Mitral Regurgitation: Transcatheter Repair

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Mitral Regurgitation
Most Common Etiologies

Functional Mitral Regurgitation
- Dilated Cardiomyopathy
  - ischemic cardiomyopathy
  - non-ischemic cardiomyopathy

Organic (Degenerative) Mitral Regurgitation
- floppy mitral valve/mitral valve prolapse

Valvular Heart Disease
Factors Contributing to Changing Etiology

- Rheumatic fever
- Syphilis
- Life expectancy
- Prosthetic valves
- Cardiomyopathy
- Hemodialysis
- Transplantation
- Technology
- New diseases

Time

Mitral Regurgitation
Most Common Etiologies

Mechanisms of Functional Mitral Regurgitation in Dilated Cardiomyopathy

- Normal left ventricle, left atrium and mitral valve
- Cardiomyopathy: left ventricular and left atrial enlargement with mitral regurgitation
  - Papillary muscle function, orientation
  - Changes in LV geometry
  - Annular dilation

Functional Mitral Regurgitation (FMR) Natural History - Survival

- Ischemic cardiomyopathy (n = 645)
- Non-ischemic cardiomyopathy (n = 645)

Survival (%)

Survival (%)

Survival (%)

Years

Years

Years

P<0.0001

P<0.0001


Mitral Regurgitation Due To Floppy Mitral Valve/Mitral Valve Prolapse (FMV/MVP)

- Normal Mitral Valve
- FMV/MVP

Organic (Degenerative) Mitral Regurgitation Survival Based on New York Heart Association Class

Survival (%)

Years After Diagnosis

P < 0.001


Floppy Mitral Valve/ Mitral Valve Prolapse (FMV/MVP)

- Prevalence is 2-3%.
- At least 2 forms of inheritance:
  - autosomal dominant with variable degree of penetration (most common)
  - chromosome X
- Collagen dissolution and pars fibrosa disruption of mitral valve leaflets.
- Leaflets replaced with loose myxomatous connective tissue.
- Similar histologic abnormalities may be seen in chordae tendineae.
Organic (Degenerative) Mitral Regurgitation Survival Based on Left Ventricular Ejection Fraction (EF)


Survival (%)

Years After Diagnosis

P = 0.034

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<th>Device Name</th>
<th>Manufacturer</th>
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Mitral Ring

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Transcatheter Devices for Mitral Regurgitation

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Open Position

Closed Position

MitraClip
Mitral Regurgitation
Mitral Leaflet Repair - MitraClip

- Multicenter study that randomized patients with moderate-to-severe (3+) or severe (4+) mitral regurgitation to transcatheter MitraClip versus surgical repair/replacement of the mitral valve.
- 27% functional and 73% organic (degenerate) mitral regurgitation.

Mitral Regurgitation
Mitral Leaflet Repair - MitraClip

Chest radiograph showing two mitraclips projecting over the heart.

Author: Hellerhoff (CC BY-SA 3.0)

MitraClip Versus Surgery for Functional or Organic Mitral Regurgitation
EVEREST II Randomized Trial

- 3+ or 4+ mitral regurgitation prior to hospital discharge:
  - 23% in MitraClip group (surgery within 6 months)
  - 0% in Surgical group
- Similar 30-day mortality (~1-2%)
- Small, but statistically significant decrease in LV size (systolic and diastolic) and LV ejection fraction (~2-6%) at 1 year in both groups compared to baseline.

EVEREST II. NEJM. 2011;364:1395-406.
**MitraClip Versus Surgery for Functional or Organic Mitral Regurgitation EVEREST II Randomized Trial**

4-Year Follow-up

- Decrease in LV size (systolic and diastolic) sustained at 4 years in both groups.
- Decrease in LV ejection fraction < 5% in both groups.
- Improved NYHA functional class III-IV in both groups:
  - Baseline 46% and at 4 years ~ 6%


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**Mitral Regurgitation**

**EVEREST II High Risk and REALISM Registries**

**Procedural Results**

- 95% successful implantation
- Average hospital length-of-stay 2.9 days
- ~ 90% discharged to home
- No intra-procedural deaths
  - 30-day mortality 6.3% (STS predicted peri-operative mortality 13%)

MitraClip for Organic (Degenerative) Mitral Regurgitation in High Risk Patients

**EVEREST II High Risk and REALISM Registries**

1 Year Follow-up

- Mortality 23.6%
- ~85% maintained ≤ 2+ mitral regurgitation
- Small, but statistically significant decrease LV size
- Improved NYHA functional class:
  - Baseline: 86% NYHA class III-IV
  - 1 year: 86% NYHA class I-II
- Significant reduction (73%) in hospitalizations (12 months pre- versus 12 months post-procedure)
- Improved quality-of-life


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**Survival in High Risk Patients with Mitral Regurgitation**

**EVEREST II High Risk Prospective Study**

1 Year Follow-up

- 75.4% MitraClip
- 55.3% No MitraClip

\[ p < 0.05 \]

\[ n = 114 \]

Data from EVEREST II High Risk Study. J Am Coll Cardiol. 2012;59:130-9 used to construct slide.

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**FDA Approved MitraClip for Organic (Degenerative) Mitral Regurgitation**

- Transcatheter reduction of significant symptomatic mitral regurgitation (≥ 3+) due to organic (degenerative) mitral regurgitation in patients determined to be at prohibitive risk for mitral valve surgery.
- Prohibitive risk includes ≥ 1 of the following:
  - STS ≥ 8% for mitral valve replacement or ≥ 6% for mitral valve repair
  - Porcelain aorta
  - Frailty
  - Hostile chest
  - Severe liver disease
  - Severe pulmonary hypertension
  - Other

**Cardiovascular Outcomes Assessment of the MitraClip Percutaneous Therapy for Heart Failure Patients with Functional Mitral Regurgitation (The COAPT Trial)**

- Randomized, multicenter study of the MitraClip device for the treatment of moderate/severe or severe functional mitral regurgitation in symptomatic heart failure patients not appropriate for mitral valve surgery.
- Randomized to MitraClip device or no device
- Primary end-point: safety and recurrent heart failure hospitalizations
- Secondary end-points: death, stroke, myocardial infarction, mitral regurgitation, LV size, symptoms.

**Factors Predicting Decrease Survival after MitraClip Implantation**

- End-stage heart failure with significant increase in NT-proBNP (≥ 5000 pg/ml)
- Severe renal impairment (GFR <30 ml/min)
- Chronic obstructive pulmonary disease
- Tricuspid regurgitation ≥ 3+
- Residual mitral regurgitation > 2+

**CASE**

- 86 year old female with symptomatic NYHA class III heart failure.
- History of CABG.
- LVEF 30% and moderate-to-severe mitral regurgitation.
- Optimal medical therapy for heart failure (carvedilol, lisinopril, spironolactone, furosemide).
- QRS 94 ms on ECG.
- Coronary and bypass angiogram performed (did not require additional revascularization).
- Systolic pulmonary artery pressure (right heart catheterization) 55 mmHg.
- Assessed by Structural Heart Team for COAPT trial.

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**MitraClip for Functional Mitral Regurgitation Non-Randomized Studies**

- Inoperable or high-risk surgical patients with symptomatic heart failure and 3+ or 4+ functional mitral regurgitation.
- Mean LV ejection fraction ~ 30%.
- Follow-up 6 to 12 months post-MitraClip:
  - significant decrease mitral regurgitation
  - significant reduction LV size
  - significant increase LV ejection fraction
  - significant improvement NYHA functional class
  - 30 day mortality 1-6%


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Baseline Transesophageal Echocardiogram
Moderate to Severe Mitral Regurgitation

MitraClip and Delivery Device
Fluoroscopy

MitraClip Positioning
Transesophageal Echocardiogram

MitraClip Deployment
Fluoroscopy
Hemodynamics Changes Associated with MitraClip

- Pressure changes:
  - decrease left atrial pressure (v-wave by ~9 mmHg; mean by ~4 mmHg)
  - decrease PCWP (mean ~5 mmHg)
  - decrease pulmonary arterial pressure (systolic by ~9 mmHg; mean by ~5 mmHg)
- Increase cardiac output by 0.5 to 1.5 L/min

MitraClip for Significant Organic (Degenerative) Mitral Regurgitation (MR)

Summary

- MitraClip is effective and can be used in patients at high risk for mitral valve surgery:
  - safe and effective in reducing severity of MR in majority of patients
  - improves symptoms
  - decreases hospitalizations
  - may have beneficial effect on survival if residual MR post-procedure was not severe
- Mitraclip is FDA approved for use in patients with organic MR who are high surgical risk
- Low and intermediate risk patients do better with mitral valve surgery.
MitraClip for Significant Functional Mitral Regurgitation (MR) Summary

- MitraClip is safe and effective in reducing severity of MR in the majority of patients.
- Improves symptoms.
- May decrease LV size and improve LV function.
- May increase survival?
- These important questions will be further addressed in ongoing prospective, randomized studies (COAPT, other).

MitraClip for Significant Mitral Regurgitation (MR) Concluding Remarks and Future Considerations

- MitraClip is a relatively new method still in evolution for the management of significant MR.
- MitraClip is beneficial in patients with severe organic (degenerative) MR who are at high risk for surgery; MitraClip may be considered in certain critically ill patients with severe organic MR who are high risk for surgery as a bridge to mitral valve surgery.
- MitraClip may be used in certain symptomatic patients due to heart failure with significant functional MR.
- MitraClip or other transcatheter devices may become a common procedure for functional MR in the near future.

Mitral Valve Repair vs. Replacement for Degenerative Mitral Regurgitation

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Director, Division of Cardiac Surgery
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Disclosure

- Research Grants:
  - Medtronic Inc.
  - Abbot Vascular
  - Boston Scientific
Mitral Valve Regurgitation

Degenerative

Functional

Degenerative Mitral Regurgitation

Natural History – Mortality

Survival (%)

Years after diagnosis


David H. Adams, Raphael Rosenhek, Volkmar Falk
Degenerative Mitral Regurgitation
Natural History – Mortality

NYHA Class | LVEF
---|---

Degenerative Mitral Regurgitation
Yearly Rate of Sudden Death: 1.8%/year

Degenerative Mitral Regurgitation
Repair vs. Replacement

Year Replacement Repair
2015 7027 8764
Degenerative Mitral Regurgitation Surgical Results

Very Long-Term Survival and Durability of Mitral Valve Repair for Mitral Valve Prolapse

Dania Moltky, MD; Thomas A. Ozcanuk, MD; Hartnell V. Schaff, MD; Jean-Francois Avierinos, MD; Jamil A. Tajik, MD; Mauricio Enriquez-Sarano, MD

917 patients (MVR in 238, MVR repair in 679)
Follow up: 20 years

Re-Operation Rate: 23% vs 16% p=NS
Degenerative Mitral Regurgitation Surgical Results

Valve repair versus valve replacement for degenerative mitral valve disease

A. Merc Stellino, MD; Eugene K. Blackstone, MD; Edward F. Noreika, MD; Werner Sieker, MD; Dhiran Al-Dorzi, MD; Douglas R. Johnstone, MD; Kristophor M. George, MD; Peery L. Houghtaling, MD; Brian Giffen, MD; Joseph F. Suh, MD; and Laura S. Bernstein, MD, PhD

3265 patients (MVR in 235, MVRepair in 3051)
Follow up: 20 years
Long term survival was better for Repair than MVR
Propensity Matched Survival was the same

Propensity Matched Survival was the same

ECHOCARDIOGRAPHIC FOLLOW UP
Freedom from MR>2+ 90% at 8 years

Degenerative Mitral Regurgitation Surgical Results

4-Year Results of a Randomized Controlled Trial of Percutaneous Repair Versus Surgery for Mitral Regurgitation

Lauri Maiuri, MD; Elke Feuer, MD; Donald D. Glower, MD; Patrick Aasman, MS, Joseph M. Massumi, PhD; Howard R. Horvath, MD; James Horrow, MD; William Gray, MD; Andrew Wong, MD; Wesley R. Pulmon, MD; Yancey Hone, MD; John Lautz, MD, PhD; Margaret Liver, MD; Paul Guygirich, MD; Ted Feldman, MD

MVRRepair (95 patients) vs. MitraClip (184 patients)
Rigorous ECHO Follow up
MV Repair: MR 3+ or 4+: 9% at 4 years

Is All Mitral Valve Disease the Same?

David H. Adams, Raphael Rosenhek, Volkmar Falk
Degenerative Mitral Regurgitation Surgical Results

Survival Advantage and Improved Durability of Mitral Repair for Leaflet Prolapse Subsets in the Current Era

Rakesh M. Suri, MD, DPhil, Hartnell V. Schaff, MD, Joseph A. Dearani, MD, Thorell M. Suri, MD, Maurice Enriquez-Sarano, MD

Survival

Repair (1173 patients) or MVR (238 patients) for leaflet Prolapse

20 year follow-up

- Posterior Leaflet: Survival better for MV Repair (HR 0.49)
- Bi Leaflet: Survival better for MV Repair (HR 0.59)
- Anterior Leaflet: Survival MVR=Repair (HR 0.78)

Re-Operation Rate

MVRepair equal to MVR with Mechanical Valve

MVR with tissue valve much higher

Re-Operation Rate and Risk of Reoperation

Lowest for Posterior Leaflet Prolapse (0.5%/yr)

Highest for Anterior Leaflet Prolapse (1.6%/yr)

Bileaflet Prolapse=MVR with Mechanical valve (0.9%/yr)
Degenerative Mitral Regurgitation Surgical Results

Predictors of Left Ventricular Remodeling After Surgical Repair or Replacement for Pure Severe Mitral Regurgitation Caused by Leaflet Prolapse

Mario Sinitchik, MD**, Jimmy Machluf, MD**, Olivier F. Bertrand, MD, PhD**, Kim O’Connor, MD**, Julie Patrini, MD**, Jean-Nicolas Dupont-Sinitchik**, Olivier Costanzo, PhD**, Michelle Dubois, MSc, and Pierre Voumard, MD**

Repair vs. Replacement

Repair (42 patients) or MVR (30 patients) for leaflet Prolapse

2 yr ECHO follow-up

Similar Improvements in LVEF, LV dimensions and Volumes

Degenerative Mitral Regurgitation Surgical Results

15 years Mechanical(%) Bioprosthesis(%) Freedom From Thromboembolism, Bleeding, Endocarditis

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<th>Mechanical (%)</th>
<th>Bioprosthesis (%)</th>
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Freedom From Thromboembolism, Bleeding, and Endocarditis

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<th>1 yr (%)</th>
<th>5 yr (%)</th>
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4-Year Results of a Randomized Controlled Trial of Percutaneous Repair Versus Surgery for Mitral Regurgitation

Laura Marx, MD, TY Elyse Foster, MD, DJ Donald D. Glover, MD, DJ Paticia Apgarman, MS, DJ Joseph M. Massaro, MD, DJ Howard C. Herrmann, MD, DJ James Herrold, MD, DJ William Gray, MD, DJ Andrew Wang, MD, DJ Wodzislaw P. Podesta, MD, DJ Tino Billes, MD, DJ John Landl, MD, DJ Reginald Low, MD, DJ Paul Coghlan, MD, DJ Tod Fildes, MD, DJ for the EVEREST II Investigators

MV Repair (95 patients) vs. MitraClip (184 patients)

Rigorous Follow up

MV Repair: 93% NYHA class I or II 4 years
## Degenerative Mitral Regurgitation Repair vs. Replacement

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