Recommendations for Non-Invasive Evaluation of Native Valve Regurgitation

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April 21, 2017
Disclosures

• None
ASE GUIDELINES AND STANDARDS

Recommendations for Noninvasive Evaluation of Native Valvular Regurgitation
A Report from the American Society of Echocardiography Developed in Collaboration with the Society for Cardiovascular Magnetic Resonance

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Objectives

- Describe important additions in the 2017 guidelines
- Review 3D echo / CMR approaches
- Summarize approach to regurgitation assessment
  - MR / AI / TR/ PR
- Area of controversy
- Cases
Principles

• Comprehensive imaging
• Integrative interpretation
• Individualization
• Precise language

• Goal of imaging should be

  – To define etiology, mechanism, severity, and impact on cardiac remodeling
Additions in 2017
Systematic Approach / Targeted Quantification

Chronic Tricuspid Regurgitation by Doppler Echocardiography

- Does TR meet most specific criteria for mild or severe TR?
  - Yes, mild
  - Yes, severe
  - No

Specific Criteria for Mild TR
- Thin, small central color jet
- VC width < 0.3 cm
- PISA Radius < 0.4 cm at Nyquist 30-40 cm/s
- Incomplete or faint CW jet
- Systolic dominant Hepatic vein flow
- Tricuspid A-wave dominant inflow
- Normal RV/RA

Minority of criteria or Intermediate Values:
TR Probably Moderate

Perform VC measurement, and May perform quantitative PISA method, whenever possible

VC width < 0.3 cm
- EROA < 0.2 cm²
- RVol < 30 mL

Mild TR

VC width 0.3-0.69 cm
- EROA 0.2 - 0.4 cm²
- RVol = 30 - 44 mL

Moderate TR

VC width ≥ 0.7 cm
- EROA > 0.4 cm²
- RVol ≥ 45 mL

Severe TR

Specific Criteria for Severe TR
- Dilated annulus with no valve coaptation or flail leaflet
- Large central jet > 50% of RA
- VC width ≥ 0.7 cm
- PISA radius > 0.9 cm at Nyquist 30-40 cm/s
- Dense, triangular CW jet or sine wave pattern
- Systolic reversal of Hepatic vein flow
- Dilated RV with preserved function

Indeterminate TR
Consider further testing: TEE or CMR for quantification

- Poor TTE quality or low confidence in measured Doppler parameters
- Discordant quantitative and qualitative parameters and/or clinical data

Clinical experience in quantitation of TR is much less than that with mitral and aortic regurgitation
Use of 3D Approaches
The use of cardiac MRI techniques

- Direct and Indirect Techniques
The use of cardiac MRI techniques

Volume = Area x Thickness

LV EDV = 41 ml 41 ml 38 ml 34 ml 28 ml 19 ml 5 ml = 206 ml

LV ESV = 0 ml 30 ml 27 ml 24 ml 18 ml 3 ml 0 ml = 102 ml
The use of cardiac MRI techniques

Diastole

La

LV: EDV = 250 mL

LV Stroke Volume (LVSV):

LVSV = LVEDV-LVESV
LVSV = 250 mL - 100 mL
LVSV = 150 mL

Systole

Ao Stroke Volume 80 mL

Mitral Regurgitant Volume (M RVol):

M RVol = LVSV - Ao Stroke Volume
M RVol = 150 mL - 80 mL
M RVol = 70 mL
The use of cardiac MRI techniques

<table>
<thead>
<tr>
<th>Approach</th>
<th>MR</th>
<th>AR</th>
<th>TR</th>
<th>PR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preferred method for quantitation</td>
<td>(LV SV)–(AO total forward SV)</td>
<td>Direct diastolic reverse volume at AO root</td>
<td>(RV SV)–(PA total forward SV)</td>
<td>Direct diastolic reverse volume at PA</td>
</tr>
<tr>
<td>Secondary methods for quantitation</td>
<td>(LV SV)–(PA forward SV)</td>
<td></td>
<td>(RV SV)–(AO total forward SV)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(LV SV)–(RV SV)</td>
<td></td>
<td>(RV SV)–(RV SV)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Mitral inflow SV)–(AO total forward SV)</td>
<td></td>
<td>(RV SV)–(LV SV)</td>
<td></td>
</tr>
<tr>
<td>Corroborating signs of significant regurgitation</td>
<td>LV dilation, LA dilation</td>
<td>LV dilation</td>
<td>RV dilation, right atrium dilation</td>
<td>RV dilation</td>
</tr>
</tbody>
</table>
When is cardiac MRI indicated

- Echo images suboptimal
- Discrepancy between clinical TTE/TEE
- Discrepancy between quantitative techniques
- To understand mechanism / associations
- Assessment of consequences of regurgitation
  - LV/RV volumes function
  - AO/PA size
Illustrations for all quantitative techniques

<table>
<thead>
<tr>
<th>Modality</th>
<th>Optimization</th>
<th>Example</th>
<th>Advantages</th>
<th>Pitfalls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color flow Doppler 2D</td>
<td>Align direction of flow with isometric beam to avoid distortion of hemisphere from noncoaxial imaging</td>
<td>Apical four color view</td>
<td>Rapid qualitative assessment</td>
<td>Multiple jets</td>
</tr>
<tr>
<td></td>
<td>Zoomed view</td>
<td></td>
<td></td>
<td>Nonhemispheric shape</td>
</tr>
<tr>
<td></td>
<td>Change baseline of Nyquist limit in the direction of the jet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adjust lower Nyquist limit to obtain the most hemispheric flow convergence</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| VC                | Zoomed view                                                                  |                                            | Summate for regurgitant orifice size                                        | Problematic in the presence of multiple jets |
|                   | Apical four chamber view                                                     |                                            | Independent of flow rate and driving pressure for a fixed orifice          | In order to measure it, convergence zone needs to be visualized |
|                   | RV inflow view                                                               |                                            | Less-dependent on technical factors                                        |                                               |
|                   | Four chamber, RV inflow of subcostal views                                   |                                            | Good at identifying severe TR                                               |                                               |
|                   | Four chamber, RV inflow of subcostal views                                   |                                            |                                                                            |                                               |

| Jet area          | Four chamber, RV inflow of subcostal views                                   | Qualitative                               | Dependent on the driving pressure and jet direction                       |                                               |
|                   |                                                                             |                                            | Direction and shape of jet may overestimate (central entrainment) or underestimate ( eccentric, wall-imposing) jet area |                                               |

| Color flow Doppler 2D| Color flow sector should be narrow                                           | Multiple jets of differing directions may be measured | Dynamic jets may be over- or underestimated                              |                                               |
|                     | Align orthogonal cropping planes along the axis of the jet                  |                                            | Time-consuming                                                             |                                               |
|                     | Choose a midystolic cycle                                                   |                                            | Limited spatial resolution will lead to overestimation                    |                                               |
|                     | Nonobstructive jets or aliasing flow may appear “narrow” but still represent regurgitant flow |                                            |                                                                            |                                               |
Online illustrative cases

Valvular Regurgitation Cases

Now Available: Recommendations for Noninvasive Evaluation of Native Valvular Regurgitation

Instructions for viewing the cases: For best viewing results, we recommend using the Google Chrome or Mozilla Firefox browsers. Click on the link below the case to see the file in full-screen.

Case 1: Color Flow Doppler in Mitral Regurgitation

View Case 1 in full screen.

Case 2: Pulmonary Regurgitation in a Repaired Tetralogy of Fallot
Multi-valvular disease considerations

<table>
<thead>
<tr>
<th>Valve</th>
<th>AR Impact</th>
<th>AS Impact</th>
<th>MR Impact</th>
<th>TR Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS</td>
<td>Little impact, although hemodynamically significant AR may increase AS gradient. For CMR, phase-contrast plane better in LVOT.</td>
<td>For constant ROA, AR increases in proportion to square root of increase in heart rate, and jet area is exaggerated beyond this. ROA may increase if UV dilates.</td>
<td>Little impact unless PH ensures.</td>
<td>Little impact unless PH ensures.</td>
</tr>
<tr>
<td>AR</td>
<td>N/A</td>
<td>LV dilation may increase ROA (especially in secondary MR). Mixed regurgitant lesions require volumetric methods challenging, as one must find some location reflective of net forward flow (e.g., RVOT). For CMR: MVOI = LVSV - heart forward flow; MR = MVI forward flow - MVOI/RVOT (LVSV + AR Rest).</td>
<td>Little impact unless PH ensures.</td>
<td>Little impact unless PH ensures.</td>
</tr>
<tr>
<td>MS</td>
<td>Little direct impact, although the delayed LV filling might theoretically lengthen AR pressure half-time.</td>
<td>If LV is heavily dilated, may shorten and decrease jet area and appearance of jet.</td>
<td>Little direct impact.</td>
<td>Little direct impact.</td>
</tr>
<tr>
<td>MR</td>
<td>Little direct impact, but mixed regurgitant lesions require volumetric methods challenging, as one must find some location reflective of net forward flow (e.g., RVOT). Rapid ventricular filling may decrease AR pressure half-time.</td>
<td>N/A</td>
<td>Likely to increase RV pressure and therefore RV dilatation and jet area.</td>
<td>Likely to increase RV pressure and therefore RV dilatation and jet area.</td>
</tr>
<tr>
<td>PS</td>
<td>Little direct impact</td>
<td>Little direct impact</td>
<td>Little direct impact</td>
<td>Increased RVSP will women RV and jet area.</td>
</tr>
<tr>
<td>TR</td>
<td>Little direct impact</td>
<td>Little direct impact</td>
<td>N/A</td>
<td>Increased RV volume may increase ROA, which will women RV and jet area. For CMR: TrVmax = RVP - pulmonary forward flow.</td>
</tr>
<tr>
<td>TS</td>
<td>Little direct impact</td>
<td>Little direct impact</td>
<td>Little direct impact</td>
<td>RNP filling from TR may further shorten RV pressure half-time, and color RV jet more brief.</td>
</tr>
</tbody>
</table>
Assessment of Specific Valvular Regurgitation
# Mitral Regurgitation

<table>
<thead>
<tr>
<th>Table 8</th>
<th>Grading the severity of chronic MR by echocardiography</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MR severity</strong></td>
<td>Mild</td>
</tr>
<tr>
<td><strong>Structural</strong></td>
<td></td>
</tr>
<tr>
<td>MV morphology</td>
<td>None or mild leaflet abnormality (e.g., mild thickening, calcifications or prolapse, mild tenting)</td>
</tr>
<tr>
<td><strong>LV and LA size</strong></td>
<td>Usually normal</td>
</tr>
<tr>
<td>Qualitative Doppler</td>
<td></td>
</tr>
<tr>
<td>Color flow jet area</td>
<td>Small, central, narrow, often brief</td>
</tr>
<tr>
<td>Flow convergence</td>
<td>Not visible, transient or small</td>
</tr>
<tr>
<td>CWD jet</td>
<td>Faint/partial/parabolic</td>
</tr>
<tr>
<td>Semiquantitative</td>
<td></td>
</tr>
<tr>
<td>Vcw (cm)</td>
<td>&lt;0.3</td>
</tr>
<tr>
<td>Pulmonary vein flow</td>
<td>Systolic dominance (may be blunted in LV dysfunction or AF)</td>
</tr>
<tr>
<td>Mitral inflow</td>
<td>A-wave dominant</td>
</tr>
<tr>
<td>Quantitative</td>
<td></td>
</tr>
<tr>
<td>EROA, 2D PISA (cm²)</td>
<td>&lt;0.20</td>
</tr>
<tr>
<td>RVol (mL)</td>
<td>&lt;30</td>
</tr>
<tr>
<td>RF (%)</td>
<td>&lt;30</td>
</tr>
</tbody>
</table>

*The Promise of a Healthy Heart.*

[UHN Peter Munk Cardiac Centre] [TED ROGERS CENTRE FOR HEART RESEARCH]
Mitral Regurgitation

Degenerative MR

Functional MR

3D Echocardiography Techniques - VCA

VCA = 0.49 cm²

VCA = 0.69 cm²

VCA = 0.43 cm²
# Aortic Regurgitation

## Table 11: Grading the severity of chronic AR with echocardiography

<table>
<thead>
<tr>
<th>AR severity</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structural parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aortic leaflets</td>
<td>Normal or abnormal</td>
<td>Normal or abnormal</td>
<td>Abnormal/flail, or wide coaptation defect</td>
</tr>
<tr>
<td>LV size</td>
<td>Normal</td>
<td>Normal or dilated</td>
<td>Usually dilated</td>
</tr>
<tr>
<td>Qualitative Doppler</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jet width in LVOT, color flow</td>
<td>Small in central jets</td>
<td>Intermediate</td>
<td>Large in central jets; variable in eccentric jets</td>
</tr>
<tr>
<td>Flow convergence, color flow</td>
<td>None or very small</td>
<td>Intermediate</td>
<td>Large</td>
</tr>
<tr>
<td>Jet density, CW</td>
<td>Incomplete or faint</td>
<td>Dense</td>
<td>Dense</td>
</tr>
<tr>
<td>Jet deceleration rate, CW (PHT, msec)</td>
<td>Incomplete or faint Slow, &gt;500</td>
<td>Medium, 500-200</td>
<td>Steep, &lt;200</td>
</tr>
<tr>
<td>Diastolic flow reversal in descending aorta, PW</td>
<td>Brief, early diastolic reversal</td>
<td>Intermediate</td>
<td>Prominent holodiastolic reversal</td>
</tr>
<tr>
<td><strong>Semi-quantitative parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VCW (cm)</td>
<td>&lt;0.3</td>
<td>0.3-0.6</td>
<td>&gt;0.6</td>
</tr>
<tr>
<td>Jet width/LVOT width, central jets (%)</td>
<td>&lt;25</td>
<td>25-45</td>
<td>46-64</td>
</tr>
<tr>
<td>Jet CSA/LVOT CSA, central jets (%)</td>
<td>&lt;5</td>
<td>5-20</td>
<td>21-59</td>
</tr>
<tr>
<td><strong>Quantitative parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RVol (mL/beat)</td>
<td>&lt;30</td>
<td>30-44</td>
<td>45-59</td>
</tr>
<tr>
<td>RF (%)</td>
<td>&lt;30</td>
<td>30-39</td>
<td>40-49</td>
</tr>
<tr>
<td>EROA (cm²)</td>
<td>&lt;0.10</td>
<td>0.10-0.19</td>
<td>0.20-0.29</td>
</tr>
</tbody>
</table>

The Promise of a Healthy Heart.

[Logo: UHN Peter Munk Cardiac Centre TED ROGERS CENTRE FOR HEART RESEARCH]
Aortic Regurgitation

Chronic Aortic Regurgitation by Doppler Echocardiography

- Does AR meet specific criteria of mild or severe AR?
  - Yes, mild
    - Intermediate Values: AR Probably moderate
      - Perform quantitative methods whenever possible to refine assessment
  - Yes, severe
    - Specific Criteria for Severe AR
      - Perform quantitative methods whenever possible to refine assessment

Specific Criteria for Mild AR
- VC width < 0.3 cm
- Central Jet, width < 25% of LVOT
- Small or no flow convergence
- Soft or incomplete jet by CW
- PHT > 500 ms
- Normal LV size

Specific Criteria for Severe AR
- Flat Valve
- VC width > 0.6 cm
- Central Jet, width ≥ 65% of LVOT
- Large flow convergence
- PHT < 200 ms
- Prominent holodiastolic flow reversal in the descending aorta
- Enlarged LV with normal function

2-3 criteria
- RVol < 30 mL
  - RF < 36%
  - ERDA < 0.1 cm²
  - AR Grade I
- RVol 30-44 mL
  - RF 30-39%
  - ERDA 0.19-0.19 cm²
  - AR Grade II
- RVol 45-59 mL
  - RF 40-49%
  - ERDA 0.20-0.29 cm²
  - AR Grade III
- RVol ≥ 60 mL
  - RF ≥ 50%
  - ERDA ≥ 0.3 cm²
  - AR Grade IV

3 specific criteria for severe AR

Mild AR
- Poor TTE quality or low confidence in measured Doppler parameters
- Discontant quantitative and qualitative parameters and/or clinical data

Moderate AR

Severe AR
- Indeterminate AR
  - Consider further testing: TEE or CMR for quantitation

Beware of limitations of color flow assessment in eccentric AR jets; volumetric quantification and integration of other parameters is advised.
Aortic Regurgitation
Aortic Regurgitation
Aortic Regurgitation

Chronic Aortic Regurgitation by Doppler Echocardiography

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  - Enlarged LV with normal function

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  - RVol < 30 mL
  - RF < 36%
  - ERDA < 0.1 cm²
  - AR Grade I

- RVol 30-44 mL
  - RF 30-39%
  - ERDA 0.10-0.19 cm²
  - AR Grade II

- RVol 45-58 mL
  - RF 40-49%
  - ERDA 0.20-0.29 cm²
  - AR Grade III

- RVol ≥ 60 mL
  - RF ≥ 50%
  - ERDA ≥ 0.3 cm²
  - AR Grade IV

- 3 specific criteria for severe AR

- Perform quantitative methods whenever possible to refine assessment

- Mild AR

- Moderate AR

- Severe AR

- Indeterminate AR
  - Consider further testing: TEE or CMR for quantitation

- Poor TTE quality or low confidence in measured Doppler parameters
- Discrepant quantitative and qualitative parameters and/or clinical data

* Beware of limitations of color flow assessment in eccentric AR jets, volumetric quantitation and integration of other parameters is advised
Aortic Regurgitation
# Aortic Regurgitation

<table>
<thead>
<tr>
<th>Table 1</th>
<th>LV [indexed]</th>
<th>RV [indexed]</th>
</tr>
</thead>
<tbody>
<tr>
<td>End-diastolic volume</td>
<td>162mL [84 mL/m2]</td>
<td>164 [85 ml/m2]</td>
</tr>
<tr>
<td>End-systolic volume</td>
<td>51 mL [27 mL/m2]</td>
<td>82 [43 mL/m2]</td>
</tr>
<tr>
<td>Stroke volume</td>
<td>111 mL [57 mL/m2]</td>
<td>81 [42 ml/m2]</td>
</tr>
<tr>
<td>Ejection fraction</td>
<td>68%</td>
<td>50%</td>
</tr>
<tr>
<td>Mass</td>
<td>164g [85g/m2]</td>
<td></td>
</tr>
</tbody>
</table>
Aortic Regurgitation

Moderate AI
Dilated Aortic Root, No Coarctation

Rvol 34ml
RF 38%
# Tricuspid Regurgitation

Table 14: Grading the severity of chronic TR by echocardiography

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structural</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TV morphology</td>
<td>Normal or mildly abnormal leaflets</td>
<td>Moderately abnormal leaflets</td>
<td>Severe valve lesions (e.g., flail leaflet, severe retraction, large perforation)</td>
</tr>
<tr>
<td>RV and RA size</td>
<td>Usually normal</td>
<td>Normal or mild dilatation</td>
<td>Usually dilated</td>
</tr>
<tr>
<td>Inferior vena cava diameter</td>
<td>Normal &lt; 2 cm</td>
<td>Normal or mildly dilated 2.1 - 2.5 cm</td>
<td>Dilated &gt; 2.5 cm</td>
</tr>
<tr>
<td><strong>Qualitative Doppler</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color flow jet area</td>
<td>Small, narrow, central</td>
<td>Moderate central</td>
<td>Large central jet or eccentric wall-impinging jet of variable size</td>
</tr>
<tr>
<td>Flow convergence zone</td>
<td>Not visible, transient or small</td>
<td>Intermediate in size and duration</td>
<td>Large throughout systole</td>
</tr>
<tr>
<td>CWD jet</td>
<td>Faint/partial/parabolic</td>
<td>Dense, parabolic or triangular</td>
<td>Dense, often triangular</td>
</tr>
<tr>
<td><strong>Semiquantitative</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color flow jet area (cm²)</td>
<td>Not defined</td>
<td>Not defined</td>
<td>&gt;10</td>
</tr>
<tr>
<td>VCW (cm)</td>
<td>&lt;0.3</td>
<td>0.3-0.69</td>
<td>≥0.7</td>
</tr>
<tr>
<td>PISA radius (cm)</td>
<td>≤0.5</td>
<td>0.6-0.9</td>
<td>&gt;0.9</td>
</tr>
<tr>
<td>Hepatic vein flow</td>
<td>Systolic dominance</td>
<td>Systolic blunting</td>
<td>Systolic flow reversal</td>
</tr>
<tr>
<td>Tricuspid inflow</td>
<td>A-wave dominant</td>
<td>Variable</td>
<td>E-wave &gt;1.0 m/sec</td>
</tr>
<tr>
<td><strong>Quantitative</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EROA (cm²)</td>
<td>&lt;0.20</td>
<td>0.20-0.39</td>
<td>≥0.40</td>
</tr>
<tr>
<td>RVol (2D PISA) (mL)</td>
<td>&lt;30</td>
<td>30-44</td>
<td>≥45</td>
</tr>
</tbody>
</table>

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Tricuspid Regurgitation

Chronic Tricuspid Regurgitation by Doppler Echocardiography

Does TR meet most specific criteria for mild or severe TR?

Yes, mild

Specific Criteria for Mild TR
- Thin, small central color jet
- VC width < 0.3 cm
- PISA Radius < 0.4 cm at Nyquist 30-40 cm/s
- Incomplete or faint CW jet
- Systolic dominant Hepatic vein flow
- Tricuspid A-wave dominant inflow
- Normal RV/RA

Minority of criteria or Intermediate Values:
TR Probably Moderate

Perform VC measurement, and May perform quantitative PISA method, whenever possible

VC width < 0.3 cm
- EROA < 0.2 cm²
- RVol < 30 mL

Mild TR

VC width 0.3-0.69 cm
- EROA 0.2 - 0.4 cm²
- RVol = 30 - 44 mL

Moderate TR

VC width ≥ 0.7 cm
- EROA > 0.4 cm²
- RVol ≥ 45 mL

Severe TR

Yes, severe

Specific Criteria for Severe TR
- Dilated annulus with no valve coaptation or flail leaflet
- Large central jet > 50% of RA
- VC width ≥ 0.7 cm
- PISA radius > 0.9 cm at Nyquist 30-40 cm/s
- Dense, triangular CW jet or sine wave pattern.
- Systolic reversal of Hepatic vein flow
- Dilated RV with preserved function

Indeterminate TR

Consider further testing:
TEE or CMR for quantification

- Poor TTE quality or low confidence in measured Doppler parameters
- Discordant quantitative and qualitative parameters and/or clinical data
- Clinical experience in quantitation of TR is much less than that with mitral and aortic regurgitation
# Pulmonic Regurgitation

## Table 16: Echocardiographic and Doppler parameters useful in grading PR severity

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonic valve</td>
<td>Normal</td>
<td>Normal or abnormal</td>
<td>Abnormal and may not be visible</td>
</tr>
<tr>
<td>RV size</td>
<td>Normal*</td>
<td>Normal or dilated</td>
<td>Dilated†</td>
</tr>
<tr>
<td>Jet size, color Doppler $\dagger$</td>
<td>Thin (usually $&lt;10$ mm in length) with a narrow origin</td>
<td>Intermediate</td>
<td>Broad origin; variable depth of penetration</td>
</tr>
<tr>
<td>Ratio of PR jet width/pulmonary annulus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jet density and contour (CW)</td>
<td>Soft</td>
<td>Dense</td>
<td>Dense; early termination of diastolic flow</td>
</tr>
<tr>
<td>Deceleration time of the PR spectral Doppler signal</td>
<td></td>
<td></td>
<td>Short, $&lt;260$ msec</td>
</tr>
<tr>
<td>Pressure half-time of PR jet</td>
<td></td>
<td></td>
<td>$&lt;100$ msec</td>
</tr>
<tr>
<td>PR index $\ddagger$</td>
<td>$&lt;0.77$</td>
<td>$&lt;0.77$</td>
<td>$&lt;0.77$</td>
</tr>
<tr>
<td>Diastolic flow reversal in the main or branch PAs (PW)</td>
<td>Prominent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulmonic systolic flow (VTI) compared to systemic flow (LVOT VTI) by PW $\S$</td>
<td>Slightly increased</td>
<td>Intermediate</td>
<td>Greatly increased</td>
</tr>
<tr>
<td>RF $\S$</td>
<td>$&lt;20%$</td>
<td>20$%$–40$%$</td>
<td>$&gt;40%$</td>
</tr>
</tbody>
</table>
Pulmonic Regurgitation

Chronic Pulmonic Regurgitation by Color Doppler

Does PR meet most specific criteria for mild or severe PR?

Yes, mild

Specific Criteria for mild PR
- Small Jet, with narrow width
- Soft or faint CW jet
- Slow deceleration time
- Normal RV Size

Minority of criteria or Intermediate Values:
PR Probably Moderate

May Perform volumetric quantitative methods, if possible, whenever significant PR is suspected

RF <20%
Mild PR

RF 20-40%
Moderate PR

RF >40%
Severe PR

Yes, severe

Specific Criteria for Severe PR
- Jet width/Annulus ≥ 70%
- Dense jet, PHT < 100 ms
- Early termination of PR flow
- Diastolic flow reversal in PA branches
- Dilated RV with NL function

Indeterminate PR
Consider CMR for quantitation

Poor TTE quality or discordant parameters with clinical data, particularly when significant PR may be suspected

* Clinical experience in quantitation of PR is sparse.
Pulmonic Regurgitation
Pulmonic Regurgitation

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Pulmonic Regurgitation

RVOT SV 125ml

LVOT SV 57ml

RVOL of 68ml, RF 54%
Area of controversy

• Primary vs secondary MR, therapeutic approaches vary

• Ischemic MR EROA by 2D $\geq 0.2\text{cm}^2$ Rvol of $\geq 30\text{ml}$ in -
  poor prognosis
  – Any degree of secondary MR is associated with poor
    prognosis
  – Prognostic value of this cut off due to MR or underlying
    cardiac disease
  – No evidence that surgical correction of secondary MR
    improves outcomes (unnecessary interventions)
  – Clear separation of primary vs secondary not always easy
  – Should all parameters be based on prognosis – LVEF?
Summary

• Quantitative parameters unchanged, some additions
• Guided approach
• Focus on targeted quantification
• Use of 3D VCA
• Complimentary role of cardiac MRI
• Algorithms based on expert consensus / validation
Thank you