Minimally Invasive Mitral Valve Repair Through Right Mini-Thoracotomy in a High Risk Patient with Previous Aortocoronary Bypass Surgery and Patent Grafts: A Case Presentation and Literature Review

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Abstract

Redo mitral valve (MV) surgery via sternotomy in the presence of dense adhesions can be associated with significant complications including injuries to the heart, great vessels, and patent coronary artery grafts that can increase morbidity and mortality. Although less likely to occur during minimally invasive MV surgery, adhesion-related injuries can be more difficult to repair because of limited surgical field. We report an 88-year-old obese male patient with sleep apnea and previous coronary artery bypass graft (CABG) surgery who presented with severe mitral regurgitation and patent grafts. He underwent minimally invasive mitral valve repair (MVR) through right mini-thoracotomy (RMT) under direct vision during which the patent right coronary artery (RCA) graft the right atrial appendage and the aorta were injured and subsequently successfully repaired in a systematic fashion that did not preclude an adequate repair of the MV. We also summarize the results of reported redo MV surgery through RMT studies that included patients with previous CABG surgery to demonstrate that the performance of this procedure in a very elderly patient with multiple risk factors for redo cardiac surgery not included in these studies is challenging yet possible.

ABBREVIATIONS

MV: Mitral Valve; CABG: Coronary Artery Bypass Graft; MVR: Mitral Valve Repair; RCA: Right Coronary Artery; P1: Lateral Scallop Of Posterior Mitral Valve Leaflet; P2: Central Scallop Of Posterior Mitral Valve Leaflet

INTRODUCTION

As patients continue to live longer following cardiac surgery, the number of patients with indications for redo surgery will increase worldwide. Redo cardiac surgery represents a clinical challenge due to an increased rate of perioperative morbidity and mortality especially in patients with other co-morbid conditions [1-4].

Minimally invasive surgical approach through a RMT represents a standard and valid alternative to a redo MV surgery by providing excellent exposure with less risk from re-entry associated complications [5-10]. Nevertheless, the repair of adhesion-related injuries during minimally invasive MV surgery can be very difficult because of the small incision. In addition, quick recognition of such complications is very important to prevent catastrophic outcomes especially in high risk patients. We describe the management of adhesion-related injuries that occurred during minimally invasive MVR through RMT under direct vision in an 88-year-old obese patient with previous aortocoronary bypass surgery and patent grafts demonstrating that the performance of this procedure in patients with multiple risk factors for redo cardiac surgery is very challenging yet possible.

CASE PRESENTATION

An 88-year-old male known to have hypertension and sleep apnea using continuous positive airway pressure device who underwent five graft CABG surgery 10 years before had developed shortness of breath and visited the clinic for checkups. Upon examination he was obese with a body mass...
index of 35.6 and a loud systolic murmur was noted at the apical area. Electrocardiogram showed normal sinus rhythm with left bundle branch block. Echocardiogram demonstrated normal left ventricular size and function with an ejection fraction of 55-60%: dilated central (P2) scallops of posterior mitral valve leaflet causing severe eccentric mitral regurgitation (Figure 1): dilated right ventricle: biventricular enlargement: mild tricuspid regurgitation and pulmonary hypertension with a pulmonary artery systolic pressure of 52 mmHg. Coronary angiography demonstrated that all bypass grafts were patent (Figure 2). Calculated EuroSCORE II was 6.95%.

Written informed consent was obtained from the patient and his family and the patient was taken to the operating room for a corrective surgery. The patient was intubated with a double-lumen endotracheal tube and was positioned in a supine position with the right side of the chest slightly elevated on the right arm above the head. A right lateral mini thoracotomy was performed and the right pleural space was entered via the fourth intercostal space. Dissection was carried out to free the pericardium from severe adhesion in the anterior portion of the right atrium. The right femoral vein and artery were exposed and the Seldinger technique under direct vision was used to cannulate the femoral artery with a 21 French femoral arterial cannula the femoral vein with a 30/33 two-stage femoral venous cannula and cardiopulmonary bypass was initiated after systemic heparinization. The patient was then cooled towards 25 and the rest of the procedure was performed under fibrillatory arrest without cross clamp. Further dissection was carried out to gain better exposure. The RCA graft was severely adherent to the pericardium and right atrium. Because of dense adhesions: attempt to free this graft from the surrounding tissue was unsuccessful and resulted in injuring the right atrial appendage. Again: right atrial appendage was further adherent underneath to the aorta: which was injured during the attempted repair of the right atrial appendage. The aorta was first repaired with interrupted 3-0 prolene pledged sutures and the right atrium was repaired with multiple 3-0 prolene pledged sutures as well. During this process and because of the severe adhesions the RCA vein graft was injured and it was felt that it is not feasible to free the vein graft from the surrounding tissue without causing further damage to the atrial and aortic tissue. Therefore the proximal end of the vein graft was ligated to be repaired by an interposition graft eventually. We first proceeded with MVP portion of the surgery. CO₂ insufflation was initiated. The left atrium was entered via the intra-atrial groove and the MV and its subvalvular apparatus were inspected. The valve a myxomatous-type with prolapsed lateral (P1) scallops of posterior mitral valve leaflet and P2 causing severe regurgitation. Both P1 and P2 were first repaired by a quadrangular resection and were reapproximated with multiple interrupted 4-0 Tycron sutures. At this stage the regurgitation was still central and the MV became completely competent after inserting a 32 mm CE Physio 2 annuloplasty ring (Edwards Lifesciences: Irvine: California) using a total of ten 2-0 Tycron mattress sutures. After the left atriotomy was closed using running 3-0 prolene sutures and the patient was rewarmed towards 34 and further rewarming was continuing. At this stage the patient defibrillated himself into atrial fibrillation rhythm which was converted to sinus rhythm by one cardio version. After that a saphenous vein was harvested from the right upper thigh and was first anastomosed proximally onto the ascending aorta and distally to the end of the existing RCA vein graft in an end-to- end fashion using running 7-0 Prolene sutures and an excellent flow achieved. Afterwards the patient was weaned off cardiopulmonary bypass without any difficulty. The drain and temporary wires were left in place. Protamine was given: all cannulae were removed and hemostasis was secured and the mediastinum was irrigated. The thoracotomy was closed using interrupted heavy vicryl sutures and skin and subcutaneous tissue were closed using running sutures. Transesophageal echo showed no residual mitral regurgitation and less than 2 mmHg of gradient across the MV and well preserved left and right ventricular function. The patient tolerated the procedure well and was transferred back to the Cardiac Intensive Care Unit in a stable condition. Before discharge: transthoracic echo confirmed that the MV was completely competent (Figure 3).

DISCUSSION

Since its first introduction in the mid-1990s: minimally invasive mitral surgery through RMT has emerged as a good alternative to the conventional full sternotomy approach with similar perioperative outcome and favorable resource-related outcomes [11-14]. Recently: outcomes of minimally invasive mitral surgery in high risk patients were studied in relation to EuroSCORE II [15]. Patients with EuroSCORE II ≥ 6 - <9% had acceptable early and long-term results: indicating that minimally invasive mitral surgery may be considered as an at least equivalent alternative to standard sternotomy in these patients. However: patients with EuroSCORE II ≥ 9% showed a high operative mortality and significantly reduced survival time: and hence maybe potentially candidates for alternative procedures such as catheter-based interventions.

A redo cardiac surgery: particularly for the MV position is generally associated with a higher risk of morbidity and mortality than the first operation mainly due to risk of injury to major vascular structures or patent coronary grafts during sternal reentry: especially in the presence of extensive pericardial adhesions [1-3]. Also previously implanted aortic valve prosthesis can make the exposure of the MV through a sternotomy particularly difficult [3]. In addition: age >80 years as well as: other co-morbid conditions such as congestive heart failure: chronic kidney disease: diabetes mellitus: chronic lung disease and morbid obesity can further increase the rate of perioperative morbidity and mortality in these patients [4]. Several studies have documented the utility and highlighted its advantageous in reoperative mitral valve procedures (Table 1) [5-10].

Onnasch et al. reported 39 series of patients who underwent redo MV surgery through a RMT using the port-access technique and videoscopic assistance and femoro-femoral cannulation. In the 11 patients with prior CABG the operation was performed using deep hypothermia and ventricular fibrillation. The authors demonstrated in this study that redo MV surgery can be performed safely using a RMT in patients with a previous sternotomy with a mortality of 5.1% [5]. Similarly: Thompson and colleagues reported 125 patients (mean age 63 range: 30-
80 years) who had undergone previous minimally invasive MV operations. Twenty-two had also undergone previous CABG. The operation was carried out on a beating heart using normothermic bypass without cross-clamping the aorta. Arterial inflow was achieved via the femoral artery or ascending aorta and venous drainage with bi-caval cannulae. Complication rates were low: pleuro-pulmonary: 30 patients (24%); re-operation for bleeding: four patients (3.2%) and cerebrovascular accident: two patients (1.6%). Eight patients (6.4%) died within 30 days. The authors concluded that mitral prosthetic replacement via a right thoracotomy on beating heart under normothermic bypass offers a safe alternative to redo median sternotomy in this high-risk group.

### Table 1: Main data of the reported studies of minimally invasive redo mitral valve surgery through right mini-thoracotomy in patients with previous CABG.

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Patients (n)</th>
<th>Mean age (years)</th>
<th>CABG in previous surgery (%)</th>
<th>Type of surgery MVr/MVR (% / %)</th>
<th>In-hospital/30-day mortality (%)</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onnasch et al.</td>
<td>2001</td>
<td>39</td>
<td>59 ± 13</td>
<td>28.2</td>
<td>51/49</td>
<td>5.1</td>
<td>Re-operative MV surgery can be performed safely using a right mini-thoracotomy in patients with a previous sternotomy.</td>
</tr>
<tr>
<td>Thompson et al.</td>
<td>2003</td>
<td>125</td>
<td>63 (range: 30–80)</td>
<td>16.6</td>
<td>0/100</td>
<td>6.4</td>
<td>MVR via a right thoracotomy on beating heart under normothermic bypass offers a safe alternative to redo median sternotomy in this high-risk group.</td>
</tr>
<tr>
<td>Casselman et al.</td>
<td>2007</td>
<td>80</td>
<td>65 ± 12</td>
<td>29.0</td>
<td>45/50 (TVR 5%)</td>
<td>3.8</td>
<td>Right video-assisted minimal access correction of atrioventricular valve disease after previous cardiac surgery is not only feasible but had lower than predicted mortality.</td>
</tr>
<tr>
<td>Seeburger et al.</td>
<td>2009</td>
<td>181</td>
<td>64.5 ± 12</td>
<td>51</td>
<td>60/40</td>
<td>6.6</td>
<td>Right-sided lateral minithoracotomy approach is a useful alternative for patients requiring a MV procedure after a previous cardiac operation particularly in patients with patent coronary bypass grafts or previous aortic valve replacement.</td>
</tr>
<tr>
<td>Umakanthan et al.</td>
<td>2010</td>
<td>90</td>
<td>66 ± 9</td>
<td>73</td>
<td>11/89</td>
<td>2</td>
<td>Minimally invasive right thoracotomy without aortic cross-clamping is safe and effective in reducing operative mortality in patients undergoing reoperative cardiac surgery.</td>
</tr>
<tr>
<td>Arcidi et al.</td>
<td>2012</td>
<td>167</td>
<td>66.9 ± 9</td>
<td>71</td>
<td>62/38</td>
<td>3.0</td>
<td>Confirmed the effectiveness of minimally invasive right thoracotomy to treat mitral pathology while avoiding reoperative sternotomy risk. Fibrillatory and cardioplegic arrest methods were found to be safe myocardial preservation strategies with this approach.</td>
</tr>
<tr>
<td>Romano et al.</td>
<td>2012</td>
<td>450</td>
<td>63 ± 15</td>
<td>74.7</td>
<td>65/35</td>
<td>6.9</td>
<td>Redo right thoracotomy mitral valve surgery on the beating heart is associated with shorter bypass time, less transfusion requirements, shorter postoperative ventilation and lower mortality.</td>
</tr>
</tbody>
</table>

**Abbreviations:** CABG: Coronary Artery Bypass Graft; MV: Mitral Valve; MVR: Mitral Valve Repair; MVR: Mitral Valve Replacement; TVR: Tricuspid Valve Replacement
MVR with fibrillation. Cardiopulmonary bypass was instituted through axillary:femoral:or direct aortic cannulation and the operative mortality was 2%. The findings demonstrated that surgery through a right thoracotomy with fibrillation is a safe and effective alternative to conventional redo-sternotomy for reoperative MV surgery [8].

Arcidi et al. reported their fifteen-year experience (from June 1996 to April 2010) with minimally invasive right thoracotomy and peripheral cannulation for reoperations involving the MV in 167 patients (mean age 66.9 ± 9 years):71% of whom had undergone previous CABG. Fibrillatory arrest was used in 77% and aortic clamping and root cardioplegia in 23%. Nineteen procedures were performed with robotic assistance. Thirty-day mortality was 3.0% and from 2005-2010 that was decreased to no mortalities. These results confirmed the effectiveness of minimally invasive right thoracotomy to treat mitral pathology while avoiding reoperative sternotomy risk: as well as: the safety of fibrillatory and cardioplegic arrest methods as myocardial preservation strategies with this approach [9]. During the same period:Romano and colleagues reviewed the outcomes of 450 patients (mean age 63 ± 15 years) who underwent redo MV surgery via a RMT from 1996 to 2011. Of these:134 patients underwent redo MV surgery with ventricular fibrillation:and 316 patients underwent beating heart surgery. 74.7 % of these patients had undergone CABG. Although the 30-day mortality was similar for both (6.9% for beating heart and 7.4% for ventricular fibrillation):the beating heart surgery was associated with shorter bypass time:less transfusion requirements:shorter postoperative ventilation. The authors concluded that reoperative MV surgery via a right thoracotomy on the beating heart is a safe effective and reliable procedure [10].

The results of these studies demonstrated that minimally invasive redo MV surgery through a RMT could be safely performed with a low incidence of major vascular injury and perioperative mortality. Also they documented the utility and highlighted the advantages of this approach in reoperative mitral valve procedures. The right thoracotomy was highly suitable to observe valve pathology and function and facilitated efficient exposure to the MV which could be easily approached in all cases. In addition:through the same approach it was also possible to enter the right atrium for additional right heart procedures such as tricuspid valve repair/replacement/atrial fibrillation ablation or atrial septal defect or patent foramen ovale closure [9,10].

In this case presentation we added to these advantages by demonstrating that minimally invasive MVR through RMT under direct vision could be performed in a high risk patient for redo cardiac surgery. The patient in our report had an EuroSCORE II of 6.95% with multiple risk factors for redo cardiac surgery including age of 88 years (older than patients included in the previous studies):obesity with sleep apnea and history of five graft CABG 10 years before with patent grafts [11-15]. These risk factors and the extensive adhesions put the patient in a high risk category for redo cardiac surgery. The occurrence of adhesion-related injuries during the minimally invasive MVR via RMT in our patient was recognized and dealt with quickly as detailed
in the report. This demonstrates that the performance of this procedure in patients with multiple risk factors for redo cardiac surgery and a EuroSCORE II ≥ 6 - <9% is very challenging yet possible.

REFERENCES


Cite this article