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Short-Term Results Of Annuloplasty Techniques In Secondary Tricuspid Regurgitation

Sekonder Triküspid Yetmezliğinde Anüloplasti Tekniklerinin Erken Dönem Sonuçları

Ahmet Dolapoğlu [1*], Emin Barbarus [1]

[1]Department of Cardiovascular Surgery, Balikesir University, Bigadic, Balikesir 10145, Turkey
e-mail: ahmetdolapoglu@yahoo.com, eminbarbarus@gmail.com
ORCID: 0000-0001-9161- 2632
ORCID: 0000-0001-8586-9810

*Sorumlu Yazar / Corresponding Author: Ahmet Dolapoğlu
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Öz

Giriş ve Amaç: Sekonder Triküspid Yetmezlik(TY) sol taraflı cerrahi planlanan hastalarda önceki dönemlerde genellikle konservatif takip edilmiş olup kliniğimizde gerçekleştirilen Triküspid tamir prosedürlerinin erken dönem sonuçlarını paylaşmayı amaçladık.

Gereç ve Yöntemler: 2018 Ocak-2023 Mayıs arası Balıkesir Üniversitesi Tıp Fakültesi Hastanesinde sekonder TY nedeniyle opere edilen 62 hastanın verileri retrospektif olarak incelendi. Sol taraflı kalp cerrahisi planlanan ve orta-ileri TY mevcut olan hastalarla Triküspid anülüs çapı >40 mm olan hastalara yapılan tirküspid tamir prosedürleri çalışmaya alındı. .46 hastaya Triküspid Ring anüloplasti (TRA) , 16 hastaya De Vega sütür anüloplasti prosedürleri uygulandı Primer TY nedeniyle opere edilen hastalar,aktif endokardit bulunanlar,18 yaş altı olan hastalar ve gebelik durumu olan hastalar çalışmaya dahil edilmedi.

Bulgular: Çalışmaya dahil edilen hastaların yaş ortalaması 63.74 ± 10.2 , 46'sı kadın (%74.2) ve 16'sı erkek (%25.8) idi. 46 hastaya Triküspit Ring Anüloplasti (TRA) ve 16 hastaya De Vega-sütür anüloplasti prosedürleri uygulandı. Ameliyat öncesi kreatinin değeri De-Vega grubunda daha yüksekti (p=0.037). TY evrelemesine göre yapılan girişimde TRA grubundaki hastaların %87,5'inde ciddi TY varken, De-Vega grubunda bu oran %50 idi ve anlamlı fark bulundu. (p=0.004) 30 günlük mortalite toplamda %12.9 iken Ring anüloplasti grubunda %10.4, De-Vega sütür anüloplasti grubunda %21.4 idi ancak istatistiksel olarak anlamlı fark yoktu (p=0.365).

Sonuç: Bu çalışmada sekonder triküspid yetmezlikte De-Vega ve TRA onarım yöntemlerinin erken dönem sonuçlarını sunmayı planladık

Anahtar kelimeler: Triküspit Yetmezlik, Ring anüloplasti, Sütür anüloplasti

Abstract

Aim; Patients with Secondary Tricuspid Regurgitation (TR) scheduled for left-sided surgery were generally followed conservatively in previous periods, but tricuspid intervention has recently become increasingly common. In this study, we aimed to report the short-term results of tricuspid repair procedures performed in our tertiary university clinic.

Method; Data of 62 patients who underwent surgery for secondary TR at Balıkesir University Faculty of Medicine Hospital between August 2018 and May 2023 were retrospectively analyzed. Tricuspid repair procedures performed in patients with moderate to severe TR and tricuspid annulus diameter >40 mm who were scheduled for left-sided cardiac surgery were included in the study. Patients operated for primary TR, patients with active endocarditis, patients under 18 years of age, and patients with pregnancy status were excluded.

Results; The mean age of the patients included in the study was 63.74 ± 10.2 years, 46 were female (74.2%) and 16 were male (25.8%). 48 patients underwent Tricuspid Ring Annuloplasty (TRA) and 14 patients underwent De Vega suture annuloplasty procedures. Preoperative creatinine value was higher in the De-Vega group (p=0.037). In the intervention according to TR clascification, 87.5% of the patients in the TRA group had

severe TR, while this rate was 50% in the De-Vega group and a significant difference was found. (p=0.004) 30-day mortality was 12.9% in total and 10.4% in the Ring annuloplasty group and 21.4% in the De-Vega suture annuloplasty group, but there was no statistically significant difference (p=0.365).
Conclusion; In this study, we planned to report the short-term results of two repair methods of De-Vega and TRA for secondary TR.

Keywords: Tricuspid Regurgitation, Ring annuloplasty, Suture annuloplasty

1. Introduction

Tricuspid regurgitation is characterized by systemic fluid retention findings such as edema, increased jugular venous pressure, ascites, hepatic edema, anasarca, as well as low cardiac output findings such as exercise intolerance, dyspnea, fatigue and ventricular or atrial arrhythmias. The etiology is classified as Primary and Secondary (Functional TR)[1]. Primary TR is caused by congenital or acquired causes affecting the valves and/or subvalvular apparatus. Secondary TR is the most common cause (90%) and is caused by tethering and coaptation defects in the valves after tricuspid annular dilatation due to left-sided heart diseases (Mitral regurgitation, Mitral Stenosis, Aortic Stenosis), Pulmonary Hypertension (PHT) or Right Ventricular/Atrial pathologies[2]. In left-sided heart disease, pulmonary venous hypertension and then pulmonary arterial HT develops as a result of increased left atrial filling pressures. As a result, four main pathologic changes lead to TR upon dilatation and extension of the right ventricle.

1- Tethering and tenting in Tricuspid Leaflets
2- Change in the location of the papillary muscles
3- Right ventricular dysfunction
4- Tricuspid annulus dilatation with or without right atrial dilatation[3]

Surgical interventions for secondary TR have been increasing recently and are strongly recommended especially in patients going for left-sided surgery in case of moderate to severe insufficiency and if there is enlargement of the annulus (>40 mm)[4].

Secondary TR is associated with increased postoperative mortality and morbidity in patients undergoing left-sided surgery if not intervened and followed up conventionally[5]. For this purpose, we aimed to report the early results of repair procedures performed for secondary TR in our clinic.

2. Materials and Methods

Approval for this retrospective study was obtained from Balıkesir University Health Sciences Non-interventional Research Ethics Committee with decision number 2024/142.

Between August 2018 and May 2023, data of patients operated for secondary TR were analyzed. Patients with primary TR, endocarditis, cardiac implantable device related TR, and patients under 18 years of age and pregnant women were excluded. TR grading on echocardiography was classified as mild-moderate and severe. Indications for surgery were an annulus diameter greater than 40 mm and the presence of moderate or severe TR.

The patients were operated with De-Vega Annuloplasty and TRA techniques. 3D Medtronic Ring and Edwards brand rings were used as tricuspid rings. The ring scale was measured by calculating the distance between the posterior and anterior commissure and the anterior leaflet area. Postoperative data of the patients at 30 days, 6 months mortality and 1 year survey were analyzed.

Data were evaluated with IBM SPSS 26 program (IBM Corp. Released 2019). The assumption of normality was examined with the Shapiro-Wilk test. Mann Whitney U test was used to compare non-normally distributed data and independent two-sample t test was used to compare normally distributed data according to tricuspid annuloplasty status. Pearson chi-square test, Yates correction and Fisher's exact test were used to compare categorical data according to tricuspid annuloplasty status. Multiple comparisons were analyzed with Bonferroni corrected Z test. Analysis results for quantitative variables[6].

3. Results

The age range of all patients included in the study was 29-82 years and the mean age was 63.74 years. 74.2% of the patients were female. Diabetes Mellitus (DM) was present in 40.3%, Hypertension (HT) in 62.9%, Cerebrovascular accident (CVA) in 6.5%, Coronary Artery Disease (CAD) in 54.8%, %, preoperative atrial fibrillation (AF) in 72.1% and and preoperative congestive heart failure (CHF) in 16.1%. While 85.5% of the patients had no previous cardiac surgery, 11.3% of the patients with previous cardiac surgery had Mitral valve replacement (MVR) operation(Table 1). Tricuspid ring annuloplasty was performed in 77.4% of the patients. When the primary procedures of the patients were analyzed, MVR was observed with a majority of 90.3%. When the concomitant surgical conditions of the patients were analyzed, it was

seen that 79% of the patients had MVR. TR grade was found to be severe in 80% of the patients.

Table 1 : Demographic data of the patients

	Ring Annuloplasty	**De Vega**		
Age	64 (29 - 82)	71.5 (47 - 79)	-1.576	0.115[m]
Gender				
Female	37 (77.1)	9 (64.3)	-	0.488[f]
Male	11 (22.9)	5 (35.7)		
DM	17 (35.4)	8 (57.1)	1.319	0.251[y]
HT	28 (58.3)	11 (78.6)	1.134	0.287[y]
SVA	3 (6.3)	1 (7.1)		
CAD	28 (58.3)	6 (42.9)	0.516	0.472[y]
Creatinine	0.93(0.52-2.21)	1.19(0.73-1.62)	-2.088	0.037m
Preoperative AF	33 (70.2)	11 (78.6)		0.738[f]
Preoperative CHF	7 (14.6)	3 (21.4)	-	0.681[f]
Previous Cardiac				
MVR	5 (10.4)	1 (7.1)		
AVR	0 (0)	1 (7.1)		
MVR + CABG	0 (0)	1 (7.1)		
CABG	1 (2.1)	0 (0)		

m: Mann Whitney U test, *t: Independent two-sample t test* y: Yates correction, f: Fisher's exact test, median (min.-max.), mean ± s. deviation, median (min.-max.), n (%)

Demographic and clinical characteristics of patients who underwent ring annuloplasty were analyzed;

The mean age of the patients was 62.9 years (age range: 29-82 years). 77.1% of the patients were female. DM was observed in 35.4%, HT in 58.3%, CVA in 6.3%, CAD in 58.3%, AF in 70.2% and preoperative CHF in 14.6%. While 87.5% of the patients had no previous cardiac surgery, 10.4% had a history of MVR. When the primary procedures of the patients were analyzed, it was found that 89.6% of the patients had MVR. MVR was the concomitant surgery in 93.8% of the patients. It was determined that 87.5% of the patients had advanced TR grade. It was observed that 10.4% of the patients developed 30-day mortality and 2.3% developed 6-month mortality. When the postoperative TR grades of the patients were analyzed, it was observed that 97.7% of the patients had mild TR. Residual/recurrent TR was present in 2.3% of the patients. The mean creatinine value of the patients was 1 (creatinine range: 0.52-2.21). When the ring size of the patients was analyzed, it was found to be 30 with a majority of 44.4% .The mean preoperative pulmonary artery pressure (PAP) value was 50.39 (PAP range: 25-90), mean left ventricular ejection fraction (LVEF) value was 55 (LVEF range: 35-65), mean left ventricular end-diastolic diameter (LVEDD) value was 52.97 (LVEDD range: 39-64) and mean left ventricular end-systolic diameter (LVESD) value was 37.5 (LVESD range: 26-49). The mean cardiopulmonary bypass (CPB) time was 116.67 (CPB range: 68-221) and the mean cross-clamp (X-clamp) time was 85.56 (X-clamp range: 50-152). The mean postoperative LVEF was 53.14 (Postoperative LVEF range: 30-65).

Demographic and clinical characteristics of patients with de Vega were analyzed;

The mean age of the patients was 66.64 years (age range: 47-79 years). 64.3% of the patients were female. It was observed that 57.1% of the patients had DM, 78.6% had HT, 7.1% had SVA, 42.9% had CAD, 78.6% had preoperative AF and 21.4% had preoperative CHF. While 78.6% of the patients had no previous cardiac surgery, 7.1% had a history of MVR, Aortic valve replacement (AVR) and MVR+Coronary Bypass (CABG). When the primary procedures of the patients were analyzed, it was determined that MVR was performed with a majority of 92.9%. It was determined that 50% of the patients had severe TR. It was observed that 21.4% of the patients developed 30-day mortality. When the postoperative TR grades of the patients were analyzed, it was observed that 90.9% of the patients had mild TR. The mean creatinine value of the patients was 1.16 (creatinine range: 0.73-1.62). The mean PAP was 53.85 (PAP range: 30-100), mean LVEF was 55 (LVEF range: 40-65) and mean LVEDD was 54.9 (LVEDD range: 42-64). The mean CPB duration was 125.57 (CPB range: 78-197) and the mean X-clamp duration was 96.29 (X-clamp duration range: 60-151)(Table 2). The mean postoperative EF was 49.5 (postop EF range: 30-60).

Table 2: Preoperative and postoperative echocardiographic data of the patients

	Ring Annuloplasty	De Vega		
Preoperative TR grade				
Mild	2 (4.2)	0 (0)		
Moderate	4 (8.3)[a]	6 (50)[b]	9.81	0.004[f]
Severe	42 (87.5)[a]	6 (50)[b]		
PAP	45 (25 - 90)	50 (30 - 100)	0.830	0.406[m]
LVEF	55 (35 - 65)	55 (40 - 65)	0.230	0.818[m]
LVEDD	52.97 ± 5.78	54.9 ± 7.03	0.893	0.376[m]
LVESD	37.5 ± 8.12	30¨	-	-
Postoperative TR grade				
Mild	42 (97.7)	10 (90.9)	-	
Moderate	0 (0)	1 (9.1)		
Severe	1 (2.3)	0 (0)		
Residual /Recurrent TR	1 (2.3)	1 (9.1)		
Postoperative LVEF	55 (30 - 65)	55 (30 - 60)	0.897	0.370[m]

m: Mann Whitney U test, t: Independent two-sample t testf: Fisher's exact test, a-b: No difference between groups with the same letter (Z test with Bonferroni correction), median (min.-max.), mean ± s. deviation, median (min.-max.), n (%), ¨: Observation in a single person.

There was a statistically significant difference between the distribution of TR grades according to tricuspid annuloplasty status (p=0.004). This difference was observed between the proportions of moderate and severe TR grades according to tricuspid annuloplasty status. The proportion of patients with moderate TR grade was 8.3% in patients with ring annuloplasty, while this proportion was higher with 50% in patients with De Vega. While the rate of patients with severe TR was 87.5% in patients with ring annuloplasty, this rate was 50% higher in patients with De Vega.

Table 3: Operative data and postoperative outcome analysis of patients

	Ring Annuloplasty	De Vega (n=14)		
Primary Procedure*				
ASD	3 (6.3)	0 (0)	3.658	0.723[x]
AVR	11 (22.9)	6 (42.9)		
CABG	4 (8.3)	2 (14.3)		
MVR	43 (89.6)	13 (92.9)		
Redo AVR	1 (2.1)	0 (0)		
Redo MVR	4 (8.3)	1 (7.1)		
CPB	114.5 (68 - 221)	120 (78 - 197)	0.716	0.474[m]
X-clamp	81.5 (50 - 152)	95 (60 - 151)	1.297	0.195[m]
Need for permanent				
	0	0		
Ring Size				
26	1 (2.2)	0 (0)	-	
28	7 (15.6)	0 (0)		
30	20 (44.4)	0 (0)		
32	12 (26.7)	0 (0)		
34	4 (8.9)	0 (0)		
36	1 (2.2)	0 (0)		
30-day all-cause mortality				
	5 (10.4)	3 (21.4)	-	0.365[f]
6 month all-couse mortality				
	1 (2.3)	0 (0)	-	-
1 year survey				
	42 (87.5)	11 (78.5)	-	-

m: Mann Whitney U test, t: Independent two-sample t test, x: Pearson chi-square test, f: Fisher's exact test, median (min.-max.), mean ± s. deviation, median (min.-max.), n (%), ¨: Observation in a single person.

There was a statistically significant difference between the creatinine values of the patients according to the tricuspid annuloplasty status (p=0.037), and the creatinine value of the patients with De Vega was higher than that of the patients with ring annuloplasty. There was no statistically significant difference between tricuspid annuloplasty status and other demographic and clinical characteristics of the patients (p>0.05).There was no need for permanent pacemaker in our patients in both groups. 6-month and one-year survival was 82.8%, 78.5% in the De-Vega group and 87.5% in the Ring annuloplasty group(Table 3).

4. Discussion

Surgical interventions for Functional Tricuspid Regurgitation have been increasing in the recent period and are strongly recommended especially in patients who will undergo left-sided surgery in case of moderate to severe regurgitation and if there is enlargement of the annulus (>40 mm).

When the data of the patients in our study were analyzed, no significant difference was found between the suture annuloplasty and ring annuloplasty groups in terms of demographic data. MVR was the most common primary procedure and when the data of all patients who underwent left-sided surgery were analyzed, it was seen that the most mortality was observed in the postoperative 30 days before discharge. Total all-cause mortality was 12.9% in the first 30 days in both groups and 10.4% in the ring annuloplasty group and 21.4% in the De Vega suture annuloplasty group, but no statistically significant difference was observed. During follow-up, recurrent TR was seen in only one patient and the rate was calculated as 2.3%. No additional mortality was observed in 1-year follow-up. No permanent pacemaker was required in our patients. Recurrent/Residual TR was found in 1 patient in both groups. In terms of ring scales, 28, 30 and 32 scales were used most frequently.

In a meta-analysis by Pagnesi et al., the outcomes of patients who underwent left-sided surgery for TR and were followed conservatively were analyzed. Both cardiac and all-cause mortality rates were significantly lower in the TR repair group compared to the conservatively followed group. In addition, at a mean follow-up of 4.7 years, TR progression and increase in TR grade were found to be statistically significantly lower in the repaired group[5].

Brescia et al. performed TriAd ring annuloplasty in 171 patients operated for functional TR. 26 or 28 scales were used in each patient. 30-day mortality was 0.6%. 1-year expected survival was 95±4% and 5-year survival was 92±5%. At 6-month echocardiographic follow-up, 93±6% did not develop modarete-severe TR and 89±8% at 3-year follow-up and mortality was found to be lower compared to our study[7].

Guenther et al. analyzed the data of 717 patients operated for functional TR between 1975 and 2009. 433 patients underwent Ring annuloplasty, 255 patients underwent De-Vega suture annuloplasty and 29 patients underwent other tricuspid repair techniques. The Ring annuloplasty group was predominantly performed in the current period. The mean 30-day total mortality was 13.8%, which was 15.7% in the De-Vega group and 12.7% in the ring annuloplasty group. The 10-year survival was 46±7% in the Ring annuloplasty group and 39±3% in the De Vega group. The need for repeat tricuspid valve operation during this period was 4%. At 10 years, the rate of TR progression was 87.9±3% in the De Vega group and 98.4±1% in the ring annuloplasty group[8].

Czapla et al. in a study of 136 patients compared rigid ring, flexible band annuloplasty and suture annuloplasty techniques. The mean follow-up period was 3.4 years and 5-year survival was 80.1±3.4% in the rigid annuloplasty group, 83.5±4.7% in the flexible band annuloplasty group and 85.1±6.5% in the suture annuloplasty group, with no statistically significant difference between the groups. Renal failure, diabetes and advanced right heart failure classified as TAPSE<10 were reported as independent risk factors for late mortality. At 5-year follow-up, TR recurrence was 15.9% in the rigid annuloplasty group, 19.4% in the flexible annuloplasty group and 21.1% in the suture annuloplasty group, with no statistically significant difference between the groups. Severe pulmonary hypertension, a TR grade of more than 2 at discharge and an advanced preoperative TR grade were reported as risk factors for TR recurrence independent of the annuloplasty technique[9].

In a meta-analysis by Parolari et al., prosthetic rings and suture annuloplasty techniques were compared in terms of long-term recurrence of TR in functional TR and ring annuloplasty was reported to be superior to suture annuloplasty in the long term[10]. When compared with these available studies, total mortality and early recurrent TR development seem to be consistent with the literature.

There were several limitations in our study that should be acknowledged. First, the sample size of the patient population was relatively small, which may have impacted the statistical power of our

findings. Additionally, the distribution of patients between the suture annuloplasty group and the ring annuloplasty group was uneven, which could potentially introduce bias and limit the generalizability of our conclusions. Another limitation was the relatively short follow-up period, which may not have been sufficient to capture the long-term outcomes, particularly regarding the recurrence of tricuspid regurgitation (TR). Future evaluations will focus on extending the follow-up period to include both clinical assessments and comprehensive echocardiographic examinations, allowing for a more thorough analysis of patient outcomes over time.

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