

**How to Cite:**

Gholizadeh, B., Nabavi, S. S., Khamooshi, A. J., Ghavidel, A. A., Samiei, N., & Hoseini, S. (2022). Evaluation of results of repair of patients undergoing tricuspid surgery in Shahid Rajaei Heart Hospital. *International Journal of Health Sciences*, 6(S3), 5389–5399. <https://doi.org/10.53730/ijhs.v6nS3.7108>

## **Evaluation of results of repair of patients undergoing tricuspid surgery in Shahid Rajaei Heart Hospital**

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**Abstract**---If tricuspid regurgitation (primary and secondary) is left untreated, it will be associated with significant complications and death, even if left ventricular dysfunctions are corrected, TR does not decrease in many cases. Since many studies have not been conducted

in this area, we decided to evaluate the results of tricuspid repair. In this retrospective study conducted since 2006 to 2011, 448 patients undergoing tricuspid surgery with different methods with or without surgery were studied. Statistical analysis was performed by Friedman, Fisher exact and Pearson chi-square methods. In the Mod and Severe RV dysfunction section, the mean age of the patients was 52 years, 289 were female (64%), 343 (76%) had rheumatic pathology, 79 (17%) had myxomatous pathology, 12 (2%) had endocarditis pathology, and 14 had an unknown pathology. Before surgery, Mod and Severe dysfunction was seen in 226 patients (40%) and after surgery (follow up), it was seen in 85 patients (19%). Before surgery, Mod and Severe TR was seen in 356 patients (79%) and after surgery, it was seen in 91 patients (20%). The mean of PAP before surgery was 54 mmHg and after surgery, it was 37 mmHg, which was significant in all cases ( $P < 0.05$ ). Out of 282 people with Mod to Severe TR before the surgery by bicuspidization method, 37 people reached follow up and out of 156 people operated by devega method, 22 people reached follow up and out of 65 people operated by ring method, 9 people reached follow up. Based on the results obtained in this study, all the methods used for tricuspid repair are useful, but the results of ring use and bicuspidization were better than devega method and had less residual TR after surgery. Therefore, it is recommended to use the Ring method in cases of TR with or without involvement of other valves, since it showed better results and bicuspidization method and devega method are not recommended.

**Keywords**---RV dysfunction, RV enlargement, TR repair, Rajaei Hospital.

## Introduction

The most common cause of secondary tricuspid regurgitation is left ventricular dysfunction (mostly mitral). Pulmonary hypertension due to left ventricular dysfunction leads into dilatation of the right ventricle, resulting in dilatation of the tricuspid annulus. It also results in shortened cords, and finally disrupts coaptation of leaflets and tricuspid regurgitation. Primary causes account for 25% and secondary causes account for 75% of cases. These causes with different pathologies are: Eisenmenger syndrome, primary pulmonary hypertension, right ventricular infarction, Marfan syndrome, penetrating or blunt trauma, endocarditis, carcinoid syndrome, rheumatism, etc. (1, 2, 3). TR patients are referring due to symptoms of fatigue and weakness due to decreased cardiac output (CO), atrial fibrillation, jvp protrusion, ascites, hepatomegaly, pleural effusion, and peripheral edema are common in these patients. In severe cases, patients are referring due to cyanosis, jaundice, and cachexia. Echocardiography is usually performed in patients with clinical symptoms (4, 5).

Echocardiography is necessary to diagnose the causes of TR, especially in the above-mentioned cases, which are repairable. Various assessments should be performed to evaluate the intensity of TR because TR intensity is influenced by

many factors such as Preload, After load, etc. For example, right ventricular function is better assessed by four-chamber view by echocardiography, but systolic end and diastolic end volumes are better assessed on MRI (6). If TR is left untreated, it leads to right and left heart failure and finally death. There are many findings at present time that suggest that tricuspid regurgitation, without considering its causes, is effective in patients. The result of these findings is that TR surgery alone is both common and necessary, although left heart diseases should not be ignored in these patients and the best means for assessment and thus the need for surgery is echocardiography (7). Patients undergoing TR repair are high-risk patients and their long-term survival is very low, and TR repair using a ring or band have better survival and probability of TR is low in them (8). In a study conducted by Dreyfus et al in 2005 on 300 patients, TR repair was performed only based on annulus dilation regardless of TR.

Patients with a tricuspid annulus greater than 70 mm in diameter were divided into two groups. Patients who underwent left surgery without TR repair and patients who underwent both left heart surgery and TR repair. They concluded that patients who underwent tricuspid repair had an increase in TR in only 2% of cases, but patients who did not undergo TR repair had an increase in TR in 48% of cases and TR repair based on annulus dilation without considering the value of TR improves activity and quality of life and does not improve the value of TR (9). The surgical method to remove the functional TR involves using a hard or flexible ring or band that is done to reduce the size of the annulus as a result of better contact between the leaflet. Another technique used is posterior leaflet bicuspidization. In this technique, Pledget sutures are inserted from the anterior-posterior commissure to the posterior-septal commissure along the posterior annulus, which was performed by Deloche et al (10). If residual postoperative tricuspid regurgitation is exacerbated after surgery, it will be associated with poor postoperative outcomes, even if the result of mitral surgery is good.

The results of surgery have shown that successful repair of tricuspid regurgitation (primary or secondary) has been very effective in patients' survival and recurrence of TR. Approximately 50 to 70% of patients undergoing mitral surgery simultaneously undergo tricuspid valve surgery (11). If tricuspid regurgitation (primary and secondary) is left untreated, it can result in significant complications and mortality. Even if left ventricular dysfunction is corrected, TR levels do not decrease in many cases (12). At present, studies investigating the long-term results of tricuspid valve repair and deciding whether or not to perform an annuloplasty or to use a ring or other methods are more based on the surgeon's preference and there is no detailed information on the preference of a method. Most studies on tricuspid regurgitation have focused more on survival and the need for reoperation, and less investigated postoperative TR value and other findings. Since many studies have been conducted in this regard, we decided to review the results of tricuspid repair. Thus, the present study was conducted to review the results of tricuspid valve repair during the last 6 years (2006-2011) in Shahid Rajaei Heart Hospital.

## Methods

This study was designed and conducted as a descriptive and retrospective study and based on examining of patients (Case Series). The statistical population of the study was all patients who underwent tricuspid repair alone or in combination with other operations in the Cardiovascular Center of Shahid Rajaei Heart Hospital from 2006 to 2011. A total of 448 medical files were reviewed. Also, sampling was performed by reviewing the medical files of all patients who underwent tricuspid valve repair in different methods during the last 6 years (2006-2011) in this hospital. Patients who had TR due to birth defects were excluded from the study. However, PFO was not considered as a congenital defect. The needed information was collected based on a questionnaire prepared from the patients' medical files. First, the names and medical file numbers of patients underwent tricuspid repair surgery alone or in combination with other heart surgeries in this center from 2006 to 2011 were selected, and about 600 medical files were extracted. After excluding those with tricuspid regurgitation due to congenital heart disease (approximately 150 cases), 448 cases were reviewed.

Demographic information: Preoperative echocardiographic information, previous surgeries, type of tricuspid repair, types of rings, pathology of the disease that led to TR, duration of aortic clamp and pump, complications, mortality, echocardiographic information after surgery and during follow-up and surgery procedures were recorded. If the patient has not had an echocardiogram in the last year, he/she was asked to refer to hospital via phone call for follow-up echocardiography. Kolmogorov-Smirnov test was used to evaluate the normality of numerical methods. The numerical data in this study did not have a normal distribution. Kruskal-Wallis non-parametric test was used to compare numerical indices among 4 different methods in repairing tricuspid regurgitation and Pearson chi-square and Fisher's Exact test were used to compare nominal variables among 4 different surgical methods. Finally, Friedman test was used to examine the changes in indices over time in different surgical methods were used regarding ranked variables repeated measure Anova test was used for numerical diagnoses.

## Results

The demographic characteristics of the patients are as shown in the table below (Table 1).

| variable                            | variable range | variable mean |
|-------------------------------------|----------------|---------------|
| patient age                         | 14-82 days     | 52.71±43.13   |
| length of hospital stay in patients | 6-128 days     | 22.51±14.13   |
| length of hospital stay in ICU      | 2-69 days      | ±8.05 5.52    |
| Intubation duration                 | 3-1564 hours   | 157 ± 43.34   |
| duration Ventilation                | 2-1564 hours   | 38±156.01     |

|                       |                |              |
|-----------------------|----------------|--------------|
| pump duration         | 27-456 minutes | 139.86±79.72 |
| Aortic clamp duration | 17-248 minutes | 79.65±35.36  |

Comparison different types of tricuspid valve repair methods and demographic information: In bicuspidization method, the mean age of patients was 52 years (14-79), mean length of hospital stay was 21 days (7-130), mean pump duration was 126 minutes (44-370), mean aortic clamp duration was 76 minutes (20-248), mean ICU was 4 days (2-57), mean preoperative PAP was 54 mmHg (24-140), mean PAP at follow-up was 35 mm Hg (15-70), mean preoperative EF was 46% (20-65), and the mean EF at discharge was 41% (15-65). In Devega method, mean age of patients was 54 years (24-79), mean length of hospital stay was 23 days (7-126), mean pump duration was 151 (456-60), mean aortic clamp duration was 78 minutes (15-237). Length of hospital stay ay ICU was 7 days (2-69), mean preoperative PAP was 51 mm Hg (30-30), mean PAP at follow-up was 41.81 mm Hg (25-70), mean preoperative EF was 44%, and mean EF at discharge was 41% (10-60). In Ring repair method, the mean age of patients was 49 years (17-77), mean length of hospital stay was 23 days (6-12-68) mean pump duration was 145 minutes (62-458), mean duration of aortic clamp was 83 minutes (30-129), mean length of hospital stay in ICU was 5 days (2-49), mean preoperative PAP was 52 mm Hg (22-290), mean PAP at follow-up was 37 mm Hg (16-70), mean preoperative EF was 45.20 % (20-70), and mean EF at discharge was 45% (30-60) (Table 2). Post Pump PAP (P = 0.046), length of hospital stays at ICU (P = 0.033), duration of aortic clamp (P = 0.040) and the duration of pump (P = 0.003) were significantly different among three groups.

Table 2  
Comparing different tricuspid valve repair methods and demographic information

| variable types of repair methods | age (year)        | length of hospital stay (days) | pump duration (minutes) | Aortic clamp duration (minutes) | length of stay at ICU (days) | preoperative PAP (mmhg) | postoperative POP (mmhg follow up) | preoperative EF %    | postoperative EF% (at discharge) |
|----------------------------------|-------------------|--------------------------------|-------------------------|---------------------------------|------------------------------|-------------------------|------------------------------------|----------------------|----------------------------------|
| Bicuspidization                  | 52<br>-79)<br>(14 | 21<br>7-)<br>(130              | 126<br>44-)<br>(370     | 76<br>20-)<br>(248              | 4<br>(2-57)                  | 54<br>24-)<br>(140      | 35<br>(15-70)                      | 46.19<br>20-)<br>(95 | 41<br>-65)<br>(15                |
| Devega                           | 54<br>24-)<br>(79 | 23<br>7-)<br>(126              | 151<br>(60-456)         | 78<br>15-)<br>(237              | 7<br>(2-69)                  | 56<br>30-)<br>(140      | 41<br>(25-70)                      | 44.20<br>10-)<br>(60 | 41<br>10-)<br>(60                |
| Ring                             | 49<br>17-)<br>(77 | 23<br>6-)<br>(128              | 145<br>62-)<br>(458     | 83<br>30-)<br>(129              | 5<br>(2-49)                  | 52<br>(22-90)           | 37<br>(16-70)                      | 45.20<br>20-)<br>(70 | 45<br>30-)<br>(60                |

Concerning RV dysfunction: out of 395 (88%) patients before surgery, 33 (7%) were in the normal range, 136 (30%) were in the Mild and Mild to Mod range, 167 (37%) were in the Mod range, 38 patients (8%) were in the Mod to Severe range, and 21 (4%) were in the severe range. Concerning Post Pump: out of 150 (33%) patients, 11 (2.5%) were in the normal range, 46 (10%) were in the Mod Mild and

Mild range, 67 (15%) were in the Mod range, 11 (2%) were in the Mod to Severe range and 15 (3%) were in the Severe range. Before discharge: out of 283 (63%) patients, 9 (2%) were in normal range, 70 (15%) were in Mild and Mild to Mod range, 130 (29%) were in Mod range, 40 (8%) were in the Mod to Severe range and 34 (7%) were in the Severe range. Follow up: out of 156 (34%), 6 (1%) were in normal range, 64 (14%) were Mild and Mild to Mod range, 51 (11%) were in Mod range, 30 (6%) were in Mod to Severe range, and 5 were (1%) in Severe range (Table 3)

Table 3  
RV enlargement before and after TR repair

| RV Enlargement variable           | total    | normal  | Mild T Mild to Mod | Mod     | Mod To Severe | Severe |
|-----------------------------------|----------|---------|--------------------|---------|---------------|--------|
| preoperative RV Enlargement value | 227(%50) | 53(%11) | 105(%23)           | 41(%9)  | 14(%3)        | 14(%3) |
| Post Pump                         | 18(%4)   | —       | —                  | 10(%2)  | —             | 8(%1)  |
| before discharge                  | 11(%22)  | —       | —                  | 64(%14) | —             | 37(%8) |
| Follow up                         | 153(%34) | 45(%10) | 56(%12)            | 26(%5)  | 9(%2)         | 17(%3) |

Comparison of RV Function in tricuspid regurgitation repair methods before surgery. In the bicuspidization group, 23 (3%) were in normal group, 55 (31%) were in the Mild and Mild to Mod range, 76 (43%) was in Mod range, 12 (11%) were in Mod to Severe range and 8 (4%) were in Severe range. In Devega group, 2 (6%) were in normal range, 14 (28%) were in Mild and Mild to Mod range, 42 (38%) were in Mod range, 12 (11%) were in Mod to Severe range and 10 (9%) were in Severe range. In the Ring group, 3 (6%) were in the normal range, 14 (28%) were in the Mild and Mild to Mod range, 5 (10%) were in the Mod range, 24 (49%) were in the Mod to Severe range, and 3 (6%) were in the Severe range. This comparison showed no significant difference statistically (Table 4).

Table 4  
Comparison of RV Function in tricuspid regurgitation repair methods before surgery

| RV Function in different TR repair methods | normal | Mild t Mild to Mod | Mod     | Mod to Severe | Severe | total |
|--|--------|--------------------|---------|---------------|--------|-------|
| Bicuspidization                            | 23(%3) | 55(%31)            | 76(%43) | 12(%11)       | 8(%4)  | 176   |
| Devega                                     | 2(%6)  | 14(%28)            | 42(%38) | 12(%11)       | 10(%9) | 109   |

|        |        |          |          |         |        |           |
|--------|--------|----------|----------|---------|--------|-----------|
| Ring   | 3(%6)  | 14(%28)  | 5(%10)   | 24(%49) | 3(%6)  | 49        |
| Others | 5(%15) | 12(%36)  | 13(%39)  | 3(%9)   | 0      | 33        |
| total  | 33(%9) | 124(%33) | 155(%42) | 34(%9)  | 21(%5) | 367(%100) |

Comparison of RV Function in tricuspid regurgitation repair methods after surgery (follow up). In bicuspidization group, 4 (5%) were in normal range, 30 (41%) were in Mild and Mild to Mod range, 22 (30%) were in Mod range, 13 (18%) were in Mod to Severe range and 3 (4%) were in Severe range. In devega group, 1 (2%) were in normal range, 16 (44%) were in Mild and Mild to Mod range, 10 (27%) were in Mod range, and 9 (25%) were in Mod to Severe range. In Ring group, 1 (6%) was in the normal range, 8 (44%) were in the Mild and Mild to Mod range, 3 (16%) were in the Mod range, and 6 (33%) were in Mod to Severe range (Table 5). This comparison showed no significant difference statistically.

| RV Function in different TR repair methods | normal | Mild t Mild to Mod | Mod     | Mod to Severe | Severe | total     |
|--|--------|--------------------|---------|---------------|--------|-----------|
| Bicuspidization                            | 4(%5)  | 30(%41)            | 22(%30) | 13(%18)       | 3(%4)  | 72        |
| Devega                                     | 1(%2)  | 16(%44)            | 10(%27) | 9(%25)        | 0      | 36        |
| Ring                                       | 1(%6)  | 8(%44)             | 3(%16)  | 6(%33)        | 0      | 18        |
| Others                                     | 0      | 5(%33)             | 4(%26)  | 5(%33)        | 1(%6)  | 15        |
| total                                      | 59(%4) | 6(%4)              | 29(%20) | 43(%30)       | 4(%2)  | 141(%100) |

## Discussion

In the case of TR, which was the most important variable we discussed in this study, previous normal echocardiography was used from surgery to follow up. It was shown that all of the used annuloplasty methods were effective. Out of a total of 62% of patients who were in the range of above Mod before TR surgery, it decreased to 40% with a reduction of 20%. In the Severe TR group, it decreased from 41% before surgery to 2%, indicating a reduction of about 39%. Before surgery, 26% of patients were in the mild range, while it increased to 45% after surgery. It suggests that the used surgical methods have been effective in reducing TR, at least in the mid-term, similar to the study conducted by Ghanta (13). Also, by comparing the methods in terms of TR value in this study, we concluded that bicuspidization and ring annuloplasty methods were more effective than devega method in reducing TR value in the med-term ( $P = 0.023$  and  $P = 0.001$  vs.  $P = 0.989$ ), which is probably more due to traction and long suture line on suture areas. Similar results have been reported in other studies (14).

The means of EF before and after surgery were not significantly different, similar to the study conducted by Chancellor (15). In this study, the mortality rate was 6.5%, which similar to other previous research conducted by Carthy (13),

significant difference was nor found among surgery methods in terms of mortality rate. However, compared to the study conducted by Wong, who reported a mortality rate of 13%, the mortality rate in this study was lower, which was probably due to the lower mean age (52 years) in our study (16). There was no statistically significant difference among the surgery groups in terms of mortality rate, similar to the study conducted by Wong and Brescia (16, 17).

Results revealed that patients who underwent bicuspidization surgery had aortic pump and clamp durations of 126 minutes and 76 minutes, respectively, while in the devega group, they were 151 minutes and 78 minutes, respectively, and in the ring group, they were 145 minutes and 83 minutes, respectively, and in other methods, they were 164 minutes and 90 minutes, respectively, which significant difference was found among the groups in this regard ( $P = 0.003$  for pump and  $P = 0.04$  for aortic clamp). In the bicuspidization group, this time was shorter. In the case of aortic clamp, similar to the study conducted by Hirji, the pump and aortic durations were shorter in the bicuspidization group (14). However, unlike the study conducted by Ghanta (15), there was no significant difference in aortic clamp and pump durations, probably due the fact that only tricuspid was present in all samples. Regarding PAP, it showed a significant difference before and after surgery ( $P = 0.046$ ), indicating the effectiveness of TR repair surgery compared to PAP, similar to the study conducted by Shingu et al, who observed a significant improvement in PAP after mitral surgery (18). In this study, 409 patients had simultaneously mitral valve and aortic surgeries, which this improvement in PAP may have been due to mitral surgery, which reduced PAP after surgery. There was no difference among the groups in terms of length of hospital stay and the mean length of hospital stay was almost the same and was not significantly different among the groups. However, in the case of length of stay at ICU ( $P = 0.033$ ), the mean length of stay at ICU was lower in bicuspidization and ring groups compared to devega group, which was probably due to accompanying operations. This result was in contrast to the study conducted by Wong et al, in which no significant difference was found among the groups in terms of length of stay at ICU (16).

Concerning RV Function following surgery, no significant difference was found between before and after tricuspid repair in this study ( $P = 0.959$ ), similar to the study conducted by Cao and Chancellor (19, 15). However, in Rv Function, 21 (5%) were in sever range before surgery, which decreased to 4 (2%) after the surgery and 34 (9%) were in the Mod to Severe range before the surgery (9%) and decreased to 5 (33%) after surgery, which was not statistically significant, but showed a decrease in the severity of RV dysfunction it and was probably due to the small number of patients to follow up. 279 patients (75%) were in Mild and Mild to Mod range, which decreased to 35 patients (24%) after surgery, indicating a decrease, but it was not statistically significant due to the above-mentioned reason. The surgical method to remove the TR Functional involves using a rigid or flexible ring or band that is performed with the aim of reducing the size and as a result better contact between the leaflets.

Another technique used is posterior leaflet bicuspidization. In this technique, Pledget sutures are inserted from the anterior-posterior commissure to the posterior-septal commissure along the posterior annulus, which was performed

by Nagaraja et al. (18). The present study suffered some imitations, such as not-referring of all patients for follow-up echocardiography, incompleteness of many medical files to fill out the questionnaire, most patients did not have post-pump echocardiography, incomplete echocardiographic findings, incomplete patients' medical history and symptoms in follow-up, lack of access to patients to examine the out-of-hospital mortality and morbidity, and finally, the study was retrospective and patients were not randomly selected.

## **Conclusion**

Based on the results, we concluded that the methods used for TR repair (Ring, devega, bicuspidization (TR) had good results to reduce the TR value, although in the case of the devega method, this result was less useful than other methods over time. Finally, the Ring method showed better results, followed by bicuspidization, but the devega method is not recommended for TR repair.

## **Acknowledgments**

We hereby appreciate the cooperation and participation of Shahid Rajaei Heart Hospital staffs and patients, who helped us in collecting the data of this research. This stud was derived from research project approved with the code of 9120.

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