



Il trattamento chirurgico dell'insufficienza tricuspidalica: tecniche, risultati e limiti



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Tricuspid regurgitation: most common surgical scenarios

- Functional TR in patients undergoing left-sided valve surgery
- Late TR following left sided valve surgery



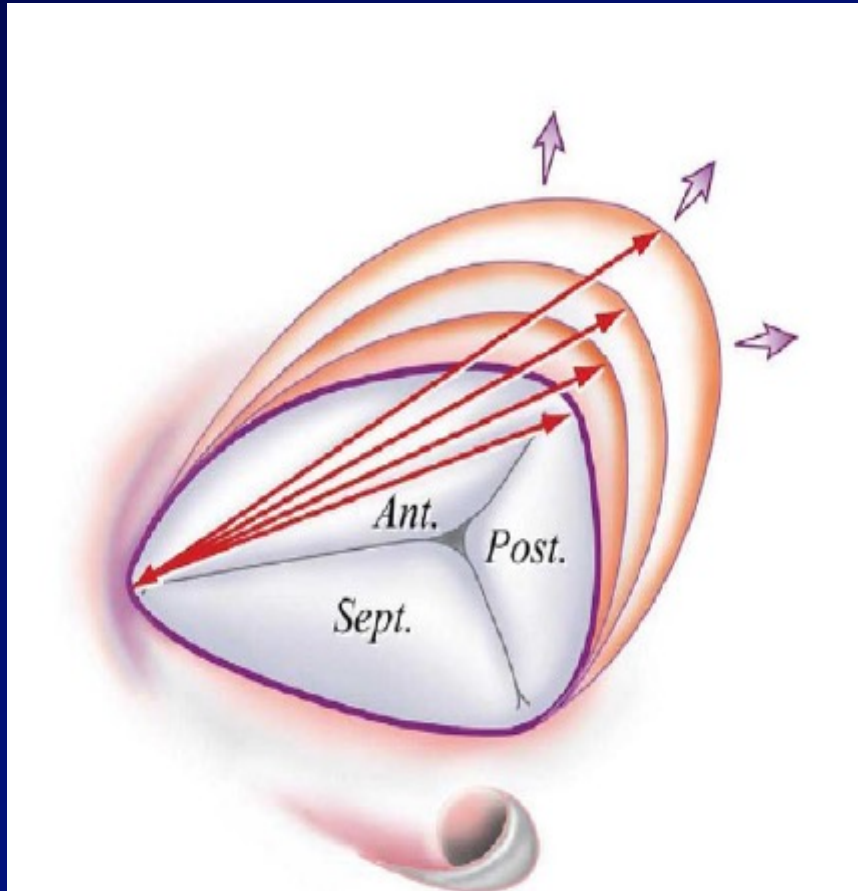
Tricuspid regurgitation: most common surgical scenarios

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- Late TR following left sided valve surgery



Tricuspid annulus dilatation

Asymmetric annular dilatation

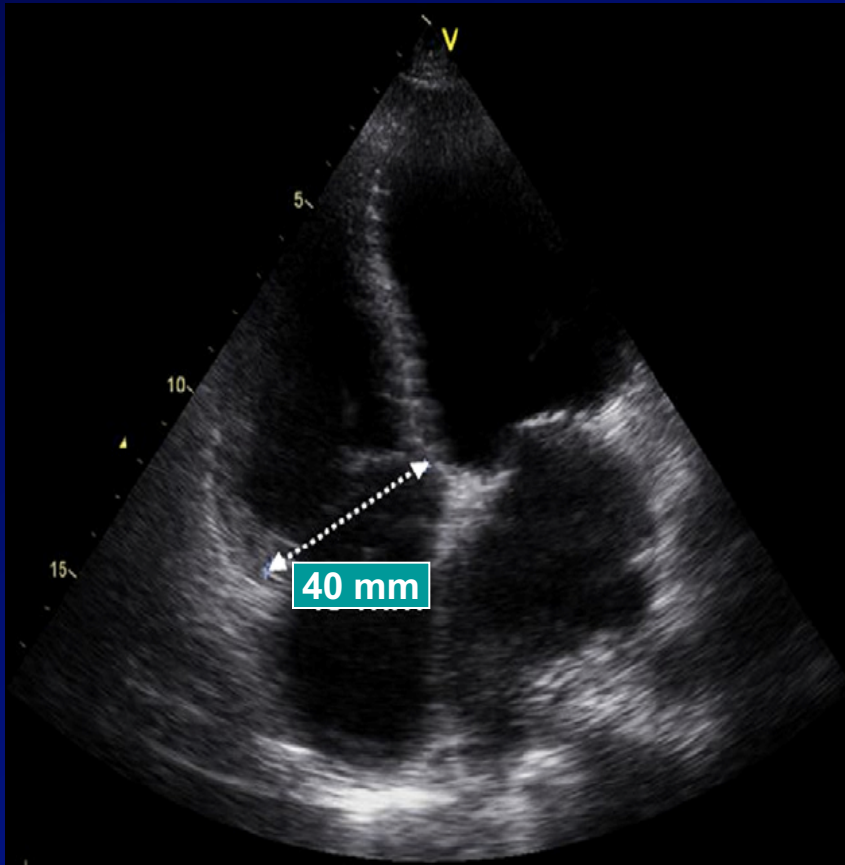


Dreyfus G et al. *Ann Thorac Surg*
2005;79:127–32

Antero-septal to antero-posterior
commissure distance > 7 cm

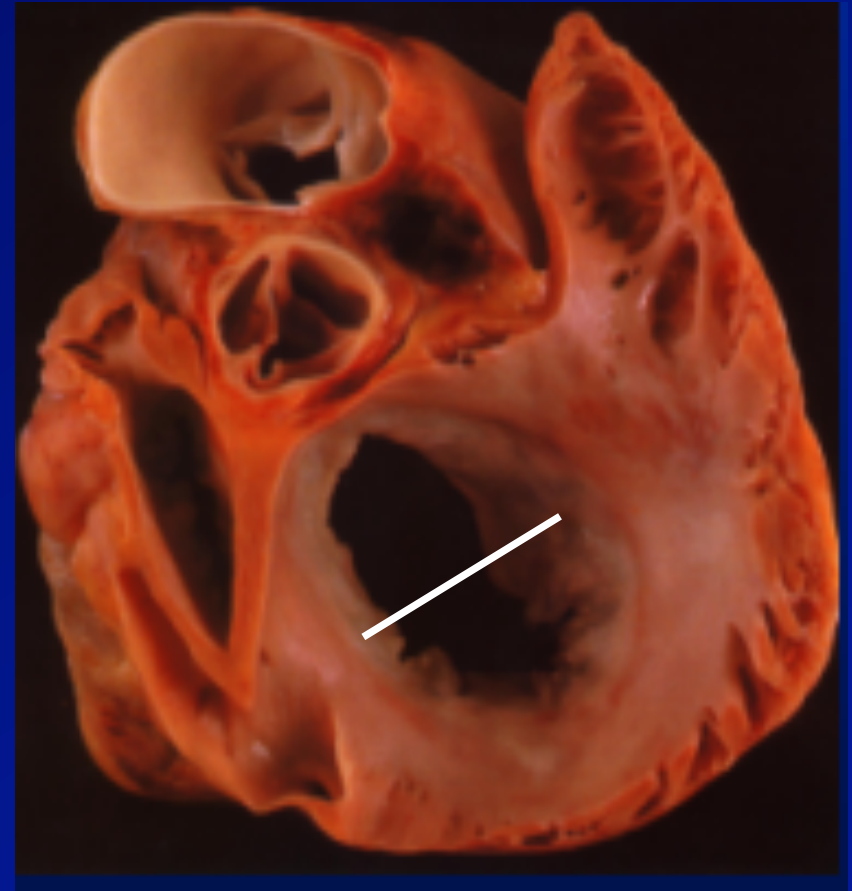
Tricuspid annulus dilatation

TT apical 4-chamber view
in late diastole



≥ 4 cm or 21 mm/m²

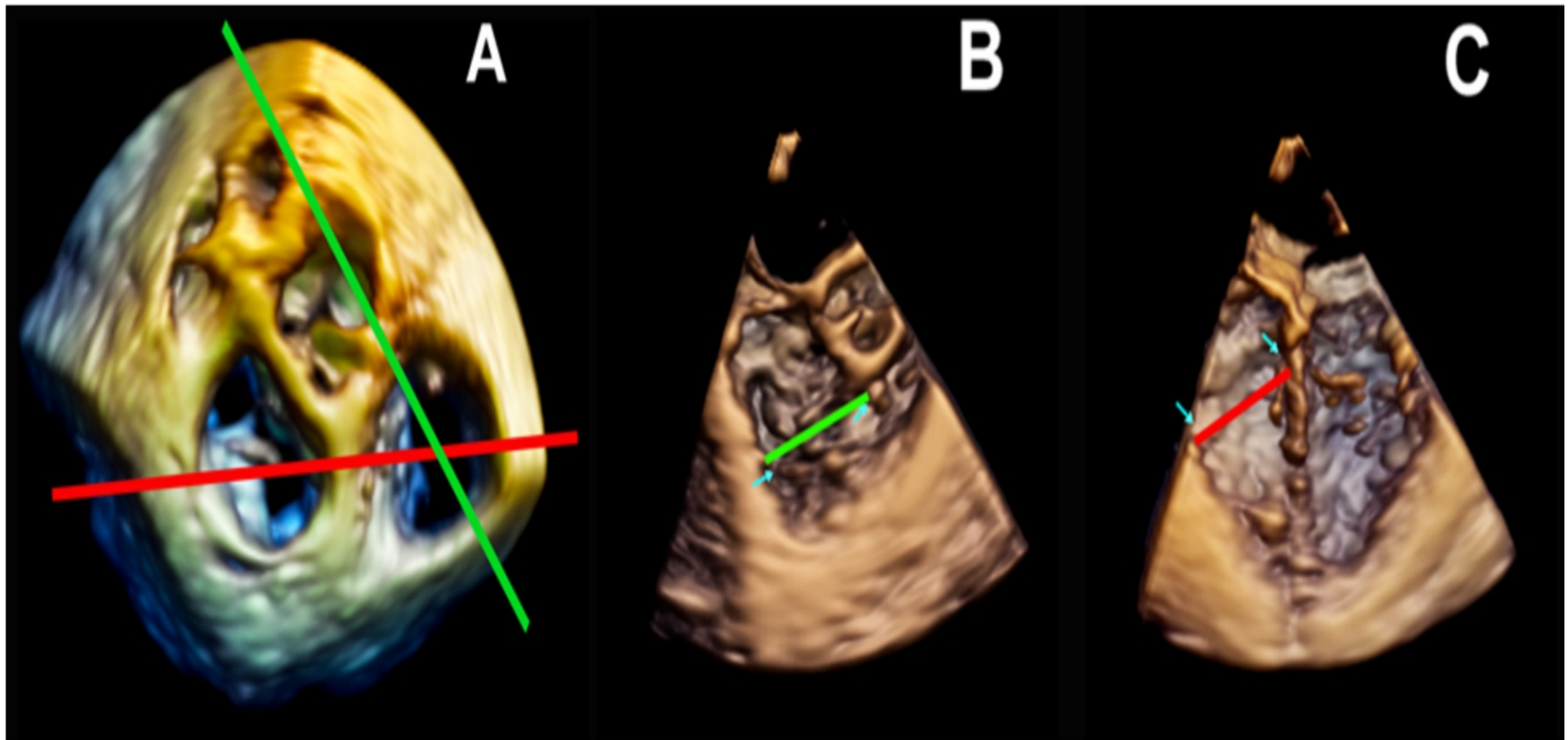
Surgical view



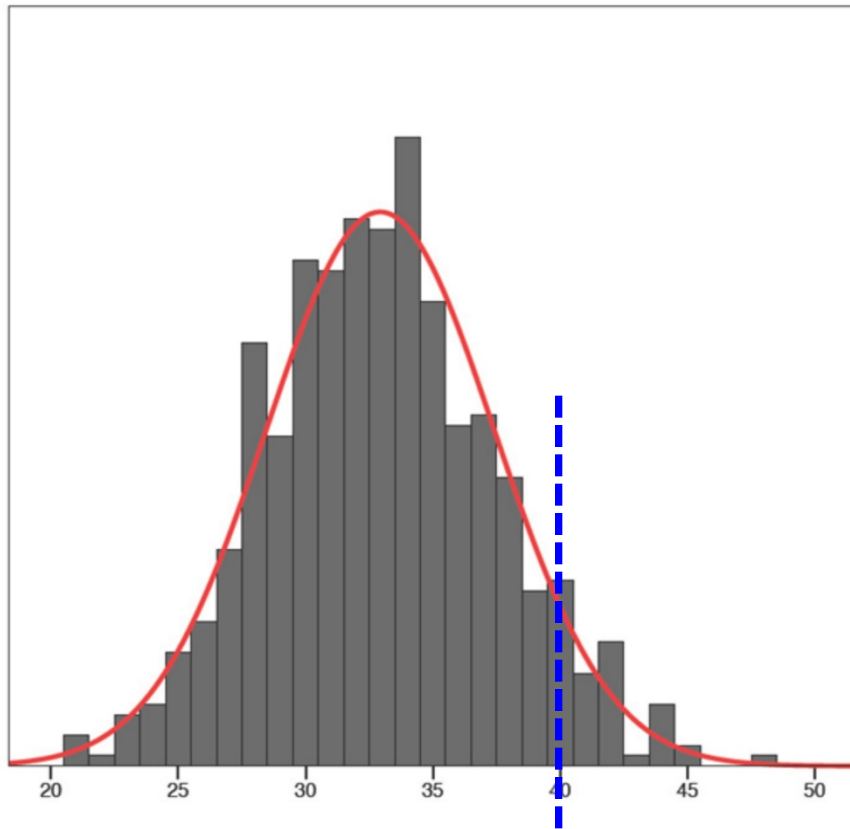
septal to anterior leaflet distance

San Raffaele University

- Tricuspid valve evaluation in early MV repair pts-

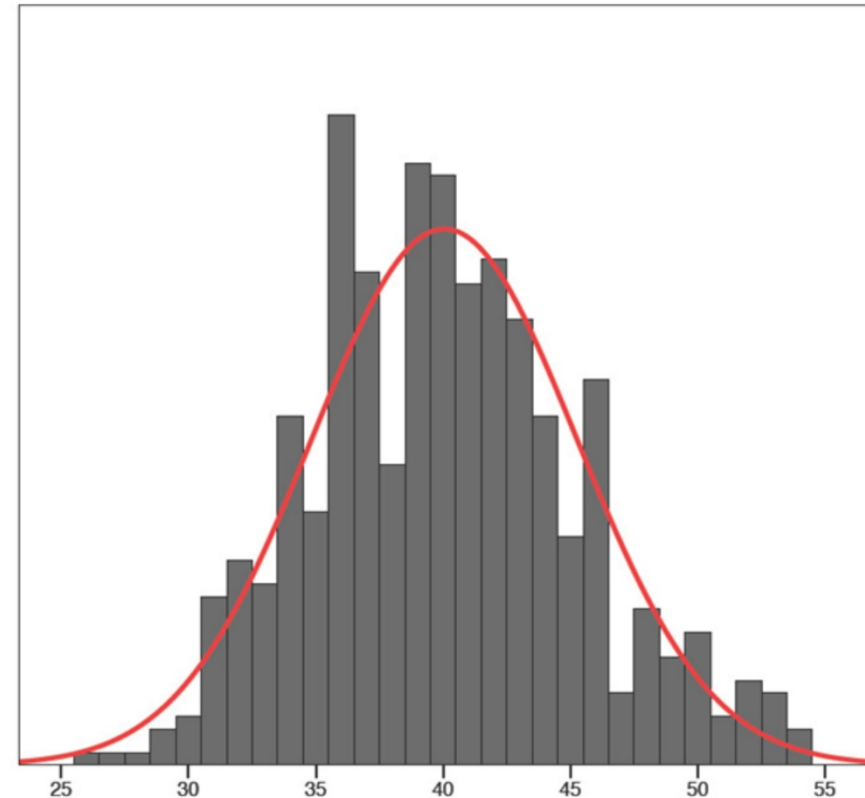


Distribution of pre-operative tricuspid annulus diameters at TEE



40 mm

Septo-lateral diameter (mm)



Antero-posterior diameter (mm)

Using a cut-off ≥ 40 mm or ≥ 21 mm/m², 49 (6.9%) and 65 (9.2%) patients had pre-operative SL dilatation, respectively

Guidelines on the management of valvular heart disease (version 2012)

	Class ^a	Level ^b
Surgery is indicated in symptomatic patients with severe TS. ^c	I	C
Surgery is indicated in patients with severe TS undergoing left-sided valve intervention. ^d	I	C
Surgery is indicated in patients with severe primary or secondary TR undergoing left-sided valve surgery.	I	C
Surgery is indicated in symptomatic patients with severe isolated primary TR without severe right ventricular dysfunction.	I	C
Surgery should be considered in patients with moderate primary TR undergoing left-sided valve surgery.	IIa	C
Surgery should be considered in patients with mild or moderate secondary TR with dilated annulus (≥ 40 mm or > 21 mm/m ²) undergoing left-sided valve surgery.	IIa	C
Surgery should be considered in asymptomatic or mildly symptomatic patients with severe isolated primary TR and progressive right ventricular dilatation or deterioration of right ventricular function.	IIa	C
After left-sided valve surgery, surgery should be considered in patients with severe TR who are symptomatic or have progressive right ventricular dilatation/dysfunction, <i>in the absence</i> of left-sided valve dysfunction, severe right or left ventricular dysfunction, and severe pulmonary vascular disease.	IIa	C

Should prophylactic tricuspid annuloplasty be performed at the time of mitral valve surgery?





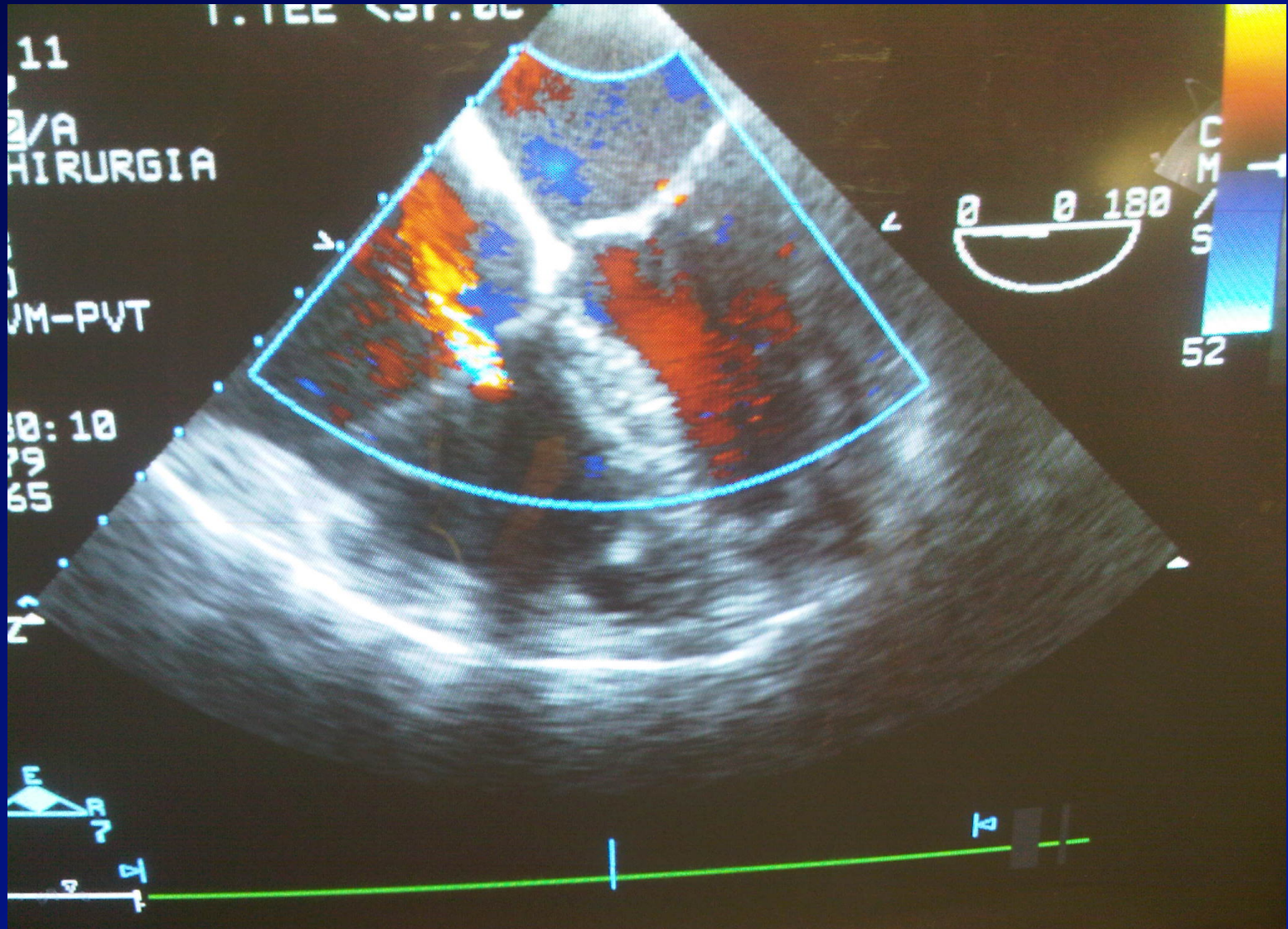
Why?



**There are no strong
randomized data!**

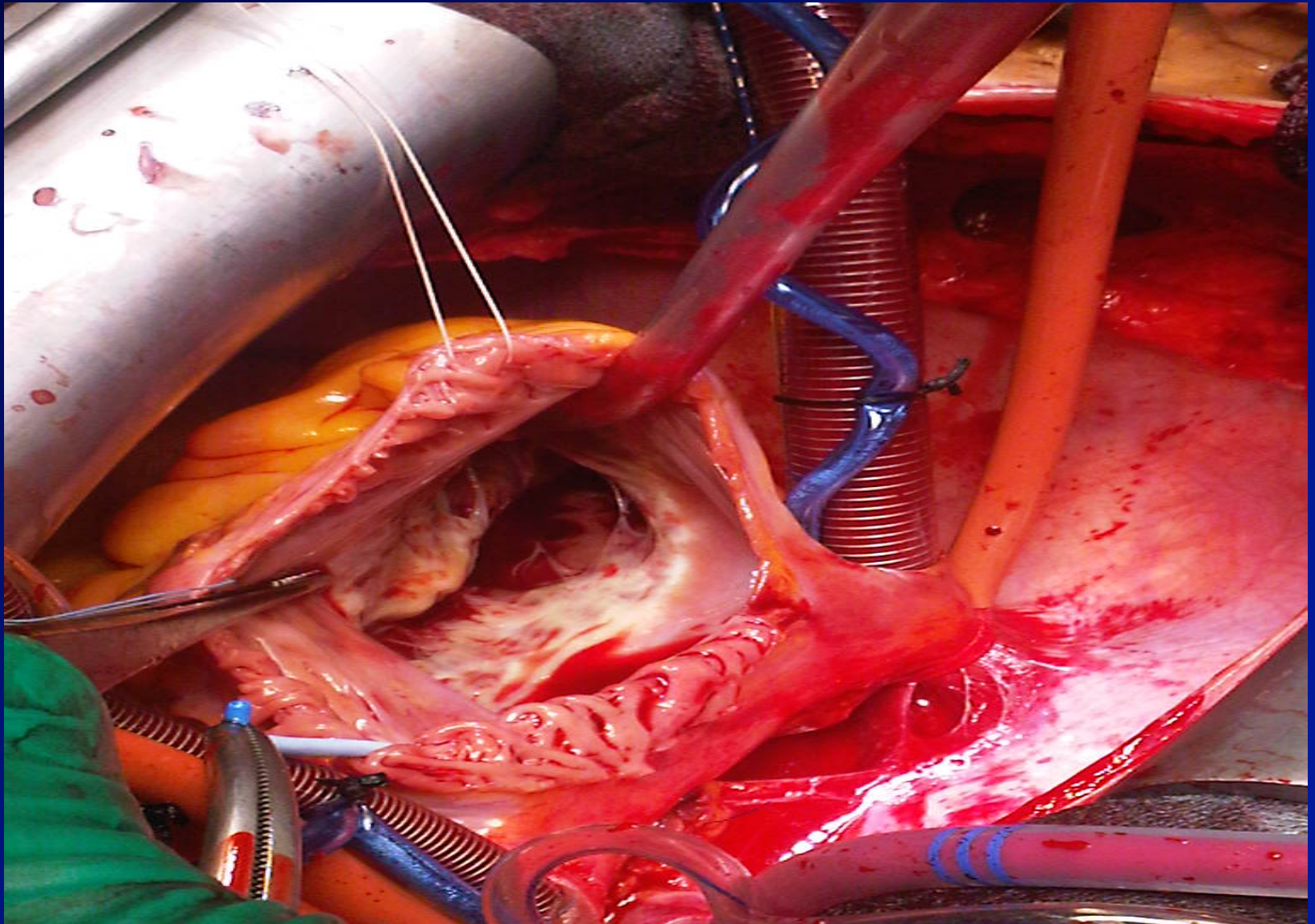


Mild-moderate functional TR





Intraoperative view of the tricuspid valve





Predictors of progression of less than severe functional TR

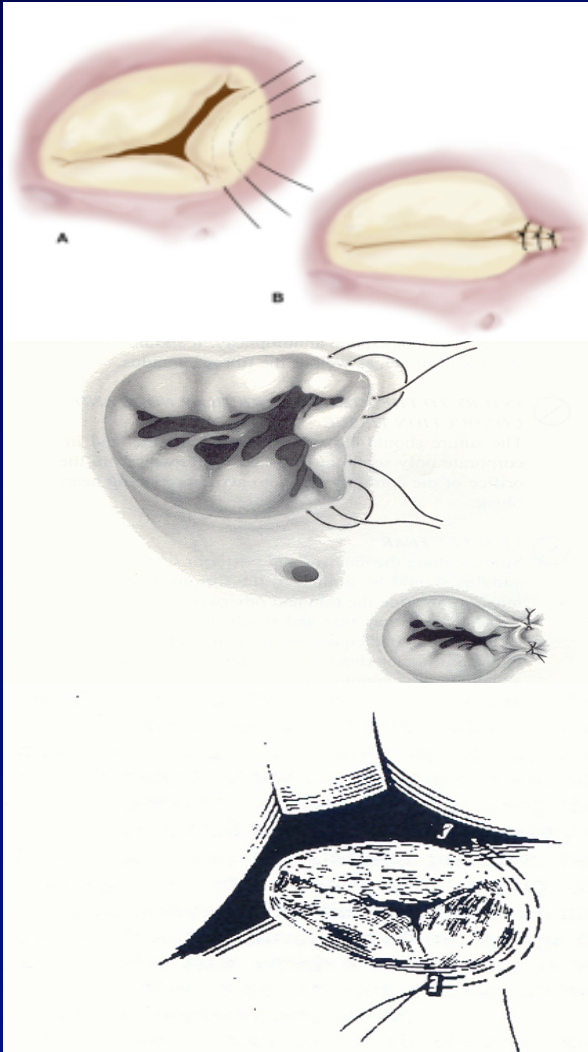
- LV dysfunction
- RV dilatation/dysfunction
- AF
- Pace-maker leads
- PHT
- Etiology
 - Rheumatic
 - Dilated cardiomyopathy

Surgical techniques

- Annular plication by suture annuloplasty
 - Localized
 - Kay repair (bicuspidization)
 - Semicircular
 - De Vega repair
- Reduction annuloplasty with flexible rings
 - SJM Tailor Annuloplasty ring
 - Cosgrove-Edwards ring
 - Duran ring
- Remodeling annuloplasty with semi-rigid rings
 - Medtronic 3D Contour
 - Edwards MC3 system
- Clover technique

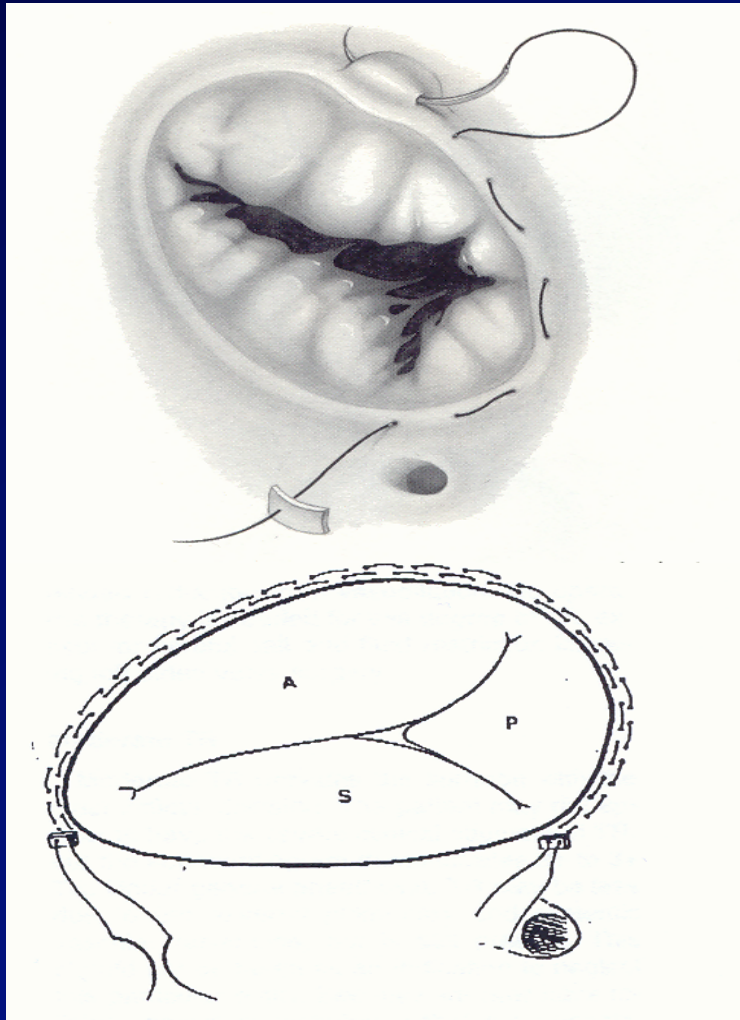
Annular plication

Kay repair (bicuspidization)



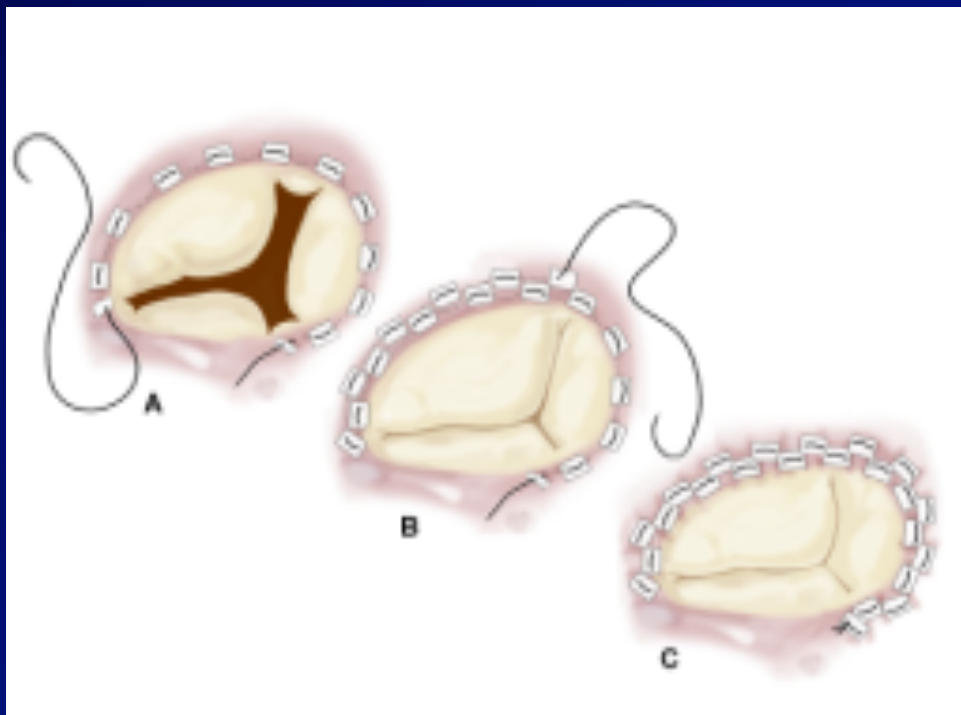
- Bicuspidization of the TV by exclusion of the posterior leaflet
- Simple, fast, unexpensive and safe (conduction system avoided)
- Late dilatation of the anterior annulus

Semicircular annuloplasty (De Vega)



- Simple, fast, unexpensive
- No prosthetic material
- No AVN injury
- Significant late recurrence of TR

Modified De Vega repair

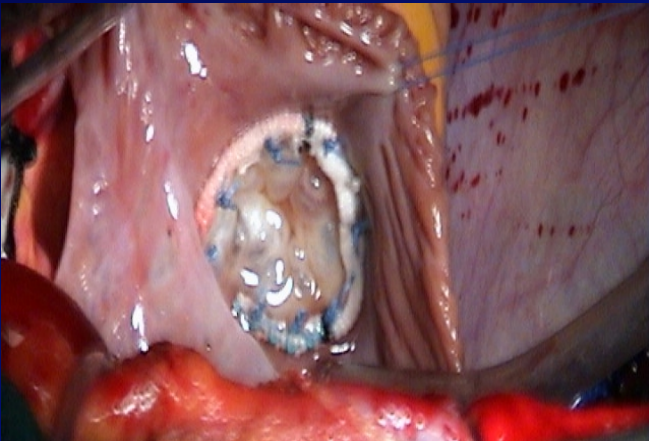


- Avoid tearing of the suture

Antunes et al. Ann Thorac Surg. 1983, 6.

Reduction annuloplasty

SJM Tailor Annuloplasty ring



- Prevents recurrent annular dilatation
- Allows dynamic changes of the annulus
- Disadvantages
 - Does not restore the physiological shape of the annulus
 - Risk of overcorrection

Remodeling annuloplasty

Edwards MC³ tricuspid annuloplasty system



- Near complete and semirigid
- 3D design accomodating the saddle shaped tricuspid annulus
- Stress on sutures minimized

New remodeling rings



Tri-Ad™ Adams Tricuspid Annuloplasty Ring

Targeted, semi-rigid remodeling for tricuspid disease

Our newest ring technology expands your treatment options for tricuspid repair. Anchored by a semi-rigid segment and supported by flexible, soft segments for suturing delicate tissue, the Tri-Ad ring offers the first ring designed for targeted remodeling of tricuspid disease. The design adapts to the three-dimensional geometry of the tricuspid valve in systole and diastole. A braided sewing ring construction also provides smooth needle penetration and prevents bunching for easy implantation.



Contour 3D™ Tricuspid Annuloplasty Ring

Natural dimensions for tricuspid valve repair

This is our most innovative ring to date. The unique design is based on CT data from functional human tricuspid valves. The result is a three-dimensional remodeling ring, anatomically shaped to the normal tricuspid annulus. Contour 3D is also the first annuloplasty system to offer single-use and reusable sizers. It features an open design to avoid the conduction system and septal lateral compression to address annular dilation. Add smooth needle penetration and a low-profile, and you have a unique and innovative option for tricuspid repair.

Persistent/recurrent functional TR is still a problem

Significant rate of tricuspid annuloplasty failure

TABLE 3. Predicted prevalence across time of grades 3+ and 4+ tricuspid valve regurgitation for various annuloplasty techniques*

Technique	TR grade	1 month		1 year		5 years		8 years	
		%	CL (%)	%	CL (%)	%	CL (%)	%	CL (%)
Carpentier	3+	10	9-11	10	9-12	11	9-13	11	8-14
	4+	5.2	4.6-5.9	5.5	4.7-6.3	6	4.3-7.4	6	4-8
Cosgrove	3+	10	9-11	12	11-13	12	9-14		N/A
	4+	5.3	4.6-6.0	6	6-7	6	5-8		N/A
De Vega	3+	9	8-10	12	10-13	17	15-20	20	17-22
	4+	4.6	4-5	6	5-7	11	9-13	13	10-16
Peri-Guard	3+	10	9-11	13	12-14	19	17-21	22	19-24
	4+	5.4	4.8-6.0	7	6-8	13	10-15	15	12-18
Overall	3+	10	9-11	13	11-14	15	14-17	19	17-21
	4+	5	5-6	7	6-8	9	8-10	12	10-15

TR, Tricuspid regurgitation; CL, 68% confidence limits; N/A, not applicable (not enough patients in follow-up at this time).

*Model-based time-related estimates (%).

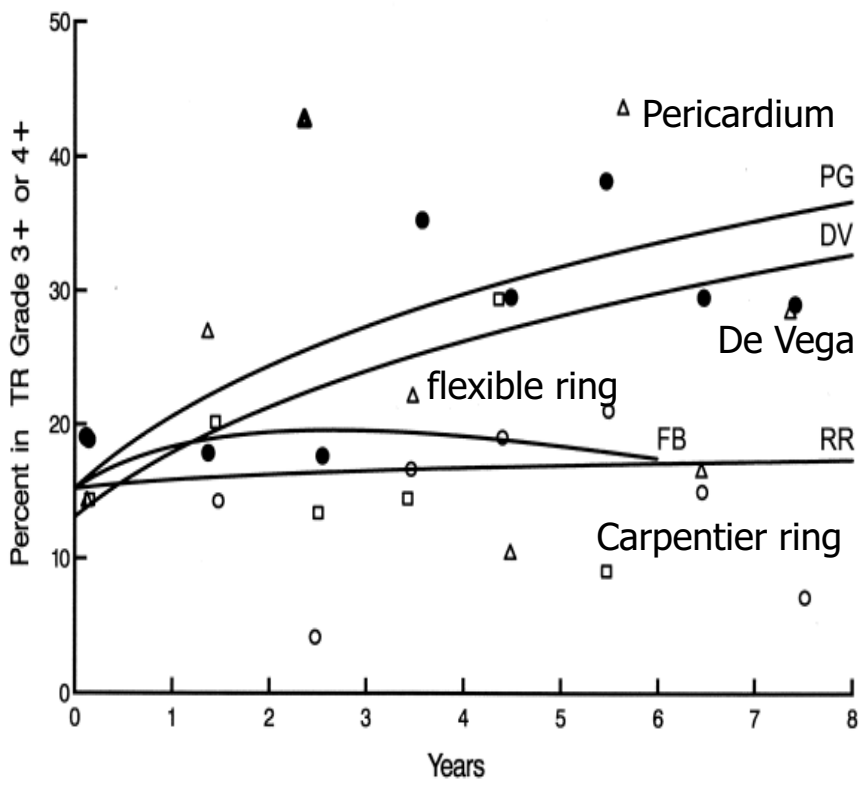
Tricuspid repair and durability

Table 1. Outcome of Tricuspid Repairs

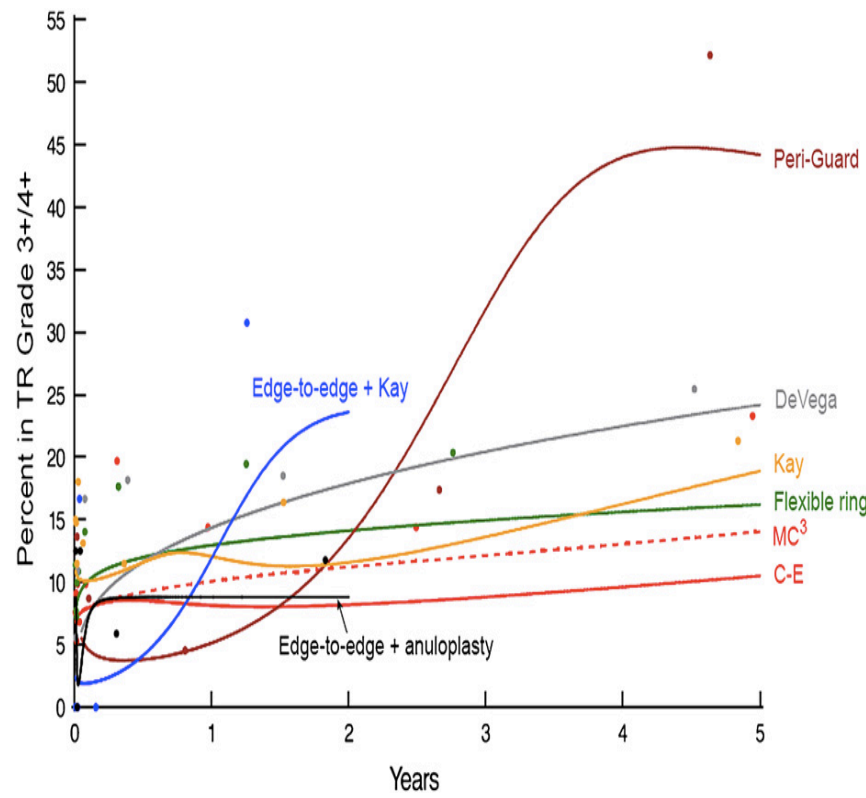
Authors	Number of Patients	Technique	Recurrent TR (% of Patients) at Last Follow-up
Rivera et al, 1985 ⁶	83	De Vega	34 3.8 yrs
		C-E ring	10 3.8 yrs
Matsuyama et al, 2001 ⁷	45	De Vega	45 3.3 yrs
		C-E ring	6 3.3 yrs
McCarthy et al, 2004 ²	795	De Vega	33 8 yrs
		Peri-Guard	37 8 yrs
		Flexible band	18 5 yrs
		C-E ring	17 8 yrs
Bonis et al, 2004 ⁵	14	Clover	0 1.1 yrs
Tang et al, 2006 ¹⁰	702	De Vega	61 15 yrs
		Rings and band (Duran, CE, flexible)	17 15 yrs
Filsoufi et al, 2006 ¹¹	75	MC3 Ring	0 1.3 yrs
Fukuda et al, 2007 ⁹	136	MC3 Ring	14 >1 yr
Ghanta et al, 2007 ¹	237	Bicuspidization	25 3 yrs
		Rings and band (Duran, CE, flexible)	31 3 yrs
Chang et al, 2008 ³	334	De Vega/Kay	28 8 yrs
		Pericardial strip	13 8 yrs
Dreyfuss et al, 2008 ⁴	15	Tricuspid leaflet augmentation	0 0.5-1.7 yrs
Sarraj et al, 2009 ¹³	17	Adjustable segmental	18 2.5 yrs
Roshanali et al, 2009 ¹⁴	210	De Vega	28 1 yr
		C-E ring	14 1 yr
		De Vega + pericardial patch	10 1 yr
		C-E Ring + pericardial patch	8 1 yr

TR, tricuspid regurgitation.

Current results of tricuspid annuloplasty are suboptimal



McCarthy et al. JTCVS 2004;127:675

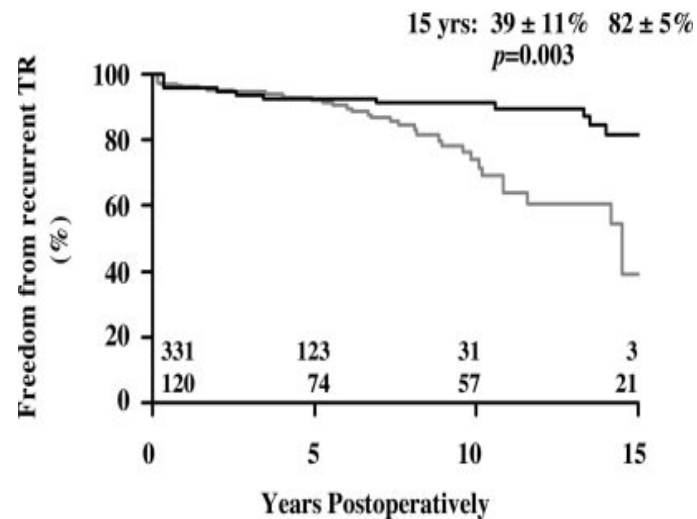
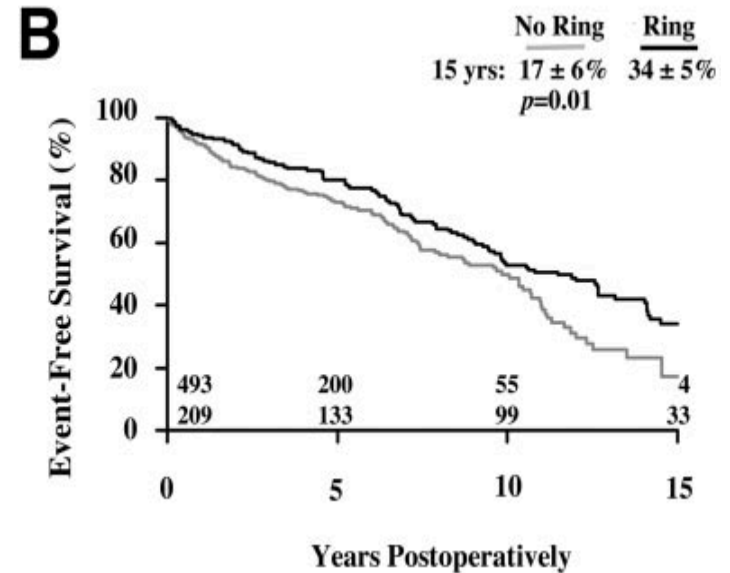
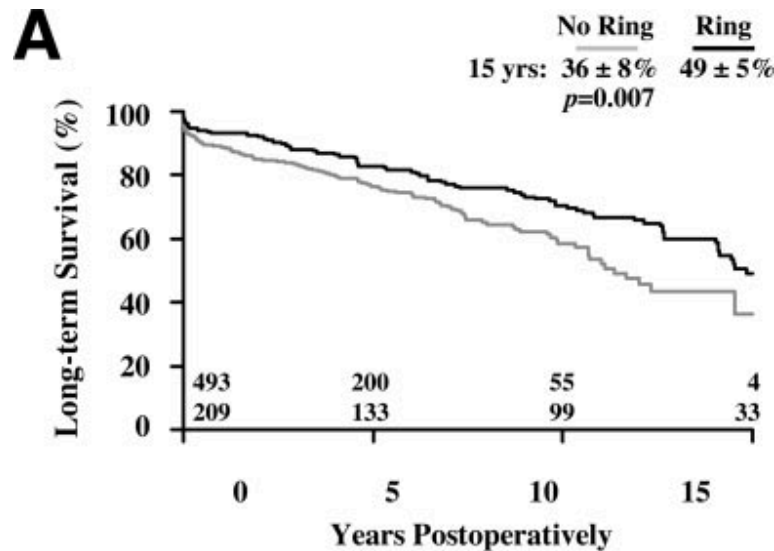


Navia et al. JTCVS 2010;139

The presence of **significant TR** after
MV surgery is strictly related to **late**
mortality !

Tricuspid Valve Repair With an Annuloplasty Ring Results in Improved Long-Term Outcomes

Gilbert H. L. Tang, MD; Tirone E. David, MD; Steve K. Singh, MD; Manjula D. Maganti, MSc; Susan Armstrong, MSc; Michael A. Borger, MD, PhD



Circulation. 2006;114[suppl I]:I-577-I-581.

To improve the results, the surgical treatment of TR has to be **tailored** to the stage of the disease

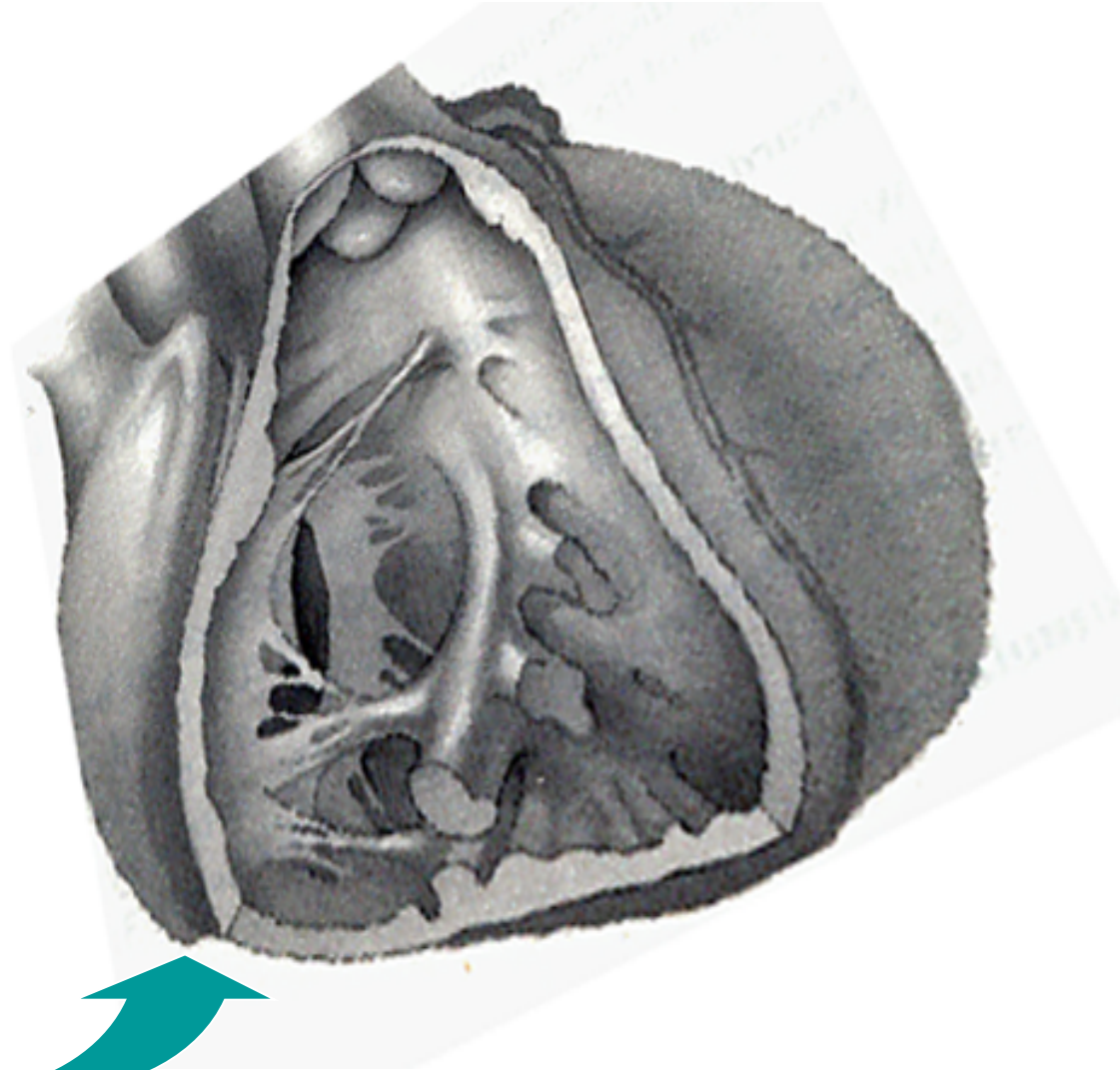
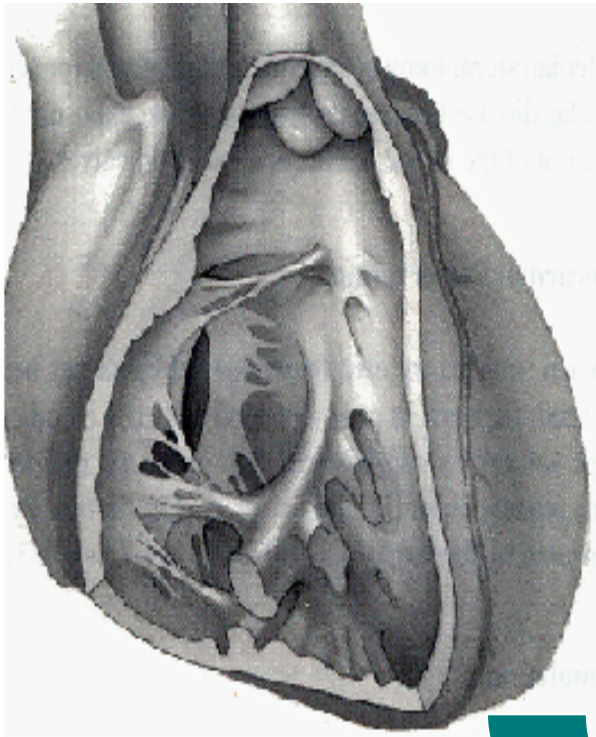
TR due to annular dilatation alone

remodeling
annuloplasty with a
semirigid ring is
associated with the
most durable
results



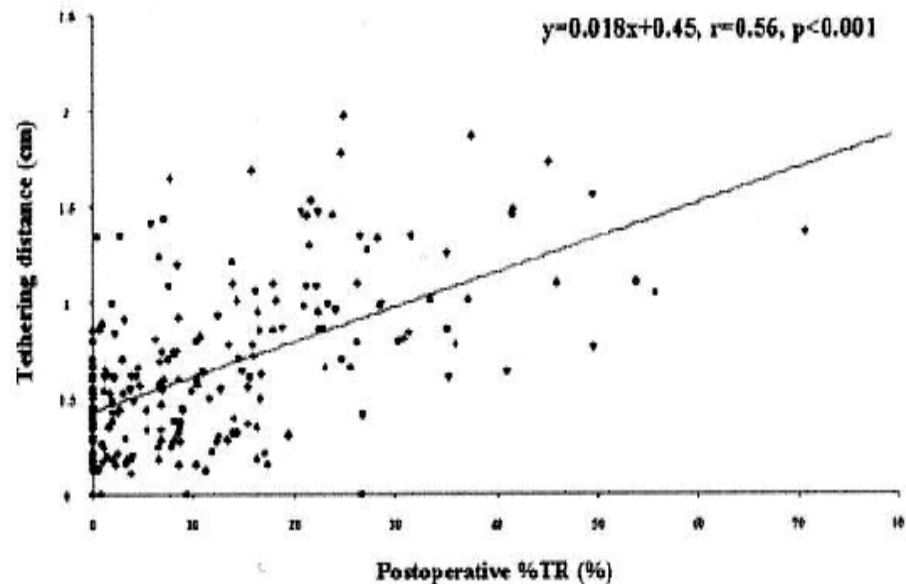
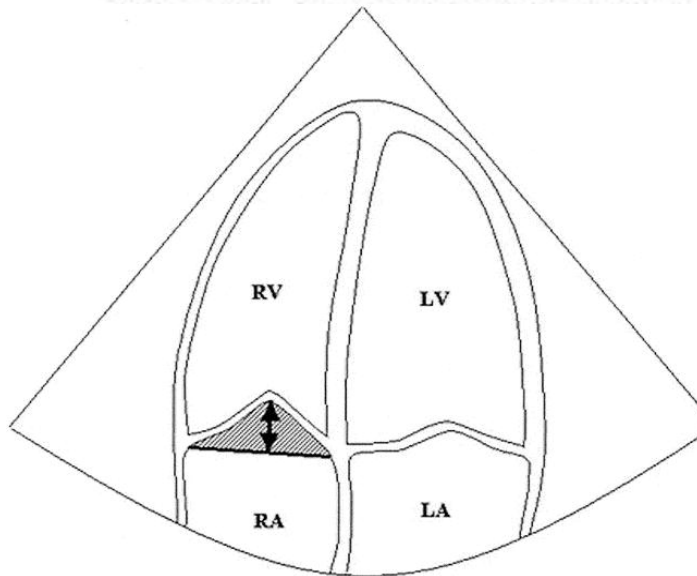
Functional TR

Increased leaflet tethering



Tricuspid Valve Tethering Predicts Residual Tricuspid Regurgitation After Tricuspid Annuloplasty

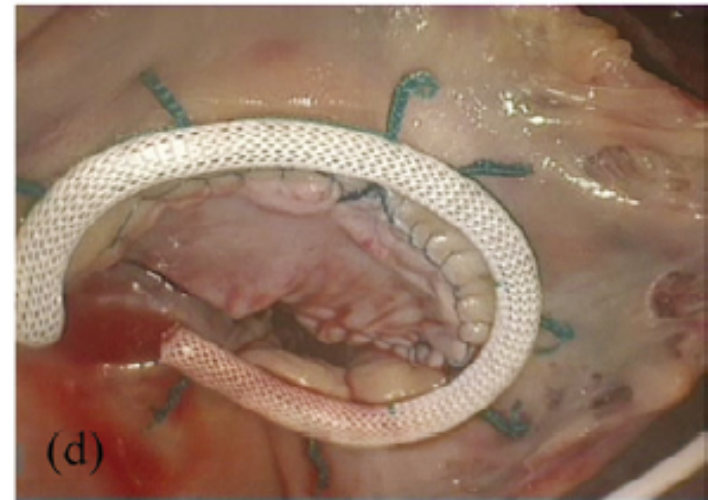
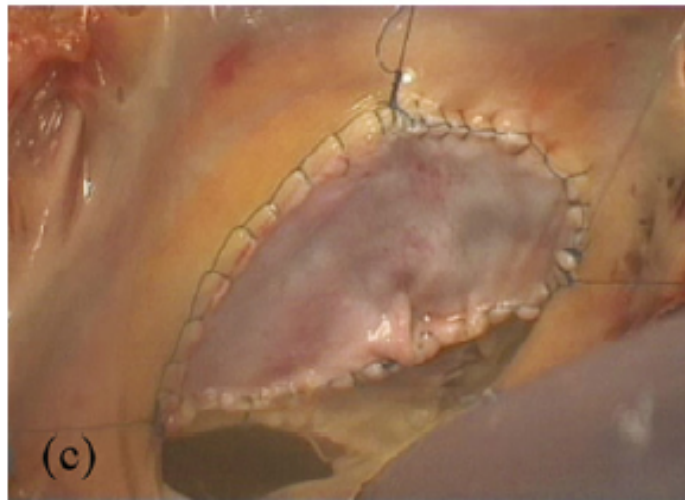
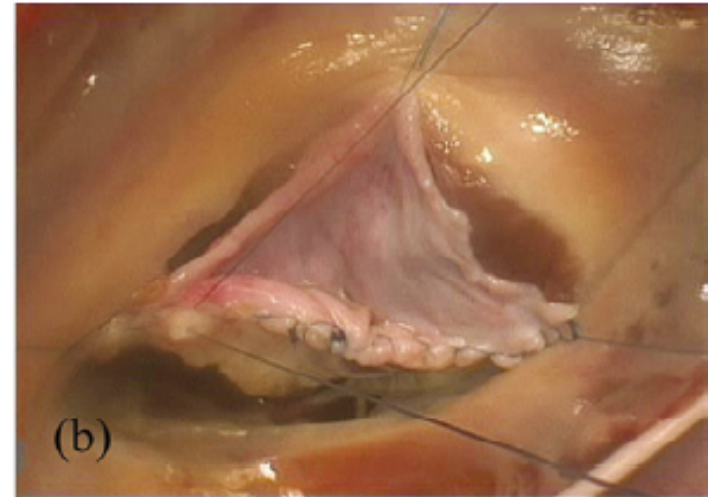
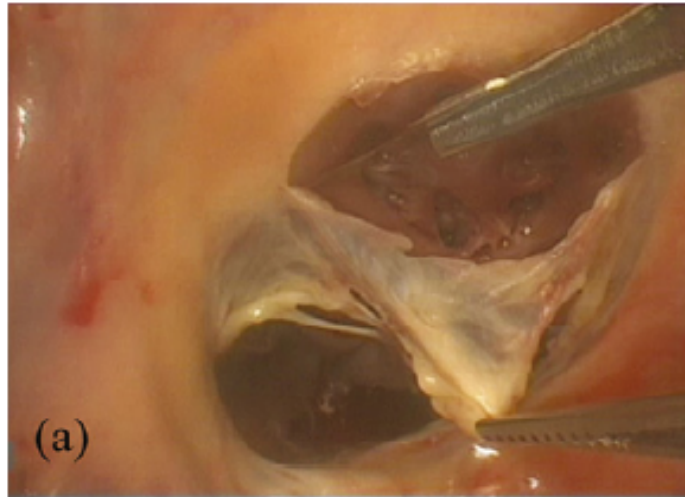
Shota Fukuda, MD; Jong-Min Song, MD; A. Marc Gillinov, MD; Patrick M. McCarthy, MD; Masao Daimon, MD; Vorachai Kongsarepong, MD; James D. Thomas, MD; Takahiro Shiota, MD



Conclusion:

..... patients with extensive leaflet tethering (>1.0 cm) require additional maneuvers to ensure valve competence. (J Am Soc Echocardiogr 2007;20:1236-1242.)

Tricuspid leaflet augmentation





Tricuspid regurgitation: most common surgical scenarios

- Functional TR in patients undergoing left-sided valve surgery
- Late TR following left sided valve surgery

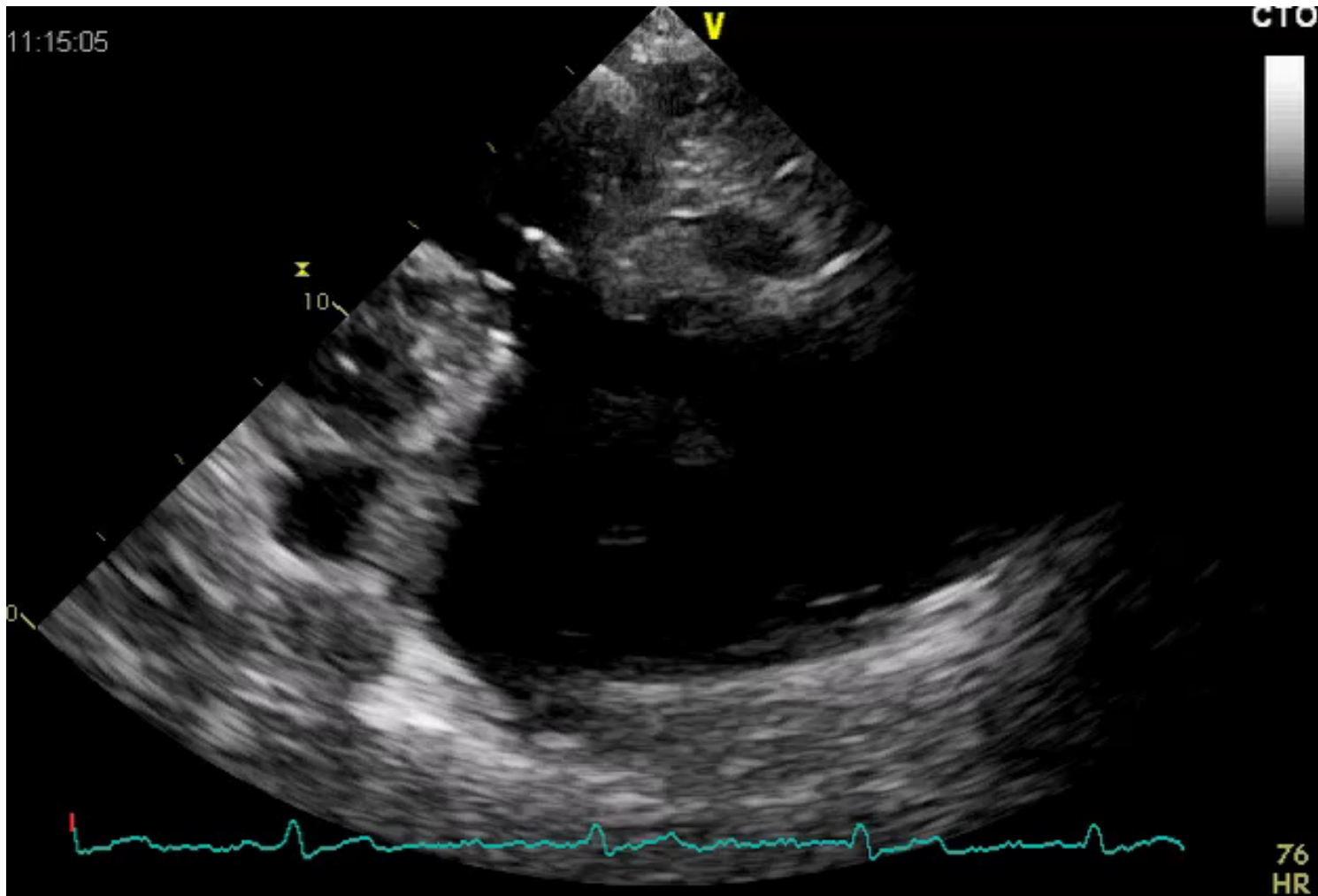
- **Severe TR severa (VC 11 mm)**
 - Tricuspid annulus: 46 mm
 - Tethering of the leaflets + fibrosis
 - Tenting area: 2.9 cm²
 - Coaptation distance: 1.37 mm
- RV dilatation (EDD 57 mm)
- RV dysfunction
 - TAPSE 13 mm
 - Tricuspid annulus systolic velocity (S-TDI): 8 cm/sec
- SPAP 50 mmHg
- Extreme right atrial enlargement (550 ml)
- FE 55%
- Well functioning mitral prosthesis (mean gradient 6 mmHg)

Chest X ray



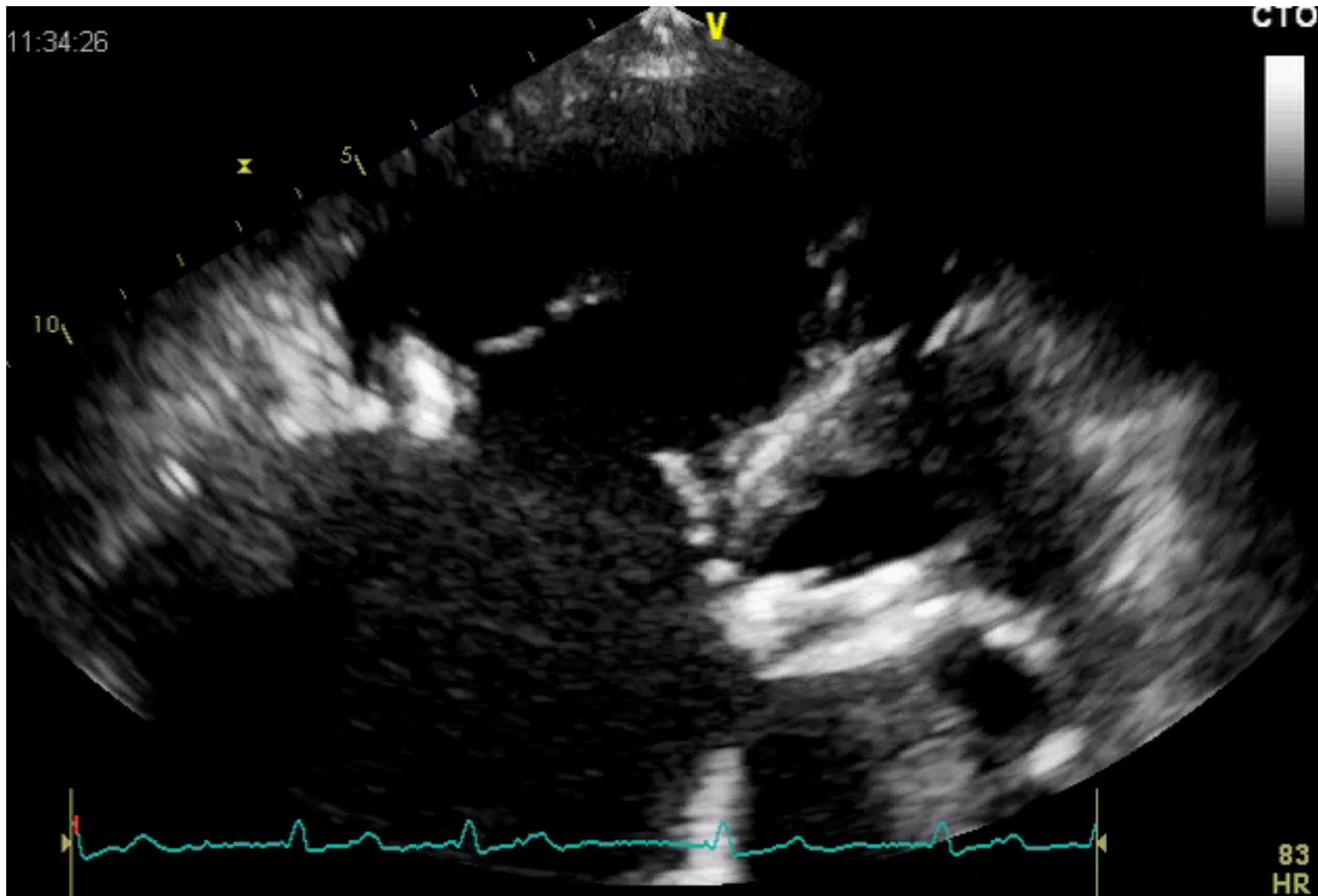


ECOCARDIOGRAPHY



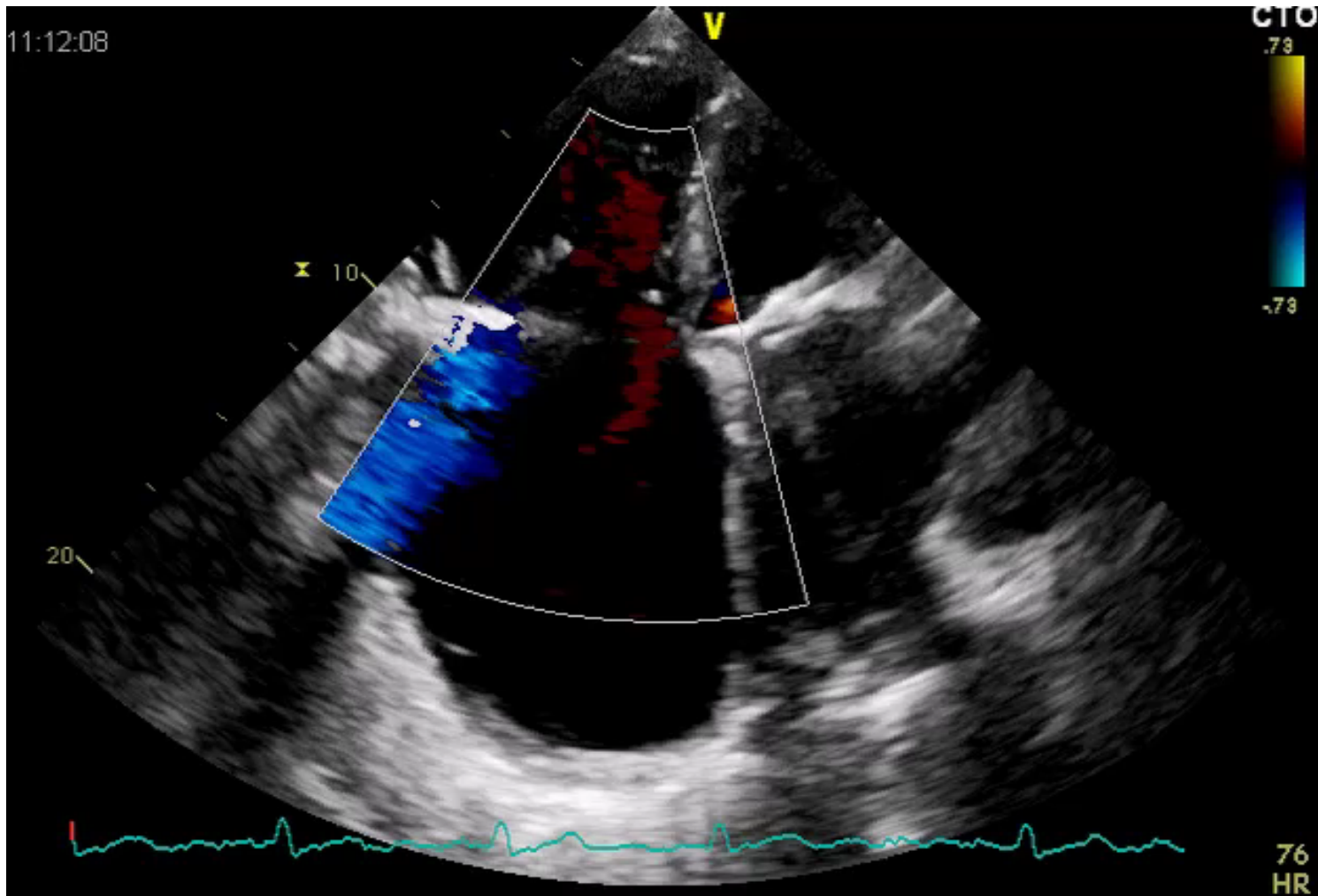


ECOCARDIOGRAPHY





ECOCARDIOGRAPHY



2012 ESC Indications for surgery in tricuspid disease

	Class	Level
Surgery is indicated in symptomatic patients with severe TS.	I	C
Surgery is indicated in patients with severe TS undergoing left-sided valve intervention.	I	C
Surgery is indicated in patients with severe primary, or secondary, TR undergoing left-sided valve surgery.	I	C
Surgery is indicated in symptomatic patients with severe isolated primary TR without severe right ventricular dysfunction.	I	C
Surgery should be considered in patients with moderate primary TR undergoing left-sided valve surgery.	IIa	C
Surgery should be considered in patients with mild or moderate secondary TR with dilated annulus (≥ 40 mm or > 21 mm/m ²) undergoing left-sided valve surgery.	IIa	C
Surgery should be considered in asymptomatic or mildly symptomatic patients with severe isolated primary TR and progressive right ventricular dilation or deterioration of right ventricular function.	IIa	C
After left-sided valve surgery, surgery should be considered in patients with severe TR who are symptomatic or have progressive right ventricular dilatation/dysfunction , in the absence of left-sided valve dysfunction, severe right or left ventricular dysfunction, and severe pulmonary vascular disease.	IIa	C



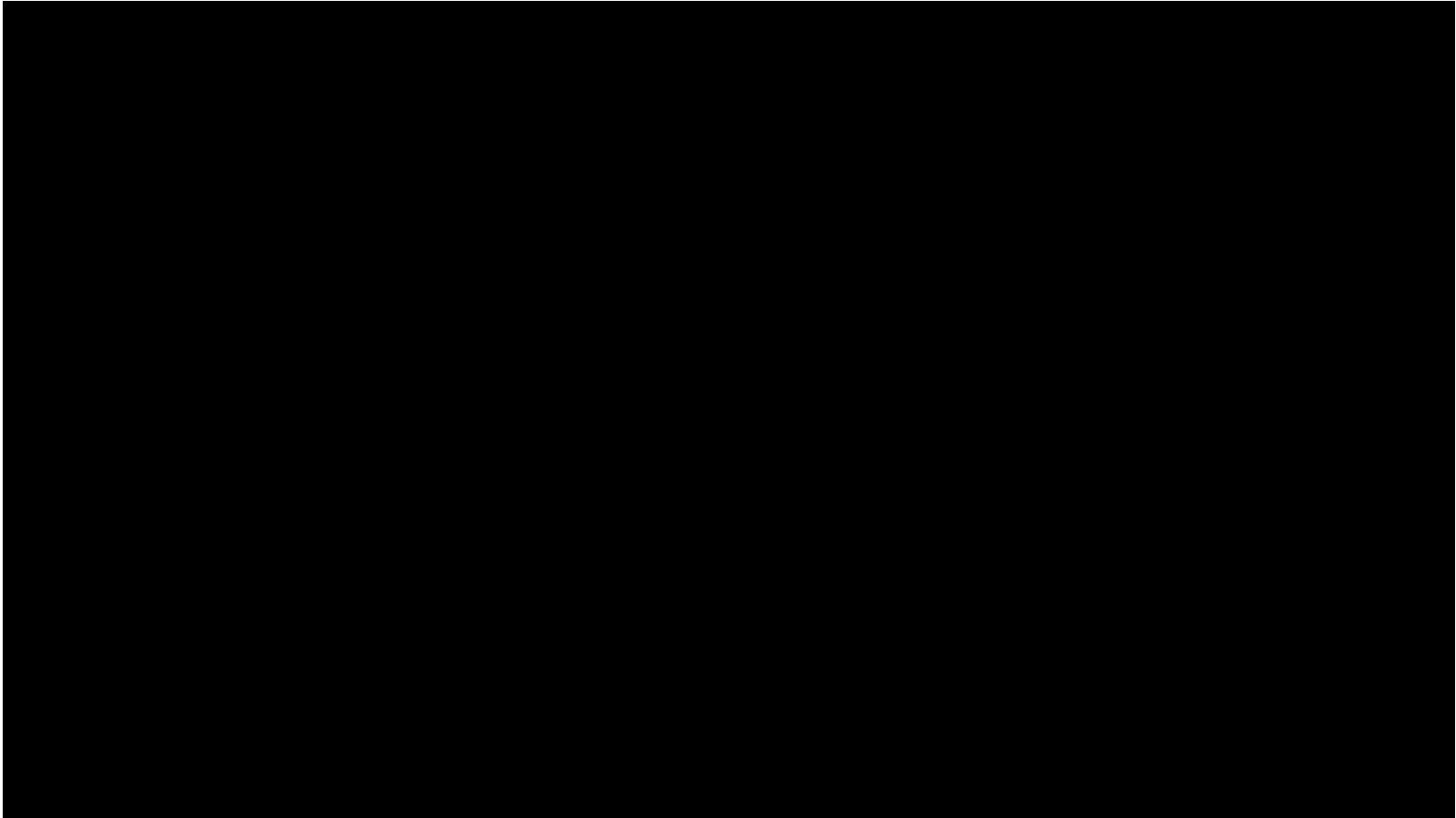


Surgical Beating Heart TV «implantation»

- Median sternotomy/Right thoracotomy
- Beating heart (No cross clamp and cardioplegic arrest)
- No tissue dissection (minimal postoperative bleeding in redos)
 - Peripheral cannulation
 - Exposure limited to the right atrium
 - No SVC/IVC snaring (vacuum assisted venous drainage)
- Complete preservation of the tricuspid valve apparatus
(RV function preserved)
- Short CPB time
 - Bioprosthesis implantation with a continuous suture



Surgical Beating Heart TV «implantation»



Late TR after MV surgery - San Raffaele series

Table 1. Major baseline clinical characteristics.

	All patients (n=117)	I-TVR (n=61)
Age mean, years	63.7±9.8	61.7±10.7
Male gender	29 (24.8%)	17 (27.9%)
Previous cardiac surgery >1	34 (29.1%)	17 (27.9%)
Logistic EUROScore	11.8 (8.4-17.8)	12.0 (6.1-17.4)
Atrial Fibrillation	100 (85.5%)	54 (88.5%)
Permanent PM/ICD	33 (28%)	20 (32.8%)
Coronary artery disease	17 (14.5%)	10 (16.4%)
CKD	25 (21.4%)	12 (19.7%)
Diabetes mellitus	18 (15.4%)	9 (14.7%)
NYHA class III-IV	93 (79.5%)	48 (78.7%)
Ascites	41 (35.0%)	24 (39.3%)
LVEF, %	54.6±8.8	54.4±8.3
RV dysfunction		
mild	26 (22.2%)	13 (21.3%)
moderate	24 (20.5%)	12 (19.7%)
severe	4 (3.4%)	0 (0%)
sPAP, mmHg	48.4±14.1	45.3±8.9

Buzzatti N et al. Long-term outcomes of tricuspid valve replacement after previous left-side heart surgery. *Eur J Cardiothorac Surg.* 2014 Oct;46(4):713-9.

30-day results

Acute 30-day post-operative outcomes.

	All patients (n=117)	I-TVR (n=61)
In-hospital length of stay, days	11.5 (7-17)	11 (6.5-16)
Reoperation for bleeding	16 (13.7%)	9 (14.7%)
New acute renal failure	41 (35.0%)	18 (29.5%)
New PM implantation	17 (14.5%)	9 (14.7%)
Neurological deficit	5 (4.3%)	3 (4.9%)
Transient	4 (3.4%)	2 (3.3%)
Permanent	1 (0.9%)	1 (1.6%)
RV failure	54 (46.1%)	25 (40.9%)
Death	7 (6.0%)	5 (8.2%)

Preoperative predictors of 30-day mortality.

	Alive (n=110)	Dead (n=7)	p value	OR (95% CI)	ROC cut-off value	NPV	PPV	Sens	Spec
Age, years	62.8±9.7	58.4±10.9	0.25	0.96 (0.89-1.03)	-	-	-	-	-
<u>LES</u>	11.6 (8.1-16.0)	38.7 (13.3-45.9)	0.002*	1.16 (1.06-1.27)	18.1	98.5	19.0	80.0	79.0
<u>Ascites</u>	35 (31.9%)	6 (85.7%)	0.004*	12.86 (1.49-110.89)	-	98.7	14.6	85.7	68.2
REDO>1	30 (27.3%)	4 (57.1%)	0.09	3.56 (0.75-16.83)	-	-	-	-	-
I-TVR	56 (50.9%)	5 (71.4%)	0.29	2.41 (0.45-12.96)	-	-	-	-	-
LVEF, %	54.9±8.5	46.2±11.8	0.07	0.92 (0.84-1.01)	-	-	-	-	-
<u>RV dysfunction</u> ≥ moderate	24 (21.8%)	4 (57.1%)	0.03*	4.78 (1.00-22.82)	-	96.6	14.3	57.1	78.2
<u>sPAP, mmHg</u>	47.5±12.9	63.7±24.9	0.04*	1.05 (1.00-1.11)	57.5	96.6	18.2	50.0	86.4

Late results – cardiac death

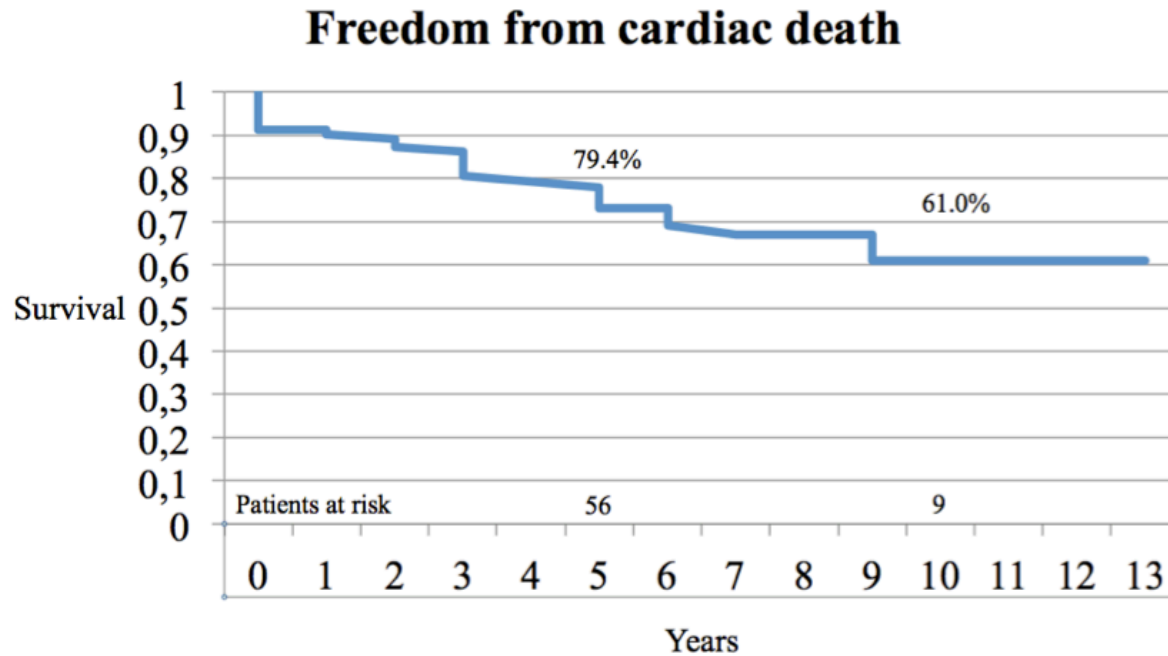
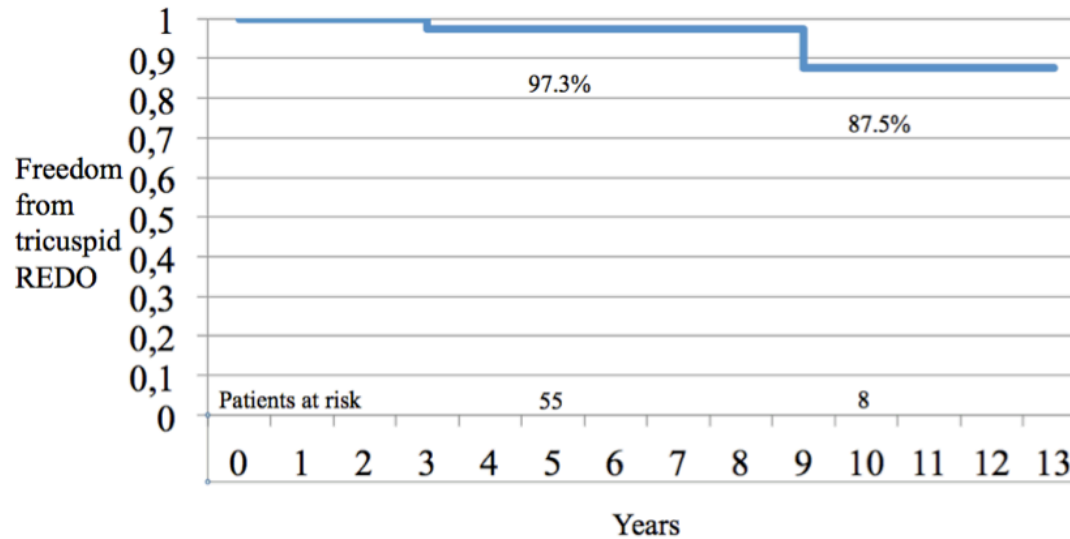


Table 5. Preoperative predictors of late cardiac mortality.

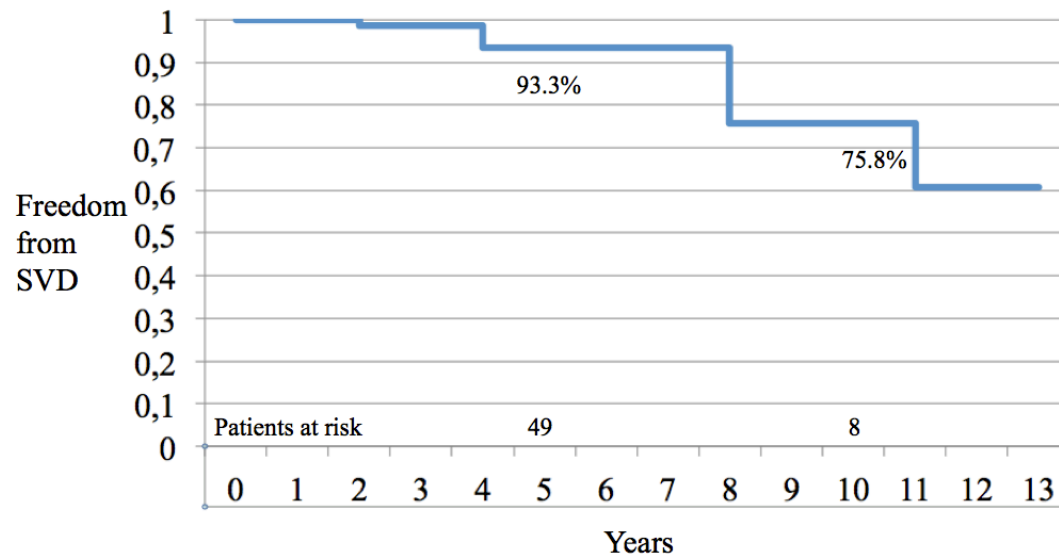
	Not cardiac death (n=86)	Cardiac death (n=22)	p value	HR (95% CI)
Age, years	62.7±10.0	62.9±8.8	0.51	1.02 (0.97-1.10)
LES	11.3 (7.2-15.4)	14.3 (9.7-22.6)	0.14	1.05 (0.98-1.13)
Ascites	28 (32.6%)	6 (27.3%)	0.77	1.15 (0.45-2.95)
REDO >1	21 (24.4%)	9 (40.9%)	0.14	1.93 (0.81-4.59)
I-TVR	42 (48.8%)	12 (54.5%)	0.48	1.35 (0.58-3.14)
LVEF, %	55.0±8.8	54.8±7.3	0.91	1.00 (0.94-1.06)
RV dysfunction ≥ moderate	17 (19.8%)	7 (31.8%)	0.27	1.67 (0.67-4.14)
sPAP, mmHg	46.0±11.3	58.1±19.4	0.05*	1.04 (1.00-1.08)

Late results

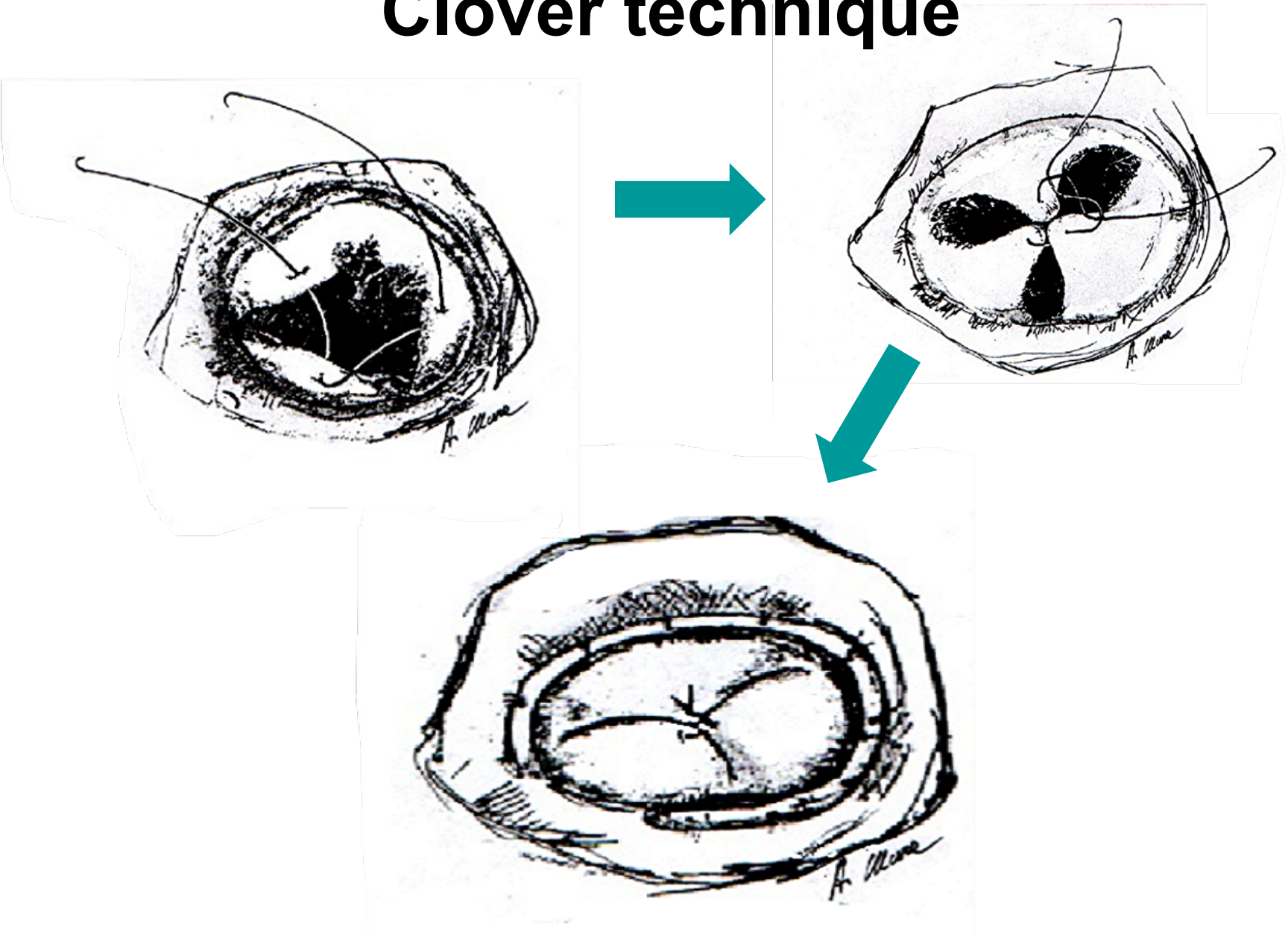
Freedom from tricuspid reoperation



Freedom from SVD



Clover technique



“Complex tricuspid lesions” (not treatable with annuloplasty only)

Post-traumatic TR

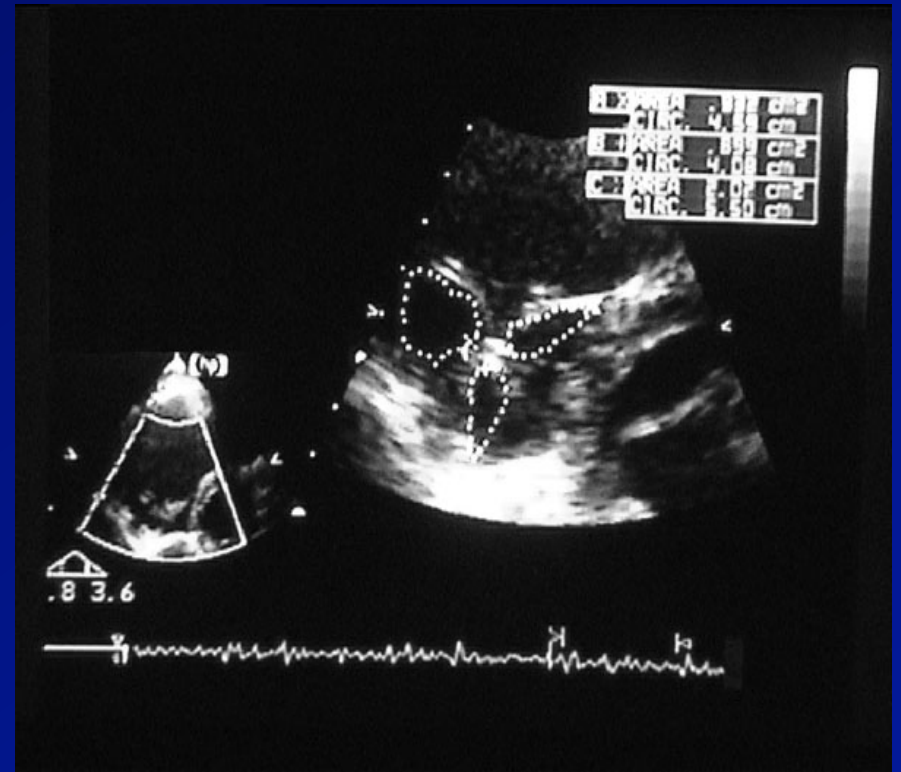
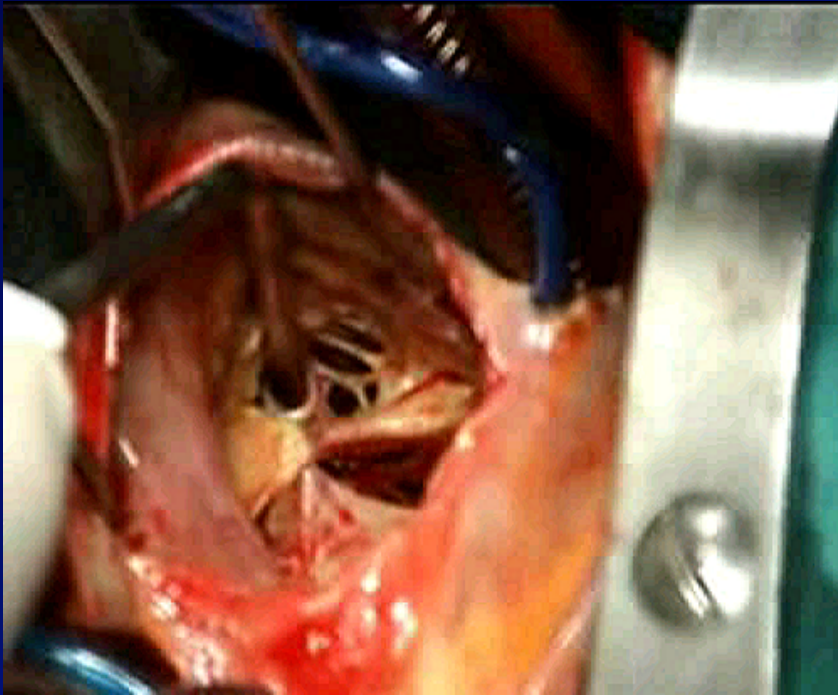
Degenerative TR

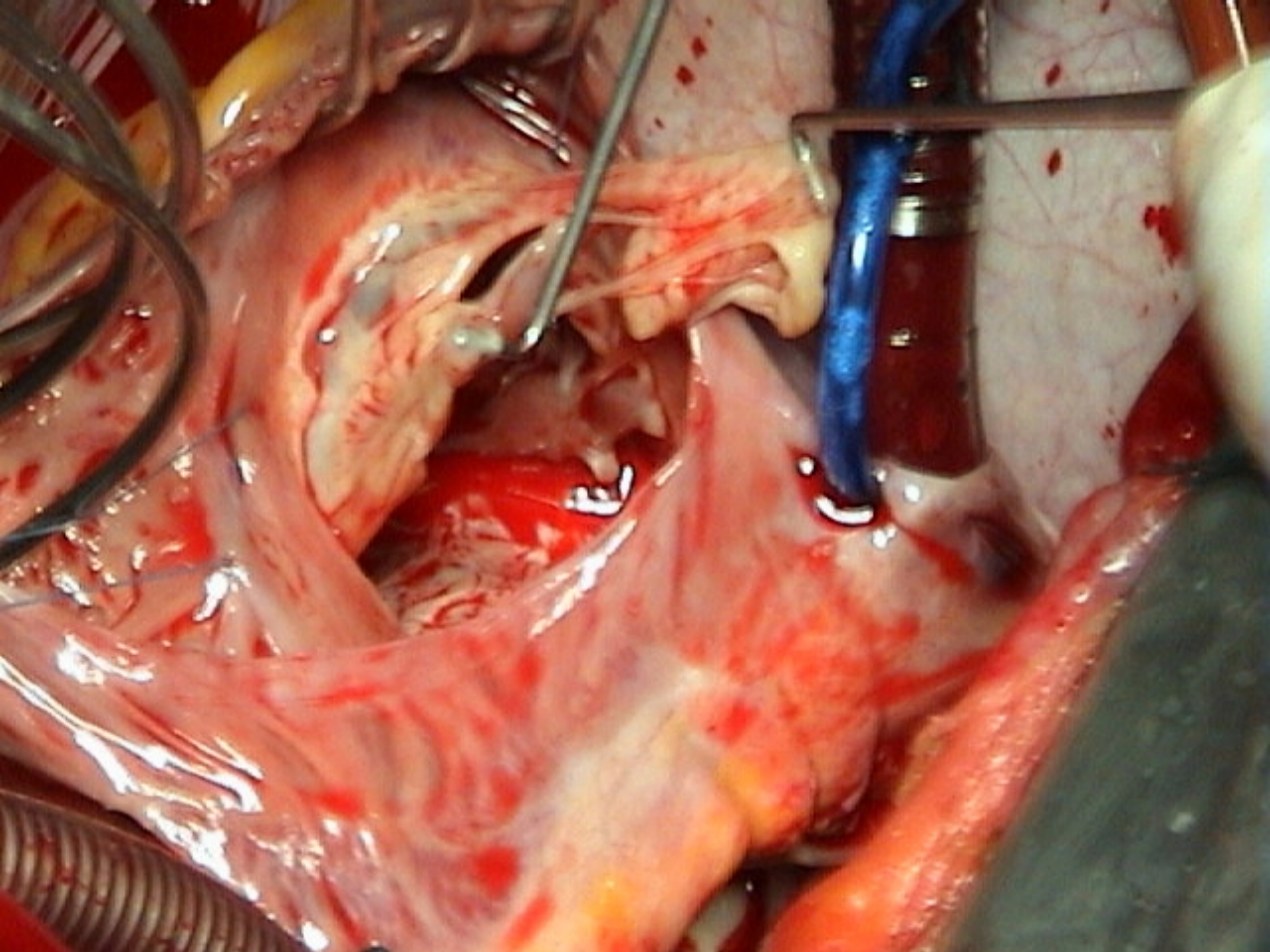
Large prolapse/flail of multiple leaflets

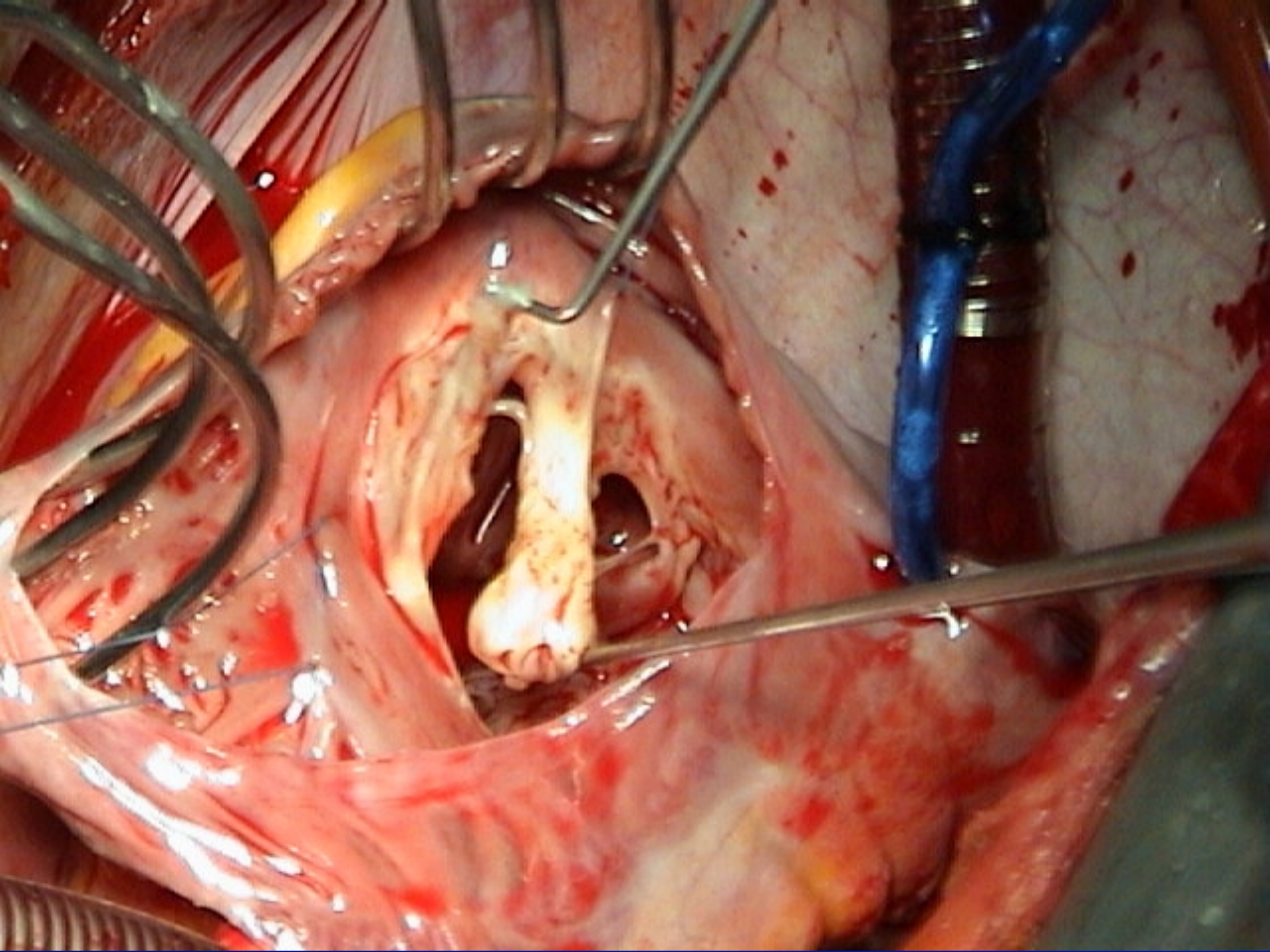
Restricted leaflet motion due to RV dilatation

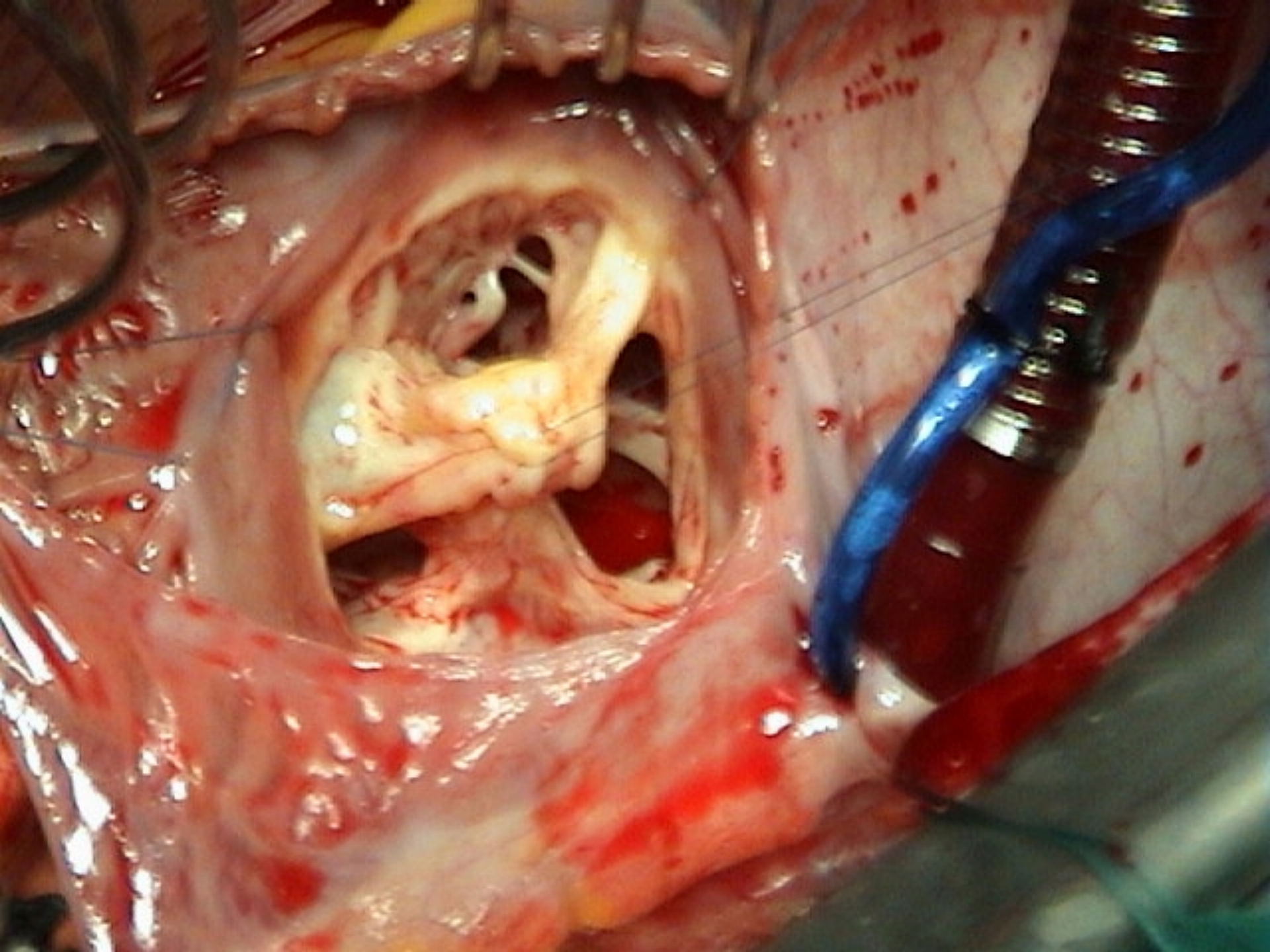
TR in dilated CMP

Surgical and TEE view









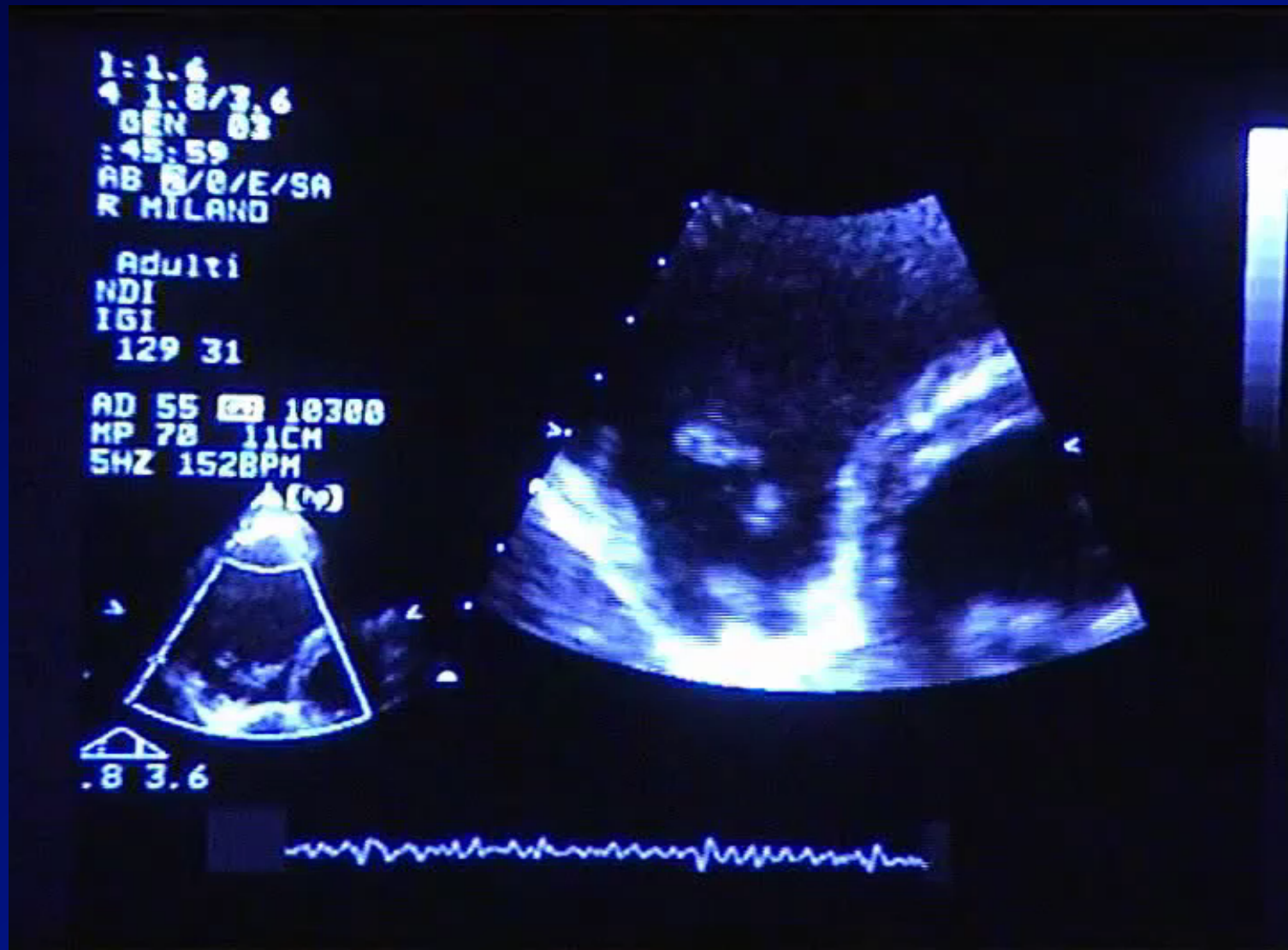






Results

Hospital mortality	7/96 (7.2%)
Follow-up (median,yrs)	9 years, (IQR 5.1;10.9) (up to 14.3 years)
Tricuspid regurgitation	
- absent / mild (1+)	69/89 (77.5%)
- moderate (2+)	18/89 (20.2%)
- severe (3-4+)	2/89 (2.2%)
Reoperation	1 pt
Tricuspid gradient (mean \pm SD)	2.8 \pm 1.4 mmHg
Tricuspid valve area (mean \pm SD)	4.3 \pm 0.6 cm ²





Thank you!