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CASE REPORT
Cardiac imaging

Ultrasound emergency lateral-to-medial parasternal pericardiocentesis with high frequency probe in COVID-19: a case report

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Background The pathological involvement of the heart is frequent in SARS-Coronavirus-2 infection (COVID-19) with various clinical and echocardiographic manifestations during the course of the disease.

Case summary A 69-year-old female patient with severe COVID-19-related acute respiratory distress syndrome undergoing mechanical ventilation developed acute left ventricular dysfunction, that successfully improved with vasoactive therapy. After 5 days, she suddenly developed hemodynamic instability due to acute onset of pericardial effusion, which required emergency pericardiocentesis. Ultrasound-guided parasternal pericardiocentesis with high-frequency linear probe and lateral-to-medial in-plane approach was performed by inserting a central venous catheter using a Seldinger technique. 700 mL of serous fluid was drained resolving the acute critical state.

Discussion Pericardial effusion with cardiac tamponade is a rare manifestation of Covid-19. Despite the diffusion of echocardiography, emergency cardiac procedures could be particularly difficult to be performed in a pandemic scenario of limited resources and the heterogeneous skills of the professional figures involved in the management of COVID-19 patients. The spread of expertise in ultrasound-guided vascular cannulation makes this approach attractive for anesthesiologists, emergency medicine and critical care specialists too. Furthermore in this pericardiocentesis' technique, the high-frequency linear probe adds optimal spatial resolution to maintain a close control of the needle's direction. However the need of a good parasternal view and a deep ultrasound knowledge are crucial to avoid iatrogenic complications. In conclusion, ultrasound-guided lateral-to-medial parasternal pericardiocentesis with high-frequency linear probe is an alternative to treat potential lethal acute haemodynamic instability due to cardiac tamponade.

Keywords COVID-19 • Ultrasound-guided pericardiocentesis • Pericardial effusion • Cardiac tamponade • Case report

ESC Curriculum 2.1 Imaging modalities • 2.2 Echocardiography • 7.1 Haemodynamic instability

Learning points

- Cardiac tamponade is a rare but life-threatening manifestation of myopericarditis that should be suspected and diagnosed in the acute onset of haemodynamic instability in COVID-19 patients.
- Ultrasound-guided lateral-to-medial parasternal pericardiocentesis guided by high-frequency linear probe could be useful in a pandemic scenario of limited resources and of heterogeneous professional skills.

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Introduction

Despite the lung is the most known target of SARS-Cov-2 infection, literature has underlined the important involvement of the heart in all its components too. Myopericarditis with isolated left or biventricular dysfunction has been described in several reports, worsening the prognosis of COVID-19 patients.[1] The formation of pericardial effusion as an effect of pericardium inflammation is a rare complication of SARS-Cov-2 infection, but the evolution to cardiac tamponade can be a life-threatening condition, especially in a pandemic scenario of limited resources and the presence of clinicians of various specialties and of heterogeneous expertise, not frequently involved in urgent cardiac procedures.[2,3] As ultrasound guidance lowers the complication rates and increases the patient's safety, pericardiocentesis should be performed under ultrasound guidance. Since its inception in 1979, the echocardiographically guided technique evolved with procedural adaptations and introduction of new approaches to optimize simplicity and safety.[4]. We hereby report the case of a patient undergoing mechanical ventilation for severe acute respiratory distress syndrome (ARDS) and cardiac manifestations of SARS-COV-2 infection, aggravated by the rapid formation of pericardial effusion, in whom ultrasound-guided lateral-to-medial parasternal emergency pericardiocentesis with high-frequency linear probe and the insertion of a central venous catheter was able to resolve a near fatal cardiac tamponade.

Timeline

Days	Symptoms	Diagnosis/specific treatment
Day 1	Fever, dyspnoea	Clinical symptoms nasopharingeal polimerase chain reaction positive for SARS-Cov-2 infection
Day 5	Desaturation, severe respiratory insufficiency	CT-scan/Mechanical ventilation, prone position, steroids
Day 5	Left ventricular dysfunction with hypotension and hypoperfusion (myopericarditis)	Echocardiography/vasoactive therapy Levosimendan and norepinephrine
Day 10	Pericardial effusion and cardiac tamponade	Echocardiography/ Pericardiocentesis
Day 15	Difficult weaning from mechanical ventilation	Tracheostomy
Day 30	Complete ventilator weaning	Discharged to respiratory rehabilitation center

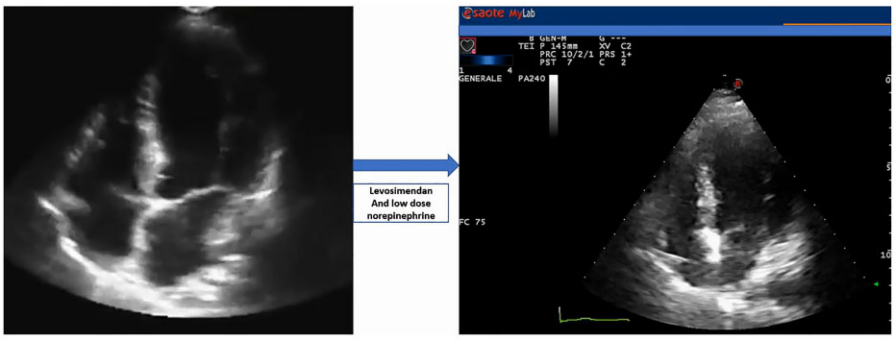
Case presentation

A 69-year-old female patient was admitted to the Emergency Department after 5 days from onset of symptoms related to SARS-Cov-2 infection. She referred worsening dyspnoea, extreme fatigue, and palpitations. She was tachycardic (120 beats/min) and tachypnoeic (42 breaths/min) with no fever on physical examination. Her past medical history was negligible for cardiac or any other pathology The arterial blood gas analysis revealed severe hypoxaemia (paO2/fiO2 87) and respiratory alkalosis (pH 7.51, pCo2 27 mmHg) Her CT scan showed diffuse bilateral infiltrates. She was intubated and transferred to the intensive care unit for severe COVID-19-related ARDS and treated with protective ventilation and cycles of prone positioning. Her laboratory tests revealed a state of hyperinflammation with increased C-reactive protein (peak value 300 mg/L, reference range <4 mg/L), D-dimer (peak 2000 mcg/mL, reference value <100 mcg/mL), fibrinogen (550 mg/dL, reference value 200–400 mg/dL), and lymphocytopaenia (85/μL, reference value >1000/μL). The course of the disease was complicated by left cardiac dysfunction with signs of hypoperfusion, increased lactate levels (3 mmol/L, reference value <1 mmol/L), hypotension (mean arterial pression <70 mmHg), central vein oxygen saturation of 58% (normal value >70%). Transthoracic echocardiography showed segmental left ventricular wall motion abnormalities mostly involving apex and distal septum, slight increase of high sensitive cardiac troponin 200 pg/nL (normal values <14 pg/nL), absence of ST segment elevation, estimated cardiac index of 1,8 l/min/m^2. Coronarography was considered not urgent and postponed. Cardiac function, haemodynamic status, and peripheral perfusion improved with low dose of norepinephrine (0,2 μg/kg/mi) and Levosimendan (0,2 μ/kg/min for a period of 24 h). No pericardial effusion was present in the first echocardiography (*Video 1*).

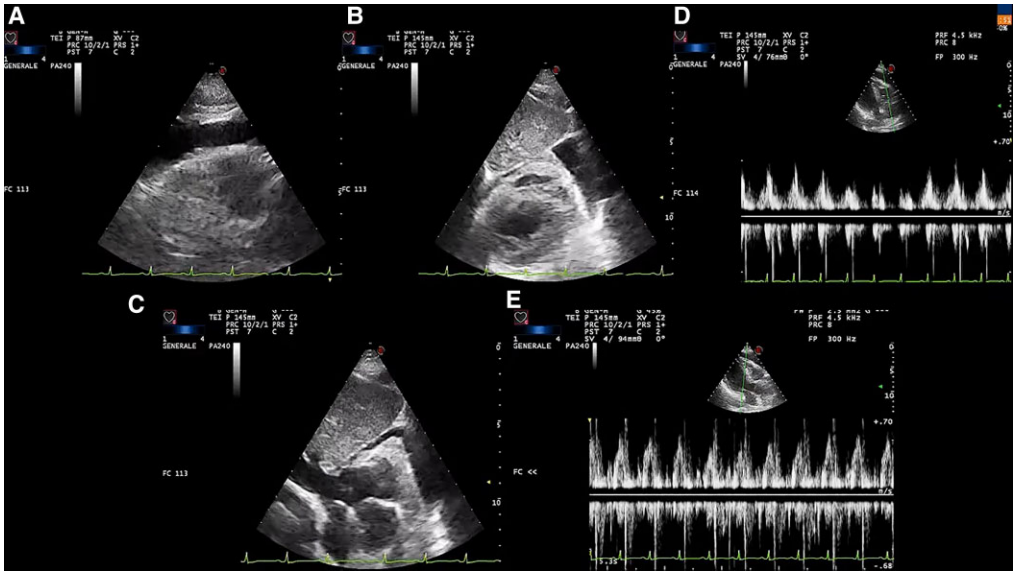
Five days after admission to the intensive care unit the patient suddenly developed an episode of shock with tachycardia (114 bpm) and hypotension (systolic arterial pressure of 55 mmHg), unresponsive to fluid loading and vasoactive therapy. The peripheral saturation remained stable and the ultrasound assessment of the lung was positive for bilateral sliding. A transthoracic echocardiography showed the presence of a new onset large pericardial effusion (3,5 cm) with evident signs of cardiac tamponade (diastolic compression of right ventricle, inferior vena cava enlargement, mitral valve flow variations >25% and tricuspid inflow fluctuations) (*Video 2*).

The ward cardiologist was called but he could not be on the scene before 30 min.

The need of emergency pericardiocentesis was established due to deterioration of the haemodynamic condition in the context of a difficult setting and the absence of a dedicated kit. A modified off-axis parasternal echocardiographic view at 5th intercostal space with high-frequency linear probe was performed (*Figure 1*), evidencing the point of intersection between lung and pericardium, the pericardial fluid over the right ventricle and the intercostal vessels (*Video 3*). This view was obtained with a gently clockwise rotation of the high-frequency linear probe until the ribs were displayed on a trasversal plane, ensuring a solid support surface away from lung sliding. The depth of the image was adjusted to enhance needle's visualization and the movement of the right ventricle wall. This approach let to insert a central venous catheter with an in-plane ultrasound-guided Seldinger technique (*Video 4*). Small horizontal movements under the probe were essential to monitor the tip of the needle, its pathway, and guidewire's progression in the pericardial sac (*Video 4*). Colour doppler avoided accidental puncture of the intercostal vessels. The procedure was uneventful and the drainage of 700 mL of



Video 1 Left ventricular dysfunction and its improvement with levosimendan and low dosage of norepinephrine, without pericardial effusion evaluated by echocardiography.



Video 2 Pericardial effusion with cardiac tamponade evidenced by collapse of right ventricle in long axis parasternal (*A*) and subxiphoid short axis (*B*), plethora of inferior vena cava (*D*), tricuspid (*C*), and mitral (*E*) diastolic flow oscillations.

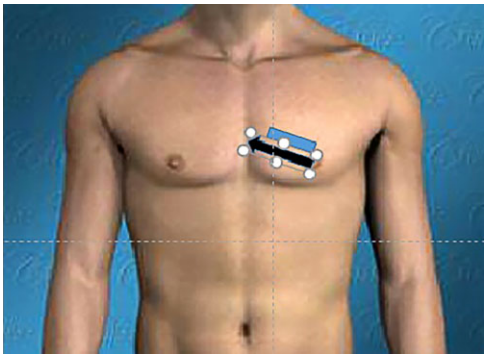


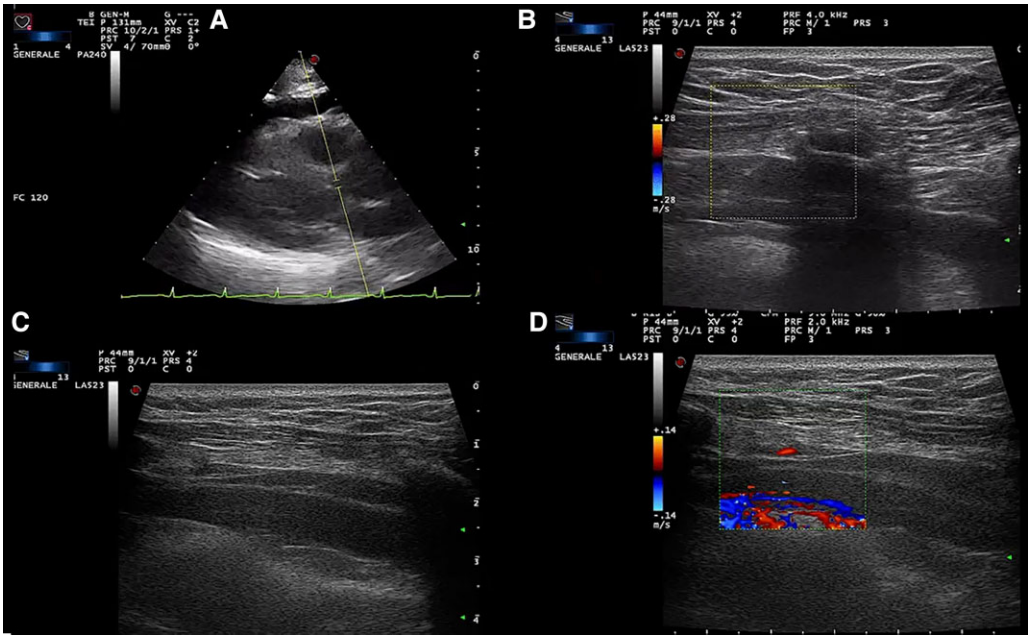
Figure 1 High-frequency linear probe's position on the chest and lateral-to-medial needle's direction to perform pericardiocentesis. Modified with permission from Dr T Cruise MD (https://lagynecomastia.org/gynecomastia-overview/ideal-male-chest/)

serous fluid resolved the critical condition (*Figure 2*). The patient needed tracheostomy and a slow ventilator weaning of another 15 days prior to discharge to rehabilitation centre. CT scan showed near complete resolution of infiltrates, and echocardiography was normal at discharge.

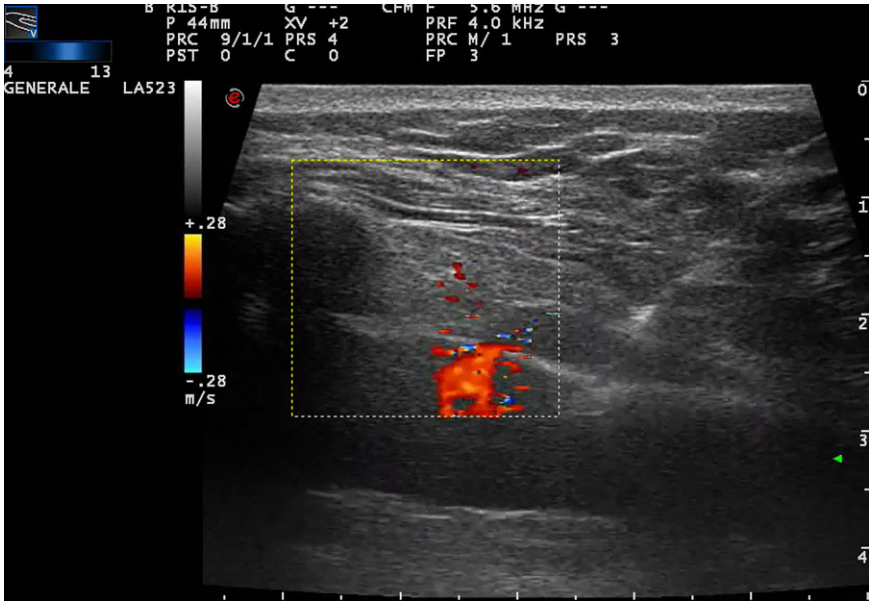
Discussion

Despite its rare incidence,[5] we described a modified ultrasound-guided lateral to medial parasternal pericardiocentesis to resolve a rare but life-threatening condition of cardiac tamponade in a COVID-19 patient und. Clinical presentation of pericardial effusion depends on the rapidity of production and accumulation of fluid in the pericardial sac. Even small amount of effusion can produce dramatic increase of intrapericardial pressure, when the pericardial sac has not the time to increase its compliance lowering its stiffness.[6]

A position statement of the European Society of Cardiology Working Group on Myocardial and Pericardial Diseases advocates



Video 3 Parasternal short axis view with cardiac probe (*A*). Enlargement of the view of the pericardial effusion with high-frequency linear probe at 5th intercostal space and slight clockwise tilting, with identification of lung-pericardium intersection point (*B-C*) and intercostal vessels (*D*).



Video 4 In-plane visualization of the needle and guidewire insertion.

the use of a stepwise scoring system to triage patients with cardiac tamponade. A score >6 (recent viral infection = 1 point, systolic blood pressure < 95 mmHg = 2 points, sinus tachycardia = 1 points rapid worsening of symptoms = 2 points, circumferential pericardial effusion >2 cm in diastole = 3 points, right ventricular collapse = 1 point, mitral/tricuspid respiratory fluctuations = 1 point; inferior vena cava collapse <50% = 1 point, total = 12 points) suggests to perform urgent pericardiocentesis without delay in this clinical situation.[7] The traditional subxiphoid is the preferred way by cardiologist, but different approaches depend on patient condition and expertise. In the subxiphoid approach a longer trajectory and a more difficult view of the needle's pathway through the abdomen is potentially aggravated by serious complications (liver puncture, right ventricle perforation) in not expert hands.[4] The

Figure 2 Central venous catheter position and drainage of pericardial serous effusion (*A*). Absence of pericardial fluid on echocardiographic control (*B*) with no fluctuation of diastolic filling (*C*).

apical approach to pericardiocentesis reduces the risk of cardiac complications by taking advantage of the proximity to the thick walled left ventricle and the small apical coronary vessels. However, proximity to the left pleural space increases the risk for iatrogenic pneumothorax.[8]

Osman *et al.*[9] described the technique of ultrasound-guided parasternal medial-to-lateral pericardiocentesis, showing the advantages of the procedure in terms of time and practical considerations. In this report, the lateral-to-medial parasternal approach with an off-axis view, guided by the linear probe let us to perform a safe pericardiocentesis with a perfect view of all surround structures (intercostal vessels, the lung, and the right ventricle). This approach could be useful when subxiphoid image is difficult to obtain as in obese patients. Furthermore the use of high-frequency probe guarantees an optimal spatial resolution for the complete in-plane visualization of the needle and of the guidewire during the procedure.

This technique has an important limitation: the need of a good parasternal view is crucial, but it could be absent in ventilated or emphysematous patients. A short expiratory pause or disconnection from mechanical ventilator could increase the rate of visualization, also reducing the risk of pneumothorax.

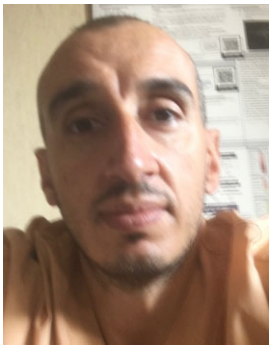
The spread of expertise in ultrasound-guided vascular cannulation makes this approach attractive to different professional emergency figures, but it must be accompanied by a deep ultrasound knowledge to reduce possible iatrogenic fatal complications as right ventricle perforation or pneumothorax.

Conclusion

Despite the diffusion of echocardiography in intensive care units, the ability of performing urgent cardiac procedures can be lacking, especially in a pandemic scenario of limited resources and the involvement of various professional figures in the management of COVID-19 patients.

The lateral-to-medial parasternal pericardiocentesis technique is of interest because it can be spread to specialists with skills in ultrasound-guided vascular cannulation using a high-frequency linear probe, as critical care or emergency doctors and anaesthesiologists.

Lead author biography



Baldassare Ferro is a critical care doctor with expertise and interest in haemodynamic monitoring and advanced echocardiography's research.

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Consent: The author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

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References

1. Cizgici AY, Agus HZ, Yildiz M. COVID-19 myopericarditis: it should be kept in mind in today's conditions. *Am J Emerg Med* 2020;**38**:1547.e5–1547.e6.
2. Madjid M, Safavi-Naeini P, Solomon SD, Vardeni O. Potential effects of coronaviruses on the cardiovascular system. *JAMA Cardiol* 2020;**5**:831–840.
3. Inciardi RM, Lupi L, Zaccone G, Italia L, Raffo M, Tomasoni D, Cani DS, Cerini M, Farina D, Gavazzi E, Maroldi R, Adamo M, Ammirati E, Sinagra G, Lombardi CM, Metra M. Cardiac involvement in a patient with coronavirus disease 2019 (COVID-19). *JAMA Cardiol* 2020;**5**:819–824.
4. Tsang TS, Freeman WK, Sinak LJ, Seward JB. Echocardiographically-guided pericardiocentesis: evolution and state-of-the-art technique. *Mayo Clin Proc* 1998;**73**:647–652.
5. Sauer F, Dagrenat C, Couppie P, Jochum G, Leddet P. Pericardial effusion in patients with COVID-19: case series. *Eur Heart J Case Rep* 2020;**4**:1–7.
6. Adler Y, Charron P, Imazio M, Badano L, Barón-Esquivias G, Bogaert J, Brucato A, Gueret P, Klingel K, Lionis C, Maisch B, Mayosi B, Pavie A, Ristić AD, Sabaté Tenas M, Seferovic P, Swedberg K, Tomkowski W, ESC Scientific Document Group. 2015 ESC Guidelines for the diagnosis and management of pericardial diseases: the Task Force for the Diagnosis and Management of Pericardial Diseases of the European

Society of Cardiology (ESC)Endorsed by: The European Association for Cardio-Thoracic Surgery (EACTS). *Eur Heart J* 2015;**36**:2921–2964.
7. Ristić AD, Imazio M, Adler Y, Anastasakis A, Badano LP, Brucato A, Caforio ALP, Dubourg O, Elliott P, Gimeno J, Helio T, Klingel K, Linhart A, Maisch B, Mayosi B, Mogensen J, Pinto Y, Seggewiss H, Seferovi PM, Tavazzi L, Tomkowski W, Charron P. Triage strategy for urgent management of cardiac tamponade: a position statement of the European Society of Cardiology Working Group on Myocardial and Pericardial Diseases. *Eur Heart J* 2014;**35**:2279–2284.
8. Blanco P, Figueroa L, Menéndez MF, Berrueta B. Pericardiocentesis: ultrasound guidance is essential. *Ultrasound J* 2022;**14**(1):9.
9. Osman A, Wan Chuan T, Ab Rahman J, Via G, Tavazzi G. Ultrasound-guided pericardiocentesis: a novel parasternal approach. *Eur J Emerg Med* 2018;**25**: 322–327.