Cardiac point-of-care ultrasound in hospitalized coronavirus disease-2019 patients: findings and association with outcome

Vered Gilad[a], Vincenzo De Marzo[a,b], Giulia Guglielmi[a,b], Roberta Della Bona[a], Stefano Giovinazzo[a], Fabio Pescetelli[a,b], Alberto Valbusa[a], Gian Paolo Bezante[a], Andrea De Maria[c,d], Nicolò Patroniti[e,f], Diego Ferone[g,h], Paolo Pelosi[e,f], Matteo Bassetti[c,d], Italo Porto[a,b], on behalf of the GECOVID study group*

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[a]DICATOV - Cardiothoracic and Vascular Department, San Martino Hospital, IRCCS for Oncology and Neurosciences, [b]Department of Internal Medicine and Medical Specialties (DIMI), Clinic of Cardiovascular Diseases, University of Genoa, [c]Infectious Diseases Unit, San Martino Hospital, IRCCS for Oncology and Neurosciences, [d]Department of Health Sciences (DISSAL), University of Genoa, [e]Anaesthesia and Intensive Care, San Martino Policlinico Hospital, IRCCS for Oncology and Neurosciences, [f]Department of Surgical Sciences and Integrated Diagnostics, University of Genoa, [g]Endocrinology Unit, IRCCS Ospedale Policlinico San Martino and [h]Endocrinology Unit, Department of Internal Medicine and Medical Specialties (DIMI) and Centre of Excellence for Biomedical Research (CEBR), University of Genoa, Genoa, Italy

Correspondence to Italo Porto, MD, PhD, Department of Internal Medicine and Medical Specialties (DIMI), Clinic of Cardiovascular Diseases, University of Genoa, Viale Benedetto XV, 10, 16132 Genoa, Italy
Tel: +39 10 5551; e-mail: italo.porto@unige.it

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To the Editor

Coronavirus disease (COVID-19), caused by novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), rapidly spread worldwide becoming a pandemic.[1,2] Whereas most clinical manifestations of COVID-19 are related to respiratory distress, cardiovascular involvement has been reported, showing association with worse outcome and higher mortality.[3–5]

Given consistent limitations and risks for echocardiography in COVID-19, both American and European echocardiography societies released recommendations to limit systematic echocardiography examination to problem-tailored and time-limited examination, also known as 'point-of-care ultrasound' (POCUS).[6,7] We aimed to describe cardiac POCUS findings in COVID-19 patients admitted to a tertiary Italian university hospital, stratified according to respiratory distress grade, and to assess the association of cardiac POCUS findings with outcome.

* The names of members of the GECOVID-19 Study group are mentioned in the Acknowledgements section.

Methods

All laboratory-confirmed COVID-19 patients admitted to our hospital, San Martino Hospital, Genoa, Italy, between 1 March 2020 and 30 April 2020 who underwent cardiac POCUS during hospital stay were analysed. According to the respiratory distress degree,[8] patients were classified into mild, moderate, and severe respiratory distress grade.

All methods were extensively described in Supplemental Digital Content S1, http://links.lww.com/JCM/A366.

Results

The final population included 138 patients. Table 1 depicts the patients' characteristics and findings.

POCUS findings are described in Fig. 1, and outcomes are described in Fig. 2, both stratified according to respiratory distress grade at time of POCUS execution.

At multivariate logistic regression analysis, left ventricular (LV) hypertrophy ($P = 0.030$) was significantly associated with severe respiratory distress and right ventricular (RV) dilatation ($P = 0.036$) was significantly associated with longer in-hospital stay. No cardiac POCUS parameter was associated with cardiovascular outcomes (all $P > 0.05$) (Table 2).

Comment

Our study has the following main findings: most common cardiac POCUS abnormalities in COVID-19 patients were LV hypertrophy, mild pericardial effusion and RV dilatation, with LV and RV systolic functions mostly preserved; LV hypertrophy was independently associated with severe respiratory distress; RV dilatation was independently associated with longer hospital stay; no cardiac POCUS parameter was associated with in-hospital mortality.

Arterial hypertension, highly prevalent within our cohort (53.6%), is the most common cause for LV hypertrophy.[9] Hypertensive heart disease is characterized by cardiac fibrosis, increased myocardial stiffness, microvascular dysfunction, abnormal ventricular–vascular interactions and progressive diastolic dysfunction.[10]

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Table 1 Baseline clinical features, point-of-care ultrasound findings, and outcome

		Respiratory distress grade			
Variable	Overall ($n=138$)	Mild ($n=38$)	Moderate ($n=35$)	Severe ($n=65$)	*P* value
Baseline clinical features					
Age	65.5 (12.9)	69.3 (16.2)	67.1 (11.1)	62.5 (10.8)	**0.022**
Sex (male)	100 (72.5)	21 (55.3)	24 (68.6)	55 (84.6)	**0.005**
Caucasian	125 (90.6)	34 (89.5)	30 (85.7)	61 (93.8)	0.399
Hypertension	74 (53.6)	21 (55.3)	22 (62.9)	31 (47.7)	0.340
Diabetes	23 (16.7)	7 (18.4)	9 (25.7)	7 (10.8)	0.151
Respiratory disease	23 (16.7)	8 (21.1)	5 (14.3)	10 (15.4)	0.689
Chronic kidney disease	21 (15.2)	7 (18.4)	10 (28.6)	4 (6.2)	**0.010**
Inflammatory disease	22 (15.9)	4 (10.5)	11 (31.4)	7 (10.8)	**0.015**
Ischemic heart disease	21 (15.2)	10 (26.3)	8 (22.9)	3 (4.6)	**0.004**
Previous LV dysfunction	10 (7.2)	5 (13.2)	5 (14.3)	0 (0.0)	**0.008**
Atrial fibrillation	16 (11.6)	10 (26.3)	4 (11.4)	2 (3.1)	**0.002**
D-dimer (μg/l)	2108.0 (1246.8–6914.8)	1424.00 (858.0–2688.3)	1757.0 (1359.5–3619.5)	4406.0 (1673.0–13553.0)	**<0.001**
CRP (mg/l)	90.0 (36.0–177.0)	46.0 (11.8–73.9)	80.0 (51.4–143.0)	136.0 (62.5–262.5)	**<0.001**
Troponin (μg/l)	0.02 (0.01–0.12)	0.01 (0.01–0.08)	0.01 (0.01–0.06)	0.03 (0.01–0.15)	**0.001**
NT-proBNP (ng/l)	674.0 (166.0–2036.0)	904.5 (221.0–2786.5)	369.0 (114.3–2114.5)	674.0 (168.0–1396.0)	0.344
POCUS findings					
LV dilatation	7 (5.1)	2 (5.3)	2 (5.7)	3 (4.6)	0.550
LV hypertrophy	53 (38.4)	8 (21.1)	15 (42.9)	30 (46.1)	**0.026**
EF					0.188
Normal	120 (87.0)	33 (86.8)	30 (85.7)	57 (87.7)	
Mild dysfunction	12 (8.7)	3 (7.9)	5 (14.3)	4 (6.2)	
Moderate dysfunction	3 (2.2)	1 (2.6)	0 (0.0)	2 (3.1)	
Severe dysfunction	3 (2.2)	1 (2.6)	1 (2.9)	1 (1.5)	
LV regional dysfunction	17 (12.3)	6 (15.8)	6 (17.1)	5 (7.7)	0.339
Prosthesis valve	6 (4.3)	1 (2.6)	2 (5.7)	3 (4.6)	0.799
Valve disease	20 (14.5)	6 (15.8)	5 (14.3)	9 (13.8)	**0.073**
LA enlargement	20 (14.5)	9 (23.7)	6 (17.1)	5 (7.7)	0.150
RV dilatation	37 (26.8)	5 (13.2)	6 (17.1)	26 (40.0)	**0.004**
RV dysfunction	7 (5.1)	1 (2.6)	1 (2.9)	5 (7.7)	0.404
Tricuspid regurgitation					0.500
Moderate	14 (10.1)	4 (10.5)	3 (8.5)	7 (10.7)	
Severe	2 (1.4)	0 (0)	1 (2.8)	1 (1.5)	
Augmented sPAP	32 (23.1)	9 (23.7)	5 (14.3)	18 (27.6)	0.305
Pericardial effusion	50 (36.2)	13 (34.2)	12 (34.3)	25 (38.5)	0.622
Mild	48 (35.6)	13 (34.2)	12 (34.3)	23 (35.4)	
Moderate	2 (1.5)	0 (0.0)	0 (0.0)	2 (3.1)	
Severe	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Tamponade	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Intracardiac thrombosis	2 (1.5)	0 (0.0)	0 (0.0)	2 (3.1)	0.340
Outcomes					
All-cause death	37 (26.8)	5 (13.2)	6 (17.1)	26 (40.0)	0.171
Myocardial injury	51 (37.0)	10 (26.3)	11 (31.4)	30 (46.2)	**0.001**
Pulmonary embolism	37 (26.8)	6 (15.8)	8 (22.9)	23 (35.4)	**0.029**
Macro	22 (15.9)	4 (10.5)	6 (17.1)	12 (18.5)	
Micro	15 (10.9)	2 (5.3)	2 (5.7)	11 (16.9)	
Venous thromboembolism	4 (2.9)	0 (0.0)	1 (2.9)	3 (4.6)	**0.053**
Thrombolysis	6 (4.3)	0 (0.0)	0 (0.0)	6 (9.2)	**0.032**
Myocardial infarction	4 (2.9)	1 (2.6)	1 (1.9)	2 (3.1)	0.308
New onset LV dysfunction	5 (3.6)	0 (0.0)	0 (0.0)	5 (7.7)	**0.056**
Arrhythmia	15 (10.9)	2 (5.3)	2 (5.7)	11 (16.9)	0.292
Atrial	14 (10.1)	2 (5.3)	2 (5.7)	10 (15.4)	
Ventricular	1 (0.7)	0 (0.0)	0 (0.0)	1 (1.5)	
Myocarditis	1 (0.7)	0 (0.0)	0 (0.0)	1 (1.5)	0.405
Pericarditis	1 (0.7)	1 (2.6)	0 (0.0)	0 (0.0)	0.308

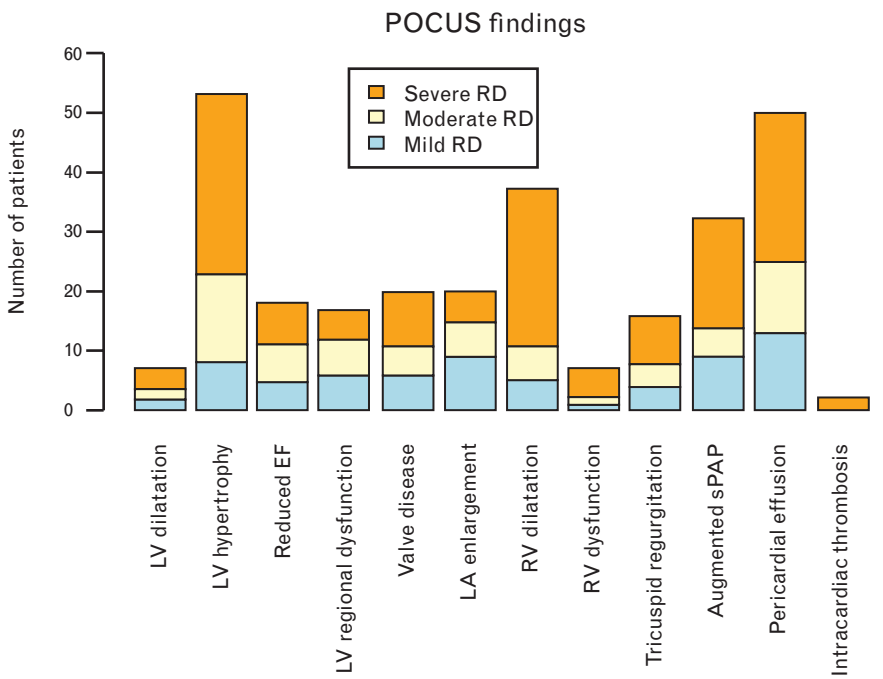
All measures expressed as *n* (%), mean (SD) or median with IQR (quartile 1 to quartile 3). CRP, C-reactive protein; EF, ejection fraction; LV, left ventricular; NT-proBNP, N-terminal pro-B-type natriuretic peptide; POCUS, point-of-care ultrasound; RV, right ventricular; sPAP, systolic pulmonary artery pressure. Bold face reports significant *p* values (<0.05).

Diastolic dysfunction was demonstrated as a major predictor of mortality in patients with sepsis and septic shock,[11] and recent reports showed a higher degree of diastolic dysfunction associated with poorer prognosis in COVID-19 patients.[12,13]

Multiple extracardiac mechanisms may induce RV dilatation in COVID-19 patients: extensive lung damage, hypoxic vasoconstriction, excessive positive end-expiratory pressure, high-pressure mechanical ventilation, pulmonary vascular diseases, and pulmonary embolism.

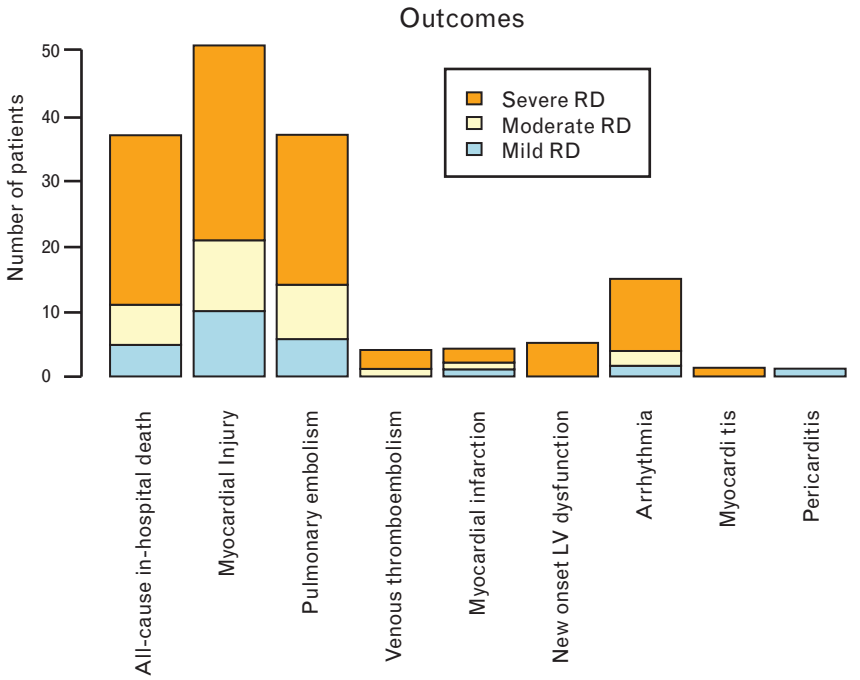
Whereas RV dilatation was a common finding, RV dysfunction was infrequent (5.1%) in our cohort. Although our results are in contrast to previous reports, conventional RV functional parameters (TAPSE, Tei index and

Fig. 1



Point-of-care ultrasound findings according to respiratory distress grade. EF, ejection fraction; LA, left atrium; LV, left ventricle; RD, respiratory distress; RV, right ventricle; sPAP, systolic pulmonary artery pressure.

Fig. 2



Outcomes according to respiratory distress grade. LV, left ventricle; RD, respiratory distress.

Table 2 Multivariate logistic regression models for severe respiratory distress and length of hospital stay (adjusted for age and sex); Cox regression model for all-cause in-hospital death (adjusted for age and sex)

	Univariate			Multivariate		
Variable	OR	95% CI	*P* value	OR	95% CI	*P* value
Severe respiratory distress						
Age	**0.96**	**0.94–0.99**	**0.010**	**0.96**	**0.92–0.99**	**0.041**
Sex (male)	3.42	1.54–8.10	0.003	–	–	–
D-dimer	1.01	1.00–1.02	0.055	–	–	–
CRP	**1.01**	**1.01–1.02**	**<0.001**	**1.02**	**1.01–1.04**	**<0.001**
Myocardial injury	**8.20**	**3.69–19.66**	**<0.001**	**2.49**	**1.77–9.19**	**0.024**
Previous ischemic heart disease	**0.15**	**0.03–0.47**	**0.003**	**0.35**	**0.13–0.91**	**0.012**
Atrial fibrillation	**0.13**	**0.02–0.51**	**0.010**	**0.18**	**0.06–0.52**	**0.005**
RV dilatation	3.76	1.71–8.74	0.001	–	–	–
LV hypertrophy	**3.18**	**1.38–8.09**	**0.010**	**3.59**	**1.20–12.40**	**0.030**
Length of hospital stay						
Age	**1.03**	**1.00–1.05**	**0.027**	**1.03**	**1.01–1.12**	**0.038**
Sex (male)	1.34	0.63–2.86	0.447			
Respiratory failure of severe grade	**2.26**	**1.14–4.56**	**0.020**	**2.83**	**1.22–6.79**	**0.027**
D-Dimer	1.01	1.01–1.02	0.024	–	–	–
Troponin elevation	3.65	1.59–8.23	0.004	–	–	–
RV dilatation	**5.22**	**3.14–27.05**	**0.038**	**2.80**	**1.43–24.06**	**0.036**
LV regional dysfunction	5.23	1.82–8.52	0.038			

	Univariate			Multivariate		
Variable	HR	95% CI	*P* value	HR	95% CI	*P* value
All-cause in-hospital death						
Age	**1.06**	**1.02–1.11**	**0.004**	**1.03**	**1.01–1.07**	**0.029**
Sex (male)	1.25	0.48–3.69	0.662	–	–	–
D-Dimer	1.01	1.01–1.02	0.024	–	–	–
Troponin elevation	**2.97**	**1.45–6.07**	**0.003**	**2.61**	**1.26–5.41**	**0.010**
New onset arrythmia	2.73	1.23–6.06	0.014	–	–	–

CI, confidence interval; CRP, C-reactive protein; HR, hazard ratio; LV, left ventricle; OR, odds ratio; RV, right ventricle. Bold face reports significant *p* values (<0.05).

RV S' velocity) resulted within normal ranges both by Szekely *et al.*[13] and Li *et al.*,[14] for which RV dysfunction was determined by short pulmonary acceleration time and reduced RV strain, respectively. These results suggest that RV dysfunction in COVID-19 patients is generally modest and that conventional RV function parameters may be insufficient for risk stratification in this population.

Left ventricle dysfunction was uncommon (13%) and the vast majority of patients had only mild LV dysfunction (66.6%), similar to D'Andrea *et al.*'s[15] findings. Moreover, whereas myocardial injury was frequent and independently associated with in-hospital mortality, most patients had minimal troponin I increase.

Limitations to our study are principally related to the particular situation in which we were operating: the retrospective design, the potential selection bias as only selected COVID-19 patients underwent cardiac POCUS, the lack of prior echocardiographic data for comparison, the lack of systematic diastole assessment, the small sample size, and the large confidence intervals of the estimates.

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Conflicts of interest

There are no conflicts of interest.

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