Minimally Invasive
PORT ACCESS
Mitral Valve Surgery
The majority of isolated mitral valve procedures can be performed with minimally invasive approaches that reduce patient trauma, blood loss and hospital length of stay, speed recovery and produce a superior cosmetic result.\(^1\)\(^4\)

The most commonly employed minimally invasive approach for mitral valve surgery is a right mini-thoracotomy. This approach relies upon peripheral cannulation for cardiopulmonary bypass, specialized techniques for myocardial protection, and use of long-shafted instruments. The right mini-thoracotomy provides excellent visualization of the mitral valve and facilitates tricuspid valve surgery or surgical ablation of atrial fibrillation when indicated.

The objective of this monograph is to illustrate the right mini-thoracotomy approach for mitral valve surgery with particular emphasis on techniques for cardiopulmonary bypass, myocardial protection, and valve exposure. We illustrate a classic PORT ACCESS approach that employs the EndoClamp catheter for aortic occlusion and a modified approach that relies upon a transthoracic clamp for aortic occlusion.

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A. Marc Gillinov, MD and Tomislav Mihaljevic, MD are paid consultants to Edwards Lifesciences.

The surgical techniques presented herein are the techniques used by A. Marc Gillinov, MD and Tomislav Mihaljevic, MD. Edwards Lifesciences does not endorse any particular surgical technique.
MINIMALLY INVASIVE PORT ACCESS SURGERY
ANESTHESIA PREPARATION INCLUDING RETROGRADE CARDIOPLEGIA CATHETER AND PULMONARY ARTERY VENT

Before surgical incision, transesophageal echocardiography is used to confirm mitral valve dysfunction and to ensure that the aortic valve is competent; aortic regurgitation that is more than mild is a relative contraindication to a right mini-thoracotomy approach to the mitral valve. Bilateral upper extremity arterial monitoring lines are placed if the EndoClamp catheter is to be used for aortic occlusion. A right internal jugular venous line is placed for possible conversion to a venous cannula if additional venous drainage is necessary. Using echocardiographic guidance and if required fluoroscopy assistance, the anesthesia team places a coronary sinus catheter for delivery of retrograde cardioplegia and a pulmonary artery vent. With experience, these catheters can be positioned in only a few minutes.
PATIENT POSITIONING AND INCISION

The patient is positioned supine with a roll under the right scapula. The right arm is distracted from the torso in order to expose the axilla. The incision is marked in the 4th intercostal space lateral to the nipple. In a woman, the incision is placed in the inframammary crease. The incision is 4-8 cm in length depending upon surgeon preference.
SOFT TISSUE RETRACTORS

The chest is entered in the 4th intercostal space and a soft tissue retractor is placed; the arms of the soft tissue retractor are affixed to the skin under tension to form an “X.” A fine catheter is placed in the chest to insufflate CO₂ at a rate of 6 liters/minute.
CHEST WALL RETRACTOR

The chest wall retractor is placed over the soft tissue retractor. In most instances, the cross bar is placed toward the patient’s left; however, it may also be placed with the cross bar to the patient’s right. The retractor articulates to optimize exposure. A stitch placed through the central tendon of the diaphragm and taken through the chest wall caudal to the incision improves exposure if the diaphragm obstructs visualization of the pericardium.
PERICARDIOTOMY

The pericardium is opened 3-4 cm anterior to the phrenic nerve. The pericardiectomy is extended down to the diaphragm and cephalad to expose the aorta; occasionally the cephalad portion of the pericardiectomy is most easily completed once the patient is on cardiopulmonary bypass.
CANNULATION FOR CARDIOPULMONARY BYPASS

The femoral artery and vein are exposed via a small transverse incision in the skin crease. In smaller patients, it is prudent to expose the femoral vessels before constructing the thoracotomy in order to ensure that they are of adequate size for cannulation. Purse-string sutures are placed in the femoral artery and vein. With guidewire technique and echocardiographic guidance, the femoral venous cannula is advanced so that its tip is in the superior vena cava, usually extending 2-3 cm into the vessel. The femoral arterial cannula is introduced into the femoral artery with guidewire technique and echocardiographic confirmation that the guidewire is intraluminal. The EndoClamp catheter is advanced into the ascending aorta over a guidewire with echocardiographic guidance.
AORTIC OCCLUSION AND CARDIOPLEGIA DELIVERY

Cardiopulmonary bypass is initiated and adequate drainage is confirmed. Vacuum-assisted venous drainage is routinely employed. If drainage is not adequate, a right internal jugular venous catheter placed by anesthesia is changed over a wire to a superior vena cava cannula for cardiopulmonary bypass. The perfusionist achieves the systemic blood pressure that will be maintained during the case, and the EndoClamp catheter is inflated.

EndoClamp catheter inflation is accomplished in a step-wise fashion, with constant monitoring of balloon position on echocardiogram, aortic root pressure, and upper extremity pressures. Initially, 5 cc of saline is added to the balloon. To prevent balloon migration towards the aortic valve, remove excess slack from the EndoClamp catheter by gently retracting it at the groin incision. If the balloon still migrates toward the aortic valve, it is manually retracted with echocardiographic visualization in order to maintain position in the ascending aorta. Saline is gradually added in 5 cc increments, maintaining balloon position. When the aortic root pressure falls to zero, the root is occluded and the balloon is locked into place by the rotating hemostasis valve.

Antegrade cardioplegia delivery is started. Balloon pressure is generally 300-350 mmHg at this point. Antegrade cardioplegia flow is confirmed by using color flow Doppler echocardiography to examine the aortic root. Upper extremity pressures, aortic root pressure and balloon pressure are monitored throughout the operation. Myocardial protection is achieved with a combination of antegrade cardioplegia, retrograde cardioplegia, and mild systemic hypothermia (28-32˚ C).
MITRAL VALVE EXPOSURE

A standard left atriotomy is constructed and an appropriate retractor blade is chosen to expose the mitral valve. The shaft of the retractor is introduced through the 3rd or 4th intercostal space near the mid-clavicular line and screwed onto the retractor blade. Care must be taken not to injure the internal thoracic vessels. Minor adjustments in position of the blade may be necessary to optimize exposure.
MITRAL VALVE EXPOSURE

In most cases, mitral valve exposure is excellent. Early placement of annuloplasty sutures enhances exposure by distracting the valve toward the surgeon.
MINIMALLY INVASIVE MODIFIED PORT ACCESS SURGERY
Before surgical incision, transesophageal echocardiography is used to confirm mitral valve dysfunction and to ensure that the aortic valve is competent; aortic regurgitation that is more than mild is a relative contraindication to this approach. A right internal jugular venous line is placed for possible conversion to a venous cannula if additional venous drainage is necessary. Using echocardiographic guidance and if required fluoroscopy assistance, the anesthesia team places a coronary sinus catheter for delivery of retrograde cardioplegia and a pulmonary artery vent. With experience, these catheters can be positioned in only a few minutes. The patient is positioned supine with a roll under the right scapula. The right arm is distracted from the torso in order to expose the axilla. The incision is marked in the 4th intercostal space lateral to the nipple. In a woman, the incision is placed in the inframammary crease. The incision is 4-8 cm depending upon surgeon preference.
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PERICARDIOTOMY

The pericardium is opened 3-4 cm anterior to the phrenic nerve. The pericardiotomy is extended down to the diaphragm and cephalad to expose the aorta; occasionally the cephalad portion of the pericardiotomy is most easily completed once the patient is on cardiopulmonary bypass. Two stay sutures are placed in the pericardium anterior to the phrenic nerve and brought out through the chest wall laterally, exposing the right atrium and right pulmonary veins.
CANNULATION AND MYOCARDIAL PROTECTION

The femoral artery and vein are exposed by a small transverse incision in the skin crease. The femoral venous cannula is advanced with guidewire technique and echocardiographic guidance into the superior vena cava, usually extending 2-3 cm into the vessel. The femoral arterial cannula is advanced into the femoral artery. Cardiopulmonary bypass is established and drainage is assessed; if drainage is inadequate, the surgeon may reposition the cannula to achieve better drainage. Occasionally, a second venous cannula is advanced percutaneously into the superior vena cava by rewiring a right internal jugular venous line. Vacuum-assisted venous drainage is routinely employed. An antegrade cardioplegia catheter is placed in the proximal ascending aorta.
TRANSTHORACIC AORTIC CROSS-CLAMP

A transthoracic aortic cross-clamp is introduced through the chest wall in the 3rd intercostal space as posteriorly as possible; the clamp is positioned in the transverse sinus for aortic occlusion. The clamp is oriented so that its concave aspect is directed cephalad. Alternatively, a cross-clamp with a flexible shaft may be introduced through the primary incision.
MITRAL VALVE EXPOSURE

A standard left atriotomy is constructed and an appropriately-sized retractor blade is chosen to expose the mitral valve. The shaft of the retractor is introduced through the 3rd or 4th intercostal space near the mid-clavicular line and screwed onto the retractor blade. Care must be taken not to injure the internal thoracic vessels. Minor adjustments in position of the blade may be necessary to optimize exposure. In most cases, mitral valve exposure is excellent. Early placement of annuloplasty sutures enhances exposure by distracting the valve toward the surgeon.
References


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