

Determinants of surgical outcome in patients undergoing surgery for isolated tricuspid regurgitation

Comprehensive analysis combining preoperative and immediate postoperative echocardiographic results

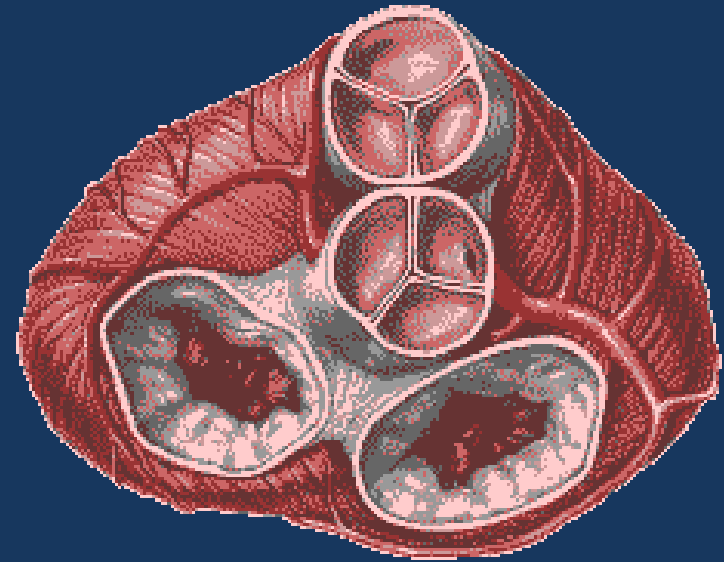


Kyungil Park, MD
Division of Cardiology
Department of Internal Medicine
Seoul National University Hospital

Tricuspid valve

In the past

- Forgotten valve
- Underdiagnosed



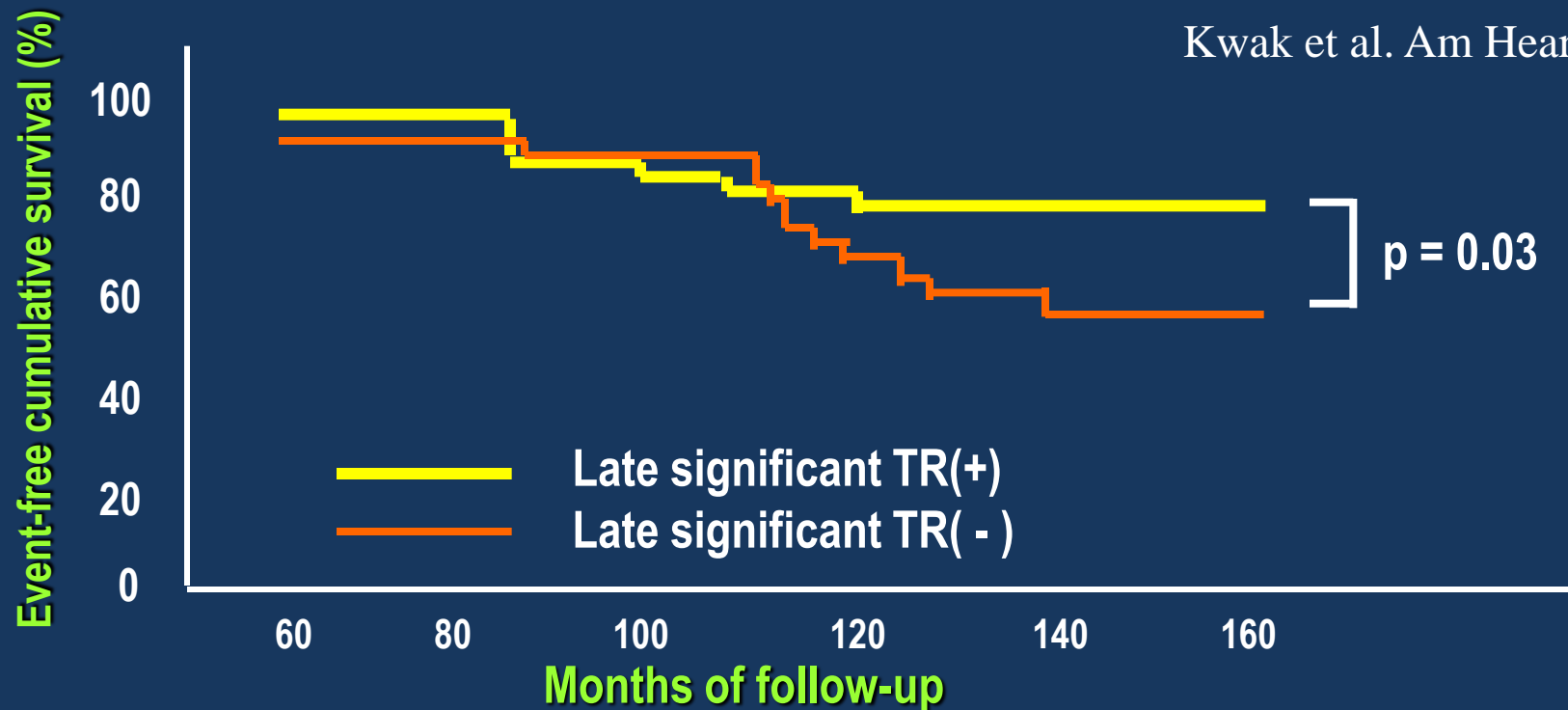
In the present

- More complex entity than it appears

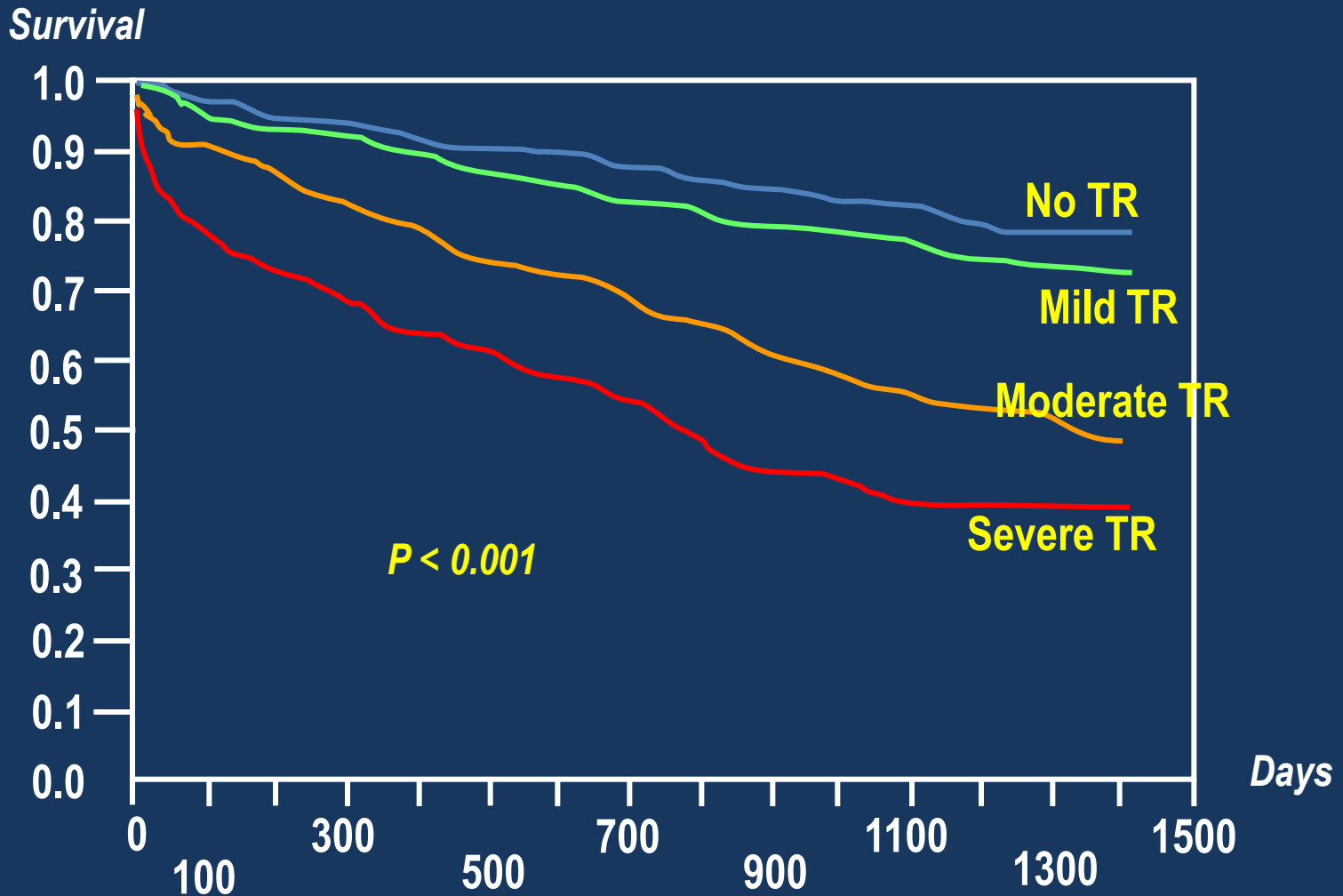
Development of significant TR

Seoul University Hospital Data (N=615)

- Incidence after left-sided valve surgery: 27% (16-67%)
- Associated with poor prognosis
- Predictor of development of late TR: atrial fibrillation



Impact of TR on Long Term Survival



When to operate?

Class I

- Severe TR with MV disease requiring MV surgery

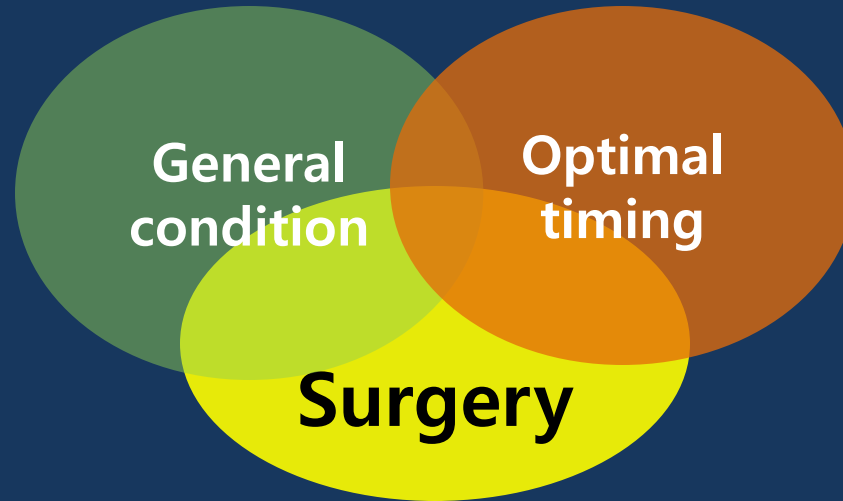
Class IIa

- Symptomatic Severe primary TR

Optimal time for surgery?

- Severe TR undergoing corrective surgery (N=61)
- median follow-up: 32 months
- Independent predictors of postoperative outcome
 - preoperative Hb level >11.3 g/dL
 - preoperative RV ESA < 20 cm²

Predict the surgical outcome



“ But, the surgical results would be not as good as anticipated if surgical correction is not successful.”



“수술 직후 시행한 심초음파 검사가 환자의 예후를 평가하는데 도움이 될 것인가?”

Study Design

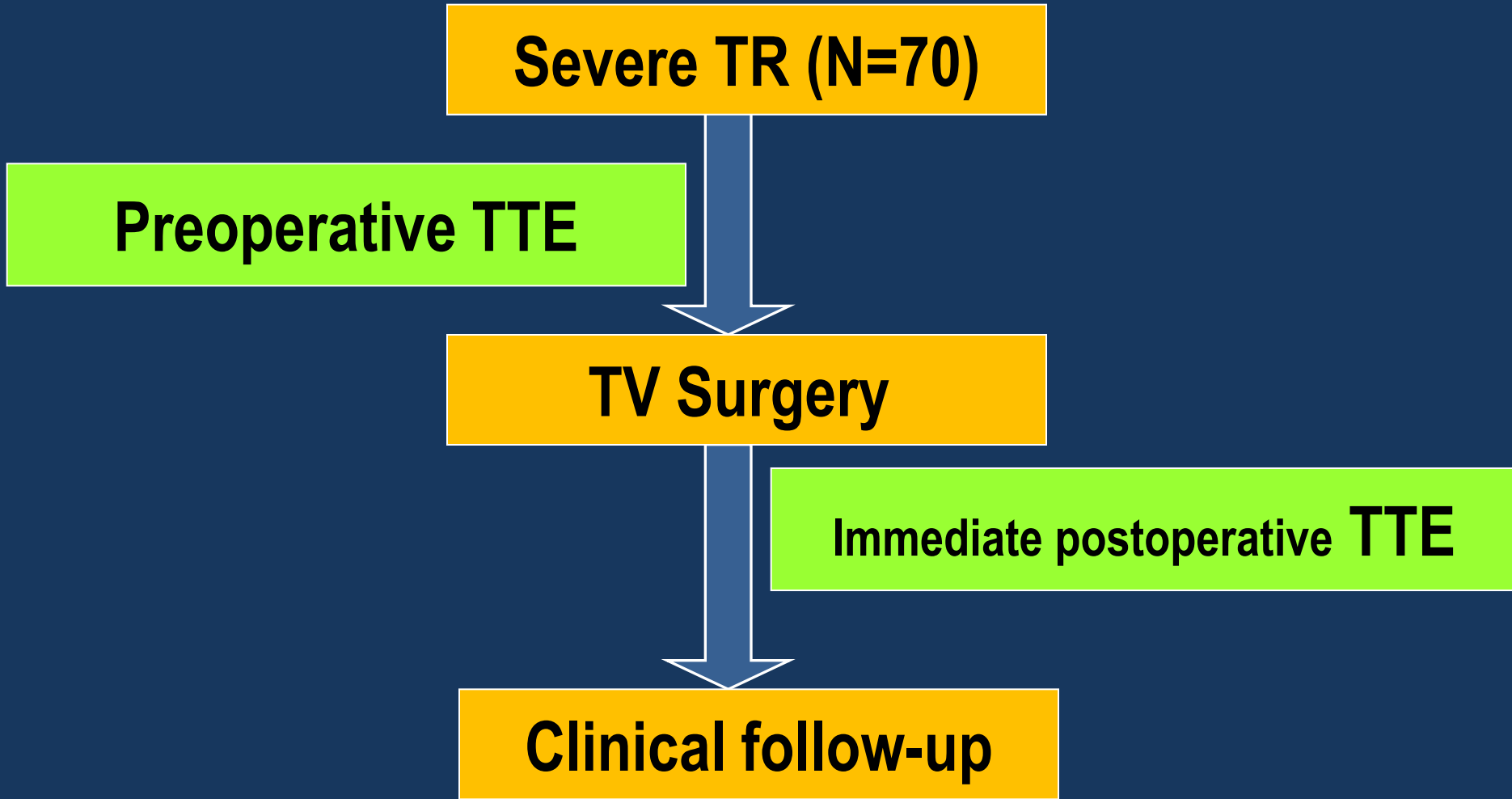
Severe TR (N=70)

Preoperative TTE

TV Surgery

Immediate postoperative TTE

Clinical follow-up



Methods I

- **March 2003 ~ April 2009**
- **Inclusion:**
 - **Patients with Severe TR**
 - **Underwent corrective surgery**
- **Prospectively enrolled**
- **Exclusion: concomitant left-sided valve surgery**
- **Follow-up**
 - **Clinical events**
 - **Immediate postoperative echocardiographic parameters**

Methods II

Severe TR

- (1) TR jet $>$ 30% of right atrial area
- (2) inadequate cusp coaptation
- (3) systolic flow reversal in the hepatic vein.

End point: Clinical events

- **Operative mortality**
 - Death within 30 days after surgery or before discharge
- **Cardiovascular events**
 - cardiovascular death
 - repeated open-heart surgery
 - congestive heart failure requiring hospital admission

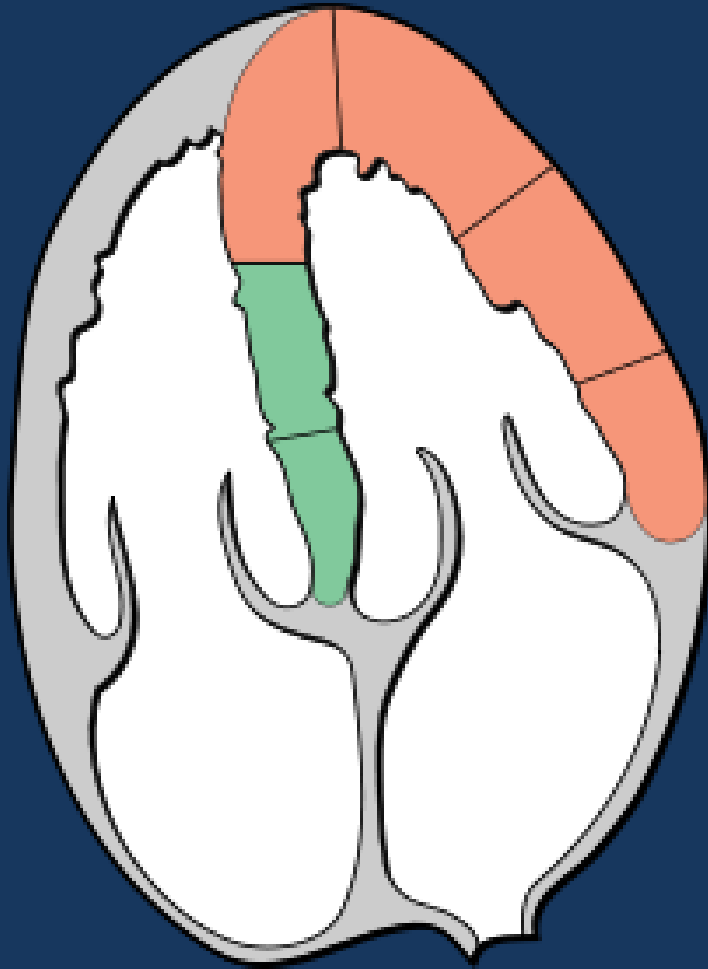
Clinical parameters

- Age
- Gender
- Atrial fibrillation
- NYHA functional class
- Previous left-sided valve surgery

Laboratory parameters

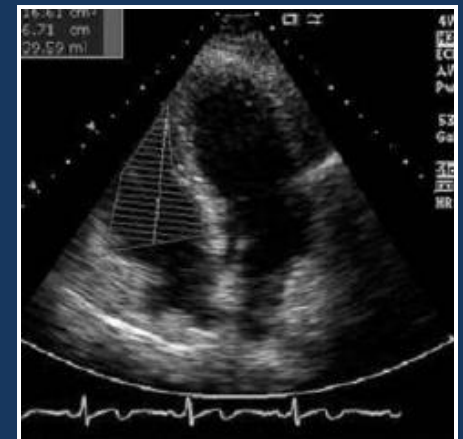
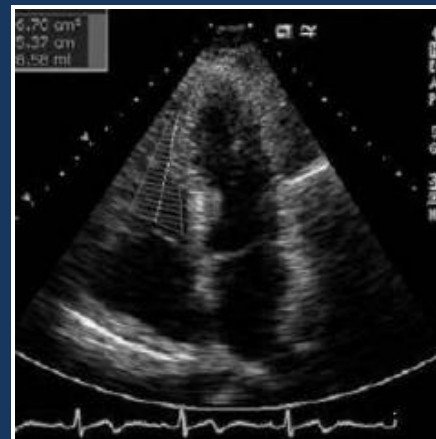
- Creatinine
- Urea nitrogen
- Albumin
- Total cholesterol
- Hemoglobin
- platelets

Echocardiographic parameters

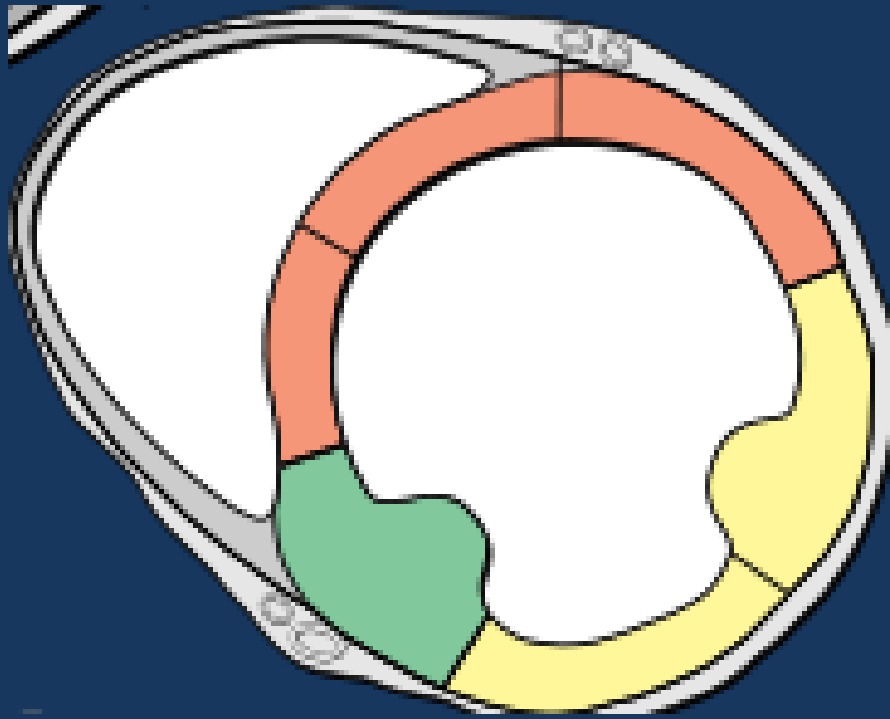


Apical 4 chamber

- RV ESA
- RV EDA
- RV FAC



Echocardiographic parameters



Parasternal short axis

- LV EDD
- LV ESD
- LV EF

PASP

TR area

RA area

Tricuspid annular diameter

Results: Baseline clinical characteristics

Variables	
Age, y	57.6±8.8
Female gender, n	61 (87%)
Weight, kg	53.6±8.8
Preoperative atrial fibrillation, n	58 (83%)
NYHA functional class, II:III:IV	27:37:6
Previous left-sided valve surgery, n	52 (88%)
Systolic blood pressure, mm Hg	117±15
Diastolic blood pressure, mm Hg	65±9
Urea nitrogen, mg/dL	21.4±13.4
Creatinine, mg/dL	1.0±0.3
Total protein, mg/dL	7.2±0.8
Albumin, mg/dL	4.0±0.6
Total cholesterol, mg/dL	154.8±40.2
Hemoglobin, g/dL	12.1±1.7
Platelet × 10 ³ /mm ³	153±58
Intensive care unit admission, day	13.7±18.9
Admission, day	36.2±26.6

Results: baseline characteristics

Functional capacity

- NYHA functional class I: 0
- NYHA functional class II: 27 (38%)
- NYHA functional class III: 37 (53%)
- NYHA functional class IV: 6 (9%)

Medication

- Diuretics: 91%
- Digitalis: 70%
- ACE inhibitor: 14%
- Beta-blocker: 14%

Results: Baseline echocardiographic characteristics

Preoperative Echocardiographic parameters

Tricuspid annulus diameter,mm	44.1±7.7
Right atrial area, cm ²	52.9±20.1
Tricuspid regurgitation area, cm ²	24.1±10.9
Pulmonary artery systolic pressure, mm Hg	40.8±8.8
End-diastolic LV diameter, mm	45.9±8.3
End-systolic LV diameter, mm	29.5±6.6
LV ejection fraction, %	57.6±8.9
RV end-diastolic area, cm ²	34.6±8.6
RV end-systolic area, cm ²	20.3±6.5
RV fractional area change, %	41.8±7.9

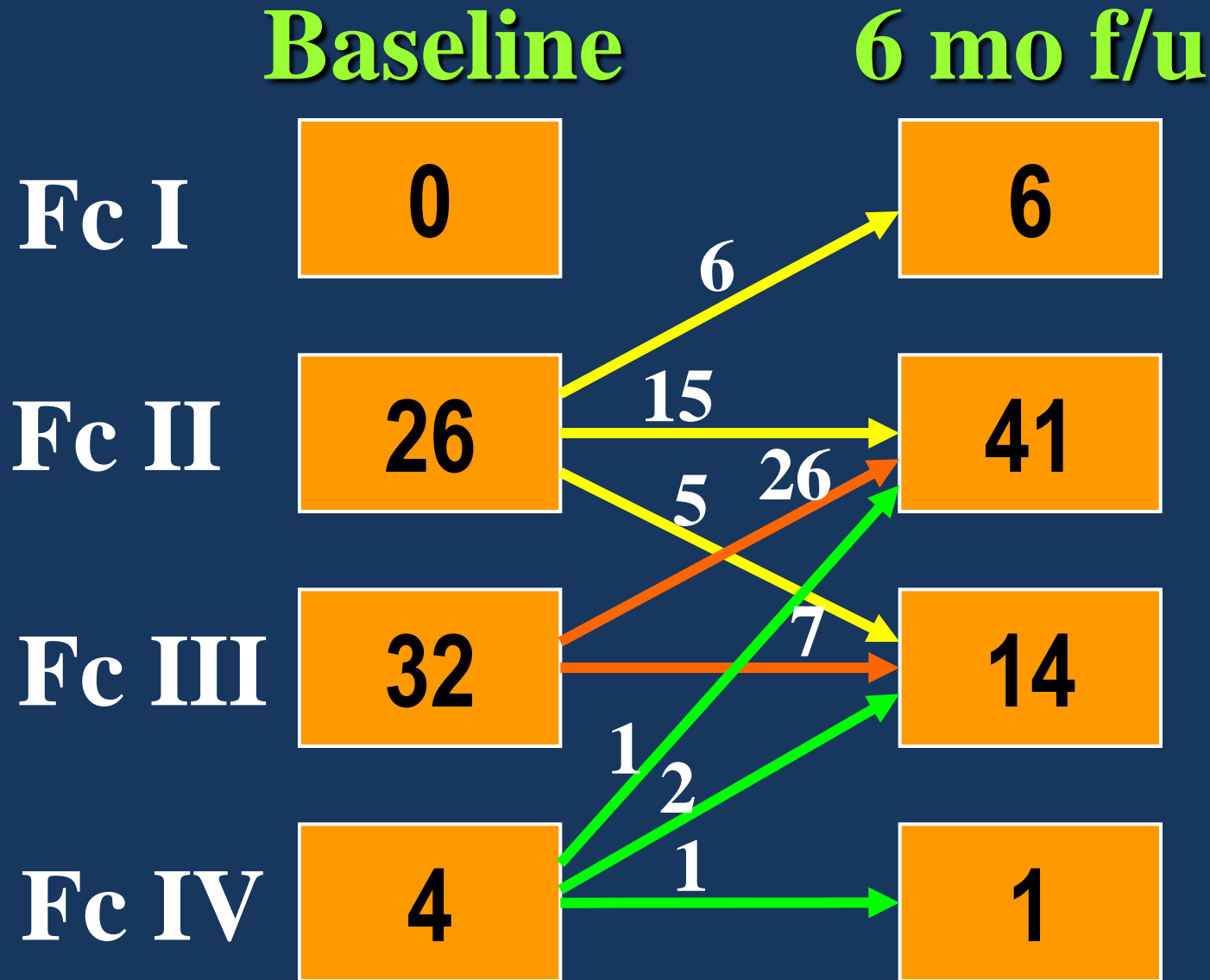
Results: baseline characteristics

- **Type of TR (N=70)**
 - **Functional:55 (79%)**
 - **Rheumatic:13 (19%)**
 - **Chordal rupture: 1 (1%)**
 - **Congenital : 1 (1%)**
- **Previous history of left-sided valve surgery: 63 (90%)**
- **Previous history of tricuspid annuloplasty: 11 (16%)**

Operative data (N=70)

- **Tricuspid valve repair : 8 (11%)**
- **Tricuspid valve replacement : 62 (89%)**
 - ┌ **Tissue valve : 37**
 - └ **Mechanical valve: 25**
 - ┌ **Total cardiopulmonary bypass time: 189 ± 59 min**
 - └ **Aortic cross-clamp time: 104 ± 36 min**

Changes in functional capacity



Postoperative outcomes

Follow-up duration

;mean 37 ± 22 (range: 6~86 months)

- Operative mortality; $7/70=10\%$
 - : Death before discharge: **7**
- Cardiovascular events
 - Cardiovascular deaths
 - : Death after discharge: **4**
 - Heart failure: 2
 - Hemorrhagic stroke: 1
 - Sudden cardiac death: 1
 - congestive heart failure requiring hospital admission: **8**

Comparison between patients with & without clinical events

Clinical parameters

Variables	Without Event (n=51)	With Event (n=19)	<i>p</i>
Age, y	57±9	59 ±8	0.29
Female, n/N (%)	46/51 (90)	15/19 (78)	0.24
Weight, kg	53.4±8.9	54.0 ±8.7	0.78
Atrial fibrillation, n/N (%)	41/51(80)	17/19(89)	0.49
NYHA functional class, II:III:IV	24:25:2	4:11:4	0.010
Previous left-sided valve surgery, n/N (%)	45/51 (90)	19/19 (100)	0.18
Tricuspid replacement, n/N (%)	46/51 (90)	15/19 (78)	0.24
Systolic blood pressure, mm Hg	119±15	115±14	0.42
Diastolic blood pressure, mm Hg	67±8	62±11	0.06

Comparison between patients with & without clinical events

Laboratory parameters

Variables	Without Event (n=51)	With Event (n=19)	<i>p</i>
Urea nitrogen, mg/dL	19.3±8.9	26.8±20.2	0.14
Creatinine, mg/dL	1.0±0.2	1.2±0.4	0.012
Total protein, mg/dL	7.3±0.8	7.1±0.8	0.22
Albumin, mg/dL	4.1±0.6	3.7±0.6	0.02
Total cholesterol, mg/dL	160.6±36.7	139.2±45.8	0.047
Hemoglobin, g/dL	12.5±1.7	10.9±1.3	<0.001
Platelet × 10 ³ /mm ³	167±61	122±38	0.001

Comparison between patients with & without clinical events

Pre-operative echo parameters

Pre operative echocardiographic parameters	Without Event (n=51)	With Event (n=19)	p
Tricuspid annulus diameter, mm	43.5±7.3	45.7±8.5	0.30
Right atrial area, cm ²	51.6±20.1	56.5±20.1	0.40
Tricuspid regurgitation area, cm ²	22.9±10.0	27.4±13.2	0.16
Pulmonary artery systolic pressure, mm Hg	39.7±8.4	43.6±9.7	0.11
End-diastolic LV diameter, mm	45.4±7.9	47.2±9.4	0.43
End-systolic LV diameter, mm	29.2±6.5	30.4±6.9	0.53
LV ejection fraction, %	58.3±8.7	55.5±9.2	0.24
RV end-diastolic area, cm ²	33.3±7.0	38.1±11.5	0.10
RV end-systolic area, cm ²	18.9±4.8	24.0±8.7	0.02
RV fractional area change, %	43.3±7.7	37.9±7.3	0.01

Comparison between patients with & without clinical events

Post-operative echo parameters

Post operative echocardiographic parameters	Without Event (n=51)	With Event (n=19)	<i>p</i>
End-diastolic LV diameter, mm	47.5±7.2	49.8±6.9	0.25
End-systolic LV diameter, mm	28.9±6.8	37.3±9.6	0.03
LV ejection fraction, %	58.4±9.0	53.9±10.5	0.08
RV end-diastolic area, cm ²	24.7±4.5	24.2±8.2	0.83
RV end-systolic area, cm ²	15.2±2.8	18.6±7.2	0.14
RV fractional area change, %	38.3±5.5	24.6±5.4	< 0.001

Univariate analysis, p value

- **Clinical**

- Functional class 0.044

- **Lab**

- Hb <0.001

- Platelet 0.011

- Cr 0.001

- Albumin 0.009

- Total cholesterol 0.024

- **Echo**

- Preoperative

- RV EDA 0.029

- RV ESA 0.001

- RV FAC 0.014

- Postoperative

- LV ESD 0.034

- RV ESA 0.006

- RV FAC <0.001

Cox regression analysis

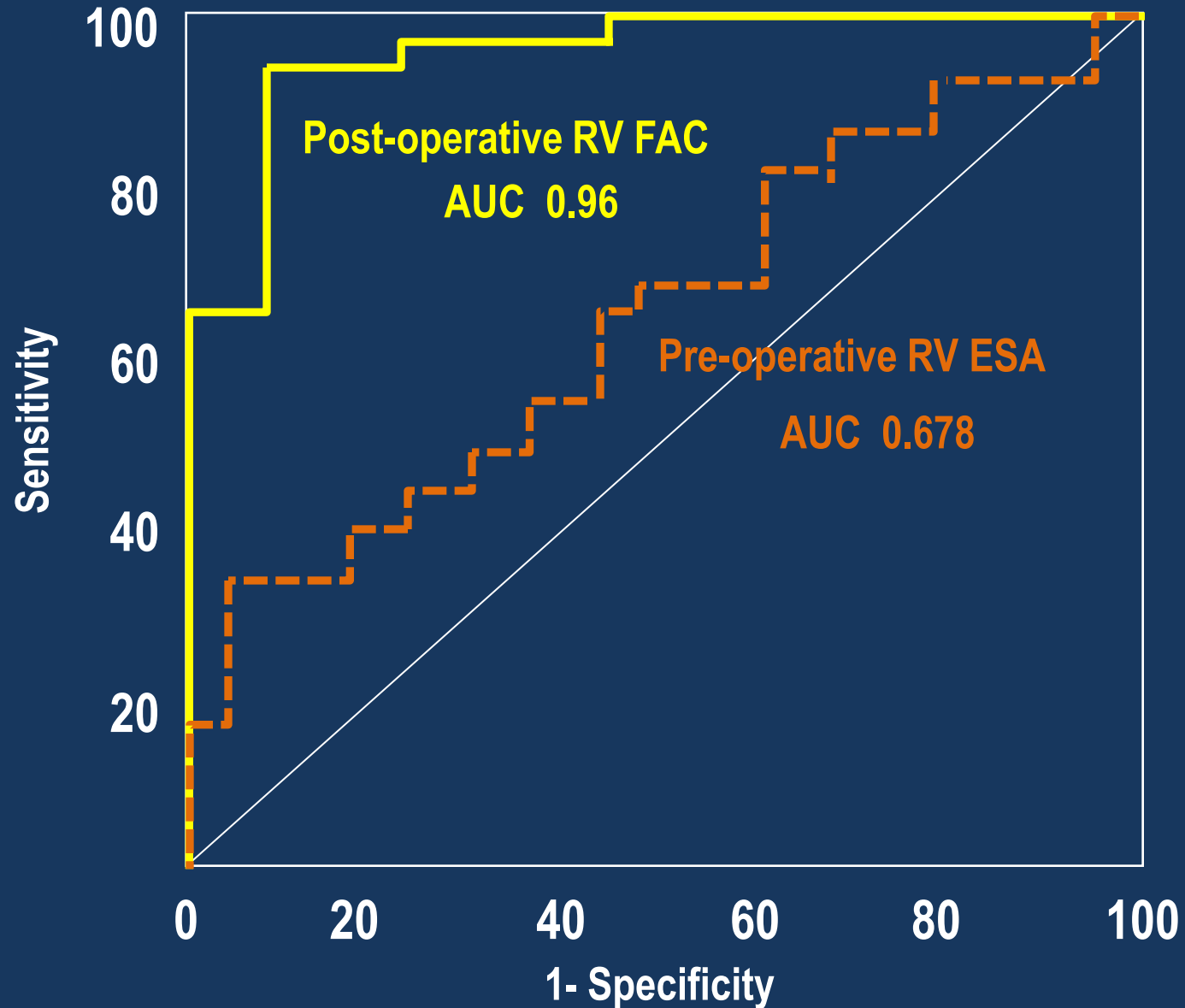
Based on pre-operative data

: RV ESA

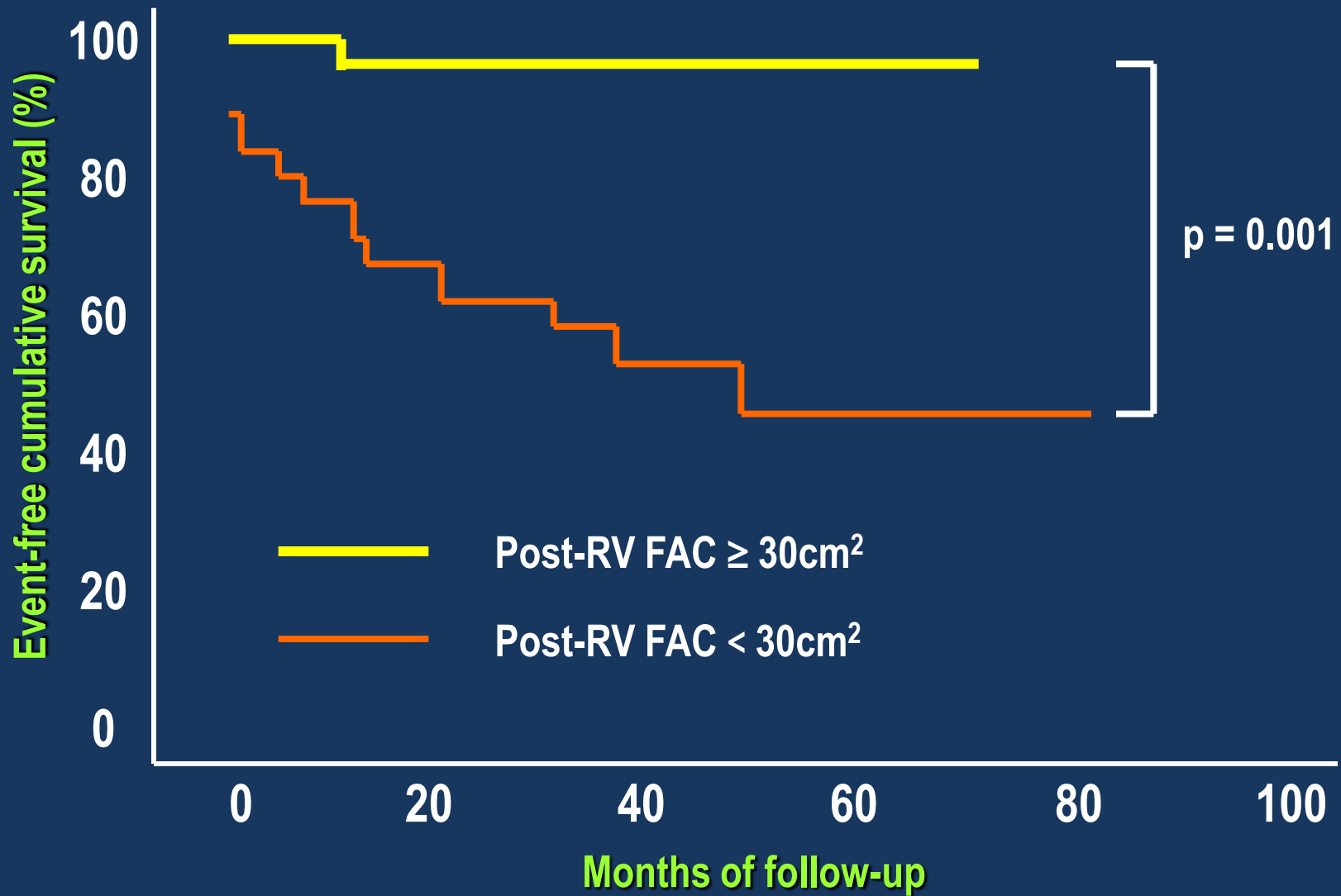
Based on pre & post-operative data

: “Post-operative RV FAC” emerged as a significant predictor for long-term prognosis after TR surgery

ROC curve: RV FAC vs RV ESA



Post-operative RV FAC



	0	12	24	36
RVFAC <30cm ²	12	6	3	2
RVFAC ≥30cm ²	45	36	23	8

Results

Postoperative RV FAC $\geq 30\text{cm}^2$

- Operative mortality: 2.1%
- 2 – year event-free survival rate: 95%

Preoperative RV ESA $< 20\text{cm}^2$

- Operative mortality: 4.6%
- 2 – year event-free survival rate: 88%

Conclusions of present study

- 1. *It is possible to predict the surgical outcomes with help of immediate postoperative echocardiography.***
- 2. *Immediate postoperative RV FAC is better than other preoperative parameters to predict surgical outcomes.***

Thanks for your attention!!



Discussion

Goal of surgery

- decrease event
 - expand life
-
- Not simply replace or repair TV
 - Preserve RV function
 - Surgical correction : before RV failure
 - Not delay surgical timing

Limitations of present study

- **Functional TR** was in most
- **Tricuspid valve replacement** rate is high
- **Not enough** Long-term follow-up data
- **Small** Number of patients undergoing TV surgery

Development of significant TR

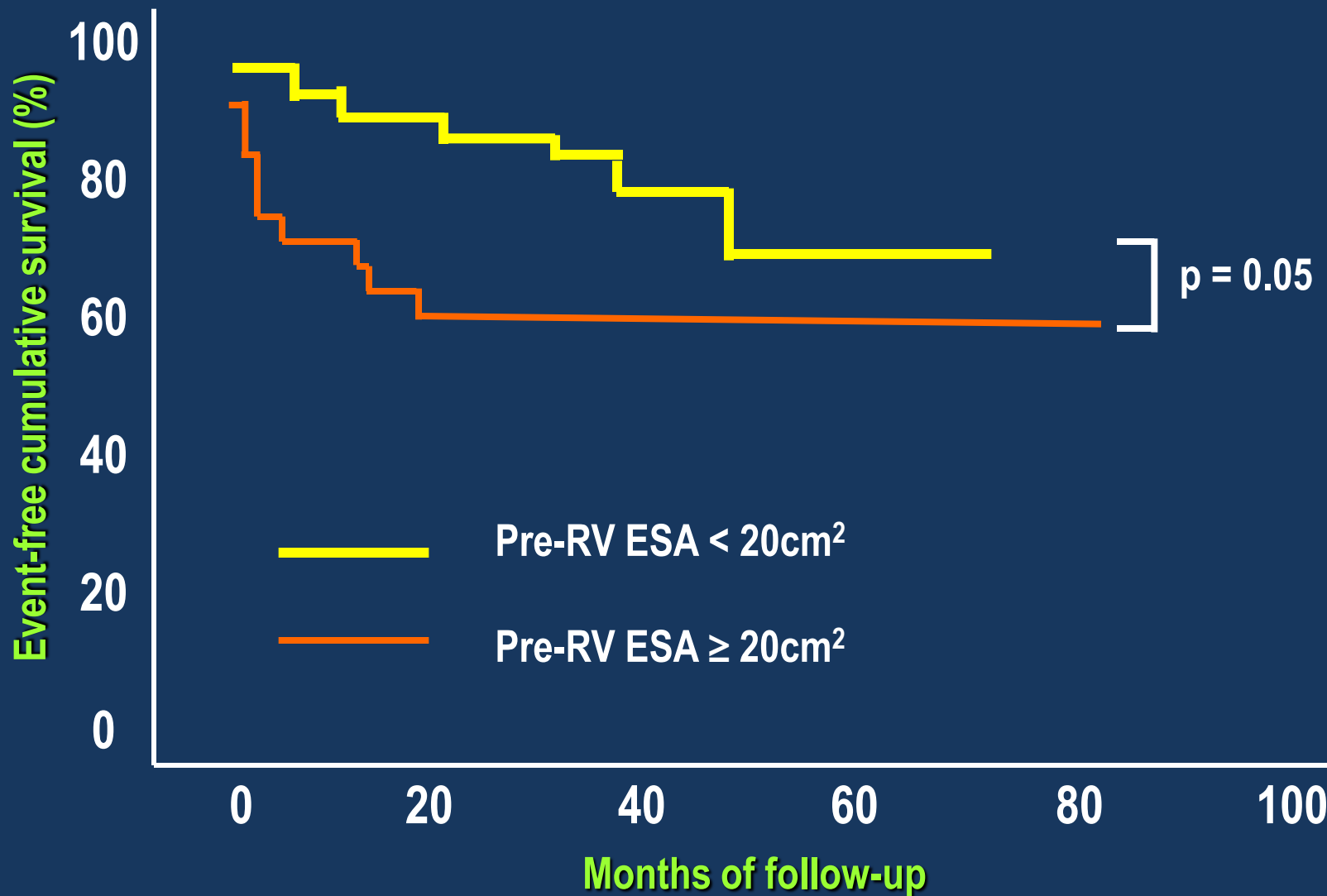
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- Associated with poor prognosis
- Predictor of development of late TR: atrial fibrillation

Asan Medical Center Data (N=638)

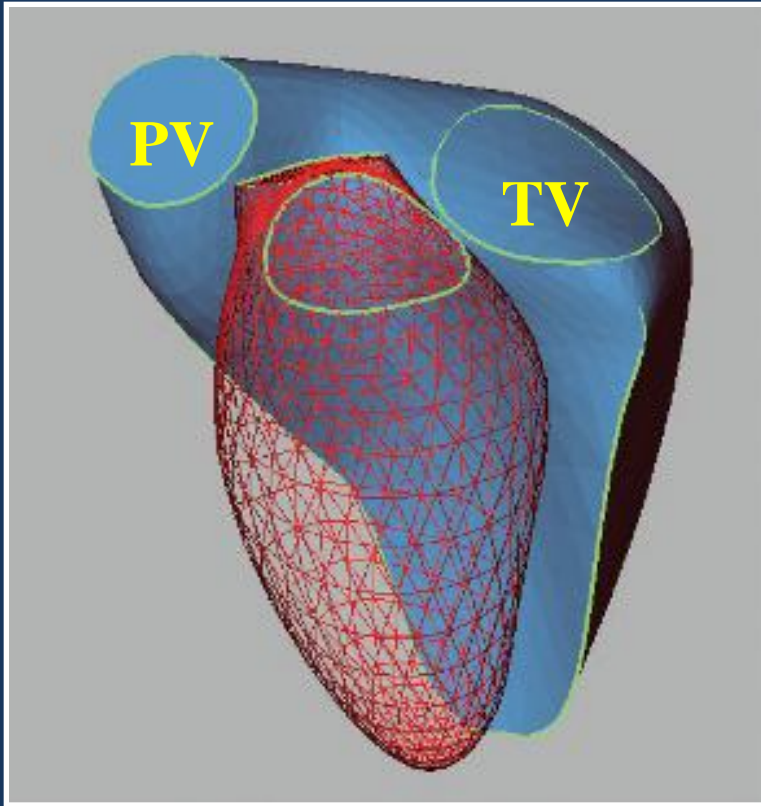
- Incidence according to surgical procedure : 7.6%
 - Mitral valve surgery: 9.6%
 - Aortic valve surgery: 3.2%
 - Double valve surgery: 11.7%
- Predictor: Af, female gender, age, rheumatic aetiology

Pre-operative RV ESA

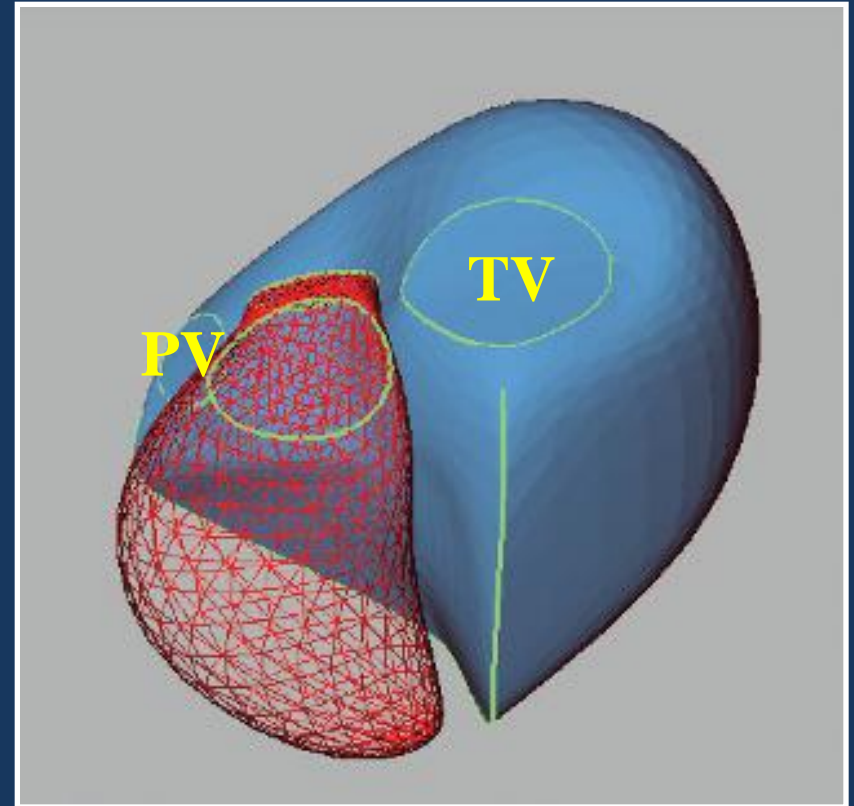


	Months of follow-up					
	0	20	40	60	80	100
RVFAC <20cm ²	42	32	10	8	4	1
RVFAC ≥20cm ²	26	17	12	8	6	3

Anatomy of RV



Normal RV



Dilated RV

Optimal timing to surgery

- **50 patients**
 - rheumatic mitral disease
 - associate secondary tricuspid insufficiency
- **Surgical indication: tricuspid annuloplasty**
 - tricuspid annulus diameter $> 21 \text{ mm/m}^2$
- **Preoperative fraction shortening of the tricuspid annulus (P = 0.038) as factor predictive of late negative result.**
- **Tricuspid annulus function is guide to TV repair**

RV EF vs RV FAC

N= 36

- Cardiac MRI
 - : RV volume, RV EF
- Echocardiography
 - : RV FAC, tricuspid annular motion, tricuspid fractional shortening

→ RV FAC from Echo correlate RVEF from MRI

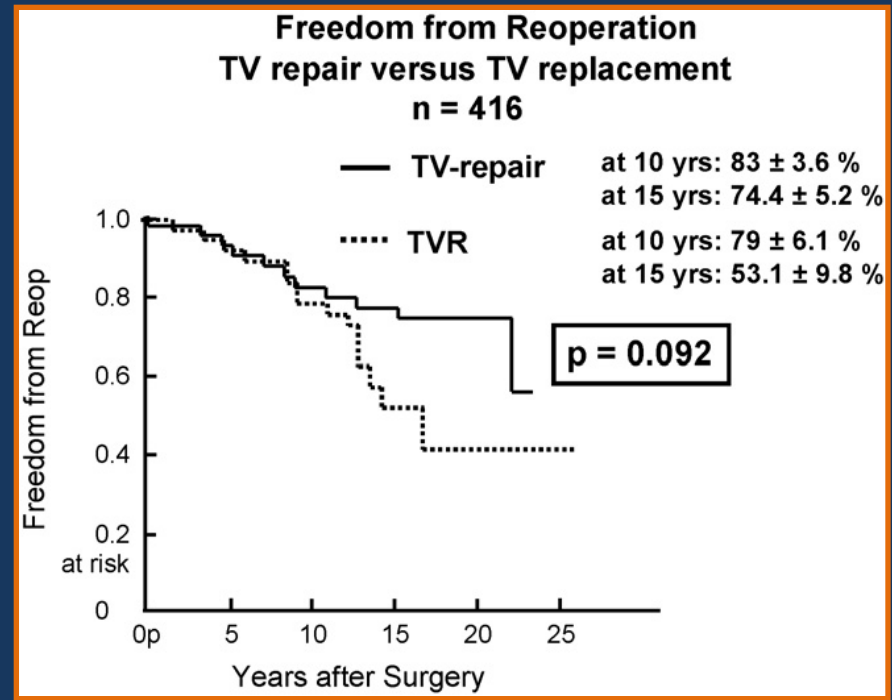
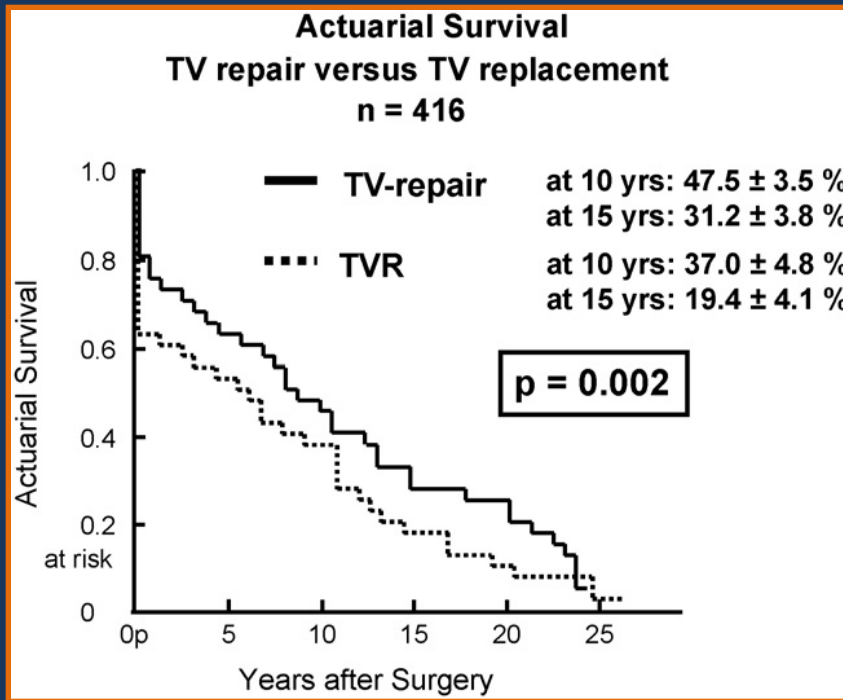
RV FAC

Advantage

- **Calculation:**
 - easily performed
 - not require any geometric assumptions
- **Clinical significance**
 - heart failure, pulmonary embolism, post MI
 - independently predict adverse CV outcomes

TV surgery: 30 yr F/U

- TV surgery with or without concomitant surgery (N=416)
- Operative mortality: 18.8% (33.3% → 11.1%)



Phase of functional TR

- **1st phase:**
 - dilatation of RV → dilatation of tricuspid annulus
 - TR (-) or TR(+)
 - Tx: annuloplasty
- **2nd phase**
 - progressive dilatation of RV & tricuspid annulus
 - failure of leaflet coaptation
 - Tx: annuloplasty
- **3rd phase**
 - progressive RV dilatation & eccentricity
 - tethering of tricuspid leaflets

Summary of TR

