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Original Article

Impact of the degree of tricuspid valve tethering on the early outcome of tricuspid valve repair with the De-Vega technique

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Abstract

Background: Functional tricuspid regurgitation (TR) is usually caused by leaflet tethering, and annuloplasty is usually recommended to repair annulus dilatation. This work aimed to evaluate the impact of the degree of the tricuspid valve (TV) tethering on the early outcome of tricuspid valve repair with the De-Vega technique.

Methods: This prospective study included 50 patients with De-Vega tricuspid valve repair. Patients were divided into two groups; Group A (n= 25) included patients with tricuspid valve tethering of 8 mm or less, and Group B (n= 25) included patients with tricuspid valve tethering distance of more than 8 mm.

Results: The mean age of Group A was 46.1 ±3.5 years compared to 49.6 ±7 years in Group B. There were significant differences in postoperative ejection fraction (48.7 ±12.5 vs. 39.1 ±9.4 %, P= 0.003), TV tethering distance (0.6 ±0.2 vs. 1.1 ±0.4 cm, P <0.001), and area (1.1 ±0.5 vs. 2.6 ±0.9 cm2; P<0.001), and right ventricle fractional area (32.2± 7.9 vs. 25.4 ±9.7 cm2, P= 0.008) in Group A vs. B, respectively. There were no differences in postoperative complications, ICU, and hospital stay between groups.

Conclusion: Residual tricuspid regurgitation after De-Vega annuloplasty could be related to TV tethering distance. Increased TV tethering distance could be associated with reduced postoperative ejection fraction.

KEYWORDS

Tricuspid valve; Valve tethering; Annuloplasty; Tricuspid valve repair

Article History

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Introduction

Management of functional tricuspid regurgitation (TR) is still debatable. Conservative management is reserved for patients with mild TR, and surgery is usually required in severe TR [1, 2]. Several surgical techniques are available for managing functional TR. Recently, bi-cuspidation has gained popularity over other techniques because of a more stable physiological annulus. De-Vega annuloplasty is a simple technique with a low cost; however, it is associated with a high recurrence rate of TR [3,4]. Moreover, the De-Vega technique is associated with residual TR at earlier stages after surgery in 10-20% of patients [5-7].

Factors associated with residual TR after De-Vega repair are not fully explored. Tricuspid valve (TV) tethering and annulus dilatation are the main causes of functional tricuspid regurgitation that are thought to be caused by right ventricular dilatation. TV tethering is the main factor affecting the severity of TR manifestations leading to increased morbidity and mortality [8-10].

Therefore, this study aimed to evaluate the impact of the degree of tricuspid valve tethering

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on the early outcome of tricuspid valve repair using the De-Vega technique.

Patients and Methods

Design and patients

We conducted a prospective study on 50 tricuspid valve repair patients in a single center from October 2018 to June 2020. Patients were divided into two groups, Group A (n= 25) included patients with tricuspid valve tethering of 8 mm or less, and Group B (n= 25) included patients with tricuspid valve tethering of more than 8 mm. This study was conducted after the approval of the Human Ethics Committee of our Institute, and written consent was taken from all patients.

All patients had tricuspid valve repair using De-Vega annuloplasty for severe isolated functional tricuspid valve regurgitation. We excluded patients with previous surgery, infective endocarditis, pulmonary hypertension, and combined valve or coronary artery bypass grafting. Emergency and stuck valve cases were also excluded.

Study data and techniques

The following data were collected; preoperative clinical, laboratory (complete blood count (CBC), coagulation profile, liver and kidney functions and random blood sugar (RBS)), electrocardiographic and echocardiographic data (ejection fraction (EF), left ventricular end-diastolic dimension (LVEDD), left ventricular end-systolic dimension (LVESD), wall motion abnormalities and degree of tricuspid valve tethering). Apical views could give information about any changes in the fractional area of the right ventricle (RVFA) and the ejection fraction of the left ventricle. The diameter of the tricuspid valve and the distance of tricuspid valve tethering were also measured. The severity of the tricuspid valve regurgitation was calculated by the ratio of the maximal jet area to the corresponding right atrial area.

Coronary angiography, or multi-slice computed tomography coronary angiography, was done for patients over 40 years to exclude coronary artery disease.

Conventional median sternotomy was the incision of choice in all patients. All patients were operated on under systemic hypothermia via antegrade cardioplegia and cannulation through bicaval technique. Under cardiac arrest, the tricuspid valve was repaired using the modified De-Vega technique with 5 Teflon pledged. Evaluation of the TV after annuloplasty was performed by injection of saline into the right ventricle through the tricuspid valve.

Table 1: Comparison of the preoperative, operative, and postoperative data in patients with tricuspid valve tethering of 8 mm or less (Group A) and more than 8 mm (Group B). Continuous data were presented as mean and standard deviation, and categorical data as numbers and percentages.

	Group A (n= 25)	Group B (n= 25)	*P*-value
Age (years)	46.1 ±3.5	49.6 ±7	0.03
Gender (M/F)	8/17	10/15	0.637
Diabetes mellitus	7 (28%)	9 (36%)	0.617
Atrial fibrillation	4 (16%)	8 (32%)	0.248
Body mass index (Kg/m2)	22.4 ±3.4	21.9 ±3.3	0.587
CPB time (minutes)	108.3 ± 20.1	113.1 ± 19.1	0.376
Weaning from CPB			
Defibrillator use	2 (8%)	6 (24%)	0.157
Smooth	23 (92%)	19 (76%)	
Ischemic time (minutes)	96.3 ± 11.7	101.1 ± 14.2	0.213
ICU stay (days)	5 ± 1.14	5.1 ± 1.22	0.831
Total hospital stay (days)	10.8 ± 3.6	12.2 ± 4.8	0.227

CBP: Cardiopulmonary bypass; ICU: intensive care unit

Table 2: Comparison of the postoperative echocardiographic data in patients with tricuspid valve tethering distance of 8 mm or less (Group A) and more than 8 mm (Group B)

Echocardiographic parameters (3 months)	Group A (n= 25)	Group B (n= 25)	P-value
Ejection fraction (%)	48.7 ±12.5	39.1 ±9.4	0.003
RVFA (cm^2)	32.2 ±7.9	25.4 ±9.7	0.008
RVSP (mmHg)	54.8 ±13.6	52.7 ±13.3	0.587
TR tethering distance (cm)	0.6 ±0.2	1.1 ±0.4	<0.001
TR tethering area (cm^2)	1.1 ±0.5	2.6 ±0.9	<0.001
TR (%)	38.7 ±7.3	45.1 ±10.9	0.019

RVSP: right ventricular systolic pressure; RVFA: right ventricular fractional area; TR: tricuspid regurgitation

The cardiopulmonary bypass, ischemic, and total operative times were measured in minutes. Other intraoperative complications such as difficult weaning from cardiopulmonary bypass were recorded. Intraoperative trans-esophageal echocardiography was done to reassess the tethering effect after repair.

Postoperative data included the duration of mechanical ventilation, intensive care unit (ICU), and total hospital stay. Complications such as prolonged ionotropic support, intra-aortic balloon pump (IABP), arrhythmias, cerebrovascular accident, thromboembolism, reoperation, infection, myocardial infarction or mortality were recorded. Postoperative echocardiography was done within two weeks and three months postoperatively, and LVEDD, LVESD, EF, and tricuspid regurgitation were reported.
Quality of life was measured using the Short Form (SF-36) Health Survey before the procedure and after three months. The score was calculated for each item to give eight scores between zero and one hundred [11].

Statistical analysis:

Data were checked, entered, and analyzed using Statistical Package for the Social Sciences SPSS v. 22.0 (IBM Corp, Armonk, NY, USA). Continuous data were presented as mean and standard deviation, and categorical data as numbers and percentages. Continuous data were compared with the t-test or Mann-Whitney test and categorical variables with the Chi-squared or Fisher exact test. Paired t-test was used for continuous correlated data. Spearman correlation was used to compare echocardiographic data and postoperative TR. A P-value of less than 0.05 was considered statistically significant.

Results

Preoperative & operative and postoperative data

The preoperative data and patient characteristics are shown in Table (1). The mean age of Group A was 46.1 ±3.5 years compared with 49.6 ±7 years in Group B. There was female predominance (62%) in functional TR (17 patients were female in Group A, 15 were female in Group B). There were no differences between groups in body mass index, diabetes mellitus, and atrial fibrillation.

There were non-significant differences between both groups in CPB, ischemic times, the need for defibrillation, ICU, and total hospital stay. (Table 1)

Postoperative echocardiographic data

Both groups had significant differences in postoperative EF, right ventricular systolic pressure (RVSP), TV tethering distance, and area. (Table 2) (Figure 1 and 2)

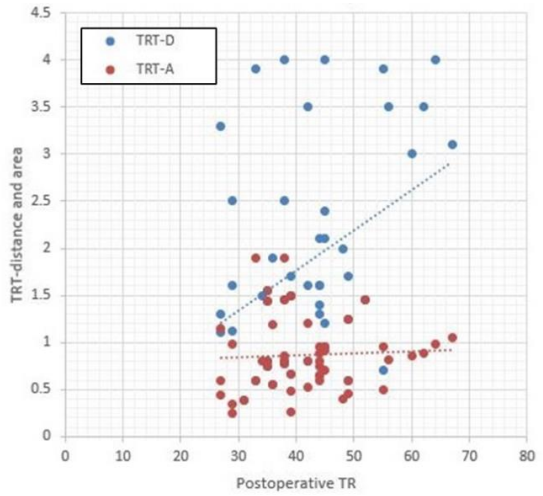

Figure 1: Correlation between tricuspid regurgitation (TR) and tethering distance and area (TRT-D) (TRT-A)

Quality of life

There was a significant difference between preoperative and postoperative parameters between both groups according to physical function, physical problem, general health perception, and social and emotional functioning. (Table 3)

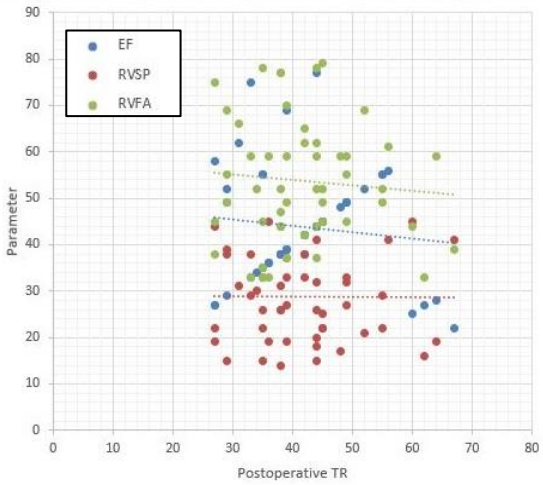

Figure 2: Correlation between postoperative tricuspid regurgitation (TR) and right ventricular parameters. (RVSP: right ventricular systolic pressure; RVFA: right ventricular fractional area; TR: tricuspid regurgitation)

Postoperative outcomes

Operative mortality occurred in 4 patients in Group A and 7 cases in Group B. Myocardial infarction occurred in 5 cases in Group A and 4 in Group B, bleeding occurred in 6 cases in Group A and 7 in Group B, pneumonia occurred in 3 cases in Group A and 4 in Group B, and wound infection occurred in 3 cases in Group A and 2 in Group B. (Table 4)

Discussion

There are several techniques for TV annuloplasty with variable outcomes [12]. The guidelines of the American Heart Association (AHA) state that severe TR is the main indication of functional TR repair (level evidence C, Class I) [13].

De-Vega repair is a simple procedure utilizing a double-ended 2-0 Ethibond suture buttered with a Teflon felt pledged. This should include the plication of the tricuspid ring that could be performed from the anteroseptal to the posteroseptal commissures [14].

In the literature, there is a higher incidence of recurrent TR after the De-Vega technique, and a severe annular defect is the main risk factor for the recurrence, so it is recommended to do ring annuloplasty for more durable repair [15].

Table 3: Pre and postoperative Short Form-36 Health Survey scores in patients with tricuspid valve tethering distance of 8 mm or less (Group A) and more than 8 mm (Group B). Data are presented as mean and standard deviation.

Short Form-36 Health Survey		Preoperative	Postoperative	P-value
Physical functioning	**Group A**	33.60 ± 10.86	46.11 ± 13.84	<0.001
	Group B	31.44 ± 14.18	44.66 ± 15.72	<0.001
Physical problem	**Group A**	30.34 ± 15.38	49.65 ± 14.17	<0.001
	Group B	29.31 ± 11.32	47.4 ±9.7	<0.001
Body pain	**Group A**	47.46 ± 16.04	51.16 ± 15.32	0.320
	Group B	48.34 ± 11.38	51.15 ± 10.15	0.531
General health perception	**Group A**	39.31 ± 9.19	46.39 ± 13.29	<0.001
	Group B	35.35 ± 7.23	44.65 ± 14.17	<0.001
Vitality	**Group A**	42.17 ± 9.16	46.83 ± 10.87	0.077
	Group B	43.22 ± 9.33	44.56 ± 8.25	0.122
Social functioning	**Group A**	35.67 ± 9.44	46.17 ± 9.35	<0.001
	Group B	33.33 ± 11.34	44.25 ± 9.77	<0.001
Emotional problem	**Group A**	45.18 ± 9.65	57.41 ± 13.71	<0.001
	Group B	44.34 ± 10.88	55.44 ± 9.81	<0.001
Mental health	**Group A**	47.01 ± 14.36	49.83 ± 10.87	0.745
	Group B	49.01 ± 15.38	49.29 ± 11.11	0.921

Table 4: Comparison of the postoperative complications in patients with tricuspid valve tethering distance of 8 mm or less (Group A) and more than 8 mm (Group B). Data are presented as numbers and percentages.

	Group A (n= 25)	Group B (n= 25)	P-value
Myocardial infarction	5 (20%)	4 (16%)	>0.99
Mortality	4 (16%)	7 (28%)	0.31
Bleeding	6 (24%)	7 (28%)	0.75
Pneumonia	3 (12%)	4 (16%)	0.70
Wound infection	3 (12%)	2 (8%)	>0.99

Kunová and associates evaluated the modified De-Vega technique to determine the rate of functional TR over the short and long-term follow-ups. After one year of follow-up, they reported mild and moderate TR in 53.3% and 13.3% of patients, respectively [16].

Previous studies identified several clinical (age, BMI, and chronic diseases) and echocardiographic (left ventricular dysfunction and severity of preoperative TR) factors associated with an increased risk of adverse clinical events after TV annuloplasty. McCarthy, Kuwaki, and associates also presented in their studies that higher preoperative TR was identified as a risk factor for residual TR after TV annuloplasty [5, 17].

Hamdy and colleagues presented a study comparing ring annuloplasty in 17 cases and De-Vega in 34 cases for patients with severe functional TR and studied its effect on the right ventricular functions. Over six months as a follow-up period, they found that the rates of mild, moderate, or severe TR were 50%, 26.5%, and 11.8% in patients with ring annuloplasty, respectively [18].

McCarthy studied the incidence of TR after different surgical procedures of annuloplasty and showed similarities in their results in the early follow-up. Still, on long-term follow-up, residual tricuspid regurgitation worsened rapidly in cases operated by the De-Vaga annuloplasty technique (P =0.002) [5]. Another study found statistical significance in comparing the right ventricular dimension before and six months after annuloplasty (P =0.023). The literature about annuloplasty by suturing technique reported higher recurrence rates, especially in patients diagnosed with severe annular dilatation. Therefore, band annuloplasty is recommended for a more durable repair [19].

Longer observation periods are required to validate the effectiveness and durability of these echocardiographic features. TV tethering changes ventricular geometry by papillary muscle displacement, which determines the annuloplasty's outcome to the tricuspid valve. 3D echocardiography may give more accurate tricuspid valve tethering and ventricular geometry data.

Limitations of the study:

The main limitations of this work are the small number of patients and the single-center experience. A multicenter study is recommended to include more patients.

Conclusion

Residual tricuspid regurgitation after De-Vega annuloplasty could be related to TV tethering distance. Increased TV tethering distance could be associated with reduced postoperative ejection fraction.

Conflict of interest: Authors declare no conflict of interest.

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