Original Article

Journal of Cardiovascular Medicine and Surgery
Volume 6 Number 3, July - September 2020
DOI: http://dx.doi.org/10.21088/jcms.2454.7123.6320.7

Minimally Invasive Noncoronary Cardiac Surgery: Study on Early and Midterm Results

Nirav H Panchal

Authors Affiliation: Assistant Professor, Department of Cardiovascular and Thoracic Surgery, U N Mehta Institute of Cardiology and Research Centre, Ahmedabad, Gujarat 380005, India.

Abstract

Introduction: Over the past decades minimally invasive cardiac surgery has grown in popularity. This growth has been driven by desire to translate many observed benefits like less pain, better cosmesis, less surgical trauma as compared to traditional cardiac surgery. This study's objective is to evaluate safety and effectiveness of minimally invasive cardiac surgery in a teaching hospital with respect to learning curve, quality of life, and mid term outcomes.

Material and methods: In this study 50 patients diagnosed having mitral or aortic valve disease requiring replacement of the valve and atrial septal defect requiring surgical closure operated between 1/08/2011 to 31/12/2018 are included.

Results: 38 patients were operated by right thoracotomy while 12 patients were operated by mini sternotomy. In our institution femoral platform is utilized for establishing cardio pulmonary bypass. Cardiopulmonary bypass time for mitral valve surgery was 116+–18.7, min, for aortic valve surgery was 138+–19.6.8 min and for ASD closure was 95+–15.4.4 min. no significant early or mid term complication including re exploration, long duration of surgery or other systemic complications pertaining to respiratory, pulmonary or nervous systempertaining to surgery. All patients showed improvement in NYHA class from their pre operative period in follow up stage.

Conclusion: Minimally invasive cardiac surgery is the upcoming boom and it can be safely performed with the available newer cannulae, anesthesia techniques and surgical instruments.

Keywords: Minimally invasive cardiac surgery; Sternal sparing cardiac surgery.

How to cite this article:

Nirav H Panchal. Minimally Invasive Noncoronary Cardiac Surgery: Study on Early and Midterm Results. J Cardiovasc Med Surg. 2020;6(3):207-211.

Introduction

Over the past decades minimally invasive cardiac surgery has grown in popularity. This growth has been driven by desire to translate many observed benefits like less pain, better cosmesis, less surgical trauma as compared to traditional cardiac surgery. Initial enthusiasm for Minimally Invasive Cardiac Surgery was tempered by concern over reduced exposure and potential for prolonged operative time and patient safety. With innovation in perfusion, development of special surgical instruments Minimally Invasive Cardiac Surgery has achieved new horizons.

Corresponding Author: Nirav H Panchal, Assistant Professor, Department of Cardiovascular and Thoracic Surgery, U N Mehta Institute of Cardiology and Research Centre, Ahmedabad, Gujarat 380005, India.

E-mail: drniravcvts@gmail.com

Aims and objectives

- Study the feasibility and outcome of minimally invasive cardiac surgery at our institute.
- Study benefits of minimally invasive methods

in cardiac surgery spectrum for early and mid term duration.

- Evaluation of hazards and complications of minimally invasive cardiac surgery if they occur.
- Study the role of minimally invasive surgery in valve replacement and congenital heart disease.

Materials and Methods

In this study 50 patients diagnosed having mitral or aortic valve disease requiring replacement of the valve and atrial septal defect requiring surgical closure operated between 1/08/2011 to 31/12/2018 are included.

Inclusion criteria: patients for valve surgery with replacement requirement of only single valve are included. Those above 45 years of age underwent coronary angiography and only those with insignificant or no coronary artery disease are included in the study. For atrial septal defect, patients with weight more than 10 kg are included in the study.

Extubation criteria: patients with stable hemodynamic, generating good spontaneous respiration, having good tone and power and no significant drain output are extubated.

Inotropic supportive infusion: patients are given inotropic support depending on the ventricular function and till stable haemodynamics are maintained with satisfactory periodical blood gas reports.

Post operative analgesics: for paediatric patients diclofenec suppository 12.5 mg 8 hrly for 2 days followed for syrup ibugesic plus half tsf. thrice daily given. For adult patients inj. Diclofenec 75 mg iv 8 hrly followed by tab diclonec twice daily for 3 days.

Criteria for mobilization: patients are mobilized after 6–8 hrs of removal of arterial line.

Stay in icu: patients are kept in icu for 1 day after mobilization.

Exclusion criteria

- Previous right thoracotomy
- Renal failure
- Liver dysfunction
- Recent myocardial ischemia (<30 days)
- Recent stroke (<30 days)
- Patients with more than one valvular pathology requiring intervention or atrial septal defect with other congenital pathology.

Results

In this study total 50 patients were operated of which 20 for ASD, 18 for mitral valve disease and 12 for aortic valve disease.

38 patients were operated by right thoracotomy while 12 patients were operated by mini sternotomy.

Cardiopulmonary bypass time for mitral valve surgery was 116+–18.7, min, for aortic valve surgery was 138+–19.6.8 min and for ASD closure was 95+–15.4.4min

Average duration of pain perceived in thoracotomy incision is 2.5 days and for ministernotomy is 3 days.

Average duration of stay in hospital for mitral valve disease is 7 days, for aortic valve 8 days and for atrial septal defect is 5 days(Table 1).

Table 1: Early Term Results.

Variables	N=50
Low cardiac output syndrome	0
Re exploration	0
Wound complications	1
Pacemaker implantation	0
Atrial fibrillation	12
Renal, gastro intestinal, neurological or pulmonary complication	0

Table 2: Midterm Results.

Follow up months (months+–SD)	36+–7.7
Mortality	1
Prosthetic valve dysfunction	0
Reoperation	0
NYHA CLASS	1.4+–0.4
Cerebro vascular events	1
Readmission for heart failure	2

Following the initial assessment all 50 patients were followed for a mean period of 36+–7.7 months. Improvements in functional status was observed in each patient. All patients returned to NYHA CLASS 1 or 2. There was no need for reoperation for any of this patients and none showed prosthetic valve dysfunction.[1] patient died due to pneumonia and 1 patient developed stroke and 2 patients required readmission due to heart failure because of tachycardia and atrial fibrillation (Table 2).

Discussion

Initially most of the cardiac operations were performed through midline complete sternotomy. But minimally invasive cardiac surgery encompasses a variety of operations through smaller and less traumatic incision than standard sternotomy incision. They may also include use of highly advanced instruments like thoracoscope and robotic system. By using these instruments cardiac surgeries can be performed through smaller and partial (complete sternotomy sparing) incisions. Recent cannulae, have become smaller and manufactured with non kinking material to maximize operative space. Application of co2 in operative field has reduced the risk of air embolism by reducing intra cardiac air. Advancement in TEE aid in visualization of intraoperative findings, conforming cannulae position and ensures proper deairing. Arterial access can be achieved with central aortic cannulation or peripheral cannulation via femoral or axillary artery. In a similar manner cardioplegia can be administered either antegrade from aortic cannula or retrograde from coronary sinus via transjugularcatheterization. Numerous incisions for minimally invasive (sternal sparing) cardiac surgery are described in form of ministernotomy, "j" sternotomy, rt. Or lt. thoracotomy, inverted "t" sternotomy or "V" incisions. Various newer technological advancement also took place in form of port access method that combines endovascular balloon aortic occlusion with antegrade cardioplegia administration. Though this method is associated with higher risk of retrograde aortic dissection or risks associated with peripheral arterial cannulation.

Minimally Invasive Cardiac Surgery And Its Current Concepts

- Today the Minimally Invasive Cardiac Surgery is classified in four different categories according to access to thoracic cavity and use of advanced instruments.

1. *Surgery by thoracotomy or partial sternotomy:* traditional cardiac surgery involves use of long midline chest incisions with sternotomy for access of heart and various structures. In thoracotomy or partial sternotomy mediastinal structures are accessed via right or left thoracic incisions or small sternotomy incisions.In 1996 ministernotomy and parasternal incisions were used first for minimally invasive aortic valve surgeries.[1] Then good access to mitral valve with low mortality (1–3%) and morbidity for mitral valve were also comparable to conventional mitral valve surgery. Cosgrov in his study of 50 minimally invasive aortic operations showed operative time approximated conventional operations and mortality was only 2% with half of the patients being discharged by 0 post operative day 5.[2]
2. *Video assisted surgery and use of micro incisions for port access:* cardiac surgery has lagged behind these specialties in utilizing the benefits of video assistance because fine coronary anastomoses and complex valve reconstructions are the counterpiece of contemporary adult cardiac surgery. Micro incisions are considered as 4–6 cm skin incisions and video assistance indicates that 50% or less of the operation is performed while viewing the operative field from a screen. Video assisted surgery was first used for close chest internal mammary artery harvest and congenital heart operations.[3,4]
3. *Video directed and port incision surgery:* in 1997 Mohr used AESOP voice activated camera robot in mitral valve repair.[6] With this device voice controlled robotic arm allows hands free camera manipulation. Surgeon commands camera movements verbally providing direct eye brain action. Port incision (1–2 cm.) can be used at this level and video direction implies that most of the operation is done via secondary or assisted vision.
4. Video directed Robotic cardiac surgery: advances in perfusion techniques, intracardiac visualization, instrumentation and robotic manipulation have hastened a shift towards efficient and safe minimally invasive cardiac surgery.

   Six degree of freedom are required to allow free orientation in space. Standard endoscopic instruments with only four degree of freedom reduce dexterity significantly. When working through fixed entry points such as trocar operations must reverse hand motions. At the same time instruments shaft shear or drag induces the need for higher manipulation forces leading to hand muscle fatigue. Computer enhanced instrumentation have been developed to overcome these limitations. They provide both telemanipulation and micromanipulation of tissue in small spaces. Surgeon operates from a consol, immersed in three dimensional view of the operative field through a computer interface his or her motions are reproduced in scaled

proportions through microwrist instruments that are mounted in robotic arm inserted through chest wall. Various robotic system like Zeus robotic system (computer motion inc. santa Barbara, CA) and da Vinci system (intuitive surgical inc. Mountain view, CA) are currently in use for minimally invasive (sternal sparing) cardiac surgery.Inmay 1998, Carpentier et. al. in Paris performed the first mitral valve repair using an early prototype of the da Vinci articulated intracardiac "wrist" robotic device.[7] Although 4 cm. incision is still used for assistant access, the advancements in three dimensional video and robotic instrumentation have progressed to a point at which totally endoscopic mitral valve procedures are feasible. Lange and associates in Munich were the first to perform a totally endoscopic mitral valve surgery using only 1 cm ports with da Vinci.[8]

Advantages of Minimally Invasive Cardiac Surgery

Minimally Invasive (Sternal Sparing) Cardiac Surgery confers many advantages over traditional cardiac surgery. They are as under:

- Smaller incisions as these surgeries are done through thoracotomy or partial sternotomy or via multiple smaller incisions through which thoracoscopic instruments or robotic instruments enter the thoracic cavity.
- Smaller scars which is more acceptable cosmetically especially in young female patients and children.
- Reduced pain as these surgeries involve sparing of sternum and less dissection of tissues as compared to traditional surgeries.[9]
- Less pain because of smaller incisions.
- Conventional knot tying add significant time to each procedure. Technological advancement and use of nitinol "u" clips decrease operative time significantly.
- Shorter recovery time as compared to traditional surgery. Patient is mobilized early and recovers fast.[10]
- Shorter hospital stay and overall cost of therapy is less as compared to traditional operations.
- Less blood loss and less requirement of transfusions. So avoidance from transfusion related hazards.[11]
- Fewer physical restrictions as compared to traditional operations in post operative period. Patient undergoing standard incision cardiac surgery are restricted from driving an automobile or lifting objects of weighing more than 5 pound in early post operative period while patients undergoing minimally invasive cardiac surgery do not subjected to these restrictions.
- Facilitates re do surgery.
- Cost effective analysis also showed favorable results.[12]

In addition to the benefits with minimally invasive cardiac surgery, there are few limitations and disadvantages are associated with minimally invasive surgeries like rigid thoracic cavity and limited exposure may impaire proper assessment of operative sites and ventricular function.

Use of long rigid instruments to grasp tissues lack the tactile feeling which is an important part of surgical skill in any operative procedures.

Cherup and associates described maldevelopment of the breast and pectoral muscles in children who had undergone thoracotomy in early childhood.[13] Scoliosis is also known to occur after extensive thoracotomies.[14] Complex congenital heart disease or pre operatively unidentified pathology if comes during surgery conversion to sternotomy has to be done as they may not be tackled by smaller incisions.

Conclusion

We consider minimally invasive cardiac surgery with acceptable early and mid term results in our study involving patients with valvular and atrial septal defect pathology. In view of increasing evidence showing safety and feasibility, this should be considered as a reasonable alternative to the standard median sternotomy approach.

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