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Original Article

Right anterolateral thoracotomy as an alternative approach to resternotomy for high-risk cardiac surgery patients

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Abstract

Introduction
Redocardiac valve surgery through median sternotomy is associated with a potential increased risk of morbidity and mortality. The study was done at the National Heart Institute of Egypt from June 2016 to June 2018 to evaluate the right anterolateral thoracotomy for high-risk patients undergoing mitral and tricuspid valve redo procedures.

Patients and methods
This study includes 26 patients operated through right anterolateral thoracotomy which include high-risk group on the basis of the proximity of sternum to the right ventricle or great vessels, mainly ascending aorta. Moreover, the presence and location of patent grafts were assessed.

Results
In right submammary thoracotomy group, the mitral valve was replaced in 19 patients and repaired in two, and tricuspid valve was replaced in two and repaired in five patients. Mortality was 7.69%.

Conclusion
Redocardiac valve surgery in high-risk patients can be performed safely through the right submammary thoracotomy with good exposure. It minimizes the need for surgical dissection and decreases the risk for accidental injury. So, in high-risk patients, avoiding resternotomy improves patient's recovery and increases safety for redo mitral and tricuspid valve surgery.

Keywords: Right anterolateral thoracotomy, resternotomy, high-risk redo cardiac surgery

Background

Redocardiac valve surgery using a median sternotomy is a common surgical approach but is technically challenging in high-risk patients. It includes several surgical risks, including injury to the right ventricle, injury to coronary patent grafts, and bleeding owing dissection of sever adhesions, thereby increasing operative morbidity and mortality [1]. In reoperative cardiac surgery, the redosternotomy is the most dangerous part of the operation, especially for patients with huge heart and severe adhesions [1,2].

Many protective techniques have been described for redocardiac valve surgical procedures, including exposure of femoral vessel before sternotomy [3], prophylactic start of cardiopulmonary bypass [1], and the use of right thoracotomy approach [4–6]. Lateral view chest radiography imaging and computed tomography scanning are performed if available to visualize the adhesions of the mediastinal contents to the sternum and to detect the patients at risk for injury during resternotomy [7]. However, we still cannot avoid accidental injury during resternotomy [3]. Moreover, postoperative complications for redosternotomy, such as mediastinitis, sternal dehiscence, and phrenic nerve injury, are higher in this group [8]. Therefore, we studied herein whether redomitral and tricuspid valve surgery

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can be performed safely through the right submammary thoracotomy in high-risk patients.

Patients and Methods

Patient enrollment

From June 2012 to June 2018, 170 patients underwent redocardiac valve surgery at the Department of Cardiac Surgery in the National Heart Institute of Egypt. All of these patients had a previous operation through a median sternotomy. A total of 26 high-risk patients were reoperated using the right submammary thoracotomy, and the rest were reoperative through the classic median sternotomy.

We define the high-risk patients as those with one of the following:

(1) Severe adhesions of right atrium or right ventricle to the sternum.
(2) Previously placed bypass graft crossing midline with less than 1 cm distance from the posterior surface of the sternum, or fixed to the sternum (lack of movement on angiography).
(3) The ascending aorta is dilated or close to the sternum less than 5 mm.
(4) History of mediastinitis, more than two sternotomies, or exposure to chest radiation.
(5) Pulmonary hypertension with right ventricle dilatation.
(6) The redo operation less than 6 months from the last operation [2].

Operation technique

General anesthesia was initiated with dual-lumen endotracheal intubation. The patients were positioned in a 30° anterior oblique position, and the fourth rib was marked anteriorly for ~12 cm. The right submammary thoracotomy was done, and the right fourth intercostal space was entered through the 12 cm incision. Cardiopulmonary bypass was started using femorofemoral cannulation in right femoral artery, right femoral vein, and superior vena cava using transesophageal echocardiography guidance.

If severe pleural adhesions are present owing to previous surgery, the right lung was gently dissected from the pericardium. After initiation of cardiopulmonary bypass, dissection of the ascending aorta for application of the aortic cross-clamp was attempted in all patients. For all patients, we used full cardiopulmonary bypass with hypothermia (28–32°C) and antegrade cold crystalloid high-potassium cardioplegic arrest. One patient was cooled to 20°C and induced ventricular fibrillation, and the surgery was continued with retrograde perfusion via coronary sinus for failure to dissect the ascending aorta (Table 1).

Statistical analysis

Statistical analysis was done using IBM SPSS version 20. Continuous variables are expressed as mean ± SD. Categorical variables are presented as number and proportions.

Table 1: Preoperative data of the patients

item	value
Age (years)	36±8.6
Sex [*n* (%)]	
Male	14 (53.8)
Female	12 (46.15)
Primary operation (*n*)	
Mitral valve repair	4
Mitral valve replacement	16
Aortic valve replacement	8
Tricuspid valvuloplasty	8
Coronary artery bypass grafting	2
New York Heart Association class [*n* (%)]	
Class III	15 (57.69)
Class IV	9 (34.6)
Mitral valve insufficiency (*n*)	21
Tricuspid valve insufficiency (*n*)	5
Atrial fibrillation (*n*)	22
Left ventricular ejection fraction	42.5±5.3%
Left atrial diameter (mm)	55±3.1

Results

Patient characteristics

We studied 26 patients (14 females and 12 males, mean age 36 ± 8.6 years) who underwent reoperation for mitral and tricuspid valve replacement or repair through right submammary thoracotomy.

A total of 21 patients had insufficiency of the mitral valve and five patients had tricuspid valve insufficiency. Atrial fibrillation was present in 22 patients. Overall, 15 patients were in NYHA Class III, and the remaining 11 patients were in Class IV. Mean left ventricular ejection fraction was 42.5 ± 5.3%, and mean left atrial diameter was 55 ± 3.1.

Operative characteristics

Most patients received mitral valve replacement using mechanical prosthetic valve. The patients take an average duration of cardiopulmonary bypass and cross-clamp of 123 and 69 min, respectively. Moreover, no major blood loss occurred during operation, and the blood transfusion was less than one unit of 500 ml of blood. The incision length was 12.4 ± 2.5. The intraoperative course was smooth, with no major complications, and no patient was converted to a full sternotomy.

Outcomes and follow-up

The chest drainage volume of the first 24 h was 223 ± 84 ml, and there was no postoperative blood transfusion in 16 patients. A total of eight patients exceeded 24 h duration of mechanical ventilation, and 12 patients stayed in the intensive care unit for more than 3 days.

Moreover, two patients received continuous renal replacement therapy for acute renal failure or oliguresis. There were two deaths during early postoperative period owing to low-output syndrome causing multisystem organ failure.

For the remaining 24 patients, the postoperative hospital stay was 12.4 ± 7.9 days.

Information after discharge was obtained at the follow-up clinic and by telephone. The duration of follow-up ranged 6–24 months, and follow-up rate was 100%. No late deaths or cardiovascular complications occurred during the follow-up period (Table 2).

Discussion

The interest in less-invasive approaches in cardiac surgery is increasing, especially those alternative access routes that decrease the surgical risk and do not affect the quality of surgery [9]. So, we reoperated high-risk patients for redomitral and tricuspid valve surgery using a less-invasive right submammary thoracotomy. This study evaluated 26 patients undergoing the less-invasive technique for redocardiac valve procedures.

The use of right submammary incision gives excellent view of the mitral and tricuspid valve structures owing to a direct-line view [10]. The use of median sternotomy during reoperations of cardiac valve needs more extensive dissection of adhesions and is time consuming. Redo through a median sternotomy carries the risk of injury to the right atrium and ventricle, which is associated with major bleeding and needs more blood transfusion [1]. In redo CABG (coronary artery bypass graft), patent conduits especially internal mammary graft are prone to injury during surgery. Hemorrhage from the accidental injury of the heart or great vessels during resternotomy has been reported to occur in 3.6–4.3% of cases [2]. The incidence of major hemorrhage or mortality associated with dissection of adhesions through right thoracotomy is less than in median sternotomy [11].

Using the right submammary thoracotomy approach, the dissection of the ascending aorta to achieve aortic cross-clamping is usually difficult and carries the risk of accidental injury. The ascending aorta showed severe adhesions in one case during this study, and we were not able to apply aortic cross-clamp. So we decided to use a different strategy including hypothermic fibrillatory arrest without an aortic cross-clamp [12]. Especial care should be taken for myocardial protection during this technique to avoid both ischemic and distention injuries and decrease the risk of stroke, which are major concerns in left heart surgery performed under fibrillatory arrest [13]. The left atrium was opened immediately upon fibrillation to keep the left ventricle decompensated. The mean pressure of arterial perfusion was maintained at over 40 mmHg to keep the aortic valve closed. Transesophageal echocardiography was used to ensure no intracardiac air before cardioversion.

Table 2: Postoperative data of the patients

Variables	Mean±SD or *n* (%)
Tube drainage at 24 h (ml)	223±84
Need for ventilator >24 h	8 (30.76)
Need for ICU >3 day	12 (46.15)
Patient on dialysis	2 (7.69)
Postoperative hospital stay (days)	12.4±7.9
Mortality	2 (7.69)

The exposure of the ventricles was poor and requires careful techniques to be able to deair, put the pacing-wire, and defibrillate the heart. We allow the left ventricle to fill with blood before closing the atrial septum. The aortic root is carefully de-aired before the removal of aortic cross-clamp. Pacing wires were inserted to the ventricular surface on empty heart during cardiopulmonary bypass.

Isolated redo tricuspid valve repair or replacement is considered a high-risk operation [4]. Usually these patients have some degree of right heart failure and its associated complications. Poor postoperative outcome may be related to the degree of tricuspid regurgitation itself or due to deterioration of general condition of the patients. In previous studies, redo valve surgery mortality ranged from 0 to 36% [14,15]. In our study, overall mortality was less than that of other studies (7.69%), and the prognosis was better. It was clear that right thoracotomy prevents excessive dissection of the right ventricle and protects excessive dilatation of the right ventricle after surgery that would result in poor right heart function. We usually use a bioprosthetic valve for tricuspid valve replacement in all patients to prevent the use of excessive anticoagulation postoperative.

We detected that dual-lumen endotracheal tube was essential for this technique to avoid excessive lung injury. No pulmonary hemorrhage was detected owing to the use of double-lumen endotracheal tube.

There was no excessive blood loss during right thoracotomy approach, and also the need for blood transfusion is less [16,17]. One of the most valuable advantages is to avoid the risk of deep sternal infection. Phrenic nerve injury is a potential risk during right submammary thoracotomy; this complication did not happen in our study. Another advantage is earlier mobilization of the patients and easy return to ordinary life activities [6].

Ethical approval statement

Ethics committee approval was taken according to national heart institute rules.

Limitations

This study has some limitations, such as the small number of patients because of the relative rarity of redocardiac valve surgery with a high-risk resternotomy, and second, it being a single-center study and one-surgeon experience.

Conclusion

The right submammary thoracotomy has become a standard approach for redomitral and tricuspid valve surgery in high-risk patients at our institution. It avoids a high-risk resternotomy and can be performed safely and reduces the possibility of injury to the heart.

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Conflicts of interest

There are no conflicts of interest.

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