Techniques for ischemic mitral valve disease: An Update
Conflict of Interest Disclosure

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Consulting Fees/Honoraria:
- Stanford PI – PARTNER Trial, Edwards Lifesciences
- Consultant, Abbott Vascular Structural Heart (MitraClip)
- Consultant, Medtronic CardioVascular Division
- Consultant, St. Jude Medical
- Executive Committee, PARTNER U.S. Pivotal Trial, Edwards Lifesciences (non-remunerative)

Major Stock Shareholder/Equity Interest:

Royalty Income:

Ownership/Founder:

Salary:

Intellectual Property Rights:

Other Financial Benefit:
FMR and IMR

PATHOPHYSIOLOGIC MECHANISMS & TREATMENT

Levine, RA  New Eng J Med  351:  1681, 2004

Stanford CV Surgery
Why do leaflets malcoapt in patients with IMR/FMR?

- Two mechanisms of leaflet malcoaptation:
  - Annular dilation with Carpentier type I leaflet motion (IMLC)
Why do leaflets malcoapt in patients with IMR/FMR?

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Most common in FMR

Early and mid systolic leak
Why do leaflets malcoapt in patients with IMR/FMR?

- Two mechanisms of leaflet malcoaptation:
  - Papillary muscle displacement with apically restricted systolic leaflet motion (type IIIb) *(apical tethering, tenting)*
Why do leaflets malcoapt in patients with IMR/FMR?

- Two mechanisms of leaflet malcoaptation:
  - Papillary muscle displacement with apically restricted systolic leaflet motion (type IIIb) (apical tethering, tenting)

Most common in IMR

Early systolic leak
Why do leaflets malcoapt in patients with IMR/FMR?

- Both mechanisms (type I and type IIb) of leaflet malcoaptation can coexist in the same patient.
Advances in Echocardiography

Are Color Doppler and rt 3-D TEE just for amateurs?

But please don’t take away my X-plane and color M-mode
Mechanisms of MR - Color M-mode echo
Early systolic (FMR)
Mechanisms of MR - Color M-mode echo Holosystolic (IMR)
Mechanisms of MR- Color M-mode echo
Late systolic (prolapse)
IMR/FMR - apical tenting (type IIIb)
IMR/FMR - apical tenting (type IIIb)
IMR/FMR - type I
s/p Bolling Procedure
IMR/FMR - type I
Bolling Procedure

Stanford CV Surgery
Human Mitral “annulus”
Standard Surgical Approach

Frank Langer, Homburg, Germany
Surgical treatment of IMR with ring annuloplasty ± CABG

Impact of Mitral Valve Annuloplasty Combined With Revascularization in Patients With Functional Ischemic Mitral Regurgitation

Tomislav Mihaljevic, MD,* Buu-Khanh Lam, MD,* Jeevanantham Rajeswaran, MSc,† Masami Takagaki, MD,* Michael S. Lauer, MD,‡ A. Marc Gillinov, MD,* Eugene H. Blackstone, MD,*† Bruce W. Lytle, MD*

Cleveland, Ohio
Postoperative TTEs were available for a subset of 247 patients (63%) with 518 assessments of MR. These studies were concentrated early postoperatively, with median time to assessment of 5.3 months after CABG alone and 1.1 months after CABG + MV annuloplasty.
Survival After CABG ± Concomitant MV Annuloplasty

Recurrent mitral regurgitation after annuloplasty for functional ischemic mitral regurgitation

Edwin C. McGee, Jr, MD
A. Marc Gillinov, MD
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Joseph F. Sabik, MD\textsuperscript{c}
Bruce W. Lytle, MD\textsuperscript{c}
Patrick M. McCarthy, I
Delos M. Cosgrove, M


![Graph showing MV Regurgitation over years](graph.png)
Recurrent/residual MR $\geq 2+$ after ring annuloplasty for IMR

Fig. 8. Incidence of postoperative $\geq 2+$ MR reported in the literature as a function of time after MVA.
Large variety of annuloplasty rings available

a.) Various shapes (flat, saddle, dog bone)
b.) Various configurations (partial, complete)
c.) Various material properties (flexible, semi-flexible, rigid)
Asymmetric Dilatation

- Dipped P3 region helps accommodate downward displacement
- Reduced anteroposterior (AP) distance helps increase leaflet coaptation
- Asymmetric 3-D design with reduced P2-P3 curvature to compensate for tethered P3 segment
- Typical symmetric-shaped design

Anterior Side
- Anterior Commissure (AC)
- A1, A2, A3
- Symmetric MR

Posterior Side
- P1, P2, P3
- Asymmetric MR

Stanford CV Surgery
IMR-FMR disease-specific ring designs
Disproportionate septal-lateral dimension reduction

Bothe W, Swanson J, et al., JTCVS 139:1114-1122, 2010

Stanford CV Surgery
IMR-FMR disease-specific ring designs
Disproportionate S-L reduction vs. CE Physio

Bothe W, Swanson J, et al., JTCVS 139:1114-1122, 2010
IMR-FMR disease-specific ring designs
Disproportionate S-L reduction vs. CE Physio
Adjunctive surgical subvalvular approaches

• **Coapsys®**, SLAC, Hvass PM sling or PM-suturing, Kron UVA stitch, Homburg “STRING”, second-order chordal cutting, CorCap™ CSD, Fontan stitch, epicardial LV balloon patch, LV wall polymer injection
CorCap™
CSD
Acorn
Medical
Mitral valve repair in heart failure: Five-year follow-up from the mitral valve replacement stratum of the Acorn randomized trial

Michael A. Acker, MD, Mariell Jessup, MD, Steven F. Bolling, MD, Jae Oh, MD, Randall C. Starling, MD, Douglas L. Mann, MD, Hani N. Sabbah, PhD, Richard Shemin, MD, James Kirklin, MD, and Spencer H. Kubo, MD

Results: As previously reported, 30-day operative mortality was only 1.6%. At 5 years, the total mortality was 30% with an average annual mortality rate of approximately 6% per year. The effects of mitral valve surgery led to a progressive decrease in left ventricular end-diastolic and end-systolic volumes, which were highly significant at all time points. At the end of 5 years, there was an average reduction in left ventricular end-diastolic volume of 75 mL, which represents a 28% reduction from baseline. During 5 years of follow-up, 29 patients had recurrent mitral regurgitation and 5 patients underwent repeat mitral valve surgery. The addition of the CorCap device led to greater decreases in left ventricular end-diastolic volume (average difference of 16.5 mL; \( P = .05 \)), indicating that the CorCap device had an additive effect to the mitral valve operation.

Conclusions: This study demonstrates long-term improvement in left ventricular structure and function after mitral valve surgery for up to 5 years. These data provide evidence supporting mitral valve repair in combination with the Acorn CorCap device for patients with nonischemic heart failure with severe left ventricular dysfunction who have been medically optimized yet remain symptomatic with significant mitral regurgitation. (J Thorac Cardiovasc Surg 2011;142:569-74)
MVR Stratum: June 2008

Est. Treatment Diff. = -16.5
p-value = 0.050

Follow-up Month

LV Volume

Study Group  Treatment  Control
MVR Stratum: June 2008

Sphericity Index

Est. Treatment Diff. = 0.071
p-value = 0.002

Follow-up Month

Study Group
Treatment
Control

JTCVS 2011; 142:569-574
Stanford CV Surgery
Hvass Papillary Muscle Sling

Hvass Papillary Muscle Sling

U Hvass, et al. JTCVS 2010;139:418-423
Ventricular Level Approaches

Papillary Muscle Imbrication (Univ. of Osaka)

Assessment of Changes in Mitral Valve Configuration With Multidetector Computed Tomography
Impact of Papillary Muscle Imbrication and Ring Annuloplasty

Yasuhiro Shudo, MD; Goro Matsumiya, MD, PhD; Taichi Sakaguchi, MD, PhD; Shigeru Miyagawa, MD, PhD; Yasushi Yoshikawa, MD, PhD; Takashi Yamauchi, MD, PhD; Koji Takeda, MD; Shunsuke Saito, MD; Satoshi Nakatani, MD, PhD; Kazuhiro Taniguchi, MD, PhD; Hironori Izutani, MD, PhD; Yoshiki Sawa, MD, PhD

CIRCULATION 2010; 122 [suppl 1] : S29–S36
MGH thrust #2 - 2° order CT cutting to AMVL

Initial results of the chordal-cutting operation for mitral regurgitation

Michael A. Borger, MD, PhD, Patricia M. Murphy, MD, Asim Alam, MD, Shafie Fazel, MD, PhD, Manjula Maganti, MSc, Susan Armstrong, MSc, Vivek Rao, MD, PhD, and Tirone E. David, MD

Objective: Division of secondary chords (chordal cutting) has been proposed as a method for decreasing mitral valve leaflet tethering and mitral regurgitation in patients with ischemic mitral regurgitation. However, very little clinical data exist to date for this procedure.

MR grade

Ring + CABG  Ring + CT cutting + CABG

![Diagram showing MR grades before and after procedures]
Event-free survival

defined as freedom from death, recurrent > moderate MR, reop, TE, hemolysis, major ACH, or PVE

J Thorac Cardiovasc Surg
2007;133:1483-92
IMR/MR

Is the MR the real culprit?
Benefits of MR Reduction in Ischemic MR Patients:

Lessons from RESTOR_MV Trial
Open CABG + ring annuloplasty
vs. OpCAB + Coapsys

Eugene A. Grossi, MD
for the RESTOR-MV Study Group

NYU School of Medicine &
NY Harbor Veterans Healthcare System
RESTOR_MV Trial: FDA Prospective Study

Minimally invasive (no CPB)
Ventricular Shape Change Device 

Coapsys Device

Stanford CV Surgery
RESTOR_MV: MR Evaluation
CABG+MVRepair vs. CABG+Coapsys

Both effect of time and treatment $p=0.0001$

Stanford CV Surgery
Intent-To-Treat: All Patient Survival

Adjusted Log-rank = 4.30; p=0.038
Hazard ratio=0.421; 95% CI (0.200 - 0.866); p=0.038
Other Approaches

LV systolic function?  
Borger JTCVS 2007

X-clamp time?  
de Varennes CIRC 2009  
Langer CIRC 2009

Stanford CV Surgery
Kron-technique
• via atriotomy
• final tension in arrested heart

STRING-technique
• via horizontal aortotomy
• final tension in loaded beating heart under TEE guidance
IMR (n=60) with severe leaflet tethering (tenting height > 10 mm)

RING

historical matched control group (n=30)

RING+STRING

study group (n=30)
> 40 mm
RING plus STRING: Papillary muscle reposition repair technique for ischemic mitral regurgitation

Frank Langer, MD, and Hans-Joachim Schäfers, MD, Homburg, Germany

Survival (%) vs. Follow-up (months)

- RING+STRING
- RING

subjects at risk:

0 12 24 36 48 60 72 84
0 20 40 60 80 100

p=0.13

F. Langer CIRC 2009
Stanford CV Surgery
RING plus STRING: Papillary muscle reposition repair technique for ischemic mitral regurgitation

Frank Langer, MD, and Hans-Joachim Schäfers, MD, Homburg, Germany

![Graph showing the freedom from MR >II (%) over follow-up (months) with subjects at risk counts.]

- **RING+STRING**
- **RING**

Follow-up (months)

Freedom from MR >II (%)

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Subjects at risk

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p=0.01
SMR Patient Abstract

STUDY TITLE: EVALUATION OF OUTCOMES FOLLOWING MITRAL VALVE REPAIR/REPLACEMENT IN SEVERE CHRONIC ISCHEMIC MITRAL REGURGITATION

MMR Patient Abstract

STUDY TITLE: SURGICAL INTERVENTIONS FOR MODERATE ISCHEMIC MITRAL REGURGITATION

Current Status: Enrolling
Abstract From the Emerging Science Series, February 29, 2012

Mitral Valve Annuloplasty in Addition to Coronary Artery Bypass Grafting Improves Functional Capacity and Promotes Reverse Left Ventricular Remodelling: Preliminary Results of the Randomised Ischemic Mitral Evaluation Trial

K. M. John Chan, John R Pepper, RIME Trial Investigators, Imperial Coll London, Royal Brompton & Harefield NHS Trust, London, United Kingdom

Background: The optimal treatment of moderate functional ischemic mitral regurgitation (FIMR) is unknown. There is controversy over whether the addition of mitral valve annuloplasty (MVA) to coronary artery bypass grafting (CABG) improves outcome. Hypothesis: We assessed the hypothesis that MVA in addition to CABG improves functional capacity, reverses left ventricular (LV) remodelling, and reduces mitral regurgitation severity compared to CABG alone. Methods: 60 patients with moderate FIMR (effective regurgitant orifice area 0.2–0.4 cm2) referred for CABG were randomised to either CABG alone (Group 1) or CABG plus MVA (Group 2). Cardiopulmonary exercise testing, echocardiography, cardiovascular magnetic resonance imaging and plasma BNP levels were measured at baseline and one year. Results: At one year following surgery, peak oxygen consumption improved by a significantly greater amount in Group 2 compared to Group 1 (3.0±0.6 ml/kg/min versus 1.0±0.4 ml/kg/min; P=0.008). In addition, left ventricular (LV) volumes, LV sphericity, and mitral regurgitation severity decreased by significantly greater amounts in Group 2 compared to Group 1 (LVESVI decrease 24.4% versus 10.2%, P=0.05; LV sphericity decrease 17.9% versus 1.7% increase, P=0.01; mitral regurgitant volume decrease 69.2% versus 14.5%, P=0.005). Plasma BNP levels were also significantly less in Group 2 compared to Group 1 (54.8±7.2 pmol/l versus 108.9±11.4 pmol/l, P=0.001). Conclusion: Compared to CABG only, the addition of MVA to CABG in moderate FIMR significantly improves functional capacity, reverses LV remodelling, restores LV geometry, and reduces mitral regurgitation severity.

Mitral Valve Repair or Replacement for Ischemic Mitral Regurgitation? The Italian Study on the Treatment of Ischemic Mitral Regurgitation (ISTIMIR)

Back to Annual Meeting
Back to Program

Roberto Lorusso1, Sandro Gelsomino2, Antonio M. Calafiore3, Atilio Renzulli4, Valentino Borghetti5, Mattia Glauber5, Davide Pacini7, Emmanuel Villa8, Giovanni Mariscalco9, Paolo Ferrazzi10, Alessandro Parolar11, Philippe-Primo Caimi12, Ugolino Liv13

1Cardiac Surgery, Civic Hospital Brescia, Brescia, Italy; 2Heart and Vessels, Careggi hospital, Florence, Italy; 3Cardiac Surgery, Ferrarotto Hospital Catania, Catania, Italy; 4Cardiac Surgery, University Hospital Catanzaro, Catanzaro, Italy; 5Cardiac Surgery, Civic Hospital Terni, Terni, Italy; 6Cardiac Surgery, Pasquini Hospital Massa, Massa, Italy; 7Cardiac Surgery, S. Orsola Hospital Bologna, Bologna, Italy; 8Cardiac Surgery, Poliambulanza Hospital Brescia, Brescia, Italy; 9Cardiac Surgery, University Hospital Varese, Varese, Italy; 10Cardiac Surgery, Ospedali Riuniti Bergamo, Bergamo, Italy; 11Cardiac Surgery, Monzino Hospital Milano, Milano, Italy; 12Cardiac Surgery, Civic Hospital Novara, Novara, Italy; 13Cardiac Surgery, S. Maria Della Misericordia Hospital, Udine, Italy

Objective(s): It is still uncertain whether mitral valve (MV) replacement is really inferior to mitral valve repair (MVR) for the treatment of chronic ischemic mitral regurgitation (CIMR). This multicentric study is aimed to give a contribution to answer this question.

Methods: Among 1,067 patients with CIMR and impaired left ventricular (LV) function (ejection fraction <40%) operated on at 13 Italian Institutions between 1996 and 2011, 298 (27.9%) underwent mitral valve (MV) replacement whereas 769 (72.1%) had a MVR. Propensity scores (PS) were calculated by a non-parsimonious multivariable logistic regression and 244 pairs of patients were successfully matched using calipers of width 0.2 SDs of the logit of the PS. The post-matching median standardized difference was 0.031143 (Interquartile Range[95%CI] 0.015661-0.075236) and in none of the covariates it exceeded 10%.

Results: Early death were 3.3% (n=8) in MVR vs. 5.3% (n=13) in MV replacement (p=0.32). During a median 46.5-month follow up (IQR 26-69) thirty-six patients (14.7%) undergoing repair and 41 (16.8%) in the replacement group died (p=0.51). Eight year survival were 81.6 ±2.8 and 79.6 ±4.8 (stratified log-rank test 0.42) whereas freedom from valve-related death were 99.1 ±4.6 and 99.2 ±6.4 (p=0.84) in the repair and replacement group, respectively.

Recurrence of MR (% of +) was observed in 61 patients (25%) vs. 41.6% in repair and replacement, respectively (p=0.001). Freedom from reoperation were 80±4.1 vs. 64.3 ±4.3 (p<0.001). Freedom from valve-related complications was 85.5±5.2 after repair and 87.8±4.6 after MVR (p=0.88). Left ventricular ejection fraction did not significantly improve and it was comparable in the two Groups at follow up control (36.9 ±38.5, p=0.66).

At Cox proportional hazard regression models stratified on the matched pairs MVR was a strong predictor of reoperation (HR 2.84 [95% CI 2.51-3.26], p<0.001)

Conclusions: MV replacement is a suitable option for patients with CIMR and impaired LV function. It provides better results in terms of freedom from reoperation with comparable long-term survival and valve-related complication rates.
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

SIU School of Medicine, Division of Cardiothoracic Surgery, Springfield, IL, USA

Received 20 April 2010; received in revised form 24 June 2010; accepted 29 June 2010; Available online 19 August 2010

Summary

The optimal surgical strategy for the management of ischemic mitral regurgitation (IMR) is still debated. The purpose of this study was to perform a meta-analysis summarizing the evidence favoring one technique over another (repair vs replacement). A search of the English literature in PubMed was performed using 'ischemic mitral regurgitation' and 'repair or replacement or annuloplasty' in the title/abstract field. Articles were excluded if they lacked a direct comparison of repair versus replacement, or used Teflon/pericardial strip or suture annuloplasty in >10% of the repairs. Nine articles were selected for the final analysis. All studies except one were relatively recent (2004–2009). The patient characteristics between treatment groups were similar across studies. All studies excluded patients with degenerative etiology and used a rigorous definition of IMR. Most patients had concomitant coronary artery bypass graft. In the patients with mitral valve replacement, at least the posterior and, in many cases, the entire subvalvular apparatus were preserved. Mean ejection fraction and proportion of patients with severe ventricular dysfunction were similar between the repair and replacement groups. The odds ratios for the studies, comparing replacement to repair, ranged from 0.884 to 17.241 for short-term mortality and the has significantly increased likelihood of both short-term mortality (summary term mortality (summary hazard ratio 1.352 (95% CI 1.131–1.618)) for analysis of the current relevant literature, mitral valve repair for IMF mitral valve replacement. Our conclusion should be interpreted in ti

Goal for CHF and FMR / IMR

Accomplish something below the annulus in conjunction with disease-specific undersized annuloplasty ring designs and/or other adjunctive procedures to restore and maintain more elliptical LV shape and minimize MR

Which should translate into better reverse LV remodeling

Stanford CV Surgery
Thank you