Comparison of Valveplasty and Replacement for Surgical Treatment of Infective Tricuspid Valve Endocarditis

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Research article

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Abstract

Background

In recent years, due to the increase in intravenous drug injection and intracardiac and vascular interventional treatments among drug users, infective endocarditis involving the right heart of the tricuspid valve has gradually increased. At present, there is no systematic report on surgical treatment of tricuspid infective endocarditis. This paper summarizes the experience of surgical treatment of 56 patients with tricuspid infective endocarditis in our hospital and analyzes its clinical effect.

Methods

From January 2006 to August 2019, 56 cases of tricuspid infective endocarditis treated by tricuspid valve surgery in our hospital were analyzed retrospectively, including 23 cases of tricuspid valvuloplasty (TVP) and 33 cases of tricuspid valve replacement (TVR). All patients were complicated with tricuspid valve vegetations or moderate and severe tricuspid regurgitation and had surgical indications. The perioperative data were collected and followed up for 6 months to 14 years to summarize and analyze the clinical effect of surgical treatment of tricuspid infective endocarditis.

Results

Compared with TVR group, the CPB time (79.68 ± 19.02 min VS 107.39 ± 25.64 min, $P < 0.01$), ACC time (50.29 ± 16.14 min VS 65.52 ± 20.62 min, $P < 0.01$), postoperative mechanical ventilation time (18.65 ± 8.18 h VS 44.85 ± 57.68 h, $P < 0.01$) and ICU stay time (38.13 ± 21.80 h VS 102.64 ± 142.11 h, $P = 0.015$) in TVP group were shorter. The perioperative red blood cell transfusion (4.87 ± 3.81 U VS 7.55 ± 5.42 U, $P < 0.01$) and the incidence of postoperative complications (8.7% VS 33.3%, $P < 0.01$) were lower. Perioperative death occurred in 1 case in the TVR group, and there was no perioperative death in the TVP group. There was no significant difference between the two groups (3.03% VS 0, $P = 0.855$). A total of 52 cases were followed up for an average of (5.50 ± 3.79) years. The postoperative 3-year, 5-year and 7-year survival rate were 100%, 100%, 91.7% in TVP group and 95.2%, 93.8% and 87.5%. The 5-year and 10-year reoperation rate were 0%, 0% in TVP group and 6.7%, 20% in TVR group.

Conclusion

Surgical treatment of severe tricuspid valve endocarditis has achieved good mid-term clinical results, and the rate of avoiding reoperation is better in TVP group than in TVR group.

Introduction

Right heart infective endocarditis accounts for 5-10% of all infective endocarditis cases, and about 90% of them involve the tricuspid valve, that is, tricuspid valve infective endocarditis.^[1] In recent years, due to the increase in intravenous drug injection and intracardiac and vascular interventional treatments among drug users, infective endocarditis involving the right heart of the tricuspid valve has gradually increased.^[2]

At present, while removing vegetation, the surgical treatment of diseased tricuspid valve mainly includes two types of surgery: tricuspid valvuloplasty(TVP) and tricuspid valve replacement(TVR).^{[3][4]}

TVP mainly includes Kay suture angioplasty, De Vega angioplasty, pericardial patch angioplasty, and artificial annuloplasty. Different shaping methods are suitable for functional tricuspid regurgitation caused by different reasons.^{[5][6]} TVR includes tricuspid biological valve replacement and tricuspid mechanical valve replacement. Tricuspid valve replacement should be considered in time when tricuspid valve disease cannot be formed or tricuspid valve formation fails.^{[7][8]} Because of their incidence rate is not high, and most patients under drug treatment to be improved, thus previous studies on the tricuspid valve endocarditis surgery using two methods of operation are still rare. This article discusses the mid-term clinical effects of two surgical treatments for infective tricuspid endocarditis.

Patients And Methods

This study retrospectively analyzed 56 patients with tricuspid valve endocarditis who were surgically treated in our hospital from January 2010 to June 2020, including 23 patients in the TVP group and 33 patients in the TVR group. All diagnoses were in accordance with the revised Duke criteria, and preoperative echocardiograms showed the formation of tricuspid valve vegetation with moderate or severe tricuspid regurgitation.

Patient Characteristics

There was no significant difference in sex, age, course of fever, preoperative cardiac function, preoperative complications and underlying diseases between the two groups ($P > 0.05$). In TVP group, 3 cases had previous cardiac surgery, 4 cases had cardiac pacemaker implantation, 12 cases were complicated with congenital heart malformation, 4 cases were complicated with left ventricular valvular disease (4 cases were complicated with left endocarditis). In TVR group, there were 3 cases of previous cardiac surgery, 13 cases of congenital heart malformation and 10 cases of left ventricular valvular disease (5 cases with left endocarditis). (**table.1**)

All patients exhibited signs of acute infection, such as high fever and leukocytosis. Blood cultures revealed *Staphylococcus aureus* (n=8), *Staphylococcus epidermidis* (n=3), *Enterococcus faecalis* (n=3), *Streptococcus bovis* (n=10), *Acinetobacter baumannii* (n=3). In the remaining patients no bacterial growth was detected, which was most likely due to previous antibiotic therapy.

Surgical procedure

All operations were performed under general anesthesia, the sternum was cut in the middle, and cardiopulmonary bypass was established through the ascending aorta and the superior and inferior vena cava. After cardiopulmonary bypass, the temperature was uniformly cooled to 32 °C, and HTK solution was infused from the root of the aorta to protect the myocardium. The size of tricuspid annulus, the lesion of tricuspid valve, the location and size of vegetation, the degree of valve lesion, the destruction of subvalvular structure and the formation of perivalvular abscess were examined routinely before operation. According to the results of exploration, different tricuspid valve operations were selected. Vegetation removal was performed in all cases. In patients with left heart valve disease or other intracardiac malformations, left heart valve surgery or intracardiac malformation correction should be performed first, followed by tricuspid valve surgery. After tricuspid valve treatment, the effect of tricuspid valvuloplasty, the opening and closing of tricuspid valve, conduction block and other arrhythmias were observed, and the residual tricuspid regurgitation was observed by drawing water. After operation, the effect of operation, tricuspid valve activity and residual regurgitation were evaluated again by transesophageal ultrasound.

Tricuspid valve plasty

For patients with moderate or severe tricuspid regurgitation, tricuspid valvuloplasty should be performed as far as possible if the tricuspid valve lobe and subvalvular structure are normal, the valve is not damaged, and the diameter of the diastolic tricuspid annulus is greater than 40mm. The methods of tricuspid valvuloplasty include Kay's valvuloplasty, DeVega valvuloplasty, pericardial patch valvuloplasty and artificial annuloplasty.

Tricuspid valve replacement

Tricuspid valve replacement should be performed in patients with tricuspid valve failure, poor tricuspid valvuloplasty or severe tricuspid valvuloplasty. During tricuspid valve replacement, artificial valves were implanted in situ, all the septal valves were preserved, and all or part of the subvalvular structures of tricuspid valves were selectively preserved during the operation. The anterior and posterior valve leaves were resected and sutured with 2-0 double-head needles with gaskets. Start from the septal lobe, insert the needle into the atrial surface, shallow suture at the root of the septal valve, and then sew to the free edge of the septal lobe to fold the septal valve leaf, strengthen the suture, avoid damaging the conduction bundle in the deep part of the valve ring, and prevent the suture from tearing the valve ring tissue. The anterior valve ring and the posterior valve ring were sutured according to this order, and then sutured to the artificial valve ring in turn, and the artificial valve was sent to the valve ring and tied with a knot.

Observation index

The ACC time, CPB time, mechanical ventilation time, ICU stay time, perioperative red blood cell transfusion, pericardial drainage flow, total hospital stay, perioperative mortality and complication rate were collected. The postoperative 3-year, 5-year, 7-year survival rate and 5-year and 10-year reoperation rate were collected, and the results of echocardiography were followed up.

Statistical analysis

All statistical analyses were performed using SPSS 20.0 (SPSS, Chicago, IL). Data are expressed as percentages, mean $\pm$ SD, Fisher's exact test was applied for categoric variables, and the Mann-Whitney U test or Kruskal-Wallis test was applied for continuous variables. The actuarial survival and freedom from reoperation were calculated using the Kaplan-Meier method. A *P* value <0.05 was considered statistically significant.

Results

Comparison of intraoperative and postoperative data between the two groups

The ACC time, CPB time and mechanical ventilation time in TVP group were significantly lower than those in TVR group (50.29 $\pm$ 16.14 min VS 65.52 $\pm$ 20.62 min, 79.68 $\pm$ 19.02 min VS 107.39 $\pm$ 25.64 min, 18.65 $\pm$ 8.18 min VS 44.85 $\pm$ 57.68 min)(*P*<0.01). The ICU stay time(38.13 $\pm$ 21.80h) and postoperative red blood cell transfusion(4.87 $\pm$ 3.81U) in TVP group were lower than those in TVR group (102.64 $\pm$ 142.11h , 7.55 $\pm$ 5.42U). There was no significant difference between the two groups in pericardial and mediastinal drainage (*P*= 0.225) and hospitalization time (*P*=0.496).

The total number of complications was 2 cases (8.7%) in TVP group and 11 cases (33.3%) in TVR group. There was significant difference in the incidence of postoperative complications between the two groups(*P*=0.032). The postoperative complications in TVP group mainly included bone marrow (n=1) , and III degree atrioventricular block (n=1) . In TVR group, there were hepatic insufficiency (n=1), renal insufficiency (n=2), III degree atrioventricular block (n=2), low cardiac output syndrome (n=1), incision infection (n=1), severe pneumonia (n=2) and MODS (n=2). There was no perioperative death in TVP group, and 1 perioperative death in TVR group, with a mortality rate of 3.0%.(table.2)

Comparison of postoperative follow-up between the two groups

After multi-channel follow-up from 6 months to 14 years, the average follow-up was (5.50 $\pm$ 3.79) years. 52 patients were followed up successfully, including 22 patients (95.7%) in TVP group and 30 patients (93.8%) in TVR group. In TVP group, endocarditis recurred in 1 case (4.5%), which was cured after antibiotic treatment. Endocarditis recovered in 2 cases (6.7%) in TVR group, all of which were cured by tricuspid valve replacement. 1 case of heart failure was followed up in TVP group, 1 case of heart failure, 1 case of pulmonary embolism and 4 cases of tricuspid valve dysfunction were followed up in TVR group. There was no significant difference between the two groups(*P*>0.05). In TVP group, 1 case died of heart failure 6 years after operation, and 1 case in TVR group died of heart failure 2 years after operation. The postoperative 3-year, 5-year and 7-year survival rate were 100%,100%,91.7% in TVP group and 95.2%, 93.8% and 87.5% in TVR group. The 5-year and 10-year reoperation rate in TVP group was lower than that in TVR group.(table.3)

Combined with the postoperative follow-up, the cumulative survival function diagram was drawn at the end point of postoperative death, which showed that there was no significant difference in early and medium-term survival rate between TVP group and TVR group. ($P=0.669$)(**Figure.1**).

Combined with the condition of patients undergoing tricuspid valve reoperation after tricuspid valve operation, 6 patients in TVR group received reoperation, including 2 cases of recurrent endocarditis and 4 cases of mechanical valve dysfunction caused by tricuspid thrombosis. There was no reoperation in TVP group, and the function of exemption from reoperation was plotted. The mid-and long-term reoperation-free rate of TVP group was significantly better than that of TVR group. ($P=0.012$)(**Figure.2**).

Discussion

In recent years, TIE has continued to rise. A considerable number of studies believe that the occurrence of TIE is related to the increase in the number of intravenous drug users^[9], the progress of interventional electrophysiology^[1], the long-term use of central venous catheter therapy, and the increase in immunodeficiency diseases such as AIDS. Most TIE can be cured by sensitive antibiotic treatment, but 20% of them still require surgery to achieve a better prognosis. Relevant literature shows that when there are uncontrollable infections, congestive heart failure, paravalvular abscesses, and other cardiac surgery is required at the same time, surgical treatment is usually required^{[10][11][12]}. TIE neoplasms are usually large in size and mainly colonize the valve leaflet tissues. The valve leaflets, valve annulus and adjacent tissues are prone to infection. Different surgical methods should be selected according to the specific location and cumulative range of specific lesions^{[13][14]}. In this study, 25 patients were enrolled with congenital heart disease before surgery, and 14 patients had surgery with left heart system valve before surgery. The surgery was performed after 2 weeks of antibiotic treatment. Among the enrolled patients, 23 cases underwent TVP and 33 underwent TVR. Among these 33 cases, 1 patient died of perioperative sepsis. Except for this patient, the infections of the other patients were controlled after the operation and the cardiac function was significantly improved compared with that before the operation.

In this study, there was no significant difference in preoperative basic data between the TVP group and the TVR group ($P>0.05$), but some cases in the TVR group were due to poor valve quality and severe valve damage that could not be repaired during the TVP operation. The other part of the cases was changed to TVR because of the failure of the TVP operation or the unsatisfactory results of the operation. The mean cardiopulmonary bypass time and aorta occlusion time of these patients were significantly longer than those who underwent TVR directly, resulting in prolonged intraoperative myocardial ischemia and anoxia time and myocardial ischemia and reperfusion injury, which is not beneficial to postoperative rehabilitation of patients. Compared with the TVP group, patients in the TVR group had an increased risk of postoperative complications.

The reasons for the higher incidence of postoperative complications in the TVR group may be the following: 1. TVR cardiopulmonary bypass time and aortic block time are longer than TVP, resulting in increased destruction of blood cells and prothrombin, leading to postoperative coagulation dysfunction.

Compared with the TVP group, the perioperative blood transfusion volume of the TVR group increased. In this study, the perioperative blood transfusion volume of the TVR group was higher than that of the TVP group ($P<0.05$). 2. TVR surgery requires foreign body implantation. The implanted valve is in a relatively low pressure area. Compared with the mitral valve area and the aortic valve area, the blood flow in this area is slower and thrombosis is more likely to form^{[15][16]}. Especially for mechanical tricuspid valve replacement, tricuspid valve position is more prone to thrombosis, resulting in valve dysfunction. In this study, 4 cases of tricuspid valve dysfunction occurred in the TVR group after surgery, all of which required reoperation. 3. Compared with the TVP group, the TVR group has relatively longer intraoperative aortic block time and extracorporeal circulation time, resulting in a larger perioperative blood transfusion. Therefore, patients in the TVR group need to bear longer organ blood insufficiency and more high organ ischemia-reperfusion injury risk, resulting in increased incidence of postoperative organ dysfunction. 4. For patients with tricuspid paravalvular abscess, we routinely perform TVR surgery. Because the formation of paravalvular abscess may affect the surrounding conduction system, and the removal of diseased valves and artificial valve implantation may also compress the surrounding conduction system, patients with tricuspid valve abscesses are more likely to have atrioventricular block after TVR^{[17][18]}. In this study, there were 2 cases of III-degree atrioventricular block in the TVR group, which was more than 1 case in the TVP group, but the difference was not statistically significant.

The survival rate of patients in the TVP group was not significantly different from that in the TVR group, but the incidence of postoperative complications and the rate of long-term reoperation were significantly lower than that in the TVR group. More patients in the TVR group were re-hospitalized for surgery due to artificial valve infection or valve dysfunction. This is consistent with reports by Luc Jessica GY, Choi Jae-Hwan and others^[19]. Moreover, compared with TVR, TVP can avoid intraoperative foreign body implantation, especially for intravenous drug users, avoiding foreign body implantation can reduce the risk of postoperative endocarditis recurrence, avoid long-term postoperative anticoagulant therapy, and reduce the possibility of heart block^[20]. Although we cannot conclude that TVR is the most effective surgical option compared with TVP, TVP is indeed more beneficial to patients based on the overall surgical effect and prognosis analysis. Compared with TVP, TVR has more postoperative complications and higher rates of re-hospitalization and reoperation.

In this study, the results of cardiac color Doppler follow-up in the TVP group showed that the number of cases with more than moderate tricuspid regurgitation was significantly more than that in the TVR group (6 cases VS 0, $P=0.004$). Although both operations can completely remove the infected lesions and improve the postoperative cardiac function, the TVR group is better than the TVP group in improving the degree of tricuspid regurgitation. However, considering that TVP has a high postoperative quality of life, on the other hand, the right cardiac system has a relatively high tolerance to valvular regurgitation and can tolerate residual or recurrent tricuspid regurgitation. With the gradual recovery of cardiac function and the decrease of right cardiac volume load, valvular function can be partially restored. Therefore, TVP is still a priority surgical treatment for TIE patients with mild valvular disease in most surgeons^{[21][22][23]}.

Limitation

This study is a single-center study and lacks a multi-center controlled study. The time span of cases included in this study is large, and the improvement of the treatment level and the improvement of medical devices will inevitably affect the treatment decision and treatment effect in different time periods. In the future research, we will strive for joint multi-center research to collect case data in a more timely, comprehensive and accurate manner. We will also strengthen follow-up efforts to obtain more scientific and objective conclusions.

Conclusion

Surgical treatment of infective endocarditis with tricuspid valve can achieve good medium-term results, and tricuspid valve plasty is significantly better than tricuspid valve replacement in terms of avoiding resurgery.

Abbreviations

TIE

tricuspid infective endocarditis; ACC:aortic cross-clamp; CPB:cardiopulmonary bypass; ICU:intensive care unit; TVR:tricuspid valve replacement; TVP:tricuspid valve plasty; MODS:multiple organ dysfunction syndrome; SD:standard deviation.

Declarations

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Authors'contributions

This study was conceptualised by Linfeng Xie, Xiaodong Chen, Jian He, Sixian Lin, Xinfeng Chen, Qingsong Wu, Ling chen, Jingxiang Zhuang, Zhihuang Qiu, Liangwan Chen. Data collection was performed by Xiaodong Chen and Linfeng Xie. Zhihuang Qiu performed the data analysis. All the authors contributed in the writing up of the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Declarations

Ethics approval and consent to participate

This study was approved by the institutional review board of our hospital and the need for informed consent was waived.

Consent for publication

Not applicable.

Competing interests

The authors declare no conflicts of interest.

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Tables

Table 1
preoperative characteristics

Valuables	TVP group n = 23	TVRgroup n = 33	p
Age(y)	37.57 ± 15.05	42.24 ± 15.51	0.266
Male(n,%)	10(43.48%)	17(51.52%)	0.554
Course of disease(day)	48.52 ± 62.08	32.82 ± 24.18	0.192
hypertension(n,%)	0	2(6.06%)	0.343
intravenous drug abuse(n,%)	3(13.04%)	4(12.12%)	0.613
infected pacemaker(n,%)	4(17.39%)	4(12.12%)	0.812
prior cardiac surgery(n,%)	3(13.04%)	3(9.09%)	0.479
Atrial fibrillation(n,%)	4(17.4%)	6(18.2%)	0.614
Pulmonary embolism(n,%)	2(2.87%)	3(9.1%)	0.670
Abnormal liver function(n,%)	1(4.3%)	1(3.0%)	0.666
Associate cardiac lesion	12(52.2%)	13(39.4%)	0.344
Ventricular septal defect(n,%)	12(52.2%)	9(27.27%)	
Atrial septal defect(n,%)	1(4.3%)	3(6.06%)	
Associate left heart valvular disease	4(17.4%)	10(30.3%)	0.272
endocarditis of mitral valves(n,%)	2(8.70%)	5(15.15%)	
endocarditis of aortic valves(n,%)	3(13.04%)	6(18.18%)	
Cardiac function classification(NYHA)			0.834
NYHA class II(n,%)	6(26.09%)	10(30.30%)	
NYHA class III(n,%)	15(65.22%)	19(57.58%)	
NYHA class IV(n,%)	2(8.70%)	4(12.12%)	
Preoperative biochemical data			
Leucocytes > 10*10 ⁹ /L(n,%)	15(65.2%)	24(72.7%)	0.548
Hemoglobin(g/L)	98.52 ± 13.85	93.00 ± 16.87	0.201
Albumin (g/L)	30.64 ± 4.34	29.35 ± 4.54	0.186

Data are presented as mean ± standard deviation, median [P25, P75], or number (%)

Valuables	TVP group n = 23	TVRgroup n = 33	p
Positive blood culture(n,%)	16(69.6%)	20(60.6%)	0.491
Staphylococcus aureu(n,%)	3(13.0%)	5(15.2%)	
Staphylococcus epidermidis(n,%)	2(8.7%)	1(3.0%)	
Streptococcus bovis(n,%)	9(39.1%)	10(30.3%)	
Acinetobacter baumannii(n,%)	2(8.7%)	1(3.0%)	
Enterococcus faecalis(n,%)	0	3(9.1%)	
Data are presented as mean $\pm$ standard deviation, median [P25, P75], or number (%)			

Table 2
operative and postoperative data

Valuables	TVP group n = 23	TVRgroup n = 33	p
Intraoperative time			
CPB time (min)	79.68 ± 19.02	107.39 ± 25.64	< 0.001
ACC time(min)	50.29 ± 16.14	65.52 ± 20.62	0.005
Postoperative complication data			
ICU stay time(h)	38.13 ± 21.80	102.64 ± 142.11	0.015
Mechanical ventilation time (h)	18.65 ± 8.18	44.85 ± 57.68	0.001
red blood cell transfusion(U)	4.87 ± 3.81	7.55 ± 5.42	0.046
Pericardial and mediastinal fluid drainage(ml)	590.87 ± 769.86	1060.61 ± 1717.50	0.225
Hospitalization time(day)	27.74 ± 7.82	29.52 ± 10.55	0.496
30-day death (n, %)	0	1(3.03%)	0.855
Complications (total number of cases)(n,%)	2(8.7%)	11(33,3%)	0.032
Acute kidney injury (n, %)	0	2(6.1%)	0.638
Hepatic dysfunction (n, %)	0	1(3.0%)	0.855
Severe pneumonia (n, %)	0	2(6.1%)	0.638
III degree atrioventricular block (n, %)	1(4.3%)	2(6.1%)	0.747
Low cardiac output syndrome (n, %)	0	1(3.0%)	0.855
Surgical incision infection (n, %)	0	2(6.1%)	0.638
MODS (n, %)	0	1(3.0%)	0.855
Myelosuppression(n,%)	1(4.3%)	0	0.855
Data are presented as mean ± standard deviation or number (%)			
CPB, cardiopulmonary bypass, ACC, aortic cross-clamp,MODS, multiple organ dysfunction syndrome, ICU, intensive care unit			

Table 3
Postoperative follow-up data

Valuables	TVP group n = 22	TVRgroup n = 30	p
reoperation(n, %)	0	6(18.18%)	0.085
Postoperative recurrence(n,%)	1(4.5%)	2(6.7%)	0.617
Artificial valve dysfunction(n,%)	0	4(13.3%)	0.101
Pulmonary embolism(n,%)	0	1(3.3%)	0.577
Heart failure(n,%)	1(4.5%)	1(3.3%)	0.672
NYHA class III- IV(n,%)	4(18.1%)	10(33.3%)	0.230
Three-year survival rate(%)	100	95.2	0.553
Five-year survival rate(%)	100	93.8	0.553
Seven-year survival rate(%)	91.7	87.5	0.692
Five-year reoperation rate(%)	0	6.7	0.101
Ten-year reoperation rate(%)	0	20	0.029
Tricuspid regurgitation above moderate(n,%)	6(27.3%)	0	0.004
LVEF(%)	65.18 ± 4.64	62.13 ± 7.30	0.092
Data are presented as number (%), LVEF, Left ventricle ejection fraction			

Figures

Figure 1

Kaplan-Meier estimates of survival of patients with infective tricuspid valve endocarditis who underwent valveplasty and replacement for surgical treatment ($P=0.669$).

Figure 2

Kaplan-Meier estimates of reoperation rate of patients undergoing valvuloplasty and valve replacement ($P=0.012$).