

Minimally Invasive Mitral Valve Replacement and Multivessel Coronary Artery Bypass Through a Limited Right Lateral Thoracotomy using a Balloon Aortic Cannula

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ABSTRACT

Mitral valve replacement and coronary artery bypass grafting were performed in an 80-year-old woman through an 8 cm lateral thoracotomy using central cannulation with a balloon aortic cannula. Visualization permitted the delivery of both retrograde and antegrade cardioplegia. This technique provides excellent exposure of the mitral valve and all coronary vessels and decreases the operative risks associated with a sternotomy.

CASE REPORT

An 80-year-old white female was hospitalized for management of acute pulmonary edema. Her workup included cardiac catheterization, which demonstrated 4+ mitral regurgitation and severe coronary artery disease in the circumflex artery (80% stenosis) and the right coronary artery (90% stenosis), with an ejection fraction of 45%. Her past medical history was significant for arthritis, which, for the last two years, had required prednisone therapy.

The patient was taken to the operating room and a single lumen endotracheal tube was inserted. A minimally invasive 8 cm right lateral thoracotomy incision was made in the fourth intercostal space. The incision began several centimeters lateral to the nipple and coursed for 8 cms toward the axilla. An aortic balloon arterial cannula was placed (Chase Medical, Richardson, TX/TYCO-US Surgical, Norwalk, CT) and venous return was collected through a single right angle DLP cannula in the right atrium. After placing antegrade and retrograde cardioplegia cannulae, the balloon cannula was insufflated and cardioplegia was administered antegrade and retrograde. The heart arrested immediately, and was decompressed via an incision above the right superior pulmonary vein into the left atrium.

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The heart was rotated 180 degrees out of the pericardium and into the right chest to expose the circumflex artery, and a reversed saphenous vein bypass graft was performed using 7-0 Surgipro (U.S. Surgical, Norwalk, CT). Before returning the heart into the pericardium, the vein graft was carefully oriented to prevent rotation and clipped to the pericardium. The left atrium was opened widely and inspected for planned repair. Both leaflet chordae were thin and significantly elongated, and therefore, the anterior mitral valve leaflet was excised, leaving the posterior leaflet intact. A #25 Carpentier-Edwards bioprosthetic valve (Edwards Lifesciences, Irvine, CA) was sutured into the annulus. By insufflating the lung gently during knot tying, the mediastinum shifted upward permitting the knots to be hand tied. A knot pusher was used to secure certain knots. The patient was then rewarmed, and the distal right coronary artery was bypassed with saphenous vein. After creating two 5 mm aortotomies, the proximal saphenous vein anastomoses were performed with 6-0 Surgipro (U.S. Surgical, Norwalk, CT). The heart was then de-aired by filling it with blood, ventilating the lungs, and manually manipulating the heart. The balloon was deflated and venting instituted through the cardioplegia needle. Normal sinus rhythm resumed spontaneously. The left atrial suture line was closed, and the patient was separated from cardiopulmonary bypass without difficulty. The cross clamp time was 108 minutes. The cardiopulmonary bypass time was 145 minutes.

The patient had an uneventful postoperative course and remained in normal sinus rhythm. She was discharged home on the fifth postoperative day. She is alive and well more than one year after her surgery.

DISCUSSION

Reduction of surgical trauma remains one of the primary aims of minimally invasive cardiac surgery. Decreasing operative trauma is likely to translate into decreased operative morbidity. This is particularly important in the elderly. Elderly patients have been found to be at greater risk for perioperative complications. Octogenarians have an increased incidence of deep sternal wound infections [Borger 1998], an operative mortality of 9.1%, a stroke rate of 5.4%, and a median 5-year survival of 55% following conventional open heart surgery [Craver 1999].

Avoiding a sternotomy and reducing incision size may reduce the trauma of surgery. Although approaching the mitral valve through a right thoracotomy was routinely used in the 1950's [Kay 1954, Neptune 1958], it tended to be through a large anterior-lateral thoracotomy. The procedure described herein is different because the incision is small. In order to optimize the exposure through this small incision, and to avoid a crushing crossclamp in an 80-year-old patient, we used an aortic-direct balloon arterial cannula. This cannula is placed similar to standard cannula and fixed to the aorta at the point of insertion. A cross-clamp in the operative field would effectively reduce workspace.

Previous reports of mitral valve replacement through a right thoracotomy have employed controlled fibrillation or profound hypothermic circulatory arrest with peripheral cardiopulmonary bypass [Litchford 1976, Calleja 1996]. Use of a balloon arterial cannula reduces the risk of femoral arterial cannulation and possibly, neurologic injury. It also permits instillation of cold blood cardioplegia to optimize myocardial protection, providing a quiescent operative field.

Profound hypothermic circulatory arrest does render the heart motionless. However, this technique has the disadvantage of increasing operative time to cool and rewarm the patient. Furthermore, lower temperatures exacerbate platelet and clotting factor dysfunction, which is known to be worse in the elderly. This may lead to increased postoperative bleeding, a known risk factor for infection [El Oakley 1997].

Coronary revascularization has been performed through a right thoracotomy in the past. However, most reports of this approach have focused on revascularization of the right coronary circulation [Uppal 1994, Usui 1995, Wilde 1997]. As this patient demonstrates, a minimally invasive, right lateral thoracotomy can provide exposure to all coronary arteries. Rotation of the heart out of the pericardium and into the right chest provides exposure to all left coronary vessels.

An aortic balloon cannula may be less invasive than a metallic crossclamp because it avoids crushing the aorta. In patients with severe atherosclerosis, and at higher risk for showering of atheroemboli, a balloon cannula, which conforms to the inner wall of the aorta, makes good sense to these authors.

Patient selection is important in the algorithm for minimally invasive cardiac surgery. This elderly patient with severe arthritis and steroid dependence was not an ideal candidate for a median sternotomy or aortic crossclamp placement. A minimally invasive right lateral thoracotomy provided good exposure to the mitral valve and all coronary vessels. In addition, a balloon aortic cannula prevented aortic deformation as well as incisional space constraint by a crossclamp. This novel approach enhances the surgeons' repertoire in difficult clinical situations.

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REVIEW AND COMMENTARY

1. Editorial Board Member DB515 writes:

This is a good case report and demonstrates innovative surgeons minimizing trauma to an old patient undergoing a traditionally very large procedure.

The authors need to explain the following:

- a) Method of visualization?
- b) Endoscopic tools?
- c) Were all maneuvers done through the main incision?
- d) Is this becoming the preferred technique for MVR/CABG in the institution or by the surgeons? If not why?

Authors' Response by Robert E. Michler, MD:

- a) Direct.
- b) Knot pusher.
- c) Yes.
- d) This technique has been reserved for patients with a significant risk associated with median sternotomy. These patients include the elderly, those at high risk for sternal wound complications, reoperations, and patients who strongly desire a minimally invasive approach.

3. Editorial Board Member AR11 writes:

The authors should have some extended (at least 30-day) follow-up (complications, returns to hospital, etc.)

Authors' Response by Robert E. Michler, MD:

There were no deaths, no significant complications, and no readmissions.

4. Editorial Board Member PB44 writes:

I would be concerned that a complete 180 rotation of the heart with someone with her co-morbidity might tear tissues which would be hard to get at for repair.

Authors' Response by Robert E. Michler, MD:

Complete rotation of the heart is commonly performed in

the setting of conventional revascularization through a sternotomy at our institution and many others. We obviously take great care during the procedure to rotate the heart gently into the right chest on the axis of the cava. The heart readily rotates into the right chest and should be practiced during conventional coronary bypass surgery with the right pleural space open.