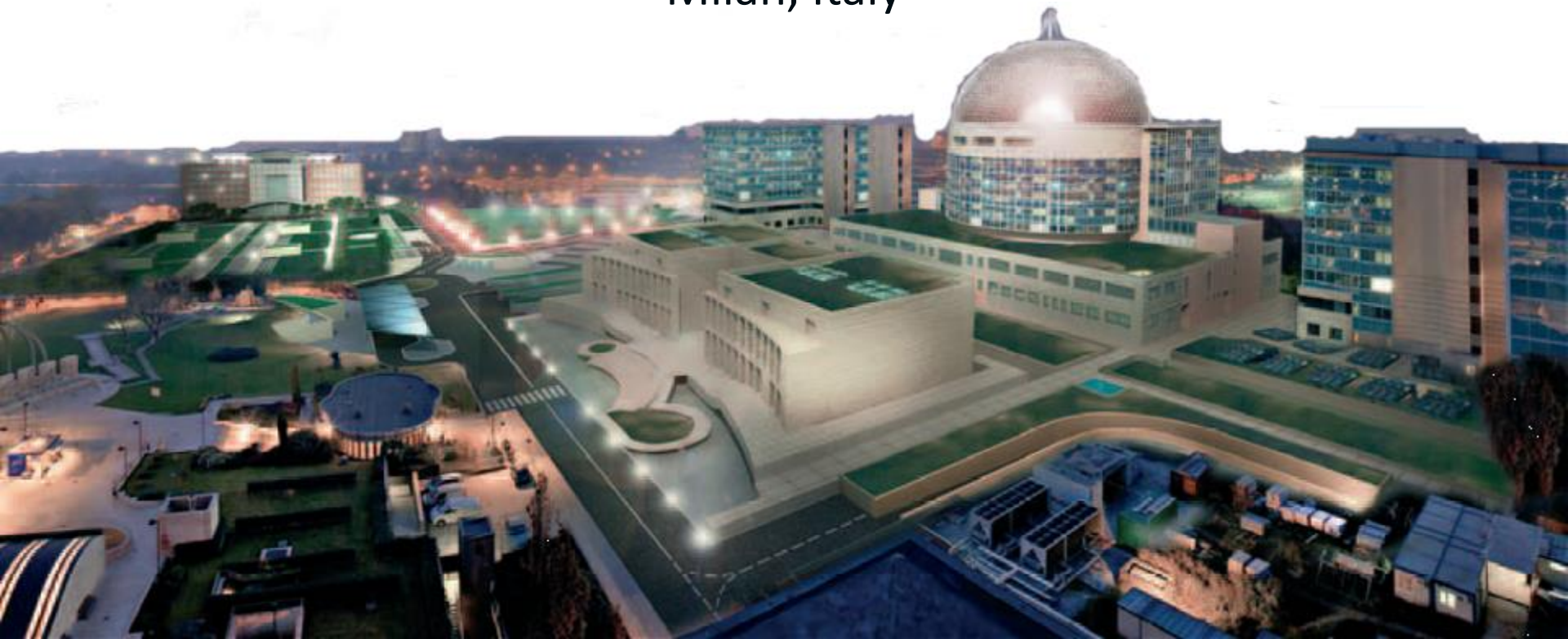
Secondary MR: what have we learned from the surgical experience?

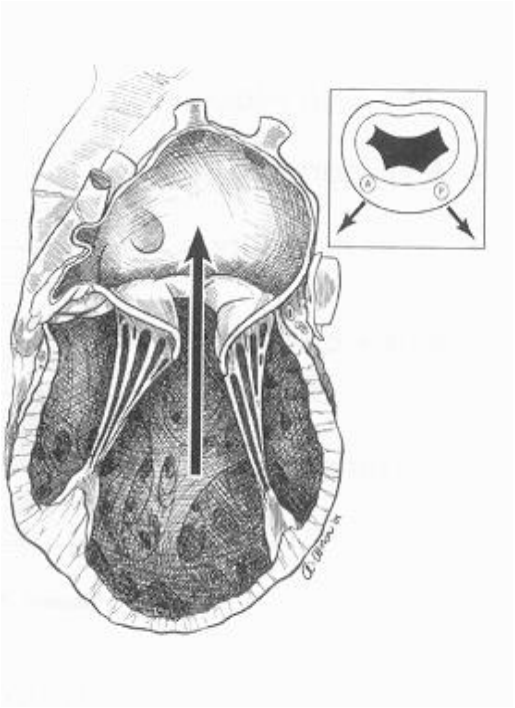
Nicola Buzzatti, MD
San Raffaele Scientific Institute
Milan, Italy

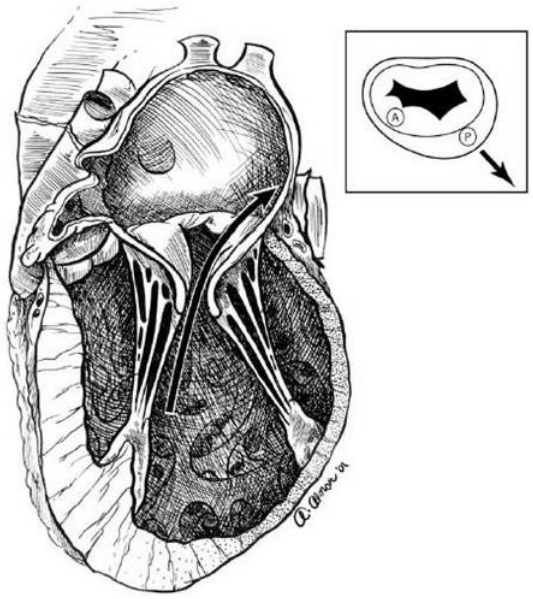


Disclosures

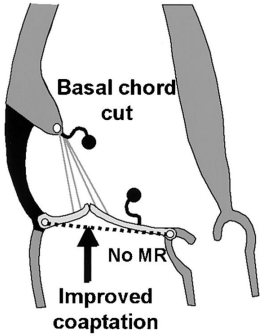
- Minor shareholder of Neovasc Inc.

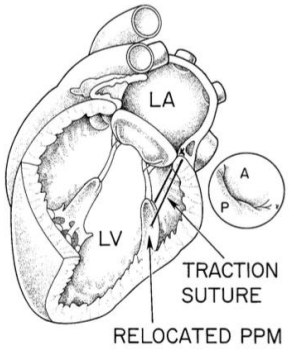
FMR:
a dynamic ventricular disease

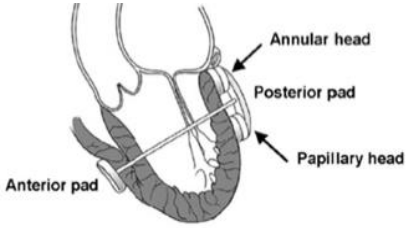


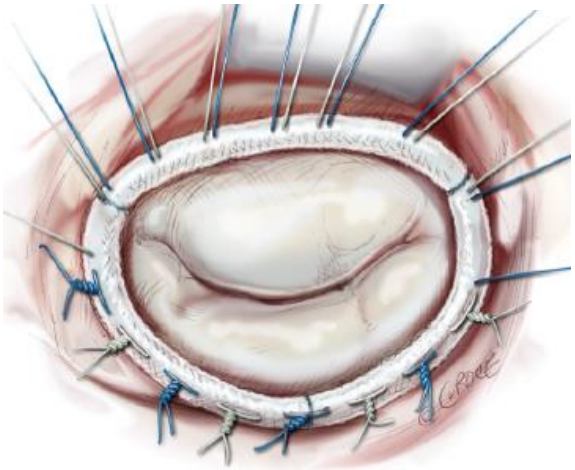


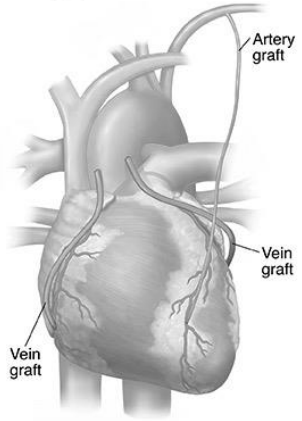
Surgery for FMR

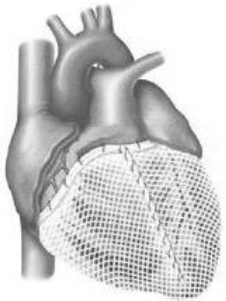


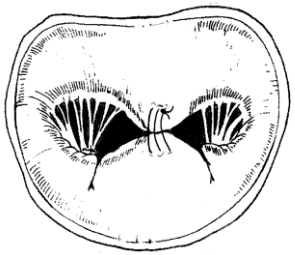


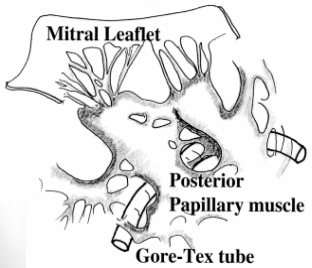


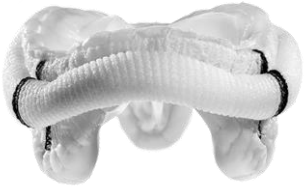


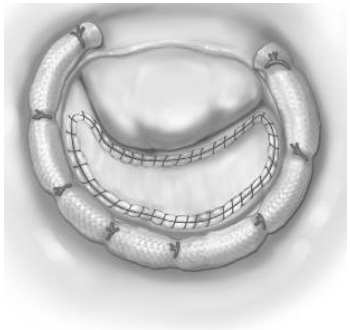


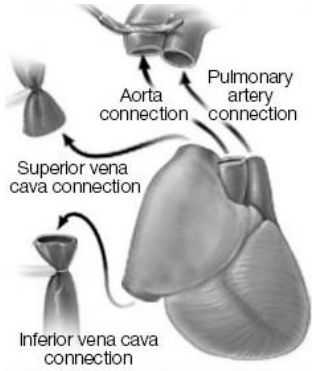






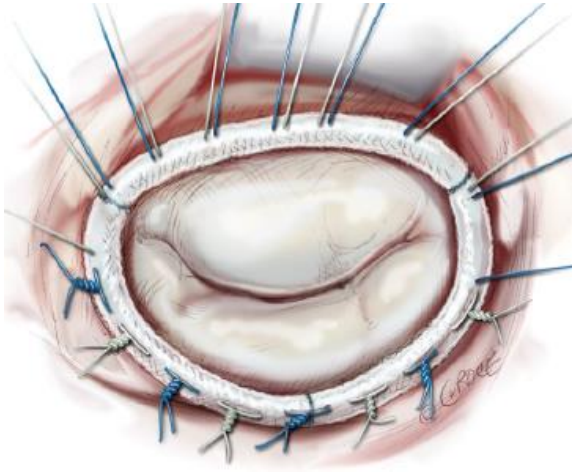






Study	Year	Pts	Aethiology	EF	Mitral techniques	+ CABG	+ Tric	+ AFib	Acute Mortality
Bolling	1998	48	Isch/Idiop	17%	Undersized ring	15%	23%	no	2.1%
Wu	2005	126	Isch/Idiop	23%	Undersized ring	yes	yes	no	4.8%
Acker	2006	193	Isch/idiop/Other	24%	Undersized ring /Replacement ±Corcap	0%	no	no	1.6%
Mihaljevic	2007	290	Isch	?	Undersized ring	100%	no	no	3%
Magne	2007	51	Isch	35%	Undersized ring	96%	no	8%	na
Braun	2008	100	Isch	27%	Undersized ring	90%	20%	no	8.0%
Ciarka	2010	122	Isch/Idiop	27%	Undersized ring ±Corcap	yes	48%	10%	8.2%
De Bonis	2012	54	Idiop	30%	Undersized ring ±Edge-to-Edge	0%	31%	35%	5.6%
Acker	2013	251	Isch	41%	Undersized ring ±Subvalvular repair /Replacement	75%	15%	12%	2.8%
Fattouch	2014	115	Isch	43%	Non-undersized ring +Subvalvular repair	100%	na	na	3.4%
De Bonis	2016	105	Isch/Idiop	29%	Undersized ring ±Edge-to-Edge ±Corcap	47%	13%	14%	2.8%

Undersized annuloplasty



SURGERY FOR ACQUIRED HEART DISEASE

EARLY OUTCOME OF MITRAL VALVE RECONSTRUCTION IN PATIENTS WITH END-STAGE CARDIOMYOPATHY

Uncontrollable severe mitral regurgitation is a frequent complication of end-stage cardiomyopathy, significantly contributing to heart failure in these patients, and predicts a poor survival. Although elimination of mitral valve regurgitation could be most beneficial in this group, corrective mitral valve surgery has not been routinely undertaken in these very ill patients because of the presumed prohibitive operative mortality. We studied the early outcome of mitral valve reconstruction in 16 consecutive patients with cardiomyopathy and severe, refractory mitral regurgitation operated on between June 1993 and April 1994. There were 11 men and five women, aged 44 to 78 years (64 ± 8 years) with left ventricular ejection fractions of 9% to 25% (16% ± 5%). Preoperatively all patients were in New York Heart Association class IV, had severe mitral regurgitation (graded 0 to 4+ according to color flow Doppler transesophageal echocardiography) and two were listed for transplantation. Operatively, a flexible annuloplasty ring was implanted in all patients. Four patients also had single coronary bypass grafting for incidental coronary disease. In four patients the operation was performed through a right thoracotomy because of prior coronary bypass grafting, and four patients also underwent tricuspid valve reconstruction for severe tricuspid regurgitation. No patient required support with an intraaortic balloon pump. There were no operative or hospital deaths and mean hospital stay was 10 days. There were three late deaths at 2, 6, and 7 months after mitral valve reconstruction, and the 1-year actuarial survival has been 75%. At a mean follow-up of 8 months, all remaining patients are in New York Heart Association class I or II, with a mean postoperative ejection fraction of 25% ± 10%. There have been no hospitalizations for congestive heart failure, and a decrease in medications required has been noted. For patients with cardiomyopathy and severe mitral regurgitation, mitral valve reconstruction as opposed to replacement can be accomplished with low operative and early mortality. Although longer term follow-up is mandatory, mitral valve reconstruction may allow new strategies for patients with end-stage cardiomyopathy and severe mitral regurgitation, yielding improvement in symptomatic status and survival. (J THORAC CARDIOVASC SURG 1995;109:676-83)

Steven F. Bolling, MD, G. Michael Deeb, MD, Louis A. Brunsting, MD, and David S. Bach, MD, *Ann Arbor, Mich.*

Undersized annuloplasty: LV remodelling and symptoms improvement

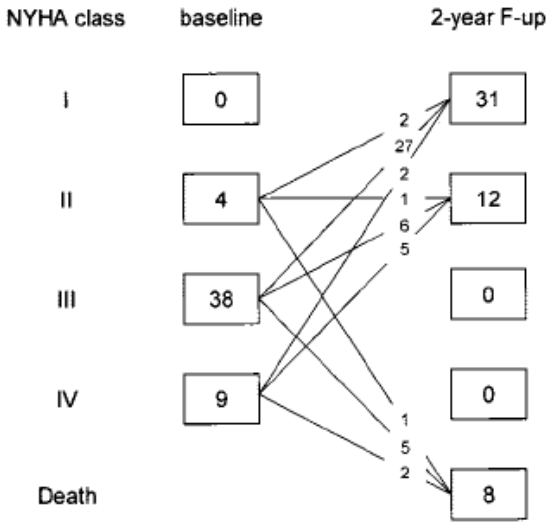
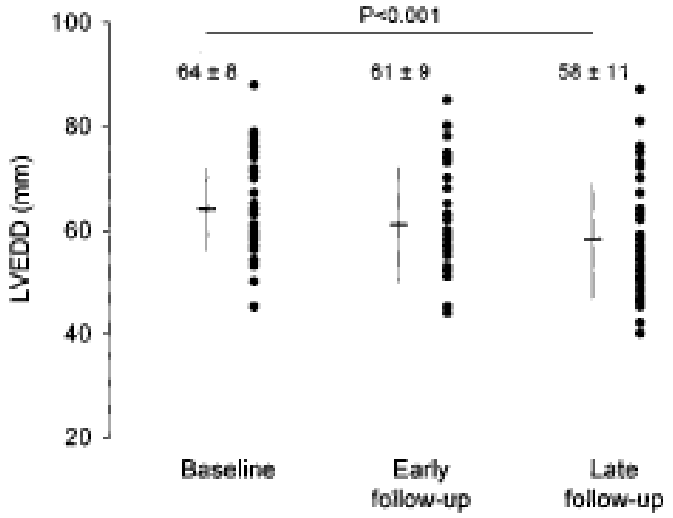


Figure 2. Individual changes in NYHA class before surgery (baseline) and at 2-year follow-up (2-year F-up). At 2-year follow-up, NYHA class had improved from 3.4±0.8 to 1.3±0.4 ($P<0.01$).



Bax et al. Circulation 2004; 110:103-108

Undersized annuloplasty: survival benefit?

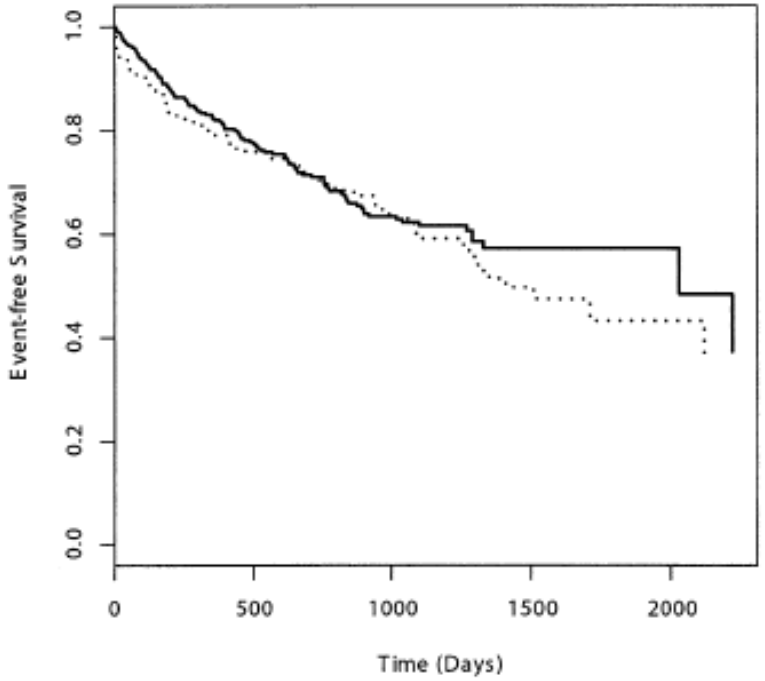


Figure 1. Event-free survival for non-mitral-valve annuloplasty (MVA) group **(solid line)** and MVA group **(dotted line)**.

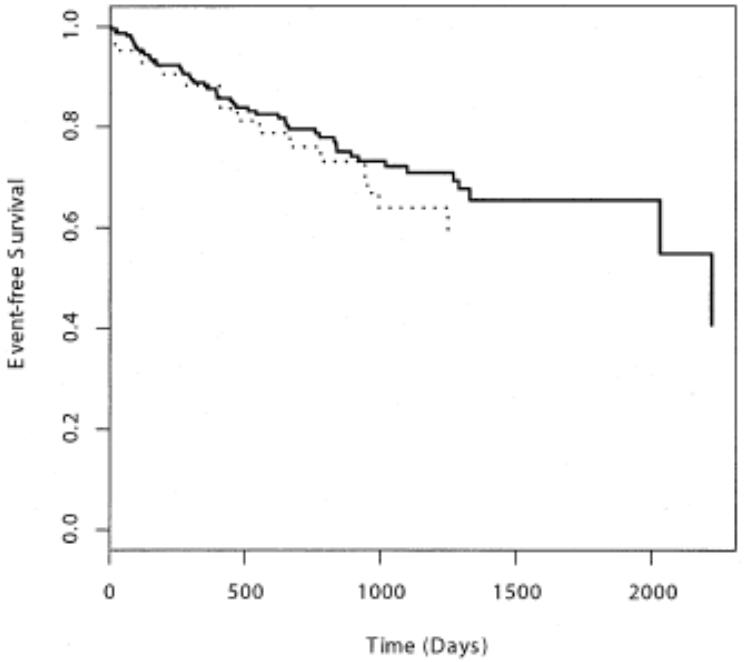


Figure 2. Event-free survival for patients without coronary artery disease in non-mitral-valve annuloplasty (MVA) group **(solid line)** and MVA group **(dotted line)**.

Wu et al. J Am Coll Cardiol 2005; 45:381-387

Why no survival benefit?

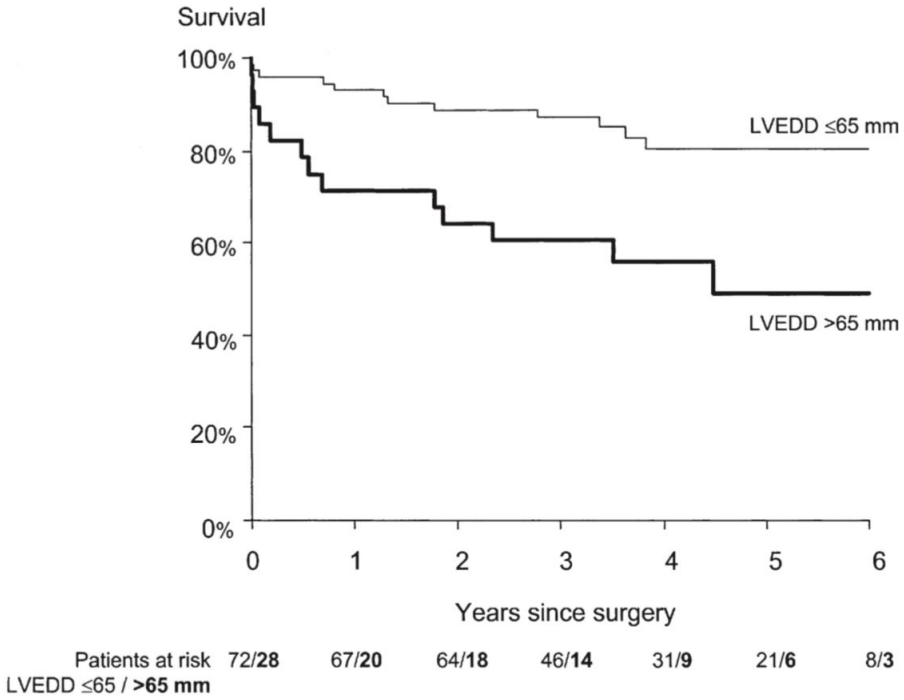
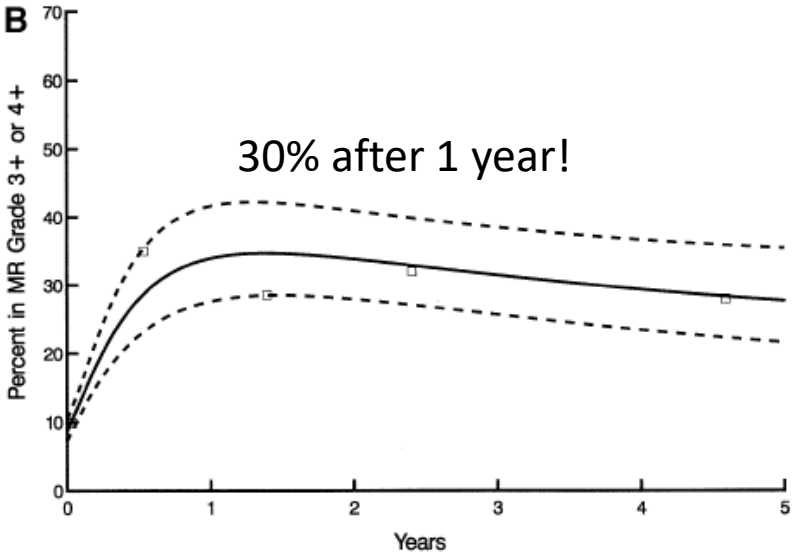


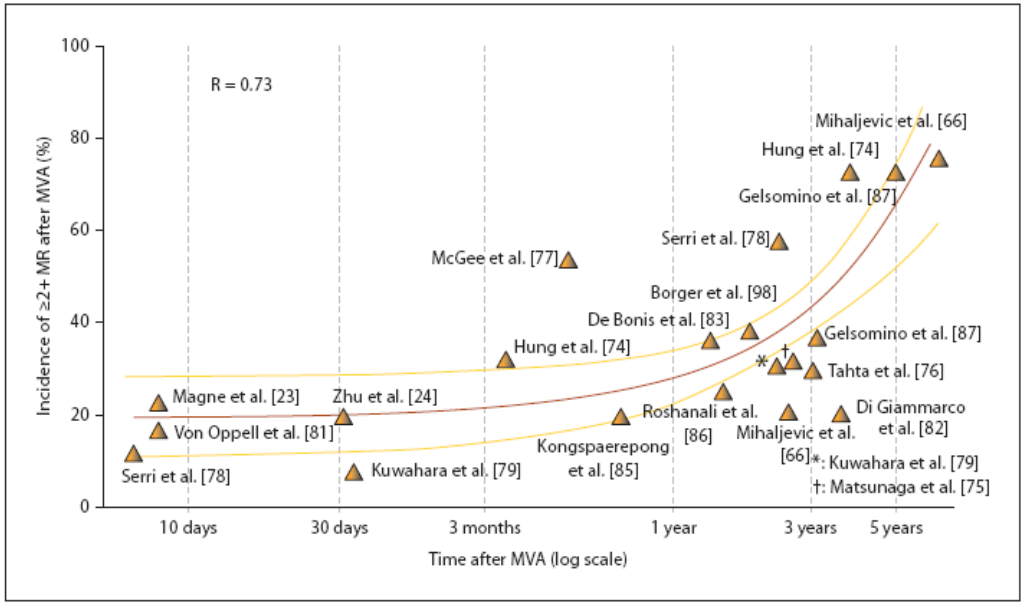
Fig 2. Actuarial survival rates for two different preoperative left ventricular end-diastolic diameter (LVEDD) cohorts, comparing LVEDD greater than 65 mm and LVEDD 65 mm or less (hazard ratio, 3.4; 95% confidence interval, 1.5 to 7.4; p = 0.002). Patients at risk per cohort are shown under the x-axis (LVEDD greater than 65 mm in bold; LVEDD 65 mm or less in regular setting).

Braun et al. Ann Thorac Surg 2008; 85:430-436

A lot of recurrent MR!



McGee et al. J Thorac Cardiovasc Surg 2004; 128:916-924



Magne et al. Cardiology 2009;112:244.

Undersized annuloplasty: recurrent MR is bad

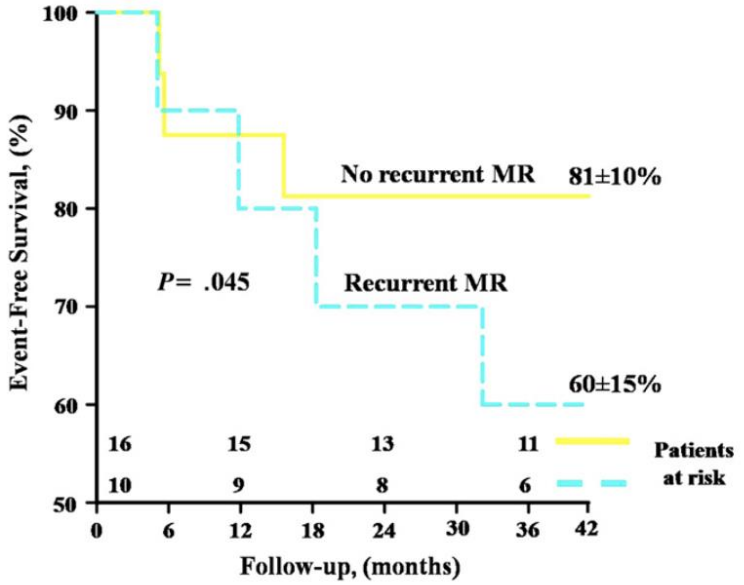
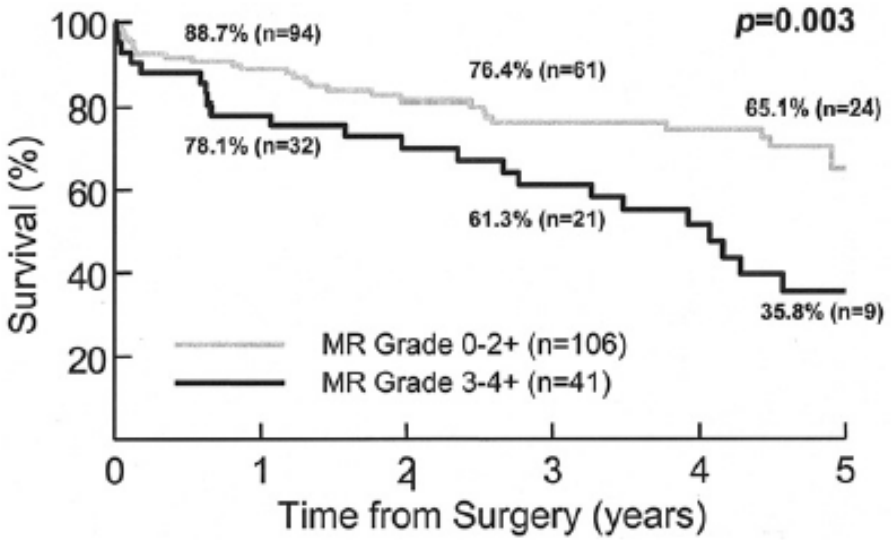


Figure 6 Event-free survival after restrictive MVA and CABG among patients with ischemic MR. *MR,* Mitral regurgitation.

Magne et al.
J Am Soc Echocardiogr 2009; 22:1256-64



Crabtree et al.
Ann Thorac Surg 2008; 85:1537-1542

ELSEVIER

European Journal of Cardio-thoracic Surgery 39 (2011) 295–303

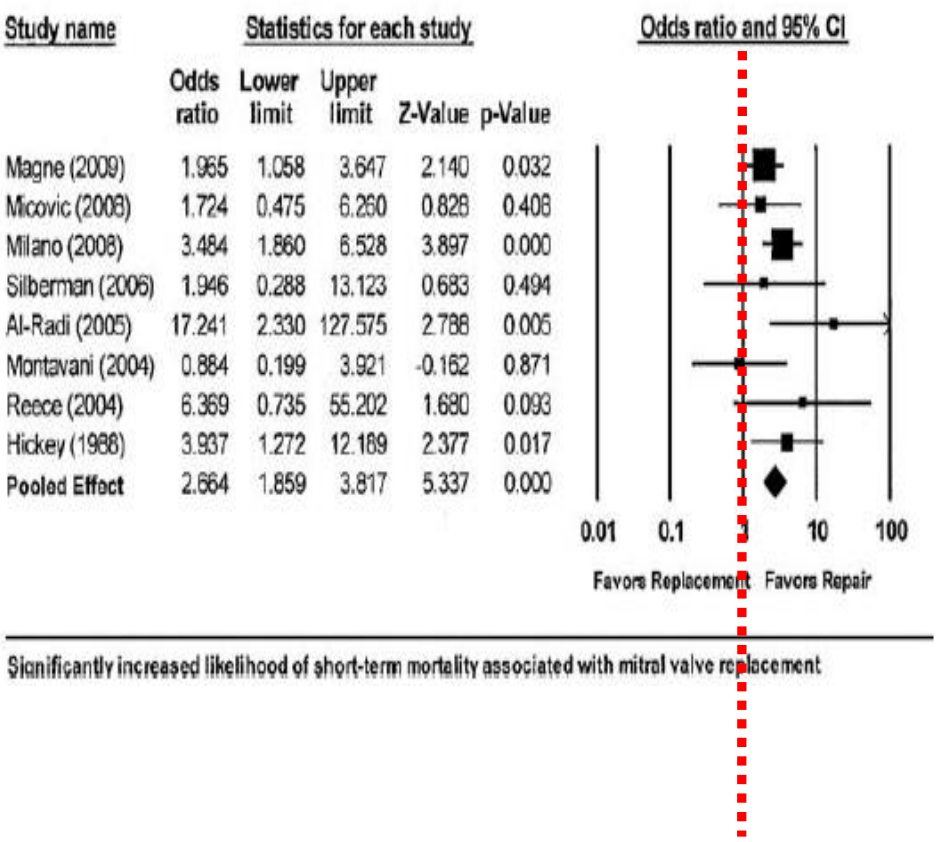
www.elsevier.com/locate/ejcts

Review

Meta-analysis of short-term and long-term survival following repair versus replacement for ischemic mitral regurgitation

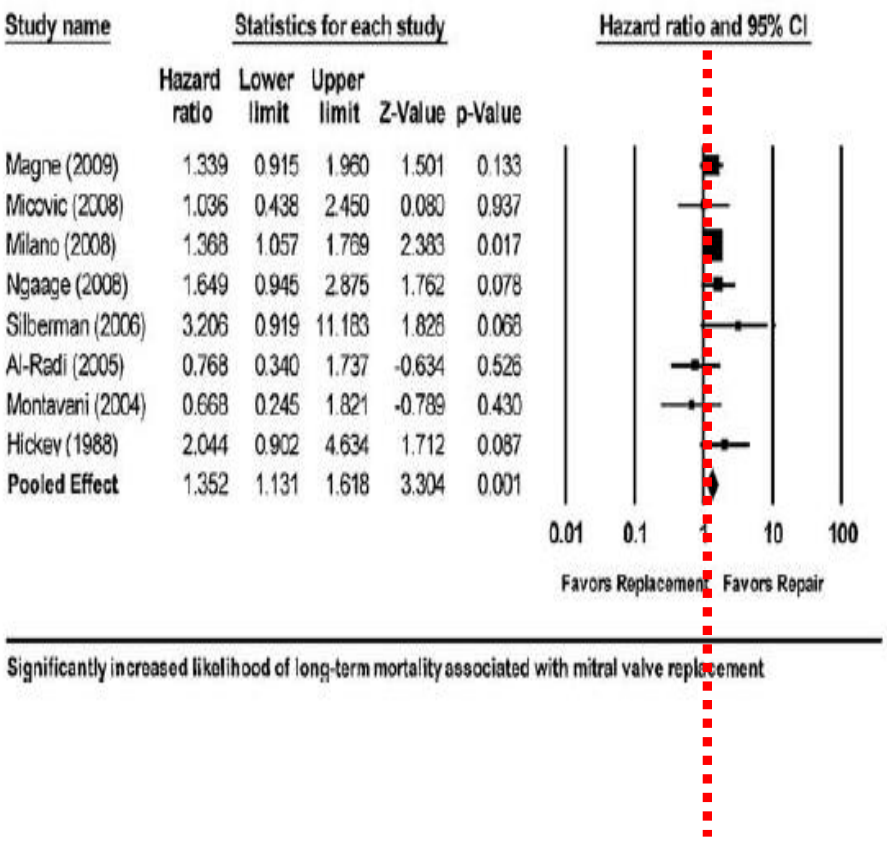
Christina M. Vassileva *, Theresa Boley, Stephen Markwell, Stephen Hazelrigg

Short term survival



Significantly increased likelihood of short-term mortality associated with mitral valve replacement

Long term survival



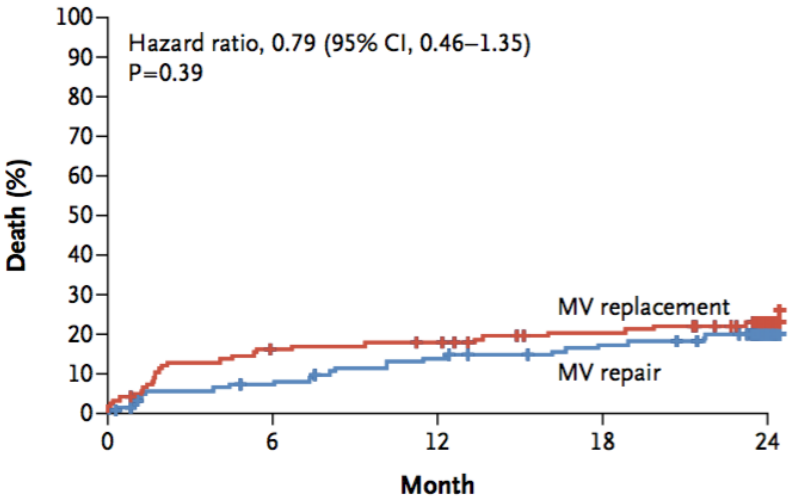
Significantly increased likelihood of long-term mortality associated with mitral valve replacement

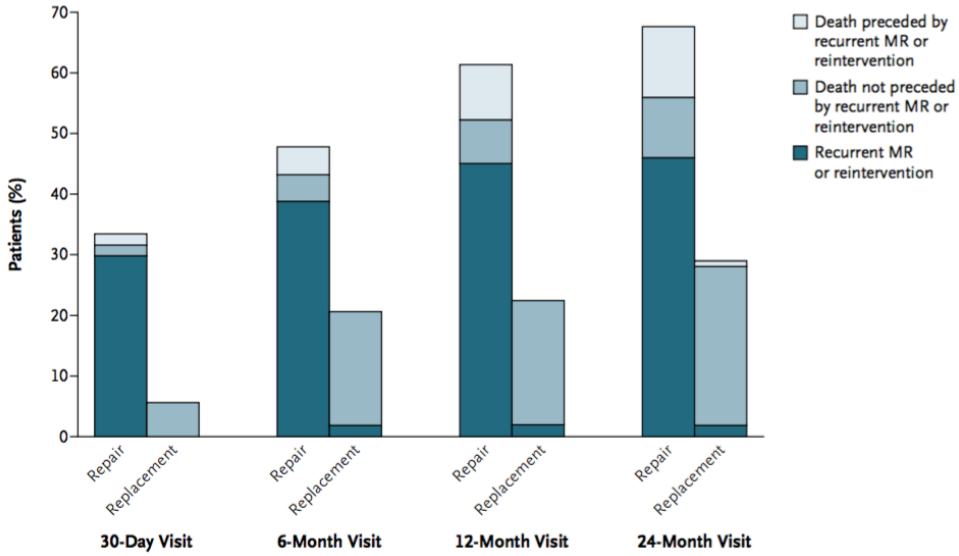
The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Two-Year Outcomes of Surgical Treatment of Severe Ischemic Mitral Regurgitation

D. Goldstein, A.J. Moskowitz, A.C. Gelijns, G. Ailawadi, M.K. Parides, L.P. Perrault, J.W. Hung, P. Voisine, F. Dagenais, A.M. Gillinov, V. Thourani, M. Argenziano, J.S. Gammie, M. Mack, P. Demers, P. Atluri, E.A. Rose, K. O'Sullivan, D.L. Williams, E. Bagiella, R.E. Michler, R.D. Weisel, M.A. Miller, N.L. Geller, W.C. Taddei-Peters, P.K. Smith, E. Moquete, J.R. Overbey, I.L. Kron, P.T. O'Gara, and M.A. Acker, for the CTSN*





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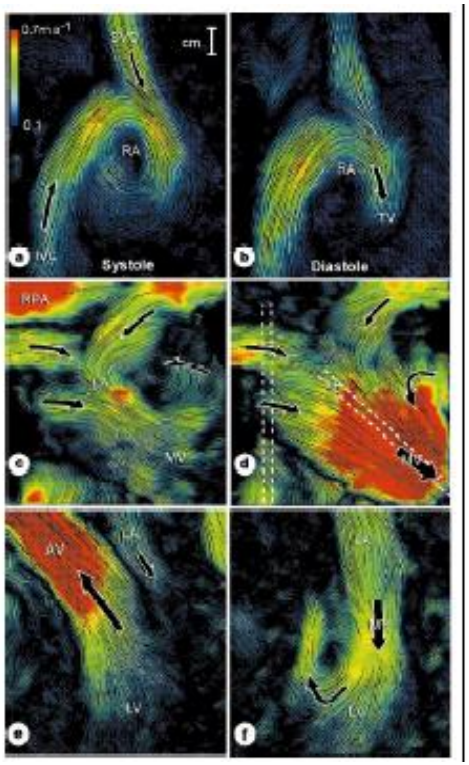
Mean **2-year LVESVI:**

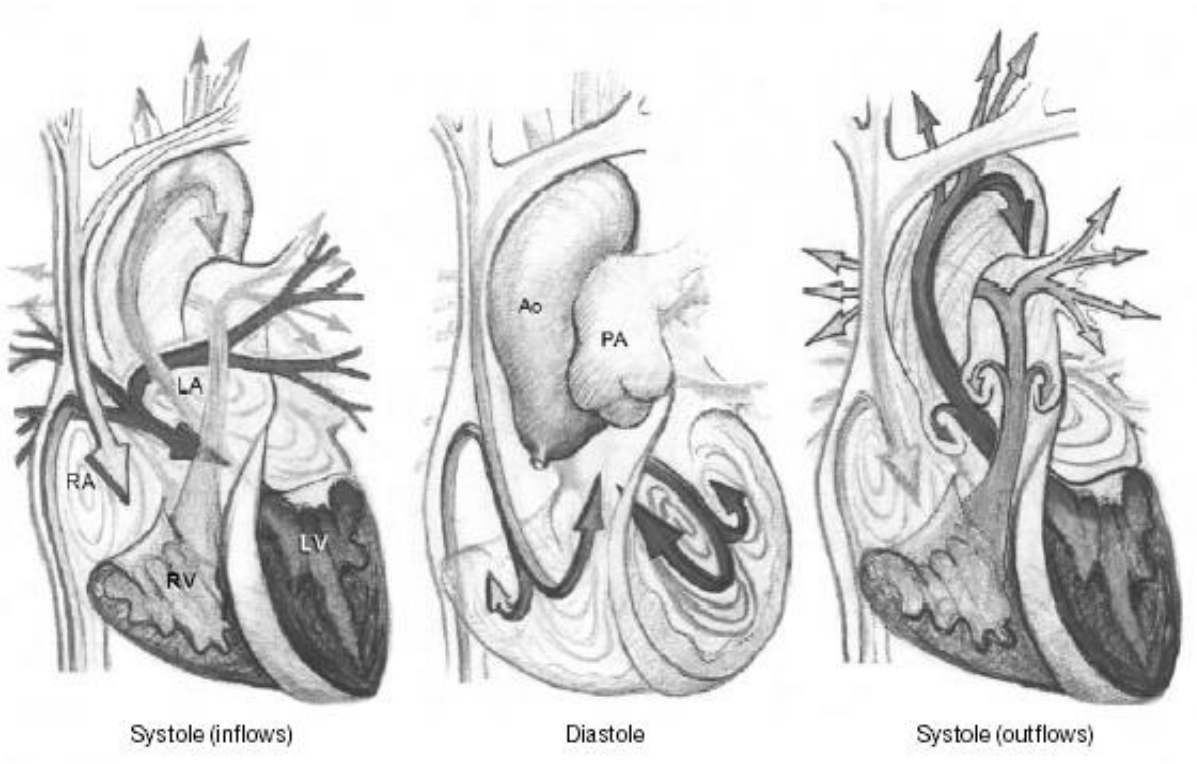
- **REPAIR: 52.6** +/- 27.7 ml/m^2 (change from baseline **–9.0 ml**).
- **REPLACEMENT: 60.6** +/- 39.0 ml/m^2 (change from baseline **–6.5 ml**).

- **REPAIR** WITHOUT RESIDUAL MR: **42.7** +/- 26.4 **(-16 ml)**
- **REPAIR** WITH RECURRENT MR **62.6** +/- 26.9

P<0.001 !

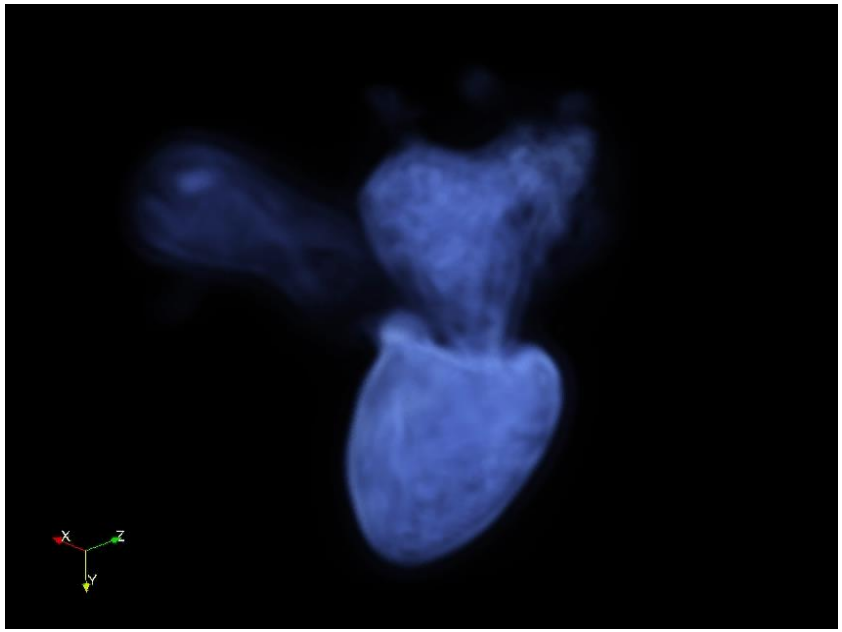
Successful repair provides the greatest LV reverse remodeling!





Circulation is based on "dynamism and crosstalk", actions and reactions play a game which principle is the preservation of energy

Sir M. Yacoub, ATS 2009



Can we reproduce this?

Any technique will impact physiologic behaviour of the mitral valve apparatus

- Repair is probably better than Replacement and should be first line option in case of early intervetion

Whenever possible, surgeons will prefer a good repair over a good replacement

1. When to do it?

2. How to do it?

Recurrence of Mitral Regurgitation Parallels the Absence of Left Ventricular Reverse Remodeling After Mitral Repair in Advanced Dilated Cardiomyopathy

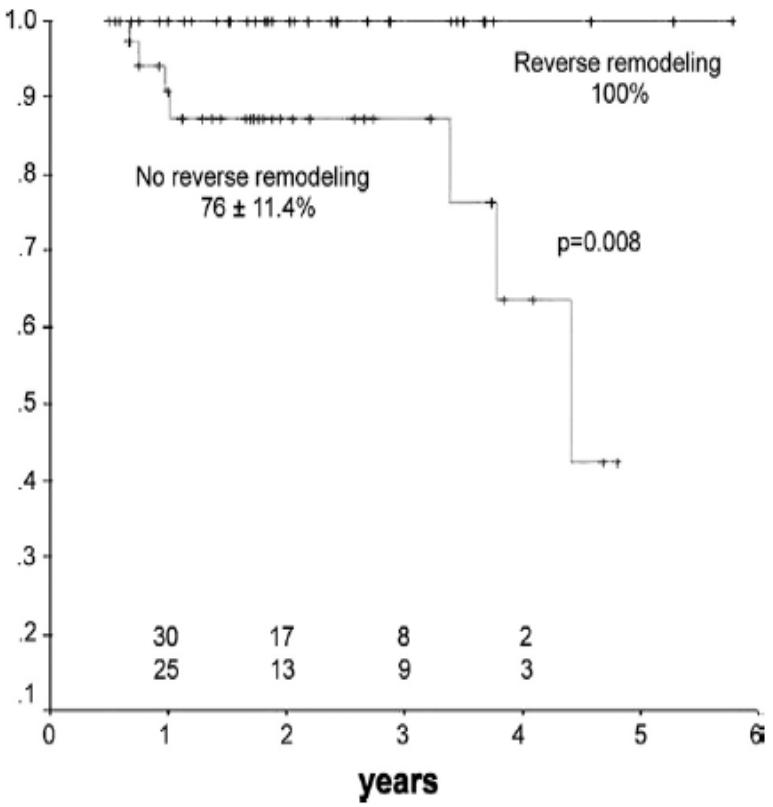
Michele De Bonis, MD, Elisabetta Lapenna, MD, Alessandro Verzini, MD, Giovanni La Canna, MD, Antonio Grimaldi, MD, Lucia Torracca, MD, Francesco Maisano, MD, and Ottavio Alfieri, MD

Ann Thorac Surg 2008;85:932–9

Table 4. Predictors of Reverse Left Ventricular Remodeling

Variable	Odds Ratio	*p* (univariate)	*p* (multivariable)
Age	0.9	0.7	
Duration of CHF	0.6	0.06	0.05
Ischemic etiology	1.5	0.04	0.9
Associated CABG	1.4	0.02	0.9
Successful ablation of AF	3.7	0.05	0.2
EF	0.9	0.3	
SPAP	0.9	0.4	
LVEDD	0.9	0.2	
LVEDVI	1	0.7	
LVESVI	1	0.3	
Tenting area	0.8	0.5	
Coaptation depth	1.8	0.2	
Use of edge-to-edge	2.1	0.08	0.09
Ring number	0.8	0.2	
Ring type	1.2	0.8	

Freedom from recurrent MR≥3+



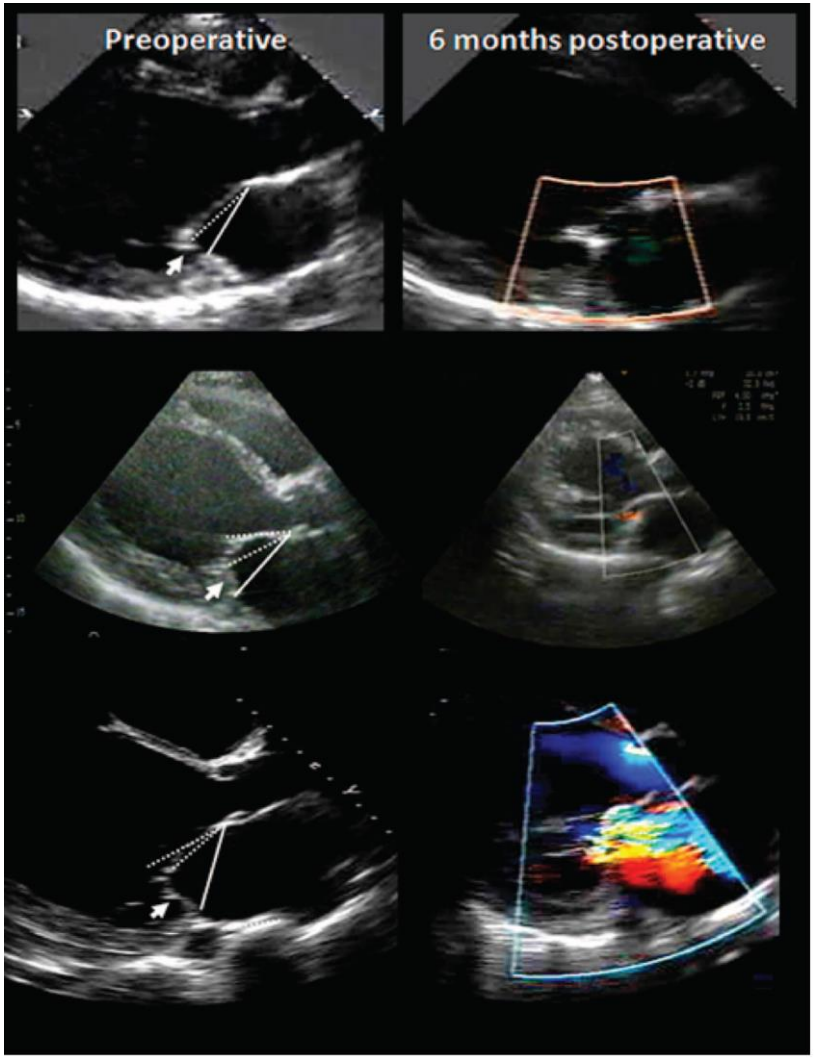
Echo predictors of annuloplasty failure

- Small annular dilatation

- Complex multiple jets

- Excessive leaflet tethering
  - Coaptation depth >10mm
  - Posterior leaflet angle > 45°
  - Distal anterior leaflet angle >25°
  - Systolic tenting area >2.5cm^2

- Advanced LV remodelling
  - Systolic sphericity index >0.7,
  - LVEDD >65mm
  - LVESV ≥ 145 ml (or ≥ 100 ml/m2)
  - ES interpapillary muscle distance >20mm
  - Basal aneurysm/dyskinesis
  - LV/ring mismatch



Lee et al. Circulation 2009;119:2606

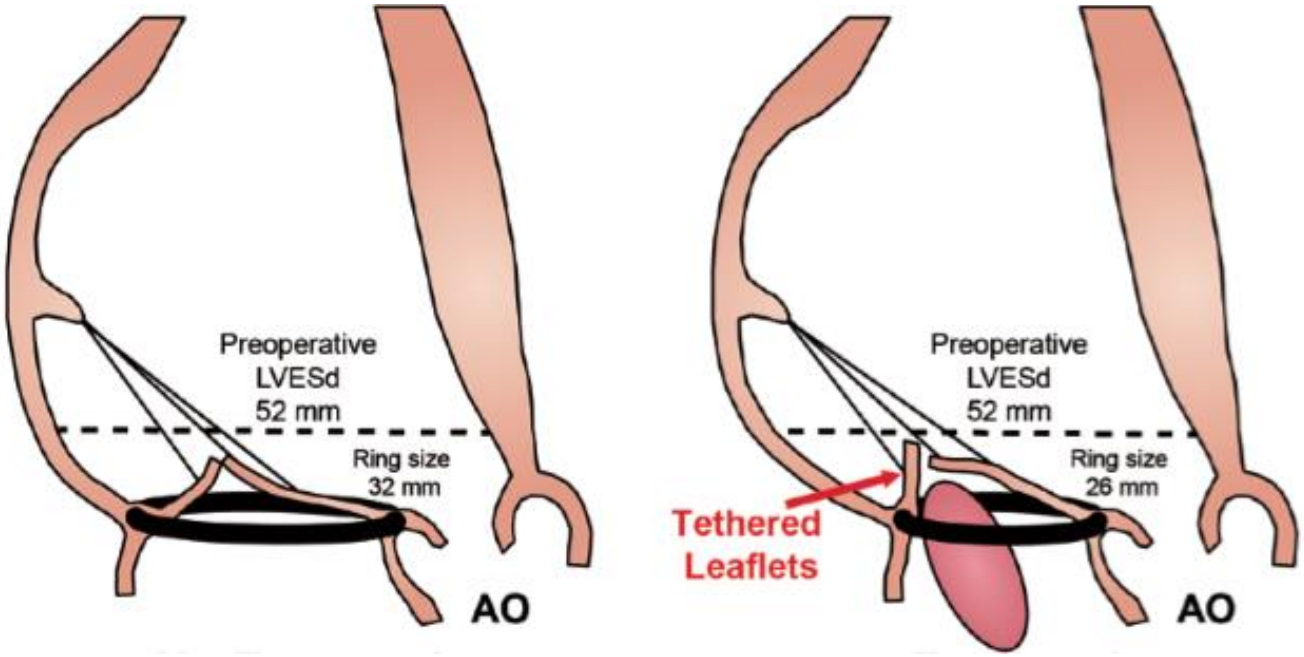
Circulation

American Heart Association

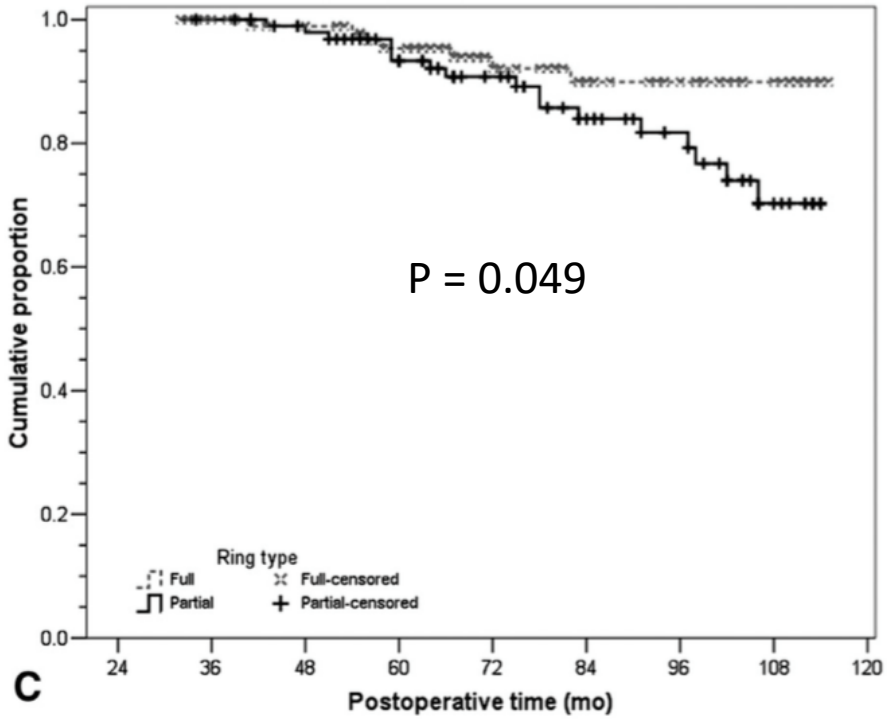
Impact of Left Ventricular to Mitral Valve Ring Mismatch on Recurrent Ischemic Mitral Regurgitation After Ring Annuloplasty

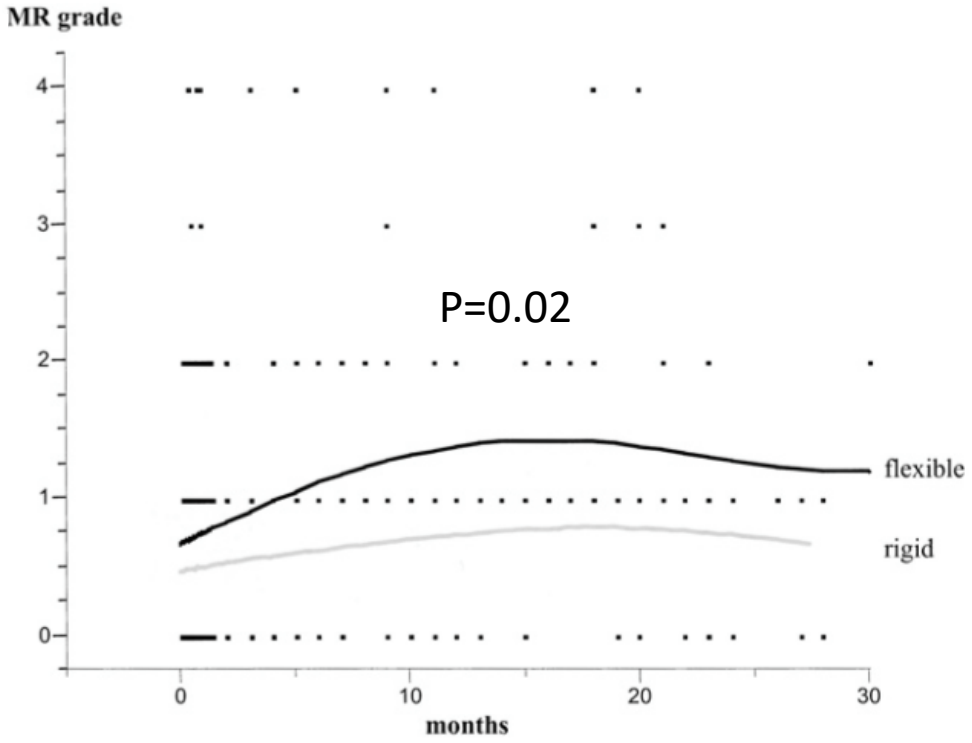
Romain Capoulade, Xin Zeng, Jessica R. Overbey, Gorav Ailawadi, John H. Alexander, Deborah Ascheim, Michael Bowdish, Annetine C. Gelijns, Paul Grayburn, Irving L. Kron, Robert A. Levine, Michael J. Mack, Serguei Melnitchouk, Robert E. Michler, John C. Mullen, Patrick O'Gara, Michael K. Parides, Peter Smith, Pierre Voisine and Judy Hung
For the Cardiothoracic Surgical Trials Network (CTSN) Investigators

Circulation. 2016;134:1247–1256. DOI: 10.1161/CIRCULATIONAHA.115.021014



Technique matters

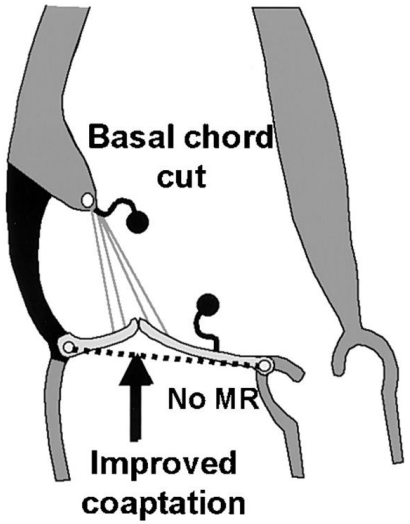


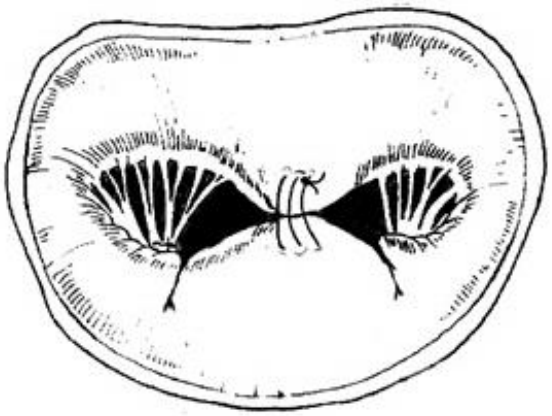


Kwon et al. JTCVS 2013; 146:616-22

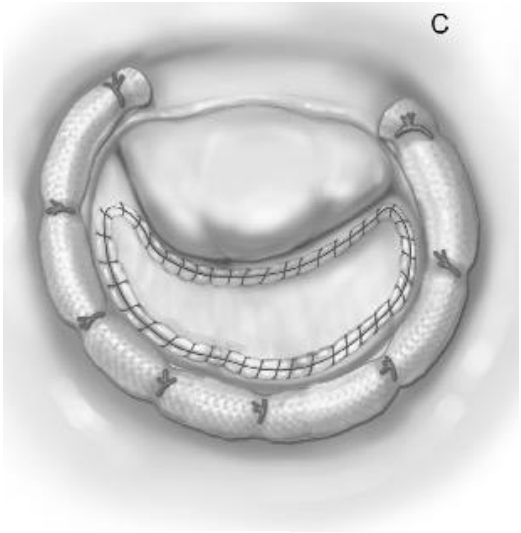
Silberman et al. Ann Thorac Surg 2009; 87:1721-1726

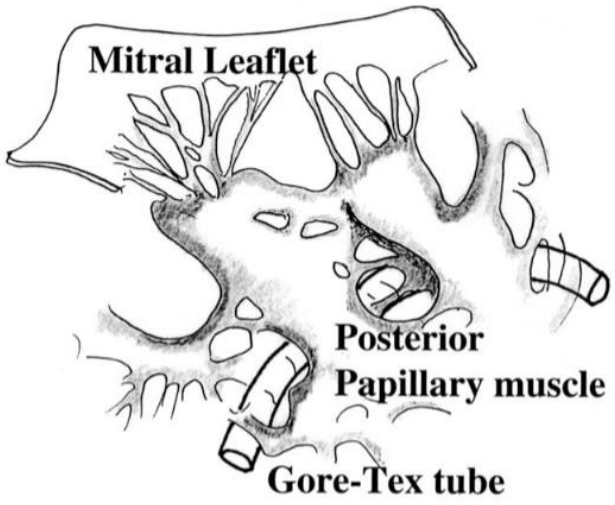
Added repair procedures

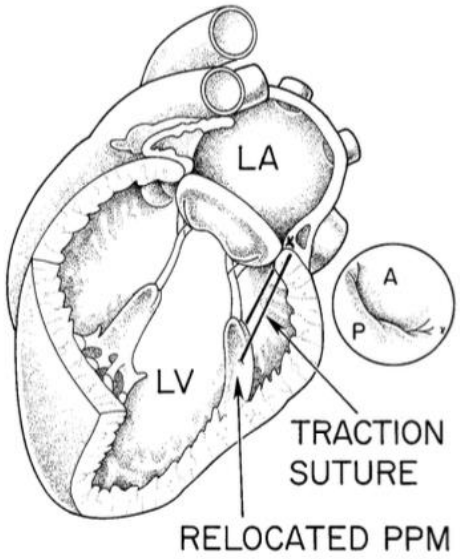




double orifice repair







European Journal of Cardio-Thoracic Surgery (2016) 1–8
doi:10.1093/ejcts/ezw139

ORIGINAL ARTICLE

Long-term results of mitral repair in patients with severe left ventricular dysfunction and secondary mitral regurgitation: does the technique matter?†

Michele De Bonis[a,*], Elisabetta Lapenna[a], Fabio Barili[b], Teodora Nisi[a], Mariachiara Calabrese[a], Federico Pappalardo[a], Giovanni La Canna[a], Alberto Pozzoli[a], Nicola Buzzatti[a], Andrea Giacomini[a], Emanuela Alati[a] and Ottavio Alfieri[a]

Table 1: Clinical and echocardiographic preoperative data in the edge-to-edge and isolated annuloplasty groups

	EE + annuloplasty *N* = 65	Annuloplasty *N* = 40	*P*-value
Male gender (*n*, %)	45 (69)	29 (72)	0.7
Age (years)	63 ± 10	63 ± 10.2	0.8
Ischaemic DCM (*n*, %)	43 (66)	26 (65)	0.9
NYHA class (*n*, %)			0.5
II	9 (14)	8 (20)	
III	40 (61)	23 (58)	
IV	16 (25)	9 (22)	
AF (*n*, %)	14 (21)	14 (35)	0.9
LVEF (%)	29 ± 6.6	31 ± 6	0.09
LVEDD (mm)	68 ± 6.3	67 ± 8.1	0.3
LVESD (mm)	52 ± 8.2	50 ± 7.4	0.4
LVEDV (ml)	203 ± 59.8	188 ± 54.2	0.2
SPAP (mmHg)	48 ± 13.3	44 ± 14.1	0.1
Tented area (cm^2)	2.9 ± 0.88	2.1 ± 0.84	0.01
Coaptation depth (cm)	1.2 ± 0.27	0.8 ± 0.15	0.0001

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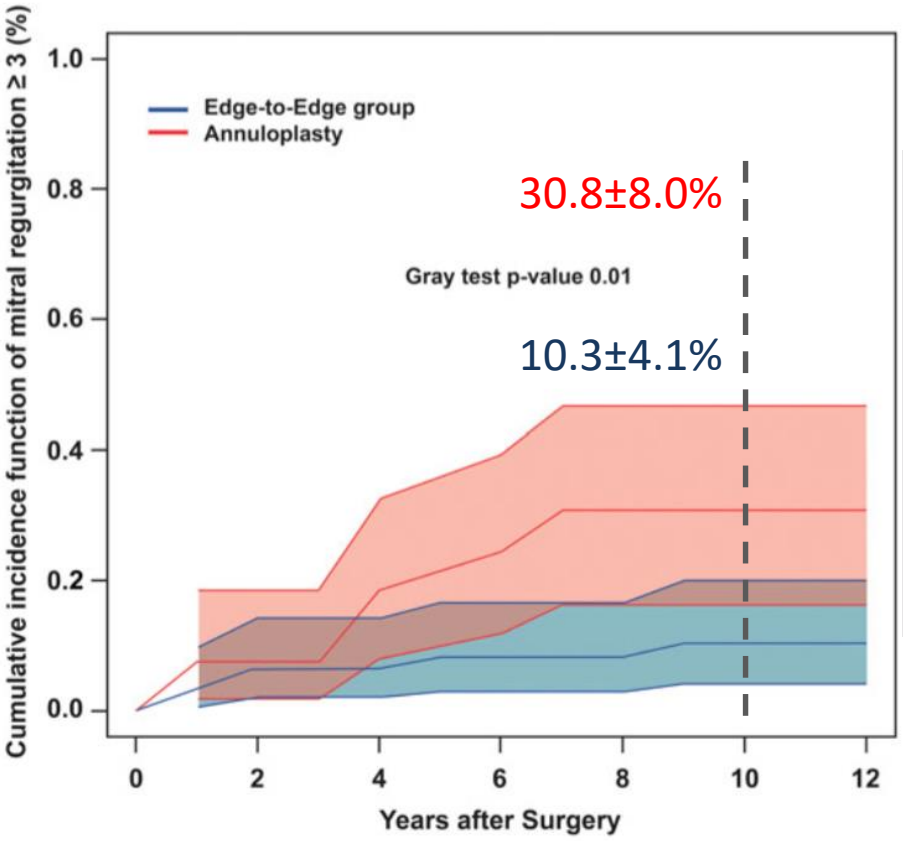
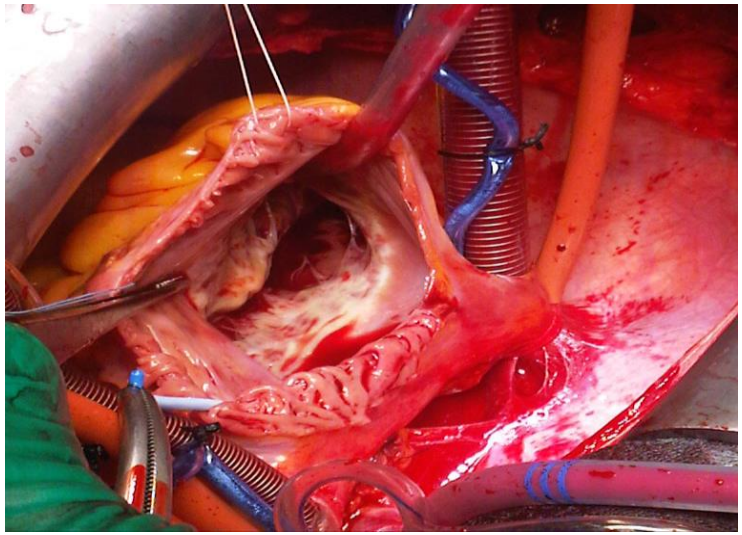
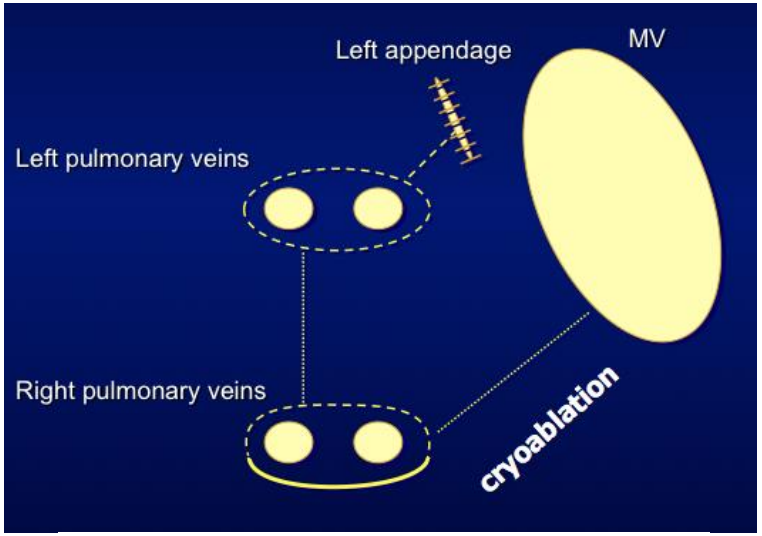


Table 3: Predictors of recurrence

Preoperative variables	Multivariate	
	HR (95% CI)	*P*-value
Age		
Atrial fibrillation		
Idiopathic DCM		
NYHA class III or IV		
LVEF	0.94 (0.87–1.01)	0.09
SPAP	1.06 (1–1.14)	0.06
LVEDD		
Isolated annuloplasty	4.84 (1.46–16.1)	0.01
MR >1+ at discharge	5.25 (2.00–13.8)	<0.001

Associated procedures: tricuspid and AFib





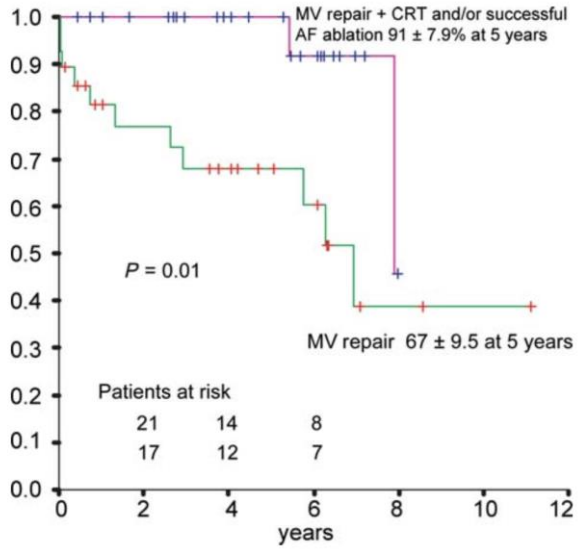


Figure 2: Actuarial survival in patients submitted to MV repair alone compared to those who underwent concomitant successful AF ablation and/or cardiac resynchronization therapy.

De Bonis M et al. EJCTS 2012

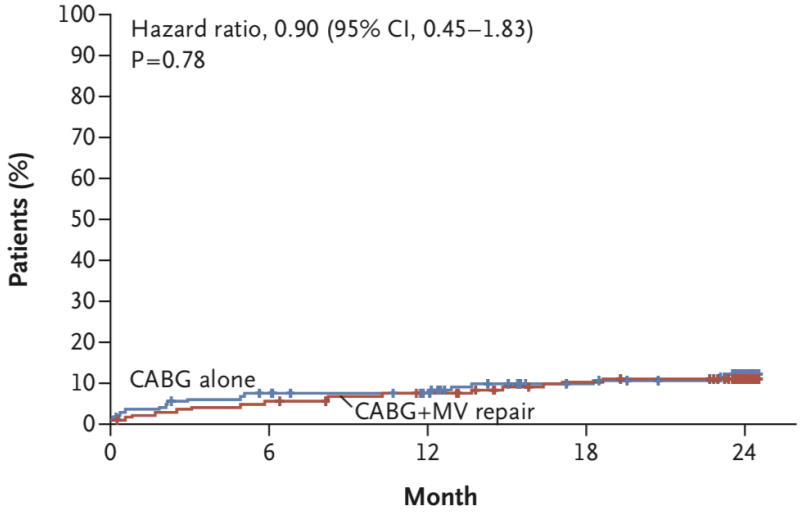
The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Two-Year Outcomes of Surgical Treatment of Moderate Ischemic Mitral Regurgitation

R.E. Michler, P.K. Smith, M.K. Parides, G. Ailawadi, V. Thourani, A.J. Moskowitz, M.A. Acker, J.W. Hung, H.L. Chang, L.P. Perrault, A.M. Gillinov, M. Argenziano, E. Bagiella, J.R. Overbey, E.G. Moquete, L.N. Gupta, M.A. Miller, W.C. Taddei-Peters, N. Jeffries, R.D. Weisel, E.A. Rose, J.S. Gammie, J.J. DeRose, Jr., J.D. Puskas, F. Dagenais, S.G. Burks, I. El-Hamamsy, C.A. Milano, P. Atluri, P. Voisine, P.T. O'Gara, and A.C. Gelijns, for the CTSN*

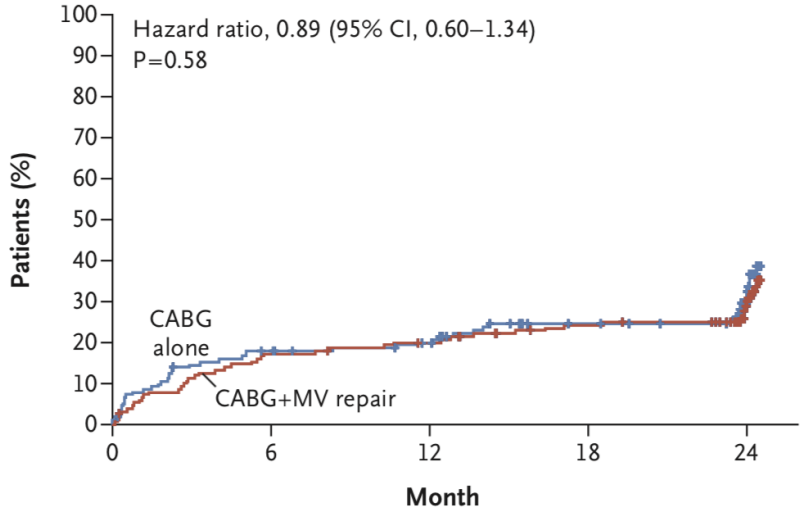
A Death



No. at Risk

CABG alone	151	138	132	117	66
CABG+MV repair	150	142	136	126	80

B Major Adverse Cardiac or Cerebrovascular Event



No. at Risk

CABG alone	151	121	113	96	53
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	CABG alone	CABG+MV Repair	P value
Moderate or Severe MR	32.3%	11.2%	<0.001
Severe MR or mitral surgery	11.4%	3.5%	0.02

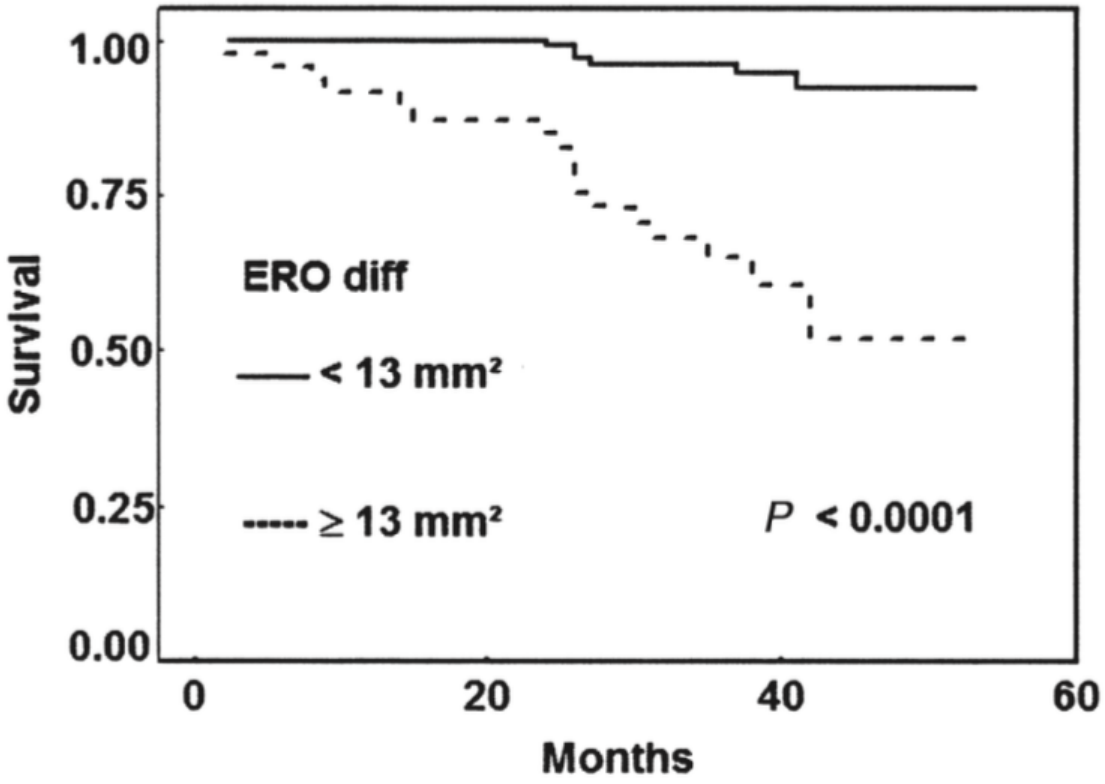
	CABG alone	CABG+MV Repair	P value
Any neurological dysfunction	3%	10.3%	0.02
Stroke	1.5%	5.1%	0.10

European Heart Journal (2005) 26, 1528–1532
doi:10.1093/eurheartj/ehi189

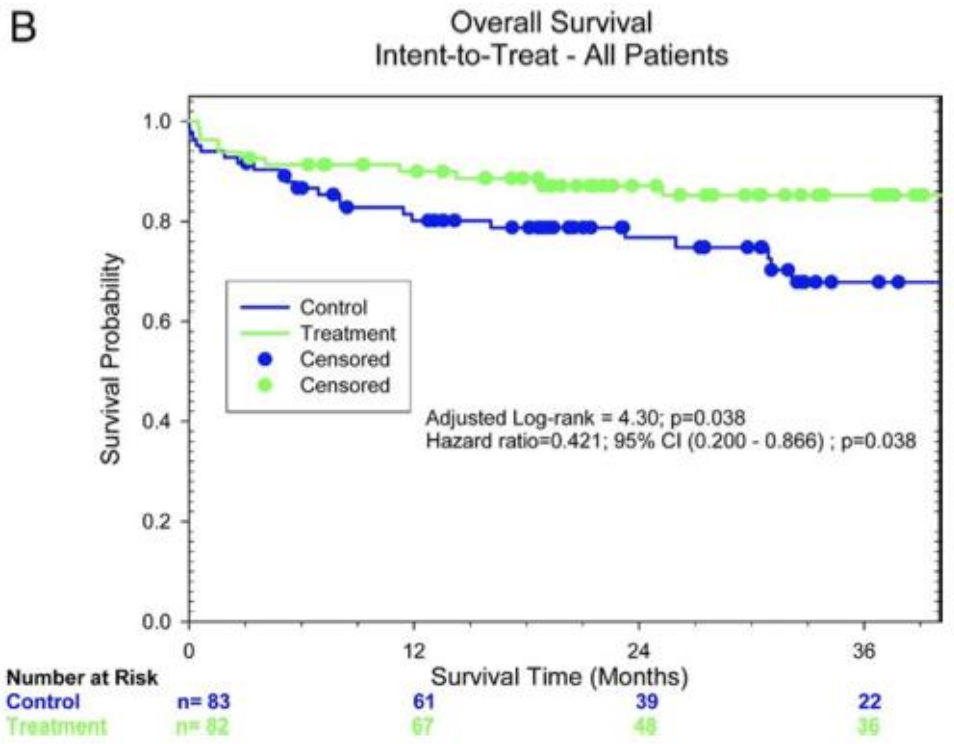
Long-term outcome of patients with heart failure and dynamic functional mitral regurgitation

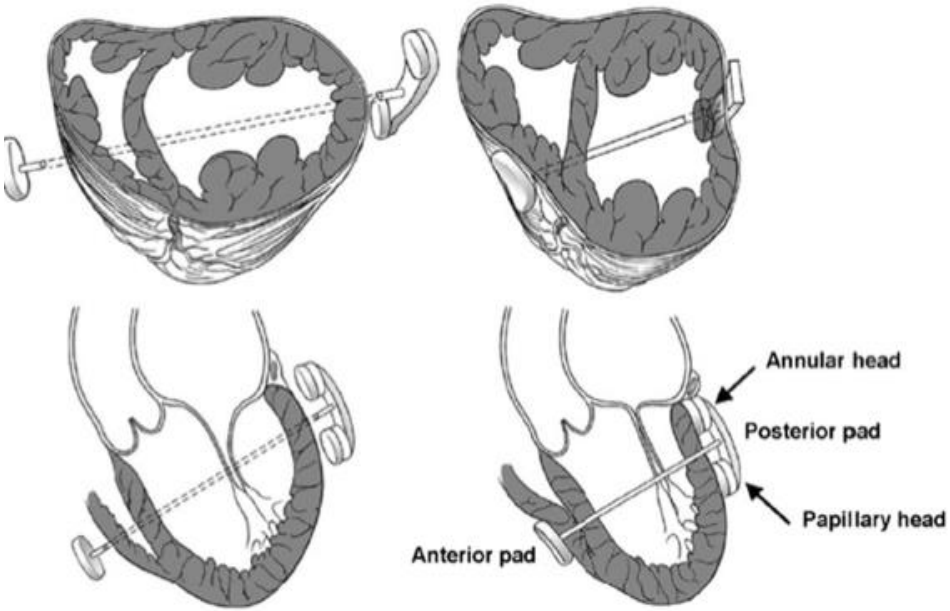
Patrizio Lancellotti[1*], Paul L. Gérard[2], and Luc A. Piérard[1*]

Worsening of MR during exercise echo predicts poor outcome



FMR: a ventricular disease





Grossi EA et al, JACC 2010

The ideal patient for FMR surgery

- Young
- Fit

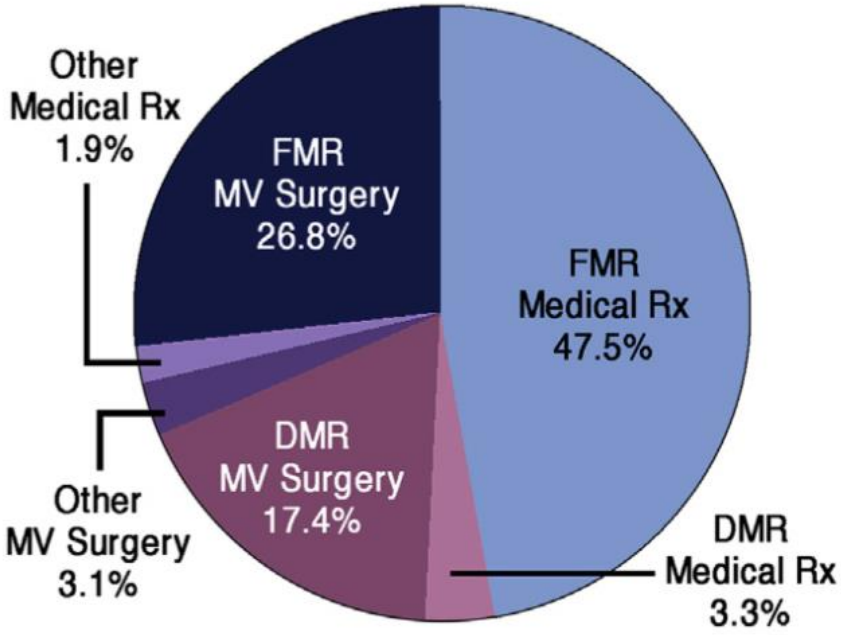
- Short history of HF

- Big annulus
- Small symmetric leaflet tethering
- Limited LV remodelling

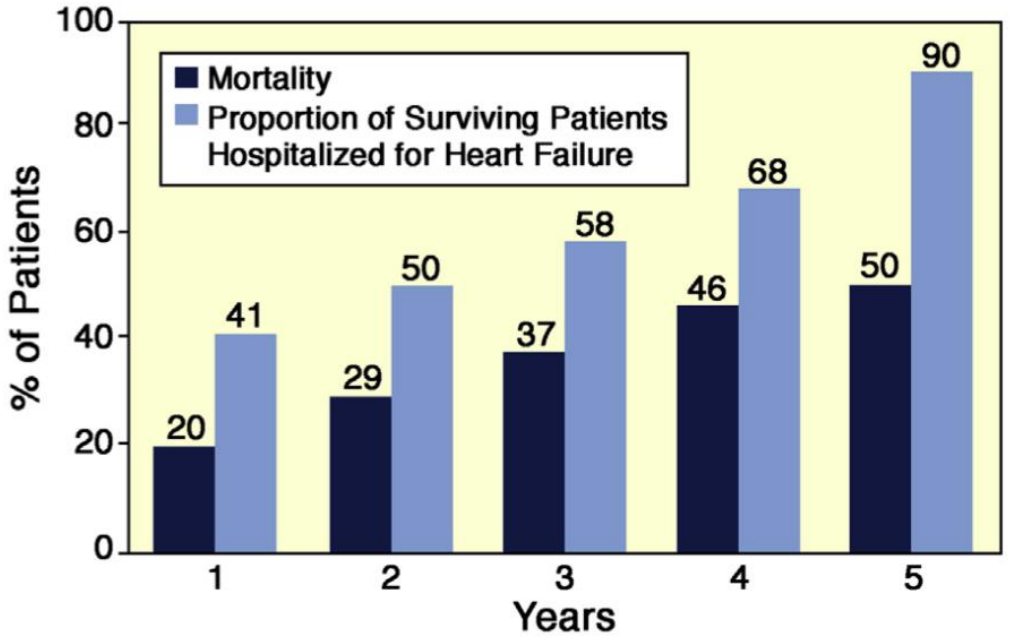
- (±TR ±Afib)

- Viable myocardium
  - option of revascularization
  - contractile reverse

Patients with severe MR and HF at Cliveland Clinic 1095 pts (2001-2008)



Prevalence of MR mechanisms



Outcomes in unoperated patients

Goel SS et al. JACC 2014

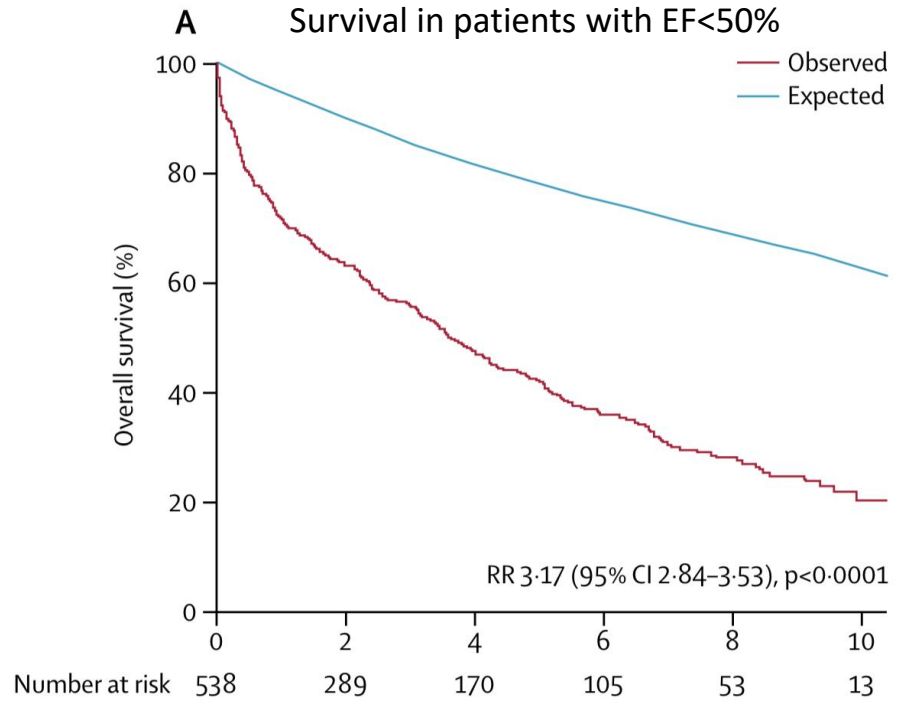
Outcome and undertreatment of mitral regurgitation: a community cohort study

Volha Dziadzko, Marie-Annick Clavel, Mikhail Dziadzko, Jose R Medina-Inojosa, Hector Michelena, Joseph Maalouf, Vuyisile Nkomo, Prabin Thapa, Maurice Enriquez-Sarano

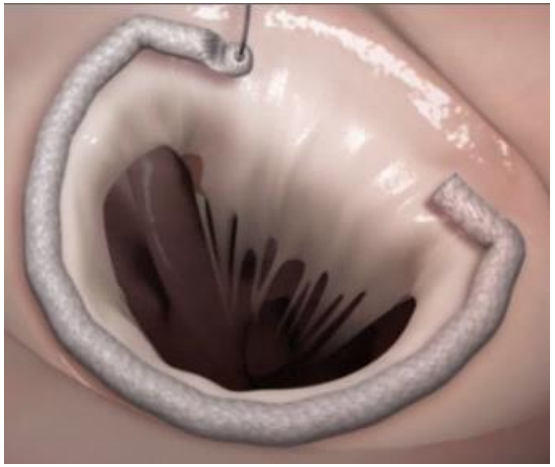
Lancet 2018; 391: 960–69

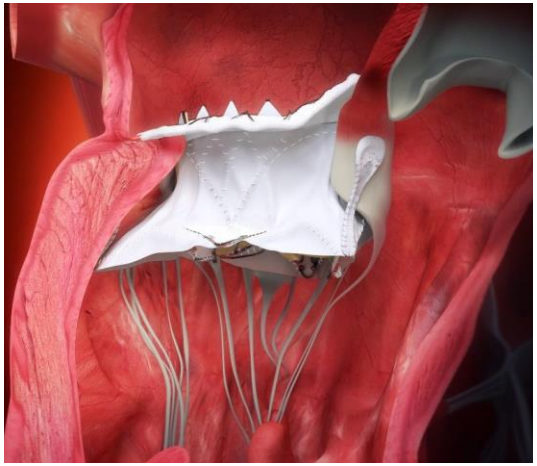
"mitral surgery was performed in 34 (5%) of 723 with secondary regurgitation."

	All patients (n=1294)	Ejection fraction <50% (n=538)	Ejection fraction ≥50% (n=756)
Mitral surgery			
Total	198 (15%)	28 (5%)	170 (22%)
Repair	149 (12%)	18 (3%)	131 (17%)
Replacement	49 (4%)	10 (2%)	39 (5%)
Tissue	23 (2%)	3 (<1%)	20 (3%)
Mechanical	26 (2%)	7 (1%)	19 (3%)
Other cardiac procedures*			
Any cardiac surgery	237 (18%)	49 (9%)	188 (25%)
Coronary artery bypass grafting	88 (7%)	27 (5%)	61 (8%)
Aortic valve surgery	27 (2%)	6 (1%)	21 (3%)
Tricuspid valve surgery	32 (2%)	9 (2%)	23 (3%)
Left ventricular assist device	6 (<1%)	6 (1%)	0
MAZE	19 (1%)	2 (<1%)	17 (2%)
Heart transplant	6 (<1%)	6 (1%)	0



The future…





…how do the lessons from surgical experience apply to transcatheter interventions???