ESC European Society of Cardiology

European Heart Journal - Case Reports (2022) **6**, 1–5
https://doi.org/10.1093/ehjcr/ytac373

CASE REPORT
Heart failure

Full myocardial recovery following COVID-19 fulminant myocarditis after biventricular mechanical support with BiPella: a case report

Silvia Ajello[1], Francesco Calvo[2], Cristina Basso [3,4], Pasquale Nardelli[1], and Anna Mara Scandroglio [1]*

[1]Cardiac Intensive Care Unit, IRCCS San Raffaele Scientific Institute, Via Olgettina, 60–20132 Milan, Italy; [2]Department of Cardiology, IRCCS San Raffaele Scientific Institute, Milan, Italy; [3]Cardiovascular Pathology Department, Padua Hospital, Italy; and [4]Cardiac, Thoracic and Vascular Sciences, University of Padua, Padua, Italy

Received 15 November 2021; first decision 8 February 2022; accepted 6 September 2022; online publish-ahead-of-print 9 September 2022

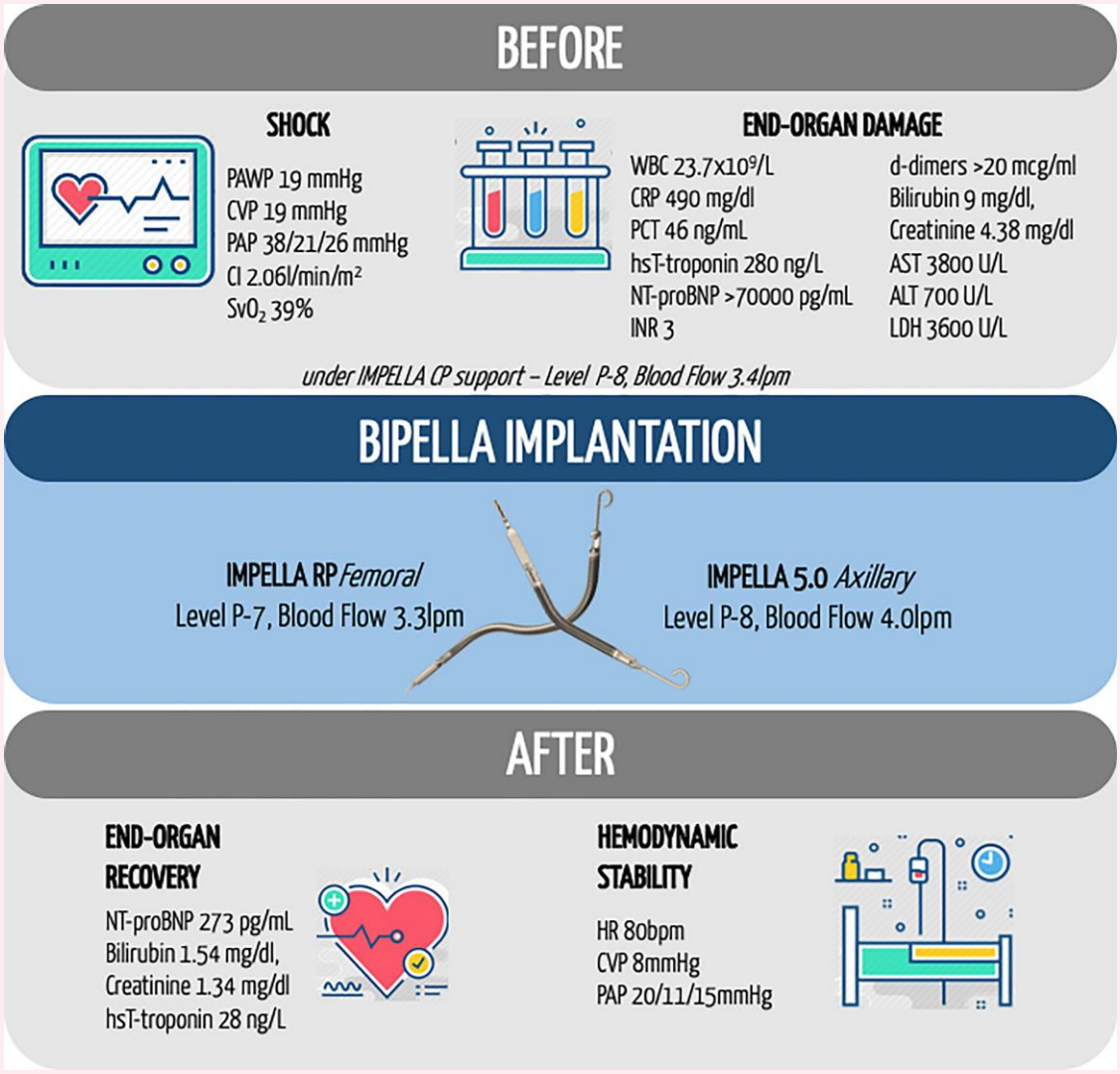
Background Fulminant myocarditis is a rare yet dreadful condition, which requires evaluation for mechanical support. The concomitant use of an Impella pump in the left and of one in the right ventricle—the so-called 'BiPella approach'—might allow recovery of the failing heart in selected cases. We report a peculiar case, in which mechanical circulatory support was used as the sole strategy to promote myocardial recovery, without the administration of any immunosuppressants in coronavirus disease (COVID)-19 fulminant myocarditis.

Case summary A previously healthy 49-year-black man presented to the emergency department with dyspnoea and severe metabolic acidosis. His nasopharyngeal swab resulted positive for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection. Echocardiography documented severe biventricular dysfunction which required support with two Impella pumps—the so-called 'BiPella approach'. Myocarditis was suspected on clinical basis. Endomyocardial biopsy showed SARS-CoV-2 localization within the endothelial cells. No antiviral or immunosuppressive therapy was administered. After 10 days of support, the patient was weaned from both right- and left-ventricular supports as complete recovery of cardiac function and end-organ damage was observed. The patient was discharged from the intensive care unit after 15 days and discharged home 1 month after presentation. The patient had no further episodes of heart failure at 6 months follow up.

Discussion Prolonged mechanical unloading with two Impella pumps in fulminant COVID-19 myocarditis is a viable and reliable strategy, as it provides the benefits of mechanical circulatory support plus additional disease-modifying effects, reducing wall stress and inflammatory response.

* Corresponding author. Tel: +39 02 2643 7154, Fax: +39 02 2643 7154, Email: scandroglio.mara@hsr.it
Handling Editor: Pierpaolo Pellicori
Peer-reviewers: Giulia Elena Mandoli; Kyriakos Dimitriadis
Compliance Editor: Hibba Kurdi
Supplementary Material Editor: Nida Ahmed

Graphical Abstract



Haemodynamic parameters and end-organ damage before and after Bipella positioning.

Keywords COVID-19 • Fulminant myocarditis • Mechanical circulatory support • Impella • Case report

ESC curriculum 6.4 Acute heart failure • 7.3 Critically ill cardiac patient • 7.1 Haemodynamic instability

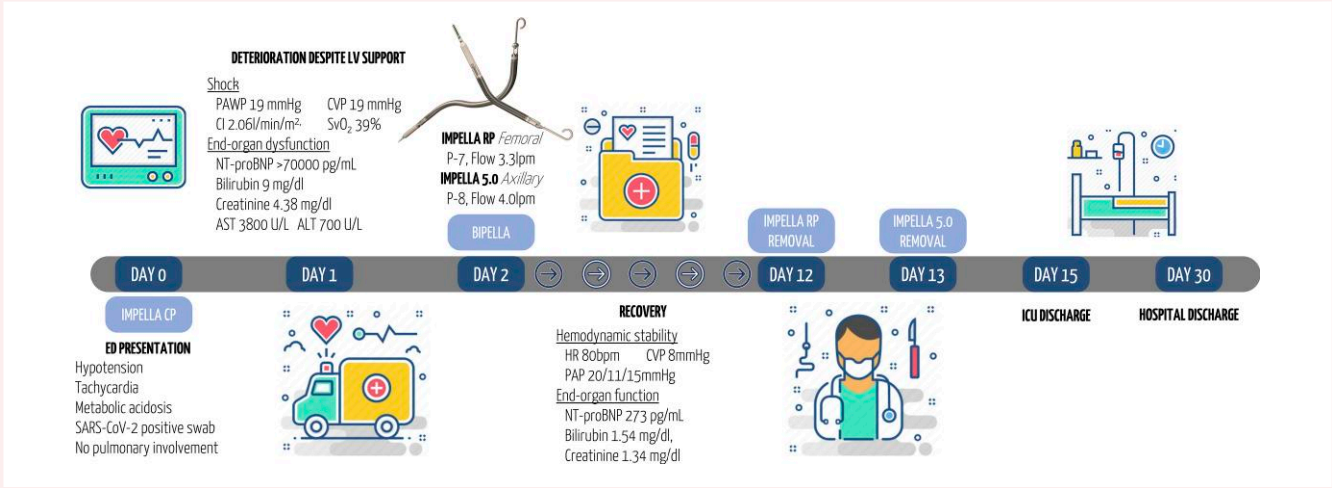
Learning points

- Fulminant myocarditis from severe acute respiratory syndrome coronavirus 2 is rare, but should be properly recognized as it may require prompt haemodynamic support.
- 'BiPella'—the concomitant use of two Impella pumps—is a viable strategy that may be considered in case of biventricular failure.
- Mechanical circulatory support alone—without the use of immunosuppressants—may allow for complete recovery of the heart in coronavirus disease 2019 myocarditis

Introduction

Fulminant myocarditis requires a prompt haemodynamic support, a timely recognition and a correct diagnosis to facilitate the use of disease-modifying drugs, including immunosuppressants and immunomodulators. Mechanical circulatory support (MCS) is mandatory for cardiogenic shock.[1]

Timeline



While coronavirus disease (COVID)-19 commonly implies a primary lung involvement, myocardial injury has been previously reported, with severity ranging between mild symptoms and cardiogenic shock.

We describe the case of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) fulminant myocarditis treated with a promising MCS strategy: the concomitant use of right and left Impella pumps—the so-called 'BiPella approach'—as bridge to recovery.[2]

Case presentation

A previously healthy 49-year-old black man presented to the emergency department in December 2020 with a 4-day history of worsening dyspnoea and fever. Upon clinical examination, he was apyretic, hypotensive, tachycardic, and tachypneic. Arterial blood gas revealed high lactate levels with compensatory respiratory alkalosis (pH 7.56—reference value 7.35–7.45, lactate 12.6 mmol/L—reference value <2 mmol/L, bicarbonates 15.2 mmol/L—reference value 22–26 mmol/L, partial arterial pressure carbon dioxide 17.1 mmHg—reference value 35–45 mmHg, base excess −6.9—reference value). His nasopharyngeal swab resulted tested positive for SARS-CoV-2 infection, but no signs of pulmonary involvement were observed.

Electrocardiogram showed sinus rhythm with lateral ST elevation; transthoracic echocardiography documented severe left-ventricular dysfunction (left-ventricular ejection fraction 10%—reference value >55%, indexed left-ventricular end-diastolic volume 70 mL/m^2—reference value 35–75 mL/m^2) with diffuse hypokinetic pattern and elevated filling pressure, and no pericardial effusion.

Urgent coronary angiography showed absence of significant coronary artery disease. He rapidly evolved in overt cardiogenic shock, requiring haemodynamic support: Impella CP was implanted at the end of the procedure.

In the next 12 h, the patient deteriorated despite left-ventricular support. Severe right-ventricular dysfunction was evident, with signs of systemic congestion and multiple end-organ hypoperfusion. Fulminant myocarditis was suspected. Extracorporeal membrane oxygenation support was considered, but was not implemented to the lack of pulmonary involvement and gas exchanges issues. A multidisciplinary evaluation was carried out involving cardiac intensivists, intensive care cardiologists, and cardiovascular surgeons. Due to patient's worsening clinical conditions, it was decided to proceed with a BiPella strategy, for its potential of providing unloading and enhance cardiac recovery. The Impella CP in the left ventricle was replaced with an Impella 5.0 surgically implanted via right axillary artery and an Impella RP was subsequently inserted percutaneously, via right femoral vein, in the right ventricle (*Figure 1*). In the same setting, endomyocardial biopsy was performed.

The systems were running as follows: Impella 5.0 blood flow 4.0 L/min (level P-8), Impella RP blood flow 3.3 L/min (level P-7). Haemodynamic stability was achieved and the patient was extubated on the day after BiPella implantation.

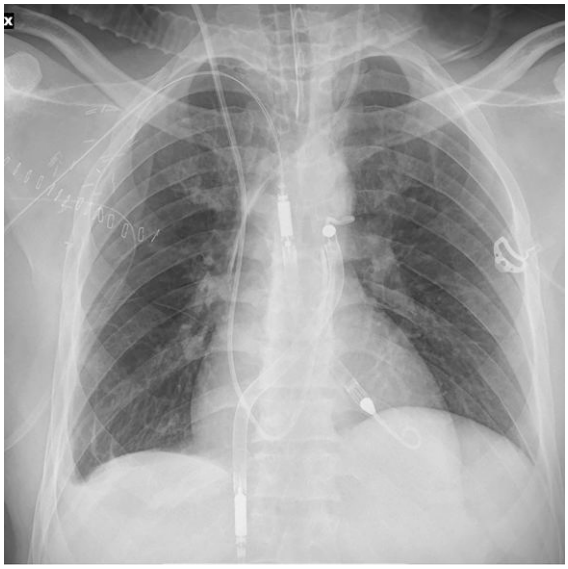


Figure 1 Bipella position at chest X-ray.

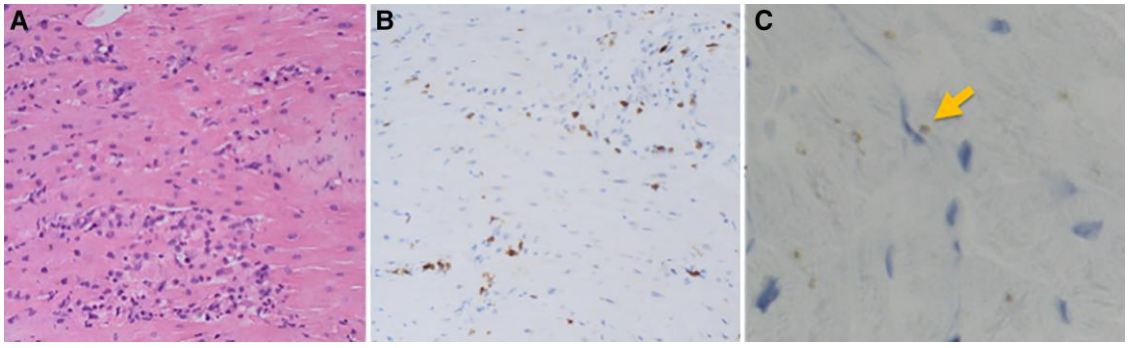


Figure 2 Endomyocardial biopsy documenting viral localization within the endothelial cells. (*A*) Haematoxylin and eosin stain; (*B* and *C*) immunohistology with anti-CD3 antibody staining (arrow) showing massive lymphomonocytic inflammatory infiltrates ($CD3^+$ >7/mm^2).

Endomyocardial biopsy documented massive lymphomonocytic inflammatory infiltrates ($CD3^+$ cells >7/mm^2) with cardiomyocytes necrosis and no replacement fibrosis (*Figure 2*). Molecular viral analysis tested positive for SARS-CoV-2 ribonucleic acid (open-reading frame-1 negative, N-gene positive). Remarkably, *in situ* hybridization documented viral localization within the endothelial cells, but not within cardiomyocytes.

No antiviral or immunosuppressive therapy was administered. Anticoagulation was performed with bivalirudin, titrated to reach a target-activated partial thromboplastin time of 60–65 s. Bleeding from the axillary access occurred 2 days after implant, which required temporary suspension of anticoagulation and blood products transfusion.

After 10 days of support, the patient was weaned from the right-ventricular support and on the day after from Impella 5.0 as complete recovery of cardiac function and end-organ damage was observed.

A cardiac magnetic resonance was later performed: diffuse increase of native T_2 (sign of myocardial oedema) and native T_1 (sign of non-ischaemic myocardial injury) were observed, meeting the 2018 Lake Louis Criteria.[3] No significant late gadolinium enhancement areas and normal biventricular function were also observed.

The patient was transferred from the intensive care unit after 15 days and discharged home 1 month after presentation. Echocardiography before discharge documented a complete recovery of heart function. Discharge therapy included a low dose of angiotensin-converting enzyme inhibitor and beta-blockers. He did not have further episodes of heart failure at 12 months follow up.

Discussion

Various degrees of myocardial involvement have been reported in up to 2.3% of cases of SARS-CoV-2 infection.[4,5] Fulminant myocarditis is a rare, yet dramatic presentation of COVID-19. As cardiogenic shock requiring mechanical support has only been described in few case reports,[6–8] the rate of recovery and the best treatment strategy are yet to be determined. Routinary use of steroids is currently not recommended in myocarditis nor in COVID-19.[9] In the present case, MCS has been used as the sole strategy to promote myocardial recovery, without the administration of any immunosuppressants. We report the use of percutaneous mechanical support in its more adaptable form, combining stepwise assistance to both ventricles. While left-ventricular support with Impella is widely used, some hesitations exist about the simultaneous use of two devices, in our experience is effective for recovery, safe, and flexible in the weaning process. In severe biventricular involvement, the implantation of both systems as primary treatment may be beneficial in this specific scenario of COVID-19. In fact, the impact of a prolonged mechanical unloading with the concomitant use of right and left Impella pumps—the so-called BiPella approach in fulminant myocarditis has been proved to provide benefits beyond its primary function of MCS in the form of additional disease-modifying effects, reducing cardiomyocyte hypertrophy and myofibroblast activation, promoting calcium homeostasis, ultimately resulting in wall stress and inflammatory response reduction.[10]

While recent studies failed to identify specific treatments for COVID-19, clinical data appear to suggest a primary support strategy, in which treatment should aim to 'navigate through the storm', buying time to allow spontaneous recovery.

Lead author biography

Dr Anna Mara Scandroglio is the responsible of cardiac intensive care unit and of the advanced heart failure and mechanical circulatory support programme at IRCCS San Raffaele Scientific Institute in Milan, Italy.

Supplementary material

Supplementary material is available at *European Heart Journal – Case Reports* online.

Acknowledgement

The authors thank ABIOMED Gmbh for supporting the Open Access Publication.

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: None declared.

Funding: None declared.

References

1. Tschöpe C, Ammirati E, Bozkurt B, Caforio ALP, Cooper LT, Felix SB, Hare JM, Heidecker B, Heymans S, Hübner N, Kelle S, Klingel K, Maatz H, Parwani AS, Spillmann F, Starling RC, Tsutsui H, Seferovic P, Van Linthout S. Myocarditis and inflammatory cardiomyopathy: current evidence and future directions. *Nat Rev Cardiol* 2020; **12**:1–25.
2. Pappalardo F, Scandroglio AM, Latib A. Full percutaneous biventricular support with two Impella pumps: the Bi-Pella approach. *ESC Heart Fail* 2018;**5**:368–371.
3. Ferreira VM, Schulz-Menger J, Holmvang G, Kramer CM, Carbone I, Sechtem U, Kindermann I, Gutberlet M, Cooper LT, Liu P, Friedrich MG. Cardiovascular magnetic resonance in nonischemic myocardial inflammation: expert recommendations. *J Am Coll Cardiol* 2018;**72**:3158–3176.
4. Saleh A, Matsumori A, Abdelrazek S, Eltaweel S, Salous A, Neumann FJ, Antz M. Myocardial involvement in coronavirus disease 19. *Herz* 2020;**45**:719–725.
5. Daniels CJ, Rajpal S, Greenshields JT, Rosenthal GL, Chung EH, Terrin M, Jeudy J, Mattson SE, Law IH, Borchers J, Kovacs R, Kovan J, Rifat SF, Albrecht J, Bento AI, Albers L, Bernhardt D, Day C, Hecht S, Hipskind A, Mjaanes J, Olson D, Rooks YL, Somers EC, Tong MS, Wisinski J, Womack J, Esopenko C, Kratochvil CJ, Rink LD; Big Ten COVID-19 Cardiac Registry Investigators. Prevalence of clinical and subclinical myocarditis in competitive athletes with recent SARS-CoV-2 infection: results from the big ten COVID-19 cardiac registry. *JAMA Cardiol* 2021;**6**:1078–1087.
6. Pirzada A, Mokhtar AT, Moeller AD. COVID-19 and myocarditis: what do we know so far? *CJC Open* 2020;**2**:278–285.
7. Hékimian G, Kerneis M, Zeitouni M, Cohen-Aubart F, Chommeloux J, Bréchot N, Mathian A, Lebreton G, Schmidt M, Hié M, Silvain J, Pineton de Chambrun M, Haroche J, Burrel S, Marot S, Luyt CE, Leprince P, Amoura Z, Montalescot G, Redheuil A, Combes A. Coronavirus disease 2019 acute myocarditis and multisystem inflammatory syndrome in adult intensive and cardiac care units. *Chest* 2021;**159**: 657–662.
8. Gaudriot B, Mansour A, Thibault V, Lederlin M, Cauchois A, Lelong B, Ross JT, Leurent G, Tadié JM, Revest M, Verhoye JP, Flecher E, Nesseler N. Successful heart transplantation for COVID-19-associated post-infectious fulminant myocarditis. *ESC Heart Fail* 2021;**8**:2625–2630.
9. Papageorgiou JM, Almroth H, Törnudd M, van der Wal H, Varelogianni G, Lawesson SS. Fulminant myocarditis in a COVID-19 positive patient treated with mechanical circulatory support—a case report. *Eur Heart J Case Rep* 2020;**5**:ytaa523.
10. Spillmann F, Van Linthout S, Schmidt G, Klein O, Hamdani N, Mairinger T, Krackhardt F, Maroski B, Schlabs T, Soltani S, Anker S, Potapov EV, Burkhoff D, Pieske B, Tschöpe C. Mode-of-action of the PROPELLA concept in fulminant myocarditis. *Eur Heart J* 2019; **40**:2164–2169.