Concomitant Transapical Mitral Valvuloplasty and CentriMag Assist Device Placement in a “No-Option” Patient

Left ventricular assist devices and percutaneous valve interventions have radically changed the treatment of advanced heart disease and minimized surgical morbidity in patients with end-stage heart failure who would not survive conventional surgery. We describe a successful approach to the simultaneous placement of a percutaneous left ventricular assist device and mitral valvuloplasty in a decompensated patient with end-stage ischemic cardiomyopathy, severe peripheral arterial disease, porcelain aorta, and severe mitral and aortic disease. (Tex Heart Inst J 2013;40(4):445-8)

We describe a combined procedure—the placement of a CentriMag® paracorporeal ventricular assist device (VAD) (Thoratec Corporation; Pleasanton, Calif), performed in conjunction with a transapical mitral balloon valvuloplasty for mitral stenosis—to overcome the shortcomings of exclusively surgical or exclusively percutaneous techniques in the treatment of critical disease in an otherwise “no-option” patient.

Case Report

A 64-year-old man presented with end-stage heart failure symptoms (New York Heart Association functional class IV), refractory pleural effusions, and recurrent pulmonary edema. He had a remote history of lymphoma, for which he had undergone chemotherapy and radiation. His end-stage heart disease was probably ischemic, rheumatic, and radiation-induced and might have been aggravated by aortic stenosis, mitral stenosis, diabetes mellitus, and chronic atrial fibrillation.

To minimize intervention in a frail patient and to define the relative contributions of the different causes (aortic disease, mitral disease, and cardiomyopathy) of his heart failure, we initially performed standard transthoracic echocardiography, the results of which showed severe mitral stenosis (mean gradient, 11 mmHg; peak gradient, 23 mmHg) (Fig. 1) and mild-to-moderate mitral regurgitation with severe annular calcification extending to the mid-leaflet in a porcelain aorta.

We also performed simultaneous right- and left-sided cardiac catheterization under 3 conditions: at baseline, under intravenous dobutamine stress, and with right ventricular (RV) pacing. A detailed hemodynamic evaluation is presented in Table I. Briefly, the patient’s heart rate at rest was 100 beats/min, right atrial pressure was 12 mmHg (mean pressure, 11 mmHg), venous oxygen saturation was 59%, and RV pressure was 43/10 mmHg. Pulmonary artery pressure was 46/23 mmHg (mean pressure, 31 mmHg), pulmonary artery saturation was 58%, and mean pulmonary capillary wedge pressure was 19 mmHg. Cardiac output (as determined by the Fick method) was 3.92 L/min with a cardiac index of 2.2 L/min/m². Pulmonary vascular resistance was 3.0 Wood units. Left ventricular (LV) systolic pressure was 144/20 mmHg, LV end-diastolic pressure (LVEDP) was 27 mmHg, aortic pressure was 128/64 mmHg, and mean arterial pressure was 91 mmHg with a peak gradient of 16 mmHg and a mean transaortic gradient of 16 mmHg.

After 40 µg of dobutamine was administered, the patient’s heart rate increased to 116 beats/min, LV systolic pressure was 138/11 mmHg, LVEDP was 22 mmHg, aor-
tic pressure was 94/69 mmHg, and mean arterial pressure was 80 mmHg, with a peak gradient of 32 mmHg and a mean transaortic gradient of 44 mmHg.

With RV pacing at 140, the patient's heart rate was recorded at 140 beats/min; LV systolic pressure was 119/21 mmHg, LVEDP was 23 mmHg, aortic pressure was 94/72 mmHg, and mean arterial pressure was 81 mmHg with a peak gradient of 25 mmHg and a mean transaortic gradient of 20 mmHg. These values are consistent with moderate-to-severe aortic stenosis and a poor chronotropic response to dobutamine.

The patient's clinical status decompensated to intractable pulmonary edema. The patient's condition made it unlikely that he would tolerate surgical implantation of a left ventricular assist device (LVAD). Therefore, as a "bridge to decision," a CentriMag paracorporeal VAD was placed to provide mechanical LV support. In combination with the anastomosis of the outflow cannula to the descending aorta, mitral valvuloplasty was performed with the patient under general anesthesia and with the aid of fluoroscopic and transesophageal echocardiographic (TEE) guidance (Fig. 2).

A left anterolateral thoracotomy was performed to expose the patient's left chest, and the left lung was collapsed. A side-biting clamp was placed on the descending aorta, and a 10-mm HemaShield® graft outlet (MAQUET Cardiopulmonary AG; Rastatt, Germany) was then sutured in place. This was completed after additional Prolene sutures were placed for the anastomosis. The graft was brought through a separate chest incision via a bullet adaptor. The apex of the LV was exposed after the pericardium was opened, and a 42F malleable catheter with an insertion catheter was then prepared and brought through a separate incision. The apical part of the ventricle was opened after pledgeted sutures were placed with felt in 2 separate purse-strings.

The inflow cannula from the LV apex and the outflow cannula to the descending aorta were then connected to the external CentriMag pump in order to minimize manipulation of the ascending aorta and cerebral embolization. At this point, a transapical approach was used to perform the mitral valve balloon valvuloplasty.

### TABLE I. Patient's Hemodynamic Variables at Baseline, under Intravenous Dobutamine Stress, with Right Ventricular Pacing, and after the Procedure

<table>
<thead>
<tr>
<th>Hemodynamic Variable</th>
<th>Baseline</th>
<th>Dobutamine Stress</th>
<th>RV Pacing</th>
<th>After Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate, beats/min</td>
<td>100</td>
<td>116</td>
<td>140</td>
<td>81</td>
</tr>
<tr>
<td>LV systolic pressure, mmHg</td>
<td>144/20</td>
<td>138/11</td>
<td>119/21</td>
<td>—</td>
</tr>
<tr>
<td>LV end-diastolic pressure, mmHg</td>
<td>27</td>
<td>22</td>
<td>23</td>
<td>—</td>
</tr>
<tr>
<td>Aortic pressure, mmHg</td>
<td>128/64</td>
<td>94/69</td>
<td>94/72</td>
<td>—</td>
</tr>
<tr>
<td>Mean arterial pressure, mmHg</td>
<td>91</td>
<td>80</td>
<td>81</td>
<td>72</td>
</tr>
<tr>
<td>Peak gradient, mmHg</td>
<td>16</td>
<td>32</td>
<td>25</td>
<td>—</td>
</tr>
<tr>
<td>Mean transaortic gradient, mmHg</td>
<td>16</td>
<td>44</td>
<td>20</td>
<td>—</td>
</tr>
<tr>
<td>Right atrial pressure, mmHg</td>
<td>12</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Mean, mmHg</td>
<td>11</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Pulmonary artery pressure, mmHg</td>
<td>46/23</td>
<td>—</td>
<td>43/19</td>
<td>29</td>
</tr>
</tbody>
</table>

LV = left ventricular; RV = right ventricular
Dashes indicate data that were not obtained at that time point.

![Fig. 1 Preoperative transthoracic echocardiogram (4-chamber view)](image1)

Click here for real-time motion image: Fig. 1.

![Fig. 2 Intraoperative transesophageal echocardiogram (4-chamber view)](image2)

Click here for real-time motion image: Fig. 2.
A needle was used to enter the LV and enable placement of a purse-string suture. A 0.035-in SuperStiff Amplatz® guidewire (Boston Scientific Corporation; Natick, Mass) was advanced through the needle under fluoroscopic guidance. Over a dilator, a 14F sheath was advanced into the LV cavity. Under TEE and fluoroscopic guidance, a 0.035-in J-wire was taken across the mitral valve and into the left atrium (Fig. 3). The J-wire was then exchanged for a 0.032-in Toray wire, which was placed in the left atrium; this position was confirmed with use of TEE and fluoroscopy. The mitral annulus was estimated to be about 27 mm in diameter. Hence, an Inoue balloon was taken over the wire, placed across the mitral valve under TEE and fluoroscopic guidance, and inflated until a full expansion of 27 mm was achieved across the mitral annulus (Fig. 4). After the procedure, the mean gradient across the mitral valve dropped from 11 to 2.1 mmHg at a heart rate of approximately 80 beats/min, with minimal mitral regurgitation (Fig. 5). The wires and the balloon were removed, and the purse-string around the sheath was tightened and closed to achieve hemostasis.

At the end of the procedure, the patient was hemodynamically stable with a heart rate of 81 beats/min, a blood pressure of 90/61 mmHg (mean pressure, 72 mmHg), and a right atrial pressure of 12 mmHg. His pulmonary artery pressure was 43/19 mmHg (mean pressure, 29 mmHg), and the pump was flowing at 3.5 L/min. When the patient was transferred to the surgical intensive care unit, his clinical hemodynamic values had improved, he was neurologically intact, and he was scheduled to undergo LVAD implantation as destination therapy.

**Discussion**

This case shows the successful integration of surgical and percutaneous techniques to overcome the shortcomings of either one in isolation, for the treatment of critical disease in an otherwise “no-option” patient. Our patient presented with poor LV function, and his clinical condition was far too poor to tolerate conventional surgical LVAD implantation, unless we definitively corrected his critical valvular disease first. In addition, the patient’s substantial mitral and aortic valve disease increased the chance of surgically related morbidity and death; the patient’s Society of Thoracic Surgeons Risk Score indicated that an isolated mitral valve replacement would carry a 42% risk of death and an 80% risk of serious procedure-related morbidity, prolonged ventilation, or both. Furthermore, the patient’s severe...
mitral disease would have undermined the efficacy of an LVAD by reducing mitral inflow while keeping left atrial pressure elevated, which could cause pulmonary hypertension, chronic RV dysfunction, and possibly a “suction event” in the immediate postoperative period.¹

To overcome the complex challenges imposed by severe mitral stenosis and decompensated LV dysfunction, we adopted a hybrid approach wherein we performed mitral valvuloplasty and placed a temporary VAD. This procedure served as a “bridge to decision” that would enable the patient to improve hemodynamically to the point of being able to tolerate a conventional surgical LVAD implantation.

During the mitral valvuloplasty, we used a minimally invasive approach at the time of the minithoracotomy to circumvent access-related morbidity and complications that are likely to occur in end-stage heart-disease patients with porcelain aorta and peripheral arterial disease. In addition, by placing the outflow anastomosis in the descending aorta, we bypassed the severe aortic stenosis and the porcelain aorta, thereby preventing comorbidity.

Other approaches to similar conditions have been attempted. For example, the combination of percutaneous transfemoral mitral valvuloplasty and aortic valve implantation was reported in 2011.² In the present case, we believed that our patient’s primary problem was poor ventricular performance due to ischemic cardiomyopathy and that valvular disease was only an aggravating factor. Therefore, a surgical valvular procedure would have presented a high risk of operative death and was not a realistic option.

Another report³ describes the successful use of the CentriMag pump as perioperative LV support in a patient with critical aortic stenosis, mitral regurgitation, and cardiogenic shock. Similarly, we chose to use the CentriMag as a VAD to support LV function, but in our patient VAD malfunction due to suction events was expected because of mitral valve stenosis in association with impaired LV filling. Therefore, immediately after VAD activation, we performed a mitral valvuloplasty through a transapical approach while using a left minithoracotomy to implant the inflow and outflow canulas. The procedure was performed with direct viewing of apical access and combined fluoroscopic and TEE guidance.

This case underscores the importance of a multidisciplinary approach in evaluating and treating patients whose conditions are too advanced to allow either direct surgical intervention or effective management by medical means alone. Percutaneous approaches offer new options to patients with otherwise terminal conditions. Integrating percutaneous and surgical techniques enables the strengths of each discipline to achieve outcomes better than those attainable with either approach alone.

Acknowledgments

Stephen N. Palmer, PhD, ELS, and Elizabeth M. Gendel, PhD, contributed to the editing of the manuscript.

References