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Surgical Options to Prevent and Treat Tricuspid Valve Regurgitation in Heart Transplant Recipients

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Disclosure: Conflict Of Interest

- Nothing to disclose in reference to this presentation

Prevalence of Tricuspid Valve Disease after Heart Transplantation

14% to 84% (depending on the definition of TR)

TABLE 5: Prevalence of TR after OHT.

Study	Number of patients	TR prevalence at the end of the followup (%)	Average follow-up period (years)	Definition of significant TR
Current study	<i>n</i> = 163	14.1%	8.2	≥mild-moderate
Chan et al. [3]	<i>n</i> = 336	34%	4.5	≥moderate
Aziz et al. [8]	<i>n</i> = 249	53.9%	5	≥moderate
Hausen et al. [14]	<i>n</i> = 251	50%	4	≥moderate-severe
Williams et al. [18]	<i>n</i> = 72	32%	2.4	≥moderate
Yankah et al. [25]	<i>n</i> = 647	5.5%	5	≥moderate
Chen et al. [27]	<i>n</i> = 178	26.4%	5	≥moderate
Huddleston et al. [28]	<i>n</i> = 183	20%	4	≥moderate

TR: tricuspid regurgitation; OHT: orthotopic heart transplantation.

Berger et al. Journal of Transplantation
Volume 2012, Article ID 120702, 8 pages
doi:10.1155/2012/120702

Clinical Manifestation and Prognosis of Mod-Sev Tricuspid Regurgitation after HTx

- Progressive fatigue (35%)
- Chronic fluid congestion (61%)
- Lower extremity edema (78%)
- Hepatomegaly (29%)
- Jugular venous distention (59%).
- Renal Failure
- Protein-losing enteropathy

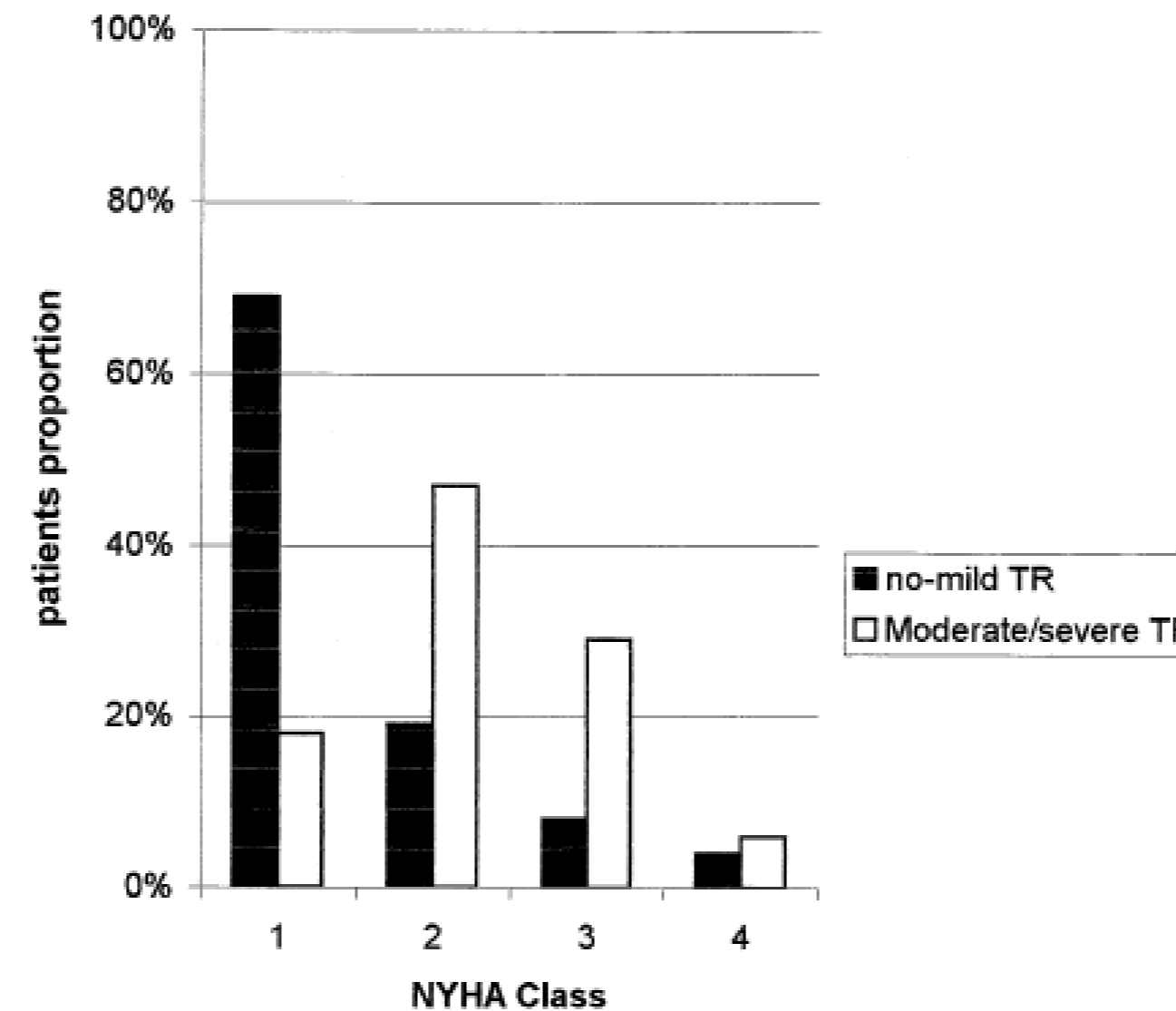


Fig 2. New York Heart Association class among heart transplant recipients with different grade TR.

Aziz et al. Ann Thorac Surg 1999;68:1247–51

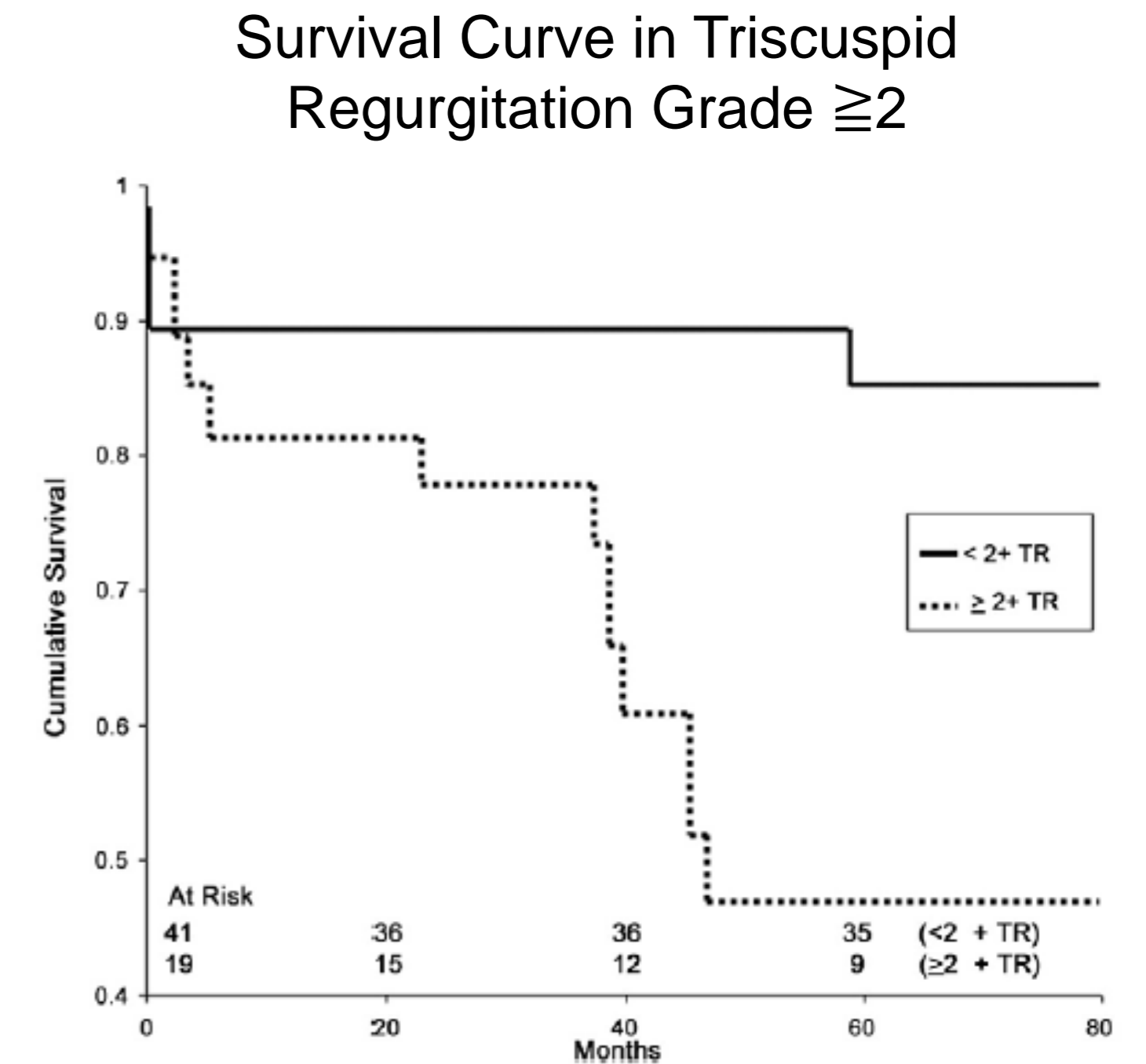


Fig 1. Kaplan-Meier survival curves for patients with tricuspid regurgitation (TR) of 2+ or greater at any point after transplant. Follow-up was complete for the entire cohort. (Solid line = <2+ TR; dotted line = ≥2+ TR.)

Jeevanadam et al. Ann Thorac Surg 2006;82:2089–95

Clinical Manifestation and Prognosis of Mod-Sev Tricuspid Regurgitation after HTx

Follow-up: 8 years

TABLE 4: Clinical outcomes of late significant (at least mild-moderate) TR.

Clinical outcome	No TR/mild TR (<i>n</i> = 140)	At least mild-moderate TR (<i>n</i> = 23)	<i>P</i> value
Mortality (% patients)	28.6%	47.8%	0.065
Median serum creatinine at the end of followup (mg/dL)*	1.4 (0.5–10.4)	1.8 (1.0–2.9)	0.081
Need for diuretic therapy \geq 10 mg furosemide/day (% patients)	10.4%	47.1%	<0.001
Need for another heart surgery	1.7%	33.3%	<0.001

TR: tricuspid regurgitation.

*Data are presented as median and range (min–max).

Berger et al. Journal of Transplantation
Volume 2012, Article ID 120702, 8 pages
doi:10.1155/2012/120702

Tricuspid Valve Disease in Heart Tx Recipients

• **Functional TR**

- Surgical Technique
 - Biatrial vs Bicaval
 - Pericardial Size Mismatch
 - Mismatch of Recipient/Donor RA ratio in Biatrial technique
- Right Ventricle Dysfunction
 - Previous Pulmonary Hypertension
 - Volume Overload
 - Rejection

• **Anatomic TR**

- EMB
- Endocarditis

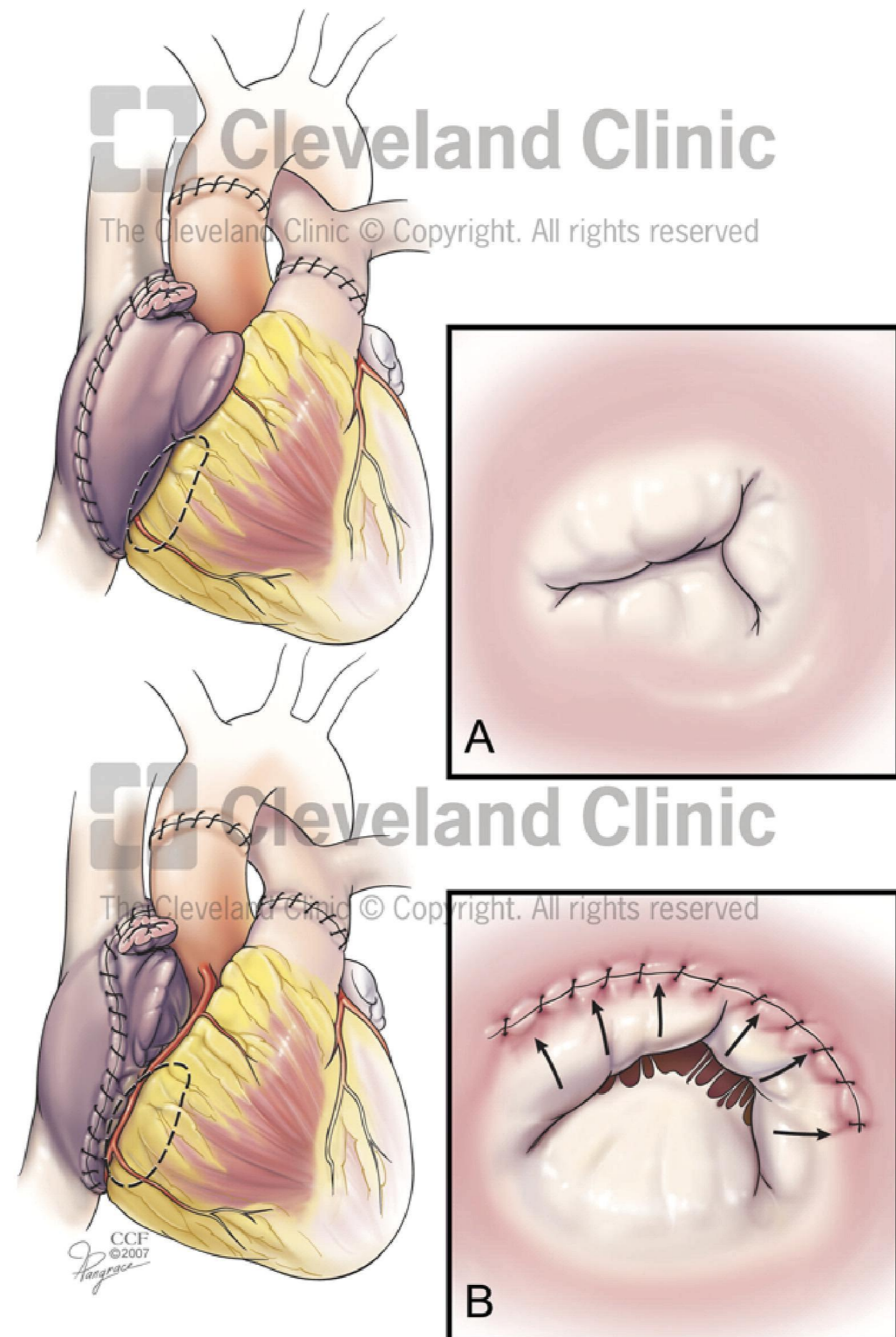
Prevention

Tricuspid Regurgitation: Biatrial Technique

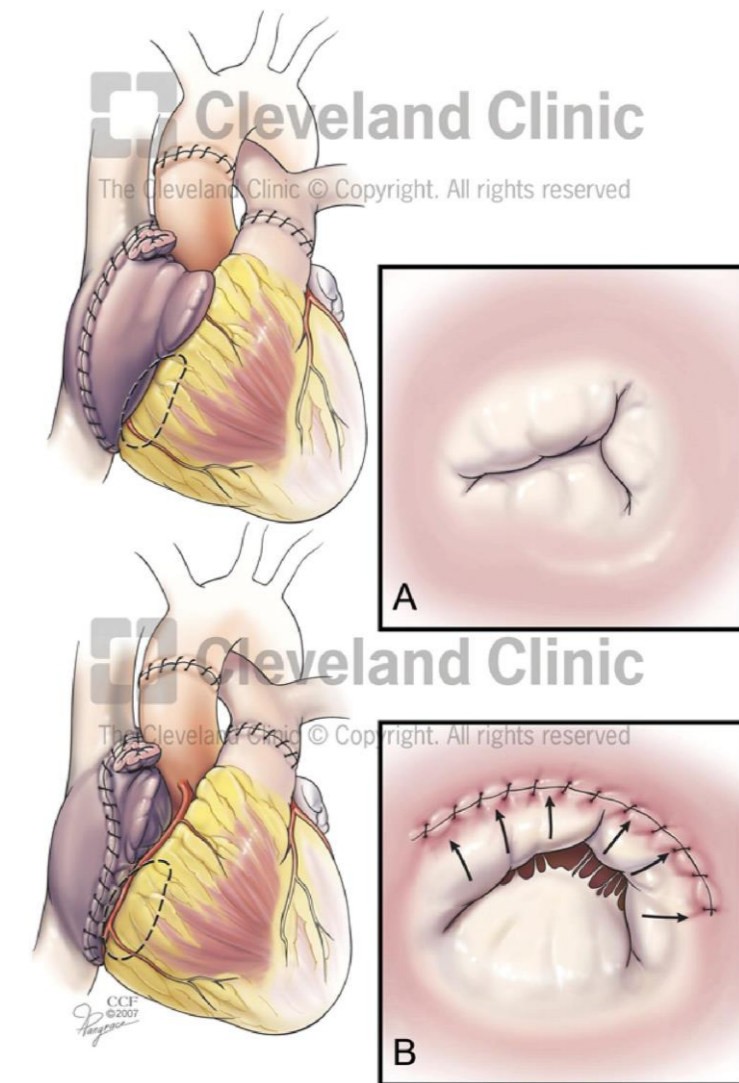
Tricuspid Regurgitation After Cardiac Transplantation: An Old Problem Revisited

Raymond Ching-Chiew Wong, MBBS, MRCP,^a Zuheir Abrahams, MD, PhD,^a Mazen Hanna, MD,^a
Joseph Pangrace, CMI,^b Gozalo Gonzalez-Stawinski, MD,^c Randall Starling, MD, MPH,^a and David Taylor, MD,^a

The Journal of Heart and Lung Transplantation
Volume 27, Issue 3, Pages 247-252 (March 2008)
DOI: 10.1016/j.healun.2007.12.011



Tricuspid Regurgitation: Biatrial vs Bicaval approach



Risk Factors for Tricuspid Valve Regurgitation After Orthotopic Heart Transplantation

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Table 2. Difference in Incidence and Severity of Tricuspid Valve Regurgitation Between Cardiac Transplant Recipients Had Standard Technique Versus Bicaval Technique

Time After Transplant	Standard Technique		Bicaval Technique		p Value
	No TR to Mild TR	Moderate to Severe	No TR to Mild TR	Moderate to Severe	
1 month	93/156 (59%)	63/156 (41%)	72/84 (85%)	12/84 (15%)	0.0001
12 months	73/146 (50%)	73/146 (50%)	62/81 (76%)	19/81 (24%)	0.002
24 months	67/138 (48%)	71/138 (52%)	56/79 (70%)	23/79 (30%)	0.002
Recently	38/119 (31%)	81/119 (69%)	49/70 (70%)	21/70 (30%)	0.0001

p value compares the prevalence of significant TR (moderate and severe TR) between each technique at different stages following transplantation.

TR = tricuspid valve regurgitation.

Ann Thorac Surg 1999;68:1247–51

Biatrial Technique is associated to Mod-Sev Tricuspid Regurgitation

Table 3 Tricuspid Regurgitation At Discharge and Follow-up

Variable	No.	None	Mild	Moderate	Severe	<i>p</i> -value
		No. (%)	No. (%)	No. (%)	No. (%)	
Discharge						
Bicaval	207	102 (49.3)	67 (32.4)	25 (12.1)	13 (6.3)	< 0.001
Biatrial	166	51 (30.7)	52 (31.3)	50 (30.1)	13 (7.8)	
5 years						
Bicaval	106	48 (44.2)	45 (42.5)	11 (10.4)	2 (1.9)	0.013
Biatrial	116	33 (28.4)	50 (43.1)	22 (19.0)	11 (9.5)	
10 years						
Bicaval	31	15 (48.4)	12 (38.7)	2 (6.5)	2 (6.5)	0.082
Biatrial	97	24 (24.7)	43 (44.3)	19 (19.6)	11 (11.3)	

Wartig et al. J HeartLungTransplant2014;33:829–835

Tricuspid Regurgitation: Biatrial vs Bicaval approach over time

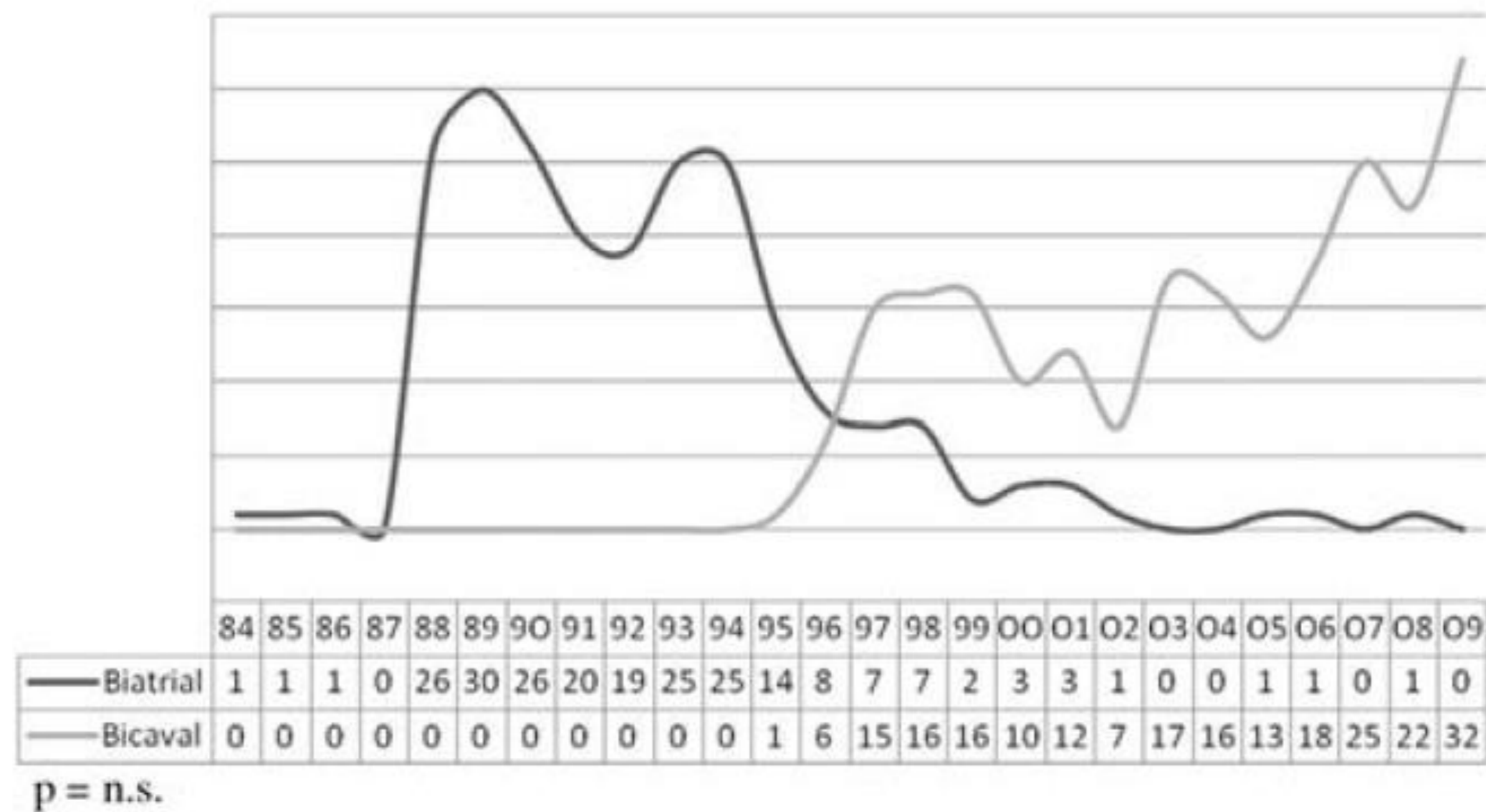
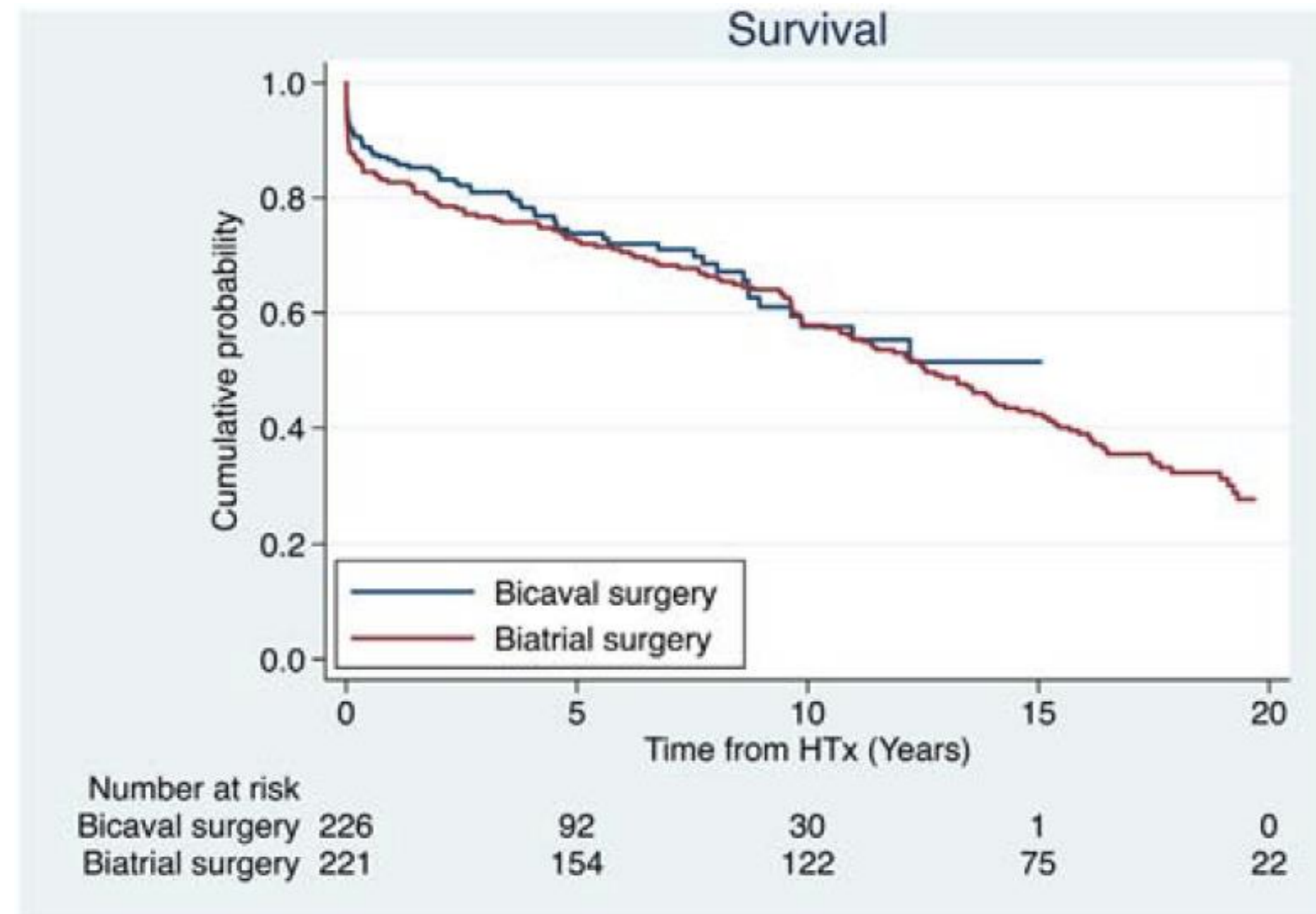


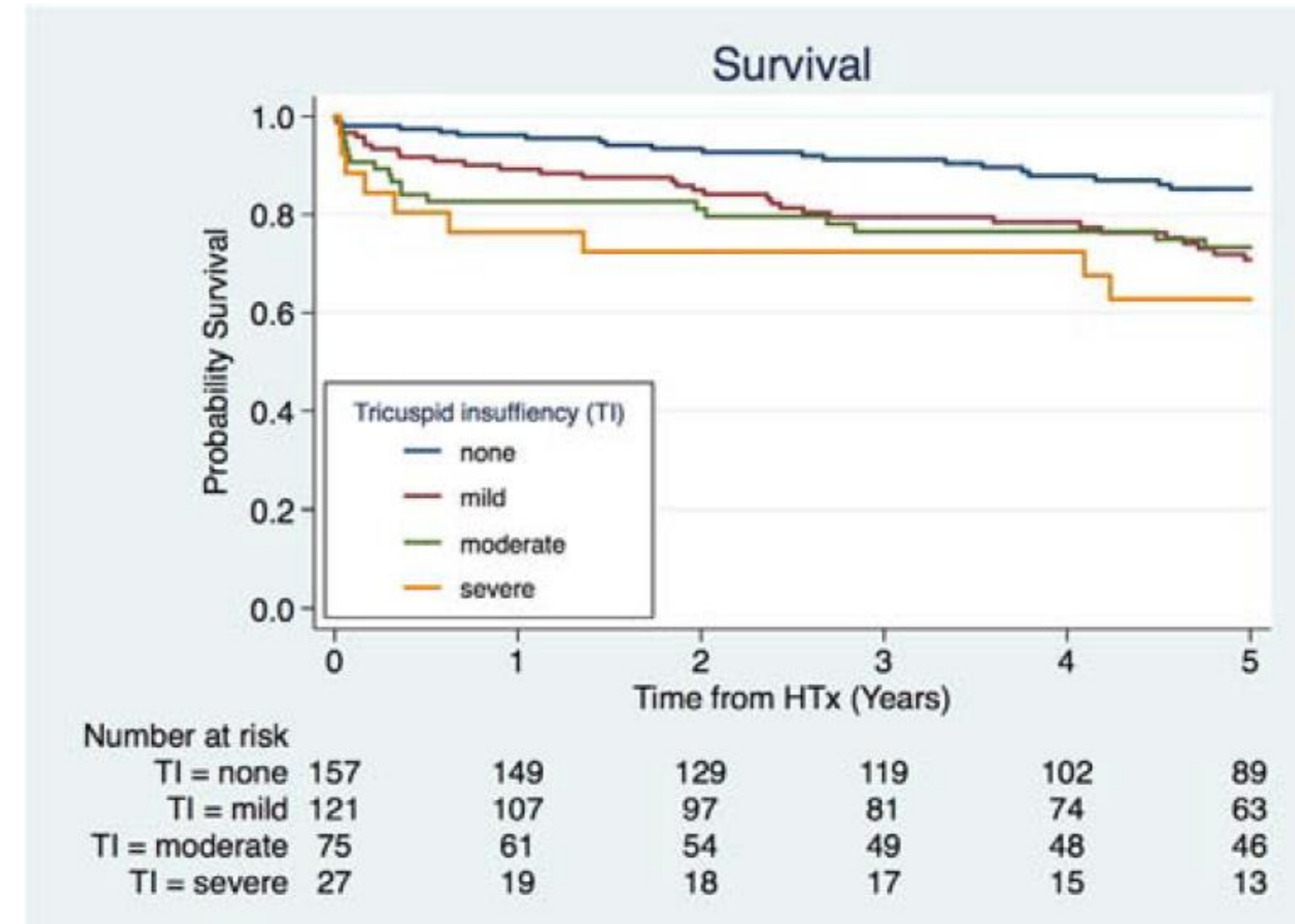
Figure 1 Heart transplantation and technique over time.

Wartig et al. J HeartLungTransplant2014;33:829–835

Worst Long Term Survival with Severe Tricuspid Regurgitation



p = 0.45



p < 0.01

Wartig et al. J HeartLungTransplant2014;33:829–835

Tricuspid valve regurgitation after heart transplantation

J Thorac Cardiovasc Surg 2009;137:1557-9

Daniel Marelli, MD, Fardad Esmailian, MD, Samantha Y. Wong, BS, Jon A. Kobashigawa, MD, Murray H. Kwon, MD, Ramin E. Beygui, MD, Hillel Laks, MD, Mark D. Plunkett, MD, Abbas Ardehali, MD, and Richard J. Shemin, MD, Los Angeles, Calif

670 patients with Bicaval Anastomoses

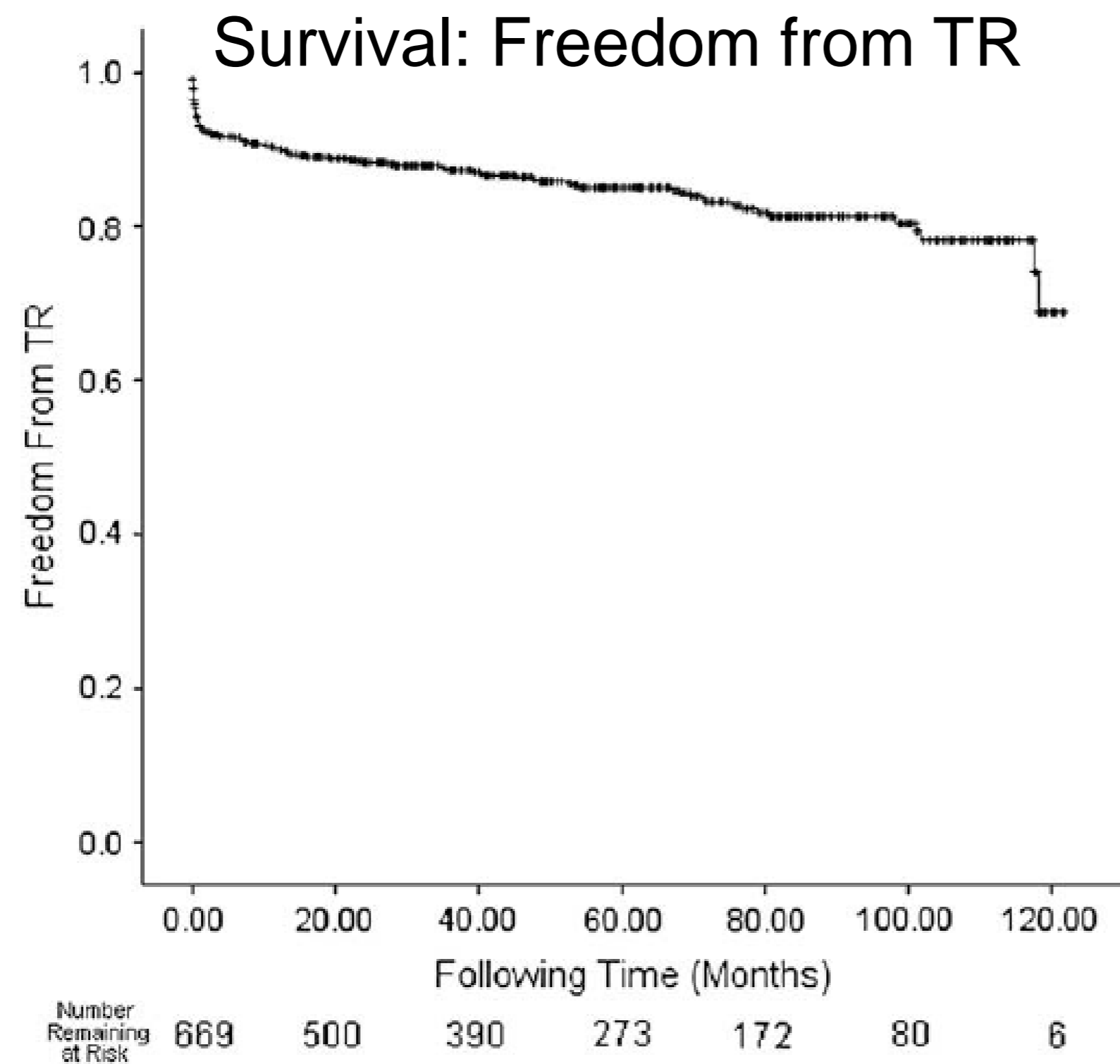


FIGURE 1. Actuarial freedom from TR in the 670 patients was 78% at 9 years. *TR*, Tricuspid regurgitation.

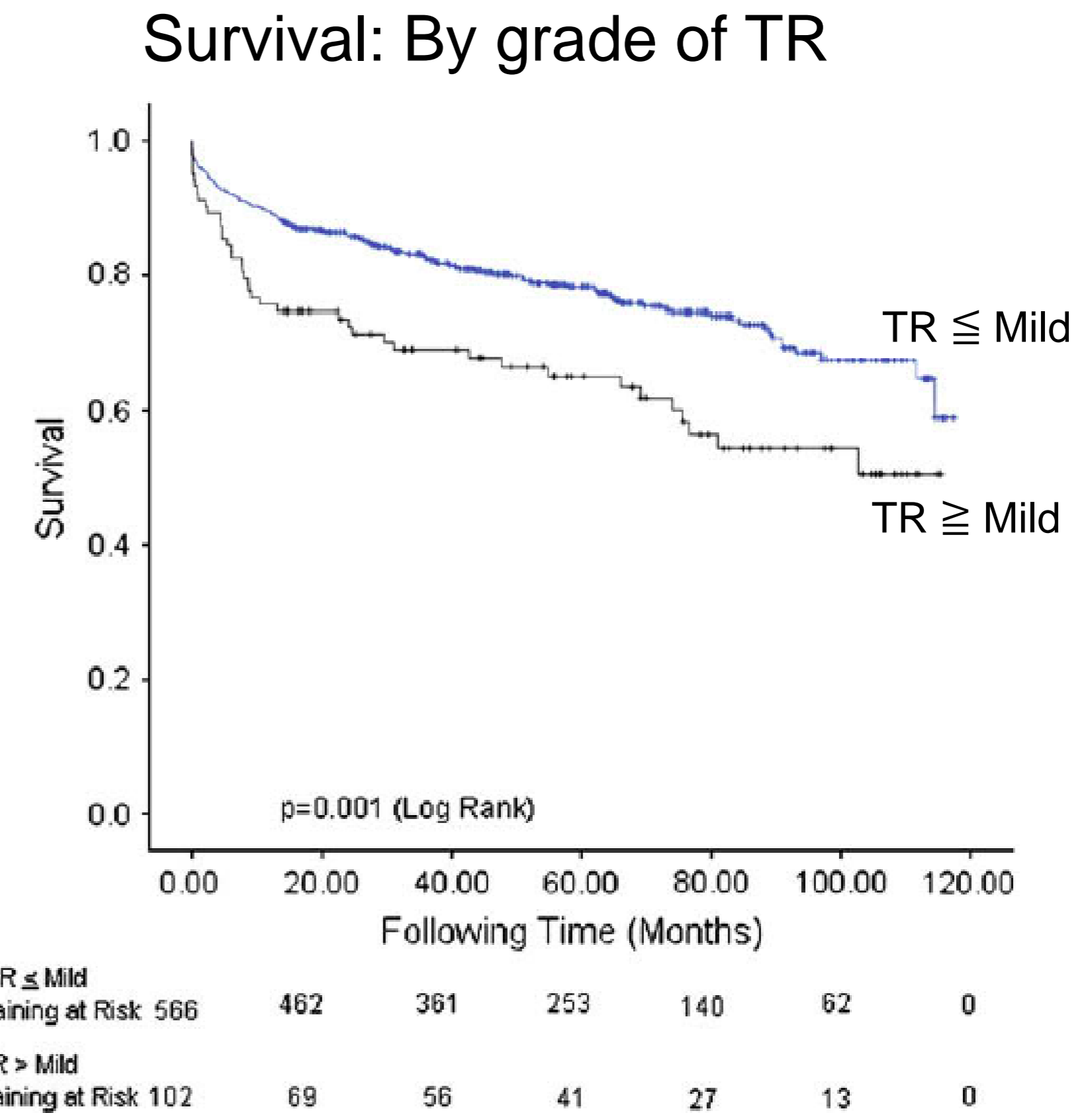


FIGURE 2. Five-year survival was 78.3% for those with $TR \leq$ mild and 65.3% for those with $TR >$ mild. *TR*, Tricuspid regurgitation.

Severe Tricuspid Regurgitation After Heart Transplantation: Does It Require Surgical Repair?

D. Geft, M. Kittleson, J. Patel, T. Aintablian, K. Yabuno, B. Kearney, E. Kransdorf, D.H. Chang, L. Czer, A. Trento, J. Kobashigawa. Cedars-Sinai Heart Institute, Los Angeles, CA.

2010 to 2014: 35 HTx patients who had developed severe TR in the first month following HTx surgery.

(1 patient required Tricuspid Valve Repair for severe TR)

Endpoints	Severe TR (n=35)
1-Year Survival	85.70%
1-Year Freedom from NF-MACE	85.70%
1-Year Freedom from Any-Treated Rejection	88.60%
1-Year Freedom from Atrial Arrhythmia	65.70%
First-Year Flail Tricuspid Valve Leaflet	8.6% (3/35)
Surgical Intervention: Tricuspid Valve Repair	2.9% (1/31)

Conclusion: HTx patients who develop severe TR following HTx surgery appear to show improvement in a majority of these valves over time. While patients who develop to severe TR should be closely monitored, surgical intervention is rarely necessary.

p=0.009

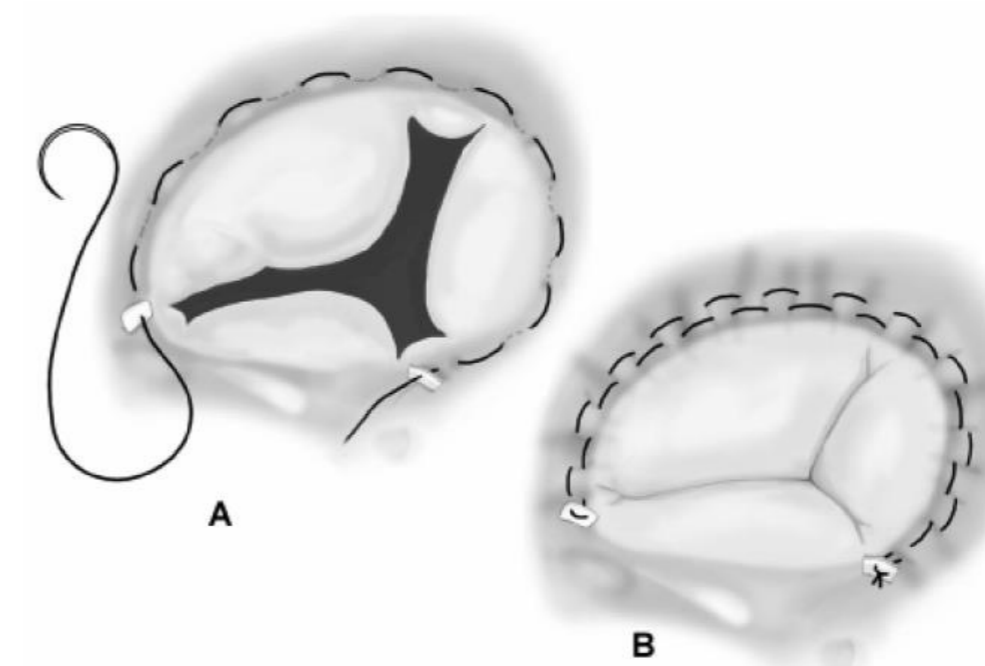
Prevention of Tricuspid Regurgitation

A One-Year Comparison of Prophylactic Donor Tricuspid Annuloplasty in Heart Transplantation

Valluvan Jeevanandam, MD, Hyde Russell, MD, Paul Mather, MD, Satoshi Furukawa, MD, Allen Anderson, MD, Frank Grzywacz, MD, and Jaishankar Raman, MD, PhD

Departments of Surgery and Medicine, University of Chicago, Chicago, Illinois, and Departments of Surgery and Medicine, Temple University, Philadelphia, Pennsylvania

Ann Thorac Surg 2004;78:759–66



De Vega N, Rev Esp Cardiol, 1972

60 patients

All of them received a bicaval anastomoses

Randomization to:

- **Standard Bicaval technique (30 pts)**
- **Tricuspid Valve Annuloplasty (30 pts)**
- **Groups were comparable in terms of recipients and donors characteristics**

Donor Tricuspid Annuloplasty During Orthotopic Heart Transplantation: Long-Term Results of a Prospective Controlled Study

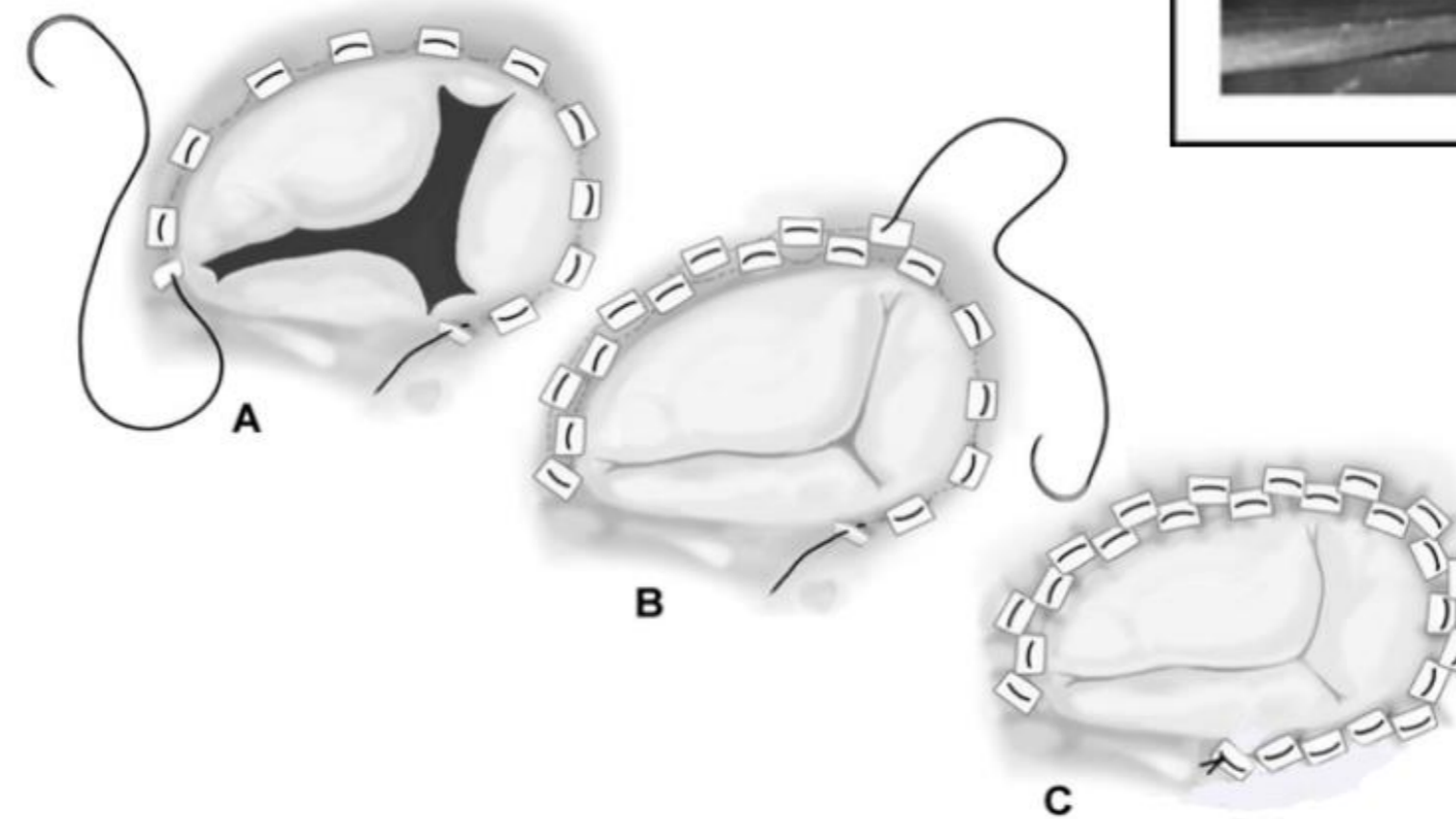
Ann Thorac Surg 2006;82:2089–95

Valluvan Jeevanandam, MD, Hyde Russell, MD, Paul Mather, MD, Satoshi Furukawa, MD, Allen Anderson, MD, and Jaishankar Raman, MD, PhD

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Prophylactic Tricuspid Valve Annuloplasty

- Visualization through the inferior right atrial opening
- DeVega type annuloplasty with double layer of pledgeted 2-0 polypropylene
- Annulus was sized to a 29-mm dilator
- If the annulus was less than 29 mm, it was stabilized to a size just a little smaller than the native annulus.



Long Term Follow-up of Prophylactic Tricuspid Valve Annuloplasty

Table 2. Distribution of the Severity of Tricuspid Regurgitation

	Intraoperative			1 Year			6 Years		
	STD	TVA	<i>p</i> Value	STD	TVA	<i>p</i> Value	STD	TVA	<i>p</i> Value
Average	1.1 ± 1.0	0.33 ± .38	0.01	1.3 ± 1.0	0.2 ± 0.3	0.01	1.5 ± 1.3	0.5 ± 04	0.01
≤1	21	30		17	27		15	22	
2	5	0		7	0		2	0	
≥3	4	0		2	0		5	0	
Percent ≥ 2	30%	0.0%	0.01	34.6%	0.0%	0.02	31.8%	0.0%	0.01
Percent ≥ 3	13.3%	0.0%	0.002	7.6%	0.0%	0.01	22.7%	0.0%	0.005

STD = standard orthotopic heart transplantation group; TVA = tricuspid valve annuloplasty group.

Long Term Follow-up of Prophylactic TVA

Table 3. Hemodynamic Measurements

	1 Year			6 Years		
	STD	TVA	<i>p</i> Value	STD	TVA	<i>p</i> Value
mSys (mm Hg)	82.1 ± 10.7	87.3 ± 9.8	ns	84.2 ± 12.1	82.6 ± 11.8	ns
mPA (mm Hg)	19.1 ± 9.2	20.4 ± 9.1	ns	23 ± 5.2	22.2 ± 6.7	ns
CVP (mm Hg)	6.5 ± 4.3	6.9 ± 4.9	ns	4.4 ± 3.2	7.8 ± 4.4	ns
mPA–CVP	13.4 ± 6.5	14.3 ± 6.32	ns	15 ± 3.2	14.5 ± 4.2	ns
Cardiac index	3.6 ± .7	3.3 ± .6	ns	2.8 ± .5	2.9 ± .5	ns

Table 4. Renal Function After Heart Transplantation

	Preoperative			1 Year			6 Years		
	STD	TVA	<i>p</i> Value	STD	TVA	<i>p</i> Value	STD	TVA	<i>p</i> Value
BUN (mg/dL)	22.3 ± 11.5	26.8 ± 15.6	ns	42.5 ± 16.5	37.7 ± 15	ns	41.0 ± 14.4	32.1 ± 12.1	ns
Crt (mg/dL)	1.02 ± .3	1.34 ± .7	0.058	2.3 ± 1.3	2.2 ± 1	ns	2.9 ± 2.0	1.8 ± 0.7	0.01
dCRT				1.3 ± .9	1.0 ± .9	0.06	2.0 ± 2.1	0.7 ± .8	0.005

Long Term Follow-up of Prophylactic TVA

Complications and Mortality after Heart Transplantation

Group	STD	TVA	<i>p</i> Value
Intraoperative complications	Bleeding 3 Pul HTN/RHF 5 CVA 1 Pulm hem 1 Donor dys 2	Bleeding 3 Pul HTN/RHF 4 Donor dys 3	
Mortality 1 year	RHF 3 Rejection 1	Rejection 1 Sepsis 1 Pneumonia 1	ns
Mortality 6 years	AF 3 Cancer 1	AF 2 Perforated bowel 2 Pneumonia 1	ns
Cardiac deaths	7	3	0.03

- Prophylactic DeVega TVA is
 - Inexpensive
 - quick to perform
 - durable at 1 year
 - offers a survival advantage in the immediate postoperative period.
- Long term, there is better preservation of renal function and prevention of TR.
- Because TVA is beneficial, it should be routinely considered during preparation of a donor heart for transplantation.

Cardiac transplantation with bicaval anastomosis and prophylactic graft tricuspid annuloplasty

Rev Bras Cir Cardiovasc 2008; 23(1): 7-13

Transplante cardíaco com anastomose bicaval e anuloplastia tricúspide profilática no enxerto

Alfredo Inácio FIORELLI¹, Carlos Alberto Cordeiro de ABREU FILHO², Ronaldo Honorato Barros SANTOS³, Fernando H. A. BUCO⁴, Lilian Renata FIORELLI⁵, Fernando BACAL⁶, Edimar Alcides BOCCHI⁷, Noedir Antonio Groppo STOLF⁸

- Group I : (10 patients) tricuspid annuloplasty by De Vega technique
- Group II : (10 patients) control w/o annuloplasty.



The authors concluded that the prophylactic application has improved the immediate function of the graft, with better right ventricle performance without an increase in immediate mortality or ischemic time.

Table 2. Complications observed in the postoperative

	Group I With Annuloplasty	Group II Without Annuloplasty	p
Renal insufficiency	2 (20%)	2 (20%)	ns
Pulmonary infection	1 (10%)	1 (10%)	ns
Mediastinitis	-	1 (10%)	ns
Postoperative bleeding	-	1 (10%)	ns
Pleural effusion	-	2 (20%)	ns
Temporary pacemaker	1 (10%)	-	ns
Late mortality	-	1 (10%)	ns

Table 3. Hemodynamic Study

Variables		Group I With Annuloplasty	Group II Without Annuloplasty	p
Right atrium pressure	mmHg	5.1	6.7	ns
Right ventricle pressure				
Systolic	mmHg	31.4	32.6	ns
Diastolic		3.5	5.7	
Pulmonary artery pressure				
Systolic		28.2	30.2	
Diastolic	mmHg	10.1	11.2	ns
Mean		17.1	20.3	
Pulmonary capillary pressure	mmHg	9.5	7.6	ns
Cardiac debit	L/min	5.42	5.37	ns

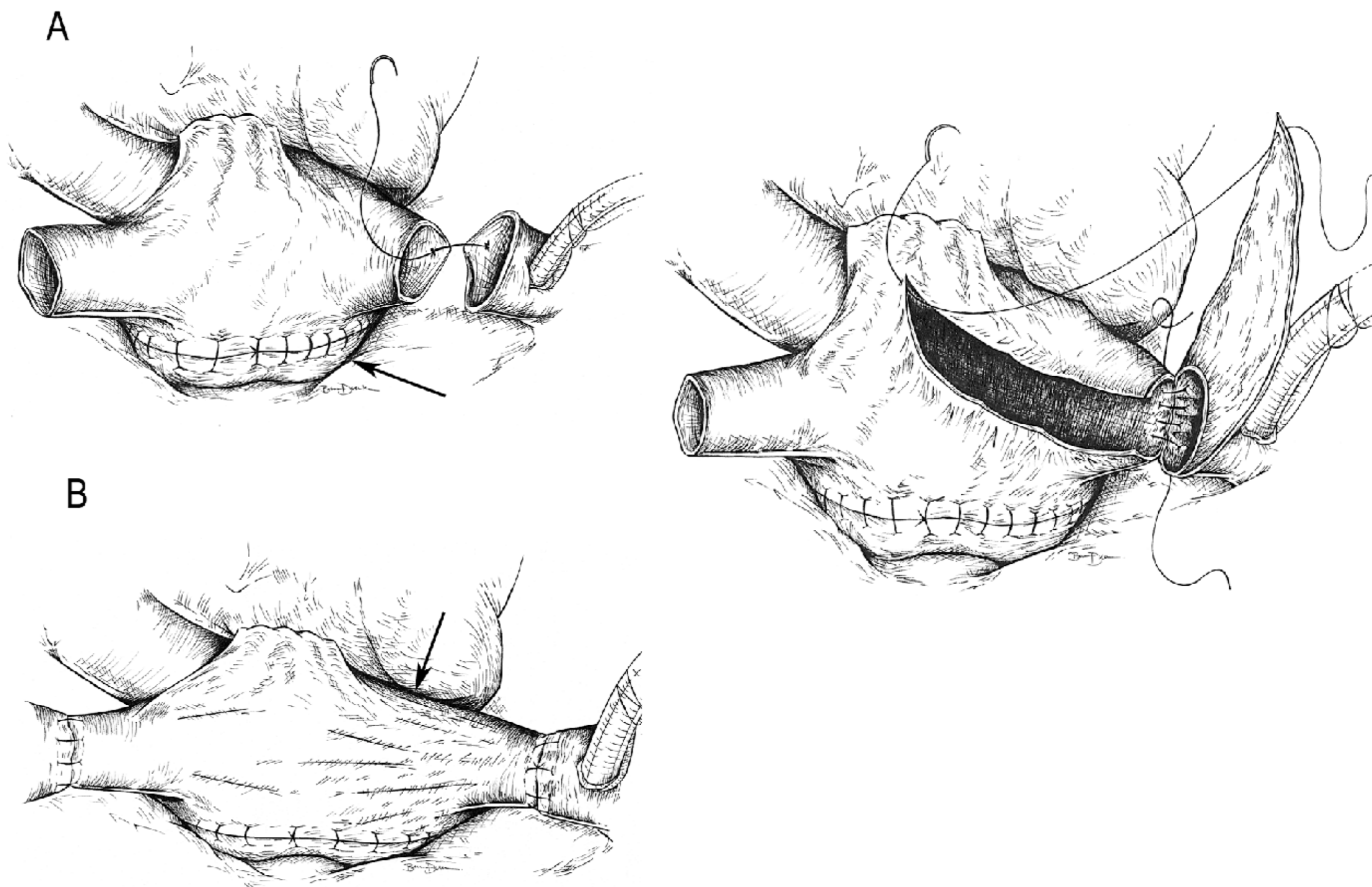
Prevention of Tricuspid Regurgitation

Modified Inferior Vena Caval Anastomosis

to Reduce Tricuspid Valve Regurgitation after Heart Transplantation

Daniel Marelli, MD
Scott C. Silvestry, MD
Donna Zwas, MD
Paul Mather, MD
Sharon Rubin, MD
Anthony F. Dempsey, BS
Louis Stein, MHS
Evelio Rodriguez, MD
James T. Diehl, MD
Arthur M. Feldman, MD, PhD

Tex Heart Inst J 2007;34:30-5



Modified Inferior Vena Caval Anastomosis

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TABLE IV. Comparison of the Incidence of Tricuspid Regurgitation among Various Studies Using Different Heart Transplantation Techniques

Study	Technique	Trace TR	Mild TR	Moderate-to-Severe TR
Aziz T, et al. ⁴	Standard	72%*		28%
	Bicaval	93%*		7%
Jeevanandam V, et al. ⁵	Bicaval	66%	27%	7%
	Bicaval with tricuspid valve annuloplasty	100%	0	0
Present study	Modified bicaval	85%	15%	0

*Trace and mild TR were combined.

TR = tricuspid regurgitation

- The modified inferior vena caval anastomosis is simple and safe.
- It eliminates moderate and severe tricuspid valve regurgitation without routine annuloplasty

Tricuspid Valve Disease in Heart Tx Recipients

- **Functional TR**

- Surgical Technique
 - Biatrial vs Bicaval
 - Pericardial Size Mismatch
 - Mismatch of Recipient/Donor RA ratio in Biatrial technique

- Right Ventricle Dysfunction
 - Previous Pulmonary Hypertension
 - Volume Overload
 - Rejection

- **Anatomic TR**

- EMB
- Endocarditis

Treatment
Surgical
Strategy

Treatment of Tricuspid Disease After HTx: Repair vs. Replacement

Tricuspid valve replacement after cardiac transplantation

Mitesh V. Badiwala and Vivek Rao

Current Opinion in Cardiology 2007, 22:123–127

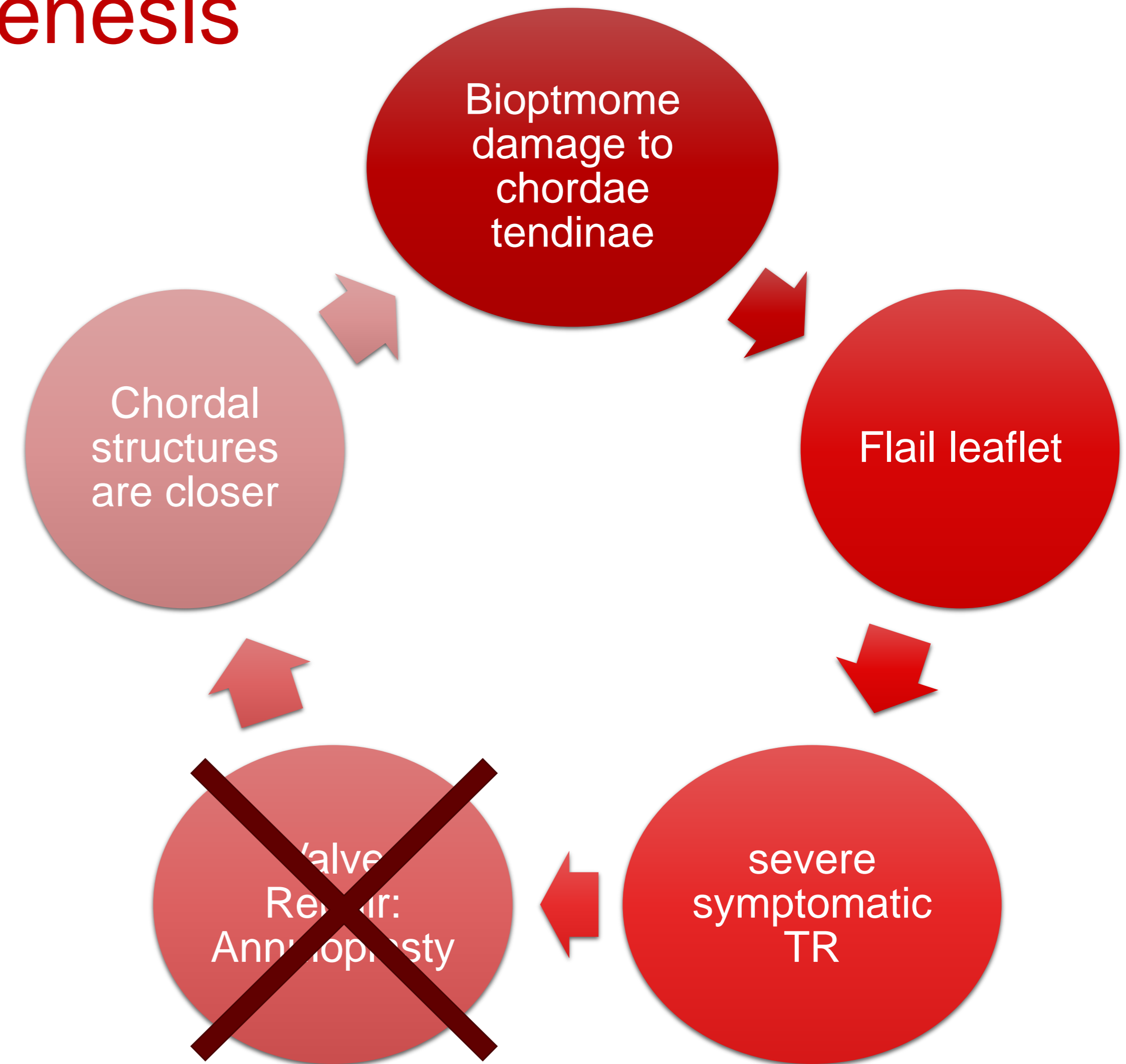
Table 1 Tricuspid valve surgery durability after cardiac transplantation

Study	Period	Total patients, <i>n</i>	Patients with TR requiring surgery, <i>n</i> (%)	Total repairs, <i>n</i>	Repair failures requiring replacement, <i>n</i> (%)	Total replacements, <i>n</i>	Re-replacements, <i>n</i> (%)
Yankah <i>et al.</i> [4]	1986–1999	647	16 (2.5)	6	1 (16.7)	11	0 (0)
Filsoufi <i>et al.</i> [2 ^{••}]	1985–2005	138	8 (5)	6	3 (50)	5	0 (0)
Alharethi <i>et al.</i> [3 ^{••}]	1992–1999	871	17 (2)	2	0 (0)	15	1 (6.7)
Overall		1656	41 (2.5)	14	4 (28.6)	31	1 (3.2)

TR, tricuspid valve regurgitation.

The Role of EMB in the Pathogenesis of Tricuspid Regurgitation

- EMB is the Gold Standard for surveillance of rejection
- EMB is implicated in development of TR
- Histologic findings of chordal tissue were found in 47% of patients with significant TR ¹
- TR is related to the number of EMB:
 - <18 biopsies: no TR
 - > 31 biopsies: 60% developed severe TR ²

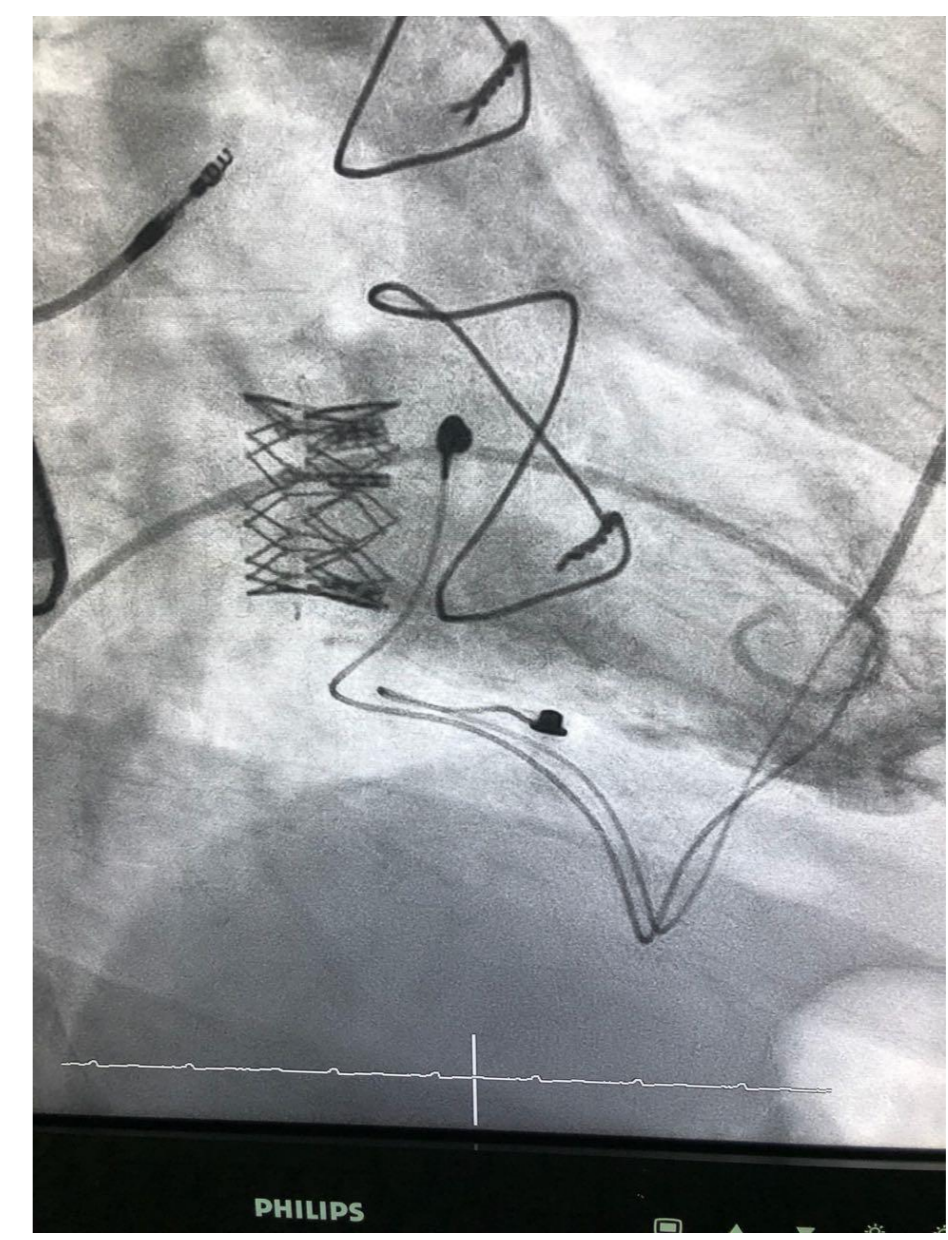
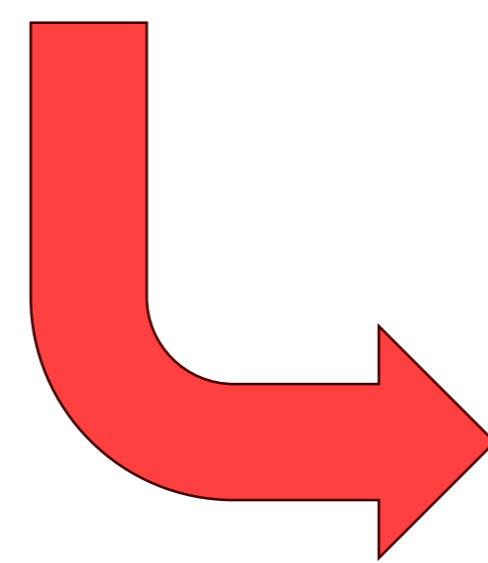
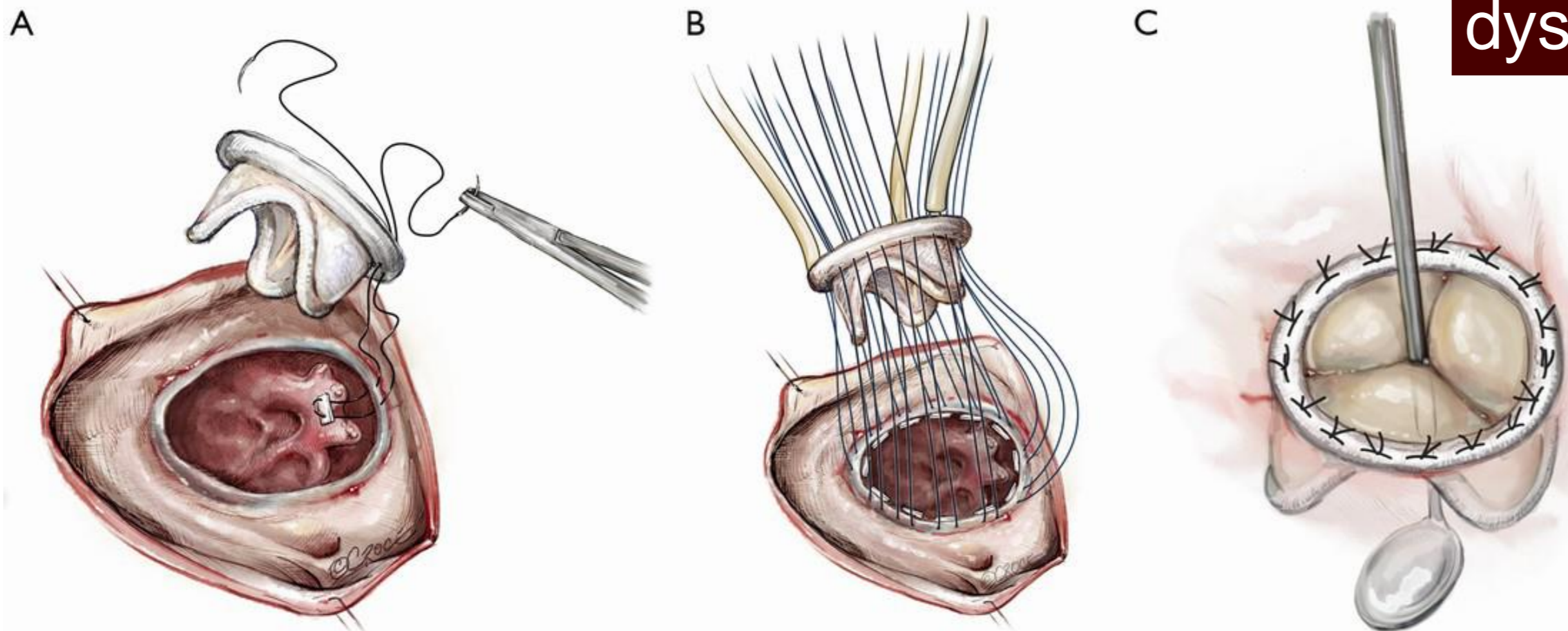


1- Mielniczuk L, et al. J Heart Lung Transplant 2005; 24:1586–1590.

2- Nguyen V, et al J Heart Lung Transplant 2005; 24 (7 Suppl):S227–S231.

Tricuspid Valve Replacement: Biological Prosthesis is the Best Option

First Choice
No need for Anticoagulation
EMB are feasible
Possibility of earlier dysfunction (fibrosis, calcification)
Possibility of valve-in-valve endoprosthesis for prosthetic dysfunction



Treatment of Tricuspid Disease After HTx

Tricuspid Valve Replacement After Cardiac Transplantation

Rami Alharethi, MD,^{a,d} Feras Bader, MD,^{a,d} Abdallah G. Kfoury, MD,^{b,d} M. Elizabeth Hammond, MD,^{b,d}
 Shreekanth V. Karwande, MD,^{a,d} Edward M. Gilbert, MD,^{a,d} Donald B. Doty, MD,^{b,d} Mary E. Hagan, MSFNP,^{c,d}
 Heidi Thomas, BS,^{b,d} and Dale G. Renlund, MD^{b,d}

Table 1. Patient's Characteristics Pre-TVR (*n* = 17)

Characteristic	
Male	14 (82%)
Average age at TVR (\pm SD)	56 \pm 17 years
Allograft vasculopathy (%)	4/17 (23%)
Symptomatic right heart failure (%)	15/17 (88%)
Average time from the transplant to the TVR (\pm SD)	77 \pm 48 months
Average number of biopsies from transplant to the diagnosis of severe T1	33 \pm 13
Bi-atrial anastomoses (%)	17/17 (100%)
Flail leaflets	16/17 (94%)

Table 3. Pre- and Post-TVR Data

Variables	Pre-TVR	Post-TVR	<i>p</i> -value
Serum Cr (mg/dl)	1.8 \pm 0.73	1.9 \pm 0.86	0.723
CO (liters/min)	4.6 \pm 1.04	5.2 \pm 0.88	0.334
CVP (mm Hg)	17.7 \pm 4.1	11 \pm 7.3	0.013
Furosemide dose (mg/day)	47.69 \pm 56.4	26.54 \pm 46.43	0.009

Cr, creatinine; CO, cardiac output; CVP, central venous pressure.

Diferent Options for Tricuspid Valve Replacement:

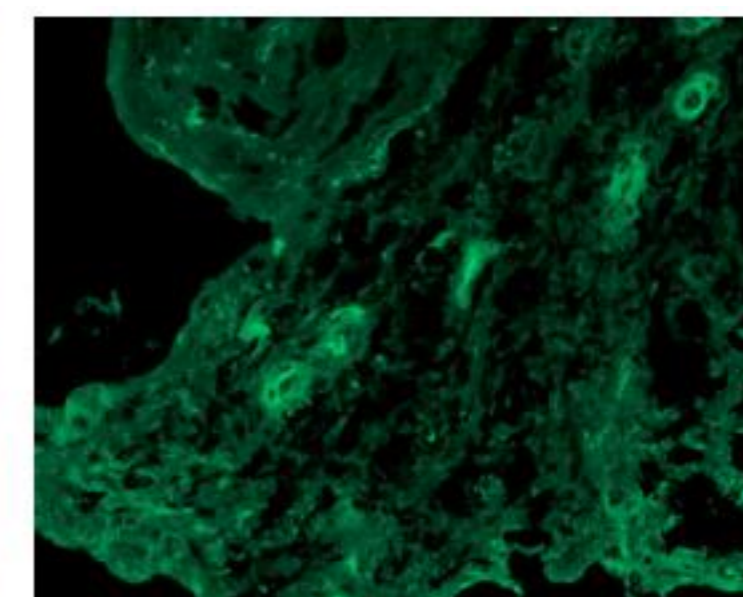
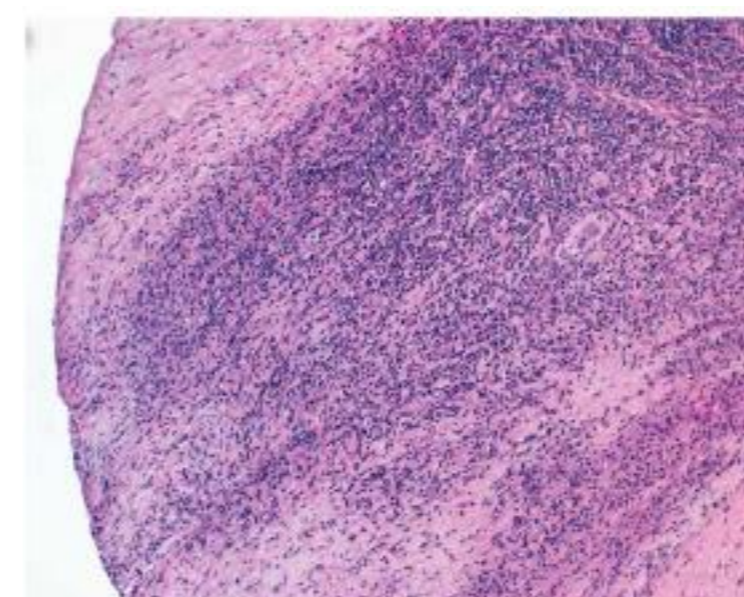
Early Failure of a Tricuspid Valve Replacement With a Mitral Valve Homograft in a Heart Transplant Recipient

Rami Alharethi, MD, Robert E. Shaddy, MD, Donald B. Doty, MD, Stephanie A. Moore, MD, M. Elizabeth H. Hammond, MD, Bashar Dabbas, MD, Thomas C. Fuller, PhD, and Dale G. Renlund, MD

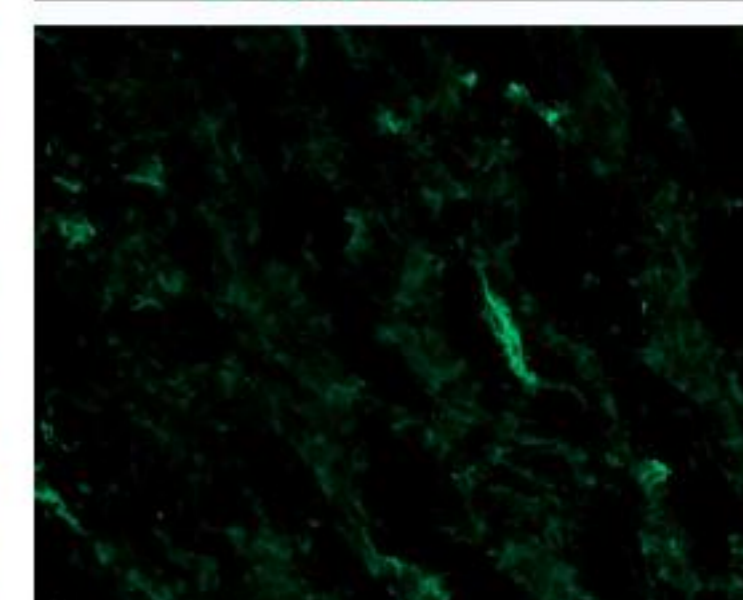
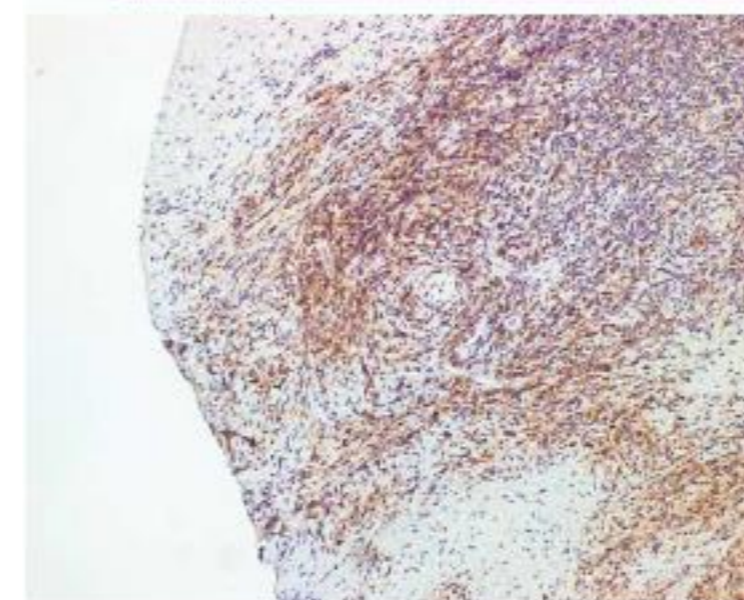
Mitral Homograft biopsies

Table 1. Time Course of Panel Reactive Antibody (PRA) Reactivity

Timing	PRA HLA Class I	PRA HLA Class II
Before tricuspid valve replacement with mitral valve homograft	0%	0%
Before mitral valve homograft replacement with porcine bioprosthesis	72%	31%
After tricuspid valve replacement with porcine bioprosthesis	19%	20%



C3d Stain



C4d Stain

Treatment of Tricuspid Regurgitation Following Heart Transplantation: Surgical Approach and Results

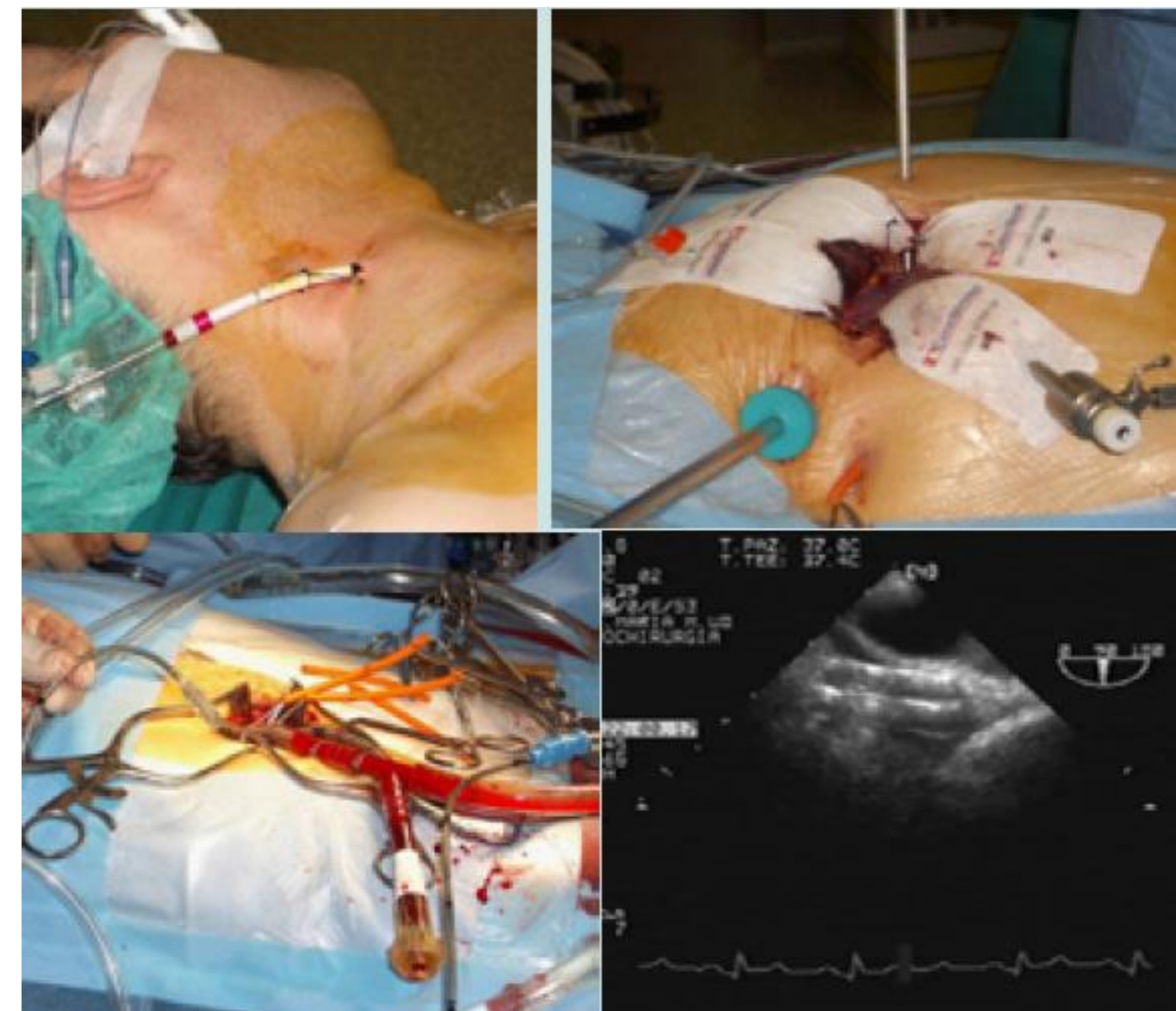
Sponga S*, Della Mattia A, Mazzaro E, Guzzi G, Daffarra C, Pavoni D, Spagna E, Tursi V and Livi U

Cardiothoracic Department, University Hospital of Udine, Italy

J Cardiobiol. 2013;1(1): 4.

Minimal Invasive Approach

- Double lumen ETT
- TEE
- Mini Right Anterior Thoracotomy
- Cannulation:
 - Femoral artery
 - Femoral vein
 - Jugular vein
- On pump Beating Heart surgery
- Direct vision / Thoracoscopy



Summary

- Tricuspid Regurgitation is the most frequent manifestation of valvular disease after Heart Transplantation
- TR during the first year post HTx tends to improve. TV surgery is rare
- Patients with Mod to Sev TR after HTx have a worst long term prognosis
- Geometry alterations of RA and EMB are implicated in the development of TR
- Bicaval anastomosis prevents the development of TR
- Prophylactic De Vega Annuloplasty has good results, but it is not used routinely by transplant centers. Consider modified Bicaval technique.
- Biological prosthetic valves are the first option for TV Replacement

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THANK YOU

