

Tricuspid annular plane systolic excursion (TAPSE) can predict the outcome of isolated tricuspid valve surgery in patients with previous cardiac surgery?

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Background: Isolated tricuspid valve replacement is rare when performed as a re-operation after a left side operation. It is important to know the factors that determine mortality and morbidity. Tricuspid Annular Plane Systolic Excursion (TAPSE) is a scoring system that is used with non-invasive Doppler echocardiography to determine right ventricular (RV) function. This study analyzed TAPSE scores and adverse outcomes of isolated tricuspid valve surgery in patients with previous cardiac surgery.

Methods: All patients who underwent tricuspid valve replacement between January 2014 and December 2015 were retrospectively reviewed. Patients having concomitant mitral or aortic valve surgery were excluded. These patients were divided into two groups: TAPSE >14 mm and TAPSE ≤14 mm. In-hospital outcomes were compared.

Results: A total of 26 patients with severe tricuspid valve regurgitation underwent tricuspid valve replacement. There were 5 males (19.2%) and 21 females (80.8%). The average age at operation was 54.77±9.61 years (range, 27–69 years). There were 16 patients in the TAPSE >14 mm group and 10 patients in the TAPSE ≤14 mm group. The BNP in the TAPSE >14 mm group was significant (TAPSE >14 mm 672.34±229.98 versus TAPSE ≤14 mm 1,054.79±684.69, P=0.03). The median cardiopulmonary bypass (CPB) time and red blood cell (RBC) transfusions in the two groups were not different. The need for prolonged ventilatory support (>48 h) in the two groups was also not different (TAPSE > 14 mm 91.2±12.31 vs. TAPSE ≤14 mm 39.00±36.80, P=0.46). Moreover, hospital stays were similar between the two groups. No differences were found in postoperative renal and respiratory complications.

Conclusions: It is important to determine the right ventricle function quantitatively. The TAPSE score is an important parameter that determines the cardiac index and right ventricle function. It should be used for the prediction of mortality and morbidity with all the other parameters as a whole.

Keywords: Tricuspid valve replacement; tricuspid annular plane systolic excursion; Tricuspid Annular Plane Systolic Excursion (TAPSE)

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Introduction

Advanced tricuspid regurgitation is associated with pulmonary hypertension and right ventricular (RV) dysfunction (1). Therefore, despite the ease of the surgical procedure, patients undergoing tricuspid valve surgery with previous cardiac surgery have higher operative mortality and a worse prognosis (2).

It is difficult to determine the best timing for surgery. It is worth considering whether a simple index, such as left ventricular ejection fraction (EF) may be an indicator for guiding treatment. Of note, it is difficult to assess RV function. Tricuspid annular plane systolic excursion (TAPSE) has been proposed as a simple and reproducible parameter for quantitative assessment of the RV EF (3). The prognostic importance of TAPSE in the evaluation of RV function in patients with severe heart failure has been well-described (4), and the parameter has been recommended in the most recent joint American European guidelines for echocardiographic quantification of RV function (5).

The present study investigated the relation of TAPSE and other echocardiographic and clinical parameters of heart failure patients, with an emphasis on TAPSE being able to predict the outcome of isolated tricuspid valve surgery in selected patients with previous cardiac surgery.

Materials and methods

From September 2013 to September 2015, a consecutive series of 26 patients who had an isolated tricuspid surgery operation for severe tricuspid valve after mitral valve replacement in Zhongshan Hospital were retrospectively enrolled in this study. The patients who had concomitant surgery apart from mitral valve replacement at the first operation or during the second operation for the TR were excluded from the present study. These patients were divided into two groups: TAPSE >14 mm and TAPSE ≤14 mm. TAPSE was measured by M-mode echocardiography at the junction of the tricuspid valve and RV free wall in the apical 4 chamber view.

Patient characteristics

There were 5 males (19.2%) and 21 females (80.8%). The average age at operation was 54.77±9.61 years (range, 27–69 years). All patients were diagnosed with rheumatic heart disease. All of the patients had previous heart surgery.

All patients had right heart failure symptoms (edema

of lower extremities, ascites, and hepatic congestion, etc.). The preoperative New York Heart Association (NYHA) functional class was 3 to 4 for all patients. All patients were investigated preoperatively by means of Doppler echocardiography. Echocardiography showed severe TR in all 26 patients. The average TAPSE score were 15.12±2.86 mm (10–21 mm). The right atrial diameter was 77.96±31.86 mm. The systolic pressure of the pulmonary artery was 38.27±11.75 mmHg ($\bar{x} \pm SE$). The LVEF was 61.37±8.65% (42–78%). Common laboratory findings in those patients were: elevation of transaminase (in 22 patients, 84.6%), hypoalbuminemia and anemia (in 6 patients, 23%). Blood urea nitrogen and creatinine were increased in 3 cases (11.5%).

All patients received milrinone or dobutamine and diuretic therapy to improve cardiac function preoperatively.

All patients underwent the operation with general anesthesia and intubation. Eleven patients underwent a midline sternotomy (42.3%), while 15 patients (57.6%) had a right anterolateral thoracotomy. The sternotomy was performed with a swing saw with the adhesion carefully dissociated and the wires removed. A cardiopulmonary bypass (CPB) was prepared routinely. Peripheral and superior vena cava cannulation was performed for the CPB in patients undergoing right thoracotomy. Myocardial protection was achieved with antegrade or a combined antegrade and retrograde cold blood high potassium cardioplegia.

All patients underwent tricuspid valve replacement. Eleven patients received a mechanical valve while 15 patients received bioprosthetic valves. The type of prosthesis used was based on the surgeon's preference.

Three patients returned to the operating room for bleeding and two patients needed permanent pacemaker placement. Respiratory complications included postoperative mechanical ventilation ≥24 h, three patients needed a tracheostomy, and one patient needed re-intubation. Pulmonary hemorrhage occurred in two patients. A sternal wound infection occurred in four patients. Renal replacement therapy (RRT) was required for four patients. Five patients died (19.2%) due to pulmonary hemorrhage or multiple organ failure. In addition, postoperative low cardiac output syndrome occurred in 12 patients that were treated successfully.

Statistical analysis

Descriptive data are presented as mean (SD) for normally

Table 1 Comparative data for TAPSE >14 mm vs. TAPSE ≤14 mm

Characteristics	TAPSE >14 mm (n=16)	TAPSE ≤14 mm (n=10)	P value
Age	53.75±10.90	56.40±7.32	0.63
Sex			0.34
Male	4	1	
Female	12	9	
Height	1.63±0.05	1.60±0.05	0.27
Body weight	58.44±7.38	53.2±7.19	0.07
BMI	22.07±2.31	20.83±2.15	0.21
Systolic pressure	123.75±11.47	116.50±13.34	0.24
Diastolic blood pressure	76.25±7.19	70.50±8.32	0.11
Hypertension	2	0	
Diabetes	2	0	
Atrial fibrillation	14	8	0.50
NYHA class ≥3	11	5	0.29
BNP	1054.79±684.69	672.34±229.98	0.03
TAPSE	16.94±1.95	12.2±1.03	0.00
sPAP	36.81±10.29	40.60±14.04	0.62
LVEF	61.03±9.62	61.90±7.26	0.98
TB	21.68±16.40	19.69±8.58	0.85
CB	7.98±6.84	8.63±4.76	0.56
Albumin	35.88±10.21	40.90±4.65	0.19
ALT	32.69±51.33	20.9±7.72	0.75
AST	33.13±17.70	44.00±22.80	0.10
Creatinine	65.14±24.68	68.80±18.23	0.85

TAPSE, tricuspid annular plane systolic excursion; NYHA, New York Heart Association.

distributed data and the median (range) was used for skewed data. For the two group comparisons, Fisher's exact tests were used for categorical variables and non-parametric Wilcoxon rank-sum tests were used for continuous variables, as appropriate. All statistical analyses were carried out using Stata 12.0 software. For all analyses, p values of 0.05 were considered significant.

Results

Table 1 compares the preoperative characteristics of patients with TAPSE >14 mm and TAPSE ≤14 mm. The NYHA class, degree of right and left ventricular dysfunction, degree of renal dysfunction, and nutritional status (albumin and hemoglobin levels) were not different between the two groups.

In-hospital outcome early results are shown in Table 2.

The median CPB time and red blood cell (RBC) transfusions in TAPSE >14 mm and TAPSE ≤14 mm groups were not different. The need for prolonged ventilatory support (>48 h) in the TAPSE >14 mm group was also not different (TAPSE >14 mm 91.2±12.31 vs. TAPSE ≤14 mm 39.00±36.80, P=0.46). Moreover, hospital stays were similar between the two groups. No differences were found for postoperative renal or respiratory complications as well as individual adverse outcomes such as tracheostomy and the need for postoperative RRT. The overall in-hospital mortality was 5 patients (19.2%), with four deaths in the TAPSE ≤14 mm group and 1 death in the TAPSE >14 mm group (14.8% and 13.8%, respectively; P=0.06).

Discussion

Treatment of isolated TR after mitral valve replacement is

Table 2 Operative outcomes for patients undergoing isolated tricuspid valve surgery

Outcomes	TAPSE >14 mm (n=16)	TAPSE ≤14 mm (n=10)	P value
Intraoperative data			
CPB time	79.38±28.00	80.00±20.28	0.49
Transfusion			
RBC (U)	7.31±7.83	5.50±5.13	0.40
Plasma (mL)	787.5±646.91	540.00±550.15	0.31
Postoperative			
Hospital stay (days)	10.75±6.13	8.70±6.46	0.46
Ventilator support (h)	39.00±36.80	91.2±12.31	0.46
Tracheostomy	2	1	0.68
Dialysis	2	2	0.50
Death	1	4	0.06

TAPSE, tricuspid annular plane systolic excursion; CPB, cardiopulmonary bypass; RBC, red blood cell.

a rather complicated issue. There are no clear treatment recommendations from the European Society of Cardiology (ESC), American College of Cardiology and the American Heart Association (ACC/AHA) guidelines, especially for patients with isolated TR after left heart valve replacement surgery, and there are many uncertainties with the surgical indications, methods, timing and long-term results.

When clinical symptoms are mild, patients usually do not consider surgery. When patients have significant symptoms of right heart failure, they often decide to accept the surgery. RV function may have irreversible deterioration at this time and the surgical results are often poor. Most surgeons suggest patients with severe TR should have tricuspid valve repair or replacement before irreversible right heart failure.

Such RV failure patients often have poor kidney and liver function and it is difficult to determine the best timing for surgery. The RV is considered one of the most significant indicators of survival in valvular heart disease patients (6,7). The presence of RV dysfunction is known to increase operative as well as late mortality rates in tricuspid valve surgery (8). We hypothesized that worsening grades of preoperative RV dysfunction would be a risk factor for increased mortality after isolated TV surgery. Moderate and severe forms of dysfunction in our study were not associated with worse outcomes as compared to mild degrees of RV dysfunction.

It is apparent that RV function plays a central role in both preoperative clinical status and postoperative

outcomes. However, it is difficult to assess RV function. Whether there is a simple index, such as LVEF, that could be an indicator for guiding treatment remains a question.

Evaluation of RV function is often difficult because of the complex geometry of the right ventricle. Analysis of its size and function is often limited to subjective visual analysis. More sophisticated measures of RV function; i.e., the calculation of RV end systolic areas and the right index of myocardial performance (RIMP) ratios, have been shown to be valid predictors of mortality in TV disease (9,10). These procedures, however, require experienced personnel for image acquisition. This highlights the necessity for simple validated markers to assess and quantify RV dysfunction.

TAPSE is a widely recognized, clinically useful, and feasible marker of RV dysfunction, and it has been proven to be a valuable prognostic marker in various cardiac diseases, including heart failure. TAPSE refers to an apical four-chamber view with an M-mode ultrasound technique to measure the displacement of the tricuspid ring in the longitudinal direction of the RV. It is the most commonly used method to evaluate RV systolic functions, which is one of the most in-depth studies of echocardiographic parameters. The TAPSE measurement method is simple and has low dependence on the ultrasound image quality, requires no specific ultrasound equipment and analysis software, and has high repeatability. There is a good correlation between RV fractional area changes (11) and the biplane Simpson method (12), radionuclide RV (13), and the MRI (14) method for the determination of EFs. Decreased

TAPSE values mean RV systolic dysfunction.

We hypothesized that TAPSE, as a simple index similar to LVEF, could be an indicator for guiding treatment. In this group of patients with left heart valve replacement surgery, long-term occurrence of isolated tricuspid regurgitation left ventricular function was normal in all patients. Albumin, bilirubin, and creatinine levels were not different between the two groups. Therefore, theoretically, TAPSE should be related to the postoperative results. However, regarding the occurrence of low cardiac output, there were no differences between the TAPSE >14 mm group (4/34, 11.8%) and the TAPSE ≤14 mm group (1/11, 9.1%, $P>0.05$). There were no differences between the two groups with regard to the length of the hospital stay, postoperative renal or respiratory complications as well as individual adverse outcomes such as tracheostomy and the need for postoperative RRT. The likely reason is our sample was too small, which is also a limitation of this study. Our group of surgical cases was a select group with various aspects of a good condition. Doctors often reject severe patients whose TAPSE is low for outpatient surgery. Therefore, TAPSE may not be sensitive in this group of patients. Perhaps patients with TAPSE less than 10 mm and more than 10 mm would be more meaningful as study criteria.

RV function is not the only important factor. The nutritional status of patients and creatinine, albumin, bilirubin, and hemoglobin levels are other factors to consider. Therefore, establishing these indicators together with a scoring system may better predict the results of surgery.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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