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Role of ECMO and echocardiography in a COVID-19 positive patient

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Abstract

Background. Over 46 million people have been diagnosed with COVID-19. Cardiac injury occurs in approximately a third of the patients and echocardiography is a useful diagnostic and management tool. ***Case presentation.*** A 39-year-old patient was admitted with respiratory distress due to COVID-19. The transthoracic echocardiogram showed right ventricular dilation and dysfunction. He progressively deteriorated and required extracorporeal life support for refractory Acute Respiratory Distress Syndrome. Transesophageal echocardiography was performed to guide extracorporeal life support cannulation and corroborated the findings. ***Conclusion.*** This case exemplifies the risk of myocardial involvement with COVID-19 and highlights the role of ECMO and echocardiography in these patients. *Anestezjologia i Ratownictwo 2020; 14: 318-322.*

Keywords: COVID-19, echocardiography, extracorporeal membrane oxygenation

Background

Over 3.3 million COVID-19 cases are reported weekly worldwide. To date more than 46 million people have been infected and more than 1.2 million have died [1, 2]. The main system affected by COVID-19 is the respiratory system, with a range of disease from asymptomatic to severe pneumonia that can progress to acute respiratory distress syndrome (ARDS) [3].

Approximately 5% of patients require admission to an intensive care unit (ICU). Reasons for ICU admission are respiratory failure, shock and sepsis [4,5]. Cardiac injury has been reported in 28% of patients [6. The mortality rate among patients with myocardial injury is higher 51.2% compared to 4.5% in patients with no cardiac involvement [7]. Cardiovascular manifestations are not unique to this coronavirus pandemic. Since 2009, the interaction between the Severe Acute Respiratory Syndrome Coronavirus (SARS-COV) subfamily and myocardial damage leading to systolic dysfunction and arrhythmias has been suggested [3].

Echocardiography is a helpful diagnostic tool to evaluate myocardial structure and function, due to its high availability, cost-effectiveness, and the ability to be performed at the bedside [6]. Echocardiographic abnormalities can be detected in up to 55% of patients with COVID-19 and are associated with more severe disease and worse prognosis [8,9].

Here we report the echocardiographic findings of a patient diagnosed with COVID-19 who required Extracorporeal Membrane Oxygenation (ECMO) for respiratory support.

Case presentation

A 39-year-old male, previously healthy was admitted to ICU with respiratory failure due to COVID-19. He had a spontaneous left pneumothorax and required intubation. He was transferred to our hospital for consideration for ECMO support. The patient was sedated

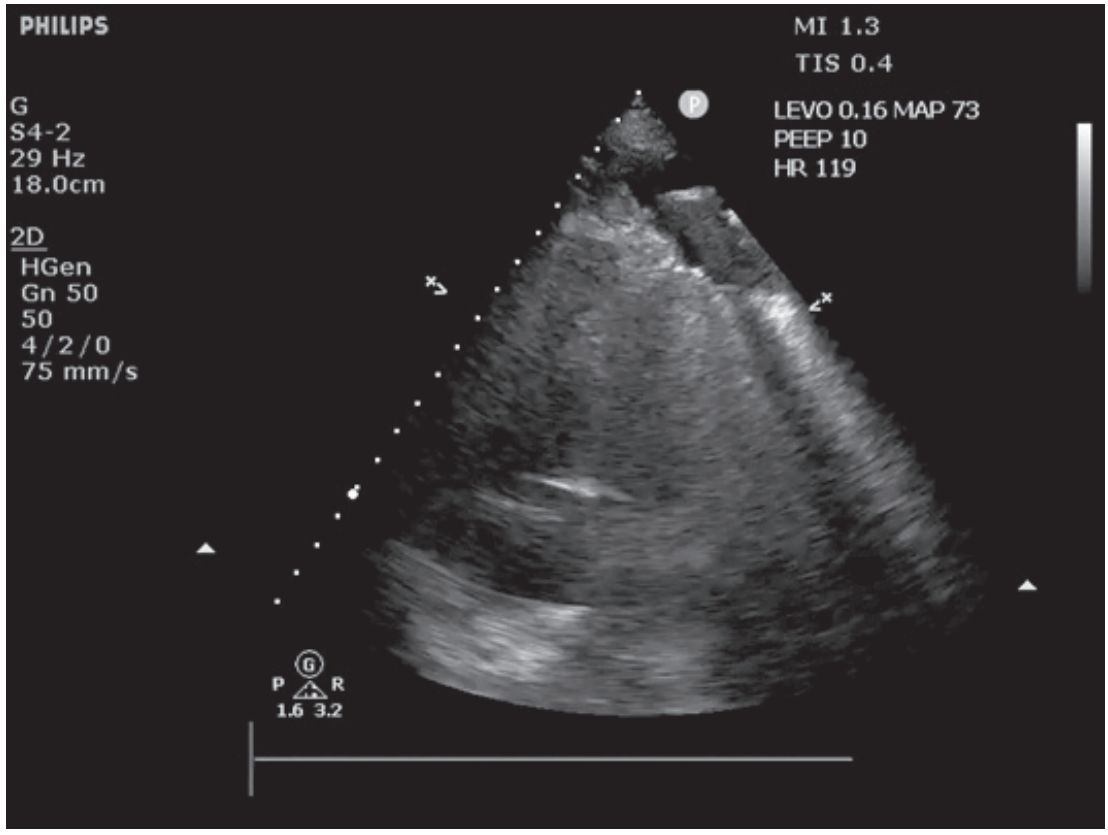
and paralyzed and required moderate amount of norepinephrine to maintain an adequate blood pressure.

Troponin I was 15 ng/L, electrocardiogram showed sinus tachycardia, T wave inversion in DIII, V1, and V2. A bedside transthoracic echocardiogram (TTE) was performed as part of ICU care. The apical images were poor, due to lung and left chest tube interference (Video 1). The rest of the images were considered of diagnostic quality. The TTE showed right ventricular (RV) dilation with volume and pressure overload (Video 2) and mildly reduced RV systolic function. A moderate tricuspid regurgitation allowed an estimation of RV systolic pressure of 45 mmHg. The diastolic function was indeterminate due to E and A waves fusion while the left ventricular systolic function was normal, however it might have been overestimated due to RV dysfunction. The IVC was dilated with a diameter of 2.6 cm and no respiratory variations.

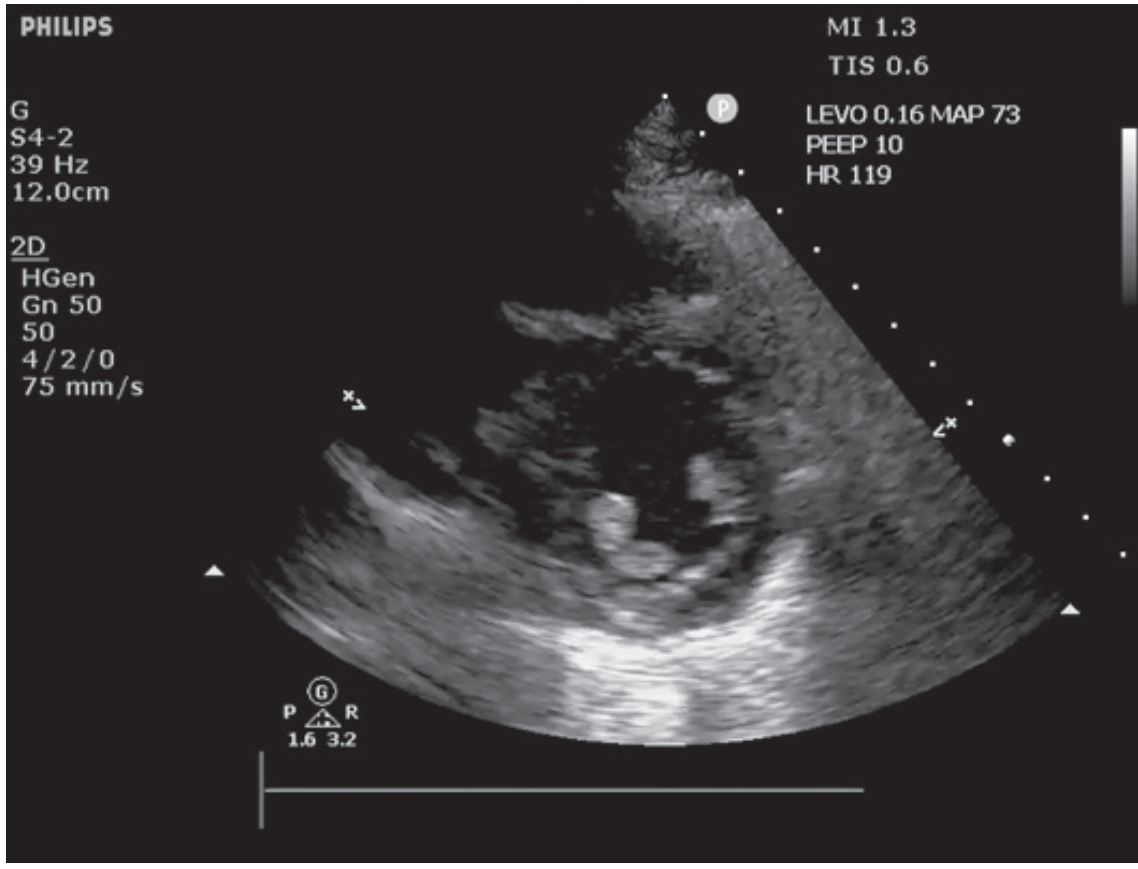
Despite lung protective ventilation and a trial of prone positioning, the patient continued to deteriorate, requiring a driving pressure of 20 cm H_2O. He developed worsening respiratory acidosis (pH; 7.16 with an arterial partial pressure of carbon dioxide of 135 mmHg) and hypoxemia ($PO2/FiO_2$ ratio of 123) prompting the decision to initiate ECMO. He was cannulated for veno-venous ECMO under transesophageal echocardiography (TEE) guidance.

TEE demonstrated a small and hyperdynamic LV and a dilated RV with a basal diameter of 4.5 cms, with mildly RV dysfunction (Video 3). Wires were visualized throughout the entire procedure and ECMO cannulas position was adequate: the drainage cannula was seen at the IVC-RA junction and the reinjection cannula was visualised in the SVC.

The patient's respiratory function improved, and he was successfully decannulated after 9 days of ECMO support. Unfortunately, he developed a large intracranial haemorrhage and did not survive his hospital stay.



Video 1. Poor echogenicity on the apical four-chamber images
Left chest tube and lung B-lines can be visualized
https://www.akademiamedycyny.pl/wp-content/uploads/2021/03/Apical_4_Chamber_V1.mp4



Video 2. Parasternal short axis of the left ventricle with a paradoxical septal motion
"D" shape LV throughout the cardiac cycle suggestive of RV volume and pressure overload
https://www.akademiamedycyny.pl/wp-content/uploads/2021/03/short_axis_mid_pap_V2.mp4

Discussion

In COVID-19 infection, complications result from various mechanisms, including systemic inflammation, immune response and oxygen supply/demand imbalance resulting in multiorgan and pathogen mediated damage [10].

Inflammatory, hematologic, and biochemical biomarkers have been demonstrated to be significantly elevated in patients with severe disease. For example, Chen et al described pro-B-type natriuretic peptide was elevated in 27% and troponin in 10% of 120 patients studied [2].

Myocardial involvement has been described in more than half of the ICU patients who did not have a pre-existing cardiac history [9]. Owing to the close lung-heart interaction, ARDS, PEEP and mechanical ventilation can lead to acute cor-pulmonale, causing RV systolic and diastolic overload, as seen in our patient [6].

Echocardiographic monitoring helps guide management of critically ill patients. In patients with respiratory failure, it allows evaluation of changes in right heart size and function, tricuspid regurgitation. It also enables assessment of volemia as well as left ventricular filling, biventricular systolic and diastolic function, pulmonary pressures, presence of pericardial effusion and/or tamponade.(11) Studies have reported a change in diagnosis and management in up to 60% of cases between echocardiography and clinical assessment [12,13]. In our experience, echocardiography plays a critical role in the management of patients with Covid 19 pneumonia.

While TTE is a non-invasive readily available tool, as exemplified by our case, the image acquisition in ICU patients is challenging. TEE could be used as a complementary tool, and allows direct visualization

of the guidewires during ECMO cannulation [6,14,15]. Furthermore, it allows diagnosis of cannulation related complications, such as vessel damage, pericardial effusion, or cardiac tamponade [16,17].

ECMO support is recommended in centers with sufficient volumes and clinical expertise, for patients suffering from refractory hypoxemia [[18,19]. Approximately 7% of the patients develop such a severe form of ARDS, thus requiring initiation of ECMO pending lung recovery.

As of today, 3440 cases of COVID 19 have been supported with ECMO worldwide, with an in-hospital mortality of 44% [20]. Selection of patients is a major determinant of outcome on ECLS. Hence, ECLS should be considered for younger patients without significant co-morbidities, nor other significant organ dysfunction. According to the Extracorporeal Life Support Organization (ELSO) registry, the median age of patients supported with ECLS is 49 (interquartile range: 40-57)). In addition, ECLS should be considered early during the course of mechanical ventilation, as injurious ventilation may be harmful even for short period of time [21]. Although ECMO is potentially life saving, its related complications may be potentially lethal, as illustrated in our case.

Conclusion

This case exemplifies how commonly cardiac involvement occurs in patients with COVID-19. It highlights the importance of lung and heart interaction and the need to include echocardiogram as standard of care for patients with shock and respiratory failure, particularly during the current pandemic. It also illustrates the benefit of ECMO, but also its potential complications.

Conflict of interest
None

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