

Right Ventricular Function in Tricuspid Regurgitation

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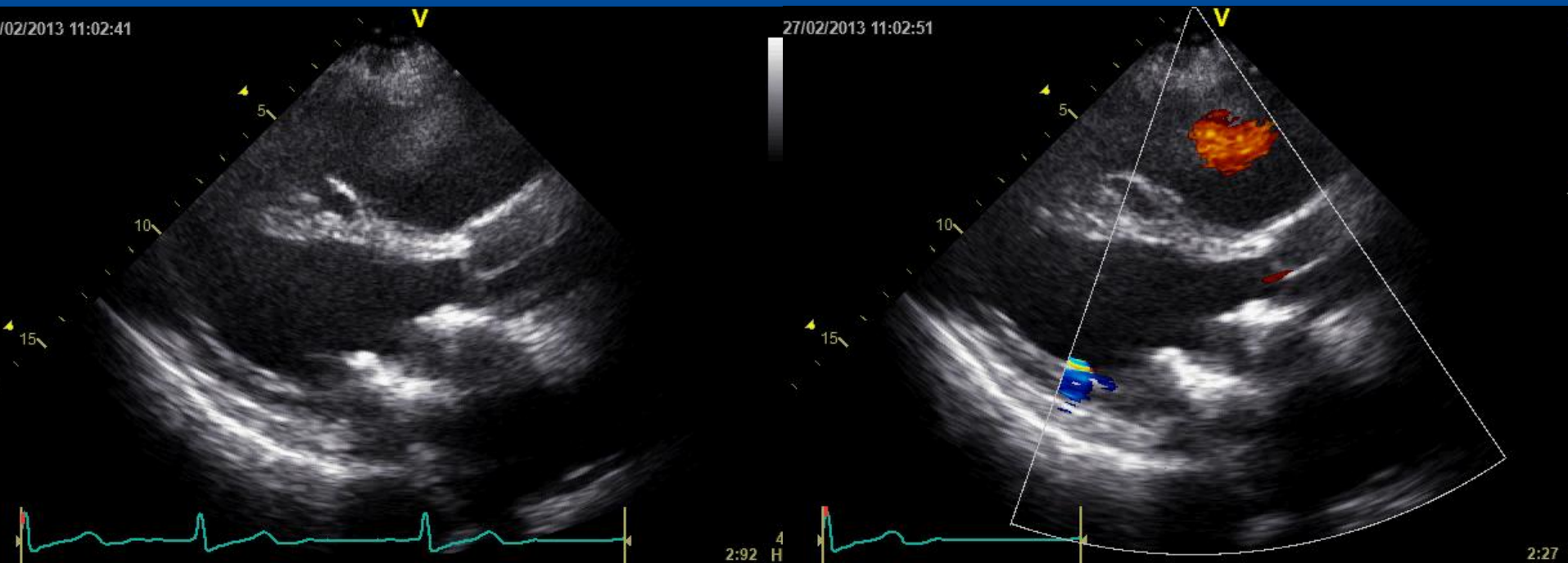
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SEOUL NATIONAL UNIVERSITY HOSPITAL



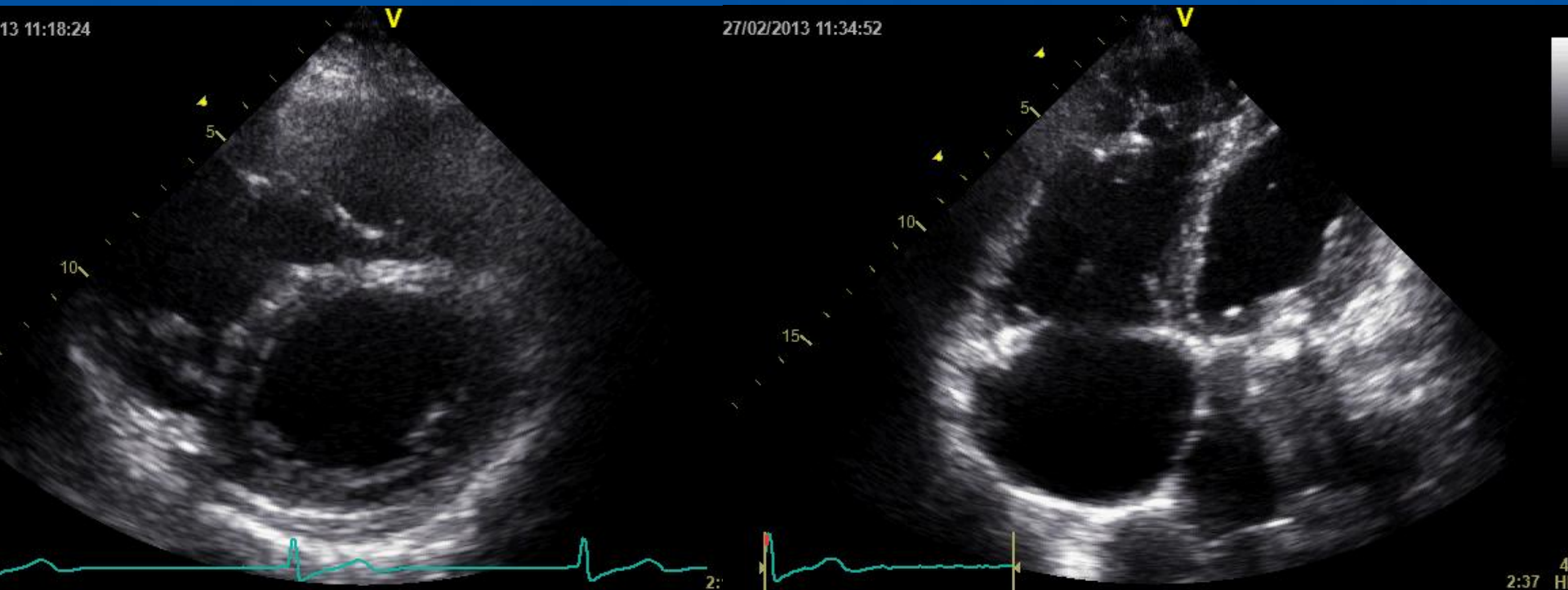
Case 1: 55yo woman with NYHA Fc 2

MVR in 1980

Redo-MVR in 1998



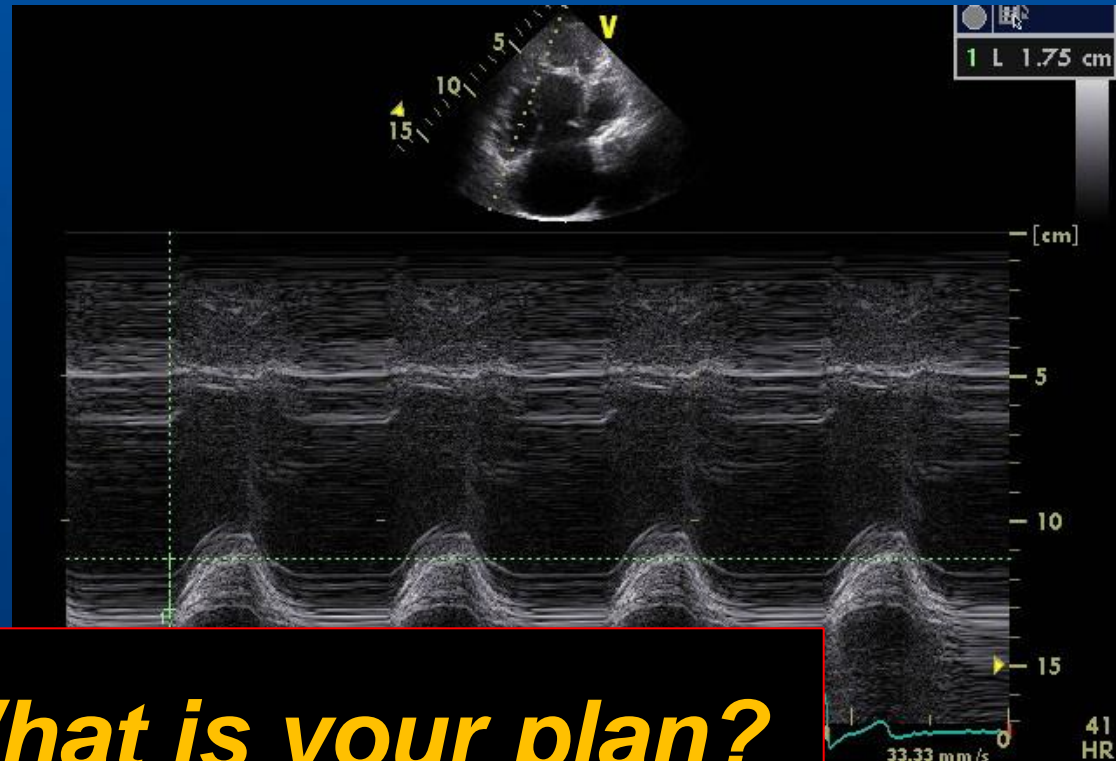
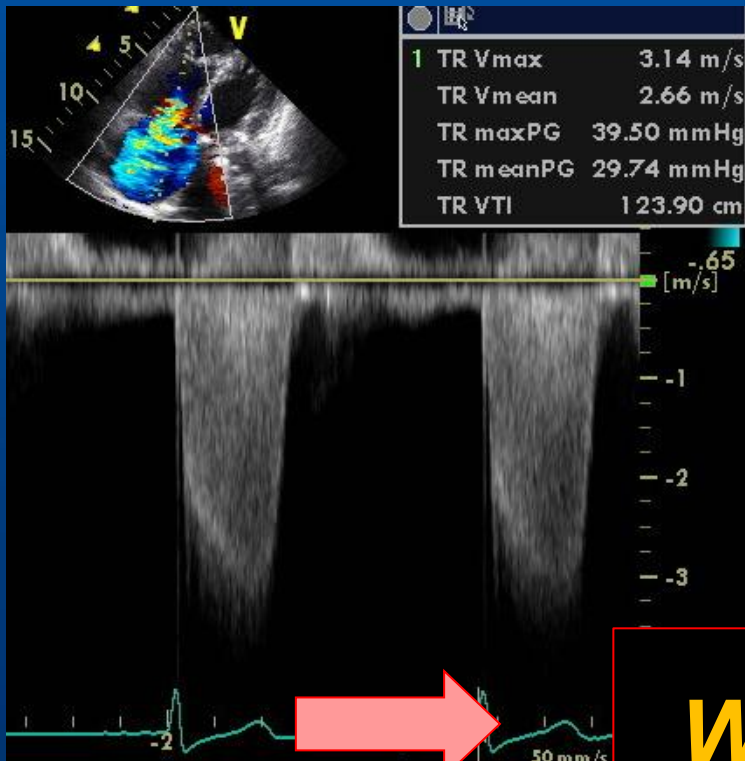
Case 1: Functional TR



Case 1: Functional TR

TR max PG = 39mmHg

TAPSE = 17 mm

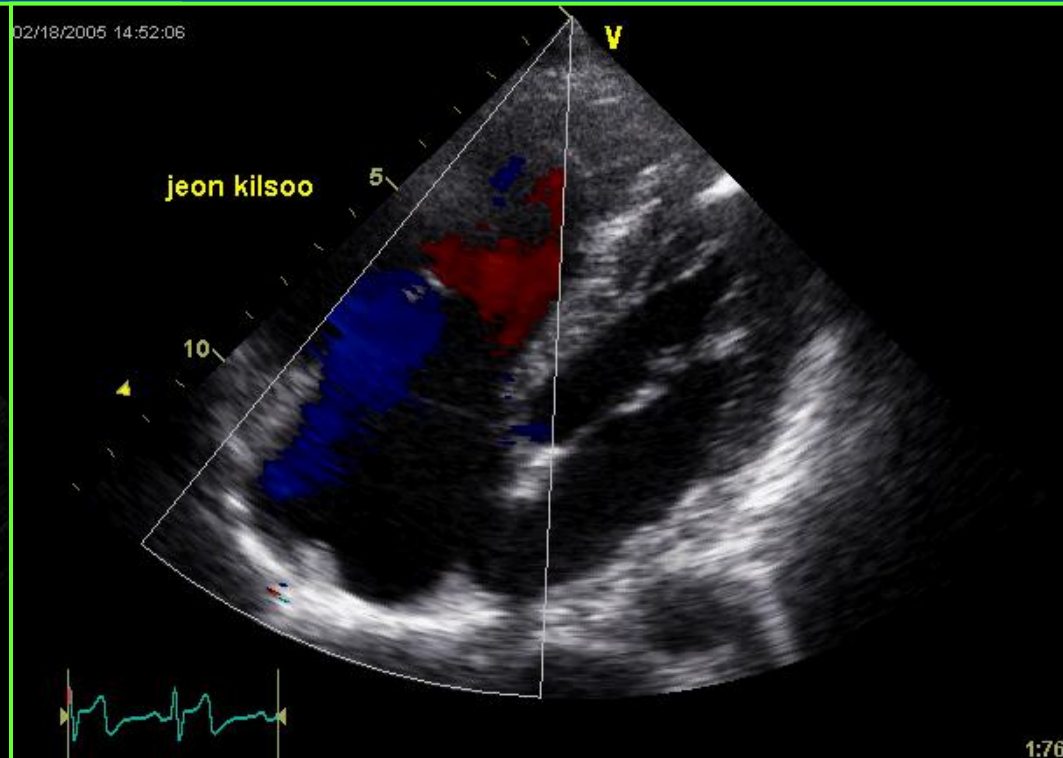
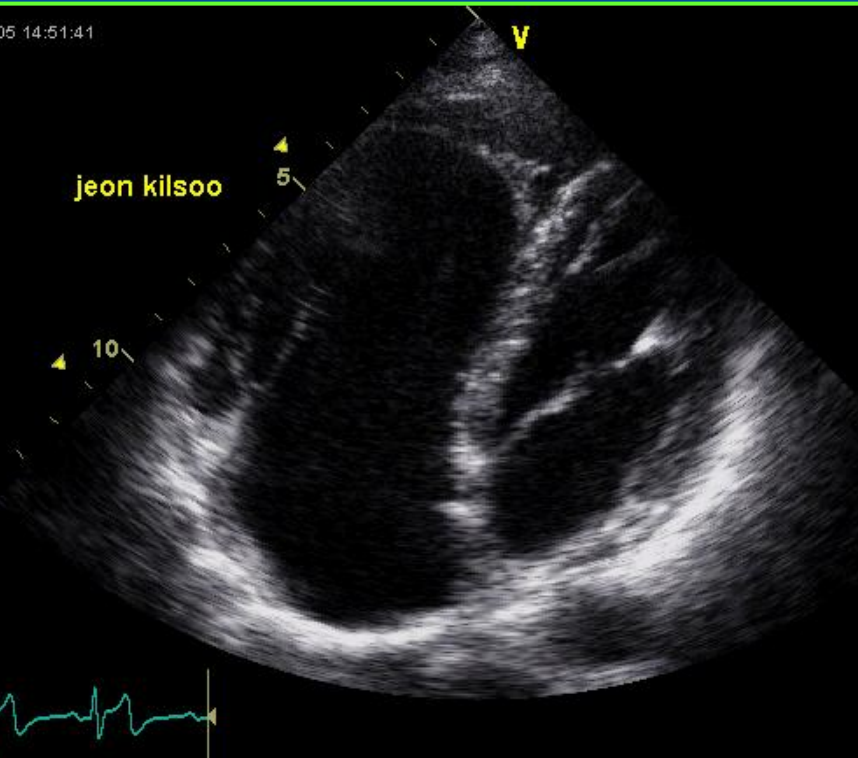


What is your plan?



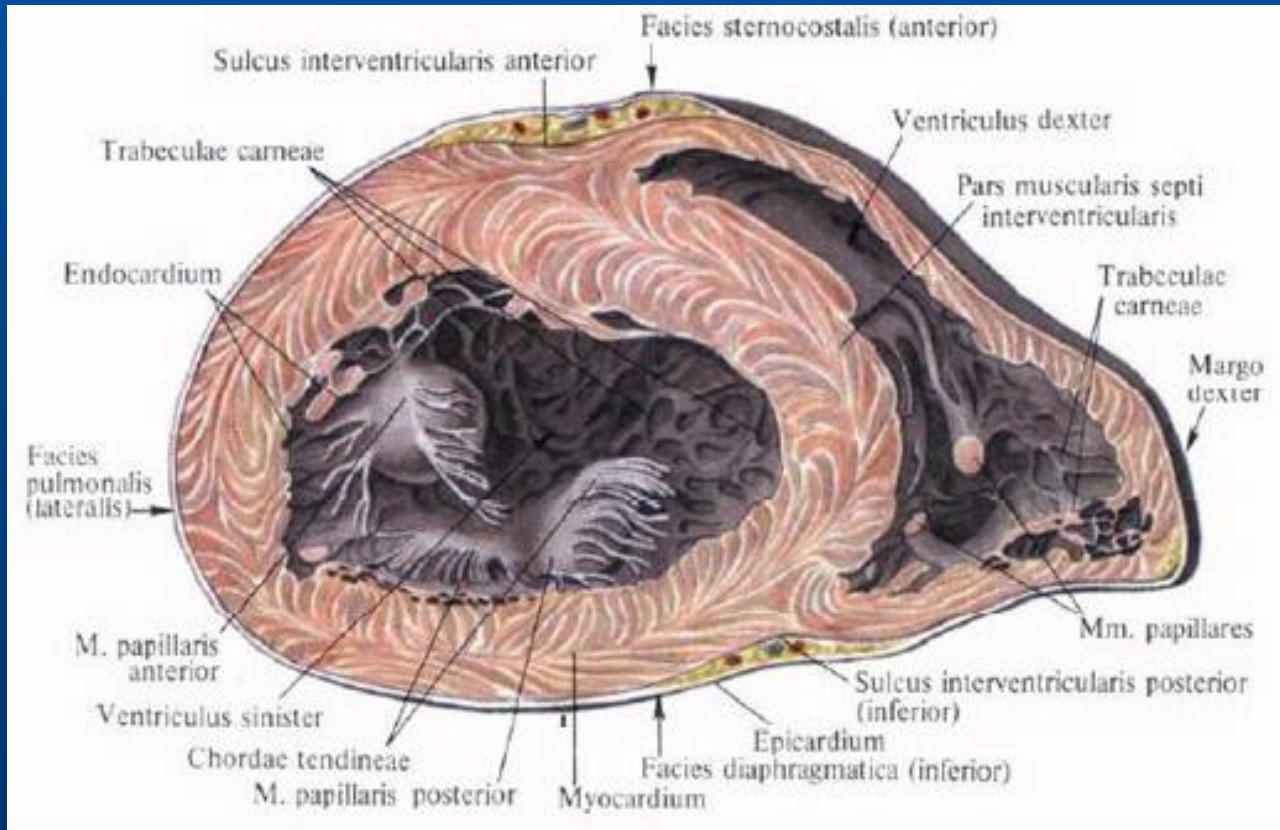
Case 2: Surgery for TR?

55yo gentleman: cardiomegaly on CXR without sx

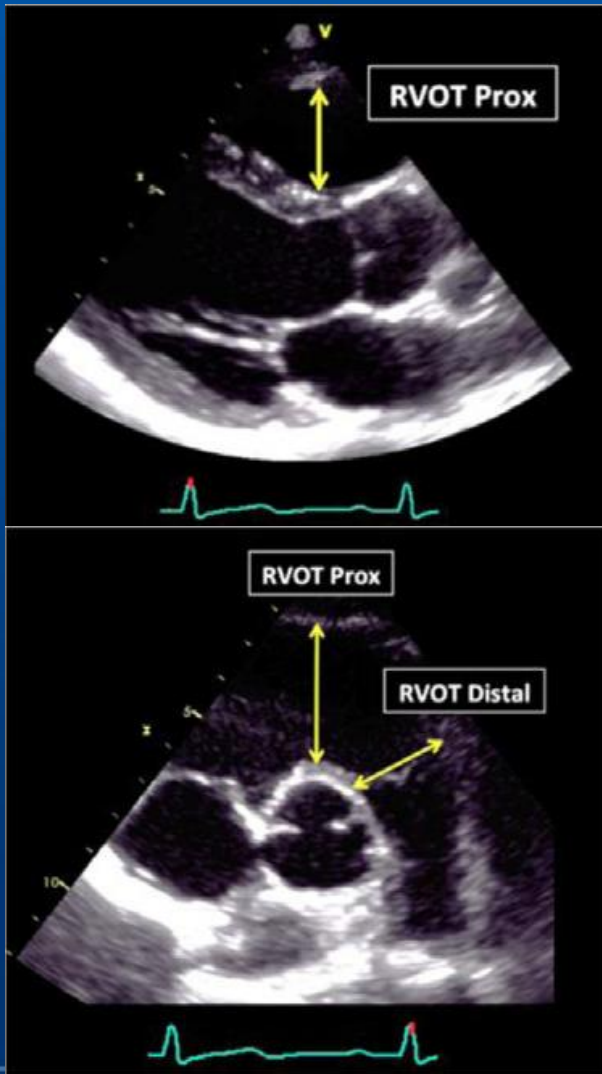


Isolated TR: RV Function

Complexity of RV morphology

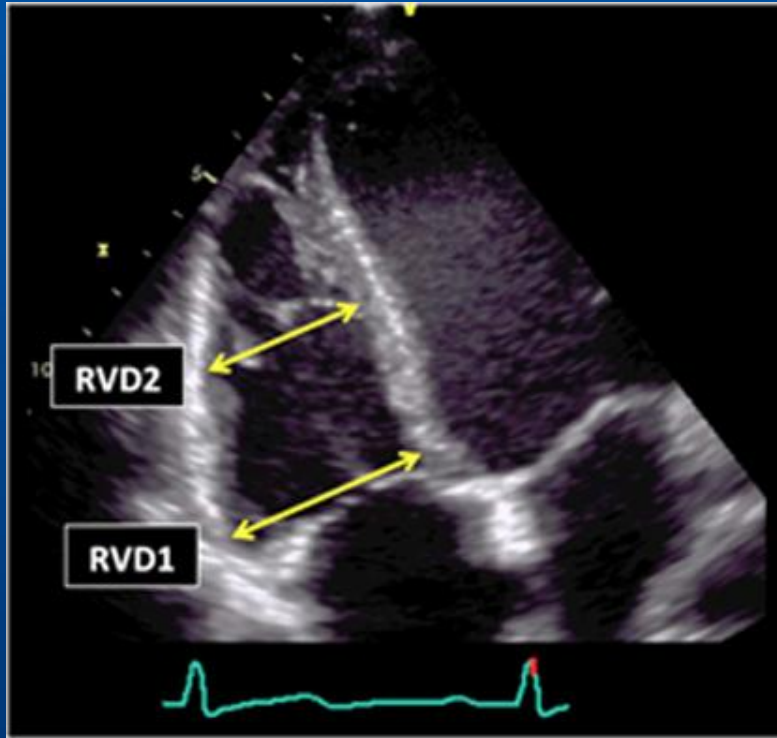


RV Size: Linear Dimensions (outflow)



- Advantage
 - easily obtainable
 - simple and fast
- Limitations
 - dependent on imaging position
 - chest or spine deformity
 - regional measure

RV Size: Linear Dimensions (inflow)



**RV-focused view
at end-diastole**

- Advantage
 - Easily obtainable
 - Simple and fast
 - Wealth of published data
- Limitations
 - Underestimation
 - High variability

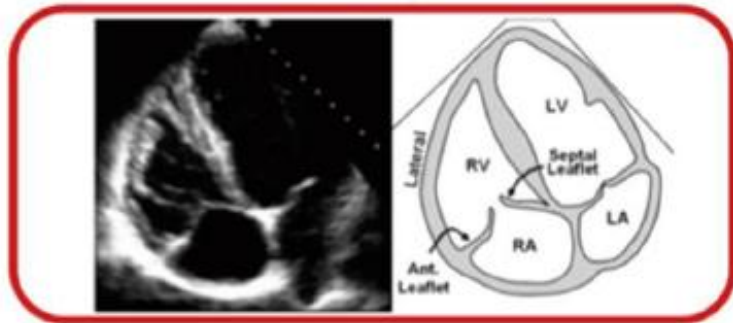
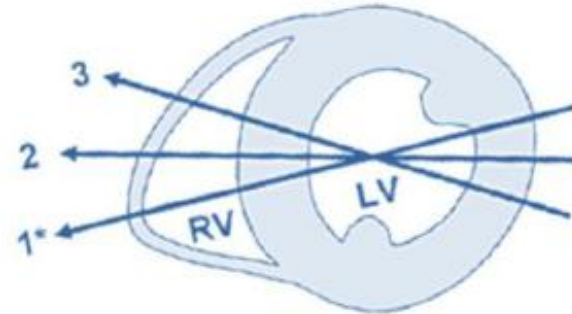
RV-focused Apical View

A

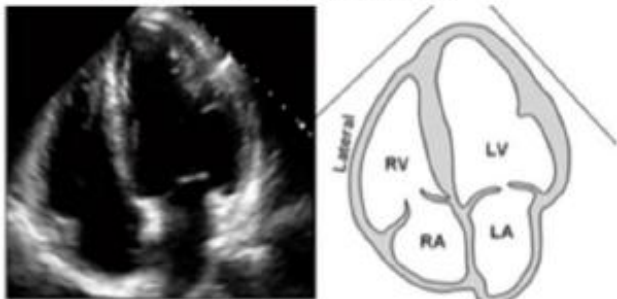


RV modified apical 4-chamber

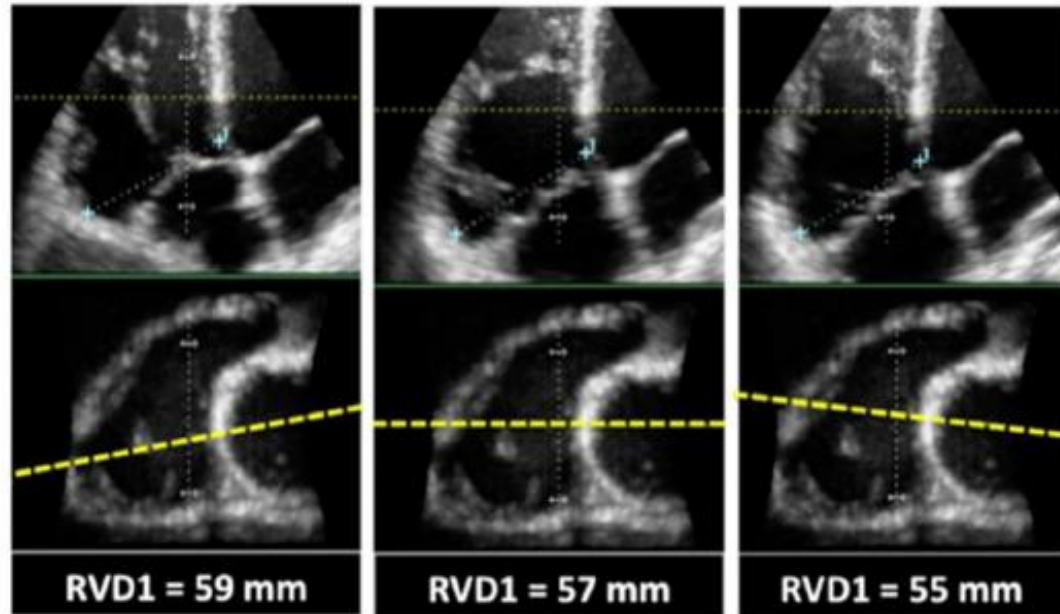
B



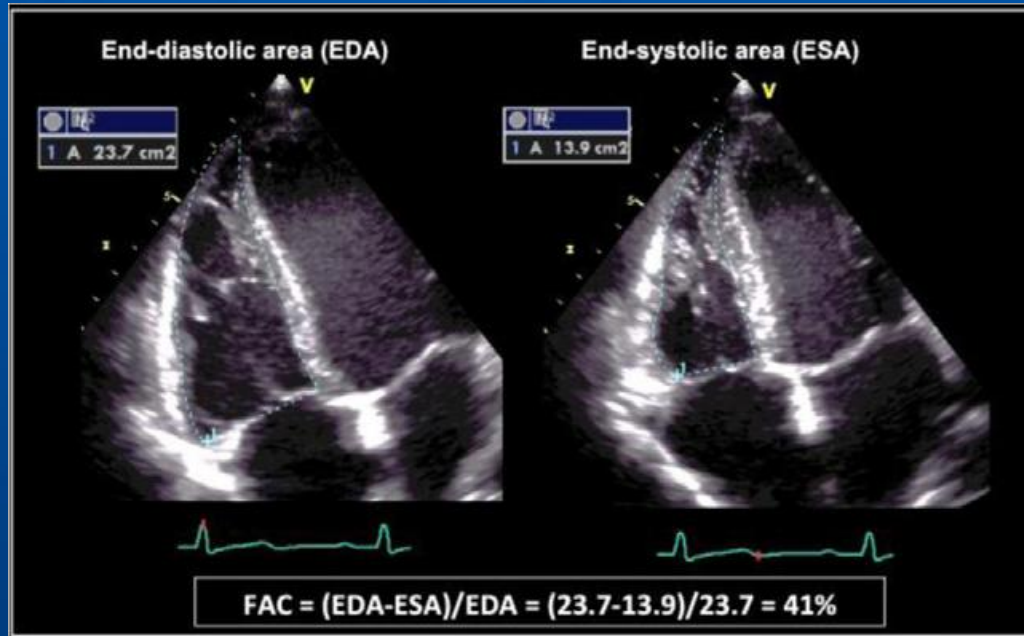
RV focused apical 4-chamber



Apical 4-chamber



RV Function: Fractional Area Change



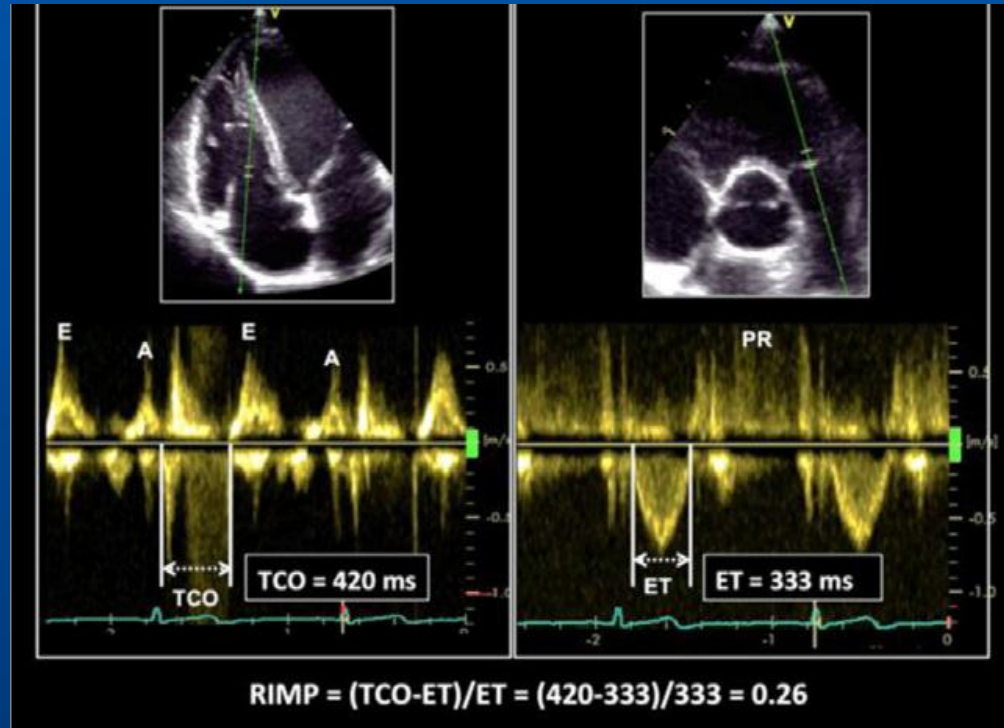
- Advantage

- established prognostic value
- correlation with RVEF by CMR

- Limitations

- neglect RVOT contribution
- only fair reproducibility

RV Index of Myocardial Performance



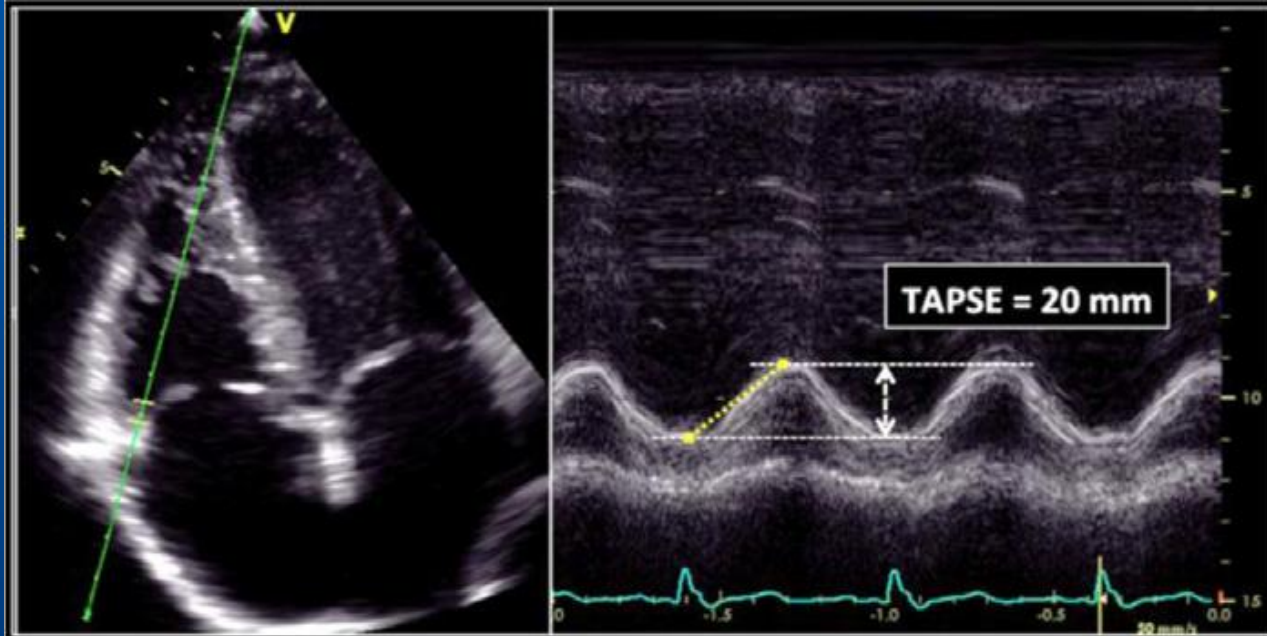
- Advantage

- prognostic value

- Limitations

- matching for R-R interval
- Unreliable with high RA pressure

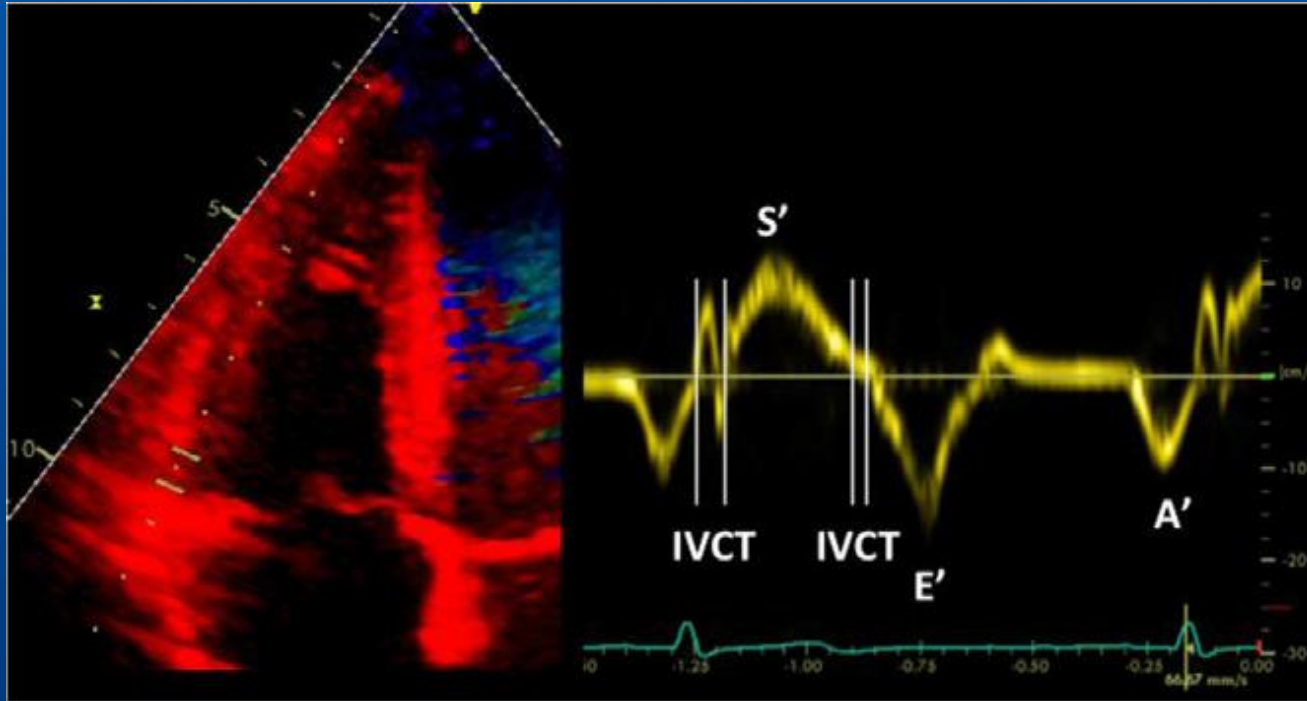
Tricuspid Annular Plane Systolic Excursion (TAPSE)



- Advantage
 - prognostic value

- Limitations
 - angle dependent
 - partially global

Systolic Tricuspid Annular Velocity (S')



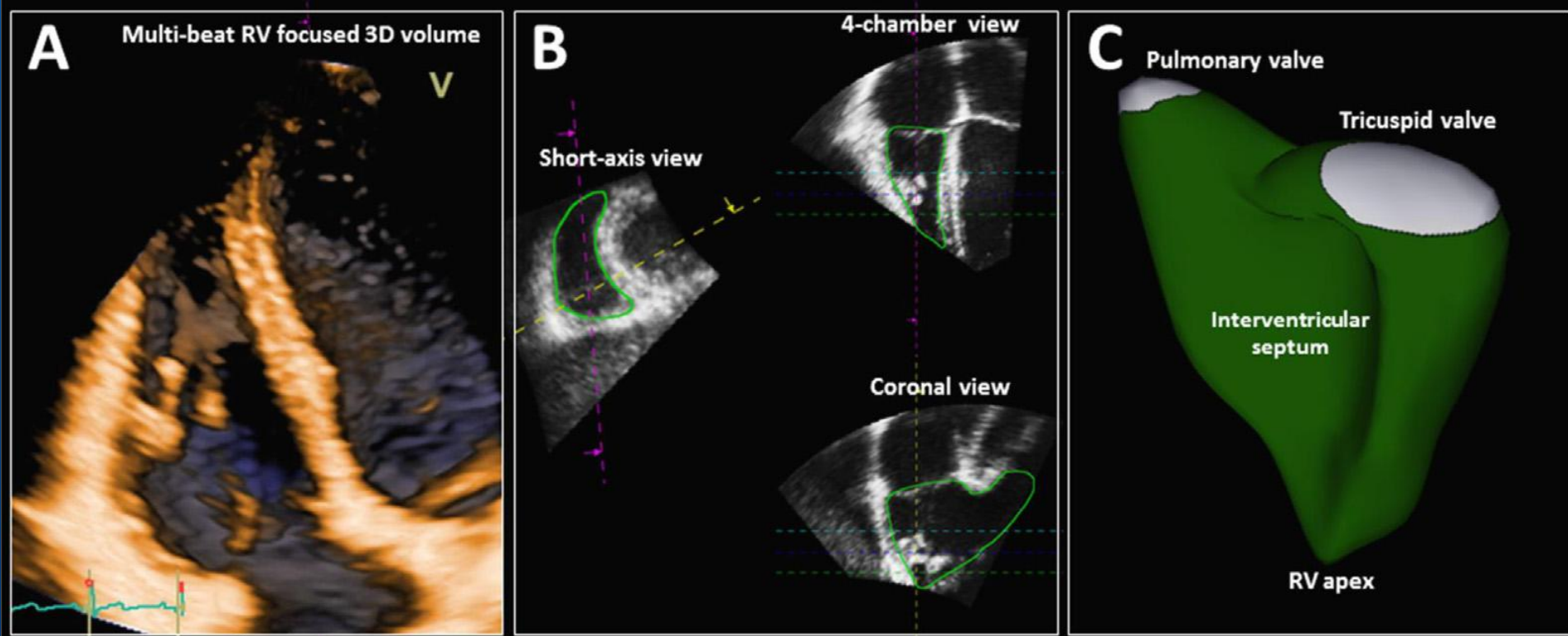
- Advantage

- easy & reproducible
- prognostic value

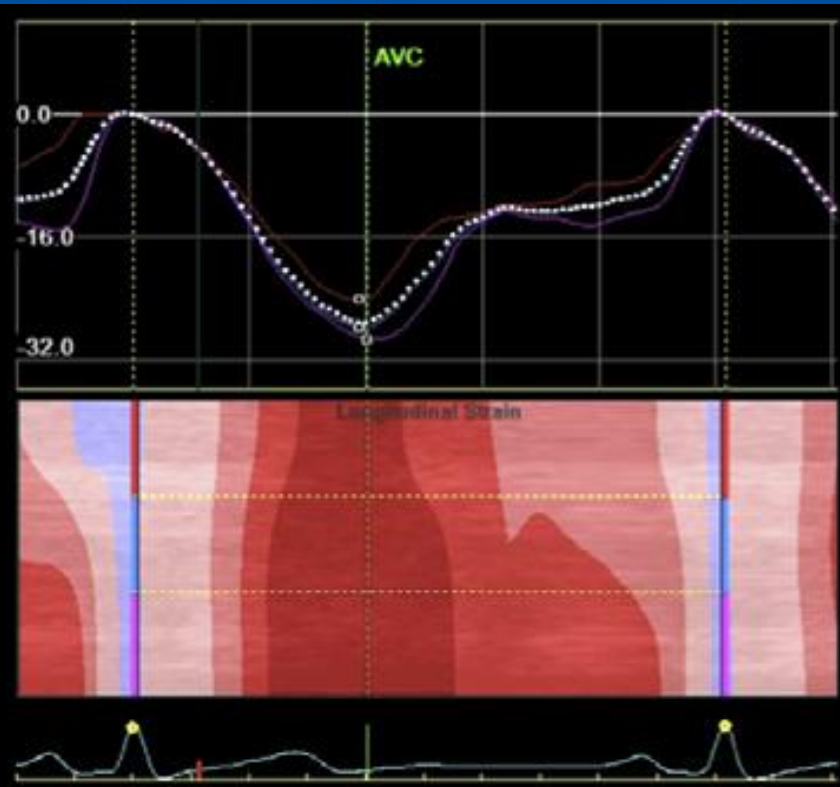
- Limitations

- angle dependent
- partially global

New Technique: 3D Echo



Global Longitudinal Strain (GLS)



Normal Values for RV Parameters

Parameter	Mean \pm SD	Abnormality threshold
TAPSE (mm)	24 \pm 3.5	<17
Pulsed Doppler S wave (cm/sec)	14.1 \pm 2.3	<9.5
Color Doppler S wave (cm/sec)	9.7 \pm 1.85	<6.0
RV fractional area change (%)	49 \pm 7	<35
RV free wall 2D strain* (%)	-29 \pm 4.5	>-20 (<20 in magnitude with the negative sign)
RV 3D EF (%)	58 \pm 6.5	<45
Pulsed Doppler MPI	0.26 \pm 0.085	>0.43
Tissue Doppler MPI	0.38 \pm 0.08	>0.54
E wave deceleration time (msec)	180 \pm 31	<119 or >242
E/A	1.4 \pm 0.3	<0.8 or >2.0
e'/a'	1.18 \pm 0.33	<0.52
e'	14.0 \pm 3.1	<7.8
E/e'	4.0 \pm 1.0	>6.0

Class 1 Surgical Indication: MR vs TR

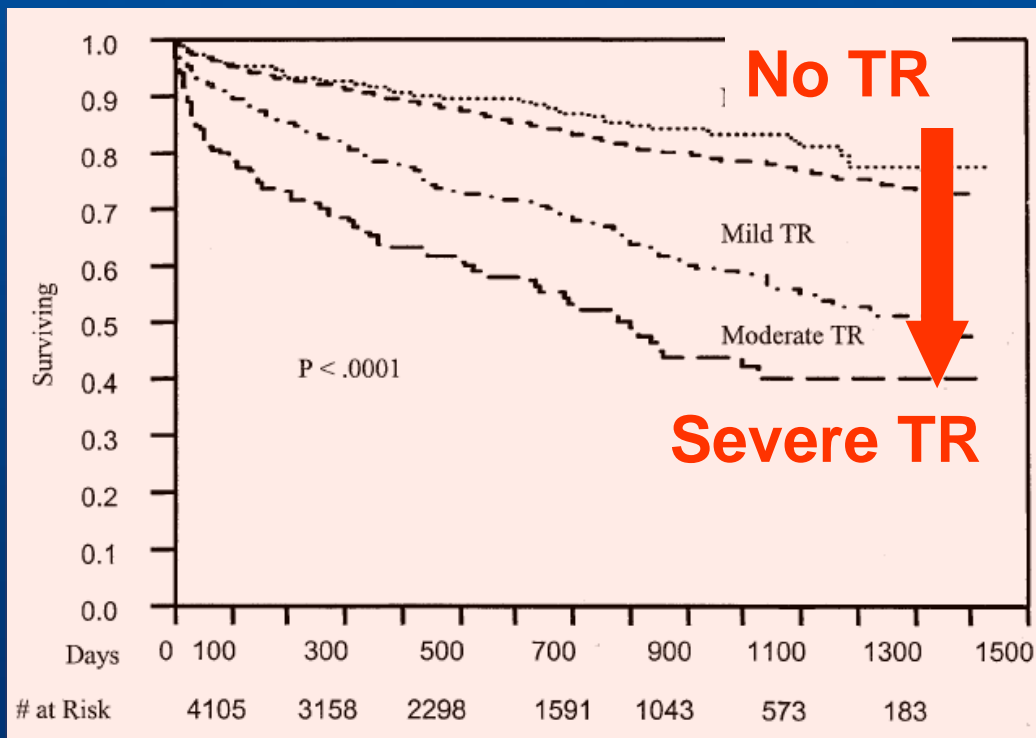
Mitral valve surgery is recommended for symptomatic patients with chronic severe primary MR (stage D) and LVEF greater than 30%

Mitral valve surgery is recommended for asymptomatic patients with chronic severe primary MR and LV dysfunction (LVEF 30% to 60% and/or LVEDD \geq 40 mm, stage C2)

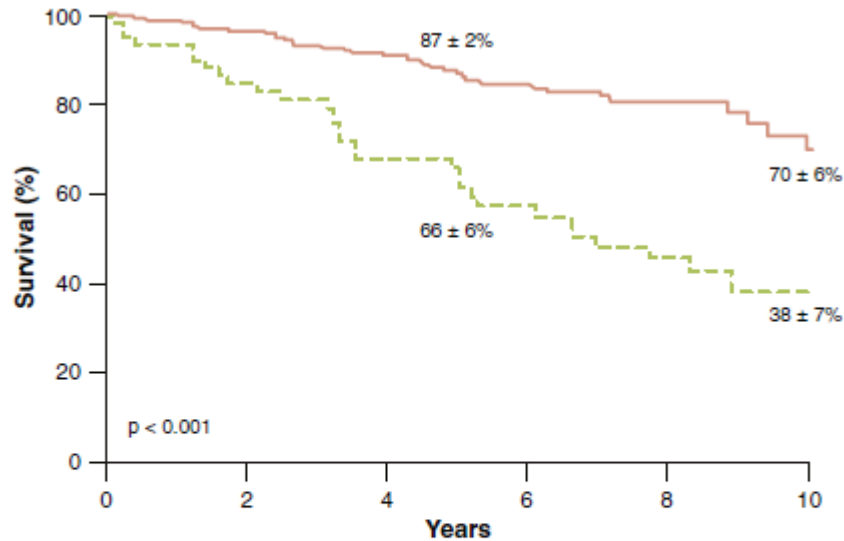
Tricuspid valve surgery is recommended for patients with severe TR (stages C and D) undergoing left-sided valve surgery. (Level of Evidence: C)

Is TR Significant Clinically?

Impact of TR on long-term survival



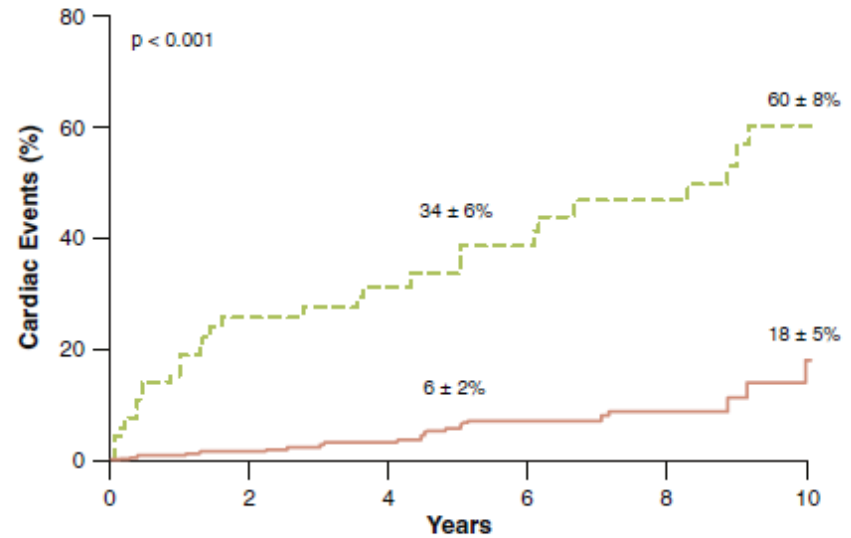
Natural History of Isolated TR



Number at Risk

Total	353	308	252	194	70	31
ERO <40	285	253	210	163	46	23
ERO ≥40	68	55	42	31	24	8

— ERO ≥ 40 mm² — ERO < 40 mm²



Number at Risk

Total	353	294	242	183	65	29
ERO <40	285	252	209	160	46	23
ERO ≥40	68	42	33	23	19	6

— ERO ≥ 40 mm² — ERO < 40 mm²

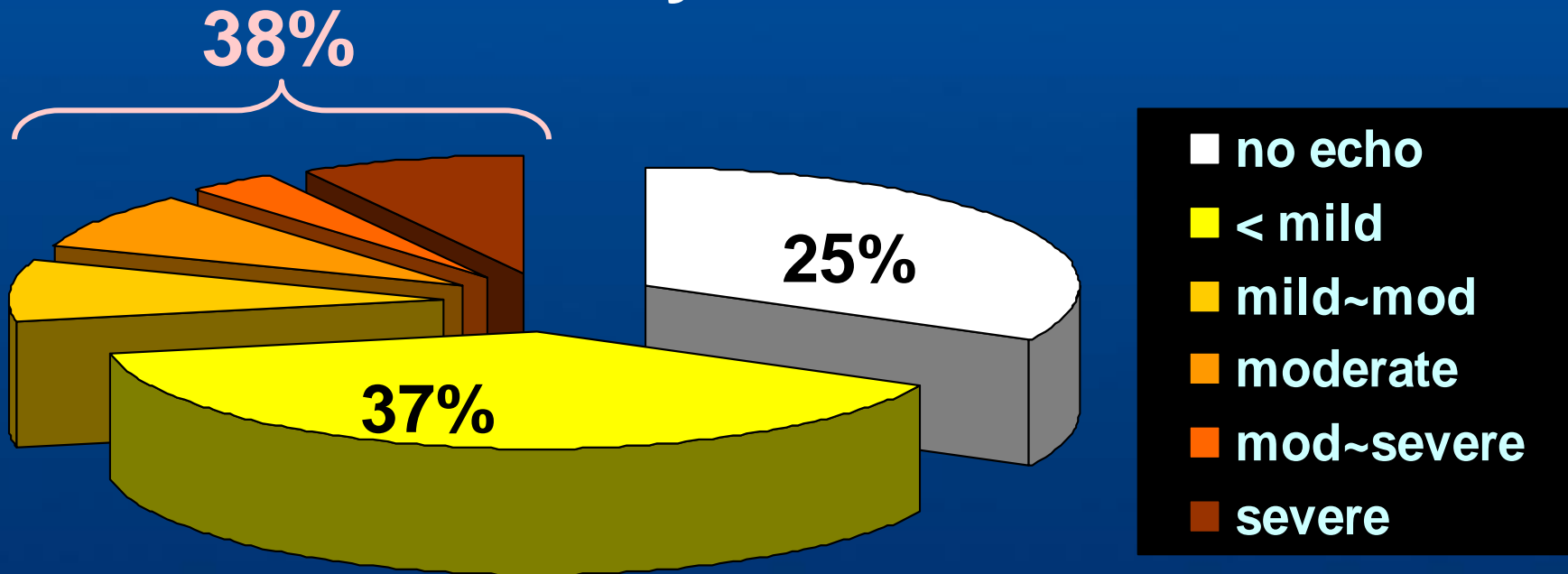
Surgery for TR

1. Combined isolated aortic valve disease

Combined Mitral Valve Disease

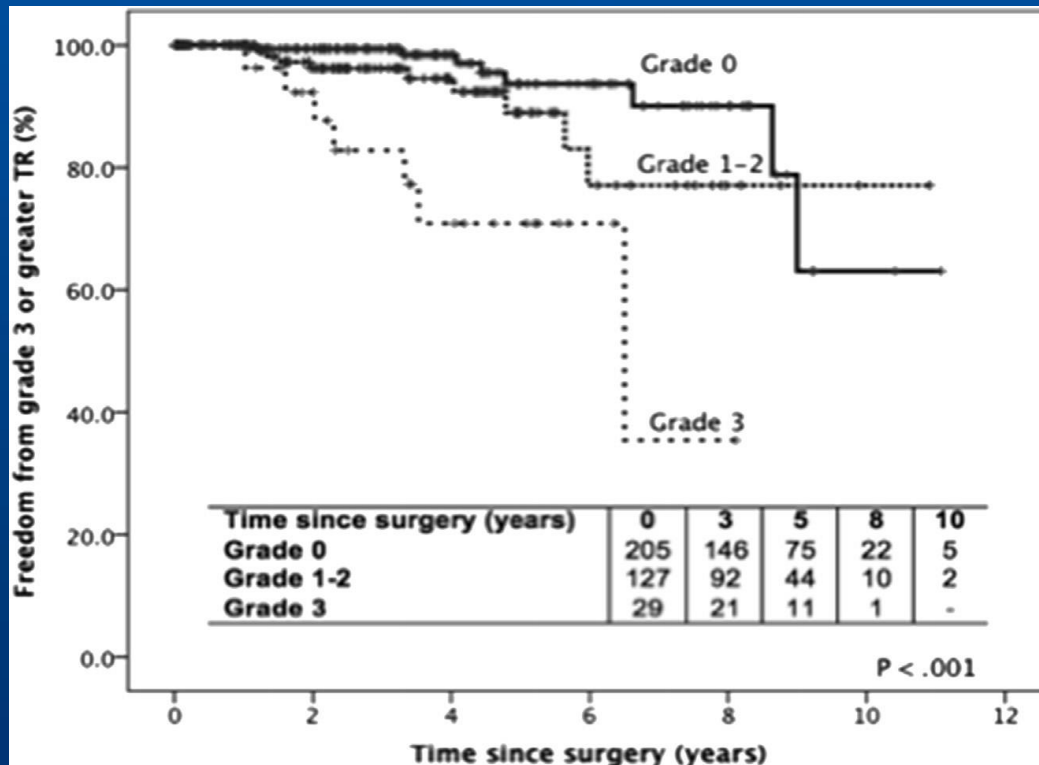
411 pts with mitral surgery (1992~1995)

10 yr echo f/u



Combined MV Disease

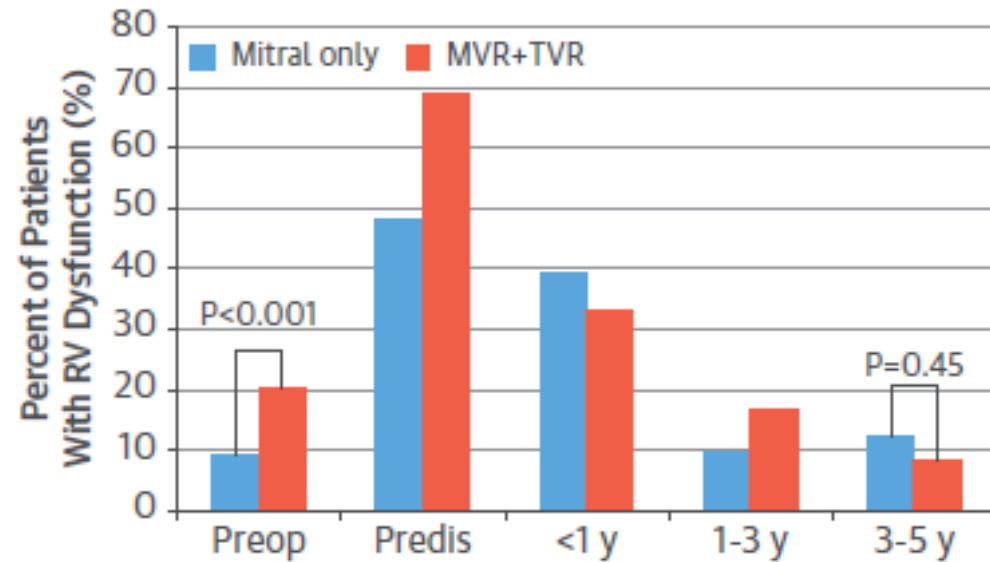
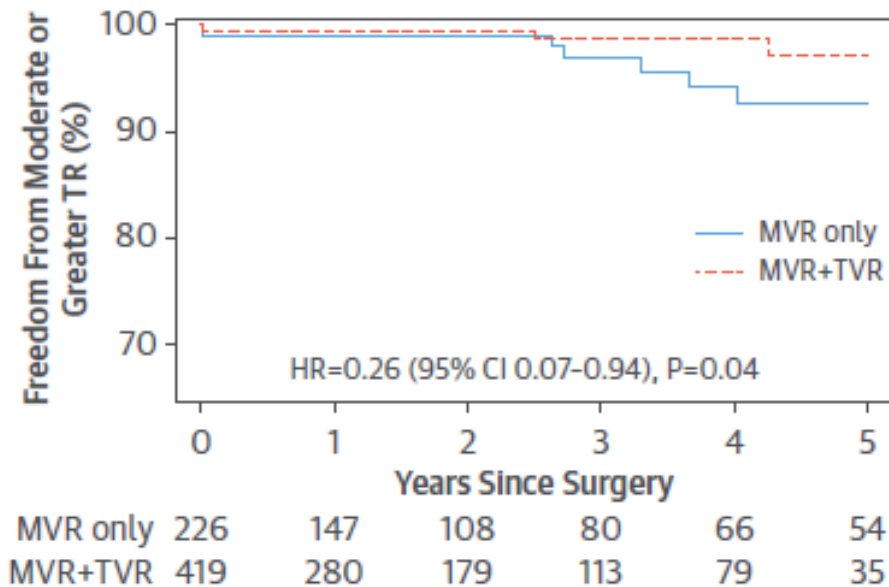
215 pts with surgery for degenerative MR



Impact of Concomitant Tricuspid Annuloplasty

Freedom from moderate or greater TR

Percent of patients with RV dysfunction



Moderate or severe tricuspid regurgitation on intraoperative or pre-operative echocardiography

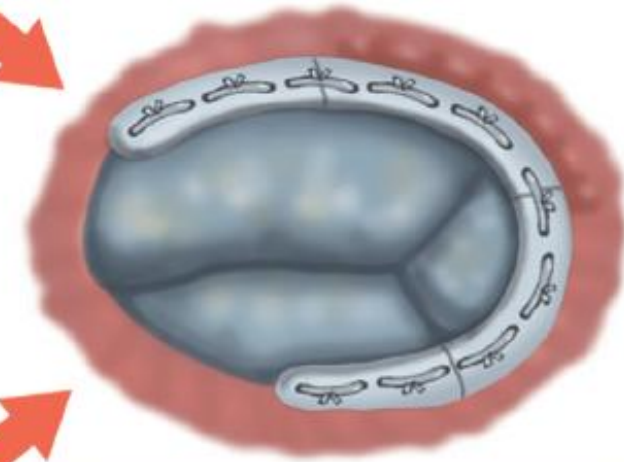
Yes

No

Assess Annular Dilation

>40 mm on 4 chamber pre-bypass transesophageal echocardiography
Or, significant size mismatch between leaflet and annulus on direct inspection

Yes



Tricuspid Annuloplasty

No

Leave Alone

Isolated TR: Etiology

Primary causes (25%) ; anatomically abnormal

Rheumatic

Myxomatous

Ebstein anomaly

Endocarditis

Carcinoid disease

Traumatic (blunt chest trauma, laceration)

Iatrogenic (pacemaker/ICD lead, RV biopsy)

Secondary causes (75%) ; functional

Left heart disease

Any cause of pulmonary HTN

Any cause of RV dysfunction

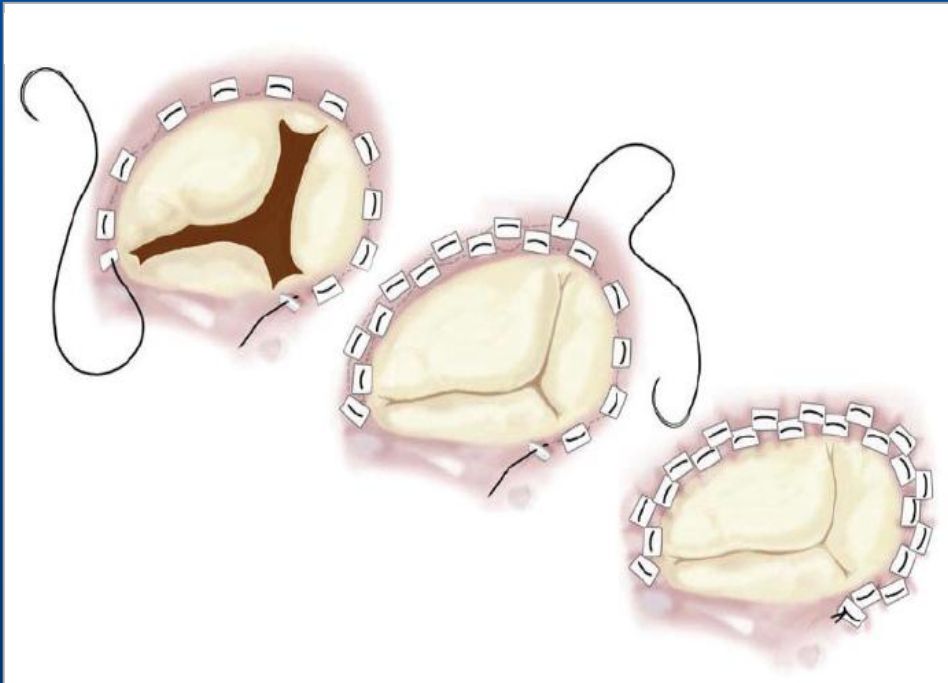
Functional TR: High Operative Risk

- *King et al, Circulation 1984*
 - 32 severe TR late after MVR
 - **hospital mortality: 25%, 5 YSR: 44%**
- *Stabb et al, JHVD 1999*
 - 34 severe TR with prior left-sided valve surgery
 - **early mortality: 8.8%**
 - **event-free survival at 5 yr: 41.6%**
 - Age, number of prior surgery
 - independent predictors

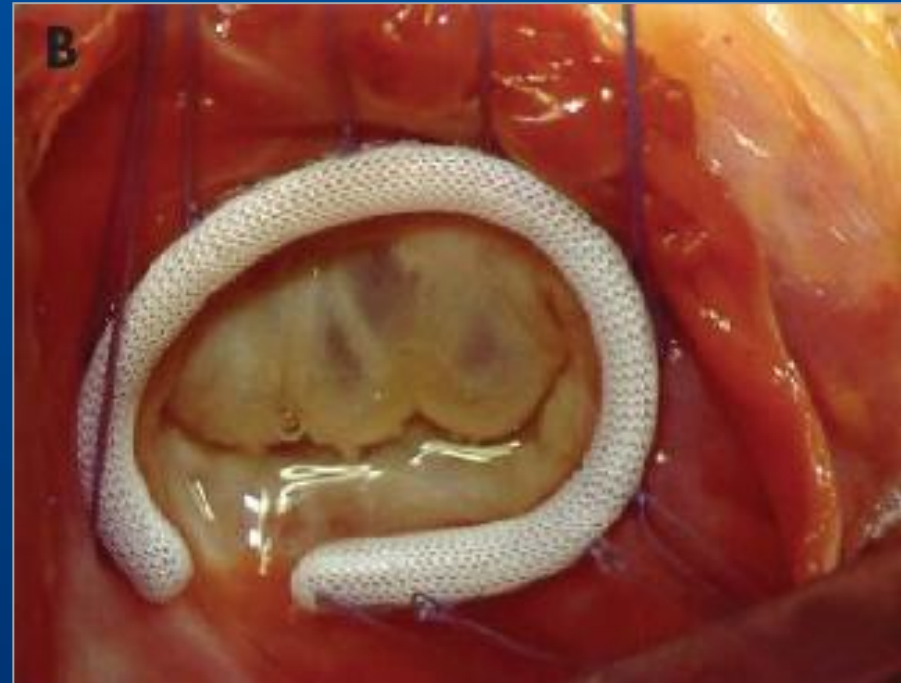


Isolated TR: Is It Repairable?

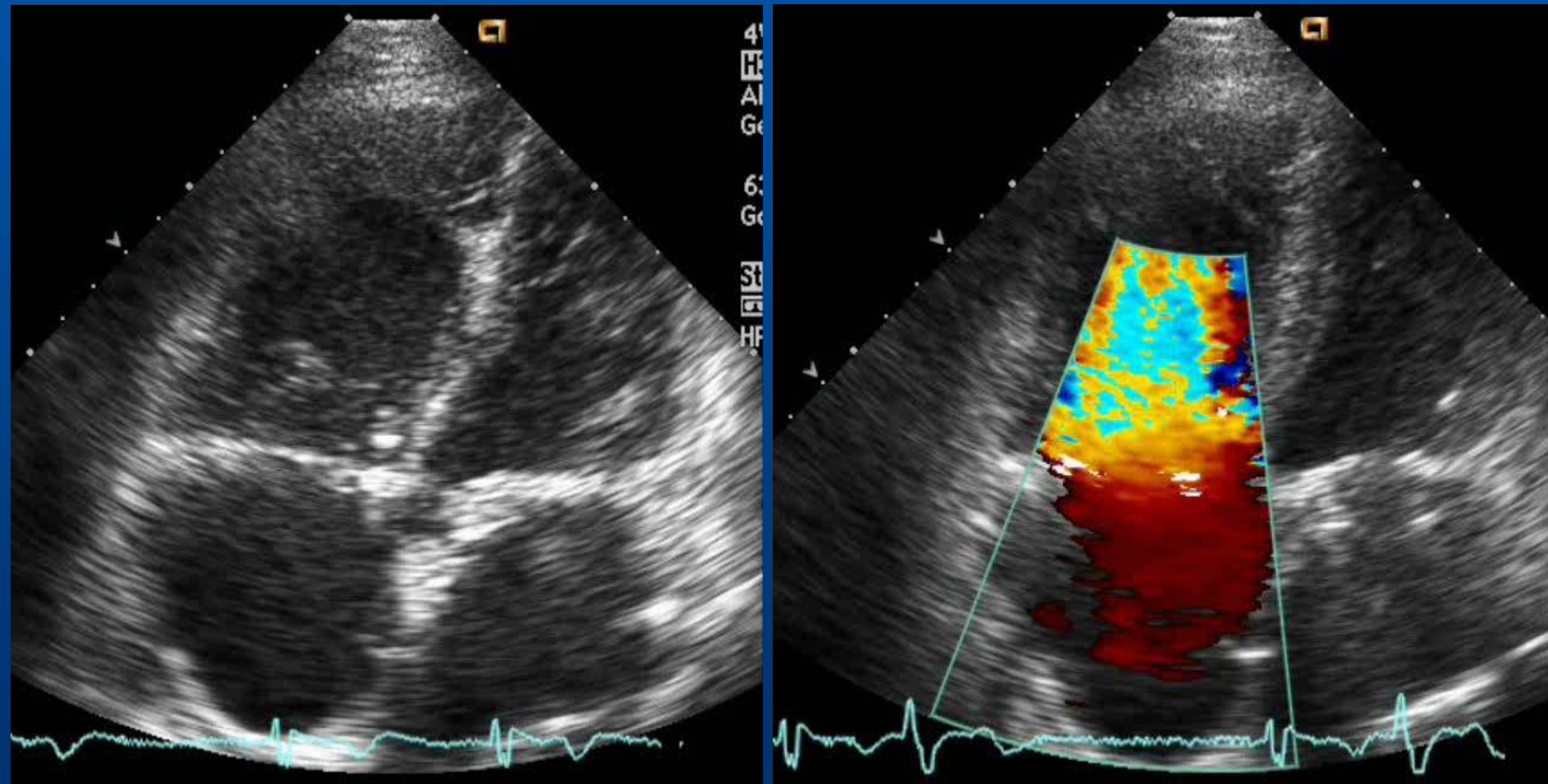
Modified DeVega annuloplasty



Ring Annuloplasty



Residual TR after Annuloplasty



Residual TR after Annuloplasty

	Postoperative TR			<i>P</i>
	Mild (n=167)	Moderate (n=33)	Severe (n=16)	
Age, y	69±12	62±17*	59±14*	<0.001
Male gender, n (%)	60 (36)	13 (39)	4 (25)	0.6
LV ejection fraction, %	48.5±13.5	41.2±16.5*	41.5±15.5	0.009
RV fractional area change, %	31.2±11.8	25.6±11.0*	25.1±12.8*	0.01
RA area, cm ²	25.3±8.8	25.6±8.7	27.1±6.9	0.7
RV systolic pressure, mm Hg	54.3±18.1	52.5±19.4	52.0±19.0	0.8
TV annulus diameter, cm	3.73±0.73	3.84±0.84	4.03±0.58	0.3
TV tethering distance, cm	0.53±0.33	1.07±0.39*	1.17±0.39*	<0.001
TV tethering area, cm ²	1.01±0.86	2.33±1.26*	2.84±1.41*	<0.001
Preoperative %TR, %	38.2±14.6	39.6±13.6	55.2±14.8†	<0.001

Assessing Tricuspid Apparatus in Functional TR

	Stage 1	Stage 2	Stage 3
TR severity	None or mild	Mild or moderate	Severe
Annular diameter, mm	<40	>40	>40
Leaflet coaptation mode	Normal*	Edge-to-edge*	Absent†
Treatment	Medical treatment	Tricuspid annuloplasty	Tricuspid annuloplasty + leaflet augmentation‡

*No leaflet tethering (<8 mm). †Leaflet tethering may be present (≥8 mm). ‡If leaflet tethering is present. TR = tricuspid regurgitation.



Isolated Severe TR: Surgery

*61 patients undergoing surgery for severe TR
Jan 2003 – Dec 2007*

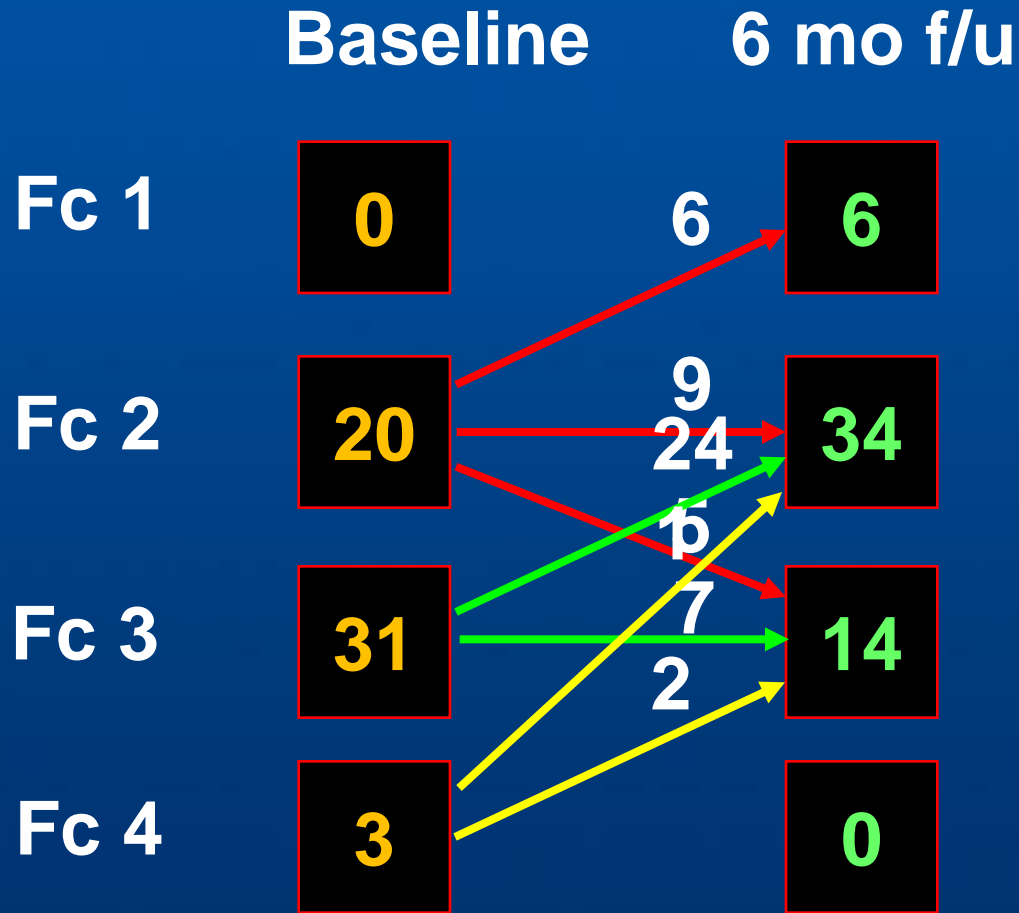
Mean f/u for 3 yrs

Op mortality
6 (9.8%)

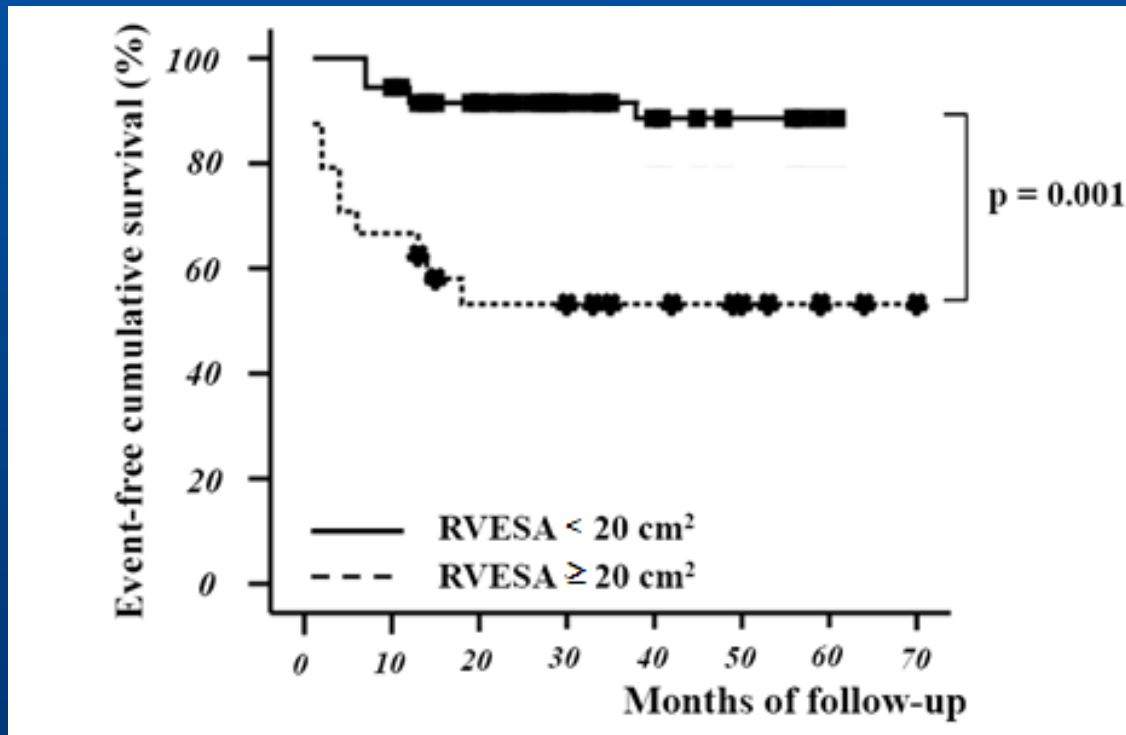
Late death
3 (4.9%)

CV events
6 (9.8%)

PostOp TR: Functional Capacity



When to Operate TR: RV ESA

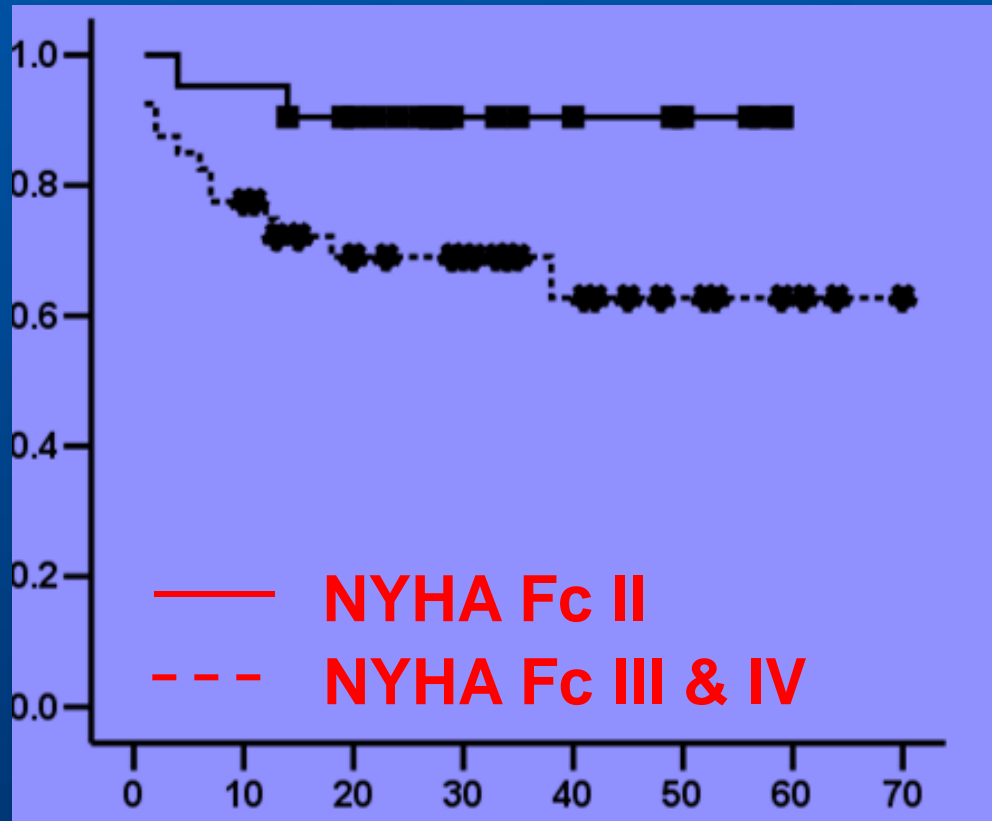


RVESA < 20 cm ²	37	35	34	34	33	33	33	33
RVESA ≥ 20 cm ²	24	16	13	13	13	13	13	13



When to Operate TR: NYHA Fc

Event-free cumulative survival (%)

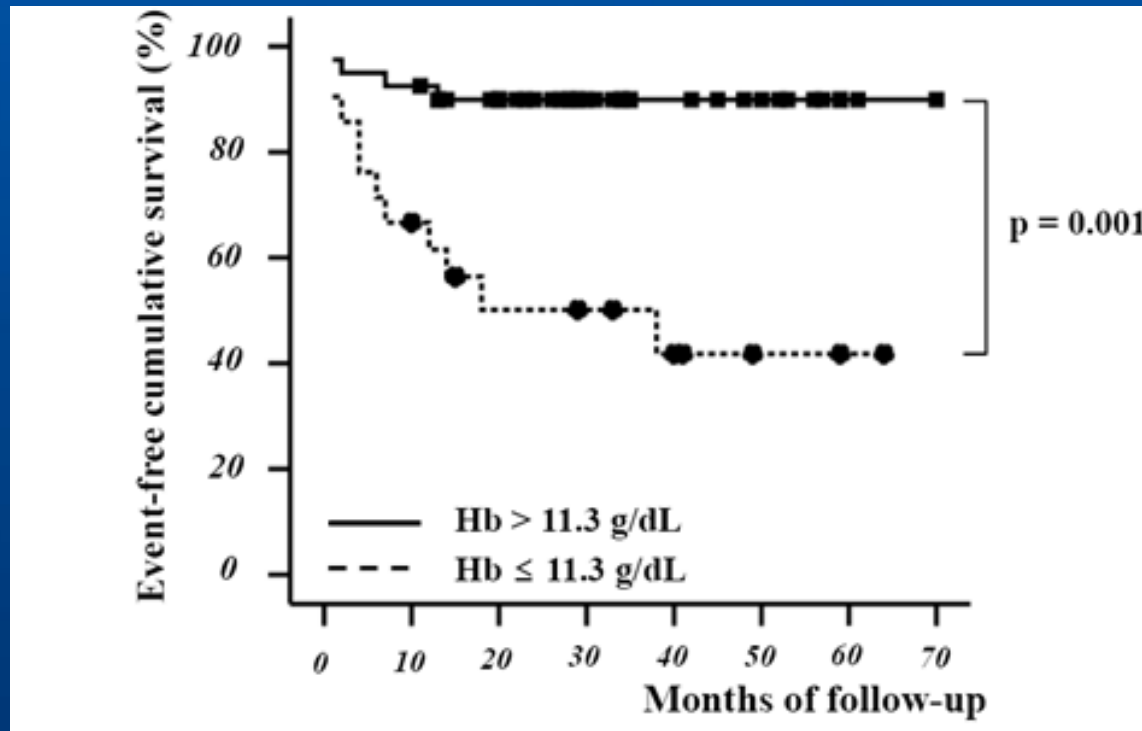


Months of follow-up

NYHA Fc II	21	20	19	19	19	19	19	19
NYHA Fc III and IV	40	31	28	28	27	27	27	27

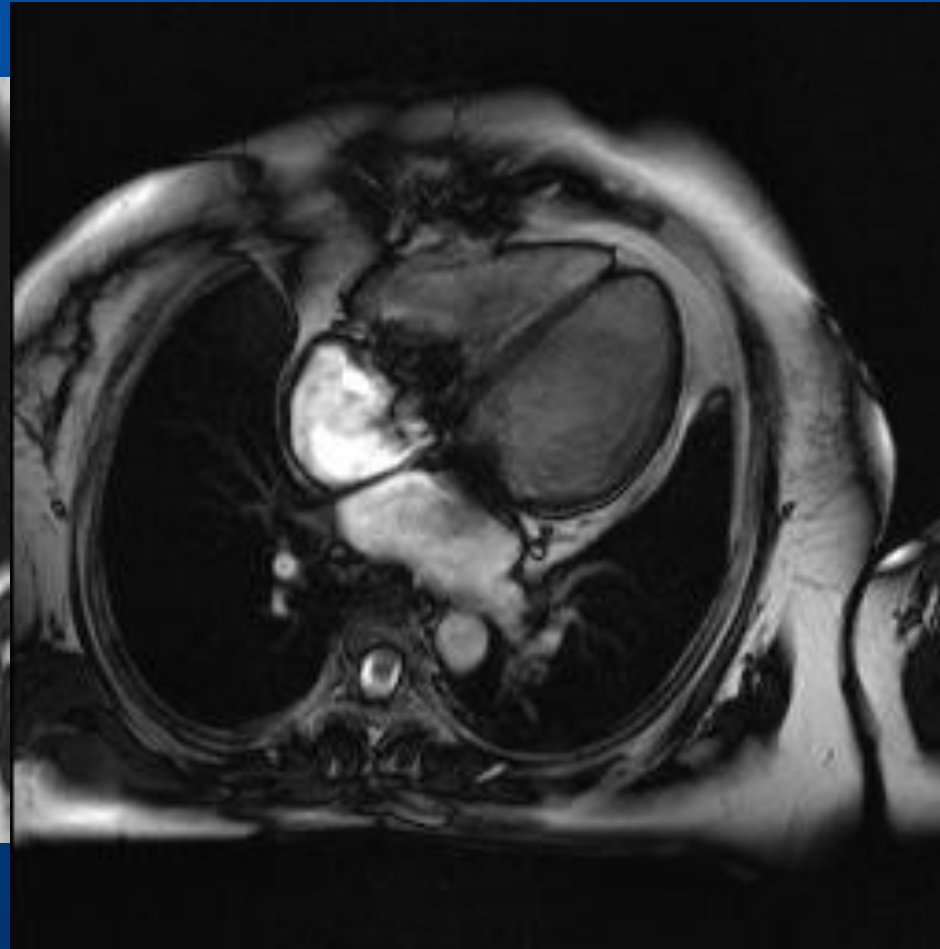
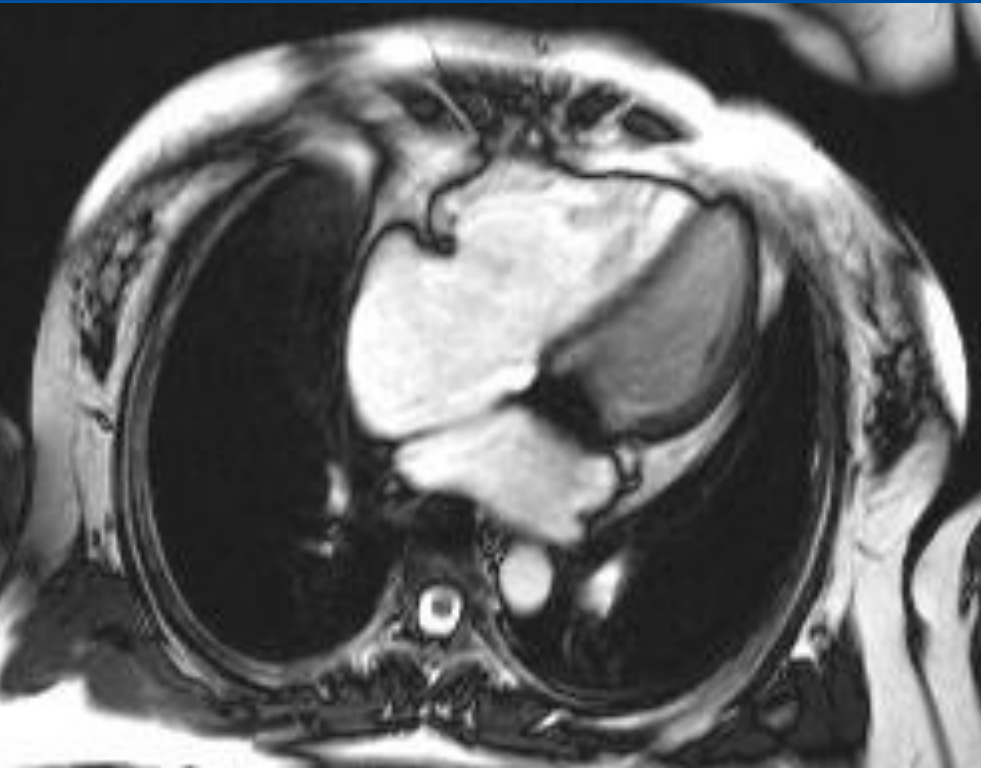


When to Operate TR: Hemoglobin

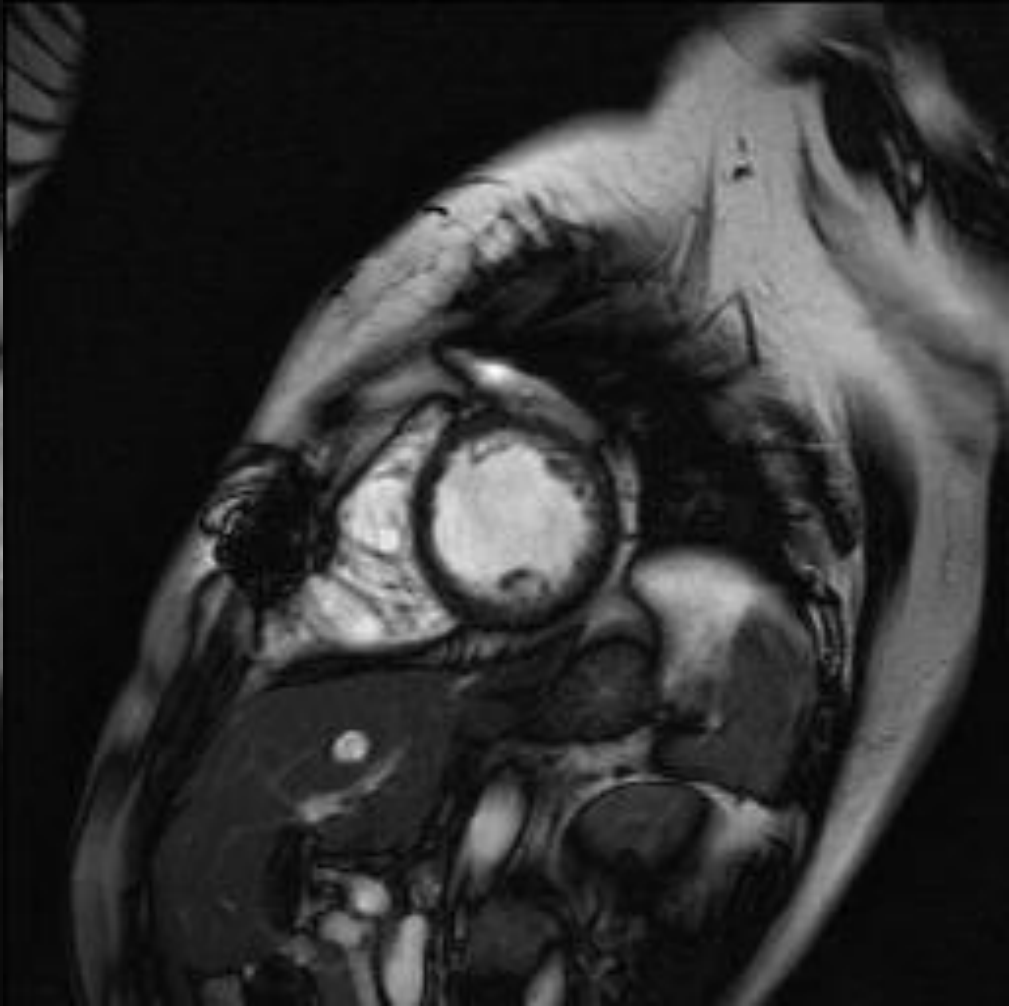
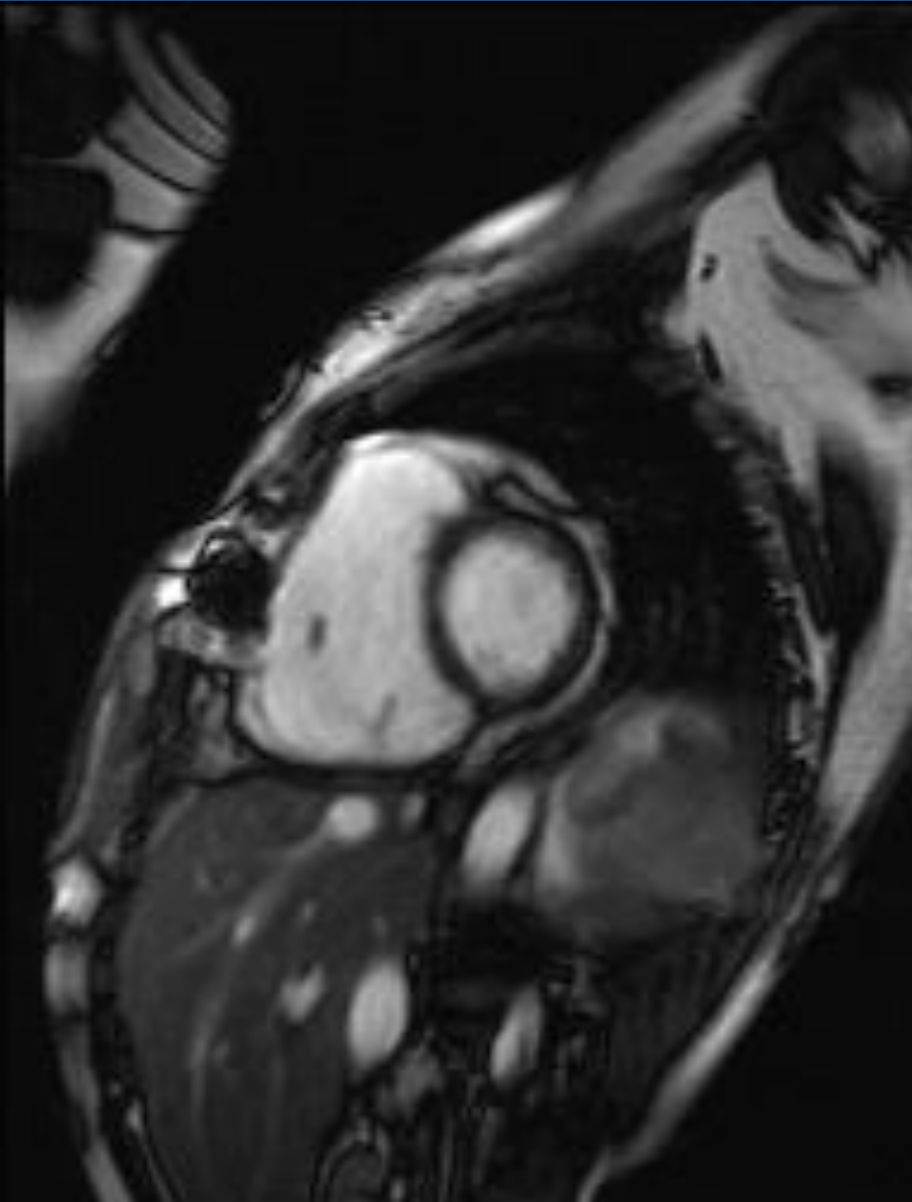


Hb > 11.3 g/dL	40	37	36	36	36	36	36	36
Hb ≤ 11.3 g/dL	21	14	11	11	10	10	10	10

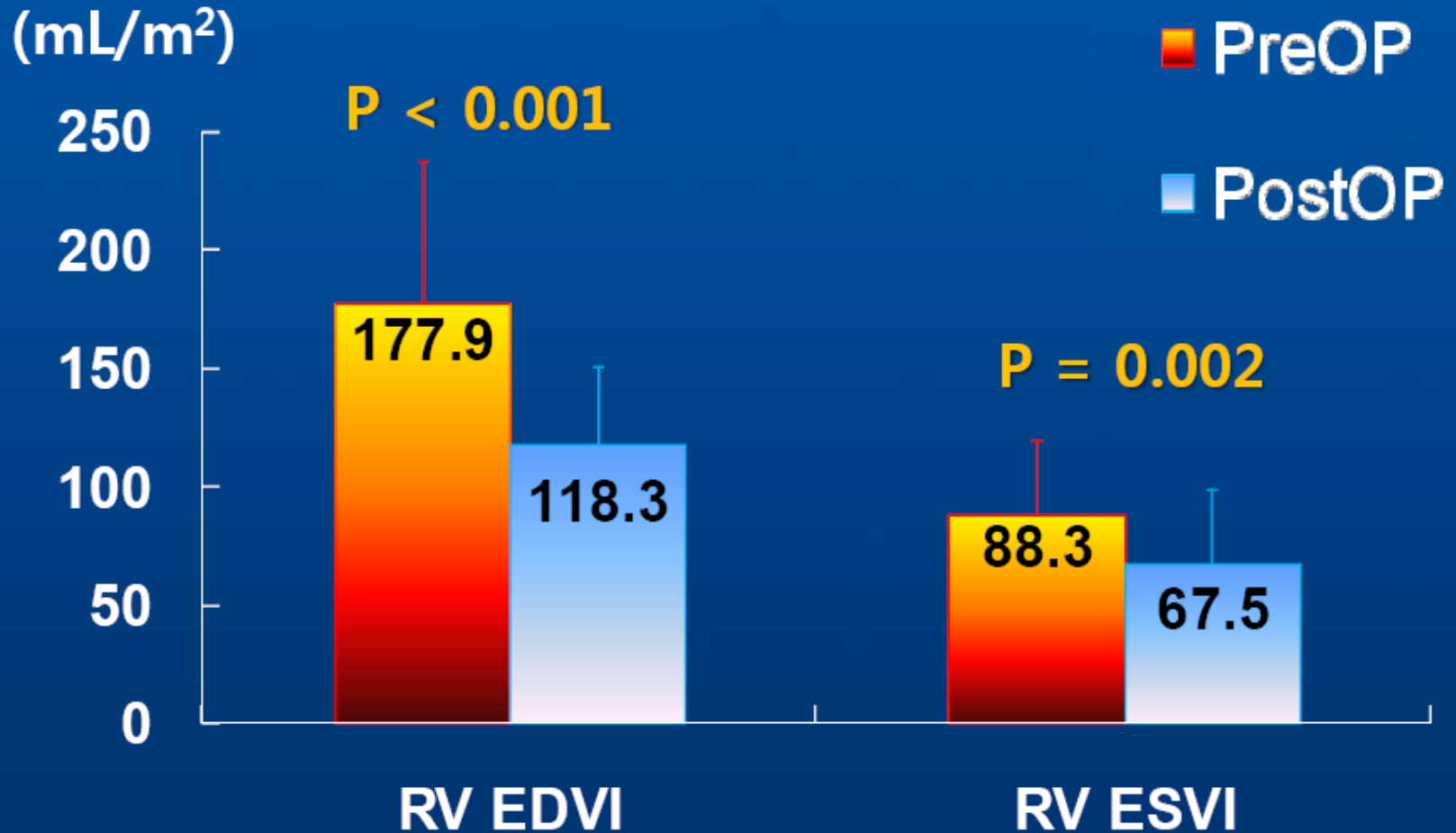
Hemodynamic Effect of Surgery



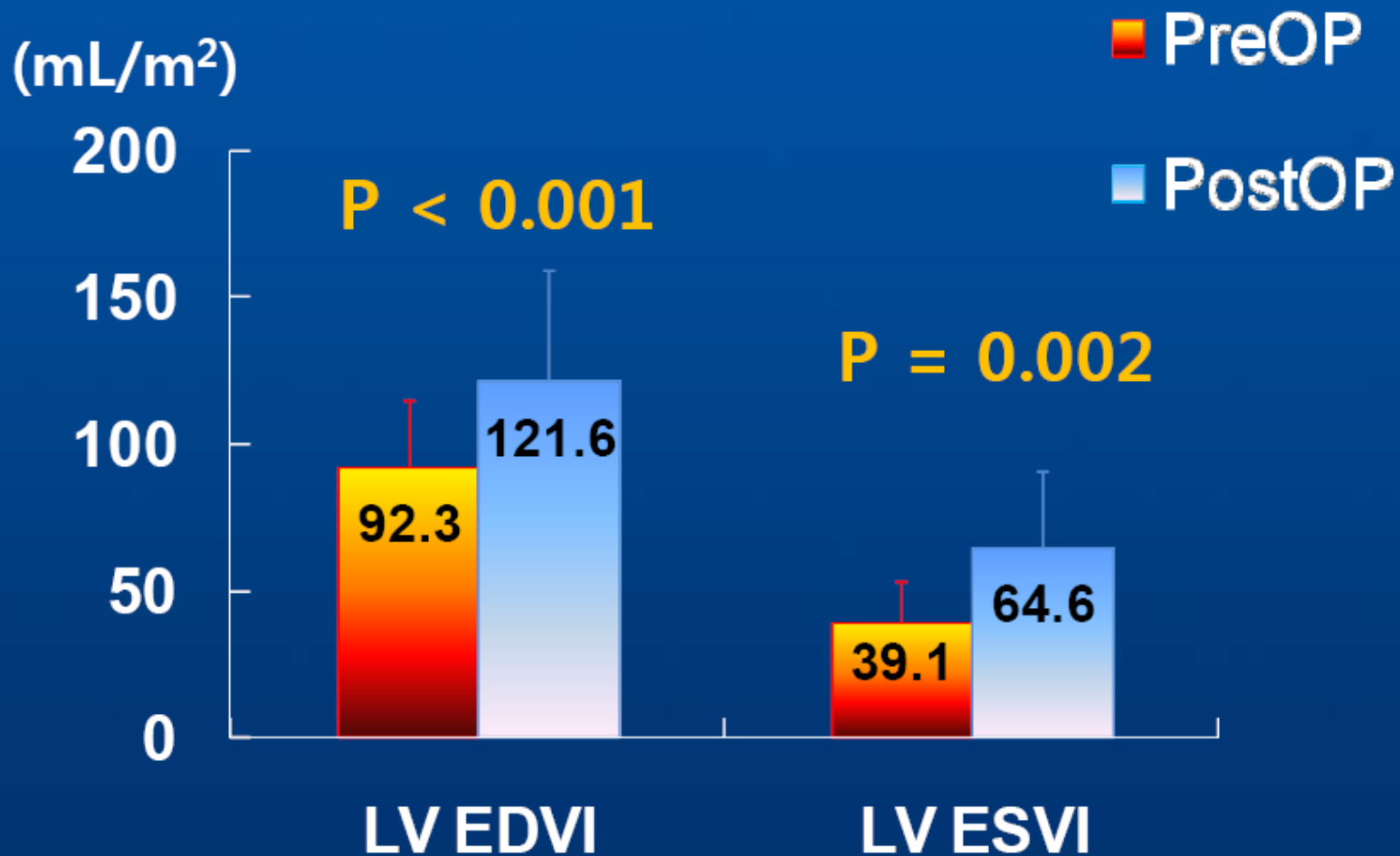
Hemodynamic Effect of Surgery



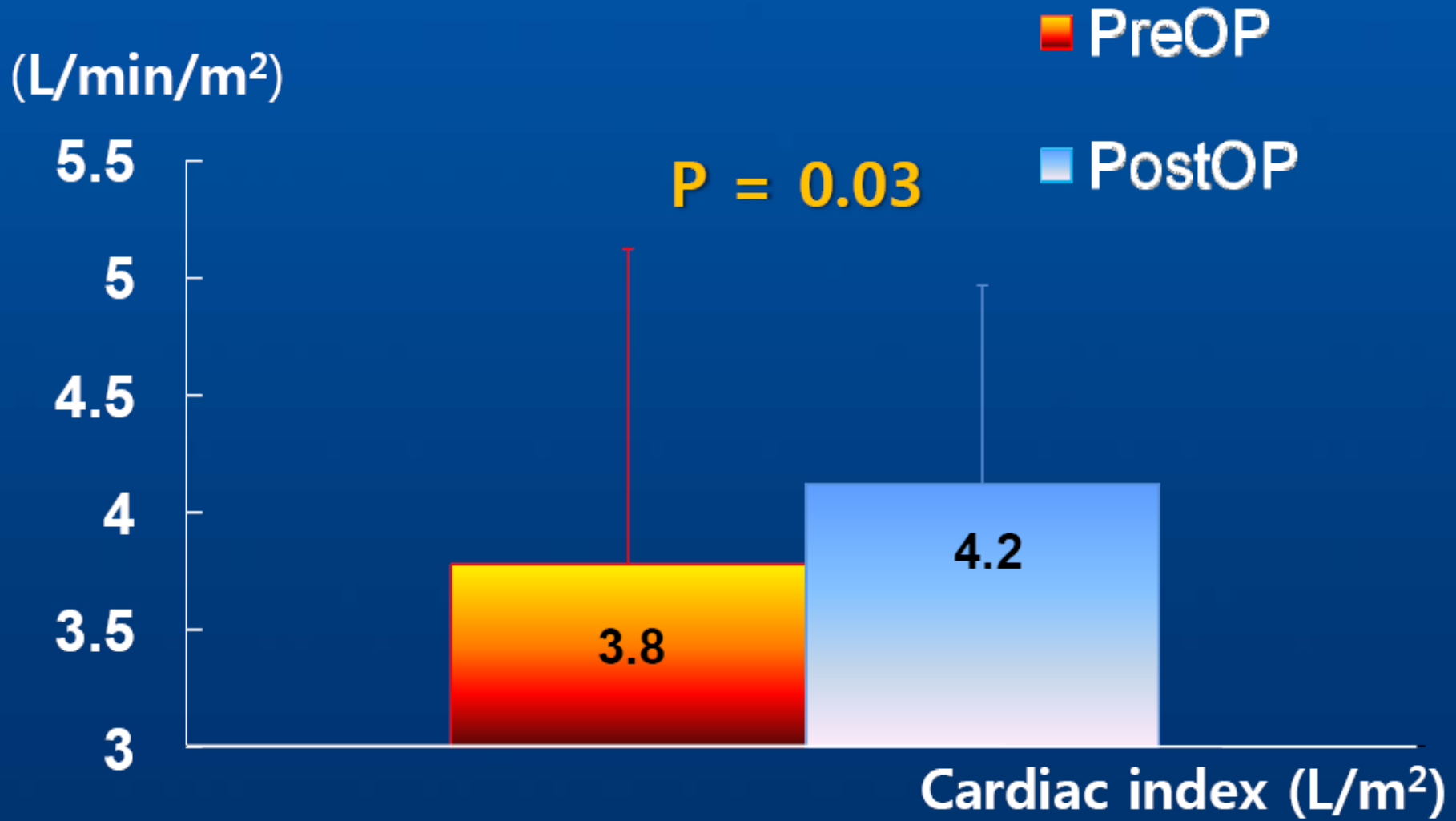
Change in RV Volume Index



Change in LV Volume Index



Change in Cardiac Index



Surgical Indication: AHA vs ESC

	ESC/EACTS	AHA/ACC
Primary TR		
Symptomatic isolated severe TR without severe RV dysfunction	I	IIa
Severe TR undergoing left-sided surgery	I	I
Moderate TR undergoing left-sided surgery	IIa	Not mentioned
Asymptomatic isolated mild or moderate TR and progressive RV dilatation or RV function deterioration	IIa	IIb (only in severe TR)
Secondary TR		
Severe TR undergoing left-sided surgery	I	I
Mild or moderate TR with dilated annulus (≥ 40 mm or > 21 mm/m ²) undergoing left-sided surgery	IIa	IIa (only with progressive RV dilatation or prior right heart failure)
Moderate TR and PH undergoing left-sided surgery	Not mentioned	IIb
Persistent or recurrent severe TR after left-sided valve surgery		
Severe TR symptomatic, progressive RV dilatation, or RV function deterioration, but without severe RV or LV dysfunction, left-sided valve dysfunction and severe PH	IIa	
Severe TR symptomatic without PH or severe RV dysfunction		IIb

Thank you for your attention !

