Innovative treatment of mitral valve diseases: What is the role of echocardiography?

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Besides the surgery......

- Amplatzer for ASD
- Amplatzer for PFO- (cryptogenic stroke)
- Sapien for PV conduit
- MitraClip
- Tendyne valve
- Mitral trial-Sapien for MAC, VIV, VIR
- Watchman LAA occluder
- Paravalvular leak repair
- Sapien3
- Core valve – Evolut
- Direct flow
- Portico
- Lotus
- Trialign for TR
We provide broad spectrum of innovative treatment for structural heart diseases.

Surgery ➔ Percutaneous

Healthy ➔ Older, and sicker
Evolution of Echocardiography

1D
- Single line
- A-mode
- M-mode

2D
- Single slice
- Full heart

3D
- Full heart beat
3D Echo is a “Must Have” for Structure Heart Disease

- Screening, planning and risk assessment
- Intra-procedural monitoring and guidance
- Post deployment assessment and management
Where are the valves?
In the cath lab

Where is the leak?
In the OR
Mitral Regurgitation
Echo = Roadmap

- Assess the severity of mitral regurgitation
- Determine the mechanism of mitral regurgitation
- Match relationship of mitral valve defect to regurgitation

Guidance:
- Surgery
- Percutaneous
How much?
Severity ---3+ or 4+/4 mitral regurgitation

Jet area /LA area >40%

Vena Contracta >0.7cm

Central Jet
Eccentric Jet

Central Jet
Eccentric Jet
Severity ---3-4+ or 4+/4 mitral regurgitation

2D PISA

Primary MR  ERO>0.4cm²
Secondary MR  ERO>0.2cm²

Central Jet  Eccentric jet

3D PISA

Regurgitant orifice area
Don’t forget the “simple” parameters

INTEGRATED APPROACH

E wave

Systolic reversal in Pulmonary vein

Dense CW with cut-off sign
Why?

Mechanism of Mitral Regurgitation
Mitral Valve Anatomy

The mitral apparatus is composed of:

- Left atrial wall
- Annulus
- Leaflets
- Chordae tendineae
- Papillary muscles
- Left ventricular wall
Surgeon’s view
Components of Mitral Valve Leaflets
Mechanism of Mitral Regurgitation

Primary MR
- Perforation
- Cleft
- Prolapse
- Thickening
- Commissure fussion
- Abnormal insertion
- Elongation/rupture
- Thickening/fussion
- Ischemia
- Fibrosis
- Rupture

Secondary MR
- Leaflets
- Chordae tendineae
- Papillary muscle
- Left ventricular free wall
- Annulus
- Dilatation
- Calcification
- Lateral distention (ischemic, fibrosis, Dilatation)
Carpentier’s Classification System of MR Mechanisms

Type 1- Normal Leaflet Motion
- Annulus dilatation
- Leaflet perforation

Type II-Increased Leaflet Motion
- Ruptured Chordae
- Elongated chordae and/or papillary muscle
- Ruptued PM

Type IIIa-Restricted leaflet motion (Systolic and diastolic)
- Commissure fusion
- Leaflet thickening
- Chordae fusion

Type IIIb-Restricted leaflet motion (Systolic)
- Ventricular Dilatation
- Ventricular dyskinesia
Type 1 (Normal Leaflet Motion)
Annulus dilatation
Type 1 (Normal Leaflet Motion)
Annulus dilatation
Type 1 (Normal Leaflet Motion)
Leaflet Perforation
Type II-Increased Leaflet Motion

Ruptured Chordae
Elongated chordae and/or papillary muscle
Ruptured PM
Spectrum of Degenerative Mitral Valve Disease

FED

FED+

Form Fruste

Barlow’s

Excess Tissue
Fibroelastic Deficiency (FED)

- Older individuals
- Short hx of MR
- Ruptured or elongated of a single chord
- Remaining segments are normal
- Posterior annulus may be dilated
Fibroelastic Deficiency

Elongated Chordae

Ruptured Chordae
Fibroelastic Deficiency
Ruptured chordae off P2
Barlow’s Prolapse

Excess leaflet tissue with billowing, thickened leaflets and chordae, large annulus
Barlow’s Disease
Barlow’s Disease
Type IIIa-Restricted leaflet motion
(Systolic and diastolic)

- Commissure fusion
- Leaflet thickening
- Chordae fusion

Rheumatic valvular disease
Type IIIa
(Systolic and diastolic Leaflet Restriction)

Commissure fusion
Leaflet thickening
Chordae fusion
Type IIIa
(Systolic and diastolic Leaflet Restriction)

MVA = 2.2 cm²
Myxomatous Mitral Valve Disease + Rheumatic Valve Disease
Type IIIb-Restricted leaflet motion (Systolic)

Ventricular dilatation
Ventricular dyskinesia

Ischemic mitral valve disease
Mitral insufficiency that occurs as a result of coronary artery disease, in absence of intrinsic structure abnormalities of the leaflets and subvalvular apparatus (Functional)
Ischemic Mitral Regurgitation

Localized LV distortion

PM Displacement
Chordal tethering
Restricted systolic leaflet motion
Ischemic Mitral Regurgitation
Ischemic Mitral Regurgitation
Carpentier’s Classification System of MR Mechanisms

Type I: Normal leaflet motion
Type II: Increased leaflet motion
Type IIIa: Restricted leaflet motion (systole and diastole)
Type IIIb: Restricted leaflet motion (systole)
Factors Affecting Decision on the Patient with MR

- Symptoms
- Feasibility of Surgical repair
- Operative risk to the patient
- Hemodynamic effects of MR on LV, LA and RV
- Severity and Mechanism of MR
- Decision to Operate
When?

- The goal is to operate asymptomatic chronic MR:
  
  - Late enough in the natural history to justify the risk of intervention, but
  
  - Early enough to prevent irreversible ventricular dysfunction, pulmonary hypertension, and/or chronic arrhythmia....and sudden death
How?

• Mitral valve replacement (Surgical vs percutaneous)

• Mitral valve repair (Surgical vs percutaneous)

• Medical treatment  none
Surgical Mitral valve replacement

Mechanical prosthesis

Bovine stented, porcine stented & stentless valves
Percutaneous Mitral Valve Replacement

Figure 2. The first-generation CardiAQ valve (A), Tendyne valve (B), Tiara valve (C), Fortis valve (D).
Clinical History

Relevant history:

57 y/o male
Severe MR - flail segment in the region between P2 and P3 d/t ruptured chordae.
Ht=182cm, Wt=93kg, BMI=30, BSA=2.2, Cr=0.6

PMHx:

SBE
Hemorgic CVA frontal temporal parietal decompressive craniotomy - 2014
LT plegia, wheel chair bound, SZ
Heart Stab wound 1989
Low PLT-unclear cause BMB neg.
Non signficant CAD
HTN, GERD
FEV1= 22% with Sev. restriction
Pre Tendyne mitral valve replacement
Post Tendyne mitral valve replacement
Post Tendyne mitral valve replacement
Mitral Valve Repair

Simple surgical repair
Annuloplasty Ring

- Classic ring
- Physio ring
- Ischemic ring
Type 1 (Normal Leaflet Motion)
Annulus dilatation
Type 1 (Normal Leaflet Motion)

Leaflet Perforation - Patch repair or replacement
Fibroelastic Deficiency (FED)

- Older individuals
- Short hx of MR
- Ruptured or elongated of a single chord
- Remaining segments are normal
- Posterior annulus may be dilated
Spectrum of Degenerative Mitral Valve Disease

- FED
- FED+
- Forme Fruste
- Barlow’s

Increase repair difficulty
Flail P2 due to ruptured chordae
Flail P2 due to ruptured chordae
Flail P2 due to ruptured chordae
FED-Preserve Tissue
No Resection, or Limited Resection
Mitral Valve Repair –P2
Post triangular resection of P2 and annuloplasty with ring
Post triangular resection of P2 and annuloplasty with ring
Mitral Valve Repair

Complex surgical repair
Barlow’s disease
Balows’s Prolapse---4 chamber
Pre mitral valve repair-Intercommissural view
Pre mitral valve repair-Gastric view
Pre mitral valve repair—mitral valve surgeon’s view
Pre mitral valve repair—mitral valve 3D color Doppler
Pre mitral valve repair—mitral valve 3D color Doppler
Hallmarks of Barlow’s disease---Large valve size, with diffuse myxomatous changes and excess leaflet tissue, with thickened, elongated chordae
Barlow’s "Remove" Tissue, Targeted Resection, Leaflet Displacement
Mitral Valve Repair

Complex surgical repair
Ruptured chordae off A2
Mitral Valve Repair
Anterior leaflet
Comparison of outcomes of minimally invasive mitral valve surgery for posterior, anterior and bileaflet prolapse

Joerg Seeburger*, Michael A. Borger, Nicolas Doll, Thomas Walther, Jurgen Passage, Volkmar Falk, Friedrich W. Mohr

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<table>
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<tr>
<td>Overall Repair Rate</td>
<td>94%</td>
<td>(1156/1230)</td>
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<tr>
<td>Posterior Leaflet Repair</td>
<td>97%</td>
<td>(651/672)</td>
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<tr>
<td>Anterior Leaflet Repair</td>
<td>91%</td>
<td>(142/156)</td>
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<tr>
<td>Bileaflet Repair</td>
<td>90%</td>
<td>(363/402)</td>
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Durability of Mitral Valve Repair

Tageted Surgeon Referral: degenerative mitral valve disease

Younger patients
Early surgery-asymptomatic patients
Anterior leaflet or bileaflet prolapse

Yes  No

Reference  Experienced

Mitral Surgeon  Valve Surgeon

Adams et al. Eur Heart J 2010;31:1958-
Transcatheter mitral repair

Simple mitral lesion with one MR jet
Significant, symptomatic, degenerative mitral regurgitation, high risk for surgery patients
Percutaneous Mitral Repair
Pre-procedure
Degenerative
Percutaneous Mitral Repair

Quantitate the severity and location of MR

ROA=1.4cm²
Percutaneous Mitral Repair
Intraprocedure

Guide transseptal puncture and assess the site of puncture

Transseptal puncture
3.5-4cm above the annular plane
Percutaneous Mitral Repair
Intraprocedure

Guiding catheter steering in LA towards mitral valve

Position clip perpendicular to leaflets and opposite A2/P2
Percutaneous Mitral Repair

Intraprocedure

Assess residual MR before releasing the clip

Mean gradient = 2 mmHg

Mitral valve area = 5.2 cm²

MVA₁ = 1.4 cm²

MVA₂ = 3.8 cm²

Mean gradient = 2 mmHg
Percutaneous Mitral Repair
Intraprocedure

Assess residual mitral regurgitation
3D Live TEE E-valve assessment
Intraprocedure

View from left atrium

View from left ventricle
Transcatheter mitral repair

Complex mitral valve prolapse with multiple MR jets
Case

92 year-old woman with multiple comorbidities presented with shortness of breath. He was found to have severe mitral regurgitation due to diffuse mitral valve prolapse.
Multiple mitral regurgitation jets along the mitral leaflets with the most mitral regurgitation emanating from the mid to medial segment of mitral valve.
After implantation of first clip in the mid segment, there is significant reduction of mitral regurgitation.

Systolic blood pressure increased from 120mm Hg to 140mmHg.
After the second mitral clip implantation, mitral regurgitation reduced to mild
Post MitraClip therapy assessment

Total mitral valve area
3.1cm²

Normal pulmonary vein inflow pattern

Mean gradient
2mmHg
Introduction

• A double orifice mitral valve (DOMV) is a rare congenital malformation.

• The hemodynamic impact of DOMV varies from a normally functioning valve to significant mitral regurgitation or stenosis.

• Surgical mitral valve repair has been reported for ruptured chordae associated with DOMV.

• We present a case of successful mitral valve repair using MitraClip for flail mitral leaflet in patient with isolated DOMV assessed by real-time 3D TEE.
86 year old man presented with exertional dyspnea.

Case

Congenital double orifice mitral valve

Diastole

Systole

Flail anterior mitral leaflet due to ruptured chordae
Noncentral Mitral Regurgitation
Congenital Double Orifice Mitral Valve
Mitral regurgitation jets emanating from the medial orifice of mitral valve.
Pre-MitraClip assessment -- TEE

Mitral regurgitation PISA radius = 1.6 cm
Pre-MitraClip assessment -- TEE

Deep gastric short axis view

MVA = 3.2 cm²
MVA = 3.7 cm²
Total MVA = 6.9 cm²
MG = 1 mmHg

Flail width = 1.4 cm
Intraprocendure MitraClip assessment -- TEE
Post MitraClip therapy assessment-TEE

Total mitral valve area=4.7cm²

MVA=3.2cm²

MVA=0.7cm²

MVA=0.8cm²

MG 1 mm Hg
Post MitraClip therapy assessment - TEE
Transcatheter mitral repair

Failed mitral valve repair
85 year-old woman with multiple comorbidities and previous surgical mitral annuloplasty presented with shortness of breath. She was found to have severe mitral regurgitation and referred for redo surgical mitral valve repair.

Flail posterior leaflet
A mid (P2 towards P1) portion of the posterior mitral leaflet is flail due to ruptured chordae.

The flail gap measures 6 mm.
Pre-percutaneous mitral valve repair

Severe MR with a PISA radius of 1.7 cm

Mitral valve area = 4 cm²

Flow reversal noted in left pulmonary vein

Mean gradient = 4 mm Hg
Post percutaneous mitral valve repair

After the mitral clip implantation, mitral regurgitation reduced to mild
Introduction

- Hemolytic anemia is one of the rare complications of mitral valve replacement or repair, mostly due to regurgitation around the prosthesis or annuloplasty ring.

- Reoperation is associated with an increased likelihood of a recurrent leak, morbidity, and mortality.

- Percutaneous transcatheter closure procedures have been applied to the treatment of paraprosthetic valve leak using a variety of techniques.

- We report a case using MitraClip therapy in a patient with hemolytic anemia induced by mitral para-annuloplasty ring leak.
A 76 years old man presented with shortness of breath and hemolytic anemia requiring frequent blood transfusion two months after mitral valve repair.
Para-ring mitral regurgitation
TEE: Para-ring mitral regurgitation
TEE: Para-ring mitral regurgitation
TEE: Para-ring mitral regurgitation
Post MitraClip
Post MitraClip

Trace intravalvular mitral regurgitation
Post MitraClip

Pulmonary vein inflow transmitral valvular gradient
Post MitraClip
Urine color

Pre MitraClip

8 hour post MitraClip
5 month post MitraClip therapy
Complete resolution of mitral regurgitation
and hemolytic anemia
Transcatheter mitral repair

Degenerative mitral bioprosthetic valve
Transvenous Transseptal Mitral Valve-in- Valve Procedure

(A) Balloon atrial septostomy is performed to allow SAPIEN valve (Edwards Lifesciences, Irvine, California) delivery. (B) SAPIEN valve is carefully positioned within prosthesis over a left ventricular anchor wire. (C) Balloon expandable SAPIEN valve is deployed within the surgical valve, and (D) equipment is removed.
Sapien S3 in the 31mm Mosaic bioprosthesis
In case you don’t know......

The word *mitral* (/ˈmaɪtrəl/) comes from **Latin**, meaning "shaped like a **mitre**" (bishop's hat).

The word *bicuspidx* uses **combining forms** of *bi-*, from Latin, meaning "double", and *cusp*, meaning "point", reflecting the dual-flap shape of the valve.
Thank You!!!
Case 1
Case 1
Case 1
Case 1
E Wave 1.7M/S

Pulmonary vein flow reversal

MR CW

PAP=57mmHg
Case 1

PISA radius=1.6cm
Case 1---TEE
Case 1---TEE
Case 1---TEE

Flail segment = 2.2cm
Case 1---Post Mitral Valve Repair TEE
Case 1--- Post Mitral Valve Repair TEE
Case 2
Case 2
Case 1---TEE
Case 1---TEE
Case 1 --- TEE

ERO = 0.3 cm²  R volume = 60 ml

PISA radius = 1.2 cm