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Redo Mitral Valve Replacement in a Patient with Bioprosthetic Valve Dysfunction: A Case Report on Surgical Challenges and Outcomes

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Abstract

Redo mitral valve replacement (Redo-MVR) is a highly challenging surgical procedure, often required to treat dysfunction of bioprosthetic valves resulting from structural valve deterioration (SVD). SVD encompasses a spectrum of pathological changes, including leaflet fibrosis, calcification, and rupture, which compromise valve integrity and function, often necessitating surgical intervention. This case report describes a 48-year-old diabetic female who underwent Redo-MVR for bioprosthetic mitral valve dysfunction following a history of closed mitral commissurotomy and prior bioprosthetic mitral valve replacement. The surgical procedure was marked by challenges such as dense adhesions, complex valve excision, and intraoperative complications, including a tear in the inferior vena cava and right atrial posterior wall. A St. Jude mechanical valve was successfully implanted, with meticulous attention to surgical precision and hemostasis. The patient experienced transient postoperative complications, including atrial fibrillation and hepatic and renal function derangements, which were resolved with appropriate management. At the 30-day follow-up, echocardiography confirmed optimal valve function, with significant improvement in hemodynamic parameters. This case underscores the technical complexities of Redo-MVR, highlights the significance of advanced imaging and surgical planning, and demonstrates the potential for favorable outcomes in high-risk re-operative cardiac surgeries.

Keywords: *Redo mitral valve replacement, bioprosthetic valve dysfunction, structural valve deterioration, mitral regurgitation*

Introduction

Redo mitral valve replacement (Redo-MVR) is a highly complex surgical procedure often required due to the failure of previously implanted prosthetic valves, commonly from structural valve deterioration (SVD) or prosthetic valve dysfunction. SVD is a well-documented long-term complication of bioprosthetic valves, characterized by irreversible degenerative changes such as pannus formation, leaflet fibrosis, calcification, connective tissue delamination, and leaflet rupture or perforation [1]. These pathological alterations compromise the biomechanical integrity and hemodynamic performance of the valve, leading to stenosis or regurgitation. Emerging evidence suggests that SVD pathogenesis involves active

processes such as chronic immune-mediated rejection and atherosclerosis-like tissue remodeling [2]. As SVD progresses, it increasingly impairs valve function, often necessitating surgical intervention like Redo-MVR. Advancements in surgical techniques and prosthetic valve designs have improved outcomes following mitral valve replacement, with freedom from SVD and reoperation showing promising trends over 10–15 years. While bioprosthetic valves are favored over mechanical valves due to a reduced risk of thrombotic complications and the avoidance of lifelong anticoagulation, their propensity for degeneration increases the likelihood of redo surgeries [3,4]. Redo-MVR poses significant challenges, including perioperative risks such as adhesions from prior surgeries, bleeding, and infection, particularly when performed via a re-sternotomy approach. Additionally, it is required in up to one-third of patients and is linked to substantial morbidity and mortality [5]. As the prevalence of patients requiring reoperations grows with an aging population and increasing numbers of prior cardiac surgeries, understanding the surgical strategies for managing SVD is essential. Here, we present a case of Redo-MVR for bioprosthetic valve dysfunction, focusing on perioperative management and outcomes to highlight strategies for successful intervention.

Case Report

A 48-year-old diabetic female presented with a three-month history of progressively worsening dyspnea and palpitations. On admission, her vital signs revealed a blood pressure of 95/60 mmHg, a heart rate of 96 beats per minute (irregularly irregular), and a respiratory rate of 16 breaths per minute. Respiratory examination revealed normal breath sounds with no added sounds. Her medical history included a closed mitral commissurotomy (CMC) in 1995 and mitral valve replacement (MVR) with a bioprosthetic valve in 2000. On precordial examination, the apex beat was located in the left 5th intercostal space, medial to the midclavicular line. Auscultation revealed a soft first heart sound and a pansystolic murmur at the mitral area radiating to the left axilla. Transthoracic echocardiography (Figure 1) revealed a malfunctioning bioprosthetic mitral valve with moderately severe mitral regurgitation and severe inflow gradient, evidenced by a peak pressure gradient (PPG) of 29.7 mmHg and a mean pressure gradient (MPG) of 16.4 mmHg. Additional findings included a dilated left atrium (48 × 64 × 53 mm), preserved left ventricular ejection fraction (LVEF = 60%), right ventricular systolic function (RVEF = 45–50%), severe pulmonary arterial hypertension (PAH), and a pulmonary artery systolic pressure (PASP) of 71 mmHg. A diagnostic coronary angiogram revealed normal epicardial vessels, and a high-resolution computed tomography (HRCT) scan of the chest showed normal findings, with evidence of prior sternotomy but no soft tissue abnormalities. The patient was diagnosed with chronic rheumatic heart disease (CRHD) complicated by severe mitral regurgitation, atrial fibrillation, pulmonary hypertension, and diabetes mellitus, with a history of bioprosthetic MVR and CMC.

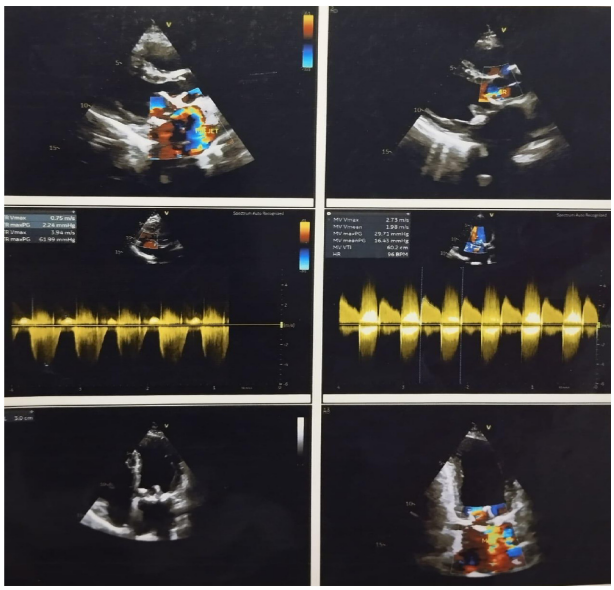

Figure 1. *Preoperative color Doppler echocardiogram showing a dysfunctional bioprosthetic mitral valve with elevated pressure gradients.*

Surgical Intervention

Under general anesthesia, a standard median sternotomy was performed, and the previous sternal wires were removed. The sternum was reopened using an oscillating saw to minimize myocardial injury. Dense adhesions around the heart and great vessels (Figure 2) were encountered and meticulously lysed. Arterial cannulation was achieved at the distal ascending aorta, and venous cannulation was performed via a bicaval approach, with the superior vena cava (SVC) accessed through the right atrium. Cardiopulmonary bypass (CPB) was initiated after achieving an activated clotting time of over 480 seconds, with hypothermia maintained at 32°C throughout the procedure. The heart was fibrillated using local ice cooling, and the

aorta was cross-clamped between the aortic cannula and the aortic root. Antegrade Del Nido cardioplegic solution was administered via the aortic root, with subsequent doses every 80 minutes as needed.

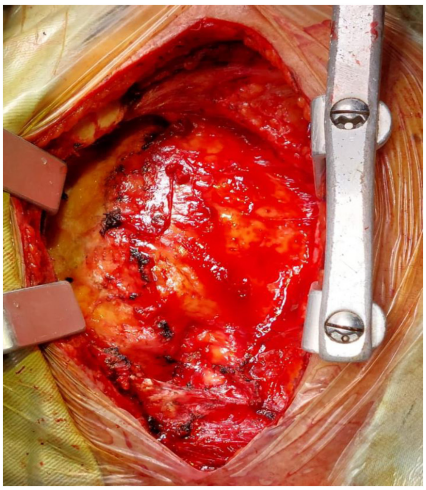

Figure 2. *Showing dense adhesions around the heart and great vessels*

A right atriotomy was performed, and the left atrium was accessed via a transseptal approach. Examination of the bioprosthetic valve revealed severely degenerated, myxomatous, fragile, and discolored leaflets (Figure 3). The valve rim was fully submerged and adherent to the ventricular muscle, with no identifiable pledgets from the previous sutures. The degenerated bioprosthetic valve was meticulously excised, and a 29 mm St. Jude mechanical valve (Figure 4) was implanted using the rim of the prior valve. Intraoperative assessment confirmed valve competency.

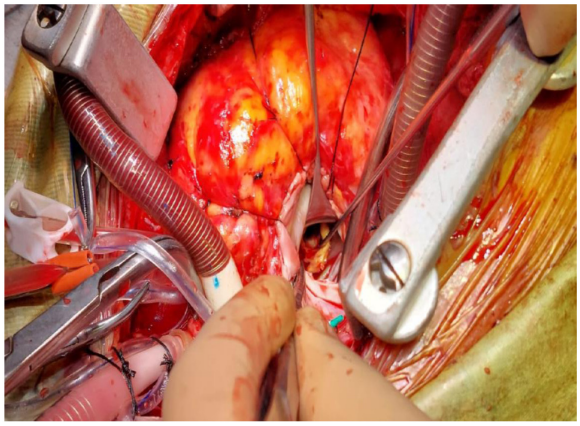

Figure 3. *shows a severely degenerated bioprosthetic valve with myxomatous, fragile, and discolored leaflets fully adherent to the ventricular muscle with no identifiable pledgets from the previous sutures.*

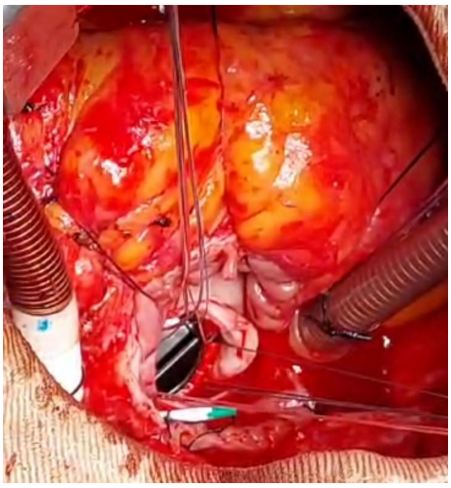

Figure 4. *Implantation of 29 mm St. Jude mechanical mitral valve*

The interatrial septum was closed with 2-0 Prolene (Figure 5), and the right atriotomy was repaired using 5-0 Prolene. Deairing was carefully performed, and the patient was successfully weaned off cardiopulmonary bypass (CPB). However, a tear in the posterior wall of the right atrium and the inferior vena cava (IVC) was identified after IVC decannulation. The patient was promptly re-instituted on CPB, and the right atriotomy was reopened to access the injury site. The posterior wall of the right atrium and the IVC tear were meticulously repaired using 4-0 Prolene. The patient was subsequently weaned off CPB successfully. Adequate hemostasis was confirmed, and the procedure was completed without further complications. The total cross-clamp time was 240 minutes, and the CPB time was 418 minutes

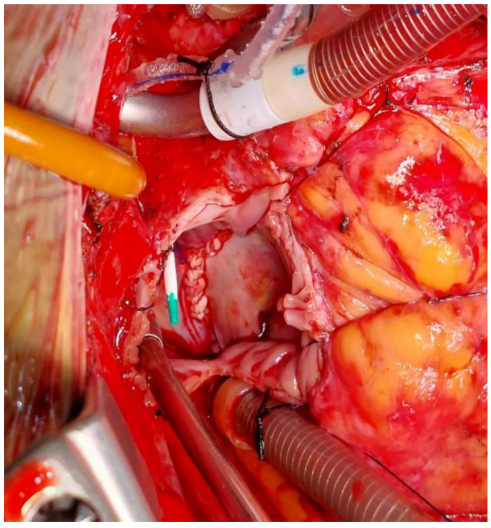

Figure 5. *Closure of the interatrial septum after mitral valve re-implantation*

Postoperative Course and Follow-Up

Postoperative bleeding through the drains was satisfactory. The patient developed postoperative atrial fibrillation, which was effectively managed with amiodarone and digoxin. She also experienced cognitive impairment, which was resolved within two days. Liver function was deranged, with significantly elevated SGPT levels and mildly raised serum bilirubin, both showing a decreasing trend. Serum creatinine was mildly elevated but also demonstrated a downward trend, with satisfactory urine output maintained throughout. The patient showed gradual improvement and was discharged after 15 days. At a 30-day follow-up, renal and liver function tests had normalized. A color Doppler echocardiogram (Figure 6) revealed a well-functioning prosthetic mitral valve with a peak pressure gradient (PPG) of 4.7 mmHg and a mean pressure gradient (MPG) of 3.5 mmHg. Both left and right ventricular systolic functions remained good, with a left ventricular ejection fraction (LVEF) of 57% and a pulmonary artery systolic pressure (PASP) of 31 mmHg. No regional wall motion abnormalities were observed. The chest X-ray findings were normal.

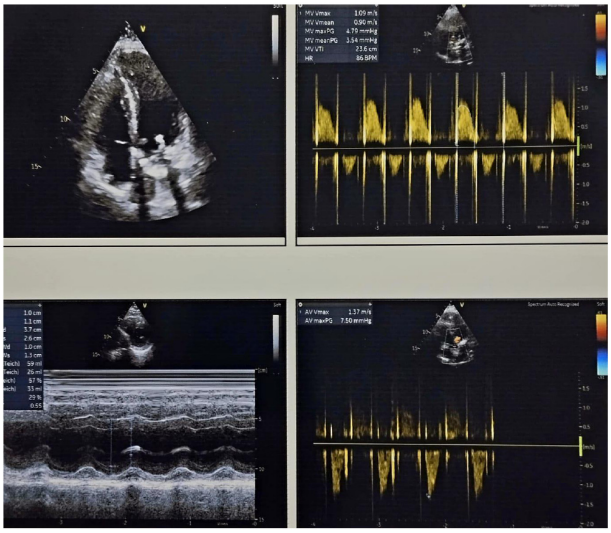

Figure 6. *Postoperative color Doppler echocardiogram showing well-functioning mechanical mitral valve*

Discussion

Redo mitral valve replacement (Redo-MVR) presents significant surgical challenges due to the complex interplay of prior interventions, patient-specific factors, and the pathological changes associated with prosthetic valve deterioration. This case highlights the inherent difficulties in managing such scenarios and the adaptations required to achieve successful outcomes. Patient-specific factors, such as age-related frailty, comorbidities like diabetes, coronary artery disease, additional valvular pathologies, and altered cardiac anatomy from earlier procedures, significantly complicate surgical planning and execution [6]. Further challenges arise from pre-existing left ventricular dysfunction, severe pulmonary hypertension, and the type and condition of the prior prosthetic valve. Dense adhesions, extensive bleeding, and a history of anticoagulation therapy contribute to the technical and perioperative complexities, emphasizing the need for meticulous preoperative assessment and strategic planning [7]. Lethal consequences including ventricular rupture, AV disruption, circumflex coronary artery injury, and acute hemorrhage can occasionally arise from such difficulties [8]. These factors elevate perioperative risks and demand precision, flexibility, and expertise in the operating room. Mechanical valves are typically the preferred choice for young patients; however, in this case, the patient's preference was prioritized. The patient opted for a tissue valve to avoid the need for lifelong oral anticoagulant therapy. Dense adhesions from previous surgeries posed a notable challenge, requiring meticulous adhesiolysis to avoid damaging the heart and great vessels. To minimize myocardial injury during re-sternotomy, an oscillating saw was used, highlighting the importance of advanced surgical tools in complex reoperations. Although the patient had a history of superior vena cava (SVC) cannulation, this did not present a significant challenge. A right atriotomy approach was employed to minimize the risk of SVC stenosis while ensuring optimal venous drainage, demonstrating the adaptability required in complex re-operative cardiac surgeries. Dense adhesions in the posterior wall of the right atrium and inferior vena cava (IVC) were carefully lysed, but despite precautions, a tear occurred in the IVC and posterior wall of the right atrium, which went unnoticed until after IVC decannulation. Locating the site of injury was initially challenging, which led to a delay in bypass time. The condition of the prior bioprosthetic valve further complicated the procedure. The valve exhibited severe degeneration, with myxomatous, discolored, non-coapting, and fragile leaflets. The valve rim was submerged and adhered to the ventricular muscle, with no identifiable pledgets from previous valve sutures. This made locating the annulus difficult, necessitating careful excision of the leaflet remnants to prepare the annulus

for the new valve. Such technical intricacies highlight the need for surgical precision and expertise. In this case, the complex reoperation resulted in a prolonged cardiopulmonary bypass (CPB) time, primarily due to the extensive adhesiolysis required to safely access the heart and great vessels. Identifying and repairing the injury to the inferior vena cava (IVC) and the posterior wall of the right atrium during IVC cannulation and taping further contributed to the extended CPB duration. Additionally, the meticulous excision of degenerated valve remnants and careful preparation of the annulus for the new prosthetic valve added to the overall procedural time. Prolonged CPB times have been associated with increased risks of postoperative complications such as renal dysfunction, neurological issues, and extended ICU stays [9]. In this instance, the patient experienced transient cognitive impairment as well as deranged liver and renal function, all of which gradually resolved. Advancements in imaging modalities, such as 3D echocardiography and computed tomography (CT), have greatly enhanced preoperative planning. These tools allow for more accurate assessment of anatomical distortions and surgical risks, improving procedural outcomes. Despite the complexity of Redo-MVR, studies report an operative mortality of approximately 3.4% for elective redo mitral valve surgeries, underscoring the progress made in managing these high-risk procedures [5]. This case exemplifies the complexity of Redo-MVR and underscores the importance of combining surgical innovation, meticulous planning, and expertise to optimize patient outcomes. It also highlights the need for continued advancements in valve technology and surgical techniques to address the growing demand for re-operative cardiac interventions.

Conclusion

Redo-MVR is associated with increased technical complexity and perioperative risks, largely due to dense adhesions and risk of heart and great vessel injury. This case highlights the importance of strategic planning, advanced surgical techniques, and meticulous execution to overcome the challenges of re-operative cardiac surgery and achieve favorable outcomes.

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