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Aortic and/or mitral valve surgery in patients with pulmonary hypertension performed via a minimally invasive approach

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Abstract

Pulmonary hypertension (PH) in the setting of left-sided valvular heart disease is common, and significantly increases the risk of perioperative morbidity and mortality in patients undergoing aortic and/or mitral valve surgery. Minimally invasive valve surgery is associated with a decreased incidence of perioperative complications, and a faster recovery, when compared with conventional sternotomy. In the present study, the outcomes of 569 patients with PH who underwent minimally invasive aortic and/or mitral valve surgery were analysed. The operative mortality was 3.5%, and postoperative strokes occurred in 1.4%. The mean intensive care unit and hospital length of stays were 50 ± 14 h and 7 ± 1 days, respectively. Patients with severe PH (mean pulmonary artery pressure ≥ 40 mmHg) had a longer duration of postoperative ventilation and intensive care unit length of stay, when compared with mild/moderate PH, and similar clinical outcomes. In conclusion, a minimally invasive approach to aortic and/or mitral valve surgery in patients with PH is safe and feasible, and may be considered as an alternative to conventional median sternotomy.

Keywords: Aortic valve • Minimally invasive surgery • Mitral valve • Pulmonary hypertension • Right thoracotomy

INTRODUCTION

Pulmonary hypertension (PH) is associated with a significantly increased risk of operative and long-term mortality in patients undergoing cardiac surgery [1]. A minimally invasive approach to valve surgery has been shown to reduce the incidence of postoperative atrial fibrillation and decrease the need for blood products, and is associated with a lower morbidity and an enhanced postoperative recovery [2]. Given the operative risk associated with the presence of PH, and the less traumatic nature of minimally invasive surgery, we sought to evaluate the outcomes of patients with PH undergoing valve surgery via a minimally invasive right thoracotomy approach.

MATERIALS AND METHODS

We retrospectively reviewed 1882 consecutive patients who underwent valve surgery at our institution between January 2011 and August 2014. All available preoperative pulmonary artery catheter readings were included for review. The mean pulmonary artery pressure (mPAP) was calculated using the formula: $(1/3 \text{ pulmonary artery systolic pressure} + 2/3 \text{ pulmonary artery diastolic pressure})$. PH was defined as $\text{mPAP} \geq 25$ mmHg, and was further classified as mild ($\text{mPAP} = 25\text{--}29$ mmHg), moderate ($\text{mPAP} = 30\text{--}39$ mmHg) and severe ($\text{mPAP} \geq 40$ mmHg) [3, 4].

The patients' baseline characteristics, operative variables and postoperative data were reviewed. The variables selected were based on the Society of Thoracic Surgeons database definitions. In all patients, the valvular lesions were documented by diagnostic catheterization and/or echocardiography, and all operative reports and echocardiograms were reviewed. Outcomes were compared between patients with mild/moderate versus severe PH, using a χ^2 test for categorical variables, and an independent *t*-test for continuous variables.

Technique for minimally invasive valve surgery

Our approach to minimally invasive valve surgery has been previously described [5]. Briefly, for mitral valve problems, the operation is performed via a 5- to 6-cm right thoracotomy, in the fourth or fifth intercostal space lateral to the anterior axillary line. For aortic valve replacements, a 4- to 5-cm transverse parasternal skin incision is made over the right second or third intercostal space, and the costochondral cartilage is transected to adequately expose the aorta. After completion of the operation, the rib is reattached to the sternum with a 1-cm metal plate (Synthes, West Chester, PA, USA). Finally, in combined aortic and mitral valve operations, a 6- to 7-cm incision is performed over the fourth intercostal space at the midclavicular line. The fourth intercostal space is entered and the cartilage is

Table 1: Baseline characteristics and valve surgery performed

Variable	N = 569
Baseline characteristics	
Age (years, mean \pm SD)	72 \pm 11
Left ventricular ejection fraction (%), mean \pm SD)	54 \pm 13
Female gender, n (%)	283 (50)
Body mass index (kg/m ² , mean \pm SD)	30 \pm 6
Chronic obstructive pulmonary disease, n (%)	117 (21)
Diabetes mellitus, n (%)	168 (30)
Hypertension, n (%)	517 (91)
Peripheral vascular disease, n (%)	66 (12)
Preoperative creatinine (mg/dl, mean \pm SD)	1.2 \pm 0.9
Mean pulmonary artery pressure (mmHg, mean \pm SD)	33 \pm 8
Mild pulmonary hypertension (mPAP 25–29 mmHg), n (%)	274 (48)
Moderate pulmonary hypertension (mPAP 30–39 mmHg), n (%)	200 (35)
Severe pulmonary hypertension (mPAP \geq 40 mmHg), n (%)	95 (17)
Valve surgery performed, n (%)	
Mitral valve replacement	152 (27)
Mitral valve repair	154 (27)
Aortic valve replacement	187 (32.8)
Aortic valve repair	2 (0.3)
Mitral valve repair + aortic valve replacement	51 (8.9)
Mitral valve replacement + aortic valve replacement	23 (4)

SD: standard deviation.

transected, and is subsequently reattached at the completion of the operation.

RESULTS

Preoperative pulmonary artery catheter measurements were available for 1433 patients who underwent minimally invasive valve surgery. A total of 569 patients, with a mean (\pm standard deviation) age of 72 \pm 11 years, were found to have PH and underwent aortic and/or mitral valve surgery via a right thoracotomy. The mean left ventricular ejection fraction and mPAP were 54 \pm 13% and 33 \pm 8 mmHg, respectively. The PH severity was mild in 274 (48%), moderate in 200 (35%) and severe in 95 (17%) patients. The types of surgery consisted of 306 mitral, 189 aortic and 74 combined mitral and aortic valve surgeries (Table 1).

No patient required conversion to median sternotomy. The mean cardiopulmonary bypass and aortic cross-clamp times were 113 \pm 23 and 80 \pm 7 min, respectively. A mean of 2 \pm 0.9 units of packed red blood cells were transfused intraoperatively. The operative mortality was 20 (3.5%), and there were 8 (1.4%) postoperative strokes. The mean postoperative ventilation time was 12 \pm 3 h. The mean intensive care unit and hospital length of stays were 50 \pm 14 h and 7 \pm 1 days, respectively. Finally, when comparing the outcomes of patients based on PH severity, those with severe PH (mean mPAP = 46 \pm 7 mmHg) had slightly greater postoperative ventilation hours, and an increased intensive care unit length of stay, when compared with mild/moderate PH (mean mPAP = 30 \pm 4 mmHg). However, there was no difference in clinical outcomes, or in the hospital length of stay (Table 2).

Table 2: Outcomes of minimally invasive valve surgery in mild/moderate versus severe pulmonary hypertension

Variable	Mild/moderate (N = 474)	Severe (N = 95)	P-value
In-hospital mortality, n (%)	17 (4)	3 (3)	0.84
Postoperative stroke, n (%)	7 (1.5)	1 (1)	0.75
Intraoperative packed red blood cell transfusion (units, mean \pm SD)	2.0 \pm 0.9	2.1 \pm 1.1	0.34
Postoperative ventilator (h)	12 \pm 3	13 \pm 2	0.006
Intensive care unit length of stay (h, mean \pm SD)	46 \pm 10	70 \pm 12	<0.001
Hospital length of stay (h, mean \pm SD)	7 \pm 1	7 \pm 1	1

SD: standard deviation.

DISCUSSION

PH in the setting of left-sided valvular heart disease is a common clinical entity and identifies a high-risk operative group. In patients undergoing valve surgery, the presence of preoperative PH leads to an approximately 2- to 3-fold underestimation of operative mortality by the Society of Thoracic Surgeons risk score. The incidence of major perioperative complications is 14.4%, including a 2.4% incidence of stroke, which increases with the severity of PH [1].

Minimally invasive approaches to valve surgery have been associated with lower perioperative morbidity, a faster postoperative recovery and decreased hospital costs, when compared with a conventional median sternotomy [2, 6, 7]. A survival benefit has also been observed in high-risk groups such as the elderly and obese [5, 8]. Also, in a study that evaluated the outcomes of 165 patients with chronic obstructive pulmonary disease, those who underwent a minimally invasive approach had a significant reduction in composite complications and shorter hospital length of stay when compared with those who underwent a median sternotomy [9].

After a median sternotomy, there are decreases in forced vital capacity, expiratory volume in the first second of forced expiration, peak expiratory flow rate and maximum voluntary ventilation [10]. Therefore, it is tempting to hypothesize that the less traumatic nature of a minimally invasive approach would benefit patients with PH. In the present study, a minimally invasive approach to aortic and/or mitral valve surgery was safely performed, with good perioperative outcomes and acceptable hospital length of stay.

The main limitation to the current analysis is that it is a single-centre retrospective study of a heterogeneous group of patients. Also, the aortic and mitral valve surgery data are presented together; therefore, it is not possible to comment on the outcome effect of PH would have in each of the valve pathologies. Finally, there is no comparison to conventional sternotomy aortic and/or mitral valve surgery, which limits the conclusions that can be drawn. Our results are best interpreted as providing evidence for the safety and feasibility of minimally invasive surgery via a right thoracotomy, as an acceptable alternative to conventional median sternotomy, for patients with PH undergoing aortic and/or mitral valve operation.

Conflict of interest: none declared.

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