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Original Article

Outcomes of tricuspid valve repair versus replacement for the surgical treatment of infective endocarditis

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Abstract

Background: The surgical management of right-sided infective endocarditis (IE) is challenging, and the superiority of tricuspid valvuloplasty (TVP) or tricuspid valve replacement (TVR) is not well established. Our study aimed to compare the clinical outcomes of TVP and TVR for right-sided IE.

Methods: All patients aged ≥18 years with isolated right-sided IE who underwent surgical treatment between 2015 and 2022 were retrospectively studied. The enrolled patients were diagnosed according to the modified Duke criteria and had tricuspid valve vegetation. The primary outcome was 6-month mortality, and the secondary outcomes included recurrence of IE, recurrence of tricuspid regurgitation (TR), need for reoperation, new need for dialysis, need for a permanent pacemaker, cerebrovascular stroke, and duration of ICU stay.

Results: 109 adult patients with isolated tricuspid valve infective endocarditis underwent surgical treatment. Sixty (55%) patients had TVP, and 49 (45%) had TVR. The patients who underwent TVR were significantly younger [54 (48-56) vs. 47 (39-52) years, p<0.001] and had greater frequencies of staphylococcal and fungal infections than the patients who underwent TVP. Compared with the TVP group, the TVR group had significantly longer cardiopulmonary bypass [79 (76-87) vs. 98 (95-108) min, p<0.001) and aortic cross-clamping times [51 (45-56) vs. 75 (72-80) min, p<0.001]. Patients with TVP had lower rates of recurrent IE (8.3% vs. 32.7%, p=0.02), recurrent TR (11.7% vs. 32.7%, p=0.023), reoperation (11.7% vs. 32.7%, p=0.023) and 6-month mortality (3.33% vs. 14.29%, p=0.06) than did those in the TVR group. There were no significant differences in blood loss, reopening for bleeding, new need for dialysis, cerebrovascular stroke or ICU stay between the two groups.

Conclusions: Compared with tricuspid valve replacement, tricuspid valve repair might be associated with lower rates of recurrent IE and reoperation. Although statistically insignificant, tricuspid valve replacement was associated with a greater mortality rate than TV repair. TVP could be the recommended treatment for patients with right-sided IE.

KEYWORDS

Tricuspid valve; Infective endocarditis; Tricuspid valve replacement; Tricuspid valvuloplasty

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Introduction

Infective endocarditis (IE) is a growing health hazard despite improvements in diagnosis and management modalities [1]. The presence of rheumatic heart disease has decreased as a predisposing factor for IE, while there is an increased incidence of IE with prosthetic valves and intracardiac devices [2]. The improved survival of patients at high risk of developing IE, such as congenital heart conditions, diabetes mellitus, hemodialysis, and immunosuppression, has increased IE incidence [3,4]. Right-sided IE accounts for 10% of all cases of IE, with an increasing incidence due to increased vascular and intracardiac interventions and drug addiction [5, 6]. Surgical management of right-sided IE includes removal of infected tissues and restoration of normal tricuspid valve function via tricuspid valve valvuloplasty (TVP) or tricuspid valve replacement (TVR) [7, 8]. However, the superiority of these two approaches has not been established. The TVP maintains the native valve tissue and avoids future complications of prosthetic valves; moreover, radical excision of the infected tissues could be an advantage of valve replacement. Few studies are comparing the outcomes of different surgical options because of the low incidence of right-sided IE, and a small proportion of these patients require surgical intervention. Thus, our study aimed to compare the clinical outcomes of TVP and TVR for right-sided IE.

Patients and Methods

Study design and population

This retrospective observational single-center study enrolled all patients aged ≥18 years with isolated right-sided IE who underwent surgical treatment between 2015 and 2022 at King Faisal Heart Center. Patients with combined left-sided and right-sided IE were excluded from the study. The enrolled patients were diagnosed according to the modified Duke criteria [9] and had tricuspid valve vegetation.

Study data and outcomes

The studied variables included preoperative clinical, laboratory, and echocardiographic variables. The causative organisms in the blood cultures were collected. The echocardiographic data included the size of the vegetation and the degree of tricuspid valve regurgitation (TR). The primary outcome was 6-month mortality, and the secondary outcomes included IE recurrence, TR recurrence, new need for dialysis, need for pacemakers, cerebrovascular stroke, and ICU stay.

Surgical treatment of IE

All the patients studied underwent surgery to remove the infected tissues and restore tricuspid valve function. Cardiopulmonary bypass (CPB) was performed, and surgical interventions started with midline sternotomy. Transesophageal echocardiography (TEE) was routinely performed to assess cardiac function, valve morphology and dysfunction, and vegetation size. Tricuspid valvuloplasty (TVP) was performed in tricuspid regurgitation (TR) cases without valve abnormalities. The TVP includes prosthetic ring annuloplasty, Kay suture valvuloplasty, pericardial patch valvuloplasty, and De Vega annuloplasty. Tricuspid valve replacement (TVR) is usually performed for severely damaged tricuspid valves or after failure of the TVP.

Ethical issues

The study was conducted after the approval of the local ethical committee, and the need for patient consent was waived. The study was conducted according to the Declaration of Helsinki.

Statistical analysis

We used SPSS software (IBM Corp., Chicago, IL, USA) for the statistical analysis. Continuous variables are reported as the mean ± standard deviation or median with interquartile range (IQR: Q1, Q3) according to the normality of the data, and comparisons were performed using t-tests or Mann–Whitney tests. Categorical variables are summarized as numbers with frequencies. The chi-square or Fisher's exact test was used for categorical variable comparisons. Univariable logistic regression was used to identify risk factors for mortality. A two-sided p-value <0.05 was considered to indicate statistical significance.

Results

Baseline and preoperative characteristics

A total of 109 adult patients who had isolated tricuspid valve infective endocarditis and who underwent surgical treatment were included. Sixty (55%) patients had TVP, and 49 (45%) had TVR. The patients who underwent TVR were significantly younger, with no difference in other clinical or laboratory variables. Patients with rheumatic valve disease underwent more replacement than repair. Patients with fungal and staphylococcal endocarditis underwent TVR more than TVP. (Table 1)

Operative and postoperative outcomes

The TVR group had significantly longer cardiopulmonary bypass (CPB) and aortic cross-clamping (ACC) times than the TVP group. All the patients in the TVR group received bioprosthetic valves. There were no significant differences in blood loss, reopening for bleeding, new need for dialysis, cerebrovascular stroke, or ICU stay between the two groups. The TVP group had lower frequencies of recurrent IE (p=0.02), recurrent TR (p=0.023), and reoperation (p=0.023) and a lower 6-month mortality rate (p=0.06) than the TVR group. Seven (11.7%) patients in the TVP group required valve replacement after six months of repair. Five patients had recurrent IE, while two had failed repair without IE. Sixteen (32.7%) patients in the TVR group developed recurrent IE and required valve replacement. (Table 2)

Table 1: Preoperative patient characteristics comparing tricuspid valvuloplasty (TVP) and tricuspid valve replacement (TVR). Continuous data are presented as the mean and standard deviation or median and interquartile range, and categorical data are presented as numbers and percentages

Variables		All patients (n=109)	TVP (n= 60, 55%)	TVR (n= 49, 45%)	p-value
Age (years)		52 (42- 56)	54 (48,56)	47 (39- 52)	<0.001
Sex, males (n, %)		63(57.8)	35 (58.33)	28 (57.14)	0.90
Diabetes mellitus (n, %)		37 (33.9)	17 (28.33)	20 (40.82)	0.17
Hypertension (n, %)		30 (27.5)	19 (31.67)	11 (22.45)	0.28
Infected pacemaker (n, %)		5(4.6)	2(3.3)	3(6.1)	0.61
Native TV (n, %)	Normal	62 (56.9)	43 (71.67)	19 (38.78)	0.001
	Rheumatic	47 (43.1)	17 (28.33)	30 (61.22)	
Renal failure (n, %)		33 (30.3)	19 (31.67)	14 (28.57)	0.73
Preoperative echocardiography	LVEF (%)	62.36 ± 3.81	62.41± 4.2	63.21 ± 4.41	0.8
	PASP (mmHg)	56.78 ± 12.19	56.32 ± 12.71	58.61 ±13.25	0.26
	Vegetation size (mm)	18.32 ± 4.18	17.46 ± 4.27	19.52 ±3.89	0.14
	Moderate TR (n, %)	50 (45.9)	32 (53.33)	18 (36.73)	0.08
	Severe TR (n, %)	59 (54.1)	28 (46.67)	31 (63.27)	0.06
Preoperative laboratory values	Hemoglobin(gm/L)	92.72 ± 10.81	93.32 ± 12.37	91.71 ± 10.81	0.41
	Platelet count ($10^{\wedge 9}$/L)	116.91 ± 28.13	116.61± 26.37	114.42 ± 32.81	0.37
	WBCs ($10^{\wedge 9}$/L)	22.4±3.52	21.14 ±4.26	24.3±3.81	0.62
	ALT (units/L)	30.17±6.81	29.71±8.41	31.21 ± 7.91	0.43
	AST (units/L)	42.6±7.23	41.3 ± 7.82	51.11 ± 8.31	0.37
	Serum bilirubin (µmol/L)	24.3 ± 6.81	21.8 ± 6.32	26.38 ±7.14	0.48
	Serum creatinine (µmol/L)	107.81 ± 24.31	107.3 ± 28.41	109.6 ± 27.18	0.37
The causative organism (n, %)	Staphylococci	41(37.6)	13 (21.67)	28 (57.14)	<0.001
	Streptococci	56(51.4)	45 (75)	11 (22.45)	
	Fungi	12(11)	2 (3.33%)	10 (20.41)	

TR: tricuspid regurgitation, TVP: tricuspid valvuloplasty, TVR: tricuspid valve replacement, ALT: alanine transaminase, WBCs: white blood cells, AST: aspartate transferase, PASP: pulmonary artery systolic pressure.

Table 2: Operative and postoperative outcomes comparing tricuspid valvuloplasty (TVP) and tricuspid valve replacement (TVR). Continuous data are presented as the mean and standard deviation or median and interquartile range, and categorical data are presented as numbers and percentages

Variables	All patients (n=109)	TVP (n= 60, 55%)	TVR (n= 49, 45%)	p-value
CPB time (minutes)	86 (82-98)	79 (76- 87)	98 (95- 108)	<0.001
Aortic cross-clamping (minutes)	72 (59-78)	51 (45- 56)	75 (72- 80)	<0.001
Blood loss (ml)	580 (490- 820)	520 (480- 575)	730 (490- 960)	0.42
Reopen for bleeding (n, %)	8(7.34)	3 (5)	5 (10.2)	0.46
Need for pacemakers	9 (8.3)	4 (6.7)	5 (10.2)	0.08
New need for dialysis (n, %)	11(10.1)	5 (8.3)	6 (12.2)	0.11
Cerebrovascular stroke (n, %)	4(3.7)	2 (3.33)	2 (4.08)	0.84
ICU stay (days)	5.5(5- 7)	5 (4- 6)	7 (5- 8)	0.20
Postoperative recurrent IE (n, %)	21 (19.3)	5 (8.3)	16 (32.7)	0.02
Recurrent TR (n, %)	23 (21.1)	7 (11.7)	16 (32.7)	0.023
Reoperation and TVR (n, %)	23 (21.1)	7 (11.7)	16 (32.7)	0.023
6-month Mortality (n, %)	9 (8.3)	2 (3.33)	7 (14.29)	0.06

CPB: cardiopulmonary bypass, ICUL intensive care unit, IE: infective endocarditis, TR: tricuspid regurgitation, TVR: tricuspid valve replacement

Univariate analysis for risk factors for 6-month mortality showed that TVR was not significantly associated with an elevated risk (OR: 4.83 (95% CI: 0.96-24.44), p=0.06). (Table 3)

Table 3: Univariate analysis of risk factors for 6-month mortality

Variables	OR (95% CI)	p-value
Age	0.97 (0.90- 1.05)	0.41
Sex, male	0.56 (0.14- 2.20)	0.40
Diabetes mellitus	2.66 (0.67- 10.56)	0.17
Hypertension	0.73 (0.14- 3.75)	0.71
Renal failure	0.64 (0.12- 3.24)	0.59
Valve pathology	1.10 (0.28- 4.36)	0.89
TR grade	0.65 (0.17- 2.58)	0.55
TV replacement	4.83 (0.96- 24.44)	0.06

TR: tricuspid regurgitation, OR: odds ratio, CI: confidence interval

Discussion

Right-sided IE represents up to 10% of all cases of IE, with a growing incidence due to the increased use of central venous catheters and intracardiac devices [5, 6]. The lower incidence of right-sided IE is attributed to the low incidence of tricuspid valve pathological conditions with lower jet velocities and pressure gradients than those of left-sided IE. Moreover, the lower oxygen content and lower wall stress in the right cardiac chambers decrease the incidence of IE compared to those in the left-sided valves [10, 11]. Our cohort reported a total mortality rate of 8.3% and a lower mortality rate in the TVP group than in the TVR group. The reported mortality rates after right-sided IE with appropriate antimicrobial drugs with or without surgery are 5-10% [6, 12-16]. Di Mauro and colleagues [12] retrospectively analyzed 157 patients with isolated TV IE, of whom 46% had TVR with bioprosthetic valves, 49% had TVP, and 5% had TVR with prosthetic valves. The reported early mortality was 11%. In another study [13], Di Mauro and coworkers studied 149 patients who underwent isolated TV surgery for IE, of whom 72 (48.3%) had TVR and 77 (51.7%) had TVP. Di Mauro et al. [13] reported that early mortality was 9%, and TVP was associated with significantly lower mortality than TVR. Xie and associates [14] fifty-six patients who underwent isolated tricuspid valve surgery due to IE and reported 30-day mortality rates of approximately 3.03% and seven-year survival rates greater than 95%, without significant differences between the TVP and TVR groups. Miró and associates [15] studied IE in individuals with drug addiction and patients with HIV and reported a good prognosis of tricuspid valve IE, with a mortality rate of 2% with surgical treatment and 5% without surgery. Stavi and colleagues [16] studied 215 patients with IE; thirty-nine patients had isolated right-sided IE, with a mortality rate of 2.6%, while the mortality rate of left-sided IE was 17%.

According to our cohort analysis, patients who underwent TVP had lower frequencies of recurrent IE, recurrent TR, and reoperation than patients who underwent TVR, without significant differences in bleeding, reopening for bleeding, new need for dialysis, cerebrovascular stroke, or ICU stay. Xie and coworkers [12] reported increased bleeding, blood transfusion, prolonged mechanical ventilation, ICU stay, and long-term reoperation in the TVR group compared to the TVP group, with a similar risk of recurrent IE. Di Mauro and associates [12] reported nonsignificant differences in early and long-term outcomes between TVP and TVR. Di Mauro and coworkers [13] reported that TVP was significantly less strongly associated with mortality and complications than TVR. Yanagawa and colleagues [17] conducted a systematic meta-analysis that enrolled 1165 patients from 12 observational studies and reported statistically significant differences in perioperative and long-term mortality between TVP and TVR patients. However, the analysis revealed that TVP was associated with lower rates of recurrent IE [relative risk (RR): 0.17, $p = 0.004$], reoperation (RR: 0.26, $p = 0.04$) and the need for a pacemaker (RR: 0.20, $p < 0.001$)], but there was a trend toward a greater risk of significant TR (RR: 4.14, $p = 0.09$).

The patients who underwent TVR in our cohort received bioprosthetic valves. The blood flow across the tricuspid valve is slower with a lower pressure than that across the left-sided valves, increasing the risk of valve dysfunction in cases of mechanical TVR [18,19]. The surgical management of TV IE includes the removal of vegetation and infected tissue and resolving valve function. It is important to avoid the use of artificial material, which is associated with better late survival and less IE recurrence [20].

Staphylococci and streptococci were the predominant causative microorganisms of IE in our cohort, accounting for a small proportion of fungal endocarditis cases. Staphylococci are common, especially in intravenous drug abusers and patients with central venous catheters [11]. Fungal endocarditis is associated with high mortality. Siciliano and associates [21] studied seventy-eight patients with fungal endocarditis and reported that the mortality rate of isolated right-sided IE was 32%, while the mortality rate of left-sided IE was 61%.

Finally, despite TVP and TVR showing similar survival, TVP may decrease IE recurrence, reoperation, and the need for a permanent pacemaker, and it should be the first approach unless there is extensive damage to the tricuspid valve.

Limitations of the study

This research was a single-center observational study with a small sample size and no long-term follow-up. There is a risk of selection bias, as the surgeon decided to perform TVP or TVR intraoperatively. Additionally, the study is retrospective in nature, with its inherent biases. Many unmeasured confounders could have affected the outcomes and were not measured. The patient and event numbers are low, making multivariable adjustments not feasible.

Conclusion

Compared with tricuspid valve replacement, tricuspid valve repair was associated with lower rates of recurrent IE and reoperation. Although statistically insignificant, tricuspid valve replacement was associated with greater mortality than TV repair. TVP could be the recommended treatment for patients with right-sided IE.

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