


**Evaluation of Aortic Regurgitation**

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**Learning objectives**

- **What causes AR?**
- **When to replace?**
- **Assessment of severity with pitfalls**
- **What is the most accurate measurement?**



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**Causes of AR in Patients Having Isolated AVR at Baylor University Medical Center (1993–2005)**

Roberts WC et al. Circulation. 2006 Aug 1;114(5):422-9.



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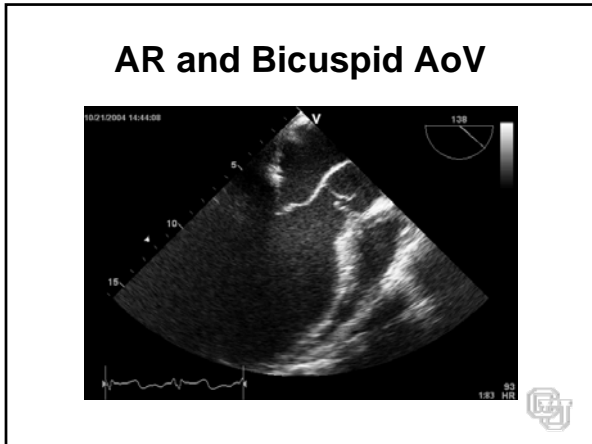
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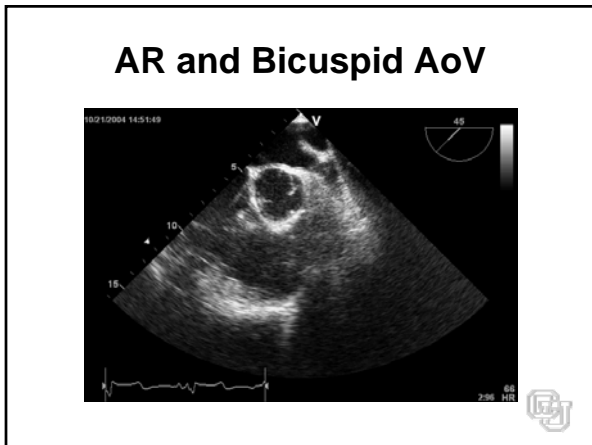
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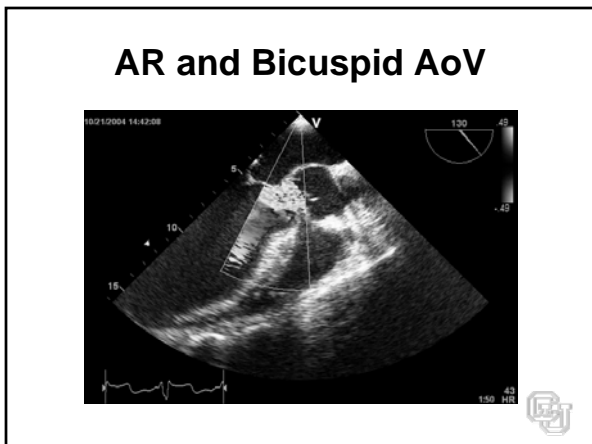
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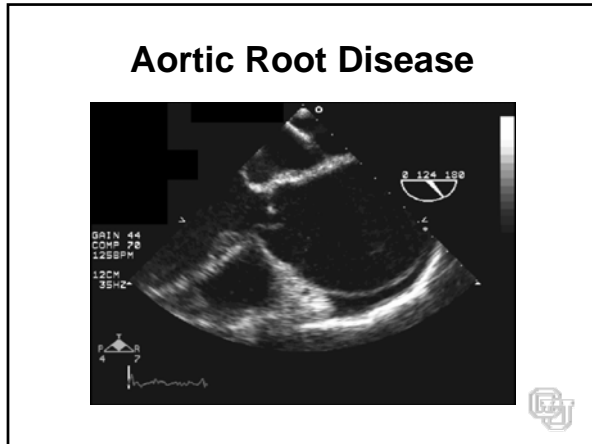
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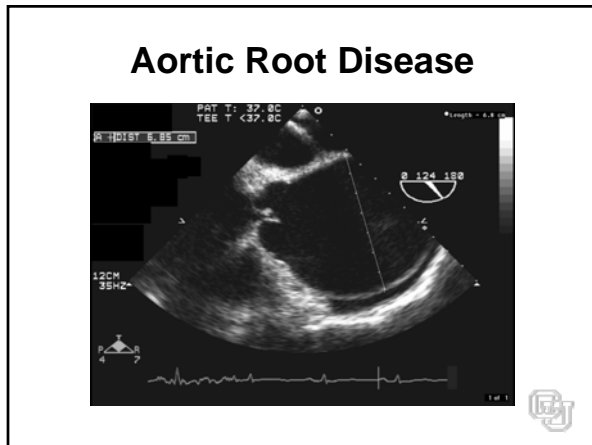
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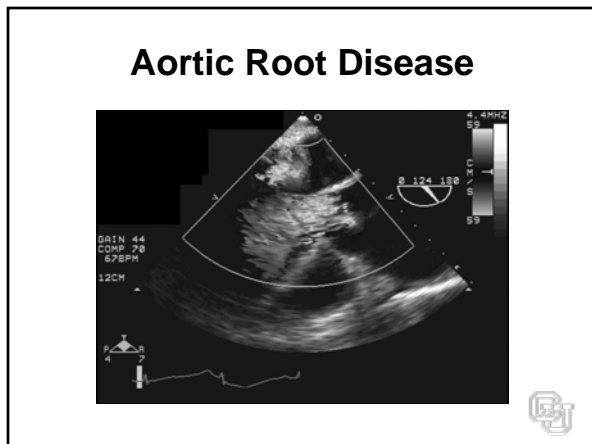
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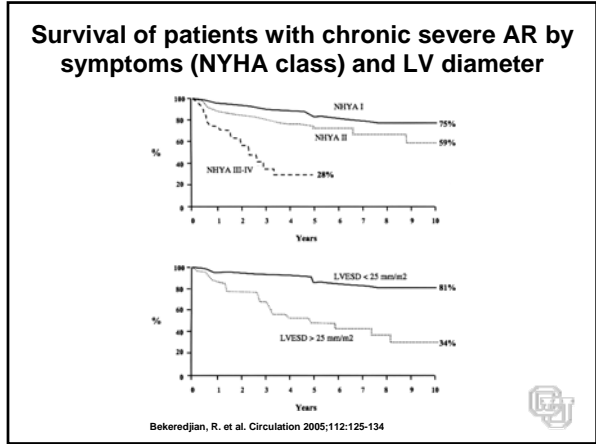
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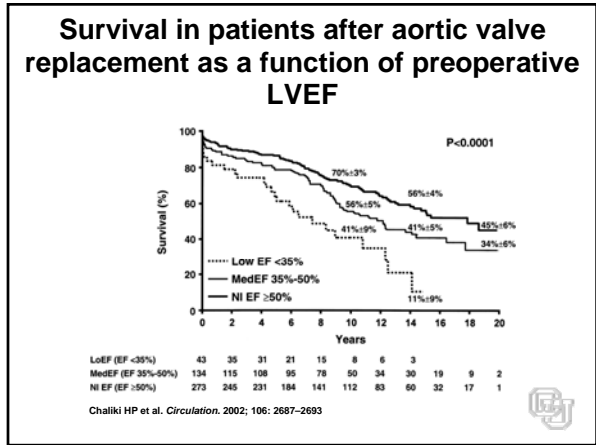
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**Indications with pure, chronic AR for AVR**

- Severe AR  $\Rightarrow$  AVR (irrespective of LV function)
- Mild AR – not candidates, if LV dysfunction, other causes have to be considered (CAD)
- Moderate AR – during CABG or surgery on Ascending Aorta  $\Rightarrow$  AVR

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**Additional Consideration for Surgery**

- Symptomatic patient with LV dysfunction (EF 0.25 to 0.5)  $\Rightarrow$  AVR
- Asymptomatic patient with LV dysfunction (EF 0.25 to 0.5)  $\Rightarrow$  AVR
- Asymptomatic patient with normal LV function, but end diastolic dimension > 75 mm, or end-systolic dimension > 50 mm is an indication for AVR




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**TEE assessment of AR severity**

- Color jet area
- Vena contracta
- AR pressure half-time (PHT)
- Aortic flow reversal
- Quantitative Doppler Flow measurements




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**Severity of Aortic Regurgitation (Qualitative)**

	Mild	Moderate	Severe
Angiographic grade	1 +	2 +	3 - 4 +
Color Doppler width	Central jet, width < 25% of LVOT	Greater than mild but no sign of severe	Central jet, width > 65% of LVOT
Doppler vena contracta width (cm)	< 0.3	0.3 - 0.6	> 0.6




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### Severity of Aortic Regurgitation (Quantitative)

	Mild	Moderate	Severe
Regurgitant volume (ml/beat)	< 30	30 – 59	≥ 60
Regurgitant fraction (%)	< 30	30 – 49	≥ 50
Regurgitant orifice area (cm <sup>2</sup> )	< 1.0	0.1 – 0.29	≥ 30
Additional criteria: LV size			Increased




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### Color jet area

- Jet width/LVOT width
- Fast, easy, helps assessing mechanism
- Impacted by blood pressure (BP) – high-pressure jets appear larger than a low-pressure jet
- Eccentric (wall) jets only 50% the size of central jets (Coanda effect)
- Effect of instrumentation (next slide)




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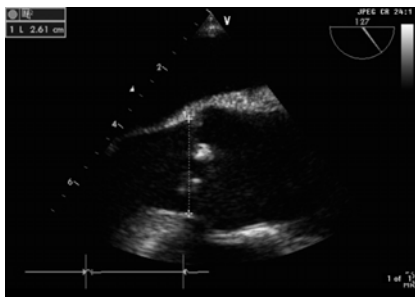
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### LVOT width




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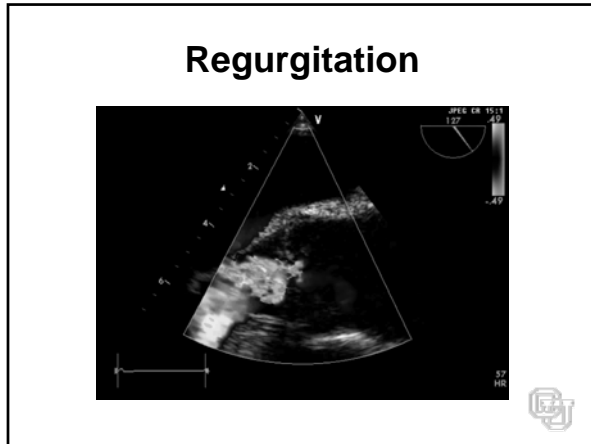
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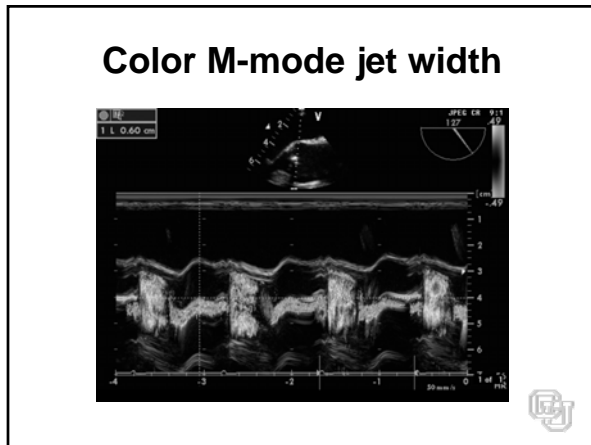
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### Effect of Color Doppler Instrumentation on Color Doppler Jet Size

- Increased Jet size:
  - ✓ ↑ Gain and output power
  - ✓ ↓ PRF (encoding lower velocities) – lowest velocity visible is 1/16 of the maximal velocity (determined by PRF)
  - ✓ ↑ Transducer frequency – Frequency effect (encoding lower velocities) – dominates TEE
  - ✓ ↓ Transducer frequency – Attenuation effect (higher frequency is attenuated more) – dominates TTE
  - ✓ ↓ Wall filter

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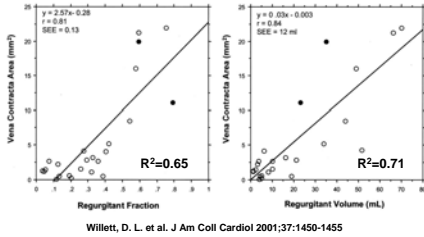
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Linear regression plots showing a comparison of vena contracta area in the short-axis view to regurgitant fraction (left) and regurgitant volume (right)



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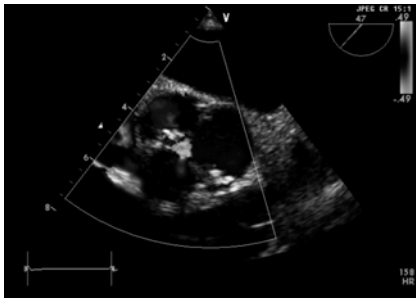
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### Short Axis VC



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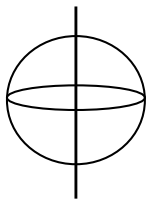
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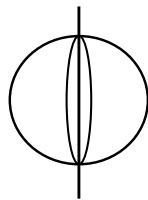
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### VC Limitations

- Jet width depends on valve morphology



Underestimates



Overestimates



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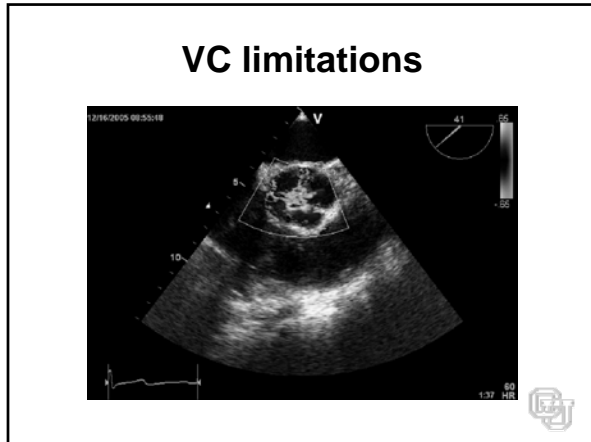
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- ### VC Limitations
- Color Doppler instrumentation changes may affect jet size
    - Increased Jet size:
      - ✓ ↑ Gain and power
      - ✓ ↑ Transducer frequency
      - ✓ ↓ PRF
      - ✓ ↓ Transducer frequency
      - ✓ ↓ Wall filter



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- ### Pressure half time (PHT)
- Quantitative parameter of the pressure equilibration between aorta and left ventricle
  - With increasing severity of AR the aortic regurgitant velocity slope gets steeper, and PHT shortens



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### Pressure half time (PHT)

- Mild AR: Slow > 500 ms, incomplete/faint spectral density
- Moderate AR: Medium 500 – 200 ms, dense
- Severe AR: Steep < 200ms, dense



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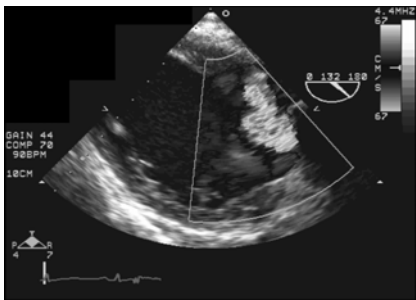
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### Color Jet Area



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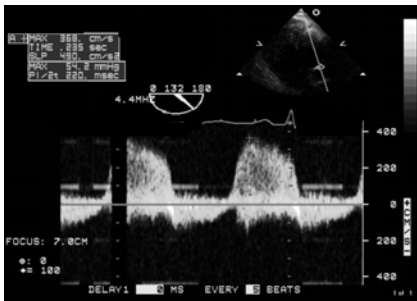
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### Pressure Half Time



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### Limitation of PHT

- Pressure equilibration is not only influenced by regurgitant orifice area BUT
- ✓ By the systemic vascular resistance:  
Increasing SVR increases regurgitation and increases PHT (contradiction!)
- ✓ By left ventricle compliance:  
Decreased compliance increases PHT



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### Limitation of PHT

- In the presence of impaired left ventricular relaxation the pressure or velocity decay of aortic regurgitation is not related to its severity
- PHT assessment of aortic regurgitation should only be used in patients with pure AR, normal EF and normal LV mass

Marchi et al. Heart. 1999;82:607  
Griffin et al. Am Heart J. 1991;122:1049



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### Aortic Flow Reversal

- PWD sample obtained in the descending aorta just beyond the aortic arch at a multiplane angle around 90°



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### Aortic Flow Reversal

- Diastolic flow reversal in descending aorta with Pulsed Wave Doppler (PWD)
  - ✓ Mild: brief, early
  - ✓ Moderate: Intermediate
  - ✓ Severe: Holodiastolic reversal
- Most Reliable!



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### Regurgitant Volume (RV) in AR

1. ERO (effective orifice area) x AR flow (VTI)
2. Difference between total SV and forward SV (no intracardiac shunt)
  1.  $RV = \text{Total SV} - \text{Forward SV}$ 
    - Total SV =  $(CSA_{LVOT} \times VTI_{LVOT})$
    - Forward SV =  $(CSA_{PA} \times VTI_{PA})$



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### Regurgitant Volume (RV) in AR

- Mild: < 30 ml/beat
- Mild to Moderate: 30 – 44 ml/beat
- Moderate to Severe: 45 – 59 ml/beat
- Severe: ≥ 60 ml/beat



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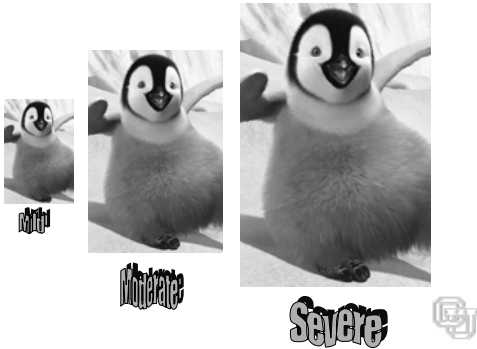
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**How Do We Measure AR?**



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**Evaluation of Aortic  
Regurgitation**

Thank you!



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