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CASE REPORT

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Percutaneous mitral valve repair assisted by a catheter-based circulatory support device in a heart transplant patient

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Abstract

Background: Systemic infections and chronic graft rejection represent common causes of mortality and morbidity in heart transplant patients. In severe cases, cardiogenic shock (CS) may occur and require hemodynamic stabilization with temporary mechanical circulatory support (tempMCS). Under these devastating circumstances, treatment of sequelae of left ventricular dysfunction, such as secondary mitral regurgitation (MR) is challenging, especially when surgical repair is deemed futile. In nontransplant patients, interventional mitral valve repair strategies such as the MitraClip system (Abbott Cardiovascular) have been used to successfully treat secondary MR and allow for weaning from tempMCS.

Case summary: We report about the first patient in whom profound CS after heart transplantation was stabilized with tempMCS followed by interventional elimination of secondary MR.

KEYWORDS

heart transplantation, Impella, MitraClip, mitral regurgitation

1 | INTRODUCTION

Cardiogenic shock (CS) ranks among the leading causes of in-hospital mortality in developed countries, requiring complex, and rapid therapy management. Temporary mechanical circulatory support (tempMCS)[1] has been established as an effective therapy in CS patients. In the case of isolated left ventricular dysfunction, microaxial catheter-based left ventricular assist devices (LVADs) are frequently used.[2] Modern Impella 5.0 and 5.5 (Abiomed) LVADs achieve full hemodynamic support with up to 5.5 L/min blood flow and simultaneously unload the ventricle.[2,3] CS is often additionally aggravated by mitral valve regurgitation (MR), representing a potential hemodynamic complication.[4] A reduced cardiac output in combination with severe MR results in backward blood stasis and may lead to pulmonary edema. In this constellation tempMCS with an Impella LVAD represents a useful solution, preventing lung edema through LV unloading.[2]

The presence of severe MR in CS patients may preclude circulatory weaning and require additional procedures. Conventional mitral valve surgery is the therapy of choice in cases of severe MR allowing complex reconstruction of the valvular apparatus but is associated with increased mortality in CS patients, especially if performed in previously operated situs, such as after heart transplant (HTx) surgery.[5] These patients represent a particularly vulnerable population in regard to the immunosuppressive therapy. Due to the high risk for severe infections and graft rejection, conciliatory and multimodal treatment concepts are required.[6]

In this constellation, the combination of Impella LVAD and percutaneous mitral valve repair (PMVR) with the MitraClip system might be considered an optimal therapy to reduce, as far as possible, the risk of intra- and postoperative complications.[7]

In this case report, we present an HTx patient with CS and severe MR treated with MitraClip implantation on tempMCS with Impella 5.5.

[Correction added on 11 September 2021, after first online publication: Projekt Deal funding statement has been added.]

1.1 | Case report

In May 2018, a 53-year-old male patient with ischemic cardiomyopathy who was listed in a high-urgency status 4 months prior underwent orthotopic HTx in the bicaval technique. The recipient was seropositive for cytomegalovirus but the donor was negative; no anti-HLA antibodies were diagnosed. The immediate postoperative course was complicated by acute right ventricular failure, pulmonary hypertension (mean pulmonary arterial pressure ranging 30–35 mmHg), and a moderate tricuspid valve regurgitation. Ventricular fibrillation and pneumonia occurred during the further course. Furthermore, the patient developed early cardiac allograft vasculopathy requiring percutaneous coronary intervention (PCI) of the medial part of the right coronary artery with full recanalization of the vessel. The patient was discharged in a stable condition (NYHA II, with normal biventricular function) after 54 days of hospitalization. No anti-HLA antibodies were detected and no MR was observed at discharge.

In the midterm follow-up, the patient developed severe vasculopathy with diffuse narrowing and tapering of the donor coronary arteries, which required multiple PCI with stenting of the RCA, the RCX, and the LAD (Figure 1A) and caused ischemic cardiomyopathy of the donor's heart.

Six months after the HTx, the patient was admitted to our hospital for emergency treatment due to severe pneumonia complicated by septic shock. Shortly, after admission, the patient developed an episode of circulatory arrest, following which peripheral venoarterial extracorporeal life support (va ECLS) implantation was performed. After 10 days of va ECLS, an Impella 5.5 was implanted through the right axillary artery and the va ECLS was explanted, to facilitate patients mobilization and potential circulatory weaning (Figure 1B). The patient's systolic heart function recovered, allowing a stepwise Impella flow reduction down to the P2 level (1.8 L/min with an LV ejection fraction of 30%). However, severe symptomatic MR (type IIIb according to Carpentier's classification) precluded further weaning. An effective regurgitant orifice area measured using three-dimensional (3D) color Doppler increased from 0.6 cm^2 with P3 Impella support level to 1.2 cm^2 under support reduction to P1, a corresponding 9 mm vena contracta was visualized. Transesophageal echocardiography (TEE) revealed severe posterolateral akinesia of the left ventricle with papillary muscle displacement and tethering of the MV leaflets resulting in multiple jets, the largest one located between P2 and P3 (Figures 2 and 3). After discussing the case with the Heart Team it was decided to perform a PMVR procedure on Impella 5.5.

1.2 | Procedure

After obtaining the patient's informed consent, the procedure was performed on the 42nd day of ongoing circulatory support with Impella 5.5. The right femoral vein was punctured and a MitraClip NTX delivery system inserted into the cavum of the left atrium by puncturing the interatrial septum of the donor's heart. The Impella 5.5 flow was reduced to the P1 level (0.8 L/min). Under echocardiographic control, the NTX clip was positioned between the A2-3 and P2-3 areas of the valve leaflets and released from the delivery catheter (Figure 4). The final TEE, performed on minimal Impella support, demonstrated an optimal result with residual trivial MR with a mean diastolic gradient pressure of 2 mmHg (Figure 5). A small iatrogenic left-to-right shunt was left untreated. The postoperative course was uneventful and the Impella 5.5 was explanted 3 days later.

Multiple right ventricular biopsies revealed no cellular rejection during admission (R0 according to the ISHLT grading) but showed signs of humoral rejection in the immunohistochemical examination (pAMR 1(i+)), which was treated with high-dose prednisolone, plasmapheresis, rituximab, and antithymocyte globulin therapy. The patient was discharged home in a stable condition (NYHA III) 76 days after admission and is currently listed for heart retransplantation (nonurgent status). The immunosuppressive therapy at discharge comprised tacrolimus, mycophenolate mofetil, and prednisolone.

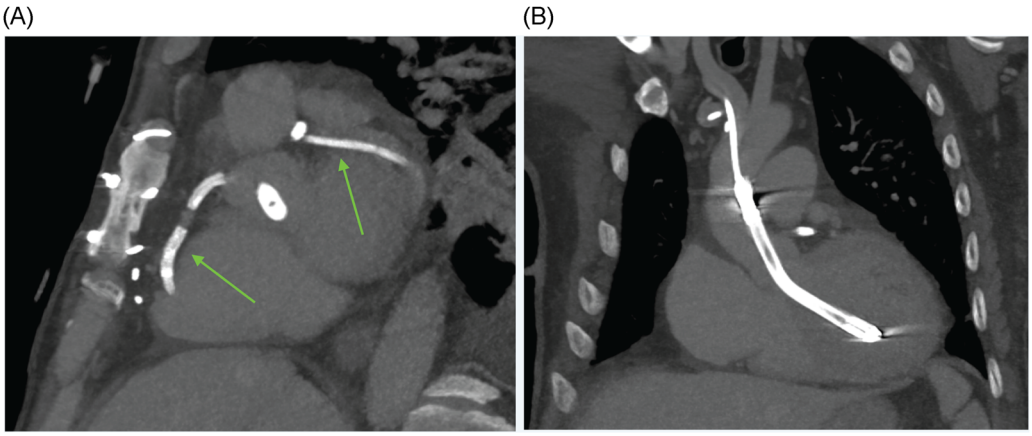

FIGURE 1 Preoperative computed tomography. (A) Preoperative computed tomography (CT) multiple coronary artery stents from previous interventions (green arrows). (B) CT image showing the position of the Impella 5.5 in the cavum of left the ventricle and the ascending aorta

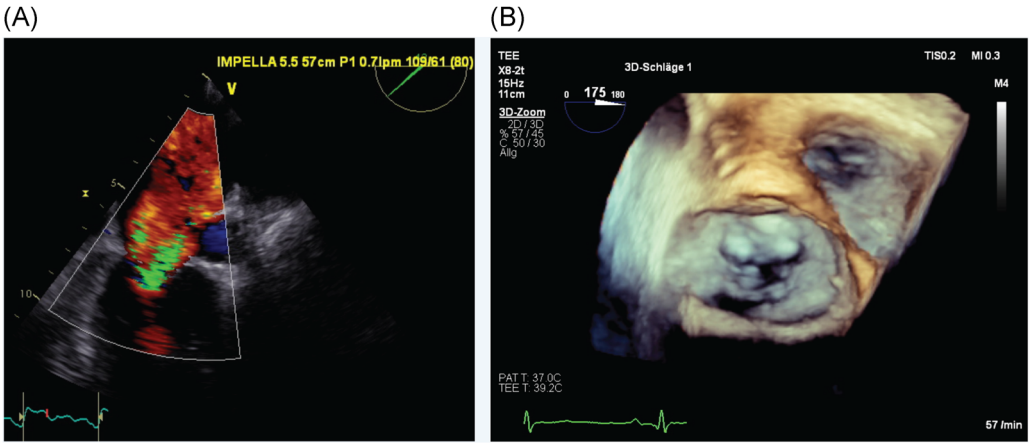

FIGURE 2 Preoperative echocardiography. Preoperative transesophageal echocardiography (TEE) showing severe mitral regurgitation due to leaflet tethering between A2-3 and P2-3 areas. Impella 5.5 flow was reduced to the P1 level (0.7 L/min) for the following diagnostics: (A) Intercommissural two-chamber view. (B) Three-dimensional reconstruction of the left atrium and mitral valve

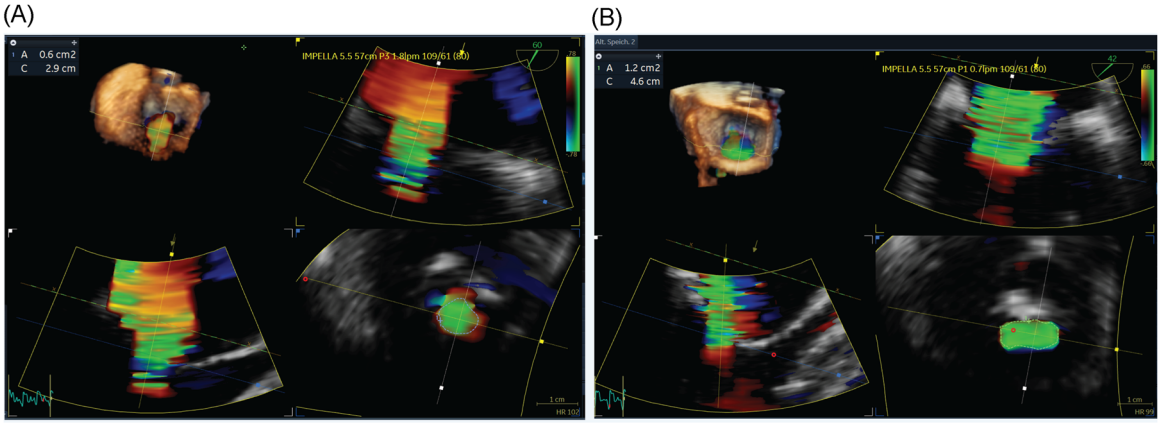

FIGURE 3 Preoperative echocardiography. (A and B) Preoperative three-dimensional transesophageal echocardiography showing the increase in effective regurgitant orifice area (EROA) after reducing the Impella 5.5 flow from P3 (1.8 L/min, EROA 0.6 cm^2) to P1 level (0.7 L/min, EROA 1.2 cm^2)

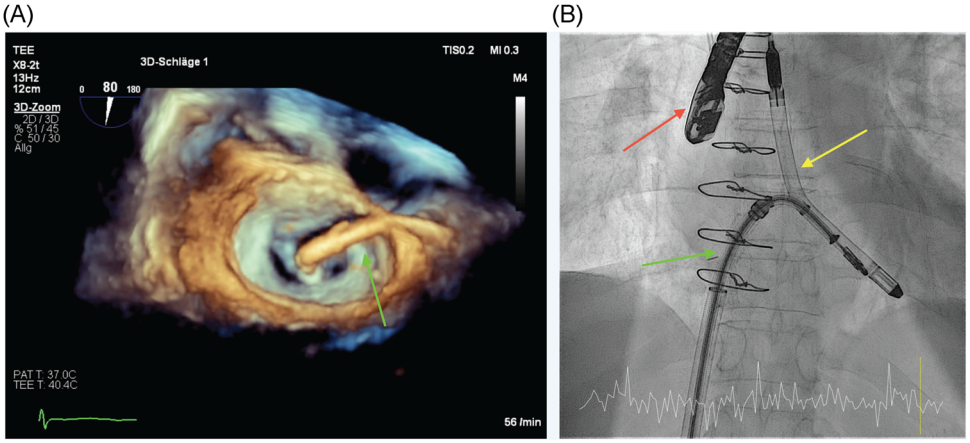

FIGURE 4 MitraClip implantation procedure. (A) Intraoperative transesophageal echocardiography (TEE) three-dimensional reconstruction visualization showing the MitraClip delivery catheter (green arrow) inserted through the atrioseptostomy. (B) Concordant fluoroscopic imaging with the Impella 5.5 device (yellow arrow) and the tip of the echocardiographic probe (red arrow). Wire cerclages after previous sternotomy closure can be seen in the middle of the picture

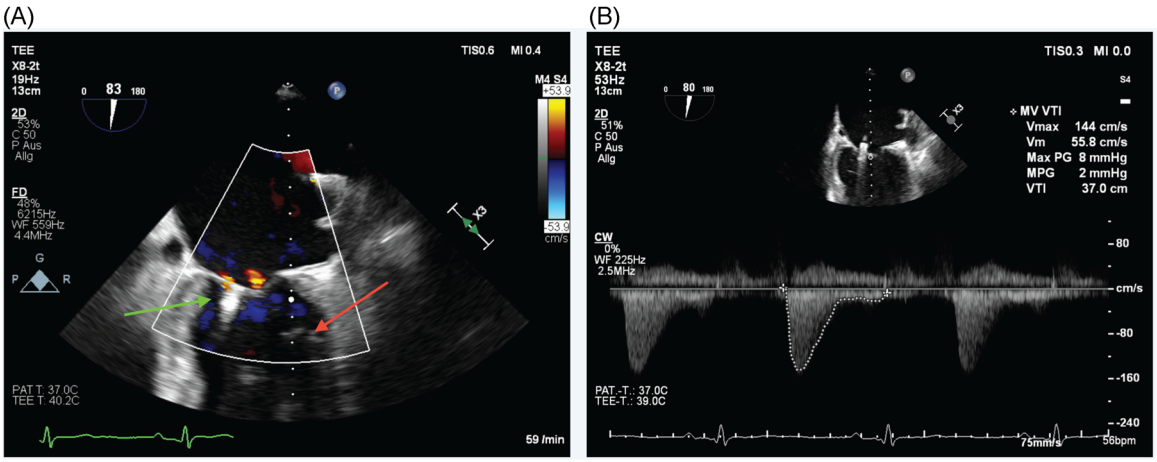

FIGURE 5 Postoperative results. (A) Postoperative transesophageal echocardiography (TEE) showing remaining trivial mitral regurgitation after the MitraClip delivery (green arrow). The red arrow points to the Impella 5.5 echocardiographic shadow in the left ventricular cavum. (B) Postoperative flow profiles through the mitral valve

2 | DISCUSSION

Modern minimally invasive and endovascular procedures represent a valuable option for patients with high-risk profiles.[7] PMVR is an established approach for patients not eligible for conventional mitral surgery. These procedures are considered superior when a cardioplegic arrest for valve repair is considered too traumatic. However, even an endovascular procedure represents a major risk for patients with a reduced cardiac output.[8]

In our case, several clinical treatment options were discussed in our heart failure team. Cardiac retransplantation represents the therapy of choice in patients with advanced allograft failure. However, the ongoing infection and severely deteriorated condition of our patient made him temporarily ineligible for retransplantation. In this constellation, the combination of different tempMCS devices was considered an optimal solution. va ECLS implantation provides rapid hemodynamic stabilization in an emergency setting of circulatory arrest, but the duration of support is limited in time due to the high incidence of complications.[9] Impella 5.5 implantation is more time-consuming, but has a better complication profile allowing longer support, and can be performed as de-escalation of ECLS therapy.[3] Durable MCS implantation is only a bailout option, especially due to the fact that the combination of immunosuppressive therapy and the percutaneous device driveline poses an extreme risk for severe infection.[10] The combined approach of tempMCS with Impella and MitraClip implantation was thus found to be a promising option with regard to restoring graft functionality.

Our case highlights some points which, in our opinion, are important for PMVR on Impella support:

- The evaluation of systolic and diastolic cardiac function and of valve structure under ongoing Impella support is challenging due to the artifacts caused by the device itself. In addition, LV unloading reduces the regurgitation volume, so the severity of MR may be underestimated. Therefore, the combination of TEE and a transient Impella flow reduction down to the P1 level represents a potential diagnostic procedure.
- During the MitraClip implantation itself, Impella flow changes could be advantageous: an increase makes it easier to capture the MV leaflet with the MitraClip, and a decrease allows for an assessment of residual MR. However, a complete device stop cannot be performed due to the retrograde flow through the device.
- Preoperative planning of a MitraClip procedure in post-HTx patients requires knowledge of the transplant surgery technique. While the MitraClip is implanted as per the standard procedure in patients after bicaval HTx, the biatrially transplanted donor heart might represent a technical challenge due to the changed anatomy of the interatrial septum. In this constellation, fusion imaging (e.g., EchoNavigator) may prove useful.

3 | CONCLUSION

Our case demonstrated the safety and feasibility of the protected MitraClip approach in a transplant patient suffering from CS complicated by severe MR.

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CONFLICT OF INTERESTS

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