Minimally Invasive Aortic and Mitral Valve Operation

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Although minimally invasive approaches for individual aortic and mitral valve surgery are commonplace,1-3 these techniques are also quite appropriate for those patients with bivalvular (aortic and mitral) disease. Through a small anterior thoracotomy incision, the surgeon gains access to operate on both the aortic and mitral valves. This incision obviates the need for a sternotomy and its attendant complications.4 This article describes the standard NYU approach for minimally invasive aortic and mitral valve disease.

Team Approach
As fully described in another article in this issue (p 176), the minimally invasive approach for valvular heart surgery requires a team approach for intraoperative patient care. Although the minimally invasive double-valve operation does not rely on "endoclamp" technology,5 the anesthesiologist should be facile with placement of a coronary sinus catheter. Transesophageal echocardiography (TEE) is a mainstay of the procedure for both catheter placement and monitoring and requires excellent echocardiographic skills, either from an echocardiologist or from cardiac anesthesia personnel trained in this discipline.6 The benefits of the minimally invasive approach to the patient are predicated on this critical mass of required skills.

Operating Room Setup
The patient is positioned on the table in the standard fashion in a supine position without the necessity to move the chest in either direction. After endotracheal intubation with a single-lumen tube, a TEE probe is placed, and the aorta is visualized and evaluated. Care is taken to note the presence of aortic atheromatous disease or concomitant anomalies such as an atrial septal defect or a persistent left superior vena cava. Such information may change the intraoperative strategy.

Next, the anesthesiologist places a coronary sinus cardioplegia catheter through a percutaneous right internal jugular introducer. Although this is not absolutely necessary, it facilitates the operation by obviating the need for handheld cardioplegia cannulas. After this catheter is placed under TEE guidance, a brief fluoroscopic exam with a coronary sinus angiogram is performed. This confirms appropriate placement of the catheter in the coronary sinus and verifies that the catheter has not been advanced into a small tributary coronary vein.

Surgical Technique

After the patient is prepped and draped, a small groin incision is made, and the femoral vein is identified and prepared with vessel loops and snares. Typically, it is not necessary to use the femoral artery for retrograde arterial perfusion, because the ascending aorta is immediately accessible and will be directly cannulated. A skin incision on the right anterior chest over the third interspace is performed, and an intercostal incision is made.
A soft tissue retractor is placed, and the chest is spread open with a small Finochetto retractor. The intercostal incision is extended posteriorly, allowing the surgeon to spread apart interspace without fracturing the rib. The fat overlying the anterior mediastinum is mobilized, and an incision is made into the pericardium, exposing the root of the aorta and the junction of the superior vena cava and right atrial appendage. The pericardial incision is continued inferiorly. Opening the retractor will provide excellent exposure. Sutures are placed laterally in the pericardium to help marsupialize the pericardial contents, bringing the pulmonary veins up fully into the operative field. If exposure is limited initially, the third rib can be disconnected from the cartilage, which will greatly facilitate exposure.

The patient is now fully heparinized, 4-0 monofilament pursestring sutures are placed in the ascending aorta, and an arterial cannula is placed. The aortic cannulation site is chosen to allow sufficient room proximally on the aorta for crossclamp application and creation of an aortotomy. A long venous cannula is placed under guidance of transesophageal echocardiography (TEE) in the femoral vein. First, a guide wire is advanced into the superior vena cava; then the venous cannula is advanced over this wire. A closed bypass system with venous vacuum is used to provide total drainage of the atrium. Occasionally, the surgeon may opt to place a second small venous cannula in the right atrial appendage to facilitate venous drainage. (Ao, aorta; RAA, right atrial appendage; SVC, superior vena cava.)
Cardioplegic arrest and exposure of the valves. With pump flow temporarily diminished, a standard crossclamp is directly applied to the ascending aorta just below the arterial cannulation site. Retrograde cardioplegia is delivered to provide cardiac arrest. With cardiac arrest achieved, the patient is typically cooled to 25°C. (Ao, aorta.)
A transverse aortotomy is performed in the ascending aorta to expose the diseased aortic valve. The incision is often curved down to the aortic root to enhance exposure. The aortic valve is resected at this point. The aortic prosthesis is not inserted at this time, because this would hinder access to the mitral valve.
Attention is now turned to the mitral valve. Pulling on the lateral sutures placed in the pericardium brings the right superior pulmonary vein into view. An incision is made just anterior to the vein and posterior to the atrial septum. This incision is continued caudally, just anterior to both pulmonary veins. (RAA, right atrial appendage.)
An intra-atrial blade retractor is placed into the left atrium under direct visualization. A separate stab wound is made on the anterior chest wall, and the handle is introduced to the blade. Typically, because bivalvular disease is most commonly rheumatic, the operation will consist of bivalvular replacement. The mitral valve is removed, and sutures are placed for the new valve. Care is taken at 4 to 5 o'clock on the mitral annulus, because deep sutures could puncture the coronary sinus catheter balloon.
After the mitral valve has been replaced, the inferior portion of the atrial incision is closed with two running layers of 3-0 Prolene suture (Ethicon, Inc., Somerville, NJ). A venting catheter is placed through the atrial closure line, across the prosthetic valve, and into the left ventricle. This catheter is connected to one of the pump suction catheters and left clamped. The superior portion of the atriotomy incision line is closed with 3-0 Prolene, and a snare is placed around the venting catheter.
The aortic annular sutures are placed, and the aortic prosthesis is sewn in place. The aortotomy is closed with standard techniques. Typically the lateral inferior portion of the incision is closed with interrupted figure eight sutures, whereas the anterior part of the incision is closed with two running layers of Prolene. The most anterior corner of the suture line is left loose; this will be used to vent the root during the de-airing process.

With the heart still decompressed, a temporary epicardial pacing wire is placed on the surface of the right ventricle and connected to an electrical fibrillator. With blood volume gradient placed in the heart, the venting catheter is placed on gentle suction, and the crossclamp is released. TEE is used to monitor the left atrium and ventricle for the presence of air. With the heart under electrically induced fibrillation, more blood volume gradient is placed into the atrium and ventricle and vented through the catheter. The lungs are manually inflated to clear any trapped air from the pulmonary venous bed. The patient is moved back and forth to help dislodge any air that may be trapped inside the ventricle. After all air is cleared, as verified by TEE, the crossclamp is reapplied. The electrical fibrillator is stopped, and the heart is cardioverted. The heart is allowed to beat against the crossclamp while the aortic root is vented through the loose corner of the aortotomy closure line.

When this has been completed, the main pump flow is temporarily diminished, and the crossclamp is completely removed. The aortotomy sutures are secured. The venting catheter is then withdrawn through the suture line, and the atriotomy is oversewn. The patient is ventilated and warmed to more than 35°C, and cardiopulmonary bypass is discontinued. The long venous cannula is removed, and the femoral vein is repaired primarily with 5-0 Prolene. Heparinization is reversed with protamine, and the arterial cannula is removed from the aorta. The pursestrings are tied shut and oversewn with monofilament suture.

A chest tube is placed through a separate stab incision. A soft silastic sump catheter is laid over the aortic root and the right atrium and exteriorized separately. Paracostal incisions are used to approximate the intercostal incision. The chest wall muscle and soft tissues are closed with running sutures.
POSTOPERATIVE MANAGEMENT

Patients are not extubated in the operating room, but rather are extubated within the first few hours in the recovery room after reversal of the neuromuscular blockade. Patients are typically discharged on the third or fourth postoperative day. Oral anticoagulation is started on the first postoperative night. Regulation of oral anticoagulation may not be achievable during the short postoperative stay, and so is adjusted on an outpatient basis.

The minimally invasive approach for combined aortic and mitral valve surgery provides excellent access to the valves. This approach is associated with diminished patient discomfort. Postdischarge, patient activity and return to function is superior to that associated with the standard sternotomy approach.

REFERENCES