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Concomitant Mitral Valve Surgery in Moderate Mitral Regurgitation Undergoing Coronary Artery Bypass Grafting

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Abstract **Case Report**

The surgical management of moderate functional mitral regurgitation (fMR) during coronary artery bypass grafting (CABG) remains a highly debated dilemma, as concomitant mitral valve (MV) intervention may prevent heart failure progression but risks prolonged cardiopulmonary bypass (CPB) and subsequent myocardial injury. This report presents two contrasting cases to highlight the critical role of intraoperative decision-making regarding concomitant MV correction. In Case 1, a combined CABG and MV repair was performed due to a mixed MR etiology, which significantly prolonged CPB time and resulted in severe post-bypass hemodynamic instability with delayed myocardial recovery. Conversely, in Case 2, a planned MV intervention was safely aborted after real-time intraoperative transesophageal echocardiography (TEE) demonstrated an immediate reduction in fMR severity following revascularization. This CABG-only approach successfully minimized ischemic exposure, leading to a rapid, smooth recovery and a dramatic early improvement in ejection fraction. These contrasting outcomes demonstrate that the management of moderate fMR during CABG should be highly individualized rather than protocol-driven. Real-time intraoperative TEE assessment and active, flexible communication between the anesthesiologist and surgeon are essential to safely omit unnecessary valvular interventions, thereby minimizing operative trauma and optimizing short-term recovery.

Keywords: Coronary Artery Bypass Grafting, Functional Mitral Regurgitation, Mitral Valve Repair, Transesophageal Echocardiography, Cardiopulmonary Bypass.

INTRODUCTION

The surgical management of moderate mitral regurgitation in patients undergoing coronary artery bypass grafting (CABG) remains a significant clinical dilemma. Current guidelines acknowledge that surgical intervention on the valve theoretically prevents the progression of heart failure, yet concomitant mitral valve repair or replacement inevitably prolongs cardiopulmonary bypass (CPB) time [Khallaf A *et al.,*2020]. In patients with severely reduced left ventricular ejection fraction (LVEF), extended CPB duration is an independent predictor of severe postoperative hemodynamic instability, systemic inflammatory insult, and deteriorated short-term prognosis [Salis S *et al.,*2008].

Crucially, the decision to intervene on the mitral valve should not be algorithmic. It requires a meticulous differentiation between primary and functional MR, an exact quantification of subvalvular tethering geometry, myocardial viability, and dynamic intraoperative evaluation. We present two contrasting cases demonstrating that even when baseline pre-bypass hemodynamics are comparable, the burden of prolonged CPB time during concomitant surgery can severely impair short-term recovery. These cases emphasize the critical role of real-time transesophageal echocardiography (TEE) and active multidisciplinary communication with the surgeon in optimizing surgical strategies.

CASE PRESENTATION

Case 1: Concomitant CABG and Mitral Valve Repair Resulting in Prolonged CPB and Delayed Myocardial Recovery

A 77-year-old male with heart failure with reduced ejection fraction (HFrEF) and three-vessel disease (3VD) involving the left main (LM) coronary artery presented for surgical revascularization. Preoperative echocardiography revealed moderate left

ventricular (LV) systolic dysfunction (LVEF 36%) with regional wall motion abnormalities and moderate mitral regurgitation (MR) with an effective regurgitant orifice area (ERO) of 0.19 cm^2 (Figure 1).

In the operating room, routine non-invasive monitors – including electrocardiography, non-invasive blood pressure, and pulse oximetry – were attached. Baseline hemodynamic parameters were stable, with blood pressure of 149/65 mmHg, a heart rate of 65 beats/min, and an oxygen saturation (SpO2) of 99% on room air. Advanced monitoring was applied utilizing a bispectral index (BIS) monitor and cerebral oximeter (baseline regional oxygen saturation : left 67%, right 58%). General anesthesia was induced with propofol and remifentanil via a target-controlled infusion (TCI) system and rocuronium (80 mg) was administered.

Immediately after anesthetic induction, an arterial line was placed in the right radial artery and a Swan-Ganz pulmonary artery catheter was inserted via the right internal jugular vein. A TEE probe was subsequently inserted for real-time intraoperative assessment. Prior to the initiation of CPB, invasive monitoring demonstrated an adequate baseline hemodynamic profile: a cardiac index (CI) of 4.1–4.7 L/min/m^2, central venous pressure (CVP) of 2–6 mmHg, and pulmonary artery pressure (PAP) ranging from 11–25 mmHg (systolic) to 4–5 mmHg (diastolic) (mean 7–13 mmHg).

The pre-bypass intraoperative TEE confirmed moderate mitral regurgitation. Color Doppler evaluation revealed a dual-component jet profile: a central jet, and a distinct eccentric jet tracking posteriorly and inferior (Figure 2). Continuous-wave Doppler interrogation across the mitral orifice yielded a peak velocity (Vmax) of 6.09 m/s, a velocity-time integral (VTI) of 226 cm, and a mean pressure gradient (Mean PG) of 83 mmHg.

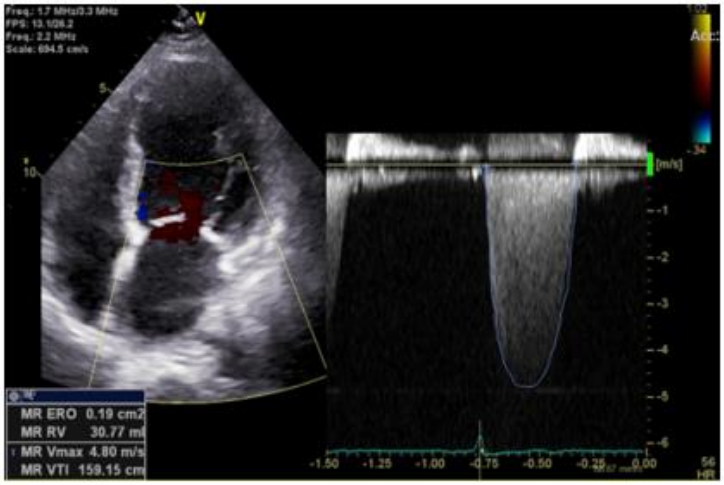

Figure 1: Preoperative transthoracic echocardiography (TTE). Apical view demonstrating moderate left ventricular systolic dysfunction and functional mitral regurgitation

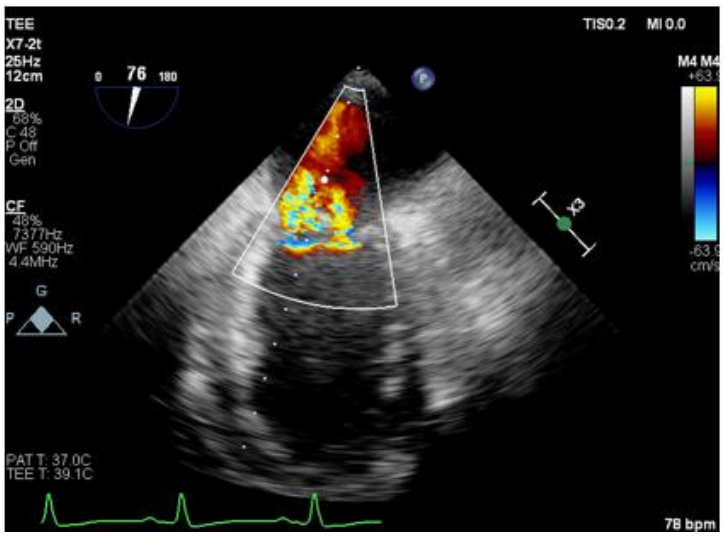

Figure 2: Pre-bypass intraoperative transesophageal echocardiography (TEE). Color Doppler systolic frame showing a dual-component eccentric mitral regurgitation jet: a central jet combined with a eccentric jet tracking posteriorly and inferiorly

Subsequent to median sternotomy, the surgeon established CPB through arterial cannulation of the ascending aorta and bicaval venous cannulation involving the superior and inferior vena cavae (SVC and IVC). The patient underwent surgical coronary revascularization combined with mitral valve repair. Intraoperative surgical inspection of the mitral apparatus revealed a mixed, non-pure functional etiology. The mitral annulus was significantly dilated, and the anterior leaflet exhibited mild prolapse, which explained the eccentric regurgitant component observed on pre-bypass TEE. Concurrently, the P2 and P3 segments of the posterior leaflet demonstrated tethering, which further compromised leaflet coaptation.

To address this complex valvular pathology, a restrictive annuloplasty was performed utilizing a 32 mm CG Future rigid ring, which successfully reduced the anteroposterior (AP) diameter, elevated the posterior annulus, and secured an adequate coaptation margin. Consequently, the combined dual-procedure extended the total CPB time to 255 minutes.

After weaning from CPB, the patient developed profound hemodynamic instability with severe blood pressure fluctuations, requiring aggressive resuscitation with norepinephrine, vasopressin, dobutamine and epinephrine infusion. This transiently impaired contractility coincided with severe concurrent metabolic derangements, including a drop in hemoglobin to 8.8 g/dL and hypocalcemia (ionized calcium 0.65 mmol/L).

Postoperatively, the patient was transferred to the intensive care unit (ICU), where continuous inotropic and vasopressor support was maintained for several days due to persistent hemodynamic instability.

Follow-up transthoracic echocardiography on postoperative day 7 revealed a moderate left ventricular systolic dysfunction with LVEF of 39%, persistent regional wall motion abnormalities. Evaluation of the mitral valve apparatus confirmed a stable status post-mitral valve repair with the annuloplasty ring well-positioned. Transmitral flow dynamics were excellent, demonstrating Vmax of 1.29 m/s, a Mean PG of 3 mmHg, and a mitral valve area (MVA) of 3.14 cm^2 determined by pressure half-time (Figure 3).

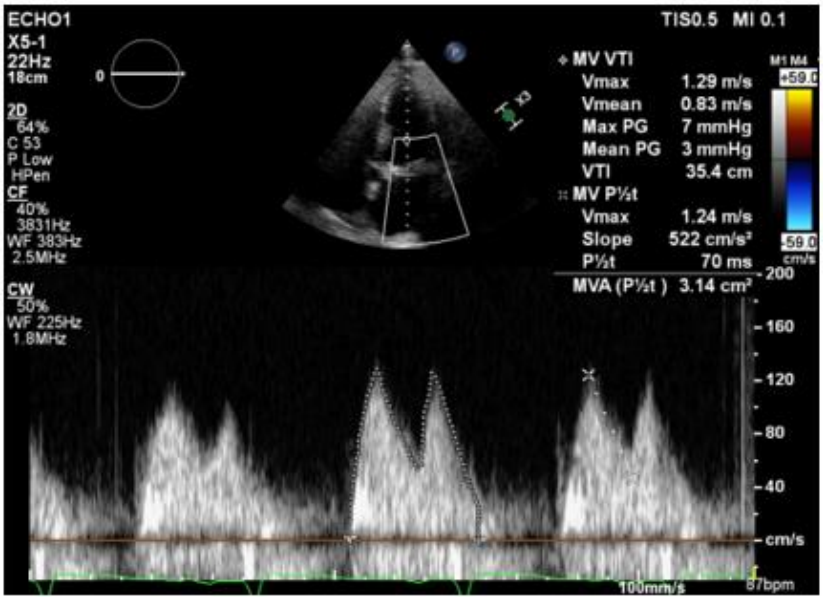

Figure 3: Postoperative day 7 transthoracic echocardiography (TTE) in Case 1. Continuous-wave Doppler interrogation across the mitral valve following annuloplasty ring repair

Case 2: Isolated CABG and Omission of Valve Intervention Guided by Intraoperative TEE

A 58-year-old male with severe heart failure, who had been diagnosed with three-vessel disease involving the left main coronary artery one month prior, was scheduled for CABG and concomitant MVR to treat moderate MR (ERO = 0.39 cm^2). Preoperative transthoracic echocardiography showed severe LV systolic dysfunction (LVEF 21%) with global hypokinesia and biventricular enlargement.

On presentation to the operating room, routine monitors and advanced neuro-surveillance (BIS and regional cerebral oximetry; baseline: left 47%, right 37%) were instituted. Pre-induction hemodynamics demonstrated a blood pressure of 90/55 mmHg, a heart rate of 76 beats/min, and an SpO2 of 98% on room air. Total intravenous anesthesia (TIVA) was achieved using target-controlled infusions of propofol and remifentanil, and rocuronium (80 mg) was administered for intubation.

After induction, an arterial line, a Swan-Ganz pulmonary artery catheter, and a TEE probe were promptly secured. Notably, despite the severe baseline left ventricular dysfunction, pre-bypass invasive hemodynamics were robustly maintained: a CI of 3.9–

5.0 L/min/m^2, CVP of 4–7 mmHg, and PAP ranging from 15–20 mmHg (systolic) to 5–7mmHg (diastolic) (mean 10–12 mmHg).

Pre-bypass intraoperative TEE demonstrated advanced global hypokinesia, consistent with the patient's severely compromised baseline ejection fraction of 21% and a functional (ischemic) mitral regurgitation. Continuous-wave Doppler interrogation confirmed a moderate functional mitral regurgitation with a Vmax of 4.23 m/s, a Mean PG of 34 mmHg, and a VTI of 151 cm (Figure 4).

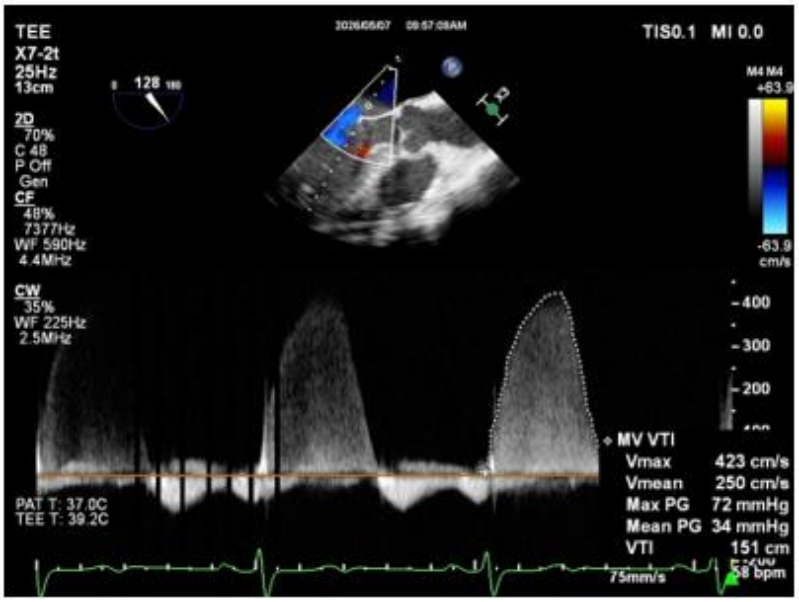

Figure 4: Baseline intraoperative transesophageal echocardiography (TEE) in Case 2. Continuous-wave Doppler measurement of moderate functional mitral regurgitation before cardiopulmonary bypass

Once the median sternotomy was complete, CPB was instituted utilizing ascending aortic and bicaval venous cannulation. The patient initially underwent on-pump beating CABG. Although cardioplegic arrest was prepared for the planned MVR, immediate post-revascularization intraoperative TEE assessment revealed a significant functional reduction in MR severity. The post-bypass continuous-wave Doppler demonstrated a decreased VTI of 121 cm and a reduced Mean PG of 27 mmHg (Figure 5).

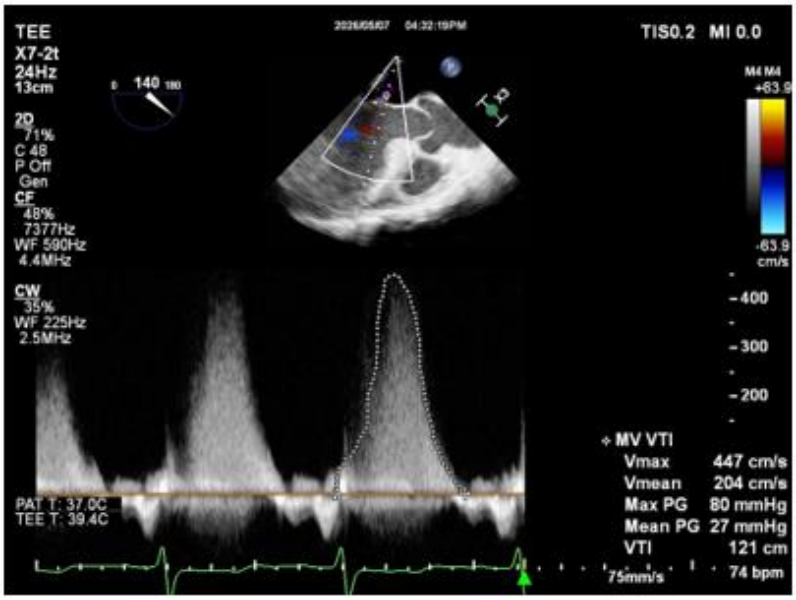

Figure 5: Post-revascularization intraoperative transesophageal echocardiography (TEE) in Case 2. Continuous-wave Doppler assessment demonstrating regression of mitral regurgitation severity following coronary artery bypass grafting

Based on these real-time morphological and quantitative improvements indicating a response to coronary reperfusion, a multidisciplinary discussion was held with the surgeon. To spare the frail myocardium from further CPB exposure and cross-clamping, the decision was made to safely abort the valve procedure. The total CPB time was 200 minutes.

In contrast to Case 1, weaning from CPB was remarkably smooth. The patient required only moderate inotropic and vasopressor support (dobutamine, norepinephrine, and nitroglycerin) and maintained stable hemodynamics without significant fluctuations. Strikingly, follow-up echocardiography on postoperative day 8 revealed a dramatic early recovery of left ventricular systolic function, with the LVEF improving from 21% to 49%, while the fMR remained effectively managed at a mild-to-moderate level (ERO = 0.16 cm^2).

DISCUSSION

These two cases illustrate the clinical dilemma encountered when moderate MR coexists with surgical coronary artery disease. The core of this dilemma lies in balancing the anatomical correction of the valve against the physiological penalty of prolonged CPB time.

Interestingly, both patients entered the CPB phase with adequate pre-bypass cardiac indices (around 4.0 L/min/m^2). However, as demonstrated in Case 1, concomitant valve surgery adds a substantial surgical complexity and time penalty. Clinical trials and retrospective cohorts have confirmed that adding a mitral procedure to CABG significantly prolongs both CPB and aortic cross-clamp times [Khallaf A *et al.,*2020; Ji Q *et al.,*2019]. This combined approach introduces greater surgical trauma, increased post-bypass mediastinal drainage, higher blood transfusion requirements, and an extended duration of intensive care unit and hospital stays [Khallaf A *et al.,*2020; Ji Q *et al.,*2019]. In a myocardium already compromised by HFrEF, this extended extracorporeal circulation exacerbates myocardial ischemia-reperfusion injury, leading to difficult CPB weaning and an excessive requirement for multi-agent vasoactive support. [Salis S *et al.,*2008]

The therapeutic decision must be guided by whether a combined intervention translates into true clinical benefits. A comprehensive meta-analysis of 1,406 patients demonstrated that adding mitral valve repair to CABG successfully reduces postoperative MR grade on follow-up echocardiography and promotes left ventricular reverse remodeling in terms of left ventricular end-systolic diameter (LVESD) [Salmasi MY *et al.,*2018]. However, this anatomical correction did not translate into a significant improvement in long-term survival, functional class, or postoperative ejection fraction compared to CABG alone [Salmasi MY *et al.,*2018].

Similarly, the Cardiothoracic Surgical Trials Network (CTSN) trial reported no significant difference in overall survival or left ventricular reverse remodeling at 1 and 2 years, despite a higher rate of neurological and supraventricular arrhythmic events in the combined surgery group [Smith PK *et al.,*2014; Michler RE *et al.,*2016]. Notably, while concomitant annuloplasty improves midterm cardiac functional class (NYHA class) and reduces fMR recurrence, it shares a similar perioperative mortality risk with CABG alone [Ji Q *et al.,*2019; Khallaf A *et al.,*2020].

Because functional MR is fundamentally a ventricular disease driven by regional wall motion abnormalities and ischemic geometric remodeling rather than structural leaflet pathology, restoring coronary perfusion can alleviate the condition [Salmasi MY *et al.,*2018]. However, the predictability of fMR regression remains controversial. Furthermore, recent registry data showed that in an unselected real-world cohort with chronic moderate fMR, isolated CABG did not result in substantial changes or regression in the degree of MR at 12 months [Sadeghian H *et al.,*2025].

Conversely, evidence suggests that fMR can be relieved by revascularization alone in carefully selected patients [Sun X *et al.,*2015]. They identified a higher preoperative LVEF (>37.1%), a greater posterior-inferior volume ratio (>31.6% via 3D echocardiography), and an early operation timing (<3.25 months after myocardial infarction) as independent predictors of fMR improvement. This directly aligns with Case 2, where the prompt revascularization of a severely hypokinetic but viable myocardium successfully relieved subvalvular papillary muscle tethering, resulting in a dramatic recovery of LVEF from 21% to 49% and an immediate reduction in fMR.

Because ischemic fMR is highly dynamic, volume-dependent, and afterload-sensitive, preoperative grading under resting conditions may not accurately reflect the intraoperative physiological state [Salmasi MY *et al.,*2018]. Therefore, continuous real-time intraoperative TEE assessment is paramount. When immediate post-revascularization TEE demonstrates improved leaflet coaptation and a significant reduction in MR severity (e.g., VTI reduction), omitting the planned valve procedure becomes a highly viable strategy. This decision-making process requires active, clear, and immediate communication between the anesthesiologist and the surgeon based on real-time echocardiographic data, ensuring that the surgical approach is dynamically tailored to the patient's immediate physiological reserves and preventing unnecessary CPB prolongation.

CONCLUSION

The management of moderate fMR during CABG should be individualized rather than protocol-driven. Concomitant valve surgery prolongs CPB time and can severely impair short-term recovery, even in

patients presenting with stable pre-bypass hemodynamics [Khallaf A *et al.,*2020; Salis S *et al.,*2008; Ji Q *et al.,*2019]. Optimizing outcomes requires a rigorous pre- and intraoperative evaluation of LVEF, tethering geometry, and real-time fMR responsiveness to revascularization [Salmasi MY *et al.,*2018; Sun X *et al.,*2015]. Most importantly, a close multidisciplinary collaboration between the anesthesiologist and the surgeon is vital to safely omit unnecessary valvular interventions, minimize operative trauma, and facilitate superior short-term ventricular recovery.

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