Transventricular Edge-to-Edge Repair of the Mitral Valve During Surgical Ventricular Restoration: Review of the Literature

Christos G. Mihos, D.O.,* Orlando Santana, M.D.,* and Joseph Lamelas, M.D.†

*Division of Cardiology and †Division of Cardiac Surgery, Columbia University, Mount Sinai Heart Institute, Miami Beach, Florida

ABSTRACT

Background: Mitral valve surgery for functional ischemic mitral regurgitation (MR) in high-risk patients, including those requiring multiple concomitant cardiac operations, carries a significant risk of morbidity and mortality. In patients undergoing surgical ventricular restoration, transventricular edge-to-edge repair provides an effective alternative to conventional mitral valve surgery. We report such a case. Methods: A 67-year-old male with ischemic cardiomyopathy and severe left ventricular dysfunction presented to our institution with a 3-month history of dyspnea on exertion, angina, and leg edema. He was found to have triple-vessel coronary artery disease, a severely dilated left ventricle with an apical aneurysm, and moderate-to-severe MR (3+). In addition to coronary artery bypass graft surgery, an edge-to-edge mitral valve repair was undertaken via a longitudinal ventriculotomy performed for concomitant surgical ventricular restoration. Results: Total cardiopulmonary bypass and aortic cross-clamp times were 101 minutes and 86 minutes, respectively. Postoperative transesophageal echocardiography revealed no MR, and the patient was discharged home on postoperative day 9. A follow-up transthoracic echocardiogram revealed trace MR on postoperative day 15. At 11 months postoperative, the patient remains in New York Heart Association functional class I. Conclusion: Transventricular edge-to-edge repair of the mitral valve in patients with ischemic cardiomyopathy and functional MR undergoing SVR is a safe and effective alternative to conventional valve surgery, and should be considered in this high-risk population. doi: 10.1111/j.1540-8191.2011.01388.x (J Card Surg 2012;27:52-55)

Ischemic cardiomyopathy, a sequela of coronary artery disease and myocardial infarction, is the most common cause of heart failure in the United States. The development of heart failure in the setting of ischemic heart disease is 3.5 times more likely in patients with functional ischemic mitral regurgitation (MR), and its incidence is directly related to the severity of the regurgitation, with 65% of patients with moderate-to-severe MR developing heart failure within five years of diagnosis. When undergoing conventional mitral valve surgery for correction of functional ischemic MR, patients with advanced age, severely reduced left ventricular ejection fraction, and those who require a concomitant cardiac surgery have an increased risk of perioperative morbidity and mortality. In high-risk patients requiring surgical ventricular restoration (SVR), a transventricular edge-to-edge repair of the mitral valve provides a simple and effective approach to correct the MR.

BACKGROUND

A 67-year-old Hispanic male with a history of ischemic cardiomyopathy and severe left ventricular systolic dysfunction, presented to our institution with a three-month history of worsening dyspnea on exertion, increasing angina, and leg edema. Coronary angiography revealed triple-vessel coronary artery disease and a severely dilated left ventricle with an ejection fraction of 20%. Transthoracic 2-D echocardiogram with Doppler also exhibited a severely dilated left ventricle with an apical aneurysm, and mild-to-moderate MR (2+). With these findings and the patient’s medical history, it was felt that coronary artery bypass graft surgery with left ventricular restoration was most appropriate.

TECHNIQUE FOR THE SURGICAL PROCEDURE

Intraoperative transesophageal echocardiography confirmed the previously reported findings, however, it demonstrated that the MR was moderate-to-severe (3+) (Fig. 1). The MR was a central jet that originated...
Intraoperative transesophageal echocardiography demonstrating moderate to severe (3+) mitral valve regurgitation. The mitral regurgitation originates from the A2-P2 portions of the mitral valve leaflets.

Surgical approach for edge-to-edge mitral valve repair during surgical ventricular restoration.

from the A2-P2 portions of the mitral valve. At the discretion of the surgeon, it was felt that the patient was too high a risk for a standard mitral valve repair. Thus, it was decided to repair the mitral valve by performing an edge-to-edge repair via a transventricular approach when performing the SVR procedure (Figs 2 and 3).

Surgical technique for edge-to-edge mitral valve repair during surgical ventricular restoration.

Postoperative transesophageal echocardiogram demonstrated no mitral regurgitation.
The patient was placed in the supine position, prepped and draped in the usual fashion. A sternotomy was performed, cardiopulmonary bypass was instituted, and both antegrade and retrograde cardioplegia was given throughout the procedure. The distal coronary anastomosis was initially performed. The saphenous vein grafts were anastomosed to the obtuse marginal branch of the left circumflex artery and the diagonal branch of the left anterior descending artery. Next, in the region of the left ventricular aneurysm, where there was thinning of the left ventricular apex, a longitudinal ventriculotomy was performed parallel to the left anterior descending artery through a scarred portion of the left ventricular anterolateral wall. The ventricular aspect of the mitral valve was visualized and the A2 and P2 segments of the mitral valve were identified. An edge-to-edge repair was then carried out with a 4-0 prolene pledgeted suture, approximately one-half centimeter from the free edge of both leaflets. A running double-layer 3-0 prolene suture was subsequently placed in the endocardium in the region of the left ventricular apex, in the transition zone between viable and nonviable muscle. This was pulled in a pursestring fashion to narrow the apex. To accommodate the reshaped ventricle, a 2.5 cm × 2.5 cm pericardial patch was then sutured to the endocardium in the area of the apical pursestring utilizing a 3-0 prolene suture in a continuous two-layered fashion. Finally, the ventriculotomy was closed with 2-0 prolene sutures buttressed by felt strips. The left internal mammary artery was then anastomosed to the left anterior descending artery in an end-to-side fashion utilizing a 7-0 prolene suture. Atrial and ventricular pacing wires, as well as substernal and pleural chest tubes were left in place. The median sternotomy incision was closed in routine fashion. Total cardiopulmonary bypass and aortic cross-clamp times were 101 minutes and 86 minutes, respectively. Post-operative transesophageal echocardiogram demonstrated no MR (Fig. 4). The patient did well postoperatively with resolution of his symptoms, and was discharged home on postoperative day nine. A follow-up transthoracic echocardiogram performed 15 days postoperatively revealed the presence of trace MR, confirming the integrity of the mitral valve repair. Throughout the 11-month postoperative period, the patient has remained in New York Heart Association functional class I.

### DISCUSSION

First described by Alfieri et al., the edge-to-edge mitral valve repair (Alfieri stitch) involves the creation of a double orifice mitral valve via the placement of a suture at the center (A2-P2 portion) of the leaflet margins, providing a simpler, yet effective, repair option in high-risk patients. The primary indications for edge-to-edge repair are functional MR secondary to ischemic or idiopathic dilated cardiomyopathy, bileaflet prolapse, anterior leaflet prolapse, and commissural prolapse.

Patients undergoing SVR for ischemic cardiomyopathy are at increased risk for perioperative morbidity and mortality, particularly in the presence of functional ischemic MR. As uncorrected MR exacerbates left ventricular remodeling in these patients due to persistent ventricular volume overload, studies have shown decreased symptoms of heart failure and improved quality of life in patients undergoing SVR with concomitant mitral valve surgery.[6, 8] Performing a transventricular edge-to-edge mitral valve repair during SVR decreases the operative time and avoids an atriotomy when compared with conventional mitral surgery. This allows for leaflet approximation in the region that lacks coaptation and early valve closure, which likely helps curb additional left ventricular remodeling.

Sartipy et al. analyzed early and late outcomes in 31 patients with left ventricular aneurysm or ischemic cardiomyopathy undergoing SVR (plus concomitant coronary artery bypass grafting) and edge-to-edge repair without annuloplasty (Table 1). Early mortality was 16%, while one-, three-, and five-year survival was 77%, 55%, and 48%, respectively. Freedom from hospital readmission or cardiac death was 56% at one year and 48% at three years.

**TABLE 1**

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of Patients</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sartipy et al.</td>
<td>31</td>
<td>16% early mortality; one, three, and five-year survival was 77%, 55%, and 48%, respectively; freedom from hospital readmission or cardiac death was 56% at one year and 48% at three years</td>
</tr>
<tr>
<td>Sartipy et al.</td>
<td>26</td>
<td>Two patients (8%) required reoperation for residual or recurrent mitral regurgitation in the first 13 months postoperatively</td>
</tr>
<tr>
<td>Bhudia et al.</td>
<td>20</td>
<td>No difference in recurrence of mitral regurgitation compared to patients who do not undergo surgical ventricular restoration</td>
</tr>
<tr>
<td>Kherani et al.</td>
<td>6</td>
<td>All patients achieved freedom from reoperation after a mean of 299 days</td>
</tr>
</tbody>
</table>

Small mitral valve area, annular calcifications or dilation, and excessive leaflet fibrosis and rigidity are relative contraindications to the procedure due to higher risk of late repair failure. Annuloplasty...
should be performed in addition to edge-to-edge repair when feasible, as its provides stabilization of the suture and increases coaptation of the leaflets, leading to decreased risk of reoperation.\textsuperscript{15} Compromise of valvular hemodynamics and risk of functional mitral stenosis have also been of concern in patients undergoing edge-to-edge repair; however, echocardiographic studies have shown similar efficacy and durability when compared to conventional surgical methods.\textsuperscript{16,17}

**CONCLUSION**

Although data are limited, we believe that transventricular edge-to-edge mitral valve repair in patients with ischemic cardiomyopathy and functional MR undergoing SVR is a safe and effective alternative to conventional valve surgery, and should be considered in this high-risk population.

**REFERENCES**