SURGERY IN PATIENTS WITH MITRAL REGURGITATION

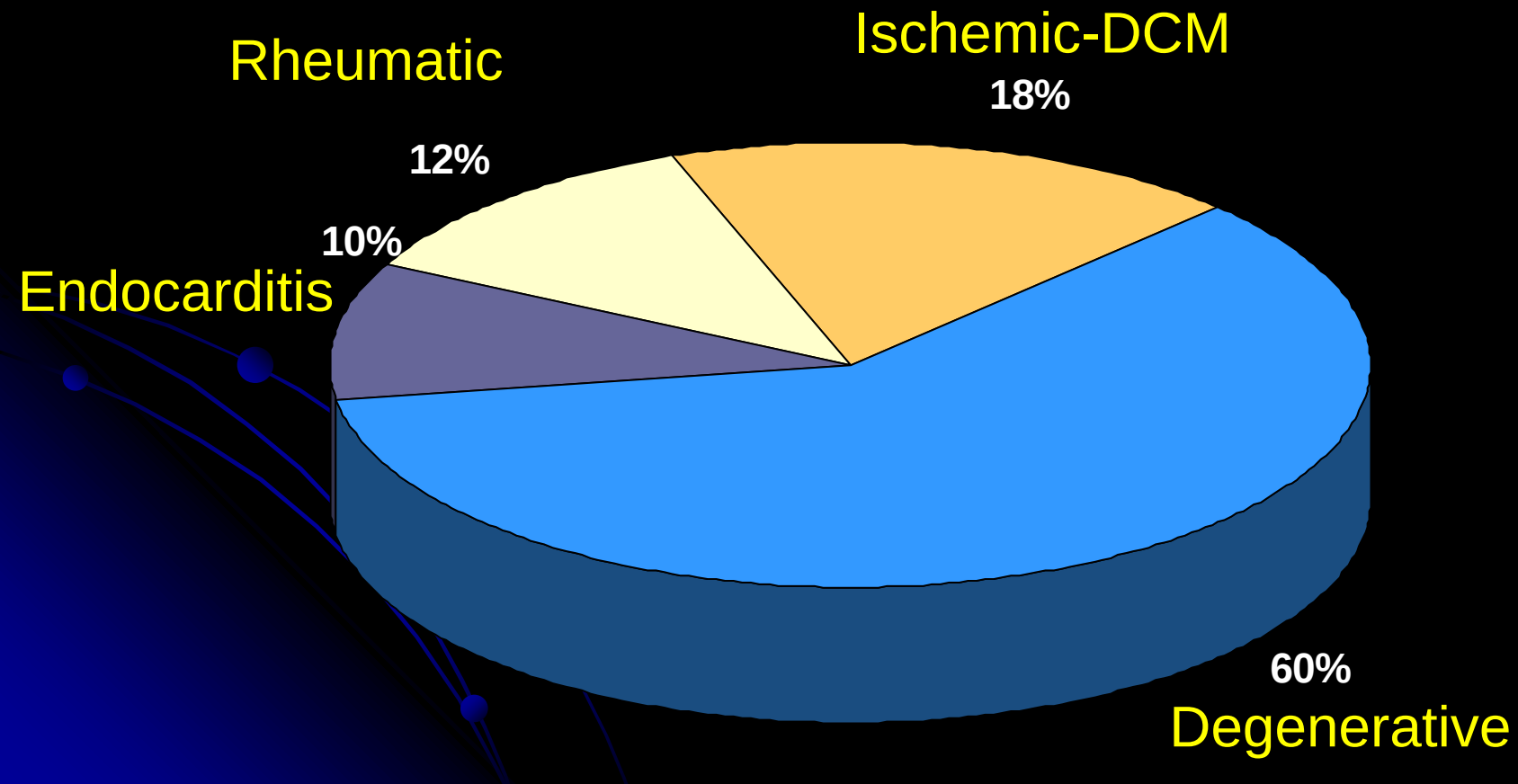
Ottavio Alfieri
S.Raffaele University Hospital
Milan, Italy

MV repair is superior to MVR

- Better preservation of LV function
- Avoidance of prosthesis related events
- Reduced hospital mortality
- Reduced morbidity and LOS
- Improved long term survival

Thourani et al, Circulation 2003; 108:298-304
Zaho et al, JTCVS 2007;1257-1263
Shuhaiber J et al, EJCTS 2007; 31:267-275
Perrier P et al, Circulation 1984;70:187
Akins CW, et al. ATS 1994; 58:668-676

Mitral Valve Repair - Etiology – HSR 2010



MITRAL VALVE REPLACEMENT

- Degenerative disease (< 10%)
- Rheumatic disease (> 50%)
- Acute endocarditis (if extensive leaflet involvement)
- Dilated cardiomyiopathy (ischemic or idiopatic, in special circumstances)

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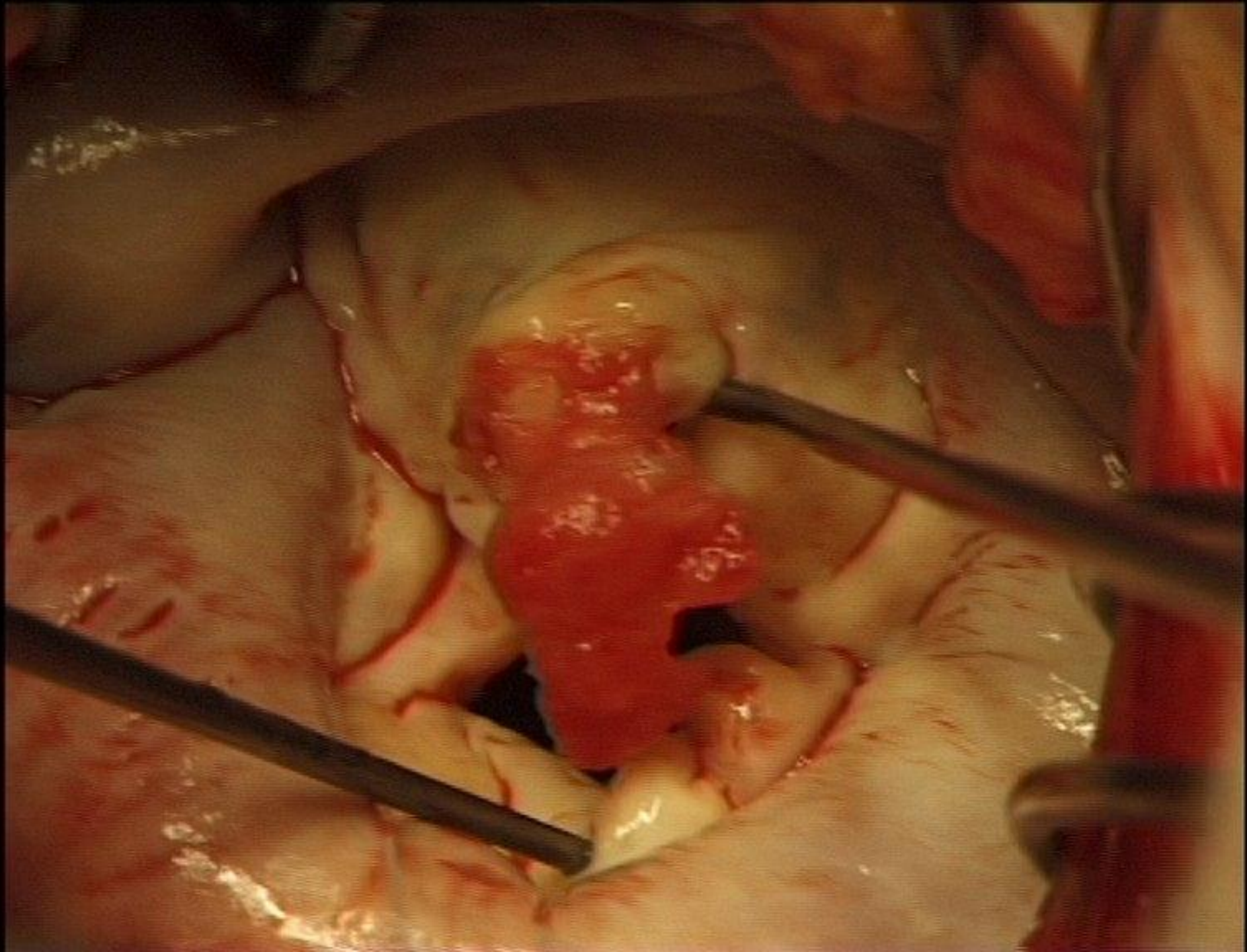
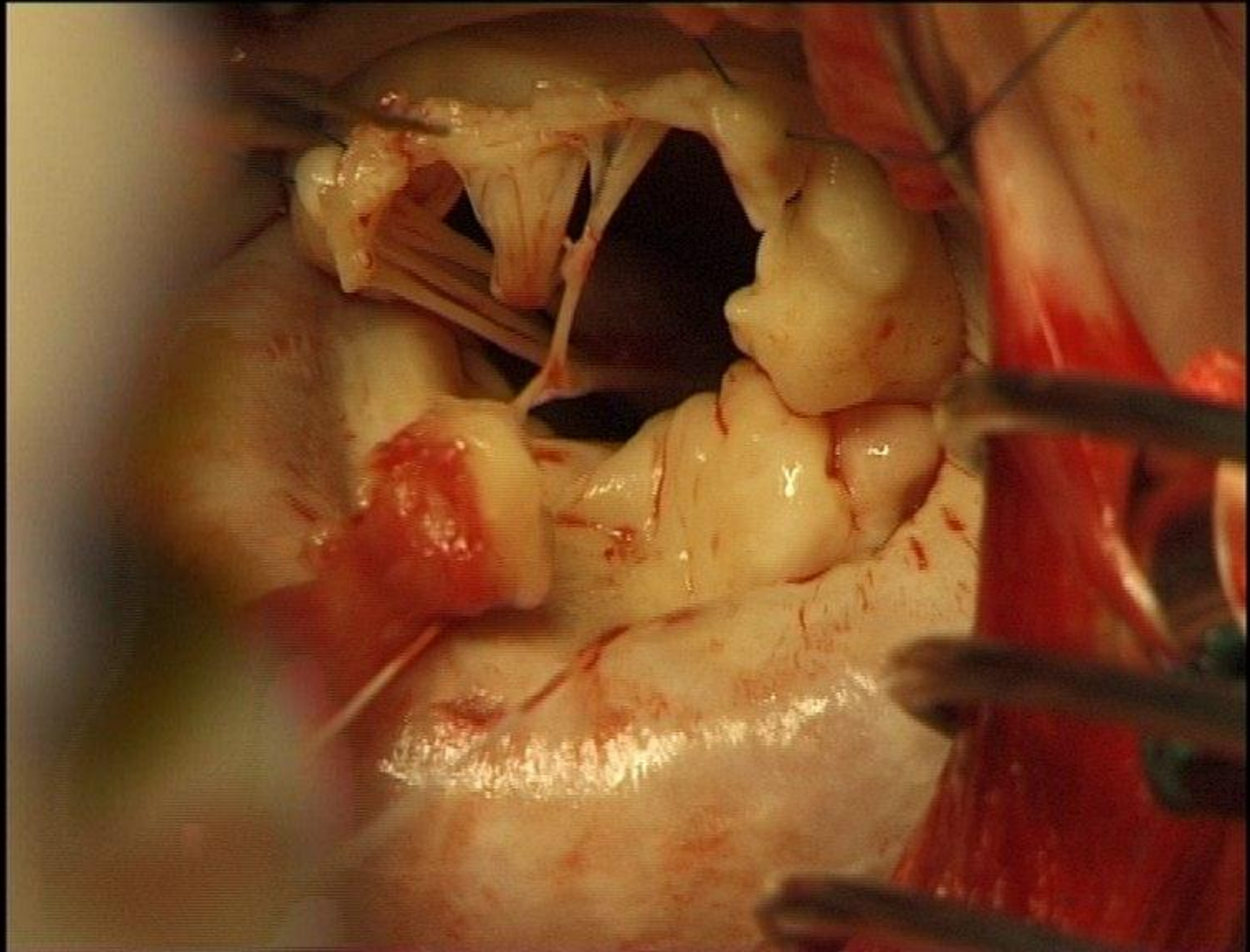
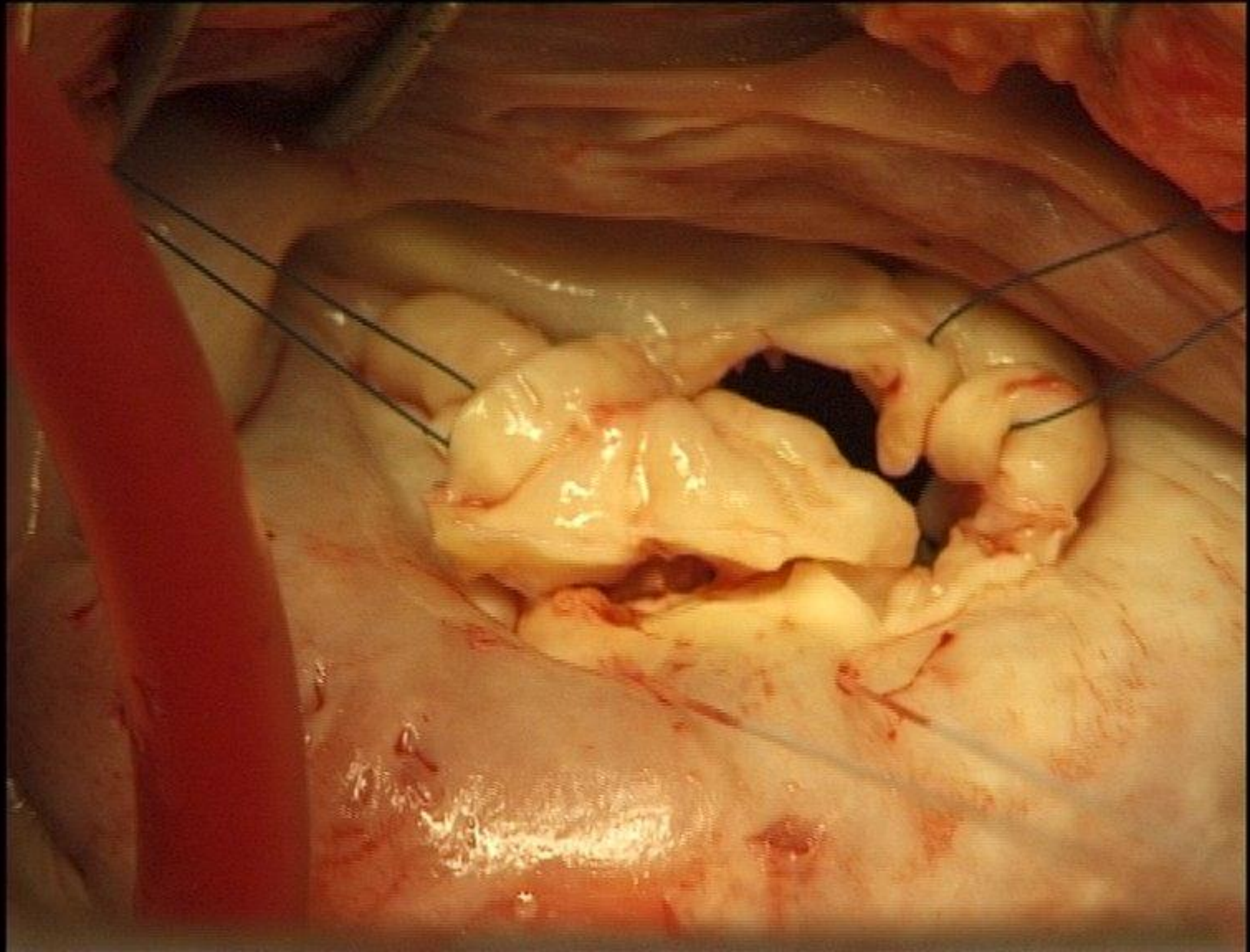
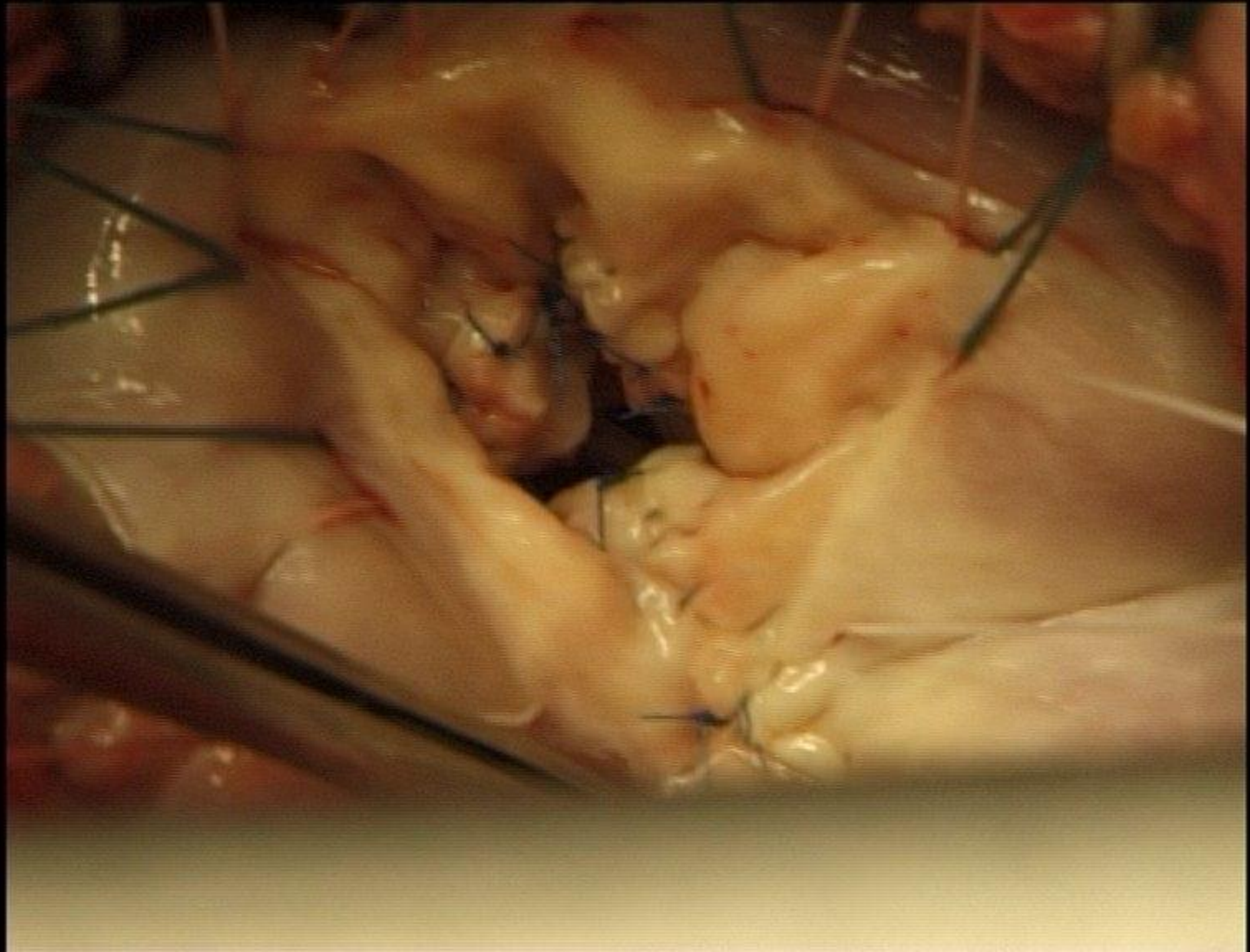
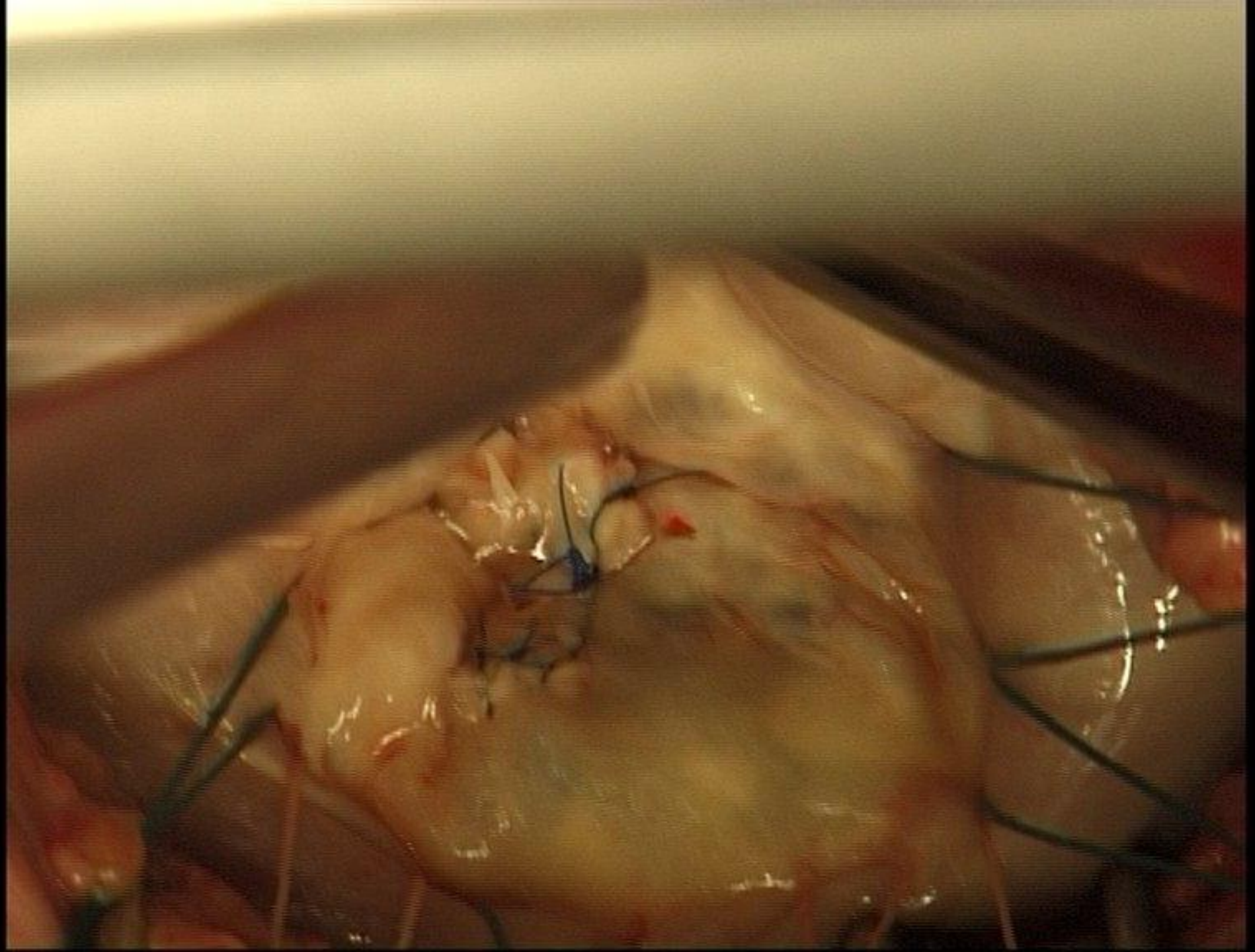










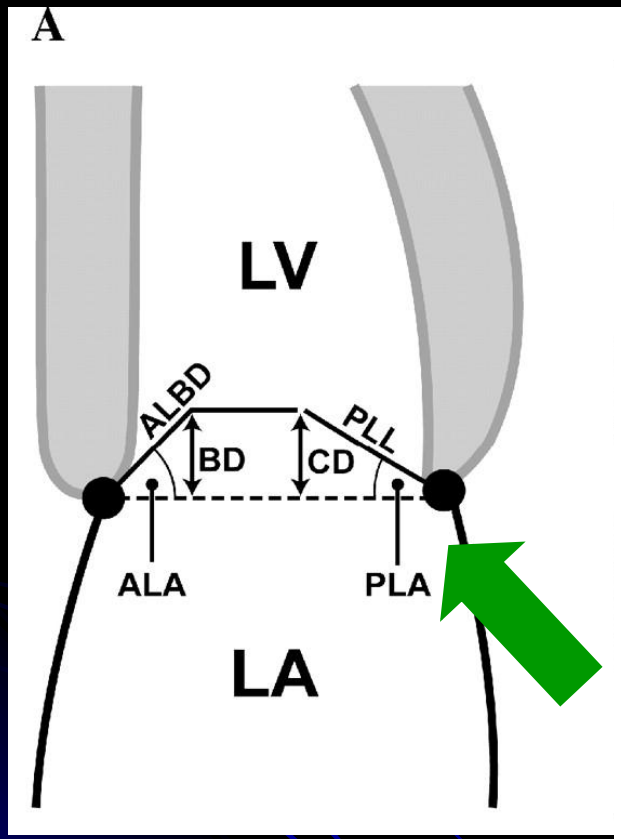
MITRAL VALVE REPLACEMENT

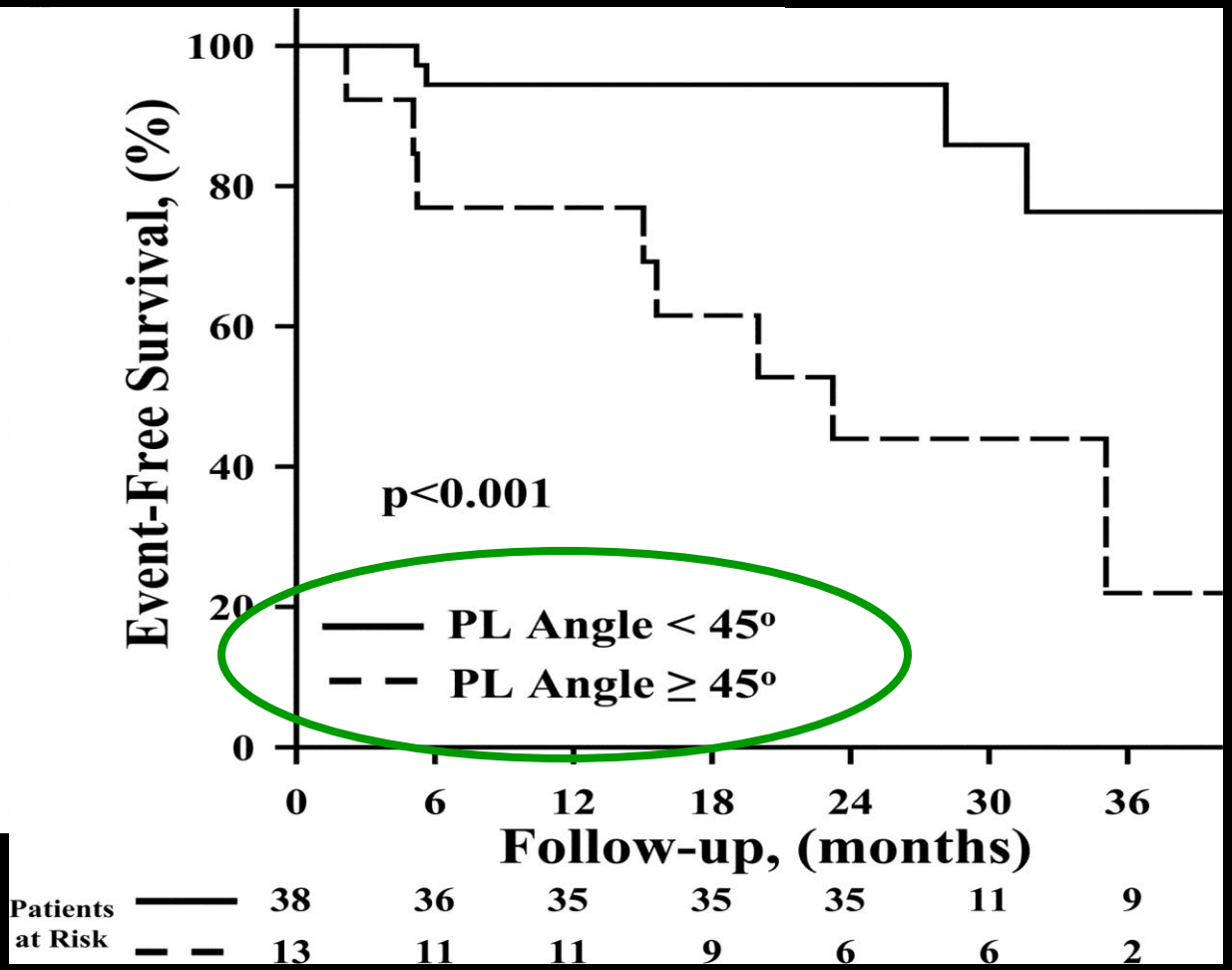
- Degenerative disease (< 10%)
- Rheumatic disease (> 50%)
- Acute endocarditis (if extensive leaflet involvement)
- Functional MR in ischemic or idiopatic CMP(if advanced LV remodeling)

Conditions likely to require mitral valve replacement in dilated CMP

- Complex multiple jets
- Advanced LV remodeling (LVEDD > 70mm)
- Large tenting area
- Coaptation deapth > 1.5 cm.
- PLA> 45°

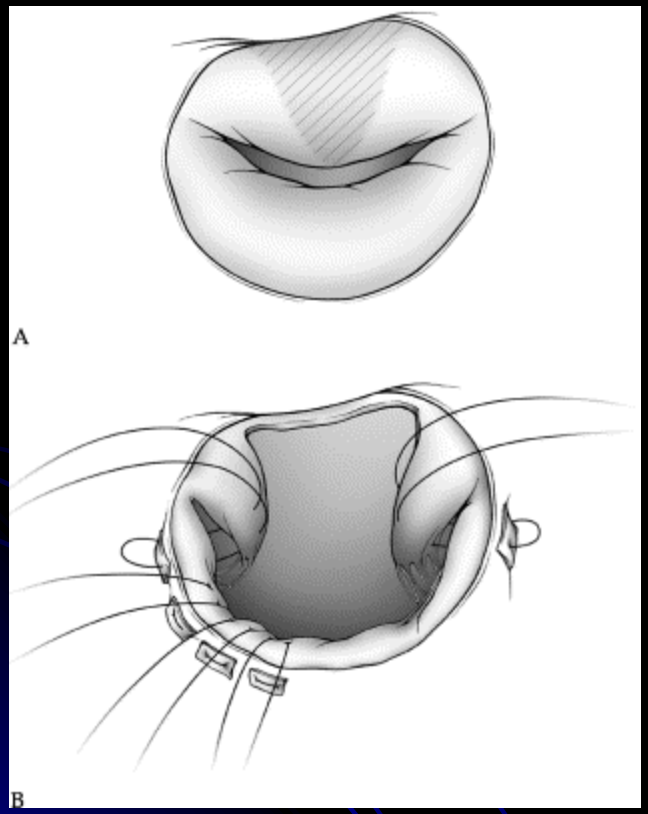
ANNULOPLASTY FOR dilated CMP

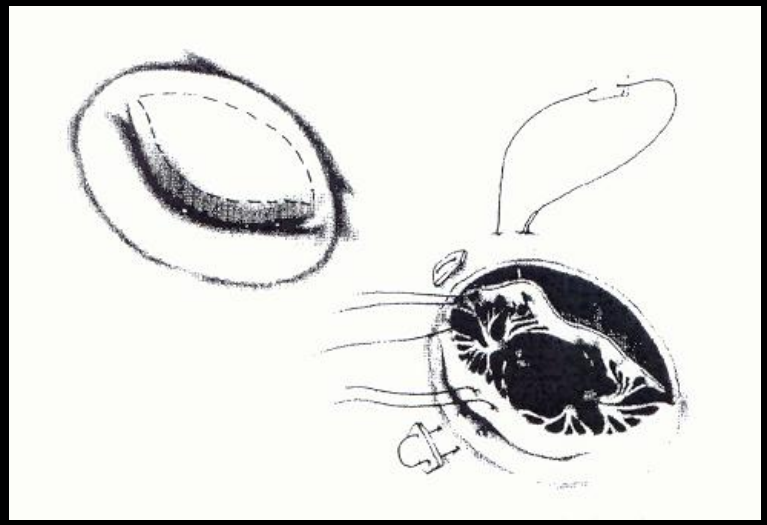


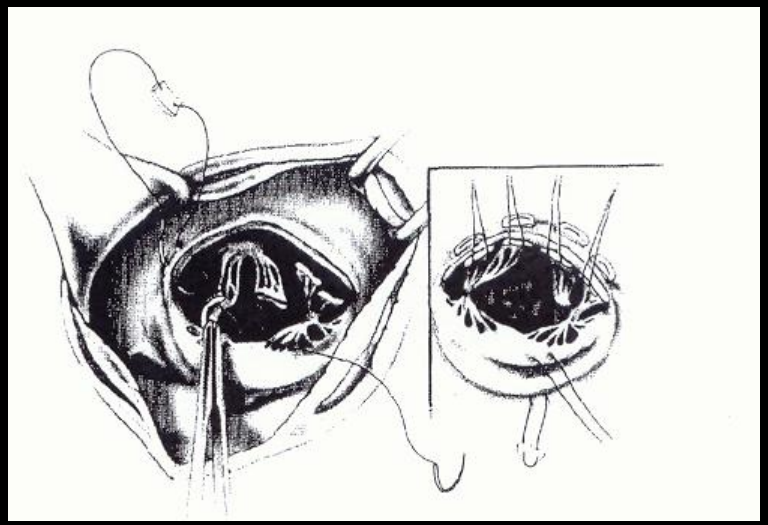


Magne, J. et al. Circulation 2007;115:782-791

CHORDAL PRESERVATION !

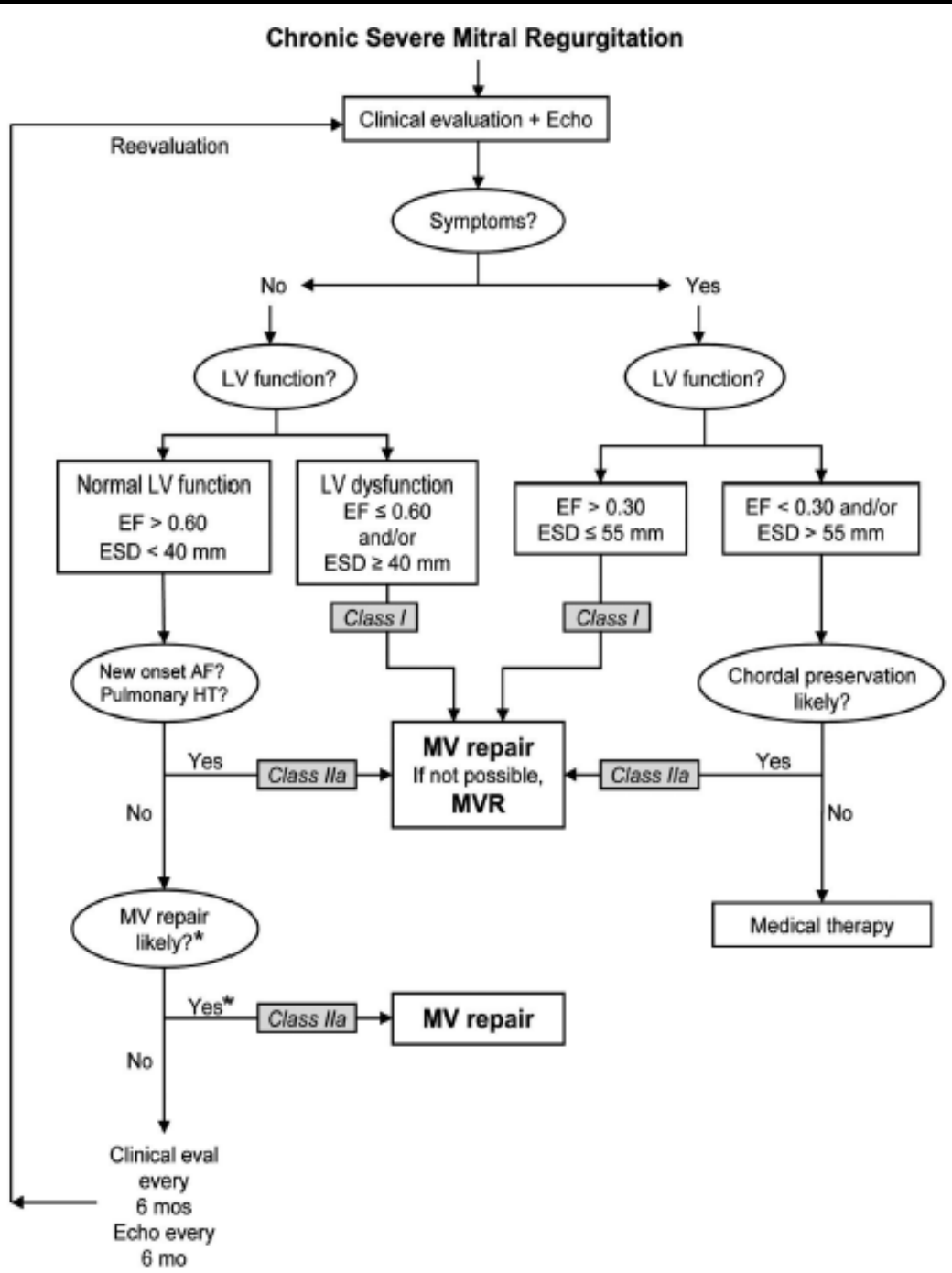






EXPANDED INDICATIONS
for mitral valve repair

(asymptomatic pt. with normal LV function, no AF, no pulmonary hypertension)



ACC/AHA 2006 Guidelines for the Management of patients with Valvular Heart Disease

Class IIa

1. MV repair is reasonable in experienced surgical centers for asymptomatic patients with chronic severe MR* with preserved LV function (ejection fraction greater than 0.60 and end-systolic dimension less than 40 mm) in whom the likelihood of successful repair without residual MR is greater than 90%. *(Level of Evidence: B)*
2. MV surgery is reasonable for asymptomatic patients with chronic severe MR,* preserved LV function, and new onset of atrial fibrillation. *(Level of Evidence: C)*
3. MV surgery is reasonable for asymptomatic patients with chronic severe MR,* preserved LV function, and pulmonary hypertension (pulmonary artery systolic pressure greater than 50 mm Hg at rest or greater than 60 mm Hg with exercise). *(Level of Evidence: C)*
4. MV surgery is reasonable for patients with chronic severe MR* due to a primary abnormality of the mitral apparatus and NYHA functional class III–IV symptoms and severe LV dysfunction (ejection fraction less than 0.30 and/or end-systolic dimension greater than 55 mm) in whom MV repair is highly likely. *(Level of Evidence: C)*

ASYMPTOMATIC MITRAL REGURGITATION WITH NORMAL LV FUNCTION surgical indication

..”the likelihood of successful repair without residual MR is greater than 90%”

ACC/AHA GUIDELINES FOR THE MANAGEMENT OF PATIENTS WITH VALVULAR HEART DISEASE

2006

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Quantitative Determinants of the Outcome of Asymptomatic Mitral Regurgitation

Maurice Enriquez-Sarano, M.D., Jean-François Avierinos, M.D., David Messika-Zeitoun, M.D., Delphine Detaint, M.D., Maryann Capps, R.D.C.S., Vuyisile Nkomo, M.D., Christopher Scott, M.S., Hartzell V. Schaff, M.D., and A. Jamil Tajik, M.D.

Preoperative symptoms in pts. operated for mitral valve prolapse

HSR: 2006-2010

NYHA I-II 50%

PURPOSE OF EARLY MITRAL REPAIR

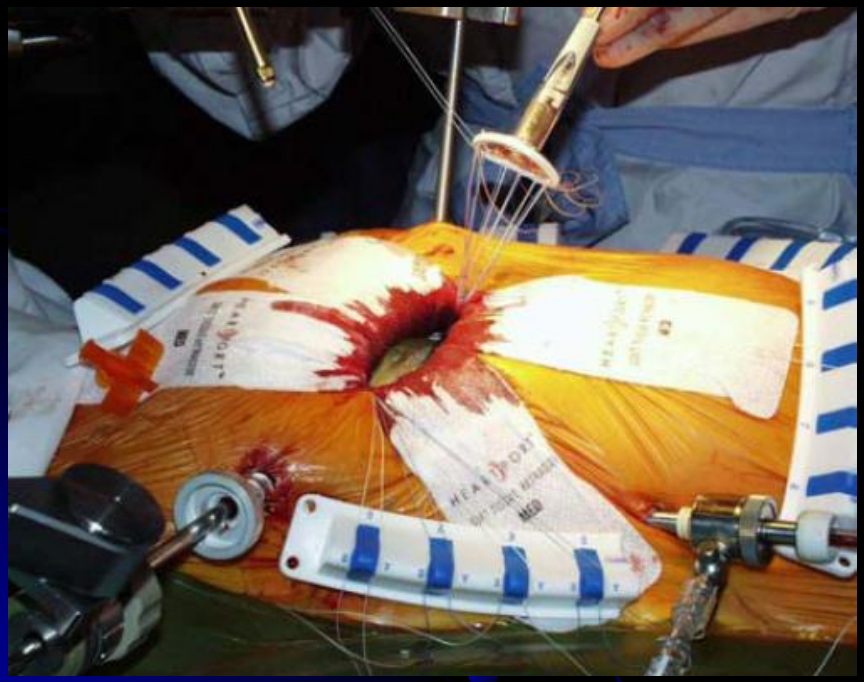
NEUTRALIZE THE DISEASE

SURVIVAL AND QUALITY OF LIFE SIMILAR TO MATCHED POPULATION

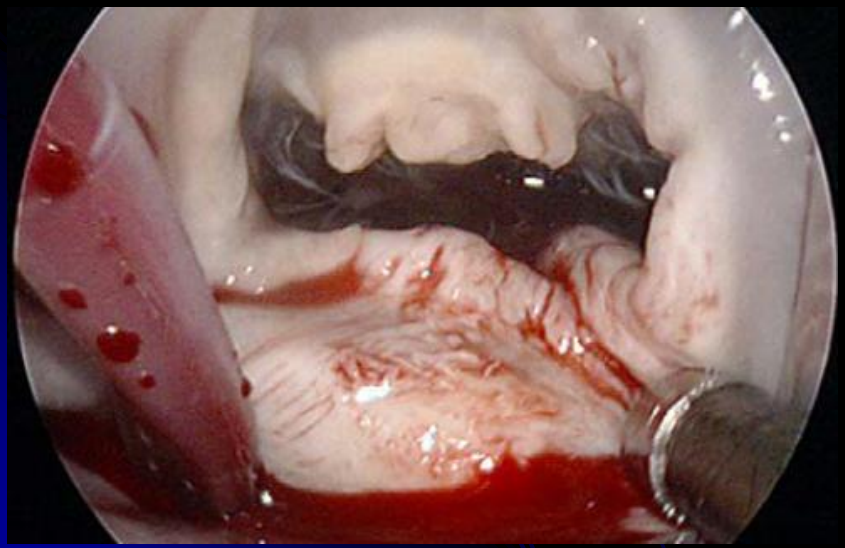
The disease is neutralized when after the operation:

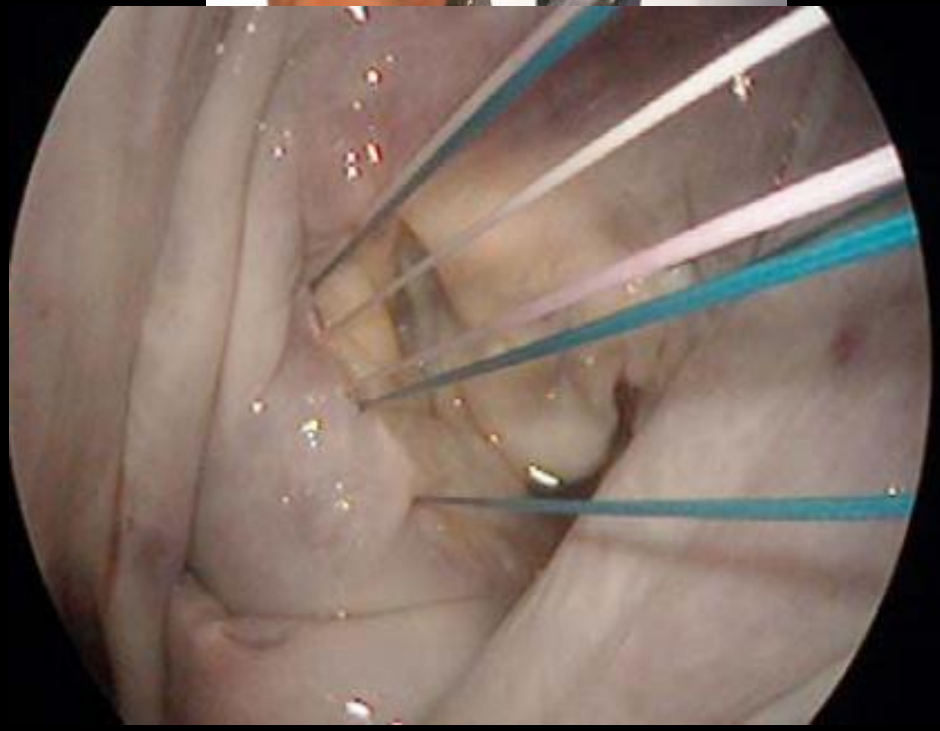
a)Normal ventricular and atrial function
b) No rythm disturbances
c) Perfect long-term valve function

Minithoracotomy



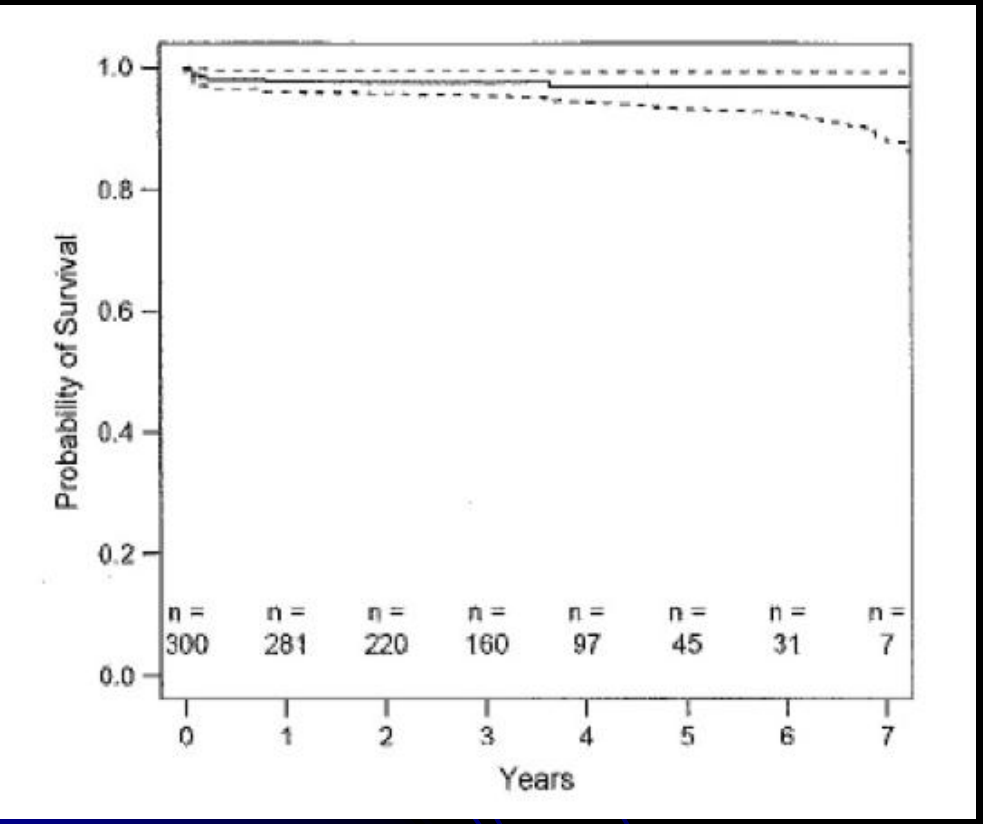
Robot Assisted

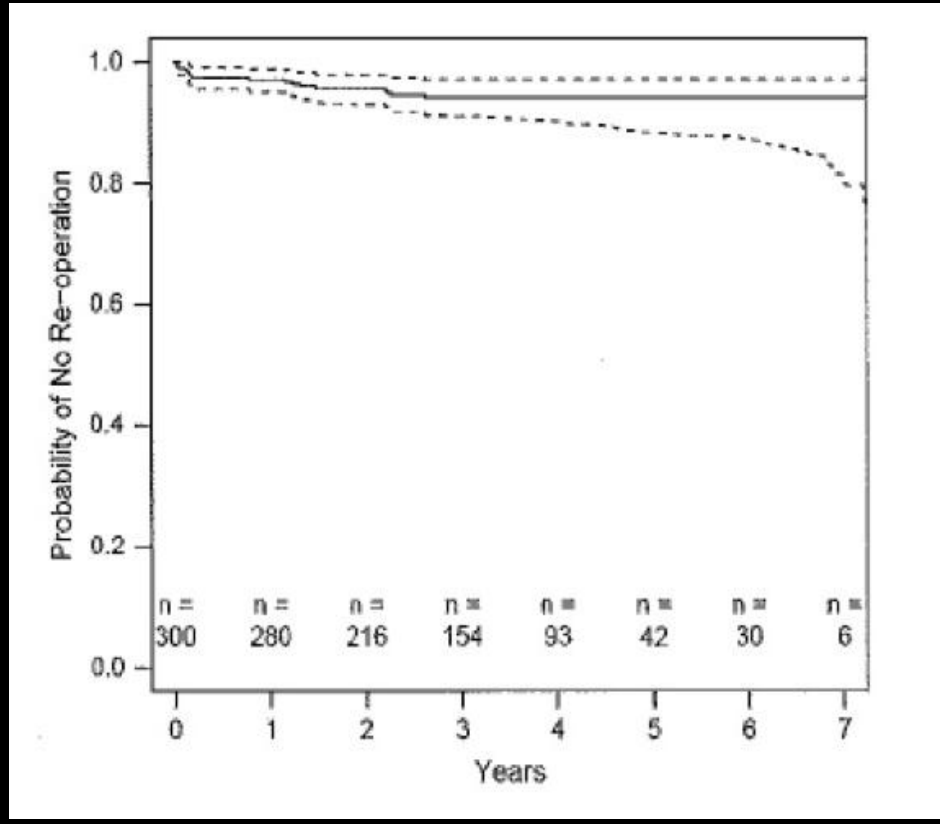




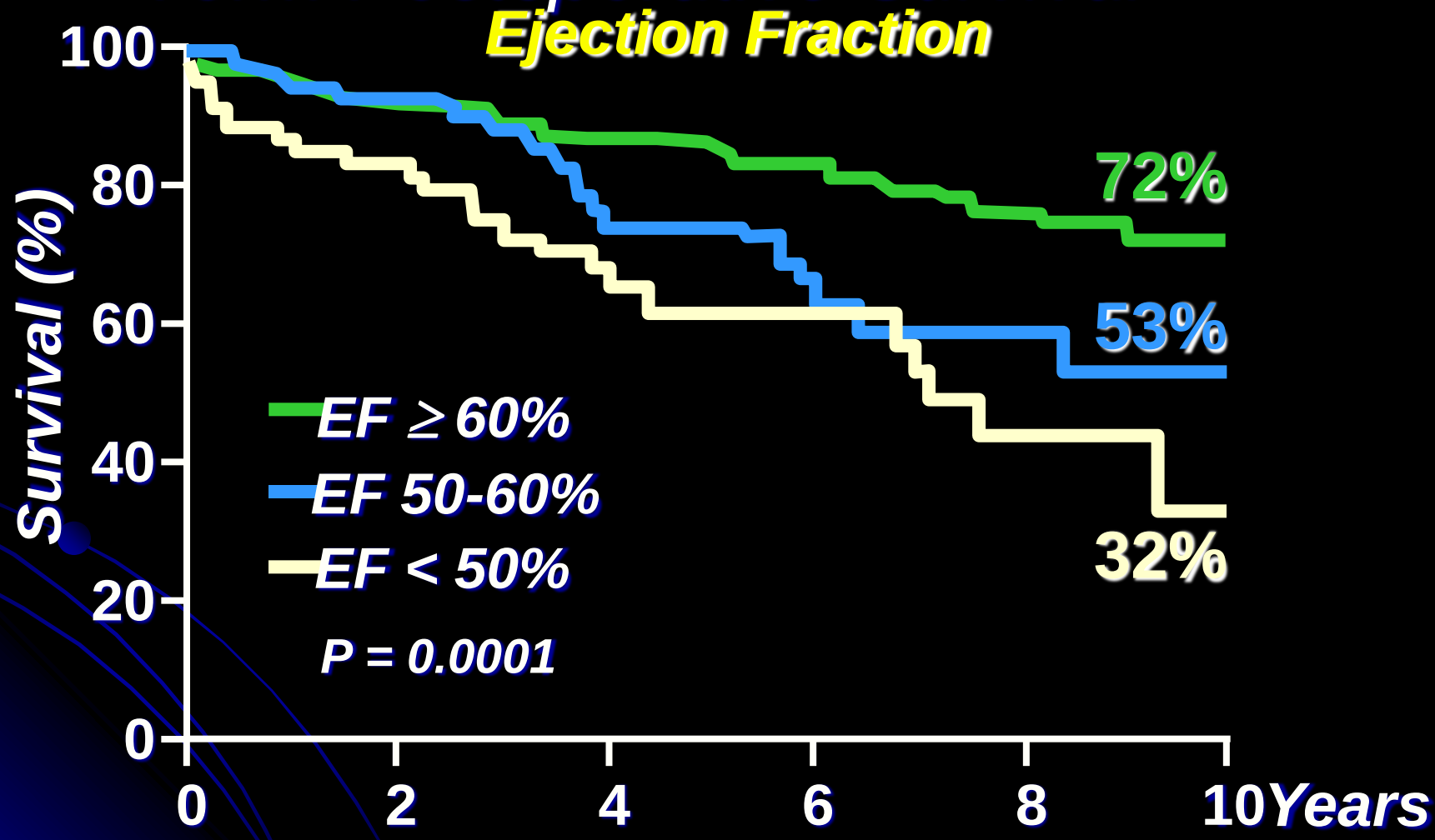
Robotic mitral valve repairs in 300 patients: A single-center experience

W. Randolph Chitwood, Jr, MD,[a] Evelio Rodriguez, MD,[a] Michael W. A. Chu, MD,[a] Ansar Hassan, MD, PhD,[a] T. Bruce Ferguson, MD,[a] Paul W. Vos, PhD,[b] and L. Wiley Nifong, MD[a]





Preoperative LV Function Predicts Long Term Postoperative Survival



Enriquez-Sarano M et al.
Circulation 1994; 90: 830 - 37

An ejection fraction > 60%
Is not a guarantee for an
Optimal result

Table 4. Incidence of Postoperative LV Dysfunction According to Classes of Preoperative LVEF

Preoperative LVEF (%)	<50	<55	<60	≥60	Total
Postoperative LVEF <50% (n)	5	3	2	10	20
Postoperative LVEF ≥50% (n)	4	9	20	118	151
Total (n)	9	12	22	128	171
Incidence of LV dysfunction* (%)	56	25	9	8	12

*Defined as LVEF <50%.
LV = left ventricular; LVEF = left ventricular ejection fraction.

Matsumura T et al.. JACC 2003; 42: 458-63

Table 5. Incidence of Postoperative LV Dysfunction Stratified by Preoperative LVDs

Preoperative LVDs (mm)	<30	<35	<40	<45	≥45	Total
Postoperative LVEF <50% (n)	1	4	3	5	7	20
Postoperative LVEF ≥50% (n)	15	48	54	18	16	151
Total (n)	16	52	57	23	23	171
Incidence of LV dysfunction* (%)	6	8	5	22	30	12

*Defined as LVEF <50%.
Abbreviations as in Tables 2 and 4.

Alterations in Transmural Myocardial Strain

An Early Marker of Left Ventricular Dysfunction in Mitral Regurgitation?

Carl J. Carlhäll, MD, PhD; Tom C. Nguyen, MD; Akinobu Itoh, MD; Daniel B. Ennis, PhD; Wolfgang Bothe, MD; David Liang, MD, PhD; Neil B. Ingels, PhD; D. Craig Miller, MD

Background—In asymptomatic patients with severe isolated mitral regurgitation (MR), identifying the onset of early left ventricular (LV) dysfunction can guide the timing of surgical intervention. We hypothesized that changes in LV transmural myocardial strain represent an early marker of LV dysfunction in an ovine chronic MR model.

Methods and Results—Sheep were randomized to control (CTRL, n=8) or experimental (EXP, n=12) groups. In EXP, a 3.5- or 4.8-mm hole was created in the posterior mitral leaflet to generate "pure" MR. Transmural beadsets were inserted into the lateral and anterior LV wall to radiographically measure 3-dimensional transmural strains during systole and diastolic filling, at 1 and 12 weeks postoperatively. MR grade was higher in EXP than CTRL at 1 and 12 weeks (3.0 [2–4] versus 0.5 [0–2]; 3.0 [1–4] versus 0.5 [0-1], respectively, both $P<0.001$). At 12 weeks, LV mass index was greater in EXP than CTRL (201±18 versus 173±17 g/m^2; $P<0.01$). LVEDVI increased in EXP from 1 to 12 weeks ($P=0.015$). Between the 1 and 12 week values, the change in BNP (−4.5±4.4 versus −3.0±3.6 pmol/L), PRSW (9±13 versus 23±18 mm Hg), tau (−3±11 versus −4±7 ms), and systolic strains was similar between EXP and CTRL. The changes in longitudinal diastolic filling strains between 1 and 12 weeks, however, were greater in EXP versus CTRL in the subendocardium (lateral: −0.08±0.05 versus 0.02±0.14; anterior: −0.10±0.05 versus −0.02±0.07, both $P<0.01$).

Conclusions—Twelve weeks of ovine "pure" MR caused LV remodeling with early changes in LV function detected by alterations in transmural myocardial strain, but not by changes in BNP, PRSW, or tau. (***Circulation***. **2008;118[suppl 1]:S256–S262.**)

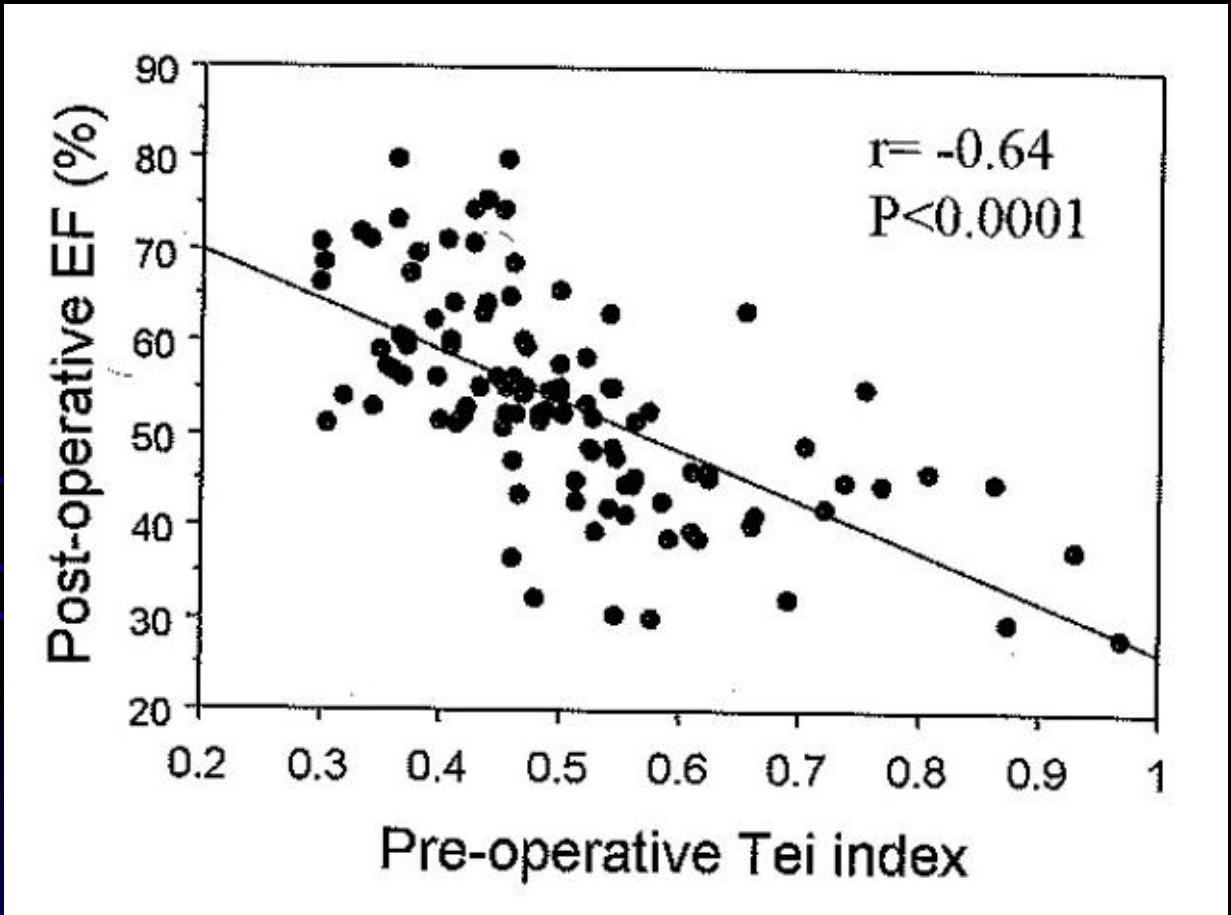
Doppler-Derived Mitral Regurgitation Volume as a Predictor of Postoperative Left Ventricular Dysfunction after Mitral Valve Repair in Patients with Preoperatively Normal Left Ventricular Function

Tetsuhiro Yamano, A. Marc Gillinov, Cleveland Clinic Foundation, Cleveland, OH; Nozomi Wada, Kawasaki Med Sch, Kurashiki, Japan; Yoshiki Matusmura, Manatomo Toyono, Takahiro Shiota; Cleveland Clinic Foundation, Cleveland, OH

We anecdotally encounter postoperative left ventricular (LV) dysfunction after surgical correction for mitral regurgitation (MR), despite preoperative ejection fraction (EF) and end-systolic dimension (LVDs) meeting the current guidelines. We sought to clarify if Doppler-derived MR volume could be predictive of "unexpected" LV dysfunction after mitral valve (MV) repair. We retrospectively analyzed pre- and post-operative (median 4th postoperative day) echocardiograms of consecutive 161 patients (104 men, age 57±13 years) who underwent MV repair for pure and isolated MR, and had preoperatively normal LV function, defined as both EF >60% and LVDs <40 mm according to the current class I indication for surgical MV correction. Quantification of MR volume was performed by the quantitative Doppler and/or proximal isovelocity surface area method. Postoperative LV dysfunction, defined as EF <50%, was noted in 32 patients (20%). In patients with postoperative LV dysfunction, preoperative MR volume was larger than those without [95 (interquartile range 85 to 101) vs. 62 (52 to 73) mL, $P<0.001$], as well as LVDs and LV end-diastolic and left atrial dimension. However, preoperative EF was not significantly different between these 2 groups [67 (63 to 73) vs. 69 (65 to 74) %, $P=0.079$]. Echocardiographic independent predictor of LV dysfunction was MR volume, as well as LVDs (TABLE). Using optimal cutoff value of 80 mL for MR volume combined with that of 35 mm for LVDs, we could predict postoperative LV dysfunction more accurately than using the value for only LVDs (correct classification rate of 0.87, 95% confidence interval 0.82 to 0.92 vs. those of 0.70, 0.63 to 0.77, $P<0.001$). Doppler-derived MR volume could be a powerful predictor of unexpected postoperative LV dysfunction. Earlier indication of MV repair than the current guidelines may prevent postoperative LV dysfunction in patients with LVDs >35 mm and MR volume >80 mL

Preoperative Detection of Left Ventricular Dysfunction by Doppler Time Analysis Including Tei Index in Normal Ejection Fraction Patients with Mitral Regurgitation

Kunitsugu Takasaki, Tetsuhiro Yamano, A. Marc Gillinov, Yoshiki Matsumura, Manatomo Toyono, Roberto M Saraiva, Takahiro Shiota; Cleveland Clinic, Cleveland, OH

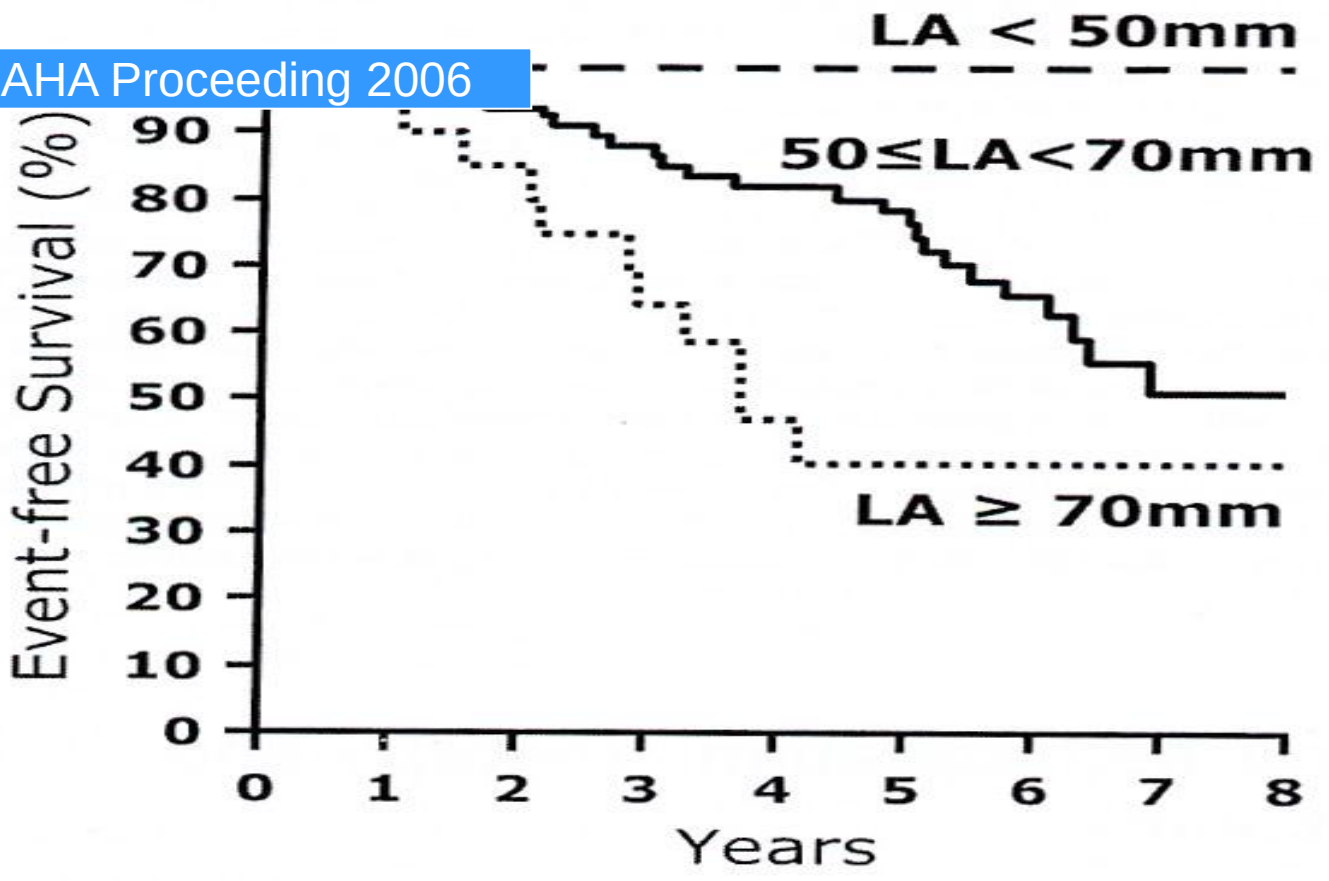


Left Atrium: the neglected chamber !

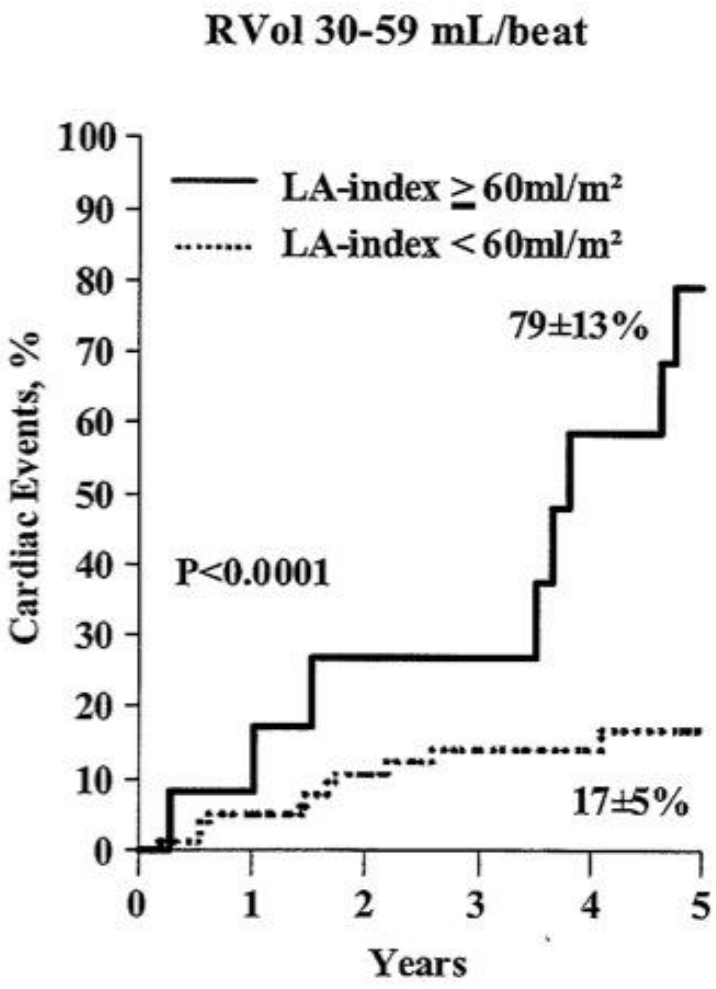
Left Atrial Size F
Regurgitation

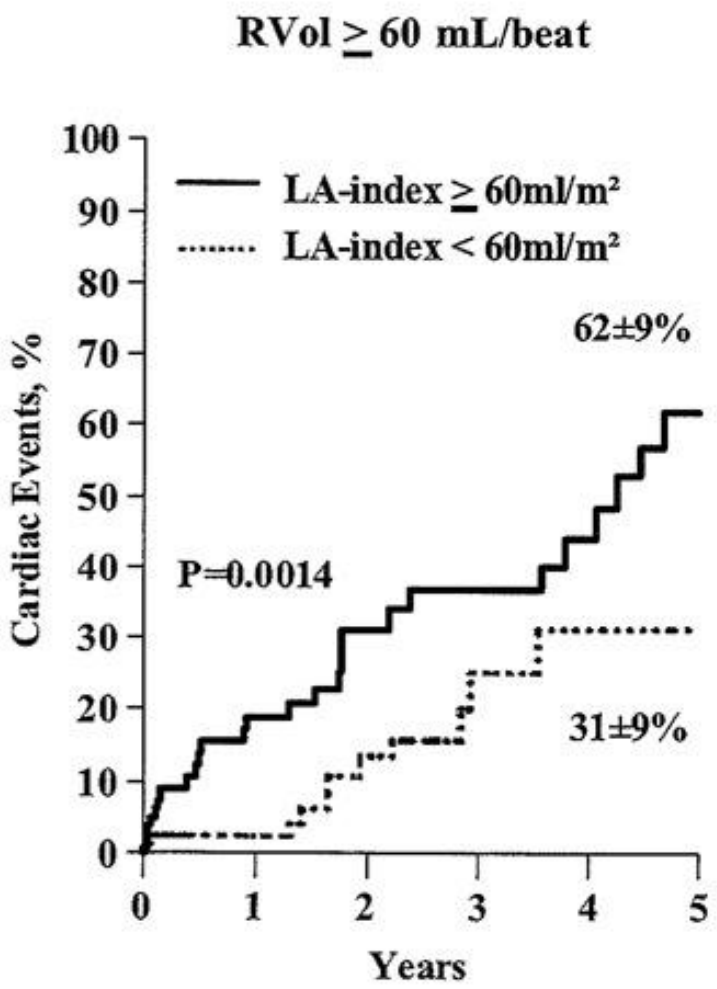
AHA Proceeding 2006

Raphael Rosenhek, I
Klaar, Gerald Maurer



Background: Left
ventricular remodelir
proposed to be a p
function. However,
dysfunction among
asymptomatic pts (a
function were prospe
and echocardiograph
size, LV diameter, pu
event-free survival
symptoms or LV dys
78±4% at 4yrs, 65±5 at 6 yrs and 55±6% at 8 yrs. LA size was the strongest independent predictor of outcome: No events were observed in the group with a LA < 50 mm. Event-free survival for patients with LA 50 to 69 mm was 94±3% at 2 yrs, 82±5% at 4 and 51±8% at 8 yrs versus 85±8% at 2 yrs, 47±12% at 4yrs and 40±12% at 8 yrs for patients with a LA ≥ 70 mm (p=0.0001). None of the other studied parameters reached significance as predictors of outcome in multivariate analysis. **Conclusion:** LA size is a strong and independent predictor of outcome in patients with asymptomatic severe MR. Patients can be stratified by LA size into groups at low, intermediate and high risk for subsequent symptom or LV dysfunction development, requiring surgery.

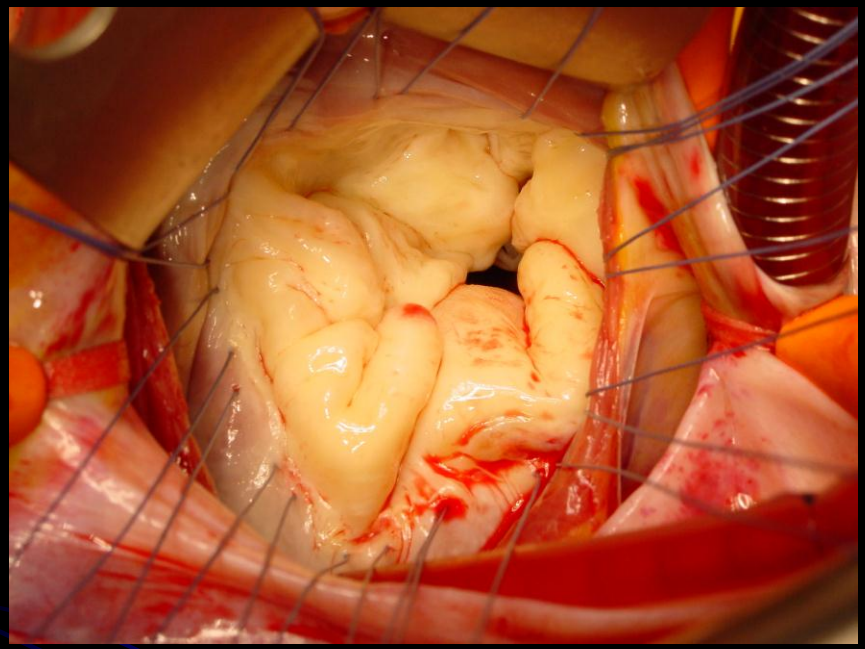




Mayo Clinic : unpublished data

TECHNIQUES

Barlow



Age < 60 yrs
Long history of murmur > 5yrs
Excess of tissue
Billowing valve
Myxoid degeneration

*Barlow 1965

FED

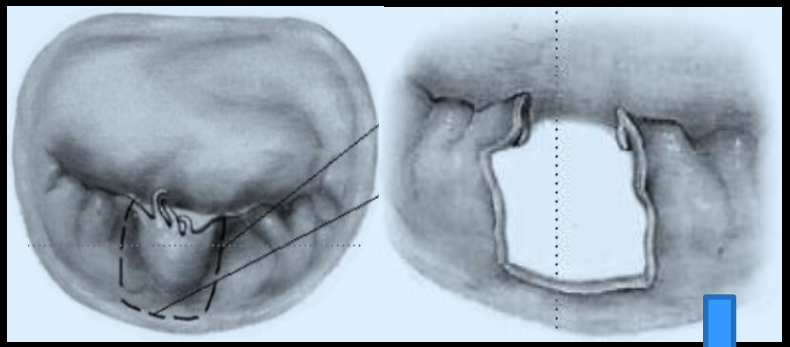
Age > 60 yrs
Brief history of murmur (few yrs)
No excess of tissue
No billowing
Collagen, elastin degeneration

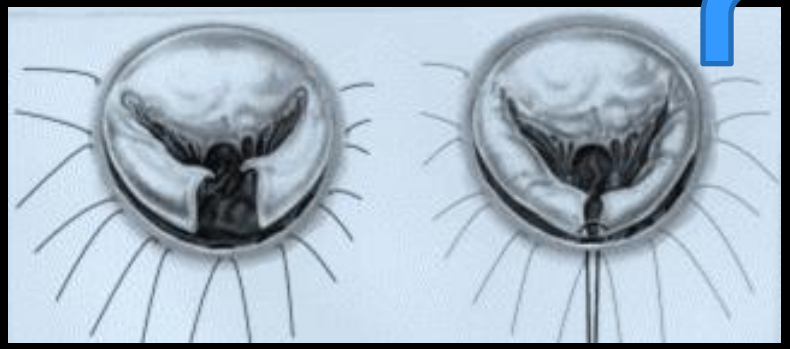
**Carpentier 1974

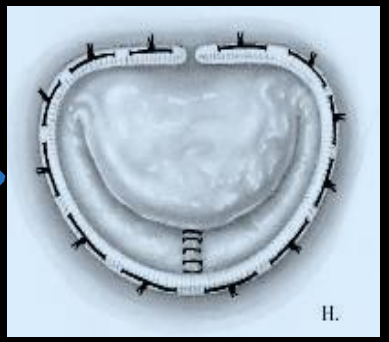
Posterior leaflet prolapse/flail

- Quadrangular resection
- Triangular resection
- Sliding plasty
- Chordal replacement
- Haircut technique
- Folding plasty
- ….

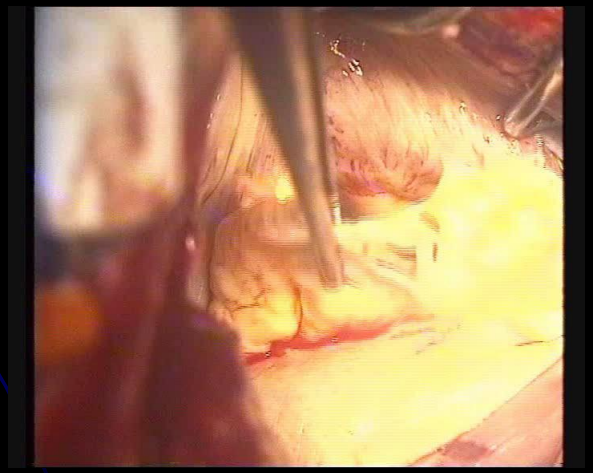
Quadrangular resection

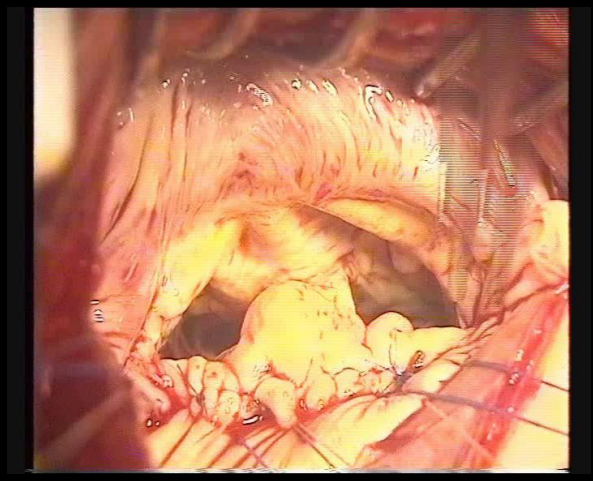






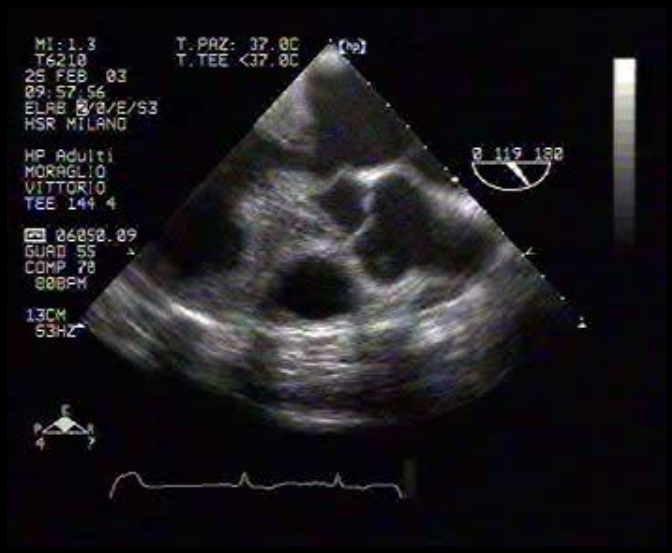
Sliding plasty





Anterior and Bileaflet disease

- Chordal replacement
- Quadrangular resection-sliding
- Alfieri / E2E
- Chordal transfer
- Papillary muscle repositioning
- Triangular resection
- …..

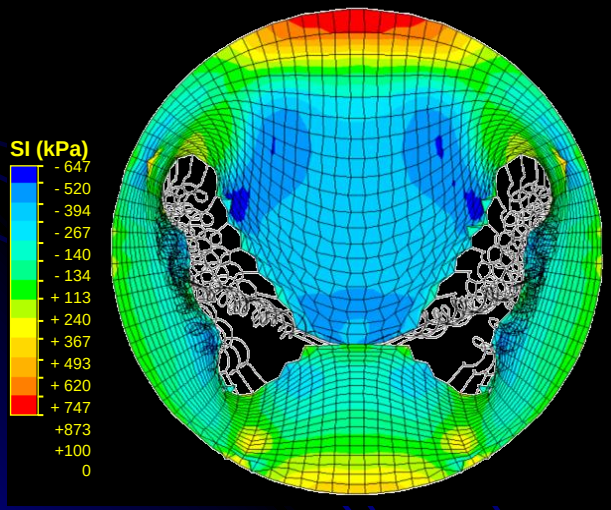


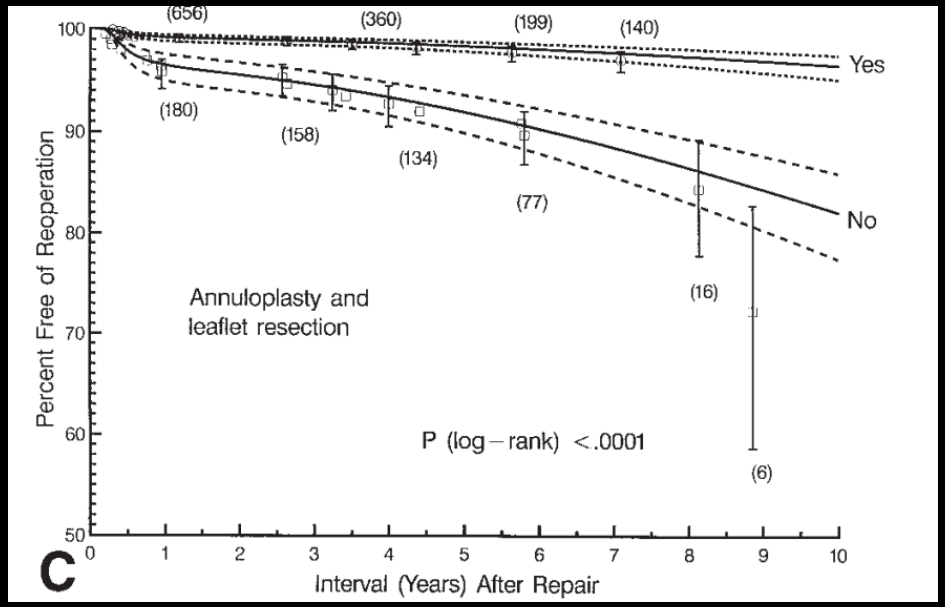
POSTHETIC RING ANNULOPLASTY

- Reduce the annular dimensions
- Improve coaptation lenght
- Stabilize the repair

PROSTHETIC RING ANNULOPLASTY

- Annuloplasty is routinely performed during MV repair
- Annuloplasty reduces stresses on the suture and on the valve structures
- Lack of annuloplasty is associated to accelerated failure in the overall surgical population





Maisano F, et al Eur J Cardiothorac Surg. 1999;15:419-25
Gillinov et al J Thorac Cardiovasc Surg 1998;116:734-43

Risk of SAM after repair

Conditions favoring SAM

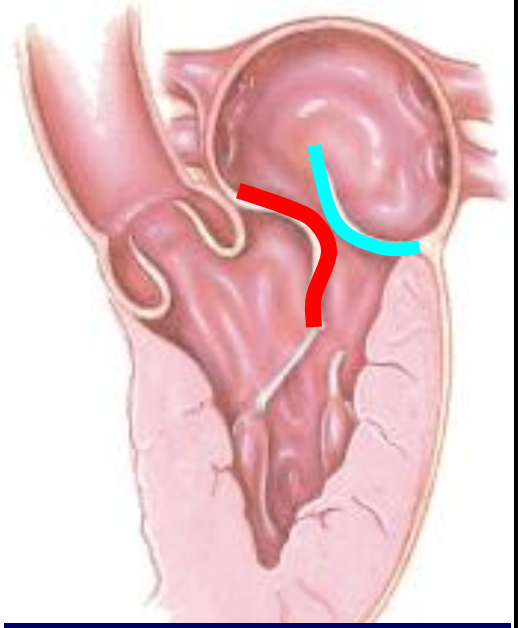
The mitro-aortic angle is narrower than normal (130°)

The left ventricle is small

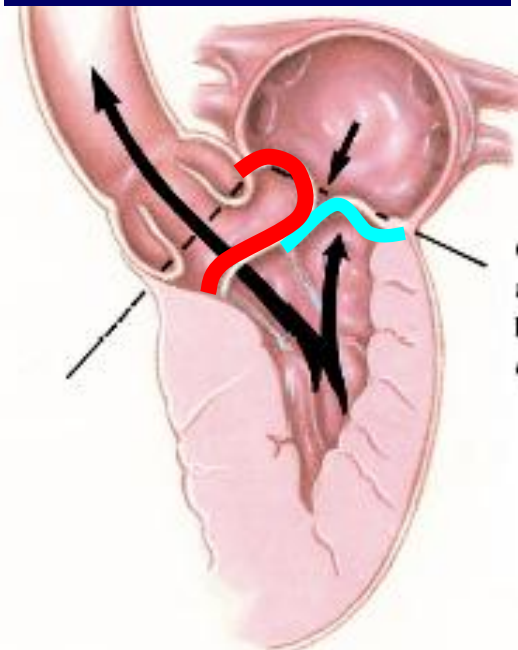
High of PL > 2 cm

Precautions to avoid SAM

- Remove excess PL tissue
- Use a large ring



- Excess tissue of the mural leaflet is defined whenever the height of the leaflet is > 1 cm.



Obtain optimal coaptation / Avoid SAM

Adjustable rings

Mitral Solutions

Micardia

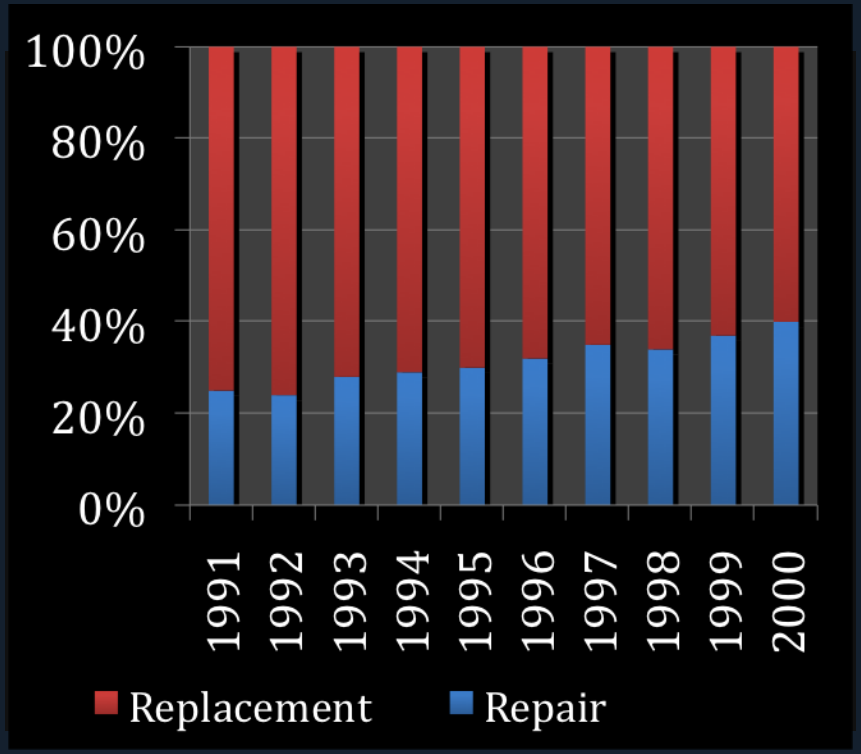
Valtech

RESULTS

Hospital mortality and repair rate

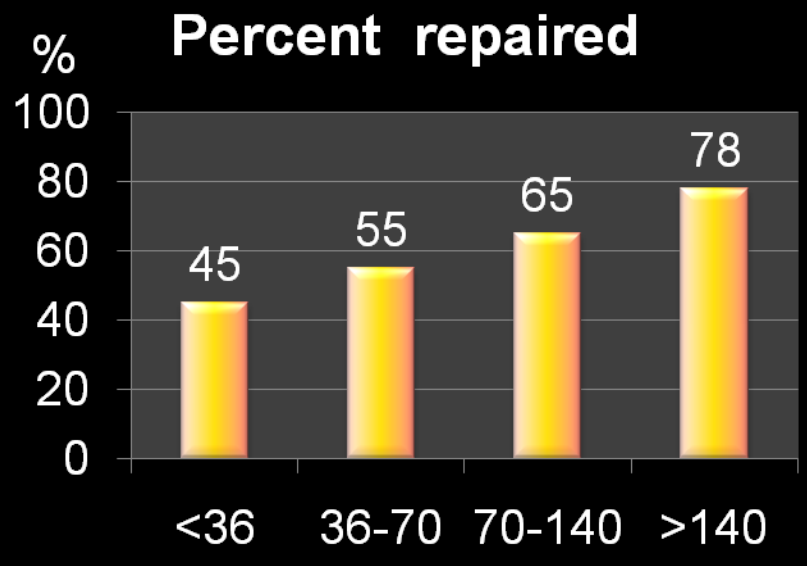
STS National Adult Cardiac Database

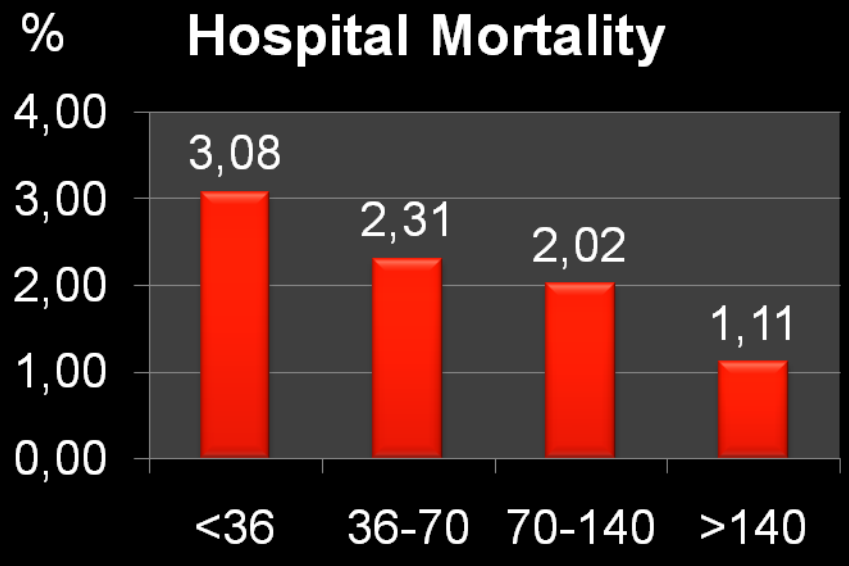
- Hospital mortality for isolated first time elective MV repair is 2.5% (males) to 3.9% (females)
- Operative risk is higher in elderly pts, associated CABG, NYHA III-IV, low EF and reoperation



Savage EB, et al Ann Thorac Surg 2003;75:820–5

Influence Of Hospital Volumes on Repair Prevalence and Risk





13.614 patients having elective isolated MR surgery between 2000 and 2003 in 575 US centers participating in the STS National Cardiac Database

Gamie et al. Circulation. 2007;115:881-887

Age and comorbidities

- Older age is associated to
  - Higher mortality
  - Higher morbidity
  - Longer LOS

Table 3. Outcomes

Characteristics	< 50 years	50–59 years	60–69 years	70–79 years	≥ 80 years
Sample size	4315	5037	8472	11144	2720
Complications (%)	13.51	17.79	23.11	29.47	35.48
Permanent stroke (%)	1.23	1.79	2.70	4.16	4.52
Prolonged ventilation (%)	8.20	11.83	16.09	20.21	24.56
Reoperation for bleeding (%)	3.75	4.61	5.21	6.74	8.53
Renal failure (%)	3.87	5.74	8.23	11.28	15.22
Deep sternal wound infection (%)	0.44	0.75	0.74	0.68	0.51
Length of stay (d)					
Mean (SD)	11.43 (12.23)	12.36 (13.52)	13.32 (13.20)	15.18 (14.66)	16.31 (14.13)
Postoperative length of stay (d)					
Mean (SD)	8.71 (9.74)	9.69 (11.04)	10.58 (11.37)	12.21 (13.11)	13.22 (13.17)
Operative mortality (%)	4.08	5.46	7.91	12.19	16.99

SD = standard deviation.

Mehta et al. Ann Thorac Surg 2002;74:1459-67


LONG-TERM SURVIVAL

Very Long Term Survival >20 years in 162 pts

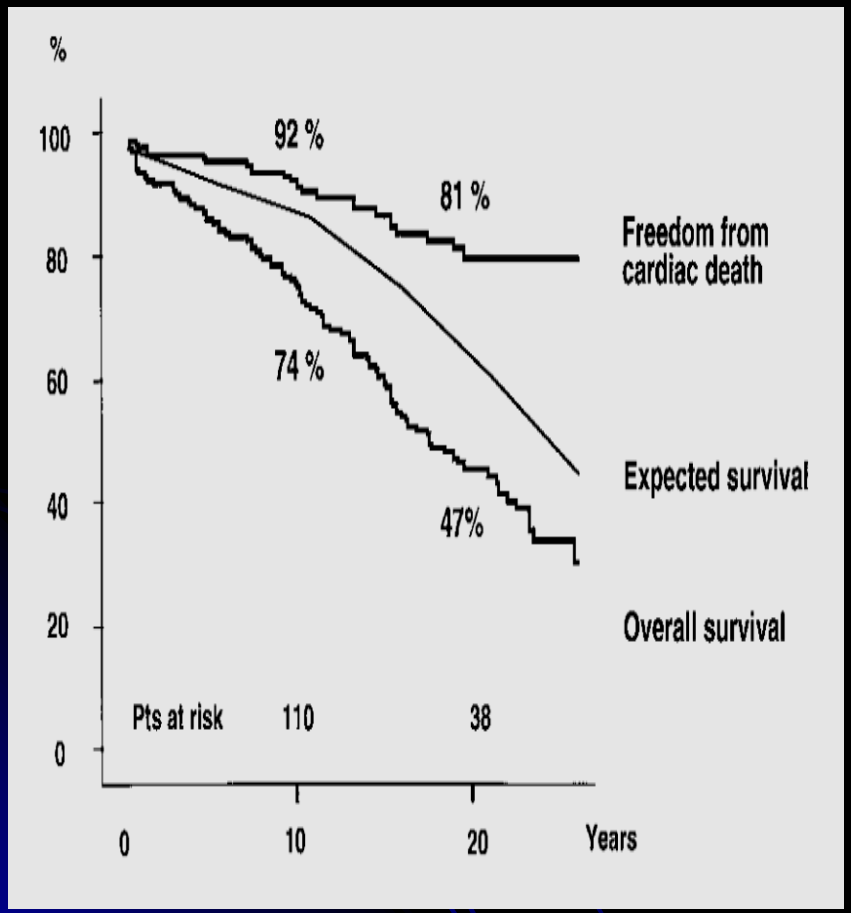


TABLE 2. Causes of Death

Cause	No. of Patients
Cardiac	
Heart failure	11
Sudden death	10
Cerebrovascular accident	2
Reoperation	1
Total	24
Noncardiac	
Malignancy	19
Neurologic	9
Motor vehicle accident	5
Infection	4
Cirrhosis	3
Respiratory disease	3
Pulmonary embolism	2
Suicide	1
Other	19
Total	65
Overall total	89

Braunberger, et al
Circulation. 2001;104[suppl I]:I-8-I-11.

Preoperative Symptoms and Long Term Survival

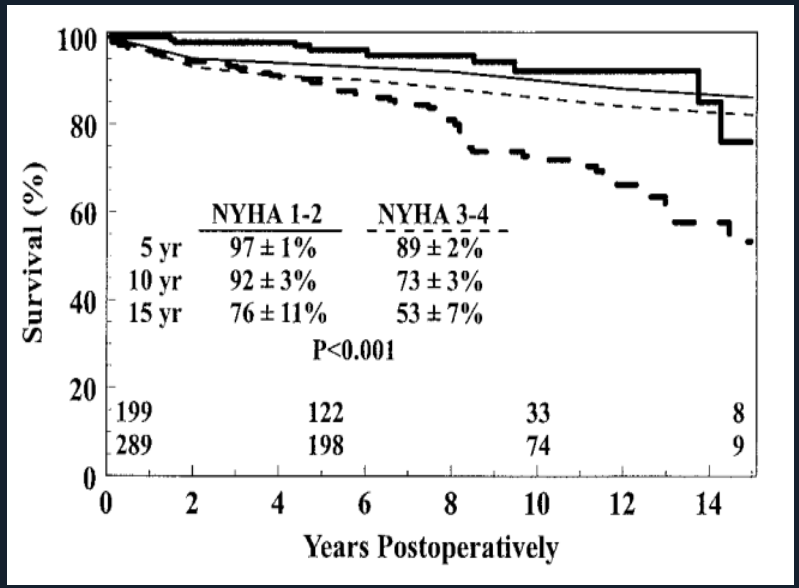
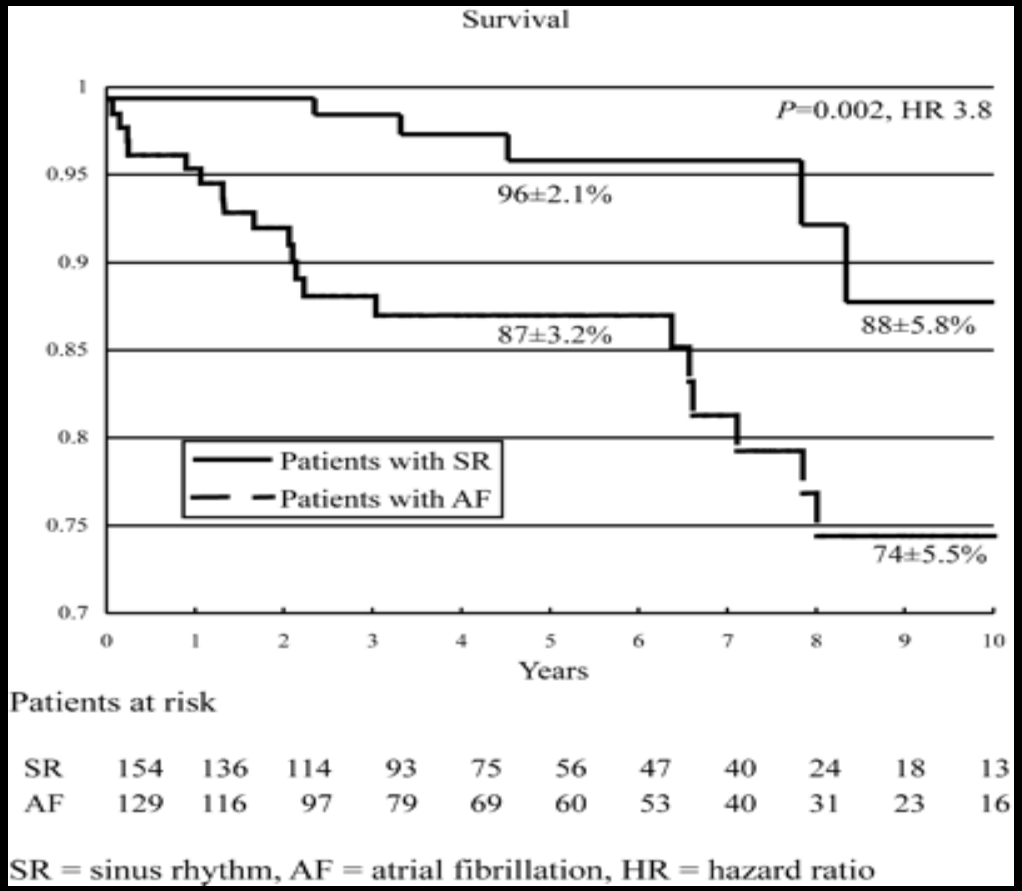


TABLE 5. Kaplan-Meier estimates of freedom from valve-related deaths, cardiac deaths, and other deaths

Freedom from:	5 y	10 y	15 y	*P* value*
Valve-related death				
NYHA 1-2	100	100	92 ± 2	.008
NYHA 3-4	97 ± 1	94 ± 3	86 ± 5	
Cardiac death				
NYHA 1-2	99 ± 1	99 ± 1	89 ± 9	.005
NYHA 3-4	97 ± 1	92 ± 2	88 ± 4	
Other death				
NYHA 1-2	98 ± 1	93 ± 3	93 ± 3	.016
NYHA 3-4	97 ± 1	85 ± 3	72 ± 7	

- **If mitral repair is performed before the onset of symptoms (congestive heart failure, arrhythmias), life expectancy is restored**

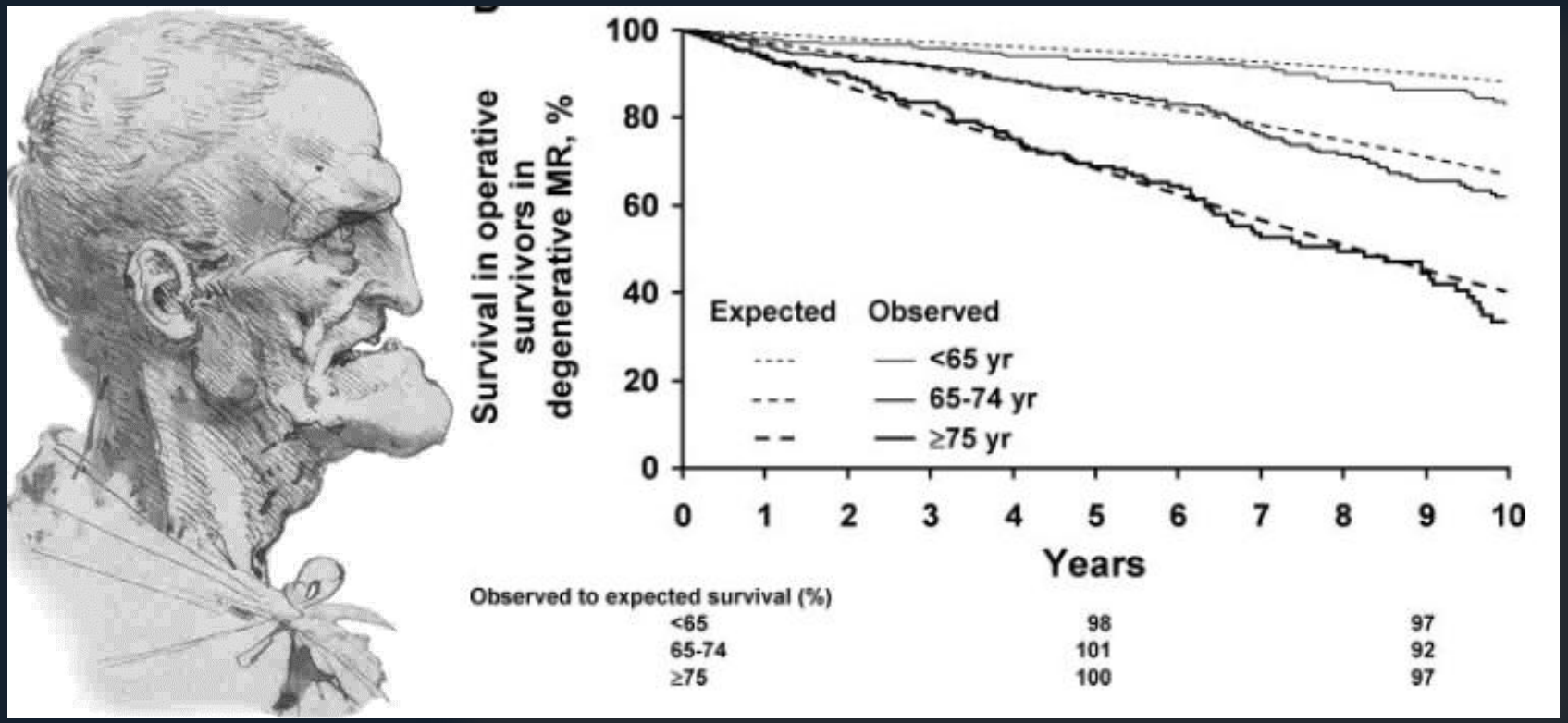
David T et al,
J Thorac Cardiovasc Surg 2003;125:1143-52



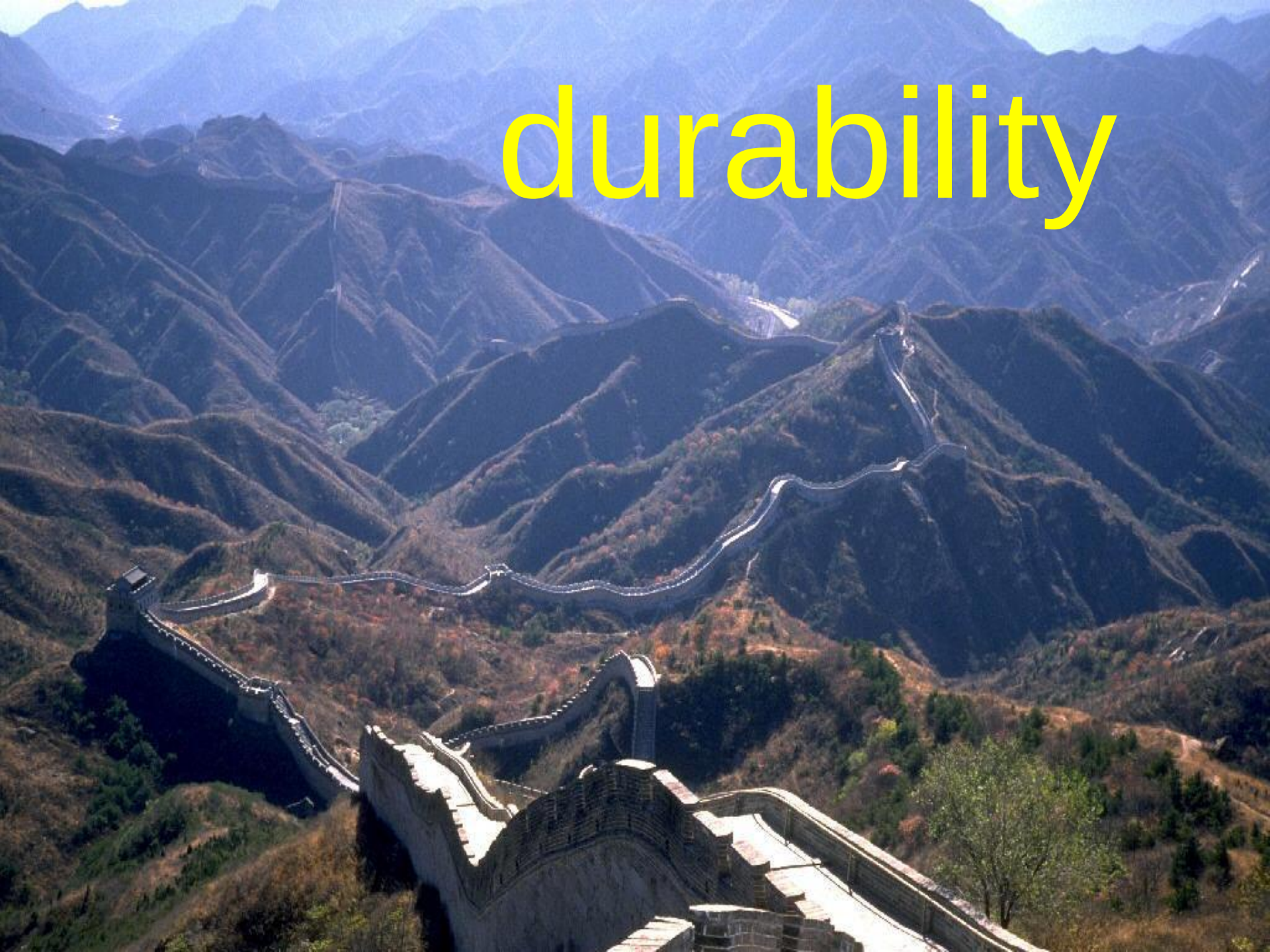
Pre-operative atrial fibrillation as the key determinant of outcome of mitral valve repair for degenerative mitral regurgitation

Eguchi K,et al: Eur Heart J 2005

- If repair is carried out before symptoms LV dysfunction and AF, normal life expectancy is observed at any age



Detaint, et al.
Circulation. 2006;114:265-272


durability

Recurrence of Mitral Valve Regurgitation After Mitral Valve Repair in Degenerative Valve Disease

Willem Flameng, MD, PhD; Paul Herijgers, MD, PhD; Kris Bogaerts, MSc

***Background*—**Durability assessment of mitral valve repair for degenerative valve incompetence is actually limited to reoperation as the primary indicator, with valve-related risk factors for late death as a secondary indicator. We assessed serial echocardiographic follow-up of valve function as an indicator of the durability of mitral valve repair.

***Methods and Results*—**In 242 patients who had undergone mitral valve repair for degenerative valve incompetence, echocardiographic follow-up of valve function, rate of reoperation, survival, and clinical outcome was studied. At 8 years after repair, clinical outcome was excellent, survival was 90.9±3.2%, freedom from reoperation was 94.2±2.3%, and freedom from anticoagulation bleeding and thromboembolic events was 90.4±2.7%. However, freedom from non-trivial mitral regurgitation (>1/4) was 94.3±1.6% at 1 month, 58.6±4.9% at 5 years, and 27.2±8.6% at 7 years. Freedom from severe mitral regurgitation (>2/4) was 98.3±0.9% at 1 month, 82.8±3.8% at 5 years and 71.1±7.4% at 7 years. The linearized recurrence rate of non-trivial mitral regurgitation (>1/4) was 8.3% per year and of severe mitral regurgitation (>2/4) was 3.7% per year. Inadequate surgical techniques (chordal shortening, no use of annuloplasty ring or sliding plasty) could only partially explain recurrence of regurgitation. In selected patients who did not have these risk factors, linearized recurrence rates were 6.9% per year and 2.5% per year, respectively.

***Conclusion*—**The durability of a successful mitral reconstruction for degenerative mitral valve disease is not constant, and this should be taken into account when asymptomatic patients are offered early mitral valve repair. **(*Circulation*. 2003; 107:1609-1613.)**

Key Words: echocardiography ■ mitral valve ■ follow-up studies ■ valvuloplasty

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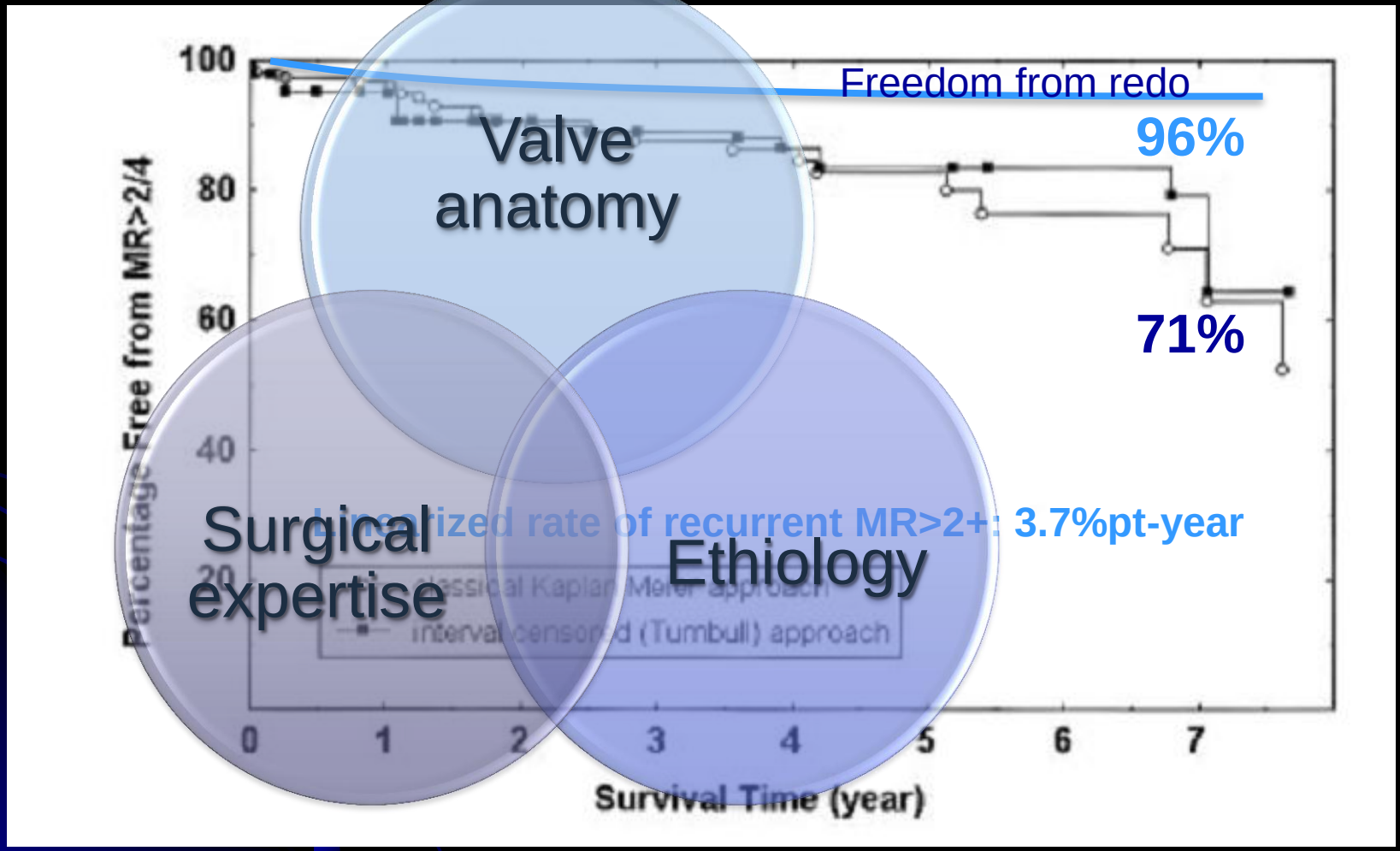
Flameng W, et al.
Circulation. 2003;107:1609-1613

Durability: Freedom from recurrent MR>2+



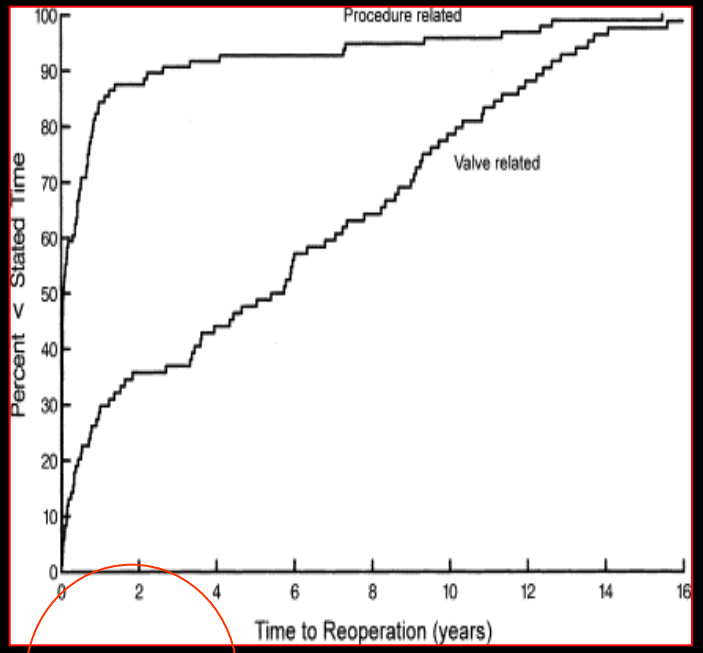
Flameng W, et al.
Circulation. 2003;107:1609-1613

Mechanisms of Repair Failure

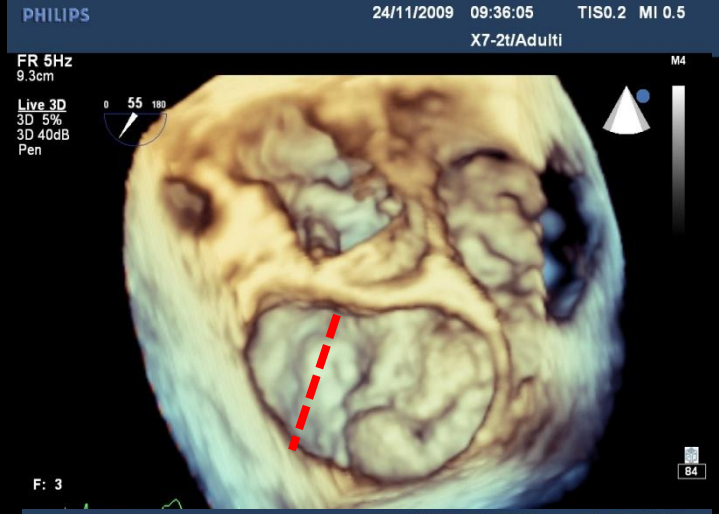
- **Procedure related** 96
  - Suture dehiscence 40
  - Hemolysis 21
  - Chordal shortening 20
  - Systolic Anterior Motion 20
  - Incomplete initial repair 11
- **Valve related** 109
  - Progressive degeneration 100---→prolapse
  - Endocarditis 11
  - Unknown 8

Early failure

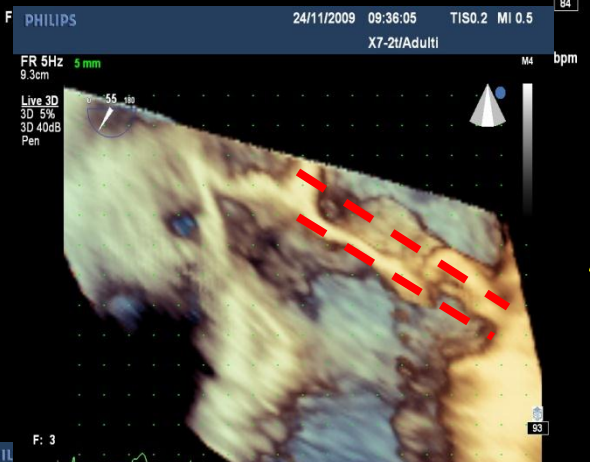
Late failure



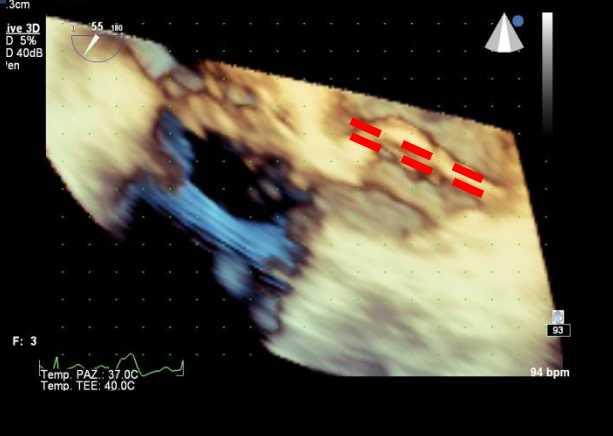
Dumont E, et al: Reoperation after mitral valve repair for degenerative disease Ann Thorac Surg 2007;84: 444-50



A1-P1
(normal)



A2-P2
Prolapse A2-P2
5 mm (dominant)



A3-P3
Prolapse A3
2 mm (secondary)


Thank you

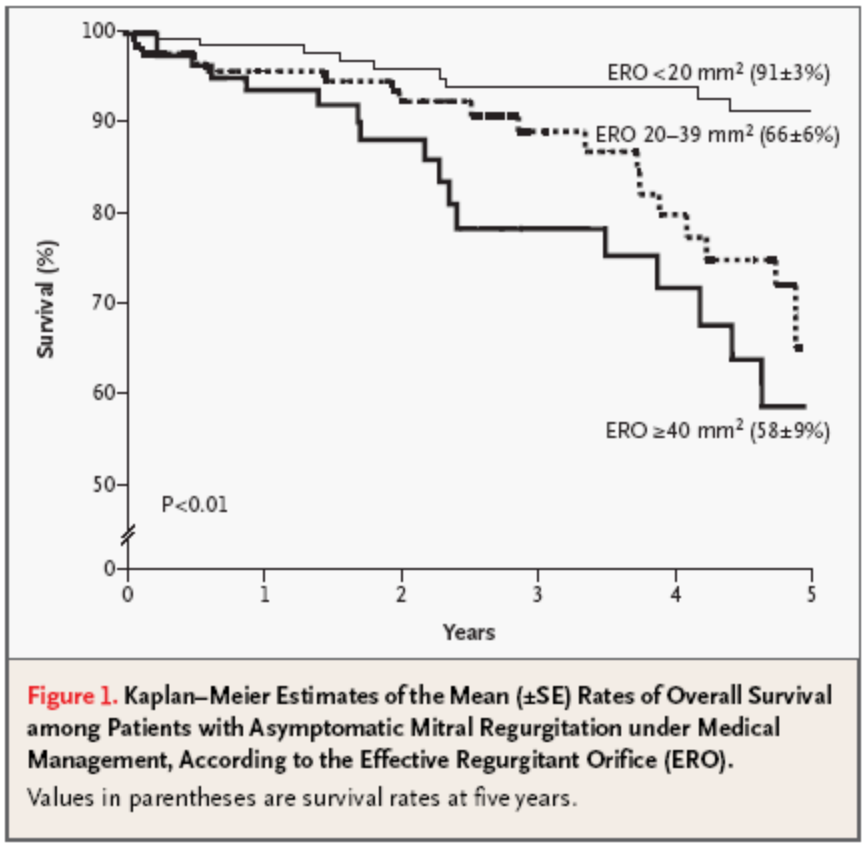


Figure 1. Kaplan–Meier Estimates of the Mean (±SE) Rates of Overall Survival among Patients with Asymptomatic Mitral Regurgitation under Medical Management, According to the Effective Regurgitant Orifice (ERO).
Values in parentheses are survival rates at five years.

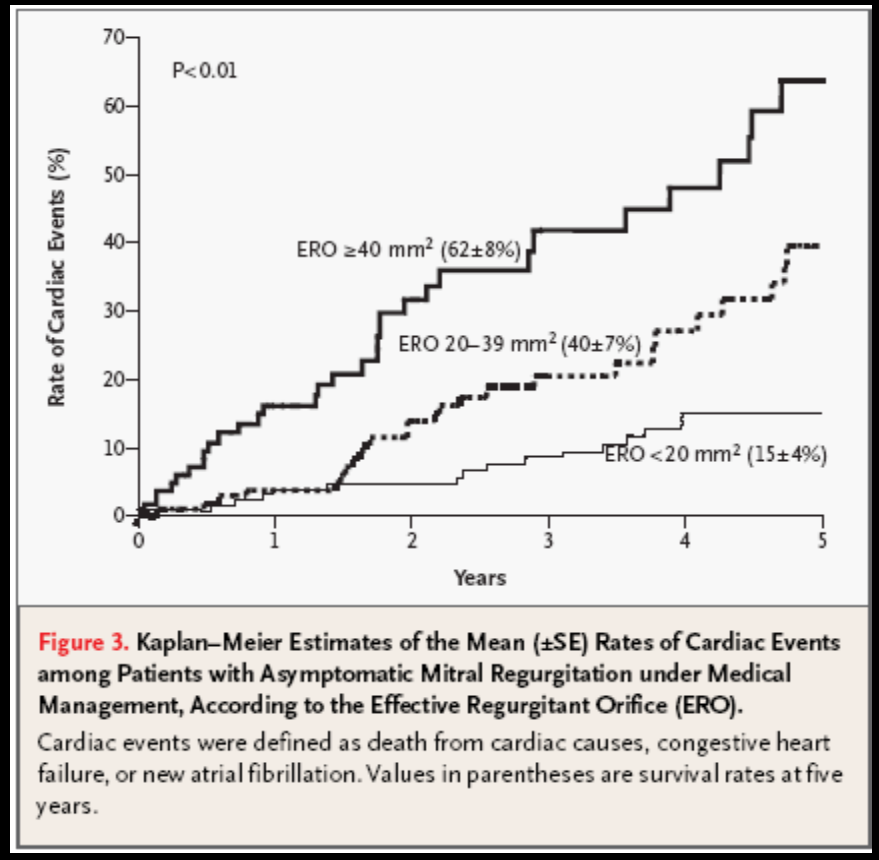


Figure 3. Kaplan–Meier Estimates of the Mean (±SE) Rates of Cardiac Events among Patients with Asymptomatic Mitral Regurgitation under Medical Management, According to the Effective Regurgitant Orifice (ERO).
Cardiac events were defined as death from cardiac causes, congestive heart failure, or new atrial fibrillation. Values in parentheses are survival rates at five years.

Enriquez-Sarano et al. NEJM 2005;352:875-83