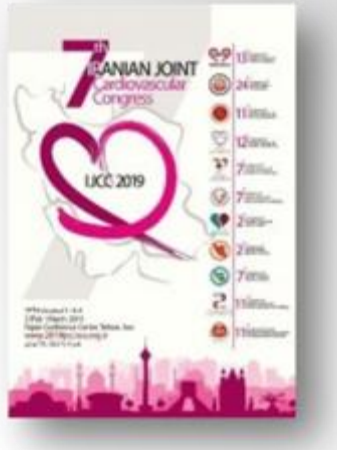
Conflict of Interest: None



Surgical Challenges in IMR

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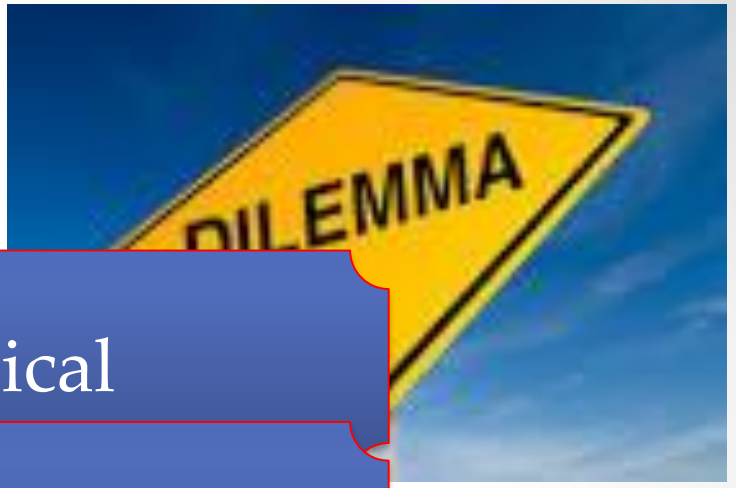


Surgical vs Medical

Repair vs Replacement

RA vs Additional techniques

Saddle shape vs Flat

Surgical vs Medical

Repair vs Replacement

RA vs Additional techniques

Saddle shape vs Flat

Acute IMR /
Non acute IMR

MR severity

Table 4 Guideline based reference ranges for grading mr 2014 AHA/ACC Guidelines

2014 AHA/ACC Guidelines				
Parameter	**Stage A "At risk"**	**Stage B "Progressive"**	**Stage C "Asymptomatic Severe"**	**Stage D "Symptomatic Severe"**
Valve apparatus and anatomy	CAD or cardiomyopathy, with normal valve leaflets, chords, annulus	Regional WMA with mild tethering of MV	Regional WMA ± LV dilatation with severe tethering of MV	Regional WMA ± LV dilatation with severe tethering of MV
		Annular dilatation with mild loss of central coaptation	Annular dilatation with severe loss of central coaptation	Annular dilatation with severe loss of central coaptation
LV (ischemic or primary myocardial disease)	No or mild dilatation with infarct or inducible ischemia, or cardiomyopathy with LV systolic dysfunction and dilatation	Regional WMA with reduced LV systolic function ± dilatation	Regional WMA with reduced LV systolic function ± dilatation	Regional WMA with reduced LV systolic function ± dilatation
Symptoms	May be present, may respond to GDMT	May be present, may respond to GDMT	May be present, may respond to GDMT	Symptoms persist despite GDMT
EROA-CIMR (cm^2)	< 0.2	< 0.2	≥ 0.2	≥ 0.2
Jet/LA area	No MR jet or jet area/LA area <20%	20-39%	≥ 40%	≥ 40%
VC width (cm)	< 0.3		≥ 0.7	≥ 0.7
Regurgitant Fraction		< 50%	≥ 50%	≥ 50%
Regurgitant Volume		< 30 mL	≥ 30 mL	≥ 30 mL

Alajaji et al. BMC Res Notes (2015) 8:712
DOI 10.1186/s13104-015-1704-9

BMC Research Notes

RESEARCH ARTICLE Open Access

Surgical versus medical management of patients with acute ischemic mitral regurgitation: a systematic review

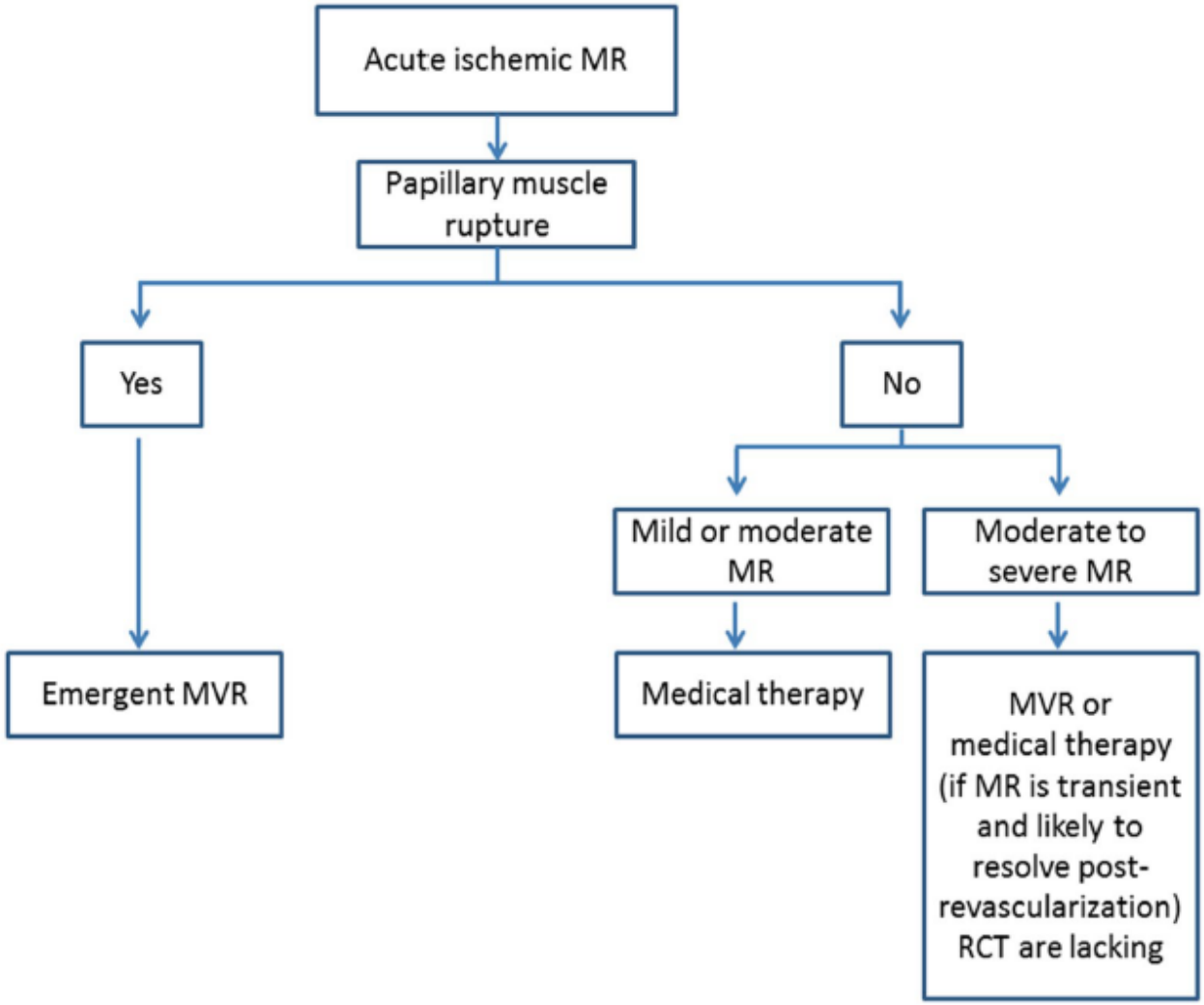


Fig. 1 Proposed algorithm for management of patients with acute ischemic mitral regurgitation. *MR* mitral regurgitation; *MVR* mitral valve replacement/repair; *RCT* randomized clinical trial

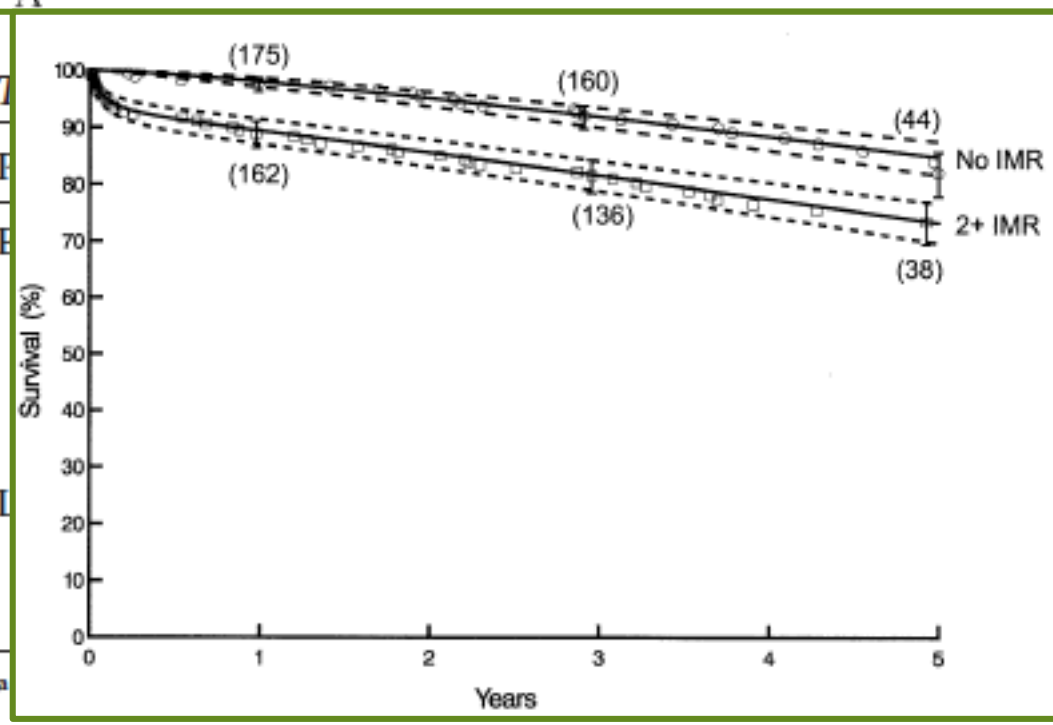
In absence of robust data, the management of acute ischemic MR mostly remains based on expert opinion.

Importance of Moderate Ischemic Mitral Regurgitation

B-Khanh Lam, MD, A. Marc Gillinov, MD, Eugene H. Blackstone, MD, Jeevanantham Rajeswaran, MS, Bertram Yuh, BS, Sunil K. Bhudia, MD, Patrick M. McCarthy, MD, and Delos M. Cosgrove, MD

Departments of Thoracic and Cardiovascular Surgery, and Biostatistics and Epidemiology, The Cleveland Clinic Foundation, Cleveland, Ohio

(Ann Thorac Surg 2005;79:462–70)



Importance of Moderate Ischemic Mitral Regurgitation

B-Khanh Lam, MD, A. Marc Gillinov, MD, Eugene H. Blackstone, MD, Jeevanantham Rajeswaran, MS, Bertram Yuh, BS, Sunil K. Bhudia, MD, Patrick M. McCarthy, MD, and Delos M. Cosgrove, MD

Departments of Thoracic and Cardiovascular Surgery, and Biostatistics and Epidemiology, The Cleveland Clinic Foundation, Cleveland, Ohio

Background. The importance of moderate ischemic mitral regurgitation in patients presenting for coronary artery bypass grafting (CABG) is controversial. Therefore, we tracked the course of unrepaired moderate ischemic mitral regurgitation after CABG surgery alone, identified factors associated with worsening postoperative ischemic mitral regurgitation, and assessed the impact of unrepaired moderate ischemic mitral regurgitation on survival.

Methods. From 1980 to 2000, 467 patients with moderate ischemic mitral regurgitation underwent CABG alone. The course of unrepaired mitral regurgitation was estimated by a longitudinal analysis of 267 follow-up echocardiograms from 156 patients. The survival impact of moderate ischemic mitral regurgitation was determined among propensity-matched patients with and without ischemic mitral regurgitation.

Results. Mitral regurgitation was dynamic early postoperatively. Immediately postoperatively, it was absent or mild in 73% and severe in 6%; by 6 weeks, these figures were 40% and 22%, respectively. The course of postoperative mitral regurgitation was not associated with the preoperative extent of coronary artery disease or left ventricular dysfunction. Five-year survival of matched bypass patients without ischemic mitral regurgitation was 85% compared with 73% for patients with moderate ischemic mitral regurgitation ($p = 0.003$).

Conclusions. Moderate ischemic mitral regurgitation does not reliably resolve with CABG surgery alone and is associated with reduced survival. Therefore, a mitral valve procedure may be warranted for such patients presenting for CABG. A randomized trial comparing strategies of revascularization with mitral valve repair and revascularization alone is required to determine optimal treatment.

(Ann Thorac Surg 2005;79:462–70)

Curr Cardiol Rep (2016) 18: 22
DOI 10.1007/s11886-016-0701-5

Does Surgical Repair of Moderate Ischemic Mitral Regurgitation Improve Survival? A Systematic Review

Conclusion

In summary, our review suggests that there are conflicting results from different studies regarding survival benefit and improvement in the functional class after performing MVR in addition to CABG in moderate ischemic MR. Most of the studies we selected do not favor MVR as most of the studies failed to show any long-term survival benefit, and there is mixed data regarding improvement in functional status. However, these results cannot serve as guidelines and cannot be generalized as there are many flaws in study design of parent studies, differences in the baseline characteristics of patients in comparison groups, as well as potential for inherent biases. Large-scale RCTs are necessary to establish a universal approach that benefits patients with moderate ischemic regurgitation in terms of long-term and event-free survival and meaningful improvement in morbidity.

In summary

- Mild to mod. IMR: Negative impact on survival

  MVr improve functional status No survival benefit

- Mod IMR: No clinically meaningful benefit from MVr during 1yr F/U , CTSN trial

  but may long term survival benefit

  Especially in patient with low EF

- Sever IMR: MVr/MVR have symptomatic & survival benefit

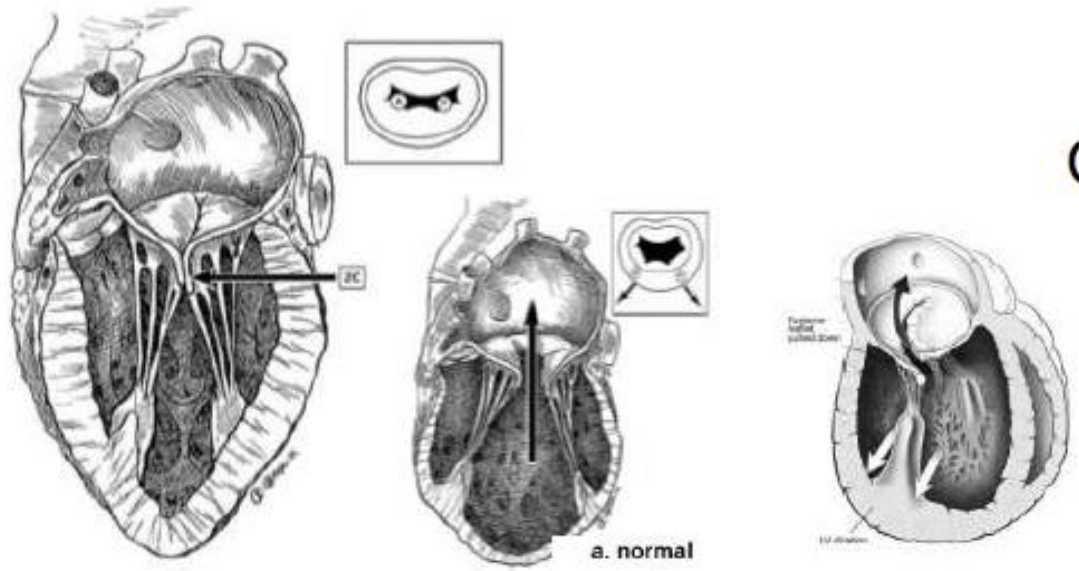
Surgical vs Medical

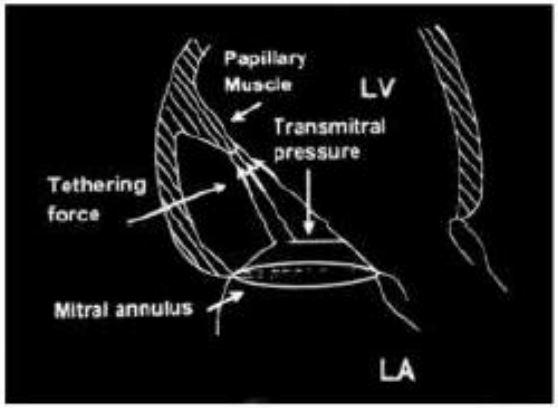
Repair vs Replacement

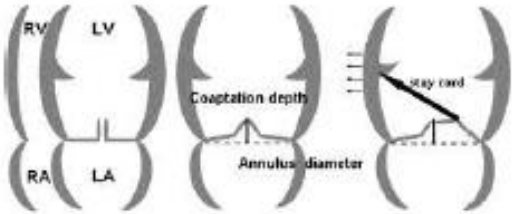
RA vs Additional techniques

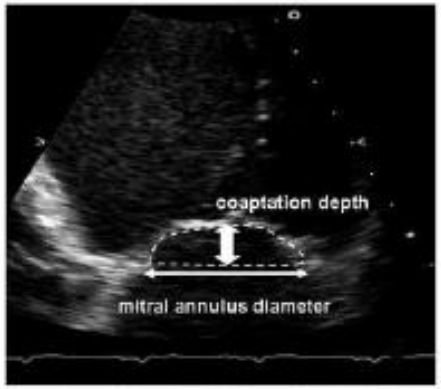
Saddle shape vs Flat

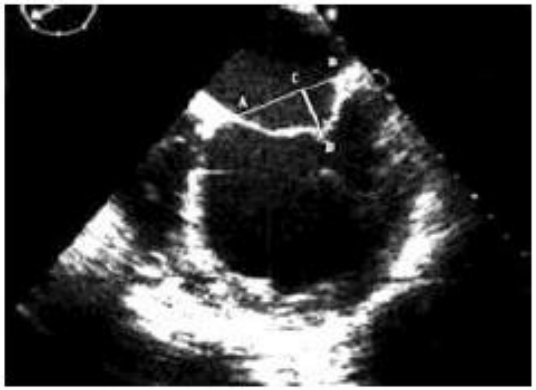
Carpentier Type 1+IIIb

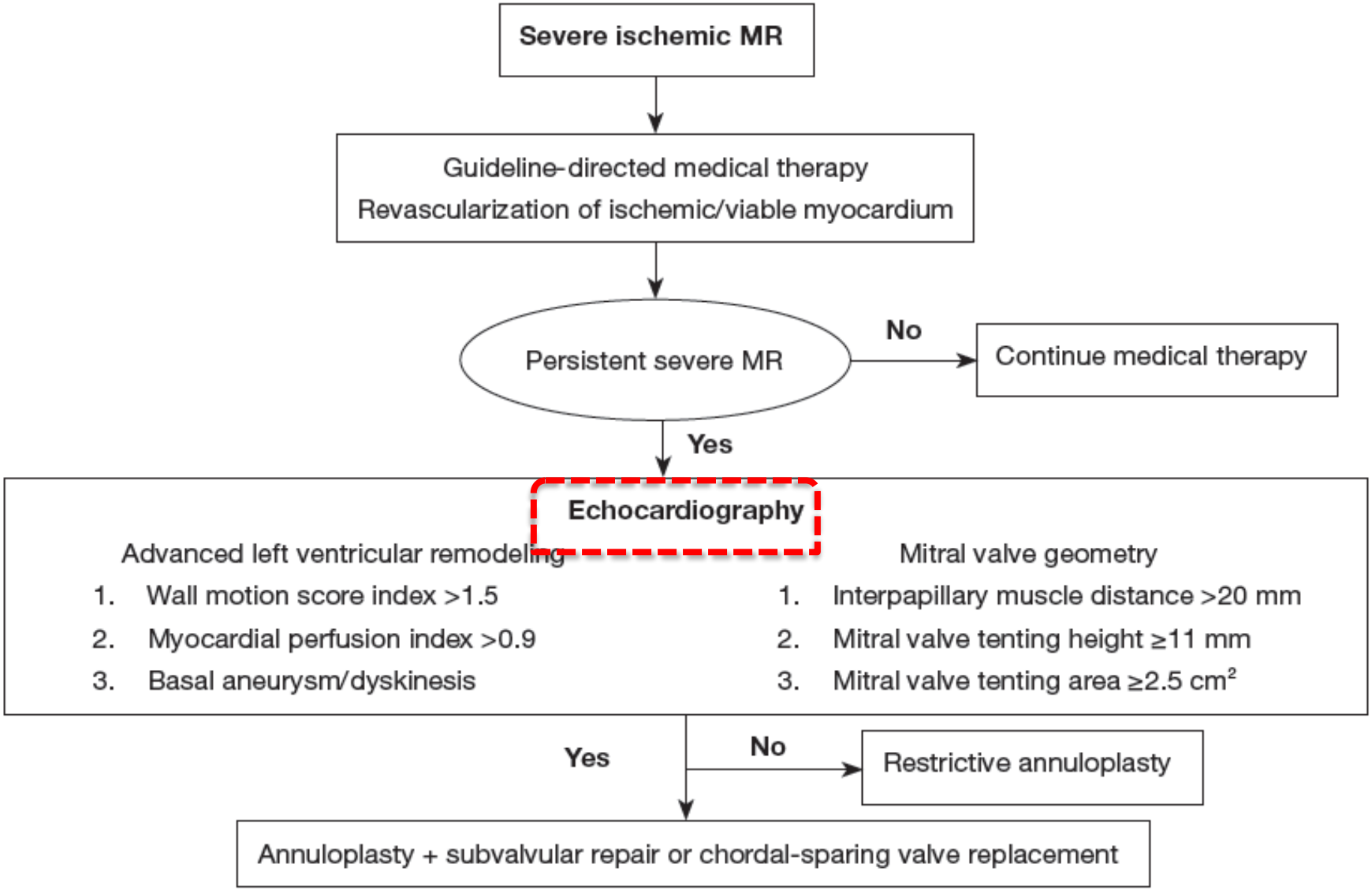











Severe ischemic MR
Guideline-directed medical therapy
Revascularization of ischemic/viable myocardium
Persistent severe MR
No
Continue medical therapy
Yes
Echocardiography
Advanced left ventricular remodeling
1. Wall motion score index >1.5
2. Myocardial perfusion index >0.9
3. Basal aneurysm/dyskinesis
Mitral valve geometry
1. Interpapillary muscle distance >20 mm
2. Mitral valve tenting height ≥11 mm
3. Mitral valve tenting area ≥2.5 cm²
Yes
No
Restrictive annuloplasty
Annuloplasty + subvalvular repair or chordal-sparing valve replacement

High risk of recurrent MR

- **Significant PML restriction *(preop systolic PML angle to the plane of mitral annulus > 45°)***

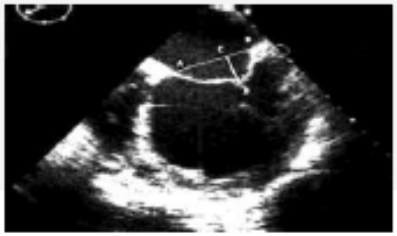
Magne et al Circulation 2007;11:782-91

- **Significant increase of PML tethering after *undersized mitral annuloplasty***

Zhu et al Circulation 2005;112 (9 suppl):I396-401

- **Coaptation distance *(the end-systolic distance between the coaptation point of the leaflets and the plane of mitral annulus) > 10 mm***

Calafiore et al Ann Thorac Surg 2001;71:1146-52



Systematic Review

A meta-analysis of mitral valve repair versus replacement for ischemic mitral regurgitation

Sohaib A. Virk[1], Arunan Sriravindrarajah[1], Douglas Dunn[1], Kevin Liou[2], Hugh Wolfenden[3], Genevieve Tan[3], Christopher Cao[1]

Ann Cardiothorac Surg 2015;4(5):400-410

Overall, 22 observational studies (n=3,815 patients) and one randomized controlled trial (n=251)

Background: The development of ischemic mitral regurgitation (IMR) portends a poor prognosis and is associated with adverse long-term outcomes. Although both mitral valve repair (MVr) and mitral valve replacement (MVR) have been performed in the surgical management of IMR, there remains uncertainty regarding the optimal approach. The aim of the present study was to meta-analyze these two procedures, with mortality as the primary endpoint.

Methods: Seven databases were systematically searched for studies reporting peri-operative or late mortality following MVr and MVR for IMR. Data were independently extracted by two reviewers and meta-analyzed according to pre-defined study selection criteria and clinical endpoints.

Results: Overall, 22 observational studies (n=3,815 patients) and one randomized controlled trial (n=251) were included. Meta-analysis demonstrated significantly reduced peri-operative mortality [relative risk (RR) 0.61; 95% confidence intervals (CI), 0.47-0.77; I^2=0%; P<0.001] and late mortality (RR, 0.78; 95% CI, 0.67-0.92; I^2=0%; P=0.002) following MVr. This finding was more pronounced in studies with longer follow-up beyond 3 years. At latest follow-up, recurrence of at least moderate mitral regurgitation (MR) was higher following MVr (RR, 5.21; 95% CI, 2.66-10.22; I^2=46%; P<0.001) but the incidence of mitral valve re-operations were similar.

Conclusions: In the present meta-analysis, MVr was associated with reduced peri-operative and late mortality compared to MVR, despite an increased recurrence of at least moderate MR at follow-up. However, these findings must be considered within the context of the differing patient characteristics that may affect allocation to MVr or MVR. Larger prospective studies are warranted to further compare long-term survival and freedom from re-intervention.

Keynote Lecture Series

Ann Cardiothorac Surg 2015;4(5):411-416

Repair or replace for severe ischemic mitral regurgitation: prospective randomized multicenter data

Damien J. LaPar[1], Michael A. Acker[2], Annetine C. Gelijns[3], Irving L. Kron[1]

Conclusions

Level 1 randomized controlled data now exists to address the question of the most efficacious surgical approach to severe IMR. Severe IMR remains a significant clinical challenge in the modern surgical era that can be corrected with surgical mitral repair using restrictive annuloplasty or complete chordal sparing replacement techniques. Both surgical approaches improve LV remodeling with reduced LVESI at 12 months and are associated with similar 1-year mortality. Higher rates of recurrent MR after MV annuloplasty are more common among patients with preoperative evidence of basilar LV aneurysms and/or dyskinesis. For these patients, either MV replacement or repair techniques that address leaflet tethering may provide a more durable, long-term result. Multi-institution clinical trial collaborations are essential in the modern surgical era to most appropriately address areas of clinical equipoise in order to improve patient outcomes and provide generalizable consensus guidelines and treatment recommendations.

Do age, diabetes and left ventricular function affect the outcomes of ischemic mitral valve repair?

Loreta Jankauskiene[1,2], Milda Svagzdiene[1,2], Edmundas Sirvinskas[1,2], Sarunas Kinduris[1,2], Darius Adomavicius[2]

Kardiochirurgia i Torakochirurgia Polska 2014; 11 (3): 239-245

Conclusions: Elderly age, concomitant DM and lowered LVEF do not influence either early or late mortality, including early postoperative outcomes after MV repair for ischemic MR following CABG. Concomitant DM increases the rate of perioperative MI and impairs reverse remodeling of LV.

Published in final edited form as:

J Thorac Cardiovasc Surg. 2015 March ; 149(3): 752–61.e1. doi:10.1016/j.jtcvs.2014.10.120.

Predicting recurrent mitral regurgitation after mitral valve repair for severe ischemic mitral regurgitation

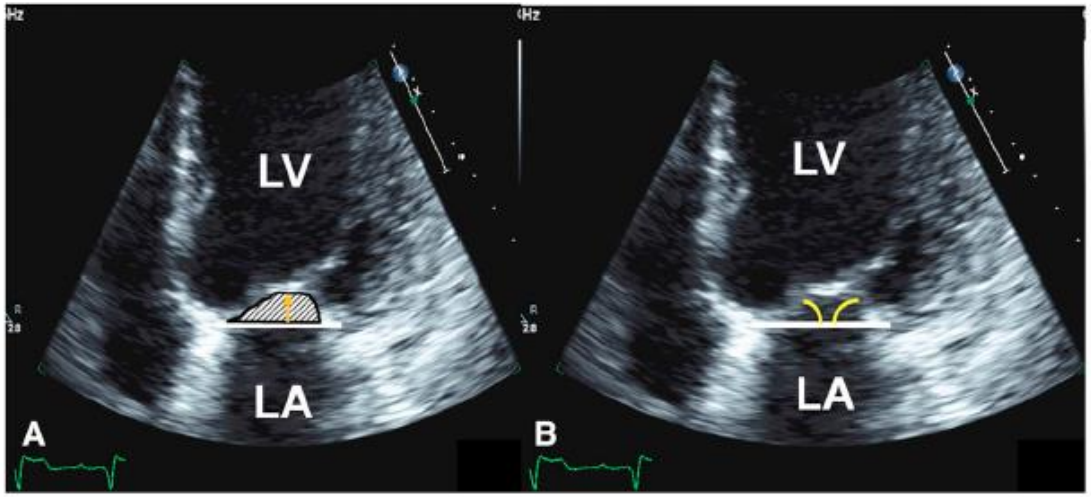


FIGURE 1.

Echocardiographic measures of MV tethering. A, MV tenting area (*hashmark area*) and MV tenting height (*gold arrow*). B, Anterior and posterior leaflet angle measurements (*yellow angle*). *LA*, Left atrium; *LV*, left ventricle.

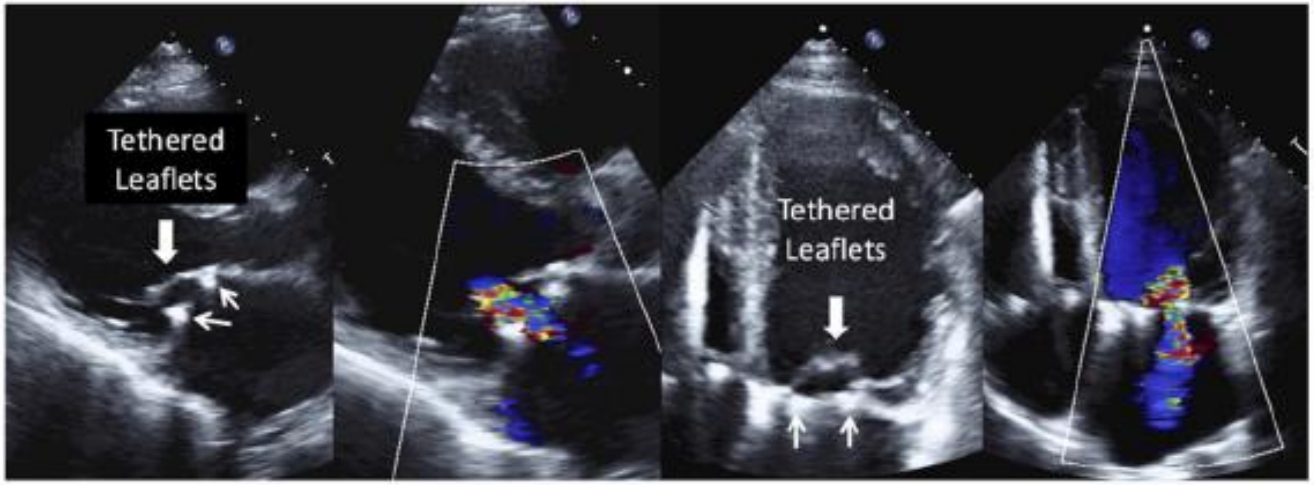


FIGURE 2.

Tethering mechanism for recurrent MR after repair. Mitral leaflets remain tethered (*large arrows*) after MV ring annuloplasty (*small arrows* show ring) with moderate MR (*blue* and *red* color flow).

A new approach: Ischemic mitral regurgitation guidelines *by* and *for* surgeons

Patrick M. McCarthy, MD

lines in Table 3 of the Kron document. The American Association for Thoracic Surgery guidelines for surgeons get "down in the weeds" and recommend replacement for patients with a basal aneurysm (dyskinesis), significant echocardiographic evidence of leaflet tethering, or moderate to severe left ventricular remodeling (left ventricular end-diastolic diameter >65 mm). They further recommend preserving both anterior and posterior cords during replacement. These are significant advances in our understanding of the surgical treatment of IMR. For years, we have known that severe tethering is one of the risk factors for repair failure. Going forward, we have 3 choices: to identify the patients before surgery who are at high risk for repair failure and treat those with a cord-sparing replacement; to come up with a better way to do repair (likely involving the subvalvular apparatus), such that the repair becomes durable; or just to replace all valves with IMR

Basal aneurysm is a risk factor for repair failure.

Mitral valve replacement therapy causes higher 30-day postoperative mortality than mitral valvuloplasty in patients with severe ischemic mitral regurgitation: A meta-analysis of 12 studies

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Department of Cardiac Surgery, Beijing An Zhen Hospital, Capital Medical University, Beijing 100029, China

International Journal of Cardiology 185 (2015) 304–307

Table 1
Characteristics of included studies (n = 12).

Author	Year	Study design	Study size	Surgical procedures and patients characteristics
Hickey	1988	OB	59	Patients undergoing valve replacement or repair in addition to coronary bypass for moderate and severe IMR
Gillinov	2001	OB	482	Patients undergoing either mitral valve repair or replacement for IMR
Mantovani	2004	OB	102	Patients with a preoperative diagnosis of CIMR, underwent mitral valve repair or prosthetic replacement, along with myocardial revascularization
Reece	2004	OB	110	Patients undergoing CABG and MVP or MVR for IMR
Al-Radi	2005	OB	202	Patients with IMR undergoing repair or replacement
Silberman	2006	OB	80	Patients with severely impaired LV function (ejection fraction < 25%) and severe IMR
Milano	2008	OB	522	Patients undergoing CABG and MVP or MVR for IMR
Micovic	2008	OB	138	Patients with IMR undergoing either MVR or MVP
Magne	2009	OB	370	Patients with CIMR who underwent mitral valve surgery
Bonis	2012	OB	132	Patients with advanced dilated and ischemic cardiomyopathy and severe functional MR and systolic dysfunction underwent mitral surgery in the same time frame.
Lorusso	2013	OB	488	Patients with CIMR and LV ejection fraction (LVEF) < 40% undergoing CABG procedure associated with MVP with downsizing ring annuloplasty or MVR.
Acker	2014	RCT	251	Patients with severe IMR undergoing either MVR or MVP

Surgical vs Medical

Repair vs Replacement

RA vs Additional Techniques

Saddle shape vs Flat

Ann Thorac Cardiovasc Surg 2015; 21: 370–377

Online February 16, 2015
doi: 10.5761/atcs.oa.14-00204

Original Article

Surgical Strategy for Ischemic Mitral Regurgitation Adopting Subvalvular and Ventricular Procedures

Table 1 Clinical stages of ischemic mitral regurgitation and surgical procedures

	Stage 1	Stage 2	Stage 3
Severity of MV tethering and LV remodeling			
MV tethering	Not extensive (CD <10 mm and IPMD <30 mm)	Extensive (CD ≥10 mm or IPMD ≥30 mm)	Extensive (CD ≥10 mm or IPMD ≥30 mm)
LV remodeling	Small LV (LVDd <65 mm)	Small LV (LVDd <65 mm) or large LV (LVDd ≥65 mm) with a small scar or no scar	Large LV (LVDd ≥65 mm) with a large scar
Surgical procedures			
Valvular	Annuloplasty (downsized)	Annuloplasty (true-sized)	Annuloplasty (true-sized)
Subvalvular	None	PMA (transvalvular or transventricular)	PMA (transventricular)
Ventricular	None	None	Left ventriculoplasty

CD: coaptation distance; IPMD: interpapillary muscle distance; LV: left ventricle; LVDd: LV end-diastolic diameter; MV: mitral valve; PMA: papillary muscle approximation

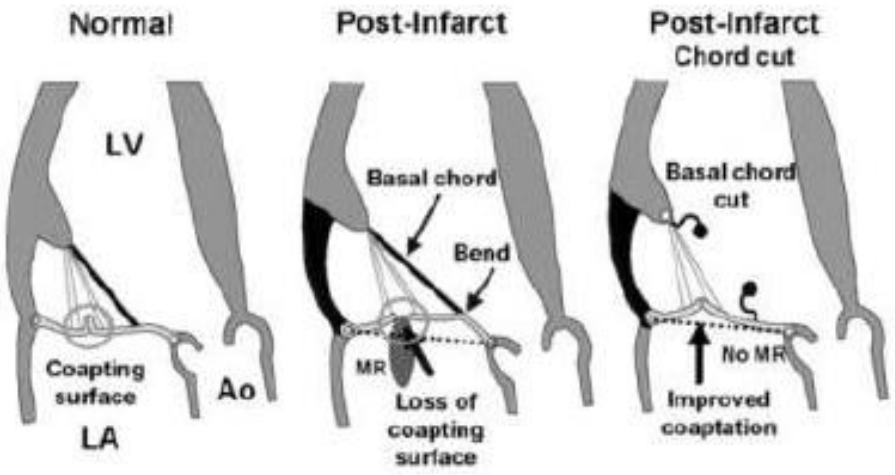
What should be the optimal surgical target or structure in the correction of ischemic MR ?

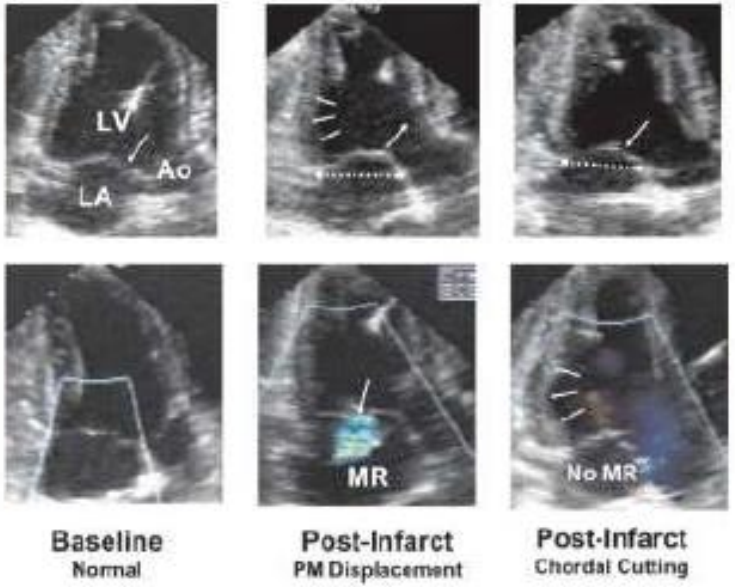
- Annulus : Undersized mitral annuloplasty
- Chordae tendinae
- Left ventricle
- Papillary muscles

Secondary chordal cutting

Messas et al Circulation 2001;104:1958-63
Borger et al. JTCVS 2007;133:1483-92

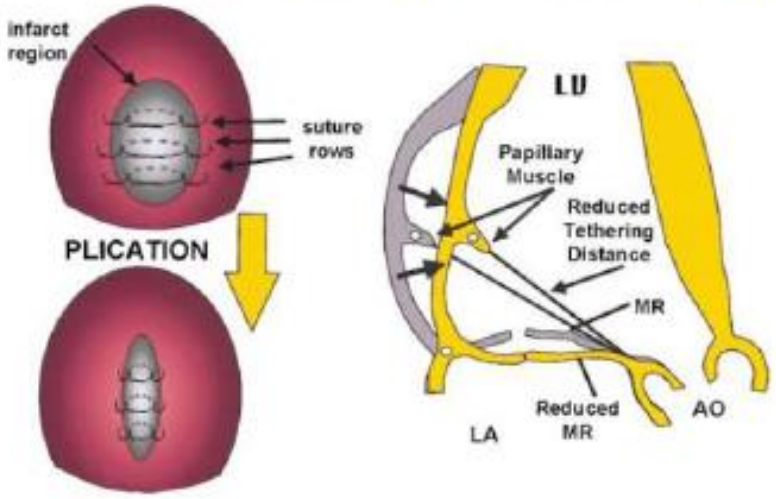
- Improve leaflet coaptation by eliminating the bend in the anterior leaflet

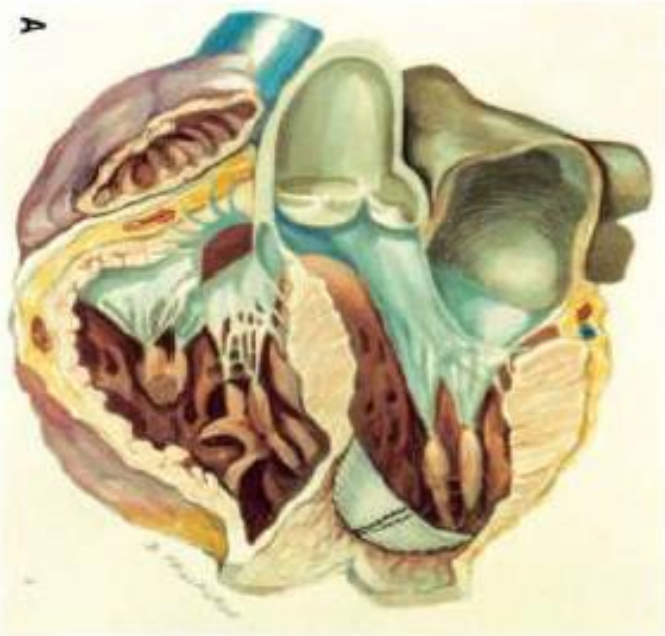




Ventricular restoration

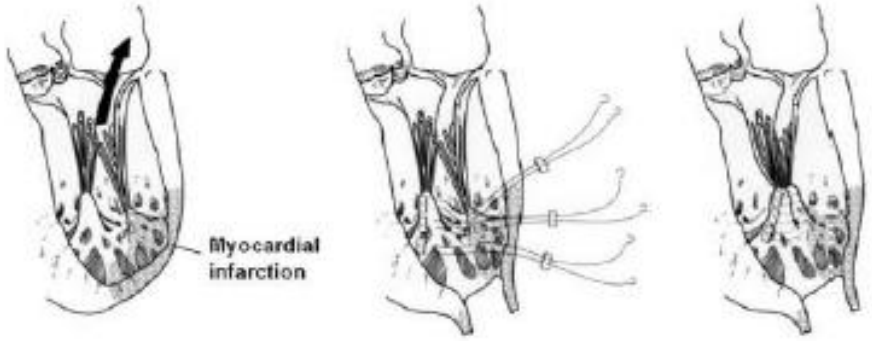
- Reducing the longitudinal length of the posterolateral fibrous scarring either by direct plication or by a small endoventricular patch
  - *Ramadan et al JTCVS 2005;129:440-2*
  - *Tanaka et al JTCVS 2007;133:1633-5*



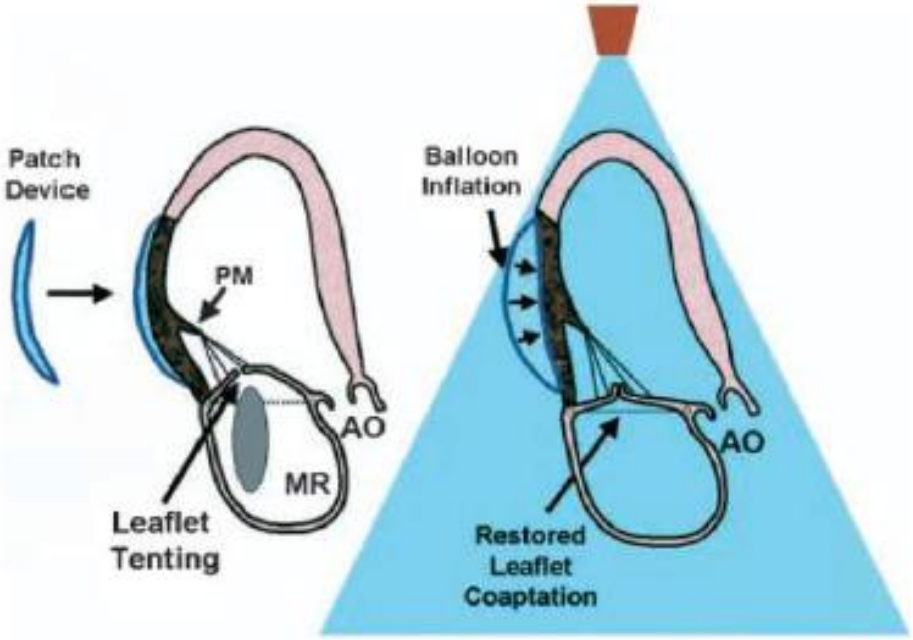


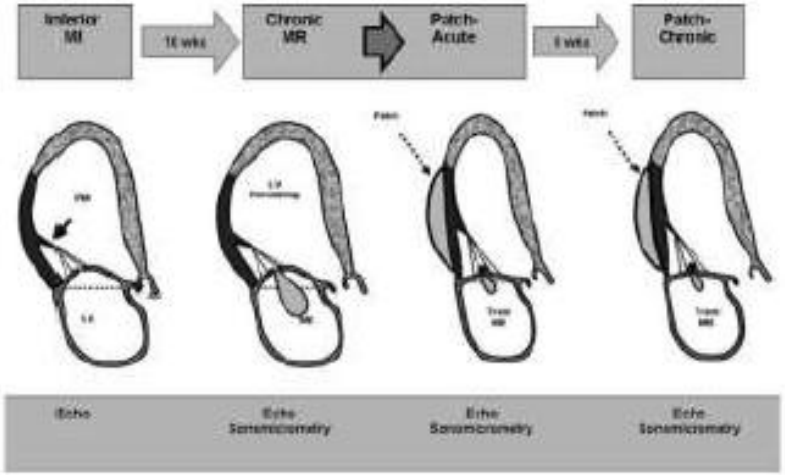
Plicating the interpapillary myocardium in combination with LV restoration

– *Irie et al JTCVS 2006;131:233-5*



VENTRICULAR RESTORATION
Patch-balloon device:Echo-guided device application in the beating heart
Hung et al Circulation 2002;106;2594-2600

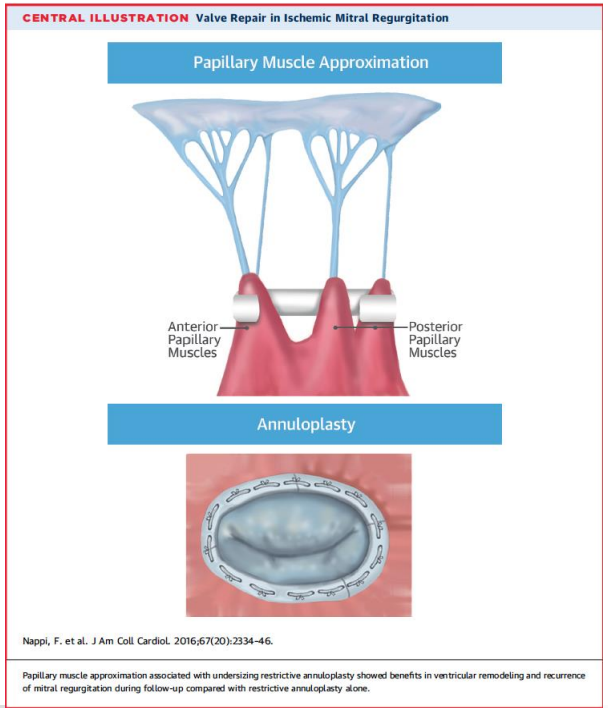


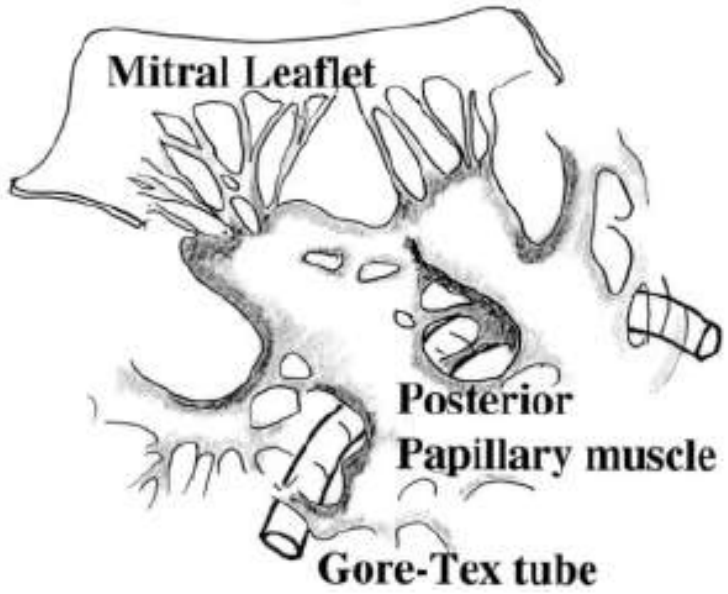


Papillary muscle relocation

Approximation of the two PMs by the sling technique

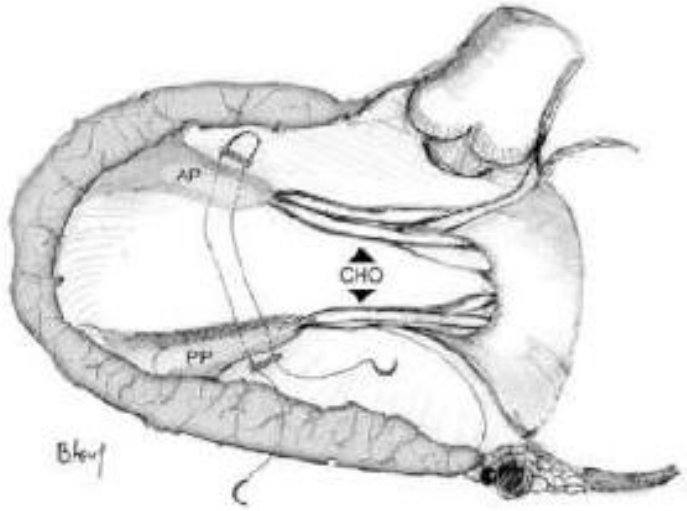
– *Hvass et al Ann Thorac Surg 2003;75:809-11*

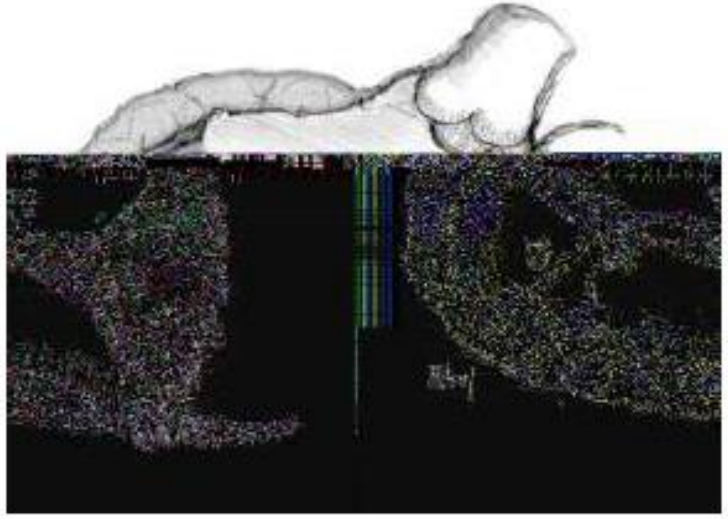




Direct suturing of both PM tips

Rama et al Ann Thorac Surg 2007;84:2130-1

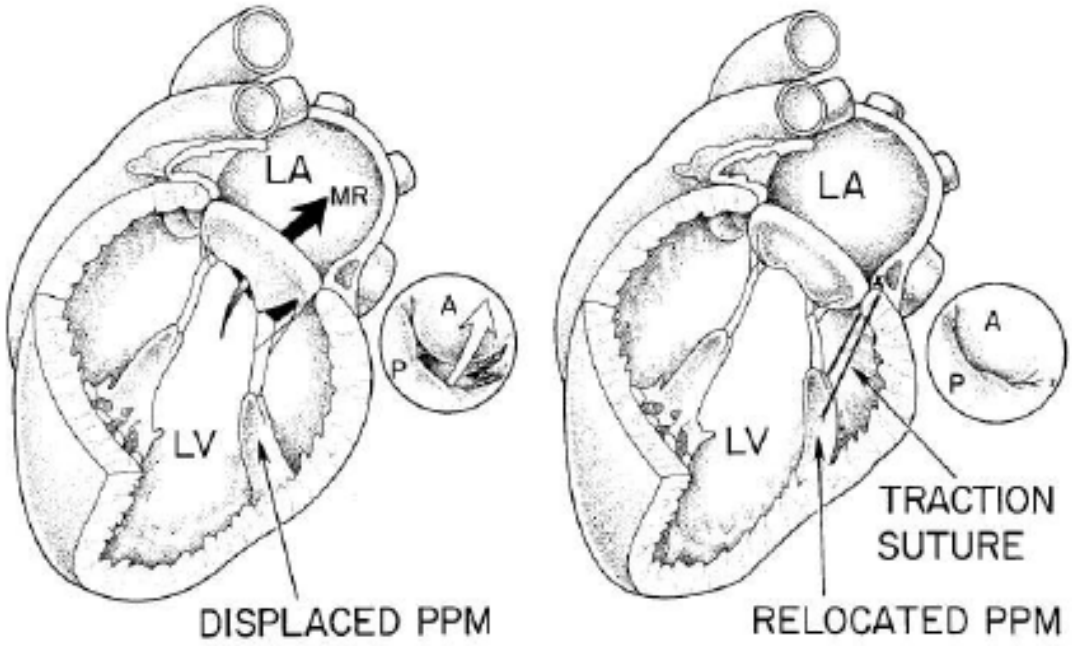




Kron's procedure

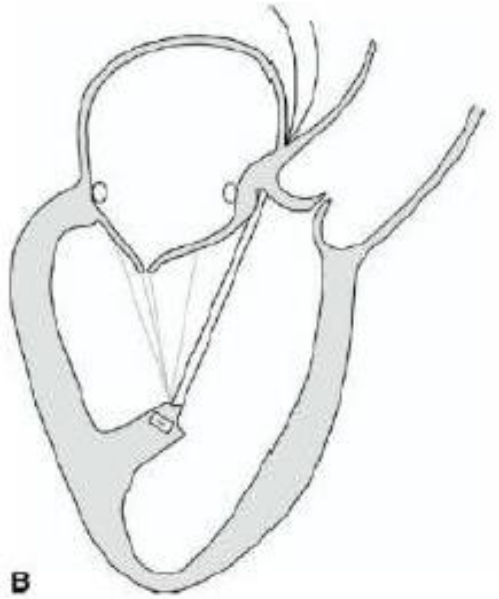
Kron et al Ann Thorac Surg 2002;74:600-1

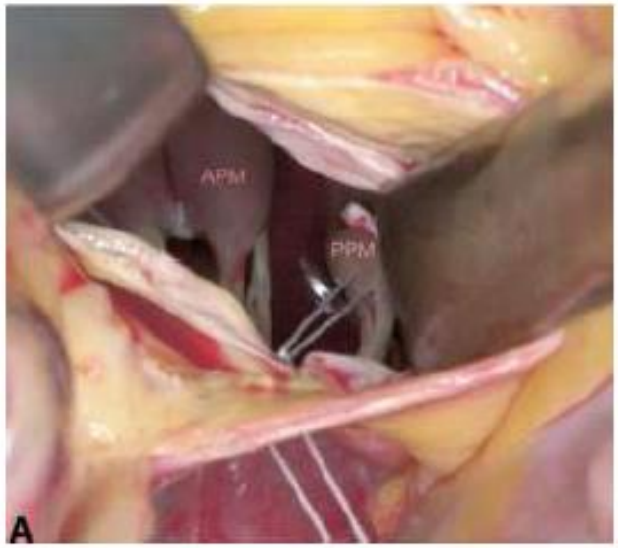
- Relocation of the posterior PM by suspending its tip closer to the mitral annulus posterior to the right fibrous trigone



Modified posterior PM relocation by a transventricular suture technique

Langer et al. JTCVS 2007;133:247-9





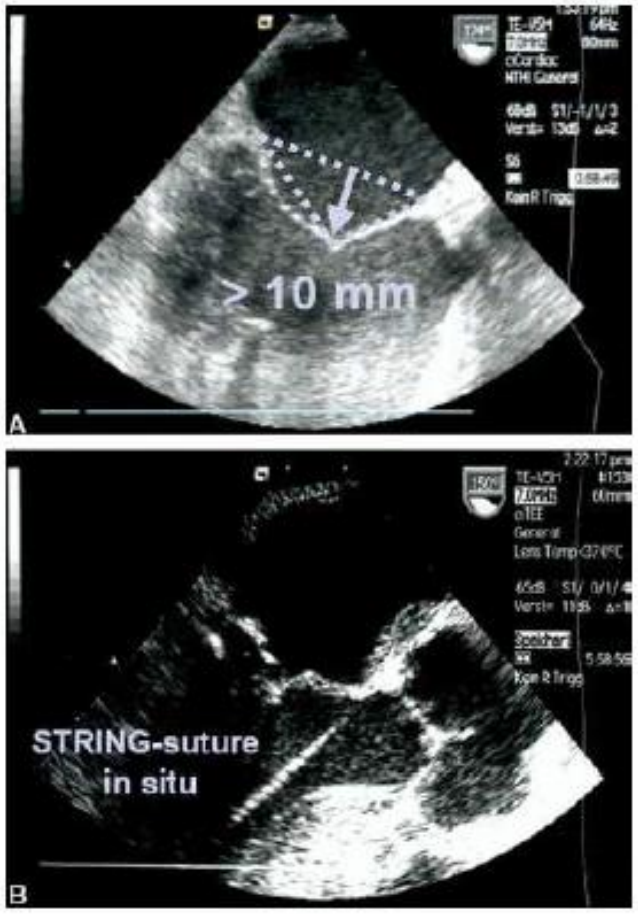


TABLE 1. Adjunctive papillary muscle interventions for ischemic mitral regurgitation

Procedure	Surgical technique
Papillary muscle sling	• Placement of a 4-mm polytetrafluoroethylene sling around each papillary muscle base • Anchored by weaving the graft between the ventricular trabeculae • Annuloplasty ring size based on size of the anterior leaflet
U-shaped suturing	• Single 2-0, U-shaped suture passed through the middle height of the papillary muscles • Reinforced by 2 patches of autologous pericardium • Undersized ring annuloplasty
Papillary muscle realignment	• 2 to 3 mattress sutures placed through the base and body of each papillary muscle, avoiding the fibrous tips • Tied to create contact between the muscles • Undersized ring annuloplasty
"Ring + String"	• Transventricular suture through the tip of the posterior papillary muscle to the intervalvular fibrosa • Suture exteriorized through the aortic wall • Undersized ring annuloplasty
Posterior papillary muscle relocation	• Suture of the posterior papillary muscle tip through the posterior annulus • Placed posterior to the right fibrous trigone • Undersized ring annuloplasty
Papillary muscle elevation	• 2 felt-reinforced sutures on either side of the posterior papillary muscle base used to elevate the muscle • Via ventriculotomy and concomitant plication of the infarcted wall • Undersized ring annuloplasty
Mitral complex remodeling	• Multifaceted approach 1. Secondary chordal cutting 2. Polytetrafluoroethylene (Gore-Tex, registered trademark of W. L. Gore & Associates, Inc, Flagstaff, Ariz) artificial chords from both papillary muscles to the anterior mitral leaflet 3. Two sutures from each papillary muscle to the posterior annulus for realignment 4. Undersized ring annuloplasty

Perspective

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A novel approach to ischemic mitral regurgitation (IMR)

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	MVR	Mini-MVR	PEER
CABG	CABG + MVR	CABG + mini-MVR	CABG + PEER
HCR	HCR + MVR	HCR + mini-MVR	HCR + PEER
PCI	PCI + MVR	PCI + mini-MVR	PCI + PEER

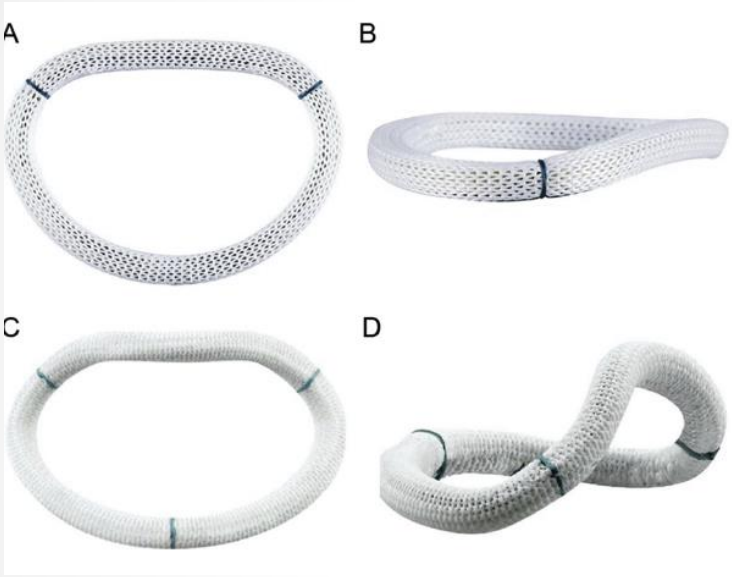
Surgical vs Medical

RA vs Additional Techniques

Saddle shape vs Flat ring

Saddle-Shaped Annuloplasty Improves Leaflet Coaptation in Repair for Ischemic Mitral Regurgitation

Wobbe Bouma, MD,* Chikashi Aoki, MD,* Mathieu Vergnat, MD, Alison M. Pouch, PhD, Shanna R. Sprinkle, MD, Matthew J. Gillespie, MD, Massimo A. Mariani, MD, PhD, Benjamin M. Jackson, MD, Robert C. Gorman, MD, and Joseph H. Gorman, III, MD



Conclusions. This study shows that the use of undersized saddle-shaped annuloplasty rings in mitral valve repair for IMR improves leaflet coaptation, whereas the use of undersized flat annuloplasty rings worsens leaflet coaptation. Because one of Carpentier's fundamental principles of mitral valve repair (durability) is to create a large surface of coaptation, saddle-shaped annuloplasty may increase repair durability.

Flat annuloplasty rings may leave up to 30% of patients with residual or recurrent MR

Gillinov et al. JTCVS 2001;122:1125-41

McGee et al JTCVS 2004;128:916-24

Filsoufi et al Mt Sinai J Med 2005;72:105-15

IMR surgery is complex

No Standard approach

Management should Individualized