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Case report

Transapical ischemic ventricular septal defect repair with simultaneous centrifugal left ventricular assist device placement: A case report

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ABSTRACT

Introduction and importance: Post-infarct ventricular septal defect (PIVSD) is an often-fatal complication of myocardial infarction despite the use of temporary mechanical circulatory support.
Case presentation: A 46-year-old male presented with myocardial infarction complicated by PIVSD. Clinical course was characterized by declining systolic function and hemodynamic instability. To provide hemodynamic support, a ventricular assist device was placed at surgical repair of the defect. The patient successfully recovered with no complications 21 months post-repair. He has undergone evaluation for heart transplantation.
Clinical discussion: Mortality among patients with PIVSD is high. For patients with cardiogenic shock at the time of defect repair, concomitant ventricular assist device therapy shows promise to decrease morbidity through durable hemodynamic support following surgery.
Conclusion: Placement of a durable left ventricular assist device (LVAD) at the time of PIVSD repair through a single ventriculotomy may be an effective strategy for this lethal condition.

1. Introduction

Surgical repair is considered a gold standard of treatment for post-infarct ventricular septal defect (PIVSD) and 30-day mortality ranges from 38.2% to 61% [1,2]. Patients typically suffer cardiogenic shock and its sequelae, including multi-organ failure [3]. Several authors have described the use of temporary mechanical support to bridge patients through the period of shock and to surgery; despite these interventions, mortality remains high [4,5].

Left ventricular assist devices (LVADs) are well established in the treatment of end stage heart failure with contemporary 1-year survival rate in excess of 80% [6]. While 14–20% of patients receiving LVADs are deteriorating or in-extremis at the time of implant, peri-operative survival remains acceptable [6]. To date VAD therapy has not been routinely used in the setting of PIVSD.

We report a case of transapical surgical repair of a PIVSD with simultaneous placement of a fully magnetically levitated centrifugal flow LVAD for long-term mechanical support. This report was prepared in accordance with the SCARE criteria [7].

2. Presentation of case

A 46-year-old male with a history of hypertension and tobacco abuse presented to the emergency department with four days of epigastric pain. Medications prior to arrival included amlodipine 10 mg daily, ibuprofen 800 mg every 8 h as needed, and levothyroxine 50 μg daily. Relevant family history included hypertension in the patient's father and mother. An electrocardiogram revealed anterolateral and inferior ST changes concerning for acute myocardial infarction; emergent percutaneous coronary intervention with one drug eluting stent was performed for a 99% stenosis in the mid-left anterior descending artery (LAD). Two days later, physical examination revealed a loud precordial murmur. Transthoracic echocardiogram (TTE) demonstrated a large ventricular septal defect (VSD) and moderate left ventricular (LV) systolic dysfunction. The patient was transferred to our institution in stable condition, with normal end-organ function. The plan was to delay

Abbreviations: PIVSD, Post-infarct ventricular septal defect; LVAD, Left ventricular assist device; LAD, Left anterior descending; TTE, Transthoracic echocardiogram; TEE, Transesophageal echocardiogram; VA ECMO, Venoarterial extracorporeal membrane oxygenation; VT, Ventricular tachycardia; IABP, Intra-aortic balloon pump; RHC, Right heart catheterization.

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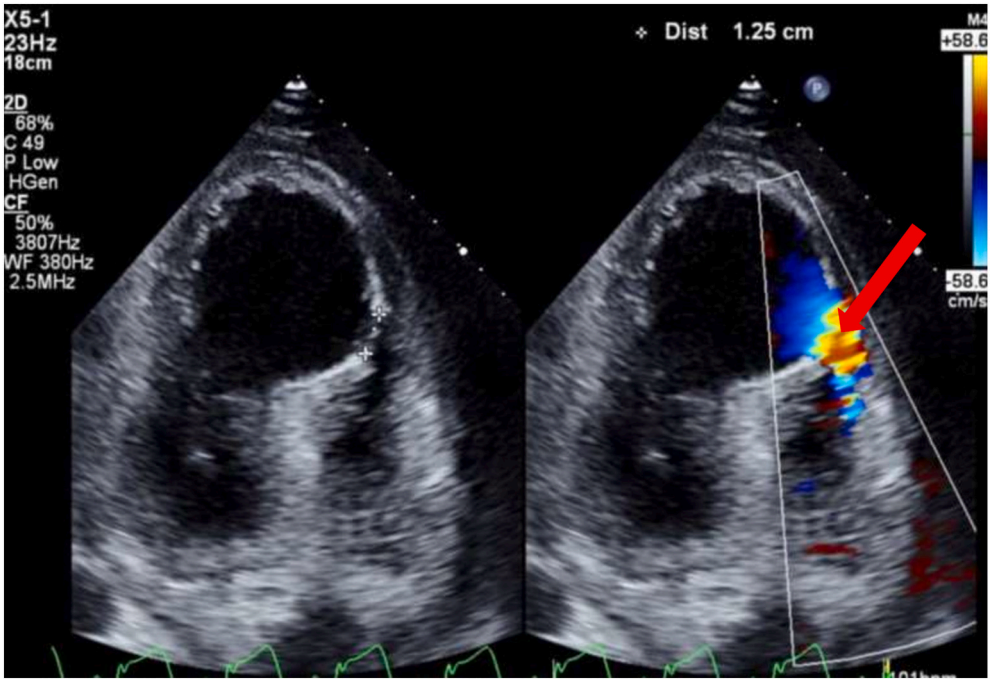

Fig. 1. Reverse apical 4-chamber showing muscular VSD (arrow) with color Doppler indicating left-to-right shunt.

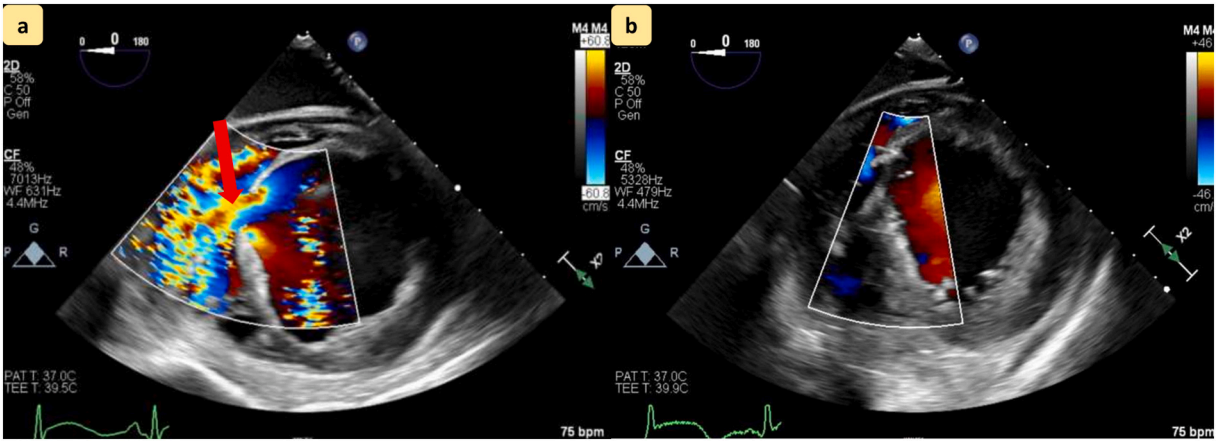

Fig. 2. a) Intra-operative TEE transgastric short-axis view showing the muscular VSD (arrow) with color Doppler confirming left-to-right shunt. b) Intra-operative TEE transgastric short-axis view showing VSD repair without evidence of residual shunt.

surgery allowing the infarct to mature for easier surgical repair [8]. Eleven days following initial admission, the patient experienced sustained ventricular tachycardia (VT) requiring synchronized cardioversion. Repeat TTE redemonstrated an approximately 2 cm anterior VSD with peak gradient across the VSD of 60 mmHg and LV ejection fraction reduced to 30% (Fig. 1). Right heart catheterization (RHC) revealed high left- and right-sided filling pressures, Fick calculated cardiac index of 1.52, and large left-to-right shunt (QP/QS: 3.53). A milrinone infusion and temporary mechanical support with an intra-aortic balloon pump (IABP) were initiated. Multi-disciplinary discussion highlighted LAD infarction, progression to severe LV systolic dysfunction, large PIVSD and hemodynamically unstable VT; recommendation was for VSD repair in conjunction with LVAD placement.

The patient underwent VSD repair and placement of HeartMate 3 LVAD (Abbott, Abbott Park, IL). The performing surgeon had 11 years of experience in cardiothoracic surgery and was trained specifically in mechanical circulatory support. Surgical strategy included bicaval venous cannulation for cardiopulmonary bypass, cardioplegic arrest of the heart with mild-moderate systemic hypothermia. The LV apex was cored, four stitches placed to retract the edges of the ventriculotomy. The VSD was easily visualized; a 4 × 4 cm bovine pericardial patch was secured to the edges of the VSD with interrupted pledgeted horizontal mattress sutures placed from the RV to the LV. Pledgeted horizontal mattress sutures were used to secure the LVAD sewing ring at the apex. The LVAD inflow was placed in the apex and the outflow graft was sewn to the ascending aorta. Intra-operative transesophageal echocardiogram (TEE) demonstrates the presence (Fig. 2A) and closure (Fig. 2B) of the defect.

The patient made an uneventful recovery and was discharged to his home with skilled nursing support 13 days after the surgery. An implantable cardioverter defibrillator was placed prior to discharge. At 21 months of follow up he has had no major complications of VAD therapy, has been adherent to the medical regimen, and is very pleased with the algorithm that was followed in his management especially given the critical nature of his disease and presentation. He underwent ambulatory evaluation for heart transplantation and is currently actively

listed.

3. Discussion

Currently, morbidity and mortality after PIVSD repair is high due to post-operative cardiogenic shock [3]. Temporary mechanical support has been established as a modality to bridge PIVSD patients to definitive closure of the defect [5], but this may ignore the post-repair needs for ongoing mechanical support.

An option for the management of low cardiac output after PIVSD repair is the use of venoarterial extracorporeal membrane oxygenation (VA ECMO). However, post-cardiotomy VA ECMO is associated with well-documented morbidities, and substantial risk of mortality. Successful use of VA ECMO would depend upon recovery of LV function, which is unlikely in a large, completed infarct. In addition, VA ECMO has been associated with LV distension which might jeopardize the VSD repair and LV recovery [9]. The rationale to use a durable LVAD in a patient with PIVSD is to: 1) provide mechanical support for the failing left ventricle exacerbated by post-operative stress and increased afterload with VSD closure; 2) decompress the LV to stabilize the VSD repair and allow the tissue to fibrose and heal.

To our knowledge, VAD placement in conjunction with VSD repair has been described only once in the literature; that case utilized the axial flow HeartMate II device [10], making this the first description for this use of a centrifugal flow LVAD. Ton et al. previously described two separate ventriculotomies: one for VSD repair and the other for placement of the HeartMate II LVAD inflow cuff [10]. We describe a simple technique in which the ventriculotomy created for the implant of the VAD was utilized for access to the septum and repair of the defect. Tissue at the VSD and apex held the sutures well; this may be attributed to delay between the initial infarct and definitive repair. The precise timing of surgical intervention has been debated in the literature. A delay of greater than 7 days to operative repair has been associated with better surgical outcomes- this may be attributed to patient selection, alternatively it may reflect the benefits of medical optimization prior to surgery and improved tissue quality allowing for a more effective repair [8].

A multi-disciplinary approach to the initial and subsequent management of these patients is critical. Once recovered from the acute event the patient can follow the conventional algorithm of VAD recipients i.e., consideration for continued destination therapy, bridge to recovery or bridge to transplantation.

4. Conclusion

This case describes a novel approach to a patient with hemodynamic instability and PIVSD. We propose that surgical repair of the VSD with concomitant LVAD placement should be considered after stabilization of organ function if multi-disciplinary evaluation highlights concern for LV function and recovery. We expect that such a strategy would lead to improved outcomes in the management of this lethal condition by mitigating post-operative cardiogenic shock.

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None.

Ethical approval

N/a.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contribution

Noah Free: data collection, analysis, interpretation and manuscript writing; Dr. Marian Urban: data collection, analysis, interpretation and manuscript writing; Dr. Scott Lundgren: data collection, analysis, interpretation and manuscript writing; Dr. Aleem Siddique: study concept, data collection, analysis, interpretation and manuscript writing.

Research registration

Not applicable for this case.

Guarantor

Dr. Aleem Siddique.

Provenance and peer review

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Declaration of competing interest

S.L. receives remuneration as a speaker for Abbott.

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