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CASE REPORT

Impella in Takotsubo syndrome complicated by left ventricular outflow tract obstruction and severe mitral regurgitation

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Abstract

The treatment of cardiogenic shock in patients with Takotsubo syndrome (TTS) is challenging because it depends on the mechanisms leading to the haemodynamic instability.

We report the case of a 70-year-old woman admitted for TTS complicated by cardiogenic shock. The early echocardiographic identification of left ventricular outflow tract obstruction (LVOTO) and severe mitral regurgitation (MR) prompted us to implant an Impella CP assist device as a bridge-to-recovery therapy. After device positioning, the haemodynamic status improved and LVOTO and severe MR disappeared. Because of the persistence of severe hypotension, the mechanical circulatory support was continued in intensive care unit and stopped only 5 days later, when intraventricular gradient spontaneously dropped. The patient was discharged after 1 week in stable conditions.

Our case suggests that Impella circulating support may be a useful bridge-to-recovery therapeutic option in selected patients with cardiogenic shock due to TTS complicated by LVOTO and severe MR.

Keywords Takotsubo syndrome; Left ventricular outflow tract obstruction; Mitral regurgitation; Mechanical circulatory support; Impella

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Introduction

Although generally considered a benign disease, in-hospital course of Takotsubo syndrome (TTS) may be characterized by adverse events such as acute heart failure and cardiogenic shock and is associated with a 2% mortality.[1]

Cardiogenic shock occurs in about 10% of patients. Reasons are severe left ventricular (LV) systolic dysfunction, malignant arrhythmias, transient mitral regurgitation (MR), LV outflow tract obstruction (LVOTO), and right ventricular involvement.[2,3] The prevalence of cardiogenic shock in TTS is substantially comparable with acute coronary syndrome and carries a 10-fold increase of the in-hospital mortality rate (>20%).[4]

Up to date, no standardized therapy is recommended for TTS during the acute phase. In particular, management of patients with TTS complicated by cardiogenic shock is challenging. Early recognition of complications leading to haemodynamic instability is fundamental to adopt a therapy addressing the mechanisms involved in cardiogenic shock.[5]

Case Presentation

A 70-year-old woman with history of hypertension and hyperlipidaemia was admitted to the emergency department of our institution with typical chest pain associated with shortness of breath and dizziness. Sinus tachycardia (110 b. p.m.) and systolic blood pressure of 90 mmHg were detected. Physical examination showed medium-basal lung

rales and a harsh systolic murmur at the left lower sternal border. An electrocardiogram revealed ST-segment elevation in the precordial and III–aVF leads (*Figure 1A*). Troponin T was 5 ng/mL (normal value <0.01 ng/mL), and brain natriuretic peptide was 3254 pg/mL (normal value <400 pg/mL). Owing to the suspicion of anterior ST-elevation myocardial infarction, the patient was treated with acetylsalicylic acid 250 mg, ticagrelor 180 mg, and intravenous unfractionated heparin 5000 IU. Because of haemodynamic instability, low-dose dobutamine (5 μg/kg/min) was started. Patient was scheduled for emergency coronary angiography, which showed no significant coronary artery disease. Of note, the left ventriculography revealed a wide akinesia of the LV apex suggestive for typical apical ballooning TTS and left atrium opacification due to severe MR (*Figure 1B–1D*). During catheterization, the patient was dazed and restless, cold, and clammy and had severe systemic hypotension (70/40 mmHg). Because of blood desaturation (82%), oxygen therapy delivered by facemask was promptly started. Transthoracic echocardiography (TTE) confirmed the severe LV systolic dysfunction [LV ejection fraction (EF) was 30%] secondary to wall motion abnormalities involving circumferentially the mid-ventricular and apical LV segments and associated with basal hyperkinesia. Noteworthy, systolic anterior motion (SAM) of the anterior mitral leaflet associated with severe LVOTO (continuous-wave Doppler peak velocity of 4.2 m/s and peak gradient of 70.9 mmHg; *Figure 2A*) and severe MR were detected. Dobutamine was promptly discontinued. Transoesophageal echocardiography confirmed the severity of the MR in the absence of lesions in the mitral valve apparatus (*Figure 2B*).

Owing to the persistence of poor haemodynamic conditions, an Impella CP® assist device (Abiomed, Danvers, MA) was placed through the right femoral artery (*Figure 3A and 3B*). The haemodynamic status promptly improved (blood pressure increased to 95/60 mmHg), and oxygen saturation raised to 93%. Pulsed-wave TTE showed a substantial reduction of the intraventricular gradient (peak velocity of 2.2 m/s and peak gradient of 18.9 mmHg; *Figure 3C*) and of the MR severity. The patient was transferred

Figure 1 (A) Electrocardiogram at admission showing ST-segment elevation in the precordial and III–aVF leads. (B, C) Coronary angiography demonstrating the absence of lesions of the right and left coronary arteries. (D) Left ventriculography demonstrating a wide akinesia of the apical and mid-ventricular segments (typical apical ballooning) suggestive for Takotsubo syndrome. Ao, aorta; LA, left atrium; LV, left ventricle.

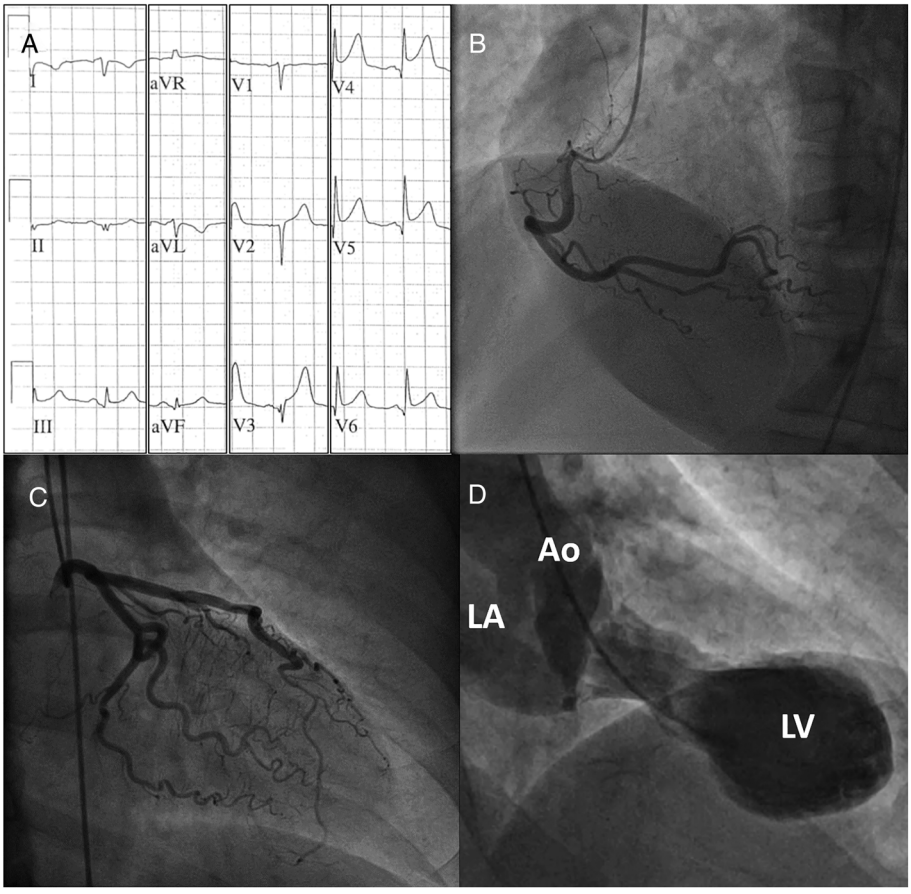

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Figure 2 (A) Continuous-wave Doppler transthoracic echocardiography performed in the catheterization laboratory demonstrating left ventricular outflow tract obstruction (peak velocity of 4.2 m/s and peak gradient of 70.9 mmHg). (B) Mid-oesophageal 0° transoesophageal echocardiography showing severe mitral regurgitation (arrow) and aliasing phenomenon of colour flow Doppler suggestive for turbulent blood flow in the left ventricular outflow tract (asterisk). Ao, aorta; LA, left atrium; LV, left ventricle; RV, right ventricle.

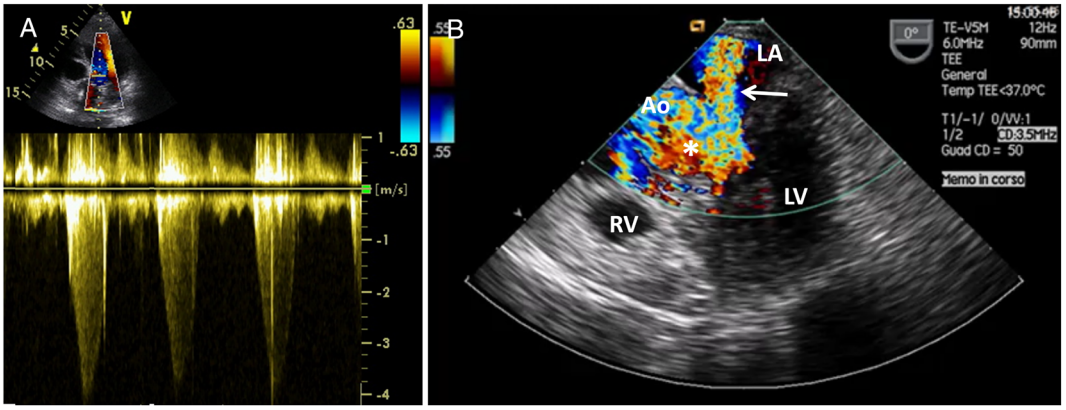
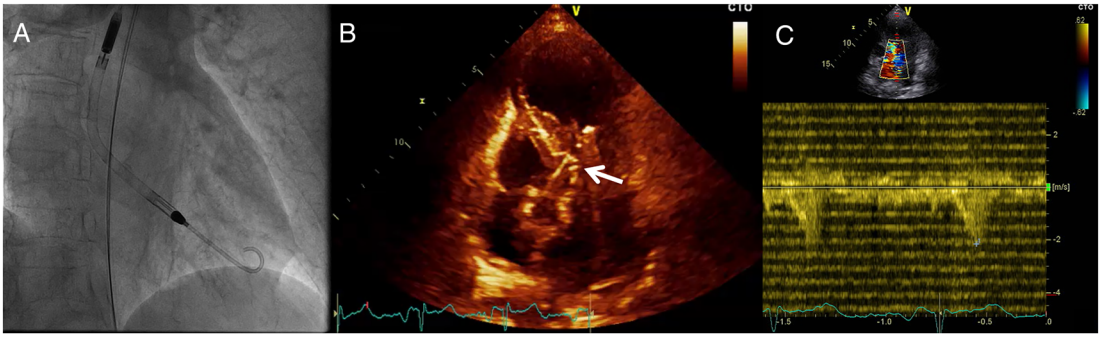


Figure 3 (A) Fluoroscopic and (B) transthoracic echocardiography evidence of Impella CP device placed across the aortic valve. (C) After Impella implantation, pulsed-wave Doppler transthoracic echocardiography showed a substantial reduction of the left intraventricular gradient (peak velocity of 2.2 m/s and peak gradient of 18.9 mmHg).

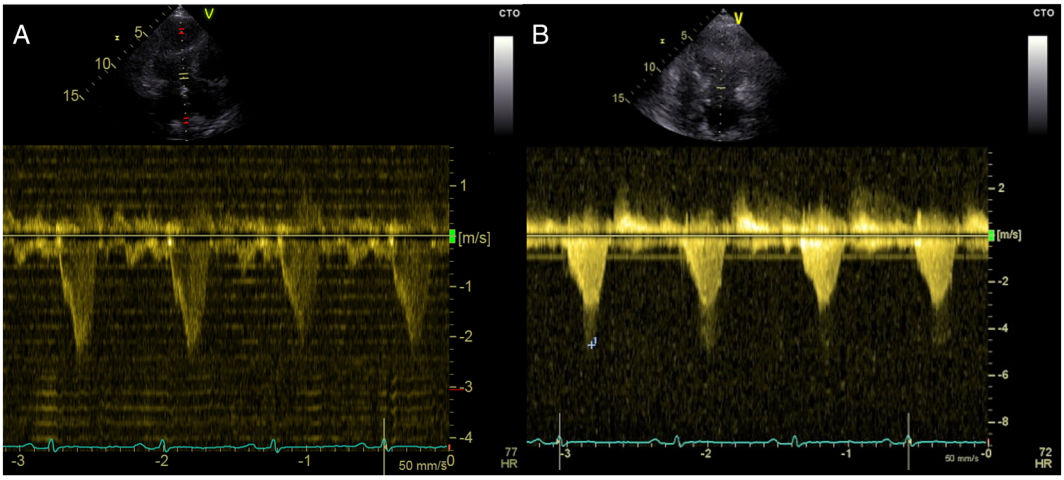


to the cardiac care unit where she was maintained on adequate hydration, low-dose (0.1 μg/kg/min) norepinephrine infusion, and Impella support. Over the next 2 days, the patient's clinical status further improved, and she was successfully titrated off norepinephrine. TTE on Day 3 revealed a significant partial recovery in LV systolic function (LV EF: 40%), but LVOTO persisted at the attempt to wean off the patient from the Impella assistance (*Figure 4*). Therefore, mechanical circulatory support (MCS) was continued until Day 5, when TTE showed a further improvement of LV EF (50%) and the disappearance of the LVOTO during prolonged standby of the Impella assistance. The device was removed. During the hospitalization, no bleeding or vascular complications were observed. The patient was discharged after 1 week in stable haemodynamic and clinical conditions with beta-blockers, ACE inhibitor, and furosemide. Brain natriuretic peptide was 360 pg/mL. At 1 month, TTE confirmed the complete recovery of wall motion abnormality and LV systolic function (LV EF: 60%), mild MR, and the absence of LVOTO.

Discussion

The high in-hospital mortality risk reported for TTS patients with cardiogenic shock (one in five does not survive) emphasizes the importance of early echocardiographic identification of underlying mechanical complications potentially involved in haemodynamic instability.[5,6] LVOTO and significant MR are reported in 13–25% of TTS patients, respectively, and correlate with acute heart failure, cardiogenic shock, and in-hospital death.[7–10] In patients with typical apical ballooning, dynamic LVOTO may be precipitated by the basal segments hyperkinesia, particularly in elderly women with small LV and pre-existing septal bulge.[7]

Figure 4 Attempt of weaning off the patient from the mechanical circulatory support. Doppler transthoracic echocardiography showed the absence of left ventricular outflow tract obstruction during Impella assistance (A), but a significant intraventricular gradient when the device was switched to standby mode (B) associated to hypotension.



Transient moderate-to-severe MR is frequently caused by tethering of mitral leaflets secondary to papillary muscles displacement, which itself is well observed in apical ballooning TTS.[9] Alternatively, the coexistence of SAM, observed in 36% of TTS patients, may contribute to the reversible MR and the dynamic LVOTO as in this case.[8] Therefore, these two serious conditions share common pathophysiological pathways and are involved in haemodynamic instability and cardiogenic shock.[5,8]

Echocardiography plays a key role in the guidance of therapeutic management during the acute phase. The recognition of LVOTO prompted us to stop dobutamine infusion and to place an MCS device.[11] In fact, catecholamine might worsen cardiogenic shock by increasing the intraventricular gradient and should be avoided in this clinical scenario.[12,13] Moreover, the coexistence of moderate-to-severe MR and the pulmonary congestion discouraged intravenous fluid infusion, which may be beneficial in patients with LVOTO in absence of severe acute heart failure.

Beta-blockers, even short acting and at low dose, were not considered owing to the poor haemodynamic status. In fact, despite some authors hypothesize a beneficial effect of beta-blockers for treatment of LVOTO complicating TTS, these drugs are not indicated in patients with acute heart failure and severe hypotension.[12,13]

Despite the absence of specific recommendation by established guidelines, the use of MCS device has been recently suggested for the management of TTS patients with severe hypotension.[12] Venoarterial extracorporeal membrane oxygenation does not seem a valid option because it reduces LV preload and may even increase the LVOTO.[14] Intra-aortic balloon pump is also contraindicated because the afterload reduction may worsen the degree of obstruction in patients with LVOTO.[12,15]

The Impella assist device is a continuous, non-pulsatile, axial flow pump that provides both LV volume unloading and active circulating support by expelling aspirated blood from the LV into the ascending aorta. The use of the Impella in TTS complicated by LVOTO and severe MR has been actually reported in one single case.[16] In our patient, sudden unexpected haemodynamic improvement along with disappearance of LVOTO and severe MR were observed after Impella positioning. The beneficial effect of MCS was confirmed by the patient's course in cardiac care unit.

We hypothesized that Impella device, by propelling blood from the LV into the ascending aorta, allowed skipping the LVOTO and the maintenance of the systemic pressure. Moreover, the position of the device in the LV outflow tract might interfere with the SAM, favouring the resolution of LVOTO and MR.

Also for TTS, an optimal patient selection and good operators' technique are critical given the possibility of device-related complications such as bleedings, thrombosis, haemolysis, major vascular complications, and limb ischaemia.[17] This risk needs to be closely balanced with potential benefit in the individual patient.

Conclusions

Although the therapeutic benefit of Impella device as compared with standard medical therapy needs confirmation, early MCS with Impella may be a promising bridge-to-recovery therapy in TTS patients with cardiogenic shock due to LVOTO and severe MR.

Conflict of interest

None declared.

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