Interventional Management of Mitral Valve Disease

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Secretary General PACHDA
• The mitral valve is the most complex of the heart’s 4 valves and is the one most commonly associated with disease.

• Complex structure better described as **MITRAL VALVE COMPLEX**.
• Comprised of the MV annulus, leaflets, chordae and papillary muscles
• Integral part is LA and myocardium
Percutaneous Mitral Valve Interventions

- Mitral stenosis
- Mitral regurge
- Paravalvar leaks

Trans septal puncture
Mitral Stenosis

Since its introduction BMV has demonstrated good immediate and midterm results and is considered the standard non surgical treatment of rheumatic mitral stenosis.
Endemic diseases such as rheumatic fever have had a considerable influence on cardiovascular disease in Egypt and have created different priorities from those in Europe," Dr Ramzy says. In particular, he notes that the high prevalence of mitral valve stenosis has allowed Egyptian interventionalists to perform balloon valvuloplasty at extraordinarily high level.

Circulation February 6, 2007
### Indications for percutaneous mitral commissurotomy

<table>
<thead>
<tr>
<th>Indication</th>
<th>Class</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMC is indicated in symptomatic patients with favourable characteristics.</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>PMC is indicated in symptomatic patients with contraindication or high risk for surgery.</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>PMC should be considered as initial treatment in symptomatic patients with unfavourable anatomy but without unfavourable clinical characteristics.</td>
<td>IIA</td>
<td>C</td>
</tr>
<tr>
<td>PMC should be considered in asymptomatic patients without unfavourable characteristics and:</td>
<td>IIA</td>
<td>C</td>
</tr>
<tr>
<td>• high thromboembolic risk (previous history of embolism, dense spontaneous contrast in the left atrium, recent or paroxysmal atrial fibrillation), and/or</td>
<td></td>
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<tr>
<td>• high risk of haemodynamic decompensation (systolic pulmonary pressure &gt; 50 mmHg at rest, need for major non-cardiac surgery, desire for pregnancy).</td>
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</tr>
</tbody>
</table>
Contraindications for percutaneous mitral commissurotomy

- Mitral valve area > 1.5 cm².
- Left atrial thrombus.
- More than mild mitral regurgitation.
- Severe or bicommissural calcification.
- Absence of commissural fusion.
- Severe concomitant aortic valve disease, or severe combined tricuspid stenosis and regurgitation.
- Concomitant coronary artery disease requiring bypass surgery.
Patient selection

Wilkins Score

- Mobility
- Thickening
- Chordal Involvement
- Calcification
Balloon size

DB and multitrack, sum of 2 balloons = annulus

IB = Height (cm) (rounded to nearest 0) ÷ 1/10 plus 10
Pooled Analysis Of Percutaneous Mitral Valvuloplasty In Egypt

Department of Cardiology, AinShams University, Cairo, Egypt

- 2,256 pts with MS of rheumatic origin
- 292 males and 1,964 females.
- Double balloon was used in 1,148 pts (51%)
- Inoue balloon in 914 pts (40.5%)
- Metallic commissurotome in 142 pts (6%),
- Multi-Track in 33 patients (1.5%)
- Single balloon in 19 patients (1%).
Pooled Analysis Of Percutaneous Mitral Valvuloplasty In Egypt

• Success rate = 91.5%
• MVA increased to $1.92 \pm 0.36 \text{cm}^2$
• MPG dropped to $5.58 \pm 2.6 \text{mmHg}$
• The most common complication was the occurrence of MR [ 36% ]
• Short term follow up data [ for $5.7 \pm 5.9 \text{m} $ ]
• Sustained favorable MVA
Pooled Analysis Of Percutaneous Mitral Valvuloplasty In Egypt

Conclusions

• The Multi-Track system, and the DB resulted in the largest MVA
• The IB resulted in the least increase in MR.
• The most common complication of PMV is the increase in the degree of MR.
Comparison of early results of percutaneous metallic mitral commissurotome with Inoue balloon technique in patients with high mitral echocardiographic scores.

Zaki AM, Kasem HH, Bakhoum S, Mokhtar M, El Nagar W, White CJ, El Guindy M.

Department of Cardiology, Cairo University Hospitals, Cairo, Egypt.

Catheter Cardiovasc Interv. 2002 Nov;57(3):312-7

Despite the favorable early results
• Vascular trauma
• Mitral regurgitation
• Cost
Percutaneous Mitral Valvotomy versus Closed Surgical Commissurotomy Up To 15 Years Of Follow-up Of A Prospective Randomized Study.


Cardiology Department, Faculty of Medicine, Ain Shams University, Cairo, Egypt

J Cardiol. 53(1):28-34.
Redo Versus First PBMV For Mitral Stenosis: Results And Factors Related To Time To Redo Procedure

O.A. Rifaie, M.I. Mohamad, M.M.Helmi, M.M. Elbiali
1Cardiology Department, Ain Shams University, Cairo, Egypt, 2National Heart Institute, Cairo, Egypt

40 pts PBMV as a redo procedure vs. 30 pts first time PBMV.

Multi variate analysis showed that the factors which determined longer time to redo PBMV were:
• Sinus Rhythm (P=0.009)
• Post procedure increment in MVA (p=0.004)
• Low echo score (p=0.008)
• Long acting penicillin (p=0.007)
Five-year Follow-up After Percutaneous Balloon Mitral Valvuloplasty In Children
Adel Zaki, MD, Mai Salama, MD, Magdy El Masry, MD, Abdou Elhendy, MD

• 46 Children
• Success rate 98%
• MVA index $1.54 \pm 0.23 \text{ cm}^2/\text{m}^2$
• Follow up $66 \pm 6$ Months
• Restenosis rate 6.5%

Volume 83, Issue 5, Pages 735-739 (1 March 1999)
Complications


Incidence of severe MR after PTMC in the literature varies b/w 1.4% and 7.5% (Hernandez et al. American Journal of Cardiology, vol.70, no.13, pp.1169-1174, 1992); (Padial et al. JACC, vol.27, no.5, pp.1225-1231, 1996)
Causes of MR

• Commissural calcification is a strong predictor of adverse outcomes of BMV as well as of the occurrence of severe MR as a major complication of BMV [JACC 1996;27:1225-31]

• Oversizing

• Chordal rupture – severe subvalvular affection- ? Cong MS

• Leaflet puncture
Studies of surgically excised mitral valves of patients who developed severe MR after BMV have consistently shown 3 anatomic characteristics:

- Heterogeneously thickened MV with thick areas coexisting with thin or almost normal zones
- Severe fusion, thickening and shortening of subvalvular apparatus
- Calcium on one or both commissures

Mitral Regurgitation
Mitral Regurgitation

- The estimated prevalence of moderate to severe MR in the population is:
  - 6.4% in the 65-74 yrs age group
  - 9.3% in people over the age of 75 yrs

- The rate if death from CVS causes among asymptomatic patients with at least moderate MR or an LVEF if less than 50% exceeds 3% per year
Etiology of MR

- Degenerative MR
  - Redundant leaflets, elongated or ruptured chords
- Functional MR
  - Annular dilation
  - Annular calcification
  - Papillary muscle dysfunction
    - Fixed (LV dysfunction related posterior tethering)
    - Transient (ischemia)
- Rheumatic changes
- Endocarditis
Annulus devices
Leaflet repair
Artificial chords
Ventricular remodeling
Valve replacement
Trans catheter MV Milestones - MR

1990

1999
First TCMV animal studies by Morales

2000

2003
First in Human TCMV Repair (MitraClip)

2008
First CE approved for TCMV Repair (MitraClip)

2010

2012
First in Human TCMV Replacement (CardiAQ)

2013
First CE approved for TCMV Repair (MitraClip)

2020
## Transcatheter Mitral Valve Landscape

<table>
<thead>
<tr>
<th>Approach</th>
<th>Commercial</th>
<th>In Development</th>
<th>Abandoned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edge-to-Edge Repair</td>
<td>Abbott Vascular</td>
<td>St. Jude Medical</td>
<td></td>
</tr>
<tr>
<td>Direct Annuloplasty</td>
<td>Kardium, Valcare, Mitralign, Valedis, Medtronic, Boston Scientific, Edwards</td>
<td>QuantumCor, ReCor Medical</td>
<td></td>
</tr>
<tr>
<td>Indirect Annuloplasty</td>
<td>Cardiac Dimensions</td>
<td></td>
<td>St. Jude Medical, VIACOR, Edwards</td>
</tr>
<tr>
<td>Chordal Repair</td>
<td>nCord</td>
<td>Valtech</td>
<td></td>
</tr>
<tr>
<td>Ventricular Remodeling</td>
<td>CardioKinetix Inc., Mardi Medical, Boston Scientific, Edwards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhanced coaptation</td>
<td>middle peak, Mitralix, MitrAssist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MV Replacement</td>
<td>Medtronic, Valtech, endoValve, Medtronic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device name and therapy type</td>
<td>Device structure</td>
<td>Status international</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------------</td>
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</tr>
<tr>
<td>MitraClip (Abbot Vascular)</td>
<td><img src="image" alt="MitraClip" /></td>
<td>CE Mark approval gained, FDA approved</td>
<td>- Percutaneous mitral repair based on Alfieri edge-to-edge surgical approach, designed for both degenerative and MVR. - Features a tiny V-shaped clip.</td>
</tr>
<tr>
<td>NeoChord (NeoChord DS1000)</td>
<td><img src="image" alt="NeoChord" /></td>
<td>CE Mark approval gained</td>
<td>- Indication requested for FDA approval is significant symptomatic DMR in presence of prohibitive risk for mitral valve surgery</td>
</tr>
<tr>
<td>Chordal repair</td>
<td></td>
<td></td>
<td>- Instrumentation used to enable beating heart, transapical approach, mitral valve repair by artificial chordae implantation</td>
</tr>
<tr>
<td>V-Chordal-Off Pump (Valtech)</td>
<td><img src="image" alt="V-Chordal" /></td>
<td>First-in-man study complete</td>
<td>- Designed for leaflet prolapse</td>
</tr>
<tr>
<td>Chordal repair</td>
<td></td>
<td></td>
<td>- Off-pump, the chordal length can be adjusted under live echo guidance, on beating heart</td>
</tr>
<tr>
<td>CARILLON (Cardiac Dimensions)</td>
<td><img src="image" alt="CARILLON" /></td>
<td>CE Mark approval gained, IDE submitted for pivotal study</td>
<td>- Implantable mitral annular constraint device percutaneously placed into the coronary sinus and great cardiac vein - Constructed of nitinol wire with distal and proximal anchors connected by an intervening cable</td>
</tr>
<tr>
<td>Indirect Annuloplasty</td>
<td></td>
<td></td>
<td>- Designed specifically for heart failure patients with significant MR due to mitral annular enlargement</td>
</tr>
<tr>
<td>Direct Annuloplasty</td>
<td>International feasibility trial underway</td>
<td>Catheter-based delivery of a sub-valvular left ventricular reshaping (ventriculoplasty) system designed to reshape and resize the left ventricular base</td>
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<tr>
<td>---------------------</td>
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</tr>
<tr>
<td>Mitalign Bident (Mitalign) Direct annuloplasty</td>
<td>CE Mark trial completed US feasibility trial planned</td>
<td>Re-establish native mitral valve geometry while preserving native leaflet function, and restore leaflet coaptation</td>
<td></td>
</tr>
<tr>
<td>Cardioband TF (Valtech) Direct annuloplasty</td>
<td>CE Mark trial underway</td>
<td>Transcatheter annuloplasty for mitral repair</td>
<td></td>
</tr>
<tr>
<td>Millipede Ring (Millipede) Direct annuloplasty</td>
<td>Preclinicals underway</td>
<td>Involves delivery of polyester pledgets via LV through posterior mitral annulus</td>
<td></td>
</tr>
</tbody>
</table>

- **Pledgets are plicated and locked directly on the annulus**
- **Nitinol ring designed for tricuspid or mitral valve repair**
- **Catheter-based treatment for MR featuring a clip that holds together the leaflets of the mitral valve**
Edge-to Edge repair with the MitraClip (Abbott Vascular)
MitraClip
EVEREST II Randomized Clinical Trial
Surgical and Percutaneous Therapy for Mitral Regurgitation

Mitral Valve Surgery Repair/Replacement

or

Catheter Based Mitral Valve Repair MitraClip® System
EVEREST II Randomized Clinical Trial Study Design
279 Patients enrolled at 37 sites
  Significant MR (3+-4+)
  Specific Anatomical Criteria
  Randomized 2:1

Device Group
MitraClip System
n=184

Control Group
Surgical Repair or Replacement
n=95

Echocardiography Core Lab and Clinical Follow-Up:
  Baseline, 30 days, 6 months, 1 year, 18 months, and annually through 5 years
Conclusions of EVEREST II

• MitraClip is safer than surgery
• Shorter hospital stay
• Surgery is more effective at MR reduction than MitraClip
• Both improve ventricular remodeling and HF class
• MitraClip might be best targeted to higher surgical risk patients
## Worldwide Experience Using the MitraClip

<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>N*</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEVERST I (Feasibility)</td>
<td>Feasibility patients</td>
<td>55</td>
</tr>
<tr>
<td>EVEREST II (Pivotal)</td>
<td>Pre-randomized patients</td>
<td>60</td>
</tr>
<tr>
<td>EVEREST II (Pivotal)</td>
<td>Non-randomized patients (High Risk Study)</td>
<td>78</td>
</tr>
<tr>
<td>EVEREST II (Pivotal)</td>
<td>Randomized patients (2:1 Clip to Surgery)</td>
<td>279</td>
</tr>
<tr>
<td></td>
<td></td>
<td>184 Clip</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95 Surgery</td>
</tr>
<tr>
<td>REALISM (Continued Access)</td>
<td>Non-randomized patients</td>
<td>899</td>
</tr>
<tr>
<td>Compassionate/Emergency Use</td>
<td>Non-randomized patients</td>
<td>66</td>
</tr>
<tr>
<td>ACCESS Europe Phase I</td>
<td>Non-randomized patients</td>
<td>567</td>
</tr>
<tr>
<td>ACCESS Europe Phase II</td>
<td>Non-randomized patients</td>
<td>286</td>
</tr>
<tr>
<td>Commercial Use</td>
<td>Commercial patients</td>
<td>&gt;20,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>&gt;20,000</strong></td>
</tr>
</tbody>
</table>
FDA approval 11/2013

MitraClip is FDA approved for patients with symptomatic MR of primary (degenerative) etiology that are poor surgical candidates as designated by the Heart Team.
Outcomes of the Initial Experience with Commercial Transcatheter Mitral Valve Repair in the U.S.

A report from the STS/ACC TVT Registry

Paul Sorajja, MD, Saibal Kar, MD, Amanda Stebbins, Sreekanth Vemulapalli, MD, D. Scott Lim, MD, Vinod Thourani, MD, Michael Mack, MD, David R. Holmes, Jr., MD, Wesley A. Pedersen, MD, and Gorav Ailawadi, MD

Study Population
564 Patients
Change in Mitral Regurgitation

Clip implantation occurred in 94%.

- 93% MR ≤ 2
- 63.7% MR ≤ 1

p < 0.001
Clinical Outcomes

- Procedure success.... 91.8%
- Complications........... 7.8%
- Length-of-stay............ 3 d (1,6 d)
- Home discharge............ 81.9%
Commercial TMVR with MitraClip

Data Summary

- Prohibitive risk population with 86% DMR
- 91.8% procedure success
- Device-related adverse events: 2.7%
- Mortality: 2.3% in-hospital, 5.8% at 30-days
- Procedure complications: 7.8%
- EDD, MR, volume, clip site related to success
SECONDARY (FUNCTIONAL) MR

THE COAPT TRIAL

Clinical Outcomes Assessment of the MitraClip Percutaneous Therapy for High Surgical Risk
Trial Design

420 patients enrolled at up to 75 US sites
Significant FMR (≥3+ by core lab)
High risk for mitral valve surgery
Specific valve anatomic criteria

Randomize 1:1

MitraClip
N=210

Control group
Standard of care
N=210

Clinical and TTE follow-up:
1, 6, 12, 18, 24, 36, 48, 60 months

Protocol conditionally approved by FDA July 26, 2012
Trans-catheter Mitral Valve Replacement (TMVR)

- TS and TA access approaches
- All self-expanding
- All in the FIM or Phase 1 trials
Paravalvular leak
How to Approach Mitral Valve Leaks?

• How to Cross the leak?
• How and from where to advance the sheath?
• Which devices?
How to Cross?

Antegrad

Antegrade
Stearable
sheath

Retrograde

Trans-apical
Devices

[A] [B] [C] [D] [E] [F]

Square
Rectangular
T = twisted
W = waist

Two PET patches
One in each disc
Device should match the anatomy!

Round

oval
crescentic

Slit-like

Crescentic cutting edge
Visualizing the apex using the pigtail to get the trans apical puncture
MP catheter crossed one of the defects
6 FR sheath positioned across the defect
1\textsuperscript{st} device introduced into LA ADOII 5x4 mm
Confirm wire position, introduce the long sheath and the second device (ADO 2 5x4)
Finally
AVP II 12mm
Thank You