Minimally Invasive Versus Sternotomy Approach for Mitral Valve Surgery: A Propensity Analysis

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Background. Over the past decade, minimally invasive (MI) mitral valve surgery has grown in popularity. The purpose of this study was to compare both short- and long-term outcomes of mitral valve repair and replacement performed through a MI versus traditional sternotomy (ST) incision using a propensity analysis approach to account for differences in baseline risk.

Methods. From January 2000 to December 2008, a total of 1,121 isolated mitral valve operations were performed at our institution (548 ST, 573 MI). Data were retrospectively collected on all patients, and a logistic regression model was created to predict selection to a MI versus ST approach. Propensity scores were then generated based on the regression model and matched pairs created using 1:1 nearest neighbor matching. There were 382 matched pairs in the analysis for a total sample size of 764, or 68.2% of the original cohort. Major outcomes of interest included cardiopulmonary bypass time, cross-clamp time, hospital length of stay, major in-hospital complications, and both short- and long-term survival.

Results. Cardiopulmonary bypass time was 117.1 ± 2.0 minutes in the ST group and 139.7 ± 2.6 minutes in the MI group ($p < 0.0001$), and cross-clamp time was 79.6 ± 1.5 minutes in the ST group and 83.7 ± 1.9 in the MI group ($p = 0.106$). The average hospital length of stay was 9.81 ± 0.61 days among ST patients and 7.76 ± 0.37 days among MI patients ($p = 0.0043$). There was no significant difference in the frequency of major in-hospital complications between groups. The mean duration of survival follow-up was 4.2 ± 2.4 years. There was no significant difference in mortality at 30 days ($p = 0.622$) or 1 year ($p = 0.599$). In addition, there was no significant difference in long-term survival between groups ($p = 0.569$).

Conclusions. Although minimally invasive mitral valve surgery required a slightly longer cardiopulmonary bypass time, there was no difference in cross-clamp time, morbidity, or mortality, and hospital length of stay was significantly shorter when compared with matched sternotomy control patients.

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The field of minimally invasive (MI) cardiothoracic surgery continues to grow in popularity owing to improvements in technology, surgical technique, and a growing acceptance of MI approaches for operations previously performed through a traditional median sternotomy [1–4]. Although MI approaches have been integrated into many areas of cardiac surgery, MI mitral valve surgery has been particularly influenced by MI techniques [5–6].

Beginning in the early 1990s, a variety of MI incision types have been developed for mitral valve surgery, including partial sternotomy, parasternal incisions, minithoracotomy, and totally endoscopic approaches [7–10]. While the technical aspects of each approach differ, the overall goals are similar—development of a safe and effective mitral valve repair or replacement with minimal surgical trauma. The proposed benefits of a MI approach include decreased postoperative pain, improved cosmesis and patient satisfaction, improved postoperative recovery, decreased hospital length of stay (LOS), decreased resource utilization, and ultimately faster return to normal activities [11–15].

Although several single-institution studies have shown that these described benefits can be achieved with low perioperative morbidity and short-term mortality [16–20], no prospective, randomized clinical trials exist that compare MI mitral valve surgery to the traditional sternotomy (ST) approach. Moreover, significant differences in baseline characteristics between groups create a challenge for comparing outcomes. Thus, the goal of this study was to compare MI and ST approaches using a propensity matched approach to control for differences in baseline risk.

Material and Methods

Study Population

From January 1, 2000, to December 31, 2008, a total of 1,121 patients underwent isolated mitral valve surgery at our institution. Isolated mitral valve surgery was defined

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as mitral valve repair or replacement in the absence of a major concomitant procedure such as coronary artery bypass grafting or aortic valve surgery. There were 294 patients (26.2%) who underwent minor concomitant procedures, which included atrial fibrillation ablation (n = 198, 17.7%), atrial septal defect repair (n = 75, 6.7%), and tricuspid valve repair (n = 21, 1.9%). There were 438 mitral valve replacements (39.1%) and 683 mitral valve repairs (60.9%) in the cohort. A traditional median ST approach was used in 548 patients (48.9%) patients, and a MI approach was used in 573 patients (51.1%). After obtaining Institutional Review Board approval, data on patient demographics, operative variables, and both short- and long-term morbidity and mortality were retrospectively gathered using data combined from the New York State Cardiac Surgery Database [21] and institutional medical records and operative reports that comprise our internal cardiac surgery registry.

Operative Technique

For the series, MI mitral valve surgery was defined as any mitral valve repair or replacement performed through an incision other than a full median sternotomy. Of the MI cases, 569 (99.3%) were performed through a right minithoracotomy (Fig 1), and 4 (0.7%) were performed through a hemisternotomy. The operative procedure for cases performed through a minithoracotomy is presented here. Briefly, after induction of general anesthesia, the endotracheal tube is replaced by a double-lumen tube. The patient is then placed in a left lateral decubitus position and a 6- to 8-cm skin incision is made in the right chest along the fifth rib, lateral to the midclavicular line. After establishment of single (left) lung ventilation, the chest is entered in the fourth intercostal space. A small chest retractor is then inserted and the pericardium entered. After heparinization guided by activated clotting time, aortic and venous cannulation is carried out.

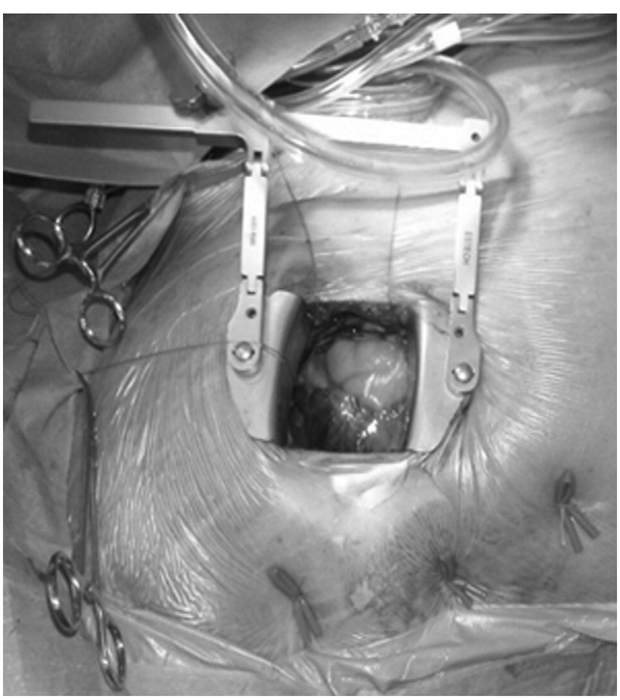

Fig 1. Right minithoracotomy approach for mitral valve surgery.

For the series, aortic cannulation was most commonly performed in a central fashion, and venous drainage was most commonly achieved through a percutaneous femoral vein approach with a single multistage venous cannulation. Central aortic cannulation is performed through the initial MI incision. After placing the patient on cardiopulmonary bypass (CPB), antegrade and retrograde cardioplegia catheters are placed, and Sondergaard's groove is dissected. The retrograde cardioplegia is placed directly by the surgeon through the right atrium. The patient's pressure is temporarily reduced to 50 mm Hg, and a transthoracic aortic cross clamp (Chitwood) is passed through a stab wound in the right axilla, and applied to the ascending aorta. Cold blood (4:1) cardioplegia is then given through an antegrade cardioplegia catheter, and repeated every 20 minutes through antegrade and/or retrograde catheters. The left atrium is opened, and a transthoracic left atrial retractor positioned. The mitral valve is then inspected, and repair or replacement carried out. The left atriotomy is closed, the patient deaired, and the left atrium closed in the standard fashion.

Propensity Analysis

To account for differences in baseline characteristics between groups, a propensity analysis approach was used for data analysis. A parsimonious model of risk factors for selection to a MI versus sternotomy approach was created using baseline patient characteristics (Appendix 1). A stepwise logistic regression approach (backward, remove $p > 0.20$) was used for variable selection to create the final model (Appendix 2). From this model, propensity scores were generated for each patient. Propensity scores were then nearest neighbor matched 1:1 to create ST and MI matched pairs for analysis.

Outcome Measures

Major outcomes of interest included CPB time, cross-clamp time, hospital LOS, major in-hospital complications, and both short- and long-term survival. Major complications included intubation for more than 72 hours, renal failure, sepsis, reoperation for bleeding, stroke less than 24 hours after surgery, stroke 24 hours or more after surgery, gastrointestinal bleeding, and transmural myocardial infarction. Multivariable logistic regression (backward stepwise, remove $p > 0.20$) was used to assess the simultaneous effect of multiple variables (Appendix 1) on in-hospital complications.

Long-term survival rates were calculated using the Kaplan-Meier method, and statistical significance was calculated by the log rank test. Multivariable Cox proportional hazards regression (backward stepwise, remove $p > 0.20$) was used to assess the simultaneous effect of multiple variables on survival. (In addition to variables in Appendix 1, the major complications described above were also included in the multivariate model.) Survival data were obtained from the New York State Cardiac