MINIMALLY INVASIVE MITRAL VALVE REPAIR

ERNESTO JIMENEZ, MD

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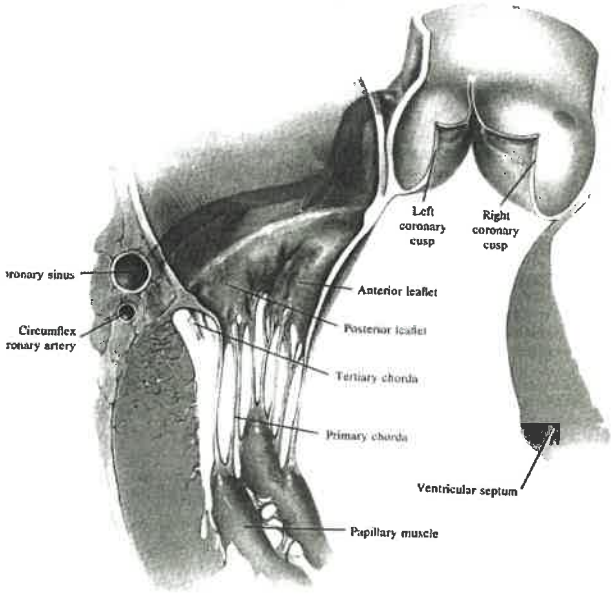
The overall prevalence of mitral regurgitation in the general population is 2%.

Its etiology can be primary (organic) or secondary (functional) . Secondary MR is a function of annular dilatation and geometric distortion of the subvalvular apparatus as a consequence of LV remodeling due to cardiomyopathy or coronary artery disease.

Anatomy of Mitral Valve



Causes Of Primary Mitral Regurgitation

Structural Abnormality	Disease
Annulus	• Annular calcification
Leaflet	• Myxomatous degeneration (Fibroelastic and Barlow's)
	• Rheumatic deformity
Chordae tendineae	• Infectious perforation
	• Myxomatous degeneration
	• Spontaneous rupture
	• Rheumatic shortening
Papillary muscle	• Infectious destruction
	• Infarction

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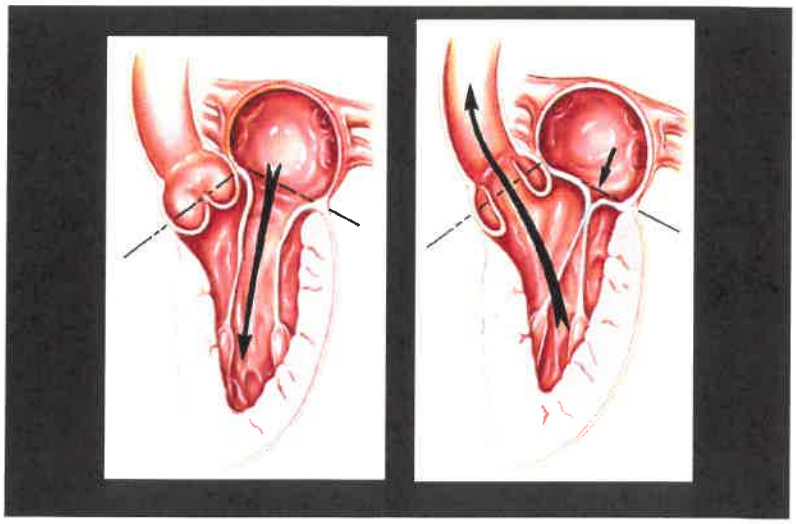
Normal Mitral Valve Orifice



Pathophysiology

- MR is a progressive disease! When one element of the (MV) apparatus becomes defective it puts stress on the existing elements
- For any given patient, the rate of deterioration (i.e. mild to severe) is unpredictable. For the patient with severe MR, the progression to left ventricular (LV) muscle dysfunction is also quite variable

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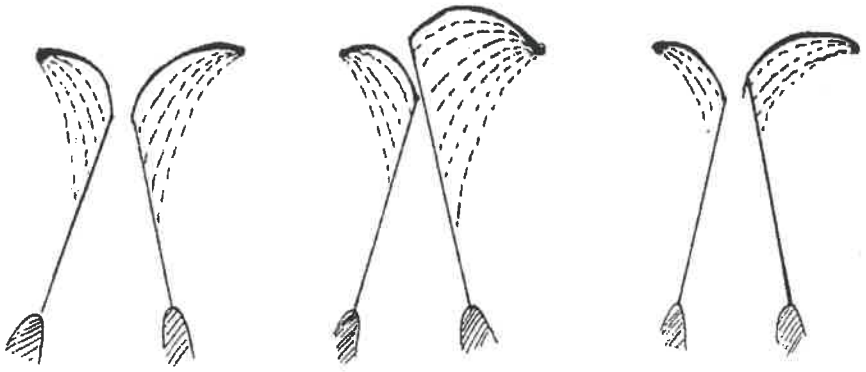
Functional Analysis Detail

- Type I – *Normal Leaflet Motion*
- Type II – *Leaflet Prolapse*
  - *Chordal Rupture or Elongation*
  - *Papillary muscle Rupture or Elongation*
- Type III – *Restricted Leaflet Motion*
  - Commissural Fusion
  - Leaflet Thickening
  - Chordal Fusion or Thickening
  - Tethering

Functional Analysis



Type I **Type II** **Type III**

Repair vs. Replacement Mitral Valve Regurgitation Caused By Leaflet Prolapse

Sarano, JTCVS, 2009

- Article questioned whether choice of mitral valve procedure (i.e. replacement versus repair) affected LV function
- Reviewed 1063 patients
- MV replacement / with chordal sparring in 89%
- MV Repair patients had significantly higher long-term LV function than MV Replacement

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Is the LV dysfunction that occurs in MR reversible?

- Experimental and clinical studies in patients before and after MV surgery have found that at least at some point of the disease, the LV dysfunction that occurs is reversed, by the removal of volume overload.

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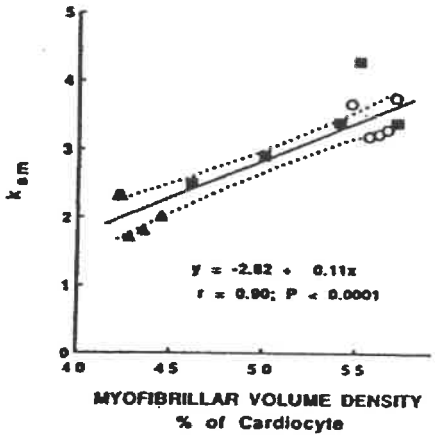
BLASE A. CARABEL



Reduced contractility in mitral valve regurgitation is due in part to a loss of contractile elements. This loss is reversible in animals by mitral valve repair

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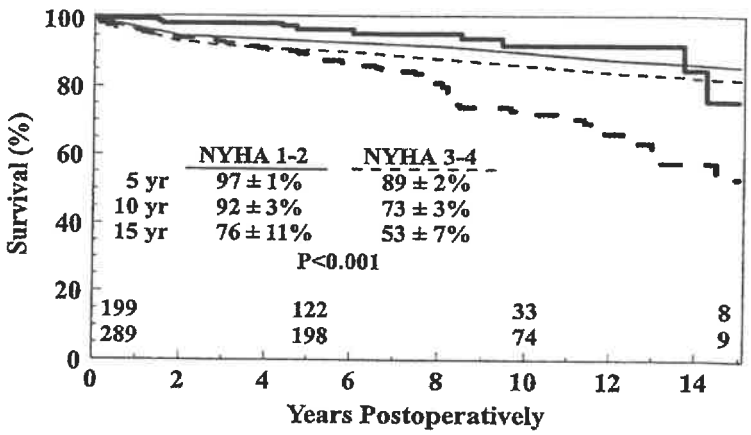

Figure 2. Survival after mitral valve repair in asymptomatic and symptomatic patients in comparison with that in the general population matched for age and sex, as depicted by the *thinner lines*.

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- Repair of **severe** MR caused by a "floppy" mitral valve in **asymptomatic patients** allows for survival **identical** to that of the general population
- Waiting for patients to become symptomatic **significantly lowers the survival**, when compared to the general population

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If a repair can be performed in the asymptomatic patient with:

1) Severe MR
2) An operative risk of less than 1%
3) 95% likelihood of a successful repair with no bioprosthetic

Then asymptomatic patients with severe MR and normal LV function should be operated on to avoid the potential risks of:

1) Decrease long term survival due to LV dysfunction
2) Atrial-fib
3) Pulmonary HTN

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WHY OFFER PATIENTS

PORT ACCESS Minimally Invasive Mitral Valve Surgery?

- Eliminates median sternotomy and its associated wound morbidity
- Shorter hospital stay[1]
- Quick return to work or routine activities[2]
  - 46% at 4 weeks
  - Total of 71% at 6 weeks

Relative contraindications for some of the PORT ACCESS Minimally Invasive Valve Surgery products include moderate to severe peripheral or aortic arteriosclerosis and a history of thoracic trauma. Absolute contraindications for some of the PORT ACCESS Minimally Invasive Valve Surgery products include aneurysm of the ascending aorta and severe aortic regurgitation. Do not use PORT ACCESS arterial cannula and catheter introducer sheath if the patient has severe peripheral atherosclerosis or is otherwise contraindicated for cardiopulmonary bypass.

1. Grossi E, Galloway AC, Ribicove GH, Zakow PK, Derivaux CC, Baumann FG, Schwesinger DW, Colvin SB. Impact of minimally invasive valvular heart surgery – a case control study. *Ann Thorac Surg*. 2001;71:807-810
2. Casselman FP, Slycke SV, Wellens F, De Geest R, Degrieck I, VanPraet F, Vermeulen Y, Vanermen H. Mitral Valve Surgery Can Now Routinely Be Performed Endoscopically. *Circulation*. 2003; 108 Suppl 1:II48-54.

11/16/2008

Anesthesia

- TEE
- Double –lumen endotracheal tube
- Position coronary sinus cardioplegia and pulmonary artery vent catheters
- CFA and CFV cannulation for cardiopulmonary bypass

e1

Right inframammary crease is pulled upwards…..

….as sterile drape is affixed to skin.

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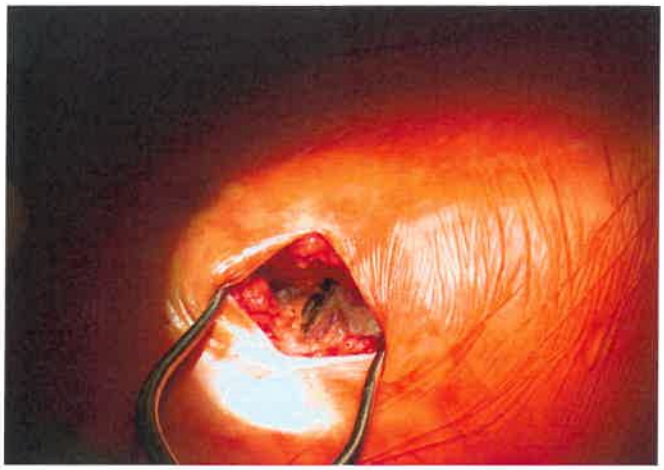
Slide 16

e1 ejcardiac@gmail.com, 7/6/2021



Single – lung ventilation allows atraumatic entry of right pleural cavity through 4th ICS

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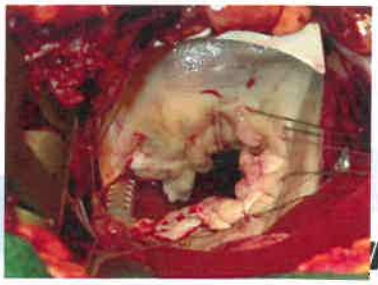
Femoral and Direct MVR Approaches

Using the Left Atrial Retractor, the appropriate blade size is chosen and a small stab incision is made on the anterior chest wall. The blade handle is inserted down into the left atrium and attached to the blade. The handle is pulled anteriorly to lift the intra-atrial septum and provide full exposure of the mitral valve.

The full extent of mitral pathology can be evaluated at this point with standard surgical techniques.

CardioVations Atrial Retractor



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Minimally Invasive Mitral Valve Surgery – "A Reality"

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Mitral Valve Repair Rate at a Veterans Affairs Hospital Utilizing a Multidisciplinary Heart Team

Ernesto Jimenez, MD • Darrell Wu, MD • Shuab Omer, MD • ... Paulino Nunez, MD • Todd K. Rosengart, MD • Joseph S. Coselli, MD • Show all authors

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Between 2000 and 2008, the mitral valve (MV) repair rate in patients with severe mitral regurgitation at our low-volume Veterans Affairs hospital was 21%. After instituting a multidisciplinary valve team in 2009, we determined whether this rate increased and characterized the outcomes of patients with degenerative disease. We retrospectively reviewed data from 103 MV operations performed at our hospital between 1/2009 and 8/2016. MV pathology was categorized as degenerative, rheumatic, endocarditis, ischemic, hypertrophic cardiomyopathy, or failed prior MV repair. The surgical techniques used for MV repair were reviewed. For the patients with degenerative disease who underwent MV repair, we assessed leaflet involvement and postoperative valve function. For the full cohort, the MV repair rate was 67% and the 30-day mortality rate was 0.97%. Of the 74 patients with degenerative disease, 64 (86.5%) underwent MV repair (none required reoperation). For these patients, the MV repair rate was significantly higher when the surgical approach was sternotomy rather than minimally invasive right minithoracotomy (92.5% vs 71.4%, $P = 0.03$). After MV repair, 95.3% of the degenerative disease patients had mild or less mitral regurgitation; median echocardiography follow-up time was 555 days. Anatomic features associated with a reduced MV repair rate in patients with degenerative disease were dystrophic leaflet calcification and severe mitral annular calcification. In an institution with a low volume of MV operations, preoperative surgical planning with a multidisciplinary valve team was associated with improved MV repair rates and excellent repair quality in patients with

Seminars of Thoracic and Cardiovascular Surgery AATS , Jimenez et al, 9/2019

- 100 consecutive mitral operations
- Mortality rate of 0.97 %
- 93% valve repair rate for degenerative disease
- Median Echo follow up of 555 days
- Less than 5 % rate of recurrence > than mild MR in repaired valves
- No re-operations
- Anatomic features associated with reduced mitral valve repair were dystrophic leaflet calcification and annular calcification

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Mitral Repairs : WMC 2021 to present

- **42 Total Mitral Repairs**
  { Repairs only + (repairs + concomitant procedures)}
  97.5 % performed for degenerative disease
  2.5 % performed for functional MR
  2.5 % performed for endocarditis

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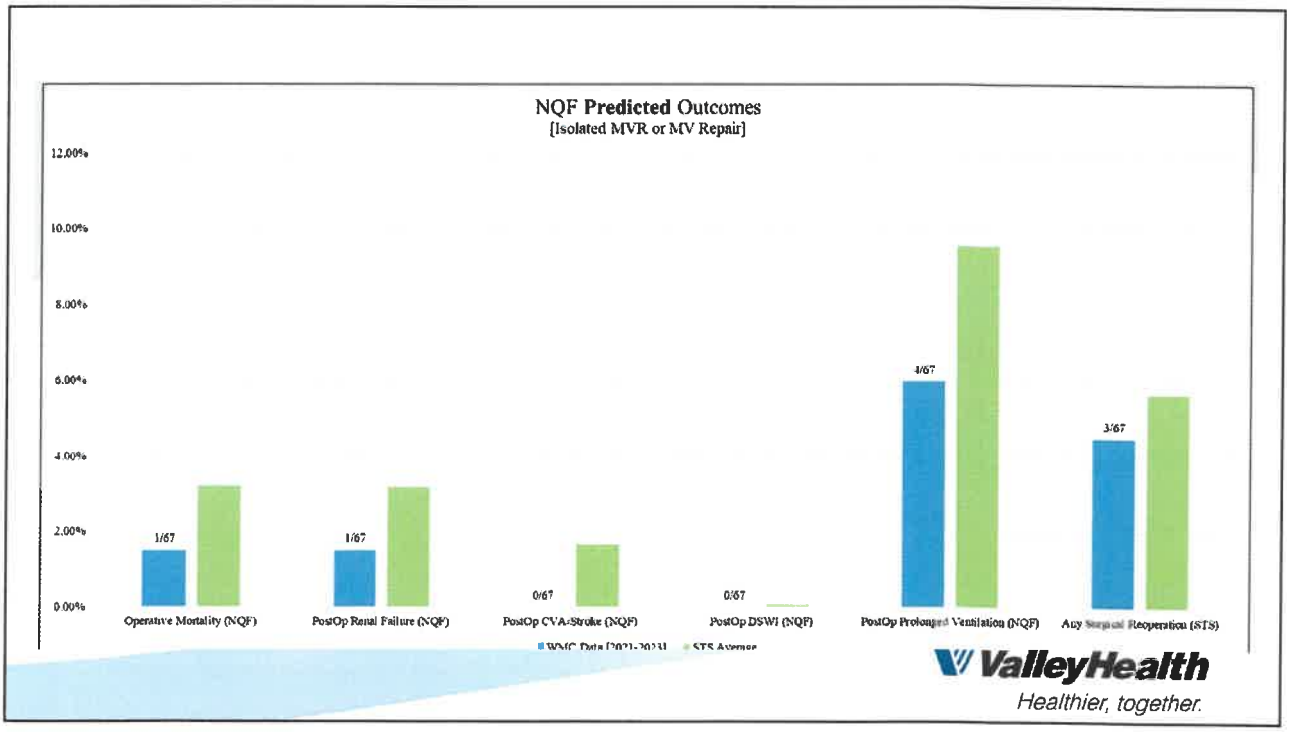
Degenerative Mitral Repair Pathology

Anterior leaflet prolapse : 16%
Posterior leaflet prolapse : 52%
Anterior +posterior leaflet prolapse : 23 %
Barlow's valve : 9%



Post Degenerative Repair Residual MR (last follow up echo)

Mild or less MR
97.6 %

50% Trace
25% No MR
25% Mild

Moderate
2.4 %

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Functional MR

- A disease process that is caused by annular dilatation and geometric structural changes of the left ventricle :

  Ischemic MR

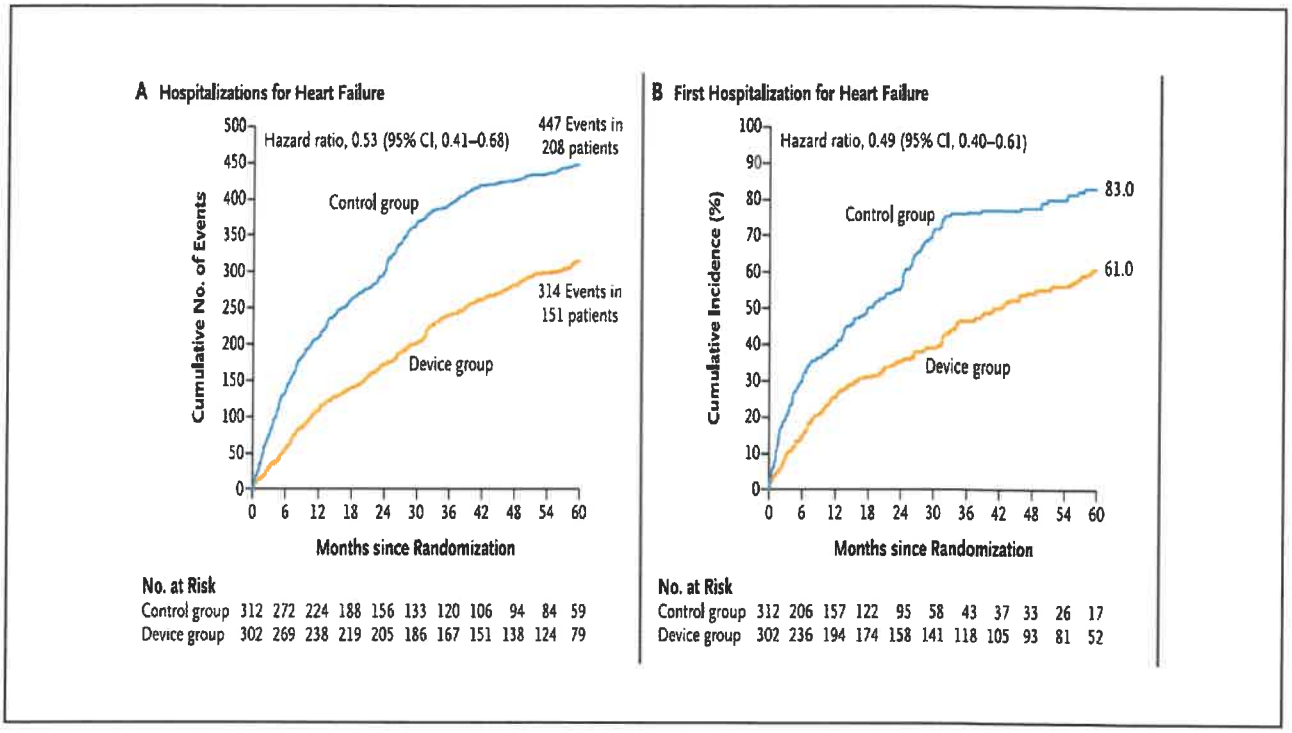
  Non ischemic cardiomyopathies with LV dilatation

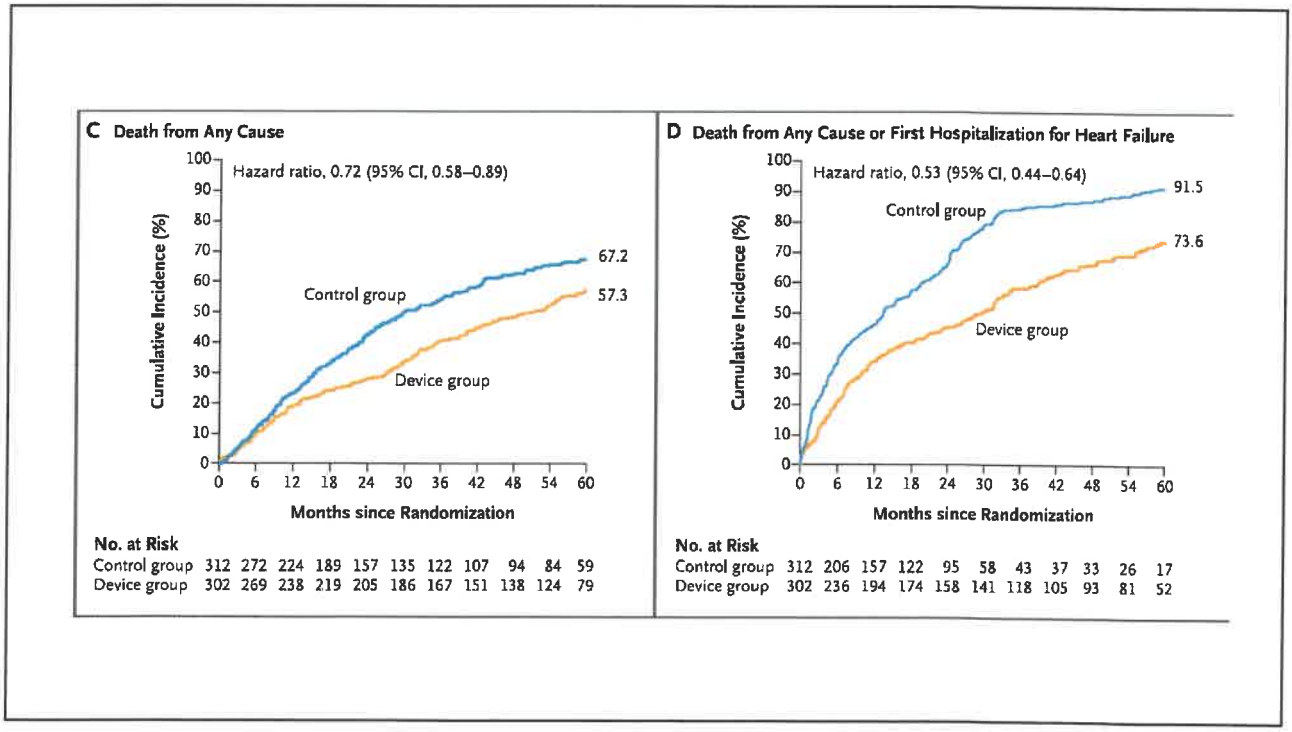
  Atriogenic MR (atrial fibrillation)

Mitral Clip

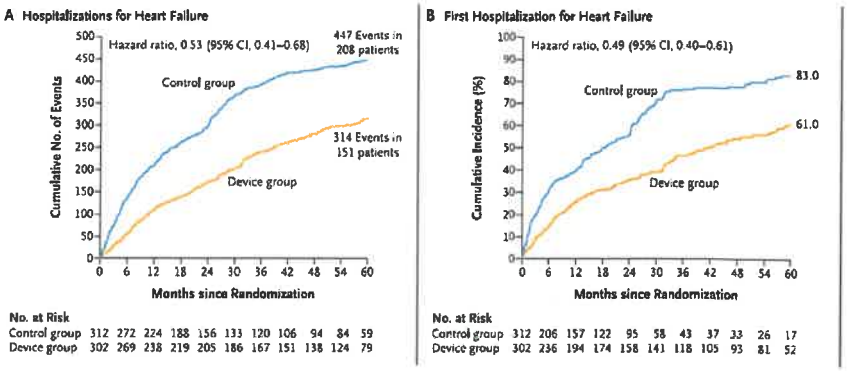
Coapt Trial : Two-year Data 2018, NEJM

- *First Randomized trial that demonstrated improved outcomes vs medical therapy in patients with functional MR*
- Death from any cause at two years : *29%* vs 46 %
- Annual rate of rehospitalization within two-year period for heart failure : *36%* vs 67 %


A Hospitalizations for Heart Failure
Hazard ratio, 0.53 (95% CI, 0.41–0.68)
447 Events in 208 patients
314 Events in 151 patients
Control group
Device group
Cumulative No. of Events
Months since Randomization
No. at Risk
Control group 312 272 224 188 156 133 120 106 94 84 59
Device group 302 269 238 219 205 186 167 151 138 124 79
B First Hospitalization for Heart Failure
Hazard ratio, 0.49 (95% CI, 0.40–0.61)
83.0
61.0
Control group
Device group
Cumulative Incidence (%)
Months since Randomization
No. at Risk
Control group 312 206 157 122 95 58 43 37 33 26 17
Device group 302 236 194 174 158 141 118 105 93 81 52


C Death from Any Cause
Hazard ratio, 0.72 (95% CI, 0.58–0.89)
67.2
57.3
Control group
Device group
Cumulative Incidence (%)
Months since Randomization
No. at Risk
Control group 312 272 224 189 157 135 122 107 94 84 59
Device group 302 269 238 219 205 186 167 151 138 124 79
D Death from Any Cause or First Hospitalization for Heart Failure
Hazard ratio, 0.53 (95% CI, 0.44–0.64)
91.5
73.6
Control group
Device group
Cumulative Incidence (%)
Months since Randomization
No. at Risk
Control group 312 206 157 122 95 58 43 37 33 26 17
Device group 302 236 194 174 158 141 118 105 93 81 52

Coapt 5 Year Results



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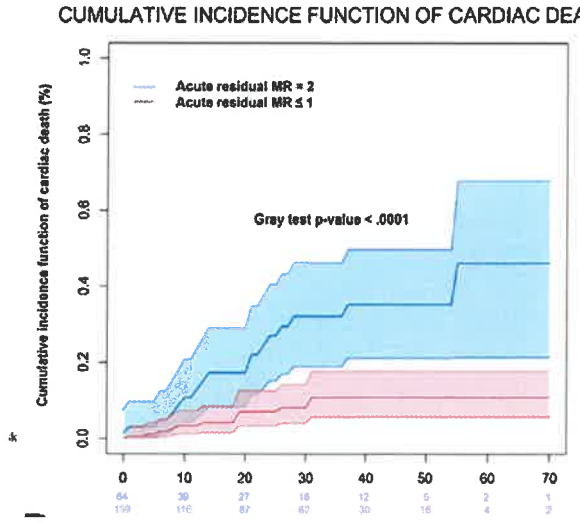

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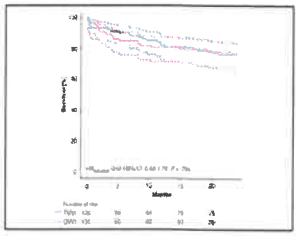
Surgical versus transcatheter repair for secondary mitral regurgitation: A propensity score–matched cohorts comparison

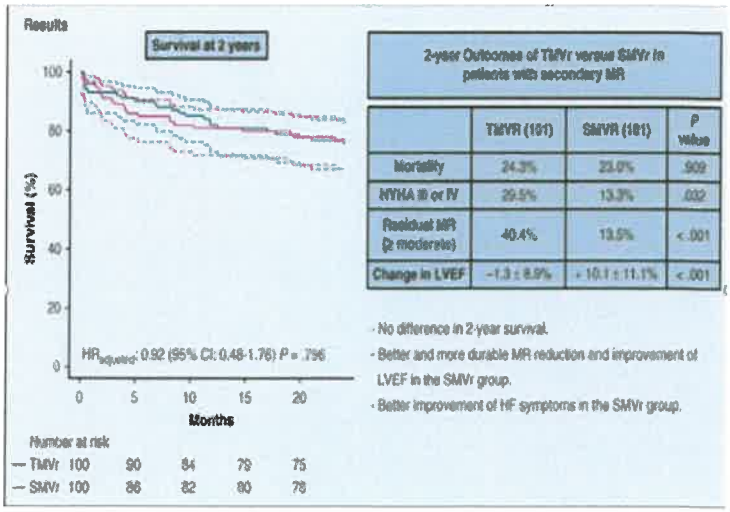
Taishi Okuno, MD,[a] Fabien Praz, MD,[a] Mohammad Kassar, MD,[a] Patric Biaggi, MD,[b] Maks Mihalj, MD,[c] Mischa Külling, MD,[b] Sonja Widmer, MD,[a] Thomas Pilgrim, MD, MSc,[a] Jürg Grünenfelder, MD,[d] Alexander Kadner, MD,[c] Roberto Corti, MD,[b] Stephan Windecker, MD,[a] Peter Wenaweser, MD,[b] and David Reineke, MD[c]

ABSTRACT

Objectives: To compare the efficacy and clinical outcomes of transcatheter edge-to-edge mitral valve repair (TMVr) and surgical mitral valve repair (SMVr) among patients with secondary mitral regurgitation (SMR).

Methods: Consecutive patients with SMR treated using either TMVr (n = 199) or SMVr (n = 222) at 2 centers were included and retrospectively analyzed. To account for differences in patient demographic characteristics, 1:1 propensity score matching was performed. The primary endpoint was all-cause death within 2 years after





Randomized Trial MVr vs MVR NEJM, 1/2016 (n= 251)

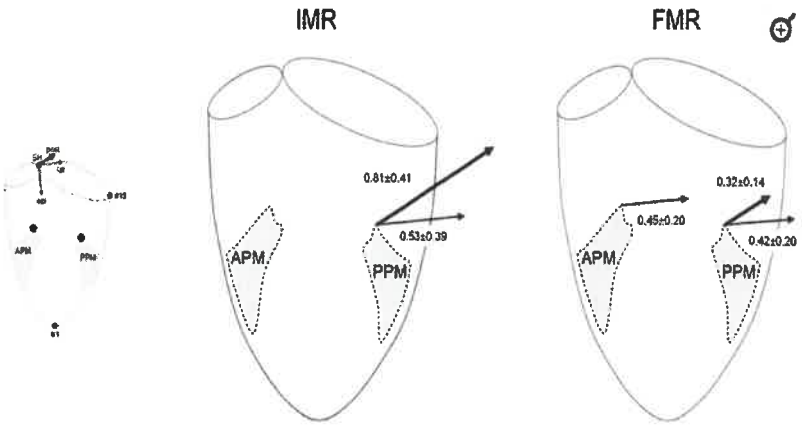
ORIGINAL ARTICLE

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. Tadden-Peters, P.K. Smith, E. Moquete, J.P. Overbey, I.L. Kron, P.T. O'Gara, and M.A. Acker, for the CTSN*

- 30-day mortality 1.6 % MVr vs 4 % MVR
- Two-year mortality 19% MVr vs 23 % in MVR
- Rehospitalization for heart Failure 21 % vs 17 %
- Two- year Rate of MR recurrence 59 % vs 3.8 %

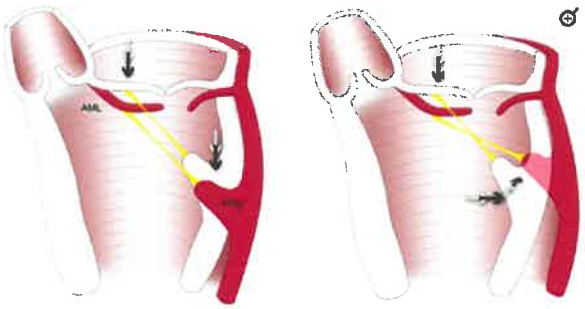
Figure 1:



Schematic illustrations depicting three-dimensional anterior and posterior papillary muscle (APM and PPM, respectively) displacement vectors in experimental ovine models of ischemic and functional mitral regurgitation (IMR and FMR, respectively). Arrows indicate vectors that reached statistical significance according to Table 2. Arrow lengths are proportionate to the average of the differences between Control and the respective IMR/FMR values. The small schematic illustrates the coordinate system used (see Methods). SH=saddle horn, api=apical, lat=lateral, post=posterior, #18=mid-lateral mitral annular marker.

Mechanism of leaflet tethering

Figure 2:



Schematic illustrating the hypothesized predominant mechanism leading to leaflet tethering during IMR/FMR: Apical leaflet displacement is not – as frequently hypothesized – associated with apical (A), but with a postero-lateral displacement of the posteromedial papillary muscle (PPM) (B). AML=anterior mitral leaflet

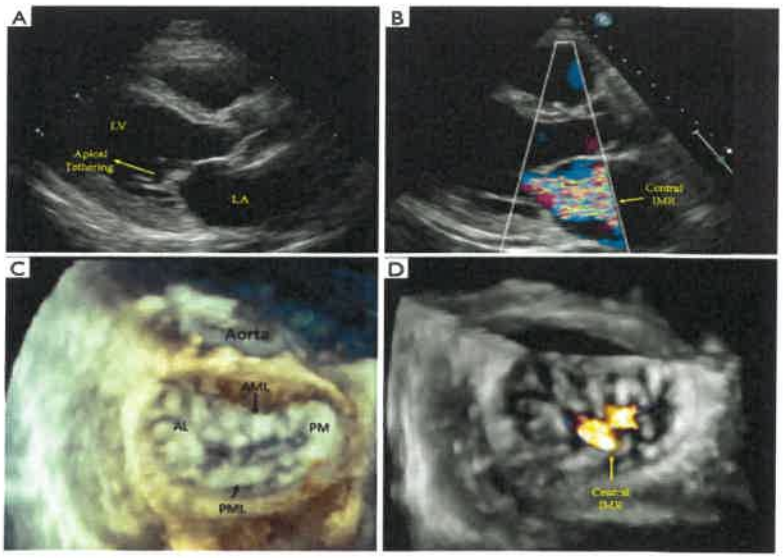


Figure 3 Symmetric pattern of mitral valve tethering on two- and three-dimensional echocardiography. Symmetric mitral valve leaflet tethering in primarily the apical direction results in a central ischemic mitral regurgitant jet (A,B). En face (surgeon's view) of the mitral valve exemplifies a central, crescentic-shaped regurgitant orifice and MR jet (C,D). AL, anterolateral commissure; AML, anterior mitral leaflet; IMR, ischemic mitral regurgitation; LA, left atrium; LV, left ventricle; PM, posteromedial commissure; PML, posterior mitral leaflet.

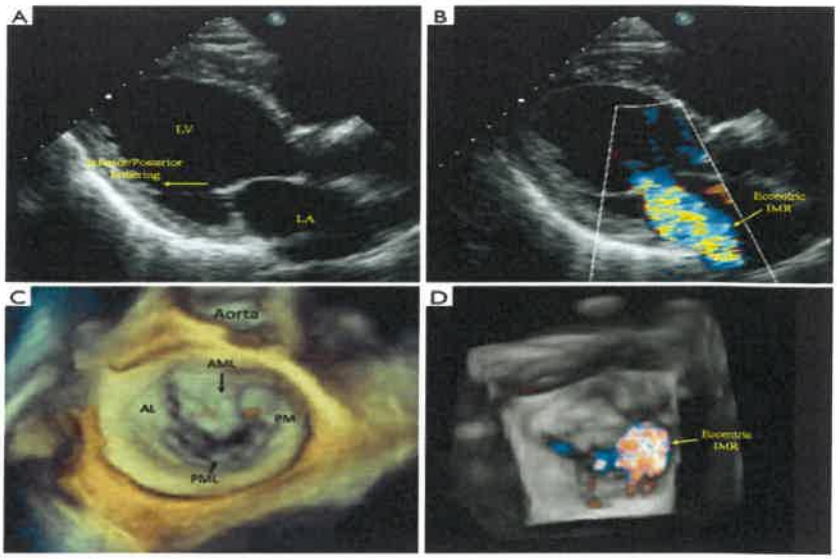


Figure 2 Asymmetric pattern of mitral valve tethering on two- and three-dimensional echocardiography. Asymmetric mitral valve leaflet tethering in the inferior/posterior direction (yellow arrow) results in posteriorly-directed eccentric ischemic mitral regurgitation (IMR) (A,B). En face (surgeon's view) of the mitral valve exemplifies the resultant regurgitant orifice, which is more medially located, and the eccentric MR (C,D). AL, anterolateral commissure; AML, anterior mitral leaflet; IMR, ischemic mitral regurgitation; LA, left atrium; LV, left ventricle; PM, posteromedial commissure; PML, posterior mitral leaflet.

IMR Recurrence after MV Repair and PMA
Nappi et al ,ATS 2019

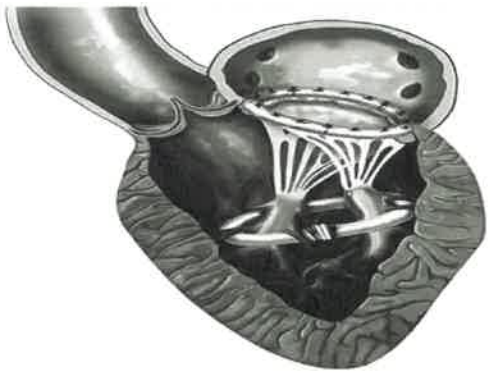


Fig 1. Sagittal illustration of ring annuloplasty mitral valve repair and papillary muscle approximation using a 4-mm polytetrafluoroethylene graft.

Treatment Algorithm

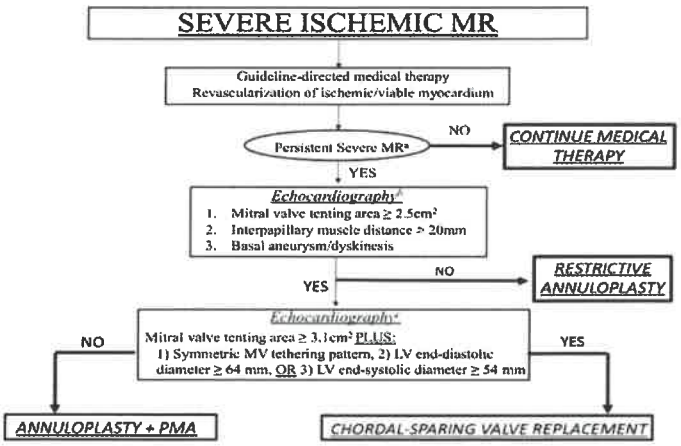


Fig 3. Example of treatment algorithm for patients with severe ischemic mitral regurgitation (MR) undergoing mitral valve (MV) surgery. [a]Patients with severe ischemic MR undergoing isolated mitral valve surgery or combined coronary artery bypass grafting and MV surgery. [b]Preoperative echocardiographic markers for recurrent MR after undersized restrictive ring annuloplasty MV repair. [c]Preoperative echocardiographic markers for recurrent MR after combined undersized restrictive ring annuloplasty MV repair and papillary muscle approximation (PMA). (LV = left ventricular.)

Functional MR

COR	LOE	RECOMMENDATIONS
2a	B-R	1. In patients with chronic severe secondary MR related to LV systolic dysfunction (LVEF <50%) who have persistent severe symptoms (NYHA class II, III, or IV) while on optimal GDMT for HF (Stage D), TEER is reasonable in patients with appropriate anatomy as defined on TEE and with LVEF between 20% and 50%, LVESD ≤70 mm, and pulmonary artery systolic pressure ≤70 mm Hg (318,338-344).
2a	B-NR	2. In patients with severe secondary MR (Stages C and D), mitral valve surgery is reasonable when CABG is undertaken for the treatment of myocardial ischemia (345-351).
2b	B-NR	3. In patients with chronic severe secondary MR from atrial annular dilation with preserved LV systolic function (LVEF ≥50%) who have severe persistent symptoms (NYHA class III or IV) despite therapy for HF and therapy for associated AF or other comorbidities (Stage D), mitral valve surgery may be considered (352-356).
2b	B-NR	4. In patients with chronic severe secondary MR related to LV systolic dysfunction (LVEF <50%) who have persistent severe symptoms (NYHA class III or IV) while on optimal GDMT for HF (Stage D), mitral valve surgery may be considered (317,345,348,357-378).
2b	B-R	5. In patients with CAD and chronic severe secondary MR related to LV systolic dysfunction (LVEF <50%) (Stage D) who are undergoing mitral valve surgery because of severe symptoms (NYHA class III or IV) that persist despite GDMT for HF, chordal-sparing mitral valve replacement may be reasonable to choose over downsized annuloplasty repair (317,345,348,357-367,379-382).