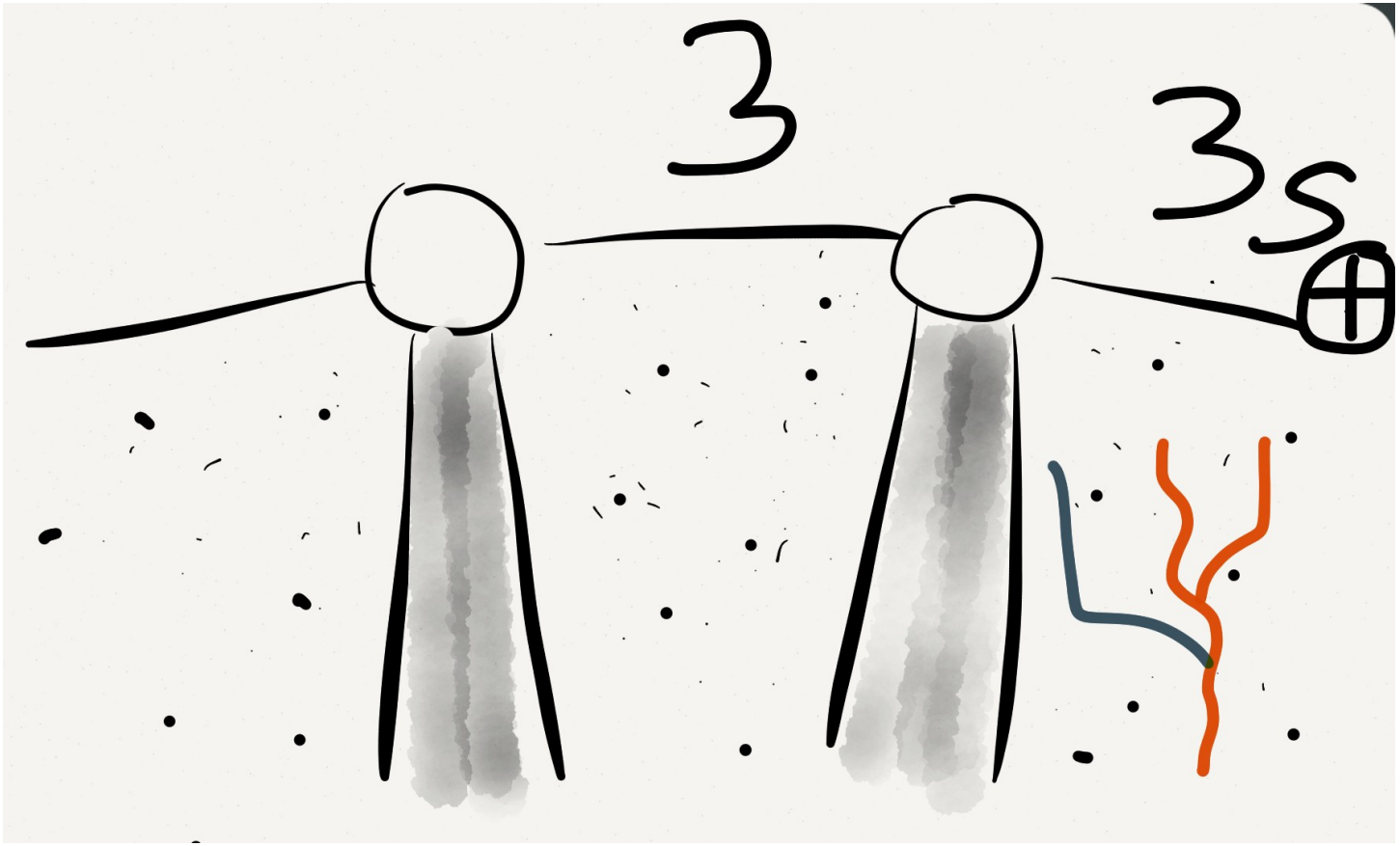
6. Syndrome alvéolaire

Forme trans-lobaire : Le signe pseudo-tissulaire





Images punctiformes hyperéchogènes :
BRONCHOGRAMMES aériques (flèches)



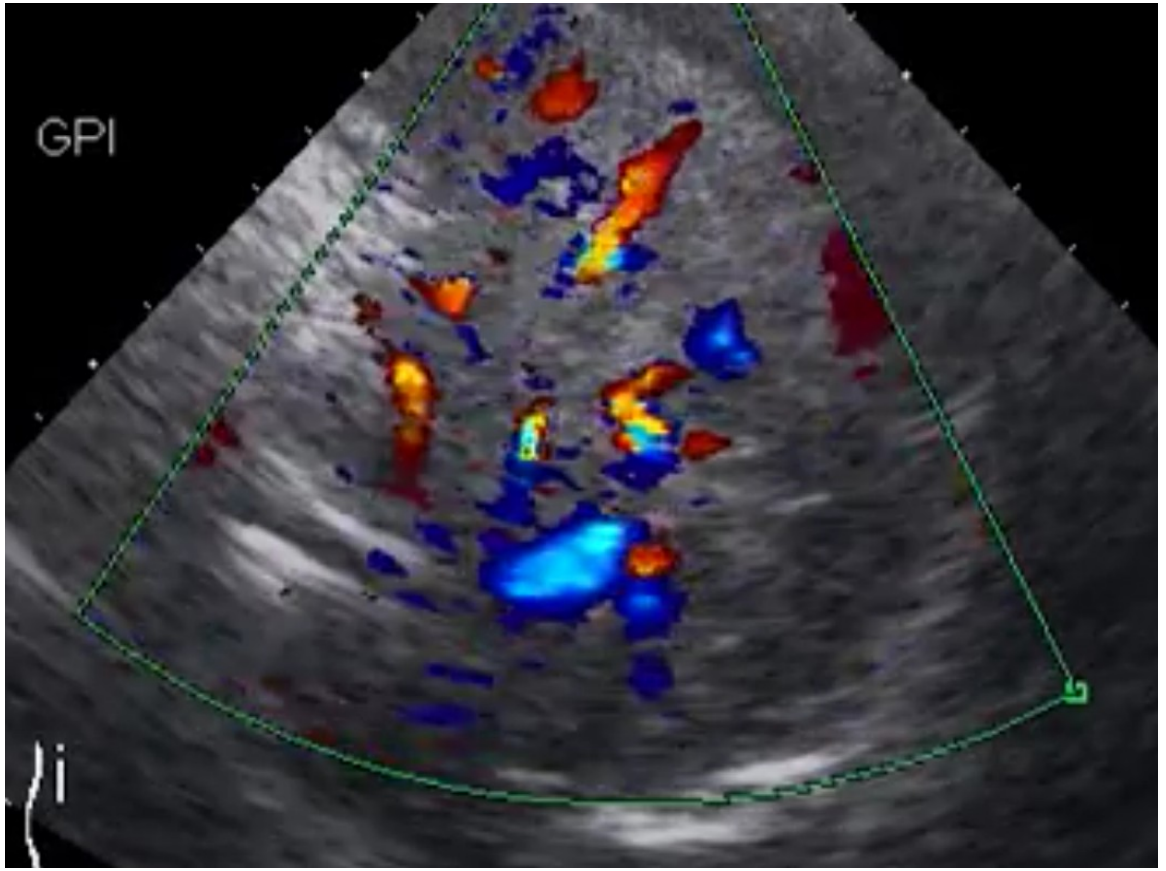
Consolidation -aspect hépatisé

Perte d'aération complète

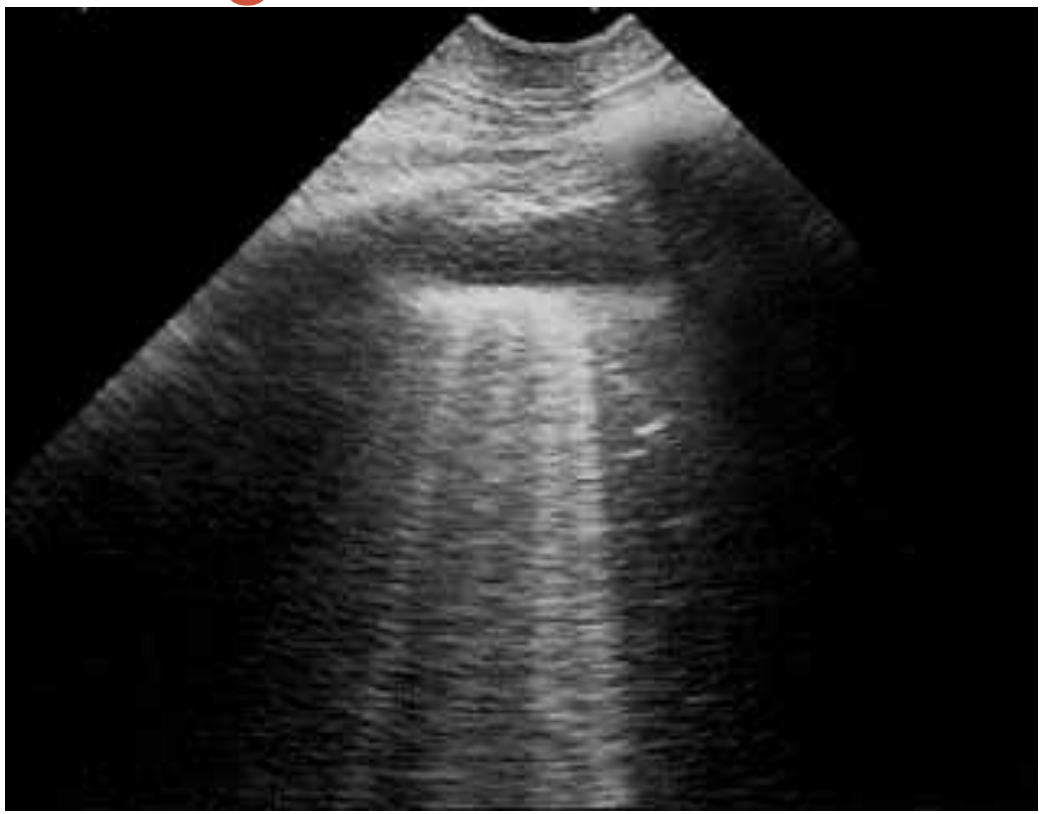
Cotation **3** ou **3S +** si shunt présent

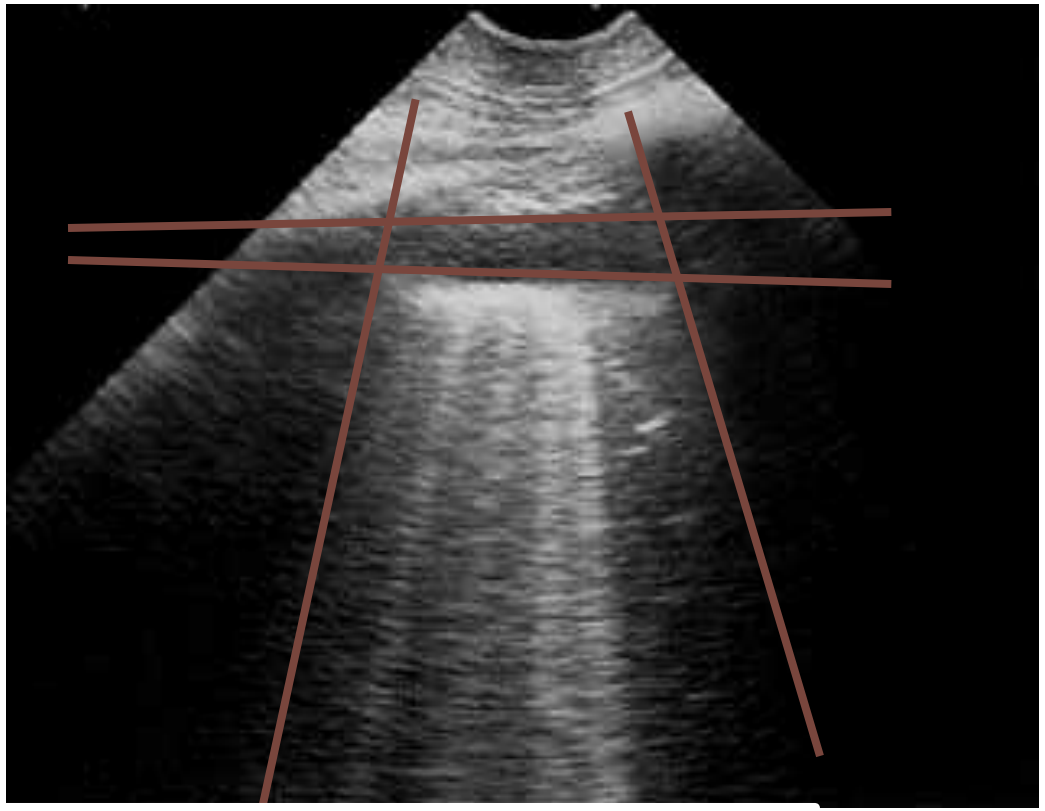
3

3S+

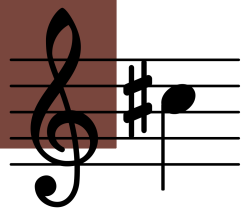


7. Épanchement pleural
Signe du dièse

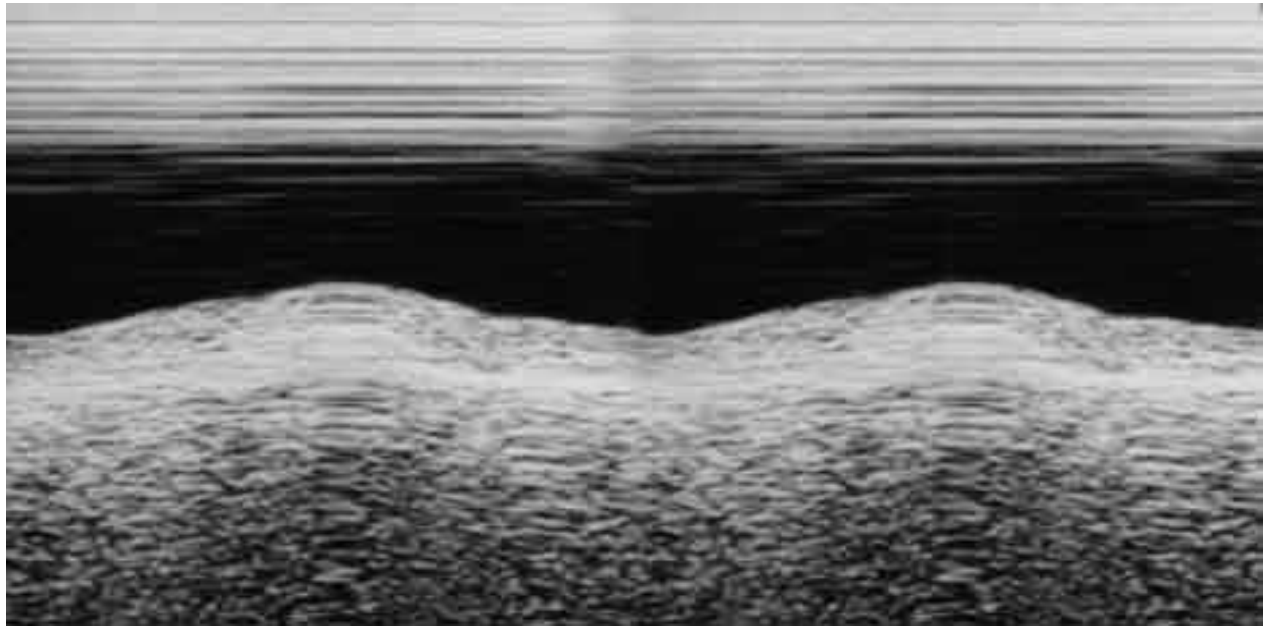




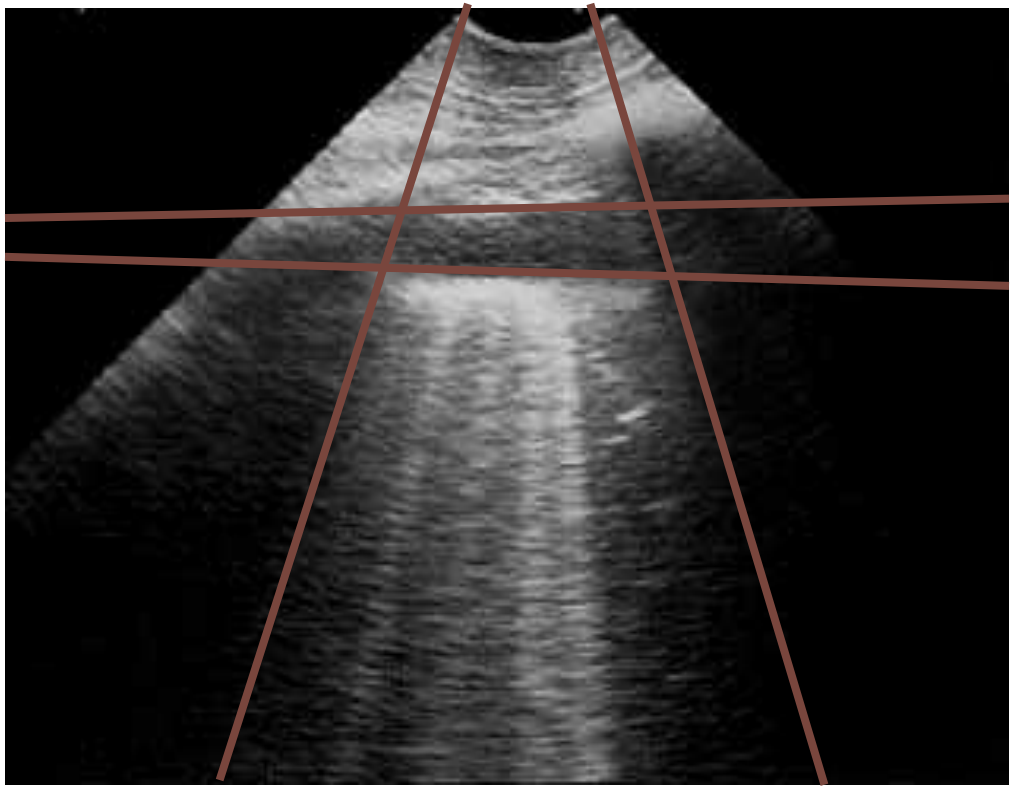
Visualisées :
1. La plèvre viscérale (limite profonde)
2. La plèvre pariétale



8. Épanchement pleural
Signe de la sinusoïde

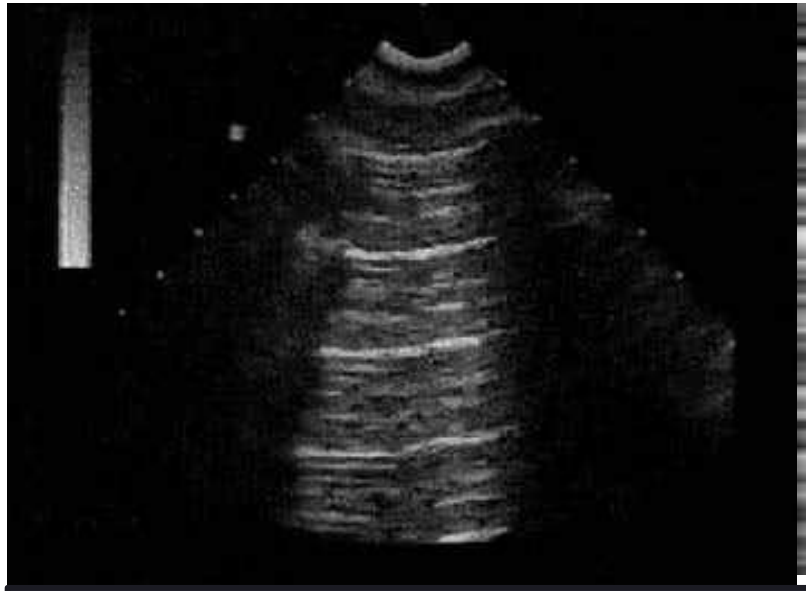


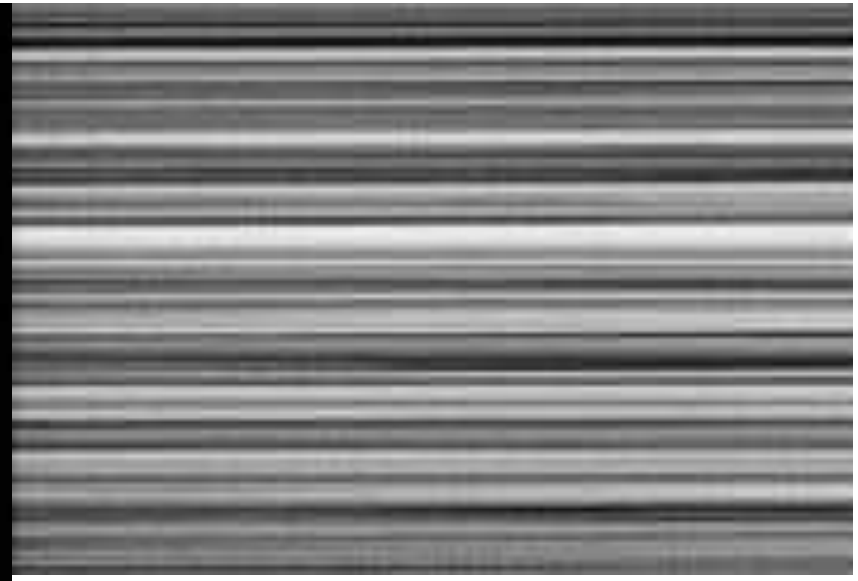
Mouvement centrifuge inspiratoire de la ligne pulmonaire vers la ligne pleurale



Signe du dièse et de la sinusoïde sont des signes universels permettant de définir tout type d'épanchement quelle que soit son échogénicité

9. Pneumothorax et Profil A





DEUX signes non spécifiques :

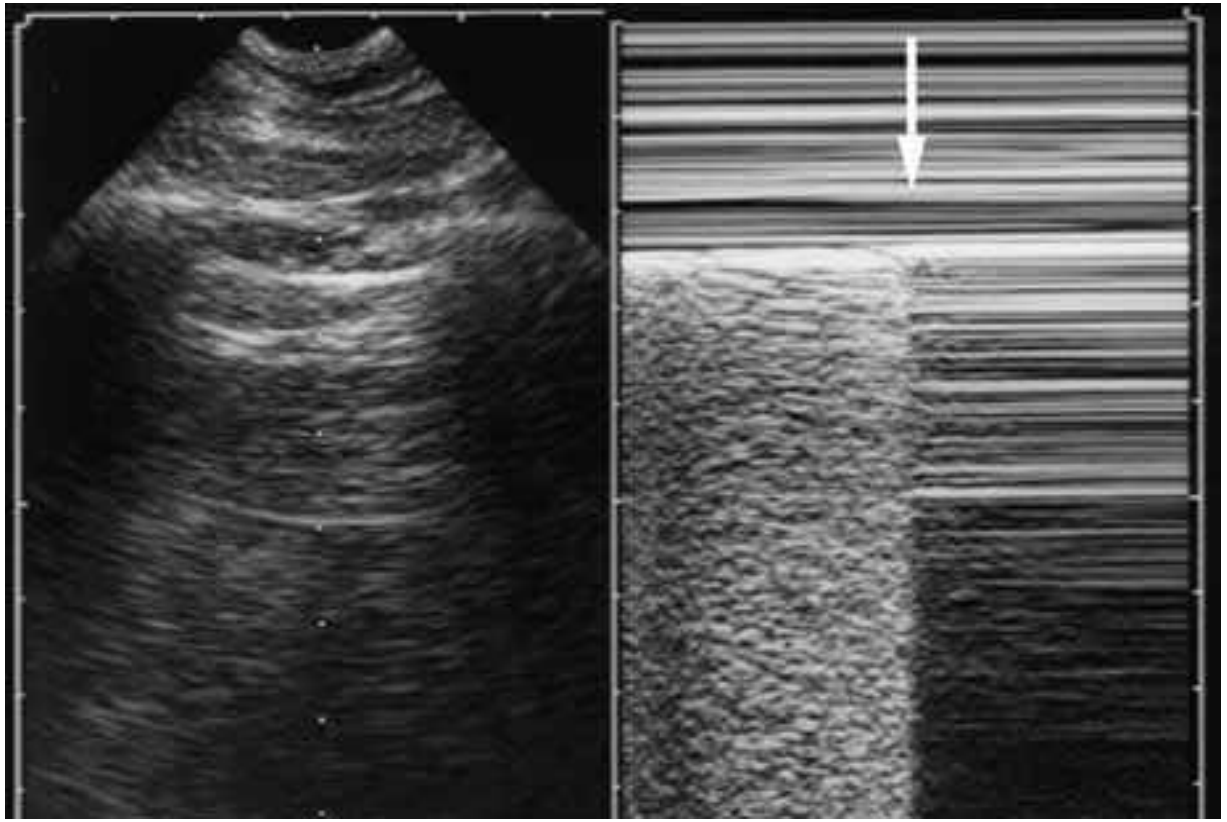
1) Glissement pleural

2) Lignes A exclusives

Le signe de la stratosphère

Mais l'association de ces deux signes est hautement suggestive de pneumothorax.
Le moindre glissement, la moindre ligne B éliminent le diagnostic

10. Pneumothorax et signe du **point poumon**



Apparition soudaine d'une activité pulmonaire en un point donné de la paroi thoracique, alors que la paroi antérieure montre un glissement aboli et des lignes A (Profil A)

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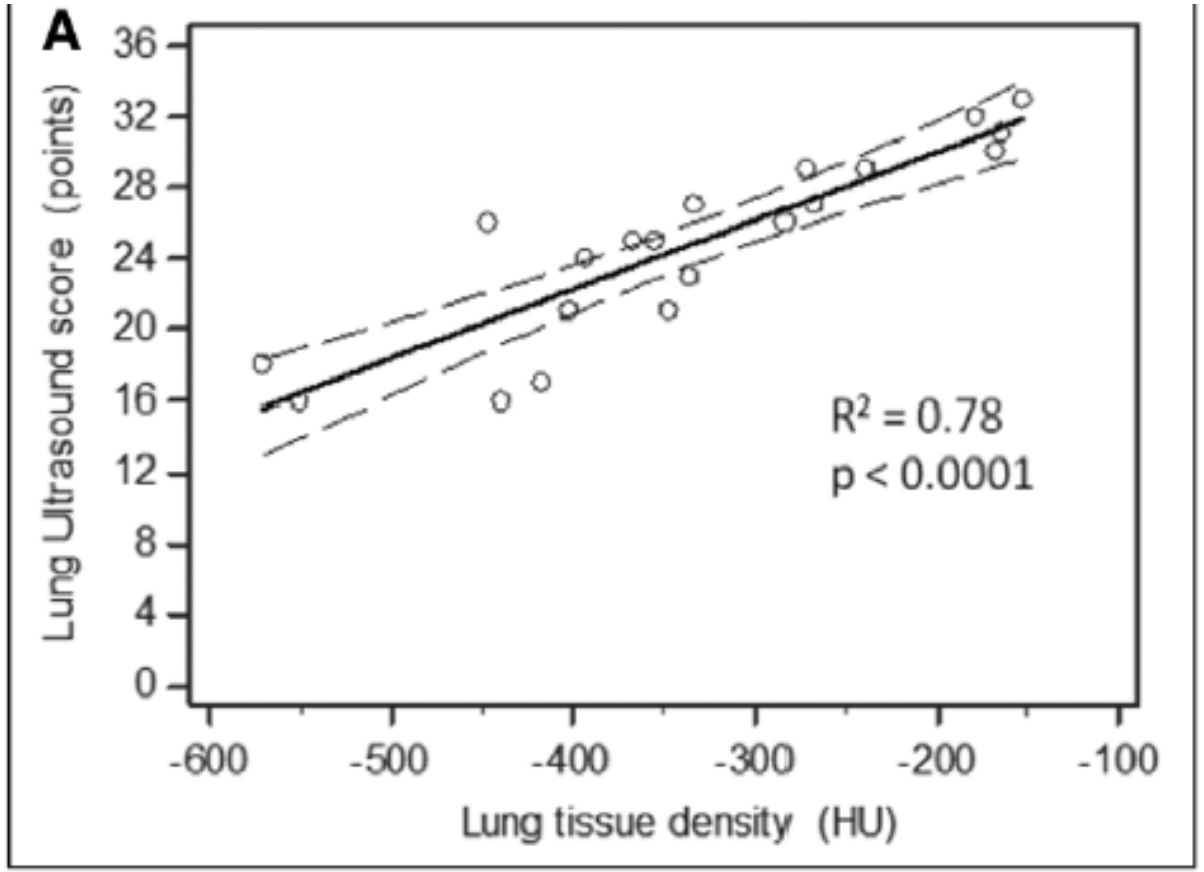
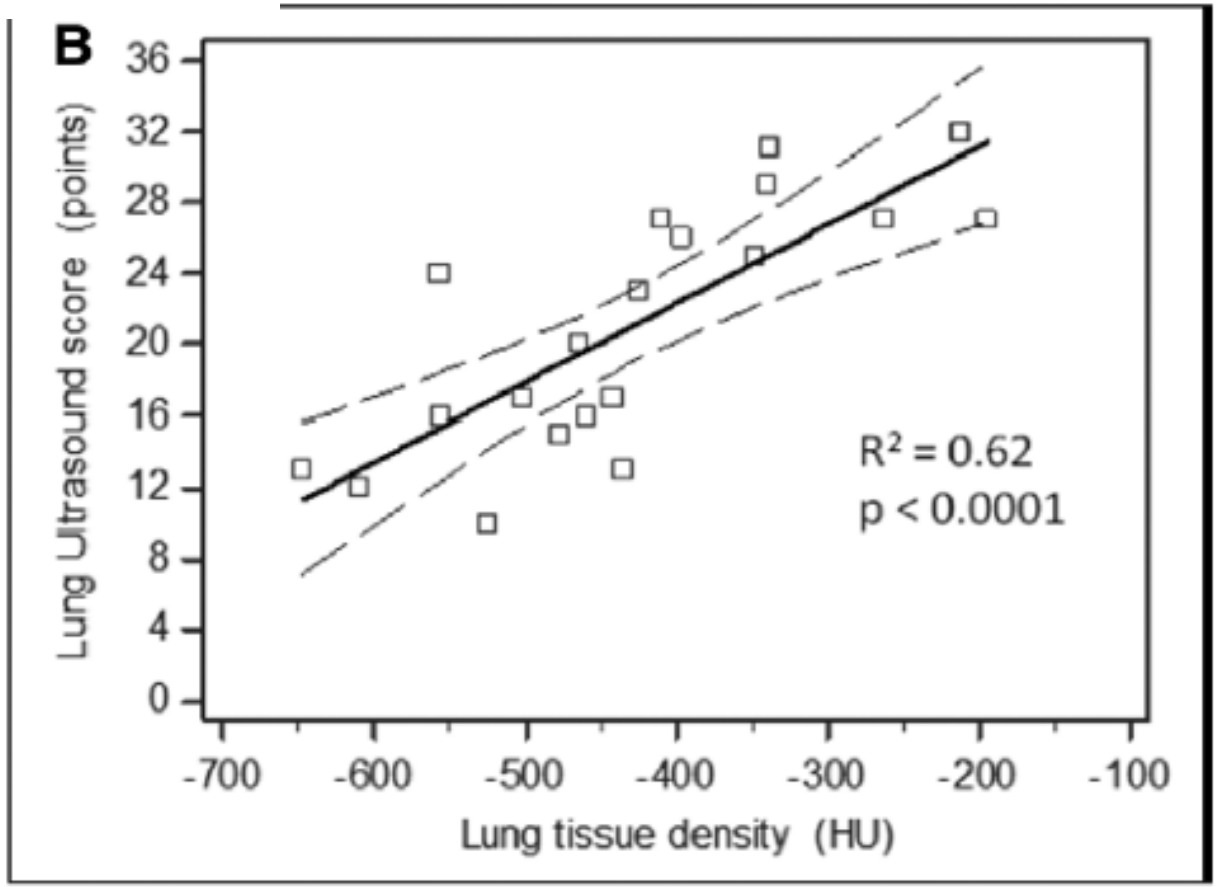
Assessment of Lung Aeration and Recruitment by CT Scan and Ultrasound in Acute Respiratory Distress Syndrome Patients*

Davide Chiumello, MD[1,2]; Silvia Mongodi, MD[3]; Ilaria Algieri, MD[4]; Giordano Luca Vergani, MD[1]; Anita Orlando, MD[3,4,5]; Gabriele Via, MD[6]; Francesco Crimella, MD[7]; Massimo Cressoni, MD[1]; Francesco Mojoli, MD[3,5]





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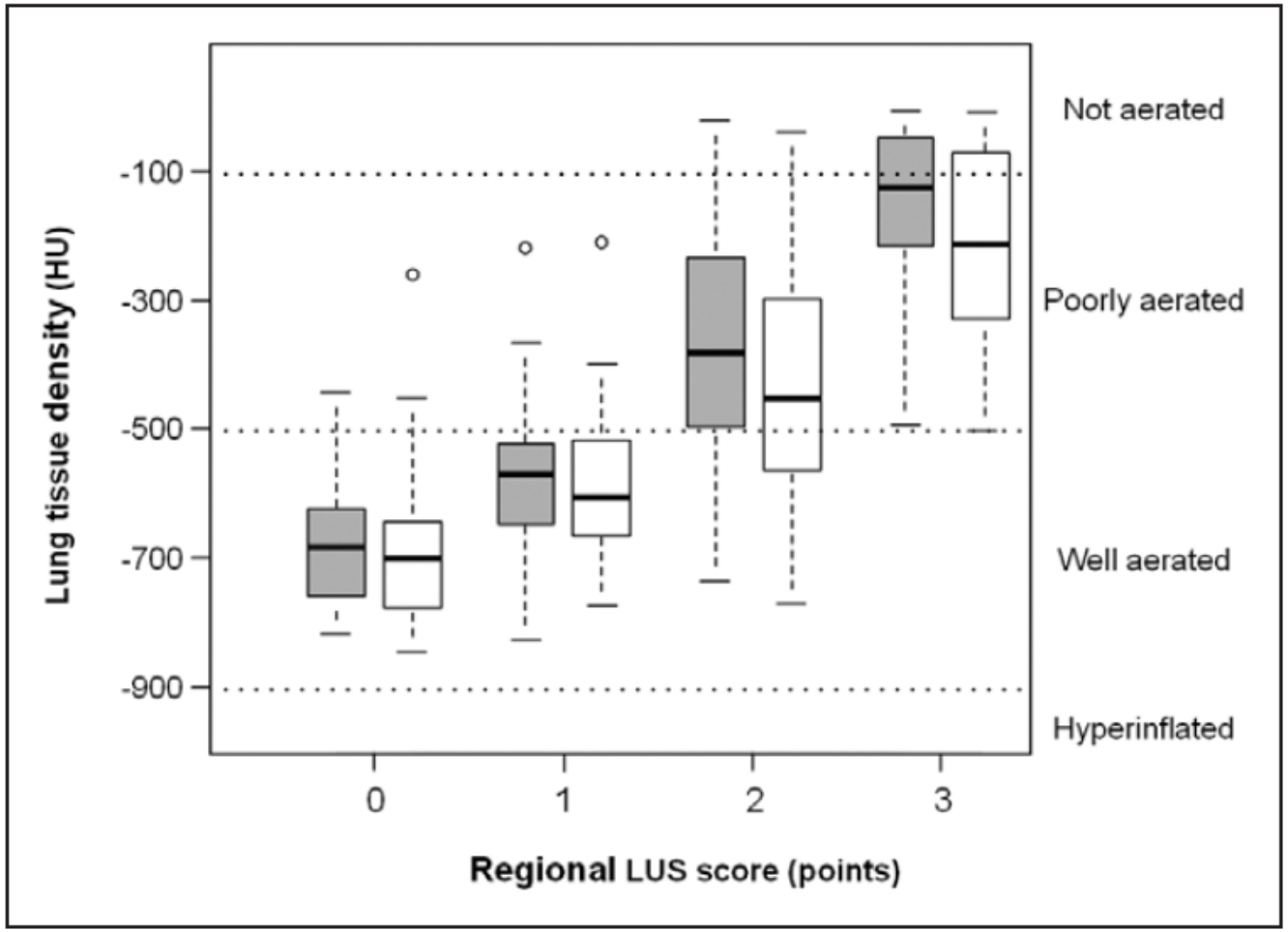
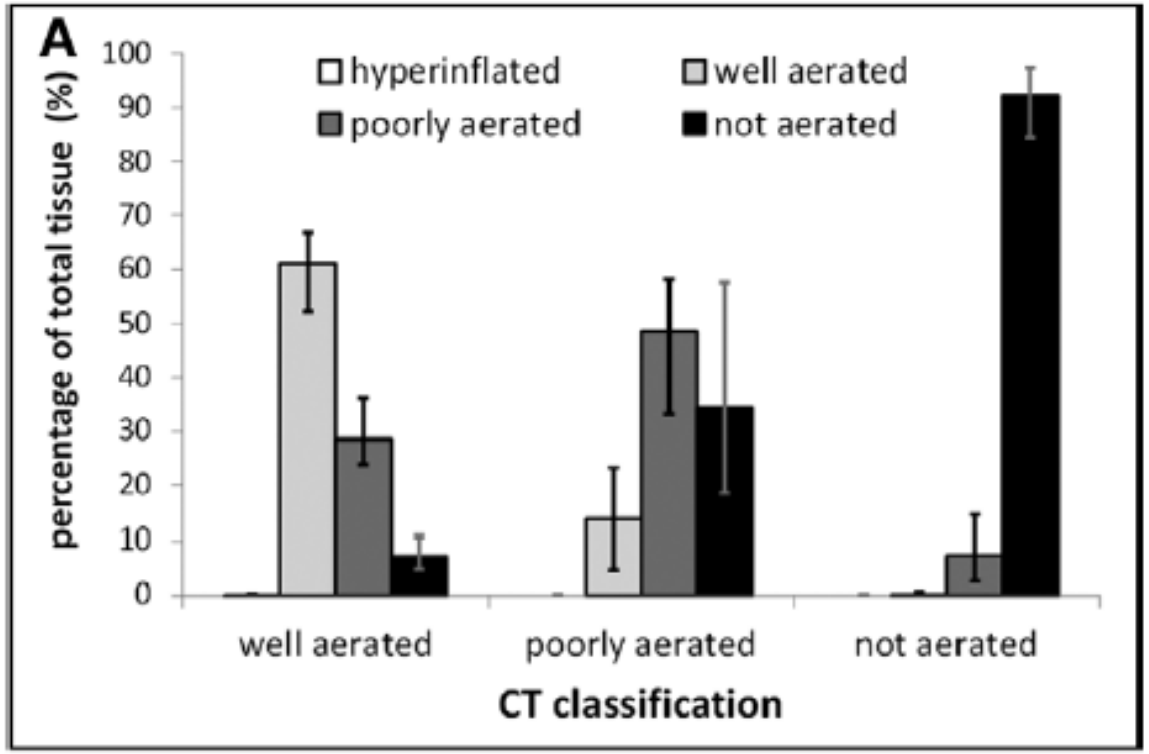


Box and whiskers plot

PEEP 5 = *rectangle gris*

PEEP 15 = rectangle blanc



Lung ultrasound can be used to predict the potential of prone positioning and assess prognosis in patients with acute respiratory distress syndrome

Xiao-ting Wang†, Xin Ding†, Hong-min Zhang, Huan Chen, Long-xiang Su, Da-wei Liu* and Chinese Critical Ultrasound Study Group (CCUSG)

Wang *et al. Critical Care* (2016) 20:385

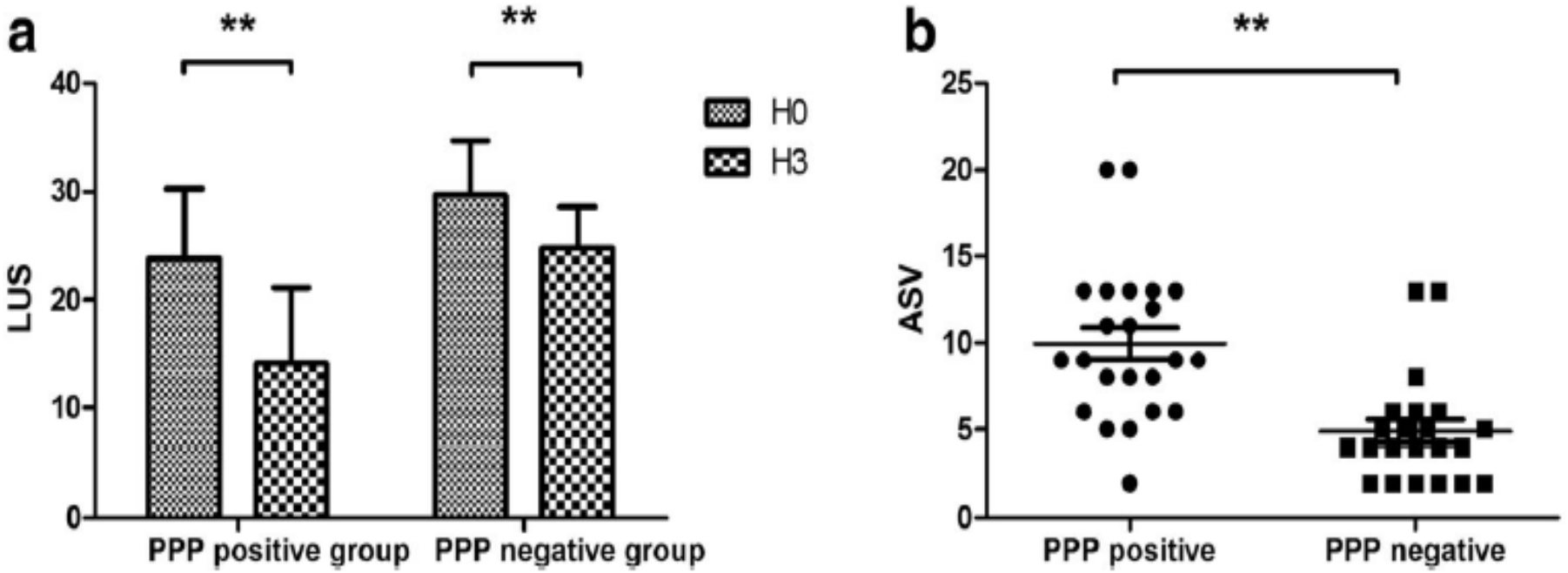


Fig. 4 **a** Lung ultrasound scores at H0 and H3 in the PPP-positive and PPP-negative groups. **b** The aeration score variations between H3 and H0 in the PPP-positive and PPP-negative groups (** $p < 0.01$). *ASV* Aeration score variation, *H0* Start of prone positioning, *H3* 3 h after prone positioning, *LUS* Lung ultrasound score, *PPP* Prone positioning potential

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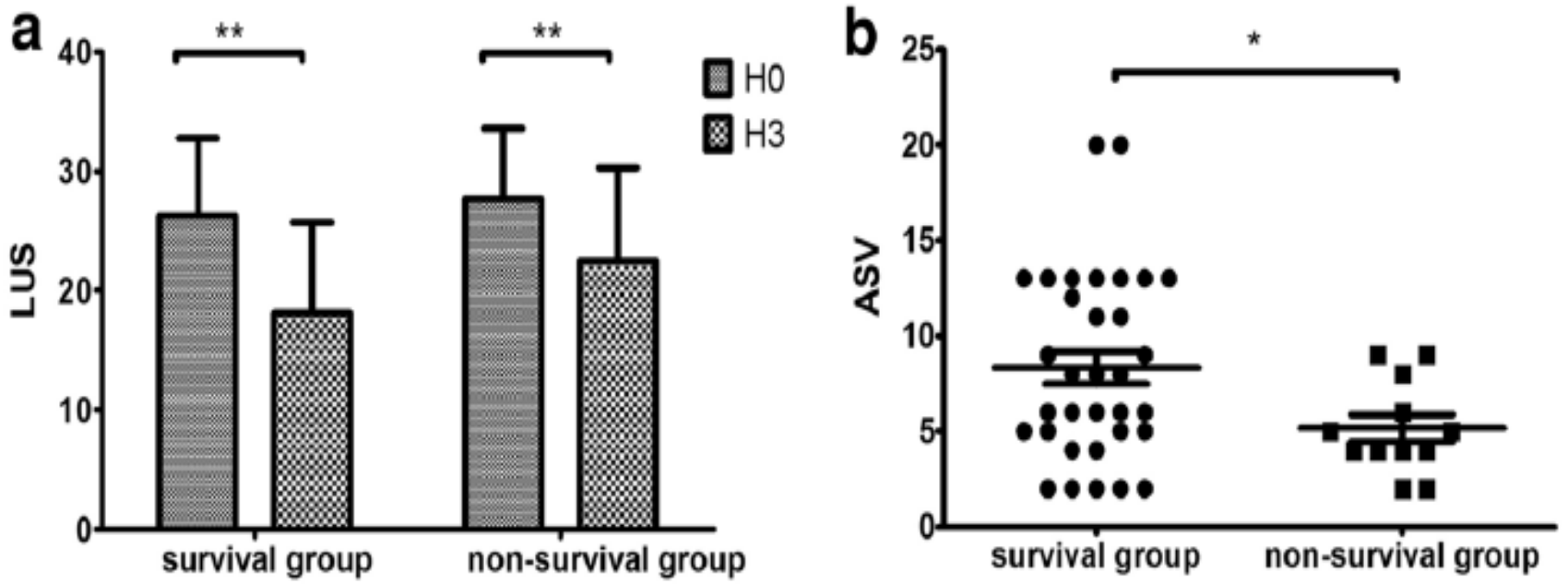
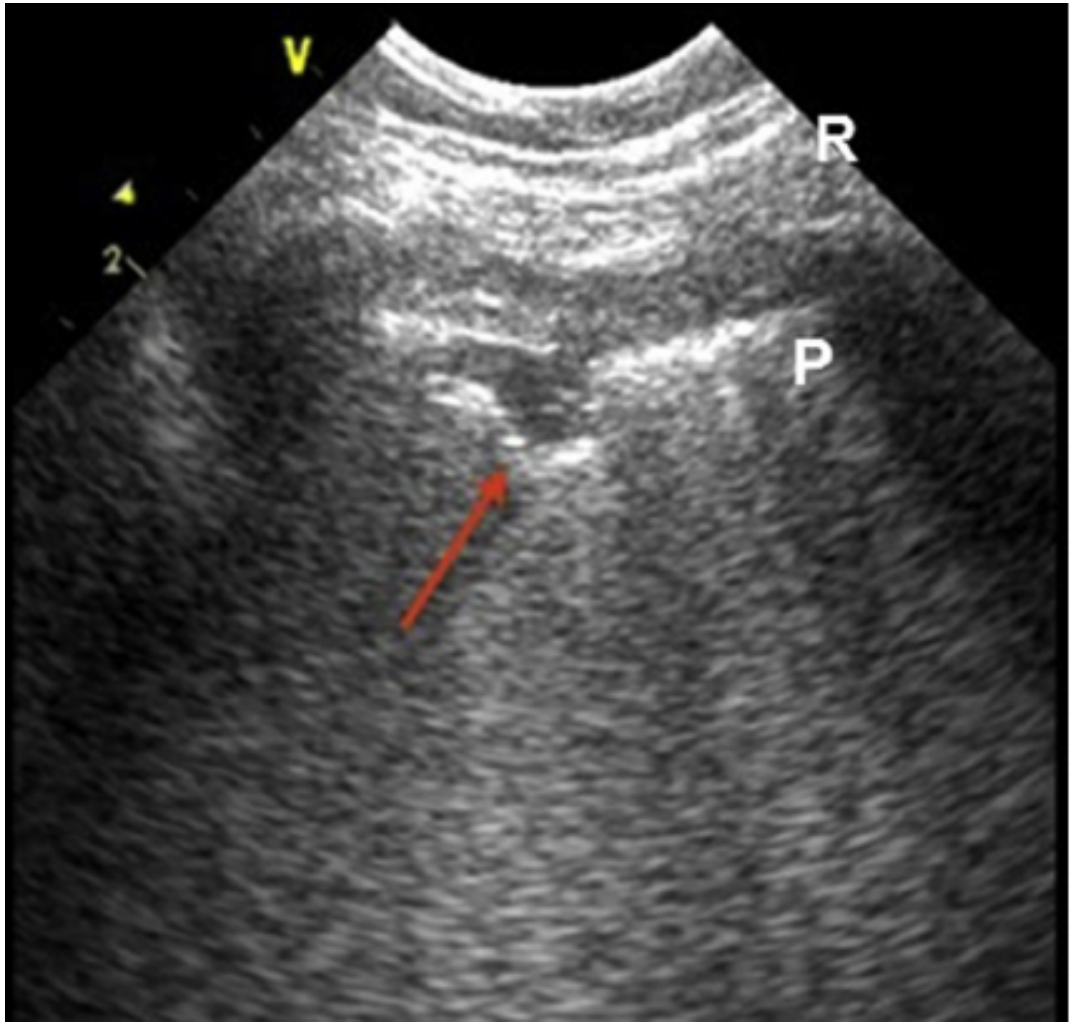


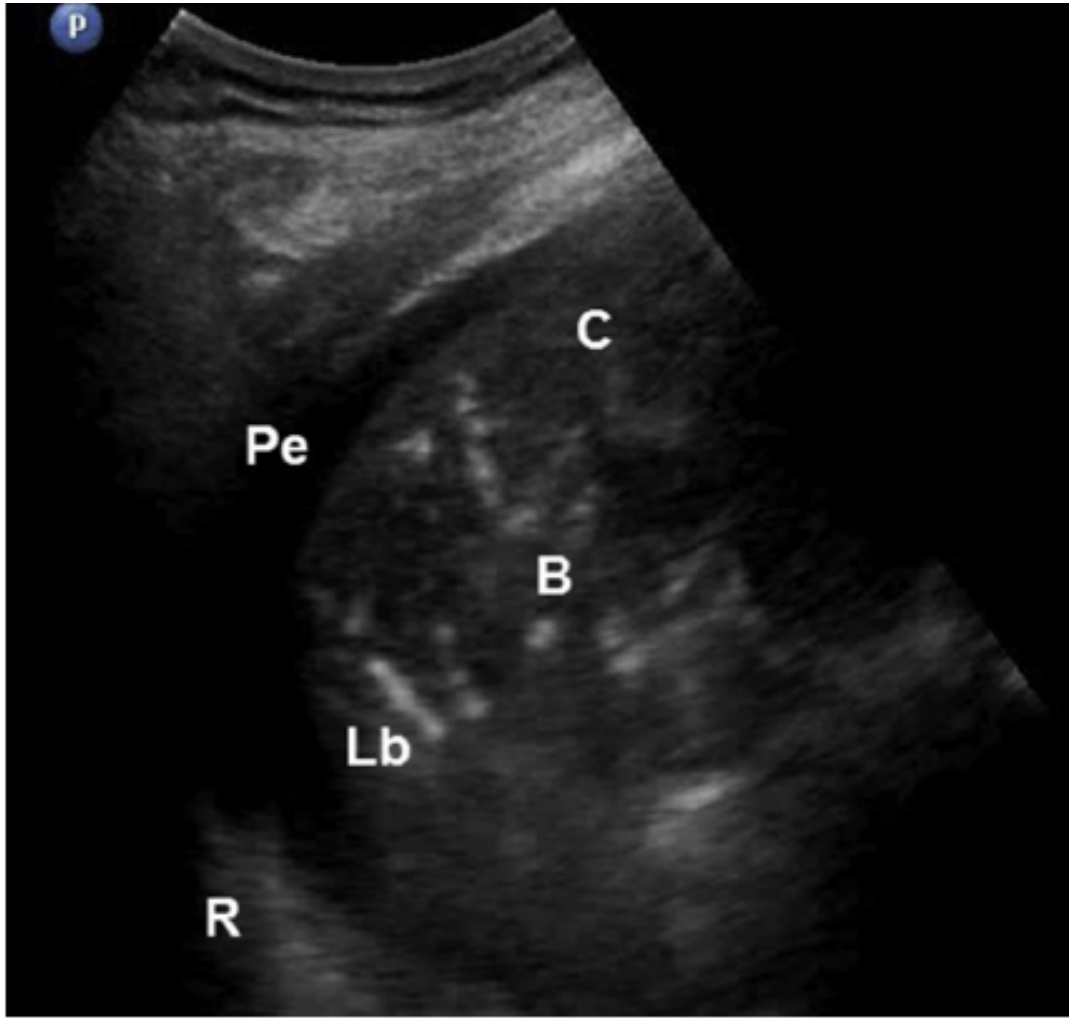
Fig. 6 **a** Lung ultrasound scores at H0 and H3 in the survival and nonsurvival groups. **b** Aeration score variations between H3 and H0 in the survival and nonsurvival groups (** $p < 0.01$, * $p < 0.05$). *LUS* Lung ultrasound score, *ASV* Aeration score variation, *H3* 3 h after prone positioning, *H0* Start of prone positioning

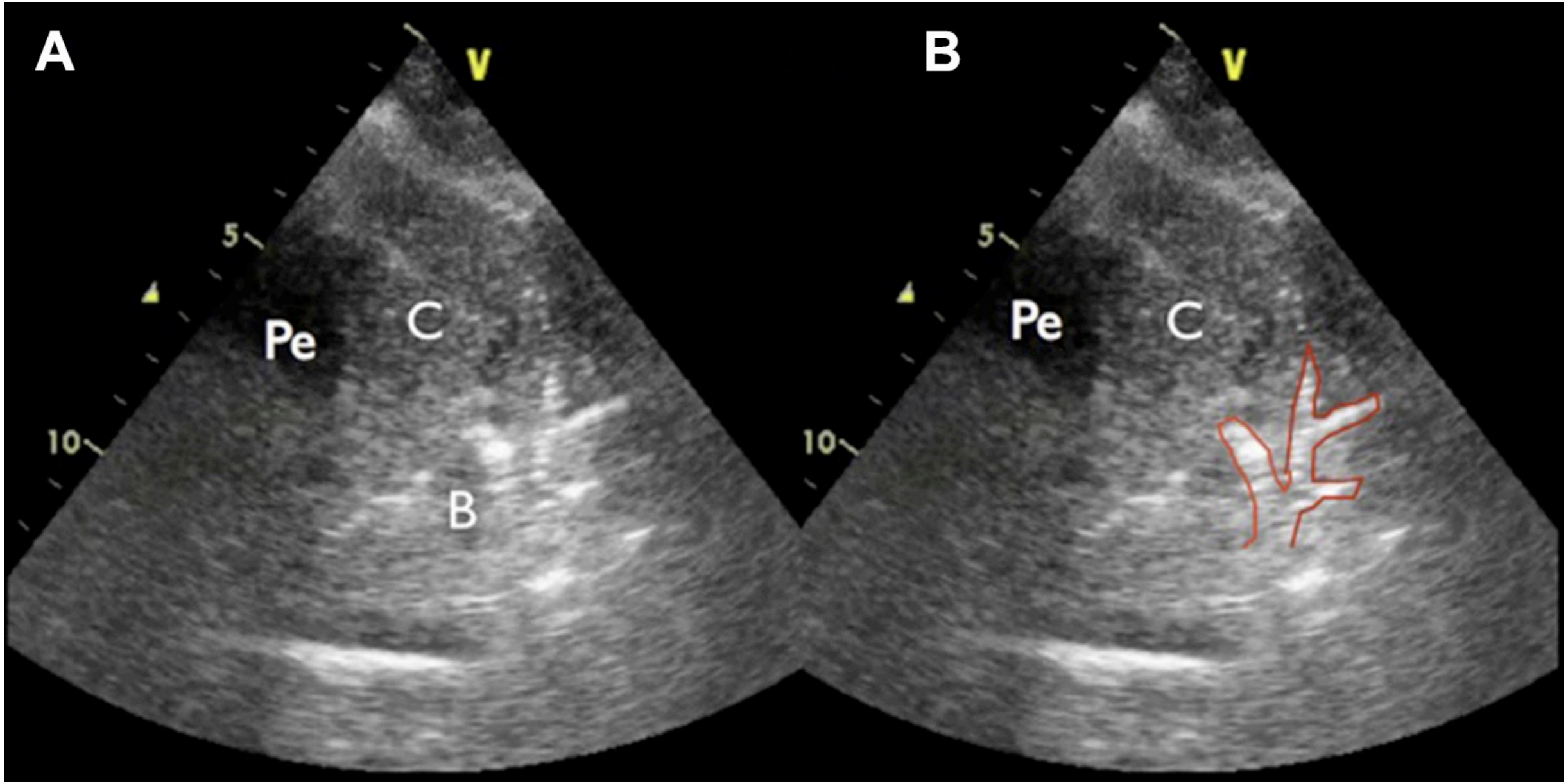
Lung Ultrasound for Early Diagnosis of Ventilator-Associated Pneumonia

Silvia Mongodi, MD, PhD; Gabriele Via, MD; Martin Girard, MD; Isabelle Rouquette, MD; Benoit Misset, MD, PhD; Antonio Braschi, MD; Francesco Mojoli, MD; and Bélaïd Bouhemad, MD, PhD

CHEST 2016; 149(4):969-980

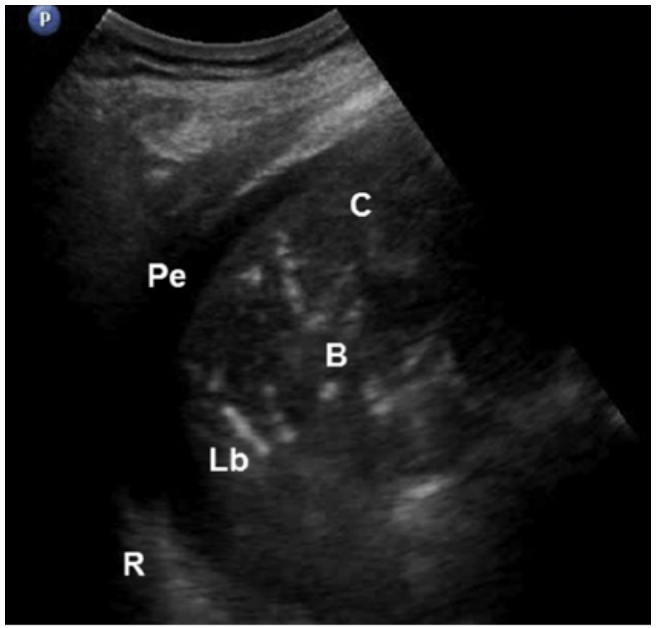





A
V
5
10
Pe
C
B
B
V
5
10
Pe
C

VPLUS : **V**entilator-associated **P**neumonia **LU** **S**core

VPLUS	Points
≥ 2 subpl consolidations	1
≥ 1 air-bronchograms	2
purulent secretions	1
positive EAgram (µVPLUS)	2



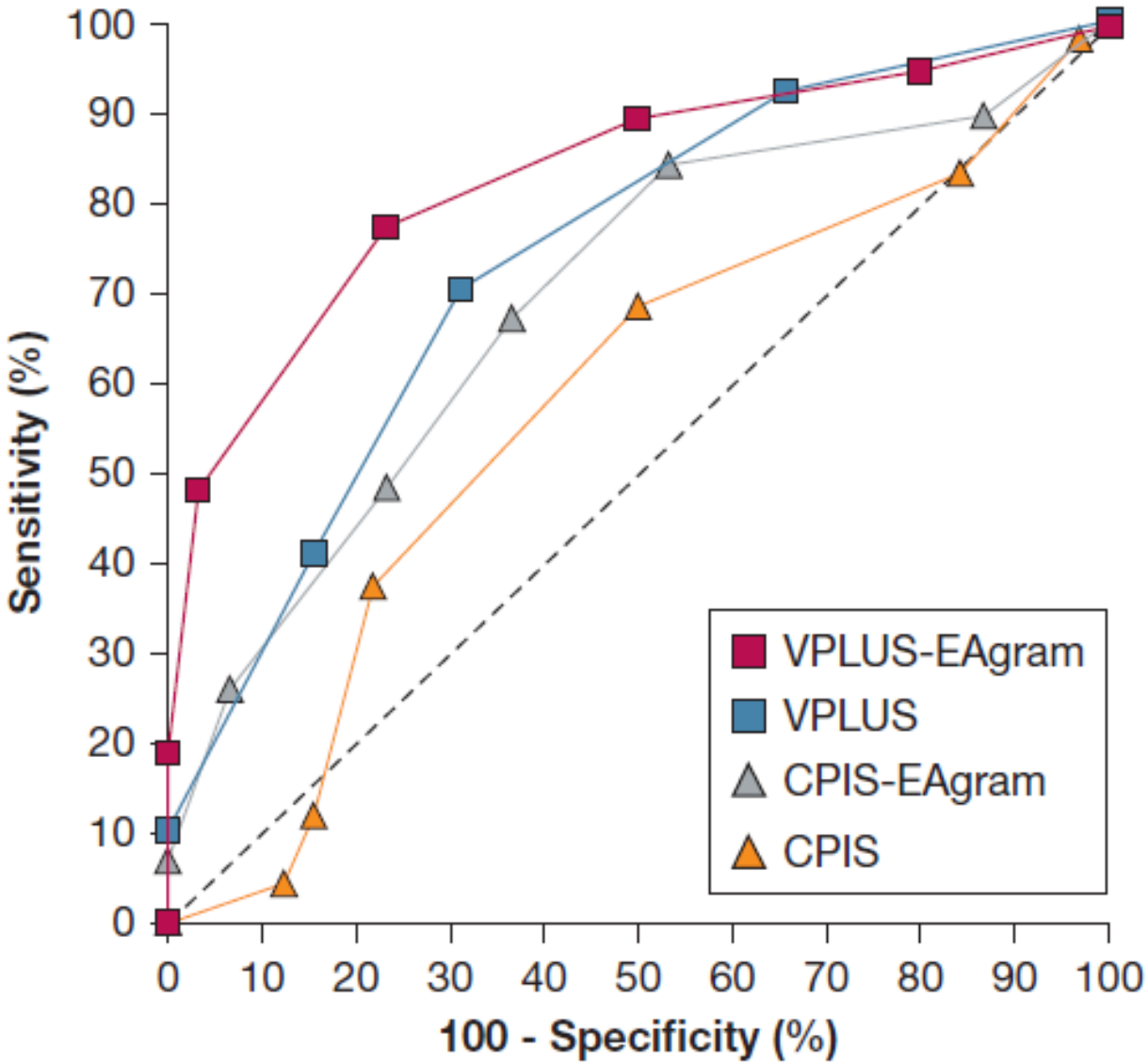
CPIS	Points
Temperature (°C)	
≥ 36.5 and ≤ 38.4	**0**
≥ 38.5 and ≤ 38.9	**1**
≥ 39.0 or ≤ 36.0	**2**
Leukocytes /ml	
≥ 4000 and ≤ 11000	**0**
< 4000 or >11000	**1**
Tracheal Secretions	
Few	**0**
Moderate	**1**
Large	**2**
Purulent	**+1**
Oxygenation	
PaO_2/FiO_2 > 240	**0**
PaO_2/FiO_2 ≤ 240	**1**
Chest X-rays	
No infiltrates	**0**
Patchy or diffuse infiltrate	**1**
Localized infiltrate	**2**
Positive EAgram (µCPIS)	**2**

VPLUS : **V**entilator-associated **P**neumonia **LU** **S**core

VPLUS	Points
≥ 2 subpl consolidations	1
≥ 1 air-bronchograms	2
purulent secretions	1
positive EAgram (µVPLUS)	2

VPLUS SP et SE **70%**
VPLUS-EAgram SP et SE **80%**

Tous les critères presents **100%**



Ultrasound assessment of lung aeration loss during a successful weaning trial predicts postextubation distress*

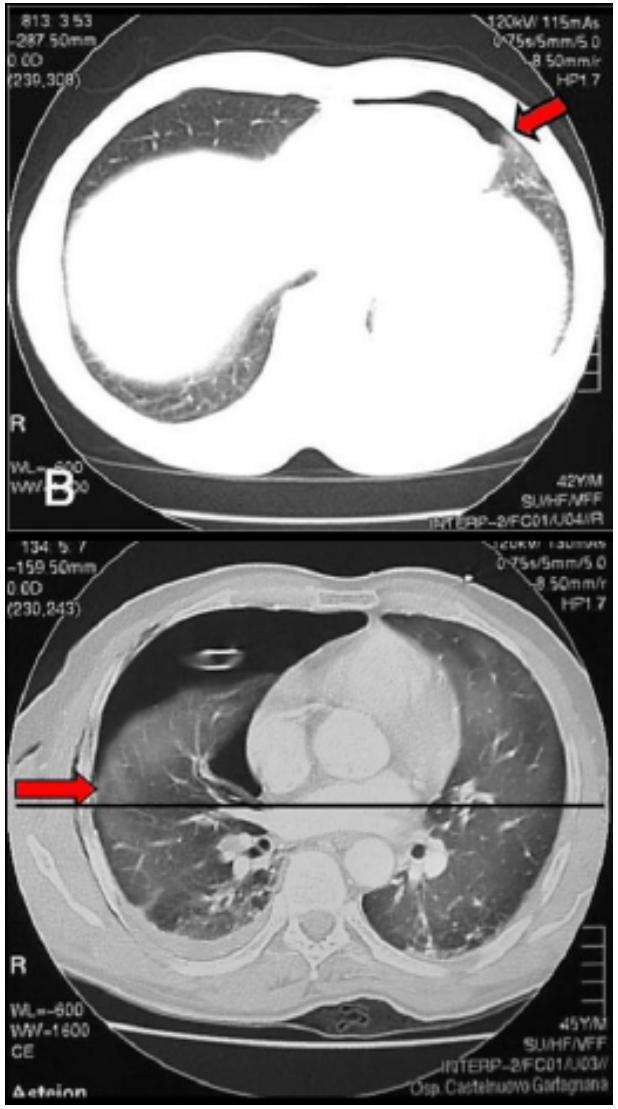
Alexis Soummer, MD; Sébastien Perbet, MD; Hélène Brisson, MD; Charlotte Arbelot, MD; Jean-Michel Constantin, MD, PhD; Qin Lu, MD, PhD; Jean-Jacques Rouby, MD, PhD; and the Lung Ultrasound Study Group Crit Care Med 2012 Vol. 40, No. 7

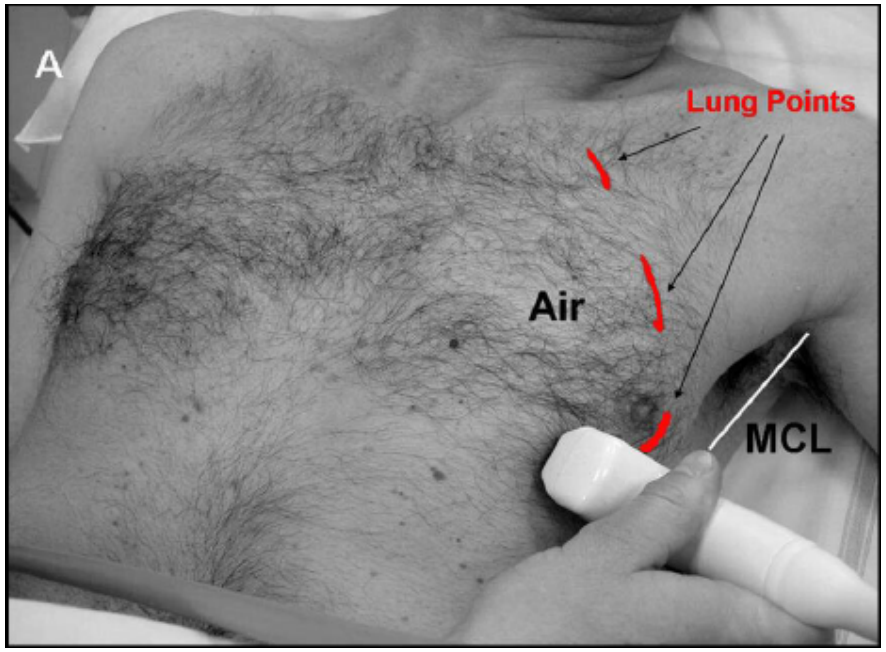
Table 2. Spontaneous breathing trial-induced changes in lung ultrasound parameters and B-type natriuretic peptide

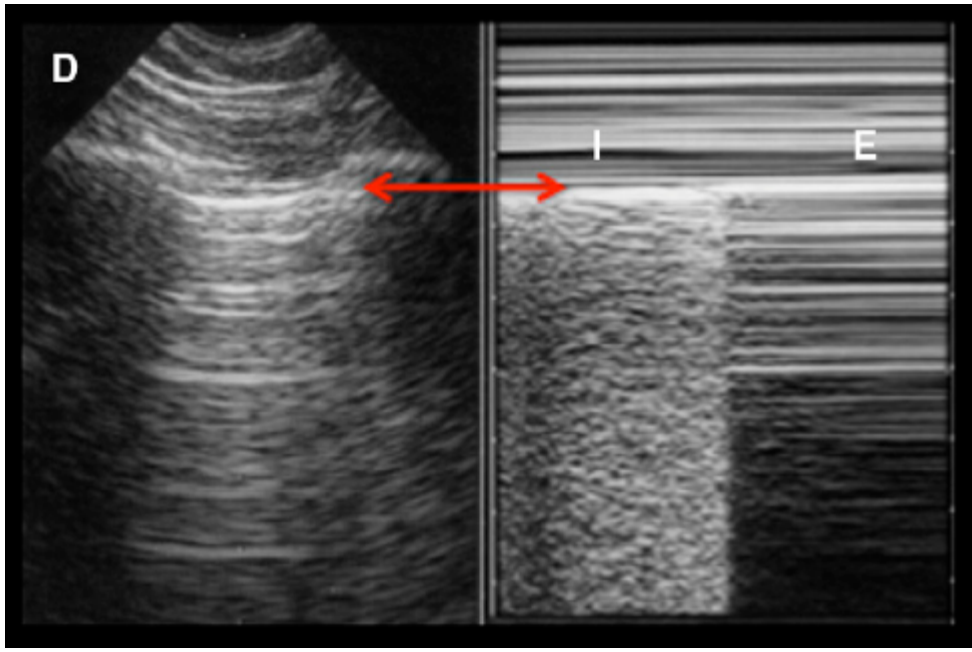
	Overall 100 Patients	SBT Failure 14 Patients	SBT Success 86 Patients	*p*	Postextubation Success 57 Patients	Postextubation Distress 29 Patients	*p*
LUS before SBT	12 [9–15]	13 [10–17]	12 [8–15]	NS	10 [6–13]	15 [13–17]	<.001
LUS end of SBT	13 [9–17][a]	15 [13–21][a]	13 [8–17][a]	.002	10 [7–13]	19 [16–21][a]	<.001
LUS H4 postextubation	—	—	—	—	10 [7–15]	20 [17–23][b,c]	<.001
BNP before SBT, pg/mL	227[80–590]	180 [75–823]	241 [79–541]	NS	139 [64–316]	475 [232–689]	.003
BNP end-SBT, pg/mL	205 [75–628][b]	207 [75–1260][b]	201 [73–518]	NS	137 [65–315]	459 [152–958]	.002
BNP H4 extubation	—	—	212 [82–553]	—	152 [63–301]	465 [166–915]	.001

LUS, lung ultrasound score; SBT, spontaneous breathing trial; BNP, B-type natriuretic peptide; NS, not significant.
[a]$p < .01$ for end-SBT vs. before SBT; [b]$p < .05$; [c]$p < .05$ for LUS H4 postextubation vs. end-SBT LUS.
p indicates statistical significance between groups. All data are presented as median quartile [first–third].

Délimitation du pneumothorax : suivre les **points poumons!**

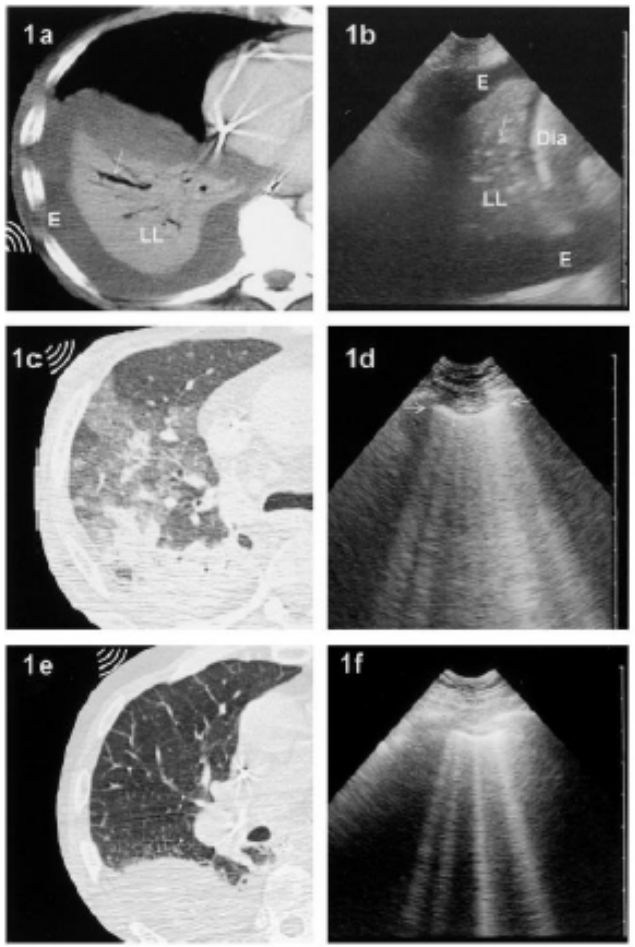






Comparative Diagnostic Performances of Auscultation, Chest Radiography, and Lung Ultrasonography in Acute Respiratory Distress Syndrome

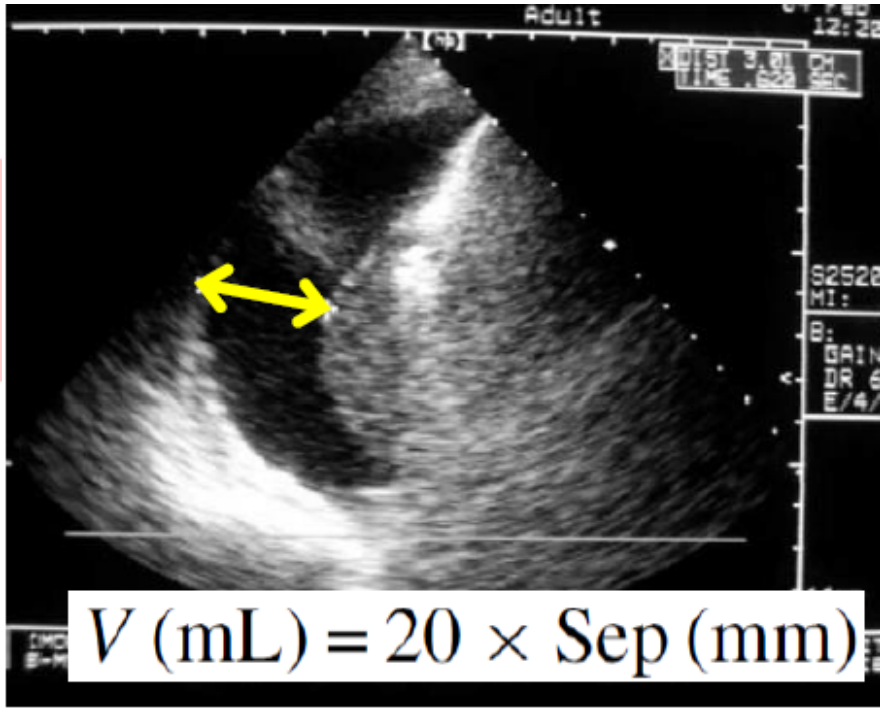
Daniel Lichtenstein, M.D., Ivan Goldstein, M.D.,† Eric Mourgeon, M.D.,† Philippe Cluzel, M.D., Ph.D.,‡ Philippe Grenier, M.D.,§ Jean-Jacques Rouby, M.D., Ph.D.‖*



	Auscultation, %	Chest Radiography, %	Lung Ultrasonography, %
Pleural effusion			
Sensitivity	42	39	92
Specificity	90	85	93
Diagnostic accuracy	61	47	93
Alveolar consolidation			
Sensitivity	8	68	93
Specificity	100	95	100
Diagnostic accuracy	36	75	97
Alveolar–interstitial syndrome			
Sensitivity	34	60	98
Specificity	90	100	88
Diagnostic accuracy	55	72	95

Anesthesiology 2004; 100:9–15

Ultrasound estimation of volume of pleural fluid in mechanically ventilated patients



$$V\,(\mathrm{mL}) = 20 \times \mathrm{Sep}\,(\mathrm{mm})$$

Intensive Care Med (2006) 32:318–321
DOI 10.1007/s00134-005-0024-2

CONCISE CLINICAL REVIEW

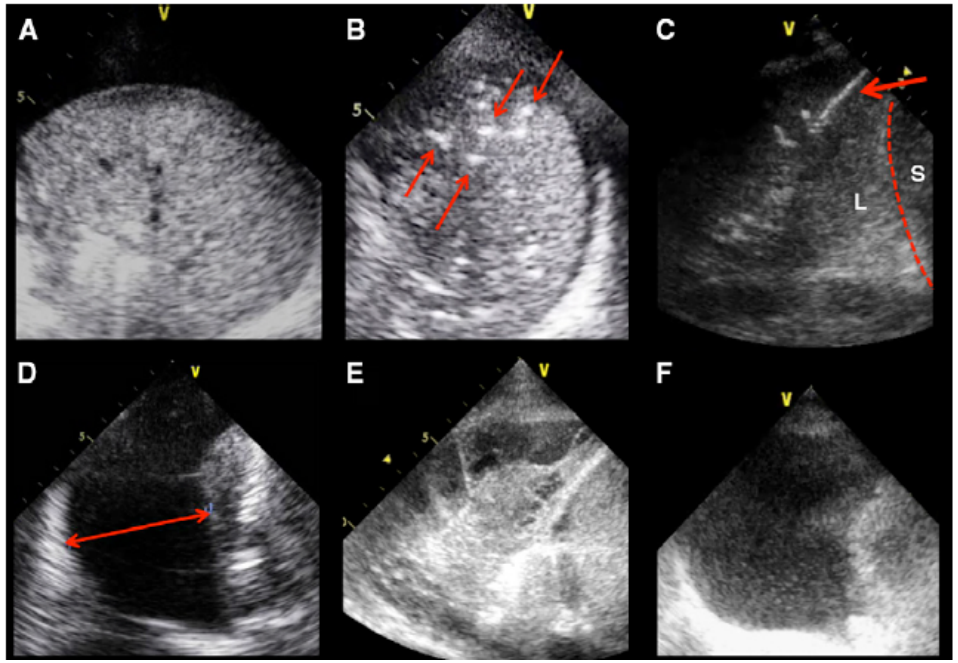
Lung Ultrasound for Critically Ill Patients

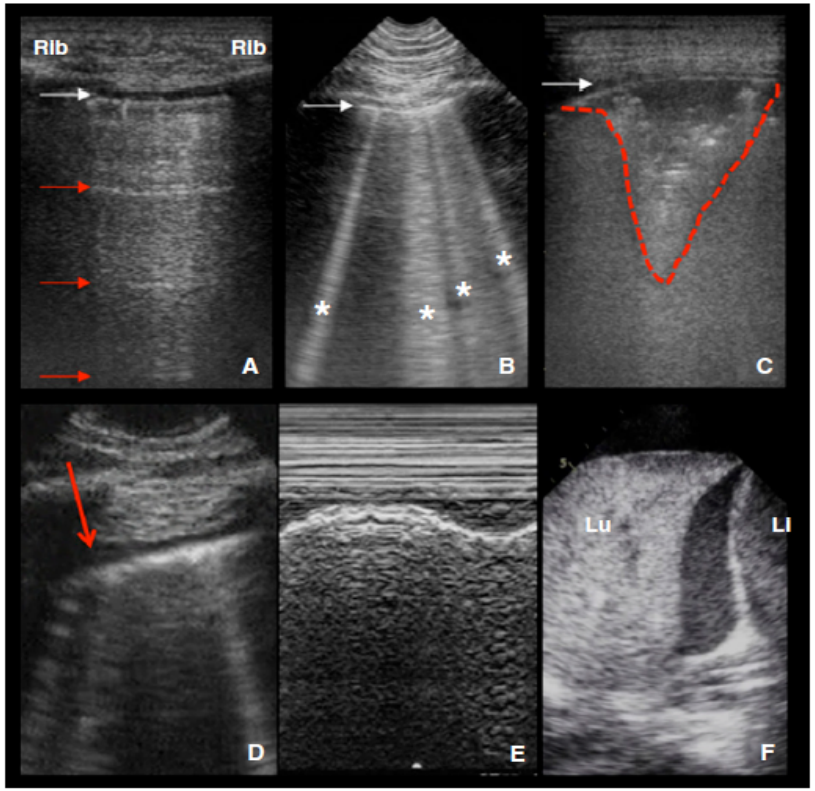
Francesco Mojoli[1,2], Bélaid Bouhemad[3,4], Silvia Mongodi[2], and Daniel Lichtenstein[5]

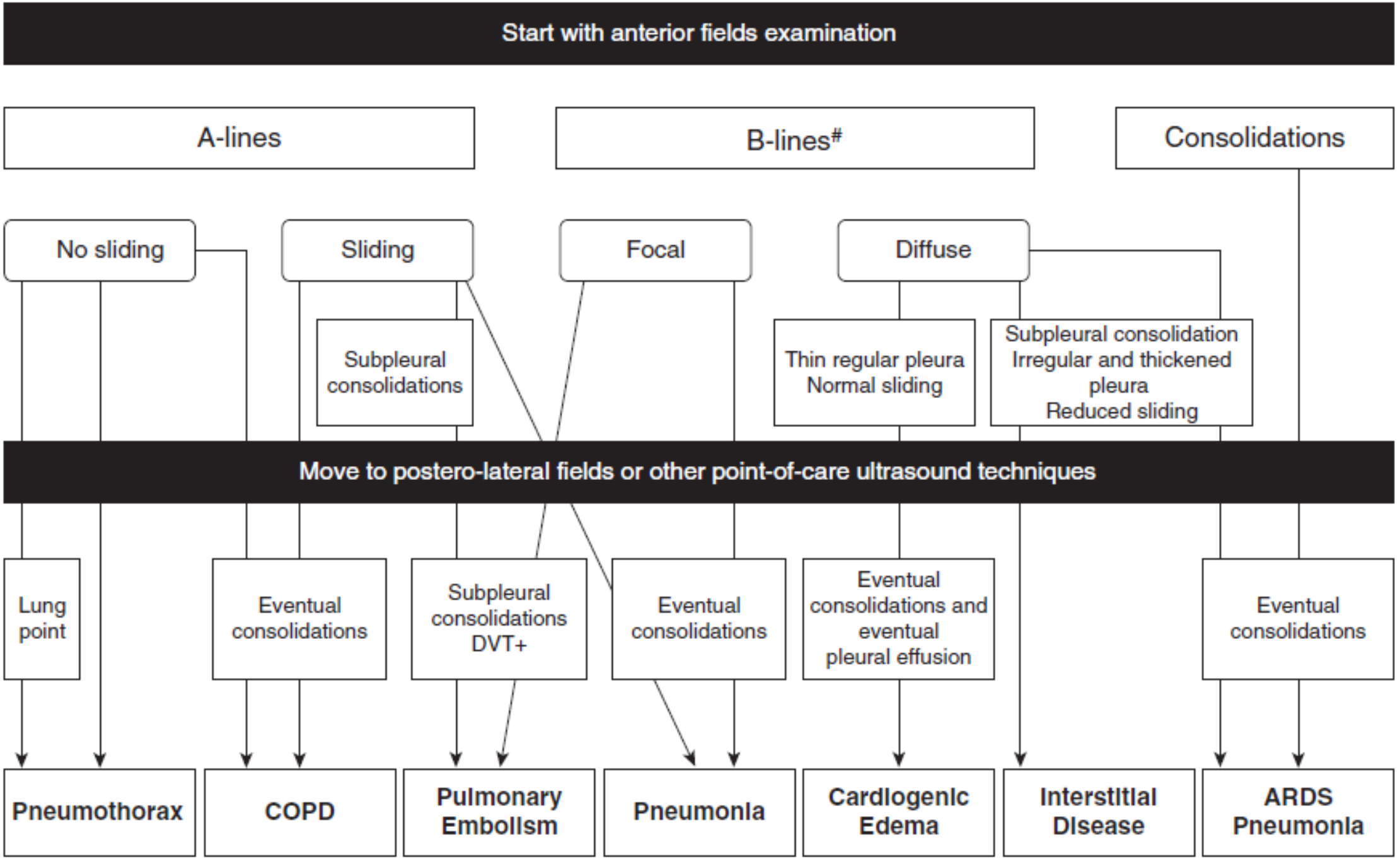
[1]Department of Clinical-Surgical, Diagnostic, and Pediatric Sciences, Unit of Anaesthesia and Intensive Care, University of Pavia, Pavia, Italy; [2]Anestesia e Rianimazione I, Fondazione Istituto di Ricovero e Cura a Carattere Scientifico, Policlinico San Matteo, Pavia, Italy; [3]Dijon et Université Bourgogne Franche-Comté, Lipides Nutrition Cancer Unité Mixte de Recherche 866, Dijon, France; [4]Département d'Anesthésie et Réanimation, Centre Hospitalier Universitaire Dijon, Dijon, France; and [5]Medical Intensive Care Unit, Hospital Ambroise Paré, Boulogne (Paris-West University), France

ORCID ID: 0000-0002-6031-6336 (F.M.).

American Journal of Respiratory and Critical Care Medicine Volume 199 Number 6 | March 15 2019






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 consolidations and eventual pleural effusion
Eventual consolidations
Pneumothorax
COPD
Pulmonary Embolism
Pneumonia
Cardiogenic Edema
Interstitial Disease
ARDS Pneumonia

Messages importants

- L'écho pulmonaire est **performante** dans le diagnostic des différents syndromes pulmonaires et pour guider les gestes thérapeutiques
- L'exploration du poumon en écho est un examen dynamique, reproductible, au chevet
- L'échographie pulmonaire possède une courbe d'apprentissage *rapide*
- Le LUS vise à objectiver le degré de l'aération pulmonaire et ses tendances constituent un outil clinique incontournable **diagnostique**, de **suivi**, **d'orientation** du traitement, et **pronostique**.