How to Use Imaging in Multiple and Mixed Valvular Heart Disease

Key Points

Theodora Zaglavara, MD, PhD
BSCI/BSCCT Accredited for Cardiac CT

ADVANCED CARDIAC IMAGING
INTERBALKAN MEDICALCENTRE
Thessaloniki GREECE
The most frequent associations:
- AS plus MR
- AR plus MR
Main Hemodynamic Interactions that May Impact on Diagnosis of Multiple and Mixed VHD

1. Low – flow, low –gradient stenosis is frequent (e.g. AS & MR).

2. Mixed valve disease may be associated with increased antegrade flow and gradient. Moderate Stenosis & Moderate Regurgitation equals Severe valvular lesion.

3. Any severe valvular lesion may induce or increase upstream secondary MR or TR.

4. Pressure Half-Time derived methods may be invalid in the presence of altered LV compliance/relaxation or abnormal LV filling in the presence of mixed VHD.
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<td>1.</td>
<td>Remains the cornerstone of diagnosis,</td>
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<td>2.</td>
<td>Pathogenesis - Mechanisms</td>
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<td>3.</td>
<td>Severity - Progression</td>
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<td>4.</td>
<td>Consequences</td>
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<td>5.</td>
<td>Indication and timing of surgery</td>
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<td>6.</td>
<td>Likelihood of successful repair - Suitability for transcatheter intervention</td>
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<td>7.</td>
<td>Hemodynamic consequences in blood flow, LV size and function can affect diagnosis in multiple or mixed valve disease.</td>
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<td>8.</td>
<td>Measurements independent of loading conditions should be preferred (EROA, vena contracta, planimetry of a stenotic orifice)</td>
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Secondary Imaging Modalities

1. Dobutamine Stress Echocardiography for Low Gradient AS.
2. Exercise Stress Echocardiography in patients with symptoms despite moderate valve abnormalities.
3. CT for assessing valve opening (if echo suboptimal and CMR not possible).
4. CT for valve calcification in Low flow AS.
5. CT for Coronary Artery Anatomy prior to intervention.
6. CMR for valve morphology if echo suboptimal.
7. CMR for grading AR, MR (if uncertain on echo), PR
8. CMR ventricular volume calculation can be misleading, Phase-contrast velocity mapping should be preferred for quantifying valvular regurgitation.
Assessment of Patients With Discordant Grading of AS Severity at Doppler Echocardiography

**Discordant Grading - Low Gradient AS at TTE**
AVA ≤1.0 cm², AVAi <0.6 cm²/m², MG <40 mm Hg (See Tables 1 & 2)

**Step 1:** Confirm accuracy of TTE measurements (See Table 3)

**Step 2:** Corroborate AVA by hybrid MDCT-Doppler imaging
Hybrid AVA <1.2 cm² (See Figure 2)

**Step 3:** Confirm AS severity

- **Low Gradient AS with Preserved LVEF**
  - Aortic Valve Calcium Score by MDCT:
    - Severe AS: AVC ≥2000 AU in men, ≥1200 AU in women (See Figure 3)

- **Low Gradient AS with Reduced LVEF**
  - Dobutamine Stress Echo:
    - Severe AS: MG ≥40 mm Hg and AVA <1.0 cm²
    - Projected AVA <1.0 cm²

Secondary Imaging Modalities: CMR

1. CMR for valve morphology if echo suboptimal.
2. CMR for grading AR, MR (if uncertain on echo), PR
3. CMR ventricular volume calculation can be misleading, Phase-contrast velocity mapping should be preferred for quantifying valvular regurgitation.
Coexistence of Aortic and Mitral Valve Disease: Key Issues for Imaging

1. The presence of hemodynamically significant AR will increase AS gradient by Echo-doppler.

2. High LV pressure due to AS will increase MR RV for a given EROA.

3. MV PHT and MVA by Continuity Equation not valid in the presence of AR.

4. LV dilatation due to AR may increase MR EROA especially in functional MR.

5. Volumetric calculations challenging

6. AR PHT not accurate in the presence of MR or other causes of impaired LV compliance.
Coexistence of Aortic and Mitral Valve Disease: Main Solutions for Imaging.

Phase-Contrast CMR for AR Severity
Vena Contracta: Flow Independent for AR Assessment
PISA Method Remains Accurate for MR Assessment
CLINICAL SCENARIOS

STEP 1: ASSESS NUMBER, TYPE, AND SEVERITY OF VALVULAR LESIONS

TWO OR MORE SEVERE LESIONS

ONE SEVERE AND AT LEAST ONE NON-SEVERE LESION

TWO OR MORE NON-SEVERE LESIONS

STEP 2: ASSESS PRESENCE OF SYMPTOMS AND CONFIRM THAT VALVULAR LESIONS ARE THE CAUSE OF SYMPTOMS

STEP 3: ASSESS REPERCUSSION OF VALVULAR LESIONS ON CARDIAC CHAMBER FUNCTION
- LV systolic dysfunction
- RV systolic dysfunction
- Pulmonary hypertension
- Atrial fibrillation

PRESENCE OF SYMPTOMS, LV/RV SYSTOLIC DYSFUNCTION, PULMONARY HYPERTENSION, AND/OR ATRIAL FIBRILLATION

STEP 4: ASSESS THE INDICATION AND SELECT THE TYPE, AND TIMING OF VALVE PROCEDURE(S)

Double valve surgery usually considered
Possible role of transcatheter procedures, combined or staged, in patients with extreme / high surgical risk

Surgical or transcatheter correction of the predominant valvular lesion according to current guidelines recommendations for single valvular lesion

AND

Case-by-case management of the non-severe lesion: concomitant correction, staged correction, or conservative

Case-by-case strategy determined by the global consequences of all lesions
Surgical or transcatheter correction of one or more lesions

Primary modality:
Doppler-echocardiography
Secondary modalities:
Dobutamine stress echo
Cardiac catheterization
CMR
MDCT

Primary modality:
Exercise testing, ECG
Secondary modalities:
Exercise stress echo
Plasma BNP

Primary modality:
Doppler-echocardiography
Secondary modalities:
Exercise/ Dobutamine stress echo
CMR
Cardiac catheterization

Heart Team
Surgical risk scores
Frailty
Likelihood and risk of re-intervention
Natural history of the unoperated valve
Clinical Case: 30 Year Old Patient with AR & MR
3-D ECHO : A1 Flail
What About the Aortic Valve?
Cardiac CT EROA Measurement in Bicuspid Aortic Valve
What to do Next?

Lack of data on combined or multiple valve disease.

This does not allow for evidence based recommendations.
If You Do CMR Do it Right

Volumetric Method!!

Phase Contrast Imaging!!
Indications for Concomitant Valve Surgery on Less-Than Severe Valve Lesions in Patients Undergoing Surgery on Another Valve.

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<td>AS</td>
<td>AVR is reasonable for patients with moderate AS who are undergoing other cardiac surgery (class IIa, LOE C)</td>
<td>Surgical AVR should be considered in patients with moderate AS undergoing surgery of the ascending aorta or another valve, after Heart Team decision (class IIa, LOE C)</td>
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<tr>
<td>AR</td>
<td>AVR is reasonable in patients with moderate AR who are undergoing other cardiac surgery (class IIa, LOE C)</td>
<td>Not mentioned</td>
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<td>MS</td>
<td>Concomitant mitral valve surgery may be considered for patients with moderate MS (MV area, 1.6–2.0 cm²) undergoing other cardiac surgery (class IIb, LOE C)</td>
<td>Not mentioned</td>
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<td>MR</td>
<td>Concomitant mitral valve repair is reasonable in patients with chronic moderate primary MR (stage B) undergoing cardiac surgery for other indications (class IIa, LOE C)</td>
<td>Primary MR: not mentioned</td>
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<td>Mitral valve repair may be considered for patients with chronic moderate secondary MR (stage B) who are undergoing other cardiac surgery (class IIb, LOE C)</td>
<td>The potential impact of mitral valve intervention (surgery and catheter intervention) on survival in patients with secondary MR needs to be evaluated</td>
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<td>Tricuspid valve repair can be beneficial for patients with mild, moderate, or greater functional TR (stage B) at the time of left-sided valve surgery with either (1) tricuspid annular dilation or (2) prior evidence of right heart failure (class IIa, LOE B)</td>
<td>Tricuspid valve surgery should be considered in patients with moderate primary TR undergoing left-sided valve surgery (class IIa, LOE C)</td>
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<td>Tricuspid valve repair may be considered for patients with moderate functional TR (stage B) and pulmonary artery hypertension at the time of left-sided valve surgery (class IIb, LOE C)</td>
<td>Tricuspid valve surgery may be considered in patients undergoing left-sided valve surgery with mild or moderate secondary TR, even in the absence of annular dilatation when previous recent right heart failure has been documented (class IIb, LOE C)</td>
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THE HEART VALVE TEAM

- Patient life expectancy
- Nature and severity of symptoms
- Which valve lesion is dominant
- Etiology and severity of each valve lesion
- LV – RV size and function
- Presence and severity of PH
- Anticipated progression of a secondary valve lesion if left untreated
- Transcatheter options
- Staged procedures versus all at once treatment
- Procedural risk
- Local expertise of the treatment team
- Patient wishes