Small-Incision Mitral Valve Repair

Safe, Durable, and Approaching Perfection

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Objective: To critically evaluate an initial experience with small-incision mitral valve operation with respect to safety, durability, and effectiveness.

Summary Background Data: Mitral valve (MV) surgery is dominated by a sternotomy approach, with MV repair rates which average 60%. Advantages of valvular repair compared with replacement include lower operative and long-term mortality, decreased stroke and infection risks, and superior freedom from reoperation and complications of anticoagulation.

Methods: Right chest small-incision MV surgery was performed on 187 consecutive patients. Outcomes including operative mortality and major morbidity were recorded. All patients underwent predismissal echocardiography in a core laboratory.

Results: Between 2003 and 2008, 57% (187/327) of isolated MV operations were performed using an anterolateral 6 cm 4th intercostal space small-incision. Operative techniques included femoral arterial and venous plus internal jugular cannulation and direct aortic cross-clamping. Pathology of the anterior leaflet was present in 22%, and PTFE neochordal repairs were used in 36% of cases. The rate of MV repair was 96.3% (180/187) and was 100% for patients with degenerative disease. Median cardiopulmonary bypass and aortic cross-clamp times were 108 and 82 minutes, respectively. There were no deaths, strokes, renal failure, or wound infections. Two patients (1.1%) were re-explored for bleeding, and 27% received blood transfusions. The median hospital stay was 4 days. Clinical core laboratory-assessed freedom from significant (MR > mild) at hospital discharge was 99%. Survival at a median follow-up of 2.5 years was 99%.

Conclusions: Direct visualization of the mitral valve through a right chest small-incision enables safe and effective performance of complex MV repair, with repair rates in excess of 95%.

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Nearly 90% of mitral valve operations in North America are performed using a median sternotomy.[1] Less-invasive mitral valve operations are characterized by some permutation of incision (small right thoracotomy, hemisternotomy), aortic cannulation (femoral), aortic occlusion (direct or endoaortic), tissue manipulation (robotic), and/or visualization (endoscopic). Widespread adoption of minimally invasive techniques for mitral valve repair is limited by concern for long operative times, insufficient valve exposure and visualization, lack of compelling outcomes data, and operator inexperience. Repair of the mitral valve is associated with the lowest mortality rate of any major cardiac operation, with an unadjusted mortality rate of 2%.[2] Despite patients' uniform preference for nonsternal splitting surgical approaches to the heart, any alteration to a conventional surgical approach should have demonstrably equivalent or better outcomes. We initiated a small-incision approach to mitral valve surgery that includes femoral cannulation, a small right thoracotomy, direct aortic cross-clamping, and direct visualization in hopes of decreasing the morbidity of mitral valve surgery. The purpose of this report is to critically evaluate our initial experience with small-incision mitral valve operation with respect to safety, durability, and effectiveness.

METHODS

Between May of 2003 and March of 2009, 187 consecutive patients underwent small-incision mitral valve surgery at the University of Maryland Medical Center. This experience represents 57% (187/327) of all isolated mitral valve operations performed during this period. Criteria for choosing a small-incision rather than a sternotomy approach included age less than 75 years, adequate ventricular function (ejection fraction ≥40%), body mass index less than 30, lack of significant aortic insufficiency, peripheral vascular disease, or active infective endocarditis. Approval for this study was obtained from the University of Maryland Institutional Review Board and the requirement for individual patient consent was waived (HP-00040385).

Echocardiographic Assessment

All patients underwent predismissal Doppler echocardiography in a core clinical laboratory, with reading cardiologists blinded to the method of mitral repair and surgical approach performed. Grading of mitral regurgitation was performed using guidelines established by the American Society of Echocardiography.[3] A composite mitral regurgitation grade was assigned based on structural, Doppler, and quantitative parameters. When mitral regurgitation was reported to range between 2 values, the more severe reading was used.

Outcomes Measures

The primary outcome was operative mortality, defined as in-hospital or 30-day mortality, whichever was greater. Late mortality was confirmed using the Social Security Death Master File.[4] A cross-sectional (common closing date) method of follow-up was used.[5] Follow-up echocardiographic and clinical progress reports were obtained from treating physician's offices.

Operative Techniques

Double-lumen endotracheal intubation was performed at the time of induction and in most cases was converted to a single-lumen endotracheal tube following operation and before transfer to the intensive care unit. A 16-French heparin-bonded venous drainage cannula (Fem-flex II Duraflo, Edwards Lifesciences DIIFEMII016A, Irvine, CA) was inserted in the right internal jugular (IJ) vein using Seldinger technique and maintained sterile for later connection to the cardiopulmonary bypass circuit. The right arm was at the patient's side, and a small towel used to elevate the right chest. The common femoral vein and artery were exposed and directly cannulated with wire-wound heparin-bonded cannulae (Bio-Medicus, Medtronic, Minneapolis, MN)

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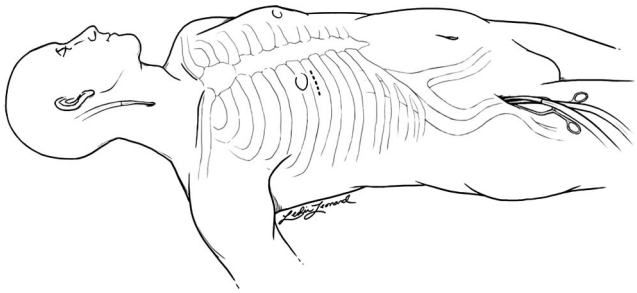

FIGURE 1. Patient positioning and incision site for small-incision mitral valve repair.

using Seldinger technique and transesophageal echocardiographic guidance (Fig. 1). For most patients a size 19-F arterial cannula enabled inflow at acceptable resistances and a size 25 femoral venous combined with the IJ catheter provided superb venous drainage decompression of the heart. For patients weighing more than 100 kg, a size 27 venous cannula provided improved venous drainage. Vacuum-assisted venous drainage was routinely employed. A 6-cm incision was made overlying the 4th intercostal space (centered below the right nipple in men and in the inframammary fold in women). After insertion of soft tissue (Alexis O wound retractor C8401, Applied Medical, Rancho Santa Margarita, CA) and mechanical (CARDIAC Fehling MIS Valve Retractor, Fehling Surgical Instruments, Inc. Acworth, GA) retractors, the pericardium was opened longitudinally above the pedicle of the phrenic nerve. A pledgeted suture was placed in the dome of the right hemi-diaphragm and passed outside the chest to improve exposure of the heart. The diaphragm was drawn inferiorly by tensioning the suture. After initiation of bypass and assurance of appropriate drainage (repositioning of the venous cannula was frequently helpful), a standard antegrade cardioplegia/venting needle was placed in the ascending aorta. The operative field was flooded with carbon dioxide. Under direct vision, a flexible aortic cross-clamp (Cygnet, Novare Surgical Systems, Inc., Cupertino, CA) was applied and antegrade cardioplegia administered. Subsequent cardioplegia doses were given every 15 minutes, with great care to avoid distortion of the aortic valve and aortic insufficiency from either the atrial retractor or annulur sutures. A standard interatrial groove incision was used to gain access to the left atrium, and a left atrial retractor (Fehling Surgical Instruments, Inc., Acworth, GA) was inserted just lateral to the sternum in the 4th intercostal space and exposure obtained. Annular sutures were helpful in achieving complete exposure of the valve (Fig. 2). Isolated posterior leaflet prolapse was treated with triangular resection of the prolapsed segment early in our experience (Fig. 3).[6] We have now evolved to a selective approach to posterior leaflet repair: involvement of less than 30% of the posterior leaflet is treated with a triangular resection, while involvement of greater than 30% of the area of the posterior leaflet is treated with either a combination of triangular resection and PTFE resuspension, or PTFE resuspension alone. A flexible partial annuloplasty ring was always used in cases of isolated posterior leaflet prolapse. Sliding annuloplasty was never performed. Anterior leaflet prolapse was treated with PTFE resuspension of the anterior leaflet. Anterior leaflet resections were never performed. In cases of anterior leaflet involvement, a complete semi-rigid annuloplasty ring was employed. Carpentier type I (pure annular dilation) and type IIIb (functional/geometric) valves were repaired with undersized (size 26 or 28) complete semi-rigid annuloplasty rings. At the completion of mitral valve repair (or replacement) a 14-French urinary catheter was placed across the valve for subsequent deairing. A warm dose of cardioplegia was administered and the aortic cross-clamp removed. Meticulous deairing was performed, and the patient weaned from cardiopulmonary bypass and the repair quality assessed. A brief return to bypass was routinely employed to allow removal of the antegrade aortic needle from a decompressed aorta.

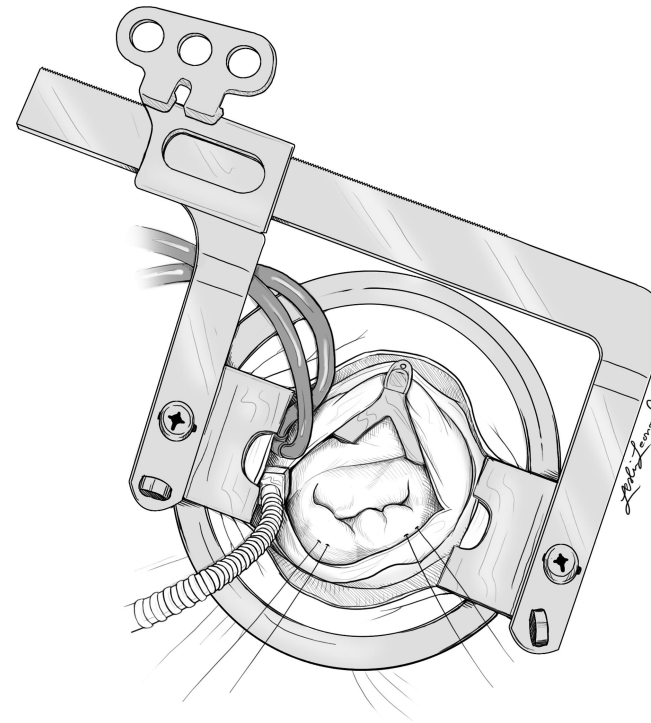

FIGURE 2. Mitral valve exposure.

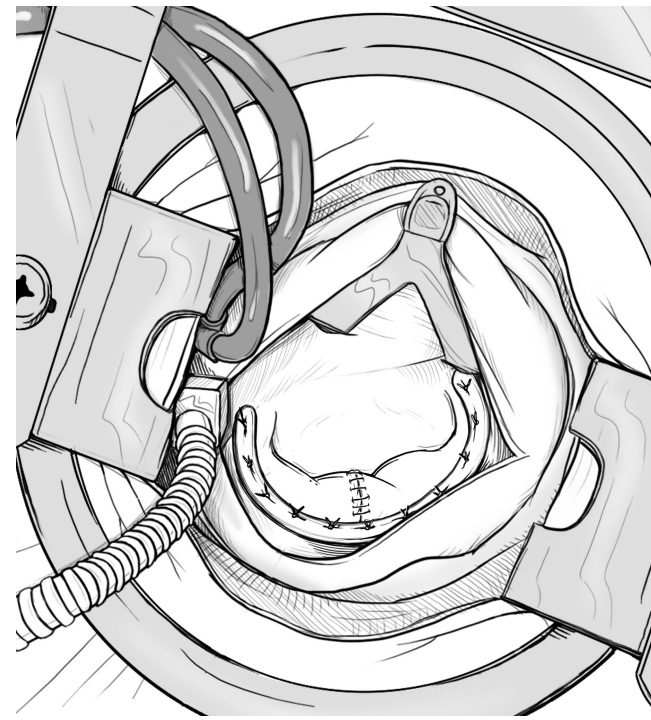

FIGURE 3. Completed repair.

Postoperative Care

All patients were treated with daily aspirin only.

RESULTS

Patient Characteristics

Patient demographics are listed in Table 1. The mean age was 53.6 ± 11.6 years (range: 20–82); 120 patients (64%) were male and 67 (36%) were female. Isolated mitral valve surgery was performed in 156 patients (83%); 29 (16%) had CryoMaze atrial fibrillation (AF) correction surgery[7] and 2 (1%) had tricuspid valve repair and AF correction surgery in combination with mitral valve surgery. Two patients had previous cardiac surgery: one who developed a paravalvular leak 2 years after a mechanical mitral valve replacement and one with recurrent mitral regurgitation 1 year after combined mitral valve repair, aortic valve replacement, AF correction surgery and coronary artery bypass grafting.

Perioperative Outcomes

The MV repair rate was 96% (180/187). The repair rate for degenerative disease was 100% (154/154), for rheumatic disease 50% (5/10), and for infective endocarditis 80% (8/10). Among patients undergoing mitral valve replacement, there were 5 mechanical and 2 bioprosthetic replacements. Anterior leaflet pathology was repaired in 40 of 180 (22%) of patients. PTFE neochordal repairs were performed in 64 of 180 (36%) of patients. Among patients having mitral valve repair, complete rigid rings were inserted in 40 of 180 (22%) and partial flexible annuloplasty bands in 129 of 180 (72%). Median aortic cross-clamp and cardiopulmonary bypass times were 82 and 108 minutes, respectively. No patient died after operation. There were no strokes, wound infections, or renal failure requiring dialysis. No intra-aortic balloon pumps were inserted, and there were no vascular complications related to femoral or IJ cannulation. Three patients required conversion to sternotomy: 2 early in our experience and 1 recently (3/190, 1.6%). One was converted for inadequate exposure related to a pectus excavatum, another had significant systolic anterior motion of the mitral valve and required a second bypass run for rerepair, and the final patient had dense pleural adhesions that precluded safe exposure of the heart. Two patients (1.1%) were re-explored for bleeding, and 26.7% (50/187) required blood products during their hospital stay. One patient required urgent tracheostomy before transfer to the intensive care unit when replacement of the double-lumen tube with a single lumen tube was unsuccessful. The median intubation time was 5.4 hours (IQR 3.1–9.6, range: 0–27 hours). Five patients (2.7%) were intubated for more than 24 hours. The median hospital length of stay was 4 days (IQR 3–5 days, SD ± 2.1 days). Thirteen patients (6.9%) required readmission. One patient required subxiphoid pericardial window for pericardial effusion 2 weeks after operation. Early in our experience we performed routine predismissal lower extremity venous Doppler examinations in all patients to rule out lower extremity venous thrombosis related to venous cannulation. No patient among the 67 examined had evidence of lower extremity deep venous thrombosis.

Results of predismissal echocardiography for mitral valve repair patients are presented in Figure 4. Freedom from significant MR (>mild) was 99%. Echocardiographic follow-up was available for 81% (114/140) of patients more than 1 year after surgery, with a mean follow-up of 522 ± 373 days. Freedom from MR > mild was 105 of 114 92.1% (Fig. 5). Two patients required late operative repair of chest wall incisional hernias. Three patients have required mitral valve reoperation at 39, 41, and 52 months after initial repair. Causes of repair failure included restenosis of a stenotic rheumatic valve after commisurotomy, late rupture of a PTFE neochord to the midportion of the anterior leaflet, and recurrent MR in a patient with extensive mitral annular calcification. Following reoperation (via

TABLE 1. Patient Demographics

Age (yr) (mean ± SD) (range)	53.6 ± 11.6 yr (20–82)
Male gender (%)	120 (63.5)
Ejection fraction (median, IQR, range %)	60, 55–65, 20%–82%
Preoperative atrial fibrillation (%)	31 (16.6)
NYHA class (%)	
I	45 (24)
II	71 (38)
III	61 (33)
IV	10 (5)
HTN	87 (47)
BMI (median, IQR, range, kg/m^2)	25.8, 23.2–28.5, 11.7–37.0
Reoperation (%)	2 (1.1)
Mitral regurgitation (%)	182 (97)
Mitral stenosis (%)	7 (3.7)
Etiology (%)	
Degenerative	154 (82.4)
Annular dilation	11 (5.9)
Infective endocarditis	10 (5.3)
Rheumatic	10 (5.3)
Radiation valve disease	1 (0.5)
Paravalvular Leak	1 (0.5)

NYHA indicates New York Heart Association.

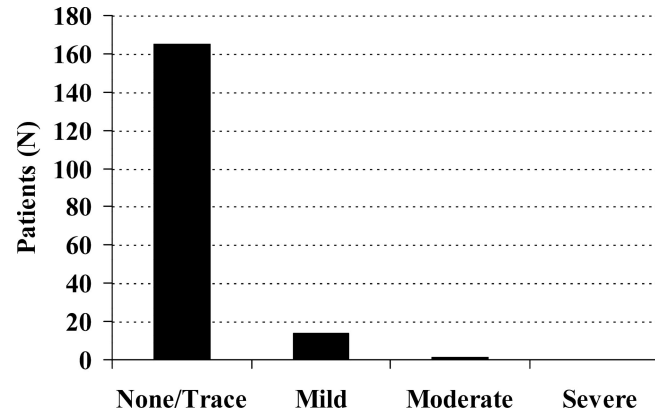

FIGURE 4. Predismissal mitral regurgitation grade.

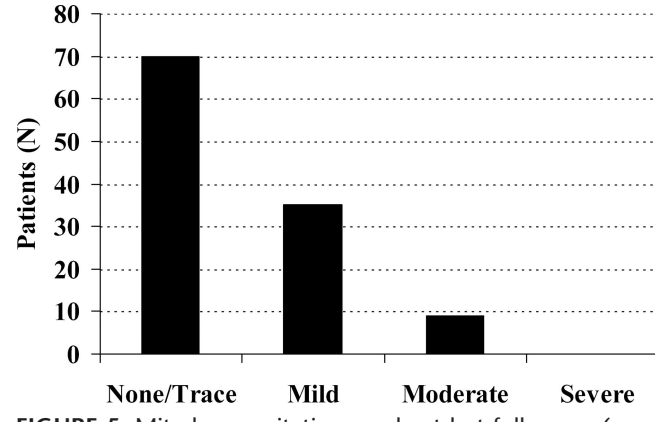

FIGURE 5. Mitral regurgitation grade at last follow-up (mean 522 days).

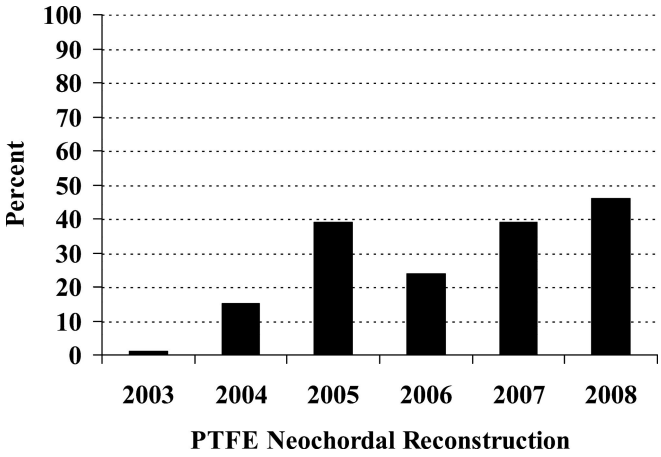

FIGURE 6. PTFE Neochordal Reconstruction Rates over time.

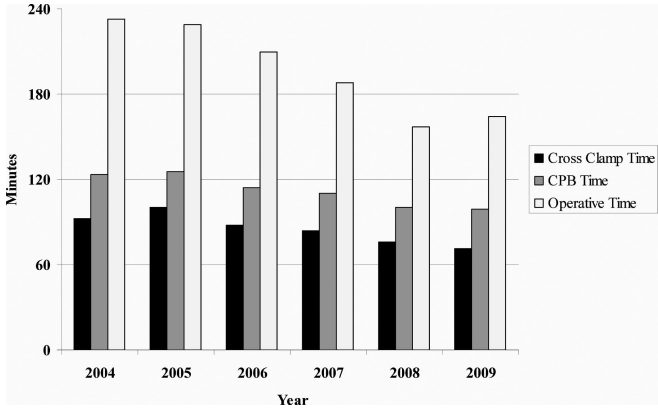

FIGURE 7. Operative times as a function of experience.

sternotomy with mechanical valve replacement, rerepair, and replacement with a bioprostheses, respectively) each patient is doing well in class I functional status and without MR. Survival at a median follow-up of 2.5 years is 99.4% (186/187). Fig. 6 demonstrates progressive adoption of PTFE neochordal repair techniques over time ($P < 0.02$). (likelihood ratio)-contingency analysis; Fig. 7 demonstrates a progressive decrease in operative, cardiopulmonary bypass, and aortic cross-clamp times with increasing experience.

Key Findings

The key findings of this single-institution clinical experience with small-incision MV operations include: (1) Zero operative mortality and low perioperative morbidity, (2) High rates of mitral valve repair, including complex anterior leaflet and PTFE neochordal reconstructions, (3) Reliable resolution of MR, as defined in a core clinical echocardiography laboratory before hospital dismissal, (4) Durability of mitral valve repair at midterm follow-up, including a low rate of reoperation, and (5) Excellent midterm survival (99%) at 2.5 years.

Comment

This study demonstrates that small-incision mitral valve surgery can be performed safely with minimal mortality and morbidity, a short hospital stay, high rates of mitral valve repair, and reliable resolution of mitral regurgitation.

During the last decade, several trends have exerted important effects on the management of mitral valve disease. There has been a steady decline in the proportion of patients presenting for surgery with rheumatic (inflammatory) mitral valve disease, and a concurrent increase in the number of those with degenerative mitral valve disease.[8] Degenerative disease, which is more amenable to mitral valve repair, is the dominant underlying disease process in patients requiring mitral valve operation in North America. Outcomes of surgery have improved (decreased mortality, increased rates of mitral valve repair), and there is a better understanding that operative mortality is related to the consequences of chronic mitral regurgitation, including pulmonary hypertension, ventricular dysfunction, and declining functional status in addition to patient-related risk factors. The superiority of MV repair compared with replacement is now widely accepted, with demonstrated benefits including lower operative mortality,[8–10] lower risk of stroke and infection,[11,12] improved left ventricular function,[13] improved freedom from reoperation and complications of anticoagulation, and superior long-term survival.[14–16] In addition to traditional indications for surgery such as the presence of symptoms and ventricular dysfunction, there is an increased propensity to refer asymptomatic patients with severe mitral regurgitation and preserved ventricular function to surgery, based on data demonstrating that MR is a progressive disease,[17] that the natural history of unoperated severe MR is hazardous with progression to death or surgery being nearly inevitable,[18] and that worsening symptom status or deteriorating ventricular performance is associated with worse perioperative and long-term outcomes.[8,19] Successful MV repair of the asymptomatic patient with severe MR affords survival equivalent to a normal age-matched population.[20] The decision to recommend mitral valve surgery requires confidence that repair rates will be high. This is reflected in current ACC/AHA guidelines, which recommend surgery for this patient group when repair rates exceed 90%.[21] Unfortunately, rates of mitral valve repair are highly variable, both by institution[22] and by surgeon, and currently average 60%[8] for all mitral valve operations and 70% for patients with pure MR.

The results of the present experience with small-incision mitral valve surgery are at least equivalent, and perhaps superior to, results of conventional sternotomy-based mitral valve surgery. The performance of mitral valve repair was predictable (all patients with degenerative disease underwent repair) and the results gratifying. Proponents of percutaneous mitral valve repair techniques have criticized previously published surgical series as lacking quantitative echocardiographic assessment of postoperative MR grade and have questioned the assertion that significant MR after operative intervention is uncommon.[23] Our experience was notable for complete routine quantitative core clinical echocardiographic evaluation of MR grade before hospital dismissal. Freedom from significant MR ($>$ mild) was 99%. This contrasts sharply with early results with percutaneous edge-to-edge mitral valve repair, where the reported incidence of postprocedural moderate or greater MR exceeds 40%.[24] We believe that routine predismissal echocardiography is an essential component of quality control in any mitral valve surgery program.[25] At midterm follow-up the rate of recurrent significant MR was low, as was the rate of reoperation. Survival at 2.5 year mean follow-up was equivalent to an age-matched control population.

We have documented a progressive improvement in operative efficiency over time, with decreasing operative, cardiopulmonary bypass, and cross-clamp times. Performance improved throughout the first 5 years (135 cases) of the experience and seems to have reached a plateau.

As we have developed progressive experience with the small-incision right chest approach, the use of PTFE neochordal reconstruction has increased. In addition to greater comfort with the operation and progressive selection of more patients with complex degenerative mitral valve disease for this procedure, we have in-

creasingly adopted neochordal reconstruction (either alone or in concert with leaflet resection) for posterior leaflet disease. Use of PTFE chordal replacement (compared with leaflet resection) is supported by a recent randomized trial that demonstrated equivalence of leaflet resection and leaflet preservation with PTFE neochordal reconstruction in patients with isolated posterior leaflet prolapse.[26]

Technical Lessons Learned

Important technical lessons learned during this experience include scrupulous attention to detail during cannulation of the femoral vessels. Transesophageal guidance is essential for safe cannula positioning. Adequate venous drainage is a prerequisite for safe performance of small-incision MV surgery. We have found the use of combined IJ and large femoral venous cannulae in concert with vacuum-assisted venous drainage mandatory to achieve this objective. Adjustment of cannula position to allow optimal drainage is a worthwhile investment before proceeding with cardiac arrest. As in any mitral valve operation, exposure is essential and accurate placement of the chest and atrial incisions, the atrial retractor and annular sutures allows progressive and full exposure of the valve. Although we routinely employ retrograde cardioplegia for sternotomy mitral valve surgery, we have used only antegrade cardioplegia in the present experience. This leads to a less cluttered field and is a simpler approach, but does demand attention to adequate de-airing of the aortic root during subsequent cardioplegia doses, and it is important to assure that neither annular sutures nor the atrial retractor cause aortic valve distortion and incompetence during cardioplegia administration.

Our results compare favorably to other published experiences. Previously published experience with less-invasive mitral valve surgery has examined outcomes with a right-chest approach and shown low mortality (1%–3%), morbidity, and variable rates of mitral valve repair (37%–87%).[27–30] A recent meta-analysis of published studies (primarily case-control series) comparing outcomes of minimally invasive and sternotomy MV operations found similar rates of mortality, neurologic complications, and length of hospital stay for both groups.[31] Reoperation for bleeding was less common among the minimally invasive group, whereas both cross-clamp and cardiopulmonary bypass times were substantially longer in the minimally invasive group.

Chitwood et al recently reported results of 300 robotically-assisted small-incision mitral valve repairs.[32] Mortality was 2.7% with a stroke rate of 0.7%. The requirement for blood products and the duration of hospital stay were similar to our experience. Cardiopulmonary bypass and aortic cross clamp times were 159 and 122 minutes, respectively, nearly 50% longer than in our experience. Reoperation for recurrent mitral regurgitation was required in 5.3% of patients (n = 16), the majority of whom suffered technical failures, primarily annuloplasty ring dehiscence. A recent report describing an initial experience of 100 patients undergoing robotic mitral valve repair reports cardiopulmonary bypass times similar to the Chitwood experience, as well as a 2% stroke rate and a troublesome 5% early reoperation and replacement rate for repair failure.[33] The authors conclude that the learning curve for robotic mitral valve surgery is "steep and long." Based on our experience, we have not yet been unable to justify the additional operative, bypass and cross-clamp time, expense, and risks associated with a robotic approach.

This report is from a single high-volume mitral valve surgery center with a strong interest in mitral valve repair. We are uncertain if this more technically demanding approach is appropriate for occasional mitral valve surgery, or for surgeons who have not yet achieved high MV repair rates using conventional techniques. This experience does represent a selected group of patients with isolated mitral valve disease, and we continue to avoid a small-incision strategy in patients that are markedly obese, elderly or who have significantly depressed ventricular function or require concomitant aortic valve or coronary artery bypass grafting.

Summary

This article reports outcomes of 187 consecutive patients undergoing small-incision right chest mitral valve surgery. Repair rates were high, mortality and morbidity negligible, and outcomes durable. Small-incision mitral valve surgery is now our operative strategy of choice for the patient with isolated mitral valve disease.

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Discussion

DR. THOMAS J. VANDER SALM (SALEM, MASSACHUSETTS): This article largely fulfills the expectations raised by the bold and rather provocative title. Granted, the presentation describes a selected population, as the exclusionary criteria indicate, and the 43% of patients in the excluded cohort would have been a higher risk population regardless of the incision used. Nevertheless, a 96% repair rate 100% in degenerative disease, the most common group we treat with virtually no complications, good cross-clamp and perfusion times, and excellent long-term outcomes are results to be envied by anybody performing mitral valve surgery regardless of the incision used. I do have a few questions. Is removing air from the left ventricle and the left atrium more difficult with this approach? Are there special techniques that you employ for this? Aortic cannulation is generally thought of as less complication prone than femoral cannulation. Was the absence of femoral artery complications a result of patient selection, or have you refined femoral cannulation to make it safer? Could you compare this incision to lower hemi sternotomy espoused by the surgeons at the Brigham and Women's Hospital in Boston? Finally, does any of this make a difference? A recent meta-analysis from the Mayo Clinic evaluated minimally invasive aortic valve replacement using an upper partial sternotomy and found few objective advantages of the approach. Is the advantage of the incision you describe that it benefits the patient in a measurable way such as reducing pain, intubation time or hospital stay, or is its primary advantage cosmetic? Finally, do you think that it contributed to the increase in the volume of your program?

DR. JAMES S. GAMMIE (BALTIMORE, MARYLAND): I appreciate your questions. The de-airing question is a good one. I think that this approach enhances our ability to de air the heart because we can flood the field with carbon dioxide more readily than in an open sternotomy approach. As you know, carbon dioxide is more soluble in blood than nitrogen (room air). We routinely remove our vents shortly before weaning from bypass. Femoral artery cannulation is a key part of this operation and in fact is what I consider one of the two most critical technical aspects of the procedure. We felt that if we were going to use this approach we needed to have a complication rate related to cannulation that was equivalent to central cannulation. I do not know that we introduced anything new here. We do not allow the cardiologists to catheterize the right femoral vessels, where we typically cannulate. We pay scrupulous attention to cannulating the common rather than the superficial femoral artery, and we use both TEE (transesophageal) and wire guidance. Finally, I think that the engineering of the Biomedicus cannulae is fabulous and has allowed to us perform this procedure safely. The question as to whether or not this makes a difference is a good one, and I think that the only way we can know whether or not this is superior to a conventional approach would be a properly performed prospective randomized trial. There are only 2 randomized trials in the literature that look at this and they both suffer from significant shortcomings, one being very small and the other looking at full thoracotomy. Thus, in the absence of such a trial, all we have are retrospective cohort studies, which have their obvious selection biases. Randy Chitwood's group recently published a meta-analysis suggesting that mortality is equivalent for these approaches, there is a decreased need for reoperation for bleeding through the right chest, and there is some evidence, albeit not terribly strong, that there is less pain and a faster return to normal activities. So we are basically left with our own experience and clinical impressions. Based on the series that we presented today, we feel that this is an efficient operation and it does not compromise the ability to perform mitral valve repair, repair that is performed is durable, and patients return to work in a rapid fashion. An additional advantage, of course, to this approach is that it is impossible to develop mediastinitis. As you know, mediastinitis was recently deemed a "never" event; we never see this because we do not do a median sternotomy. Reentry for reoperation is quite straightforward after such an approach. Finally, in terms of the growth of our program, we have enjoyed a robust growth in mitral valve surgery at the University of Maryland. I think this has been due primarily to our focus on mitral valve repair rather than replacement, and I tell the patients that the top 3 considerations for a mitral valve operation are: Repair, repair, and repair. We emphasize that this is the same operation, just through a smaller incision.

DR. ORLANDO C. KIRTON (HARTFORD, CONNECTICUT): I must disclose that I am not a card carrying cardiac surgeon. Through your port access or small incision minimal access mitral valve repair surgery, your results are sensational. Is there any improvement or role for robotic assisted mitral valve surgery? A cardiac surgeon at my institution is pursuing robotic mitral valve surgery as a more minimally invasive approach, but given your success with small incision mitral valve repair, do you see any future in robotic assisted mitral valve repair?

DR. JAMES S. GAMMIE (BALTIMORE, MARYLAND): That is a very good question. We have a robot, one of my partners does totally endoscopic coronary bypass surgery and we keep asking ourselves if

we should move to that approach. Dr. Chitwood recently published a series of 300 robotic mitral valve repairs with a 2.7% mortality rate. What was notable about this series was that patients stayed in the hospital an average of 5 days, similar to our experience. There was a fairly high reoperation rate. Among those 300 patients, 16 came back to the operating room. The majority of failures were technical, related to annuloplasty ring dehiscence. I am concerned that the lack of tactile feedback in placing those crucial annuloplasty sutures with the robot may be related to the increased reoperation rate. In addition, the robotic approach is associated with substantially longer cross clamp and bypass times. For example, in Dr. Chitwood's series, the average bypass time was 159 minutes and the average cross clamp time was 122 minutes. So we have not felt as of yet that a robotic approach is justified based on the additional time, the additional expense, and perhaps a higher reoperation rate. That being said, we remain open to this technology and look forward to further data and would readily adopt it if we felt it offered our patients an advantage.

Dr. Vaughn A. Starnes (Los Angeles, California): Our valve experience has gone entirely toward minimally invasive surgery. We were able to get rid of the neck cannulas or the venous drainage, which caused complications, and that seems to have helped us a great deal. One of the challenges that we are facing at our institution is education and how we teach our residents. We tried to come up with headlight cameras that allow us to feel comfortable with our residents performing this operation and yet have some feedback and control. Could you just comment on the educational opportunities for our residents in training?

Dr. James S. Gammie (Baltimore, Maryland): This is an operation that is difficult to teach, because only one person can see what is going on, and as may have mentioned, small incision mitral valve operations made up 57% of our isolated mitral valve experience. We still perform a large number of open mitral valve operations. Our last Fellow graduated as primary surgeon with five 74 mitral valve operations; very few were with this approach. Thus, this remains a challenge. I would be interested in speaking with you about better visualization, because clearly the attending surgeon needs to be able to see what the trainee is doing while this is occurring. That being said, in a high volume mitral program, I think we have enough open mitral work with which we can teach mitral valve repair.

Dr. Harold L. Lazar (Boston, Massachusetts): I just have 3 comments to make. Like Dr. Vander Salm, I would also encourage you to review your standard median sternotomy incisions and conduct some sort of prospective or retrospective propensity based analysis to determine what the advantages are of this small incision. But the question I would like to ask is whether or not you have noticed any difference in pain. I have noticed that many times these smaller thoracotomy incisions, result in a little bit more pain, especially after the 3 to 4-week period, as opposed to the mediastinotomy which is usually pain free after 6 weeks. My second question relates to the percentage of patients in which you were you actually able to do this procedure. In the abstract it says about 39%, which seems to be a low number for a technique that you propose has many advantages. What else can you do to increase the number of patients that will benefit from this or do you think this is going to remain at about 39% of all patients who require a mitral valve surgery? Finally, mean follow up in the study was 1½ years, and a third of your repairs involved an anterior leaflet problem. As you know, many of the recurrences with this occur after 5 years, and since your series started in 2003 I wonder if you had any late term results and whether you noticed any further degeneration especially in the anterior leaflet pathology.

Dr. James S. Gammie (Baltimore, Maryland): Our median follow up was actually 2½ years. In the manuscript, 57% of isolated mitral valve operations in our institution were done this way, and I think that the applicability is increasing over time. Obviously, early in our experience we chose to do the most straightforward cases. Now we do this for anyone with isolated mitral valve disease who does not meet the exclusion criteria that I outlined. In terms of pain, that is very hard to quantitate and that remains a fairly subjective impression. We seem to see equivalent pain in the first 48 hours and thereafter it seems to be less. Patients return to work quickly.