Outcome following isolated tricuspid valve replacement

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Abstract

Objectives: The clinical outcome of isolated tricuspid valve replacement is not well defined because this procedure is usually performed concomitantly with other valve surgery. Methods: We retrospectively studied the short and long-term outcome of 15 consecutive patients (six men and nine women, aged 61 ± 3 years) undergoing isolated tricuspid valve replacement from 1984 to 1996. The cause of valve dysfunction was rheumatic heart disease in 12 patients, healed endocarditis in two patients, and sarcoidosis in one patient. The tricuspid valve was stenotic in one patient, regurgitant in eight patients, and both stenotic and regurgitant in six patients. A St. Jude Medical prosthesis was placed in eight patients, Carpentier±Edwards in five patients, and Björk±Shiley and Starr±Edwards in one patient each. Results: The median survival was only 1.2 years. Three patients (20%) died <30 days after the surgery or before discharge, and six other patients (40%) died within 3 years of surgery. Anasarca was the only predictor of short-term mortality ($P < 0.03$), while the predictors of long-term mortality were anemia ($P < 0.01$), rheumatic heart disease ($P < 0.04$), previous stroke ($P < 0.04$), and previous mitral valve surgery ($P < 0.04$). Conclusions: Isolated tricuspid valve replacement is characterized by a poor short and long-term outcome. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Heart valve surgery; Tricuspid regurgitation; Tricuspid stenosis; Tricuspid valve

1. Introduction

The decision as to whether a patient should undergo isolated tricuspid valve replacement (TVR) is one of the most difficult challenges facing clinicians in the management of valvular heart disease. Tricuspid valve disease is commonly insidious in onset and may be well tolerated for years. Few patients undergo isolated TVR; most patients who undergo tricuspid valve surgery for rheumatic heart disease have concomitant mitral and/or aortic valve surgery. In most previous reports of outcome following TVR, patients undergoing isolated TVR were intermingled with those undergoing concomitant surgery for left-sided valvular lesions [1–16]. In these reports, operative mortality rates ranged from 0–44% and 3-year mortality rates from 20–50%. No previous study has focused on the short and long-term clinical outcome of a consecutive series of patients undergoing TVR alone and sought to determine prognostic factors in this group of patients. We therefore reviewed the course of 15 consecutive patients undergoing this surgical procedure at the Massachusetts General Hospital during a 12-year period.

2. Materials and methods

2.1. Patients

We reviewed the hospital records for all patients who underwent isolated TVR at our institution from July 1984 through January 1996. Fifteen consecutive patients with tricuspid valve dysfunction requiring replacement without concomitant surgical procedures were identified and form the basis of this study. Four patients managed with tricuspid valve reconstruction and two patients with congenitally corrected transposition of the great vessels and replacement of a systemic atrioventricular valve were not included.

2.2. Cardiac catheterization

All patients underwent preoperative right heart catheterization and coronary arteriography, while 12 of the 15 patients also had left heart catheterization. Cardiac output was measured by either the Fick oxygen or thermodilution...
technique. Significant coronary stenoses were defined as lesions that reduced luminal diameter by 50% or more.

2.3. Operative procedure

Isolated TVR was performed within 6 months of cardiac catheterization in all patients. Standard cardiopulmonary bypass was used. The aorta was cross-clamped in three patients. Systemic and topical hypothermia was used in 14 patients and cold blood potassium cardioplegia in the other patient. The anterior and posterior tricuspid valve leaflets were generally excised, but the septal leaflet left in place. Porcine heterografts (Carpentier–Edwards) were placed in five patients and mechanical prostheses in the remaining ten patients (one Björk–Shiley, one Starr–Edwards, and eight St. Jude Medical). The decision regarding tissue or mechanical prosthetic valves was in general based on age of the patient and the presence of tissue or mechanical prosthetic valves on the left side of the circulation. Surgery was performed by five different surgeons.

2.4. Clinical data

Preoperative and in-hospital postoperative data were obtained from hospital records. Pre-operative variables recorded included items regarding clinical history (cardiac and noncardiac), medications, physical findings (as documented in the examination of the attending cardiologist), laboratory data, electrocardiogram, chest radiograph, echocardiogram, and cardiac catheterization. Operative variables recorded included urgency of surgery (elective, urgent, or emergency), prosthesis type, aortic cross-clamp and cardiopulmonary bypass times, and requirements for pressor therapy or intraaortic balloon pump placement during weaning from bypass. Post-operative variables recorded included the number of days spent in surgical intensive care and regular hospital care units, laboratory and hemodynamic data (central venous pressure and cardiac index), and specific complications. Respiratory failure was defined as the need for more than 72 h of mechanical ventilation or for reintubation. Renal failure was defined as a rise in the serum creatinine to a value above 3 mg/dl.

Late follow-up data were obtained from hospital records, patients’ personal physicians, and telephone contact with patients. Follow-up data collection was complete for all 15 patients. We prospectively defined 3-year survival as a satisfactory long-term outcome and death within 3 years as an unsatisfactory long-term outcome.

2.5. Statistical analysis

Data are presented as mean ± SEM. The means of normally distributed continuous variables were compared between groups by Student’s t-test. Rates and proportions were compared by the Fisher exact test. Stepwise multiple logistic regression analysis was performed by Program LR (BMDP Statistical Software, Los Angeles, CA) to identify independent predictors of long-term (3-year) survival. The significance level chosen for the entry of the independent variables into the logistic model was \( P < 0.05 \).

3. Results

3.1. Patient characteristics

There were six men and nine women, aged 61 ± 3 years (range, 38–72 years). The cause of tricuspid valve dysfunction was rheumatic heart disease in 12 patients, previous endocarditis in two patients, and cardiac sarcoidosis in one patient. The indications for tricuspid valve replacement were tricuspid stenosis in one patient, tricuspid regurgitation in eight patients, and both stenosis and regurgitation in six patients. Thirteen patients had undergone 23 previous cardiac operations, 13 involving the mitral valve alone, five involving both the mitral and aortic valves, three involving both the mitral and tricuspid valves, one involving the mitral, aortic, and tricuspid valves, and one consisting of resection of a subaortic membrane. The duration of symptoms attributable to tricuspid valve disease was 24 ± 8 months (range 1–96 months).

New York Heart Association (NYHA) class III or IV heart failure symptoms were present in 11 patients (73%). Hepatomegaly, ascites, peripheral edema, and anasarca were present in 12, eight, 14, and two patients, respectively. On admission to the hospital, 13 patients were taking diuretics, 12 digoxin, four angiotensin converting enzyme inhibitors, and three nitrates. Comorbid conditions included diabetes in four patients, hypertension in five, renal insufficiency in three, chronic obstructive pulmonary disease in four, and transitional cell carcinoma of the bladder (treated with radiotherapy until 1.5 years before surgery) in one.

Hemodynamic parameters are summarized in Table 1. Right atrial pressure was 17 ± 2 mmHg, mean pulmonary arterial pressure 27 ± 2 mmHg, pulmonary capillary wedge pressure 16 ± 2 mmHg, and cardiac index 2.4 ± 0.2 l/min/m². There were 13 elective, one urgent, and one emergency operation. One patient had 70% stenosis of the first left circumflex marginal and 50% stenosis of the second marginal; another had 60% proximal stenosis of the left circumflex; coronary bypass grafting was not deemed necessary in either patient.

3.2. Clinical outcome

No patient experienced a complication during the surgical procedure. No patient was placed on intraaortic balloon counterpulsation. Cardiopulmonary by-pass time was 93 ± 10 min. Pathology reports indicated fibrocalcific degeneration of the tricuspid valve in 14 patients and granular tissue consistent with sarcoidosis in the other. The last central venous pressure recorded in the postoperative period was 11 ± 1 mmHg (range 8–16 mmHg) and cardiac index
3.8 ± 0.2 l/min/m² (range 2.8–4.9 l/min/m²); the latter parameter was recorded in eight patients.

Fig. 1 shows the Kaplan–Meier survival curve for the group of 15 patients. There were three early deaths (20%), all before hospital discharge. One death occurred one h after surgery and was caused by refractory ventricular tachycardia. The other two deaths occurred 26 and 43 days after surgery and were caused by kidney failure; the preoperative values of blood urea nitrogen and creatinine in these two patients were 15 and 50 mg/dl and 0.7 and 1.2 mg/dl, respectively. Another patient had ventricular fibrillation resulting in irreversible anoxic encephalopathy. Two patients had postoperative heart block; one had preoperative atrial flutter with an intraventricular conduction defect and received a permanent pacemaker before discharge, while the other had preoperative atrial fibrillation with left bundle branch block and did not require a pacemaker. Other complications included bleeding in three patients (gross hematuria in two patients and lung hemorrhage in the other), respiratory insufficiency in four patients, renal insufficiency in one patient, and infection in three patients. Overall, ten patients (67%) had significant in-hospital complications, including death.

Three-year mortality, including in-hospital deaths, was 60% (nine of 15 patients); another patient died 5 years after surgery. For all 15 patients, the median survival was 1.2 years. The median duration of follow-up for the five patients still alive was 4.2 years. As shown in Fig. 2, only five patients had improvement in NYHA class, while, in the other patients, NYHA class either remained unchanged or worsened. The causes of late death were thrombosis of the prosthetic tricuspid valve in one patient, heart failure in two patients, sudden cardiac death in one patient, septicemia in one patient, retroperitoneal bleeding in one patient, and acute respiratory insufficiency in one patient.

Autopsies were performed in three patients. The tricuspid prostheses appeared normal in all three cases. In addition, the examinations showed chronic lung disease, pneumonia, and cirrhosis of the liver in one patient; recent anterolateral myocardial infarction, bilateral pleural effusions, passive congestion of both the liver and spleen, ascites, nephrosclerosis, and multiple old renal infarcts in one patient;

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Overall</th>
<th>3-year survivors (N = 6)</th>
<th>Others (N = 9)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>LA (mm)</td>
<td>54 ± 3</td>
<td>47 ± 7b</td>
<td>58 ± 3</td>
<td>0.11</td>
</tr>
<tr>
<td>LVEDD (mm)</td>
<td>47 ± 2</td>
<td>44 ± 2</td>
<td>50 ± 3</td>
<td>0.20</td>
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<td>SWT (mm)</td>
<td>10.3 ± 0.3</td>
<td>9.8 ± 0.7b</td>
<td>10.6 ± 0.2</td>
<td>0.22</td>
</tr>
<tr>
<td>PWT (mm)</td>
<td>10.2 ± 0.2</td>
<td>10.2 ± 0.2b</td>
<td>10.2 ± 0.3</td>
<td>0.95</td>
</tr>
<tr>
<td>HR (b/min)</td>
<td>68 ± 2</td>
<td>71 ± 4</td>
<td>65 ± 3</td>
<td>0.29</td>
</tr>
<tr>
<td>MAP (mmHg)</td>
<td>89 ± 4</td>
<td>95 ± 7c</td>
<td>86 ± 5</td>
<td>0.37</td>
</tr>
<tr>
<td>RAP (mmHg)</td>
<td>17 ± 2</td>
<td>15 ± 2</td>
<td>19 ± 3</td>
<td>0.42</td>
</tr>
<tr>
<td>RVEDP (mmHg)</td>
<td>13 ± 1</td>
<td>12 ± 1</td>
<td>14 ± 2</td>
<td>0.48</td>
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<tr>
<td>MPAP (mmHg)</td>
<td>27 ± 2</td>
<td>22 ± 1</td>
<td>31 ± 3</td>
<td>0.06</td>
</tr>
<tr>
<td>PCWP (mmHg)</td>
<td>16 ± 2</td>
<td>13 ± 1b</td>
<td>18 ± 2</td>
<td>0.07</td>
</tr>
<tr>
<td>LVEDP (mmHg)</td>
<td>17 ± 1</td>
<td>14 ± 1b</td>
<td>19 ± 2</td>
<td>0.08</td>
</tr>
<tr>
<td>CI (l/min/m²)</td>
<td>2.4 ± 0.2</td>
<td>2.2 ± 0.3</td>
<td>2.6 ± 0.2</td>
<td>0.35</td>
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<tr>
<td>SVR (units)</td>
<td>1431 ± 157</td>
<td>1791 ± 308c</td>
<td>1271 ± 165</td>
<td>0.13</td>
</tr>
<tr>
<td>PVR (units)</td>
<td>218 ± 41</td>
<td>194 ± 42</td>
<td>234 ± 64</td>
<td>0.65</td>
</tr>
<tr>
<td>PVR/SVR</td>
<td>0.16 ± 0.02</td>
<td>0.10 ± 0.01c</td>
<td>0.18 ± 0.03</td>
<td>0.14</td>
</tr>
</tbody>
</table>

a CI, cardiac index; HR, heart rate; LA, left atrium; LVEDD, left ventricular end diastolic diameter; LVEDP, left ventricular end diastolic pressure; MAP, mean arterial pressure; MPAP, mean pulmonary arterial pressure; PCWP, pulmonary capillary wedge pressure; PVR, pulmonary vascular resistance; PWT, posterior wall thickness; RAP, right atrial pressure; RVEDP, right ventricular end diastolic pressure; SWT, septal wall thickness; SVR, systemic vascular resistance.

b N = 5.

c N = 4.
d N = 7.

Fig. 1. Kaplan–Meier plot showing probability of survival after isolated TVR.
Early death

Fig. 2. Comparison of preoperative and early postoperative New York Heart Association (NYHA) functional class.

NYHA  | PREOPERATIVE | POSTOPERATIVE |
--- | --- | --- |
I | 0 | 0 |
II | 4 3 | 6 |
III | 6 3 2 1 | 5 1 1 |
IV | 5 | 3 |

and two healed myocardial infarctions without significant coronary heart disease in the other patient. Echocardiographic evaluation done in eight other patients showed normal prosthetic valve function in six, with mean prosthetic valve gradient 5 ± 1 mmHg (range 2–7 mmHg), limited excursion of the Björk–Shiley prosthesis with mean gradient 12 mmHg in one, and two jets of regurgitation (one central and the other paravalvular) in one.

Of the six patients who were alive 3 years postoperatively, three had a marked improvement in their symptoms, while the remaining three did not. One of these underwent another TVR, because of thickening and stiffening of the cusps of a Carpentier–Edwards porcine bioprosthesis, with concomitant mitral and aortic valve replacement, 8 years after initial surgery. No other patient underwent repeat tricuspid valve surgery.

3.3. Predictors of outcome

Of the preoperative variables, anasarca (P = 0.03) was the only predictor of short-term mortality. The univariate predictors of long-term (3-year) mortality were low hematocrit (P = 0.01), rheumatic heart disease (P = 0.04), previous stroke (P = 0.04), and previous mitral valve surgery (P = 0.04). Stepwise multivariate logistic regression identified previous stroke (P = 0.04) as the only independent predictor of long-term mortality. All three patients with non-rheumatic causes of tricuspid valve disease were alive 3 years after surgery, while only three of 12 patients with rheumatic heart disease were 3-year survivors. Patients who died within 3 years of surgery tended to have higher preoperative blood urea nitrogen (27 ± 5 vs 19 ± 2 mg/dl, P = 0.07), and, as shown in Table 1, higher mean pulmonary arterial pressure (P = 0.06), pulmonary capillary wedge pressure (P = 0.07), and left ventricular end diastolic pressure (P = 0.08). There were no significant differences between the two groups in preoperative creatinine, SGOT, bilirubin, or albumin. Neither prosthesis type (mechanical vs bioprosthesis) nor postoperative central venous pressure was a predictor of either short or long-term mortality.

4. Discussion

In this series, we describe the clinical outcome of 15 consecutive patients undergoing isolated TVR. Analysis of both short and long-term outcome demonstrates that this unusual type of surgery is associated with poor survival and a high rate of serious postoperative complications, particularly for patients with rheumatic heart disease and previous mitral valve replacement.

4.1. Previous studies

The only previous report that focused on isolated TVR was limited to a selected group of patients with endocarditis; in this cohort of young (aged 22–39 years) patients without previous cardiac surgery, there were no early deaths and three late deaths [17]. In other reports, patients undergoing isolated TVR were intermingled with larger numbers of patients undergoing this procedure concomitant with other valve surgery, usually mitral valve replacement [1–16]. Sanfelippo et al. [1] reported a 53% early mortality rate for patients with isolated TVR, compared to 23% for combined tricuspid and mitral valve replacement and 25% for triple valve replacement. Fourteen of the 15 patients undergoing isolated TVR had had previous valve surgery. King et al. [3] reported on a cohort of 32 patients undergoing tricuspid valve surgery for tricuspid regurgitation after a clinically unsatisfactory result of mitral valve replacement. Among the 11 patients in this series who had isolated TVR, there were three early deaths (27%). The authors advocated tricuspid repair or replacement at the time of mitral valve replacement. In the more recent series of Munro et al. [12] 30 of 90 patients undergoing TVR had no concomitant valve surgery. The early mortality rate in this subgroup (13%) was similar to that for tricuspid valve replacement with other valve surgery (15%). The late mortality rate was 12% per patient-year in the first group and 8% per patient-year in the second group. This report did not provide detailed clinical data or analyze predictors of outcome in patients with isolated TVR [12]. Finally, Glower et al. [11] reported an operative mortality of 14% (two of 14) in patients undergoing isolated TVR as a first operation and 19% (four of 21) in patients with previous surgery undergoing this procedure.

4.2. Cause of poor outcome

Thus, our finding of a median survival of only 1.2 years after isolated TVR confirms and extends the demonstration of poor short and long-term prognosis after this procedure. The unfavorable outcome does not appear to be related to intraoperative technical problems. Echocardiographic and
autopsy data indicated a normal tricuspid valve prosthesis in all but one patient. The type of the valve used seems not to play a role, since we did not observe any difference in the outcome between mechanical and bioprosthetic valves.

It is possible that the explanation for the poor outcome is incomplete correction of bisesided heart failure. Factors associated with adverse outcome included rheumatic heart disease with previous mitral valve replacement and trends towards higher left ventricular end diastolic, pulmonary capillary wedge, and pulmonary artery pressures; preoperative pulmonary capillary wedge pressure in the patients who did not survive for 3 years was 18 ± 2 mmHg. Elevation of pulmonary capillary wedge pressure after mitral valve replacement may reflect residual left ventricular systolic and/or diastolic dysfunction, a diastolic gradient across the mitral prosthesis, a component of postoperative pericardial constriction, or a combination of these. While TVR corrects the volume load on the right ventricle and brings about some reduction of right atrial pressure, persistent right heart failure may result from uncorrected pulmonary hypertension and residual right ventricular systolic dysfunction.

Although the prevalence of both rheumatic heart disease and previous mitral valve surgery was significantly higher in the group with poor outcome, it was not possible to consider these factors separately, since every patient with rheumatic heart disease had undergone previous mitral valve surgery. Either factor alone or their interaction could have increased the risk of postoperative death.

The presence of anasarca, which was the only predictor of early death, was undoubtedly a marker for patients with the most advanced heart failure. The two patients with anasarca had high preoperative right atrial pressure (20 and 25 mmHg, respectively) and abnormal liver function tests despite high doses of diuretics (200 and 160 mg/day of furosemide, respectively). Furthermore, the need for TVR rather than reconstruction may itself be a marker for more advanced rheumatic heart disease. Alternatively, it is possible that tricuspid valve excision has a detrimental effect on right ventricular function. These considerations raise the question of the proper timing of tricuspid valve surgery. It is possible that earlier surgery would have yielded a more favorable outcome. In addition, our current practice for patients with multivalvular disease undergoing left-sided valvular surgery incorporates into the operative plan a low threshold for performing concomitant tricuspid valve reconstruction by ring annuloplasty, as has been advocated by others [18]. This strategy is designed to prevent the progression of right heart failure and, hence, the need for isolated tricuspid valve replacement. Thus, we suggest that early tricuspid repair (concomitant with left sided valvular surgery) is preferable to late (isolated) tricuspid valve replacement.

4.3. Study limitations

The number of patients in this single-center study was small. The analysis carries the limitations of a retrospective study. Thus, patients did not undergo systematic pre and postoperative evaluation of hemodynamics and ventricular function. Thus, we were unable to test the hypothesis that outcome was related to right ventricular systolic function and postoperative pulmonary artery pressure. Furthermore, the choice of valve type was at the discretion of the individual surgeons. While the durability of bioprostheses in the tricuspid position would tend to exceed the life expectancy of these patients, most patients received mechanical prostheses, largely because chronic anticoagulation was indicated at any rate for left-sided mechanical prostheses.

4.4. Clinical implications

Isolated TVR is an unusual type of valve surgery associated with poor short and long-term outcome and a high rate of postoperative complications, in particular in patients with rheumatic heart disease and previous mitral valve replacement. Isolated TVR should be performed only in selected cases after careful clinical and hemodynamic evaluation. The need for this surgical procedure may be obviated by concomitant tricuspid valve surgery at the time of left-sided valvular surgery for rheumatic heart disease.

Acknowledgements

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References


