‘Assessment of Valves’

The 2nd Cambridge Advanced Emergency Ultrasound Course

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Assessment of Valves

Aortic valve
- Aortic stenosis
- Aortic regurgitation

Mitr al valve
- Mitr al stenosis
- Mitr al regurgitation

Tricuspid valve
- Tricuspid regurgitation

Pulmonary valve
Assessment of Valves

- Appearance
- Mobility
- Assessment of LV and/or RV
- Colour map
- Spectral Doppler Measurements
Aortic Valve
**Aortic Valve**

- **Composed of 3 cusps of equal size**

- **When viewed from a conventional TTE short-axis projection**, the closure lines of the 3 cusps forms a ‘Y’ shape.

- **Behind each cusp there is a sinus of valsalva.**

- **The left and right coronary arteries arise from the left and right sinuses respectively, and are associated with the left and right cusps.**

- **Normal aortic valve area: 2.5 - 3.5 cm²**
Aortic Stenosis

- **Normal area of the aortic valve is > 2cm²**

- **Significant narrowing restricts LV outflow imposing a pressure load on the LV**

- **Leads to Hypertrophy of the LV**

- **Symptoms:** Exertional angina
  - Dyspnoea
  - Exertional syncope
Aortic Stenosis

AS may occur at 3 Levels - Valvular

Subvalvular
Supravalvular

Valvular AS

Rheumatic Heart Disease: Usually associated with mitral valve disease

Calcific (degenerative) AS

Congenital Bicuspid Valve (1-2% of the population)
Aortic Stenosis

Appearance

- Degree and distribution of thickening
- How many cusps
- Is the closure line central or eccentric (Bicuspid)
Aortic Valve
Aortic Stenosis

Mobility

- Is it normal or reduced?
- Is there systolic bowing? (Bicuspid, Rheumatic)
- Is there diastolic prolapse? (Floppy valve, Tear, Bicuspid)
AORTIC VALVE
AORTIC VALVE
Aortic Stenosis
Aortic Stenosis

Severe Aortic Stenosis
Aortic Stenosis

Mild Aortic Stenosis
Severe Aortic Stenosis
Assessment of the LV in Aortic Stenosis

- **Look for hypertrophy of the LV which suggests (but **Does not** Prove) **severe stenosis** (IVS / Posterior wall > 11mm in Diastole)

- **If the LV function is impaired, the transaortic pressure difference may underestimate the severity of the stenosis**
Aortic Stenosis

Aortic Stenosis with Severe LV Dysfunction
Aortic Stenosis

Quantification of AS severity using Continuous wave Spectral Doppler

- Measure Maximum aortic jet velocity
- Calculate maximum and mean transaortic pressure gradients
- Calculate the effective orifice area
**Trans-Aortic Jet Velocity**

- **Measure the continuous waveform of the aortic jet from the apex**

- **Normal trans-aortic jet velocity is 1.0 - 1.7 m/s**

- **Aortic \( V_{\text{max}} \):**
  - **Mild Stenosis:** 2.0 - 3.0 m/s
  - **Moderate Stenosis:** 3.0 - 4.5 m/s
  - **Severe Stenosis:** > 4.5 m/s
Trans-Aortic Jet Velocity

4.3 m/s
Peak & Mean Aortic Valve Pressure Gradients

The peak & mean pressure gradients across the aortic valve can be calculated from the maximal aortic jet velocity using the Bernoulli Equation

$$\Delta P \text{ (in mm Hg)} = 4v^2$$
Peak & Mean Aortic Valve Pressure Gradients

**NB:**

- If there is co-existent LV systolic dysfunction there may be a decreased trans-aortic pressure gradient and so the severity of the Aortic Stenosis will be **underestimated**

- If there is coexistent aortic regurgitation there will be increased trans-aortic volume flow which will increase the trans-aortic pressure gradient and therefore moderate to severe AR may **overestimate** the severity of the Aortic Stenosis
# Severity in Aortic Stenosis

<table>
<thead>
<tr>
<th></th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
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<tbody>
<tr>
<td><strong>Aortic $V_{max}$ (m/s)</strong></td>
<td>2.0 - 3.0</td>
<td>3.0 - 4.5</td>
<td>&gt;4.5</td>
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<tr>
<td><strong>Peak Gradient (mmHg)</strong></td>
<td>&lt; 40</td>
<td>40 - 80</td>
<td>&gt; 80</td>
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<tr>
<td><strong>Mean Gradient (mmHg)</strong></td>
<td>&lt; 20</td>
<td>20 - 50</td>
<td>&gt; 50</td>
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<tr>
<td><strong>EOA (continuity eqn) ($cm^2$)</strong></td>
<td>&gt;1.0</td>
<td>0.6 - 1.0</td>
<td>&lt; 0.6</td>
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Aortic Stenosis: Summary

- Valve anatomy: Aetiology of stenosis

- Exclude other causes of left ventricular outflow obstruction

- Stenosis severity: Jet velocity
  - Maximum & Mean Pressure Gradient
  - Effective valve area

- Degree of co-existent aortic regurgitation

- Left ventricular hypertrophy & systolic function
Mitral Valve
Mitral Valve

Anatomy

- Mitral valve apparatus includes the mitral annulus, the leaflets, chordae tendineae, papillary muscles, and the underlying ventricular wall.

- There are 2 mitral valve leaflets; anterior and posterior, the anterior being the larger.

- Each leaflet is divided into 3 scallops.

- Chordae attached throughout the entire length of the coaptation line and insert into the tips of the papillary apparatus.
Mitral Valve

- **2 major papillary muscles**

- **Anterolateral Papillary Muscle:**
  - Chordae to anterolateral half of both mitral valves
  - Dual blood supply

- **Posteromedial Papillary Muscle:**
  - Chordae to posteromedial half of both mitral valves
  - Perfused by RCA

- **Zona Coapta:** Coaptation of the mitral valve is complex and involves overlap of the mitral valve tissue

- **Normal Mitral Valve area:** 4-6cm²
Parasternal Long-Axis
Parasternal Short-Axis
Apical 4-Chamber
Mitral Regurgitation

Aetiology

- Ischaemic:
  - Restricted posterior leaflet prolapse
  - Papillary muscle rupture or dysfunction

- Functional

- Floppy Mitral Valve

- Rheumatic

- Endocarditis

- Other ie SLE
Mitral Regurgitation

Features of MR

- Acute vs Chronic
- LV volume overload with dilatation
- LA dilatation
Assessment of Mitral Regurgitation

- Appearance & Movement of the Valve Leaflets
- Colour Flow Mapping
- Continuous Wave Doppler
- Left Ventricular Function
- Pulmonary Artery Pressure
Appearance & Movement

- What is the distribution and degree of any leaflet thickening?

- Is there a discrete echogenic mass (e.g. vegetation)?

- Does the valve open normally during diastole or is there bowing to suggest of the leaflets to suggest rheumatic disease?

- Is there evidence of leaflet prolapse?

- Is there restriction of the posterior leaflet during systole?
RESTRICTED POSTERIOR MITRAL VALVE LEAFLET
Posteriorly directed MR jet due to restriction of the posterior mitral valve leaflet
MR IN A PATIENT WITH DILATED CARDIOMYOPATHY AND APICAL DISPLACEMENT OF THE PAPILLARY MUSCLES LEADING TO FUNCTIONAL MITRAL REGURGITATION
SEVERE FUNCTIONAL MR ASSOCIATED WITH APICAL DISPLACEMENT OF THE PAPILLARY MUSCLES
Colour Flow Mapping

Colour Doppler imaging is the primary echocardiographic tool for the detection and quantitation of Mitral regurgitation.

Assess the width of the base of the jet at the level of the valve.

Assess the jet area.
Mitral Regurgitation

Mild mitral regurgitation

Severe mitral regurgitation

reproduced from: Echocardiography a practical guide for reporting
Continuous Wave Doppler

- Assess the density of the Continuous Wave Doppler signal
- The intensity of the jet is greater with more severe mitral regurgitation
Mild Regurgitation

Moderate Regurgitation

Severe Regurgitation
By definition, haemodynamically significant mitral regurgitation results in volume overload of the left ventricle with subsequent LV & LA dilatation.

The increased LA pressure will lead to pulmonary congestion.
## Mitral Regurgitation

### Indicators of degree of mitral regurgitation

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<th><strong>Mild</strong></th>
<th><strong>Severe</strong></th>
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<tr>
<td>Jet width at base (cm)</td>
<td>&lt;0.5</td>
<td>&gt;1</td>
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<tr>
<td>Jet area (cm²)</td>
<td>&lt;4.0</td>
<td>&gt;8.0</td>
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<td>Density on CW Doppler</td>
<td>+</td>
<td>++</td>
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Mitral Regurgitation: Summary

- Valve anatomy and movement: Aetiology of regurgitation
- Assess severity using colour flow mapping & continuous wave Doppler
- Assess for LV dilatation and systolic dysfunction
- Assess for other valve disease
Questions?