Percutaneous Mitral Valvuloplasty

STATE OF ART

Seung-Jung Park, MD, PhD, FACC

Mitral Stenosis

Critical mitral stenosis (MVA < 1.0 cm^2)

- Presented with incapacitating dyspnea
- Pulmonary hypertension
- Right heart failure, peripheral edema, orthopnea,
- Atrial fibrillation: 80%
- Systemic thromboembolism: 20%

Better Treatment for Mitral Stenosis ?

PMV vs SURGERY

PMV vs OMC

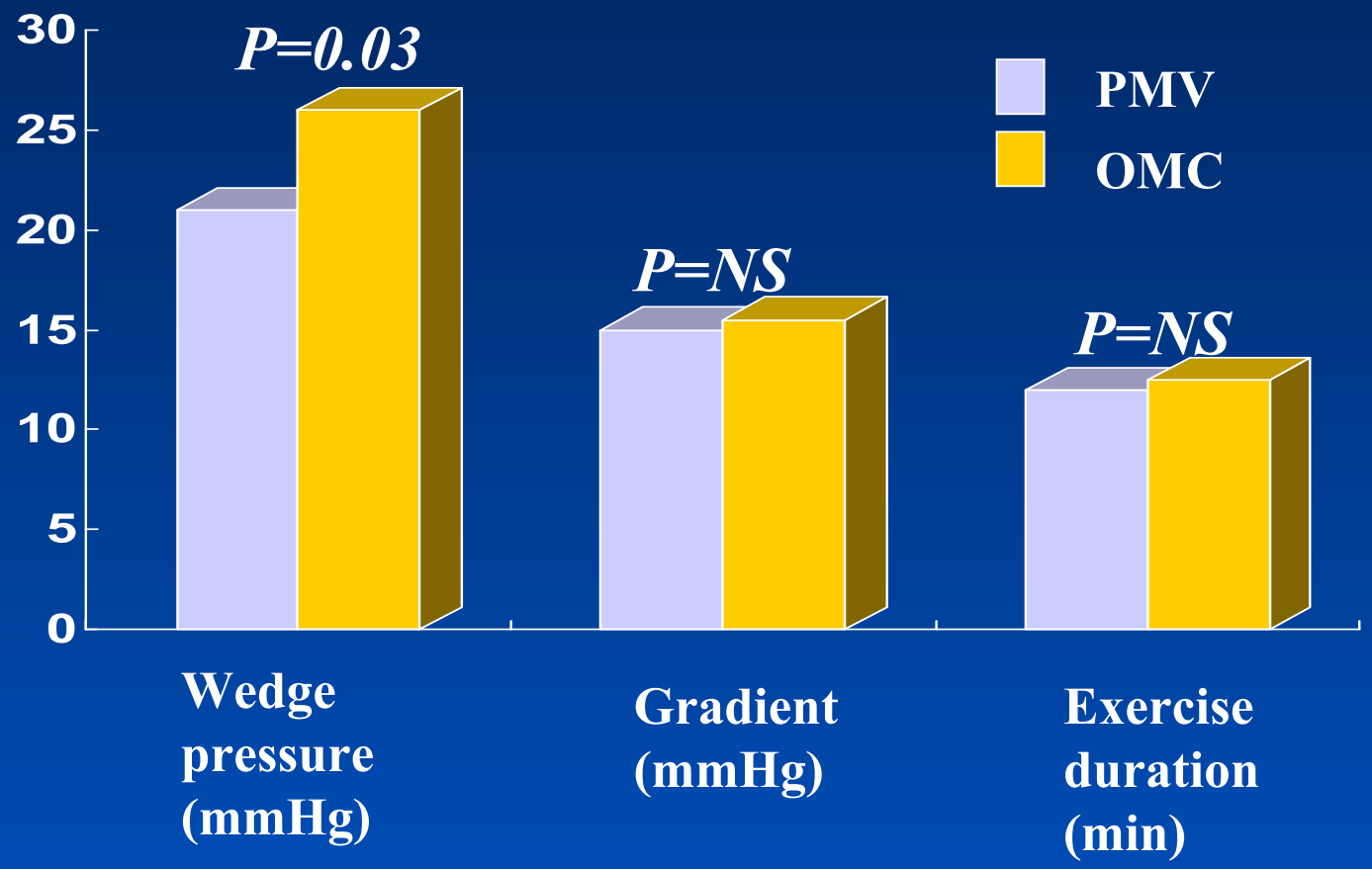
Serial change of MVA

	PMV (n=30)	OMC (n=30)	*P*
Mean age	39±9	31±9	NS
Echo Score	6.7±1.3	7.0±1.1	NS
MVA (cm^2)			
Before	0.9±0.3	0.9±0.3	NS
Immediate after	2.1±0.6	2.0±0.6	P<0.001
6 months	2.3±0.6	1.9±0.4	P<0.001
3 years	2.4±0.6	1.8±0.4	P<0.001
Restenosis	3(10%)	4(13%)	NS

Reyes VP et al. N Engl J Med 1994

HEMODYNAMIC STATUS

At three-year



Reyes VP et al. N Engl J Med 1994

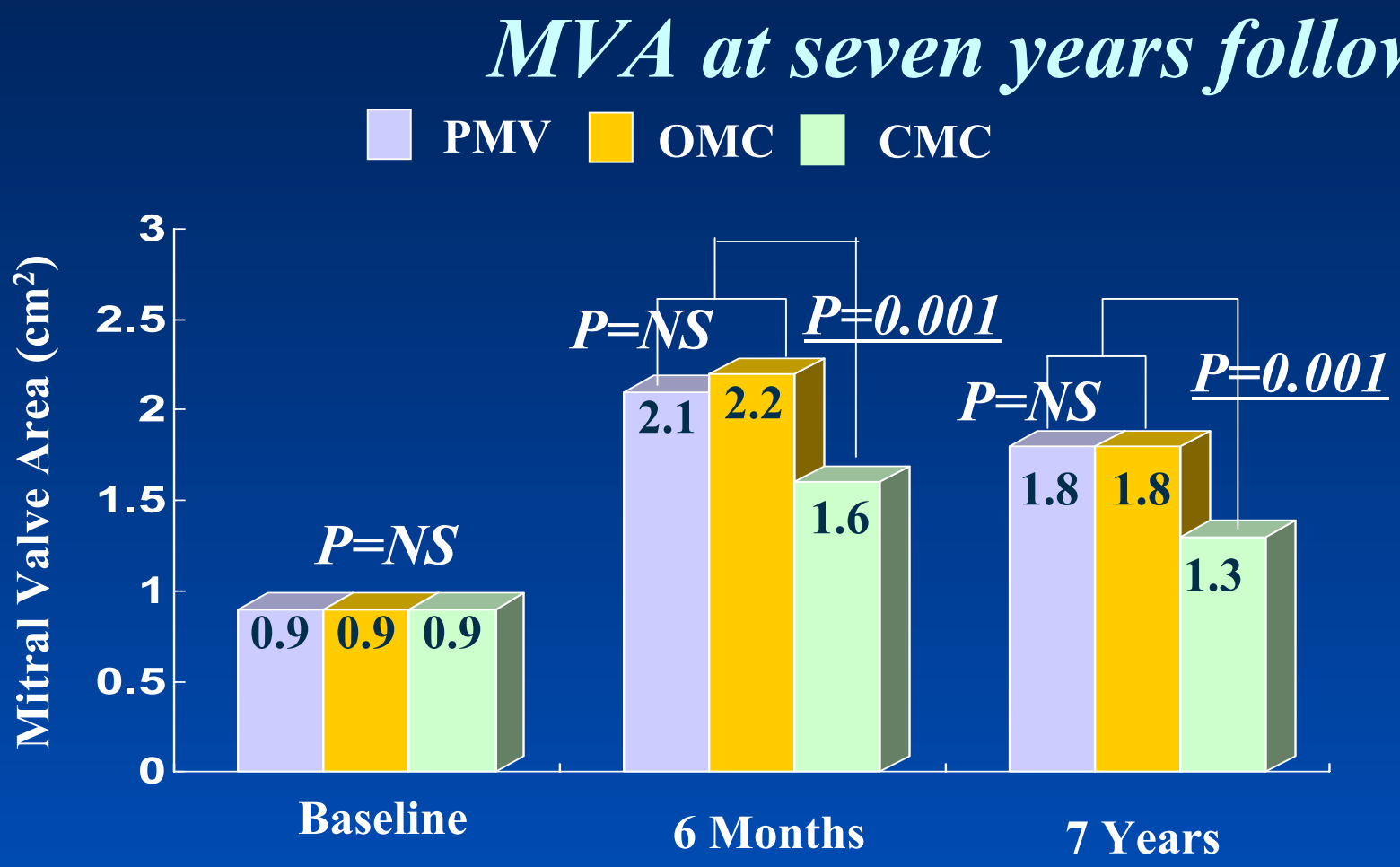
COMPLICATIONS

Through three-year F/U

	PMV (n=30)	OMC (n=30)
Acute procedure-related events	0	0
Cardiovascular Death	1 (late)	0
Stroke	1 (late)	0
Myocardial infarction	0	0
Atrial septal defect	4	0
Atrial fribrillation	0	0
Severe mitral regurgitation	2	1

Reyes VP et al. N Engl J Med 1994

PMV vs OMC vs CMC



Farhat et al. Circulation 1998

CONCLUSIONS

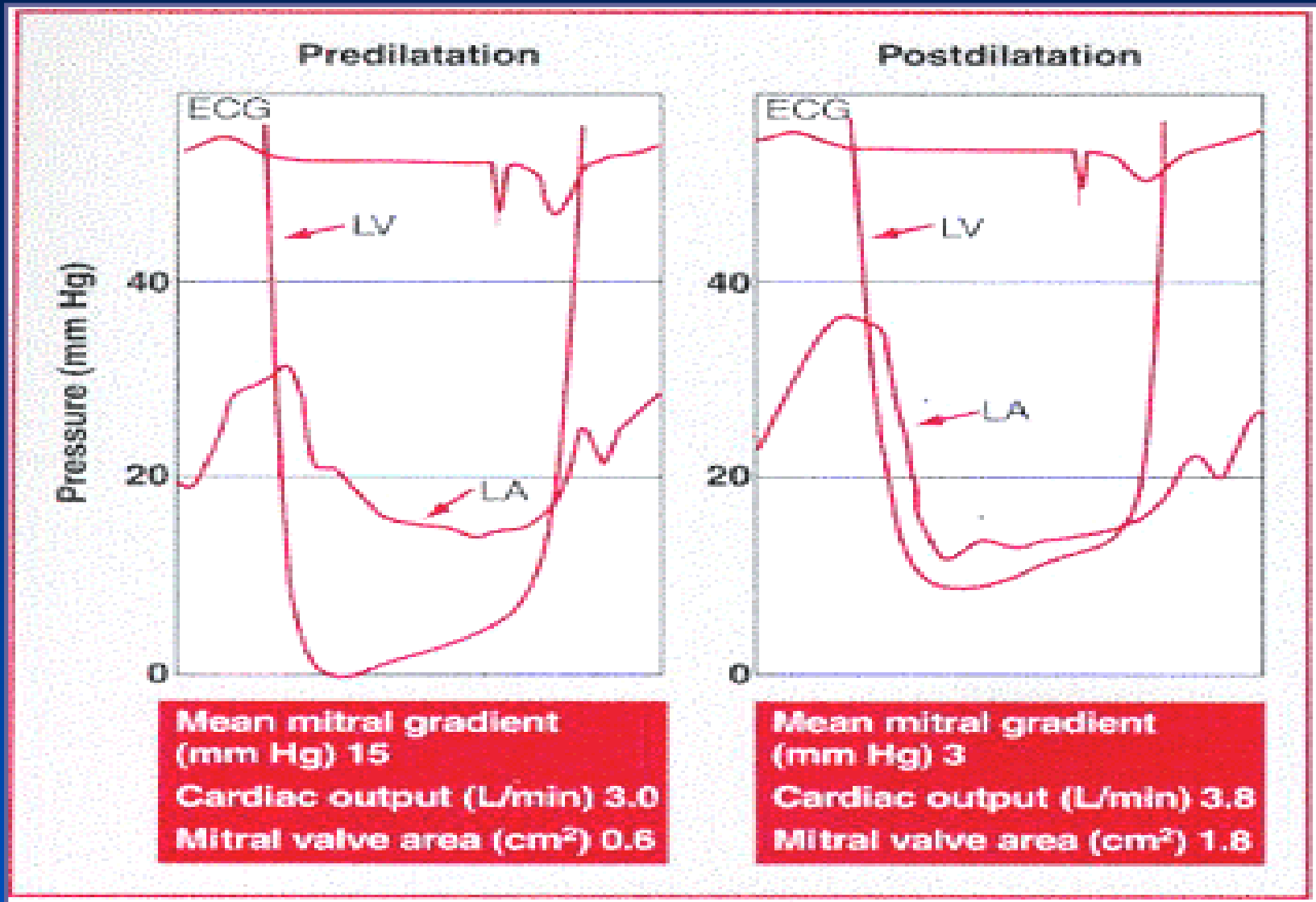
- PMV and OMC have comparable initial results and low rates of restenosis, and both produce good functional capacity for at least three years.

- The better hemodynamic results at three years, lower cost, and elimination of the need for thoracotomy suggest that PMV should be considered for all patients with favorable mitral-valve anatomy.

Mechanism of PMV

PMV relieve mitral stenosis by *splitting fused commissure*, which is similar to surgical commissurotomy

Hemodynaic change of PMV



PMV Technique

Transseptal antegrade approach

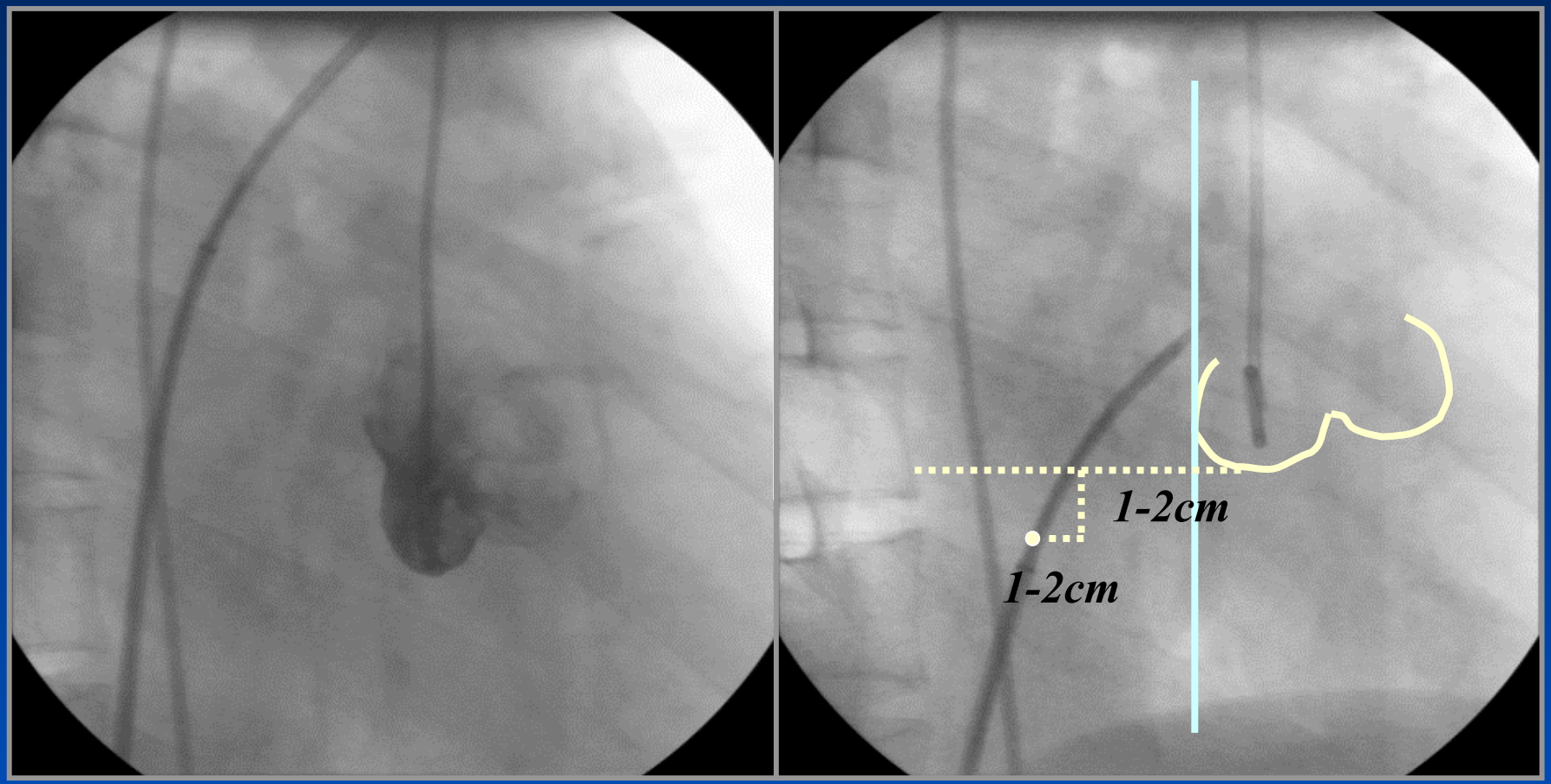
Double balloon technique
Inoue balloon technique

Retrograde approach

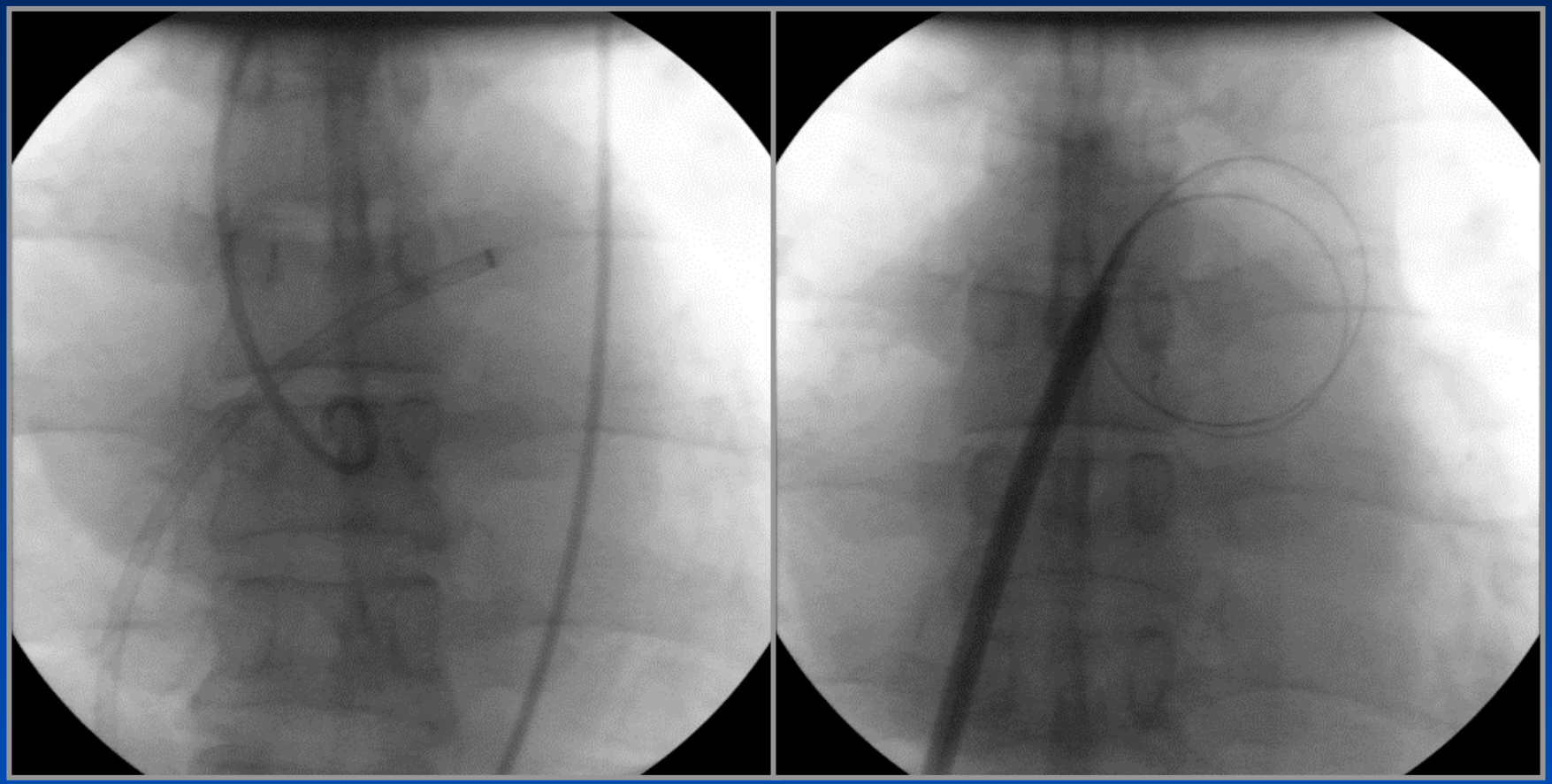
PMV vs Double balloon

Which is better treatment for mitral stenosis ?

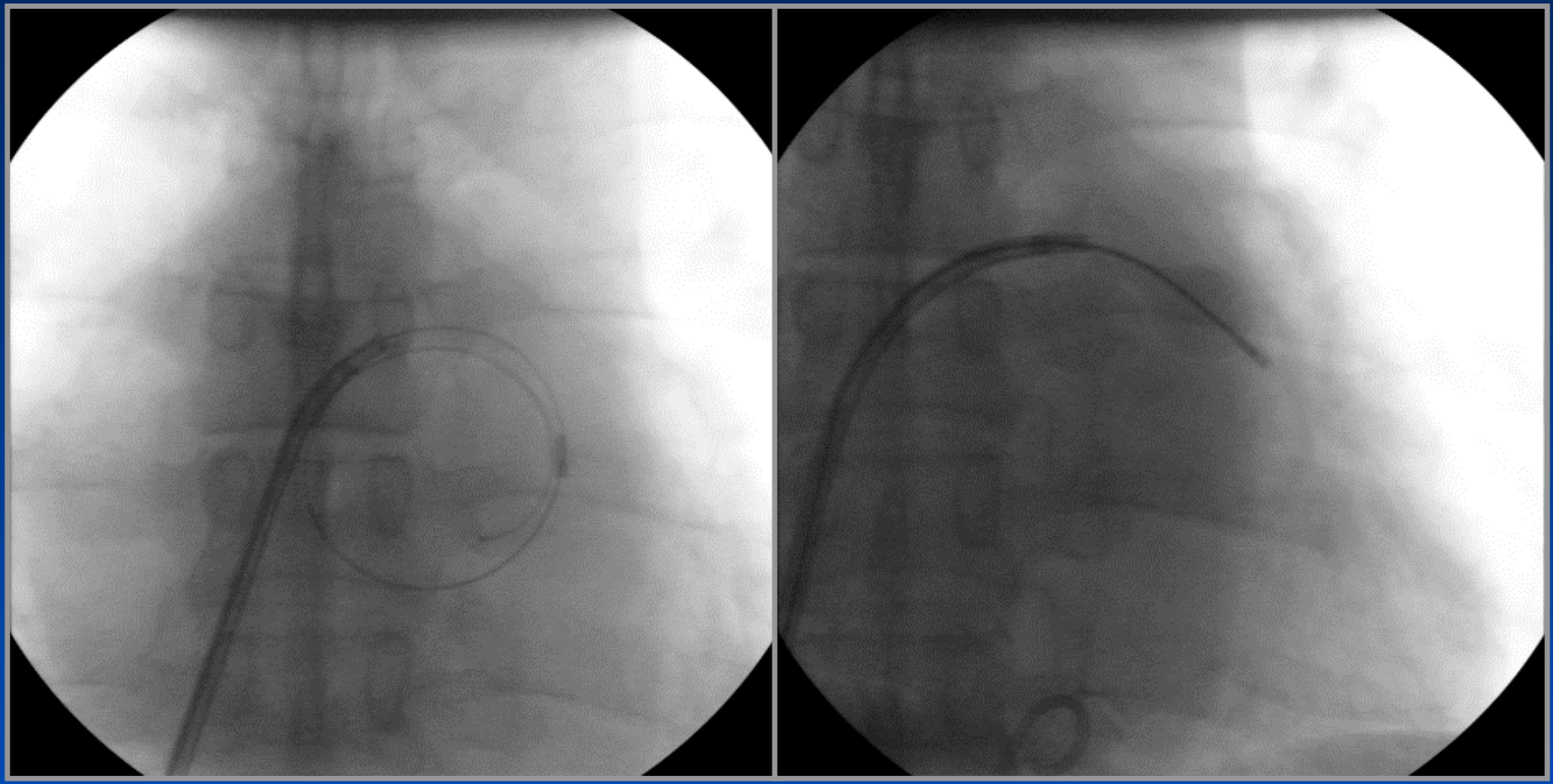
Septal Puncture



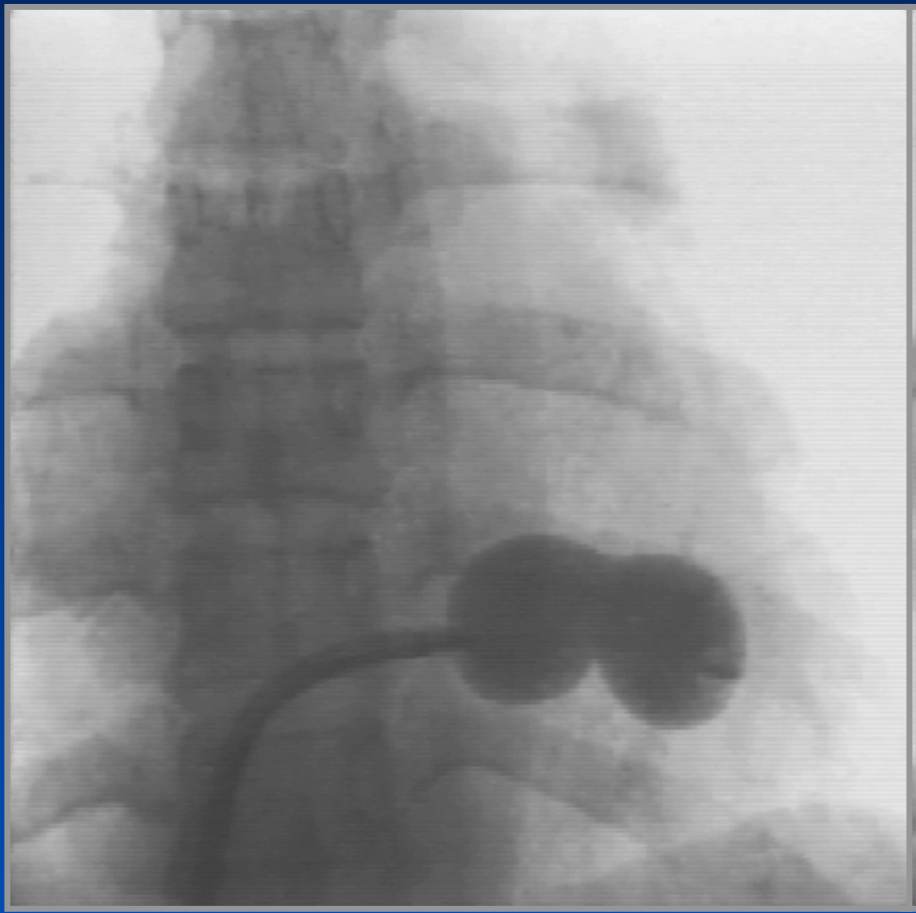
Guidewire Advancement

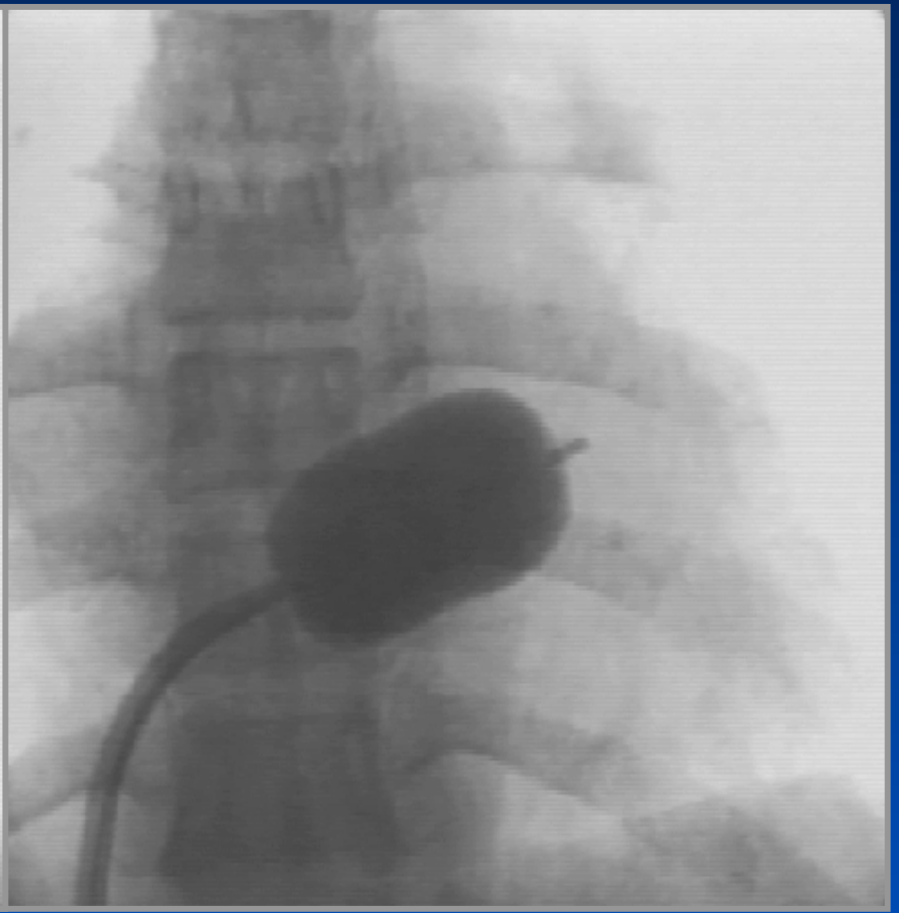


Inoue Balloon Advancement



Balloon Dilatation





Double Balloon Technique

Inoue vs Double Balloon

Inoue balloon

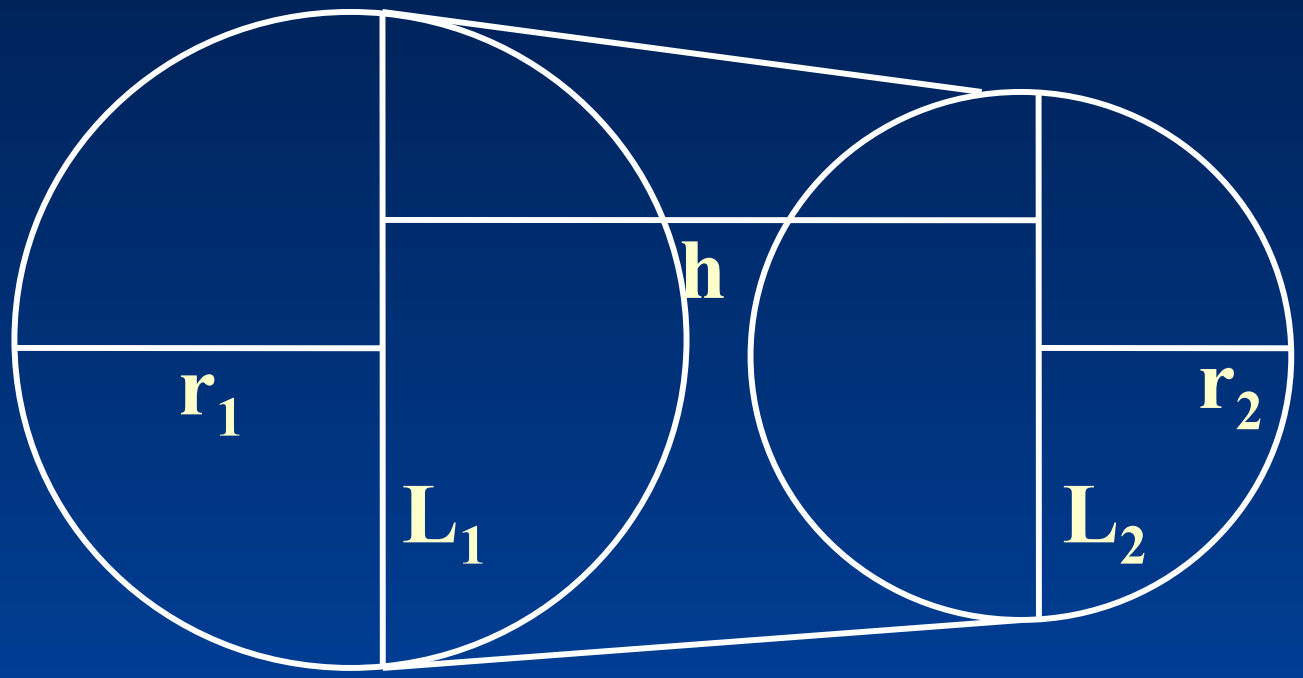
- Easy to use, steeper learning curve, technically less demanding
- Short balloon , flexible tip, self-seating, no LV wiring
- Steerable tip
- Stepwise dilatation, allow LA hemodynamic measurements
- 12F dilator to enlarge atrial septum

Double balloon

- Harder to use, technically demanding
- Long balloon, stiff tip, not self positioning, LV wiring mandatory
- Not-steerable tip
- All or none dilatation, cannot measure LA pressure
- Larger ASD (5-8 mm balloon

Balloon Size Selection For PMV

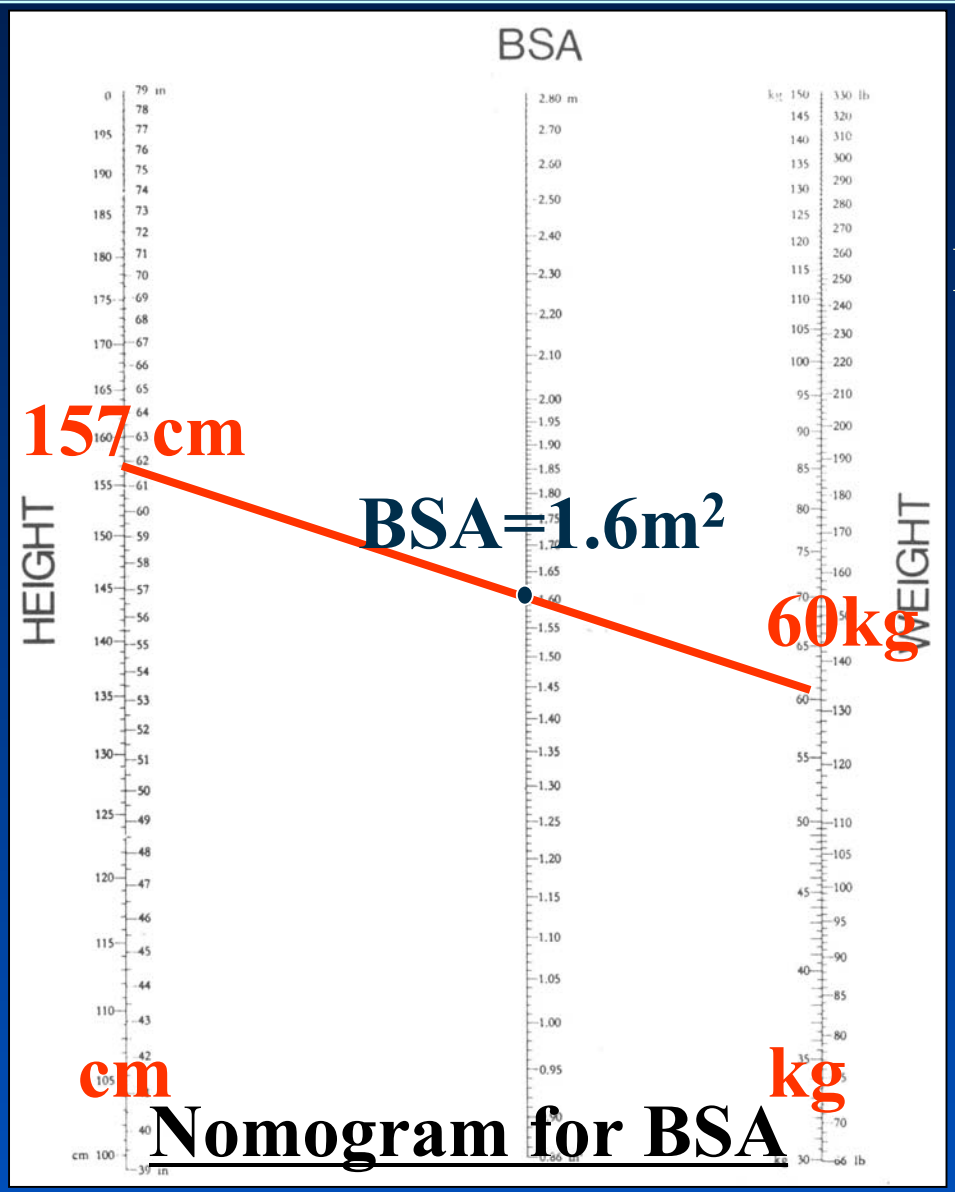
Effective Balloon Dilating Area



$$EBDA = h\left(\frac{L_1+L_2}{2}\right) + \frac{\pi\,(r^2{}_1+r^2{}_2)}{2}$$

BSA x 4 cm^2/m^2 = EBDA (cm^2)

Body Surface Area



Nomogram for BSA

$$BSA(m^2) = \sqrt{\frac{\text{Height x Weight}}{3600}}$$

Body weight 60kg
Height 157 cm

$BSA=1.6m^2$

$BSA \times 4\ cm^2/m^2 = EBDA$

$EBDA=6.4(cm^2)$

BALLOON SIZE SELECTION

Inoue Balloon Size

25mm : 4.91
26mm : 5.30
27mm : 5.72
28mm : 6.15
29mm : 6.6
30mm : 7.06

$$BSA(m^2) = \sqrt{\frac{\text{Height x Weight}}{3600}}$$

$$BSA \times 4\ cm^2/m^2 = EBDA\ (cm^2)$$

Effective Balloon Dilating Area For Double Balloons

Balloon size	0	15	*18*	20
15	1.77	4.02	4.89	5.55
18	2.54	4.89	5.78	6.46
20	3.14	5.55	6.46	7.14
23	4.15	6.57	7.55	8.27
25	4.91	7.46	8.41	9.11

EBDA(cm^2) = BSA x 4

Pilot Study

Immediate and one-year results of percutaneous mitral balloon valvuloplasty using Inoue and double-balloon techniques.

Seung-Jung Park, MD, PhD, FACC

Baseline characteristics

	Inoue (n=59)	Double (n=61)	*P*
Age, years	41±11	40±11	NS
Rhythm, n			NS
Sinus	33(56%)	33(49%)	
AF	26(44%)	31(51%)	
NYHA class			NS
II	22	19	
III	35	39	
IV	2	3	
Echo score	8.2±1.3	8.0±1.3	NS

Park SJ et al. Am J Coll 1993

Inoue vs Double Balloon

Serial change of MVA

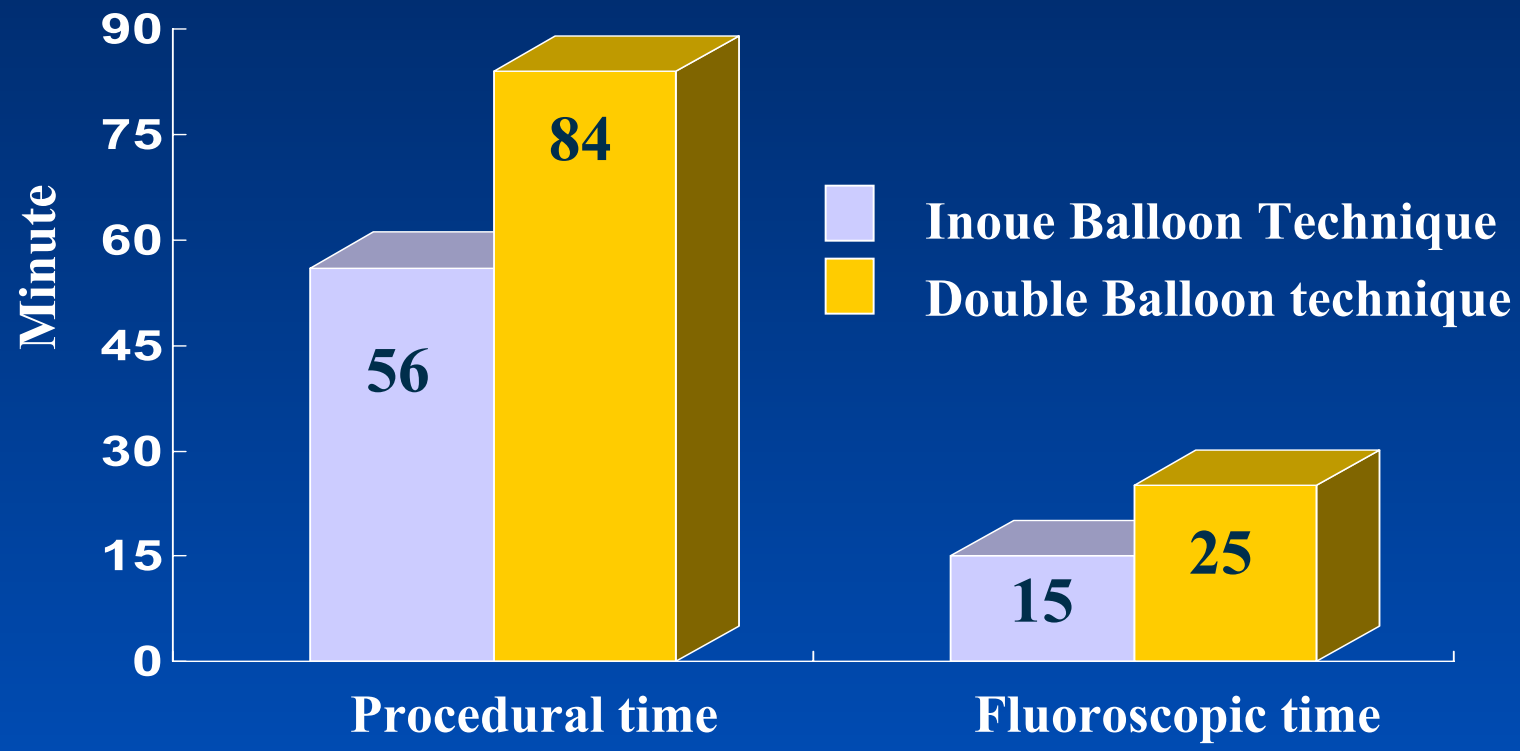
	Inoue (n=59)	Double (n=61)	*P*
Success	88%	89%	NS
MR ≥ 3	2(3.4%)	2(3.3%)	NS
MVA (cm^2)			
Before	0.9±0.3	0.9±0.2	NS
Immediate after	1.8	1.9	NS
6 months	1.6	1.8	NS
1 year	1.6	1.7	NS

Park SJ et al. Am J Coll 1993

Inoue vs Double Balloon

Procedural time

P<0.05



Park SJ et al. Am J Coll 1993

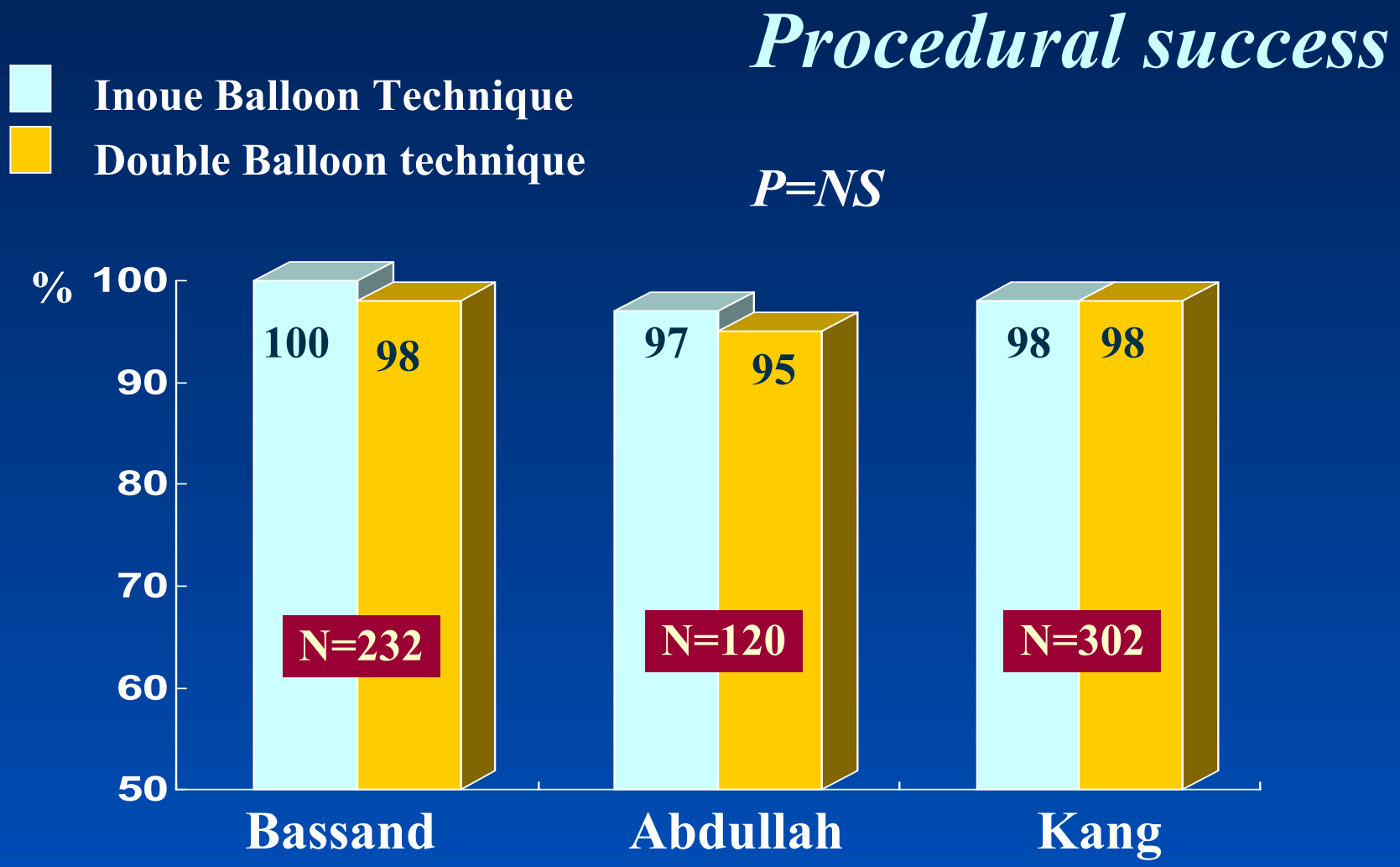
CONCLUSIONS

The Inoue and double-balloon techniques obtained equivalent results in the success rate and frequency of complications.

Complication of PMV

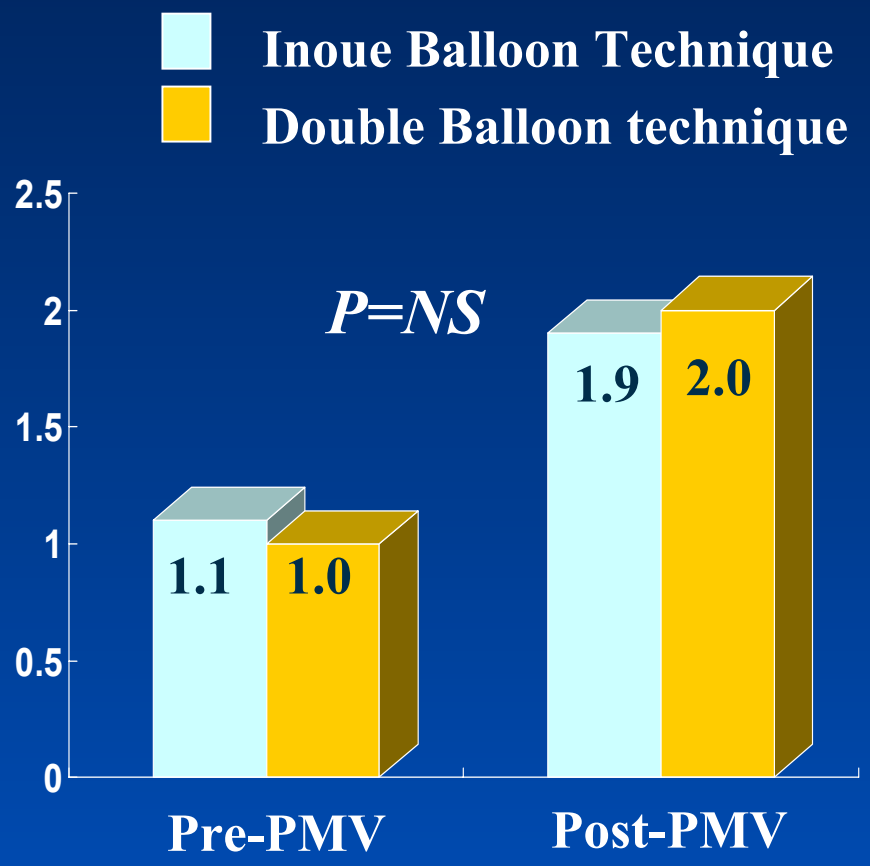
- Mortality 0-1.6%
- Systemic embolization 0-6.5%
- Severe MR(+4) 0.9-3%
- Left to right shunt 19%
- Transient heart block and tamponade <5%

Inoue vs Double Balloon

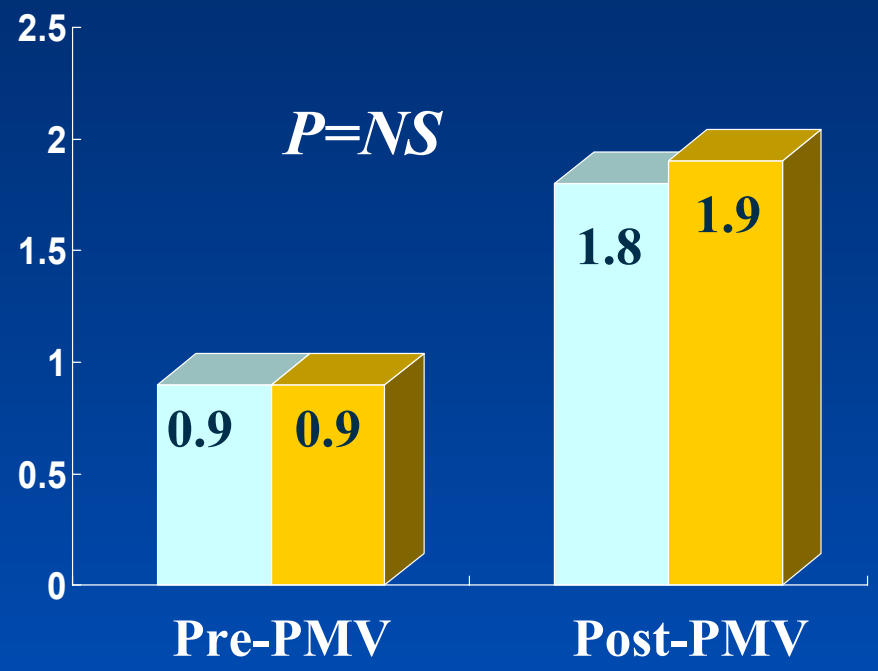


Inoue vs Double Balloon

Change of PMA



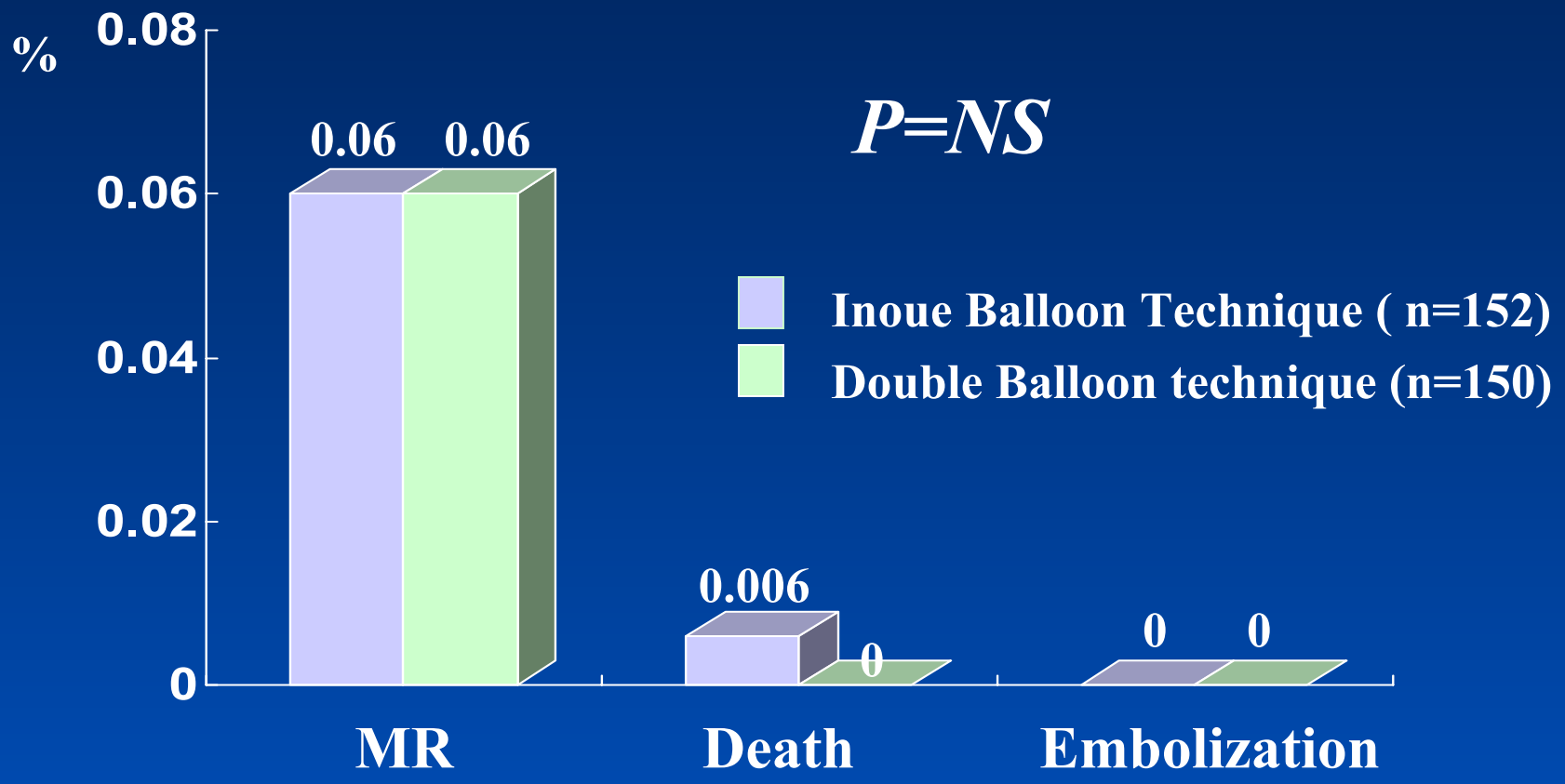
Bassand et al. J Am Coll Cardiol 1991



Kang et al. J Am Coll Cardiol 2000

Inoue vs Double Balloon

Complication



Kang et al. J Am Coll Cardiol 2000

Inoue Balloon vs Double Balloon

Long term outcomes ?

Inoue vs Double Balloon

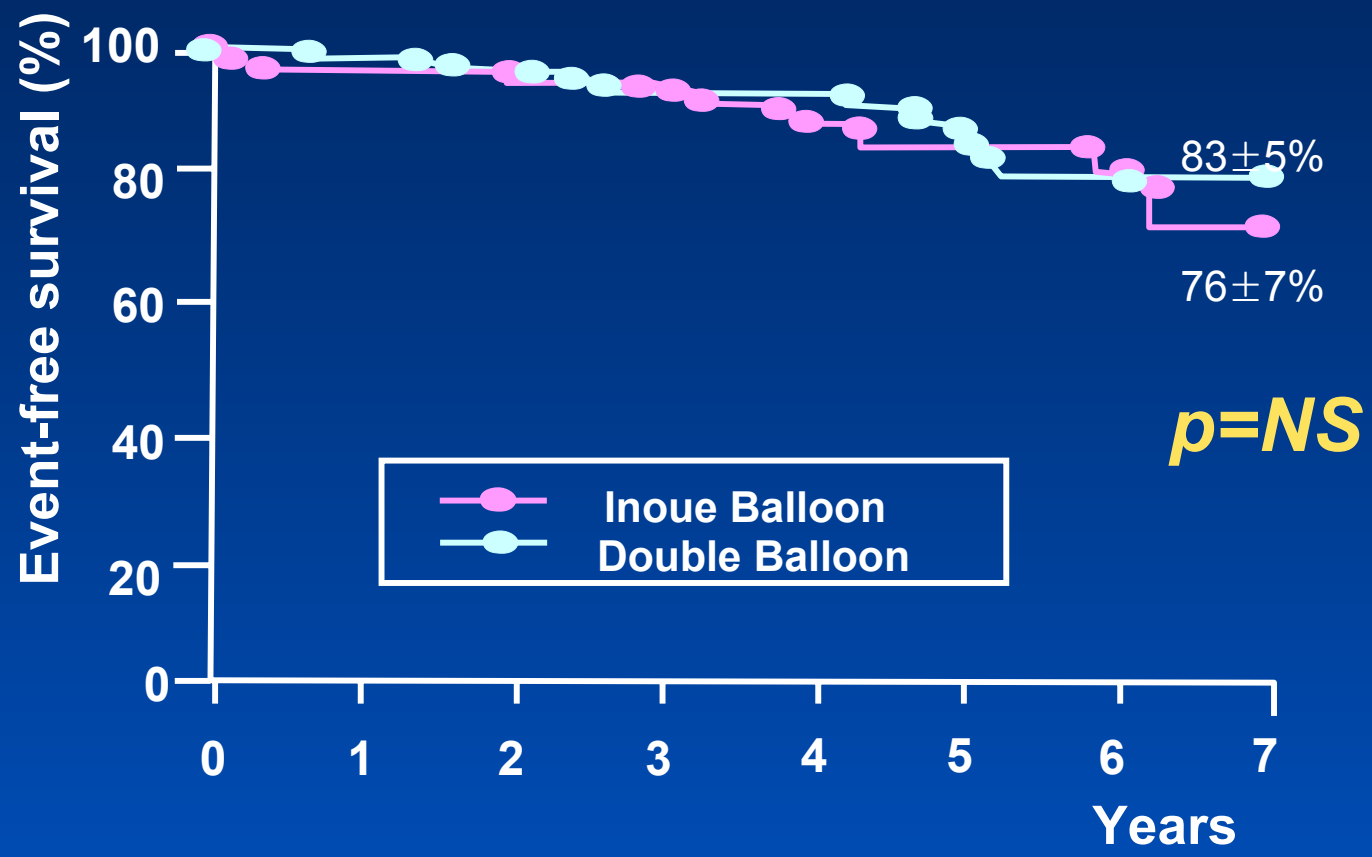
Baseline characteristics

	Inoue (n=152)	Double (n=150)	*P*
Age, years	42±11	40±11	NS
Rhythm, n			NS
Sinus	87	93	
AF	65	57	
Echo score	7.8±1.5	7.7±1.4	NS
MVA(cm^2)	0.9±0.2	0.9±0.2	NS
Transmitral PG (mmHg)	16±7	17±7	NS

Kang et al. J Am Coll Cardiol 2000

Event-free Survival

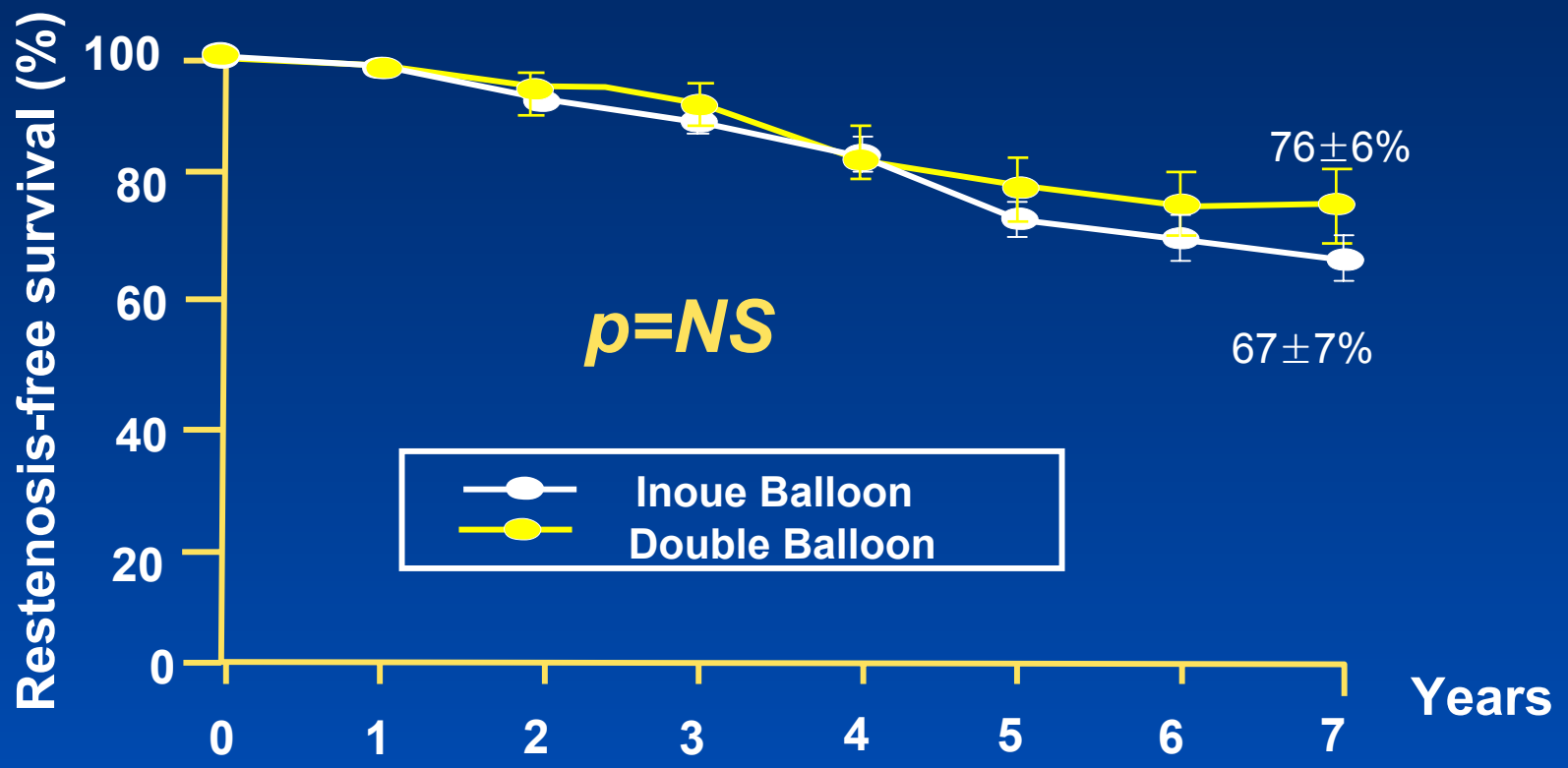
Death, MVR, redoPMV, NYHA≥3



Kang DH, et al *J Am Coll Cardiol* 2000

Restenosis-free Survival

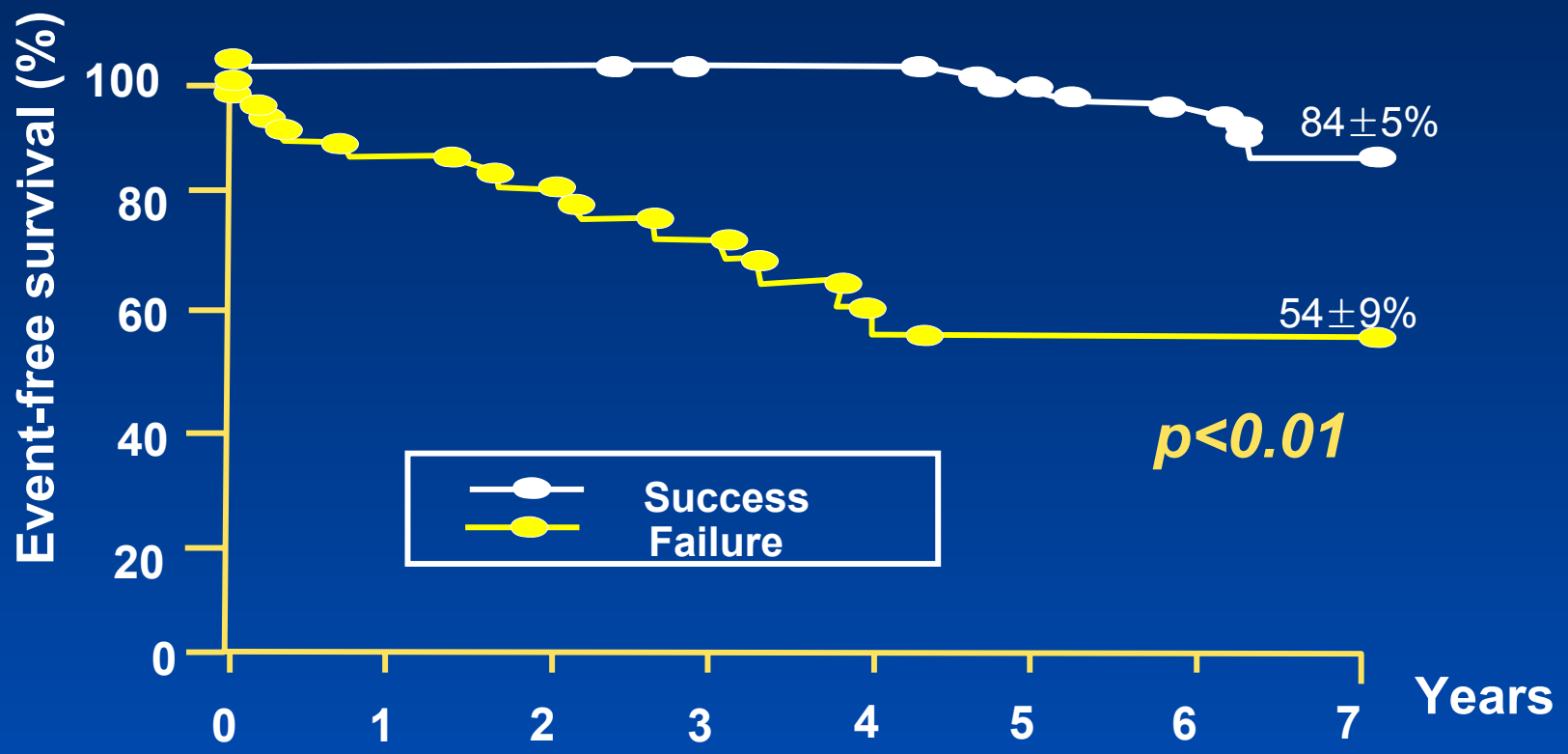
MVA≤ 1.5cm², Loss of initial gain ≥ 50%



Kang DH, et al *J Am Coll Cardiol* 2000

Event-free Survival

According to immediate PMV results



Kang DH, et al *J Am Coll Cardiol* 2000

CONCLUSIONS

Inoue vs Double Balloon

- Two methods appear to yield same success rate and complication rate.
- Inoue methods is extensively preferred than Double balloon technique in terms of several reasons such as short balloon, a flexible catheter tip, stepwise dilatation, allowance of LA hemodynamic measurements.

Patient Selection

Indication of PMV

- Good valve morphology
- Absence of LA thrombus or moderate to severe MR

- Class I
  - Symptomatic patients (≥ NYHA Class II)
    & moderate to severe MS (MVA ≤ 1.5 cm^2)
- Class IIa
  - Asymptomatic pts with moderate to severe MS & pulmonary hypertension
    (>50 mmHg at rest, >60 mmHg during exercise)
  - Moderate to severe MS with ≥ NYHA Class III
    & nonpliable calcified valve
    & high risk of surgery

Contraindication of PMV

- Left atrial thrombus
- Apical left ventricular thrombus
- MR>2+
- Bleeding diathesis
- Severe cardiothoracic deformity

Patients selection is fundamental in predicting outcome of PMV ?

Mitral valve morphology

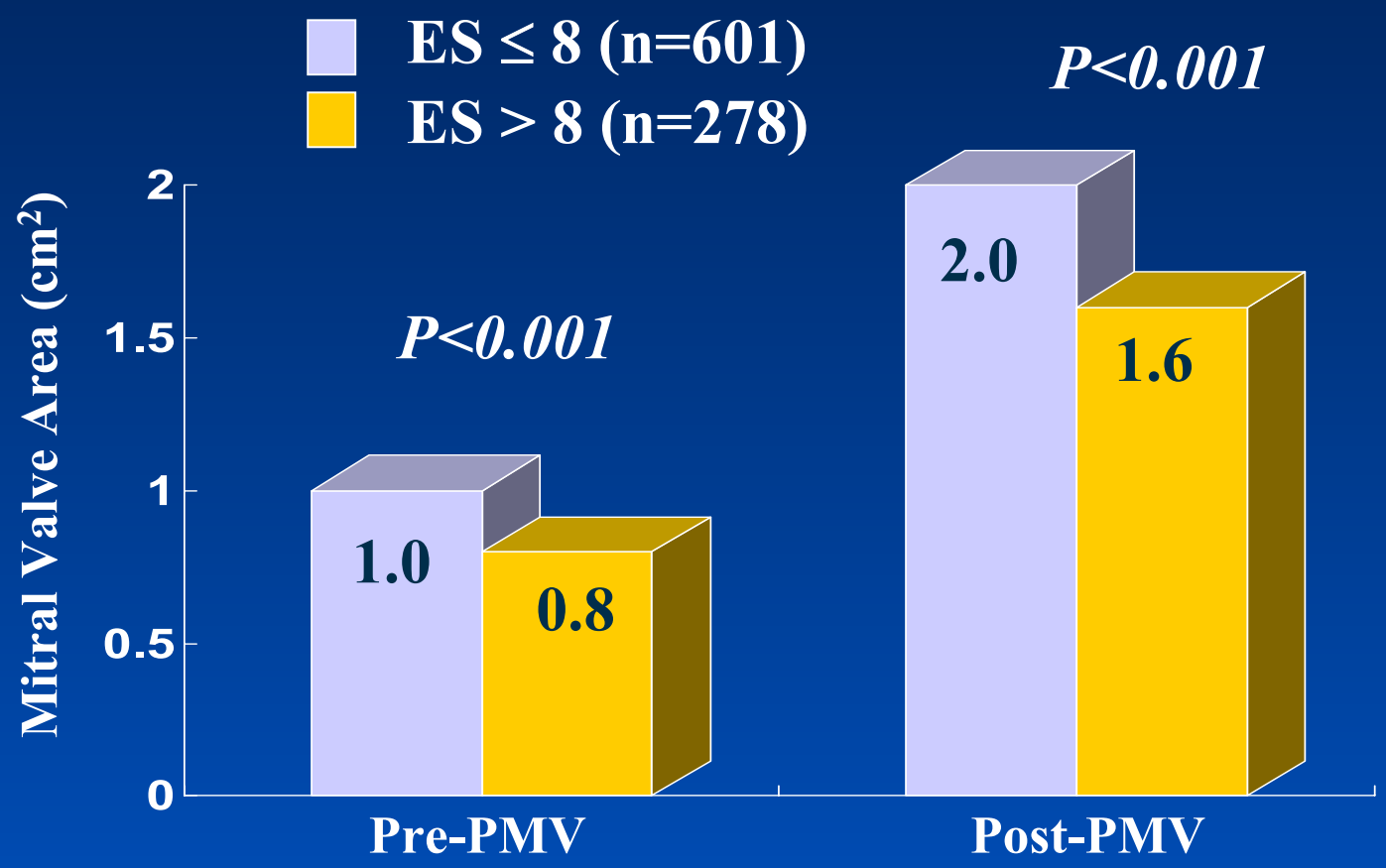
Echocardiographic Score !!!

Echo Score

Mitral valve morphology

	1	2	3	4
Rigidity	mobile valve			immobile valve
Thickening	thin			severe thick
Calcium	no bright echos			multiple bright echo
Subvalvular apparatus	sparse echos			multiple thick chorda

MVA according to ES



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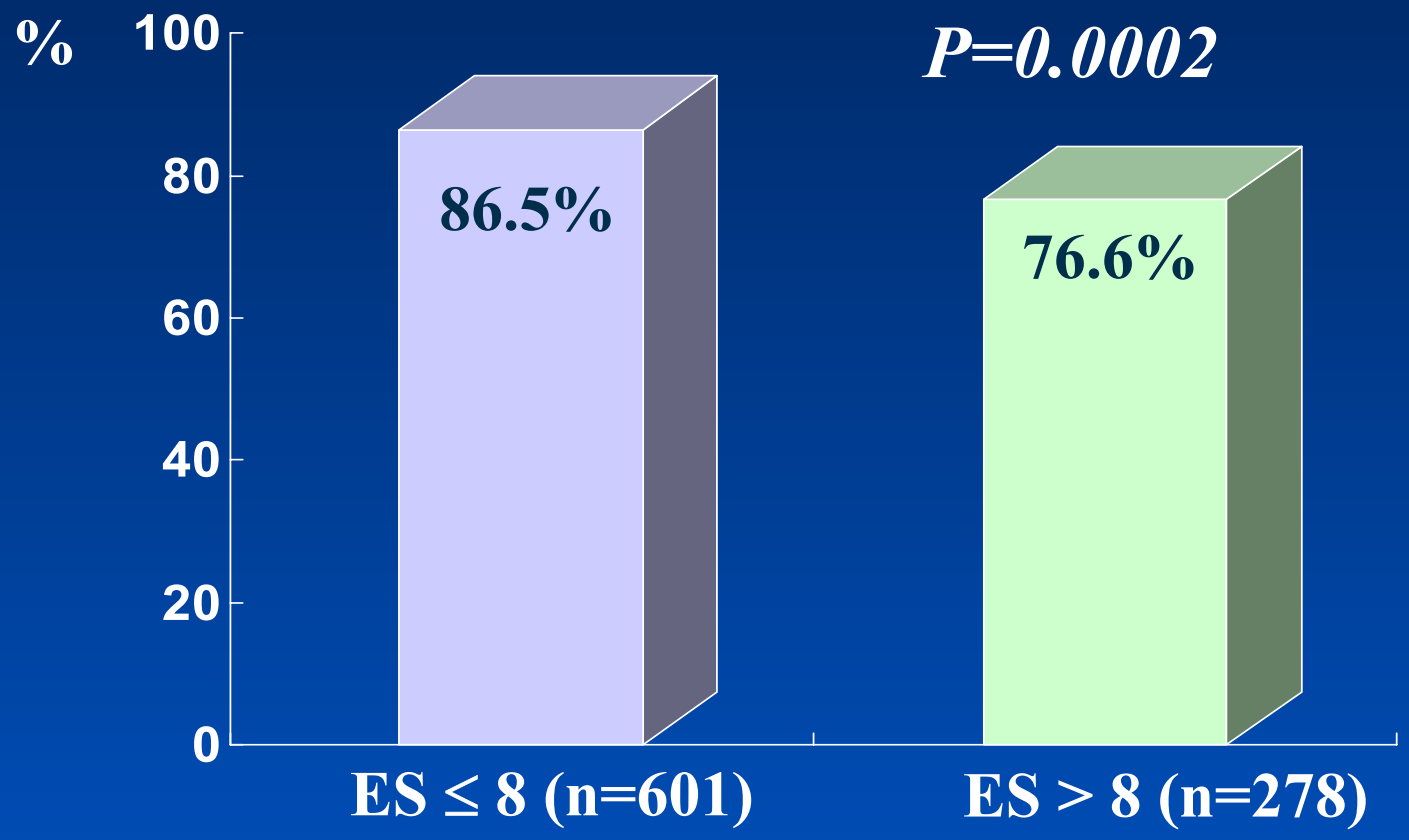
Success according to ES

Post-PMV MVA ≥ 1.5, 50% increase in MVA, MR ≤ 2



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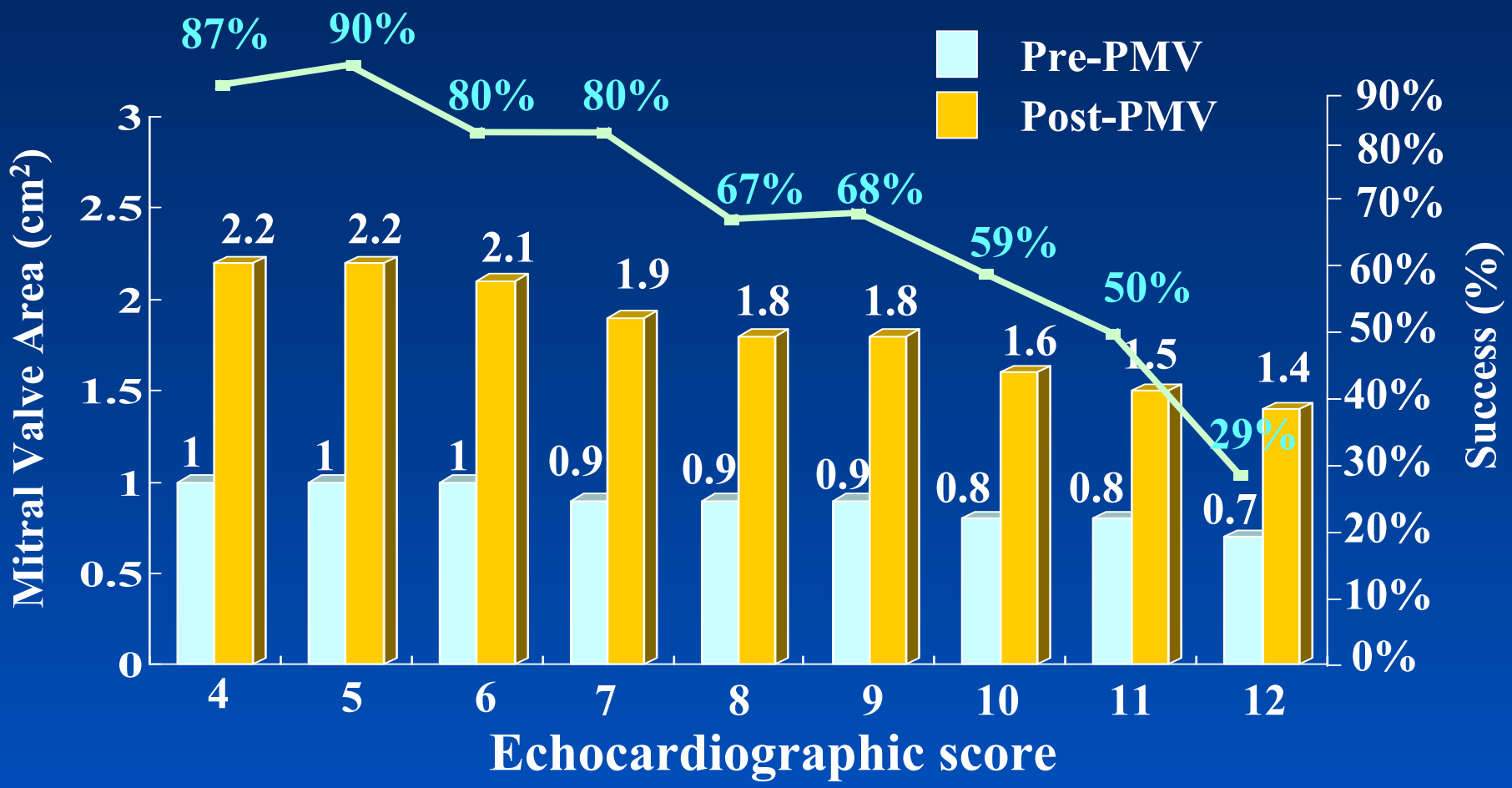
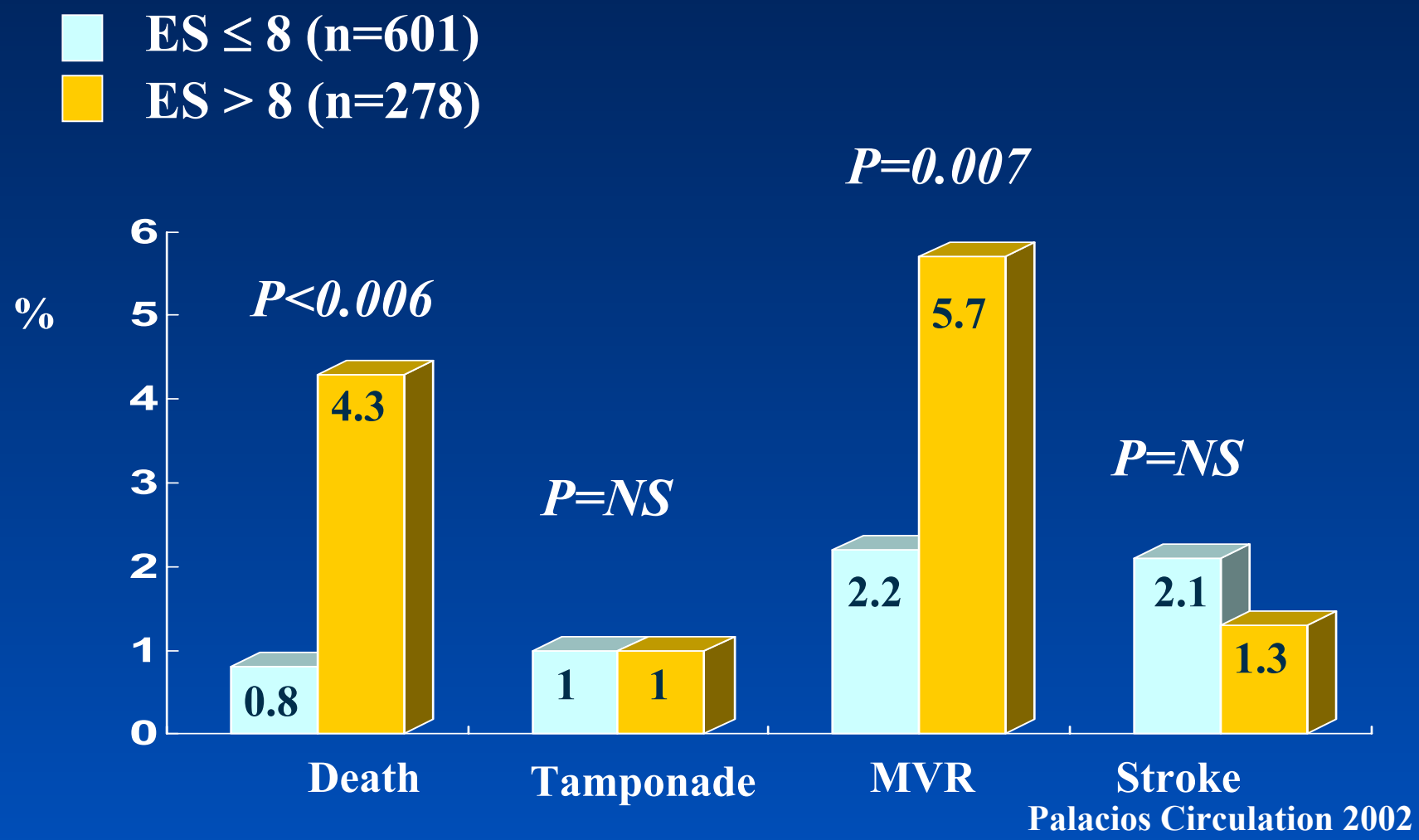
Changes in MVA & Success



In-Hospital Events



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Immediate Success

Independent predictors

Variables	OR	CI	P
Pre-PMV MVA	13.05	7.74-22.51	<0.00001
Less degree of pre-MVA	3.85	2.27-6.66	<0.00001
Younger age	3.33	1.41-7.69	0.006
Prior commissurotomy(-)	1.85	1.20-2.86	0.004
Male sex	1.92	1.19-3.13	0.008
ES ≤ 8	1.69	1.18-2.44	0.004

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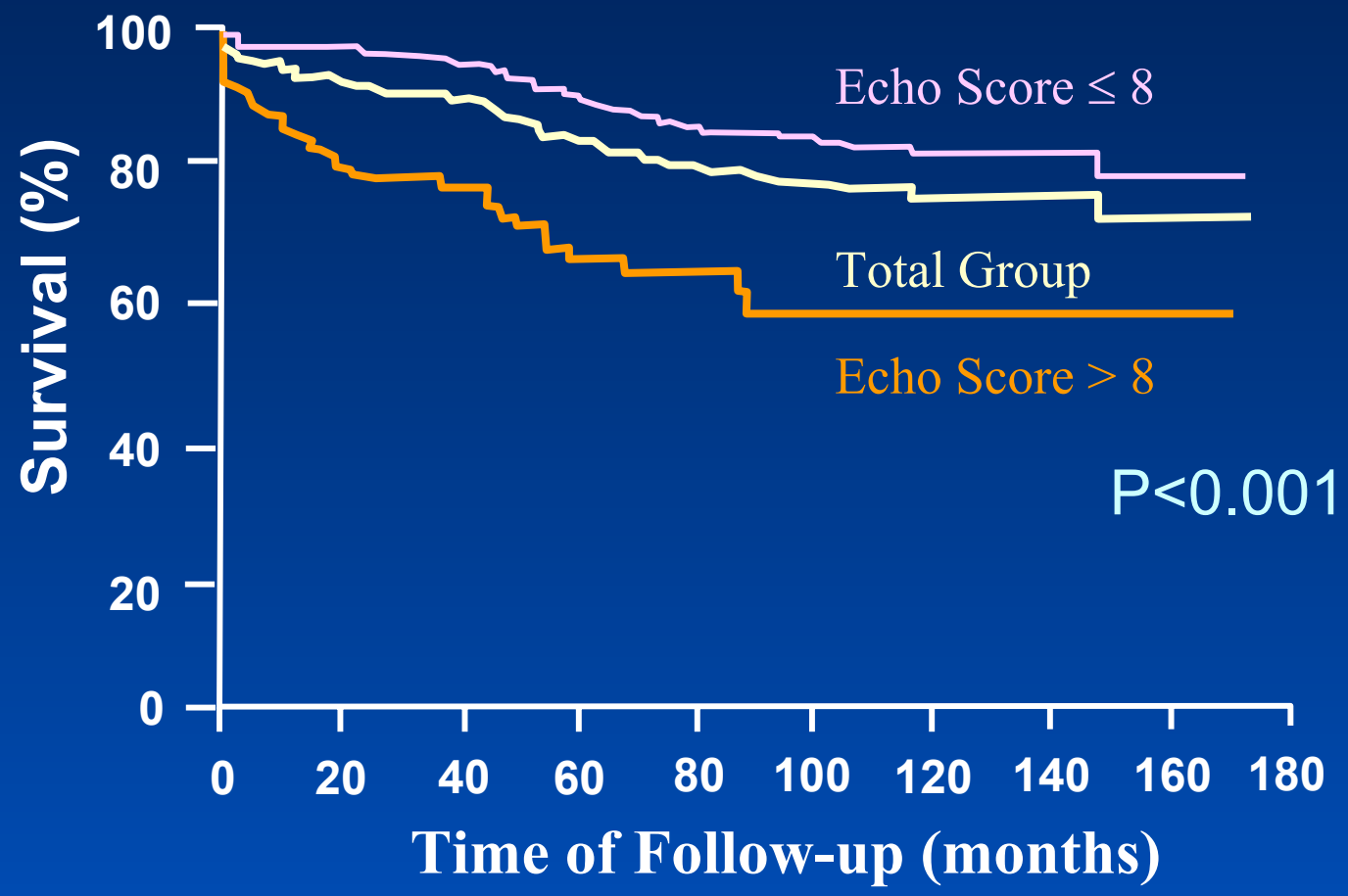
Survival according to ES



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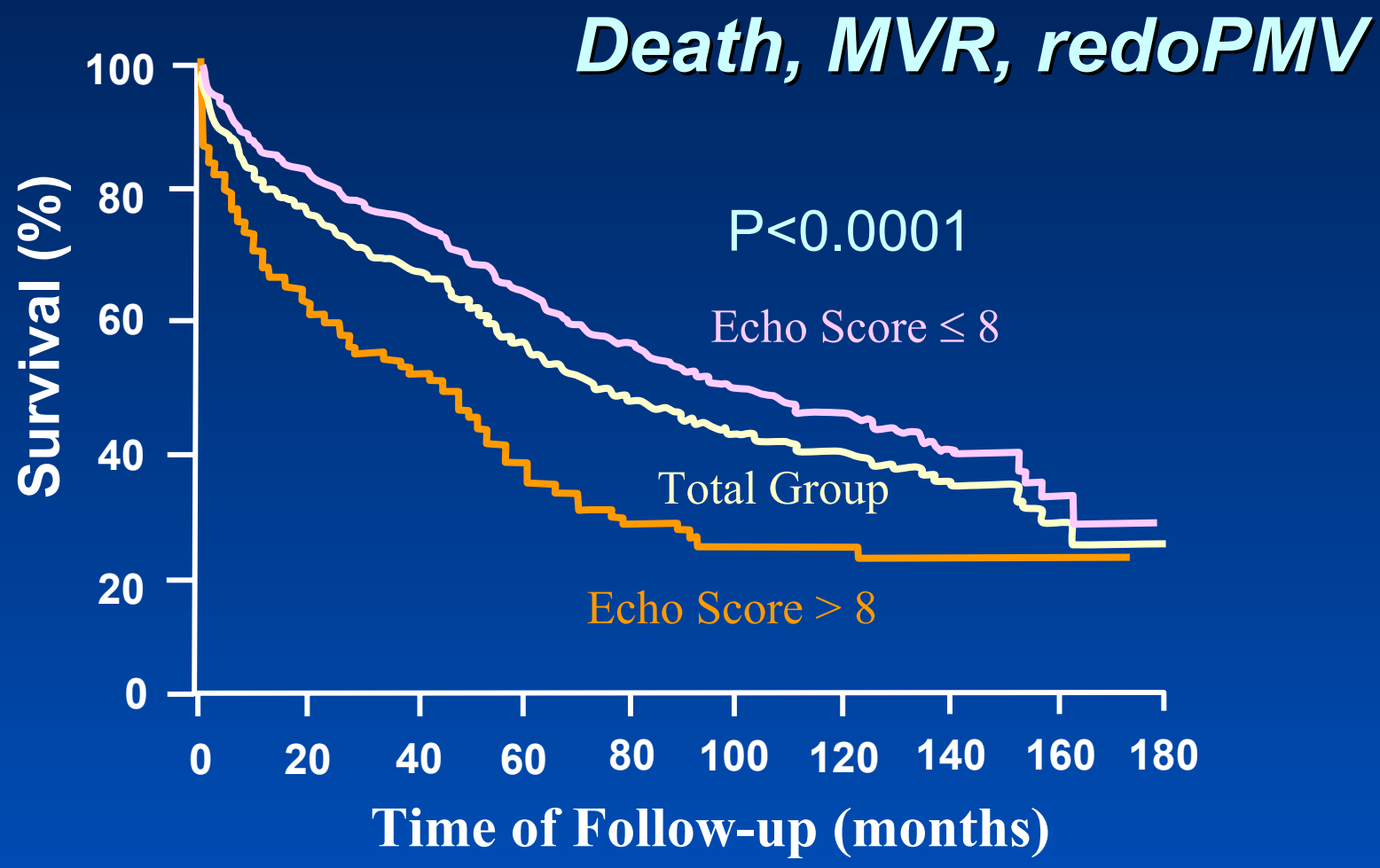
Events-Free Survival according to ES



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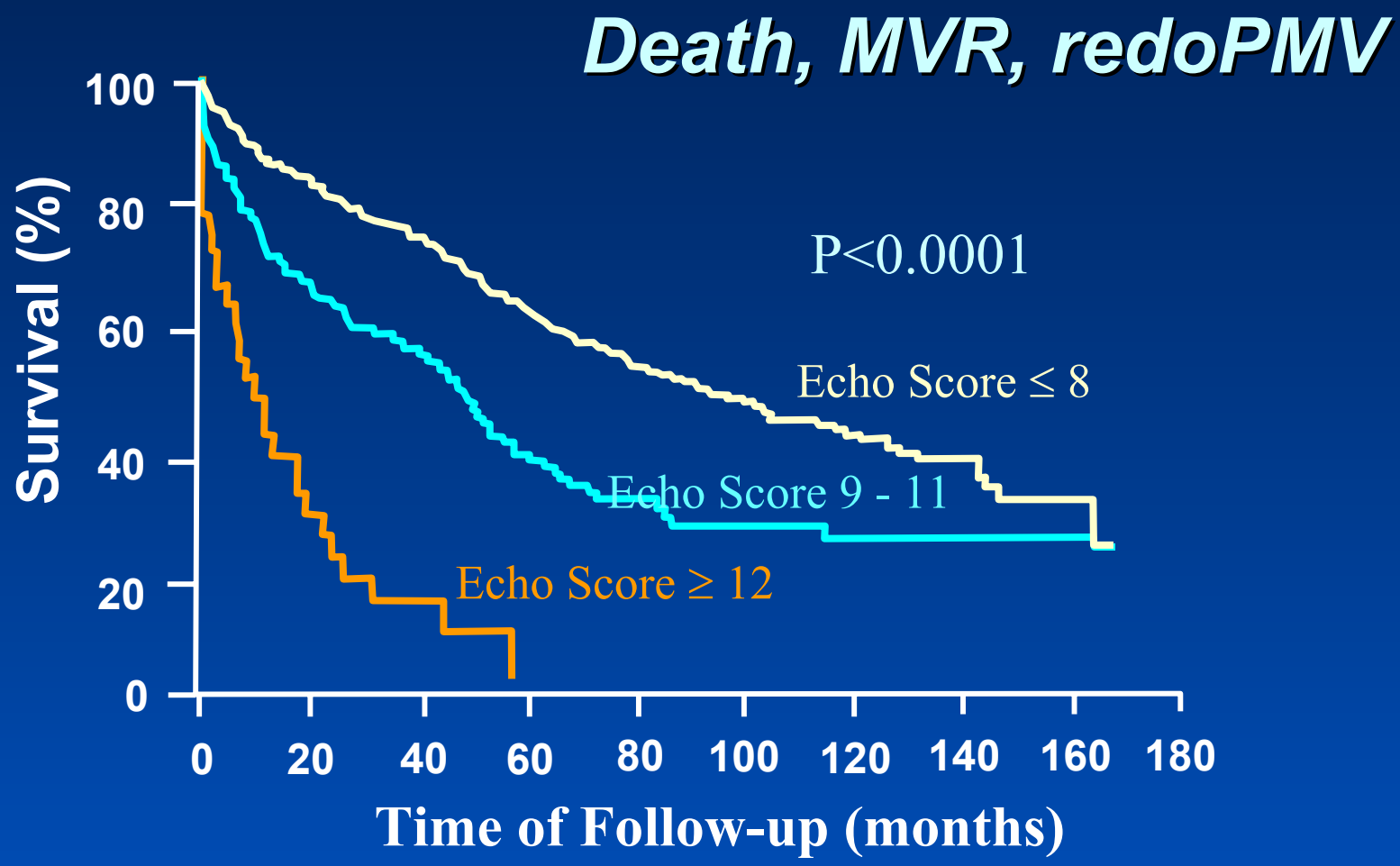
Events according to ES



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Long-Term Events

Independent predictors; Redo MVP, MVR, Death

Variables	OR	CI	P
Age	1.02	1.01-1.03	<0.00001
NYHA IV	1.35	1.00-1.81	0.05
Prior commissurotomy	1.50	1.16-1.92	0.002
Echo score	1.31	1.02-1.67	0.03
Pre-PMV MR ≥ 2+	1.56	1.09-2.22	0.02
Post-PMV MR ≥ 3+	3.54	2.61-4.72	<0.00001
Post PMV Pul A pressure	1.02	1.01-1.03	<0.00001

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Determinants of PMV

Atrial fibrillation

Predictors of worse outcomes ?

Baseline characteristics

Variables	AF (n=355)	NSR (n=379)	P
Age	62±12	48±14	<0.00001
Female gender	282(80%)	319(84%)	NS
NYHA			
Class II	65(18.3%)	119(31.4%)	<0.00001
Class IV	65(18.3%)	30(7.9%)	<0.00001
Echo score ≤ 8	212(59.9%)	284(74.9%)	<0.00001
Echo score > 8	142(40.1%)	95(25.1%)	<0.00001
Fluoroscopic calcium	114(32.4%)	71(18.8%)	<0.00001
Pre-PMV MR ≥ 1+	143(41.2%)	133(35.4%)	0.003
Post-PMV MR ≥ 2+	34(9.6%)	12(3.2%)	0.0003

Leon MN, et al *J Am Coll Cardiol* 1999

Hemodynamic characteristics

Variables	AF (n=355)	NSR (n=379)	P
MG pre-PMV (mmHg)	13±5	16±6	<0.00001
MG post-PMV (mmHg)	5±3	5±3	NS
MVA pre-PMV (mmHg)	0.86±0.3	0.94±0.3	0.0002
MVA post-PMV (mmHg)	1.7±0.7	2.0±0.7	<0.00001
PA pre-PMV (mmHg)	37±12	36±14	NS
PA post-PMV (mmHg)	31±10	27±11	<0.00001
LA pre-PMV (mmHg)	24±7	25±7	NS
LA post-PMV (mmHg)	17±6	15±6	<0.00001

Leon MN, et al *J Am Coll Cardiol* 1999

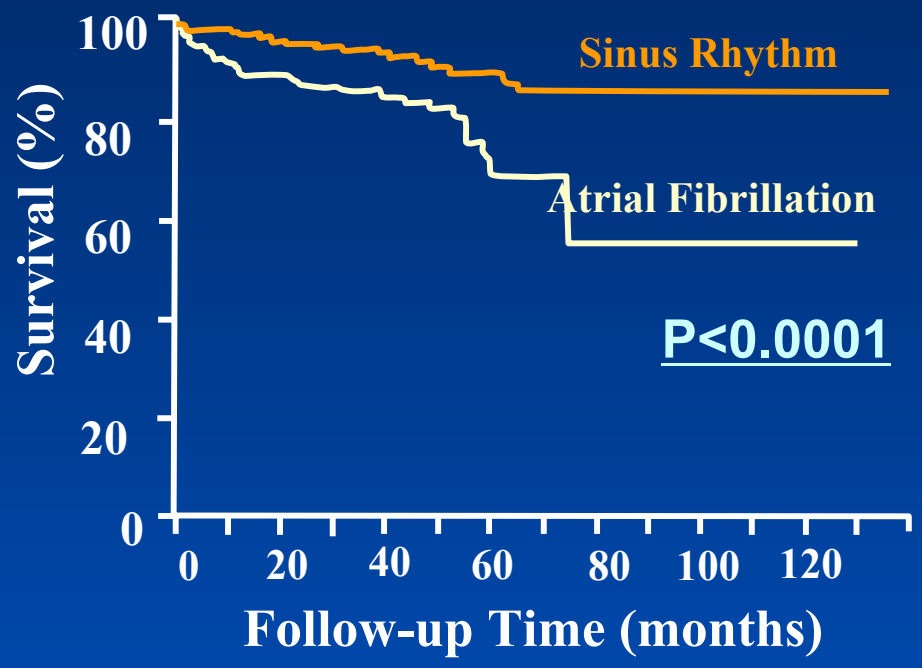
In-Hospital Events

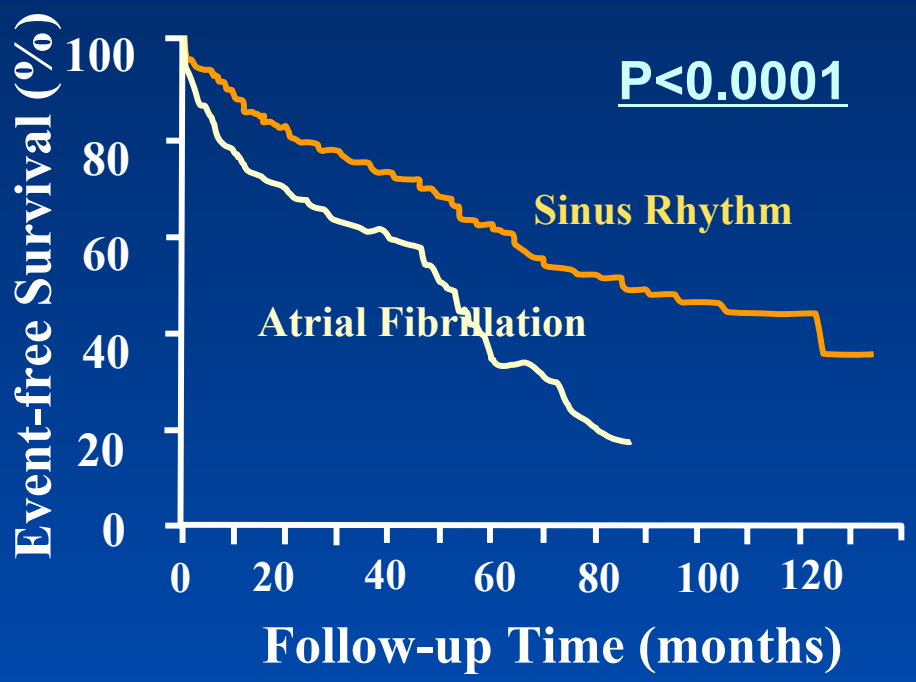
Variables	AF (n=355)	NSR (n=379)	P
Procedural success	212(61.1%)	284(76.1)	<0.00001
Procedural death	4(1.1%)	0	NS
In-hospital death	11(3.1%)	2(0.5%)	0.01
Post-PMV MR			
3+	25(7.2%)	20(5.4%)	NS
4+	9(2.6%)	15(4%)	NS
Emergent MVR	4(1.1%)	5(1.3%)	NS
In-hospital MVR	10(2.8%)	14(3.7%)	NS
Tamponade	4(1.1%)	2(0.5%)	NS
Thromboembolism	7(2%)	3(0.8%)	NS

Leon MN, et al *J Am Coll Cardiol* 1999

Events after PMV

Atrial fibrillation vs Sinus rhythm

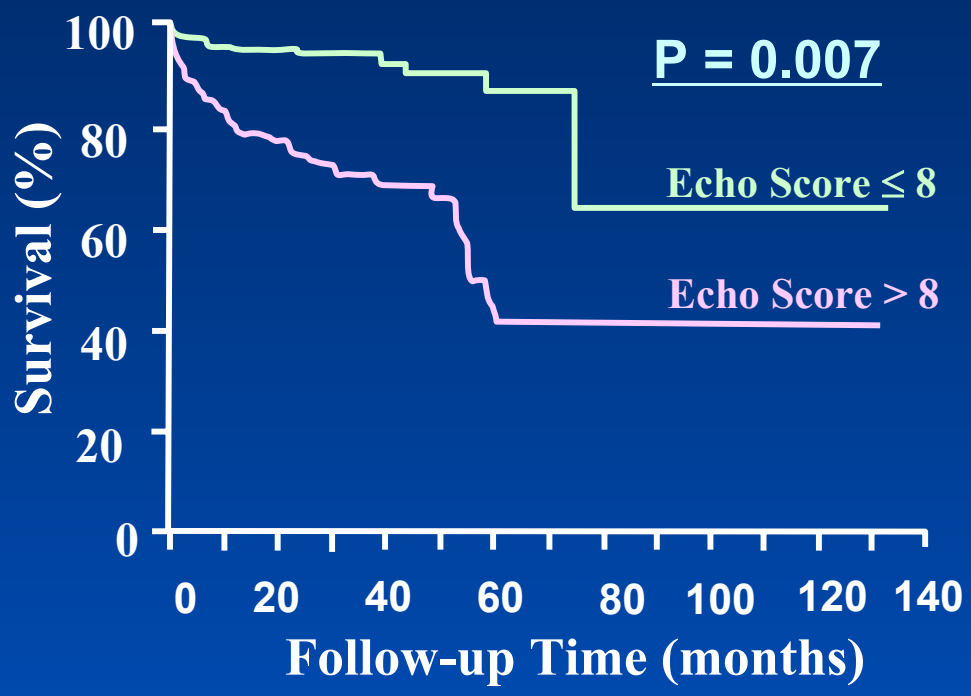


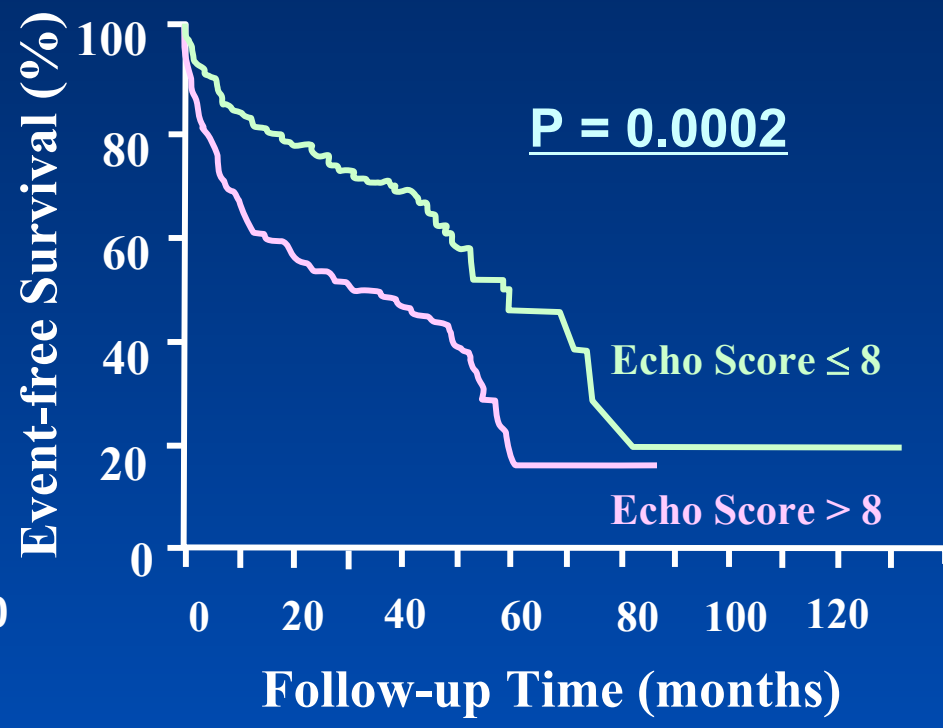


Leon MN, et al *J Am Coll Cardiol* 1999

Events after PMV

Atrial fibrillation group





Leon MN, et al *J Am Coll Cardiol* 1999

CONCLUSIONS

- Patients with AF have a worse immediate and long-term outcomes after PMV.

- However, the presence of AF by itself does not unfavorably influence the outcome, but is a marker for clinical and morphologic features associated with inferior results after PMV.

CONCLUSIONS

- PMV should be the procedure of choice the treatment of patients with MS for optimal candidates from morphologic and clinical points

- Immediate post-PMV variables in conjunction with pre-PMV clinical and mitral morphologic variables identify most likely to benefit long-term