AZJCVS
AZerbaijan Journal of CardioVascular Surgery

AZJCVS 2024;5(3):73-8
DOI: 10.5455/azjcvs.2024.10.022

Original Article

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Received: 12 September, 2024
Accepted: 30 October, 2024
Published: 11 November, 2024

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**CITATION**
Ozer E, Erbasan O, Tackin VB. Approach to concomitant moderate-to-severe TR in patients undergoing mitral valve surgery, should we intervene?. AZJCVS. 2024;5(3):73-8.



# Approach to concomitant moderate-to-severe TR in patients undergoing mitral valve surgery, should we intervene?

**Abstract**

**Aim:** The aim of this study was to investigate the changes in postoperative tricuspid valve function in patients with preoperative moderate to severe Tricuspid Regurgitation (TR) who underwent tricuspid valve surgery concomitantly with mitral valve surgery according to intraoperative tricuspid valve evaluation.
**Material and Methods:** The study included 89 patients with moderate-to-severe additional tricuspid valve regurgitation who underwent mitral valve replacement for isolated mitral stenosis, isolated mitral regurgitation, and combined mitral stenosis and regurgitation in our clinic between 2014 and 2021. All patients were divided into two groups; those who underwent mitral valve replacement were divided into Group 1 (n=43) and those who underwent tricuspid valve intervention in addition to mitral valve replacement were divided into Group 2 (n=46).
**Results:** Median weight and Body Mass Index (BMI) values of Group 2 were significantly higher than Group 1 (p=0.002 and p=0.005). Preoperative Atrial Fibrilation (AF) rate in Group 2 (89.1%) was significantly higher than in Group 1 (46.5%) (p<0.001). The mean Left Atrial Diameter (LAD) in Group 2 (5.17±0.69) was significantly higher than in Group 1 (4.76±0.62). The reduction in the degree of TR was significantly higher in Group 2 (-1 [IQR: -2-0]) than in Group 1 (0 [IQR: -1-0]) (p=0.002).
**Conclusion:** DeVega annuloplasty, the simplest method, can be applied as a simple and effective method. Therefore, it should be considered as an alternative to other annuloplasties in patients with moderate to severe secondary tricuspid regurgitation.

**Keywords:** Tricuspid valve, mitral valve, cardiac valve annuloplasty, left ventricle

## INTRODUCTION

Tricuspid valve regurgitation can result from primary abnormalities of the leaflets as primary tricuspid valve regurgitation or secondary tricuspid valve regurgitation can occur with remodeling of normal leaflets (1). Functional Tricuspid Regurgitation (TR) is a condition that develops secondary to mitral and aortic valve disease and is caused by right ventricular geometry that is distorted by increased pulmonary pressure and consequent annular dilatation of the tricuspid valve (2). However, studies have shown that moderate to severe functional TR, if left uncorrected, can progressively lead to heart failure and premature death (3). The estimated prevalence of moderate-to-severe TR in the United States is 1.6 million patients, of whom 8,000 undergo tricuspid valve surgery annually (4). Most surgeons argue that patients with functional or organic tricuspid valve regurgitation who undergo mitral valve surgery should also undergo tricuspid valve surgery (5,6). The prognosis and natural history of patients requiring mitral valve surgery and neglecting moderate TR is very difficult to predict (7,8). The surgical risk of isolated mitral valve surgery is lower than the risk of combined mitral and tricuspid surgery (9,10). The aim of this study was to investigate the changes in postoperative tricuspid valve function in patients with preoperative moderate to severe TR who underwent tricuspid valve surgery simultaneously with mitral valve surgery according to intraoperative tricuspid valve evaluation. In this way, it was aimed to determine the best decision by comparing the decision made according to the preoperative evaluation with the intraoperative evaluation; in addition, it was aimed to increase the survival of the patients and to reduce the need for reoperation.

## MATERIAL AND METHODS

### Patients and Methods

The study was approved by the scientific ethics committee of Akdeniz University Faculty of Medicine Hospital on February 23, 2021 with the number 70904504/124. Between 07.05.2014 and 25.10.2021, the data of all patients who underwent mitral valve replacement at Akdeniz University Faculty of Medicine Hospital were retrospectively analyzed. The Akdeniz University Faculty of Medicine Hospital database, electronic patient files, epicrisis forms and telephone interviews were used to obtain information about the patients.

The study included patients who underwent mitral valve replacement for isolated mitral stenosis (MS), isolated mitral regurgitation (MR) and combined MS and MR and who had at least moderate additional tricuspid valve regurgitation. Other inclusion criteria were the absence of a history of cardiac surgery and interventional interventions for valves for any reason. As a result of screening, patients who underwent reoperation, patients with severe hemodynamic impairment in the preoperative period and need for intensive care, patients who underwent valve repair or replacement other than mitral and tricuspid valves, patients who underwent concomitant coronary artery bypass surgery, patients with intraoperative mortality, and patients with unavailable echocardiographic data for the first postoperative year were excluded.

The study included 89 patients. All patients included in the study were grouped according to whether the tricuspid valve was intervened in addition to mitral valve replacement in patients with moderate to severe TR. All patients were divided into two groups; those who underwent mitral valve replacement were divided into Group 1 (n=43) and those who underwent tricuspid valve intervention in addition to mitral valve replacement were divided into Group 2 (n=46).

### Surgical Technique and Postoperative Care

The mitral valve was accessed by transseptal approach or left atriotomy through Waterson's groove. The valve tissue was resected and the mechanical and in some cases biologic mitral valve was implanted in the anatomic location. Single sutures with Teflon plaged support were used during implantation. After checking the function of the valve, the left atriotomy or septotomy if a transseptal approach was used and the right atriotomy was closed with primary closure. The right atrium was opened through a transverse incision and the tricuspid valve was exposed. The annulus, valve and subvalve tissues were examined. In the absence of pathologies preventing annuloplasty such as calcification, tight fibrosis and chordae rupture, the decision to intervene in the tricuspid valve was made by controlling the annulus width with a hegar dilator. Starting with a Teflon-supported suture just anterior to the anteroseptal commissure with a pledged 2/0 double-needle polypropylene suture material, a double row of sutures is passed 5-6 mm apart, deep in the endocardium and fibrous ring, including the anterior leaflet and then the annulus of the posterior leaflet, respectively, until the commissure formed by the posterior and septal leaflets. Then a pledget is passed through both ends of the sutures, the annulus is narrowed sufficiently and the sutures are tied (Figure 1). The degree of narrowing of the annulus was controlled with a Hegar dilator or a valve gauge between 25 mm and 29 mm, depending on the patient's body surface. The tricuspid valve was tested by injecting cold saline into the right ventricle with a syringe.

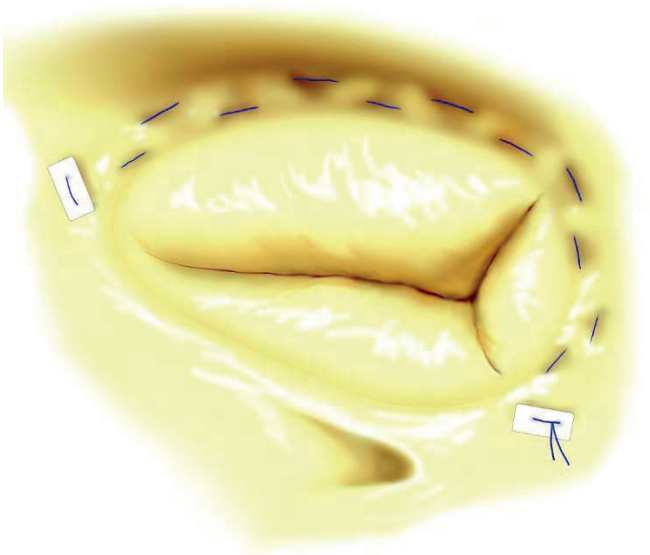

**Figure 1.** Tricuspid valve suture annuloplasty (DeVega procedure)

Postoperatively, all patients were followed up in the cardiovascular surgery intensive care unit. Cardiac rhythm, invasive arterial pressure, central venous pressure, oxygen saturation were monitored instantaneously in patients who were followed up under mechanical ventilation. Arterial blood gas monitoring was performed periodically. Patients whose intensive care follow-up was completed were removed from the intensive care unit by removing drainage tubes and arterial and venous catheters and were taken to the ward. Patients who completed the clinical recovery period were discharged.

### Follow-up

Preoperative demographic data, functional status, cardiac rhythm, preoperative echocardiographic data [mitral stenosis grade, mitral regurgitation grade, mitral valve peak gradient, mitral valve mean gradient, Mitral Valva Area (MVA), TR grade, Left Ventricular Ejection Fraction (LVEF), Left Ventricular End Diastolic Diameter (LVEDD), Left Ventricular End Systolic Diameter (LVESD), Left Atrial Diameter (LAD), Pulmonary Artery Pressure (PAP)], operative data (valve size and brand, biological valve use, ablation for Atrial Fibrilation (AF) rate, tricuspid valve DeVega repair) were included in the evaluation. Postoperative Electrocardiogram, mortality, and final echocardiographic data (LVEF, LVEDD, LVESD, LAD, PAP) of each patient were also evaluated. Patient observations, laboratory and imaging results were recorded to reveal patient characteristics. In the postoperative period, patients were

followed up with echocardiographic evaluation. The outcomes of primary importance were whether there was a significant reduction in TR compared to patients with moderate to severe TR who underwent tricuspid valve intervention in addition to mitral valve replacement. The other outcomes of interest were the comparison of preoperative and postoperative first-year echocardiographic findings according to tricuspid valve intervention in addition to mitral valve replacement.

### Statistical Analysis

Categorical variables were presented as frequency (n) and percentage (%) and analyzed with Pearson chi-square and Fisher's Exact test. Normally distributed continuous variables were presented as mean±standard deviation (SD) and non-normally distributed continuous variables were presented as median (IQR: 25th-75th percentile). The assumption of normality was checked by Shapiro Wilk test. The Mann-Whitney U test was used to analyze the difference between Group 1 and Group 2 measurements when they did not conform to normal distribution and Independent t-test when they did. The analysis of the difference between the preoperative and postoperative echocardiography measurement values of the patients was performed with Wilcoxon Signed Ranks test when the assumption of normal distribution was not met and Paired Samples t-test when it was met. All analyses were performed with IBM SPSS 23.0 package program (IBM Corp., Armonk, NY) and p values less than 0.05 were considered statistically significant.

## RESULTS

The study population was predominantly female. Hypertension was the most common comorbidity among the patients. The diagnosis of isolated mitral insufficiency was observed to be common in the study population. Most of the patients included in the study were found to be in New York Heart Association (NYHA) class 1. The mean age (p=0.713) and gender distribution (p=0.501) of the groups were statistically similar. While no significant difference was observed in the mean height of the two groups (p=0.778), median weight and Body Mass Index (BMI) values were significantly higher in Group 2 compared to Group 1 (p=0.002 and p=0.005). No significant difference was observed in the proportion of patients with Diabetes Mellitus (DM) and Hypertension (HT) (p=0.232 and p=0.901) and NYHA classification distribution (p=0.120). The distributions of MR (p=0.533), MS (p=0.082), and MR+MS (p=0.500) diagnoses were statistically similar between the groups. The distribution of principal diagnoses was statistically similar in the groups (p=0.212). The preoperative AF rate in Group 2 (89.1%) was significantly higher than in Group 1 (46.5%) (p<0.001). Tables 1 and 2 compare the general characteristics of the patients according to the groups.

**Table 1. Descriptive characteristics of patients-1**

| Variables | All patients (n=89) | Group 1 (n=43) | Group 2 (n=46) | p |
|---|---|---|---|---|
| **Age (years)** | 59.18±12.16 | 59.67±12.05 | 58.72±12.38 | 0.713 |
| **Gender** | | | | |
| **Male** | 28 (31.5) | 15 (34.9) | 13 (28.3) | 0.501 |
| **Female** | 61 (68.5) | 28 (65.1) | 33 (71.7) | |
| **Height (cm)** | 162.36±8.54 | 162.09±8.28 | 162.61±8.86 | 0.778 |
| **Weight (kg)** | 70 (60-80) | 65 (58-75) | 75 (66-84) | **0.002** |
| **BMI (kg/m²)** | 26.64 (23.44-29.76) | 24.98 (22.43-28.89) | 27.81 (24.24-32.89) | **0.005** |
| **DM** | 17 (19.1) | 6 (14) | 11 (23.9) | 0.232 |
| **HT** | 42 (47.2) | 20 (46.5) | 22 (47.8) | 0.901 |

Results are expressed as mean±SD, median (IQR) or n (%); Independent t-test, Mann-Whitney U test, Pearson chi-square test, Fisher's Exact test; BMI: body mass index, DM: diabetes mellitus, HT: hypertension

**Table 2. Descriptive characteristics of patients-2**

| Variables | All patients (n=89) | Group 1 (n=43) | Group 2 (n=46) | p |
|---|---|---|---|---|
| **Main diagnosis** | | | | |
| **MR** | 55 (61.8) | 28 (65.1) | 27 (58.7) | 0.533 |
| **MS** | 12 (13.5) | 3 (7) | 9 (19.6) | 0.082 |
| **MR+MS** | 22 (24.7) | 12 (27.9) | 10 (21.7) | 0.500 |
| **NYHA** | | | | |
| **1** | 10 (11.2) | 4 (9.3) | 6 (13) | 0.120 |
| **2** | 40 (44.9) | 24 (55.8) | 16 (34.8) | |
| **3** | 26 (29.2) | 12 (27.9) | 14 (30.4) | |
| **4** | 13 (14.6) | 3 (7) | 10 (21.7) | |
| **Pre-op AF** | 61 (68.5) | 20 (46.5) | 41 (89.1) | **<0.001** |

Results are expressed as mean±SD, median (IQR) or n (%); Independent t-test, Mann-Whitney U test, Pearson chi-square test, Fisher's Exact test; MR: mitral regurgitation, MS: mitral stenosis, NYHA: New York Heart Association, AF: atrial fibrilation

When the operative results of the patients were analyzed, the median mechanical mitral valve number was 29 (IQR: 27-29), 55.1% of the patients had ST jude, 40.4% had medtronic and 4.5% had Sorin mechanical mitral valve. In 7 patients (7.9%), a biological valve was used and 2 patients (2.2%) underwent ablation for Artial Fibrilation Rhythm (AFR).

The distribution of mechanical mitral valve no values (p=0.894), ST jude (p=0.772), medtronic (p=0.865) and sorin (p=0.276) valve brands, mechanical mitral valve brand (p=0.673), biologic valve use (p=0.708) and ablation for AFR (p=0.495) were statistically similar between the study groups. Operative characteristics of the patients are given in Table 3.

**Table 3. Operative findings of the patients**

| Variables | All patients (n=89) | Group 1 (n=43) | Group 2 (n=46) | p |
|---|---|---|---|---|
| **Mechanical mitral valve number** | 29 (27-29) | 29 (27-29) | 29 (27-29) | 0.894 |
| **Mechanical mitral valve brand** | | | | |
| **ST jude** | 49 (55.1) | 23 (53.5) | 26 (56.5) | 0.772 |
| **Medtronik** | 36 (40.4) | 17 (39.5) | 19 (41.3) | 0.865 |
| **Sorin** | 4 (4.5) | 3 (7) | 1 (2.2) | 0.276 |
| **Use of biological mitral valve** | 7 (7.9) | 4 (9.3) | 3 (6.5) | 0.708 |
| **Ablation for AFR** | 2 (2.2) | 0 (0) | 2 (4.3) | 0.495 |

Results are given as median (IQR) or n (%); Mann-Whitney U test, Pearson chi-square test, Fisher's Exact test; AFR: atrial fibrilation rhythm

In the postoperative period, new-onset AF was observed in 7 patients (7.9%) and Atrioventricular (AV) block was observed in 2 patients (2.2%). It was observed that 9 patients (10.1%) died. In the postoperative period, there were 37 patients (41.6%) with mild tricuspid insufficiency. The LAD mean of Group 2 (5.17±0.69) was found to be significantly higher than Group 1 (4.76±0.62). The information of the patients regarding the postoperative period is presented in Table 4.

**Table 4. Postoperative findings of the patients**

| Variables | All patient (n=89) | Group 1 (n=43) | Group 2 (n=46) | p |
|---|---|---|---|---|
| **Arrhythmia** | | | | |
| **Absent** | 25 (28.1) | 19 (44.2) | 6 (13) | **0.001** |
| **New-onset AF** | 7 (7.9) | 5 (11.6) | 2 (4.3) | 0.204 |
| **AV block** | 2 (2.2) | 1 (2.3) | 1 (2.2) | 0.999 |
| **Chronic AF** | 55 (61.8) | 18 (41.9) | 37 (80.4) | **<0.001** |
| **Mortality** | 9 (10.1) | 3 (7) | 6 (13) | 0.487 |
| **TR degree** | | | | |
| **Mild** | 37 (41.6) | 17 (39.5) | 20 (43.5) | 0.795 |
| **Moderate** | 30 (33.7) | 16 (37.2) | 14 (30.4) | |
| **Severe** | 22 (24.7) | 10 (23.3) | 12 (26.1) | |
| **LVEF (%)** | 60 (50-65) | 60 (50-65) | 60 (50-62) | 0.511 |
| **LVESD (cm)** | 3.2 (2.7-3.7) | 3.1 (2.7-3.7) | 3.25 (2.8-3.9) | 0.500 |
| **LVEDD (cm)** | 4.95±0.6 | 4.91±0.58 | 4.98±0.62 | 0.579 |
| **LAD (cm)** | 4.97±0.69 | 4.76±0.62 | 5.17±0.69 | **0.005** |
| **PAP (mmHg)** | 42.39±9.76 | 43.4±9.48 | 41.46±10.02 | 0.352 |

Findings are given as mean±SD, median (IQR) or n (%); Independent t-test, Mann-Whitney U test, Pearson chi-square test, Fisher's exact test. In post-hoc pairwise comparisons, significant cases are shown with different lower case letters; AF: atrial fibrilation, AV: atrioventricular, TR: tricuspid regurgitation, LVEF: left ventricular ejection fraction, LVESD: left ventricular end systolic diameter, LVEDD: left ventricular end diastolic diameter, LAD: left atrial diameter, PAP: pulmonary artery pressure

In all patients, there was a significant decrease in postoperative TR (p<0.001), EF (p=0.008), LAD (p=0.003) and PAP values (p<0.001) compared to preoperative measurements. The changes in LVESD (p=0.715) and LVEDD (p=0.316) were not statistically significant.

In group 1, a significant decrease was observed in the postoperative TR grade (p=0.007), LVEF (p=0.019), and PAP values (p<0.001) compared to the preoperative period. In group 1, the change in LVESD (p=0.841), LVEDD (p=0.106), and LAD (p=0.113) was not statistically significant.

In group 2, the postoperative TR grade (p<0.001), LAD (p=0.007) and PAP values (p<0.001) were significantly lower compared to the preoperative period. Postoperative LVEF (p=0.125), LVESD (p=0.503), and LVEDD (p=0.830) values of patients in group 2 were similar to preoperative measurements. The reduction in the degree of TR in Group 2 (-1 [IQR: -2-0]) was significantly higher than in Group 1 (0 [IQR: -1-0]) (p=0.002). The change in the echocardiographic findings of the patients before and after the operation is compared in Table 5.

**Table 5. Comparison of preoperative and postoperative (1st year) echocardiographic results in all patients and treatment groups**

| Variables | Group 1 (n=43) | | | Group 2 (n=46) | | |
|---|---|---|---|---|---|---|
| | Pre-op | Post-op | P value | Pre-op | Post-op | P value |
| **TR** | | | | | | |
| **Mild** | - | 17 (39.5%) | | - | 20 (43.5%) | |
| **Moderate** | 34 (79.1%) | 16 (37.2%) | **0.007** | 9 (19.6%) | 14 (30.4%) | **<0.001** |
| **Severe** | 9 (20.9%) | 10 (23.3%) | | 37 (80.4%) | 12 (26.1%) | |
| **LVEF (%)** | 63 (58-65) | 60 (50-65) | **0.019** | 60 (55-65) | 60 (50-62) | 0.125 |
| **LVESD (cm)** | 3.2 (2.9-3.5) | 3.1 (2.7-3.7) | 0.841 | 3.2 (2.8-3.5) | 3.25 (2.8-3.9) | 0.503 |
| **LVEDD (cm)** | 5.06±0.61 | 4.91±0.58 | 0.106 | 4.97±0.68 | 4.98±0.62 | 0.830 |
| **LAD (cm)** | 4.93±0.77 | 4.76±0.62 | 0.113 | 5.38±0.61 | 5.17±0.69 | **0.007** |
| **PAP (mmHg)** | 53 (45-61) | 41 (35-50) | **<0.001** | 53 (45-63) | 41 (33-48) | **<0.001** |

Results are expressed as mean±SD, median (IQR) or n (%); Paired Samples t-test, Wilcoxon Signed Ranks test; TR: tricuspid regurgitation, LVEF: left ventricular ejection fraction, LVESD: left ventricular end systolic diameter, LVEDD: left ventricular end diastolic diameter, LAD: left atrial diameter, PAP: pulmonary artery pressure

The reduction in the degree of TR in patients in Group 2 (-1 [IQR: -2-0]) was significantly higher than in Group 1 (0 [IQR: -1-0]) (p=0.002). The evaluation of the changes in the pre-op and post-op echocardiography results of the patients is shown in Table 6.

**Table 6. Evaluation of the change in echocardiography results of the patients (Preop-Postop)**

| | Group 1 (n=43) | | Group 2 (n=46) | | |
|---|---|---|---|---|---|
| **Variables** | **Mean±SD** | **Median (IQR)** | **Mean±SD** | **Median (IQR)** | **p** |
| **TR** | -0.37±0.85 | 0 (-1-0) | -0.98±0.86 | -1 (-2-0) | **0.002** |
| **LVEF (%)** | -2.49±6.95 | 0 (-5-1) | -2.28±9.63 | 0 (-5-2) | 0.705 |
| **LVESD (cm)** | 0±0.47 | -0.1 (-0.3-0.2) | 0.08±0.59 | 0.05 (-0.2-0.2) | 0.580 |
| **LVEDD (cm)** | -0.14±0.56 | 0 (-0.5-0.2) | 0.02±0.55 | 0 (-0.2-0.2) | 0.179 |
| **LAD (cm)** | -0.16±0.66 | -0.2 (-0.4-0.2) | -0.21±0.5 | -0.25 (-0.4-0.1) | 0.712 |
| **PAP (mmHg)** | -11.51±9.33 | -10 (-18- (-5)) | -13.67±10.52 | -16 (-21- (-7)) | 0.203 |

Independent t-test, Mann-Whitney U test; TR: tricuspid regurgitation, LVEF: left ventricular ejection fraction, LVESD: left ventricular end systolic diameter, LVEDD: left ventricular end diastolic diameter, LAD: left atrial diameter, PAP: pulmonary artery pressure

## DISCUSSION

Many studies have reported Left Atrial (LA) volume changes after mitral valve intervention (11-13). In some studies, a decrease in LA volume was observed in patients who underwent mitral valve intervention due to mitral stenosis and mitral valve insufficiency (14,15). Our study supports the findings.

In a study, regression was observed in PAP and LAD in patients who underwent mitral valve replacement (16). The findings show that our study also supports this.

In the case of Functional TR, which is progressive, surgical treatment of left heart systemic valve disease alone did not adequately resolve or prevent Tricuspid Valve (TV) insufficiency, this was especially true in persistent pulmonary hypertension (17). In our study, on the contrary, treatment of left heart systemic valve disease showed a decrease in tricuspid regurgitation, but we think that a similar situation will occur in longer-term follow-up of the patients.

King et al. (6) studied patients who required a repeat TV procedure after Mitral Valve (MV) surgery and observed that they had high early and late mortality rates. In our study, the authors also recommend a simultaneous tricuspid valvuloplasty procedure during MV surgery.

The results of this study should be interpreted with caution in the presence of some important limitations. First, the tricuspid valve

repair technique applied to the patients included in this study was a single type (DeVega) and repair can be performed with other tricuspid valve repair methods. At the same time, the decision for surgical intervention of the tricuspid valve is made by the primary surgeon and there is no standardization, which limits the study. Other limitations are that our study is retrospective, the number of patients included in the study is limited and it is a single-center study. Better results can be obtained by conducting larger centered studies with more patients and longer follow-up periods.

## CONCLUSION

Our study shows that isolated mitral valve replacement reduces the severity of TR in moderate to severe TR, but DeVega annuloplasty provides a better repair result. DeVega annuloplasty, which is the simplest method, can be applied as a simple and effective method. Therefore, it should be considered as an alternative to other annuloplasties in patients with moderate to severe secondary TR. However, it would be appropriate to evaluate long-term results with a larger number of patients.

**Conflict of Interests:** The authors declare that there are no conflict of interests.

**Financial Disclosure:** The authors declare that there is no financial support.

**Ethics Committee Approval:** Ethics committee approval was obtained on 02/10/2021 with decision number KAEK-114.

**Patient Informed Consent:** Since our study was retrospective, consent was not obtained from the patients.

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