

## A New Technique in the Surgical Treatment of Secondary Tricuspid Regurgitation: Crescent-Like Annuloplasty With Asymmetric Circular Pericardial Band

### INTRODUCTION

Tricuspid regurgitation (TR) may be classified as either primary or secondary (functional), with over 90% of cases falling into the latter category. Secondary TR is most commonly associated with left-sided valvular pathology or myocardial dysfunction. It typically arises due to right ventricular (RV) remodeling in response to pressure and/or volume overload, leading to annular dilatation and leaflet tethering.<sup>1</sup>

Severe TR is an independent risk factor associated with poor prognosis. In a large echocardiographic study involving 5223 patients, the 1-year survival rates were 91.7% in patients without TR, 90.3% with mild TR, 78.9% with moderate TR, and 63.9% in those with severe TR.<sup>2</sup> These observations underscore the critical importance of effectively treating TR in order to improve patient outcomes.<sup>2,3</sup>

Unlike other cardiac valves, the tricuspid valve has historically attracted limited attention from cardiac surgeons, earning it the designation of the "forgotten valve." This may be partly due to the fact that even severe TR can remain clinically silent for a prolonged period. However, the more fundamental issue lies in the limited success of current surgical techniques for tricuspid valve repair or replacement, which have yet to achieve the early and long-term outcomes seen with left-sided valve procedures.<sup>4</sup> Limited durability of current repair methods or incomplete correction, moreover, persistent pulmonary hypertension, atrial fibrillation, and RV dysfunction after left-sided valve surgery may lead to residual or recurrent TR.<sup>5</sup>

Although novel techniques have been proposed to break this vicious cycle of tricuspid regurgitation, their reproducibility or effectiveness remains low. The search for a surgical technique that will provide a standard of success in the treatment of TR continues.<sup>6</sup> The case presented here is the result of such a search. The technique also has the important advantage of being cost-effective.

### Case Reports Surgical Technique

The surgeries were performed via median sternotomy. A sufficiently sized pericardial patch was then removed, treated with glutaraldehyde, rinsed thoroughly, and stored in saline solution. Following cannulation, a cross-clamp was applied. Myocardial protection was achieved using alternating antegrade and retrograde blood cardioplegia enriched with potassium. First, mitral procedures were performed. In both patients, the mitral valve was explored via a superior septal approach. Intraoperative evaluation revealed that the valves were unsuitable for repair. In case 1, a 29 mm St. Jude Epic bioprosthetic valve was used for mitral valve replacement, and in case 2, a 29 mm Corcym mechanical valve was used.

Tricuspid valve exploration revealed secondary tricuspid insufficiency due to annular dilatation, consistent with echocardiographic findings. In the second case, there were also mild rheumatic changes in the anterior leaflet. The cases were

### CASE REPORT



Kemal Uzun 

Department of Cardiovascular Surgery,  
Ahi Evren Thoracic and Cardiovascular  
Surgery Training and Research Hospital,  
Trabzon University Faculty of Medicine,  
Trabzon, Türkiye

#### Corresponding author:

Kemal Uzun  
✉ drkemaluzun@hotmail.com

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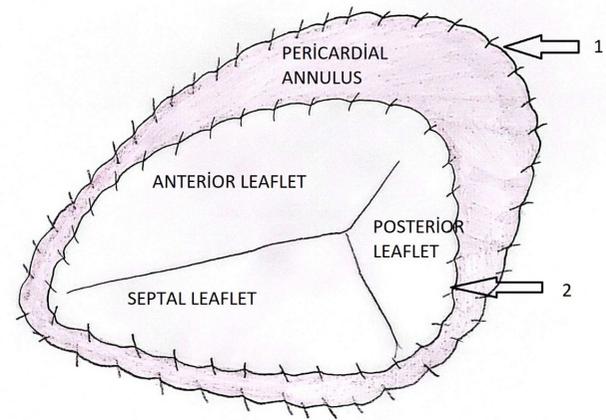
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evaluated as suitable for the planned repair. Using Edwards MC3 tricuspid annuloplasty scales, it was determined that size 32 was appropriate for the first case and size 34 was appropriate for the second case. Next, a circular pericardial band was created by cutting out the center of the autologous pericardium according to the selected sizer. This band was then approximated to the natural annulus and shaped so that its outer border was consistent with the contour of the natural annulus. Special care was taken to ensure that the band was slightly narrower than the natural annulus. Given that the annulus expansion of the TR is most pronounced in the anteroposterior commissure, the band was cut to be widest in this segment and narrowest in the septal leaflet segment, resulting in a crescent-like configuration (Figure 1).

The native leaflets were then completely detached from the annulus. The outer edge of the pericardial band was continuously sutured to the native annulus using 5-0 polypropylene. The leaflets were subsequently reattached to the inner edge of the pericardial ring with a continuous 5-0 polypropylene suture as well (Figures 2, 3).

**Case 1**

An 80-year-old female patient, with a history of multiple hospital admissions for palpitations and shortness of breath, presented to the emergency department with similar complaints. Transthoracic (TTE) and transesophageal

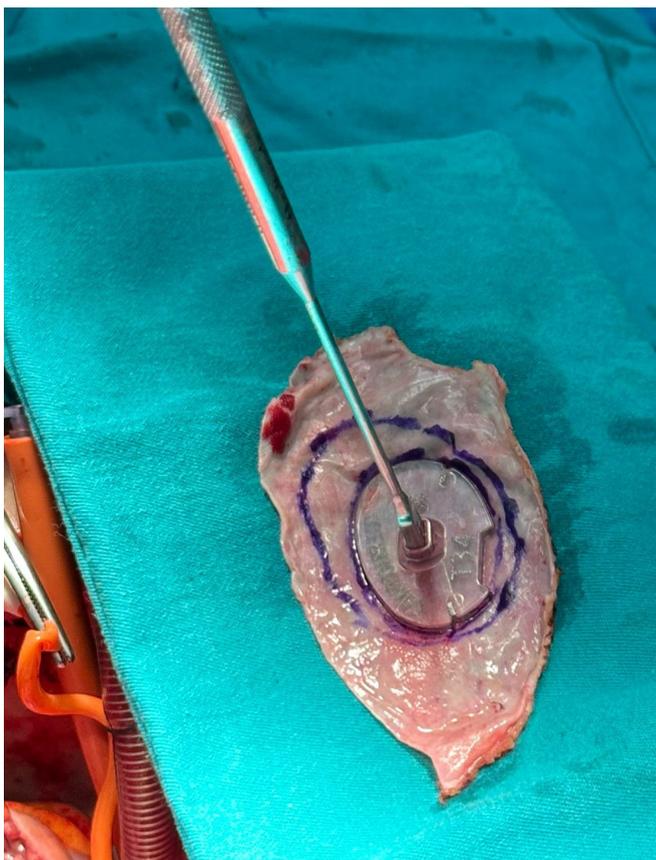


**Figure 2. Illustration of the tricuspid valve after repair. 1: previous annulovalvular junction, 2: new annulovalvular junction.**

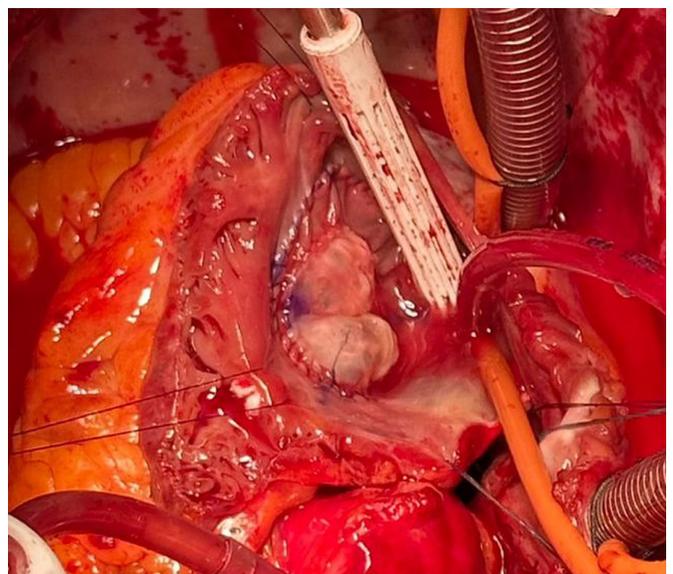
echocardiography (TEE) revealed severe mitral and tricuspid regurgitation. The patient was weaned from cardiopulmonary bypass with moderate inotropic support. Intraoperative TEE showed only mild residual TR. She remained in the ICU for 3 days. On day 5, echocardiography revealed only trace TR. With no complications during ward follow-up and once she regained adequate physical condition, the patient was discharged in sinus rhythm on postoperative day 13. At 1, 3, 6, and 12 month follow-ups, the patient remained asymptomatic, showing marked improvement in her overall condition. At the last checkup (12 months), the patient had trace TR (Video 1). The annulus diameter, which was 41 mm preoperatively, was measured at 20 mm. The leaflet mobility and coaptation were excellent (Video 2).

**Case 2**

A 58-year-old female patient with a history of hospitalization due to pulmonary edema. The TTE and TEE revealed



**Figure 1. Determining the size of the pericardial annulus using tricuspid ring scales and cutting it in a crescent shape.**



**Figure 3. Surgical image of the completed repair.**

severe rheumatic mitral and tricuspid insufficiency. The patient was weaned from cardiopulmonary bypass with mild inotropic support. Mild residual TR was observed on TEE. The patient remained in the intensive care unit for 2 days. Mild TR was detected on TTE on the fifth day. The annulus diameter, which was 43 mm preoperatively, was measured as 25 mm. The patient, who had an uneventful postoperative course, is scheduled for discharge once the INR level stabilizes.

## DISCUSSION

With this repair, using a novel technique, favorable clinical and imaging results were achieved in a patient with secondary advanced tricuspid regurgitation. The technique focuses on the pathophysiology of secondary TR by reconstructing the annulus to the desired size, thereby achieving an effective downsizing in the valve area. Currently, the most common treatment for TR is ring annuloplasty; however, TR may not be effectively treated due to challenges such as selecting the appropriate ring size, variability in surgical experience regarding suture placement and depth, and the risk of suture dehiscence. Even in the hands of the most experienced surgeons, it may not be curative, especially in patients with significant annular dilation. Annuloplasty does not guarantee the same level of success in every patient. In fact, it has been reported that approximately 40% of patients experience recurrent TR in the long term following a seemingly successful repair.<sup>7</sup>

For secondary tricuspid regurgitation to develop, there must be dilation of the right ventricle and tricuspid annulus. The severity of TR and the clinical presentation are determined by the size of the annulus.<sup>8</sup> Tricuspid regurgitation typically occurs when the annulus diameter exceeds 33-34 mm, and as the size of the annulus increases, the regurgitant volume also proportionally increases. A critical threshold is considered at 40 mm.<sup>9</sup> Therefore, the effective and permanent reduction of the annular ring to which the leaflets are attached should be the primary goal of tricuspid valve repair.

In this technique, the annulus is reduced in 2 stages with 2 suture lines. The first stage involves suturing the outer circumference of the pericardial ring to the native annulus, slightly narrowing the native annulus. In the second stage, the inner circumference of the pericardial ring, where the leaflets are sutured, is adjusted to the size measured with the sizer, achieving a clear and measurable narrowing at the valve orifice. In the patient, the preoperative end-diastolic annular diameter of 41 mm was reduced to 20 mm postoperatively. The width of the pericardial ring changes according to the difference between the wide native annulus and the targeted annular size. This procedure can be easily performed by all surgeons and, most importantly, this method provides a standard success similar to that of a prosthetic valve.

In ring annuloplasty, surgical procedures are performed at the periphery of the natural annulus-valve junction, indirectly reducing the orifice. In this approach, as shown in Figure 1, all interventions are performed centrally, targeting

the orifice region directly on the orifice side of the natural annulus.

The expansion of the tricuspid annulus is possible only in the anterior and posterior aspects. These correspond to the free wall of the right ventricle.<sup>8</sup> Due to this asymmetric nature of tricuspid annular expansion, the area between where the annulus should be and where it currently is resembles a crescent shape with its ends at the anteroseptal commissure and posteroseptal commissure and its widest point at the anteroposterior commissure. Considering the shape of this area, the pericardial patch was shaped similarly to a crescent. An asymmetrical shape with the widest part at the anteroposterior commissure was created, narrowing in both directions, with the narrowest part matching the septal leaflet annulus.

The long-term success rates of existing treatment methods decrease over time. Continued annular dilation and changes in RV geometry can lead to recurrent insufficiency after a successful repair. Therefore, to ensure durable repair, stabilization of the RV base is essential.<sup>6</sup> In this technique, the glutaraldehyde-treated, robust pericardial tissue, with the advantage of maintaining complete ring integrity, supports the entire annulus in a circular fashion, creating excellent stabilization at the right ventricular base. It was believed that, especially in patients with severe pulmonary hypertension and/or large annular diameters, this method will remain stable over the long term and prevent insufficiency, even in cases where recurrence is common.

The technique described is novel and has not been previously performed, although it bears some resemblance to tricuspid anterior leaflet augmentation.<sup>10</sup> Augmentation is used in cases where ring annuloplasty alone is insufficient and is typically combined with ring implantation. The aim is to enlarge the anterior leaflet, thereby increasing the coaptation surface. Although successful early outcomes have been reported, it has not found widespread clinical application. This may be attributed to the inability to standardize the technique, which is highly dependent on the surgeon's experience. Furthermore, it is not suitable for all cases of functional tricuspid regurgitation, and clear criteria for determining which patients would benefit from it have not yet been defined. However, it is believed that the technique can be applied to most TR cases resulting from annular dilation and tethering.

Although tricuspid valve repair was performed simultaneously with mitral valve surgery in the case, this technique is also suitable for isolated tricuspid valve procedures. Depending on the surgeon's preference, it can be performed via sternotomy or right thoracotomy, either under cross-clamp or on a beating heart.

## CONCLUSION

It is believed that if the favorable clinical and imaging results seen in the initial cases are achieved in more cases, this technique will make significant contributions to the surgical treatment of secondary tricuspid regurgitation caused by annular dilation and tethering.

**Informed Consent:** Written informed consent was obtained from the patients.

**Declaration of Interests:** The author has no conflicts of interest to declare.

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**Video 1:** Trace tricuspid regurgitation on postoperative 6<sup>th</sup> month echocardiography.

**Video 2:** Visualization of valve coaptation on postoperative 6<sup>th</sup> month echocardiography.

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