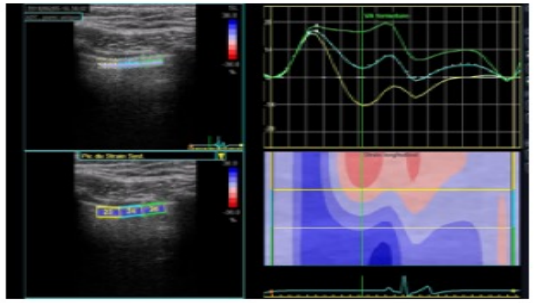
Nouveautés en échographie pleuropulmonaire



Pr Laurent Zieleskiewicz

Service d'Anesthésie et de Réanimation

Hôpital Nord–Marseille

APHM – AMU

GE Healthcare: honoraires pour cours d’échographie

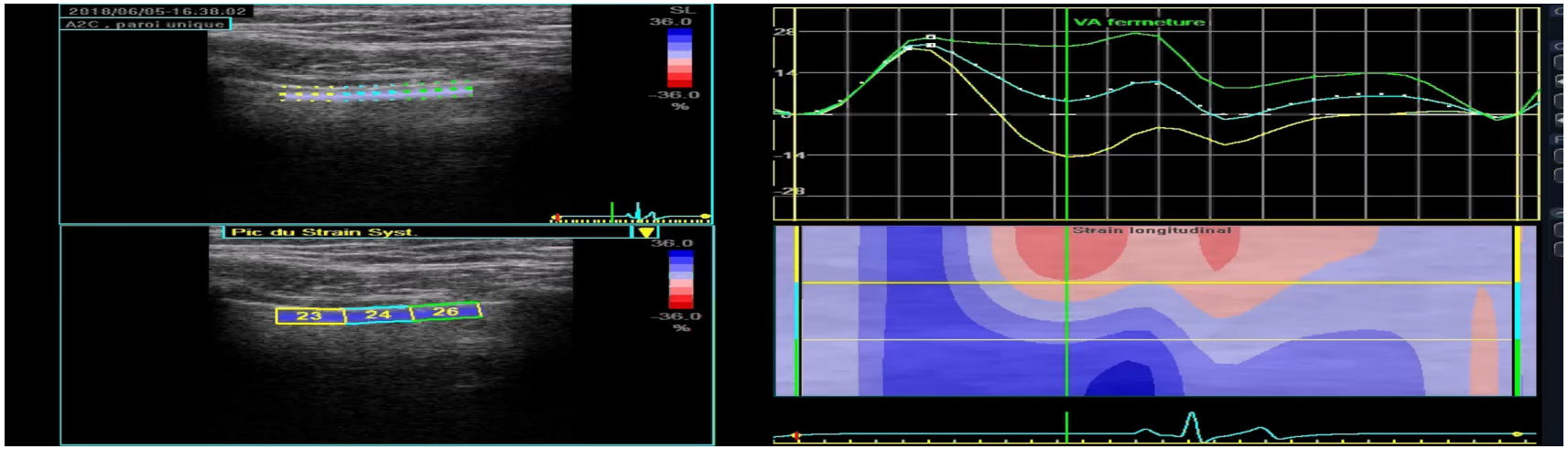
Plan

Définitions/ rappels

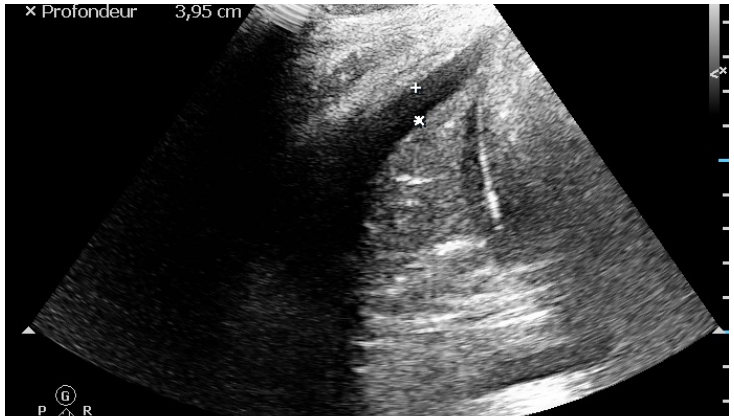
L'outil / possibilités

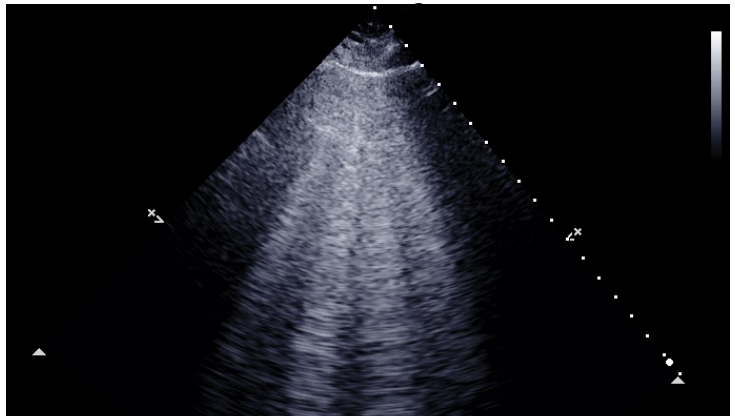
Nouvelles techniques

Nouvelles utilisations



Stéthoscope
Imagerie = Syndromes





Poumon normal

Epanchements pleuraux

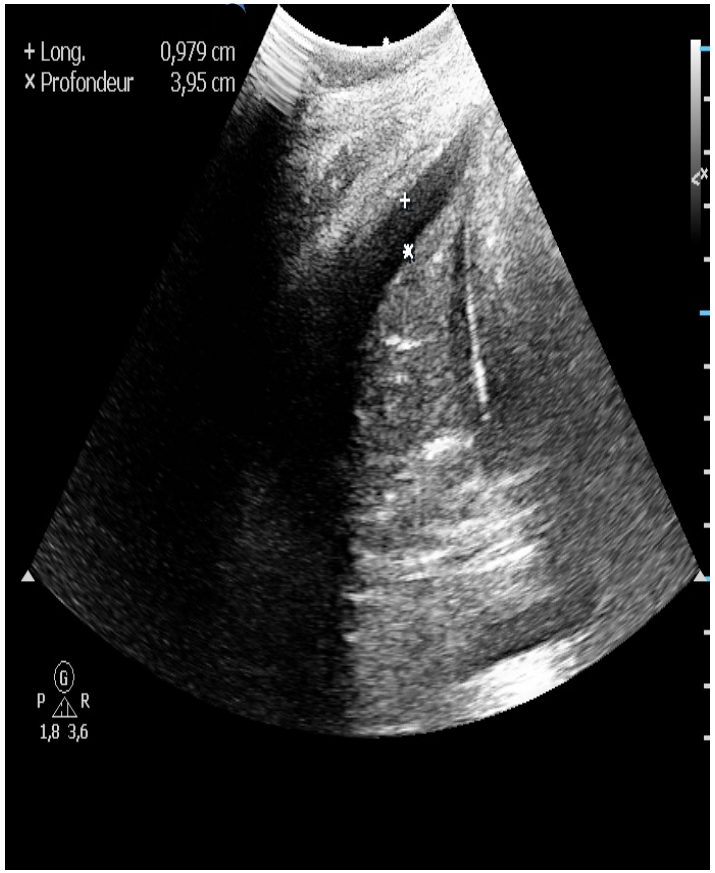
Syndrome interstitiel

Consolidation

Rapport air/tissus du Poumon

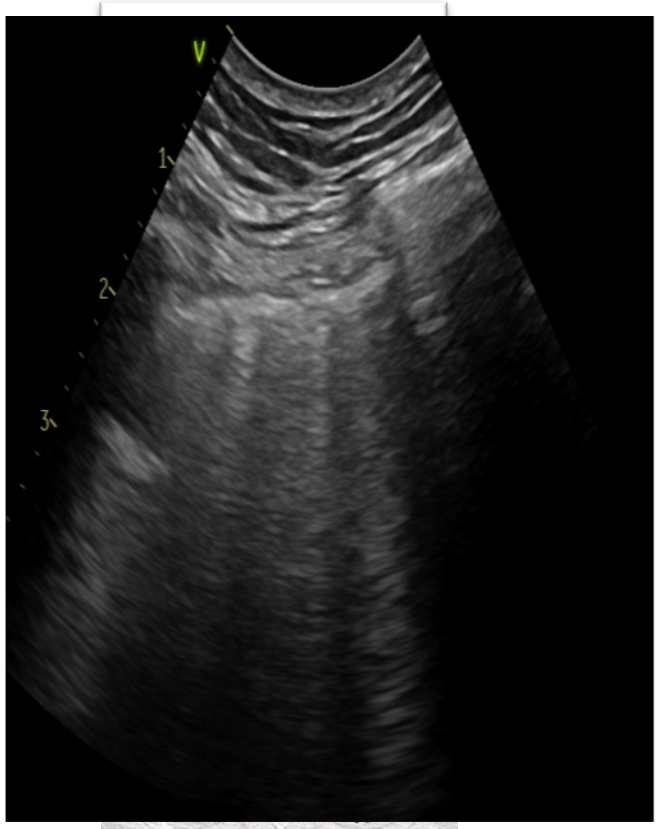
Normal :
Air>>>Tissu
= visualisation
indirecte

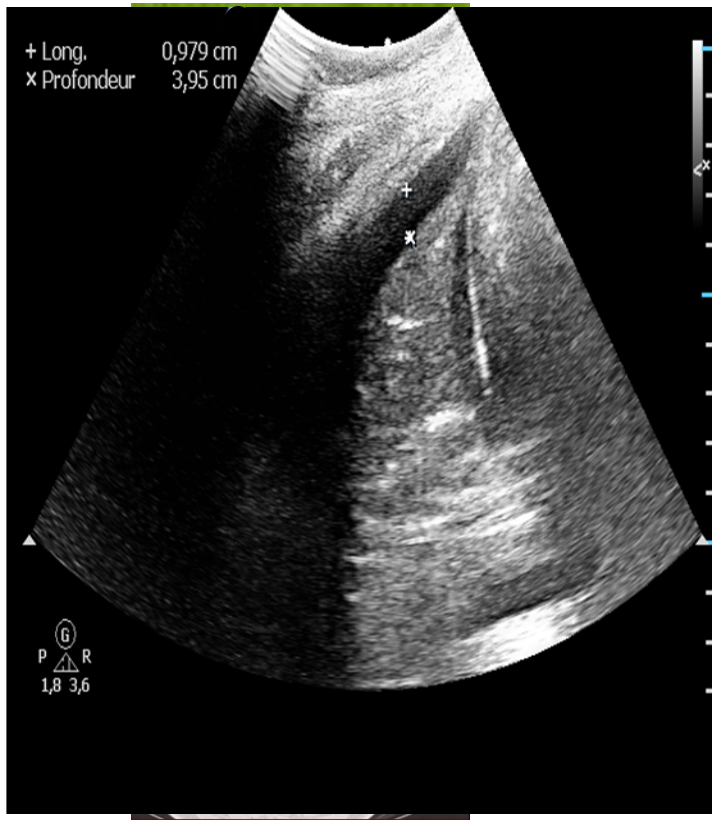
Sd interstitiel :
Air et Tissu
= visualisation
indirecte
(Lignes B)



Consolidation :
Tissu
= Visualisation ***directe***
(= hépatisation)

Aération pulmonaire





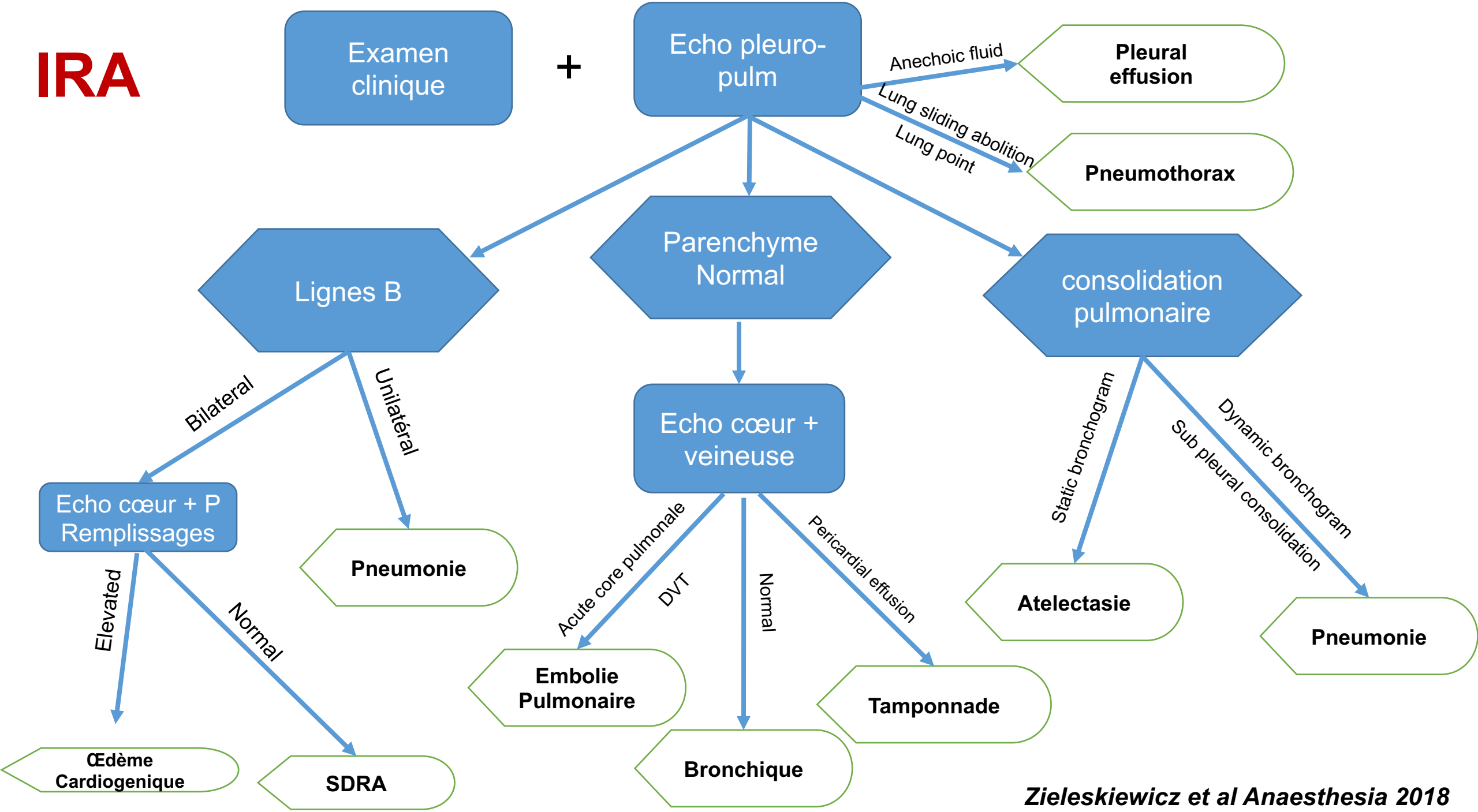
Surdistention ???

indirecte

indirecte
(Lignes B)

= Visualisation ***directe***
(= hépatisation)

IRA



Zieleskiewicz et al Anaesthesia 2018

Nouveautés technologiques

Echo 3D
Echo de contraste
AI
Speckle tracking

J Clin Monit Comput
DOI 10.1007/s10877-017-0042-y

ORIGINAL RESEARCH

Lung real time three-dimensional imaging in critically ill ventilated patients: a global diagnosis concordance study

Jean-Marc Le Goff[1] · Claire Roger[1] · Benjamin Louart[1] · Pierre Géraud Claret[1] · Aurélien Daurat[1] · Stéphanie Bulyez[1] · Jean-Yves Lefrant[1] · Xavier Bobbia[1] · Laurent Muller[1]

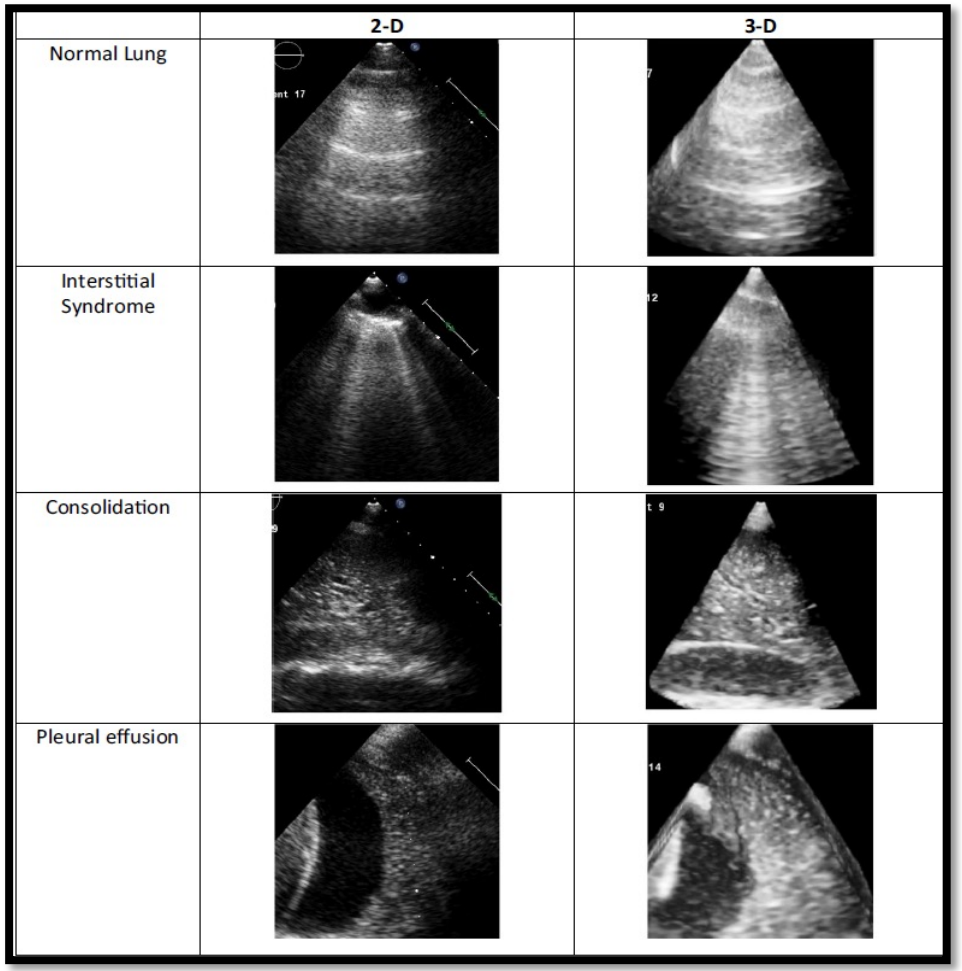


Table 2 Concordance tests for 2-D and 3-D imaging by using the Landis and Koch scale [12]

	Kappa	95% CI	Agreement
Unweighted Kappa for first expert	0.69	[0.58–0.80]	Substantial
Diagnosis-wise Kappa			
Normal lung	0.68	[0.51–0.86]	Substantial
Interstitial syndrome	0.62	[0.45–0.80]	Substantial
Consolidation	0.47	[0.30–0.64]	Moderate
Pleural effusion	0.93	[0.76–1.0]	Almost perfect

CI confidence interval, *2-D* two-dimensional, *3-D* three-dimensional

Case Report | Published: 04 August 2020

The use of contrast-enhanced ultrasound in COVID-19 lung imaging

Gibran Timothy Yusuf ✉, Adrian Wong, Deepak Rao, Alice Tee, Cheng Fang & Paul Singh Sidhu

Fig. 1

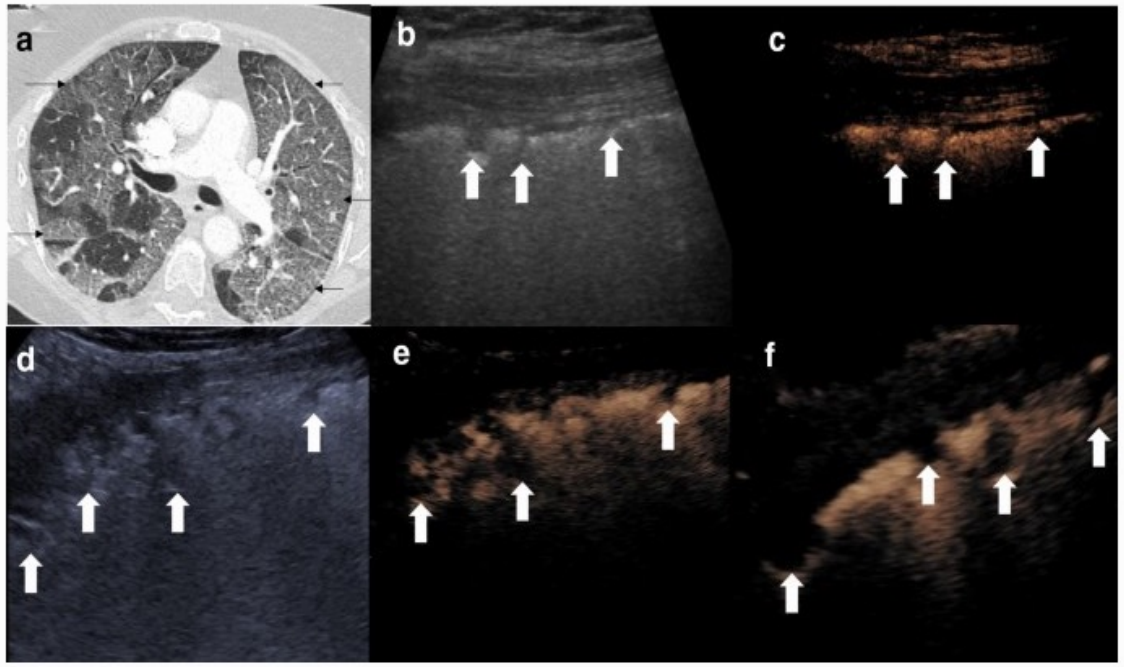
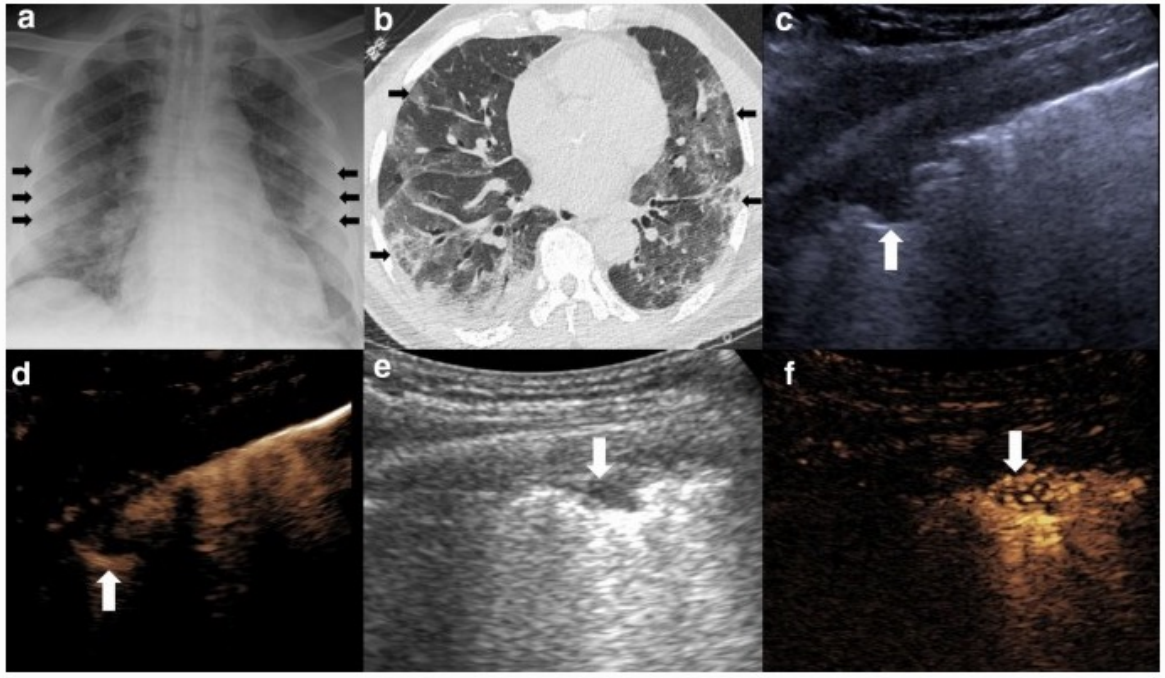


Fig. 2

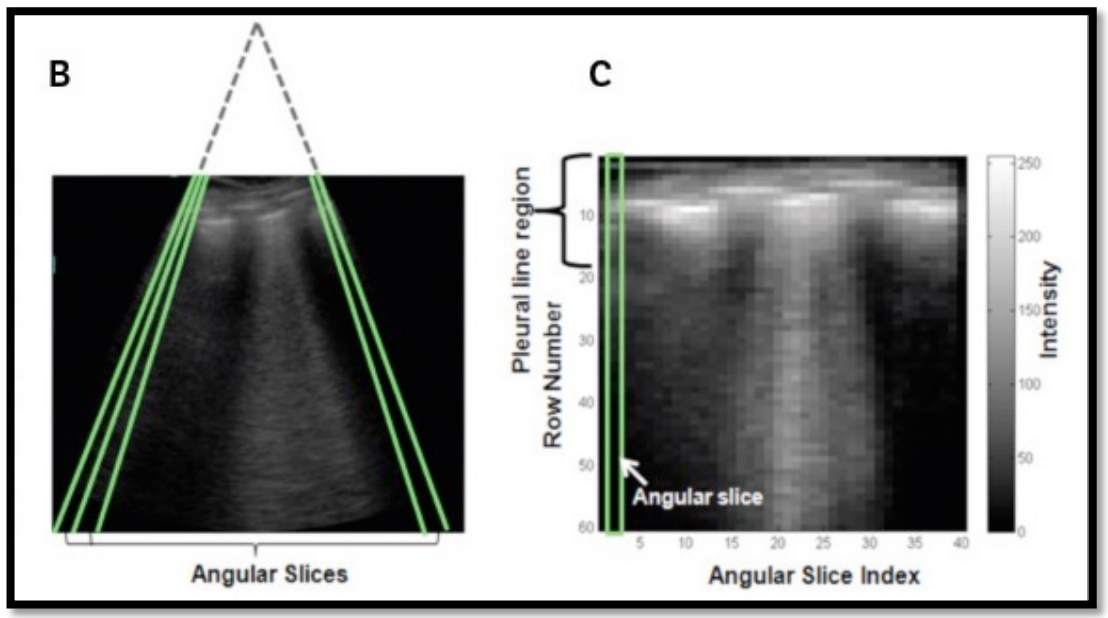


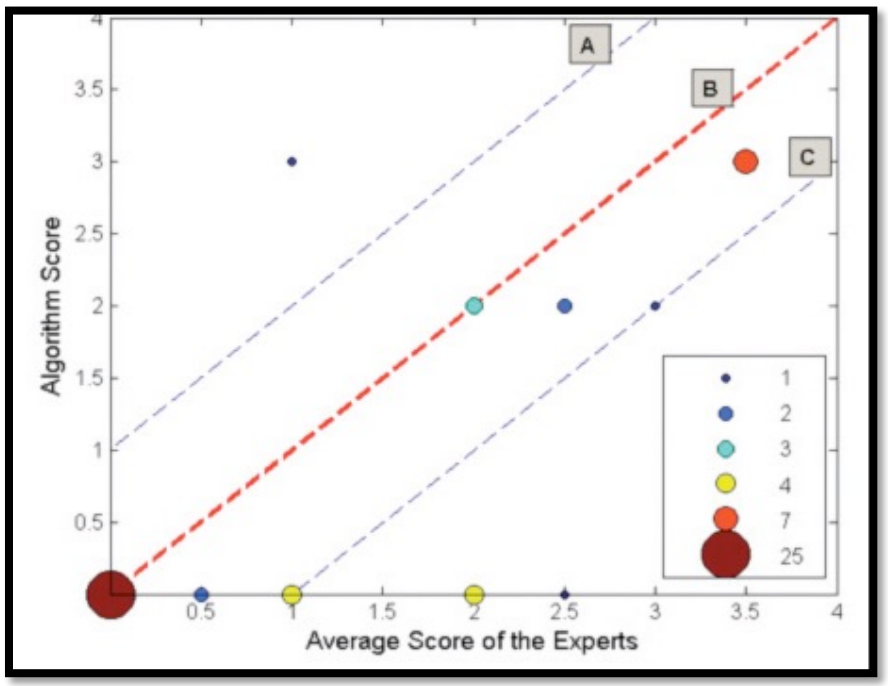
Pati
and
area
after
show

grading systems [3]. Contrast enhanced ultrasound (CEUS) is an adjunctive ultrasound technique with a range of applications [4]. Microbubbles consist of sulfur hexafluoride encased in a phospholipid shell, approximately the size of a red cell. These undergo non-linear oscillation with acoustic pressure and are detectable in a contrast-specific mode, resulting in a purely intravascular image to a capillary bed level. Critically, there is the ability to differentiate perfused, ischemic and avascular tissue.

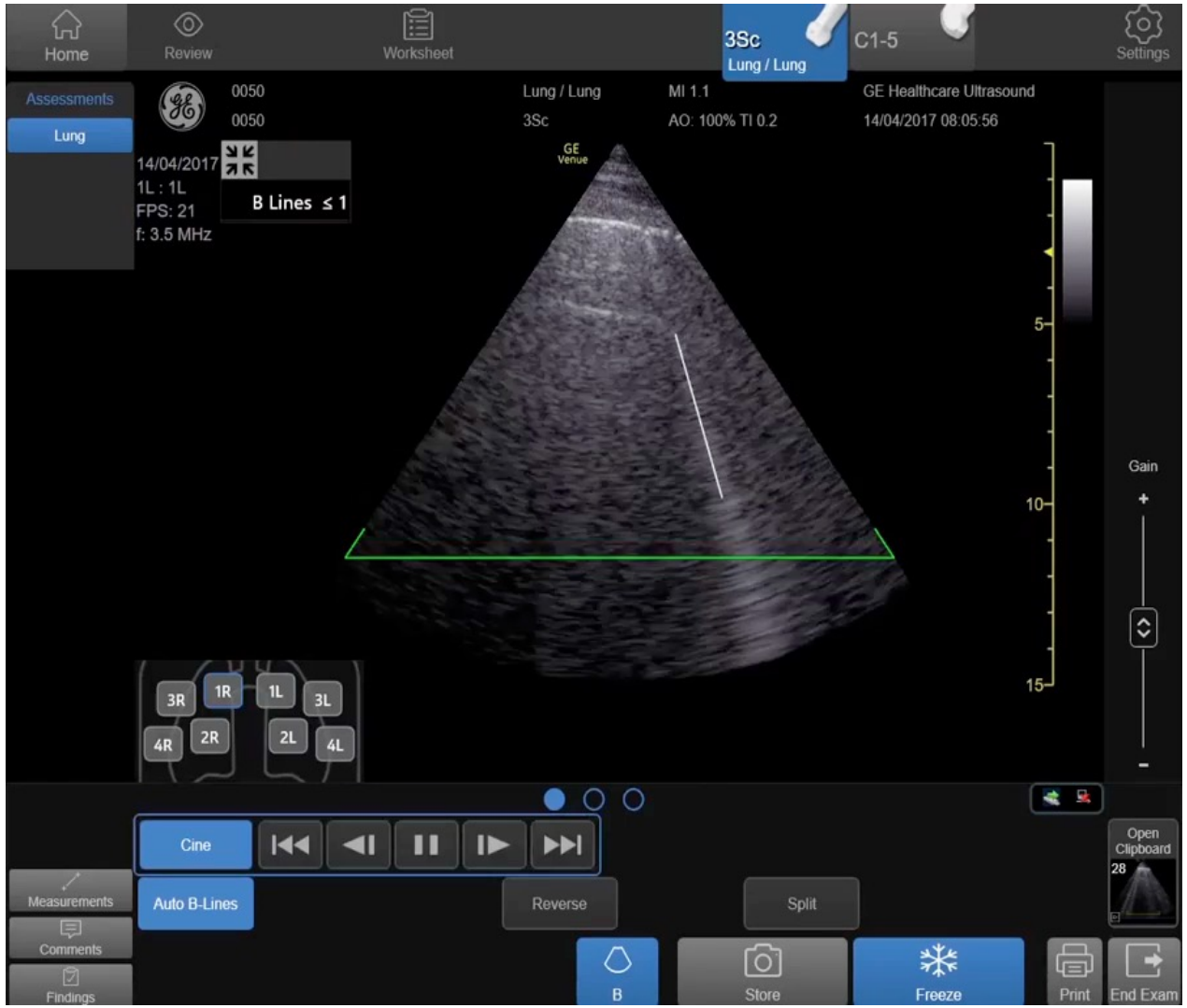
Automated B-Line Scoring on Thoracic Sonography

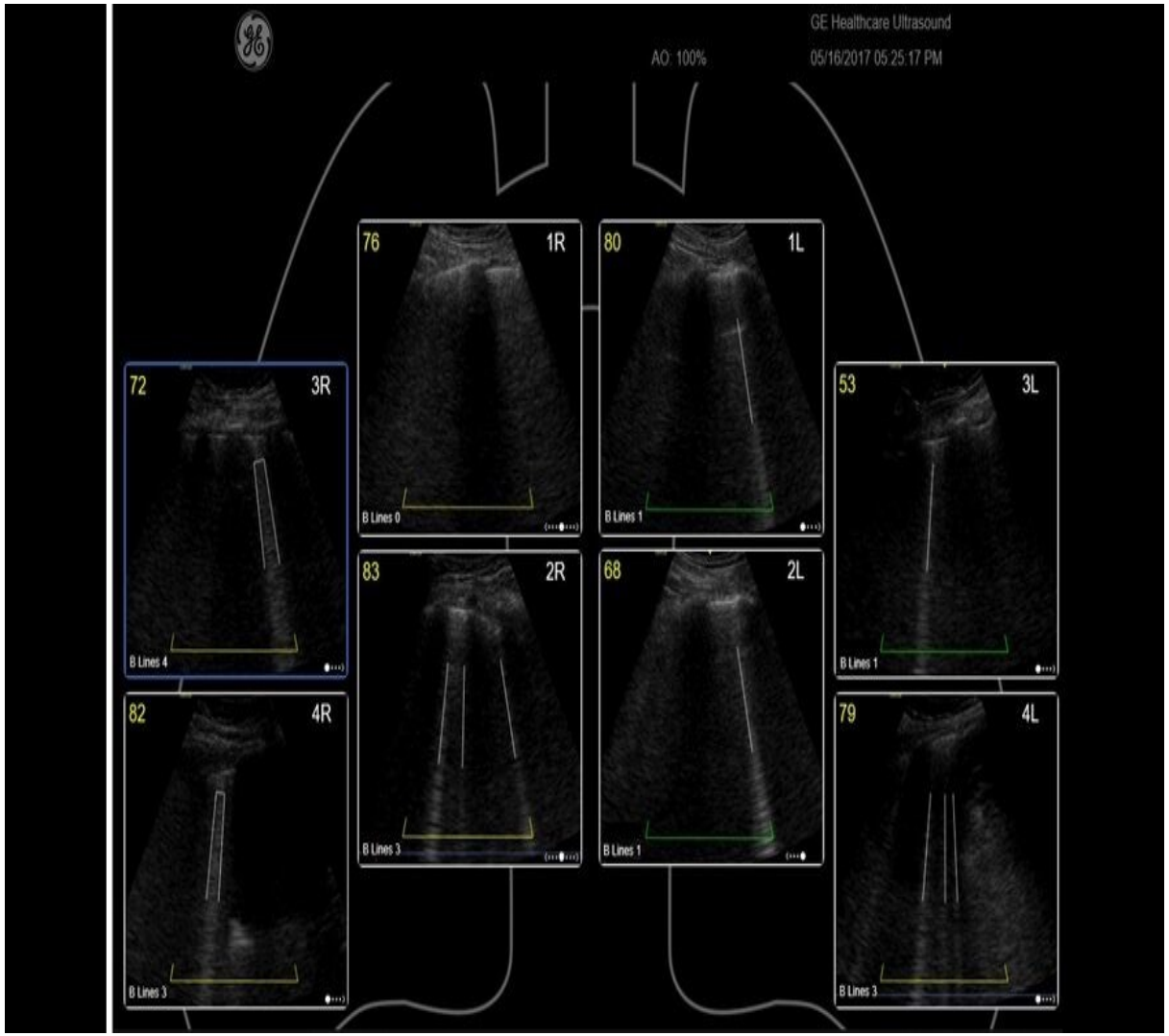
Laura J. Brattain, MS, Brian A. Telfer, PhD, Andrew S. Liteplo, MD, Vicki E. Noble, MD





Compte automatique des lignes B





ORIGINAL RESEARCH

Computerized Diagnostic Assistant for the Automatic Detection of Pneumothorax on Ultrasound: A Pilot Study

Shane M. Summers, MD, RDMS*
Eric J. Chin, MD*
Brit J. Long, MD*
Ronald D. Grisell, PhD§
John G. Knight, MD*
Kurt W. Grathwohl, MD, RDMS‡
John L. Ritter, MD†
Jeffrey D. Morgan, MD*
Jose Salinas, PhD§
Lorne H. Blackbourne, MD¶

*Brooke Army Medical Center, Department of Emergency Medicine, San Antonio, Texas
†Brooke Army Medical Center, Department of Radiology, San Antonio, Texas
‡Brooke Army Medical Center, Department of Pulmonary/Critical Care, San Antonio, Texas
§United States Army Institute of Surgical Research, San Antonio, Texas
¶United States Army Medical Department Center and School

Table 2. Overall test characteristics of the intelligent focused assessment with sonography for trauma (iFAST) when compared to the expert panel interpretation with results stratified by image quality score.

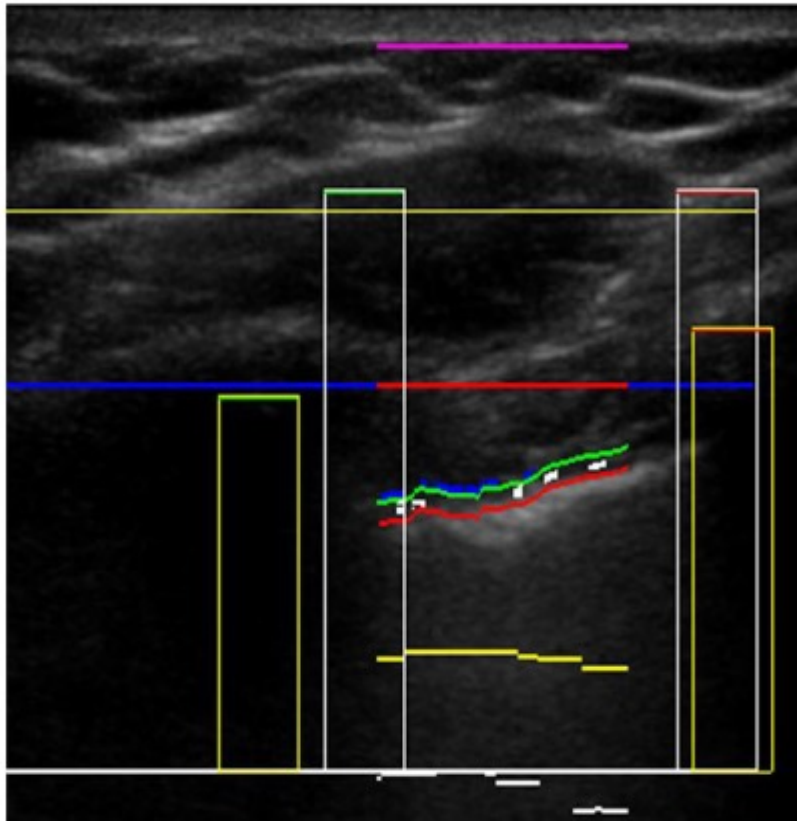
Test characteristics	Overall N=133 (95% CI)	Image quality 3 N=45 (95% CI)	Image quality 4 N=68 (95% CI)	Image quality 5 N=20 (95% CI)
Sensitivity, %	79 (63-89)	73 (39-93)	75 (53-89)	100 (65-100)
Specificity, %	87 (78-93)	88 (72-96)	84 (69-93)	92 (62-100)
PPV, %	73 (58-85)	67 (35-88)	72 (50-87)	88 (47-99)
NPV, %	90 (81-95)	91 (75-98)	86 (71-94)	100 (70-100)

PPV, positive predictive value; *NPV,* negative predictive value

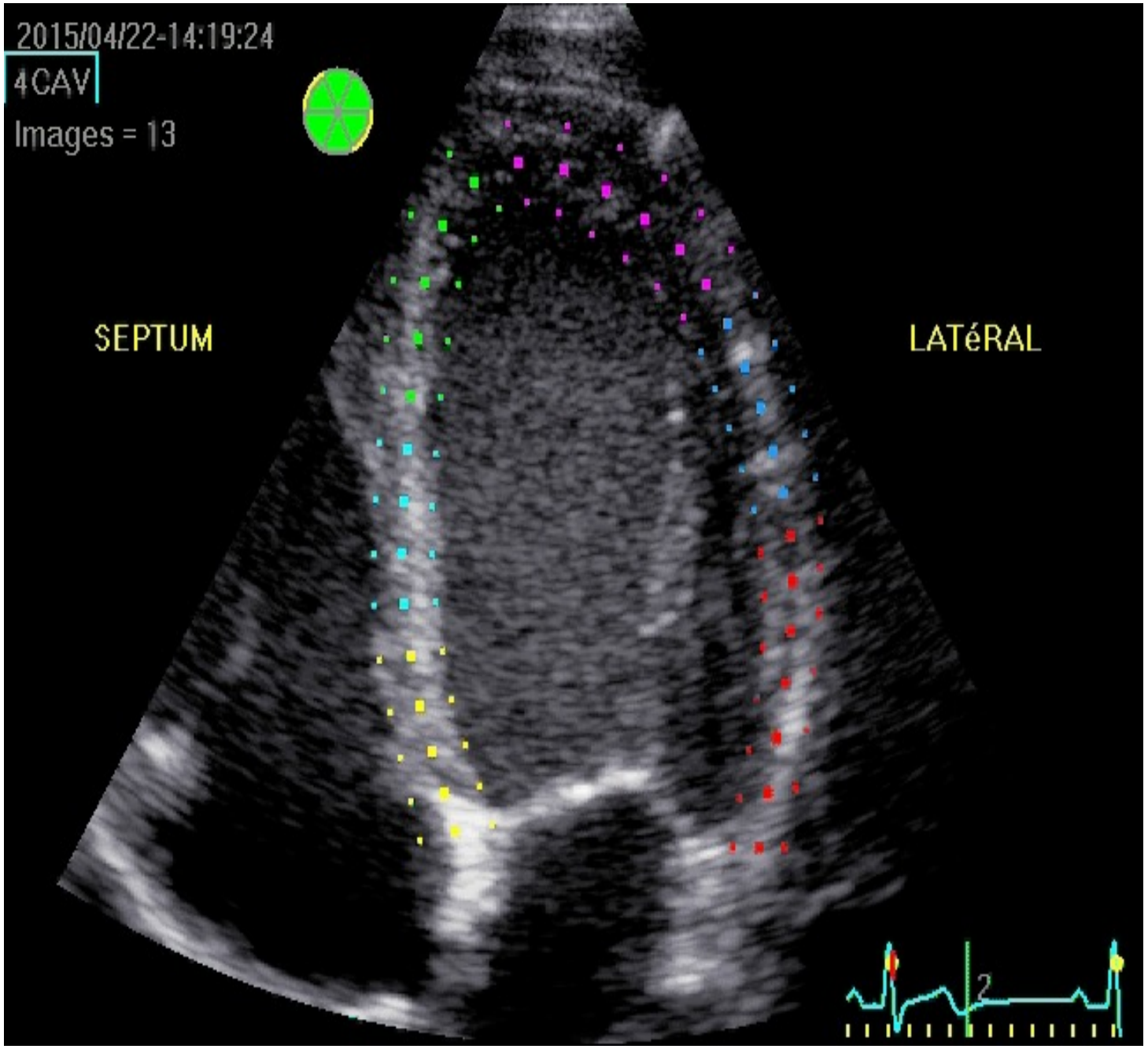
Table 3. Test characteristics of the intelligent focused assessment with sonography for trauma (iFAST) when stratified by mode of imaging and transducer selection.

Test characteristics	B-mode N=107 (95% CI)	M-mode N=26 (95% CI)	Linear array N=80 (95% CI)	Phased array N=53 (95% CI)
Sensitivity, %	87 (68-96)	58 (29-84)	76 (57-88)	89 (51-99)
Specificity, %	86 (75-92)	93 (64-100)	87 (74-95)	86 (72-94)
PPV, %	65 (56-74)	88 (47-99)	81 (62-92)	57 (30-81)
NPV, %	94 (85-98)	72 (46-89)	84 (70-92)	97 (85-100)

PPV, positive predictive value; *NPV,* negative predictive value

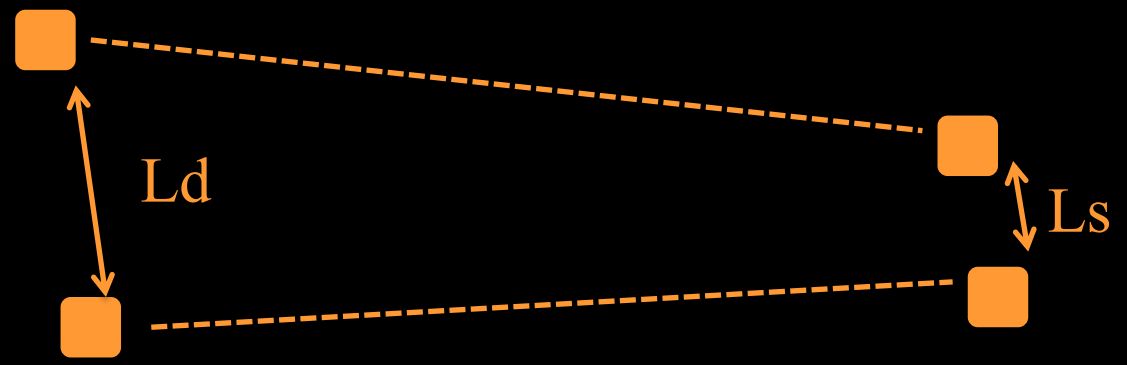


Speckle tracking et strain pleural



Diastole

Systole



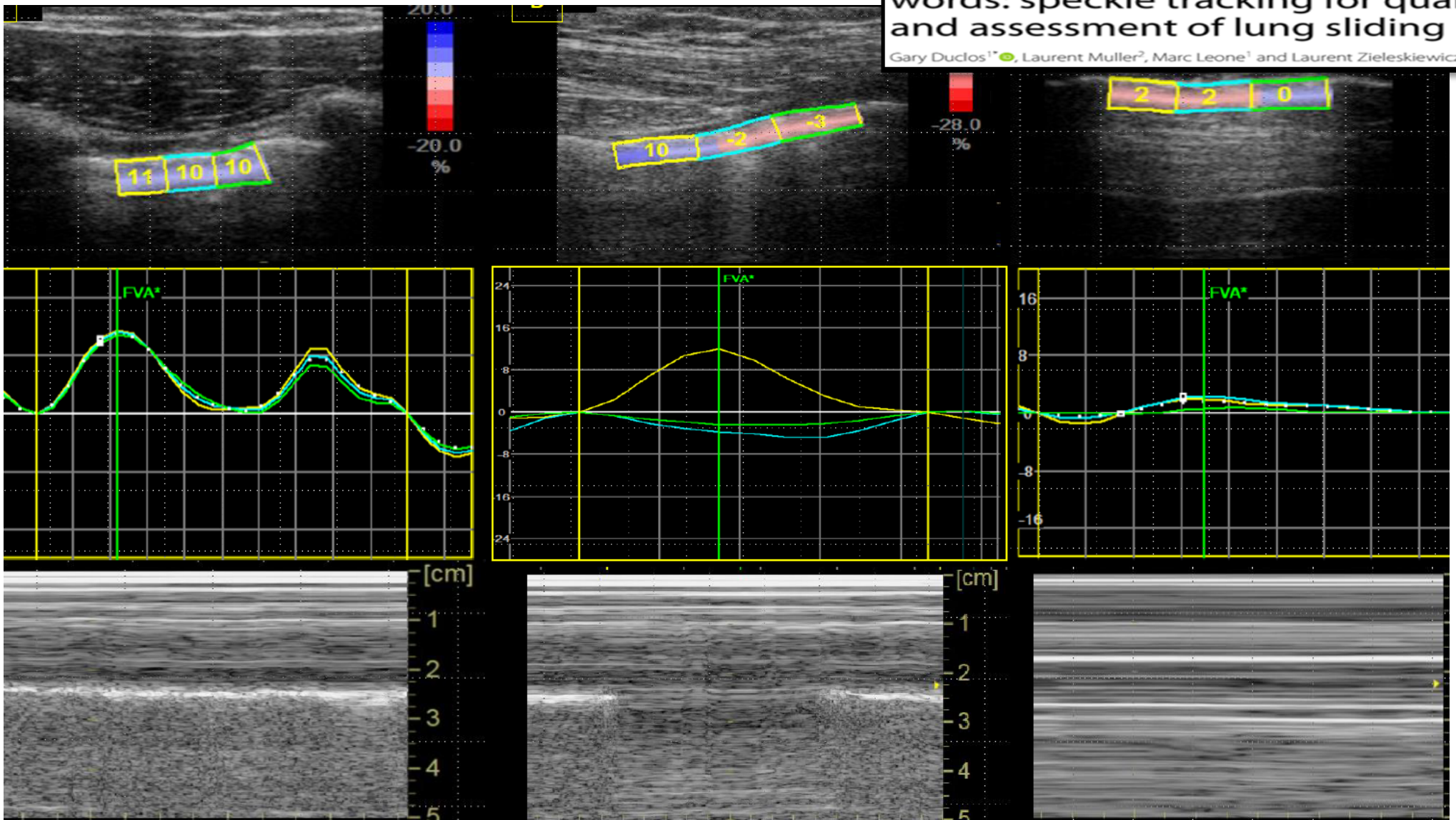
Strain systolique = (Ls – Ld) / Ls x 100%

Quantification du glissement pleural

IMAGING IN INTENSIVE CARE MEDICINE

A picture's worth a thousand words: speckle tracking for quantification and assessment of lung sliding

Gary Duclos[1*], Laurent Muller[2], Marc Leone[1] and Laurent Zieleskiewicz[3]

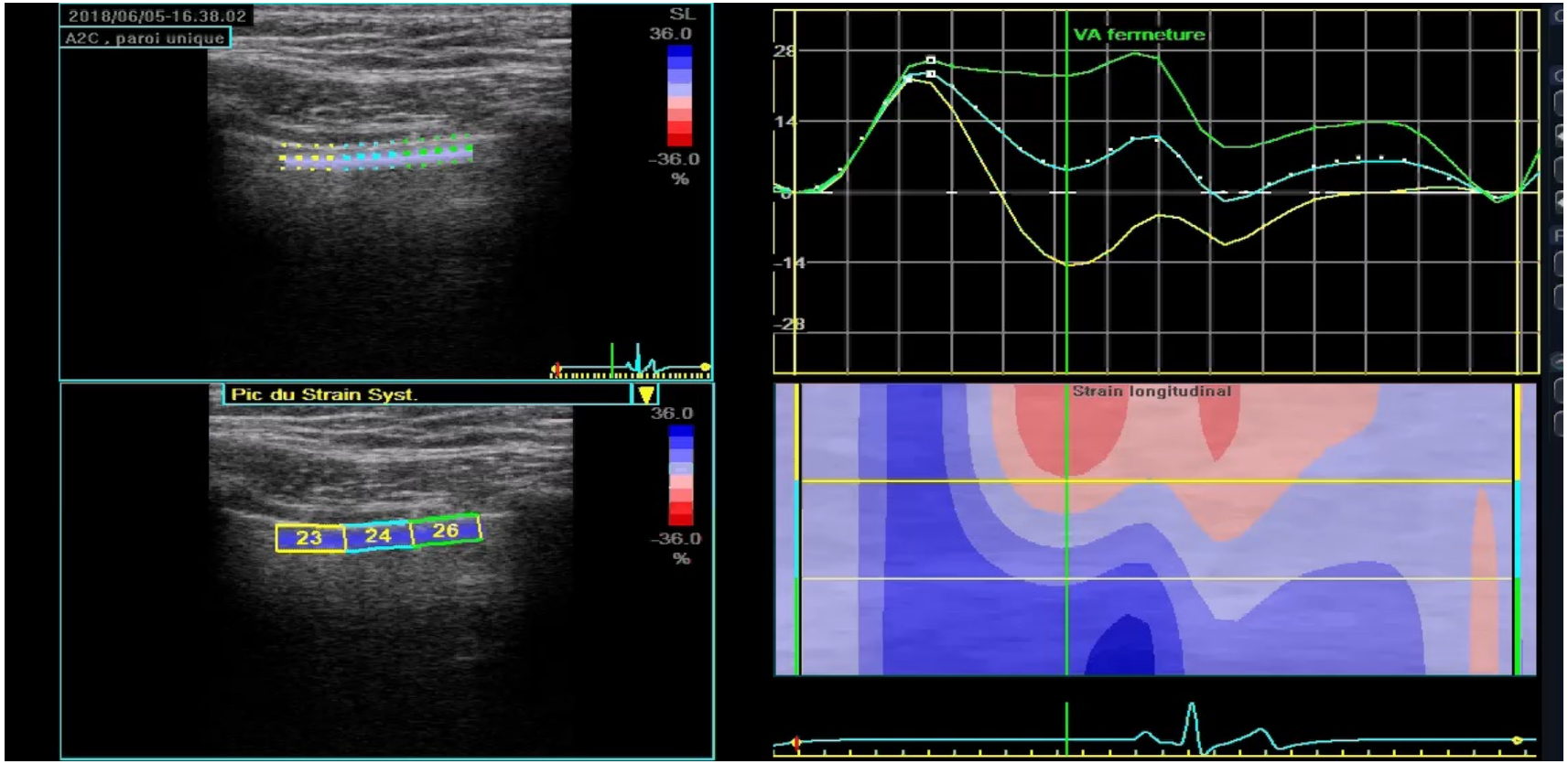


Quantification du glissement pleural

ORIGINAL

Speckle tracking quantification of lung sliding for the diagnosis of pneumothorax: a multicentric observational study

Gary Duclos[1*], Xavier Bobbia[2], Thibaut Markarian[3], Laurent Muller[2], Camille Cheyssac[1], Sarah Castillon[1], Noémie Resseguier[4], Alain Boussuges[5,6], Giovanni Volpicelli[7], Marc Leone[1] and Laurent Zieleskiewicz[1,6*]

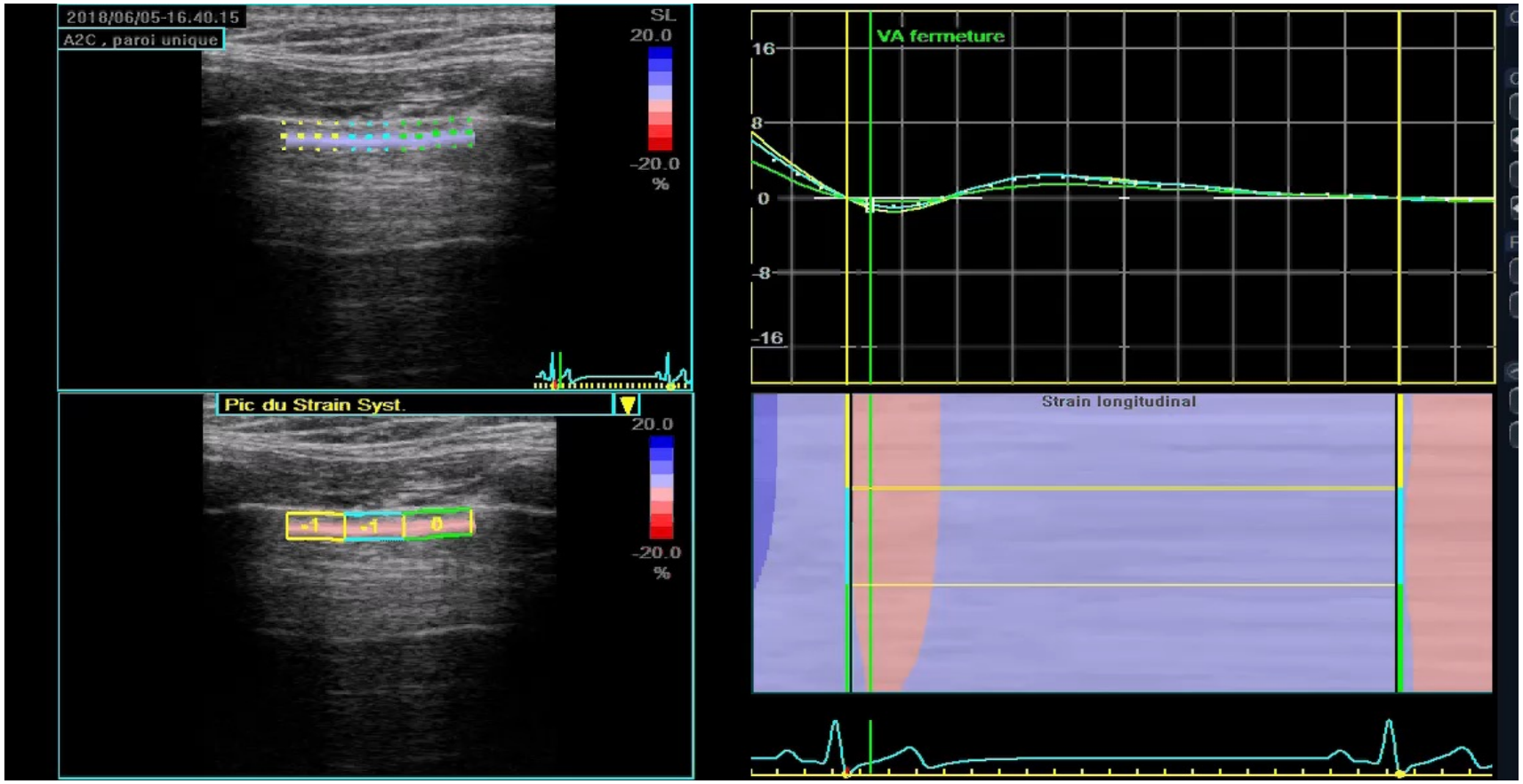


Quantification du glissement pleural

ORIGINAL

Speckle tracking quantification of lung sliding for the diagnosis of pneumothorax: a multicentric observational study

Gary Duclos[1*], Xavier Bobbia[2], Thibaut Markarian[3], Laurent Muller[2], Camille Cheyssac[1], Sarah Castillon[1], Noémie Resseguier[4], Alain Boussuges[5,6], Giovanni Volpicelli[7], Marc Leone[1] and Laurent Zieleskiewicz[1,6*]

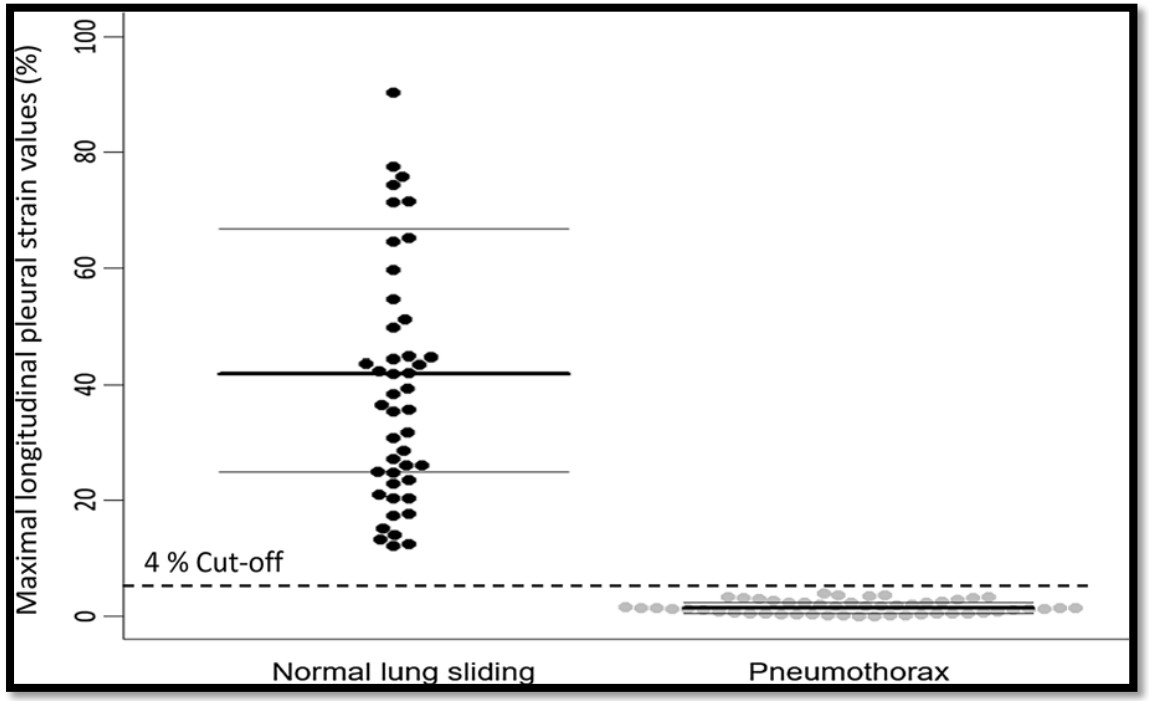


Quantification du glissement pleural

ORIGINAL

Speckle tracking quantification of lung sliding for the diagnosis of pneumothorax: a multicentric observational study

Gary Duclos[1*], Xavier Bobbia[2], Thibaut Markarian[3], Laurent Muller[2], Camille Cheyssac[1], Sarah Castillon[1], Noémie Resseguier[4], Alain Boussuges[5,6], Giovanni Volpicelli[7], Marc Leone[1] and Laurent Zieleskiewicz[1,6*]



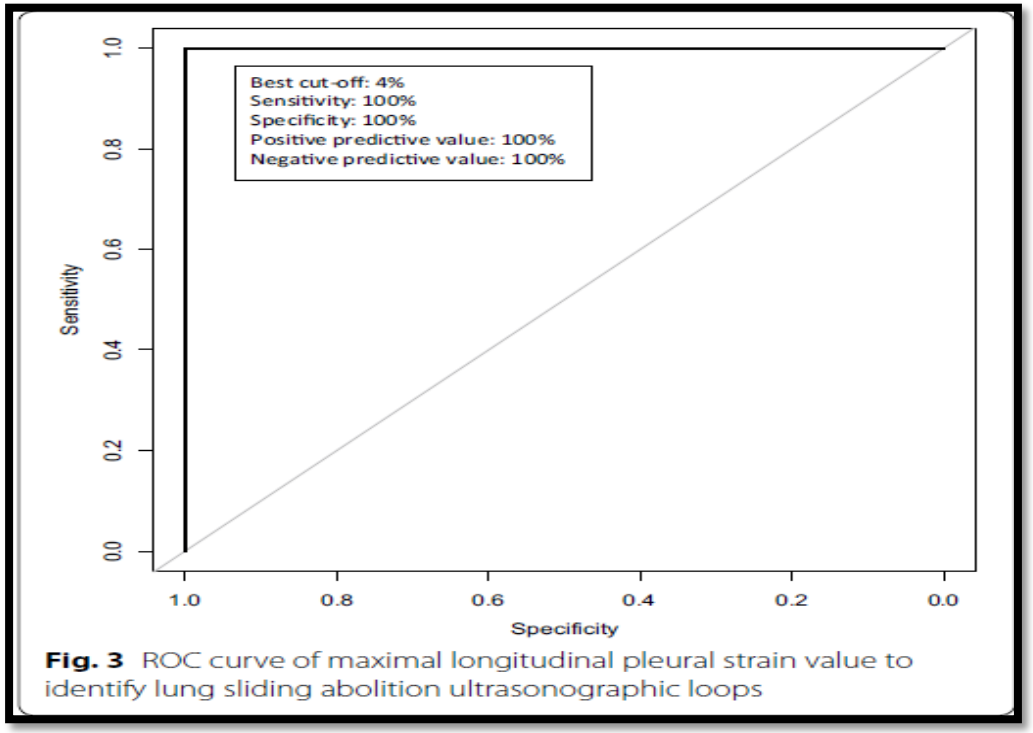


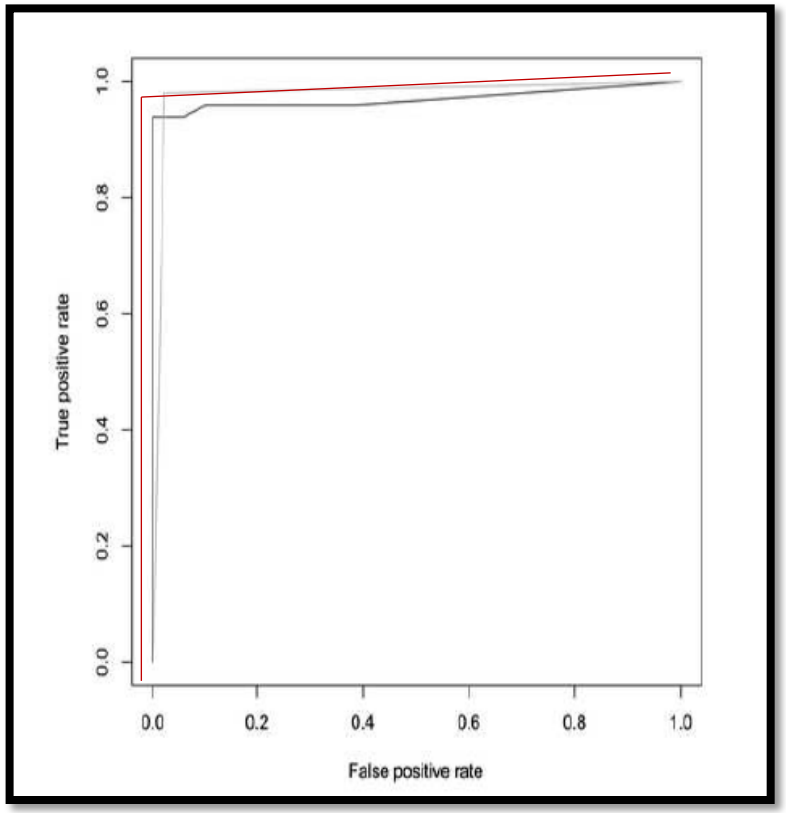
Fig. 3 ROC curve of maximal longitudinal pleural strain value to identify lung sliding abolition ultrasonographic loops

American Journal of Emergency Medicine

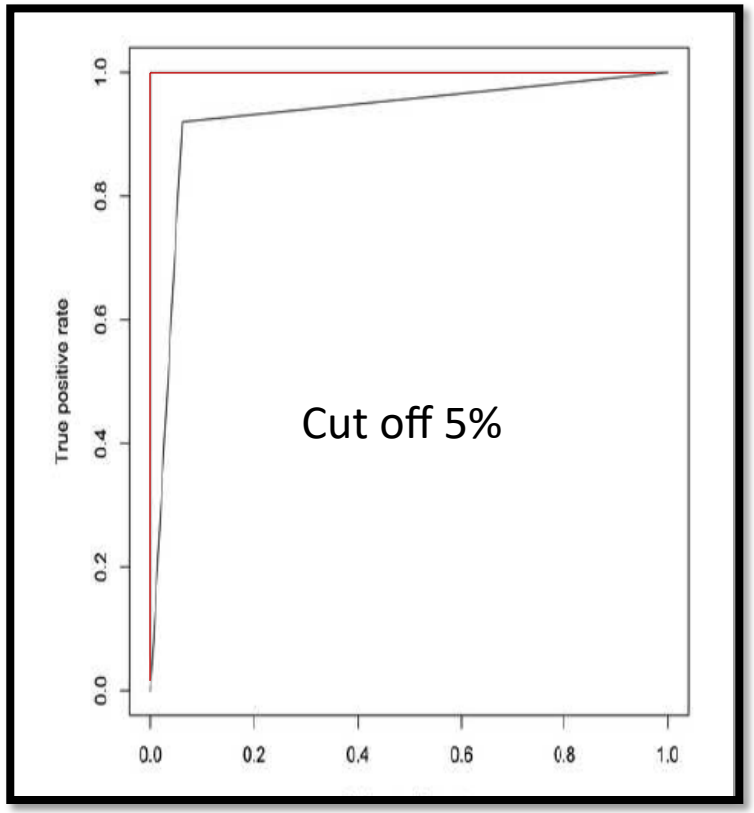
Pneumothorax diagnosis with lung sliding quantification by speckle tracking: a prospective multicentric observational study

Fissore, Zieleskiewicz….. Bobbia Mai 2021 AJEM

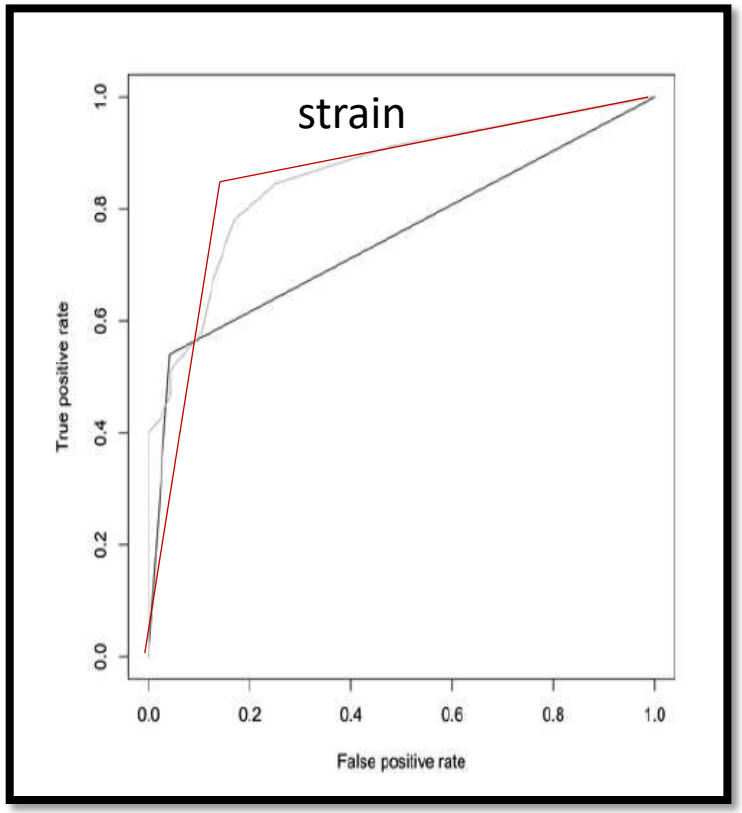
AUC strain 0,97



Expert



Intermediate



Novice

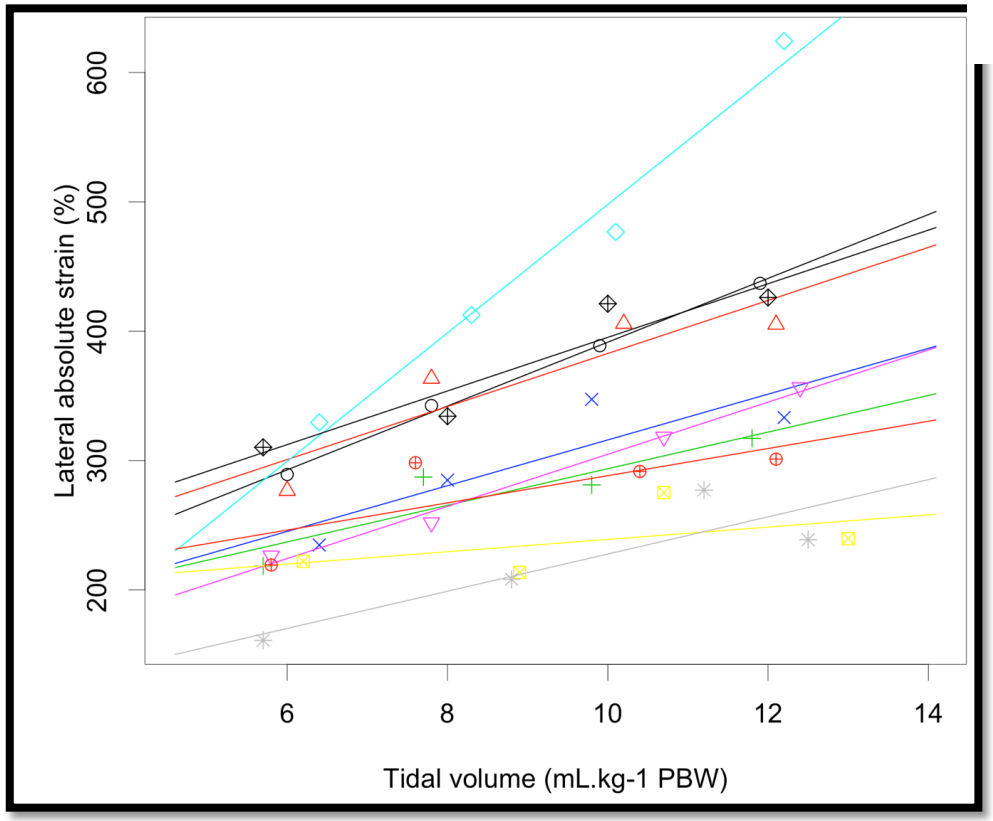
Nouvelles techniques : élastométrie

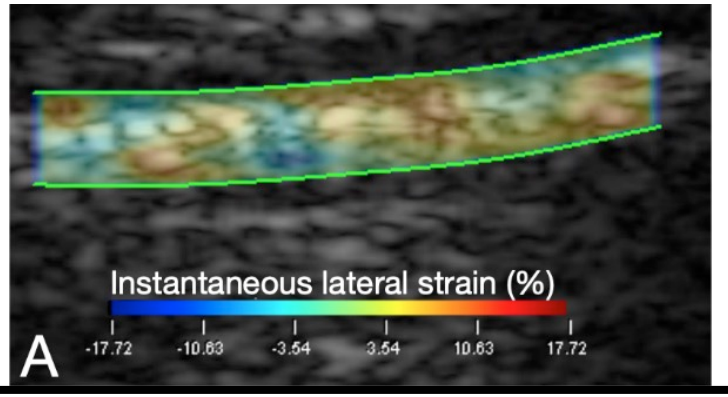
Mesure de la déformation pleurale régionale durant la ventilation mécanique par élastographie ultrasonore : une étude preuve de concept

Par

Martin Girard

Université de Montréal





Nouvelles utilisations

Covid

Morphologie du SDRA

Surdistension

LUS et Covid : diminution du risque de transmission croisée

Observational Study > Intensive Care Med. 2015 Mar;41(3):436-43.

doi: 10.1007/s00134-014-3592-1. Epub 2014 Dec 18.

Diagnostic yield and safety of CT scans in ICU

Marine Aliaga [1], Jean-Marie Forel, Sophie De Bourmont, Boris Jung, Guillemette Thomas, Martin Mahul, Magali Bisbal, Stephanie Nougaret, Sami Hraiech, Antoine Roch, Kathia Chaumoitre, Samir Jaber, Marc Gainnier, Laurent Papazian

22% d'évènements indésirables + risque transmission croisée

Intensive Care Med. 2020 May 4 : 1–4. PMCID: PMC7196717

doi: 10.1007/s00134-020-06048-9 [Epub ahead of print] PMID: 32367169

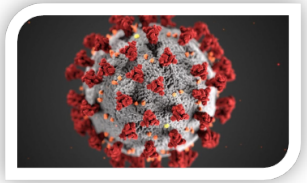
What's new in lung ultrasound during the COVID-19 pandemic

Giovanni Volpicelli,[1] Alessandro Lamorte,[2] and Tomás Villén[3]

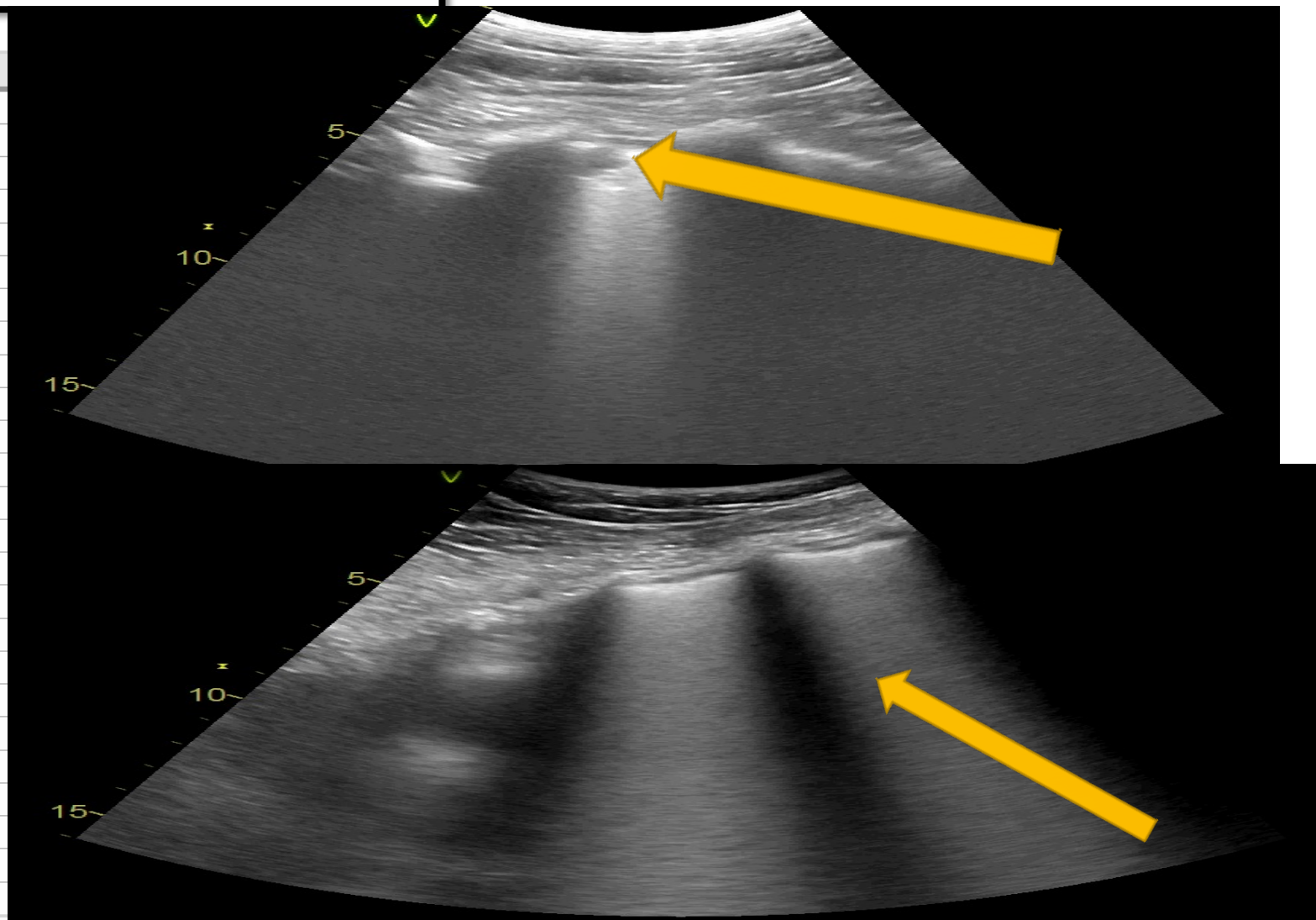
Research Letter | Open Access | Published: 28 April 2020

Lung ultrasound findings in patients with COVID-19 pneumonia

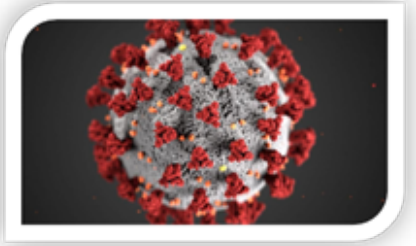
Changyang Xing, Qiaoying Li, Hong Du, Wenzhen Kang, Jianqi Lian & Lijun Yuan



	1st week (*n* = 4)
Clinical severity (%)	
Moderate	0
Severe	25% (1)
Critical	75% (3)
Pleural line abnormalities	100% (4)
B-lines	100% (4)
Separated B-lines	50% (2)
Confluent B-lines	75% (3)
Compact B-lines	25% (1)
Bilateral involvement	100% (4)
Anterior upper area	100% (4)
Anterior lower area	100% (4)
Lateral area	100% (4)
Interscapular area	100% (4)
Infrascapular area	100% (4)
Consolidation	50% (2)
Bilateral involvement	25% (1)
Anterior upper area	0
Anterior lower area	0
Lateral area	0
Interscapular area	50% (2)
Infrascapular area	25% (1)
Pleural effusion	25% (1)
Pericardial effusion	0
Deep vein thrombosis	50% (2)



LUS Covid et diagnostic



Feasibility of using point-of-care lung ultrasound for early triage of COVID-19 patients in the emergency room

Nick Narinx[1] · Annick Smismans[2] · Rolf Symons[3] · Johan Frans[2] · Annick Demeyere[3] · Marc Gillis[4]

Pré test ? Spécificité ?

Table 2 Diagnostic accuracy of POCUS lung and chest CT in the diagnosis of COVID-19 infection

	Results (*n*)				Test performance (% with 95% CI)				
	TP	TN	FP	FN	Sensitivity	Specificity	PPV	NPV	Accuracy
POCUS lung (*n* = 90)	14	16	59	1	93.3 (80.7–100.0)	21.3 (12.1–30.6)	19.2 (10.1–28.2)	94.1 (82.9–100.0)	33.3 (32.8–33.8)
Chest CT (*n* = 90)	12	65	10	3	80.0 (59.8–100.0)	86.7 (79.0–94.4)	54.5 (33.7–75.4)	95.6 (90.7–100.0)	85.6 (85.3–85.8)

LUS Covid et diagnostic

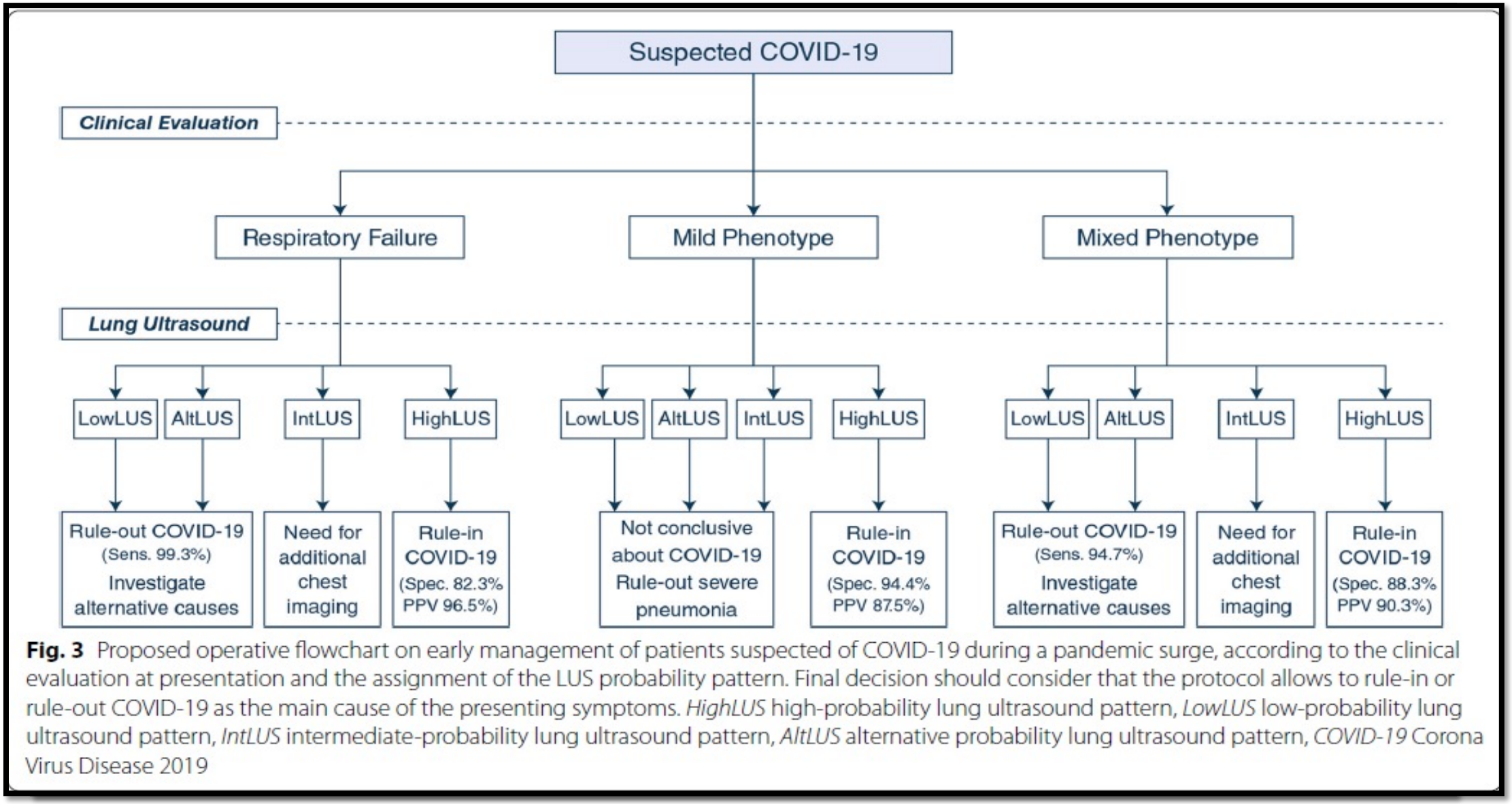
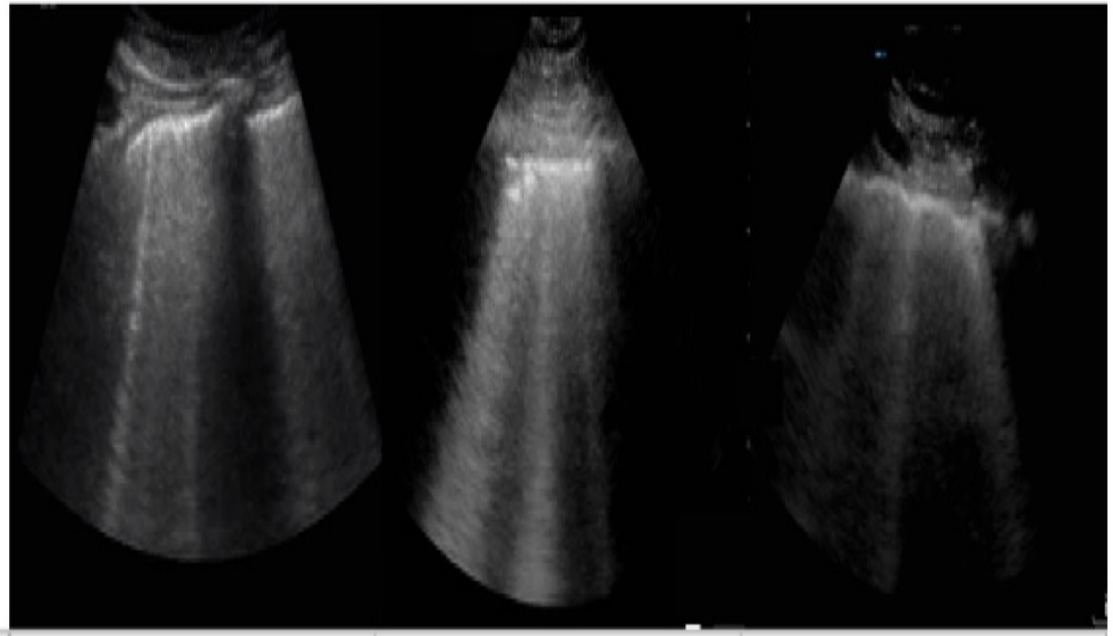


Fig. 3 Proposed operative flowchart on early management of patients suspected of COVID-19 during a pandemic surge, according to the clinical evaluation at presentation and the assignment of the LUS probability pattern. Final decision should consider that the protocol allows to rule-in or rule-out COVID-19 as the main cause of the presenting symptoms. *HighLUS* high-probability lung ultrasound pattern, *LowLUS* low-probability lung ultrasound pattern, *IntLUS* intermediate-probability lung ultrasound pattern, *AltLUS* alternative probability lung ultrasound pattern, *COVID-19* Corona Virus Disease 2019

IA et LUS = meilleure spécificité



B Lines	Homogeneous	Patchy	Patchy
Pleural Line	Smooth/Regular	Irregular/Fragmented	Irregular/Fragmented
Sub-pleural consolidation	Absent	Common	Common

Nouvelle application + nouvelle technologie

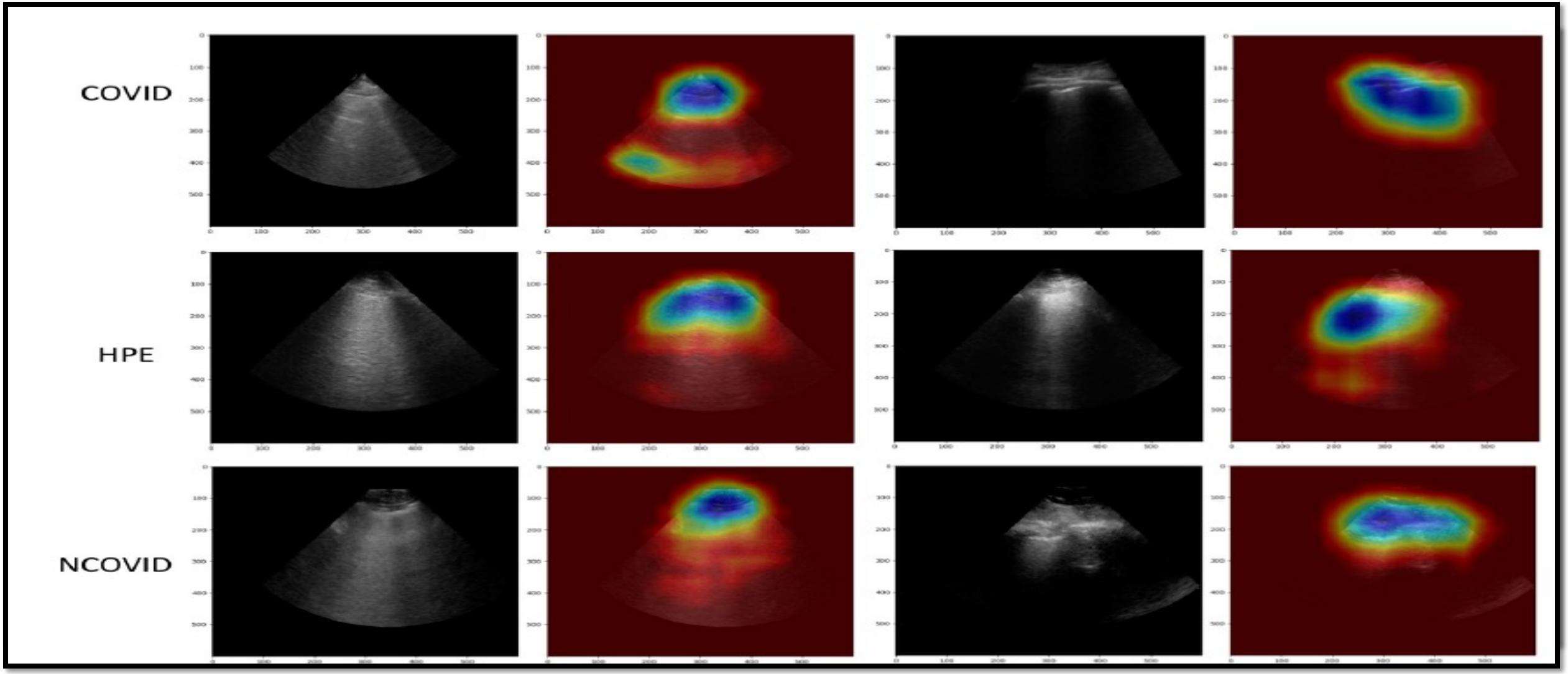
Open access Original research

BMJ Open

Development of a convolutional neural network to differentiate among the etiology of similar appearing pathological B lines on lung ultrasound: a deep learning study

Robert Arntfield ,[1] Blake VanBerlo,[2] Thamer Alaifan ,[1] Nathan Phelps,[3] Matthew White,[1] Rushil Chaudhary,[4] Jordan Ho,[2] Derek Wu[2]

IA > Physician



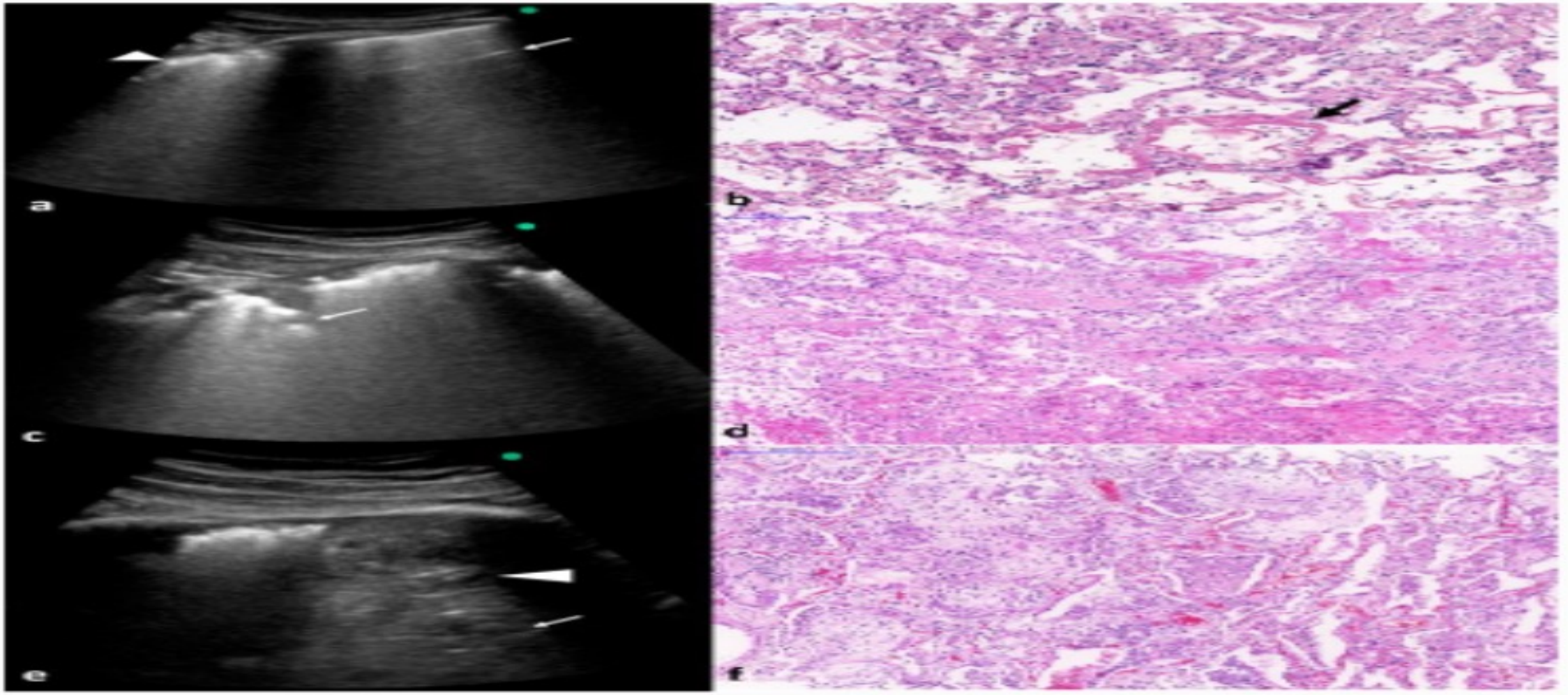
LUS et quantification de l'atteinte

Histological–ultrasonographical correlation of pulmonary involvement in severe COVID-19

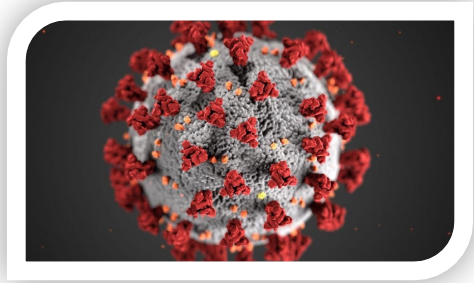
Renata Aparecida Almeida Monteiro, Ellen Pierre de Oliveira, Paulo Hilário Nascimento Saldiva, Marisa Dolhnikoff & Amaro Nunes Duarte-Neto ✉ & BIAS - Brazilian Image Autopsy Study Group

Intensive Care Medicine **46**, 1766–1768(2020) | Cite this article

Fig. 1



LUS et quantification de l'atteinte



ORIGINAL

Comparative study of lung ultrasound and chest computed tomography scan in the assessment of severity of confirmed COVID-19 pneumonia

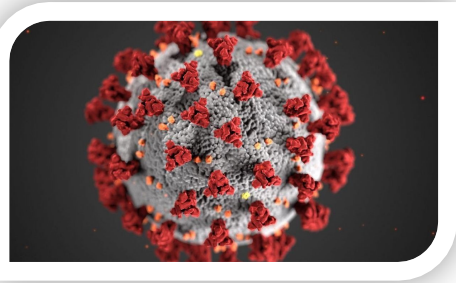
Laurent Zieleskiewicz[1,2*], Thibaut Markarian[3], Alexandre Lopez[1], Chloé Taguet[3], Neyla Mohammedi[1], Mohamed Boucekine[4], Karine Baumstarck[4], Guillaume Besch[5], Gautier Mathon[6], Gary Duclos[1], Lionel Bouvet[7,8,9], Pierre Michelet[3], Bernard Allaouchiche[6,8,9], Kathia Chaumoître[10], Mathieu Di Bisceglie[10] and Marc Leone[1] on behalf of the AZUREA Network

Table 3 Correlation: LUS score according to chest CT scan severity

Chest CT scan severity	Patients	LUS score mean ± SD	95% CI for Mean		LUS score min	LUS score max	*P* value
			Lower bound	Upper bound			
Minimal damage	18	8 ± 7	4	11	0	22	< 0.0001
Moderate damage	43	14 ± 8	11	16	0	30	
Severe damage	39	20 ± 8	18	23	5	34	

CT computed tomography; *LUS* lung ultrasound; *CI*: confidence interval, *SD* standard deviation

LUS et quantification de l'atteinte



ORIGINAL

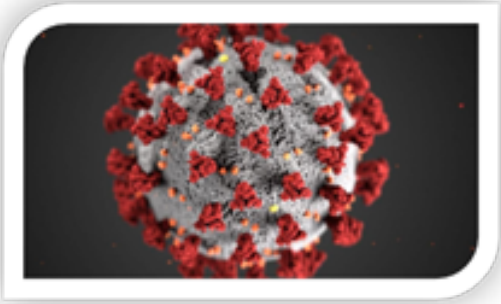
Comparative study of lung ultrasound and chest computed tomography scan in the assessment of severity of confirmed COVID-19 pneumonia

Laurent Zieleskiewicz[1,2*], Thibaut Markarian[3], Alexandre Lopez[1], Chloé Taguet[3], Neyla Mohammedi[1], Mohamed Boucekine[4], Karine Baumstarck[4], Guillaume Besch[5], Gautier Mathon[6], Gary Duclos[1], Lionel Bouvet[7,8,9], Pierre Michelet[3], Bernard Allaouchiche[6,8,9], Kathia Chaumoître[10], Mathieu Di Bisceglie[10] and Marc Leone[1] on behalf of the AZUREA Network

LUS et état clinique à un moment donné.

	Oui	Non	p
VM	LUS= 28 +/-5	LUS= 14 +/-8	<0,0001
SPO2/FiO2<370	LUS = 19 +/-8	LUS = 11+/-8	<0,0001

LUS et Covid : pronostic

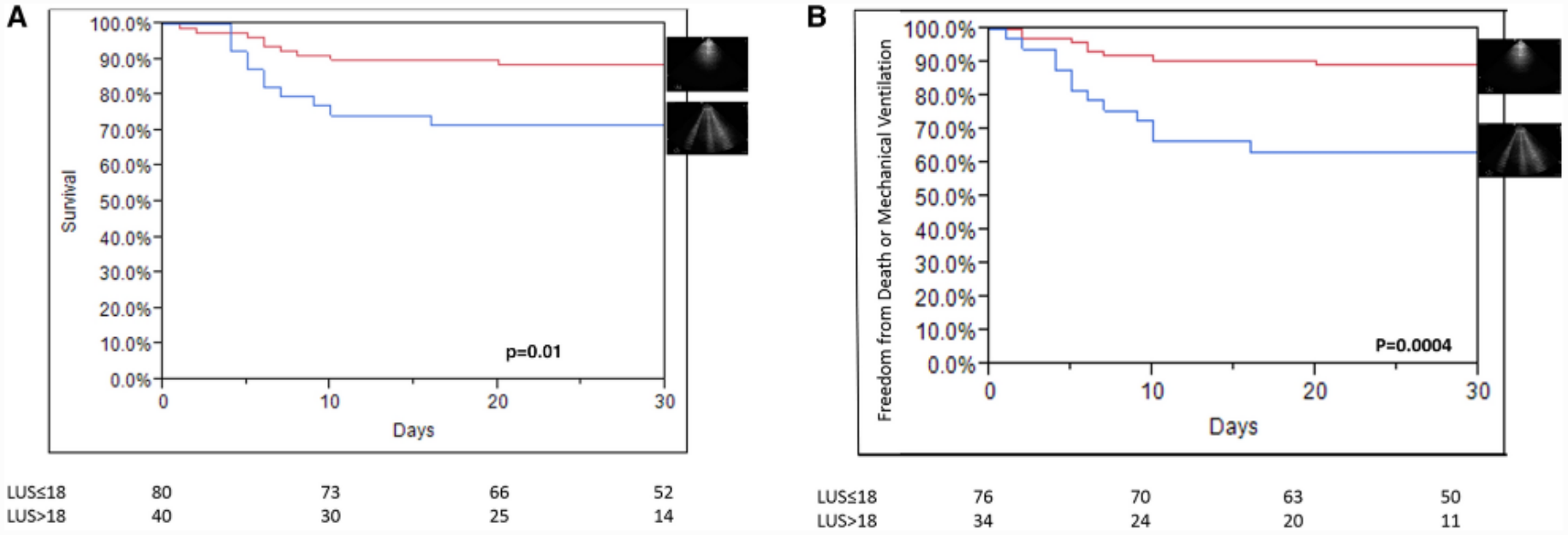


Lung ultrasound predicts clinical course and outcomes in COVID-19 patients

Yael Lichter, Yan Topilsky, Philippe Taieb, Ariel Banai, Aviram Hochstadt, Ilan Merdler, Amir Gal Oz, Jacob Vine, Or Goren, Barak Cohen, Orly Sapir, Yoav Granot, Tomer Mann, Shirley Friedman, Yoel Angel, Nimrod Adi, Michal Laufer-Perl, Merav Ingbir, Yaron Arbel, Idit Matot & Yishay Szekely

Fig. 2

From: Lung ultrasound predicts clinical course and outcomes in COVID-19 patients



a Kaplan–Meier curve for mortality according to lung ultrasound severity. **b** Kaplan–Meier curve for the combination of need for invasive mechanical ventilation or mortality according to lung ultrasound severity

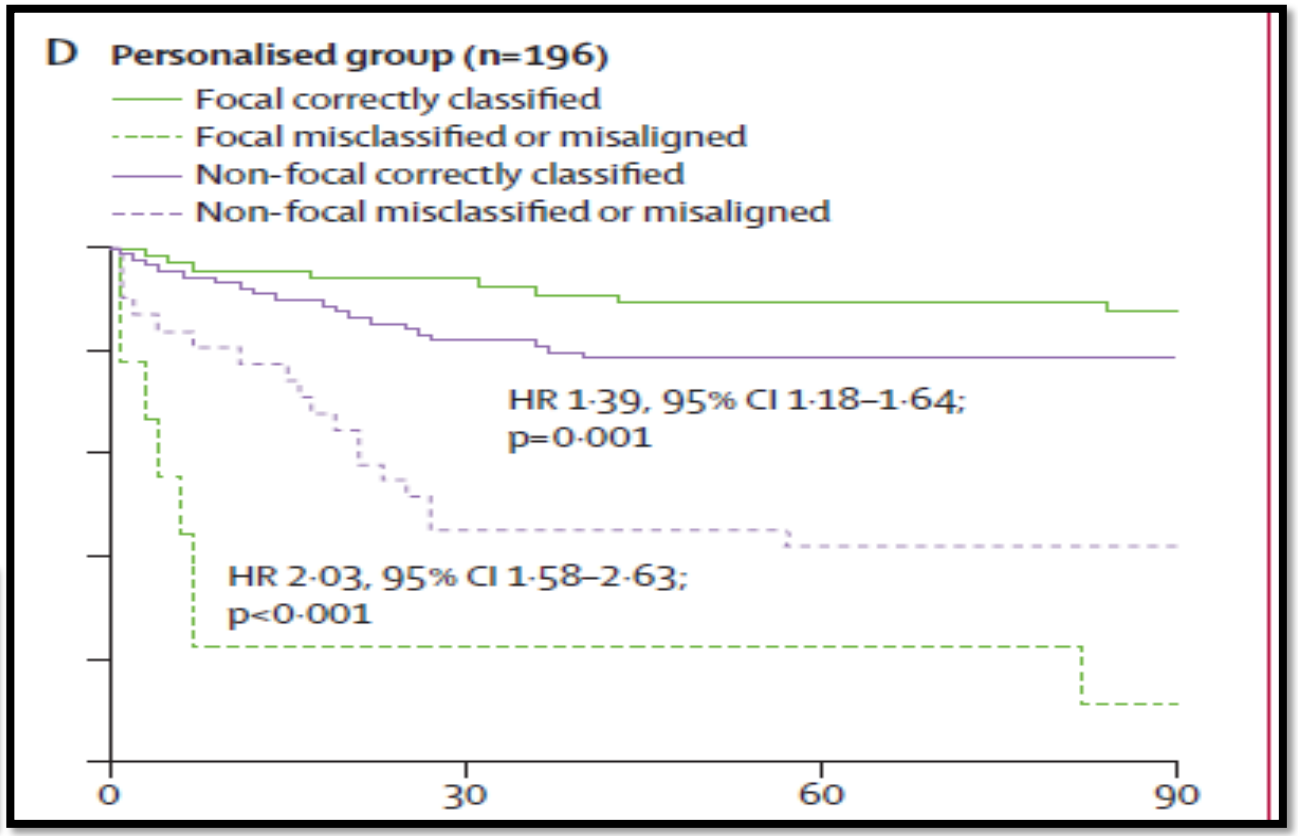
Ventilation selon la morphologie ?

Personalised mechanical ventilation tailored to lung morphology versus low positive end-expiratory pressure for patients with acute respiratory distress syndrome in France (the LIVE study): a multicentre, single-blind, randomised controlled trial

Ventiler de manière personnalisée

> Mortalité chez mal classés

Constantin et al Lancet resp med



Lancet Respir Med. 2019 Dec;7(12):e38. doi: 10.1016/S2213-2600(19)30353-4.

Personalised mechanical ventilation in acute respiratory distress syndrome: the right idea with the wrong tools?

Mongodi S[1], Santangelo E[2], Bouhemad B[3], Vaschetto R[4], Mojoli F[5].

Morphologie du SDRA

RESEARCH Open Access

Clinical performance of lung ultrasound in predicting ARDS morphology

Andrea Costamagna[1], Emanuele Pivetta[2], Alberto Goffi[3,4], Irene Steinberg[5], Pietro Arina[5], Anna Teresa Mazzeo[5,9], Lorenzo Del Sorbo[3,6], Simona Veglia[7], Ottavio Davini[7], Luca Brazzi[1,5], V. Marco Ranieri[8] and Vito Fanelli[1,5*]

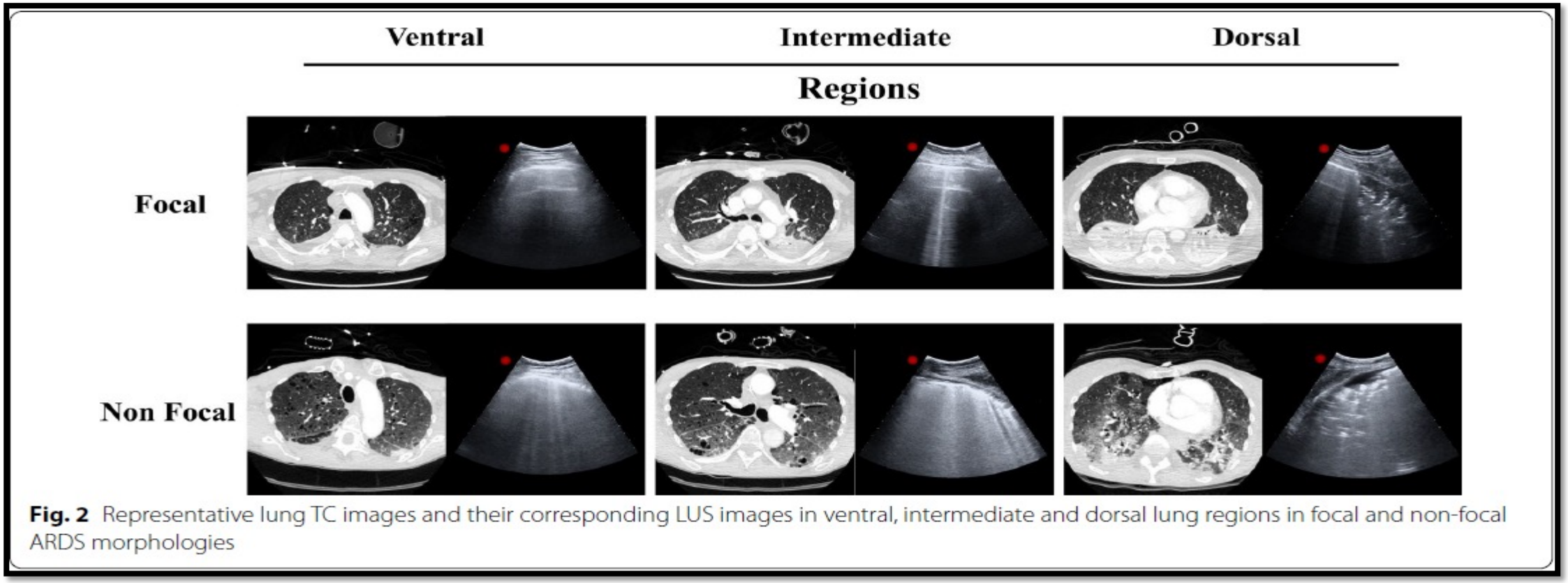
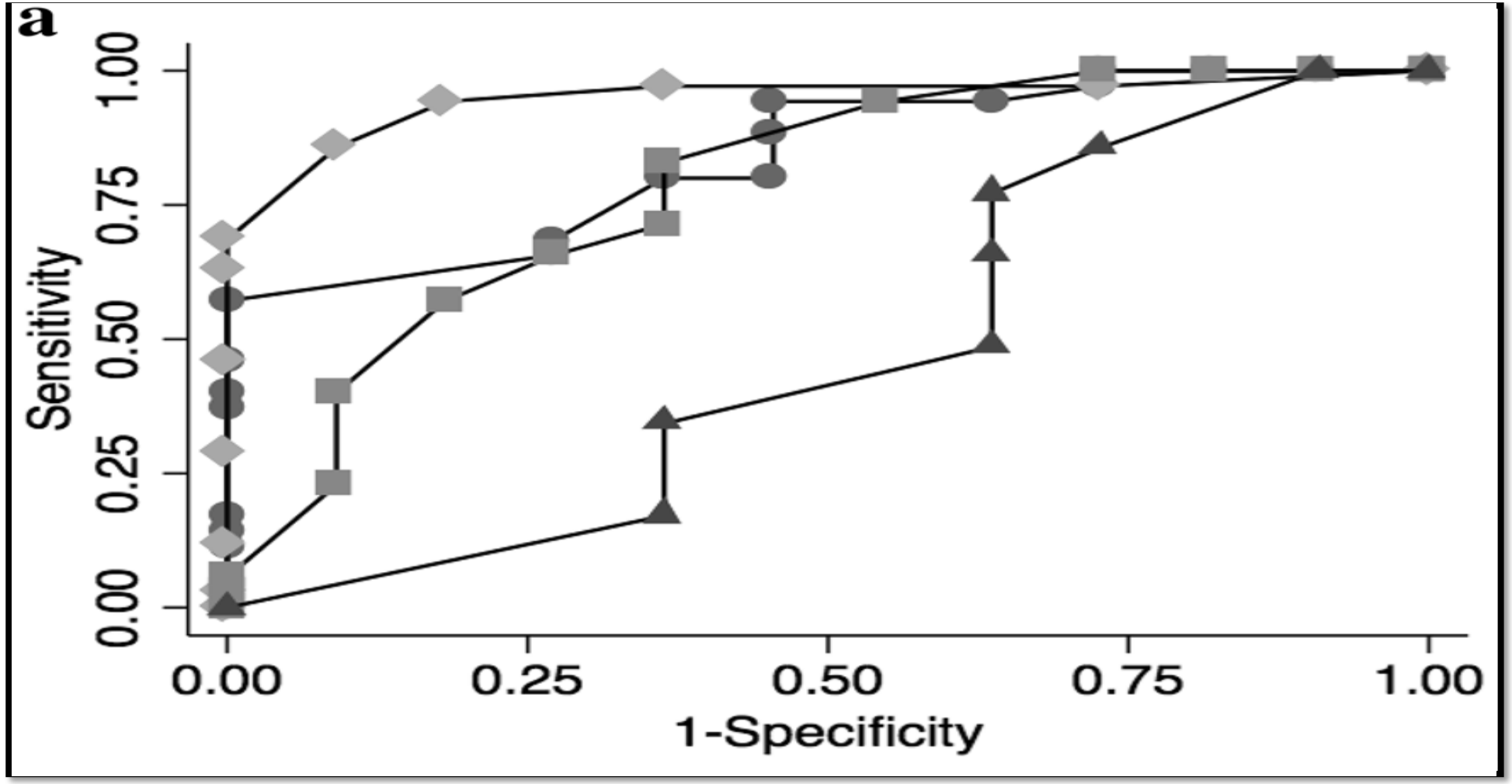


Fig. 2 Representative lung TC images and their corresponding LUS images in ventral, intermediate and dorsal lung regions in focal and non-focal ARDS morphologies

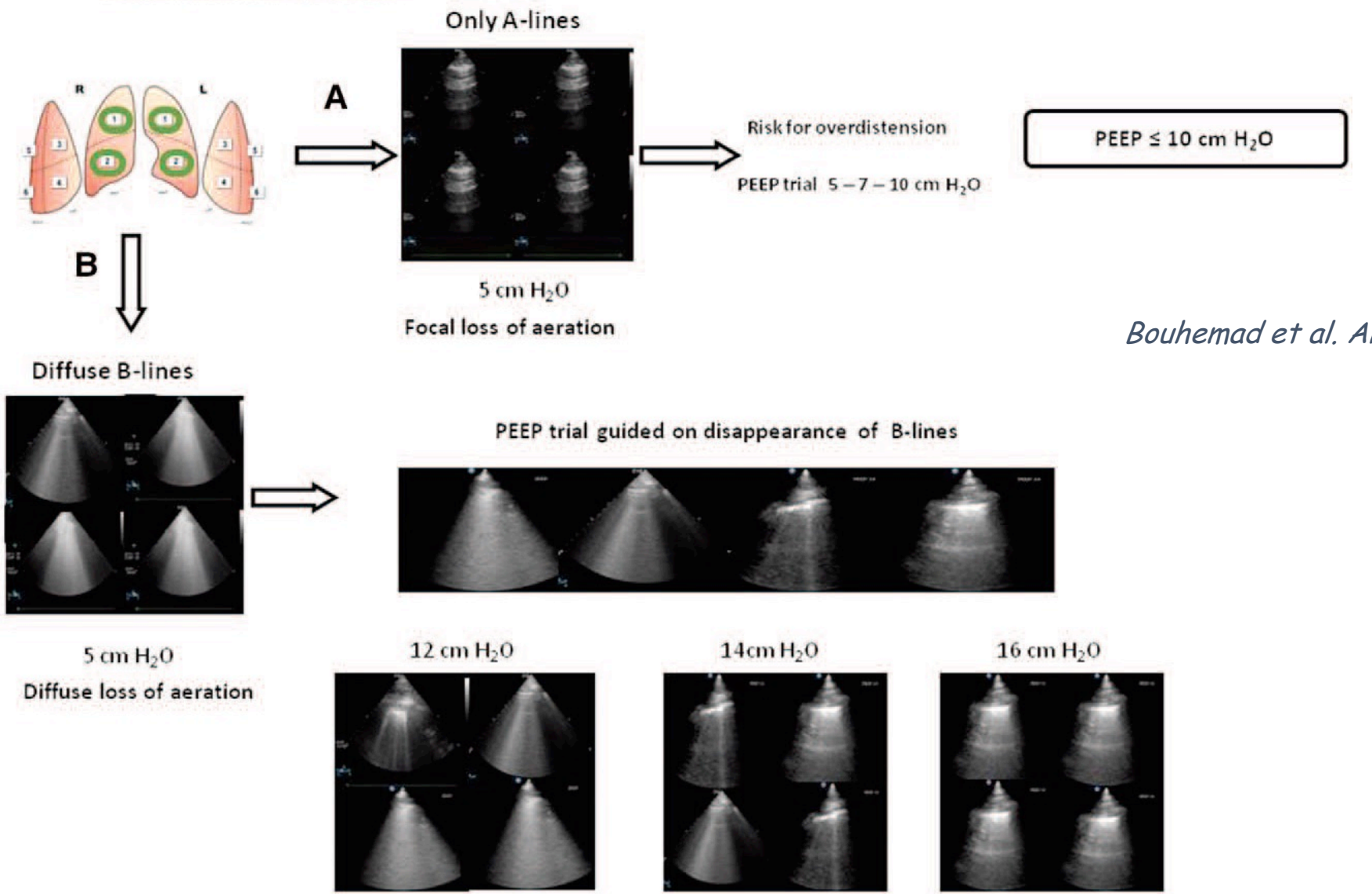
Morphologie du SDRA

LUS score ant (4)



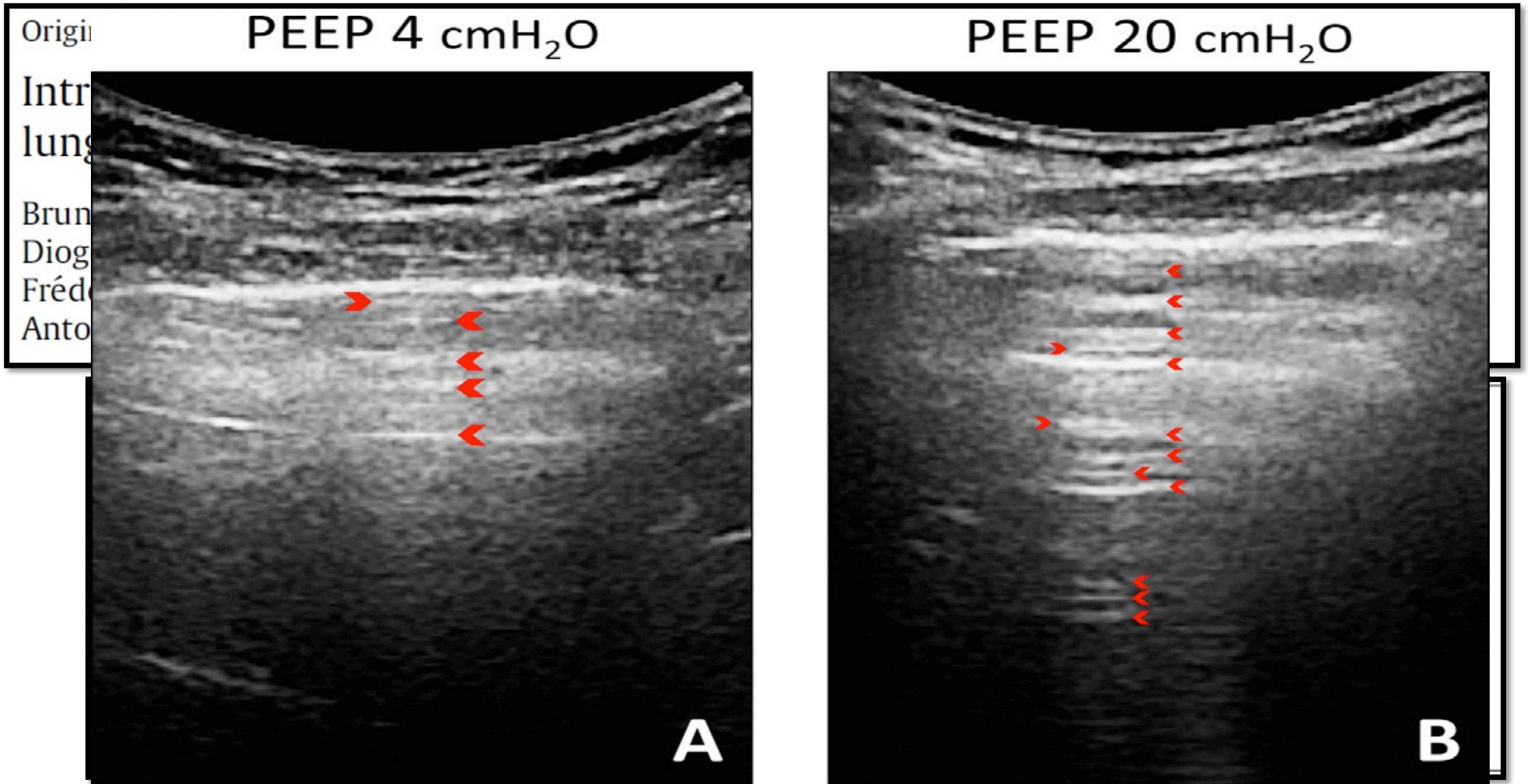
Adapter la ventilation à la morphologie du SDRA ?

At PEEP 5 cmH2O in anterior zones



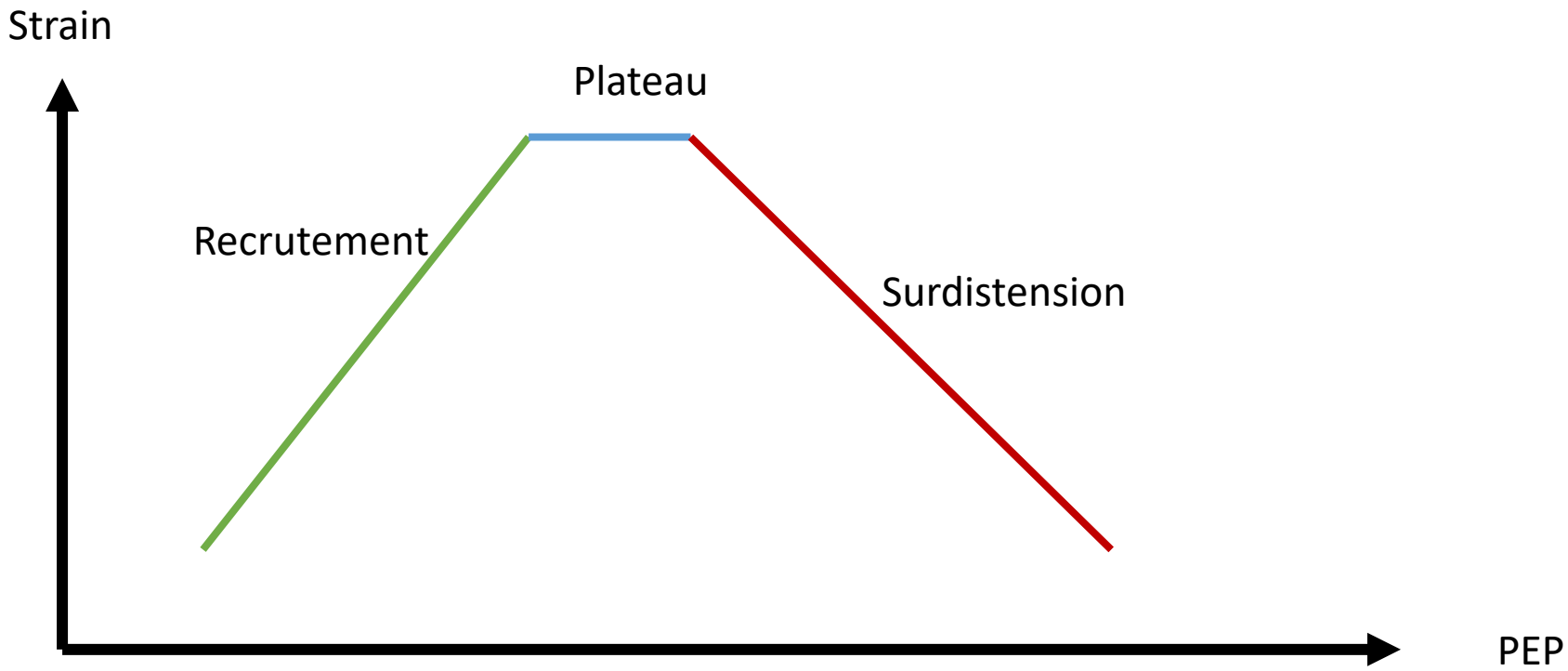
Bouhemad et al. Anesthesiology 2015

Surdistension pulmonaire



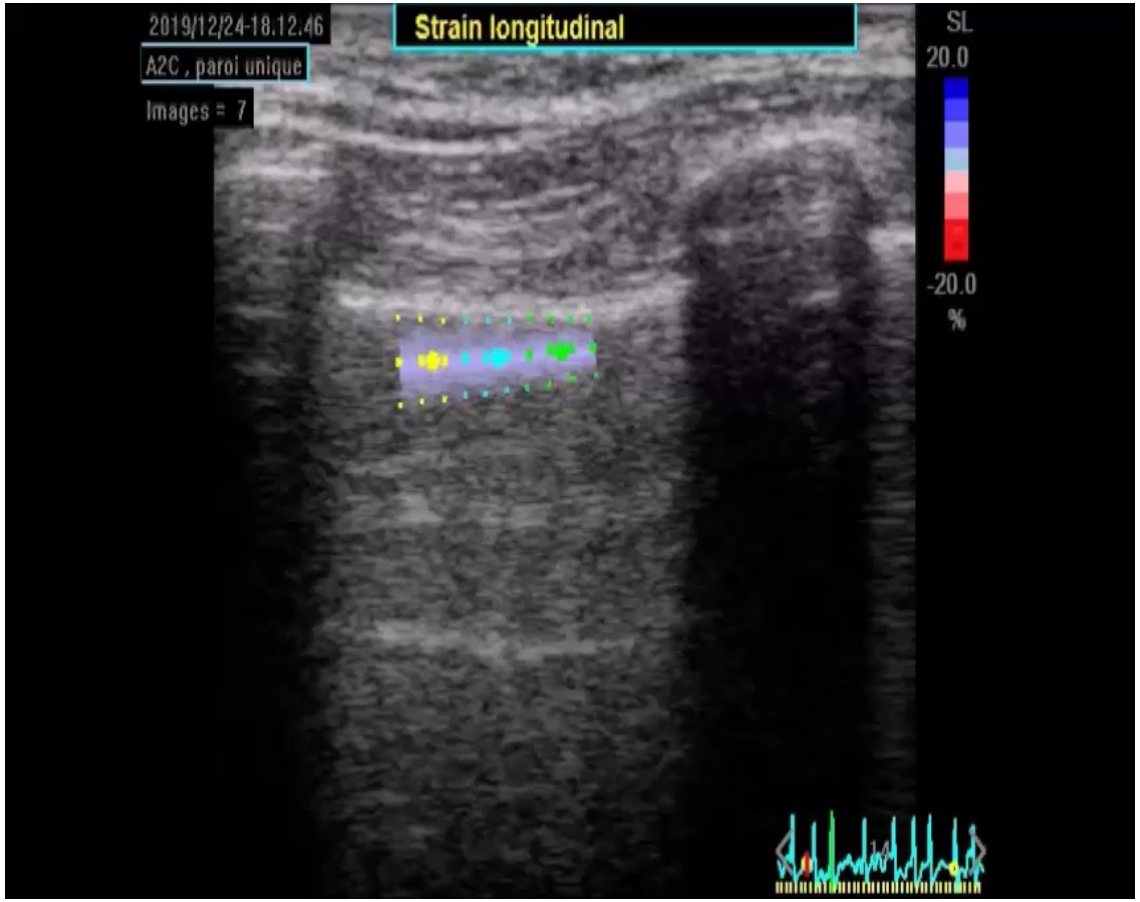
Hypothèse

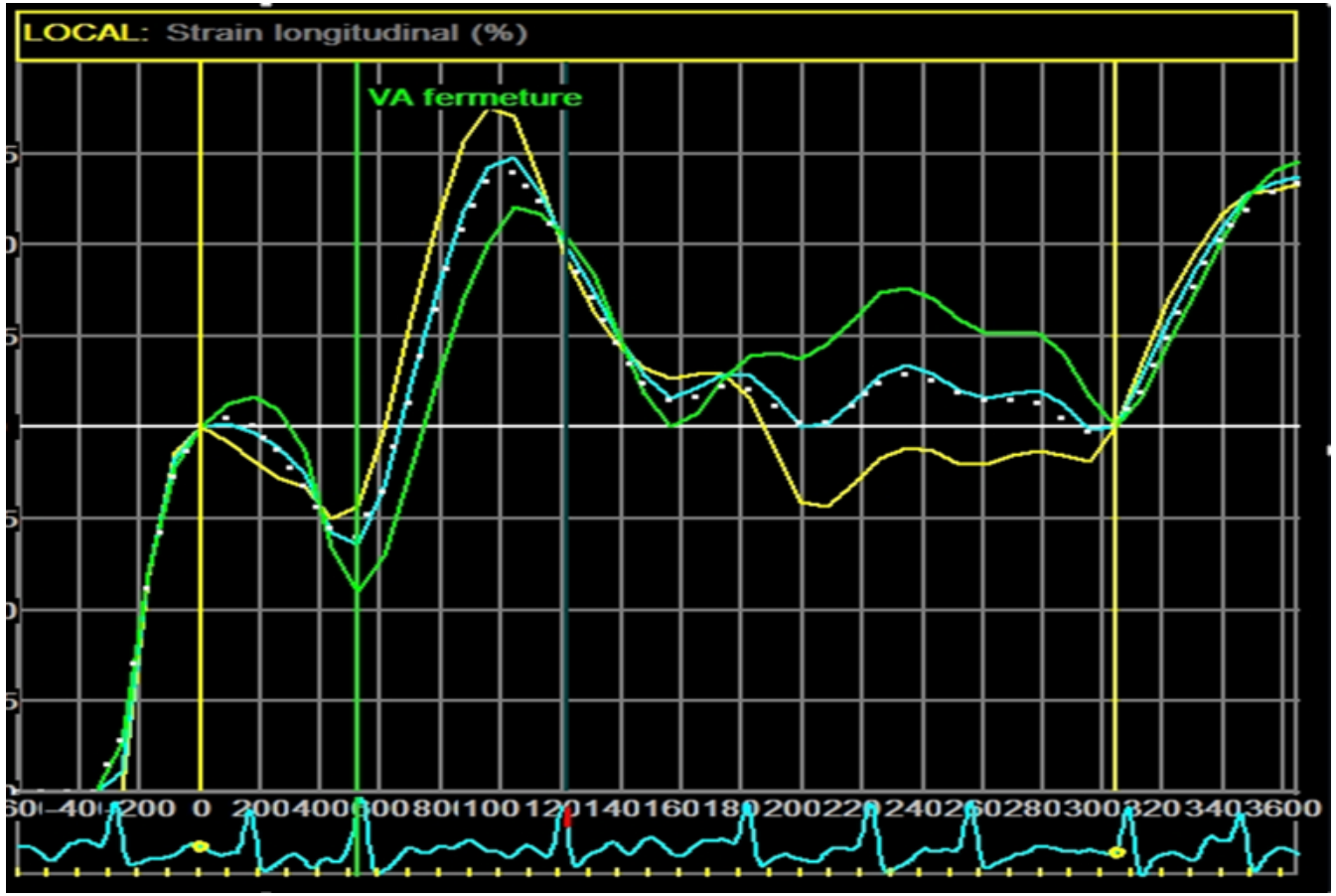
A VT constant,
strain pulmonaire = distension des alvéoles = compliance



L’avenir :
Evaluation régionale de la surdistension ?

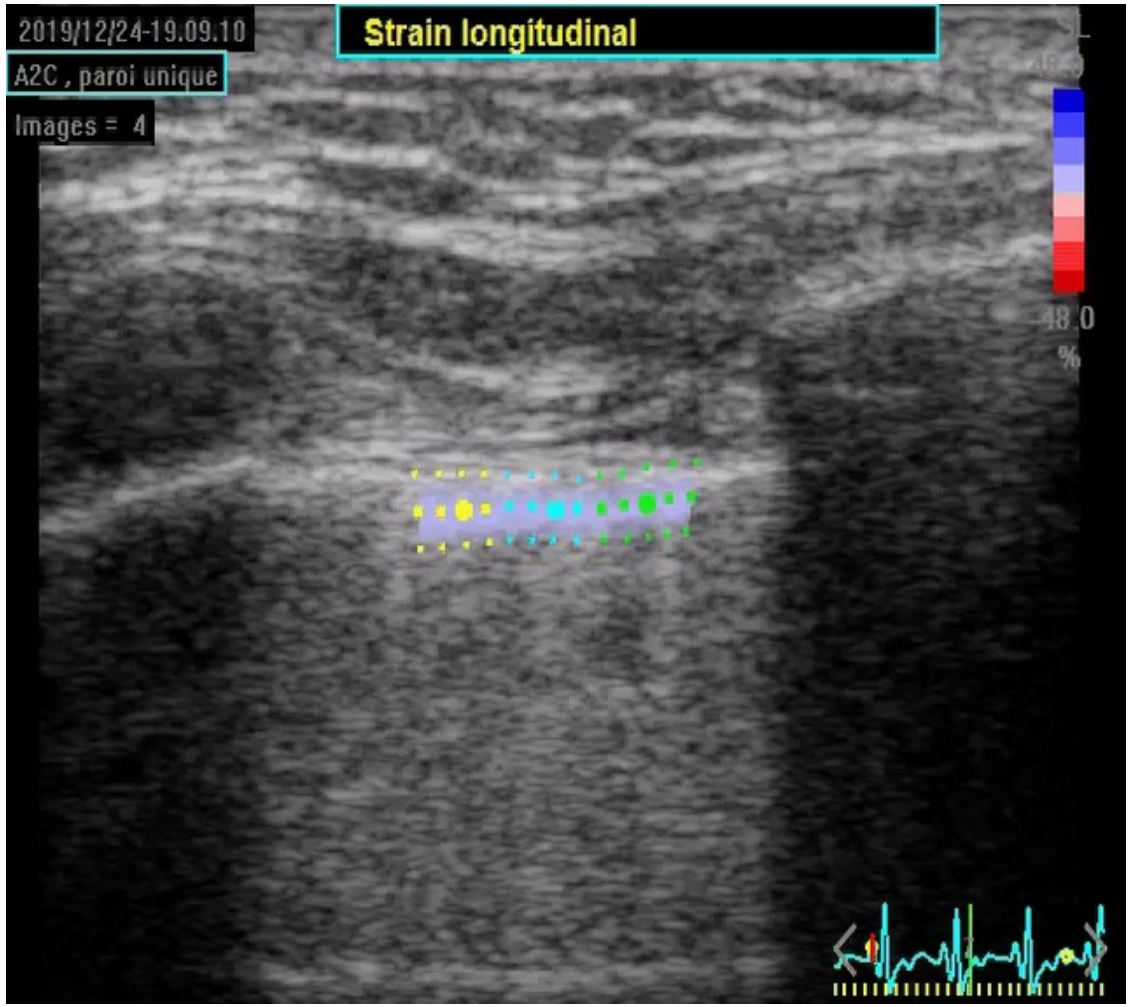
PEP 5: VT370 FR 24 / Pplat 17 / Pmotrice 11

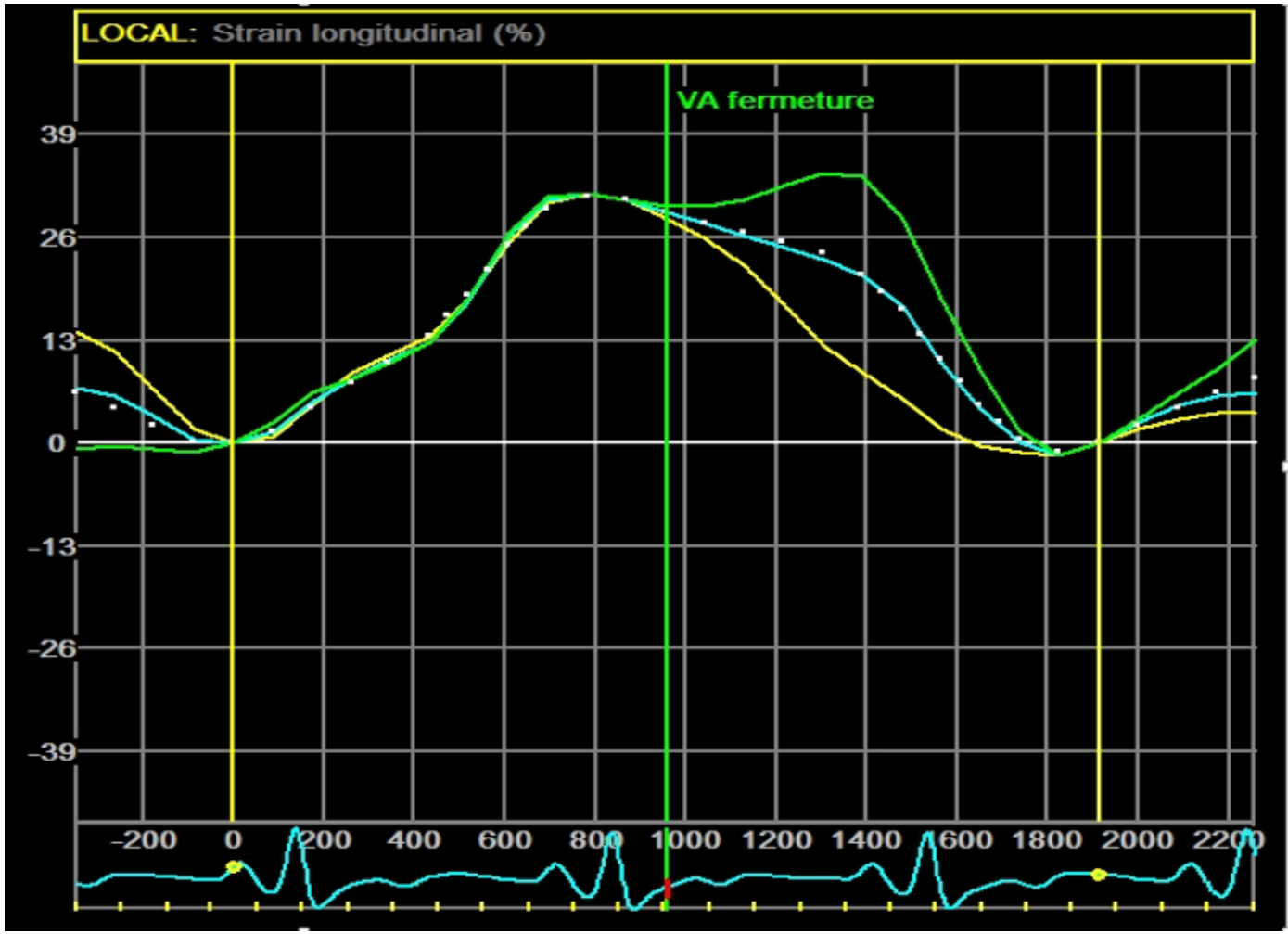




Strain 16%

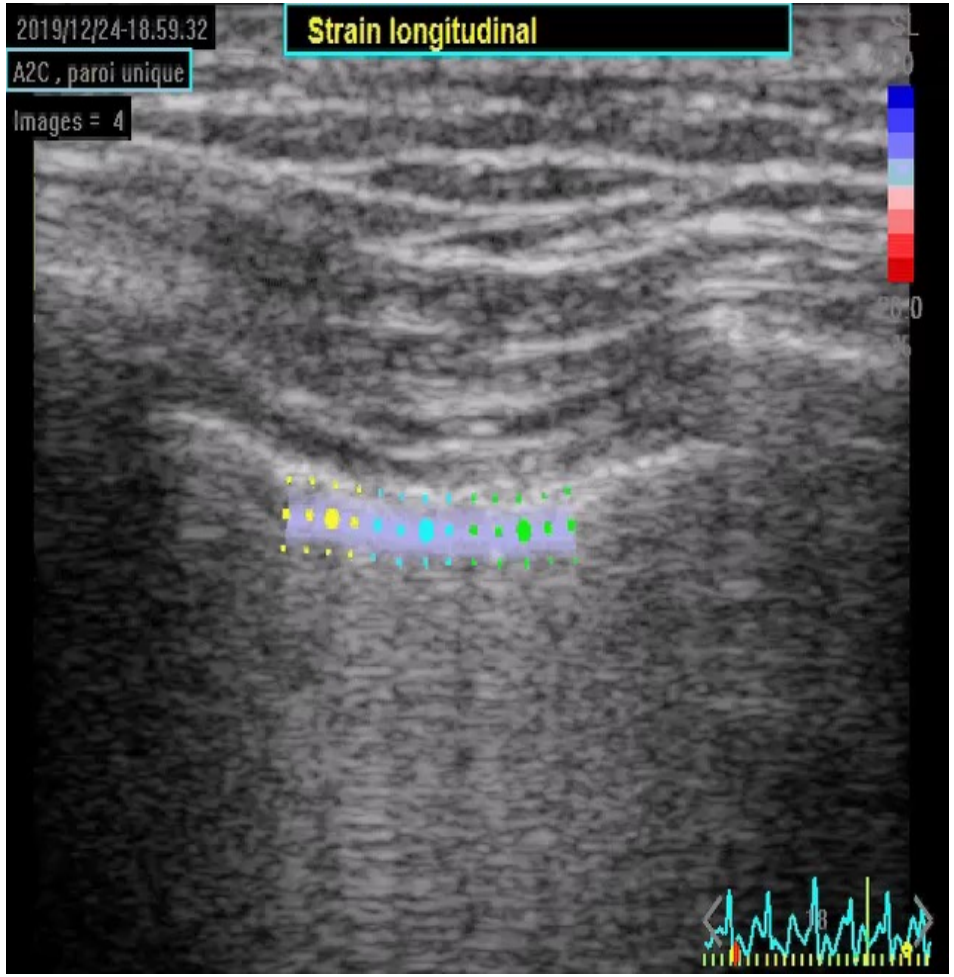
PEP 10 : VT370 FR 24 / Pplat 28 Pmotrice 15

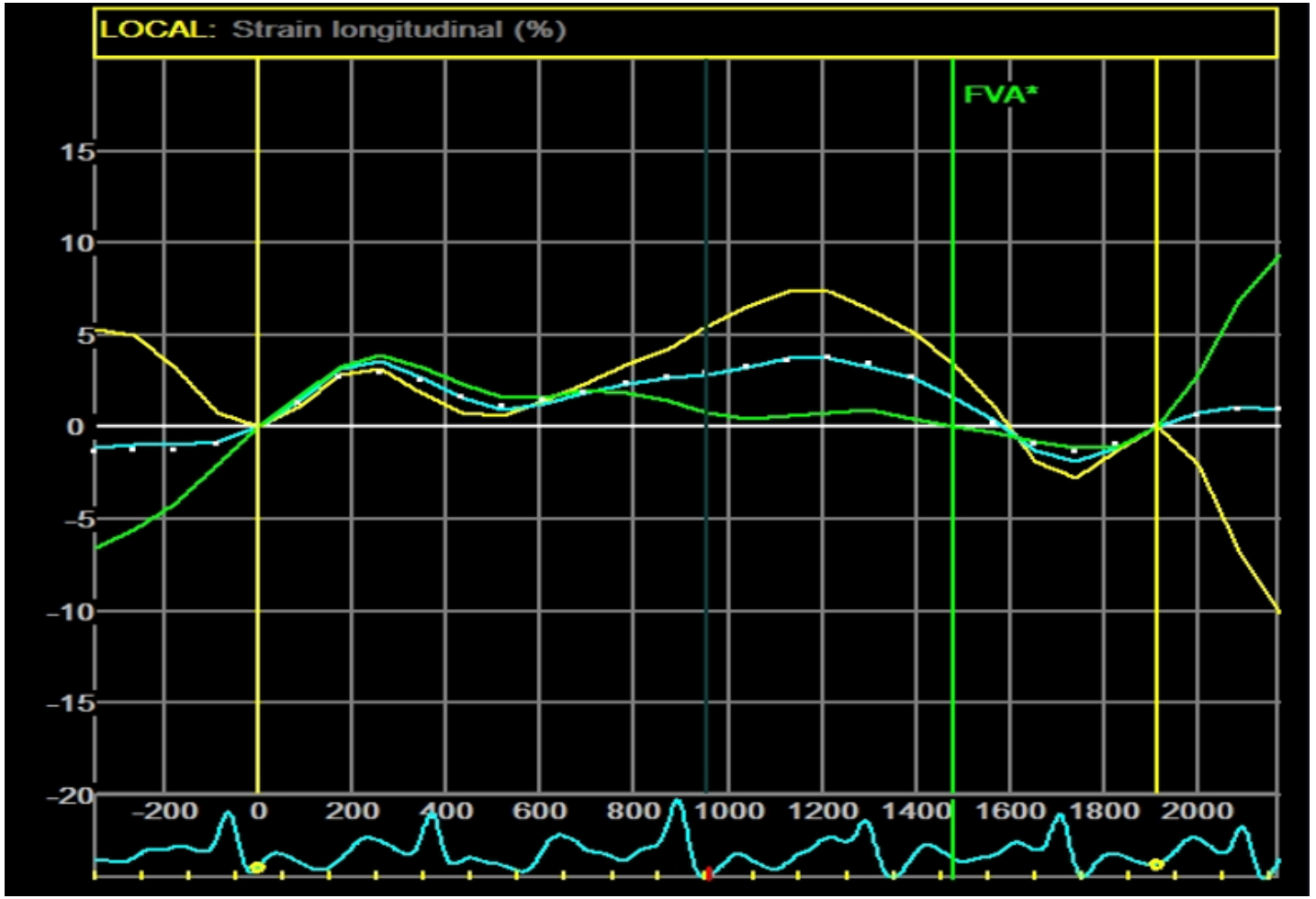




Strain 35 %

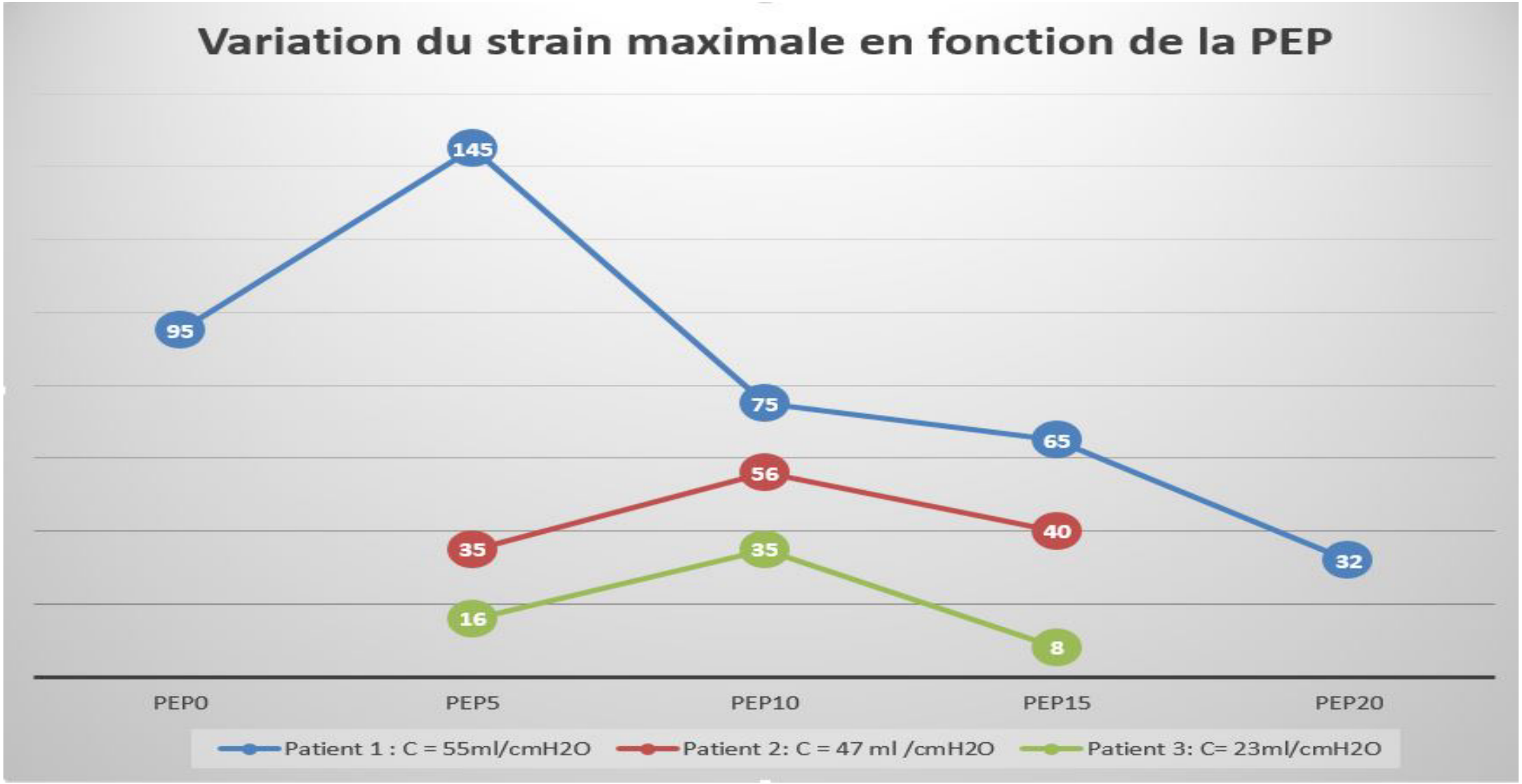
PEP 15 VT370 FR 24 / Pplat 38 Pmotrice 22





Strain 8 %

L’avenir :
Evaluation régionale de la surdistension ?



L’échographie ultra portative

Partout !

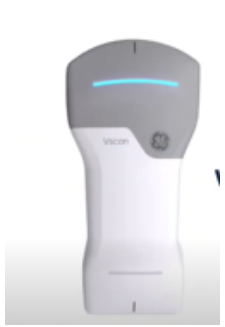
Europe 1 En direct 12h - 14h Raphaëlle Duchemin

ACCUEIL / SANTÉ

Vers la disparition du stéthoscope ?

11h20, le 28 janvier 2014 , modifié à 14h35, le 29 janvier 2014

AA

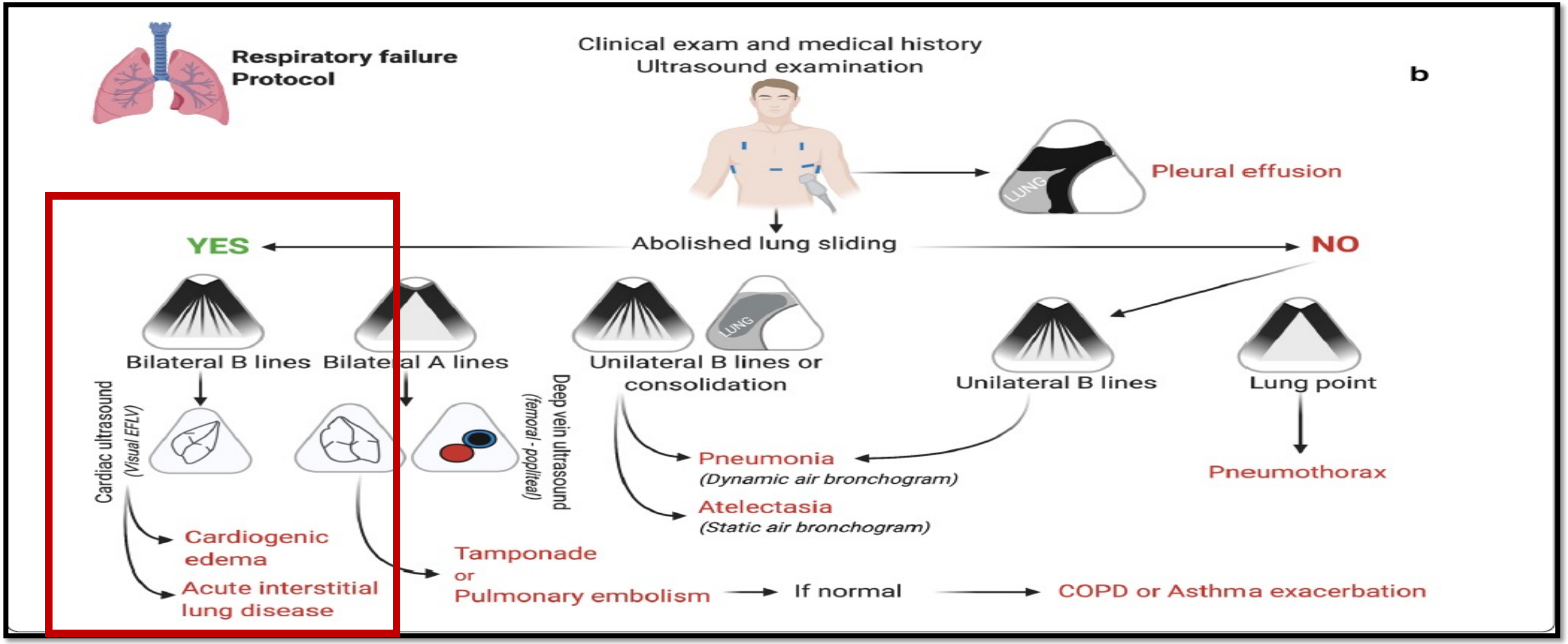


Echo POC et détresses post-opératoires service

RESEARCH Open Access

Bedside POCUS during ward emergencies is associated with improved diagnosis and outcome: an observational, prospective, controlled study

Laurent Zieleskiewicz[1,6*†], Alexandre Lopez[1†], Sami Hraiech[2], Karine Baumstarck[3], Bruno Pastene[1], Mathieu Di Bisceglie[4], Benjamin Coiffard[2], Gary Duclos[1], Alain Boussuges[5,6], Xavier Bobbia[7], Sharon Einav[8], Laurent Papazian[2] and Marc Leone[1]



Echo POC et détresses post-opératoires en service

RESEARCH Open Ac

Bedside POCUS during ward emergencies is associated with improved diagnosis and outcome: an observational, prospective, controlled study

Laurent Zieleskiewicz[1,6*†], Alexandre Lopez[1†], Sami Hraiech[2], Karine Baumstarck[3], Bruno Pastene[1], Mathieu Di Bisceglie[4], Benjamin Coiffard[2], Gary Duclos[1], Alain Boussuges[5,6], Xavier Bobbia[7], Sharon Einav[8], Laurent Papazian[2] and Marc Leone[1]

82 patients in **control group**	**83** patients in **POCUS algorithm group**
82 Primary and secondary outcomes collected	**83** Primary and secondary outcomes collected
Immediate adequate diagnosis: 66 Patients (80%)*	Immediate adequate diagnosis: 78 Patients (94%)*
Secondary outcome: In-Hospital mortality : 29 patients (35%)**	Secondary outcome: In-Hospital mortality : 14 patients (17%)**

Conclusion

- Evolutions technologiques mais pas seulement
- Poursuite de la recherche
- Avenir
  - Détection régionale de la surdistention
  - Automatisation/ quantification / IA
- **Keep it simple…**

Assistance Publique
Hôpitaux de Marseille

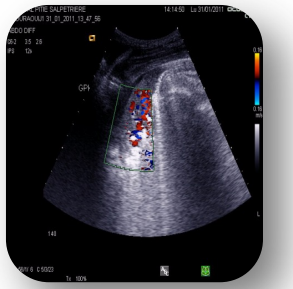
STAGE de

Formation à l'échographie du malade critique

Service d'Anesthésie-Réanimation – Pr Marc Leone

CHU Nord – chemin des Bourrelly – 13015 Marseille

Programme et Modalités d'inscription



CHU Nord

Service d'Anesthésie-Réanimation

Contact : 04 91 96 86 50

Responsable du projet

Professeur Laurent Zieleskiewicz

Gisele.chastan@ap-hm.fr

Accréditation CFAR
Points FMC