TRICUSPID VALVE REPAIR – FIVE YEAR FOLLOW UP

Thesis Submitted

By

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DECLARATION

I hereby declare that this thesis entitled, "TRICUSPID VALVE REPAIR – FIVE YEAR FOLLOW UP *" has been prepared by me under the supervision and guidance of* ***Dr****. VIVEK V.PILLAI, Additional Professor, Department of Cardiothoracic and Vascular Surgery, Sree Chitra Tirunal Institute for Medical Sciences & Technology, Thiruvananthapuram, Kerala. And* ***Dr.Varghese T. Panicker****, Cardiothoracic and Vascular surgery Additional Professor of Cardiothoracic and Vascular surgery, SCTIMST, Thiruvananthapuram.*

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CERTIFICATE

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Date: 31.7.2018

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CONTENTS

INTRODUCTION

The main goal of this retrospective study is to analyze the durability of tricuspid valve repair in the sitting of left heart valve lesions. The functional or the secondary Tricuspid regurgitation (TR) of all the tricuspid valve repair techniques, the annular reduction procedures namely the Devegas annuloplasty, ring annuloplasty and bicuspidisation technique for secondary TR in patients who is undergoing surgery for other left heart valve pathologies . Primary chordal and leaflet repairs are excluded. The principles of the treatment of secondary TR follow the surgical recommendation that tricuspid valve repair is indicated in patients with severe TR or considered in patients having significant annular dilatation.

The left sided valvular lesions, noted among the 50 patients included rheumatic aortic and mitral stenosis, and regurgitation, mitral valve prolapse which are associated with TR of several degree ranging from mild to severe. The demographics and clinical characteristics of each of the patients are analyzed.

REVIEW OF LITERATURE

Tricuspid valve disease with diseases of the mitral or aortic valve, or both, has been consistently associated. As in our country the rheumatic fever is still persisting, a many number of patients with left-sided valvular lesions and a dysfunctional tricuspid valve have still been diagnosed and treated using several repair techniques. The purpose of this study was to review our experience in patients who required correction of tricuspid valve disease operated on between 2008 and 2013 and to assess the durability of tricuspid valve repair in preserving the right ventricular function reflected indirectly by pulmonary arterial hypertension (PAH) in long-term follow up.

This study demonstrates that despite continuing advances in diagnosis and management of valvular heart disease, the decision to operate on tricuspid valve remains a dilemma in case of secondary tricuspid regurgitation . It should be noted that the decision concerning surgical treatment was made preoperatively according to echocardiographic and clinical data pre cardiopulmonary bypass assessment of TR by tee. The important role played by Doppler echocardiography in the preoperative investigation and follow-up of patients with tricuspid valve disease has also been emphasized by others [2, 3]. Although in the past patients with moderate secondary tricuspid lesions and mild tricuspid lesions, either of functional or of organic cause, were not operated on because of a general belief of improvement after surgical correction of left-side valvular lesions, since 1987

surgery was indicated in patients with grade 2 tricuspid valve disease, including functional lesions, and in patients with grade 1 lesions of organic cause if valvular stenosis was present. It is improbable to find an answer to the question of whether tricuspid valve lesions would be resolved after surgical correction of left-side valvular diseases, but taking into account that the De Vega annuloplasty is a safe and effective technique that does not excessively prolong the surgical time [4,5] and that significant tricuspid regurgitation is common after mitral valve replacement [6], suture annuloplasty to all tricuspid lesions graded 2 or greater was performed. Matsuyama and colleagues [7] observed that 16% of 174 patients who underwent mitral valve surgery without tricuspid valve surgery had progressive tricuspid regurgitation (3 or more) after a mean follow-up of 8.2 years. In the multivariate analysis, preoperative tricuspid regurgitation of 3 was a significant predictor of late recurrence of tricuspid regurgitation. In another study, Henein and associates [8] showed that tricuspid regurgitation impaired the functional results of rheumatic mitral valve replacement, with greater long-term mortality in patients with echocardiographic evidence of severe tricuspid regurgitation.

AIMS & OBJECTIVES

1) To assess durability and usefulness of tricuspid valve repair in case of secondary or functional TR, RV function in long-term follow up.

2) To evaluate the effectiveness of various techniques involved in tricuspid valve repair in long-term (example- devegas annuloplasty, suture annuloplasty, bicuspidisation)

MATERIALS AND METHODOLOGY

Retrospective, single-center, Observational case series at A Tertiary referral center (SCTIMST), which included patients operated for Left side heart valve lesions (mitral and aortic) for various etiologies with tricuspid valve repair in our institute between, 2008 to 2013.

Inclusion Criteria:

1. Patients with Functional or secondary tricuspid regurgitation with primary left sided valve lesions who underwent annular reduction procedures namely devegas annuloplasty, bicuspidisation, ring annuloplasties.

Exclusion Criteria:

1. Cases where Primary or Organic tricuspid regurgitation which are associated with leaflet or chordal pathologies.

- After obtaining permission from IEC, data including TR status, TAPSE, PAH in follow up echo in first, third and fifth year after surgery are analyzed .

  Data were collected from the medical records of patients along with their clinical status in terms of functional class (NYHA) & evaluated by Principle investigators or co-investigators. Patient details were kept confidential & Data analyzed.

After complete evaluation & confirmation of diagnosis, with left side heart valve lesions (stenotic or regurgitant and with significant TR ranging from moderate to severe grade were planned electively, angiogram done in patients with severe PAH to assess acceptable PVR and patients above 40 years of age to rule out coronary artery disease . Our patients more commonly had standard midline or thoracotomy approach, aorto-bicaval cannulation, on total bypass after arresting heart with root antegrade cardioplegia and topical cooling for myocardial protection, Left side valve lesions addressed and then in total CPB , right atrium will be opened and tricuspid valve was assessed , repaired with standard annular reduction procedures. TR status was assessed pre CPB by transesophageal echocardiogram and end result was also studied after termination of CPB. Transthoracic echocardiogram were carried out before discharge, at 3 months and at end of 1 year,3rd year and 5th year documented in patient's records along with their functional class using NYHA classification based on symptoms and clinical findings on OPD basis and compared with pre operative transthoracic echo reports.

Echocardiographic grade of regurgitation

0 = absent

1 = trivial

2 = mild

3 = moderate

4 = severe.

Any patient with moderate to severe TR undergo surgical repair along with repair or replacement of aortic or the mitral valve or both in our institution .Some echo reports read TR4+ and TR3+ in same patients evaluated at different time periods pre operatively, those patients were revaluated with transesophageal echo at the time of surgery and if found to be less than TR4+, they are considered to be TR3-4+ and repair is carried out. This modification is done to optimize the inter-observer differences in our study group. Similarly in our follow up period, patients found to have more than 3+ of TR were re-evaluated.

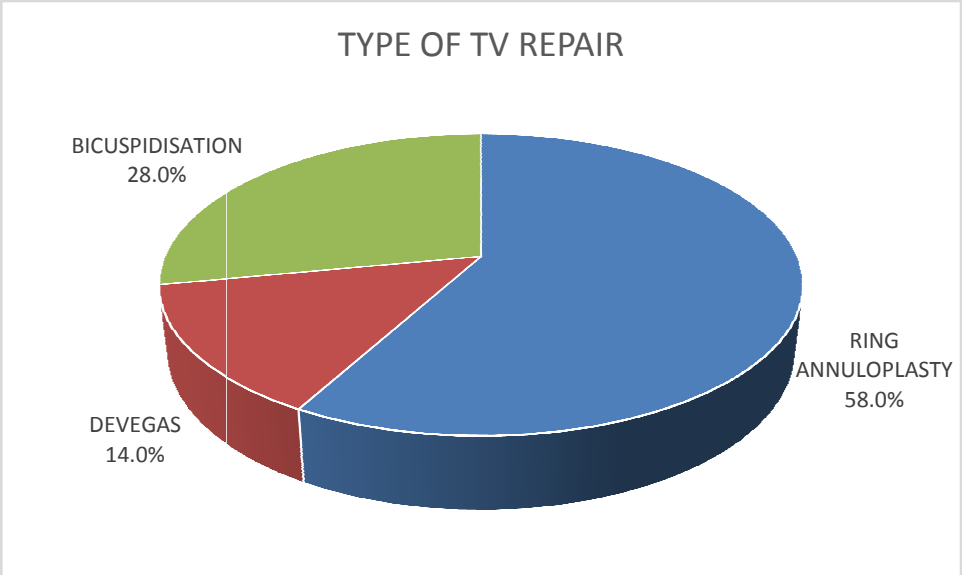
Severity of pulmonary hypertension (mPAP)

Mild	=	25-40mmHg
Moderate	=	41-55mmHg
Severe	=	> 55mmHg

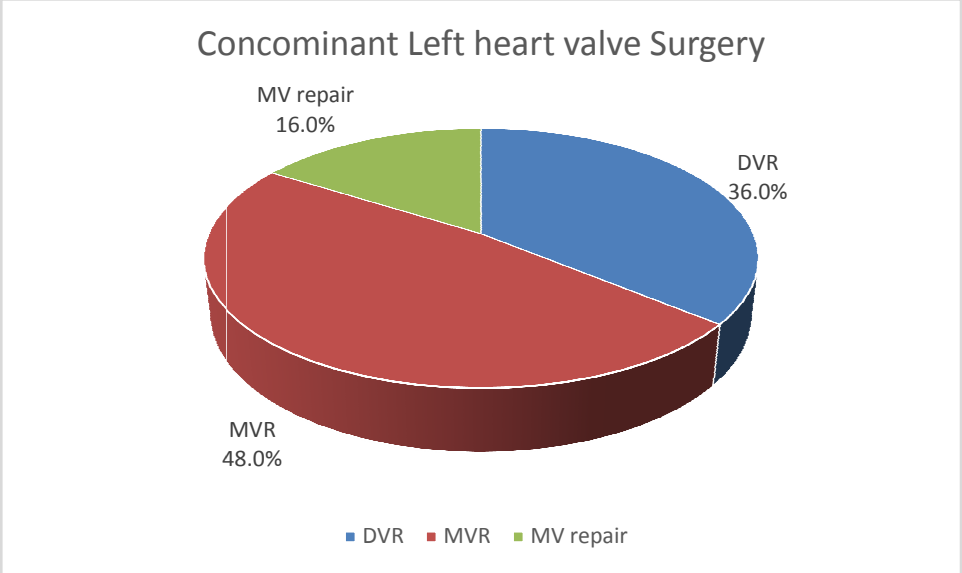
OBSERVATION AND RESULTS

In our retrospective observational study, total of 50 patients met our inclusion criteria, none of them were drop outs in our follow up time period of 2008 to 2012. Patients of all age groups were included. So there is no age or sex distribution.

TYPE OF TV REPAIR	Frequency	Percent
RING ANNULOPLASTY	29	58.0
DEVEGAS	7	14.0
BICUSPIDISATION	14	28.0
Total	50	100.0

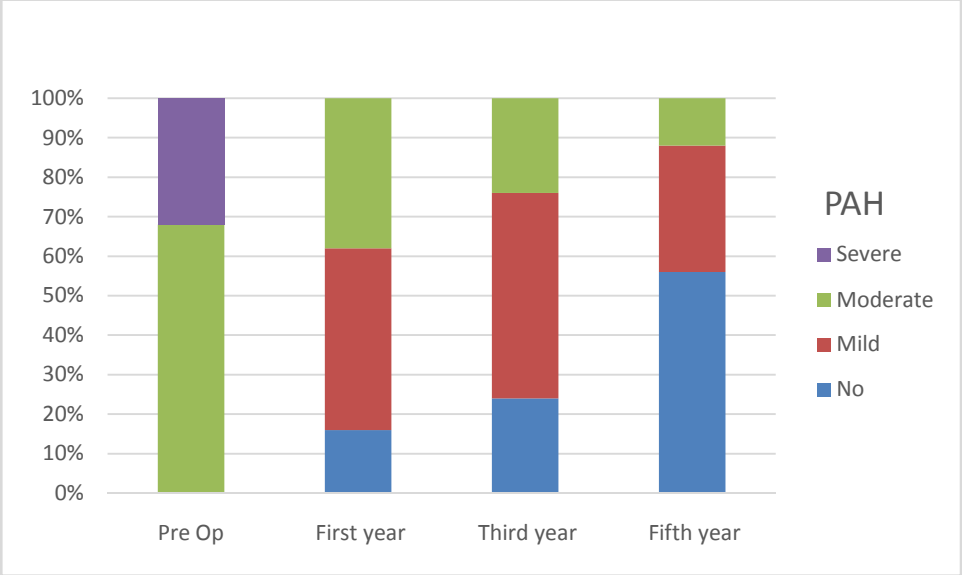


LEFT HEART VALVE SURGERY	Frequency	Percent
DVR	18	36.0
MVR	24	48.0
MV repair	8	16.0
Total	50	100.0



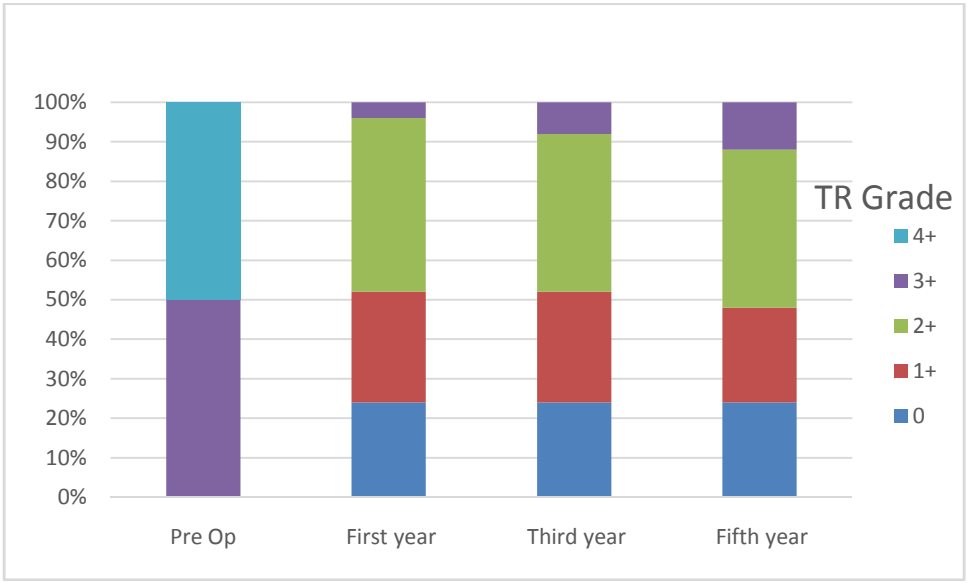
PAH	Pre Op		First year		Third year		Fifth year	
	N	%	N	%	N	%	N	%
No	0	0.0	8	16.0	12	24.0	28	56.0
Mild	0	0.0	23	46.0	26	52.0	16	32.0
Moderate	34	68.0	19	38.0	12	24.0	6	12.0
Severe	16	32.0	0	0.0	0	0.0	0	0.0
Total	50	100.0	50	100.0	50	100.0	50	100.0

	Wilcoxon signed rank test	
	z	p
Pre OP vs First year	5.844	0.000
Pre OP vs Third year	5.951	0.000
Pre OP vs Fifth year	6.131	0.000



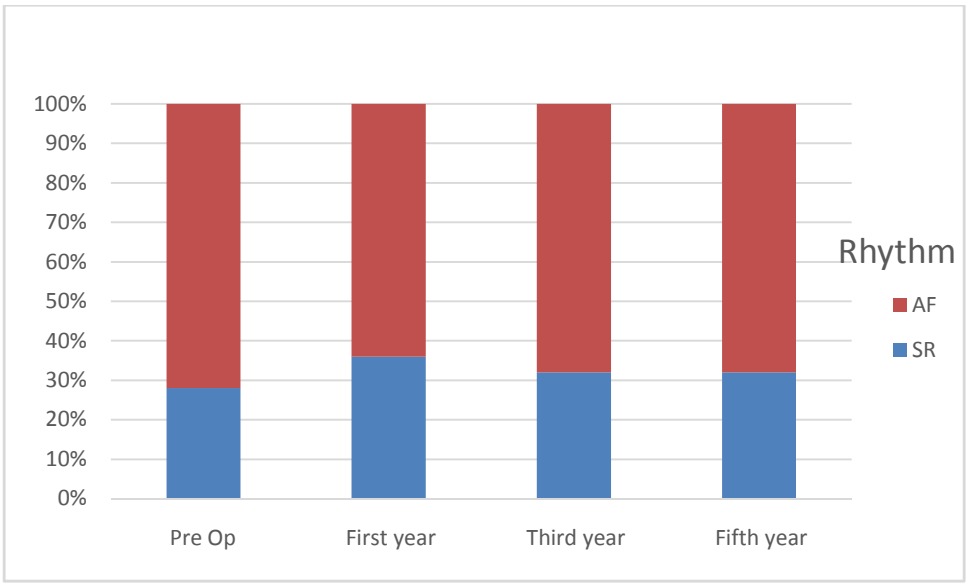
TR grade	Pre Op		First year		Third year		Fifth year	
	N	%	N	%	N	%	N	%
0	0	0.0	12	24.0	12	24.0	12	24.0
1+	0	0.0	14	28.0	14	28.0	12	24.0
2+	0	0.0	22	44.0	20	40.0	20	40.0
3+	25	50.0	2	4.0	4	8.0	6	12.0
4+	25	50.0	0	0.0	0	0.0	0	0.0
Total	50	100.0	50	100.0	50	100.0	50	100.0

	Wilcoxon signed rank test	
	z	**p**
Pre OP vs First year	6.238	<0.001
Pre OP vs Third year	6.156	<0.001
Pre OP vs Fifth year	6.157	<0.001



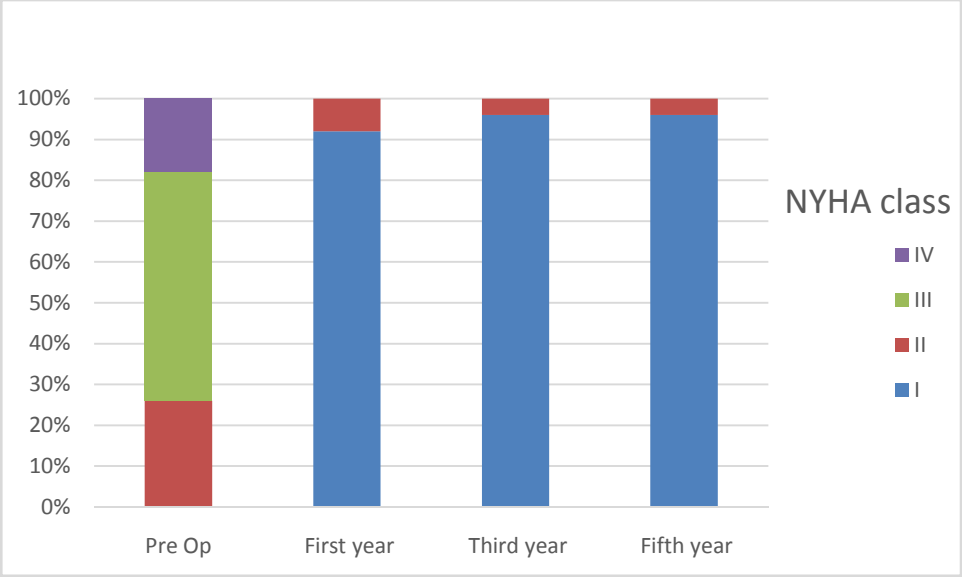
Rhythm	Pre Op		First year		Third year		Fifth year	
	N	%	N	%	N	%	N	%
SR	14	28.0	18	36.0	16	32.0	16	32.0
AF	36	72.0	32	64.0	34	68.0	34	68.0
Total	50	100.0	50	100.0	50	100.0	50	100.0

	Wilcoxon signed rank test	
	z	p
Pre OP vs First year	2.000	0.046
Pre OP vs Third year	0.816	0.414
Pre OP vs Fifth year	0.816	0.414



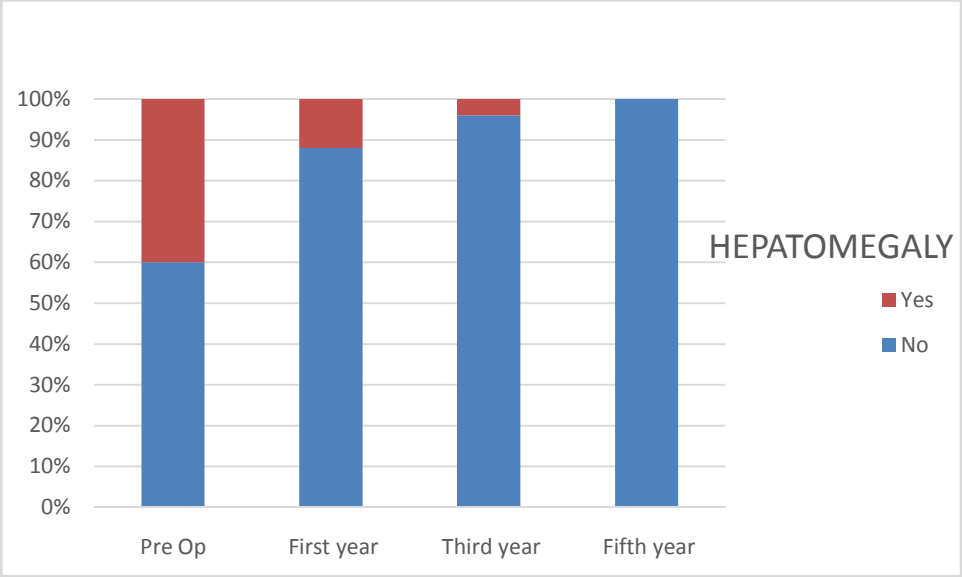
NYHA Class	Pre Op		First year		Third year		Fifth year	
	N	%	N	%	N	%	N	%
I	0	0.0	46	92.0	48	96.0	48	96.0
II	13	26.0	4	8.0	2	4.0	2	4.0
III	28	56.0	0	0.0	0	0.0	0	0.0
IV	9	18.0	0	0.0	0	0.0	0	0.0
Total	50	100.0	50	100.0	50	100.0	50	100.0

	Wilcoxon signed rank test	
	z	p
Pre OP vs First year	6.273	<0.001
Pre OP vs Third year	6.287	<0.001
Pre OP vs Fifth year	6.287	<0.001



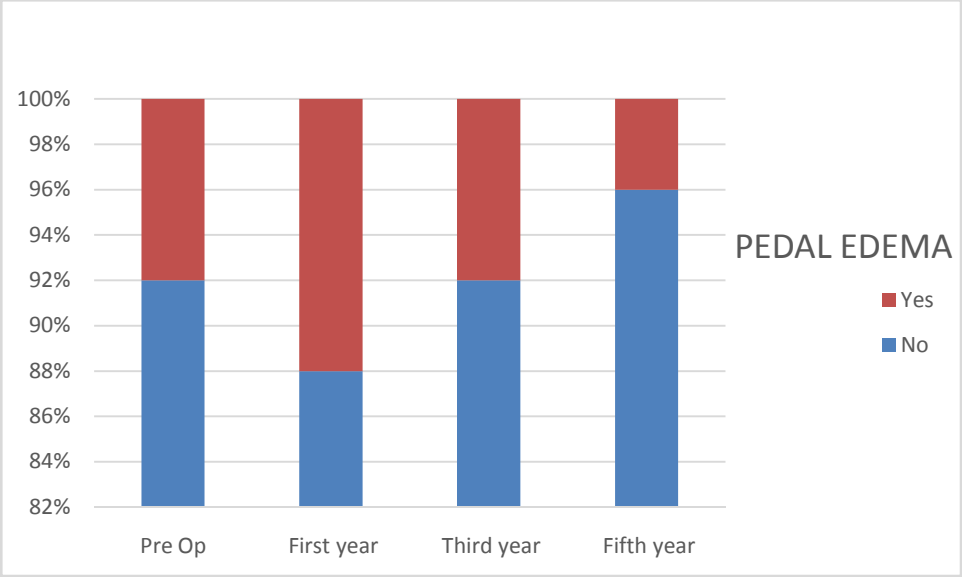
HEPATOMEGALY	Pre Op		First year		Third year		Fifth year	
	N	%	N	%	N	%	N	%
No	30	60.0	44	88.0	48	96.0	50	100.0
Yes	20	40.0	6	12.0	2	4.0	0	0.0
Total	50	100.0	50	100.0	50	100.0	50	100.0

	Wilcoxon signed rank test	
	z	p
Pre OP vs First year	3.300	0.001
Pre OP vs Third year	4.243	<0.001
Pre OP vs Fifth year	4.472	<0.001



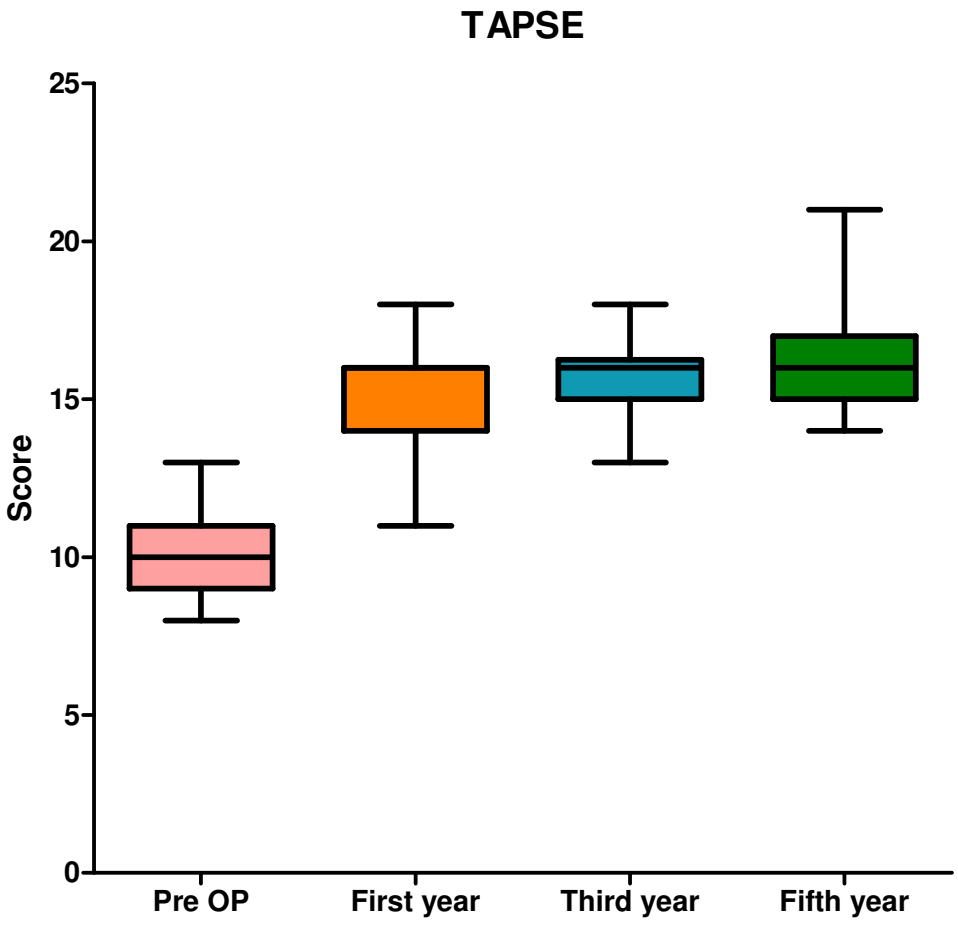
PEDAL EDEMA	Pre Op		First year		Third year		Fifth year	
	N	%	N	%	N	%	N	%
No	46	92.0	44	88.0	46	92.0	48	96.0
Yes	4	8.0	6	12.0	4	8.0	2	4.0
Total	50	100.0	50	100.0	50	100.0	50	100.0

	Wilcoxon signed rank test	
	z	p
Pre OP vs First year	0.816	0.414
Pre OP vs Third year	0.000	1.000
Pre OP vs Fifth year	0.816	0.414



TAPSE	Median	Inter quartile range
Pre Op	10.00	9-11
First year	16.00	14-16
Third year	16.00	15-16.25
Fifth year	16.00	15-17

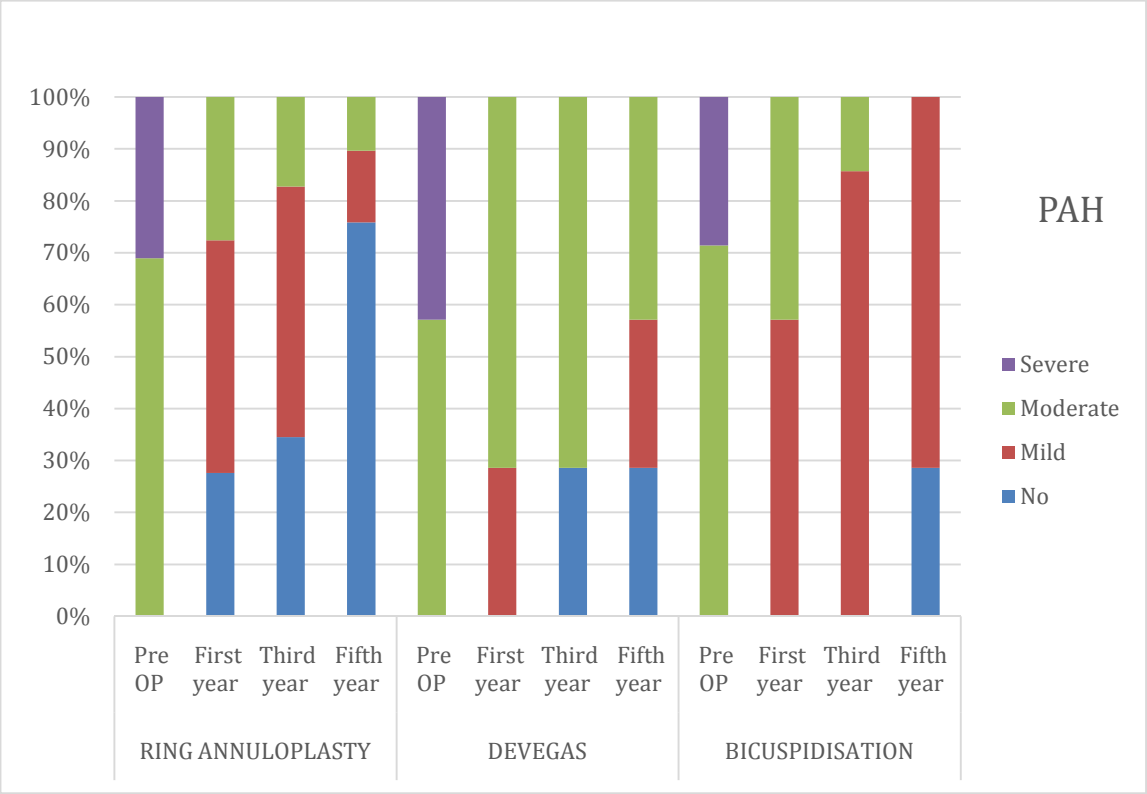
	Wilcoxon signed rank test	
	z	**p**
Pre OP vs First year	6.179	<0.001
Pre OP vs Third year	6.171	<0.001
Pre OP vs Fifth year	6.193	<0.001



PAH

PAH	RING ANNULOPLASTY				DEVEGAS				BICUSPIDISATION			
	Pre OP	First year	Third year	Fifth year	Pre OP	First year	Third year	Fifth year	Pre OP	First year	Third year	Fifth year
No		8	10	22		0	2	2		0	0	4
Mild		13	14	4		2	0	2		8	12	10
Moderate	20	8	5	3	4	5	5	3	10	6	2	0
Severe	9				3				4			

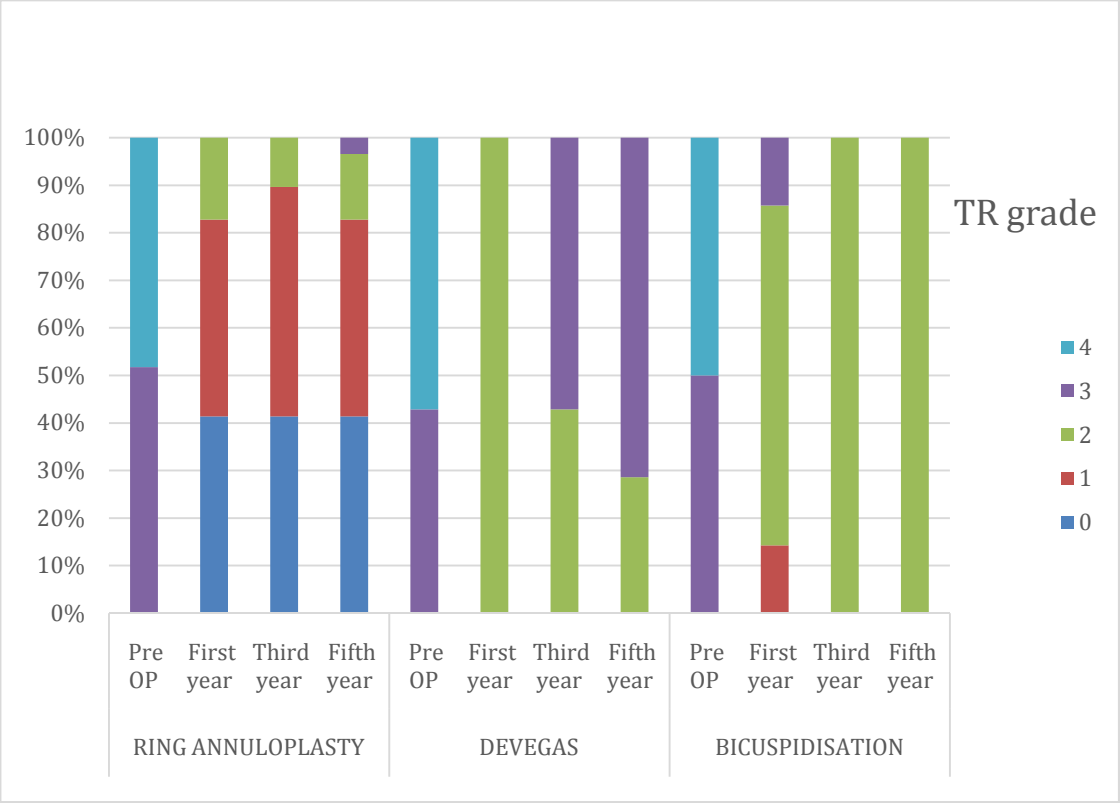
Wilcoxon signed rank test	RING ANNULOPLASTY		DEVEGAS		BICUSPIDISATION	
	z	p	z	p	z	p
Pre OP vs First year	4.388	<0.001	2.236	0.025	3.464	0.001
Pre OP vs Third year	4.652	<0.001	2.070	0.038	3.176	0.001
Pre OP vs 5^{th} year	4.635	<0.001	2.460	0.014	3.376	0.001



TR grade

TR grade	RING ANNULOPLASTY				DEVEGAS				BICUSPIDISATION			
	Pre OP	First year	Third year	Fifth year	Pre OP	First year	Third year	Fifth year	Pre OP	First year	Third year	Fifth year
0		12	12	12		0	0	0		0	0	0
1		12	14	12		0	0	0		2	0	0
2		5	3	4		7	3	2		10	14	14
3	15	0	0	1	3	0	4	5	7	2	0	0
4	14				4				7			

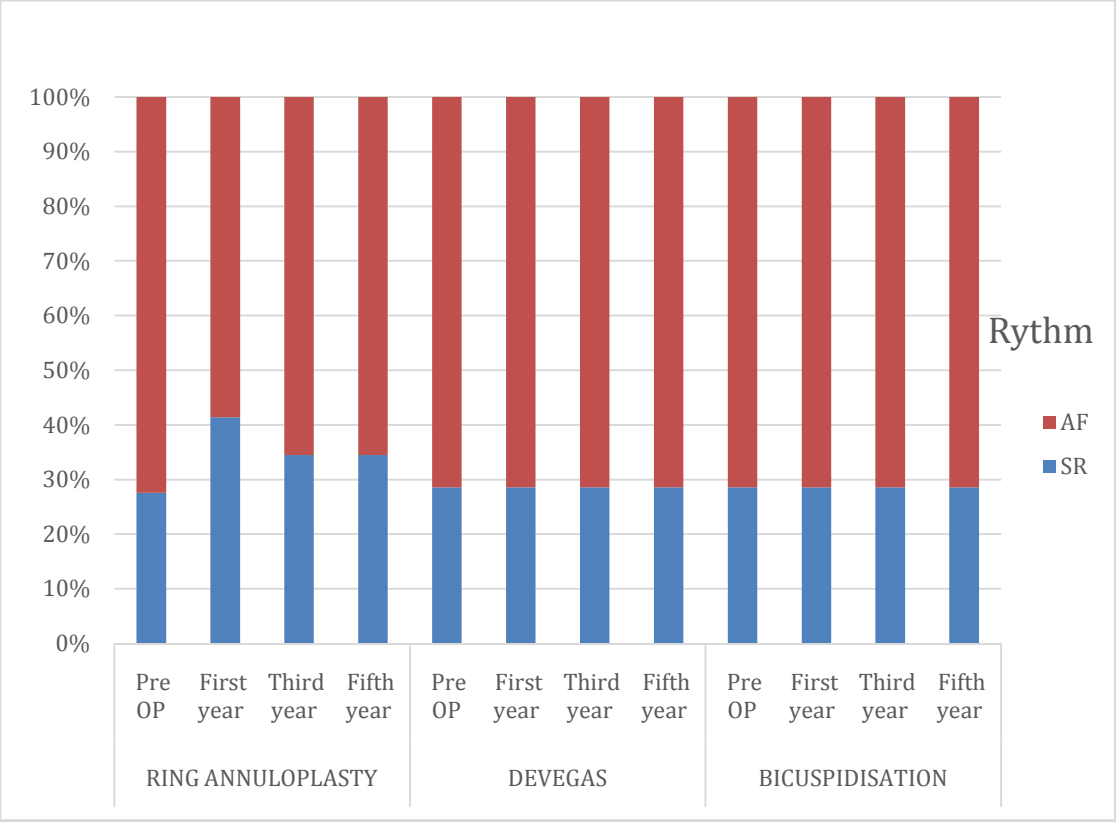
Wilcoxon signed rank test	RING ANNULOPLASTY		DEVEGAS		BICUSPIDISATION	
	z	p	z	p	z	p
Pre OP vs First year	4.777	<0.001	2.428	0.015	3.391	0.001
Pre OP vs Third year	4.787	<0.001	2.333	0.020	3.391	0.001
Pre OP vs Fifth year	4.769	<0.001	2.449	0.014	3.391	0.001



Rhythm

Rhythm	RING ANNULOPLASTY				DEVEGAS				BICUSPIDISATION			
	Pre OP	First year	Third year	Fifth year	Pre OP	First year	Third year	Fifth year	Pre OP	First year	Third year	Fifth year
SR	8	12	10	10	2	2	2	2	4	4	4	4
AF	21	17	19	19	5	5	5	5	10	10	10	10

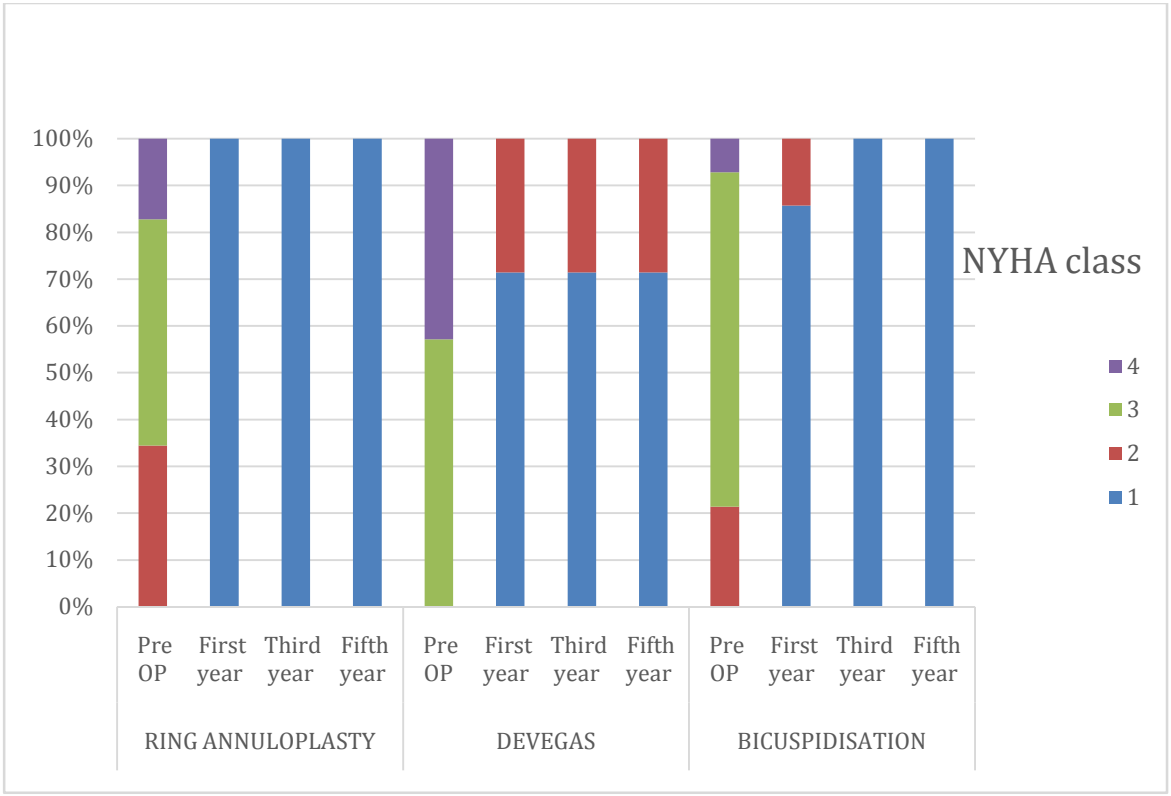
Wilcoxon signed rank test	RING ANNULOPLASTY		DEVEGAS		BICUSPIDISATION	
	z	p	z	p	z	p
Pre OP vs First year	2.000	0.046	<0.001	1.000	<0.001	1.000
Pre OP vs Third year	0.816	0.414	<0.001	1.000	<0.001	1.000
Pre OP vs Fifth year	0.816	0.414	<0.001	1.000	<0.001	1.000



NYHA

NYHA Class	RING ANNULOPLASTY				DEVEGAS				BICUSPIDISATION			
	Pre OP	First year	Third year	Fifth year	Pre OP	First year	Third year	Fifth year	Pre OP	First year	Third year	Fifth year
1		29	29	29		5	5	5		12	14	14
2	10	0	0	0	0	2	2	2	3	2	0	0
3	14				4				10			
4	5				3				1			

Wilcoxon signed rank test	RING ANNULOPLASTY		DEVEGAS		BICUSPIDISATION	
	z	p	z	p	z	p
Pre OP vs First year	4.794	<0.001	2.392	0.017	3.384	0.001
Pre OP vs Third year	4.794	<0.001	2.392	0.017	3.442	0.001
Pre OP vs Fifth year	4.794	<0.001	2.392	0.017	3.442	0.001



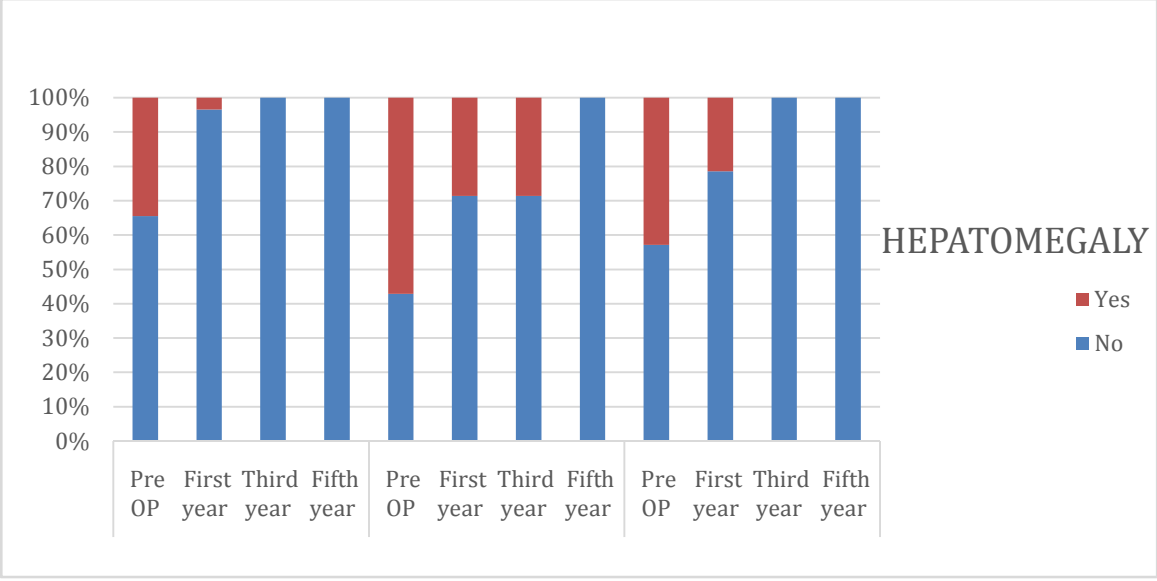
TAPSE	RING ANNULOPLASTY		DEVEGAS		BICUSPIDISATION	
	Median	interquartile range	Median	interquartile range	Median	interquartile range
Pre OP	10.0	43354.0	9.0	8-11	9.0	9-12
First year	16.0	14.5-17	15.0	11-15	15.0	14-16
Third year	16.0	16-17	14.0	13-15	15.0	15-16
Fifth year	16.0	15.-17	14.0	14-16	16.0	15-16

Wilcoxon signed rank test	RING ANNULOPLASTY		DEVEGAS		BICUSPIDISATION	
	z	**p**	**z**	**p**	**z**	**p**
Pre OP vs First year	4.734	<0.001	2.379	0.017	3.308	0.001
Pre OP vs Third year	4.717	<0.001	2.379	0.017	3.315	0.001
Pre OP vs Fifth year	4.740	<0.001	2.392	0.017	3.308	0.001

HEPATOMEGALY

HEPATOMEGALY	RING ANNULOPLASTY				DEVEGAS				BICUSPIDISATION			
	Pre OP	First year	Third year	Fifth year	Pre OP	First year	Third year	Fifth year	Pre OP	First year	Third year	Fifth year
No	19	28	29	29	3	5	5	7	8	11	14	14
Yes	10	1	0		4	2	2		6	3	0	

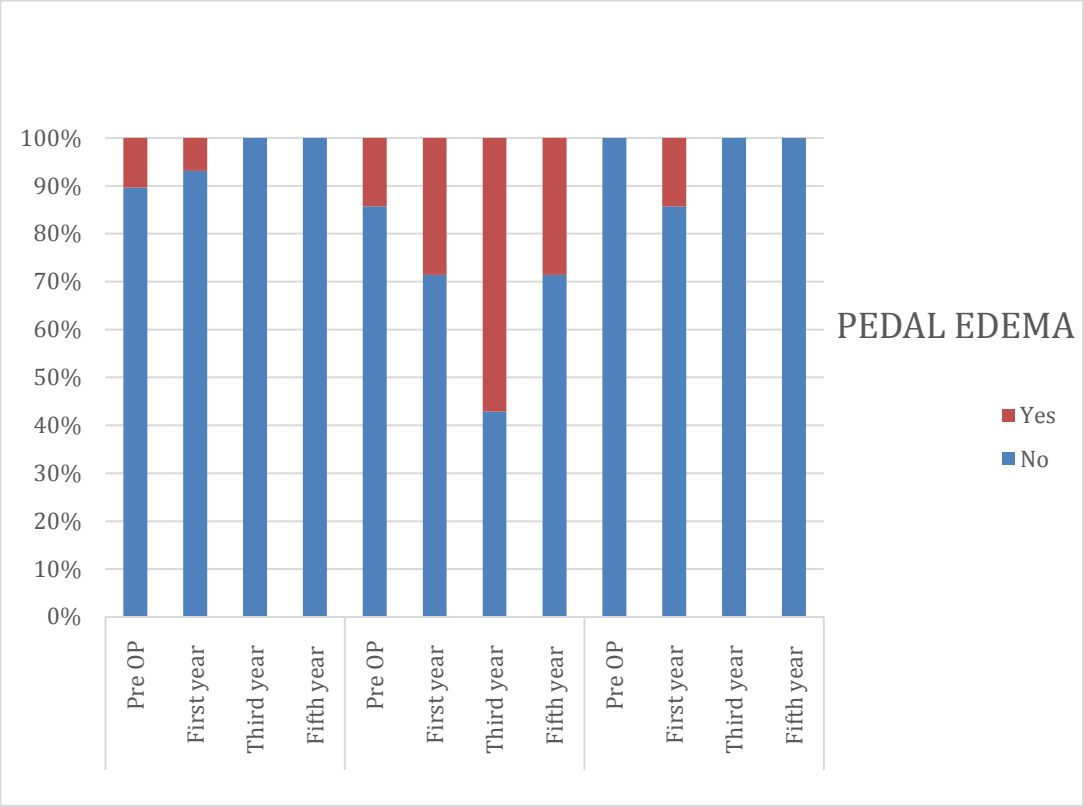
Wilcoxon signed rank test	RING ANNULOPLASTY		DEVEGAS		BICUSPIDISATION	
	z	p	z	p	z	p
Pre OP vs First year	2.714	0.007	1.414	0.157	1.342	0.180
Pre OP vs Third year	3.162	0.002	1.414	0.157	2.449	0.014
Pre OP vs Fifth year	3.162	0.002	2.000	0.046	2.449	0.014



PEDAL EDEMA

PEDAL EDEMA	RING ANNULOPLASTY				DEVEGAS				BICUSPIDISATION			
	Pre OP	First year	Third year	Fifth year	Pre OP	First year	Third year	Fifth year	Pre OP	First year	Third year	Fifth year
No	26	27	29	29	6	5	3	5	14	12	14	14
Yes	3	2	0	0	1	2	4	2	0	2	0	0

Wilcoxon signed rank test	RING ANNULOPLASTY		DEVEGAS		BICUSPIDISATION	
	z	p	z	p	z	p
Pre OP vs First year	1.000	0.317	0.577	0.564	1.414	0.157
Pre OP vs Third year	1.732	0.083	1.342	0.180	<0.001	1.000
Pre OP vs Fifth year	1.732	0.083	0.577	0.564	<0.001	1.000


100%
90%
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Pre OP
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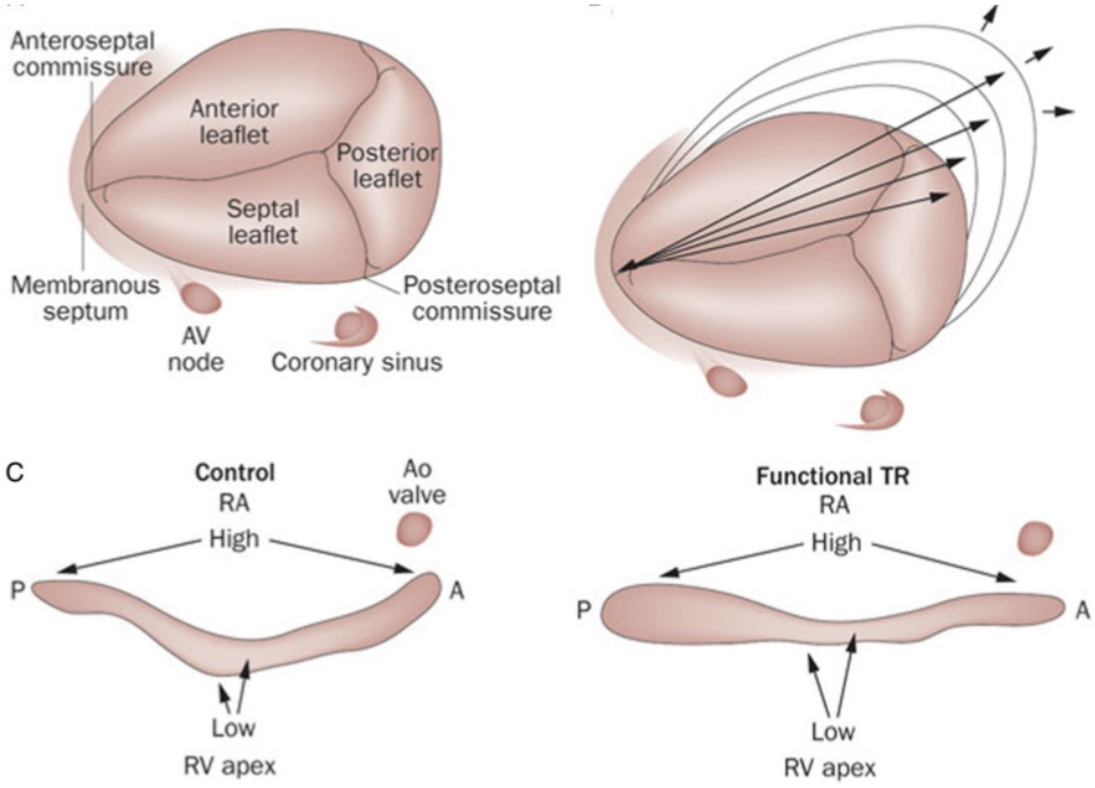
Pre OP
First year
Third year
Fifth year
Pre OP
First year
Third year
Fifth year
PEDAL EDEMA
Yes
No

DISCUSSION

SURGICAL ANATOMY

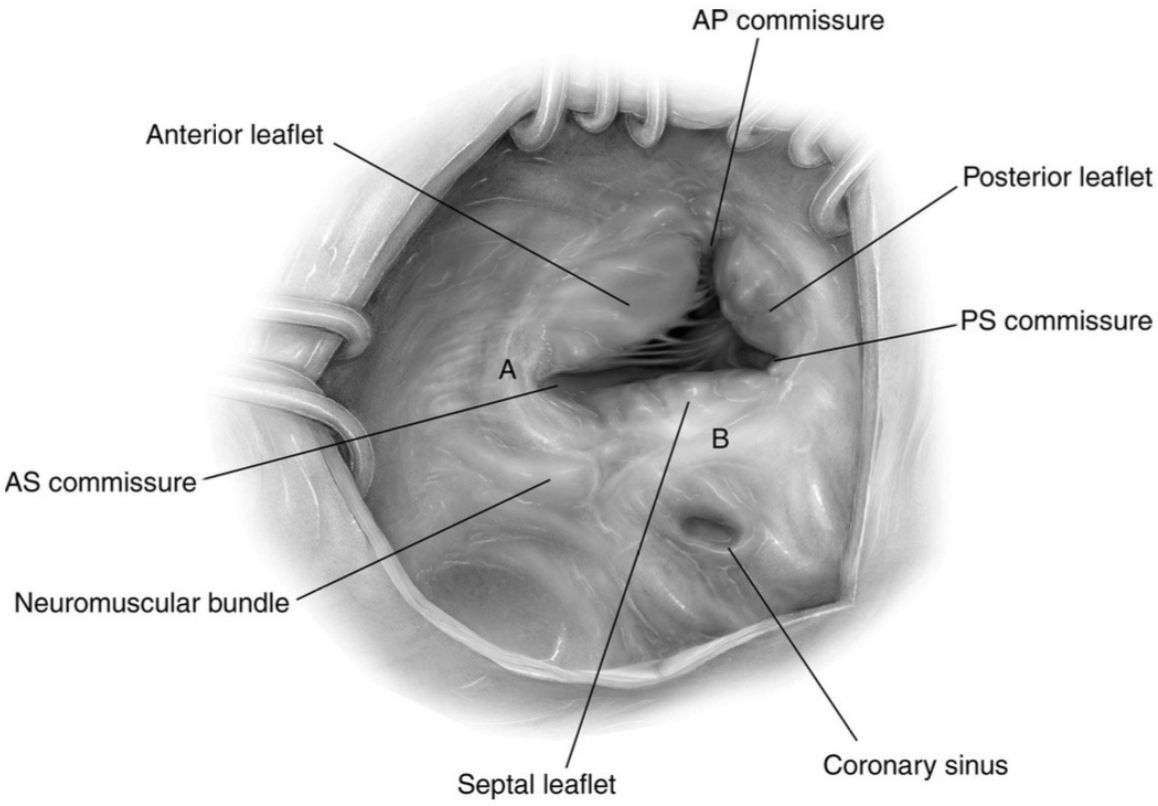
Situated at the base of the heart, the tricuspid valve separates the right atrium from the right ventricle. Traditionally, it has been accepted that the tricuspid valve consists of three very thin leaflets attached to the tricuspid valve annulus.



TRICUSPID VALVE ANULUS

Whereas the base of the anterior and posterior leaflets is attached to the free wall of the right ventricle, the septal leaflet is inserted into the base of the base of the interventricular septum. This line of leaflet attachment, known as the tricuspid value annulus, is more a landmark then an actual fibrous ring. This absence of an encircling fibrotic structure explains the large changes in the tricuspid valve's orifice during the cardiac cycle and its easy dilation in disease. The mobility and size of the tricuspid valve orifice are department on the transversely oriented myocardial fibers that surround the atrio ventricular valves. Tsakiris and associates (11) found in a canine model that the size of the tricuspid valve orifice changed continuously during the cardiac cycle. The orifice area contracted (from its maximal diastolic size) by 20% to 30%. Tei and associates (12) confirmed these findings in humans by use of echocardiography. Orifice contraction begins during the isovolumetric relaxation phase of the cardiac cycle and continues through the first half of diastole. Starting with the beginning of isovolumic contraction, a second contraction occurs during ejection, which reduces the tricuspid valve orifice to its minimum area. This contraction corresponds to closure of the valve completed at the end of isovolumic contraction. The reduction in orifice perimeter is not uniform. The segment of the annulus corresponding to the septal leaflet shortens by 12%, the anterior segment by 15% and the posterior segment by 17 %(13). The notion that the length of the septal portion of the annulus can be used to determine the size of an annuloplasty device should be revised.

This narrowing of the tricuspid valve orifice is due not only to contraction of its perimeter but, more important, to the changes in the shape of the annulus. During contraction, the orifice becomes more elliptical because of displacement of the anteroposterior commissure towards the septum and the bulging of the septum. As in the mitral valve, the "annulus" is not in a single plane. In fact, the tricuspid valve annulus is "saddle shaped" with its horn or pommel corresponding to the area of the anteroseptal commissure and its cantle to the midpoint of the base of the posterior leaflet. This saddle shape or hyperbolic paraboloid, well known to architects as an ideal design to reduce building tension, has been shown in the mitral valve to significantly reduce peak leaflet stress (14). Furthermore, the increase in the saddle shape during contraction has a folding, reducing effect on the normal tricuspid valve orifice. In cases of tricuspid regurgitation, besides in planarity or flattening of the normal annulus, which induces leaflet tethering. Rigid structures, such as stented prostheses and rigid annuloplasty rings, destroy this configuration and have a negative impact on the function of the right ventricle.



Leaflets

Although the number of tricuspid valve leaflets varies according to author, it is generally accepted that the tricuspid valve consists of three leaflets. These three leaflets are known as septal, anterior, and they are separated by three clefts or commissures named anteroseptal, anteromedial, and posteroseptal. These clefts do not reach the annulus but delineate small ”commissural leaflets” This is an important surgical point because in cases of fused commissures, their incision should not extend all the way to annulus, doing so destroys the commissural leaflets. The largest leaflet is the anterior, followed by the posterior, with the septal being the smallest. The excursion of each leaflet (defined as the angle between leaflet free edge and the plane of the annulus) is different (15). The

excursion of the septal leaflet is significantly smaller than that of the other leaflets. This normal, smaller septal excursion might explain the finding at surgery of a septal leaflet plastered against the septum. This finding, often seen in cases of functional regurgitation, is a sign of severity and a predictor of a poor result after repair.

Chordae Tendineae and Papillary Muscles

The leaflets are held down by marginal and basal chords that arise from three papillary muscle groups. The marginal chords are inserted into the leaflet's free margin, and the basal chords are inserted into the ventricular surface of the leaflets. Elongation or rupture of the marginal chords results in leaflet prolapse. The tricuspid valve's basal chords probably play a similar role in maintaining valvular and ventricular geometry. In most tricuspid valve cases, three papillary muscle groups are found and can be identified as anterior, posterior, and septal. Whereas the anterior and posterior muscles are virtually always present, the septal muscle might be absent in 20% of patients. The anterior papillary muscle is the longest; it most often has a single head and sustains the largest number of chordae (16,17).

Anatomic Relationships

The area corresponding to the anteroseptal commissure is very close to the aortic valve's noncoronary sinus of Valsalva. This fact has important surgical implications because placement of anchoring sutures for a tricuspid valve prosthetic device can be difficult at this level if a stented aortic prosthesis is already present. When a concomitant aortic valve replacement is planned, it is preferable to place the tricuspid valve sutures before undertaking the aortic valve replacement because tears at this level can be difficult to repair.

The right coronary artery and sinus run parallel to the segment of the annulus corresponding to the right ventricular free wall. Despite this proximity, injury to these vascular structure in performing a valve replacement or annuloplasty is extremely rare. The ostium of the coronary sinus is situated above the posteroseptal commissure. Because of its distance from the conducting system (close to the right trigone), it is safe to place a purse string suture around the ostium of the coronary sinus to hold a retrograde cardioplegia cannula.

PHYSIOPATHOLOGY

Tricuspid valve lesions have traditionally been classified into two groups, organic and functional. These classifications have an important impact on both the type of surgery applied and its long term results. Organic lesions are those in which the valve apparatus is macroscopically abnormal. Functional lesions are

those in which regurgitation occurs in the presence of any apparently normal tricuspid valve apparatus.

A different classification proposed by Carpentier, distinguishes three main types of disease according to the mobility of the tricuspid valve leaflets; type I. Normal leaflet motion with annular dilation; type II increased leaflet motion due to leaflet prolapse that is secondary to chordal rupture or elongation and type II reduced leaflet motion due to leaflet thickening, fused commissures, or leaflet tethering.

In our study all 50 patients who underwent Tricuspid valve repair had a functional or secondary tricuspid regurgitation due pulmonary hypertension secondary to left sided valvular lesions. Here we discuss only about functional or secondary tricuspid regurgitation .

Function or secondary Tricuspid Regurgitation:

Functional tricuspid insufficiency is understood to be exclusively due to annulus dilation and dysfunction. The leaflets, chords, and papillary muscles are otherwise normal. Because of the lack of an “anatomic fibrous annulus” the tricuspid valve’s annulus follows the dilation of the right ventricle. The total perimeter of the normal annulus is approximately 100 to 120mm. In cases of functional tricuspid regurgitation, the circumference of the annulus can reach 150 to 170mm.

This annulus dilation is nonhomogeneous. In a postmortem study that included normal controls and hearts with rheumatic or myxomatous tricuspid valve disease, Carpentier and of the annulus dilated far more than the septal portion of the annulus. This report formed the basis for all annuloplasties that selectively reduce the whole annulus except at the level of the septum.

In congestive heart failure, functional tricuspid regurgitation is a predictor of poor survival (18) and can be an independent risk factor for the development of cardiac cachexia and protein losing enteropathy (19). Koelling (20) studied a total of 1436 patients with left ventricular systolic dysfunction (ejection fraction <35%). Mitral regurgitation was moderate in 30% and severe in 19%. Moderate tricuspid regurgitation was present in 23% and sever in 12% Patients with severe mitral regurgitation were more likely also to have tricuspid regurgitation.

Advances in echocardiography have revealed another sub valvular mechanism that applies to both mitral and tricuspid functional regurgitations. Originally observed in functional ischemic mitral regurgitations, it also applies to the ischemic triscuspid valve and most probably to all functional insufficiencies. Right (or left) ventricular remodeling induces a lateral displacement of one or more papillary muscles that apically pulls (through the basal chords) the body of the corresponding leaflet. The leaflet becomes tethered down, losing its coaptation.

Functional tricuspid regurgitation is an expression of right ventricular failure with a generalized distortion of ventricular geometry. Although

annuloplasty can reduce or abolish functional tricuspid regurgitation (by reducing the dilated annulus), it does not address the altered subvalvular geometry. Awareness of this important mechanism is giving rise to new and exciting surgical approaches directed toward redressing the geometric distortion.

Surgical Approaches to the Tricuspid valve

The approach to the tricuspid valve is easy because of its anatomic location. It can be visualized through a midsternotomy or a right thoracotomy. Unless an isolated tricuspid valve lesion is contemplated, the type of thoracotomy and incision are dictated by the concomitant surgery on the other valves (for example superior septal approach for mitral valve in case of small size of left atrium can expose both right ,left atrium and tricuspid, mitral valve respectively). A standard or a minimally invasive approach can be safely used. To establish cardiopulmonary bypass, separate superior and inferior caval and ascending aorta cannulations are used. The right atrial incision is started close to the appendage and directed toward the posterior aspect of the atrium between the right inferior pulmonary vein and the inferior vena cava. This incision minimizes the problem when an accidental tear of the lower extremity of the incision occurs from over retraction. Although tricuspid valve surgery can be easily performed in the beating heart, the surgeon most often prefers an arrested heart. If retrograde cardioplegia is planned, the coronary sinus is located above the posteroseptal commissure and cannulated. To ensure maximum distribution of cardioplegia to the whole heart, a

purse string is placed around the coronary ostium. After the retrograde cannula is in place, the purse string is tightened, the balloon is inflated and the catheter is pulled outward until it is arrested by the purse string.

Very recently the principles of percutaneous approach to the cardiac valves have been applied to the tricuspid valves. Although still in its infancy, percutaneous tricuspid valve repair will become popular because of the valves accessibility and low pressure environment.

When a simultaneous mitral valve surgery is required most surgeons approach the valves through separate atriotomy incisions. An alternative is the use of the extended transatrial septal incision described by Guiraudon and colleagues.

Tricuspid valve Commissurotomy

The first closed tricuspid valve commissurotomy was performed in 1952 by Charles Bailey. Although significantly improving desperately sick patients, these early procedures, which used valve dilators, were soon replaced by the more precise open commissurotomy after cardiopulmonary bypass became available. Today, percutaneous balloon dilation has replaced closed commissurotomy. The results are similar with both techniques because they are based on the same principle of splitting the commissures through the distending pressure exercised on the leaflets.

The results of tricuspid valve balloon dilation are considerably inferior to those of mitral valve balloon dilation because of the difference between the mitral

and the tricuspid leaflets resistance to tears. Tricuspid valve balloon dilation is now reserved for a small number of patients for whom its minimal invasiveness compensates for its medicocre results. Also, the low pressure in the right cavities minimizes the importance of the frequent residual gradients and iatrogenic regurgitations. Today, most tricuspid valve lesions are treated surgically because they accompany the more florid mitral valve problems that demand surgery.

In performing an open tricuspid valve commissurotomy, the valve should be carefully inspected because, in severe cases, it may appear as a diaphragm with a central circular orifice and fibrotic edges. In these extreme cases, it is difficult to identify the commissures. The subvalvular apparatus is often fairly intact; therefore, a conservative procedure is still possible (although the result will most likely be suboptimal). Valve hooks are placed on either side of the commissure to explore the “fan” chordae always present at the commissures. The incision must ensure that its two edges are supported by chordae. It is often easier to start the incision 4 to 5 mm from the annulus rather than at the edge of the fused leaflets. A better view of the cords (through that gap) will direct the incision toward the free edge. In most cases, two “fanlike” thin cords are fused. The incision is then prolonged apically into the papillary muscle for at least 1 cm. The purpose of this essential maneuver is not only to slow the ongoing fibrotic process but also to increase leaflet mobility. At present, these very severe forms of commissural fusion are rare. However, lesser degrees of fusion are frequently present and missed unless the valve is carefully inspected. Often only one or two commissures

are affected, the anteroseptal commissure is the most frequently fused. In most cases, a tricuspid annuloplasty must accompany the commissurotomy because of a lack of leaflet tissue or because annular dilation is also present.

Repair Maneuvers

Because most tricuspid valve regurgitation are functional, repair maneuvers other than annuloplasty are less often needed than in mitral valve repair. In acute infective endocarditis, the vegetations must be excised. The vegetation is resected a few millimeters beyond its base in the leaflet. This resection should be in healthy tissue (Which is easily identified because of its normal coloration compared with the reddish color of the inflamed area). A triangular resection with its base at the free edge of the leaflet is the best solution. The gap is closed with 5-0 polypropylene sutures. Unless this resection is small, an annuloplasty must follow. Leaflet perforations present in healed endocarditis can be closed with sutures or, if extensive, with a patch of glutaraldehyde treated autologous pericardium. Fresh autologous pericardium should not be used because it will undergo progressive fibrous retraction. Important tissue destructions can be reconstructed with pericardium supported by Gore-Tax neo-cords.

Chord replacement with expended polytetrafluoroethylene sutures is becoming increasingly popular. Although papillary muscle and leaflet anchoring of the neo-cord is not a problem, determination of its appropriate length remains intuitive and based on personal experience. Following numerous in vitro approaches to this

problem, an easy and simple technique was developed. A double-ended, 5-0 Gore-Tax suture is anchored to the papillary muscle and the free edge of the prolapsing leaflet but not tied. After the annuloplasty ring is placed, the two arms of the Gore-Tax suture are tied at the level of the plane of the annuloplasty. The surgeon must resist the temptation to tie the Gore-Tax suture at the level thought to be the cooptation point. Most failures are due to overcorrection, resulting in a too short neo-cord. To further simplify this maneuver, a new ring holder incorporates two "guide sutures" that traverse the valve orifice at the level of the annuloplasty. After the ring is in place but still attached to the holder, each arm of the artificial cord is passed on either side of the guiding suture and tied. The holder is then removed. In some cases, a patient may need several neo-cords arising from the same papillary muscle, or the surgeon may not be sure whether additional neo-cords are needed after finding residual regurgitation when checking for valve competence. Implantation of new neo-cords is difficult across the annuloplasty. In these cases, a "neo-papillary muscle" is used. A loop of approximately 5mm is made with a double-ended 2-0 Gore-Tax suture. Each arm of the suture is then anchored to the papillary muscle and secured over pledgets. New artificial chords can then easily be passed through the loop. Because of their simplicity, these techniques have transformed mitral and tricuspid valve repair. The traditional repair techniques of chordal transfer, shortening and replacement, and papillary muscle plication have been largely superseded.

Recently, the edge-to-edge technique (originally described for mitral valve prolapse) has also been applied to the tricuspid valve. This technique uses a suture to bring the free edge of the prolapsing leaflet over to the midpoint of the opposite leaflet. It results in a double valve orifice. Although not widely applied to the mitral valve, it has value in case of post-repair residual regurgitation that require a second pump run. A clinical trial of its percutaneous delivery to the mitral valve is currently ongoing. Application of these techniques to the tricuspid valve must still be considered experimental.

Tricuspid Valve Annuloplasty

The principle behind all tricuspid valve annuloplasties is to selectively reduce the length (perimeter) of the tricuspid valve annulus and, consequently, the size of the tricuspid valve orifice. The lack of leaflet coaptation is compensated by the induced smaller tricuspid valve orifice. The earliest annuloplasties consisted of plication of the annulus at the level of the base of the posterior leaflet. This approach, borrowed from the early mitral valve annuloplasties, was described by wooler and coworkers and Kay and colleagues. Both have been abandoned because of the difficulty in determining the amount of plication necessary and the lack of support for the remaining annulus. Cabrol (21) and de Vega (22) independently described a partial encircling suture to narrow the annulus. The extremities of a double suture that runs along the base of the anterior and posterior leaflets are anchored with pledgets at the anteroseptal and posteroseptal

commissures. The partial purse string is tied over an obturator of the desired size. This technique has been popular because of its simplicity and low cost, but it is rarely used today because of late recurrence of incompetence resulting from suture dehiscence, which gives a guitar string appearance at reoperation. Carpentier's description of a measured rigid prosthetic ring that selectively reduces the annulus opened the era of modern mitral and tricuspid valve annuloplasty. The ring has the systolic shape of the tricuspid valve annulus and is open at the level of the anteroseptal commissure to avoid passing the anchoring sutures close to the conduction system.

Awareness of the continuous changes in size and shape of the normal valve annulus during the cardiac cycle led to the development of a totally flexible and complete ring. The flexible ring was designed to reduce and selectively reinforce the entire mitral or tricuspid valve annulus with minimal interference in the complex function of the atrioventricular valves. The surgical technique for implantation of a tricuspid valve ring is similar for all types of devices. Selection of the appropriate ring size is based on the length of the septal segment of the annulus. Large U sutures are placed around the annulus and through the ring. In the septal area, the sutures are passed through the base of the septal leaflet to avoid damaging the conduction system. The ring is brought down and the sutures are tied, reducing the overall perimeter of the tricuspid valve annulus. More recently open bands that selectively reduce the posterior mitral annulus have been developed and applied to the tricuspid valve. In the tricuspid valve, the annulus

contention is limited to the base of the anterior and posterior leaflets. The band designs are based on the assumptions that the mitral valve's intertrigonal distance and the tricuspid valve's septal annulus do not change during the cardiac cycle. However, these areas not only change continuously in the normal heart, but, more important, also dilate progressively in disease. A partial annuloplasty does not protect against further dilation.

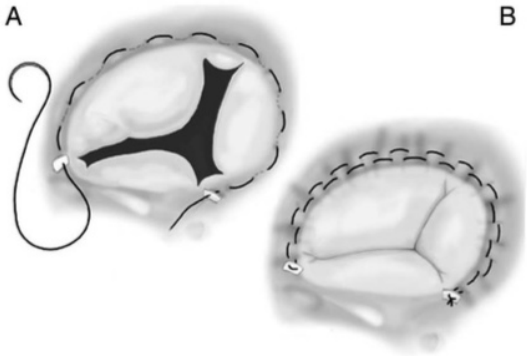


Fig A-Devegas annuloplasty

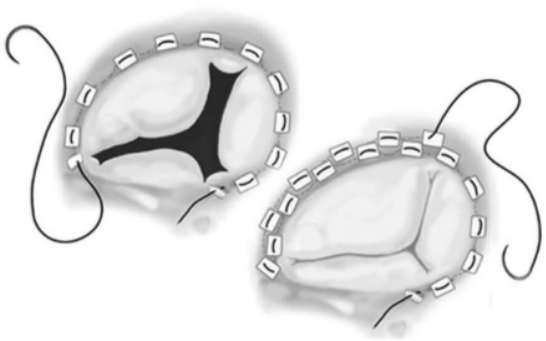


Fig B -Modified Devegas Annuloplasty

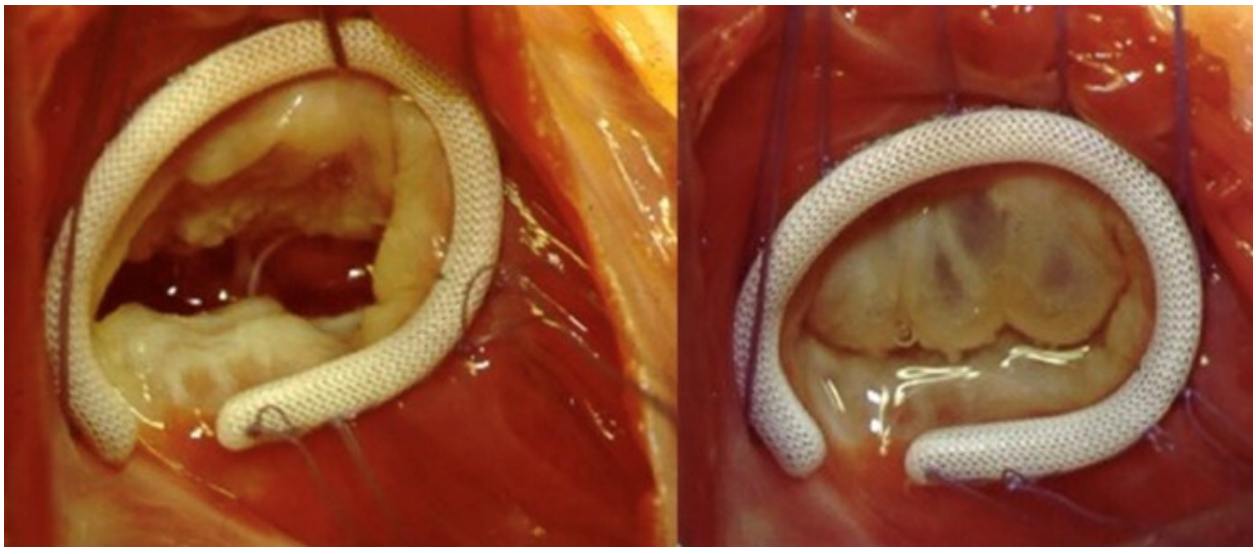


Fig C- Ring Annuloplasty

Toyono M et al mentions need for tricuspid valve repair in patients with significant TR because the persistence of PAH is invariably found in such patients, presence of TR will cause further overloading of RV, hindering the reverse remodeling and further increase in RV dimension annular dilation and further non coaptation of TV leaflets and more TR. Increase in PAH, finally deterioration of RV function and RV failure. Our study included patients with moderate to severe TR, though patients with moderate TR at the end of 1 year found to have persistent moderate PAH, majority of patients even with significant PAH and TR at the time of surgery regressed to mild TR at the end of one year without deterioration of functional status in any of our patients necessitating need for surgery or medical attention.

CONCLUSION:

Tricuspid regurgitation associated with left-side lesions is a part of the right-side disease in which right ventricular dysfunction and pulmonary hypertension are probably determining factors of a worse prognosis. Hence in our retrospective study those patients undergoing Tricuspid valve repair mainly the annular reduction procedures of which three procedures.

1) BICUSPIDISATION

2) DEVEGAS ANNULOPLASTY

3) RING ANNULOPLASTY

All 50 patients who had secondary tricuspid regurgitation for left side heart valve pathologies who underwent anyone of these procedures were followed up for a period of 5 years and assessed on clinical grounds by the presence of symptoms (NYHA Class, Hepatomegaly, pedal edema) and by 2D Echocardiography in which mainly the TR grade, TAPSE (Tricuspid annular plane systolic excursion) and PAH (Pulmonary arterial hypertension). Despite the use of modern technologic advances, tricuspid valve regurgitation is going to be a poor prognostic factor in patients with associated mitral or combined mitral and aortic valve disease.

This study provides the durability and usefulness of Tricuspid valve repair in long term and helps the surgeon to make a decision whether to address the

tricuspid valve at time of surgery for other left sided valve lesions. Moreover the presence and regression of functional Tricuspid regurgitation on a long term and pulmonary arterial hypertension indirectly helps to assess the right ventricular function.

Any change in right ventricular dimensions can cause dilatation of the annulus and in turn secondary Tricuspid regurgitation. Overall all the three annular reduction procedures gave good results and those who underwent ring annuloplasties at the time of Mitral or Aortic or Double valve replacement had no or only mild TR at the end of fifth year of follow up .

Limitations:

The study was done retrospectively in those patients who got operated at different point of time ranging from 1 to 5 years and the results may be affected by technical advancement and subjective error during follow up echos.

Of three annular reduction procedures the, bicuspidisation and devegas are performed in less numbers compared to ring annuloplasties.

Long term follow up study is required with much bigger study group. Prospective study with case control pattern will more informative. Limited clinical evaluation should have been elaborated. Detailed echocardiographic evaluation in terms of annular diameter, leaflet morphology both pre op and post op period should be carried out and documented. Comparative study between patients in whom tricuspid valve is not addressed at the time of surgery and those who

underwent annular reduction procedures and annular diameter of >40-50mm will help us for better understanding of natural history following surgery to secondary tricuspid regurgitation .

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Technical Advisory Committee (Clinical Studies)

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY
THIRUVANANTHAPURAM – 695011, INDIA

TAC Registration No: SCT-/S/2018/741 **Date: 29.05.2018**

Project title: TRICUSPID VALVE REPAIR – FIVE YEAR FOLLOW UP

Principal Investigator:
Dr.Karthik Kumaran, Senior Resident, Department of CVTS, SCTIMST — Degree: M.B.B.S, M.S(General Surgery)
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Dr. Vivek v.Pillai Associate Professor , Department of CVTS, SCTIMST Degree: Mch (Cardiovascular and thoracic surgery), M.S (General surgery), M.B.B.S
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Dr.Jayakumar.K Professor and Head, Department of CVTS, SCTIMST Degree: Mch (Cardiovascular and thoracic surgery), M.S (General surgery), M.B.B.S

Members who participated in the TAC meeting on 19/05/2018
Dr. Rupa Sreedhar (Chairperson)
Dr. Prasantakumar Dash
Dr. Sanjay G
Dr. Krishna Kumar K
Dr. Sankara Sarma P
Dr. Sylaja PN
Dr. Ashalatha. R
Dr. Bijulal S
Dr. Jayadevan ER
Dr. Syam K
Dr. Varghese T. Panicker
Dr. K. Shivakumar (Member Secretary)

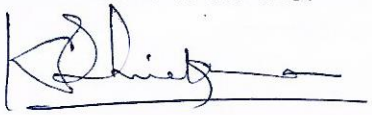
Dr. Rupa Sreedhar, Dr. Syam K, Dr. Sylaja PN, Dr. Prasantakumar Dash, Dr. Varghese T. Panicker and Dr. Ashalatha. R stayed away from the proceedings when the projects in which they are involved as investigator were discussed (#736,737, 738, 740, 741,743,744, 746, 749, 752).

Risk Classification of the project (Minimum/ Moderate/ High): Minimum

Requirement of DSMB: No

Recommended members of DSMB: Not applicable

Recommendations of TAC:
Recommended for consideration of IEC in the light of the responses received from the investigator
The PI may note that there can be no additions / alterations in the documents approved by TAC when they are submitted to the IEC.



Signature of the Member Secretary, TAC (Clinical Studies)

Note for IEC
Copy of the investigator's responses to questions/suggestions from TAC is attached (Appendix-1).

श्री चित्रा तिरुनाल आयुर्विज्ञान और प्रौद्योगिकी संस्थान, त्रिवेन्द्रम
तिरुवनन्तपुरम - ६९५०११, केरल, इंडिया
SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM
Thiruvananthapuram - 695 011, Kerala, India
(An Institute of National Importance under Govt. of India)
Grams : Chitramet, Phone : +91-471-2443152, Fax : +91-471-2550728 / 2446433, E-mail : sct@sctimst.ac.in, Website : www.sctimst.ac.in

Institutional Ethics Committee

(IEC Regn No. ECR/189/Inst/KL/2013/RR-16)

SCT/IEC/ 1227/JUNE-2018

25.07.2018

Dr. Karthik Kumaran
Senior Resident
Department of CVTS
SCTIMST, Thiruvananthapuram

Dear Dr. Karthik Kumaran,

The Institutional Ethics Committee reviewed your application to conduct the study entitled "TRICUSPID VALVE REPAIR – FIVE YEAR FOLLOW UP (IEC/ 1227)" on 25th July, 2018.

First submission
1. *Covering letter addressed to the Chairman, IEC, SCTIMST with check list*
2. *TAC Approval Letter* 3. *IEC Application Form* 4. *Project Proposal*
5. *CV of Principal Investigator and Co-Principal Investigators*

Second submission
1. *Covering letter addressed to the Chairman, IEC, SCTIMST with checklist*
2. *Forwarding Letter from the HOD dated 13.07.2018* 3. *TAC Approval Letter* 4. *IEC Application Form*
5. *Project Proposal* 6. *Proforma* 7. *CV of Principal Investigator and Co-Principal Investigators*

Third submission
1. *Covering letter addressed to the Chairman, IEC, SCTIMST dated 25.07.2018 with checklist*
2. *Modified Proforma*

The IEC Review Criteria

The study was reviewed using an expedited procedure with the permission of the Chairman to allow for submission requirement for DM/MCh final year residents wherein students were required to submit dissertation before July 31, 2018.

IEC Decision

The IEC approved the conduct of the study in the present form.

Remarks:

The Institutional Ethics Committee expects to be informed about the progress of the study, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent and asks to be provided a copy of the final report.

There was no member of the study team who participated in voting / decision making process. The ethics committee is organized and operated according to the requirements of Good Clinical Practice and the requirements of the Indian Council of Medical Research (ICMR).

Sincerely,

Mala Ramanathan
Member Secretary, IEC

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PATIENTS			preop								FIRST YEAR							NYHA
UNIQUE ID	DIAGNOSIS	PE OF TV REPA	EART VALVE SU	HEPATOMEGAL	PEDAL EDEMA	TAPSE	PAH	TR GRADE	NYHA CLASS	RHYTHM	NYHA	HEPATOMEGAL	PEDAL EDEMA	TAPSE	PAH	TR GRADE	RHYTHM	I
1	,SEV AS/MS ,S	CUSPIDISATIOI	DVR	YES	NO	10	MODERATE	4+	III	AF	I	NO	NO	14	MODERATE	2+	AF	I
2	SEV AS/MS,MO	DEVEGAS	DVR	YES	YES	11	SEVERE	4+	IV	AF	I	NO	NO	12	MODERATE	2+	AF	I
3	SEV MR/AR,MO	CUSPIDISATOI	DVR	YES	NO	9	MODERATE	3+	III	SR	I	NO	NO	15	MILD	1+	SR	I
4	AS,MOD MS/MO	G ANNULOPLA	DVR	YES	NO	8	MODERATE	3+	III	SR	I	NO	NO	16	MILD	0	SR	I
5	HD,SEV MS/MO	G ANNULOPLA	MVR	NO	NO	10	MODERATE	3+	II	AF	I	NO	NO	17	MODERATE	1+	AF	I
6	P,SEV MR,MOI	CUSPIDISATIOI	MV REPAIR	NO	NO	8	SEVERE	4+	III	SR	I	NO	NO	18	MODERATE	2+	SR	I
7	D,SEV MR,SEV	G ANNULOPLA	MVR	NO	NO	9	SEVERE	4+	II	AF	I	NO	NO	16	MODERATE	1+	AF	I
8	V MS/AS,MOD	G ANNULOPLA	DVR	YES	YES	9	MODERATE	4+	III	AF	I	NO	MILD	14	MODERATE	2+	AF	I
9	D,SEV MS,SEV	G ANNULOPLA	MVR	NO	NO	11	MODERATE	4+	II	AF	I	NO	NO	18	MILD	0	AF	I
10	P,MOD MR,SEV	G ANNULOPLA	MV REPAIR	NO	NO	12	MODERATE	3+	III	SR	I	NO	NO	16	NO	0	SR	I
11	D,SEV MS,SEV	CUSPIDISATIOI	MVR	NO	NO	13	MODERATE	3+	II	AF	I	NO	NO	16	MILD	2+	AF	I
12	SEV MS,MOD A	CUSPIDISATIOI	DVR	YES	NO	9	SEVERE	4+	III	AF	II	MILD	MILD	13	MODERATE	3+	AF	I
13	V MR,MOD MS	G ANNULOPLA	MVR	NO	NO	11	MODERATE	3+	II	AF	I	NO	NO	17	NO	0	AF	II
14	SEV MS,MOD A	DEVEGAS	DVR	YES	NO	8	MODERATE	4+	III	SR	II	MILD	MILD	11	MODERATE	2+	SR	I
15	V MR,MOD AR	G ANNULOPLA	MVR	NO	NO	13	MODERATE	4+	III	AF	I	NO	NO	16	NO	0	SR	I
16	P,SEV MR,MOI	DEVEGAS	MVR	NO	NO	9	MODERATE	3+	IV	AF	I	NO	NO	15	MILD	2+	AF	I
17	),SEV MS,MOD	G ANNULOPLA	MVR	NO	NO	9	SEVERE	4+	IV	AF	I	NO	NO	16	NO	0	SR	I
18	D,SEV MS,MOI	CUSPIDISATIOI	MVR	NO	NO	12	MODERATE	3+	IV	AF	I	NO	NO	14	MILD	2+	AF	I
19	D,SEV MS,MOD	G ANNULOPLA	MVR	NO	NO	10	SEVERE	3+	III	SR	I	NO	NO	16	MILD	1+	SR	I
20	/P,SEV MR,SEV	G ANNULOPLA	MVR	NO	NO	10	MODERATE	3+	II	AF	I	NO	NO	17	MILD	1+	AF	I
21	D,SEV MR,SEV	G ANNULOPLA	MV REPAIR	NO	NO	12	SEVERE	4+	III	AF	I	NO	NO	15	MILD	1+	AF	I
22	SEV MS/AS,MO	G ANNULOPLA	DVR	YES	NO	8	MODERATE	4+	III	AF	I	NO	NO	14	MODERATE	1+	AF	I
23	RHD,SEV MS/A	G ANNULOPLA	DVR	NO	NO	9	MODERATE	4+	IV	SR	I	NO	NO	13	MILD	2+	SR	I
24	/P,SEV MR,SEV	DEVEGAS	MVR	NO	NO	11	SEVERE	4+	III	AF	I	NO	NO	15	MODERATE	2+	AF	I
25	P,SEV MR,MOI	CUSPIDISATIOI	MV REPAIR	NO	NO	9	MODERATE	3+	II	AF	I	NO	NO	16	MILD	2+	AF	I
26	,SEV AS/MS ,S	CUSPIDISATIOI	DVR	YES	NO	10	MODERATE	4+	III	AF	I	NO	NO	14	MODERATE	2+	AF	I
27	SEV AS/MS,MO	G ANNULOPLA	DVR	YES	YES	11	SEVERE	4+	IV	AF	I	NO	NO	12	MODERATE	2+	AF	I
28	SEV MR/AR,MO	CUSPIDISATOI	DVR	YES	NO	9	MODERATE	3+	III	SR	I	NO	NO	15	MILD	1+	SR	I
29	AS,MOD MS/MO	G ANNULOPLA	DVR	YES	NO	8	MODERATE	3+	III	SR	I	NO	NO	16	MILD	0	SR	I
30	HD,SEV MS/MO	G ANNULOPLA	MVR	NO	NO	10	MODERATE	3+	II	AF	I	NO	NO	17	MILD	1+	AF	I
31	P,SEV MR,MOI	CUSPIDISATIOI	MV REPAIR	NO	NO	8	SEVERE	4+	III	SR	I	NO	NO	18	MODERATE	2+	SR	I
32	D,SEV MR,SEV	G ANNULOPLA	MVR	NO	NO	9	SEVERE	4+	II	AF	I	NO	NO	16	MILD	1+	AF	I
33	V MS/AS,MOD	G ANNULOPLA	DVR	YES	YES	9	MODERATE	3+	III	AF	I	NO	MILD	14	MODERATE	2+	AF	I
34	D,SEV MS,SEV	G ANNULOPLA	MVR	NO	NO	11	MODERATE	3+	II	AF	I	NO	NO	18	MILD	0	AF	I
35	P,MOD MR,SEV	G ANNULOPLA	MV REPAIR	NO	NO	12	MODERATE	3+	III	SR	I	NO	NO	16	NO	0	SR	I
36	D,SEV MS,SEV	CUSPIDISATIOI	MVR	NO	NO	13	MODERATE	3+	II	AF	I	NO	NO	16	MILD	2+	AF	I
37	SEV MS,MOD A	CUSPIDISATIOI	DVR	YES	NO	9	SEVERE	4+	III	AF	1	MILD	MILD	13	MODERATE	3+	AF	I
38	V MR,MOD MS	G ANNULOPLA	MVR	NO	NO	11	MODERATE	3+	II	AF	I	NO	NO	17	NO	0	AF	II
39	SEV MS,MOD A	DEVEGAS	DVR	YES	NO	8	MODERATE	4+	III	SR	II	MILD	MILD	11	MODERATE	2+	SR	I
40	V MR,MOD AR	G ANNULOPLA	MVR	NO	NO	13	MODERATE	4+	III	AF	I	NO	NO	16	NO	0	SR	I
41	P,SEV MR,MOI	DEVEGAS	MVR	NO	NO	9	MODERATE	3+	IV	AF	I	NO	NO	15	MILD	2+	AF	I
42	),SEV MS,MOD	G ANNULOPLA	MVR	YES	NO	9	SEVERE	4+	IV	AF	I	NO	NO	16	NO	0	SR	I
43	D,SEV MS,MOI	CUSPIDISATIOI	MVR	NO	NO	12	MODERATE	3+	III	AF	II	NO	NO	14	MILD	2+	AF	I
44	D,SEV MS,MOD	G ANNULOPLA	MVR	YES	NO	10	SEVERE	3+	III	SR	I	NO	NO	16	MILD	1+	SR	I
45	/P,SEV MR,SEV	G ANNULOPLA	MVR	NO	NO	10	MODERATE	3+	II	AF	I	MILD	NO	17	MILD	1+	AF	I
46	D,SEV MR,SEV	G ANNULOPLA	MV REPAIR	YES	NO	12	SEVERE	3+	III	AF	I	NO	NO	15	MODERATE	1+	AF	I
47	SEV MS/AS,MO	G ANNULOPLA	DVR	YES	NO	8	MODERATE	4+	III	AF	I	NO	NO	14	MODERATE	1+	AF	I
48	RHD,SEV MS/A	G ANNULOPLA	DVR	NO	NO	9	MODERATE	4+	IV	SR	I	NO	NO	13	MILD	2+	SR	I
49	/P,SEV MR,SEV	DEVEGAS	MVR	YES	NO	11	SEVERE	3+	III	AF	I	NO	NO	15	MODERATE	2+	AF	I
50	HD,SEV MS/MO	CUSPIDISATIOI	MV REPAIR	NO	NO	9	MODERATE	4+	III	AF	I	MILD	NO	16	MILD	2+	AF	

HEPATOMEGAL
NO
NO
NO
NO
NO
NO
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NO
NO
NO
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NO
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MILD
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NO
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NO
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MILD
NO
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NO
NO
NO
NO
NO
NO
NO
NO
NO

PEDAL EDEMA	TAPSE	PAH	TR GRADE	RHYTHM	FIFTH YEAR						
NO	15	MODERATE	2+	AF	NYHA	HEPATOMEGAL	PEDAL EDEMA	TAPSE	PAH	TR GRADE	RHYTHM
NO	13	MODERATE	2+	AF	I	NO	NO	15	MILD	2+	AF
NO	16	MILD	2+	SR	I	NO	NO	14	MODERATE	3+	AF
NO	17	MILD	1+	SR	I	NO	NO	16	MILD	2+	SR
NO	18	MILD	1+	AF	I	NO	NO	18	NO	1+	SR
NO	17	MILD	2+	SR	I	NO	NO	17	MILD	1+	AF
NO	16	MILD	1+	AF	I	NO	NO	17	NO	2+	SR
NO	15	MILD	2+	AF	I	NO	NO	16	NO	1+	AF
NO	17	MILD	0	AF	I	NO	NO	15	NO	2+	AF
NO	16	NO	0	SR	I	NO	NO	17	NO	0	AF
NO	16	MILD	2+	AF	I	NO	NO	16	NO	0	SR
NO	15	MILD	2+	AF	I	NO	NO	16	NO	2+	AF
NO	18	NO	0	AF	I	NO	NO	16	MILD	2+	AF
MILD	13	MODERATE	3+	SR	I	NO	NO	18	NO	0	AF
NO	16	NO	0	SR	I	NO	MILD	14	MILD	3+	SR
NO	15	NO	2+	AF	I	NO	NO	17	NO	0	SR
NO	18	NO	0	SR	I	NO	NO	16	NO	2+	AF
NO	15	MILD	2+	AF	I	NO	NO	21	NO	0	SR
NO	16	NO	0	SR	I	NO	NO	16	MILD	2+	AF
NO	15	MILD	1+	AF	I	NO	NO	17	NO	0	SR
NO	16	MODERATE	1+	AF	I	NO	NO	16	NO	1+	AF
NO	16	MODERATE	1+	AF	I	NO	NO	15	NO	1+	AF
NO	16	MILD	1+	AF	I	NO	NO	14	MODERATE	2+	AF
MILD	14	MODERATE	3+	AF	I	NO	NO	16	MILD	1+	AF
NO	14	MILD	2+	AF	II	NO	NO	14	MODERATE	3+	AF
NO	15	MODERATE	2+	AF	I	NO	NO	15	MILD	2+	AF
NO	13	MODERATE	2+	AF	I	NO	NO	15	MILD	2+	AF
NO	16	MILD	2+	SR	I	NO	NO	14	MODERATE	3+	AF
NO	17	MILD	1+	SR	I	NO	NO	16	MILD	2+	SR
NO	18	MILD	1+	AF	I	NO	NO	18	NO	1+	SR
NO	17	MILD	2+	SR	I	NO	NO	17	MILD	1+	AF
NO	16	MILD	1+	AF	I	NO	NO	17	NO	2+	SR
NO	15	MILD	2+	AF	I	NO	NO	16	NO	1+	AF
NO	17	MILD	0	AF	I	NO	NO	15	NO	2+	AF
NO	16	NO	0	SR	I	NO	NO	17	NO	0	AF
NO	16	MILD	2+	AF	I	NO	NO	16	NO	0	SR
NO	15	MILD	2+	AF	I	NO	NO	16	NO	2+	AF
NO	18	NO	0	AF	I	NO	NO	16	MILD	2+	AF
MILD	13	MODERATE	3+	SR	I	NO	NO	18	NO	0	AF
NO	16	NO	0	SR	I	NO	MILD	14	MILD	3+	SR
NO	15	NO	2+	AF	I	NO	NO	17	NO	0	SR
NO	18	NO	0	SR	I	NO	NO	16	NO	2+	AF
NO	15	MILD	2+	AF	I	NO	NO	21	NO	0	SR
NO	16	NO	0	SR	I	NO	NO	16	MILD	2+	AF
NO	15	MILD	1+	AF	I	NO	NO	17	NO	0	SR
NO	16	MODERATE	1+	AF	I	NO	NO	16	NO	1+	AF
NO	16	MODERATE	1+	AF	I	NO	NO	15	NO	1+	AF
NO	16	MILD	1+	AF	I	NO	NO	14	MODERATE	2+	AF
MILD	14	MODERATE	3+	AF	I	NO	NO	16	MILD	1+	AF
NO	14	MILD	2+	AF	II	NO	NO	14	MODERATE	3+	AF
					I	NO	NO	15	MILD	2+	AF