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Beating Heart Minimally Invasive Mitral Valve Surgery in Patients with Previous Sternotomy: The Operative Technique and Early Outcomes

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Abstract

Re-operative mitral valve surgery is increasingly required and can be associated with significant morbidity and mortality. The beating heart minimally invasive mitral valve surgery has a proposed benefit in avoiding the risks of repeat sternotomy, with reducing the need for adhesiolysis and cardioplegia reperfusion injury. We describe our experience with such a technique in patients with previous sternotomy.Methods: A retrospective study was performed and all patients undergoing surgery of mitral valve through a right limited thoracotomy without application of an aortic cross clamp (beating heart) as a redo cardiac surgery between January 2006 and January 2015 were included (n=25). Perioperative data as well as the operative technique are presented.

Index terms— beating heart mitral, minimal invasive mitral, redo cardiac surgery.

1 Beating Heart Minimally Invasive Mitral Valve Surgery in Patients with Previous Sternotomy: The Operative Technique and Early Outcomes

Summary-Objective: Re-operative mitral valve surgery is increasingly required and can be associated with significant morbidity and mortality. The beating heart minimally invasive mitral valve surgery has a proposed benefit in avoiding the risks of repeat sternotomy, with reducing the need for adhesiolysis and cardioplegia reperfusion injury. We describe our experience with such a technique in patients with previous sternotomy.

Methods: A retrospective study was performed and all patients undergoing surgery of mitral valve through a right limited thoracotomy without application of an aortic cross clamp (beating heart) as a redo cardiac surgery between January 2006 and January 2015 were included (n=25). Perioperative data as well as the operative technique are presented.

Results: Six patients (24%) had two previous sternotomies and one (4%) had three previous sternotomies. Mitral valve repair was performed in 11 patients (44%). No patient required conversion to median sternotomy. Inotropic support beyond four hours after operation was required in 7 patients (28%). Ventilation time was less than 12 hours in 14 patients (56%) with another 6 patients (24%) extubated within 24 hours after surgery. Postoperative course was complicated with cerebrovascular accident in 2 patients (8%). In-hospital mortality was 4% (n=1). There was no 30-day mortality after discharge.

Conclusions: Re-operative mitral valve surgery can be safely performed through a right limited thoracotomy approach on a beating heart while on full cardiopulmonary bypass. The technique can be associated with potentially shorter operation, shorter cardiopulmonary bypass, and a less complicated recovery.

2 I. Introduction

e-operative cardiac surgery is increasingly being performed as the population ages. Seven precent of cardiac surgeries performed in Australia between 2010 and 2011 were redo surgeries. 1 Re-entry median sternotomy

is associated with significant potential morbidity and mortality, especially if patent coronary artery grafts are present. 2 Hazards during re-operative surgery include sternal re-entry with attendant risks of damage to the right ventricle, aorta, in nominate vein and patent coronary grafts. Dissection of adhesions can be timeconsuming and technically challenging, especially if the aorta must be exposed for can nulation or crossclamping. Adequate exposure of the mitral valve is also a concern with adhesions potentially limiting the ability to manipulate the heart into a position to facilitate optimum exposure. In addition, in patients with poor ventricular function, as is often seen in long-standing valvular disease or in those with a history of coronary artery disease, myocardial protection becomes a concern and cardioplegiccardiac arrest will place the patient at risk of ischemia-reperfusion injury and postoperative low cardiac output. 3 The beating heart approach to mitral valve surgery was first described by Praeger and colleagues in 1989. 4 Since then, several groupshave reported good outcomes with performing mitral valve surgery on the beating heart, through a right thoracotomy. [5][6][7][8][9][10] The proposed benefit of this approach is reduction in the risks of re-do sternotomy, release of adhesions and cardioplegia reperfusion injury.

We describe our experience with redo surgery for mitral valve intervention performed through a right anterolateral thoracotomy incisiondone on a beating heart.

3 II. Methods

A retrospective study was performed and all patients undergoing surgery of mitral valvethrough a right anterolateral thoracotomy without application of an aortic cross clamp (beating heart) as a redo cardiac surgery between January 2006 and January 2015,in our institute, were included (n=25). Patients with previous sternotomy that merely required mitral valve intervention with no contraindication for a right thoracotomy were considered for this approach. Preoperative patient factors, perioperative outcomes, as well as complication rates were identified through retrospective database and case note review. Data was reported as mean and standard deviation, median and interquartile range (IQR), or frequency, as appropriate. Given the retrospective nature of the study no specific local ethics committee approval was required.

4 a) Operative technique

All patients were intubated with a single lumen endotracheal tube. They were placed in a semi-supine position with the right chest slightly raised. External defibrillation pads were placed in all cases. Normothermic cardiopulmonary bypass (CPB) was established via femoral artery using a EOPA? Arterial Cannula (Medtronic, Inc, MN, USA) and femoral vein using a Multi-Stage Femoral Cannula (Medtronic, Inc, MN, USA) with vacuum assist. A limited right anterolateral thoracotomy was then performed through the fourth or fifth intercostal space. A PeriVue soft tissue retractor (Edwards Lifescience LLC, Irvine, CA, USA), a rib spreader (Geister Medizintechnik, Tuttlingen, Germany), and malleable copper blade retractors were used to aid exposure. A 10-mm thoracoscopic camera was placed through a separate port placed in the third intercostal space. The pleural space was insufflated with carbon dioxide at a rate of 5 litres per minute to reduce intra-cardiac air. The aorta was not particularly dissected free, cannulated, or clamped and no cardioplegia was used.

The interatrial groove was dissected to expose the left atrium and the left atrium was directly entered after ensuring full CPB is achieved and the heart is well drained. The mitral valve was then inspected, and then replaced or repaired as appropriate based on the pathology. After the mitral valve repair or replacement has been performed, a pump sucker was kept inside the left ventricle and an agitator kept the mitral valve incompetent. Deairing was achieved by means of directly venting the left ventricle whilst the heart was filled and the atriotomy closed. Air removal was confirmed with trans-oesophageal echocardiography. A pleural drain was then placed. The patient was then weaned off CPB and de cannulated. An intercostal catheter for local anaesthetic infusion was inserted and the wounds were closed in a routine fashion.

5 III. Results

The commonest prior cardiac surgery was coronary artery bypass grafting (n=12, 48%, Table 1). Three patients (12%) had prior mitral valve replacement. Six patients (24%) had two previous sternotomies and one (4%) had three previous sternotomies. Mitral valve repair was performed in 11patients (44%, Table **??**). Annuloplasty rings were used in all patients that had mitral valve repair. Concomitant atrial fibrillation surgery was performed in 3 (12%) patients.

No patient required conversion to median sternotomy. Weaning from CPB was successful in all patients without requiring intra-aortic balloon pump, with or without inotropic support. Inotropic support beyond four hours after operation was required in 7 patients (28%). Ventilation time was less than 12 hours in 14 patients (56%) with another 6 patients (24%) extubated within 24 hours after surgery. Postoperative course was complicated with stroke in 1 patient (4%, Table **??**) and the patient made near complete recovery with minimal deficit. Early (in-hospital) mortality was 4% (n=1). There was no mortality within the first month after discharge.

6 IV. Discussion

Re-operative mitral valve surgery is increasingly required and carries a high burden of associated potential morbidity and mortality. 8 Alternatives for repeat mitral surgery include redo median sternotomy and cardioplegic arrest, or hypothermic ventricular fibrillatory arrest. The technique used in the current seriesis similar to what

has been described before by other groups. [4][5][6][7][8][9][10] A number of advantages are described: it avoids the need for a repeat sternotomy and its associated risk of injury to cardiac structures, potential catastrophic cardiac injury, and sternal wound infection; 11 by limiting the degree of adhesiolysis required, through entry via a preserved right pleural space and avoiding the need for dissection around the aorta for cross-clamping, there is a potential reduction in the operative and CPB times as well as the risk of perioperative bleeding. 12 In addition, maintaining normothermia can potentially decrease the risk of coagulopathy after a complex repeat mitral surgery. The transfusion rate in this series was 40% and 2 patients (8%) required return to theatre for bleeding, both managed through reopening the right thoracotomy wound.

The alternative to the beating heart technique is a ventricular fibrillation arrest. However, ventricular fibrillation arrest is known to reduce oxygen delivery to the subendocardium, and thus provides suboptimal myocardial protection. 8 Continuous myocardial perfusion in a beating heart technique is ideal as it provides optimal myocardial protection through maintenance of coronary circulation throughout the operation. 13,14 One potential disadvantage to this technique is its perceived technical difficulty. In our experience, physiological assessment of valve repair was more easily performed with the heart beating. Indeed, the current series comprised 11 (44%) mitral valve repairs, including more complex valvuloplasties with concomitant quadrangular resection and cleft closure in addition to an annuloplasty ring. Comparable repair success rates have been previously reported. 8,9 A particular concern in mitral valve surgery is air embolism, 5 especially in this case where the aorta is not clamped and no aortic vent is placed. In our experience as well as other groups experience, 6 with full CPB flow and vacuum assisted venous drainage, the aortic valve hardly opens even in the systolic phase, as confirmed by the intraoperative trans-oesophageal echocardiogram. Furthermore, the blood will be preferentially expelled across the mitral valve, since atmospheric pressure is much less than the aortic root pressure. 9 After the mitral valve repair or replacement has been performed, a pump sucker is kept inside the left ventricle and an agitator keeps the mitral valve incompetent. The left atrium is allowed to fill completely with backflow of blood prior to closing the atriotomy line. Carbon dioxide insufflation is also used to displace intra-cardiac air. By avoiding aortic manipulation by a cross-clamp, the risk of systemic embolisation is potentially avoided. In this series, 2 patients had postoperative adverse neurologic events; both were felt to be embolic in aetiology.

Another potential disadvantage is a higher rate of pulmonary complications with right thoracotomy as compared with repeat median sternotomy. Indeed, our series did present a relatively high rate of pneumonia (16%).Comparable to other reports, 8 80% of patients of this series were extubated within 24 hours of surgery with a median mechanical ventilation time of 11 hours.

Although the data for all patients were collected prospectively as part of a national database, this study was limited by its retrospective design and its relative small sample size.

Re-operative mitral valve surgery can be safely performed through a right limited thoracotomy approach on a beating heart while on full CPB. The technique can potentially be associated with a shorter operation, a shorter CPB, and a less complicated recovery. [1] [2]

1

Characteristics	Values
Gender (male), n (%)	15 (60)
Age, years (SD)	67.8 (10.4)
Hypertension, n (%)	14 (56)
Atrial fibrillation, n (%)	17 (68)
Pulmonary hypertension, n (%)	11 (44)
Baseline creatinine, µmol/L (SD)	96 (44)
Chronic pulmonary disease, n (%)	4 (16)
Cerebrovascular accident, n (%)	2 (8)
Previous cardiac surgery, n (%)	

Figure 1: Table 1 :

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