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CASE REPORT
Heart failure

One-week Impella CP support for papillary muscle rupture as a bridge to surgery: a case report

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Background Papillary muscle rupture (PMR) is a catastrophic complication of acute myocardial infarction. However, the best timing and modality of circulatory support for surgery are unknown.

Case Summary A 75-year-old man presented to the emergency room in our hospital for worsening shortness of breath accompanied by chest pain. Transthoracic echocardiograph showed severe mitral regurgitation (MR) with a flail posterior mitral valve leaflet, and coronary angiography demonstrated distal right coronary artery occlusion. We diagnosed as cardiogenic shock due to subacute myocardial infarction and ischaemic PMR. An Impella CP (Abiomed, Danvers, MA, USA) was introduced to improve haemodynamics. Despite the grade of MR was still severe, the mean blood pressure and pulmonary artery pressure improved 4 h after an Impella CP support. At day 8, the patient underwent elective mitral valve replacement with single coronary artery bypass grafting.

Discussion PMR is a rare but lethal complication of acute myocardial infarction. Expeditious surgical treatment offers the optimal chance of survival, but the post-operative mortality or morbidity is very high. Therefore, preoperative stabilization can be closely correlated with outcomes in these patients. It was reported that directly unloading the left ventricle by an Impella decreased wall stress, external work, and myocardial oxygen consumption. Therefore, an Impella can be the most suitable mechanical circulatory support for PMR. In conclusion, Impella CP alone can become one of the suitable bridges to surgery in the patients with PMR.

Keywords Papillary muscle rupture • Impella • Acute myocardial infarction • Case report

ESC Curriculum 4.3 Mitral regurgitation • 3.2 Acute coronary syndrome

Learning points

- Preoperative stabilization with mechanical support may improve the operative mortality for the pupillary muscle rupture.
- Impella CP support during several days may be considered in patients with cardiogenic shock due to papillary muscle rupture for stabilization as a bridge to surgery.

Introduction

Papillary muscle rupture (PMR) is a catastrophic complication of acute myocardial infarction.[1] However, the best timing and modality of circulatory support for surgery are unknown. We report a patient with PMR who was successfully bridged to surgery after 1-week support with an Impella CP.

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Timeline

Time	Events
Admission	He had shortness of breath. His blood pressure was 90/70 mmHg and oxygen saturation was 90% with reservoir face mask.
Investigations	Electrocardiogram showed inferior ST-segment elevation and abnormal Q wave. Transthoracic echocardiography showed severe mitral regurgitation with a flail posterior mitral valve leaflet.
A few hours after admission	Due to his forced breathing, endotracheal intubation was performed. Coronary angiography demonstrated right coronary artery occlusion. Right heart catheterization revealed a depressed cardiac index of 1.8 L/min/m^2 and high pulmonary wedge pressure of 22 mmHg.
Intervention	Impella CP (Abiomed, Danvers, MA, USA) was introduced through the right femoral artery. The mean blood pressure and pulmonary blood pressure improved after an Impella CP support.
Day 8 after admission	He underwent subacute mitral valve replacement with single coronary artery bypass grafting. In this surgery, posterior papillary muscle rupture was confirmed.
Day 95 after admission	He did well post-operatively. He was transferred to a rehabilitation ward.

Case presentation

A 75-year-old man presented to the emergency room in our hospital for complaining of shortness of breath 5 days after he had chest pain. He was alert, but he had a temperature of 39°C. Moreover, his blood pressure was 90/70 mmHg and oxygen saturation was 90% with reservoir face mask. He had jugular venous distension and lower leg oedema. Auscultation revealed a grade 3/6 holosystolic murmur at the left lower sternal border with bilateral inspiratory crackles. The patient had a history of smoking and oesophageal cancer surgery. He had no history of alcohol intake or illicit drug use.

Electrocardiogram showed sinus rhythm (110 beats/per minutes) with inferior ST-segment elevation and abnormal Q wave (*Figure 1A*). Notable laboratory results included a highly sensitive troponin I concentration of 12 ng/mL (normal value < 0.262 ng/mL), creatine phosphokinase of 257 IU/L (normal value 59–248 IU/L), creatine kinase–myocardial band of 22.6 IU/L (normal value < 5.0 IU/L), lactate dehydrogenase of 682 IU/L (normal value 124–222 IU/L), and N-terminal prohormone of brain natriuretic peptide concentration of 10 498 pg/mL (normal value < 125 pg/mL). In addition, the number of leucocytes was 11 500/μL (normal value 4000–8000/μL), the ratio of neutrophil was 80.8% (normal value 40.0–65.0%), the concentration of C-reactive protein (CRP) was 4.53 mg/dL (normal value < 0.14 mg/dL), and the serum lactate was 3.44 mmol/L (normal value < 1.56 mmol/L). Chest X ray showed asymmetric pulmonary oedema and consolidation (*Figure 1B*). The left ventricular (LV) end-diastolic diameter was 51 mm, LV ejection fraction was 43%, and LV outflow tract velocity time integral was 10.4 cm. The motion of the LV inferior wall was akinetic. The tricuspid annular plane systolic excursion was 16.6 mm (normal value ≥ 18.0 mm).[2] Parasternal long-axis view showed severe MR with a flail posterior mitral valve leaflet (*Figure 2A* and *2B*). Orientation of the MR jet was from the medial scallop towards the posterior wall of the aorta. We administered saline and gave respiratory support by non-invasive positive pressure ventilation. However, he altered mentation with forced breathing a few hours after visit. Noradrenaline and dobutamine were administered due to low blood pressure, and endotracheal intubation was performed. Coronary angiography demonstrated distal right coronary artery occlusion (*Figure 3C* and Supplementary material online, *Video S1*). Based on initial diagnostic assessment, we concluded that the patient had cardiogenic shock due to subacute myocardial infarction and ischaemic PMR. Right heart catheterization revealed a severely depressed cardiac index of 1.8 L/min/m^2 with reduced cardiac power output (CPO) of 0.4 watt (CPO = (mean arterial pressure) × (cardiac output)/451),[3] high pulmonary artery pressures of 40/27 mmHg, mean pulmonary artery pressure of 32 mmHg, and pulmonary wedge pressures of 22 mmHg, suggesting classic cardiogenic shock.[4] Therefore, an Impella CP

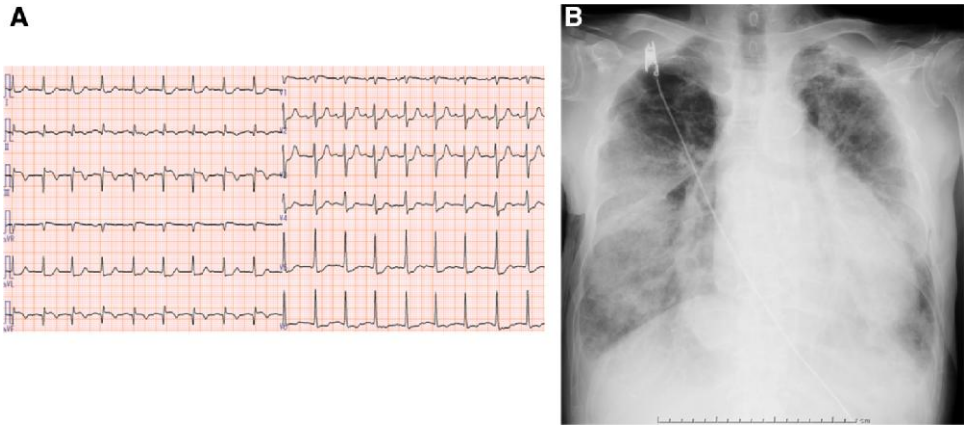

Figure 1 Electrocardiogram and chest radiograph. (*A*) Electrocardiogram showed sinus rhythm with ST-segment elevation and abnormal Q wave at III, aVF induction. (*B*) Chest X ray demonstrated pulmonary oedema and asymmetric consolidation right worse than left.

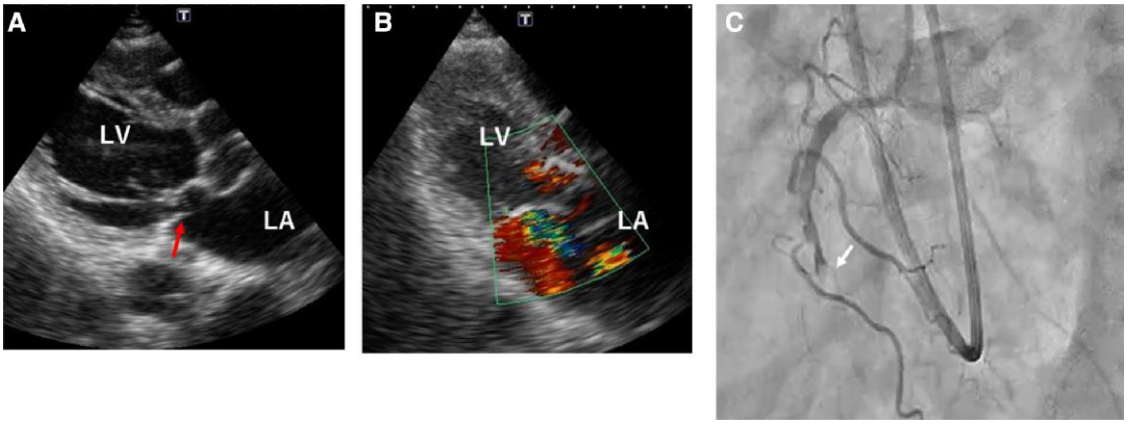

Figure 2 Transthoracic echocardiography and coronary angiography. (*A*) Parasternal long-axis view reveals the flail posterior mitral valve leaflet at systolic phase (arrow). (*B*) Color Doppler image showed severe mitral regurgitation (MR). (*C*) Left anterior oblique straight view of the right coronary artery shows complete occlusion (arrow). LA, left atrium; LV, left ventricular.

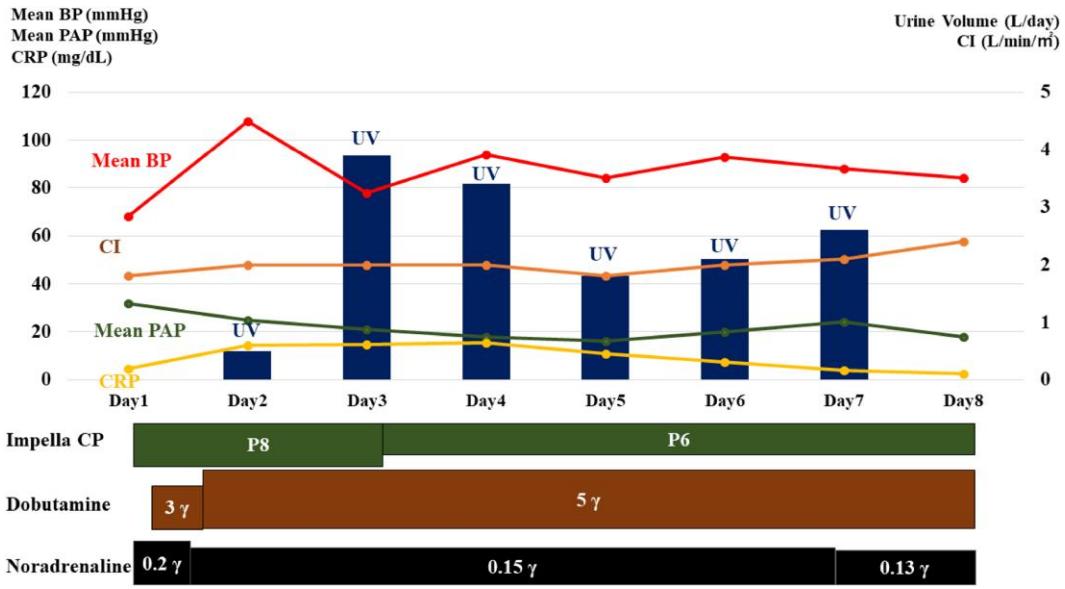

Figure 3 Haemodynamic time course during the first 8 days. The mean blood pressure and the pulmonary artery pressure were improved 4 h after Impella CP support. C-reactive protein was decreased from 14.7 mg/dL to 2.7 mg/dL during 1 week. Mean BP, mean blood pressure; Mean PAP, mean pulmonary artery pressure; CRP, C-reactive protein; UV, urine volume; CI, cardiac index.

(Abiomed, Danvers, MA, USA) was introduced through the right femoral artery. The course over the 7 days after an Impella CP support is summarized in *Figure 3*. Despite the grade of MR was still severe, the mean blood pressure and pulmonary artery pressure improved 4 h after an Impella CP support. The antibacterial drug (tazobactam piperacillin hydrate) was effective and CRP decreased from 14.7 mg/dL to 2.7 mg/dL. On day 8, the patient underwent subacute mitral valve replacement (MVR) with single coronary artery bypass grafting. In this surgery, posterior PMR was confirmed (*Figure 4*). He did well postoperatively, and we weaned him from ventilator for 66 h after the surgery. On 22 days after the surgery, aspiration pneumonia was occurred. Owing to its severity, intubation and tracheostomy were necessary for the treatment. At 95 days, he was transferred to the rehabilitation ward. He had been stable, but unfortunately, he died due to aspiration pneumonia 225 days after the surgery.

Discussion

We first proposed a clinical case report of an Impella CP support alone during 1 week for PMR as a bridge to surgery. PMR is a rare but highly lethal complication of acute myocardial infarction. Expeditious surgical

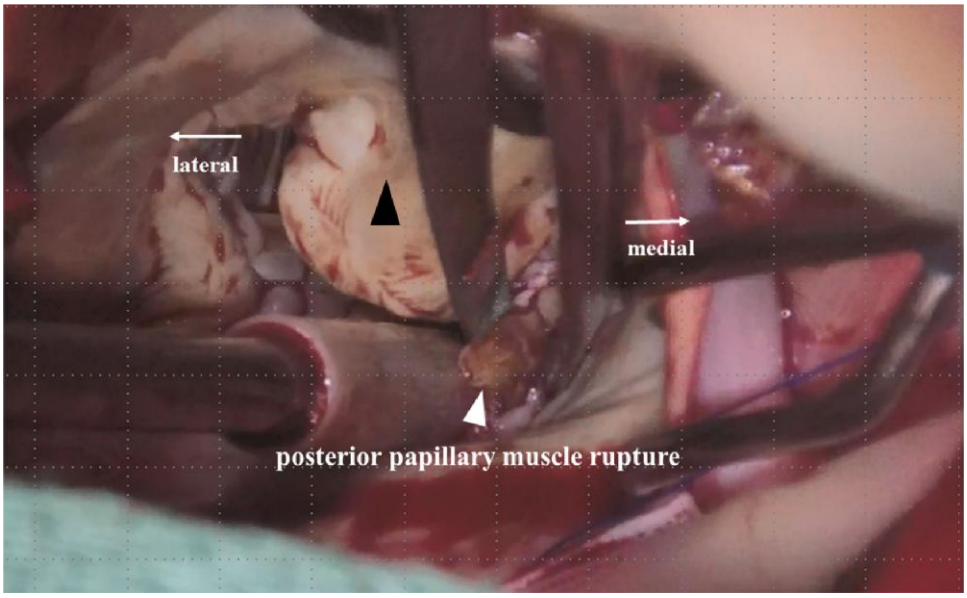

Figure 4 Intraoperative findings. Intraoperative findings show the posterior papillary muscle rupture (white arrowhead) and mitral valve anterior leaflet (black arrowhead) by surgeon's view.

treatment offers the optimal chance of survival, but the post-operative mortality or morbidity is very high.[5] A previous report has demonstrated that emergent salvage status is a predictor of post-operative mortality for PMR.[5] Therefore, preoperative stabilization can improve outcomes in these patients. A delay in operative intervention will allow damaged myocardium to become more suitable for surgical correction with improved successful repair. On the other hand, prolonged mechanical circulatory support increases the potential for complications. In fact, complications related to the venoarterial extracorporeal membrane oxygenation (VA-ECMO) occurred in 75.3% of the patients with post-infarction mechanical complications and longer duration of VA-ECMO use was associated with complications.[6] In a previous report, two patients treated with combined VA-ECMO and Impella CP underwent successful surgical MVR on hospital days from five to seven.[7] Therefore, 1 week may be enough to bridge the surgery with respect to the operative mortality and complications. However, there were little reports showing a successful case with an Impella CP support alone for 1 week as a bridge to the surgical MVR.

Despite the mechanical support is essential for preoperative stabilization of cardiogenic shock with PMR, it is not well known what mechanical support is suitable for PMR. An intra-aortic balloon pump (IABP) and VA-ECMO are commonly used as a bridge to surgery.[5] The VA-ECMO increases LV afterload, which can worsen valvular regurgitation and pulmonary oedema. Certainly, it has been reported the preoperative VA-ECMO was associated with mortality.[8] On the other hand, the IABP was most widely used in previous reports.[5,6] However, it was reported that an Impella was superior for hemodynamic support compared to IABP regarding mean blood pressure, cardiac index, and pulmonary wedge pressure.[9] There have been several reports that indicated superiority of exchanging an IABP for an Impella as a bridge to the surgery.[10,11] These results could be associated with directly unloading the left ventricle. Directly unloading the left ventricle decreases wall stress, external work, and myocardial oxygen consumption.[12] However, the bleeding rate was higher with an Impella compared to an IABP.[9,13] Thus, we should carefully manage bleeding event during an Impella CP support. In conclusion, we reported a case of 1-week stabilization with an Impella CP alone as a bridge to the surgery in the setting of cardiogenic shock due to PMR. By presenting this case, an Impella CP alone can become one of the suitable bridges to the surgery in the patients with PMR.

Lead author biography

Dr. Shodai Kawanami is an interventional cardiologist at Osaka Rosai Hospital (Sakai, Japan). He graduated from Osaka University and received the MD degree in 2018. Since 2021, He worked as a staff cardiologist at Osaka Rosai Hospital. He was interested in acute heart failure with cardiogenic shock.

Supplementary material

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

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Data availability

The data underlying this article are available in the article and in its online supplementary material.

References

1. Bhardwaj B, Sidhu G, Balla S, Kumar V, Kumar A, Aggarwal K, *et al.* Outcomes and hospital utilization in patients with papillary muscle rupture associated with acute myocardial infarction. *Am J Cardiol* 2020;**125**:1020–1025.
2. Ohte N, Ishizu T, Izumi C, Itoh H, Iwanaga S, Okura H, *et al.* JCS 2021 Guideline on the clinical application of echocardiography. *Circ J* 2022;**86**:2045–2119.
3. Basir MB, Kapur NK, Patel K, Salam MA, Schreiber T, Kaki A, *et al.* Improved outcomes associated with the use of shock protocols: updates from the national cardiogenic shock initiative. *Catheter Cardiovasc Interv* 2019;**93**:1173–1183.
4. Baran DA, Grines CL, Bailey S, Burkhoff D, Hall SA, Henry TD, *et al.* SCAI clinical expert consensus statement on the classification of cardiogenic shock: this document was endorsed by the American College of Cardiology (ACC), the American Heart Association (AHA), the Society of Critical Care Medicine (SCCM), and the Society of Thoracic Surgeons (STS) in April 2019. *Catheter Cardiovasc Interv* 2019;**94**:29–37.
5. Kilic A, Sultan I, Chu D, Wang Y, Gleason TG. Mitral valve surgery for papillary muscle rupture: outcomes in 1342 patients from the society of thoracic surgeons database. *Ann Thorac Surg* 2020;**110**:1975–1981.
6. Matteucci M, Fina D, Jiritano F, Meani P, Raffa GM, Kowalewski M, *et al.* The use of extracorporeal membrane oxygenation in the setting of postinfarction mechanical complications: outcome analysis of the Extracorporeal Life Support Organization Registry. *Interact Cardiovasc Thorac Surg* 2020;**31**:369–374.
7. Ekanem E, Gattani R, Bakhshi H, Tehrani B, Batchelor W. Combined venoarterial ECMO and Impella-CP circulatory support for cardiogenic shock due to papillary muscle rupture. *JACC Case Rep* 2020;**2**:2169–2172.
8. Fujita T, Yamamoto H, Kobayashi J, Fukushima S, Miyata H, Yamashita K, *et al.* Mitral valve surgery for ischemic papillary muscle rupture: outcomes from the Japan cardiovascular surgery database. *Gen Thorac Cardiovasc Surg* 2020;**68**:1439–1446.
9. Thiele H, Jobs A, Ouweneel DM, Henriques JPS, Seyfarth M, Desch S, *et al.* Percutaneous short-term active mechanical support devices in cardiogenic shock: a systematic review and collaborative meta-analysis of randomized trials. *Eur Heart J* 2017;**38**:3523–3531.
10. Imaoka S, Kainuma S, Toda K, Miyagawa S, Yoshioka D, Kawamura T, *et al.* Impella support as a bridge to surgery for severe mitral regurgitation with cardiogenic shock. *Circ Rep* 2021;**3**:178–181.
11. Jalil B, El-Kersh K, Frizzell J, Ahmed S. Impella percutaneous left ventricular assist device for severe acute ischaemic mitral regurgitation as a bridge to surgery. *BMJ Case Rep* 2017;**2017**;bcr2017219749.
12. Haberkorn S, Uwarow A, Haurand J, Jung C, Kelm M, Westenfeld R, *et al.* Percutaneous left ventricular assist support is associated with less pulmonary congestion and lower rate of pneumonia in patients with cardiogenic shock. *Open Heart* 2020;**7**:e001385.
13. Miller PE, Bromfield SG, Ma Q, Crawford G, Whitney J, DeVries A, *et al.* Clinical outcomes and cost associated with an intravascular microaxial left ventricular assist device vs intra-aortic balloon pump in patients presenting with acute myocardial infarction complicated by cardiogenic shock. *JAMA Intern Med* 2022;**182**:926–933.