ORIGINAL RESEARCH PAPER
Volume - 13 | Issue - 08 | August - 2024 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

# COMPARATIVE ANALYSIS OF SHORT-TERM OUTCOMES OF DEVEGA PROCEDURE VERSUS RING ANNULOPLASTY IN TRICUSPID VALVE REPAIR

Cardiothoracis

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## ABSTRACT

**Background:** The study aimed to compare the operative and one year postoperative outcomes of two surgical techniques for tricuspid regurgitation: DeVega's procedure and ring annuloplasty. **Methods:** A total of 22 patients were included, with 13 undergoing DeVega's procedure (Group A) and 9 undergoing ring annuloplasty (Group B). We evaluated operative details, postoperative outcomes, and changes in echocardiographic parameters before surgery and one year postoperatively. **Results:**Group B exhibited longer aortic cross-clamp (100.66±65.77 vs. 66.38±27.25 minutes) and CPB times (157.55±116.22 vs. 106.08±20.91 minutes), longer extubation times (6.44±2.12 vs. 5.15±0.80 hours), and higher total drain output (491.66±168.17 vs. 323.07±137.86 mL), while ICU and hospital stay durations were similar between groups. Mortality rates were higher in Group A (23.07%) compared to Group B (11.1%). One year postoperatively, both groups showed significant improvement in the degree of tricuspid regurgitation. Group A had a greater reduction in severe regurgitation and a higher number of patients with mild or trivial regurgitation. Both groups exhibited decreased TR velocity, PRVSP, and cases of pulmonary arterial hypertension, alongside a slight increase in LV mass. **Conclusion:** Ring annuloplasty for tricuspid repair demonstrated favorable outcomes with lower mortality and postoperative complications compared to DeVega's procedure. Both techniques effectively reduced tricuspid regurgitation and associated echocardiographic parameters.

## KEYWORDS

DeVega Procedure, Ring Annuloplasty, Tricuspid regurgitation

## INTRODUCTION:

The incidence of moderate or severe tricuspid regurgitation (TR) increases with age; the prevalence in the general population reaches 1.5% and 5.6% in men and women, respectively.(1) Functional tricuspid regurgitation (FTR) is the most common in patients with rheumatic mitral valve disease (2,3). The decision to repair the tricuspid valve in patients undergoing left-sided valve surgery (mitral or aortic) remains a topic of debate. Many surgeons opt to repair the tricuspid valve only in cases of severe tricuspid regurgitation. Moderate tricuspid regurgitation, often resulting from annular dilation due to right ventricular enlargement secondary to left-sided heart disease, is typically not addressed by most surgeons. However, these untreated valves can progress to severe tricuspid regurgitation over time, leading to significant symptoms and impaired right ventricular (RV) function.(4)

Functional tricuspid regurgitation (TR) is severe, If left untreated, it can significantly affect survival and quality of life. The American College of Cardiology/American Heart Association (ACC/AHA) and the European Society of Cardiology (ESC) recommend tricuspid valve repair for severe tricuspid regurgitation in patients undergoing mitral valve surgery as a Class I indication. (5,6)

Various techniques are available for tricuspid valve repair. The widely recognized DeVega procedure involves a single polypropylene suture from the anteroseptal to the posteroseptal commissure, with a pledget at each end, or a modified version with additional pledget placement between each entry site into the annulus. While this method is simple and cost-effective, its long-term efficacy is questioned due to the risk of significant tricuspid regurgitation necessitating redo surgery. Consequently, many surgeons have adopted the use of annuloplasty rings.(7) This study aims to compare the short-term outcomes between ring annuloplasty and DeVega repair of the tricuspid valve.

## METHODS:

In this retrospective study, we analyzed a cohort of 22 patients who underwent tricuspid valve repair at Sanjay Gandhi Post Graduate Institute of Medical Sciences Hospital between [insert dates]. The patients were divided into two groups: Group A comprised 13 patients who underwent DeVega's procedure, while Group B consisted of 9 patients who received ring annuloplasty. Exclusion criteria included concomitant aortic pathology, ischemic heart disease requiring coronary artery bypass grafting, and redo cases. Written informed consent was obtained from all patients prior to their surgical procedures. The indications for tricuspid ring annuloplasty were moderate or greater functional tricuspid regurgitation.

All surgeries were performed via median sternotomies with bicaval and aortic cannulation and standard hypothermic cardiopulmonary bypass by the same surgeon. Following clamping of the ascending aorta, the right atrium and interatrial septum were dissected. If a left atrial thrombus was present, it was surgically removed. Subsequently, tricuspid valve repair was performed using ring annuloplasty following concomitant mitral valve replacement and closure of the atrial septal incision. Patients were evaluated preoperatively and postoperatively using transthoracic two-dimensional echocardiography.

Data analyses were conducted using Minitab Statistical Software Version 21.1.0. Categorical variables were expressed as numbers and/or percentages and compared using the $\chi^2$ test. Continuous variables were expressed as mean ± standard deviation (SD) and compared using the Student's t-test or Mann-Whitney U test.

## RESULTS:

In this study, a total of 22 patients were analyzed, with 7 males (31.8%) and 15 females (68.2%). The mean age of the patients was 34.54 years (±11.77). Vital signs indicated an average systolic blood pressure (SBP) of 112.42 mmHg, diastolic blood pressure (DBP) of 73.23 mmHg, and heart rate of 93.68 beats per minute. Regarding co-morbidities, hypertension and diabetes were each present in 1 patient (4.55%), valvular heart disease in 7 patients (31.82%), and rheumatic heart disease (RHD) in 2 patients (9.09%). Common symptoms included chest pain (54.55%), dyspnea on exertion (DOE) (86.36%), syncope (36.36%), and palpitations (31.82%). Operative details revealed an average ICU stay of 2.22 days (±0.42), total drain output of 392.04 ml (±169.8), aortic cross-clamp time of 80.4 minutes (±48.68), cardiopulmonary bypass (CPB) time of 128.14 minutes (±79.53), flow rate of 3.41 l/min (±0.47), and a total hospital stay of 6.5 days (±0.96). (Table 1)

**Table 1: Baseline Characteristics of study population**

| Characteristics | N(%) |
|---|---|
| **Gender** | |
| Males | 7(31.8) |
| Females | 15(68.2) |
| Age | 34.54±11.77 |
| **Vitals** | |
| SBP | 112.42 |

| | |
|---|---|
| DBP | 73.23 |
| Heart rate | 93.68 |
| **Co-morbidities** | |
| Hypertension | 1(4.55) |
| Diabetes | 1(4.55) |
| Valvular heart disease | 7(31.82) |
| RHD | 2(9.09) |
| **Symptoms** | |
| Chest Pain | 12(54.55) |
| DOE | 19(86.36) |
| Syncope | 8(36.36) |
| Palpitations | 7(31.82) |
| **Operative details** | |
| ICU stay | 2.22±0.42 |
| Total Drain output | 392.04±169.8 |
| Aortic cross clamp time | 80.4±48.68 |
| CPB time | 128.14±79.53 |
| Flow | 3.41±0.47 |
| Hospital Stay | 6.5±0.96 |

The study compared operative details between two groups: Group A (DeVega's procedure, n=13) and Group B (ring annuloplasty, n=9). The aortic cross-clamp time was significantly shorter in Group A (66.38±27.25 minutes) compared to Group B (100.66±65.77 minutes). Similarly, the cardiopulmonary bypass (CPB) time was shorter in Group A (106.08±20.91 minutes) than in Group B (157.55±116.22 minutes). The flow rate was slightly lower in Group A (3.27±0.52 l/min) compared to Group B (3.6±0.33 l/min). Extubation time was shorter in Group A (5.15±0.80 hours) than in Group B (6.44±2.12 hours). ICU stay was nearly identical between the groups (2.23±0.43 days for Group A and 2.22±0.44 days for Group B). Total drain output was less in Group A (323.07±137.86 ml) compared to Group B (491.66±168.17 ml). The average hospital stay was shorter for Group A (6±0.8 days) than for Group B (7.22±0.66 days). The mortality rate was higher in Group A with 3 deaths (23.07%) compared to 1 death (11.1%) in Group B.(Figure 2)

**Figure 2: Comparison of Operative details among two groups**

| Variable | Group A | Group B |
|---|---|---|
| Aortic cross clamp time | 66.38±27.25 | 100.66±65.77 |
| CPB time | 106.08±20.91 | 157.55±116.22 |
| Flow | 3.27±0.52 | 3.6±0.33 |
| Extubation time | 5.15±0.80 | 6.44±2.12 |
| ICU stay | 2.23±0.43 | 2.22±0.44 |
| Total Drain output | 323.07±137.86 | 491.66±168.17 |
| Hospital Stay | 6±0.8 | 7.22±0.66 |
| Death | 3 (23.07%) | 1 (11.1%) |

The degree of tricuspid regurgitation was evaluated preoperatively and one year postoperatively for both groups: Group A (DeVega's procedure) and Group B (ring annuloplasty). Before surgery, Group A had 6 with severe tricuspid regurgitation. In Group B, there were 1 with moderate, and 6 with severe tricuspid regurgitation. One year after surgery, Group A showed improvement with only 1 remaining with severe regurgitation. Group B also showed improvement with 1 patient having trivial, 4 having mild, and 1 remaining with severe regurgitation due to ring was oversized.

In Group A, mortality was primarily due to severe neurological and systemic complications: one patient succumbed to a right parietal lobe infarct with bilateral subdural hematomas and multiple hemorrhagic foci, leading to multi-organ failure; another patient died from septic shock; and a third patient faced overwhelming sepsis with anuria and severe metabolic acidosis, progressing to bradycardia and asystole. In Group B, mortality was due to a catastrophic cardiac event where the patient experienced ventricular fibrillation (VF) that progressed to asystole and cardiac arrest.

The study analyzed changes in echocardiographic parameters, specifically left ventricular (LV) mass, tricuspid regurgitation (TR) velocity, pulmonary regurgitation velocity systolic pressure (PRVSP), degree of tricuspid regurgitation (TR), and pulmonary arterial hypertension (PAH), in two groups: Group A (DeVega's procedure) and Group B (ring annuloplasty), before and one year after surgery. In Group A, the LV mass increased from 133.99 to 157.14. TR velocity decreased from 3.42 to 2.57, PRVSP decreased significantly from 59.3 to 29.55, and the number of patients with TR decreased from 5 to 1. Additionally, PAH cases reduced from 4 to 1. In Group B, the LV mass increased from 126.06 to 134.48. TR velocity decreased from 3.22 to 2.38, PRVSP decreased significantly from 53.21 to 29.54, and the number of patients with TR decreased from 6 to 1. Similarly, PAH cases reduced from 3 to 1. (Figure 3)

These results indicate significant improvements in both groups, with reduced TR velocity, PRVSP, TR, and PAH, despite a slight increase in LV mass in both groups postoperatively.

**Figure 3: Comparison of Echocardiography**

| Group A | LV Mass | TR velocity | PRVSP | Severe TR | Severe PAH |
|---|---|---|---|---|---|
| Pre | 133.99 | 3.42 | 59.3 | 5(38.46) | 4(30.76) |
| Post | 157.14 | 2.57 | 29.55 | 1(7.69) | 1(7.69) |
| Group B | LV Mass | TR velocity | PRVSP | Severe TR | Severe PAH |
| Pre | 126.06 | 3.22 | 53.21 | 6 (66.7) | 3(33.3) |
| Post | 134.48 | 2.38 | 29.54 | 1(11.1) | 1(11.1) |

**DISCUSSION:**

Optimal management of tricuspid valve disease remains a challenge among cardiologists and cardiac surgeons because patients are often asymptomatic [8]. Tricuspid regurge is most commonly functional secondary to left side pathology with left sided heart failure [9]. According to AHA/ACC guidelines 2017 update, intervention for TR is indicated in patients with severe TR, moderate TR with either tricuspid annular dilatation (greater than 4 cm) or Tricuspid index greater than 21 mm/m2 . (10)

Tricuspid valve repair is indicated in symptomatic patients with significant tricuspid regurge despite optimized medical treatment. Tricuspid repair is also indicated in asymptomatic patients with significant tricuspid regurge undergoing concomitant cardiac surgery (11). The ideal technique for tricuspid valve repair is still controversial. De Vega annuloplasty is considered to be simple, easy, effective and least expensive of them, but recurrence and reoperation rate has been reported in 34% and 10% of survivors, at mid-term follow up.(12) De Vega annuloplasty has been criticized for being unpredictable and unreliable, perhaps due to the long suture line, which breaks or slides through the tissue as the annulus dilates. (13) Other investigators have reported however a high incidence of recurrence particularly in patients with severe annular dilatation and have recommended the use of annuloplasty rings to obtain a durable repair (14,15).

The study compared operative and postoperative outcomes between Group A (DeVega's procedure) and Group B (ring annuloplasty) for tricuspid regurgitation. Group B showed longer aortic cross-clamp and cardiopulmonary bypass times, longer extubation times, and higher total drain output, but similar ICU and hospital stay durations compared to Group A, and DeVega's procedure was improved the moderate tricuspid regurgitation. Mortality rates were higher in Group A (23.07%) compared to Group B (11.1%). The mortality in both groups underscores the complexity and multifactorial nature of critical illness management. In Group A, severe neurological damage compounded by systemic complications like AKI and septic shock were primary drivers of mortality. In Group B, a sudden cardiac event led to an unrecoverable state.

Both groups demonstrated significant improvement in the degree of tricuspid regurgitation one year postoperatively. Group A had more patients with mild or trivial regurgitation and fewer with severe regurgitation. Echocardiographic parameters showed a decrease in tricuspid regurgitation velocity and pulmonary regurgitation velocity systolic pressure, alongside reductions in the number of patients with tricuspid regurgitation and pulmonary arterial hypertension. Both groups experienced a slight increase in left ventricular mass postoperatively.

Comparing our findings with other studies, Bernal et al.(16) reported a lower re-operation rate after ring annuloplasty compared to the DeVega repair . Tang et al. demonstrated lower TR recurrence rates in patients receiving prosthetic ring annuloplasty, with better long-term and event-free survival (18) . Carrier et al. found similar outcomes between ring annuloplasty and DeVega repair (19) . These results are consistent with our study, which showed lower mortality and postoperative complications in the ring annuloplasty group, indicating a trend toward better outcomes with ring annuloplasty.

Pfannmüller et al.(20) investigated a large cohort and found that the

use of a rigid ring increases the risk of subsequent ring dehiscence . Additionally, Galiñanes et al (21). and Kay et al.(22) reported rare complications such as the fracture of the Carpentier rigid ring in the tricuspid position . In contrast, our study observed no occurrences of ring dehiscence in the rigid ring group during the postoperative and follow-up periods. This might be attributed to our technique of using a single suture spanning the conjunction region of the valve leaflet rather than two sutures on each side of the valve leaflet.

Filsoufi et al. suggested that the systematic downsizing of the prosthetic ring, rather than the type of ring, played a significant role in reducing the incidence of significant residual or recurrent TR after ring annuloplasty .(23) Conversely, McCarthy et al. reported that the ring size was not identified as a risk factor for recurrent TR, concluding that the strategy of undersizing the tricuspid annulus using small rings could not be validated as protection against late recurrent TR (24). Our study also found no difference in prosthetic ring size between the two groups, and univariate analysis showed that the use of large rings (28 or 30 mm) was not a risk factor for recurrent TR in both flexible and rigid ring groups. Therefore, ring size was not a significant factor in our study.

Overall, our results align positively with previous studies highlighting the efficacy of ring annuloplasty in reducing tricuspid regurgitation and associated complications. However, the slight increase in LV mass postoperatively warrants further investigation. We conclude that tricuspid repair using ring annuloplasty yields good results with low associated risks.

The limitations of this study include its single-center design and retrospective nature, with all of the inherent limitations of such investigations. A non-randomized study with relatively short duration of follow up and small sample size may produce potential bias. Therefore, the results obtained can in no way be considered conclusive and should be confirmed by further studies. Nevertheless, our findings may help cardiac surgeons select an appropriate annuloplasty ring technique for the treatment of TR secondary to rheumatic heart valve disease.

## CONCLUSION:

The study found that both DeVega's procedure and ring annuloplasty were effective in improving tricuspid regurgitation. The tricuspid repair using ring annuloplasty yields good results in terms of lower mortality and postoperative complications. However, a larger patient cohort and an extended follow-up period are necessary to conclusively determine the superiority and long-term benefits of ring annuloplasty compared to the DeVega technique.

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