Tricuspid valve surgery: a thirty-year assessment of early and late outcome

Thomas Guenther a,*, Christian Noebauer a, Domenico Mazzitelli a, Raymonde Busch b, Peter Tassani-Prell c, Ruediger Lange a

 abstract

Objective: Tricuspid valve (TV) surgery is usually performed as a concomitant reconstruction procedure in addition to the correction of other cardiac pathologies. Isolated tricuspid procedures are exceptionally rare. Prosthetic valve replacement is also seldom required. Generally, these patients face a high risk of operative mortality and long-term outcome is poor. In this study we reviewed our experience with TV surgery focusing on risk factors for operative mortality, long-term outcome and incidence of valve related complications Methods: Retrospective analysis of 416 consecutive patients >18 years with acquired TV disease operated on between 1974 and 2003. The follow-up is 97% complete (mean 5.9 ± 6.3 years). Three hundred and sixty-six patients (88%) underwent TV surgery with concomitant mitral (n = 340) or aortic (n = 100) valve surgery. The tricuspid valve was repaired in 310 patients (74.5%) and replaced in 106 (25.5%). A biological prosthesis was used in 68 patients (64%). Mean age at repair and replacement was 61 ± 12.5 and 50 ± 11.3 years, respectively (p < 0.001). Results: Overall 30-day mortality was 18.8% (78/416) and decreased from 33.3% (1974–1979) to 11.1% (2000–2003) (p ≤ 0.0001). Thirty-day mortality after TV repair and replacement was 13.9% (43/310) and 33% (35/106), respectively (p ≤ 0.001). Cox regression analysis revealed TV replacement as an independent predictor of 30-day mortality. Ten-year actuarial survival after TV repair and replacement was 47 ± 3.5% and 37 ± 4.8%, respectively (p = 0.002). Forty-five patients (10.8%) required a TV re-operation after 7.7 ± 5.1 years. Freedom from TV re-operation 10 years after TV repair and replacement was 83 ± 3.6% and 79 ± 6.1%, respectively (p = 0.092). Conclusions: Patients who require tricuspid valve surgery constitute a high-risk group. Tricuspid valve repair is associated with better perioperative and long-term outcome than valve replacement. However, patients undergoing replacement showed a significant higher incidence of risk factors for operative mortality. The incidence of re-operation is low with no significant difference when the tricuspid valve has been repaired or replaced. When valve replacement is necessary we recommend the use of a biological prosthesis considering the poor long-term survival.

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Keywords: Tricuspid valve; Valve surgery; Outcome; Valve related complications

1. Introduction

Although early mortality and late results for aortic and mitral valve repair or replacement have improved considerably over the past years [1,2], tricuspid valve (TV) surgery, remains more complex and the prognosis is not as favorable [3–5]. There is abundant literature reporting operative results of tricuspid valve surgery. However larger series with a long follow-up period are limited. Functional tricuspid regurgitation secondary to left heart pathology is the major cause of TV disease [6] and with the increasing number of patients with heart failure requiring surgical intervention for left ventricular dysfunction, tricuspid valve surgery gains increasing importance [7]. Tricuspid valve repair is the primary goal. However, there is an ongoing debate whether the tricuspid valve should be repaired using either a suture based annuloplasty or a prosthetic ring [8–10]. Valve replacement is seldom necessary. An analysis of the United Kingdom Heart Valve Registry (UKHVR) revealed only 425 tricuspid valve replacements (TVR) out of nearly 63,000 heart valve replacements performed between 1986 and 1996 [5]. However, in some patients with severe organic valvular disease valve replacement is unavoidable. Several authors have reported conflicting results advocating either the use of mechanical [11,12] or biological prostheses [3,4,12]. The lower pressures and flows in the right side of the heart predispose mechanical prostheses to valve thrombosis [13].
However, thrombosis was much more common with the older tilting disk prostheses and is less frequent with newer bileaflet prostheses [11,13]. In older patients requiring TVR, biological prostheses may be primarily considered, because the risk of structural valve degeneration and late reoperation is low. Frequent associated comorbidity that reduces life expectancy, and an increased risk for bleeding, even without anticoagulant treatment, add to the advantages of bioprostheses in elderly patients [14]. However, many of these patients require anticoagulation therapy thus, losing the potential advantage of tissue valves. The objective of the present study was to analyze the outcome of patients, who underwent TV surgery focusing on early postoperative results, long-term survival and valve related complications.

2. Materials and methods

The study population consisted of 416 patients who underwent tricuspid valve surgery with or without concomitant surgical procedures between April 1974 and December 2003 at the German Heart Center Munich. The analysis was confined to patients ≥18 years of age with acquired tricuspid valve disease. Patients living out of Europe were excluded from the study because of the inherent difficulty of accurate follow-up.

Average age at operation was 57.9 ± 13 years (range 18—87 years). During the study period, mean age at operation of patients, who underwent TV repair increased from 49 ± 10 years (1974–1984) to 63.4 ± 11 years (1985–2003). Mean age of the patients, who underwent TV replacement increased from 48 ± 10 years to 55.5 ± 13 years. One hundred and thirty-one patients (31.5%) were men and 285 (68.5%) women. Three hundred and fifty-eight patients (86%) had preoperative coronary angiography and left ventriculography in average 5.6 ± 9 months prior to the operation. Three hundred and eleven patients (74.8%) presented with predominant TV regurgitation, 25 patients (6%) with valve stenosis and 66 patients (15.9%) with combined stenosis and incompetence. In 14 patients (3.4%) TV pathology could not be ascertained retrospectively. The preoperative NYHA functional class could be assessed in 303 patients (73%). Nine patients (3%) demonstrated class I, 79 patients (26%) class II, 158 (52%) class III and 57 (19%) class IV. Ascites was present in 53 patients (12.7%), hepatomegaly in 140 (33.7%) and peripheral edema in 177 (42.5%). Fifty-five patients (13.2%) presented in sinus rhythm, 47 patients (11.3%) had undergone a previous pacemaker implantation and 7 patients (1.7%) presented with other heart rhythm disturbances. Sixteen patients (3.8%) had a history of preoperative myocardial infarction, in average 9.8 ± 5 years (median 10.2 years) prior to the operation. Preoperative clinical and hemodynamic data of the study population are summarized in Table 1. One hundred and eighty-three patients (44%) had undergone 225 previous cardiac operations on average 13.7 ± 8.4 years prior to TV surgery. Table 2 summarizes the type of surgery.

2.1. Operative data

Three hundred and ten patients (74.5%) underwent TV repair and 106 patients (25.5%) required TV replacement. Four techniques were used for TV reconstruction, the De Vega annuloplasty in 244 patients (78.7%), prosthetic ring

<table>
<thead>
<tr>
<th>Type of surgery</th>
<th>Operations (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated aortic valve surgery</td>
<td>10</td>
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<tr>
<td>Isolated mitral valve surgery</td>
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<tr>
<td>Isolated tricuspid valve surgery</td>
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<tr>
<td>Aortic and mitral valve surgery</td>
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<tr>
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<tr>
<td>Mitral and tricuspid valve surgery</td>
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</tr>
<tr>
<td>Isolated CABG</td>
<td>6</td>
</tr>
<tr>
<td>CABG + valve surgery</td>
<td>8</td>
</tr>
<tr>
<td>Heart transplantation</td>
<td>3</td>
</tr>
<tr>
<td>Other</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td>225</td>
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</tbody>
</table>
annuloplasty with a Carpentier Edwards semi-rigid ring (Edwards Lifesciences; Irvine, California, USA) or a Duran flexible ring (Medtronic, Minneapolis, MN, USA) in 43 patients (13.9%), TV commissurotomy in 15 patients (4.8%) and different types of suture annuloplasty in 8 patients. Prosthetic ring annuloplasty was performed mainly in the late study period (2000—2003) see Fig. 1. Of the 106 patients who underwent TVR, 38 patients (36%) received a mechanical prosthesis and 68 patients (64%) a biological prosthesis. The prostheses implanted included the following: Bjo¨rk—Shiley\(^\text{®}\) (\(n = 23\)) (Shiley, Inc., Irvine, CA, USA), Lillehei—Kaster\(^\text{®}\) (\(n = 7\)), St. Jude Medical\(^\text{®}\) (\(n = 3\)) (St. Jude Medical, Inc., St. Paul, MN, USA), Omnicarbon\(^\text{®}\) (\(n = 2\)), ATS\(^\text{®}\) (\(n = 3\)), Hancock\(^\text{®}\) (\(n = 35\)) (Hancock Extracorporeal, Inc., Anaheim, CA, USA), Carpentier—Edwards\(^\text{®}\) (\(n = 23\)) (Baxter Healthcare Corp., Edwards Division, Santa Ana, CA, USA), Medtronic Intact\(^\text{®}\) (\(n = 6\)), Medtronic Mosaic\(^\text{®}\) (\(n = 2\)) (Medtronic, Inc. Minneapolis, MN, USA), Ionescu—Shiley\(^\text{®}\) (Shiley Inc., Irvine, CA, USA) (\(n = 2\)). Fig. 2 lists the type of TV procedure in six consecutive time intervals (1974—2003).

Three hundred and sixty-seven patients (88%) underwent a concomitant procedure, such as mitral valve surgery in 340 patients, aortic valve surgery in 100 patients and coronary artery bypass grafting in 3 patients. Thirty-two patients (7.7%) required implantation of a permanent (epicardial lead) pacemaker postoperatively. Eleven patients (2.6%) received immediate postoperative intraaortic balloon pump support.

2.2. Follow-up

Complete follow-up was achieved in 97%, yielding a cumulative total of 2447 patient-years (mean follow-up 5.9 ± 6.3 years). The follow-up was closed on June 30, 2004. Fourteen patients were lost to follow-up. Follow-up data were obtained from patient’s follow-up visits, mailed questionnaires and by telephone interview with the patient, their families, or physicians and included activity level, current symptoms, results of diagnostic tests, occurrence of late cardiac events (e.g. re-operations, thromboembolic events) and medications being taken. Postoperative events were compiled and analyzed according to the Guidelines for reporting morbidity and mortality after cardiac valvular operations approved by the Society of Thoracic Surgeons [15]. In our study, we chose freedom from re-operation rather than freedom from structural valve degeneration (SVD) to characterize patient outcome, since echocardiographic data from the very early study period were not always available in order to determine the incidence of SVD. Furthermore we believe that the exact point in time when SVD starts is prone to subjective definition and the event of re-operation is more patient-relevant.

2.3. Statistical analysis

The data are expressed as proportions or as the mean ± standard deviation. The Kaplan—Meier method was used to study patient and event-free survival status. The log-rank test was used to ascertain differences between groups. The chi-square test (for categorical variables) and Mann—
Whitney test (for continuous variables) were used to determine statistical significance. Significant factors were entered into a multivariable proportional hazard model (Cox regression) to assess the independent impact of potential risk factors. All data were analyzed with SPSS software, release 12 (SPSS, Chicago, IL). Results were considered significant if p values were less than 0.05.

3. Results

Patients who required TV replacement were significantly younger (49.9 ± 11.3 vs 60.6 ± 12.5 years; p ≤ 0.001) and more likely to be female (79% vs 65%, p = 0.006). Tricuspid valve stenosis and combined lesions were also more prevalent and the proportion of patients in NYHA functional class III and IV were also significantly higher in the replacement group. Eleven percent of the patients, who underwent TV replacement were operated on an emergency basis compared to 3% in the repair group (p = 0.004). No significant differences between both patient groups were found regarding mean pulmonary artery pressure (p = 0.929), left ventricular ejection fraction (p = 0.922), the type and number of previous cardiac operations (p = 0.777), concomitant procedures (p = 0.065) and cardiopulmonary bypass time (p = 0.85) (Table 1).

3.1. Operative mortality

Overall 30-day mortality was 18.8% (78/416) and decreased from 33.3% (1974—1979) to 11.1% (2000—2003) (p ≤ 0.0001). The cause of death could be assessed retrospectively in 69/78 patients (88%): 49 (63%) patients died of a cardiac related (arrhythmia n = 10, heart failure n = 38, myocardial infarction n = 1) and 21 patients of a noncardiac related cause (multi organ failure n = 9, sepsis n = 6, pneumonia n = 2, pulmonary embolism n = 2 stroke n = 1). Thirty-day mortality after TV repair and replacement was 13.9% (43/310) and 33% (35/106), respectively (p ≤ 0.001). Emergency operations (within 24 h after admission) were associated with a significantly higher 30-day mortality [50% (11/22)] than elective operations [17% (67/394)] (p = 0.01). Thirty-day mortality after isolated TV surgery was 16% (8/50) compared to 19.1% (70/366) after TV surgery with concomitant procedure (p = 0.09). Univariate analysis revealed preoperative NYHA functional class ≥ III (p = 0.05), ascites (p = 0.022), earlier date of operation (p = 0.001), emergency operation (p = 0.001), concomitant aortic valve surgery (p = 0.036) and a duration of cardiopulmonary bypass >110 min (p = 0.008) as significant risk factors for 30-day mortality. Other parameters such as age (p = 0.911), sex (p = 0.893), preoperative hepatomegaly or peripheral edema, TV lesion (p = 0.106), had no significant influence on 30-day mortality (Table 3). Multivariate analysis of risk factors associated with 30-day mortality revealed TV replacement as the only independent predictor of mortality.

3.2. Late mortality

One hundred and seventy-five patients (42%) died late after an average 7.2 ± 6.2 years [TV repair (38.4%), TV replacement (52.8%)]. The cause of death could be assessed in 54/175 patients (31%): Thirty-two patients died of a cardiac related (arrhythmia n = 9, heart failure n = 22, myocardial infarction n = 1) and 22 patients of a noncardiac related cause. Ten-year actuarial survival after TV repair and replacement was 47 ± 3.5% and 37 ± 4.8%, respectively (p = 0.002). However excluding the patients who died within 30 days postoperatively the difference in actuarial survival between both patient groups disappeared (p = 0.46). There was no significant difference regarding late survival in patients undergoing isolated TV surgery and combined procedures (actuarial survival at 10 years 56.6 ± 8.7 vs 43.3 ± 3.0% p = 0.146). The type of prosthesis

<table>
<thead>
<tr>
<th>Factor</th>
<th>p value</th>
<th>Odds-ratio</th>
<th>Confidence limit (95%)</th>
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</thead>
<tbody>
<tr>
<td>Sex (male vs female)</td>
<td>0.860</td>
<td>0.95</td>
<td>[0.6—1.6]</td>
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<tr>
<td>NYHA functional class (≥III vs &lt;III)</td>
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<td>2.08</td>
<td>[1.0—4.4]</td>
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<tr>
<td>Ascites</td>
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<td>[1.1—4.3]</td>
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<td>Hepatomegaly</td>
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<td>1.40</td>
<td>[0.8—2.5]</td>
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<td>Peripheral edema</td>
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<td>[0.7—2.3]</td>
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<td>1.23</td>
<td>[0.3—4.5]</td>
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<tr>
<td>EF (&lt;55 vs &gt;55%)</td>
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<td>1.37</td>
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<td>PAmean (&lt;40 vs &lt;40 mmHg)</td>
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<td>Previous cardiac surgery</td>
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<tr>
<td>Previous mitral valve surgery</td>
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<td>[0.7—1.9]</td>
</tr>
<tr>
<td>Age (&lt;60 vs ≥60 years)</td>
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<td>1.14</td>
<td>[0.7—1.9]</td>
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<td>4.33</td>
<td>[1.9—10.0]</td>
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<td>Concomitant procedure</td>
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<td>[0.6—3.4]</td>
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<tr>
<td>Concomitant aortic valve surgery</td>
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<td>1.77</td>
<td>[1.0—3.0]</td>
</tr>
<tr>
<td>Emergency operation</td>
<td>0.001</td>
<td>4.90</td>
<td>[2.0—11.8]</td>
</tr>
<tr>
<td>TV-surgery (replacement vs repair)</td>
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<td>3.10</td>
<td>[1.8—5.2]</td>
</tr>
<tr>
<td>Aortic clamp time (&lt;60 vs ≥60 min)</td>
<td>0.466</td>
<td>0.81</td>
<td>[0.5—1.4]</td>
</tr>
<tr>
<td>Duration of CPB (&lt;110 vs ≥110 min)</td>
<td>0.008</td>
<td>2.00</td>
<td>[1.2—3.4]</td>
</tr>
</tbody>
</table>

TV, tricuspid valve; EF, left ventricular ejection fraction; Lvedp, left ventricular end-diastolic pressure; PAmean, mean pulmonary arterial pressure; CPB, cardiopulmonary bypass.

![Fig. 3. Actuarial survival after TV repair and replacement. Kaplan–Meier estimate of survival for patients, who underwent tricuspid valve repair (solid line) or replacement (dotted line). The actuarial survival probability at 10 years was 47.5 ± 3.5% for patients who underwent tricuspid valve repair and 37 ± 4.8% for patients who underwent valve replacement.](image)
3.3. Re-operation

Within an observation period of 30 years, 45 patients (10.8%) required a tricuspid valve re-operation 10 days to 22 years (mean 7.7 ± 5.1 years) after the initial operation. Twenty-seven patients required a re-operation after primary TV repair; 11 (41%) of these underwent repeat TV repair, 5 patients received a biological prosthesis and 11 a mechanical prosthesis. Freedom from TV related re-operation 10 years after TV repair and replacement was 83 ± 3.6% and 79 ± 6.1%, respectively.

had also no influence on late survival (10-year survival after TVR with a biological or mechanical prosthesis 37.7 ± 6.1 vs 35.6 ± 7.9 \( p = 0.747 \)).

3.4. Valve related complications

Overall 15 patients, 11 after TV repair and 4 after TV replacement experienced a thromboembolic event (10 were fatal). Freedom from thromboembolism 10 years after TV repair and replacement was 94.5 ± 2.0%, and 95.5 ± 2.2%, respectively \( (p = 0.978) \) Six patients (two after TV repair and four after TV replacement) presented with a bleeding complication, all of these were fatal. Freedom from bleeding complications 10 years after TV repair and replacement was 98.4 ± 1.2% and 94.3 ± 3.2%, respectively \( (p = 0.040) \). Freedom from valve related morbidity 10 years after TV repair and replacement was 76.8 ± 4.0% and 72.6 ± 6.2% \( (p = 0.067) \).

4. Discussion

According to the literature 40–75% of the patients (in our series 44%), who require tricuspid valve surgery have had one or more previous cardiac operations because of concomitant mitral and aortic valve disease \[3,4,9,12\]. In the majority of the patients (89–94%, in our series 88%) tricuspid valve surgery is associated with other cardiac procedures mainly mitral and/or aortic valve repair/replacement \[3,4,8\]. Most of the patients are in poor clinical condition with 31–97% of the patients being in NYHA functional class III or IV \[3,8,9,12\]. Therefore the need for tricuspid valve surgery reflects an advanced stage of heart disease often associated with severe right ventricular dysfunction.

Tricuspid valve repair is the treatment of choice for the majority of patients with functional tricuspid valve disease, the most common etiology of tricuspid regurgitation in North America \[6\]. Tricuspid valve replacement is mainly reserved for patients with organic valve disease. In a series of 530 patients reported by McGrath and co-workers, TV replacement was also more frequent in patients, who required concomitant mitral valve replacement \[3\]. As in other studies the majority of our patients (75%) underwent TV repair. The number of patients, who required valve replacement constantly decreased. In the late study period (2000–2003) only 4 out of 81 patients underwent valve replacement. Tricuspid valve stenosis and combined lesions were more prevalent in the replacement group.

4.1. Operative mortality

Several previous studies have shown, that tricuspid valve surgery carries a high operative risk and that long-term
prognosis is poor [3–5,16]. TV repair is usually associated with a lower perioperative risk and improved long-term outcome than valve replacement [17]. McCarthy and co-workers report a 30-day mortality of 6% in a series of 790 patients who underwent TV annuloplasty [8]. Tang and co-workers analyzed 702 patients who underwent TV repair with and without ring annuloplasty and report an in-hospital mortality of 4% and 7%, respectively [9]. Tricuspid valve replacement is associated with considerable higher mortality rates. The hospital mortality rate for TVR ranges between 14.5% and 48% [3–5,12,16–19]. In our study 30-day mortality after TV repair was 13.9% (43/310) compared to 33% (35/106) after TV replacement ($p = 0.0001$). However, during the most recent study period from 2000 to 2003 mortality decreased to 11.1%. Various risk factors for hospital-operative mortality have been identified, such as advanced age, male gender, date of operation, number of additional valves replaced, previous intracardiac repair, degree of preoperative hepatomegaly, severity of preoperative pulmonary edema, high preoperative bilirubin level, mean pulmonary artery pressure $>40$ mmHg and pulmonary vascular resistance $>6$ Wood units [3,5,12]. In our series univariate analysis revealed earlier date of operation, emergency operation, NYHA functional class $\geq$$III$, concomitant aortic valve surgery and tricuspid valve replacement as significant risk factors for 30-day mortality. TV replacement was the only independent predictor of 30-day mortality identified by multivariate analysis. In the study of Singh and co-workers TV replacement was also found to be an independent predictor of lower event-free survival [17]. The high 30-day mortality of patients with TV replacement in our series can be explained by the coincidence of various risk factors. Eleven percent of these patients were operated on an emergency basis and 88% underwent concomitant mainly aortic or mitral valve surgery. In the majority of the patients ($79/106$ (75%)) surgery was performed in the early study period (before 1985). Singh and co-workers also report a significant difference in operative mortality between patients undergoing repair (4%) or replacement (22%) [17]. However, similar to our series, repair patients were more likely to have elective surgery. Thus, the difference in operative mortality may be more influenced by patient comorbidities and the elective/nonelective status of surgery.

4.2. Late mortality

Several authors have reported conflicting results regarding the influence of the type of surgery on long-term outcome. McGrath and co-workers found no difference in the risk for early or late death whether the tricuspid valve had been repaired or replaced [3]. Singh and co-workers, analyzing 250 patients (TV repair $n = 178$, TVR $n = 72$), report a better perioperative, midterm and event-free survival for patients who underwent TV repair as opposed to replacement [17]. In our study, TV repair resulted in significantly better survival when compared with valve replacement (at 10 years $46 \pm 3.5\%$ and $37 \pm 5\%$, respectively). The survival curves of both patient groups show a parallel course and the main difference consists in the considerable operative mortality in the replacement group. Like other investigators we found no difference in long-term mortality between patients who underwent biological or mechanical valve replacement [4,19]. McCarthy and co-workers report a 8-year survival after TV repair of 50% [8]. Rizzoli and co-workers report a 10- and 15-year survival rate after TV replacement of 38% and 31%, respectively [19]. Late survival depends on patient-related factors, type of surgery, type of prosthesis and health care related factors [14]. Although many preoperative variables have been identified as potential risk factors for early and late mortality, markers of severe venous hypertension were consistently associated with increased risk for early and late phase events [3]. Therefore in these patients with usually advanced multivalvular failure mortality might be predominantly influenced by right ventricular failure and systemic venous hypertension. Singh and co-workers argue that patients who require valve replacement for organic tricuspid valve disease are at increased risk for developing progressive TV dysfunction [17]. According to Van Nooten and co-workers cardiac failure was the main cause of late death in a series of 146 patients, who underwent TV replacement [12].

4.3. Re-operation

In our series 45 patients (10.8%) required a tricuspid valve related re-operation in average $7.7 \pm 5.1$ years after the initial operation. Freedom from re-operation 10 years after TV repair was $83 \pm 3.6\%$ compared to $80 \pm 7.5\%$ and $84 \pm 8.4\%$ after valve replacement with a biological or mechanical prosthesis, respectively. McCarthy and co-workers analyzed 790 patients who underwent TV repair with four different techniques including the De Vega procedure and ring annuloplasty with different semi-rigid and flexible devices. They reported a low re-operation rate of 2.9% per year by 10 years. Freedom from re-operation was 97% at 8 years. Despite this low re-operation rate 15% of their patients showed recurrent tricuspid regurgitation grade 3+ and 4+ one month postoperatively. During the follow-up regurgitation evolved differently among the four repair techniques with a progressive increase of moderate and severe regurgitation after the De Vega suture repair compared to the Carpentier ring. The authors could identify a higher grade of preoperative regurgitation, poor left ventricular function, the presence of a trans-tricuspid pacing lead and TV annuloplasty without using an annuloplasty ring as independent risk factors for worsening regurgitation and concluded that the De Vega procedure should be abandoned and trans-tricuspid pacing leads should be replaced with epicardial leads [8]. Rivera and co-workers in a prospective randomized trial comparing the De Vega annuloplasty with Carpentier ring annuloplasty have also shown a higher recurrence of moderate and severe TV regurgitation following the De Vega repair [20]. Patients with high pulmonary resistance or with organic tricuspid valve disease are at increased risk for recurrent regurgitation irrespective of the type of annuloplasty [20]. Similarly, Tang and co-workers in a study of 702 patients reported a higher event-free survival and freedom from recurrent regurgitation in the annuloplasty ring group [9]. In our series the patients who underwent the De Vega annuloplasty showed a significantly higher freedom from re-operation compared to those with a ring annuloplasty (at 5 years $95 \pm 1.9\%$ vs $92.3 \pm 4.3\%$ ($p = 0.018$). However, ring
annuloplasty was applied predominantly in the late study period. Because of the smaller number of patients and the shorter follow-up period both patient groups are not comparable. In contrast to McCarthy and co-workers, we could not find a higher incidence of re-operation in patients with a previously implanted trans-tricuspid pacing lead. As in other studies we could not find a significant difference in re-operation rates of patients, who underwent repair or replacement. Tricuspid valve replacement with either a biological or mechanical prosthesis had no influence on the incidence of re-operation. McGrath and co-workers in a series of 530 patients operated on between 1961 and 1987 and Singh and co-workers in a recent study of 250 patients found no difference in re-operation rates either when the tricuspid valve had been repaired or replaced [3,17]. Ratnatunga and co-workers in a series of 425 patients, who underwent TV replacement with either a biological or mechanical prosthesis report 10-year freedom from re-operation to be 97.7% and 97.1%, respectively [5].

However, freedom from re-operation as marker of quality of repair may be misleading and the prevalence of recurrent tricuspid regurgitation may be underestimated. In the study of Tang and co-workers 30–36% of the patients presented with moderate or severe regurgitation at latest follow-up [9]. Tricuspid valve re-operation is associated with a high mortality rate. McCarthy and co-workers report a hospital mortality rate of 37% [8]. In our series 30-day and hospital mortality after re-operation was 15.6% and 26.7%, respectively. According to McCarthy and co-workers the discrepancy between the high recurrence rates of TV regurgitation and the low re-operation rates may be explained by the fact that TV re-operation is associated with a high mortality and thus, these patients are managed medically as long as possible before referral to surgery [8].

4.4. Thromboembolic events and bleeding complications

Thromboembolic events after TV surgery are rare. Rizzoli and co-workers reported rates of 1.28% patient/year [21]. Within an observation period of 30 years only 15 patients (3.6%) in our study experienced a thromboembolic event and 6 (1.4%) presented with a bleeding complication. Bleeding complications were more frequent in the replacement group. No difference was seen in regards to thromboembolic events. Singh and co-workers did not find a difference between patients who underwent TV repair or replacement with regard to freedom from thromboembolic events, valve thrombosis or bleeding rates [17]. However, in their series only 18 patients underwent TVR with a mechanical prosthesis.

4.5. Choice of prosthesis

The choice of valve prostheses is based on the durability of biological prostheses and on the probability of anticoagulation-related complications with mechanical prostheses. In the mid-1980s a higher incidence of valve thrombosis after TV replacement with mechanical prostheses has been reported [13]. The type of prosthesis used in most of these studies was the Björk–Shiley tilting disc valve [13]. However, design improvement in mechanical prostheses has reduced this problem significantly [11,21,22]. Nakano and co-workers report only one case of valve thrombosis in a series of 39 patients, who underwent TVR with a St. Jude Medical prosthesis [11]. In our series three patients with previous mechanical valve replacement had to be re-operated because of valve thrombosis. We noted no cases of thrombosis in biological prostheses. The type of prosthesis had no influence on 30-day and late mortality and we could not find any difference in valve related complications such as re-operation, thromboembolic events and bleeding. Similar results have been reported by various authors [3–5,18,19]. In none of these studies the superiority of one type of prosthesis over the other could be demonstrated. Degeneration of bioprostheses in the tricuspid position is rare and usually occurs after 7–10 years [12,19]. Considering the poor long-term outcome, the lower risk of valve thrombosis and the low incidence of re-operation we recommend the use of a biological prosthesis.

4.6. Study limitations

Our study is a retrospective study with all of the inherent limitations. Unfortunately no consistent, accurate echocardiographic data (especially from the early study period) were available. Thus, we have no information about the development of recurrent tricuspid regurgitation and right ventricular function during the follow-up. We also could not correlate recurrence of tricuspid regurgitation to residual mitral regurgitation. Furthermore, as with all studies of clinical experience, the data may be subject to selection bias. For instance, symptomatic patients might have been more likely to receive follow-up echocardiography than asymptomatic ones. Patients who require tricuspid valve surgery are a very heterogeneous group. Many of these have undergone previous cardiac surgery and in the majority tricuspid valve surgery is associated with concomitant mitral or aortic valve surgery. During the 30-year study period pre- and intraoperative diagnostic evaluation, surgical technique and anesthesiologic management changed considerably and it is difficult to take into consideration all the factors that might have influenced the results. However, there are only a limited number of studies available with a large number of patients and a follow-up that comprises 30 years. Tricuspid valve surgery is associated with a high operative and late mortality. Thus, the influence of the competing risk of death has to be considered when the event-free survival from valve related complications such as thromboembolism, bleeding or re-operation is calculated by the Kaplan–Meier method, because the probability of re-operation for example may be overestimated when the patients, who died before the event occurred, are censored.

5. Conclusion

Patients, who require tricuspid valve surgery are usually in an advanced stage of multivalvular heart disease and constitute a high-risk group. Tricuspid valve repair is associated with better perioperative and long-term outcome than valve replacement. However, patients undergoing replacement did worse because of a significant higher
incidence of risk factors for operative mortality. The incidence of re-operation is low with no significant difference whether the tricuspid valve has been repaired or replaced. When valve replacement is necessary we recommend the use of a biological prosthesis considering the poor long-term survival.

References


Appendix A. Conference discussion

Dr F. Mohr (Leipzig, Germany): You do have quite a number of congenital patients in this cohort I would suspect. Does that matter?

Dr Guenther: No. We selected only patients with acquired tricuspid valve disease.

Dr M. Antunes (Coimbra, Portugal): I was interested to see your recent shift from the De Vega annuloplasty to the ring annuloplasty. Considering that you had such good results with the annuloplasty group, in the repair versus replacement, why did you change the policy?

Dr Guenther: Well, there are some reports documenting a higher incidence of recurrent tricuspid regurgitation after the De Vega annuloplasty and therefore we changed our policy and now we predominantly use ring annuloplasty.

Dr Antunes: Yes, but your patients operated for 30 years with the De Vega did not show those poor results that you alluded to and made you change the policy.

Dr Guenther: In the repair group, 27 patients had to be re-operated, and as I showed you, there was a quite high incidence of recurrent annular dilatation and suture failure.

Dr A. Moritz (Frankfurt, Germany): It is somewhat similar, but the re-operation rate is not a very good indicator of failure of tricuspid repair. Many patients are not re-operated even if they have a TR grade 3 or so. Do you have any data on this, how these curves would look like if you put in TR grade 3 or greater? Do you have this data? This would be a really interesting thing also in the discussion how durable a De Vega plasty is, which in some groups did not turn out to be that stable.

Dr Guenther: You are perfectly right. This is one of the major limitations of our study. We don’t have consistent echo data. Therefore I cannot answer your question, especially because of the lack of echo data from the early study period.