Echocardiographic Assessment of Aortic Valve Stenosis

ASE American Society of Echocardiography

Technical Factors

LVOT Diameter

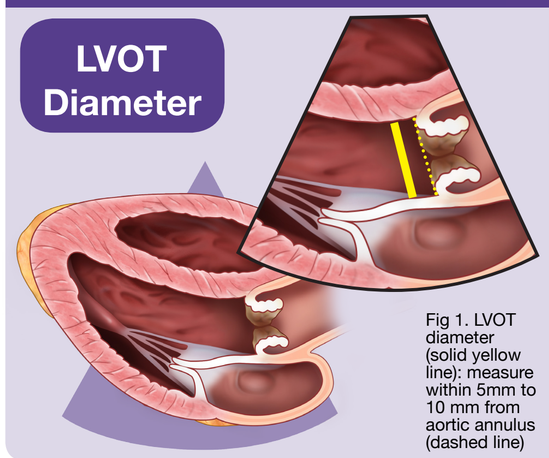


Fig 1. LVOT diameter (solid yellow line): measure within 5mm to 10 mm from aortic annulus (dashed line)

Recording	Measurement
• 2D parasternal long-axis view • Zoom mode	• Inner edge to inner edge • Mid-systole • Parallel and adjacent to the aortic valve or at the site of velocity measurement

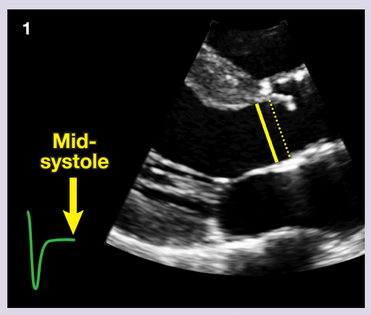
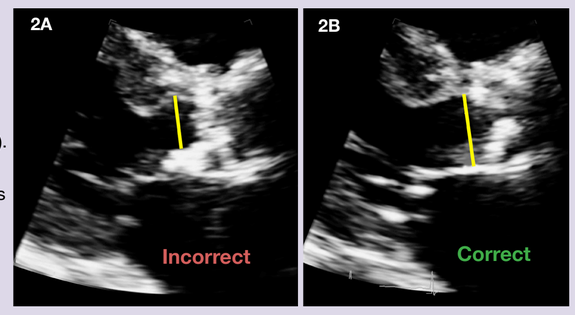
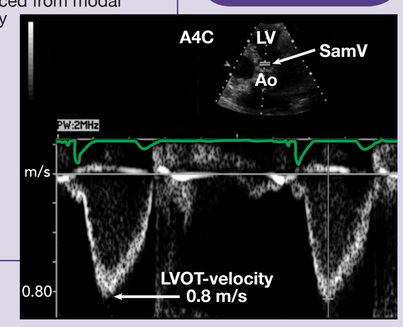


Fig 2A and B. Calcification protruding into the LVOT might yield an incorrectly small LVOT diameter (Fig 2A). Measurements should avoid these protrusions (Fig. 2B).



LVOT Doppler

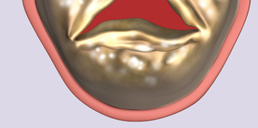
Recording	Measurement
• Pulsed-wave Doppler • Apical long-axis or five-chamber view • Sample volume positioned into the LVOT from aortic annulus level to obtain laminar flow curve • Velocity baseline and scale adjusted to maximize size of velocity curve • Time axis (sweep speed) 50-100 mm/s • Smooth velocity curve with a well-defined peak and a narrow velocity range at peak velocity	• Maximum velocity from peak of dense velocity curve • VTI traced from modal velocity



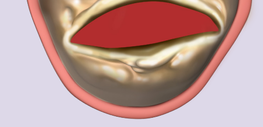
Valve Anatomy

Recording	Measurement
• Parasternal long- and short-axis views • Zoom mode	• Identify number of cusps in systole, raphe if present • Assess cusp mobility and commissural fusion • Assess valve calcification

Tricuspid stenotic aortic valve



Bicuspid stenotic aortic valve

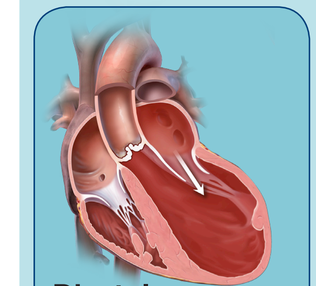


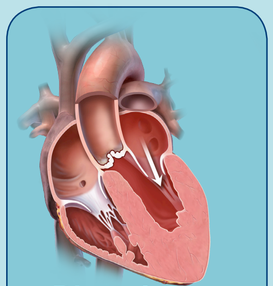
Algorithm on Approach to Grading AS Severity

Valve Morphology by Echocardiography Suspicious of Aortic Stenosis

1 Assess Velocity/Gradient

- **LOW GRADIENT AS** Vmax < 4m/s ΔPm < 40 mmHg
  - **2 Assess AVA**
    - AVA < 1.0 cm^2
    - AVA ≥ 1.0 cm^2 = moderate AS
  - **3 Exclude Measurement Errors**
  - **4 Define Flow Status**
    - Low flow (SVi < 35 ml/m^2)
      - **LFLG-AS** AVA < 1.0 cm^2; peak velocity < 4 m/s mean AV gradient < 40 mmHg SVi < 35 ml/m^2
        - LVEF abnormal < 50%
        - LVEF preserved ≥ 50%
      - **5 Assess LVEF**
        - LVEF abnormal < 50%
        - LVEF preserved ≥ 50%
          - **6 Dobutamine Echo**
            - Flow reserve
              - Pseudo-severe AS
              - True severe AS
            - No flow reserve
              - **7 Consider Calcium Score by CT**
    - Normal flow (SVi ≥ 35 ml/m^2) -> severe AS unlikely
- **HIGH GRADIENT AS** Vmax ≥ 4m/s ΔPm ≥ 40 mmHg
  - **High Flow Status Excluded**
    - No
      - Not reversible -> severe AS
      - Reversible -> re-assess at restored normal flow
    - Yes
      - Severe high gradient AS





Low Dose Dobutamine Protocol

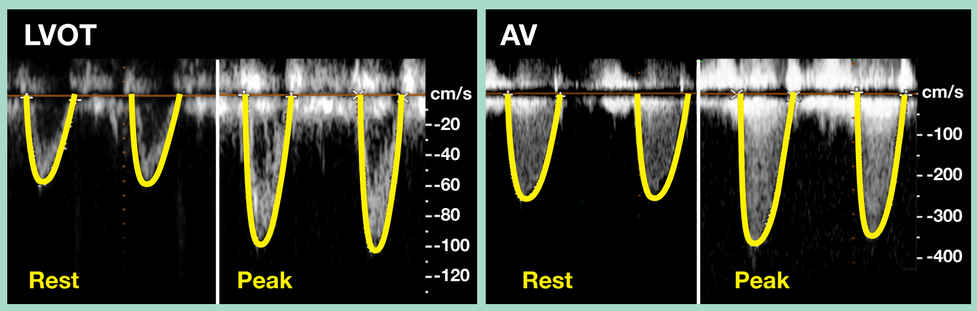
Starting dose of **2.5 or 5** mcg/kg/min

Increase dose **2.5 or 5** mcg/kg/min every 3-5 minutes

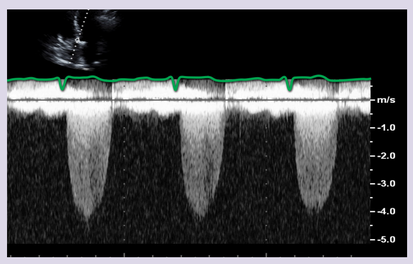
Maximum dobutamine dose of **20** mcg/kg/min

Results:
- Increase in AVA > 1.0 cm^2 (suggests not severe)
- Severe AS if AS jet velocity ≥ 4 m/s or mean > 30-40 mmHg (provided AVA does not exceed 1.0 cm^2 at any flow rate)
- Failure to increase SV by > 20% suggest absence of contractile flow reserve

Recording	Measurement
• The LVOT diameter at baseline (zoom mode) • LVOT and AS jet velocity at each stage • 2D LV images from apical 4C and 2C	• Measurement of the LVOT diameter and VTI at each stage • AS velocity, mean and peak AS gradient at each stage • Calculated SVi and AVA at each stage • LVEF (biplane) at each stage



AS Jet Velocity



Recording	Measurement
• CW Doppler (dedicated transducer) • Multiple acoustic windows (e.g. apical, suprasternal, right parasternal) • Decrease gain, increase wall filter, adjust baseline, curve and scale to optimize signal • Expanded time scale and velocity range and baseline adjusted so velocity signal fits but fills the vertical scale	• Maximum velocity at peak of dense velocity curve. • VTI traced from outer edge of dense signal • Report window where maximum velocity obtained

Table 1: Recommedations for grading of AS severity

	Mild	Moderate	Severe
Peak velocity (m/s)	2.6 - 2.9	3.0 - 4.0	≥ 4.0
Mean gradient (mmHg)	< 20	20 - 40	≥ 40
AVA (cm^2)	> 1.5	1.0 - 1.5	< 1.0
Indexed AVA (cm^2/m^2)	> 0.85	0.60 - 0.85	< 0.6
Velocity ratio	> 0.50	0.25 - 0.50	< 0.25

Table 2: Measures of AS severity obtained by Doppler-echocardiography

	Formula/method	Advantages	Limitations
AS jet velocity m/s	Direct measurement	Direct	Correct measurement requires parallel alignment of ultrasound beam, Flow dependent
Mean gradient mmHg	$\Delta P = \frac{\sum 4v^2}{N}$	Units comparable to invasive measurements	Accurate pressure gradients depend on accurate velocity data, Flow dependent
Continuity equation valve area cm^2	$AVA = \frac{CSA_{LVOT} \times VTI_{LVOT}}{VTI_{AV}}$	Measures effective orifice area; Relatively flow independent	Measurement error more likely

Table 3: Criteria that increase the likelihood of severe AS with AVA < 1.0 cm^2 and mean gradient <40 mmHg in the presence of preserved EF

1. Clinical criteria
- Physical examination consistent with severe aortic stenosis
- Typical symptoms without other explanation
- Elderly patient (> 70 years)

2. Qualitative imaging data
- LVH (additional history of hypertension to be considered)
- Reduced LV longitudinal function without other explanation

3. Quantitative imaging data
- Mean gradient 30-40 mmHg, AVA ≤ 0.8 cm^2, SVi < 35 mL/m^2
- Calcium score by MSCT†

Severe AS likely:	men ≥ 2000	women ≥ 1200
Severe AS very likely:	men ≥ 3000	women ≥ 1600
Severe AS unlikely:	men < 1600	women < 800

†Agatston method for valve calcification

Important to exclude:
- Measurement errors
- Severe hypertension
- Inconsistency between AVA and velocity/gradient cut-offs in the range of AVAs between 0.8 and 1.0 cm^2
- Clinically moderate AS (despite an AVA < 1.0 cm^2) in a patient with small body size

Abbreviations:
AS: Aortic stenosis
AV: Aortic valve
AVA: Aortic valve area
CMR: Cardiac magnetic resonance imaging
CSA: Cross-sectional area
CT: Computed tomography
CW: Continuous wave
EF: Ejection fraction
LFLG: Low flow low gradient
LV: Left ventricle
LVH: Left ventricular hypertrophy
LVOT: Left ventricular outflow tract
MSCT: Multislice computed tomography
ΔP: Pressure gradient
ΔPm: Mean pressure gradient
PR: Pressure recovery
SV: Stroke volume
SamV: Sample volume
SVi: Stroke volume index
TEE: Transesophageal echocardiography
Vmax: Maximum velocity
VTI: Velocity time integral
2-C: Two-chamber
2-D: Two-dimensional
3-D: Three-dimensional
4-C: Four-chamber

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Poster ordering information and full text of ASE guideline documents available at: ASEcho.org

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