Minimally Invasive Video-Assisted Mitral and Aortic Valve Surgery – Our Initial Clinical Experience

Amihay Shinfeld MD, Erez Kachel MD, Yoav Paz MD, Sergei Praisman MD and Aram K. Smolinsky MD

Department of Cardiac Surgery, Sheba Medical Center, Tel Hashomer, Israel

Key words: video-assisted, minimally invasive, valve surgery

Abstract

Background: After the introduction of endoscopic techniques to other surgical fields like general surgery, gynecology and thoracic surgery, cardiac surgeons sought their own methods of using minimally invasive techniques.

Objectives: To examine whether this approach is less invasive and yields better results, more desirable cosmetic results, and a more rapid and complete rehabilitation, maintaining safety, efficacy, and outcome equivalent to those of more established procedures, such as median sternotomy.

Methods: From January 2000 to July 2001, 22 patients underwent video-assisted port-access mitral or aortic valve repair or replacement with the Heartport system in our department, and one underwent closure of atrial septal defect.

Results: Intraoperative transesophageal echocardiography revealed excellent functional results. Total operating room time, perfusion time, and cross-clamp time with this technique decreased with our growing experience and remains stable. There were no intraoperative reversals to mid-steronomy, no mortalities, and only one complication 24 hours after surgery.

Conclusions: Thoracoscopic assisted cardiac surgery (via port access) provides all the advantages of minimally invasive surgery, accelerates recovery, decreases pain, and maintains overall surgical efficacy, while avoiding the complications and pathology of mid-sternotomy. For appropriate patients, this is the method of choice in our department.

IMAJ 2003;5:482–484

Minimally invasive cardiac surgery has evolved during recent years to a point where it might be more beneficial than conventional procedures. Various strategies have been followed, with different results. For these approaches to become generally accepted, however, they must meet the goals of being less invasive – yielding better comfort, more desirable cosmetic results, and a more rapid and complete rehabilitation, maintaining safety, efficacy and outcome equivalent to those of more established techniques, such as median sternotomy [1–5]. However, whether the surgeons' efforts and the learning curve are worth investing in minimally invasive mitral and aortic surgery remains unclear, and a truly randomized, prospective study has not yet been performed.

We retrospectively analyzed our 2 years of experience with video-assisted port-access mitral, aortic, and other cardiac surgery. We emphasize that minimally invasive surgery remains the philosophical attitude of surgeons, helping them approach their patients with the same safety as in conventional operations, but with truly improved postoperative comfort, better cosmetic results, and many other advantages.

Patients and Methods

We examined the records of 22 patients (13 men and 9 women) who underwent video-assisted port-access cardiac surgery with the Heartport cardiopulmonary bypass system in our department between January 2000 and July 2001. Among these patients, 18 had mitral valve surgery, 3 had aortic valve surgery, and in one patient we used this approach for closure of an atrial septal defect [Table 1]. The patients ages ranged from 27 to 73 years (mean 57). Five patients were redo cases, post-coronary artery bypass grafting or mitral surgery. Valve diseases varied from severe mitral regurgitation (n=15), combined mitral regurgitation and mitral stenosis (n=3), combined aortic stenosis and moderate aortic insufficiency (n=2), severe aortic stenosis (n=1), and atrial septal defect (1 patient) [Table 2].

Surgery

Patients were placed in a supine position, with slight elevation of the right hemithorax. All were intubated with a double lumen endotracheal tube. Total cardiopulmonary bypass was performed with a membrane oxygenator, centrifugal pump, assisted venous retour, and cold antegrade crystalloid cardioplegia. A 14 or 17 F cannula was inserted through the right jugular vein into the upper vena cava under transesophageal echocardiographic view. A 5–7 cm skin incision was made in the right infra-mammary groove to create

Table 1. Types of procedures performed

Mitral valve replacement	9
Mitral valve repair	9
Aortic valve replacement	3
Atrial septal defect	1

Table 2. Demographic data

Age	57
Range	27–73
Male/female	13/9
NYHA Class	
I	7
II	9
III	6
Rhythm	
Sinus	14
Atrial fibrillation	8
Ejection fraction (%)	56
Range	25–60

Figure 1. Postoperative view of minimally invasive mitral valve replacement.

Figure 2. Postoperative view of minimally invasive aortic valve replacement.

a small anterolateral "working port" for mitral valve surgery [Figure 1], and in the second or third intercostal space for aortic valve surgery [Figure 2].

After general heparinization, arterial and venous cannulations were performed in the right groin through a small incision covered by the natural skin folds of the groin, using the Seldinger technique to avoid clamping and arteriotomy. Arterial cannulas were introduced over a guide wire after dilatation. Venous cannulation was performed with the same method, and the tip of the venous cannula (21 to 28 F) was placed in the right atrium under TEE control.

The endo-aortic clamp was adequately positioned using TEE, and the balloon was inflated. After aortic occlusion, antegrade cold crystalloid cardioplegia was delivered to the balloon tip, and the left atrium was opened parallel to the inter-atrial septum. In mitral valve replacement, the posterior leaflet was preserved entirely when possible, while the anterior leaflet was resected. All mitral valve repairs were performed following conventional techniques (quadrangular, triangular, edge-to-edge). An annuloplasty ring was used in all but one patient, in whom commissurotomy was performed. In the three aortic valve operations we used an external clamp instead of an endo-clamp for the ascending aorta. Cardioplegia was delivered directly to the aorta or selectively to the coronary arteries. Air was removed by insufflating the lungs and simultaneously reducing venous drainage, with the patient in the Trendelenburg position. The chest wound was closed without pericostal stitches after insertion of two small drainage tubes. In the five redo operations, we used continuous perfusion of the heart without cross-clamping the aorta, under hypothermic fibrillation.

Results

The total operating room time, perfusion time, and cross-clamp time in video-assisted port-access mitral and aortic valve surgery has decreased with our growing experience, and remains stable. In comparison to conventional open heart operations, this procedure took about 50 minutes longer at the beginning of our learning curve, and cross-clamping time was approximately 25 minutes longer. However, video-assisted mitral and aortic valve surgery in our hands currently takes approximately 15–25% longer than conventional sternotomy.

Intraoperative transesophageal echocardiography revealed excellent results after valve repair and no perivalvular leak in any patient after valve replacement. We have had no mortalities, and only one complication (embolic cerebrovascular accident due to rapid atrial fibrillation) to the left anterior descending artery 24 hours after surgery, which was partially resolved. All our patients benefited from added comfort and better cosmetic results.

At follow-up, clinical and functional New York Heart Association status had improved in all patients. One developed a perivalvular aortic valve leak and underwent successful reoperation.

Discussion

Many years after its introduction in gynecologic, abdominal and thoracic surgery, minimally invasive endoscopic techniques were applied to coronary artery surgery [6,7]. Following this trend, we investigated the feasibility and potential benefits of minimally invasive techniques in open heart valve surgery. The first video-assisted complex mitral valve operation was carried out by Carpentier in 1996 [8]. Later on, several other groups began to investigate various types of minimally invasive approaches through a lateral thoracotomy, an upper midline sternotomy incision, or parasternal incision with or without video assistance [6,7,9–11].

Glower and associates [12] recently presented predictors of outcome in a multicenter port-access valve registry. About 104 centers participated, with approximately 1,311 minimally invasive operations performed between 1997 and 1999, including aortic valve replacement in 252 patients, mitral valve replacement in 568, and mitral valve repair in 491. Mortality and morbidity in that study of port-access procedures are similar to those performed by means of a sternotomy [13]. Although the patient population is not obviously different from those described in sternotomy series, few studies have directly compared the results of sternotomy to those of port-access in a controlled fashion [5,14]. In retrospect analyses,

TEE = transesophageal echocardiographic

a faster return to normal activity, lower incidence of sepsis due to wound complications, fewer blood products, and shorter hospital stay have been reported for port access relative to sternotomy [5,14].

In addition, the multivariable predictors of adverse outcome identified for port access include factors such as age, which were previously reported as risk factors for death, stroke, or new atrial fibrillation in sternotomy patients. Interestingly, the incidence of new onset of atrial fibrillation for port access in that series (10%–12.7%) is somewhat lower than that previously reported for sternotomy in mitral valve patients. That study is the largest series of port access applied to aortic valve replacement using a variety of techniques (partial sternotomy, right thoracotomy) advocated by Colvin [14], Grossi [15], Cohn [16] and their teams. Results of aortic valve replacement did not differ significantly from those of mitral valve operations. The potential advantages of port access for aortic valve replacement include avoidance of sternotomy and elimination of arterial, venous and coronary sinus cannulas from the operative field.

With this new approach to mitral and aortic valve surgery, the Heartport technique obliges surgeons to rely partially on video-assisted visualization where the chest incision is small and the operative field might not be visible directly. Thus, surgeons develop their own eye-hand coordination to work with new shafted instruments and to become acquainted with the obligatory TEE images. We found that with more experience, both perfusion and cross-clamp time significantly decreased, but remained longer than for conventional sternotomy. Low mortality, low incidence of postoperative atrial fibrillation, fewer patients with prolonged ventilation, low incidence of perioperative stroke, and the absence of myocardial infarction and postoperative sternal wound infections are possible advantages of this technique.

Conclusions

Minimally invasive port-access cardiac surgery provides a revolutionary technique that enables surgeons to perform a wide variety of cardiac operations via a small lateral incision, avoiding the complications and pathologies of sternotomy, but with the advantages of the safety of using cardiopulmonary bypass.

The major advantages of this technique are: a) mini-thoracotomy instead of median sternotomy, creating a small scar with much better cosmetic results, less trauma, and mainly excluding the possibility of deep sternal wound infection; b) more rapid return to normal activities; c) fewer arrhythmias, particularly atrial fibrillation; and d) less consumption of blood products. All these advantages are maintained without compromising the standards of conventional open heart surgery, such as direct vision of the heart, the use of cardioplegia, full heart bypass, and working on an arrested heart, which permits comfortable access and precise and delicate surgery. Access is safe and effective, and besides the medical advantages is also cosmetically beneficial. This technique is the preferred choice for these operations in our department, and we try to use it for all suitable patients. We hope this procedure will be used more frequently in the future.

References

1. Pompili MF, Stevens JH, Burdon TA, et al. Port-access coronary bypass with cardioplegia arrest: acute and chronic canine studies. *J Thorac Cardiovasc Surg* 1996;112:1268–74.
2. Pompili MF, Yakub A, Siegel LC, Stevens JH, Awang Y, Burdon TA. Port-access mitral valve replacement: initial clinical experience [Abstract]. *Circulation* 1996;94:I–553.
3. Fann JI, Pompili MF, Burdon TA, Stevens JH, St Ghoar FG, Reitz BA. Minimally invasive mitral valve surgery. *Semin Thorac Cardiovasc Surg* 1997;9:320–30.
4. Galloway AC, Ribakove GH, Miller JS, Baumann FG, Buttenheim P, Colvin SB. Minimally invasive port-access valvular surgery: initial clinical experience. *Circulation* 1997;95:I–508.
5. Glower DD, Landolfo KP, Clements F, et al. Mitral valve operation via port access versus median sternotomy. *Eur J Cardiothorac Surg* 1998;14:S143–7.
6. Bruhat MA, Manhes H. Essai de traitement per coelioscopique de la grossesse extra-uterine. *Presse Med* 1997;6:2606.
7. Soper NJ, Brunt LM, Kerbl K. Laparoscopic general surgery. *N Engl J Med* 1994;330:409–19.
8. Carpentier A, Loulmet D, Carpentier A, et al. First open heart operation (mitral valvuloplasty) under videosurgery through a minithoracotomy. *CR Acad Sci Paris Life* 1996;319:221–5.
9. Koenertz W, Waldenberg F, Schutzler M, Ritter J, Liu J. Minimal access valve surgery through superior partial sternotomy: a preliminary study. *J Heart Valve Dis* 1996;5:638–40.
10. Navia JL, Cosgrove DM. Minimally invasive mitral valve operations. *Ann Thorac Surg* 1996;62:1542–4.
11. Lin PJ, Chang CH, Chu JJ, et al. Video-assisted mitral valve operations. *Ann Thorac Surg* 1996;61:1781–7.
12. Glower DD, Siegel LC, Frischmeyer KJ, et al. Predictors of outcome in a multicenter port-access valve registry. *Ann Thorac Surg* 2000;70:1054–9.
13. Jamieson WRE, Edwards FH, Schwartz M, Bero JW, Clark RE, Grover FL. Risk stratification for cardiac valve replacement. National Cardiac Surgery Database. *Ann Thorac Surg* 1999;67:943–51.
14. Grossi EA, Galloway AC, Ribakove GH, et al. Minimally invasive port access surgery reduces operative morbidity for valve replacement in the elderly. *Heart Surg Forum* 1999;2:212–15.
15. Colvin SB, Galloway AC, Ribakove G, et al. Port-access mitral valve surgery. *J Cardiac Surg* 1998;13:286–9.
16. Pisano GP, Bohmer RMJ, Edmondson AC. Experience versus learning: evidence from the adoption of minimally invasive cardiac surgery (working paper 00-036). Boston: Harvard Business School, 1999.

Correspondence: Dr. A.K. Smolinsky, Director, Dept. of Cardiac Surgery, Sheba Medical Center, Tel Hashomer 52621, Israel.
Phone: (972-3) 530-2710
Fax: (972-3) 535-2777
email: amihaysh@hotmail.com