

Mitral Valve and Short-Term Ventricular Assist Devices; Potential Mechanical Complications

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Abstract

Keywords

- ▶ mechanical circulatory support
- ▶ heart failure
- ▶ mitral valve
- ▶ mechanical complications

Mechanical complications of ventricular assist devices (VADs) are rare but serious. The authors describe two cases of different mechanical complications of VADs that can affect the mitral valve. Attention should be paid to the position of the inflow/outflow cannula after off-loading of the ventricle, especially in acute heart failure and normal atrial dimensions. Complete off-loading of the left ventricle in the presence of a bioprosthetic mitral valve might cause fusion of the valve leaflets leading to mitral stenosis, which will call for another intervention.

Introduction

In the past 30 years, there have been great advancements in the treatment of heart failure. One of these major advances that changed the way health care teams manage these sick patients and is usually utilized as a last resort; is the introduction of ventricular assist devices (VADs) in the early 1990s. Like any surgical procedure, they are always associated with some unforeseen complications. Some of the more frequently encountered complications of these devices include stroke, thromboembolism, bleeding, sepsis, and surgical site infection. Mechanical complications of short-term VADs are not well defined in the literature, rare but serious. Here, the authors delineate two cases of device-related mechanical complications.

Case Description

The authors present two cases of mechanical complications of the mitral valve related to the use of the short-term Centri-Mag ventricular assist device (Levitronix, LLC, Waltham, Massachusetts, United States).

Case 1

The first patient was a 73-year-old male who presented with a ST-elevation myocardial infarction. He underwent a rescue percutaneous coronary intervention, which showed a left main equivalent disease, leading to an emergency coronary arteries bypass grafting. He was initially stabilized on high inotropic support but started to deteriorate. As a result, he was taken back for insertion of a temporary Levitronix left ventricular assist device (LVAD) for left heart decompression. Inflow drainage was through the right superior pulmonary vein using a single stage malleable cannula (34-French venous cannula) and outflow was in the ascending aorta (22-French DLP [Medtronic Inc., Minneapolis, Missouri, United States]). A transesophageal echocardiogram (TEE), conducted after 7 days of LVAD support, showed improved left ventricle (LV) function but also a new (4+) mitral regurgitation (MR) due to a torn chordae at the A1 level (▶ Fig. 1). The patient was taken back to the operating room and the LVAD inflow cannula was left in position. The authors approached the mitral valve through the left atrial dome. The tip of the LVAD inflow cannula was abutting on the anterolateral commissure

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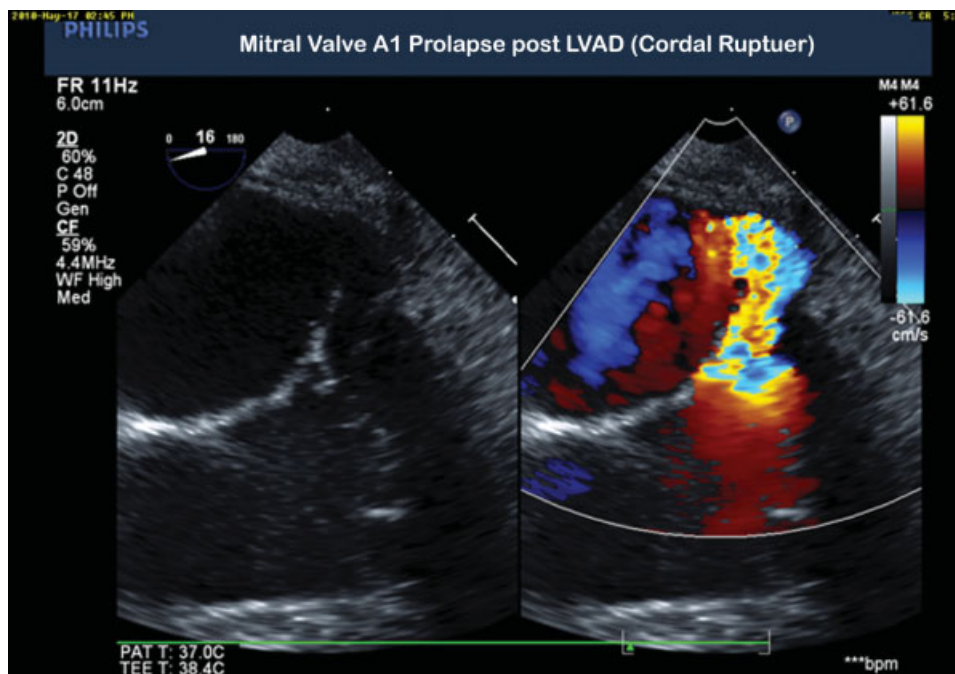


Fig. 1 Transesophageal echocardiogram showing mitral valve A1 prolapse with a posteriorly directed mitral regurge jet.

at the level of A1, and this had damaged the anterior leaflet and disrupted some of the chordal attachments. The valve was repaired by obliteration of the anterolateral commissure and the cannula got redirected away from the mitral apparatus. Postrepair echocardiography showed mild central MR. He was maintained on LVAD and subsequently successfully weaned 15 days after the original surgery, with moderately depressed LV systolic function.

Case 2

The second patient was a 78-year-old man who underwent redo mitral valve replacement with a no. 29 mm bioprosthetic valve (St. Jude Medical Epic Tissue Valve; St. Jude Medical Inc., St. Paul, Minnesota, United States) for heart failure due to severe MR. The authors failed to wean from bypass, even with the aid of an intra-aortic balloon pump. After discussion with our VAD team, a biventricular Levitronix-assist device (BiVAD) was inserted as a bridge to recovery. The right ventricular assist device inflow was through the right atrial appendage, using a single stage malleable cannula (34 French). Outflow was through the main pulmonary artery (20-French DLP). The LVAD inflow was through the right superior pulmonary vein with a single stage malleable cannula (34-French venous cannula). Outflow was through the ascending aorta (22-French DLP), and BiVAD support was initiated. While on BiVAD support, he was on a heparin drip with a partial thromboplastin time between 40 and 60 seconds. Day 4 after implant, the patient started to develop severe hemoptysis. Bronchoscopy failed to show an active source of bleeding. Anticoagulation was interrupted for 12 hours, after which it was restarted. No further bleeding occurred after that incident. After 20 days of mechanical support the patient was taken to the operating room for a trial to wean him off support. Initially, the patient did well and

was extubated two days postexplant. Unfortunately, on day 4 after explant, the patient developed acute pulmonary edema. A TEE showed severe right ventricular dysfunction with severe bioprosthetic mitral valve stenosis, with a peak gradient 13 mm Hg, due to fusion of the mitral leaflets. The patient progressed to develop low cardiac output and passed away. On autopsy, it was evident that the bioprosthetic mitral valve leaflets were fused. This fusion was composed of a thin layer of fibrin thrombus with subjacent reactive endothelial proliferation (► Fig. 2A–C). The spleen and kidneys also showed evidence of arterial thromboemboli (► Fig. 2D).

Discussion

Mechanical complications of short-term VADs are not well described in the literature. The most common complications following implantation of Levitronix CentriMag pumps are coagulopathy and bleeding,¹ and thromboembolic events.^{1,2} A recent report indicates that, in patients with mitral valve prostheses who require VAD support, leaving the prosthesis intact does not increase the incidence of adverse events.³ However, one limitation of this study is that, among the 747 patients examined, there were only 4 patients with bioprostheses. None of the explanted hearts showed intracardiac thrombus formation. Another study concluded that VAD placement in patients with a prosthetic heart valve, whether mechanical or bioprosthetic, appears to be a reasonable option.⁴ A competent mitral valve is not required for LVAD function but is for weaning. In this series, only six patients had valvular prostheses, including one mechanical mitral valve, and all of these VADs were long term. None of the six patients had the preexisting valve replaced or explanted.⁵ Postoperatively and in follow-up there were no valve thromboses, pump thromboses, or neurological events. The low rate of

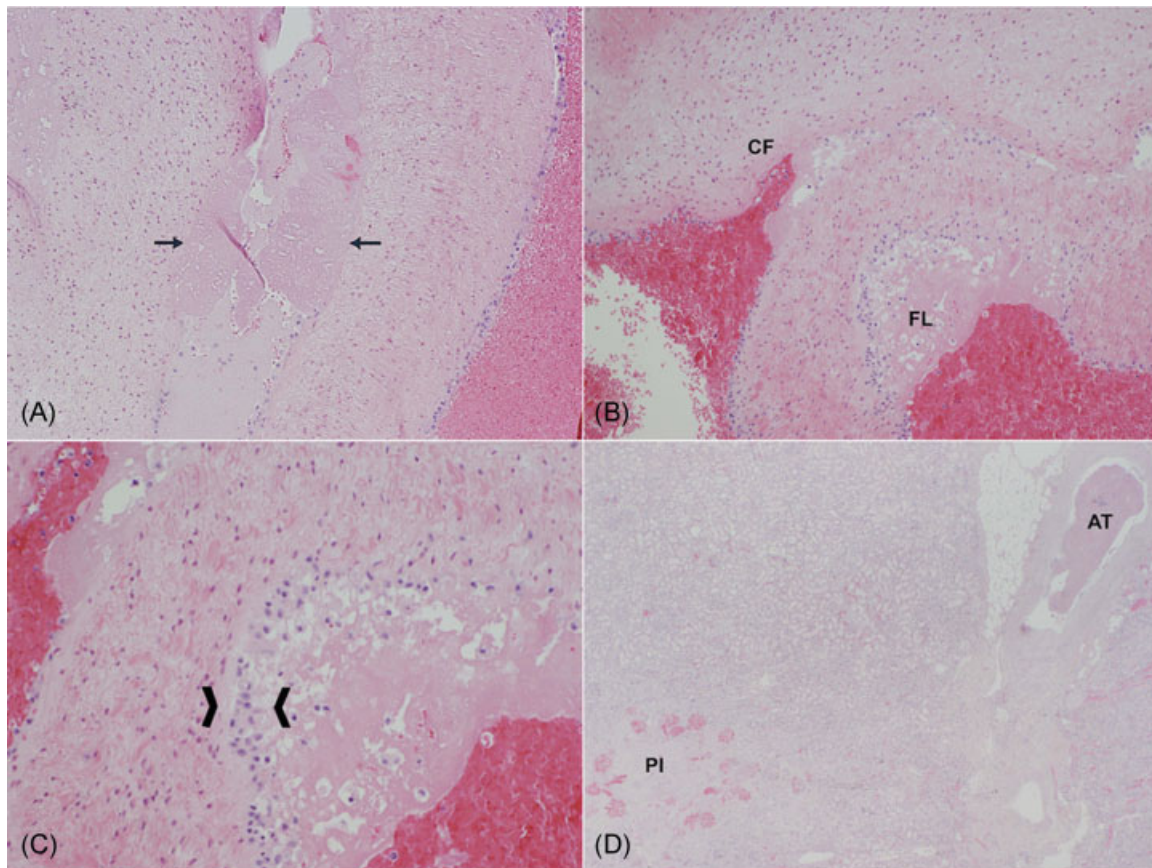


Fig. 2 (A) Photomicrograph demonstrating point of leaflet contact with fibrin thrombus adhesion ($\rightarrow \leftarrow$). (B) Demonstrating fibrin thrombus formation at both sites of contact fusion (CF) and on the free valve leaflet (FL) surface. (C) Note the brisk endothelial proliferative reaction below the fibrin thrombus ($> <$). (D) Section of kidney demonstrating the thromboembolic sequelae with arterial thromboembolus (AT) (upper right) and zone of the renal parenchymal infarction (PI) (lower left).

thromboemboli may be because, in contrast to cases with aortic prostheses with a long-term LVAD with apical cannulation, the cyclical opening and closing of the mitral valve results in no stasis and therefore lower risk for thrombosis. In contrast, another report described two cases where the presence of biological valves with LVAD (one mitral with a long-term LVAD and the other tricuspid with a short-term LVAD) became problematic due to the lack of cyclic opening and closing in the unloaded ventricle.⁶ In both cases, this led to stiffening of the valve leaflets and the valve being fixed in the open position.⁶

Here, the authors report two rare complications of the mitral valve secondary to short-term LVAD. In the first case, the position of the inflow cannula in the left atrium was verified by TEE during the VAD insertion, and there was no sign of flow impairment during the postoperative period. The tip of the cannula came in contact with the anterior mitral valve leaflet when the atrium was emptied, causing a cordial rupture that led to mitral insufficiency. This was secondary to the small size of the left atrium and the choice of a large inflow cannula, which led to significant friction between the cannula and the anterior mitral leaflet. In the second case, the choice of LA cannulation and the complete off-loading of the LV led to continuous contact, which caused fusion of the bioprosthetic valve leaflets and the development of fibrinous inflammation.

LA cannulation was chosen for easier access compared with the LV apex in a redo case. In this case, the mitral prosthesis had minimal flow through it. The LV apex would be another option for inflow cannulation, keeping in mind that it has a higher risk for bleeding, would not prevent injury to intracardiac structures and, in a redo case, would require mobilization of the apex. If this method was used it would have allowed some flow through the mitral prosthesis and could have prevented the leaflets fusion. In the case of LA cannulation the authors would recommend allowing some cyclical flow across the mitral valve, especially in the case of a bioprosthesis.

Conclusion

When VADs are used as a bridge to recovery; careful attention should be paid to inflow cannula position, left atrium size and cannula size. The atrium may be completely empty from time to time, which can put the cannula in direct contact with intracardiac structures particularly the mitral or tricuspid valves. Near-complete early off-loading of the failing ventricle is the desired outcome from placing a VAD, so as to give the failing ventricle a chance for recovery. However, in the presence of an artificial valve, a careful support and weaning plan is required. Limiting the flow across the prosthesis can lead to the development of fibrinous adhesions and fusion of

the valve leaflets. Allowing some cyclic flow through the bioprosthetic valve can help in preventing this complication.

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