Concomitant minithoracotomy aortic and mitral valve surgery: the minimally invasive "Miami Method"

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Submitted Jun 30, 2014. Accepted for publication Jul 17, 2014.
doi: 10.3978/j.issn.2225-319X.2014.09.14
View this article at: http://dx.doi.org/10.3978/j.issn.2225-319X.2014.09.14

Clinical vignette

A 69-year-old female patient with chronic renal failure requiring dialysis, insulin-dependent diabetes mellitus, hypertension and chronic obstructive pulmonary disease presented to the emergency room with epigastric pain and dyspnea upon exertion. Her initial work-up was for gastrointestinal disease. This was inconclusive. A cardiac work-up was subsequently performed. A cardiac catheterization demonstrated a high grade lesion of the proximal left anterior descending artery. Percutaneous coronary intervention with a drug eluting stent was successfully performed. An echocardiogram was also performed which demonstrated a 40% ejection fraction. There was severe aortic stenosis with a peak/mean gradient of 68/45 mmHg, respectively. In addition, she had severe mitral regurgitation with a posteriorly directed jet and moderate mitral annular calcification. She was considered a hybrid patient and taken to the operating room several weeks after the percutaneous coronary intervention on clopidogrel. She underwent a minimally invasive, minithoracotomy aortic valve replacement with a porcine bioprosthetic aortic valve and a complex mitral valve repair with anterior leaflet augmentation with autologous pericardium.

Surgical techniques

Preparation

All patients undergo a pre-operative cardiac catheterization and echocardiogram. A computed tomography angiogram of the chest, abdomen and pelvis to evaluate the location of the aorta and the atherosclerotic burden of the aorta and peripheral vasculature is not routinely performed. The patient is intubated with a single lumen endotracheal tube. We no longer utilize single lung ventilation. A Swan Ganz catheter and transesophageal echocardiogram Doppler probe are also inserted. A thorough echocardiographic evaluation is performed prior to positioning the patient.

Exposition

All patients are placed in the supine position during the anesthetic induction. Thereafter, a roll is placed behind the scapula, the patient is rolled to the left and the right arm is placed over the head. The hips are positioned as supine as possible on the operating table to facilitate peripheral cannulation.

A very simplistic approach is utilized in order to decide the exact site of entry into the chest. The sternum is marked from the suprasternal notch to the lowest point of the xiphoid. Thereafter, the midpoint of the entire sternum is located. An imaginary line is drawn from this midpoint laterally. A 6 cm incision is then made lateral to, and starting at, the anterior axillary line. This will usually correspond to the 4th intercostal space and provides excellent exposure to both the aortic and mitral valve. In female patients, the incision will be made in the infra-mammary crease laterally.

Operation

In the majority of cases, a femoral platform is utilized to establish cardiopulmonary bypass. The femoral artery is usually cannulated with a 15-19 French arterial Bio-medicus

cannula depending upon the patients body surface area and the femoral vein is cannulated with a 25 French venous Bio-medicus cannula (Bio-medicus, Medtronic, Minneapolis, MN, USA) in all patients independent of the body surface area. If severe peripheral vascular disease is present, the axillary artery in the axilla is cannulated.

Cardiopulmonary bypass is initiated using a closed membrane oxygenator and a roller pump. Venous drainage is augmented with vacuum assistance which enables the application of negative pressures of between 35 and 65 mmHg as needed to decompress the right heart. A retrograde cardioplegia cannula is inserted directly through the incision and into the right atrial appendage. The patient's temperature is allowed to drift to 34 degrees. Trans-incisional direct aortic cross clamping is then performed utilizing a flexible and retractable shaft cross clamp (Cygnet, Vitalitec, Plymouth, MA, USA). One dose of antegrade cold blood cardioplegia is given and thereafter, retrograde cold blood cardioplegia is delivered. We have recently converted to a modified 4:1 blood to crystaloid Del Nido cardioplegia solution prepared by our perfusionists.

A left atriotomy is performed and a sump suction is inserted in order to decompress the left heart. Attention is then directed to the aorta where a complete circumferential aortotomy is made above the level of the sino-tubular junction. This will allow unimpeded visualization of the entire aortic valve. The aortic valve leaflets are removed and the annulus debrided. At this point we direct our attention back to the mitral valve. The left atriotomy is extended superiorly and then inferiorly under the inferior vena cava. A specially designed atrial lift system and Visor (Miami Instruments, Miami, FL, USA) are inserted into the atrium to provide additional exposure and direct line visualization of the mitral valve. A thoracoscope is not utilized. The atrial lift post is inserted into the chest via a 16 Fr. introducer peel away sheath (Cook Medical, Bloomington, IN, USA). This maneuver has proven to be relatively atraumatic. Any complex repair or replacement can be performed because of the excellent anatomic visualization of the mitral valve. All repairs begin with placement of the mitral annular sutures. This will provide additional exposure of the mitral valve. The valve replacement and/or repairs are carried out under direct vision utilizing standard techniques. All procedures are performed with specially designed long shafted minimally invasive instruments. Carbon dioxide is infused into the operative field during the entire procedure. After partial closure of the atriotomy, attention is now directed back to the aortic valve. With the aorta completely transected, three 3-0 prolene stay sutures are placed on the commisures. If the aorotomy is not completely transected, the non coronary portion of the annulus may be difficult to visualize. The aortic valve sutures are then placed through the annulus and subsequently the valve. The sutures are tied with a knot setter (Miami Instruments, Miami, FL, USA). Thereafter the circumferential aortotomy is closed with two running sutures of 5-0 prolene (Ethicon, Johnson & Johnson) reinforced with an external felt or pericardial strip. This will diminish the potential of bleeding from the posterior suture line. Occasionally, a small one cm segment of aorta can be retained posteriorly if there is sufficient visualization of the aortic annulus.

Completion

The patient is placed in a Trendelenburg position and once the cross-clamp is removed, an angiocath is inserted in the aortic root to aid with removal of air. One Blake chest tube (Blake, Ethicon, Johnson & Johnson) is left in the pleural cavity and another in the pericardial sac. These, along with the temporary ventricular pacer and the On-Q pain relief system (I-Flow, LLC, Irvine, CA, USA), are passed through the chest tube incision. A number 2 suture is then placed in a figure of eight fashion to approximate the ribs. Of note, the ribs are not transected.

Comments

Clinical results

When compared to a standard median sternotomy approach, the potential benefits of minimally invasive valve surgery include: reduced surgical trauma, blood loss, need for re-operation for bleeding, reduced pain, a more rapid return to functional activity, and shorter intensive care unit and hospital length of stay (1-5). At our institution, from November 2008 to April 2014 we have performed 3,738 cardiac surgeries, of which 2,344 were performed utilizing a minimally invasive approach.

During this time, we performed 169 primary surgeries which consisted of aortic valve replacement with mitral valve replacement or mitral valve repair. The mean age of these patients was 73±12 years, and there were 78 (46%) males and 91 (54%) females. The median aortic cross clamp and cardiopulmonary bypass times were 116 minutes [interquartile range (IQR), 91-138] and 145 minutes (IQR, 121-178), respectively. There were 4 (2.36%) patients that

required re-operation for bleeding, and 2 (1.18%) suffered cerebrovascular accidents. The median hospital length of stay was 7 days (IQR, 6-12), and the 30-day mortality was 6 (3.55%).

Advantages

The minithoracotomy approach allows for excellent visualization of both valves as compared to a sternotomy or upper hemi sternotomy. A sternal sparing operation is beneficial in high risk patients, avoiding the potential for sternal wound infections. This procedure also benefits those patients with respiratory issues by allowing aggressive pulmonary toilet, coughing and ambulation without the fear of sternal dehiscence. In addition, the incidence of bleeding as well as transfusion requirements are diminished because a sternotomy is avoided and there is less tissue trauma. This technique also allows patients the benefit of a hybrid approach despite being on anti-platelet medications. Any complex mitral valve procedure can be performed due to the direct and unimpaired visualization of the mitral valve. The minimally invasive operation is tailored to the patients needs as opposed to its perceptual limitations.

Caveats

Choosing the correct interspace is crucial to obtain adequate exposure. Selecting the mid-point on the sternum as a landmark for entry into the chest and performing the incision lateral to the anterior axillary line is of paramount importance. Complete transection of the aorta greatly facilitates exposure of the entire aortic annulus in concomitant aortic and mitral operations, but aortotomy closure must be extremely meticulous in order to avoid bleeding. Finally, adequate myocardial protection is always the key to success.

Cite this article as: Lamelas J. Concomitant minithoracotomy aortic and mitral valve surgery: the minimally invasive "Miami Method". Ann Cardiothorac Surg 2015;4(1):85-87. doi: 10.3978/j.issn.2225-319X.2014.09.14

Acknowledgements

Disclosure: Dr. Chris Mihos and Dr. Andres Pineda for their contributions to this article. Dr. Joseph Lamelas receives honoraria for lectures from Medtronic, St. Jude and On-Q and is a partner in Miami Instruments. All procedures were performed by a single surgeon, Dr. Joseph Lamelas.

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