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Original Article

# Autologous Pericardial Band for Tricuspid Valve Annuloplasty: Midterm Results

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## Abstract

**Background:** Even though tricuspid regurgitation (TR) is a frequent cardiac valve disorder, and tricuspid valve annuloplasty (TVA) has been evolved to manage TR for more than 50 years, there is still a substantial controversy regarding the best durable method for TVA. We reported our midterm (3 years) outcomes of TVA using autologous pericardial (AP) band comparing it with DeVega annuloplasty for the management of functional TR.

**Methods:** Between January 2017 and November 2018, about 175 cases with moderate or more TR underwent TVA as a part of primary left-sided valve replacement surgery. Autologous pericardial (AP) TVA was performed in 100 patients, and DeVega TVA in 75 patients.

**Results:** Both groups are comparable as regards preoperative characteristics. Immediate postoperatively, regarding NYHA class, degree of TR, ejection fraction, and pulmonary artery systolic pressure, there was a marked improvement within the 2 groups compared to the preoperative values, without a significant difference between both groups. 94% of patients completed the follow-up period. In hospital death was 2% in the AP group, and 1% in the DeVega group. The AP group showed a marked improvement in the mean degree of TR at the same follow-up period compared to the DeVega group, 12% patients of the AP group and 21% patients of the De Vega group had 3+ or 4+ TR at 3 years postoperative follow up. There was a marked improvement in the Diastolic tricuspid annuloplasty diameter in the AP group compared to the DeVega group. There were 6.3% late deaths in our study.

**Conclusion:** TVA with an AP was more durable than the DeVega in avoiding postoperative TR progression on the midterm results.

**KEYWORDS**
Tricuspid regurgitation, Tricuspid annuloplasty, Autologous pericardial band, Suture annuloplasty

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## Introduction

Even though tricuspid regurgitation (TR) is a frequent cardiac valve disorder, tricuspid valve (TV) surgery has received little attention [1,2]. It is mostly functional rather than organic and it's linked to pulmonary hypertension (PHT) and right ventricle (RV) enlargement [3], both of which are caused by left-side valve problems [4]. As the

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neglected TR is associated with unfavorable outcomes with medical therapy alone, it increases both surgical morbidity and mortality [5]. So, many cardiac surgeons recommend tricuspid valve annuloplasty (TVA) in patients with moderate or severe TR during aortic valve (AV) or mitral valve (MV) surgery. They noticed that TVA had a positive impact on RV geometry and function postoperatively [6].

Currently, the two main procedures for TVA are the DeVega's annuloplasty and the ring annuloplasty in many centers. Nevertheless, there are several disadvantages to DeVega's approach including suture breakage, potential leaflet flaps, and a high recurrence rate of TR, which can range from 10% to 40% in the short to long term follow up [7,8]. Accordingly, ring annuloplasty is becoming more popular in TV surgery, with a decreased TR recurrence rate of 8 to 15% in the early postoperative period [9]. Nonetheless, the implantation of a mechanical ring can influence the RV movement, which can lead to ring fracture, dehiscence, thrombosis, or endocarditis [10]. In addition, the cost of the prosthetic ring is relatively high [1]. On the other hand, the autologous pericardium (AP) has been widely employed in heart surgery, because it is accessible, non-allergic, durable, flexible, infection resistant, and without cost [11]. Recently, transcatheter TVA was introduced [12]. Presently, there is no evidence that one TV annuloplasty procedure is better than the other. We compared the mid-term results of TV repair with an AP-TVA to those with DeVega TVA.

## Patients and Methods

### Study design

From January 2017 to November 2018 a retrospective study was done. This study included patients who were planned for MV, AV, or double valve replacement with concomitant moderate or more than moderate TR, and TV repair was done as a part of primary left-sided cardiac surgery. Patients who had infective endocarditis, concomitant coronary artery bypass grafting, primary PHT, redo cases, emergency cases, significant organic disease, or congenital anomalies of the TV were excluded from the study. According to the TVA techniques, patients were categorized into; an AP-TVA group (No.=100, 57%), and a DeVega TVA group (No.=75, 43%). A transthoracic echocardiography (TTE) assessment was done for all patients before surgery. Using color doppler and systolic flow, the severity of TR was divided into; grade 1+ (mild); grade 2+ (moderate); grade 3+ (moderate to severe), and grade 4+ (severe). Severe TR was considered when the width of vena contracta was >7mm, and the jet area was >10cm2. Also, TR was considered significant regardless of the degree of regurgitation when the diastolic tricuspid annulus diameter (DTAD) was >40mm [13]. When TR was less than grade 2, it was considered an acceptable outcome. The Local Ethical Committee approved the study.

*Figure 1: Intra-operative photo showing AP-TVA in place with competent TV on saline test*

### Operative technique:

After harvesting and preparing the pericardial patch (which was about 6-7 cm long and 3-5 mm wide), it was treated for 10 minutes with 0.6% glutaraldehyde solution then washed with 0.9% saline. All TVA cases were operated through median sternotomy with antegrade cold crystalloid cardioplegic arrest with simultaneous AV and/or MV surgery with mechanical valves. The AP was folded over for a smooth outer surface and sutured to the TV annulus with 5 to 8 interrupted nonabsorbable 2-0 Ethibond sutures, beginning from the posteroinferior aspect of the septal leaflet to the anteroseptal commissure. In the AP-TVA, 2-3 mm interval sutures were used, and in the tricuspid annulus, 5- 6 mm interval sutures

*Table 1: Preoperative patients' characteristics*

| Variable | AP-TVA | DeVega TVA | P value |
|---|---|---|---|
| **Age (years)** | | | |
| Mean | 41.59±11.28 | 40.4±10.7 | 0.243 |
| Range | 18-70 | 19-65 | |
| **Sex** | | | |
| Male (No.%) | 65 (65%) | 48 (64%) | 0.96 |
| **Body weight (kgs)** | | | |
| Mean | 73.9 | 72 | 0.23 |
| Range | 47-105 | 53-110 | |
| **DTAD** | | | |
| Mean | 42±5.62 | 42.6±3.54 | 0.245 |
| Range | 36-49 | 37-48 | |
| **EF (%)** | | | |
| Mean | 55.96±6.32 | 56.62±6.2 | 0.244 |
| Range | 44-70 | 45-70 | |
| **RV diameter (mm)** | | | |
| Mean | 38.48 | 38.92 | 0.316 |
| Range | 26-50 | 28-51 | |
| **Left sided lesion** | No. =100 | No. =75 | |
| MV (No., %) | 53 (53%) | 47 (63%) | |
| Double valve (No., %) | 40 (40%) | 25 (33%) | |
| AV (No., %) | 7 (7%) | 3 (4%) | |
| **PHT (mean mmHg)** | 69 | 73 | 0.145 |
| **TR grads (III, IV)** | 69 (69%) | 53(71%) | 0.15 |
| **NYHA class (III, IV)** | 55 (55%) | 43 (57%) | 0.124 |

were used (Figure 1). The DeVega TVA was done using either pledgeted ethibond 2–0 suture or pledgeted polypropylene 3–0 suture, starting from the anteroseptal commissure and ending at the posteroseptal commissure. As a desired annular size, a mitral sizer of 29 was chosen. The saline test was employed for intraoperative repair testing in all instances, with normal saline infused into the RV, and valve competency was assessed. Trans-esophageal echocardiography was only available in 70 cases.

## Results

175 patients were included in the study. AP-TVA was performed in 100 (57%) patients, while DeVega TVA was in 75 (43%) patients. Both groups are comparable as regards preoperative characteristics (Table 1). The aortic cross clamp time, total bypass time, ventilation time, and hospital stay time were 75 minutes, 111 minutes, 8.8 hours, and 7.7days in AP group, however in the DeVega group, it was 76 minutes, 115 minutes, 9.2 hours, and 8.5 days respectively. During follow-up visits (on discharge and every 6 months for 3 years), we examined the patients clinically and by TTE examination. Both techniques were completed in less than 15 minutes (8-15 min). There were 2 (2%) in-hospital deaths in the AP group, one due to low cardiac output, and the other one due to stroke at 7th and 10th postoperative days, while one patient died in the DeVega group (1%) due to pneumonia at 15th postoperative day. In the immediate postoperative period, there was a significant improvement in New York heart association (NYHA) class, degree of TR, and PASP within the two groups compared to the preoperative value (P values of 0.04, 0.01, and 0.033, respectively), with no statistically significant difference could be seen between the two groups (Table 2).

During the 3 years follow-up, 165 (94%) of patients completed the follow-up period, and 10 (6%) patients lost contact (6 from the AP group

*Table 2: Operative and postoperative data*

| Variables | AP-TVA Group | DeVega TVA Group | P value |
|---|---|---|---|
| **Bypass time (min)** | | | |
| Mean | 111.02 | 115 | 0.098 |
| Range | 57-160 | 77-170 | |
| **Cross clamp time (min)** | | | |
| Mean | 75.49 | 76.64 | 0.324 |
| Range | 50 – 110 | 55 – 115 | |
| **Ventilation (hrs)** | 8.8 | 9.2 | 0.07 |
| **Hospital stay (days)** | 7.7 | 8.5 | 0.06 |
| **Complications** | | | |
| Low cardiac output | 5 (5%) | 2 (2.6%) | |
| Rapid atrial fibrillation | 10 (10%) | 5 (6.6%) | |
| Sever pericardial effusion | 5 (5%) | 7 (8%) | |
| Stroke | 1 (1%) | 1(1.3%) | |
| Pneumonia | 0 | 1 | |
| Mediastinitis | 2 (2%) | 2 (2.6%) | |
| **In hospital mortality** | 2 (2%) | 1 (1.3%) | |

and 4 from the DeVega group). There was no significant difference between the two groups in terms of mean NYHA class, PASP, and ejection fraction (EF). The AP group showed a significant improvement in the mean degree of TR compared to the DeVega group (1.3 in group AP group and 1.8 in DeVega group; P value= 0.01) (Figure 2), 3+ or 4+ TR was detected in 11 (12%) of patients in the AP group and 15 (21%) of patients in the DeVega group at 3 years postoperative follow-up. The AP group showed a significant reduction in the DTAD compared to the DeVaga group (Figure 3).

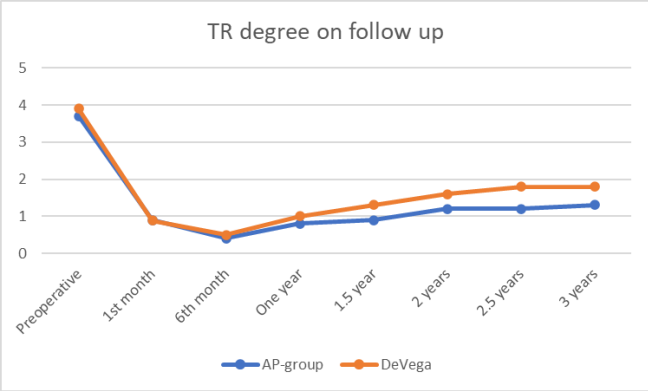


*Figure 2: The degree of improvement and severity of TR in the follow-up period*

There were 11 (6.3%) cases of late deaths in our study (7 in the AP group and 4 in the DeVega group), 4 cases with stuck MV, 2 cases with infective endocarditis, 2 cases with cerebral stroke, and 3 cases with congestive heart failure (HF). As regards the rate of hospital readmission during the 3 years follow-up, in the DeVega group, 12 patients were readmitted for HF, and the free from hospital readmission rate was 84%. While only 5 patients were readmitted for NYHA class IV in the AP group with a significantly higher rate (95%) of free from hospital admission (P = 0.023).

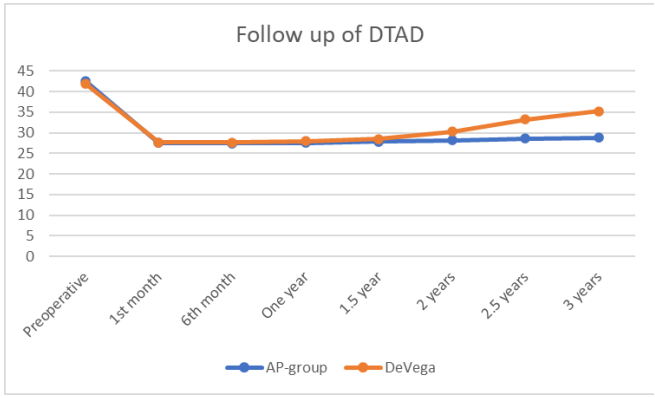


*Figure 3: Diastolic tricuspid annular diameter (DTAD) improvement in the follow up period*

## Discussion

TR is a frequent complication that results from pressure and/or volume overload in the presence of RV failure and annular dilatation in leaflets that are structurally healthy [14]. Secondary TR was thought to improve following left-sided valve surgery alone, and as a result, it was overlooked. On the contrary, some studies have indicated that

surgically untreated secondary TR is a continuing process that can remain or progress even after the accompanying left-side lesion is corrected. They recommended TVA to obtain better results [15]. In accordance, the conservative management of TR has been linked to patients' poor survival and unfavorable long-term consequences. According to current standards, surgery should be performed as soon as signs of RV dysfunction appear [16].

However, TVA is the basic surgical therapy for functional TR, as it enhances leaflets coaptation by correction of annular dilation and restoring annular geometry. The two main groups of TVA are known: the technique that uses a prosthetic ring, such as the Carpentier technique, and the other one is the suturing annuloplasty, that doesn't need a prosthetic ring, such as the DeVega technique [17]. The TV annulus can now freely contract with right ventricular contraction after suture TVA, however, increased RV pressure might cause problems such as suture material separation and breakdown. On the other hand, ring annuloplasty may result in the absence of tricuspid annular contraction, which is important for right ventricular function; although, it protects against tricuspid annulus redilatation and TR recurrence. As a result, there is still substantial dispute about the most physiologic and biocompatible TVA technique [18].

Recently, TVA using a fresh AP strip was tried in different centers and reported good early and late results. It has the following advantages: AP band tissue acts as a powerful supporting structure for the TV leaflets, enhancing their stability. Furthermore, with the migration of endothelial cells postoperatively, the AP band is incorporated into the TV structure, protecting against long-term TV annulus dilatation. The RV function is preserved because this band exhibits a high degree of compliance under stress [1,18].

Most TVA studies are small, and the survival rate and freedom from reoperation are the most important factors to consider. Survival may be attributable to a variety of variables and is not always linked to TVA. Furthermore, freedom from reoperation may be neglected in many persons with high rates of recurrent TR who are not offered surgery due to operating risk [19]. Despite logistical and statistical challenges, the degree of TR, which is the indication for operation, is a better outcome to evaluate [20]. Interestingly, the preoperative advanced right-sided HF, impaired RV function, and severe PHT, according to Czapla J et al (2021), were the independent risk factors that affect mortality and TR recurrence rate, regardless of the TVA technique employed for simultaneous repair of FTR [21].

We compared the midterm results of TVA using the AP technique and the DeVega technique. We found that the immediate postoperative NYHA class, TR degree, DTAD, EF, and PASP were significantly improved within the two groups compared to the preoperative values, without significant difference between the two groups, indicating that both techniques are effective immediately and in the short term follow up (6 months-one year). Also, regarding the aortic cross-clamp time, bypass time, ventilation time, and hospital stay, although it was slightly shorter in the AP- group, still it was not significant. In the contrary to Sohn SH et al (2021), where there was a significant decrease in cross-clamp time and bypass time in DeVega group than in ring group, this may be due to that they used a rigid ring in their study, that required much time for its implantation [22]. During the three-year follow-up, there was no significant difference between the two groups in terms of NYHA class, PASP, or EF. Otherwise, the AP-TVA group showed a marked improvement in the degree of TR and reduction of DTAD compared to the DeVega group during the same period. Similarly, Esmat AA (2011) reported that mean TR improved as a function of time in the AP group; however, it got worse in the DeVega group, and the recurrence-free survival was better for the AP group compared to the DeVega group (86.8% versus 71.9%) [23]. Also, Chang BC et al (2008), in their long-term study found that recurrence-free and long-term survivals after AP were better than that of the DeVega [18]. Tang G.H et al (2006), in their study, reported that ringless TVA causes the TV annulus to dilate with worsened TR due to higher pulmonary artery pressure and RV systolic pressure. While TVA using ring was associated with a lower incidence of TR recurrence, and as

well as improved both long-term and symptoms-free survivals. So, they recommended the routine use of a ring in TVA [24]. In accordance, many authors declared that a TVA using a ring or band had early and late favorable outcomes with lower TR recurrence rates compared to DeVega suture TVA [7,10,25,26]. Nevertheless, other studies showed better results or at least no difference when using the DeVega TVA [27,28].

In our study, there were 3 (2%) in-hospital deaths, which was like Chang et al (2008), which reported a mortality rate of 2.4% [18]. On the other hand, it is lower than previous TVA studies (7.6% - 28%), this was primarily owing to recent studies with good myocardial preservation techniques and very early management before serious HF develops [29,30].

## Study limitations

The retrospective design and midterm follow-up are study limitations. So, further prospective studies with a long-term follow are required to confirm our findings.

## Conclusion

Midterm results (3 years) recurrence-free survival after AP-TVA appeared to be better than that of conventional suture DeVega TVA technique. AP-TVA seems to be simple, reproducible, and a promising technique with great potential for treating functional TR.

**Conflict of interest:** Authors declare no conflict of interest.

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