Εκτίμηση αορτικής ανεπάρκειας

Δημήτρης Πατσούρας
Επιμελητής Α
ΓΝ Ιωαννίνων «Γ. Χατζηκώστα»
Υπερηχοκαρδιογράφημα

- Διάγνωση
- Αιτιολογία
- Βαρύτητα
- Επέμβαση
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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<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Specific etiology</th>
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<tbody>
<tr>
<td>Congenital/leaflet abnormalities</td>
<td>Bicuspid, unicuspid, or quadricuspid aortic valve</td>
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<tr>
<td></td>
<td>Ventricular septal defect</td>
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<tr>
<td>Acquired leaflet abnormalities</td>
<td>Senile calcification</td>
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<td></td>
<td>Infective endocarditis</td>
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<td>Rheumatic disease</td>
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<td>Radiation-induced valvulopathy</td>
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<tr>
<td></td>
<td>Toxin-induced valvulopathy: anorectic drugs, 5-hydroxytryptamine (carcinoid)</td>
</tr>
<tr>
<td>Congenital/genetic aortic root abnormalities</td>
<td>Annuloaortic ectasia</td>
</tr>
<tr>
<td></td>
<td>Connective tissue disease: Loeys Deitz, Ehlers-Danlos, Marfan syndrome, osteogenesis imperfecta</td>
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<tr>
<td>Acquired aortic root abnormalities</td>
<td>Idiopathic aortic root dilatation</td>
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<tr>
<td></td>
<td>Systemic hypertension</td>
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<td></td>
<td>Autoimmune disease: systemic lupus erythematos, ankylosing spondylitis, Reiter’s syndrome</td>
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<tr>
<td></td>
<td>Aortitis: syphilitic, Takayasu’s arteritis</td>
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<td></td>
<td>Aortic dissection</td>
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<td></td>
<td>Trauma</td>
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</tbody>
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### Aortic Regurgitation

<table>
<thead>
<tr>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
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</thead>
<tbody>
<tr>
<td>Normal Cusp Motion with Aortic Dilation or Cusp Perforation</td>
<td>Cusp Prolapse</td>
<td>Cusp Restriction</td>
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<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
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<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
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<tr>
<td>Increases jet area</td>
<td>Reduces jet area</td>
<td></td>
<td></td>
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<tr>
<td>-------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td></td>
<td></td>
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<tr>
<td>Higher momentum</td>
<td>Lower momentum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Larger regurgitant orifice area</td>
<td>Smaller regurgitant orifice area</td>
<td></td>
<td></td>
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<tr>
<td>Higher velocity (greater pressure gradient)</td>
<td>Lower velocity (lower pressure gradient)</td>
<td></td>
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<tr>
<td>Higher entrainment of flow</td>
<td>Chamber constraint/wall-impinging jet</td>
<td></td>
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<tr>
<td>Lower Nyquist limit</td>
<td>Higher Nyquist limit</td>
<td></td>
<td></td>
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<tr>
<td>Higher Doppler gain</td>
<td>Lower Doppler gain</td>
<td></td>
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<tr>
<td>Far-field beam widening</td>
<td>Far-field attenuation/attenuation by an interposed ultrasound-reflecting structure</td>
<td></td>
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<tr>
<td>Slit-like regurgitant orifice, imaged along the thin, long shape of the orifice</td>
<td></td>
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<tr>
<td>Multiple orifices</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modality</td>
<td>Optimization</td>
<td>Example</td>
<td>Advantages</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------------------------------------------------------------------</td>
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<td>-------------------------------------------------</td>
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<tr>
<td>Color flow Doppler 2D</td>
<td></td>
<td></td>
<td>Simple sensitive screen for AR</td>
</tr>
<tr>
<td>Jet width/LVOT diameter</td>
<td>• Long-axis view • Zoomed view • Imaging plane for optimal VC measurement</td>
<td></td>
<td>Rapid qualitative assessment</td>
</tr>
<tr>
<td></td>
<td>may be different from PISA • Measure in LVOT within 1 cm of the VC</td>
<td></td>
<td>below the orifice</td>
</tr>
<tr>
<td>Jet area/LVOT area</td>
<td>• Short-axis view • Zoom view • Measure within 1 cm of the VC</td>
<td></td>
<td>Estimate of regurgitant orifice area</td>
</tr>
</tbody>
</table>
- Parasternal long-axis view
- Zoomed view
- Imaging plane for optimal VC measurement may be different from that for PISA
- Narrowest area of jet at or just apical to the valve

- Surrogate for regurgitant orifice size
- May be used in eccentric jets
- Independent of flow rate and driving pressure
- Less dependent on technical factors
- Good at identifying mild or severe AR
- Problematic in the presence of multiple jets or bicuspid valves
- Convergence zone needs to be visualized
- The direction of the jet (in relation to the insonation beam) will influence the appearance of the jet
Color flow Doppler 3D: 3D VC

- Color flow sector should be narrow
- Align orthogonal cropping planes along the axis of the jet
- Choose a middiastolic cycle
- Noncoaxial jets or aliased flow may appear “laminar” but still represent regurgitant flow

- Multiple jets of differing directions may be measured
- Dynamic jets may be over- or underestimated
CWD

Density of regurgitant jet
- Align insonation beam with the flow
- Adjust overall gain

Simple
- Density is proportional to the number of red blood cells reflecting the signal
- Faint or incomplete jet is compatible with mild or trace AR

Qualitative
- Perfectly central jets may appear denser than eccentric jets of higher severity
- Overlap between moderate and severe AR
Jet deceleration rate (pressure half-time)

- Align insonation beam with the flow
- Usually best from apical windows
- In eccentric jets, may be best from parasternal window, helped by color Doppler

- Simple
- Specific sign of pressure relation between aorta and LV
- If long, excludes severe AR

- Qualitative
- Poor alignment of Doppler beam may result in lower pressure half-time
- Affected by changes that modify LV-aorta pressure gradient (if short, implies significant AR or high LV filling pressure)
Pulsed wave Doppler:
Flow reversal in proximal descending aorta

- Align insonation beam with the flow in the proximal descending or abdominal aorta

- Simple supportive sign of severe AR
- More specific sign if seen in abdominal aorta
- Can be obtained with both TTE and TEE

- Depends on compliance of the aorta; less reliable in older patients
- Brief velocity reversal is normal
- Can be present in arteriovenous fistula in upper extremity, ruptured sinus of Valsalva
- May not be holodiastolic in acute AR
Proximal flow convergence
- Align direction of flow with insonation beam to avoid distortion of hemisphere from noncoaxial imaging
- Zoomed view
- Change baseline of Nyquist limit in the direction of the jet
- Adjust lower Nyquist limit to obtain the most hemispheric flow convergence

Apical view

Parasternal view

Rapid qualitative assessment
- Multiple jets
- Constrained jet (aortic wall)
- Nonhemispheric shape
- Timing in early diastole

Quantitative Doppler: EROA, regurgitation volume and fraction
- Align insonation beam with the flow
- Lower the color Doppler baseline in the direction of the jet
- Look for the hemispheric shape to guide the best lower Nyquist limit
- CWD of regurgitant jet for peak velocity and VTI

Rapid quantitative assessment of lesion severity (EROA) and volume overload (RVol)

Feasibility is limited by aortic valve calcifications
- Not valid for multiple jets, less accurate in eccentric jets
- Limited experience
- Small errors in radius measurement can lead to substantial errors in EROA due to squaring of error.
**SV method**

- LVOT diameter measured at the annulus in systole and pulsed Doppler from apical views at same site
- Mitral annulus measured at middiastole; pulsed Doppler at the annulus level in diastole
- Total LV SV can also be measured by the difference between LV end-diastolic volume and end-systolic volume.
- LV volumes are best measured by 3D. Contrast may be needed to better trace endocardial borders. If 3D not feasible, use 2D method of disks.

**RVol** = \(S_{LVOT} - S_{MV}\)

**LVOT = 2.5 cm**

- Quantitative, valid with multiple jets and eccentric jets. Provides both lesion severity (EROA, RF) and volume overload (RVol)
- Verify results using LV end-diastolic volume and LV end-systolic volume

**VTI = 29 cm**

- Difficulties measuring mitral annulus diameter, particularly with annular calcification
- Not valid for combined MR and AR, unless pulmonic site is used
Automatic quantification of aortic regurgitation using 3D full volume color doppler echocardiography: a validation study with cardiac magnetic resonance imaging

Jae-Huk Choi¹ · Geu-Ru Hong² · Minji Kim³ · In Jeong Cho² · Chi Young Shim² · Hyuk-Jae Chang³ · Joel Mancina⁴ · Jong-Won Ha² · Namsik Chung²
<table>
<thead>
<tr>
<th>Structural parameters</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<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>Semiquantitative parameters§</td>
<td>VCW (cm)</td>
<td>0.3-0.6</td>
<td>&gt;0.6</td>
</tr>
<tr>
<td></td>
<td>Jet width/LVOT width, central jets (%)</td>
<td>25-45</td>
<td>46-64</td>
</tr>
<tr>
<td></td>
<td>Jet CSA/LVOT CSA, central jets (%)</td>
<td>5-20</td>
<td>21-59</td>
</tr>
<tr>
<td>Quantitative parameters§</td>
<td>RVol (mL/beat)</td>
<td>30-44</td>
<td>45-59</td>
</tr>
<tr>
<td></td>
<td>RF (%)</td>
<td>30-39</td>
<td>40-49</td>
</tr>
<tr>
<td></td>
<td>EROA (cm²)</td>
<td>0.10-0.19</td>
<td>0.20-0.29</td>
</tr>
</tbody>
</table>
Chronic Aortic Regurgitation by Doppler Echocardiography

Does AR meet specific criteria of mild or severe AR?

Yes, mild

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

≥ 4 criteria
Definitely mild
(quantitation not needed)

Intermediate Values: AR Probably moderate

RVol < 30 mL
RF < 30%
ERoa <0.1 cm²
AR Grade I

2-3 criteria
Perform quantitative methods whenever possible to refine assessment

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

RVol 45-59 mL
RF 40-49%
ERoa 0.20-0.29 cm²
AR Grade III

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

≥ 4 criteria
Definitely severe
(may still quantitate)

Mild AR

Moderate AR

Severe AR

Indeterminate AR
Consider further testing: TEE or CMR for quantitation

Yes, severe

Specific Criteria for Severe AR
- Flail 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

3 specific criteria for severe AR
CMR

A

B

C

D

Flow vs Time

Legend:
- Data
- Spline (+/- 1)

Forward: 138 mL
Reverse: 70 mL
RF: 51%
CMR

1. Κακό παράθυρο

2. Διχογνωμία μεταξύ 2D/Doppler

3. Διχογνωμία κλινική/echo

4. Αδυναμία μέτρησης διαστάσεων/συστολικής λειτουργικότητας

5. Διαστάσεις ανιούσας αορτής
Figure 2. Indications for AVR for Chronic AR
Exercise echocardiography predicts development of left ventricular dysfunction in medically and surgically treated patients with asymptomatic severe aortic regurgitation

S Wahi, B Haluska, A Pasquet, C Case, C M Rimmerman, T H Marwick
How to Use Imaging

Stress Echocardiography in Regurgitant Valve Disease

Patrizio Lancellotti, MD, PhD; Julien Magne, PhD

Circ Cardiovasc Imaging 2013
The Clinical Use of Stress Echocardiography in Non-Ischaemic Heart Disease: Recommendations from the European Association of Cardiovascular Imaging and the American Society of Echocardiography

VHD (MR, MS, AS, AR) severity not matching with symptoms

- Δ 18-20 mmHg MPG in AS
- MPG ≥15-18 mmHg in MS
- Δ > 10-13 mm² EROA in MR

Symptoms, Δ blood pressure, exercise tolerance

Valve

- Δ < 4-5% LVEF (lack of CR)
- Δ < 2% GLS (lack of CR)
- Δ SV < 20% (lack of FR)
- Δ WMSI (Ischemia)
- LV dyssynchrony
- RV dysfunction (TAPSE < 19 mm)

Match symptoms with the cardiac involvement

Risk stratification

Guide decision making and help define the optimal timing for surgery

Asymptomatic moderate-severe VHD (MR, MS, AS, AR)

Hemodynamics

- Δ E/e' (LV filling pressure)
- PH (SPAP ≥60 mmHg)

Key Points

In AR, SE is used to assess symptoms, exercise tolerance, and the LV response to stress but not the valve disease severity. A lack of contractile reserve is associated with post-operative LV dysfunction.
Εκτίμηση ανεπάρκειας αορτής

- Επίπονη
- Χρονοβόρα
- Σημασία στη λεπτομέρεια
- Εναλλακτικές τεχνικές
- Γνώσεις καρδιολογίας