

Mitral Valve Surgery Via a Right Anterior Mini-Thoracotomy with Central Aortic Cannulation and No Endoscopic Assistance

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Alex Zapolanski, MD,¹ Keith Korver, MD,¹ Michael B. Pliam, MD, PhD,¹

Richard E. Shaw, PhD,² Laurel M. Mengarelli, RN¹

¹Department of Cardiovascular Surgery,

²Departments of Biostatistics and Bioengineering,
San Francisco Heart Institute, Seton Medical Center, Daly City, California

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*Address correspondence and reprint requests to: Alex Zapolanski, MD, Director of Cardiac Surgery, San Francisco Heart Institute, Seton Medical Center, 1900 Sullivan Avenue, Daly City, California, 94015, Phone: (650) 992-8200, Fax: (650) 992-8388
Email: Zapolanski@aol.com*

ABSTRACT

Background: A variety of techniques have been described to reduce surgical access in mitral valve surgery. : Mini-sternotomy (Gundry) involves partial division of the sternum while the right anterior mini-thoracotomy approaches described involve either Port Access™ (Heartport, Redwood City, CA), indirect endoscopic techniques (Chitwood) and more recently, robotic techniques (Intuitive Surgical™). This report describes a simplified approach that “borrows” aspects from several techniques.

Methods: Using currently available technology, a simplified technique to perform mitral valve surgery (MVST) has been developed. MVST eliminates the need for endoscopic assistance and femoral arterial cannulation. The results of 50 of these patients were analyzed and compared with those of 66 patients who had isolated mitral valve surgery via a conventional approach (MVCS) over the same five-year interval.

Results: Between January 1, 1995 and December 31, 2000, 50 patients had mitral valve surgery performed with a simplified technique (MVST). Twenty-six (52%) of the MVST patients underwent mitral valve replacement and 24 (48%) underwent mitral valve repair. There were no in-hospital deaths in the

MVST group, compared to a death rate of 7.1% in the MVCS group. There were no strokes and no perioperative myocardial infarctions in the MVST group. Average ICU stay was 3.4 days (1 day shorter than the MVCS group) and average hospital stay was 8.1 days, which was significantly less than the 12.5 day length of stay for the patients having MVCS ($p < 0.01$). Blood was utilized in 36% of the MVST patients, compared to a 55% rate in the MVCS group. There were no wound infections in the MVST group. Two patients did develop bloody effusions requiring thoracentesis. Antegrade blood cardioplegia was used in 35 (70%) of the MVST patients. Antegrade and retrograde blood cardioplegia was used in 15 (30%) patients. Average cross-clamp time in the MVST group was 70 minutes compared to 85 in the MVCS group ($p < 0.05$) and the average pump run was 98 minutes in the MVST group compared to 112 for the MVCS group ($p = 0.08$).

Conclusion: Mitral valve surgery using a simplified, less invasive technique can be successfully and safely performed in selected patients, resulting in less blood utilization and shorter hospital length of stay, with a cosmetic result that rivals that of robotically assisted techniques.

INTRODUCTION

Reduction in the size of the operative incision for cardiac valve surgery has been associated with diminished perioperative blood administration, reduced postoperative discomfort, shorter intensive care and hospital lengths of stay, earlier recovery and return to work, and improved overall patient satisfaction [Cohn 1997, Cooley, 1998, Gundry 1998, Galloway 1999, Mishra 1999, Sener 2001]. While these achievements are unquestionably laudable, the techniques described to accomplish limited access surgery for the mitral valve have involved somewhat difficult and cumbersome technologies that have not been accessible to all cardiac surgeons [Carpentier 1996, Chitwood 1997, Galloway 1999, Glower 1998, Glower 1999, Mohr 1998, Vanermen 1999]. Borrowing from several recently described methods, a simplified technique to perform mitral valve surgery (MVST) has been developed. Regardless of what innovative techniques the future may bring, current patients should benefit from limited-access mitral valve surgery that is readily available and reproducible in most hands.

MATERIALS AND METHODS

Surgical Technique

Incision: Access is obtained through the right third intercostal space in males and the right fourth intercostal space in women. In women the incision is hidden under the breast and reaching the third space is more difficult. In men that tend to be taller, the access to the aorta is easier with the higher incision. The incision is kept to three inches to maximize cosmesis. While the thoracotomy is kept limited, the intercostal muscle is divided as posterior as possible. This allows separation of the ribs, preserving their integrity in most cases. Ribs are not divided or resected. The Limavator™ (Genzyme, Cambridge, MA), a device designed to dissect the internal mammary artery is used as a chest retractor. The Limavator has a lifting capability that allows easy access to the aorta. It is important to place the Rultract component of the device on the assistant's side of the OR table. This facilitates aortic cannulation, clamping and delivery of antegrade cardioplegia. In addition, the cephalad pull of the Limavator enlarges the incision creating a larger working space.

Cannulation: Aortic cannulation is accomplished conventionally. Two pledgeted purse-string sutures are placed on the aorta. While cannulation is simple, safety during the decannulation process should be emphasized. At present, we are using a US Surgical™ cannula that includes a stylet and guide wire. It is introduced into the chest through a separate skin incision. Because cannulation of the aorta is somewhat remote, the stylet provides sufficient stiffness to control the cannula from a distance. In addition, by advancing the wire first, precise direction of the wire is achieved with trans-esophageal echo control. Venous cannulation is always achieved peripherally. A number 28 DLP™ long venous drainage cannula is placed via the right groin. An incision not to exceed an inch is sufficient to gain access to the femoral vein. The vein is never clamped. A 5-0 purse-string suture is placed anteriorly, and the cannula is delivered following puncture of the vein with a #11 blade. The cannula has a guidewire and multiple dilators. Trans-esophageal echocardiographic control as well as palpation facilitates precise positioning of the cannula. It is important to place the tip of the cannula approximately an inch and a half above the superior vena cava-atrial junction. The rationale for this is that during the left atrial exposure the venous cannula is pulled upwards and its tip could be displaced thus reducing venous drainage. It is helpful to secure the venous cannula to the thigh with a simple stitch and a tourniquet to prevent

motion. We have experienced no complications related to this peripheral cannulation technique.

Cardiopulmonary bypass is initiated and the site to place the Scanlan-Chitwood (Scanlon Instruments, St Paul, MN) clamp is chosen. The clamp is to be brought inside the chest to be placed on the aorta in a perpendicular manner, therefore the site of penetration on chest wall is important. The same site is used to introduce a K-50 extension tubing to be used for cardioplegia delivery. A 14-gauge angiocath is used for antegrade cardioplegia. We do use retrograde cardioplegia in patients with mild aortic insufficiency not requiring intervention on the aortic valve. All of these maneuvers eliminate the presence of instruments, cannulas, etc. in the wound allowing the use of the space strictly as a “working port” during the valve procedure.

Following cardiac arrest, the left atrium is opened and exposure is best accomplished with the Heartport™ mitral valve retractor. The valve is repaired or replaced as deemed necessary. Carbon dioxide is used to facilitate intra-cardiac de-airing. Following atrial closure, the completion of the de-airing process is achieved with suction through the angiocath in the ascending aorta, and under careful transesophageal echocardiographic control. The heart is reperfused and the patient is separated from cardiopulmonary bypass.

The decannulation technique is particularly important. Remote tying of the aortic purse-string sutures could be hazardous. The aortic cannula is removed prior to removing the venous cannula using the following sequence. We divide the arterial inflow line from the arterial cannula and connect it to the venous line. This maneuver allows for rapid return of blood to the patient should it be necessary. The aortic cannula is removed. One of the two tourniquets is used to secure the aorta while the other purse-string is tied. Occasionally a knot-tying device is required if the cannulation site is not within finger reach. When both purse-strings are securely tied protamine is delivered. The venous cannula is then removed.

Prior to closure a long lasting local anesthetic is infiltrated in several intercostal spaces. The wound is closed cosmetically.

RESULTS

Between January 1, 1995 and December 31, 2000, 116 patients had isolated mitral valve surgery. In 50 of these patients, mitral valve surgery was performed with a simplified technique (MVST) that eliminates the need for

endoscopic assistance as well as femoral arterial cannulation. Twenty-six (52%) of the MVST patients underwent mitral valve replacement and 24 (48%) underwent mitral valve repair. The average age of this group was 57 years of age, while patients having conventional mitral valve surgery (MVCS) had an average age of 62 years. Two (4.5%) of the MVST surgeries were re-operations. There were no in-hospital deaths in the MVST group, compared to a death rate of 7.1% in the MVCS group. There were no strokes and no perioperative myocardial infarctions in the MVST group. Average ICU stay was 3.4 days (1 day shorter than the MVCS group) and average hospital stay was 8.1 days, which was significantly less than the 12.5 day length of stay for the patients having MVCS ($p < 0.01$). Two patients in the MVST group required re-exploration for bleeding. Blood was utilized in 36% of the MVST patients, compared to a 55% rate in the MVCS group. There were no wound infections in the MVST group. Two patients did develop bloody effusions requiring thoracentesis. Extubation was achieved on the day of surgery in all but one of the MVST patients. Antegrade blood cardioplegia was used in 35 (70%) of the MVST patients. Antegrade and retrograde blood cardioplegia was used in 15 (30%) patients. Average cross-clamp time in the MVST group was 70 minutes compared to 85 in the MVCS group ($p < 0.05$) and the average pump run was 98 minutes in the MVST group compared to 112 for the MVCS group ($p = 0.08$).

DISCUSSION

For the past few years, cardiac surgeons have been searching for the ideal incision to perform valvular surgery. While some techniques minimize the extent of the access they still require partial sternotomy (8). Others, less invasive in terms of avoiding bone partition, (2,10,12) require peripheral arterial cannulation or the use of expensive endoscopic equipment not available to the majority of practicing surgeons. In addition, the learning process of indirect endoscopic techniques is counter-intuitive. The Port-Access™ method, while improved with direct aortic cannulation, requires intra-aortic balloon occlusion, with its own limitations (balloon displacement, inadequate venting of the aortic root, etc...). The more recently developed robotic techniques also require the support of the Heartport™ system.

Following our initial experience with the Port-Access™ approach we analyzed every step of the operation in an attempt to simplify it and make it available to all surgeons.

The key aspect of every surgical procedure is exposure; the use of the Limavator (Genzyme, Cambridge, MA) maximizes the access with an incision slightly larger than the width of its blades. The rest of the procedure as describe in this paper is the result of unsurpassed exposure. The MVST has the following advantages:

1. Cosmetic (particularly in women)
2. Uses central aortic cannulation
3. Exposure of the mitral valve is by direct visualization
4. Cross clamping of the aorta is conventional
5. Cardioplegia is conventional
6. Aortic venting and de-airing is conventional
7. Preserves bone integrity
8. Cost effective
9. Easily reproducible

Mitral valve surgery using a simplified, less invasive technique can be successfully and safely performed in selected patients, resulting in less blood utilization and shorter hospital length of stay, with a cosmetic result that rivals that of robotically assisted techniques.

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Figure 1. Exposure of the operative field via a right anterior mini-thoracotomy. The Limavator™ elevates the superior chest wall cephalad and upward while retracting the inferior chest wall caudally. The Chitwood™ clamp is placed on the ascending aorta under direct vision after being passed through the right chest wall. Cardioplegic delivery tubing is shown here introduced through the same port as the Chitwood clamp.

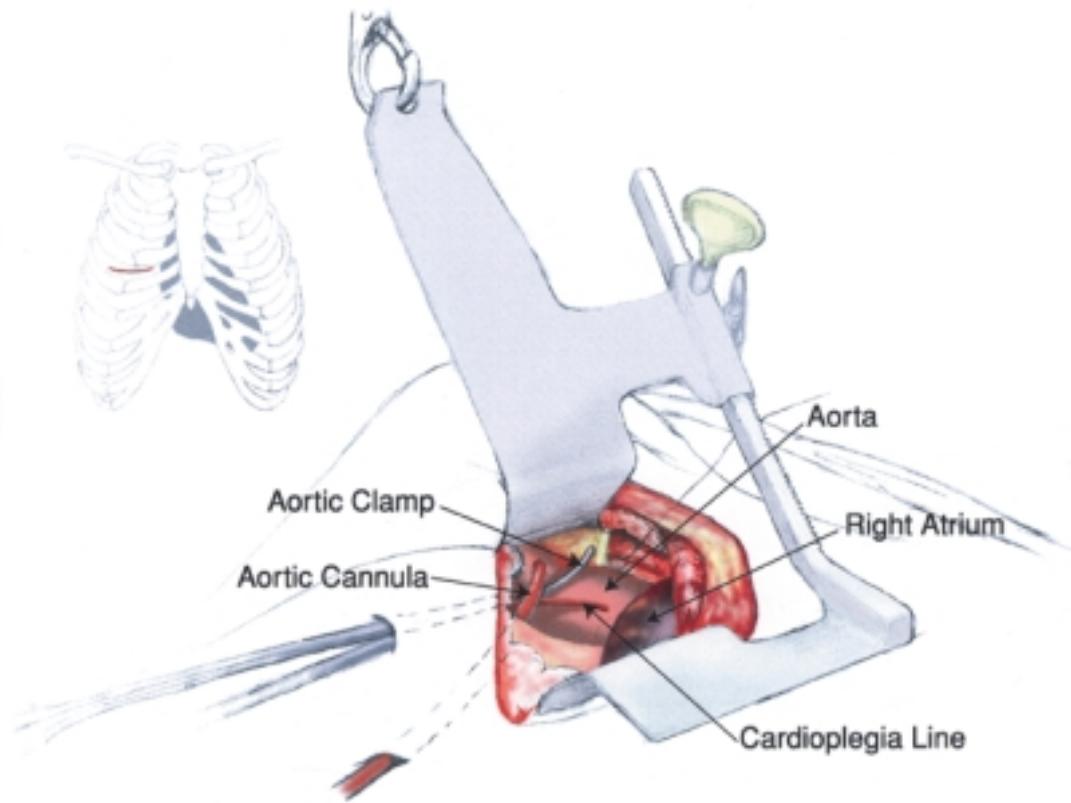


Figure 2. Direct visualization of the mitral valve is facilitated through the use of a Heart-Port™ mitral retractor. This allows for direct valve annulus suturing without the need for endoscopic assistance.

