Tricuspid annuloplasty using autologous pericardial strip versus conventional suture annuloplasty (the De Vega and Kay methods) for repair of functional tricuspid regurgitation

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Background

Tricuspid regurgitation (TR) is a common sequelae associated with left-sided heart valve diseases due to right ventricular and tricuspid annular dilatations. Surgical repair for significant TR has been demonstrated to enhance patient outcomes and lower mortality rates.

Aim

The primary endpoint is to evaluate the short-term outcomes of tricuspid annuloplasty employing a flexible band of autologous pericardium compared with the traditional suture annuloplasty procedures.

Patients and methods

A prospective study was conducted on 100 patients with moderate to severe functional TR and left-sided valvular lesions who comprised two study groups. Group (A) included 50 patients who got tricuspid valve repair utilizing a flexible band constructed of autologous pericardium. Whereas group (B) included 50 patients who had traditional suture annuloplasty. The repaired valve was evaluated intraoperatively.

Postoperative follow-up was done for mean duration of 24 ms±12 ms by clinical examination and transthoracic echocardiography.

Results

Both tricuspid annuloplasty techniques resulted in good short-term outcomes, including improvements in TR status and reduction of right a-trial diameters. The use of a pericardial stripasa flexible band did not exhibit any degeneration or retraction over the duration of the study.

Conclusion

For the surgical repair of functional TR, tricuspid annuloplasty utilizing a pericardial band made of the autologous pericardium is an effective alternative. The surgical decision should be made based on the unique characteristics of the patient and variables related to long-term durability. To verify these findings, more research with bigger populations and longer follow-up times are required.

Keywords:

autologous pericardium, functional tricuspid regurgitation, short-term outcomes, tricuspid annuloplasty, tricuspid regurgitation

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Introduction

In clinical practice, more than 80% of tricuspid regurge cases are secondary or functional in character. One which carries poor outcomes, cardiac failure, impaired functional ability, and mortality [1].

Functional tricuspid regurgitation (FTR) frequently develops as a result of right ventricular volume and pressure overload, dilatation of the cardiac chambers, and left heart failure due to myocardial or valvular causes particularly when there is mitral valve pathology [2–4].

The best surgical method to correct tricuspid regurgitation (TR), whether to repair or replace, how to gain access, and what kind of prosthesis to use, is still debatable [5].

Repair is now the most frequent surgical procedure for FTR due to the significant risk of postoperative problems following tricuspid valve replacement [6].

Suture and prosthetic annuloplasty (i.e., flexible band and remodeling ring) are the two main surgical techniques for tricuspid valve repair.

For tricuspid valve repair by suture annuloplasty techniques like the Kay method (by bicuspidization) and the De Vega approach by reducing annular size semi circularly, are frequently utilized. They are technically simple and having a minimal financial load on the patient, however, they are linked to a rather high prevalence of recurrent TR [7–10].

The dilated annulus can be reduced or remodeled using flexible or stiff prosthetic rings. Prosthetic ring annuloplasty may result in greater avoidance of annular dilatation, right ventricular volume overload, and right ventricular failure as compared with suture techniques [11].

The effectiveness and longevity of specially formed tricuspid prosthetic rings (i.e., flexible or stiff) have not yet been fully clarified [5], and still many reports showed significant postoperative recurrence [5,7,8].

The development of a novel TAP technique with nonabsorbable mattress sutures and autologous pericardial strips. This approach is thought to preserve annular structures, keep the right ventricle's pumping action flexible, and prevent redilatation. Herein, we conducted a prospective study to evaluate the short-term outcomes of tricuspid annuloplasty utilizing a flexible band of autologous pericardium compared with using a traditional suture annuloplasty (De Vaga or Kay technique), particularly in terms of the effectiveness of the repair.

Patients and methods

After local ethical committee approval and informed consent from all participants, a prospective comparative study was conducted on 100 consecutive patients with left-sided valvular lesions (mitral, aortic, and double valves) associated with functional moderate or severe TR who were scheduled for surgical tricuspid valve repair between September 2018 and September 2022.

Patients with Organic tricuspid regurge, isolated tricuspid regurge, mild to moderate tricuspid regurge, recurrent tricuspid regurge following prior repair, patients having to redo mitral or aortic surgery, patients treated with mitral repair, patients with noncardiac hepatopathy, and patients undergoing concurrent procedures like coronary artery bypass grafting were excluded.

The included patients were divided into two groups' at random and each had their left sided valvular lesion(s) addressed by mechanical valve replacement.

Group 1 (Band group): Tricuspid repair was done using pericardial band made of autologous pericardium.

Group 2 (Suture group): Tricuspid repair was done using De Vaga or Kay method of repair.

All patients had the routine preoperative evaluation including full clinical examination, Full laboratory investigations, and radiological assessment including abdominal ultrasound and echocardiography.

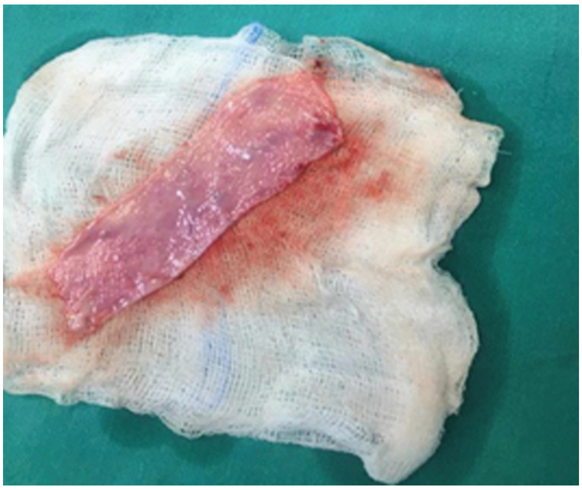
All patients were operated through a median sternotomy incision and underwent a routine one or double valve replacement operation by regular standard cannulation, 28–32°C esophageal temperature, aortic cross clamp and ante-grade cardioplegia and in both groups tricuspid annuloplasty was done on beating heart after declamping.

In the Band group, an autologous pericardial strip (8–10 cm long, 12 mm wide) was harvested and to preserve the smooth surface outward, the strip of pericardium was rolled on itself after being treated in 0.6% glutaraldehyde solution for 10 min and three times in 0.9% saline solution for 5 min Ethibond suture 2-0 was then wrapped around it to provide the pericardium the strength of a band (Figs 1 and 2).

Utilizing the Carpentier Edward tricuspid sizer, the appropriate size of the ring was determined (Fig. 3).

Starting from the postero-inferior side of theseptal leaflet to the anterior-septal commissure, seven to ten 2-0 Ethibond sutures were inserted on the annulus along the anterior and posterior leaflets.

Figure 1

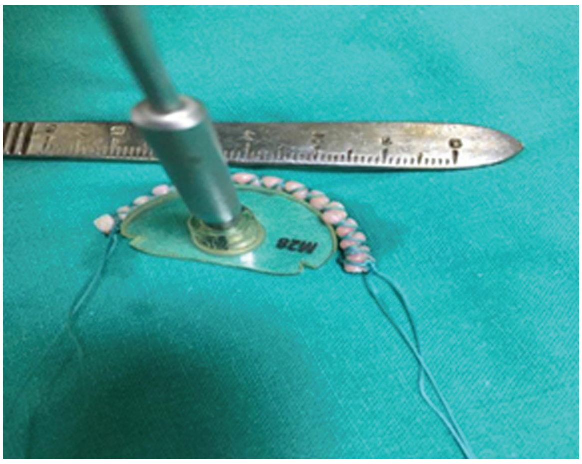


Pericardial strip 8–10 cm long and 12–20 mm wide.

Figure 2

The pericardial strip made as flexible band.

Figure 3

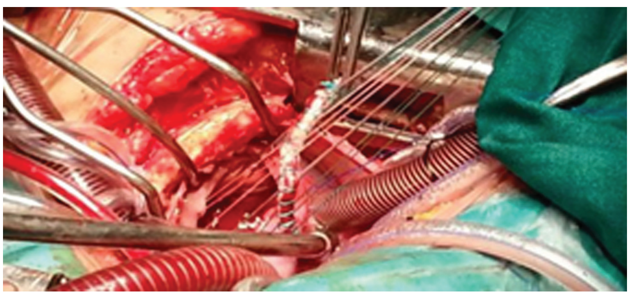


The band length measured according to the suitable sizer of Carpentier Edward tricuspid sizer.

Two–three millimeter interval sutures in the autologous pericardial band and 5–6 mm interval sutures in the tricuspid annulus. The tricuspid annulus was shortened in this manner. (Figs 4 and 5).

In the Suture group, tricuspid annuloplasty was done by conventional repair methods, either with bicuspidization of post leaflet (Kay repair) or by reducing annul arise semi circularly (De Vaga or modified De Vaga).

Figure 4



Sutures placed 5–6 mm on the annulus and 2–3 mm on the band.

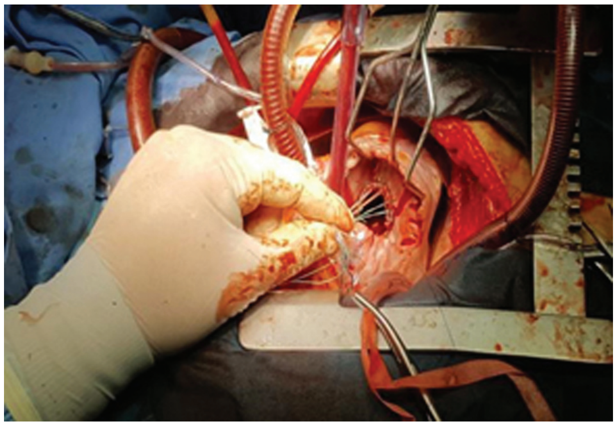
Saline test was used to test the efficacy of the repair in both groups which was confirmed later by Trans osophageal echocardiography (Fig. 6).

Patients were followed-up by clinical examination and echocardiography before discharge, at one month, and then every three months for a year. With mean follow-up period of 24 ms± 12 ms.

Statistical analysis

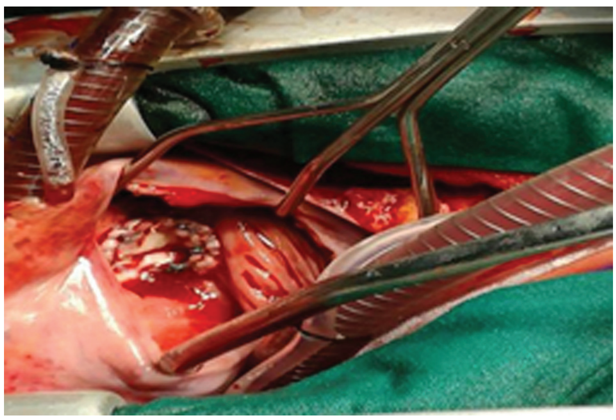
Data were gathered, reviewed, coded, and put into IBM SPSS version 20 of the Statistical Package for Social Science. The quantitative data were displayed as mean, standard deviations, and ranges when their distribution was determined to be parametric, whereas the qualitative data were given as numbers and percentages.

Figure 5



Sutures tightened to shorten the annulus.

Figure 6



Saline test to evaluate the repair for any regurgitated flow.

When the predicted count in any cell was less than 5, the comparison between two groups utilizing qualitative data was made using the Fisher's exact test in place of the χ^2 test.

The independent *t*-test was used to compare two independent groups with quantitative data and parametric distribution.

The allowable margin of error was set at 5%, while the confidence interval was set at 95%. As a result, the significance level for the *P* value was determined as follows: *P* greater than 0.05 = nonsignificant (NS), *P* 0.05 = significant (S), and *P* 0.001 = highly significant (HS).

Results

The mean age of the included patients was 45±10 years. There were 67 (67%) men, and 33 (33%) women, 66 (66%) patients had mitral valve disease, 28 (28%) patients had double valve affection (aorta and mitral), and six (6%) patients had aortic disease. Demographic data and preoperative evaluation were listed in Table 1.

There were 31 (31%) patients with moderate TR, 41 (41%) patients with moderate to severe TR and 28 (28%) patients with severe TR (Table 2).

Postoperatively, there were neither in-hospital mortality nor during the follow-up period. In terms of morbidity, one patient experienced significant pericardial tamponade10 days after surgery, which was brought on by an excessive dose of oral anticoagulant. Four individuals who had rapid atrial fibrillation throughout their hospital stay and were controlled medically with amiodarone. There were 93 (93%) patients had New York Heart Association Functional Classification (NYHA) class I at the 1-year and seven patients in NYHA class II, demonstrating a marked clinical improvement (Tables 3 and 4).

During the follow-up period, postoperative echocardiographic follow-up showed marked improvement in the degree of TR. Recurrent TR was defined as postoperative moderate TR +.

At follow-up, there were 77 (77%) patients with no or trivial regurgitation, 11 (11%) patients with mild

Table 1 Preoperative demographic and clinical data of the patients

	Pericardial Strip No.= 50	Conventional Methods No.= 50	Test value	*P* value	Significance
Age					
Mean±SD	43.82±11.87ys	46.04±14.66ys	-0.832•	0.407	NS
Range	16–68ys	17–76ys			
Sex					
Female	13 (26.0%)	20 (40.0%)	2.216*	0.137	NS
Male	37 (74.0%)	30 (60.0%)			
Preoperative NHYA classifications					
I	0	0	3.324*	0.190	NS
II	15(30.0%)	23 (46.0%)			
III	31 (62.0%)	22 (44.0%)			
VI	4 (8.0%)	5 (10.0%)			
PhysicalexaminationPre			–	–	–
Cyanosis	10 (20.0%)	12 (24.0%)	0.233*	0.629	NS
Jaundice	8 (16.0%)	10 (20.0%)	0.271*	0.603	NS
Neckveinengogment	12 (24.0%)	11 (22.0%)	0.056*	0.812	NS
Hepatomegaly	6 (12.0%)	3 (6.0%)	1.099*	0.295	NS
Prescenceofascities	8 (16.0%)	6 (12.0%)	0.332*	0.564	NS
Pitting edema	25 (50.0%)	27 (54.0%)	0.160*	0.689	NS
Atrial fibrillation	38 (76.0%)	36 (72.0%)	0.208*	0.648	NS
AST					
<40	34 (68.0%)	37 (74.0%)	0.437	0.509	NS
>40	16 (32.0%)	13 (26.0%)			
ALT					
<40	38 (76.0%)	37 (74.0%)	0.053*	0.817	NS
>40	12 (24.0%)	13 (26.0%)			
Total bilirubin					
< 1	42 (84.0%)	40 (80.0%)	0.271*	0.603	NS
≥1	8 (16.0%)	10 (20.0%)			

P-value greater than 0.05:Nonsignificant (NS); *P* value less than 0.05:Significant (S);*P* value less than 0.01:highlysignificant (HS). $^*\chi^2$Chi-square test. •Independent *t*-test. ALT, alanine transaminase; AP-TAP, Annuoplasty-Tricuspid annuloplasty pericardial strip; AST, aspartate transaminase; PAH, Pulmonary artery hypertension.

Table 2 Preoperarive echocardiography data

	Pericardial Strip No.=50	Conventional Methods No.=50	Test value	*P* value	Significance
Tricuspid rugurge assosiated with					
Mitral disease	32 (64.0%)	34 (68.0%)	0.203*	0.903	NS
Aortic disease	3 (6.0%)	3(6.0%)			
Double	15 (30.0%)	13 (26.0%)			
Degree of severity					
Moderate	13 (26.0%)	18 (36.0%)	1.169*	0.557	NS
Moderate to severe	22 (44.0%)	19 (38.0%)			
Severe	15 (30.0%)	13 (26.0%)			
Ejection fraction					
Mean±SD	57.54±8.73	55.60±8.73	1.111•	0.269	NS
Range	38–70	38–70			
Tricuspid annulus					
Mean±SD	43.03±3.449	42.51±3.54	0.553•	0.459	NS
Range	36–48	37–48			
RV Diameter					
Mean±SD	38.37±4.709	37.55±4.625	0.772•	0.382	NS
Range	29–46	29–48			
PHTN					
Mean±SD	52.30±15.19	48.70±9.78	1.409•	0.162	NS
Range	30–85	35–70			
No	0	0			
Mild	14 (28.0%)	12 (24.0%)			
Moderate	23 (46.0%)	22 (44.0%)			
Severe	13 (26.0%)	16 (32.0%)			
RV dysfunction					
No	14 (28.0%)	12 (24.0%)	0.208*	0.648	NS
Yes	36 (72.0%)	38 (76.0%)			
Mild	13 (26.0%)	10 (20.0%)			
Moderate	17 (34.0%)	20 (40.0%)			
Severe	6 (12.0%)	8 (16.0%)			
AF					
No	12 (24.0%)	14 (28.0%)	0.208*	0.648	NS
Yes	38 (76.0%)	36 (72.0%)			

P value greater than 0.05:Nonsignificant (NS); *P* value less than 0.05:Significant (S); *P* value less than 0.01:highlysignificant (HS). $^*\chi^2$ Chi-square test. •: Independent *t*-test. AF, Atrial fibrillation; EF, Ejectionfraction; PHTN, Pulmonaryhypertension; RVD, Rightventriculardiameter.

regurgitation and 12 (12%) patients with moderate regurgitation.

The 12 (12%) patient, who had recurrent TR, there were certain preoperative characteristics of low ejection fraction, severe pulmonary hypertension, associated mitral regurgitation, atrial fibrillation and severely dilated both right ventricle and tricuspid annulus which may explain the recurrence. They were treated conservatively on antifailure treatment. (Tables 5 and 6).

Discussion

FTR, particularly associated with mitral valve regurgitation or stenosis, is still a frequent finding. It is mostly brought on by right ventricular (RV) hypertrophy, which results in dilatation and flattening of the tricuspid valve (TV) annulus [12]. The uncorrected pathology during surgery that caused the late onset of tricuspid regurgitation sparked interest in tricuspid valve repair as a predictor of clinical outcome and even late death [13].

According to the 2007 European Society of Cardiology (ESC) recommendations, TV annuloplasty should be done in patients with severe TR who are having left-sided valve surgery (class IC) and in those with moderate TR who have a dilated annulus (maximum systolic tricuspid annulus, TA >40 mm, 4-chamber view) and who are getting left-sided valve surgery (class IIA, level C) [12].

According to the 2008 American Heart Association (AHA)/American College of Cardiology (ACC) guidelines, patients with severe TR who need MV surgery for MV illness (class IB) should have TV annuloplasty. In patients undergoing MV surgery

Table 3 Intraoperative data

Operative data	Pericardial Strip No.= 50	Conventional Methods No.= 50	Test value•	P- value	Significance
Clamping time			–	–	–
Tricuspid+ mitral					
Mean± SD	67.52±3.81	66.62±3.79	0.961	0.340	NS
Range	61.23–76.98	60.43–72.23			
+aortic					
Mean± SD	94.45±3.19	80.00±6.25	3.571	0.063	NS
Range	91.23 –97.6	73–85			
+double					
Mean± SD	98.33±4.67	100.88±2.13	-1.817	0.081	NS
Range	89.55 –103.44	95.43 –103.44			
Bypass time			–	–	–
Tricuspid+ mitral					
Mean± SD	92.95±5.51	92.66±7.04	0.034	0.854	NS
Range	81.24 –103	78.97 –101.24			
+aortic					
Mean± SD	102.84±6.59	85.93±18.50	2.222	0.210	NS
Range	98.76–110.44	72.30–107			
+double					
Mean± SD	122.46±8.85	127.00±3.49	3.013	0.094	NS
Range	111.6–136.6	120.67–132.2			

P value greater than 0.05:Nonsignificant (NS); *P* value less than 0.05:Significant (S); *P* value less than 0.01:highlysignificant (HS). *χ^2 Chi-square test. •Independent *t*-test

Table 4 Comparison between pericardial strip (no.=50) and conventional methods (no.=50) regarding F. status postoperative

F. Status	Pericardial Strip No. (%)	Conventional Methods No. (%)	Test value*	P value	Significance
1 Week					
Class 1	0	0	7.648	0.072	NS
Class 2	7 (14.0%)	3 (6.0%)			
Class 3	43 (86.0%)	41 (82.0%)			
Class 4	0	6 (12.0%)			
3 months					
Class 1	7 (14.0%)	6 (12.0%)	0.899	0.638	NS
Class 2	34 (68.0%)	38 (76.0%)			
Class 3	9 (18.0%)	6 (12.0%)			
Class 4	0	0			
6 months					
Class 1	46 (92.0%)	43 (86.0%)	0.919	0.338	NS
Class 2	4 (8.0%)	7 (14.0%)			
Class 3	0	0			
Class 4	0	0			
9 months					
Class 1	46 (92.0%)	47 (94.0%)	0.154	0.695	NS
Class 2	4 (8.0%)	3 (6.0%)			
Class 3	0	0			
Class 4	0	0			
F. Status					
1 Year					
Class 1	46 (92.0%)	47 (94.0%)	0.154	0.695	NS
Class 2	4 (8.0%)	3 (6.0%)			
Class 3	0	0			
Class 4	0	0			

P value greater than 0.05: Nonsignificant (NS); *P* value less than 0.05: Significant (S); *P* valueless than 0.01: highly significant (HS). *χ^2Chi-square test. •Independent *t*-test

Table 5 Follow-up echocardiography data at 1 week, and at 6 month

Post 6 months	Pericardial Strip No. (%)	Conventional Methods No. (%)	Test value*	*P* value	Significance
Follow-up of TR at 1 week					
No	20 (40.0%)	14 (28.0%)	2.717	0.437	NS
Mild	27 (54.0%)	30 (60.0%)			
Moderate	3 (6.0%)	5 (10.0%)			
Severe	0	1 (2.0%)			
Follow-up of TR at 6 month					
No	40 (80.0%)	30 (60.0%)	5.344	0.148	NS
Mild	7 (14.0%)	12 (24.0%)			
Moderate	3 (6.0%)	7 (14.0%)			
Severe	0	1 (2.0%)			
PAH					
No	23 (46.0%)	16 (32.0%)	2.465	0.482	NS
Mild	16 (32.0%)	18 (36.0%)			
Moderate	5 (10.0%)	6 (12.0%)			
Severe	6 (12.0%)	10 (20.0%)			
RV Dysfunction					
No	31 (62.0%)	25 (50.0%)	1.480	0.686	NS
Mild	11 (22.0%)	15 (30.0%)			
Moderate	8 (16.0%)	10 (20.0%)			
Severe	0	0			
LVEF					
>45%	16 (32.0%)	12 (24.0%)	0.138	0.710	NS
<45%	43 (86.0%)	38 (76.0%)			
LV Dysfunction					
No	0	0	2.158	0.540	NS
Mild	16 (32.0%)	12 (24.0%)			
Moderate	30 (60.0%)	43 (86.0%)			
Severe	4 (8.0%)	4 (8.0%)			
AF					
Yes	26 (52.0%)	27 (54.0%)	0.040	0.841	NS
No	24 (48.0%)	23 (46.0%)			

P value greater than 0.05: Nonsignificant (NS); *P* value less than 0.05: Significant (S); *P* value less than 0.01: highly significant (HS).
*χ^2Chi-square test. •Independent *t*-test.

who have pulmonary hypertension or tricuspid annular dilatation (class IIB), TV annuloplasty for TR less than severe should be recommended [14].

Surgery for functional TR is recommended by AHA/ACC recommendations in patients with severe TR who are having surgery for left-sided valvular disease (Class I, level evidence C) [15]

The 2017 ESC guidelines for Valvular Heart Disease Management, the Task Force for Valvular Heart disease management, patients receiving left-sided valve surgery (class I C) who have significant secondary TR may consider surgery. Patients having left-sided valve surgery who have mild or moderate secondary TR and a dilated annulus (defined as >_40 mm or > 21 mm/m^2 by two dimensional echocardiography) should think about surgery [15].

When prior recent right-heart failure has been established, surgery may be recommended in patients having left-sided valve surgery who have mild or moderate secondary TR even in the absence of annular dilatation (class IIb C) [15].

The conundrum of annular reduction for functional TR is how much the annulus has to be tightened. Remodeling the annulus to a certain position and circumference by either suture annuloplasty or band annuloplasty used the same concept [16].

In our study, tricuspid annular dilatation greater than 40 mm was found in 92 (92%) patients and only 8 (8%) patients had tricuspid annulus less than 40 mm. The 12 patients who had significant postoperative TR had the highest preoperative annular diameter.

The relationship between annular size and TR is not entirely evident, though. Sadeghi and colleagues reported 27 individuals with pulmonary thromboembolism who had severe pulmonary hypertension and severe TR in an intriguing

Table 6 Follow-up echocardiography data at 1 Year

Post 1 Year	Pericardial Strip No. (%)	Conventional Methods No. (%)	Test value*	*P* value	Significance
Follow-up TR at 1 Year					
No	42 (84.0%)	35 (70.0%)	2.788	0.425	NS
Mild	4 (8.0%)	7 (14.0%)			
Moderate	4 (8.0%)	8 (16.0%)			
Severe	0	0			
PAH					
No	29 (58.0%)	28 (56.0%)	4.248	0.235	NS
Mild	21 (42.0%)	18 (36.0%)			
Moderate	0	4 (8.0%)			
Severe	0	0			
RV failure					
No	41 (82.0%)	31 (62.0%)	6.349	0.095	NS
Mild	9 (18.0%)	16 (32.0%)			
Moderate	0	3 (6.0%)			
Severe	0	0			
LVEF					
>45%	47 (94.0%)	42 (84.0%)	2.554	0.110	NS
<45%	3 (6.0%)	8 (16.0%)			
LV Dysfunction					
No	22 (44.0%)	20 (40.0%)	2.559	0.464	NS
Mild	25 (50.0%)	22 (44.0%)			
Moderate	3 (6.0%)	8 (16.0%)			
Severe	0	0			
AF					
Yes	21 (42.0%)	23 (46.0%)	0.162	0.687	NS
No	29 (58.0%)	27 (54.0%)			

P value greater than 0.05: Nonsignificant (NS); *P* value less than 0.05: Significant (S); *P* value less than 0.01: highly significant (HS).
*χ^2Chi-square test. ●Independent *t*-test.

research. They had surgery without undergoing TV annuloplasty. In 19 (70%) patients the TR was reduced to mild, and the pulmonary pressure decreased by an average of 49 mmHg. Pulmonary pressure dropped to 32 mmHg in the remaining 30% of patients, which was lower than in the other group. TR remained severe in these individuals. It is interesting to note that the annular sizes in both groups were practically identical (41 mm in the first group and 42 mm in the second group in the postoperative evaluation) and similar (4 mm decrease between pre- and postoperative echocardiograms). We may infer that the processes relating to RV reverse remodeling, following pulmonary artery pressure (PAP) decrease of various degrees, are more significant than the pure annular size, even if the annulus remains dilated [17].

On the other hand, despite the previous study's easy inference, the relationship between pulmonary hypertension and the severity of TR is not always evident. In a recent echocardiographic examination of 2139 pulmonary hypertension patients, Mutlak and colleagues discovered that only 46% of those with PAPs more than 70 mmHg and over 65% of those with PAPs between 51 and 69 mmHg had TR that was relatively mild.

In our study, 45 (45%) patients had moderate pulmonary hypertension, while 29 (29%) patients had severe pulmonary hypertension. Mild pulmonary hypertension affected 26 (26%) of the individuals. The 12 patients who experienced considerable TR postoperatively had severe pulmonary hypertension before surgery, but we are unable to link this to a predisposing condition based on this finding.

Unfortunately, since the functional TR mechanism does not exclusively in the annulus, the surgical procedures often used, which are primarily oriented at annular reduction, have variable effects.

For functional TR, several of surgical tricuspid annuloplasty procedures have been developed. These included annuloplasty employing a pericardial strip, a flexible band, and hard rings, as well as suture plication [18].

According to a study by Kunová *et al.* utilizing the De Vega modified approach, after one year of follow-up, 53.3% of patients had mild TR, 13.3% had moderate TR, and none had severe TR.

Although the De Vega annuloplasty has been used frequently for functional TR in different circumstances, there has been concern that the procedure's long-term outcomes are less favorable than those of the prosthetic ring annuloplasty [19].

In their study comparing De Vega with ring annuloplasty in the treatment of severe functional tricuspid insufficiency and the effects on RV function, Hamdy *et al.* The patients were split into two groups: group A (n=34) had De Vaga suture repair, whereas group B (n=17) received ring annuloplasty. According to a six-month follow-up, group A patients had a 50% mild TR, a 26.5% moderate TR, and an 11.8% severe TR [20]

Shinn and colleagues [21]. stated in their study that for patients who had ring and suture-annuloplasty, the likelihood of residual TR grade 0 or 1 decreased with time comparable. For patients in both groups, the projected likelihood of a TR grade 3 or 4 at one year was 10%.

Numerous studies show that rigid ring annuloplasty is superior than suture repair for treating FTR when it comes to durability and the absence of residual regurgitation.

McCarthy *et al*. stated that four distinct TV repair procedures' surgical results in individuals who underwent the procedure were compared. Early follow-up revealed that the severity of TR regurgitation was comparable amongst the four operations, but as time went on, residual TR deteriorated more quickly in patients who had De Vaga suture repair (P value 0.002) [5].

As a result, using a prosthetic ring has been increasingly recognized as the best practice. On the other hand, some authors have previously suggested performing tricuspid annuloplasty using a strip of autologous pericardium rather than prosthetic material [22].

There are not many clinical studies on this approach, but one that compared the P-TAP procedure to suture annuloplasty discovered that patients who had pericardial strip treatment had a superior TR recurrence-free survival rate [18].

In a different trial, autologous pericardium was used, and with an average follow-up of just 3 years, the outcomes were equivalent to those of ring annuloplasty [23].

On the other hand, several studies back the use of flexible prosthetic bands, particularly over suture approaches, such as Dacron or polytetrafluroethil in (PTFE), due to their availability and simplicity of usage with positive postoperative outcomes. Due to the fact that both flexible bands and stiff rings proved to have positive midterm results in recent meta-analysis studies, suture annyloplasty has become less practical nowadays for FTR repair [24].

The flexibility of the band allows for a more straightforward design and implantation method with reduced chances of device breakages and tricuspid stenosis following device implantation. Additionally, there is a very little chance that the bands may damage neighboring coronary arteries and cardiac tissue during surgery. Additionally, flexible bands can help preserve RV functionality and speed up its recuperation following surgery [25].

The flexible bands are intended to let the tricuspid annulus normal physiological mobility during the cardiac cycle, however this might prevent the saddle annulus from being maintained in the ideal position [26].

Carpentier created the idea of a remodeling tricuspid ring more than three decades ago. Although this ring has a two-dimensional shape, it is semi-rigid, allowing the implant surgeon to modify it to fit the saddle-shaped TV annulus. In large series, the effectiveness of this ring has been demonstrated.

This idea has been included in the Edwards MC3 annuloplasty system (Edwards LifeSciences). It is robust, three-dimensionally designed, and preconfigured to fit the annulus' saddle-shaped configuration [27].

Other investigations have also noted ring fracture as a rare side effect of the stiff ring in the tricuspid position [28].

Following TV repair for FTR, patients saw remarkable success in regaining their typical life expectancy. When compared with suture and flexible band repair techniques, the tricuspid annular brace or semi-rigid brace repair treatment demonstrated improved durability [29].

Gatti and colleagues [30] compared band TV annuloplasty (B-TVA) with ring TV annuloplasty

(R- TVA) for functional TR, and their findings corroborated our findings in this investigation. Three flexible bands, one conventionally hard ring, and two rigid three-dimensional rings were employed, totaling six different types of tricuspid annuloplasty systems. They claimed that both were successful in repairing TVs, but that ring annuloplasty had more dramatic long-term results than band annuloplasty in terms of the total reversal of right ventricular remodeling.

McCarthy *et al.* recently published their experience at the Cleveland Clinic, which involved 790 patients who had TV annuloplasty surgery using four different techniques (the De Vega repair, the pericardial patch, the Cosgrove flexible band [Edwards LifeSciences], and the Carpentier-Edwards ring [Edwards LifeSciences]).

This study reaffirmed prosthetic annuloplasty's superiority to other repair methods.

A noteworthy result of McCarthy and colleagues' investigation was that functional TR was not always eliminated by tricuspid annuloplasty. About 15% of patients who underwent prosthetic annuloplasty were found to have considerable residual TR (i.e., 3+ to 4+) after one month, according to the investigators.

The size of the ring was not included as a risk factor for recurrent TR, they said. In contrast, 84% of patients who received remodeling annuloplasty in their series had a ring that was more than or equal to 30 mm, as opposed to 16% of patients who had a 26 mm or 28 mm ring implanted [31].

In comparison, only 33% of patients had rings implanted that were bigger than or equal to 30 mm in Filsoufi *et al.*'s study, which employed a size 26 mm or 28 mm ring in 67% of patients. With the exception of one patient, predischarge follow-up echocardiogram (n=45; 74%) did not reveal any residual or recurrent TR (i.e., > 1+) [32].

Although it is challenging to compare these two studies, it appears that systematic prosthetic ring downsizing in this series—rather than ring type—has likely played a significant role in lowering the incidence of significant residual or recurrent TR, or both, after repair [32].

In our study, patients were measured using sizers of 28 mm, which equals 5.4 cm of band length, 30 mm, which equals 5.7 cm of band length, and 32 mm, which equals 6 cm of band length.

The annular circumference was lowered to a set value of 78.5 mm (circumference of #25 mm sizer) by Calafiore *et al.* using a flexible 50 mm long band. They applied this method to 15 individuals with TR in a row. The sutures are all then converted to a 50 mm band. All patients were still alive and symptom-free 5.4 months after surgery on average. One patient had 2/4 TR residuals due to enlarged RV with high pulmonary pressure despite a well-functioning mitral prosthesis. They considered this technique for tricuspid repair simple and reliable, providing effective and reproducible results.

Chang and colleagues [33] between January 1997 and April 2006, 334 patients with functioning TR underwent tricuspid annuloplasty (mean age: 52.7 years). Mitral valve replacement and mitral-aortic valve replacement were concurrent surgeries in 261 patients and 73 patients, respectively. In 117 patients, they had traditional suture annuloplasty (De Vega or Kay), and in 217 patients, they underwent autologous pericardial strip annuloplasty.

Higher preoperative TR grade was shown by multivariate binary logistic regression analysis to be an independent predictor for the emergence of substantial postoperative residual TR following TAP (odds ratio, 2.954; 95% confidence range, 2.132 to 4.093; P 0.001).

In this study, there was significant postoperative residual TR early after De Vega or Kay annuloplasty in 11.8% (11 of 93 patients) and in 10.8% (22 of 203 patients) after AP-TAP (P=0.843).

The method of TAP was not identified as a risk factor for postoperative residual TR. They considered this technique a routine for patients with functional TR with dilatated annulus undergoing aorticormitral valve surgery because it is very simple and inexpensive and a reliable method for TAP [33].

In our study, we modified this technique giving more strength to the pericardial strip transforming it into band and measured the length of the band according to the matching sizer for each case. We gained the advantages of the flexible band taking into consideration the simplicity and reproducibility of the technique. Moreover, it is very economic.

In comparison between Pericardial Strip and conventional methods groups regarding preoperative NHYA, physical examination, pre aspartate transaminase (AST), alanine transaminase (ALT) and total bilirubin, we found that there was no statistically significant difference found between Pericardial Strip and conventional methods.

Regarding the comparison between Pericardial Strip and conventional methods for the association with tricuspid rugurge, degree of severity, ejection fraction, tricuspid annulus, RV diameter, PHTN, RV dysfunction and AF, we found that there was no statistically significant difference found between the two methods.

The improvement of TR status, after surgical repair, was accompanied by a reduction in RA diameter in both groups at the three follow-up time points. These findings coincided with the variation of TR grades at two years follow-up. Many studies have reported similar findings in regard to the outcome and durability of suture annuloplasty [34].

This study had several flaws, including a two-center design, a brief follow-up period, and a small sample size that might lead to bias. As a result, the findings cannot be taken as definitive and need to be supported by other research. To compare it to stiff annuloplasty in the future, further research has to be done. Though long-term outcomes would be extremely beneficial, our results are encouraging.

Conclusion

Tricuspid annuloplasty employing an autologous pericardial band is a recognized treatment for functional TR. Both annuloplasty methods have positive short-term results, with an improvement in TR status and a decrease in RA diameters.

The current study results show that, when compared with the results of studies using the current gold-standard annuloplasty a prosthetic ring, the TAP approach for tricuspid annuloplasty (based on the use of a strip of autologous pericardium) is not inferior.

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Conflicts of interest

There are no conflicts of interest.

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