

## TRICUSPID VALVE INSUFFICIENCY AND ITS MANAGEMENT

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### ABSTRACT

A retrospective review has been done on the management of 178 patients (mean age  $42.53 \pm 3.68$  years) who underwent tricuspid valve annuloplasty for correcting the incompetent tricuspid valves (functional regurgitation and stenosis cases). The De Vega method was practiced on 172 (97%) of the patients. Tricuspid regurgitation of varying degrees and in association with other valve lesions was present in almost all of the cases. It was severe in 84% of the cases. Mitral regurgitation was severe in 56% of the patients. Aortic regurgitation was less prevalent and was graded as severe in 12%, whereas pulmonary regurgitation was 0.6% of severity. Only 2.8% of the patients had single procedure tricuspid valve (TV) surgeries. The rest had concomitant mitral valve (MV), aortic valve (AV) and or pulmonary valve (PV) surgery. Pre and post operative regurgitation reflected an appreciable improvement and gave significant results, at the immediate and mid-term assessment. Thus the De Vega procedure, which was the method employed most during the studied period remains a valid surgical option for tricuspid annuloplasty.

**Key words:** Tricuspid valve, regurgitation, De Vega, annuloplasty, stenosis.

### INTRODUCTION

Tricuspid regurgitation (TR) and mitral regurgitation (MR) frequently develop in patients with left ventricular systolic dysfunction (LVSD).<sup>1</sup> In cases of rheumatic heart disease, TR is usually functional, occurring secondary to pulmonary hypertension, and is seen in longstanding chronic mitral or aortic valve lesions.<sup>2</sup> Correction of the left-sided lesions always resulted in regression of the condition, if the case was mild.<sup>3</sup> Failure to correct moderate or severe cases of TR probably worsens the postoperative situation due to persistent right ventricular failure.<sup>4</sup> Patients, who require tricuspid valve surgery after mitral valve operations were usually mild cases of TR.<sup>5</sup>

More than three decades ago, specific tricuspid valve repair (Carpentier ring) was in use,<sup>6</sup> though other surgeons employed different methods

of repair.<sup>7</sup> Among various methods for replacement and repair of functional TR, incompletely encircling suture<sup>8</sup> and "Prosthetic-ring annuloplasty" became more popular.<sup>9</sup> In the case of organic tricuspid valve disease (TVD), these methods are not always effective<sup>10</sup> and preference is for tricuspid valve replacement.<sup>11</sup> The Cleveland Clinic Foundation's team has shown their expertise and vast experience in repairing the functional tricuspid regurgitation, employing the different annuloplasty techniques.<sup>12</sup> These are definitely appreciable efforts in facing the regularly encountered tricuspid regurgitation, following surgical intervention for severe left ventricular dysfunction (SLVD).<sup>1,13</sup>

Most series of tricuspid valve repairs are small and focus on gross outcomes such as freedom from reoperation or survival. However, freedom from reoperation may seriously underestimate the prevalence of residual or

recurrent tricuspid regurgitation because tricuspid valve reoperation is considered "high risk" and may not be offered and late survival depends on many factors other than durability of tricuspid valve repair. The purpose of this work was to study the degree of severity of tricuspid regurgitation using echocardiography pre and postoperatively, and to evaluate the method mostly employed in managing valvular regurgitation and assess the early and late outcomes within a definite period.

## MATERIAL AND METHODS

### Patients

During the period of 1985-2003, 232 cardiac patients were treated surgically at Prince Sultan Cardiac Centre (PSCC) in Riyadh, Saudi Arabia, for tricuspid valve regurgitation alone or with other valve surgeries. Only 178 patients (58 males and 120 females; mean age  $42.53 \text{ yr} \pm 3.68 \text{ SEM}$ ; range: 7 to 88 years) were selected for this study and the rest were excluded. The exclusion criteria were based on those patients who died or did not complete five or 10 years follow-up after surgery. A study protocol was designed with the preoperative, operative and postoperative variables for recording the information that was collected from the patients' files.

### Classification of TR and follow-up

The classification of significant TR was made by echocardiography according to the procedure reported by Yada et al.<sup>14</sup> Briefly the severity of TR was assessed in four grades based on the distance in the four chambers view from the cardiac apex and graded as normal, mild, moderate and severe regurgitation.

The total follow-up period of the patients was done for 10 years. Immediate post operative and follow-up echocardiography reports for five years and ten years after surgery were collected from the patients' files. Those patients who died or did not complete 10 or five years after the operation were excluded from the study.

### Surgical technique

Though the surgeon's preference of a technique and availability of the device were a common factor but, the De Vega procedure

remained as the method of choice during all this period. The De Vega operation was used in 172 patients. There are several modifications of this technique; however, we employed the reported below in almost all of our operations.

The patient was put on the cardiopulmonary bypass and was cooled to 25 °C. The mitral and/or aortic valve procedure is performed on cross clamp and anti-grade cold blood cardioplegia. At rewarming stage, and after removal of the cross clamp on beating heart, both cavae (superior and inferior) are snared and the right atrium is opened. De Vega annuloplasty is performed with 3/0 Prolene with reflen pledgets starting at the annulus on one-side septal leaflet going to anterior and posterior leaflets annulus until the other side of the of the septal leaflet to avoid the conduction system. The suture is pursestringed on 20 cc syringe plunger or 2 fingers of surgical assistant. Testing is carried by injecting cold saline, while obstructing the pulmonary artery. Repair is accepted if TV leaflets coapted well, filling the RV and creating enough RV pressure to give a small jet of regurgitation through the coapted leaflets. The RA (Right Atrium) is closed and came off bypass. The ring is used in the same technique but, using +2 Ticron sutures to fix the ring in the same place described above of TRV (tricuspid valve replacement) annulus.

### Statistical analysis

Linear regression and Fisher's exact tests were employed to evaluate pre and post operative regurgitation comparisons. Patient characteristics and the employed annuloplasty techniques were reflected as descriptive statistics and percentages.

### Results

Medical records of 178 selected patients from 1985 to 2003 were reviewed according to the pre-designed protocol. There were 58 (32.6%) males and 120 (67.4%) females (Table 1). The De Vega procedure was performed on 97% (n = 172) of the selected patients. Other techniques, which were performed within a limited range were the Duran ring (2.8%; n = 5) and the Carpentier-Edwards (CE) ring, which was performed on a single (0.6%) patient. The patients' clinical characteristics are as shown in Table -1

**Table -1: Pre and postoperative overall patient characteristics**

Variables	Overall No (%)	De Vega No (%)	Duran Ring No (%)	CE Ring No (%)
Total patients No.	178 (100)	172 (97)	5 (2.8)	1 (0.6)
Age (yr ± SD)	41.30± 1.67	40.83± 24.08	40.40± 13.39	49.50± 4.95
Female gender	120 (67.4)	117 (65.7)	3 (1.7)	0 (0.0)
Tricuspid regurgitation grade				
Normal	1 (0.6)	1(0.6)	0 (0.0)	0 (0.0)
Mild	5 (2.8)	5 (2.8)	0 (0.0)	0 (0.0)
Moderate	23 (12.9)	21(11.8)	2 (1.1)	0 (0.0)
Severe	149 (84)	145 (81.5)	3 (1.7)	1 (0.6)
Mitral regurgitation grade				
Normal	18 (10.1)	17 (9.5)	1 (0.6)	0 (0.0)
Mild	15 (8.4)	14 (7.8)	1 (0.6)	0 (0.0)
Moderate	38 (21.3)	38 (21.3)	0 (0.0)	0 (0.0)
Severe	100 (56.2)	96 (53.9)	3 (1.7)	1 (0.6)
Aortic regurgitation grade				
Normal	54 (30.3)	54 (30.3)	0 (0.0)	0 (0.0)
Mild	57 (32)	54 (30.3)	3 (1.7)	0 (0.0)
Moderate	34 (19.1)	32 (18)	2 (1.1)	0 (0.0)
Severe	22 (12.4)	22 (12.4)	0 (0.0)	0 (0.0)
Pulmonary regurgitation grade				
Normal	37 (20.8)	35 (19.7)	2 (1.1)	0 (0.0)
Mild	7 (3.9)	6 (3.3)	1 (0.6)	0 (0.0)
Moderate	2 (1.1)	2 (1.1)	0 (0.0)	0 (0.0)
Severe	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)
Preoperative echo function				
< 30%	7 (3.9)	7 (3.9)	0 (0.0)	0 (0.0)
31-44%	15 (8.4)	14 (7.8)	1 (0.6)	0 (0.0)
45-54%	84 (47.2)	81( 45.5)	2 (1.1)	1 (0.6)
≥ 55%	69 (38.8)	67 (37.7)	2 (1.1)	0 (0.0)
Post operative echo function				
< 30%	16 (9)	16 (9)	0 (0.0)	0 (0.0)
31-44%	25 (14.1)	24 (13.5)	1 (0.6)	0 (0.0)
45-54%	66 (37.1)	64 (36)	2 (1.1)	0 (0.0)
≥ 55%	42 (23.6)	39 (21.9)	2 (1.1)	1 (0.6)
Previous cardiac surgery	62 (34.8)	59 (33.1)	3 (1.7)	0 (0.0)
Concomitant procedures				
Mitral valve - replacement	115 (64.6)	112 (62.9)	2 (1.1)	1 (0.6)
- repair	57 (32)	55 (53.9)	2 (1.1)	0 (0.0)
Aortic valve - replacement	36 (20.3)	34 (19.1)	1(0.6)	1 (0.6)
- repair	4 (2.3)	3 (1.7)	1(0.6)	0 (0.0)
Pulmonary valve - replacement	1(0.6)	1 (0.6)	0 (0.0)	0 (0.0)
- repair	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

The majority of patients were preoperatively suffering from rheumatic heart disease (RHD). Thirty-six men (20.2%) and 83 women (46.6%) of the TV group were RHD patients. Thirty-seven men (20.8%) and 83 women (46.6%) of the MV group were RHD patients. Twenty-three men (12.9%) and 41 women (23%) of the AV group were RHD patients (Table 2). A very low percentage (0.6%) of female RHD patients had associated PV problems, whilst none of the males has PV (Table 2). Preoperative tricuspid regurgitation was severe in 84% of the patients, moderate in 12.9%, mild in 2.8% and a single case with undetectable (normal) regurgitation. Mitral regurgitation was mild in 8.4%, moderate in 21.3% and severe in 56.2% of the cases. Aortic regurgitation was mild in 32%, moderate in 19.1% and severe in 12.4% of the cases. Pulmonary regurgitation was mild in 3.9% , moderate in 1.1% and severe in 0.6%.

The overall previous cardiac surgery (reoperation) in all types of valves was found in 34.8% of the patients (n = 62) three of these were Duran ring technique in addition to a single C-E ring. The echo function five years after surgery showed 32.7% with moderate TR and 19.7% severe cases. The echo function 10 years after surgery gave 29% moderate and 27% severe cases of TR. Redo (reoperation) at 10 years follow-up was done in seven cases only (3.9%). Mortality after redo-TV (tricuspid valve replacement) surgery was a single case out of the seven (14%).

Combined valve defect occurrence in patients was graded as single (one valve), double (any two valves), triple (any three valves) and quadruple (the four types of valves). Single cases were fewer than double, or triple, where a directly proportional increase with the cumulative valve combination was observed in both sexes (with the females always more than males). The quadruple combination count was the least in both sexes. Linear regression analysis gave a correlation coefficient of ( $r = 0.9545$ ,  $r^2 = 0.9111$ ) and a significant slope ( $P = 0.0455$ ).

Single procedure for tricuspid valve repair was done in only 5 patients (2.8%). Combined types of surgery (Concomitant procedures) included mitral valve (MV) or pulmonary valve (PV) operations

Table - 2: Preoperative diseases associated with the different types of valves in males and females

Associated disease	Tricuspid valve No (%)		Mitral valve No (%)		Aortic valve No (%)		Pulmonary valve No (%)	
	Female	Male	Female	Male	Female	Male	Female	Male
Rheumatic heart disease	36 (20.2)	83 (46.6)	37 (20.8)	83 (46.6)	23 (12.9)	41 (23)	0 (0.0)	1 (0.6)
Degenerate	5 (2.8)	11 (6.2)	4 (2.3)	17 (9.5)	3 (1.7)	8 (4.5)	0 (0.0)	1 (0.6)
Congenital	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	1 (0.6)	0 (0.0)
Ring dilatation	1 (0.6)	2 (1.1)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Ischemic heart disease	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Others	15 (8.4)	24 (13.5)	17 (9.5)	19 (10.7)	31 (17.4)	71 (39.9)	57 (32)	118 (66.2)
Total	58 (32.6)	120 (67.4)	58 (32.6)	120 (67.4)	58 (32.6)	120 (67.4)	58 (32.6)	120 (67.4)

(double) in 74.7%; MV and aortic valve (AV) operations (Triple) in 22.5%. Differences in the pre and immediate postoperative regurgitation were extremely significant ( $P < 0.0001$ ) in the case of TV and MV and were very significant ( $P < 0.0015$ ) in the case of AV (Table 3). No cases of PR (e" moderate) were observed beyond the age of 60 in both sexes. The lowest records of all four valves were observed at the extremes of life span ( $< 21$  yr and  $> 60$  yr), whilst the highest records were seen at the mid-ages (21-40 yr and 41-60 yr) for both sexes (Data not shown).

### Discussion

This work is an evaluation of a standard technique (De Vega procedure) which was mostly employed to correct the valvular regurgitation over a period of almost two decades. The short term results of the TV, MV and AV operations reflected an appreciable improvement, with significant differences in the degree of regurgitation. Operations done or redone, singly or concomitant on the left side of the heart (MV and the AV) usually resulted in recurring or worsening of the tricuspid regurgitation grade,<sup>2,4</sup> which was initially mild or masked.<sup>5</sup> Experience with the De Vega technique has been supported<sup>15</sup> and considered as the most popular reconstructive surgery for significant functional tricuspid insufficiency,<sup>16</sup> though a modification of this technique has been introduced to overcome the handicaps that lead to early failure after surgery "guitar string valve incompetence".<sup>16</sup>

Rheumatic heart disease (RHD) is of high prevalence in the developing global life. This situation always endows the majority of patients

with combined functional and organic lesions of the tricuspid valve.<sup>2,10</sup> A high percentage of male and female RHD patients were associated with the three types of valve lesions (TV, MV and AV). No association seems to be there between RHD and PV disease, as seen from the extremely low percentage of females and the completely unavailable records of any males. The high ratio of females suffering from TR and MR reflects their susceptibility and vulnerability to cardiac valve disease, and or RHD. The kinds of activities, capabilities and other natural differences could reflect this high ratio of females, which is almost more than double (2:1) the males.

The works of the Cleveland Clinic Foundation group represent important guide lines for the cardiac surgery and cardiology communities<sup>12</sup>. They observed that residual and recurrent regurgitation after tricuspid annuloplasty was common; though, reoperation for tricuspid regurgitation was rare. Patients with single valve disease are fewer than those with double or even triple combination. This situation is always referred to as valve disease association, especially in the case of MV and TV.

Tricuspid valve regurgitation (TR) is usually accompanied by advanced mitral valve disease and is present in 10% to 50% of patients with severe mitral stenosis or regurgitation.<sup>17</sup> The tendency to abandon reoperation may be due in part to the perception that tricuspid annuloplasty is a high-risk procedure.<sup>12</sup> Because severe functional TR rarely regresses spontaneously after repair of the mitral lesion, surgery for TR is almost always

**Table - 3: Significance of the immediate pre and post operative valvular regurgitation**

Degree of R.	Tricuspid R.		Mitral R.		Aortic R.	
	Normal	Detectable	Normal	Detectable	Normal	Detectable
Pre operative	1	177	18	94	54	68
Post operative	25	117	153	52	113	66
Significant level		$<0.0001$ * <sup>1</sup>		$<0.0001$ * <sup>1</sup>		$<0.0015$ * <sup>2</sup>

R: Regurgitation

\*<sup>1</sup>: Extremely significant

\*<sup>2</sup>: Very significant

required.<sup>17-19</sup> This association of tricuspid regurgitation is also encountered in patients with longstanding left-sided valve disease such as left ventricular systolic dysfunction (LVSD),<sup>1</sup> which can be either purely functional, secondary to pulmonary hypertension, or of mixed etiology.<sup>2</sup>

Reoperation for tricuspid valve disease proved to be a high-risk procedure, as 37% of hospital mortality has been recorded, a situation that makes it one of the highest-risk cardiac valve operations.<sup>5,12</sup> In reflection with the practice and experience of the present work, mortality rate due to the redo is appreciably less. When other risk factors related to patient disease are present; such as association of TR with tricuspid stenosis (TS), consideration of tricuspid valve replacement might be warranted<sup>12</sup> and is more often preferred.<sup>11</sup> The records of the Cleveland Clinic team created a self-fulfilling prophecy for patients with recurrent severe tricuspid regurgitation and accordingly suggested aggressive management with diuretics and medication and only referring to surgery in case the patients who develop severe disabling symptoms including hepatic and renal dysfunction.<sup>12</sup>

Mortality perpetuates the situation that tricuspid repair is high risk. The major discrepancy between echocardiography findings of recurrent tricuspid regurgitation and prevalence of reoperation for tricuspid valve disease indicates an important shortcoming in any article reporting the "success" of tricuspid valve annuloplasty techniques. It is of interest to see here a rising ratio in patient number starting from the low count of a single valve to double and triple valves, but in the case of quadruple valves, the count is the lowest and the case appears to be very scarce to document. Due to the low percentage of older PR patients, it is thought to be either of uncommon occurrence or due to mortality at this extreme of age. This could refer to the relatively short durability of the techniques employed.

The complete unavailability of any records of PR (equal to or more than moderate severity) patients beyond the age of sixty could refer to this kind of argument. Exact follow up data to evaluate

this and the survival rate were fragmentary or missing.

It is observed here, that all the techniques employed could not eradicate valvular regurgitation, though we do find a significant improvement with respect to the De Vega technique, due to the reduction in the number of cases with detectable regurgitation and the shift to normality. The significant differences between the normal patients and those with detectable regurgitation pre and post operatively, in addition to the relatively percentage of those experiencing reoperation (previous cardiac surgery), with respect to TV, adds to this kind of logic.

The record of a single death rate of seven redo-TV could be considered a fair success of the technique employed and the survival rate at the 10 year follow up, though it was noticed that most problems and faults of the De Vega intervened during the first five years of surgery. However, previous workers have documented the worsening situation of the tricuspid valve.<sup>12</sup> It is of interest to note that long term survival after triple valve replacement has also been documented.<sup>11</sup>

Recommendations should be in favor of the relative success of the method mostly employed here, at least in the short run and forwarded to the employment of other methods and techniques (especially those of the Cleveland Clinic Foundation Team). A deeper look in the future of the functions of the heart valves could be through improving the efforts and expanding in pathways at the cellular, molecular and integrated tissue, according to the experience and opinions of Yacoub and Cohn.<sup>20</sup> They suggest that achievement in this field could lead to the development of novel reparative techniques or valve replacements employing tissue engineered substitutes.

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## REFERENCES

1. Koelling TM, Aaronson KD, Cody RJ, Bach DS, Armstrong WF. Prognostic significance of mitral regurgitation and tricuspid regurgitation in patients with left ventricular systolic dysfunction. *Am Heart J.*, **144** (3): 524-529 (2002)
2. Shatapathy P, Aggarwal BK, Kamath SG. Tricuspid valve repair: a rational alternative. *J Heart Valve Dis.*, **9**(2): 276-282 (2000)
3. Braunwald NS, Ross J, Morrow AG. Conservative management of tricuspid regurgitation in patients undergoing mitral valve replacement. *Circulation.* **35** (suppl. 1): S63-S69 (1967)
4. Pluth JR, Ellis FH Jr. Tricuspid insufficiency in patients undergoing mitral valve replacement, tricuspid annuloplasty, and tricuspid valve replacement. *J Thorac Cardiovasc Surg.*, **58**: 489-499 (1969)
5. King RM, Scaff HV, Danielson GK, et al. Surgery for tricuspid regurgitation late after mitral valve replacement. *Circulation.* **70** (suppl. 1): S193-S197 (1984)
6. Carpentier A, Deloche A, Hanania G, Forman J, Sellier P, Piwnica A, et al. Surgical management of acquired tricuspid valve disease. *J Thorac Cardiovasc Surg.*, **67**: 53-65 (1974)
7. Groves PH, Hall RJ. Late tricuspid regurgitation following mitral valve surgery. *J Heart Valve Dis.*, **1**: 80-86 (1992)
8. De Vega NG. La anuloplastia selectiva regulable y permanente. *Rev Esp Cardiol.*, **25**: 555-556 (1972)
9. Carpentier A, Deloche L, Hanania G, et al. Surgical management of acquired tricuspid valve disease. *J Thorac Cardiovasc Surg.*, **67**: 53-65 (1974)
10. Duran CMG, Pomar JL, Colman T, Figuerosa A, Revuelta JM, Ubago JL. Is tricuspid valve repair necessary? *J Thorac Cardiovasc Surg.*, **80**: 849-860 (1980)
11. Jugdutt BI, Fraser RS, Lee SJ, Rossal RE, Callaghan JC. Long term survival after triple valve replacement: Results with seven different prosthesis. *J Thorac Cardiovasc Surg.*, **74**: 20-27 (1977)
12. McCarthy PM, Bhudia SK, Rajeswaran J, Hoercher KJ, Lytle BW, Cosgrove DM, Blackstone EH. Tricuspid valve repair: durability and risk factors for failure. *J Thorac Cardiovasc Surg.*, **127**(3): 674-685 (2004)
13. McCarthy PM. Synergistic approaches in the surgical treatment of heart failure: complex solutions for complex problems. *Semin Thorac Cardiovasc Surg.*, **14**: 187-189 (2002)
14. Yada I, Tani K, Shimono T, Shikano K, Okabe M, Kusagawa M. Preoperative evaluation and surgical treatment for tricuspid regurgitation associated with acquired valvular heart disease. The Kay-Boyd method vs. the Carpentier-Edwards ring method. *J Cardiovasc Surg (Torino)* **31**: 771-777 (1990)
15. De Vega NG. La anuloplastia selectiva, regulable permanente. *Rev Esp Cardiol.*, **25**: 555-560 (1972)
16. Revuelta JM. The forgotten tricuspid insufficiency: Is valve repair necessary? *J Cardiovasc Surg (CTSNet)*. [Http://www.ctsnet.org](http://www.ctsnet.org)
17. Kirklin JW, Pacifico AD. Surgery for acquired valvular heart disease. *N Engl J Med.*, **288**: 194-199 (1973)
18. Groves PH, Hall RJC. Late tricuspid regurgitation following mitral valve surgery. *J Heart Valve Dis.*, **1**: 80-86 (1992)
19. Ohata T, Kigawa I, Tohda E, Wanibuchi Y. Comparison of durability of bioprostheses in tricuspid and mitral positions. *Ann Thorac Surg.* **71**: S240-S243 (2001)
20. Yacoub HM, Cohn LH. Novel approaches to cardiac valve repair, from structure to function: part II. *Circulation.* 1064-1072 (2004)