



Efficiency of different annuloplasty in treating functional tricuspid regurgitation and risk factors for recurrence



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ABSTRACT

Background: Functional tricuspid regurgitation (FTR) is frequent in patients with mitral valve disease. Untreated tricuspid regurgitation (TR) may cause poor clinical outcomes. The surgical factors involved in annuloplasty for FTR remain controversial. Our objective was to compare effectiveness of different tricuspid annuloplasty (TVP), and reveal the risk factors of recurrence.

Methods: We analyzed the clinical details of 399 consecutive patients who underwent mitral surgery with concomitant TVP, from 2006 to 2011, in two Chinese single-centers. Three methods were used for TVP: De Vega surgery was completed in 242 patients; annuloplasty using a flexible band was completed in 98 patients; and surgery with a rigid ring was performed in 59 patients.

Results: The operative mortality rate was 2.3%. After surgery, the TR grade of all patients decreased significantly. At three years postoperatively, 13.7% of patients were diagnosed with recurrent FTR. At the three year time point, severe TR in the De Vega group was 18%, which was higher than those in the flexible (8.4%) and rigid planner ring groups (5.2%). During follow-up, the recurrent rates in the rigid group were significantly lower than in the flexible group. Multivariate analysis revealed that pre-operative atrial fibrillation, severe TR, large left atrial, ejection fraction (EF) < 40%, De Vega annuloplasty, and postoperative permanent pacemaker installation were independent risk factors for severe recurrent TR.

Conclusions: Rigid ring annuloplasty efficaciously improved post-operative tricuspid valve function in patients with FTR. Atrial fibrillation, a large left atrium, low EF and postoperative permanent pacemaker installation were independent risk factors for severe recurrent TR.

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1. Background

Tricuspid regurgitation (TR) is always present in patients with mitral valve (MV) disease, and over one-third of the patients with mitral stenosis have at least moderate TR [1]. Patients with pre-operative severe TR have severe MV disease, higher pulmonary vascular resistance, and poorer outcomes. The functional label referring to TR, which is secondary to either left-sided heart disease (LHD) or pulmonary hypertension, could be possibly a misnomer [2]. If untreated at the time of MV surgery, TR may progress, negatively impacting functional class, and survival [3]. Patients with severe TR after MV surgery and who are undergoing isolated tricuspid valve (TV) surgery, usually have high operative mortality, and no significant improvement in functional capacity

[4,5]. On the contrary, many investigators have reported that even if there was an absence of any organic pathology, TR would not reliably resolve after the correction of the primary disorder [6–8].

Due to the common belief that TR will resolve itself once the primary LHD has been treated, cardiac surgeons have placed more attention on intra-operative concomitant TR treatment. In the United States, the total number of TV procedures more than doubled over the last 10-year period [9]. Although corrective surgery of severe functional TR (FTR) showed trends toward improved survival, either significant residual or recurrent TR has been reported in 15% to 40% of patients after different TV surgery [10–12]. Tricuspid valve replacement, which allows adequate surface area of co-aptation impossible, is associated with higher mortality [13,14]. Several studies have shown better long-term freedom from recurrent TV regurgitation and repeat operation in those who underwent TV repair [15–20]; however, data regarding the outcome of such an approach and the optimal surgical technique for TV repair is lacking [6,21].

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The present article is based on our experience over the past five years with Chinese patients in our institution to advance the understanding of the effectiveness, the durability of different TV annuloplasty methods, and the risk factors involved with the surgical outcome.

2. Methods

We retrospectively analyzed the clinical reports of 399 consecutive patients (188 males, 211 females; age 46.7 years; range: 33–75 years) who underwent mitral surgery with concomitant tricuspid annuloplasty, from January 2006 to June 2011, in two Chinese single-centers (Changzheng Hospital and Changhai Hospital). Our exclusion criteria included those with: an organic disease of the TV, either congenital or infective tricuspid diseases, and either single or traumatic TR. Our institutional ethics committee approved the present study and all patients were given a written informed consent.

Each of the patients underwent pre-operative transthoracic echocardiography (TTE) within one month prior to surgery. The severity of FTR was evaluated using an apical four-chamber view, and graded from 0 to 4+ (0: none, 1+: mild, 2+: moderate, 3+: moderate-to-severe, 4+: severe).

All patients also underwent mitral surgery with cardiopulmonary bypass (CPB) established between both the venae cavae and the ascending aorta. Mild systemic hypothermia was reported in all cases. The myocardial protection used was identical for all patients, and consisted of an antegrade cold blood crystalloid cardioplegia with topical ice slush. We first corrected the mitral valve disease, and then proceeded, after aorta de-clamping, to perform a TV annuloplasty under the beating heart. There were three procedures used to apply the tricuspid annuloplasty: (1) De Vega group (DV Group): 242 patients under either traditional or modified De Vega surgery; (2) flexible band group (Flexible Group): annuloplasty with either the Duran ring (Medtronic) or Cosgrove band (Cosgrove–Edwards annuloplasty system; Edwards Lifesciences) in 98 patients; (3) and the rigid planner ring group (Rigid Group): annuloplasty with MC³ ring (Edwards Lifesciences) in 59 patients. The type of tricuspid annuloplasty depended on a preference of the surgeon. The diameter of the annuloplasty was measured from the anteroseptal commissure to the antero-posterior commissure using a sterile supple ruler [22]. And the surgeon would choose the

size of ring exactly according to the tricuspid diameter. We also performed a direct injection test, and utilized transesophageal echocardiography for intra-operative evaluation of TV function. Seven days after the valve repair, and at discharge, the temporal trend of the TR grades was assessed by TTE.

Individual patient contact after discharge was performed during either the outpatient process (69%), or with questionnaires (27%). Patients who did not respond were contacted by telephone (4%), and if no further information about the patients was available, we contacted their family physicians. The echocardiography data was evaluated based on TR grade and images were obtained at three months, six months, one year, and three years, postoperatively. The mean follow-up time was 3.3 years (range, 6 months–5.5 years). Seven patients were lost during follow-up. A total of 1467 TTE copies in 383 (96%) patients were analyzed during the follow-up.

2.1. Statistical analyses

Results are expressed as either a number (percentages), mean (standard deviation), or as a median (range) when the distribution of variables was not normal. Continuous variables were compared using either the Student *t* test or the Mann–Whitney test and categorical outcomes by either χ^2 or Fisher's exact test. Univariate and multivariate Cox proportional hazard models were used to examine the risk factors for recurrent or persistent significant TR. Variables with a *p* value < 0.20 in univariate analyses were used for the multivariate models. Multivariate analyses involved a backward elimination technique and only variables with a *p* value < 0.10 were included in the final model. All reported *p* values are two-sided and a *p* value < 0.05 was considered statistically significant. Analyses were performed using the SPSS version 13.0 (SPSS Inc, Chicago, IL).

3. Results

3.1. Baseline profiles

The etiology of the mitral lesion was rheumatic heart disease in 251 (62.9%), regressive in 108 (27.1%), and infective endocarditis in 40 patients (10.0%). When classified by using the pre-operative New York

Table 1
Preoperative clinical details of 399 patients with functional tricuspid regurgitation.

Variable	De Vega group (n = 242, %)	Flexible band group (n = 98, %)	Rigid ring group (n = 59, %)
Age	46.2 ± 15.4	46.1 ± 14.7	47.7 ± 16.3
Gender			
Males	114 (47.1)	46 (46.9)	28 (47.5)
Females	128 (52.9)	52 (53.1)	31 (52.5)
NYHA*			
Class II	90 (37.2)	35 (35.7)	20 (33.9)
Class III	92 (38.0)	38 (38.8)	23 (40.0)
Class IV	60 (24.8)	25 (25.5)	16 (27.1)
Atrial fibrillation	109 (45.0)	46 (46.9)	29 (49.2)
Echocardiographic variables			
Mitral stenosis	39 (16.1)	15 (15.3)	10 (16.9)
Mitral incompetence	88 (36.4)	37 (37.8)	23 (40.0)
Mitral mix lesions	115 (47.5)	46 (46.9)	26 (44.1)
mPAP*	34.4 ± 12.3	35.7 ± 14.6	37.1 ± 16.1
mRVSP*	43.9 ± 11.0	45.7 ± 12.9	45.1 ± 19.0
LVEF*	55.1 ± 5.9	53.4 ± 4.1	56.2 ± 5.9
TR* grade			
1+	3 (1.2)	3 (3.0)	2 (3.4)
2+	67 (27.7)	27 (27.6)	16 (27.1)
3+	89 (36.8)	35 (35.7)	21 (35.6)
4+	83 (34.3)	33 (33.7)	20 (33.9)

The results of qualitative variables are expressed in absolute values (percentages) and the results of continuous variables are expressed as mean (SD).

* NYHA = New York Heart Association; mPAP = mean pulmonary arterial pressure; mRVSP = mean right ventricular systolic pressure; LVEF = left ventricular ejection fraction; TR = tricuspid regurgitation.

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