MITRAL STENOSIS: MANY FLAVORS
Rheumatic and Calcification

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  FACC FASE
- Founding Director,
  Cardiac Non-Invasive Laboratory
- Scripps Clinic Medical Group

Rheumatic Mitral Stenosis 76yo male
Mean MV gradient 8.8cm²
Etiologies of MS

- Rheumatic Heart Disease
- Mitral Annular calcification
- Radiation-associated valve disease
- Rare causes
  - Fabrys, mucopolysaccharidosis
  - Methysergide therapy
  - Carcinoid heart disease
  - Post MV repair

Guideline Algorithm: Treatment of MS
Scoring Systems

- Wilkins
  - Mobility, calcification, thickening and subvalvular
- Anwar
  - 3D assessment of Ca++ and subvalvular

JACC CV Imag 2013;6:1191

45 y/o male with symptomatic Rheumatic Mitral Stenosis
A 79 yo male presents for a TAVR evaluation. The echo image shown is associated with a 10mmHg mitral valve gradient at a HR of 68 bt/min. Survival in such patients with degenerative calcific mitral stenosis is:

1. Same as the “expected” survival in the general population
2. Moderately reduced compared with “expected”
3. Determined entirely by the patient’s aortic stenosis and unaffected by the MAC
4. Unknown – this has not been studied in such patients
A 79 yo male presents for a TAVR evaluation. The echo image shown is associated with a 10mmHg mitral valve gradient at a HR of 68 bt/min. Survival in such patients with degenerative calcific mitral stenosis is:

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4. Unknown – this has not been studied in such patients

MAC may result in important MITRAL STENOSIS
Mitral Annulus Calcification Overview: Diagnosis, Risk Factors, and Clinical Implications

<table>
<thead>
<tr>
<th>MITRAL VALVE CALCIFICATION</th>
<th>DIAGNOSTIC IMAGING</th>
<th>RISK FACTORS FOR MAC</th>
<th>CLINICAL IMPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitral valve</td>
<td>Echocardiography:</td>
<td>Increased age</td>
<td>Increase in cardiovascular disease and mortality</td>
</tr>
<tr>
<td></td>
<td>MAC is visualized</td>
<td>Female</td>
<td>Increase in MV disease (mitral regurgitation, mitral stenosis, endocarditis)</td>
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<tr>
<td></td>
<td>as an echodense</td>
<td>Chronic kidney</td>
<td>Increase in arrhythmias (conduction system disease, atrial fibrillation)</td>
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<td></td>
<td>structure with an</td>
<td>disease</td>
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<td></td>
<td>irregular, lumpy</td>
<td>Multiple cardiovascular risk factors (hypertension, diabetes mellitus, dyslipidemia, smoking)</td>
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<tr>
<td></td>
<td>appearance and an</td>
<td>increased MV stress</td>
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<tr>
<td></td>
<td>associated acoustic</td>
<td>(hypertension, aortic stenosis, hypertrophic cardiomyopathy, MV prolapse)</td>
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<td></td>
<td>shadowing.</td>
<td>Metabolic disorders</td>
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<tr>
<td></td>
<td></td>
<td>(Marfan syndrome, Hurler syndrome)</td>
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<td></td>
<td></td>
<td>Osteoporosis</td>
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<tr>
<td>Calcification on posterior</td>
<td>Computed tomography</td>
<td></td>
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<tr>
<td>annulus</td>
<td>Highly effective</td>
<td></td>
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<tr>
<td></td>
<td>for cardiac, coronary,</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>and aortic</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>calcification</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>imaging. A useful</td>
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<td></td>
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<td></td>
<td>tool to evaluate</td>
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<td></td>
<td>the extent and</td>
<td></td>
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<tr>
<td></td>
<td>location of MAC.</td>
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</table>

Definition: chronic degenerative process in the fibrous base of the MV. More common in the posterior annulus than the anterior annulus.


Histological, clinicopathological, and contemporary imaging studies that examined the association between mitral annulus calcification and other disease entities enhanced our knowledge of the pathogenesis of MAC and enabled a better understanding of this process and its clinical importance. MAC — mitral annulus calcification; MV = mitral valve.

MITRAL VALVE CALCIUM DISTRIBUTION

Alain Carpentier et al

J Thor and CV Surg 1996;111:718
MAC Epidemiology

- MAC prevalence 8-15%
  - Increased with age and in pts with multiple CV risk factors or chronic kidney disease
  - Increasing prevalence due to growing population of elderly pts in developed world
- Associated with stenosis and regurgitation
  - (? Prevalence 0.2% of significant gradient)
- BAV not suitable for mitral stenosis due to MAC
- Mitral valve surgery - excess morbidity and mortality
- Transcatheter devices – unique challenges

Survival with Degenerative Mitral Stenosis

JASE 2016;29:461
84 yo female post SAVR 2008
HTN, CKD III, HLD, PAF
Sedentary and asymptomatic

69 yo female with alcoholic liver disease
Initial transplant eval 2004 PHT
Slowly rising MV gradient, new AF
75 yo male SAVR 2008. Moderate calcific MS not approached

Mean MV Gradient

Cardiac Output

Progression in MAC

- Paucity of serial data
- SCMG
  - Retrospective review of echo database 2001-2009
  - “moderate/severe MAC” = >4mm annulus/leaflet
  - > 2mmHg mean MV gradient
- 30 patients who met inclusion criteria
  - Mean F/U 47.1±20 months
  - Initial Mean MV gradient 4.8±1.8mmHg
  - Average gradient progression 1.4±2.1mmHg
Elderly female post transfemoral TAVR

Mean MV gradient 9mmHg

IMAGING MAC Qualitative and Quantitative

- VISUAL EXTENT OF CALCIFICATION
  - Annulus: ant post annulus and commissures
  - Leaflet involvement
  - En Face view – 3D key

- SEVERITY ASSESSMENT OF MS
  - Gradients – note HR and flow dependence
  - MV Area: continuity, planimetry or PISA
  - Exercise via PA pressure and gradients
  - Invasive hemodynamics-may alter loading and flow
  - ? CT-based MAC score
Grading MAC

Mild:
- Maximal thickness <4mm
- Focal, limited increase in echodensity of the mitral annulus

Moderate:
- Maximal thickness is usually <4mm
- Marked echodensity involving 1/3 to 1/2 of the annular ring circumference

Severe:
- Maximal thickness >4mm
- Marked echodensity involving > 1/2 of the annular ring circumference
- May be accompanied by an increased mean mitral pressure gradient when restricted anterior leaflet mobility is present
  - or -
- Intrusion of the calcification into the LVOT
  - or -
- Calcification extending on a continuous bar from the annulus to > 1/2 of the anterior or posterior leaflet length

A
MVA = 1.39 cm²
PHT = 118 msec
MVA = 1.86 cm²

C
ACC CV Imag 2016:9:1318

D
E
F
MVA = 1.45 cm²
Mitral Annular Calcium and Mitral Stenosis Determined by Multidetector Computed Tomography in Patients Referred for Aortic Stenosis

Simon Mejean, MD
de, Erik Bouvier, MD
de, Vincent Bataille, MPH
de, Patrick Seknadj, MD
de, Dominique Fouchy, MD
de, Jean-Yves Tabet, MD
de, Olivier Lairez, MD, PhD
de, and Bertrand Cormier, MD
de

- High prevalence of MAC in pts referred for TAVR
  - 34% patients with mitral calcific deposits
  - 12% severe to very severe mitral stenosis (CT planimetry)

- Agatston score correlates with severity of MS
  - Weaker relationship than for AS
  - Severity is highly dependent on topography
  - Anterior leaflet extension (A2) important role in stenosis

Questions remain about thresholds of severity by CT, functional impact, prognosis and therapeutic strategy implications
3D Printing for Procedural Simulation

IMPORTANT CLINICAL ISSUES related to MAC

- Associated with gradient complicating valve surgical planning-possibly symptomatic
- Symptomatic mitral stenosis, regurgitation or both
- Associated with increased intra-procedural surgical risk during MV repair or replacement
- Percutaneous MV interventions
  - MitraClip – feasibility
  - TMVR - risk factor for rupture, embolization or a potential useful anchor
79 yo pre TAVR patient
Mean MV gradient 10mmHg
MVA by planimetry 1.7cm²

Scripps Clinic Echo Lab 2017

<table>
<thead>
<tr>
<th>Aortic Stenosis Text</th>
<th>Yes</th>
<th>No</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild to moderate valvular aortic stenosis.</td>
<td>6</td>
<td>311</td>
<td>317</td>
</tr>
<tr>
<td>Mild valvular aortic stenosis.</td>
<td>26</td>
<td>1052</td>
<td>1078</td>
</tr>
<tr>
<td>Moderate to severe valvular aortic stenosis.</td>
<td>13</td>
<td>269</td>
<td>282</td>
</tr>
<tr>
<td>Moderate valvular aortic stenosis.</td>
<td>20</td>
<td>637</td>
<td>657</td>
</tr>
<tr>
<td>Severe valvular aortic stenosis.</td>
<td>53</td>
<td>858</td>
<td>911</td>
</tr>
<tr>
<td>Grand Total</td>
<td>118</td>
<td>3127</td>
<td>3245</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MV Press Grad &gt;= 4</th>
<th>Yes</th>
<th>No</th>
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<tbody>
<tr>
<td>Severe valvular aortic stenosis.</td>
<td>5.8%</td>
<td>94.2%</td>
</tr>
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</table>
Mitral valve annular calcium

Risk factors for posterior ventricular rupture after mitral valve replacement: results of 2560 patients

Hayati Deniz, Onur Sokullu, Soner Saniloglu, Murat Sargin, Batuhan Ozay, Umut Ayoglu, Serap Aykut Aka, Fuat Bilgen

Department of Cardiovascular Surgery, Dr. Sırraş Thoracic and Cardiovascular Surgery Training and Research Hospital, Istanbul, Turkey

- 1996 through 2007, 2560 patients
- 23 ruptures (0.8%) with 20 mortalities (86%)
- “... aggressive decalcification should be avoided during mitral valve resection ...”

MITRAL ANNULAR CALCIFICATION AND INCREASED SURGICAL RISK

- Placement of smaller valve size
- Debridment can increase stroke
- Risk longer pump run and OP time
- Risk of AV groove disruption
- Increased rate paraavalvular leak

- All more true in the elderly with comorbid conditions

TMVR: Is it applicable in patients with MAC?

- Percutaneous mitral interventions
  - MitraClip – feasibility of grasp and adequate repair
  - TMVR - risk factor for rupture, embolization and LVOT obstruction

- Might MAC be a useful anchor?
EXCLUDE MORE THAN “MINIMAL” MAC
Transseptal Transcatheter Mitral Valve Implantation for Severely Calcified Mitral Stenosis

Transcatheter Mitral Valve Replacement in Native Mitral Valve Disease With Severe Mitral Annular Calcification
Results From the First Multicenter Global Registry
<table>
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<tr>
<th>Event</th>
<th>N</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedural Complications</td>
<td>13</td>
<td>20%</td>
</tr>
</tbody>
</table>

- **LVOT Obstruction**
  - N=6 (9.3%)
  - Died Cath Lab=1
  - Surgery=1
  - Med Rx=1
  - BAV + BMV=1
  - ASA=1
  - Dead N=5
  - Alive N=1

- **Embolization**
  - N=4 (6.25%)
  - Surgical rescue N=3
  - Percutaneous rescue N=1
  - Dead N=2
  - Alive N=1

- **Perforation**
  - N=3 (3.1%)
  - Left Ventricle N=2
  - Pulmonary Vein N=1
  - Dead N=2
  - Dead N=1

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**CENTRAL ILLUSTRATION** Challenges of Transcatheter Mitral Valve Implantation in Patients With MAC

- Non-circular transcatheter valve stents
- External sealing cuff technology
- Paravascular leak closure

- Utilizing circumferential MAC as anchor for balloon-expandable prostheses
- Dedicated self-expanding transcatheter valve technology

- Alcohol septal ablation
- Septal injection
- Anterior mitral leaflet resection
- Transcatheter valve technology to minimize anterior mitral leaflet displacement
### Table 1: Proposed Mitral Annular Calcification Grading System

<table>
<thead>
<tr>
<th>MAC Grade</th>
<th>Annular Calcification</th>
<th>Extra-Annular Calcification</th>
<th>Therapeutic Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1 (Mild)</td>
<td>Focal noncontiguous calcification limited to &lt;180° total annular circumference</td>
<td>None</td>
<td>- Standard mitral valve replacement</td>
</tr>
<tr>
<td>Grade 2 (Moderate)</td>
<td>Dense continuous calcification limited to &lt;270° total annular circumference</td>
<td>Posterior and/or anterior leaflet calcification may be present</td>
<td>- Medical therapy alone</td>
</tr>
<tr>
<td>Grade 3 (Severe)</td>
<td>Dense continuous calcification extending past the commissures into anterior annulus or complete circumferential MAC (≥270° calcification arc)</td>
<td>Posterior and/or anterior leaflet calcification may be present Papillary muscle or ventricular myocardial calcification may be present</td>
<td>- Standard mitral valve replacement (if no anterior leaflet involvement) - Transcatheter mitral valve replacement with dedicated devices - LA-LV conduit (if &lt; moderate MR) - Medical therapy alone - Transcatheter mitral valve replacement with balloon-expandable or dedicated devices - LA-LV conduit (if &lt; moderate MR) - Medical therapy alone</td>
</tr>
</tbody>
</table>

JACC CV Imag 2016;9:1318

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### Image

- **A**: Ultrasound image of the heart with a focus on the mitral valve.
- **B**: Close-up of the mitral valve showing calcification.
- **C**: CT scan of the heart highlighting the calcification.
- **D**: MRI image of the heart with a detailed view of the mitral annulus.
- **E**: Additional ultrasound image with annotations.

JACC CV Imag 2016;9:1318
MITRAL ANNULAR CALCIFICATION
Transcatheter Therapies

- May be an option in carefully selected patients
  - Clinically significant MS or combined MS/MR
- Learning curve
- More studies needed
  - Define best method to quantitate MAC and its significance in individual patients
  - Device development
  - Delivery systems development
  - Strategies to prevent LVOT obstruction
- Current Need: focus attention on MAC in all new areas of MV intervention

Evolution of interventions

Surgery is the only treatment

Surgery is the gold standard treatment

Surgery is the preferred treatment for low and intermediate risk patients

Transcatheter interventions are performed in intermediate risk patients

Surgery is performed in patients with contraindication to transcatheter approach

You are here

Professor Attavio Alfieri 2017