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Original Article

Early and Late Outcomes of Isolated Tricuspid Valve Surgery Following Valvular Surgery

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Purpose: Isolated tricuspid valve surgery (TVS) following valvular surgery has been still challenging. We reviewed our experience to determine early and late outcomes.
Methods: We retrospectively analyzed 14 patients (mean age, 57.0 ± 17.8 years old) who underwent isolated TVS after valvular surgery between January 1990 and December 2010. The causes of isolated TVS were structural valve deterioration (SVD) (n = 5) and symptomatic severe tricuspid regurgitation (n = 9). The mean follow-up period was 6.4 ± 5.9 years.
Results: At redo, seven patients underwent tricuspid valve replacement (TVR) using a bioprosthesis and the remaining underwent tricuspid valve repair (TVP). Early mortality rate was 7.1% (1/14). Survival rates at 5 and 10 years were 68.8% ± 13.1% and 68.8% ± 13.1%, respectively. Three deaths (two for heart failure and one for cerebral hemorrhage) were observed. Freedom from valve-related events was 58.3% ± 14.2% at 2 and 48.6% ± 14.8% at 5 years. Six events were observed (five for heart failure and one for cerebral hemorrhage). There was no statistically significant difference between TVP and TVR as to freedom from valve-related events (log-rank p = 0.3655).
Conclusions: Early and late outcomes of isolated TVS after valvular surgery seem to be satisfactory. Special attention should be paid to heart failure following TVP.

Keywords: isolated tricuspid valve surgery, replacement, repair, redo valvular surgery

Introduction

Despite the dramatic increase in the number of redo valvular surgeries even in the era of transcatheter treatments, in-hospital mortality rate has decreased to 3.2%.[1] Introduction of new myocardial protective techniques, use of deep hypothermic circulatory arrest, cardiopulmonary bypass via peripheral vessels, improved surgical techniques, and experience have contributed to reduced mortality rate in redo valvular surgery.[2]

Tricuspid valve surgery (TVS) for redo surgery has been challenging. A previous report showed that mortality rate of reoperative TVS following tricuspid valve repair (TVP) was 35.1%.[3] Other reports also revealed the high mortality rate more than 10% after reoperative TVS.[4–6] Despite the aforementioned poor early outcomes, survivors could benefit from the reasonable survival rates of 86% at 5 years.[5] Recently, the introduction of the right thoracotomy approach in reoperative TVS contributed to reduced mortality rate ranging from 2.2% to 4.2%.[7,8] This can be an option for redo surgery. We herein reviewed our results of isolated TVS following valvular surgery to determine early and late outcomes.

Materials and Methods

The current study was approved at an institutional review board.

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Table 1 Clinical profile of patients (n = 14)

Variables	Mean ± SD or n (%)
Age (years)	57.0 ± 17.8
BSA (m^2)	1.48 ± 0.15
Female	12 (85.7)
Hypertension	3 (21.4)
Diabetes mellitus	2 (14.4)
Hyperlipidemia	2 (14.4)
COPD	0 (0)
PAD	0 (0)
Stroke	1 (7.1)
Hemodialysis	0 (0)
Creatinine level, 1.5 mg/mL	5 (35.7)
Liver cirrhosis	0 (0)
CAD	0 (0)
Atrial fibrillation	10 (71.4)
LVEF ≥ 60%	5 (35.7)
< 60%	6 (42.9)
NYHA I/II	10 (71.4)
III/IV	4 (28.6)
Non-elective surgery	1 (7.1)
Euro SCORE II (%)	6.62 ± 4.19
Number of redo surgeries	
First	8 (57.1)
Second	3 (21.4)
Third	1 (7.1)
Fourth	2 (14.4)

Values are mean ± standard deviation or number (%). BSA: body surface area; CAD: coronary artery disease; COPD: chronic obstructive pulmonary disease; LVEF: left ventricular ejection fraction; NYHA: New York Heart Association; PAD: peripheral artery disease

We retrospectively analyzed 14 patients (mean age, 57.0 ± 17.8 years old) who underwent isolated TVS after valvular surgery at our hospital between January 1990 and December 2010. The causes of isolated TVS were structural valve deterioration (SVD) (n = 5) and symptomatic severe tricuspid regurgitation (TR) (n = 9). All patients included had previously undergone TVS or other valvular surgeries. Patients who underwent concomitant valve surgeries or coronary revascularization at this time were excluded. This study was conducted in accordance with the Society of Thoracic Surgeon Guidelines.[9] **Table 1** shows the clinical profile of patients in this study.

TR was graded on transthoracic echocardiography as 0 for no regurgitation, 1 for mild regurgitation, 2 for moderate regurgitation, 3 for moderately severe regurgitation, and 4 for severe regurgitation.

The mean follow-up period was 6.4 ± 5.9 years and the rate of follow-up was 92.3%.

Statistical analysis

All statistical analyses were conducted with StatView version 5.0 software (SAS Institute Inc., Cary, NC, USA). Categorical variables were analyzed using Fisher's exact test probability and are expressed as percentages. Continuous variables were analyzed by the Student's t test and are expressed as the mean ± standard deviation. Mann–Whitney U-test was also used for data with non-normal distribution. The Kaplan–Meier method was applied to calculate estimates of late survival and freedom from valve-related events.

Surgical techniques

Our technique applied at redo surgery has been described in detail previously. At redo surgery, extracorporeal circulation was established by peripheral cannulations prior to median resternotomy to prevent great vessels or cardiac injury in cases where the right ventricle was close to the sternum on preoperative computed tomography.

Table 2 Summary of previous and present surgical procedures

Variables	Mean ± SD or n (%)
Previous surgery	
AVR	1 (7.1)
MVP	4 (28.6)
TVR	4 (28.6)
TVP	2 (14.4)
AVR+MVR	1 (7.1)
MVR+TVP	1 (7.1)
AVR+MVR+TVR	1 (7.1)
Present surgery	
TVR	7 (50.0)
Mosaic (27, 29 mm)	4 (28.6)
Hancock (25, 31 mm)	2 (14.4)
Carpentier-Edwards (29 mm)	1 (7.1)
TVP	7 (50.0)
Duran annuloplasty band/ring (25, 27, 29 mm)	6 (42.9)
Carpentier-Edwards ring (26 mm)	1 (7.1)
Concomitant surgery	
Epicardial lead placement	8 (57.1)
MAZE procedure	2 (14.4)
Thrombectomy	1 (7.1)

Values are number (%). AVR: aortic valve replacement; MVP: mitral valve repair; MVR: mitral valve replacement; TVP: tricuspid valve repair; TVR: tricuspid valve replacement

Basically, we performed resternotmy (n = 13). In one case of second-time redo surgery, the 4th right thoracotomy was applied by peripheral cannulations. Myocardial protection consisted of retrograde cold blood cardioplegia because we opened the right atrium.

Results

Most of the patients were female and 10 patients (71.4%) had a history of atrial fibrillation at the redo surgery. Preoperative New York Heart Association (NYHA) functional class III or IV were four (28.6%). One patient underwent emergency redo surgery due to medically refractory heart failure (NYHA functional class IV) due to SVD. Euro SCORE II was 6.62% ± 4.19%.

Previous and present surgery

Details are summarized in **Table 2**. Eight patients underwent previous TVS (valve replacement, 5: repair, 3) and six underwent left-sided valvular surgery.

At redo surgery, seven patients underwent tricuspid valve replacement (TVR) using a bioprosthesis. Of these seven, two patients underwent TVP previously. The remaining seven underwent TVP at redo. Of these seven, in one patient who underwent redo TVP, leaflet augmentation for the anterior leaflet using glutaraldehyde-treated pericardial patch was applied. Total durations of cardiopulmonary bypass and aortic cross clamp were 162.1 ± 75.9 minutes and 55.1 ± 44.7 minutes, respectively.

Early outcomes

Early mortality rate was 7.1% (1/14). A 30-year-old female underwent TVR 10 years after TVP. She died due to sepsis 1 month after redo surgery. Postoperative mediastinitis was observed and was cured. Postoperative implantation of a permanent pacemaker implantation after redo TVR was necessary for one patient.

Late outcomes

Survival

Survival rates at 5 and 10 years were 68.8% ± 13.1% and 68.8% ± 13.1%, respectively (**Fig. 1**). Three deaths were observed within the first 3 years after discharge. Two patients who underwent TVP died of heart failure. One patient who received TVR following TVP died of cerebral hemorrhage.

Freedom from valve-related events

Freedom from valve-related events was 58.3% ± 14.2% at 2 and 48.6% ± 14.8% at 5 years (**Fig. 2A**). There was no statistically significant difference between TVP and

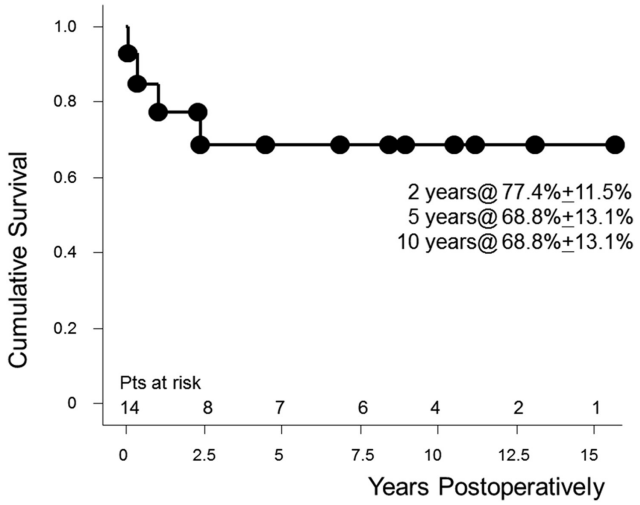

Fig. 1 Overall survival rates.

TVR as to freedom from valve-related events (log-rank p = 0.3655) (**Fig. 2B**).

Six events were observed, which were heart failure in five (four after TVP and one after TVR) and cerebral hemorrhage in one after TVR. Of these patients with heart failure, three were treated medically. However, two patients as mentioned above died of heart failure. Preoperative NYHA functional class (I/II versus III/IV) did not have an impact on freedom from valve-related events (log-rank p = 0.3724).

Echocardiographic data

Of seven patients who underwent TVP, transthoracic echocardiographic data at the final follow-up were available in six. The severity of TR grade was 2.0 ± 0.6 at final follow-up. The severity of TR grade significantly improved (p = 0.0117). Four patients with TR severity of 2.5 ± 0.3 experienced heart failure. The remaining three who did not suffer from heart failure had the TR severity of 1.5 ± 0.5 (p = 0.0702).

Following TVR, severity of TR was well-controlled thanks to a bioprosthesis.

Discussion

The mortality rate in our study was 7.1%, which was better than that from previous reports.[3–5] However, because of heart failure observed more after isolated TVP, freedom from valve-related events was 58.3% ± 14.2% at 2 and 48.6% ± 14.8% at 5 years, respectively.

Isolated TVS following valvular surgery has been still challenging with high mortality and morbidity rates due to delayed timing. It is very difficult to assess the optimal referral to redo surgery because diuretic use on heart failure contributes to improving symptoms related to heart failure.[10] Although symptomatic TR is one of the indications for redo surgery,[11] the symptoms are easily alleviated with the diuretic use. Furthermore, the biggest problem is that high doses of diuretic use continue until they get ineffective to improve the symptoms or chronic heart failure. Finally, redo surgery would be considered to treat patients who are already refractory to medical treatments and have irreversible right heart failure or multi-organ failure. Most of patients were in advanced NYHA functional class and had some symptoms related to heart failure.[3,5,6] We recommend that symptomatic patients with TR after heart valvular surgery be referred to redo surgery earlier before increasing the diuretic dose. As regard to TR due to SVD, similarly, optimal timing based on assessing the patients, their symptoms and multi-organ functions should be done.[12]

Recently, the better outcomes of TVS following valvular surgery via a right thoracotomy approach have been published. The mortality rate was surprisingly low, which was about 4%.[7,8] A possible explanation of the low mortality rate via a thoracotomy approach was that it minimized separation of tightly attached adhesion, resulting in fewer injuries to the heart compared to conventional sternotomy.[8]

With the advancement of transcatheter treatments for valvular diseases including SVD, they have shed light on severe TR and SVD. Outcomes of transcatheter treatment for severe TR with the MitraClip technique have been published.[13] In the study, 93% of the patients were in NYHA functional class III/IV and a history of previous cardiac surgery or valvular intervention was observed in 73%. Early outcomes showed no intraoperative death and major complications with three in-hospital deaths (mortality rate, 5%). At follow-up, 63% of patients remained NYHA functional class III, and none was in NYHA functional class IV. This technique can be a safe weapon to treat high-risk patients with TR.[11] For SVD, a tricuspid valve-in-valve technique using commercially available prostheses has been also improving for high-risk candidates.[14]

We experienced five cases of heart failure during the follow-up period. The patients who suffered from heart failure after reoperative TVS had the higher grade of TR than that in patients without heart failure. Persistent moderate TR after redo valvular surgery has negative impacts

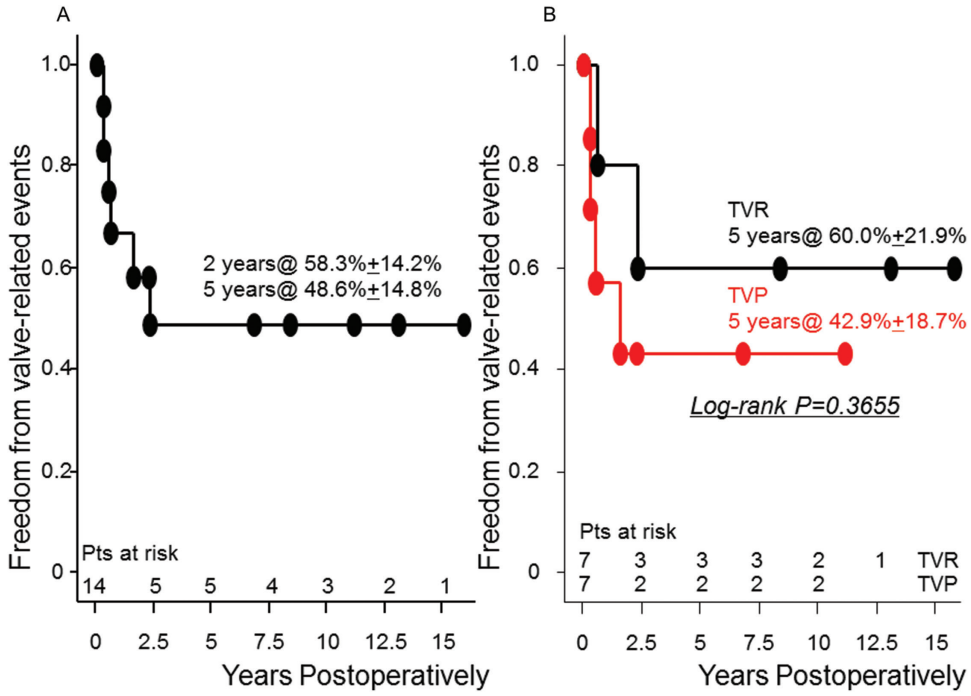

Fig. 2 Freedom from valve-related events (**A**). Freedom from valve-related events between tricuspid valve replacement and tricuspid valve repair (**B**). TVP: tricuspid valve repair; TVR: tricuspid valve replacement

on survival and valve-related events.[15,16] The point is how to reduce persistent TR less than moderate following reoperative TVS, especially TVP. Only a prosthetic ring implantation cannot control TR.[17] Even in redo surgery, three parameters including TR severity, annular dilatation, and mode of leaflet coaptation should be used to evaluate tricuspid valve pathology and determine the surgical procedures.[18] In addition to annuloplasty and leaflet augmentation, the novel techniques for targeting the right ventricular papillary muscles have emerged to regulate TR with severe tethering.[19,20]

TVR is a promising alternative to TVP to reduce postoperative TR. Type of surgery (TVR versus TVP) did not influence early mortality and late outcomes.[5,21] Although it is difficult to distinguish patients who would benefit from TVR from those who undergo reoperative TVS, TVR can be an option in terms of acceptable outcomes and reducing postoperative TR.

There were some limitations. First, this study was its retrospective nature with small patient cohort (n = 14). In addition, surgical indications or timing for redo surgery and techniques applied were not consistent and depended on surgeons' preferences. Second was the lack of transthoracic echocardiographic data including right ventricular size and function, tricuspid annular dimension, tricuspid valve tethering, and its area. However, during the study period, the concept of these parameters was not common. We have updated our knowledge and techniques and reviewed our outcomes to achieve better outcomes in addition to much experience with redo valvular surgery. These are really responsible for the better outcomes.

Conclusion

Early and late outcomes of isolated TVS after valvular surgery seem to be satisfactory. Special care should be paid to hear failure and persistent TR greater than moderate following TVP.

Disclosure Statement

Naoto Fukunaga and co-author have no conflict of interest.

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