Heart, Lung and Circulation (2016) xx, 1–6
1443-9506/04/$36.00
http://dx.doi.org/10.1016/j.hlc.2016.05.118

ORIGINAL ARTICLE

Tricuspid Valve Replacement Through Right Thoracotomy has Better Outcomes in Redo Cases

Muhammet Onur Hanedan, MD *, Ferit Çiçekçioğlu, Ayşen Aksöyek, Adem İlkay Diken, MD, Ertekin Utku Ünal, Ali İhsan Parlar, MD, Salih Fehmi Katırcıoğlu

Türkiye Yüksek İhtisas Education and Research Hospital, Cardiovascular Surgery, Ankara, Turkey

Received 29 November 2015; received in revised form 13 May 2016; accepted 24 May 2016; online published-ahead-of-print xxx

Background The tricuspid valve is usually ignored and tricuspid interventions are mostly done in the context of other planned cardiac surgery. Isolated tricuspid reoperative procedure, especially tricuspid valve replacement (TVR) is very rare and carries a very high mortality rate. In this prospective study, clinical results of isolated TVR either through a median re-sternotomy or an antero-lateral thoracotomy with conventional cardio-pulmonary bypass (CPB) have been evaluated.

Methods Thirty patients with previous open heart surgery through median sternotomy had isolated TVR between 2004 and 2011. Operative approaches were through a median re-sternotomy in 13 patients and a right antero-lateral thoracotomy in 17 patients.

Results Follow-up period is complete with a mean duration of 19.77±17.08 months. The hospital mortality rates were 46.2% (six patients) in the Median Re-sternotomy Group and 5.9% (one patient) in the Thoracotomy Group (p= 0.025). The surgical procedures lasted shorter and the postoperative drainage amounts were lower in the Thoracotomy Group (298.08±76.64 min vs 246.76±47.40 min, p= 0.032 and 1787.50±1399.53 mL vs 903.33±692.43 mL, p= 0.03 respectively). Presence of ascites in the preoperative period (p= 0.007), operative technique (median re-sternotomy) (p= 0.025), use of cross-clamp (p= 0.048), and need for inotropic support during the operation (p= 0.002) were statistically significant factors affecting the hospital mortality. The mean estimated life period was better for the Thoracotomy Group (16.7±5.03 versus 35.9±5.01 months, p= 0.044). Presence of ascites in the preoperative period was a significant risk factor for overall mortality according to Cox regression analysis.

Conclusion Thoracotomy for TVR in patients with previous median sternotomy is a practical and safe technique with lower mortality rates.

Keywords Tricuspid valve • Tricuspid valve replacement • Thoracotomy

Introduction

The tricuspid valve (TV) is usually known as the forgotten valve because it has not received as much attention as the aortic valve (AV) or mitral valve (MV) [1]. In addition, there has been far less discussion regarding surgical and percutaneous methods for tricuspid valve repair or replacement [2]. Although potential advantages of repair over replacement in the tricuspid position have been suggested by several previous researchers, it is

*Corresponding author at: Türkiye Yüksek İhtisas Hast. Kızılay Sok. 06100 Ankara/Türkiye. Tel.: +90 505 799 51 55, Email: ohanedan@hotmail.com

Please cite this article in press as: Hanedan MO, et al. Tricuspid Valve Replacement Through Right Thoracotomy has Better Outcomes in Redo Cases. Heart, Lung and Circulation (2016), http://dx.doi.org/10.1016/j.hlc.2016.05.118

difficult to develop firm conclusions as to the optimal procedure [3].

Patients are rarely referred for isolated surgical tricuspid valve repair, and most repairs are done in the context of other planned cardiac surgery, because significant tricuspid regurgitation (TR) occurs usually with late-phase myocardial and valvular heart disease except for congenital anomalies such as Ebstein's anomaly [4]. Patients undergoing reoperation for tricuspid valve dysfunction have been rarely observed, and data of these cases are mostly included in the series of reoperations for valvular surgery [5]. Reoperations for recurrent TR are especially high-risk surgical procedures (up to 37% in-hospital mortality) and are therefore not routinely offered to many patients. [4].

Isolated tricuspid valve replacement (TVR) with the right antero-lateral thoracotomy approach, on a beating heart without a cross-clamp has become popular in recent years. In this prospective study the clinical results of isolated TVR either through a median re-sternotomy or through an antero-lateral thoracotomy with conventional cardiopulmonary bypass (CPB) were evaluated.

Patients and Methods

Study Group

Thirty patients who had undergone previous valvular heart surgery through median sternotomy received isolated TVR between 2004 and 2011 in the authors' clinic. All patients were operated on by the same surgeon. Patients with a previous congenital heart operation were not included. Patients were randomised into two groups. Thirteen patients underwent TVR through a median re-sternotomy (Median Re-sternotomy Group) and 17 patients through a right antero-lateral thoracotomy (Thoracotomy Group) approach. All patients gave written consent for the study and approval of the study was obtained from the hospital's ethics committee.

Patient Follow-up

The patients' preoperative clinical and echocardiographic findings with perioperative data were recorded. Follow-up was completed during outpatient clinic visits on the 10th postoperative day, the 2nd month, 6th month, and 1st year after the operation. Hospital mortality is the mortality occurring within 30 days after the operation.

Surgical Techniques

Conventional Median Re-sternotomy

Following median re-sternotomy aorto-bicaval cannulation was performed. All patients were operated on with CPB either on a beating heart without cross-clamping the aorta or under cardioplegic arrest. Hypothermia was avoided and a nasopharyngeal temperature was kept at 35–37°C for the beating heart method, otherwise systemic moderate hypothermia was used (30°C).

Right antero-lateral thoracotomy approach

All of the patients were intubated with a double-lumen endotracheal tube and put in a right lateral decubitus position. Cushions were used to protect the brachial plexus and bone promontories. Right femoral artery cannulation was done for arterial inflow. A right antero-lateral thoracotomy 10 cm in length through the fifth intercostal space was carried out and the right lung was deflated. After minimal pericardial dissection, bicaval venous cannulas were inserted through the right atrium for venous drainage. Then SVC and IVC were encircled with tapes. The left ventricle was decompressed through a vent placed from the right upper pulmonary vein. After going on CPB with normothermia (nasopharyngeal temperature, 35 – 37 ◦C), (flow rate: 2.5 L/min/m2), mean systemic pressure was maintained at 60 mmHg. The heart was perfused through the aortic root and allowed to beat. When total CPB was begun by snaring the SVC and IVC with tapes, a right atriotomy was made. The patient was kept in Trendelenburg (head down tilt) position with continuous aortic root venting for air emboli prevention. De-airing procedures were continued until CPB was terminated. Transoesophageal echocardiography (TEE) was used to detect air bubbles before weaning from the CPB. Tricuspid valve replacement was performed by standard fashion on a beating heart technique. Tricuspid valve leaflets and papillary muscles were not removed in order to protect right ventricular function. Pledgeted sutures were placed through the tricuspid leaflet tissue in order to protect both the tricuspid annulus and the conduction system.

Inotropic agents

Inotropic support was started in marginal cardiac performance while terminating CPB (mean arterial blood pressure below 70 mmHg, pulmonary capillary wedge pressure higher than 30 mmHg). In ICU inotropic support was started to achieve a satisfactory cardiac index (2.1 L/min/m^2) and blood pressure (mean arterial blood pressure 70 mmHg). We used epinephrine as first-line drug for a borderline cardiac output in the absence of tachycardia, dopamine as first-line drug for low cardiac output, especially when systemic vascular resistance was low and dobutamine when cardiac output is marginal and SVR was high.

Statistical Analysis

Statistical evaluation was done with SPSS v16.0 (SPSS Inc., Chicago, IL, USA) packaged software. The results were reported as mean ± standard (SD) for quantitative variables and percentages for categorical variables, and the groups were compared using Student's t-test or Mann Whitney U test for continuous variables and the chi-square test (or Fisher's exact test, if required) for categorical variables. Univariate logistic binary was used for 30-day mortality prediction. Survival rates were calculated utilising the Kaplan-Meier method, and comparisons were made using the log-rank test. Risk estimations of the factors' effect on survival

Please cite this article in press as: Hanedan MO, et al. Tricuspid Valve Replacement Through Right Thoracotomy has Better Outcomes in Redo Cases. Heart, Lung and Circulation (2016), http://dx.doi.org/10.1016/j.hlc.2016.05.118

were performed using the Cox regression model. A P value of <0.05 was considered to be statistically significant.

Results

Follow-up was complete (100%) with a mean duration of 19.77±17.08 months. The follow-up periods were .08±15.40 months (range 1–35 months) for the Median Re-sternotomy Group, and 24.12±17.45 months (range 1–49 months) for the Thoracotomy Group (p= 0.112). The two groups were comparable except for a longer duration of operation in the Median Re-sternotomy Group (298.08±76.64 vs 246.76 ±47.40 min, p=0.032) (Tables 1 and 2). The preoperative data of the patients are summarised in Table 1.

Positive inotropic agent support while coming off CPB was required in nine patients in the Median Re-sternotomy Group, and five patients in the thoracotomy group, and this difference was statistically significant (p= 0.03). However in the intensive care unit (ICU) there was no significant difference between the two groups regarding the need for inotropic agent support (83.3% vs 47.1%, p= 0.064). Two patients in Median Re-sternotomy Group and three patients in Thoracotomy Group underwent re-exploration for surgical bleeding (p= 1.00). One patient had a tracheostomy and another patient needed a permanent pacemaker in the Median Re-sternotomy Group postoperatively. In the Thoracotomy Group, the numbers of these interventions were three and one respectively. From the ICU data, a statistically significant difference was found only in postoperative drainage quantities in favour of the thoracotomy group (p= 0.030) (Table 2). The mean hospital stay for the Median Re-sternotomy Group was 9.92±10.10 days, while for the Thoracotomy Group it was 14.94±20.22 days (p= 0.43).

The hospital mortality rates were 46.2% (six patients) in Median Re-sternotomy Group and 17.6% (three patients) in the Thoracotomy Group (p= 0.123). Two of the deaths in the Thoracotomy Group were not related to the cardiac surgery itself. One patient was lost because of an H1N1 infection on the 14th postoperative day, and the other because of a subarachnoid bleeding on the 15th postoperative day. When these two patients are excluded, the hospital mortality rate in the Thoracotomy Group drops to 5.9% (one patient) and the difference between the two groups becomes statistically significant in favour of the Thoracotomy Group (46.2% vs 5.9%, p= 0.025). One of the deaths in the Re-sternotomy group was associated with the technique itself. In this patient cardiac injury happened due to wound re-exploration.

It was observed that the presence of ascites in the preoperative period (p= 0.007), operative technique (median re-sternotomy) (p= 0.025), use of cross-clamp (p= 0.048), and

Table 1 Preoperative demographics, clinical and echocardiographic findings of the patients

	Median Re-sternotomy Group (n=13)	Thoracotomy Group (n=17)	*p*
Age	48.23±9.54	53.29±11.16	*0.20*
Gender (F/M)	9/4	15/2	*0.36*
NYHA Functional Class (n)			*0.52*
Class II	6	5	
Class III	6	11	
Class IV	1	1	
Previous cardiac operations (n)	1.31±0.48	1.41±0.71	*0.65*
Time to reoperation (months)	132.92±109.15	111.47±94.73	*0.57*
Tricuspid regurgitation	6 (46.2%)	13 (76.5%)	*0,13*
Tricuspid stenosis	1 (7.7%)	0	*0.43*
Tricuspid regurgitation + Stenosis	6 (46.2%)	4 (23%)	*0,26*
Preoperative EF (%)	51.69±6.24	54.29±3.85	*0.20*
sPAP (mmHg)	37.67±12.23	36.57±15.53	*0.86*
LVEDD (cm)	4.6±0.54	4.5±0.43	*0.60*
LVESD (cm)	3.0±0.40	3.1±0.54	*0.59*
Preoperative A. Fib	10(76.92%)	14(82.35%)	*1.00*
Hepatomegaly	9 (69.2%)	13 (59.1%)	*0,70*
Ascites	8 (61.5%)	8 (47.1%)	*0,48*
Pretibial oedema	11 (84.6%)	13 (76.5%)	*0,67*
Previous tricuspid valve intervention	2 (15.4%)	2 (11.8%)	*1.00*

F: Female, M: Male, NYHA: New York Heart Association, EF: Left Ventricular Ejection Fraction, sPAP: systolic Pulmonary Artery Pressure, LVEDD: Left Ventricle End Diastolic Diameter, LVESD: Left Ventricle End Systolic Diameter, A. Fib: Atrial Fibrillation.

Please cite this article in press as: Hanedan MO, et al. Tricuspid Valve Replacement Through Right Thoracotomy has Better Outcomes in Redo Cases. Heart, Lung and Circulation (2016), http://dx.doi.org/10.1016/j.hlc.2016.05.118

Table 2 Operative characteristics and postoperative follow-up data of the patients in intensive care unit

	Median Re-sternotomy Group (n=13)	Thoracotomy Group (n=17)	*p*
Operation duration (minutes)	298,08±76,64	246,76±47,40	*0,032*
CPB Time (minutes)	91,54±53,53	68,35±21,40	*0,11*
Ventilator dependant time (hours)	55,25±109,73	82,75±143,93	*0.58*
Drainage (millilitres)	1787,50±1399,53	903,33±692,43	*0.03*
Re-exploration for bleeding	2(15.38%)	3(17.65%)	*1.00*
Need for erythrocyte (PBC)	4,05±5,09	3,27±3,90	*0.48*
Need for fresh frozen plasma	6,25±7,74	4,60±4,60	*0.49*
Intensive care unit stay (days)	4,67±5,45	11,71±20,89	*0.26*
Inotropic drug usage in intensive care unit	10 (%83,3)	8 (%47,1)	*0.06*
Hospital stay (days)	9.92±10.10	14.94±20.22	*0.43*
Hospital mortality	6(46.2%)	1(5.9%)	*0.025*
Bioprosthetic valve implantation	7 (%53,8)	3 (%17,6)	
			0.06
Mechanical valve implantation	6 (%46,2)	14 (%82,4)	

CPB: Cardiopulmonary bypass. PBC: Pack blood cells

Table 3 Factors affecting hospital mortality

	Univariate analysis *(p)*	Univariate logistic binary regression (p)
Ascites	0,007	0,998
Operative technique	0,025	0,055
Cross-clamp application	0,048	0,999
Intraoperative inotropic drug requirement	0,002	
Intensive care unit inotropic drug requirement	0,058	

need for inotropic support during the operation (p= 0.002) were statistically significant factors affecting the hospital mortality (Table 3). The need for inotrope in the ICU has a p-value of 0.058. When univariate logistic binary regression was carried out among the statistically significant factors in univariate analysis, only the operative technique had a p value very close to 0.05 for hospital mortality (p=0.055) (Table 3).

The mean estimated life period was better for the Thoracotomy Group (16.7±5.03 vs 35.9±5.01 months). Survival rates were 46.2% for one and two years in the Median Re-sternotomy Group, and 76% for one and 65.2% for two years in the Thoracotomy Group (p= 0.044).

Presence of ascites in the preoperative period was a statistically significant risk factor for mortality according to the Cox regression analysis (Table 4).

Patients were evaluated according to the type of prosthesis they received. Patients with a bio-prosthetic valve (n= 10) had a hospital mortality of 20%, while patients with a mechanical valve (n= 20) had a mortality rate of 35%, having no statistically significant difference between them (p= 0.675). The two-year survival rates were also similar for both types of prosthesis (46% in the bio-prosthetic valve group and 50% in the mechanical valve group (p=0.782).

Discussion

Annular dilation and right ventricular enlargement which are mostly due to left heart failure are the main reasons for tricuspid valve regurgitation. Rheumatic, congenital, or other reasons like endocarditis are other less common aetiologic

Please cite this article in press as: Hanedan MO, et al. Tricuspid Valve Replacement Through Right Thoracotomy has Better Outcomes in Redo Cases. Heart, Lung and Circulation (2016), http://dx.doi.org/10.1016/j.hlc.2016.05.118

Table 4 Factors affecting survival

	(p)	Cox Regression (p)	Odds ratio	95% confidence interval	
Ascites	0,003	0,035	0.187	0.039	0.886
Operative technique	0,044	0,194	2.274	0.658	7.866
Cross-clamp application	0,042	0,688	0.715	0.139	3.673

factors [2]. Rheumatic disease has been more frequently seen in developing countries [4]. In the current report, 63.33% of the patients had tricuspid regurgitation due to left heart failure. The remaining patients had tricuspid regurgitation and stenosis due to rheumatic aetiology.

The frequency of reoperations for heart valve diseases increases due to the rising number of reparative procedures, prosthetic valve dysfunctions and the progressive feature of the primary disease. Unfortunately reoperation for tricuspid position is a risk factor for early mortality [5]. Current studies show that surgically ignored severe tricuspid regurgitation or reoccurrence of regurgitation after repair are indicators of poor long-term outcome [6]. High mortality rates in both groups in this study are in concordance with this observation. Many other studies also report high mortality rates after tricuspid valve replacement [7].

Even though the right thoracotomy approach has been used in tricuspid valve surgery for a long time, this method has become popular again recently in parallel to the rise in reoperations and minimally invasive procedures. With the right thoracotomy approach, patients can be protected from the undesired effects of median re-sternotomy such as injuries to the coronary by-pass grafts or cardiac chambers and massive bleeding [8]. On the other hand, with this technique there is no need to dissolve adhesions and scar tissues in order to gain an access for cannulation. This might be an advantage for the prevention of postoperative acute dilatation of the very thin right side of the heart with resultant better outcomes [9]. In our observation avoiding median re-sternotomy may be beneficial in reducing operative time, drainage amounts, positive inotropic agent requirement during the operation and cardiac mortality.

Factors with adverse effects on hospital mortality rate were ascites in the preoperative period, the operative technique (median re-sternotomy), application of cross-clamp and need for positive inotropic agents during the operation in the present study. Filsofi and et al. found that acute mortality was significantly associated with advanced stage of the disease in terms of presence of ascites, right ventricular dysfunction and higher systolic pulmonary artery pressure (sPAP) [7]. We found that ascites affects hospital and late mortality. In contrast to our study, they found that presence of ascites had no significant effect on late mortality. Ascites or sPAP show advanced stage of the disease and RV functions indirectly [10]. Preventing right ventricular dysfunction has a positive effect on survival. We believe that avoiding dissecting adhesions, as is done with a different incision such as thoracotomy, conserves RV functions.

A sub-group analysis of our study was the type of prostheses used in tricuspid position and we found no significant difference regarding hospital mortality and long-time survival rates between either bioprosthetic or mechanical valves. Similar to our current report, other series examining tricuspid valve replacements found no difference in long-time survival between either valve types [11].

Limitations of the Study

The limitations of this study are several. The two groups are not completely homogeneous. The Thoracotomy Group consisted of patients operated with only beating heart technique while the Median Re-sternotomy Group had both beating heart and cardioplegically arrested patients. Unfortunately echocardiographic right ventricular function parameters such as tricuspid annular systolic excursion (TAPSE) were not routinely employed in all patients when this study was done. Therefore in our study, we do not have reliable and more recent echocardiographic parameters reflecting right heart failure. More studies with larger patient populations and a stronger statistical power are needed to arrive at a better conclusion.

Conclusion

In the light of the data in the present study, we can say that right antero-lateral thoracotomy for tricuspid valve replacement in patients with previous sternotomy is a practical and safe technique with less operative time and postoperative bleeding and more importantly, with lower mortality rates.

Declaration of Conflicting Interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

Please cite this article in press as: Hanedan MO, et al. Tricuspid Valve Replacement Through Right Thoracotomy has Better Outcomes in Redo Cases. Heart, Lung and Circulation (2016), http://dx.doi.org/10.1016/j.hlc.2016.05.118

References

[1] McCarthy PM, Sales VL. Evolving indications for tricuspid valve surgery. Curr Treat Options Cardiovasc Med 2010;12(6):587–97.
[2] Rogers JH, Bolling SF. The tricuspid valve: current perspective and evolving management of tricuspid regurgitation. Circulation 2009; 26;119(20):2718–25.
[3] Moraca RJ, Moon MR, Lawton JS, Guthrie TJ, Aubuchon KA, Moazami N, et al. Outcomes of tricuspid valve repair and replacement: a propensity analysis. Ann Thorac Surg 2009;87(1):83–8.
[4] Bernal JM, Morales D, Revuelta C, Llorca J, Gutierrez-Morlote J, Revuelta JM. Reoperations after tricuspid valve repair. J Thorac Cardiovasc Surg 2005;130(2):498–503.
[5] Iscan ZH, Vural KM, Bahar I, Mavioglu L, Saritas A. What to expect after tricuspid valve replacement? Long-term results. Eur J Cardiothorac Surg 2007;32(2):296–300.
[6] KiraliF K., Omeoglu SN, Uzun K, Erentug V, Bozbuga N, Eren E, et al. Evolution of repaired and non-repaired tricuspid regurgitation in rheumatic mitral valve surgery without severe pulmonary hypertension. Asian Cardiovasc Thorac Ann 2004;12(3):239–45.
[7] Filsoufi F, Anyanwu AC, Salzberg SP, Frankel T, Cohn LH, Adams DH. Long term outcomes of tricuspid valve replacement in the current era. Ann Thorac Surg 2005;80(3):845–50.
[8] Buzzatti N, Iaci G, Taramasso M, Nisi T, Lapenna E, Bonis MD, et al. Long-term outcomes of tricuspid valve replacement after previous left-side heart surgery. European Journal of Cardio-Thorac Surgery 2014;46(4):713–9.
[9] Pfannmuller B, Misfeld M, Borger MA, Etz CD, Funkat AK, Garbade J, et al. Isolated reoperative minimally invasive tricuspid valve operations. Ann Thorac Surg 2012;94(6):2005–10.
[10] Aksöyek A, Demirbağ AE, Babaroğlu S, Parlar Aİ, GünaydınBahar İ, Çatav Z, et al. A risk scoring system comprised of right heart failure findings and the New York Heart Association functional classification parameters to predict mortality associated with pericardiectomies. Turk Gogus Kalp Dama 2015;23(3):454–62.
[11] Rizzoli G, Vendramin I, Nesseris G, Bottio T, Guglielmi C, Schiavon L. Biological or mechanical prostheses in tricuspid position?. A meta-analysis of intra-institutional results. Ann Thorac Surg 2004;77(5):1607–14.

Please cite this article in press as: Hanedan MO, et al. Tricuspid Valve Replacement Through Right Thoracotomy has Better Outcomes in Redo Cases. Heart, Lung and Circulation (2016), http://dx.doi.org/10.1016/j.hlc.2016.05.118