Supplementary table

Table S1. Diagnostic evaluation of traditional thoracic ultrasound and the cut-off mean and maximal elasticity indexes of ultrasound elastography based on data determined by the junior operator.

		TUS	SWE-Mean[a]	χ^2 and p[b]	SWE-Max[c]	χ^2 and p[d]
Diagnostic cut-off value (kPa)		-	46.85		69.1	
Development set	Yield (%)	71.05	85.96		84.21	
	Sensitivity (% (95% CI))	52.83 (38.77-66.48)	88.68 (76.28-95.31)		83.02 (69.70-91.48)	
	Specificity (% (95% CI))	86.88 (75.23-93.77)	83.61 (71.45-91.45)		85.25 (73.33-92.62)	
	PPV (% (95% CI))	77.78 (60.41-89.27)	82.46 (69.64-90.83)	χ^2=16.458, p<0.001	83.02 (69.70-91.48)	χ^2=11.085, p=0.001
	NPV (% (95% CI))	67.95 (56.30-77.81)	89.47 (77.81-95.65)		85.25 (73.33-92.62)	
	PLR (95% CI)	4.03 (2.01-8.07)	5.41 (3.04-9.61)		5.63 (3.04-10.41)	
	NLR (95% CI)	0.54 (0.41-0.73)	0.14 (0.06-0.29)		0.20 (0.11-0.36)	
Validation set	Yield (%)	70.00	85.38		86.15	
	Sensitivity (% (95% CI))	47.27 (33.86-61.07)	83.64 (70.70-91.80)		76.36 (62.67-86.35)	
	Specificity (% (95% CI))	86.67 (76.39-93.08)	86.67 (76.39-93.08)		93.33 (84.47-97.52)	
	PPV (% (95% CI))	72.22 (54.57-85.21)	82.14 (69.15-90.66)	χ^2=16.082, p<0.001	89.36 (76.11-96.02)	χ^2=9.860, p=0.002
	NPV (% (95% CI))	69.15 (58.66-78.05)	87.84 (77.67-93.95)		84.34 (74.34-91.07)	
	PLR (95% CI)	3.55 (1.87-6.73)	6.27 (3.48-11.30)		11.45 (4.85-27.05)	

	NLR (95% CI)	0.61 (0.47-0.78)	0.19 (0.10-0.34)		0.25 (0.16-0.41)	

TUS, traditional thoracic ultrasound; EI, elasticity index; UE, ultrasound elastography; SWE, shear wave elastography; PPV, positive predictive value; NPV, negative predictive value; PLR, positive likelihood ratio; NLR, negative likelihood ratio; 95% CI, 95% confidence interval.

a: SWE-Mean indicates the mean SWE EI.

b: Comparison of sensitivity between traditional TUS and SWE-Mean.

c: SWE-Max indicates the maximum SWE EI.

d: Comparison of sensitivity between traditional TUS and SWE-Max.

Table S2. The operating characteristic data of traditional thoracic ultrasound and ultrasound elastography in isolation and combined in the validation set

		Final diagnosis		Yield (%)	Sensitivity (%)	Specificity (%)	PLR	NLR
		MPE	BPE					
TUS	MPE	33	5	79.23	60.00	93.33	9.00	0.43
	BPE	22	70					
SWE-Mean[a]	MPE	46	7	87.69	83.64	90.67	8.96	0.18
	BPE	9	68					
SWE-Max[b]	MPE	42	7	84.62	76.36	90.67	8.18	0.26
	BPE	13	68					
SWE-Mean+TUS[c]	MPE	55	10	92.31	100	86.67	7.50	0
	BPE	0	65					
SWE-Max+TUS[d]	MPE	55	10	92.31	100	86.67	7.50	0
	BPE	0	65					

TUS, traditional thoracic ultrasound; UE, ultrasound elastography; SWE, shear wave elastography; MPE, malignant pleural effusion; BPE, benign pleural effusion; PLR, positive likelihood ratio; NLR, negative likelihood ratio.

a: SWE-Mean indicates the mean SWE elasticity index.

b: SWE-Max indicates the maximum SWE elasticity index.

c: SWE-Mean+TUS indicates the combination of SWE-Mean and TUS, which means a SWE-Mean+TUS-based diagnosis of MPE would be recorded when either SWE-Mean≥47.25 kPa or a TUS-based diagnosis of MPE was recorded.

D: SWE-Max+TUS indicates the combination of SWE-Mean and TUS, which means a SWE-Max+TUS-based diagnosis of MPE would be recorded when either SWE-Mean≥47.25 kPa or a TUS-based diagnosis of MPE was recorded.

Methods

Ultrasound details

Gray scale ultrasound was performed with an Aixplorer ultrasound scanning system (SuperSonic Imagine, Aixen Provence, France) with a bandwidth between 4 and 15 MHz and a 55-mm-long linear-array transducer, as described in previous studies[1-3]. To detect the presence of pleural effusion, scanning was performed using the intercostal spaces one by one from top to bottom as acoustic windows, with the patient in a seated position with the arms raised above the head to widen the intercostal space and facilitate scanning. The normal pleura is characterized by a smooth echogenic surface and a hypoechoic subpleural line. The normal pleura has a thickness of only 0.2 mm and reaches the limit of sonographic depiction. However, with high-resolution scanning, the visceral and parietal pleurae can be displayed as two distinct echogenic lines. Thickening pleura can be detected and measured in B mode. The pleural nodules were hypoechoic nodular lesions with defined margins located in the parietal or visceral pleura, while focal pleural thickenings were echogenic areas of increased thickness in the parietal pleura that had poorly defined margins. A diagnosis of malignant disease was recorded when the following three characteristics were founded: diaphragmatic and parietal pleural nodule or nodules, pleural thickening > 1 cm, and hepatic metastasis.

Following the physical exam measurements, pleural stiffness was measured using shear wave elastography (SWE)[4, 5]. An Aixplorer ultrasonic scanner (SuperSonic Imagine, Aix-en-Provence, France) with a linear array transducer (SL15-4; SuperSonic Imagine, Aix-en-Provence, France) was used. With musculoskeletal presettings, the ultrasound probe generates transient shear waves in the pleura by transmitting ultrasound push beams, the speed of which can be used to calculate Young's modulus. Young's modulus is the output of the Aixplorer.

2D-SWE was performed for each of the cases, and images of pleural thickening or nodules were displayed along with the grayscale US picture. After a box (frame) is placed over the pleura, a colored image appears, revealing blue and red areas on an elastogram. Dark-blue areas correspond to soft tissues, whereas red areas correspond to stiff tissues. With the aid of the device’s software, a circular region of interest was placed inside the pleural elastogram, and the diameter of the circle was increased as much as possible to between 1 and 8 mm, taking care not to surpass the limits of the analyzed pleura. The default setting for the pleural 2D-SWE scale was used (range 0 to ≥100 kPa). The summary quantitative stiffness data were automatically displayed. The following parameters for the elasticity index (EI), expressed in kPa, were provided by the system: the mean value of the EI (SWE-Mean), the maximum value of the EI (SWE-Max), the minimum value of the EI (SWE-Min), and the standard deviation of the EI (SWE-SD)[6].

References:

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