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Houston, Texas

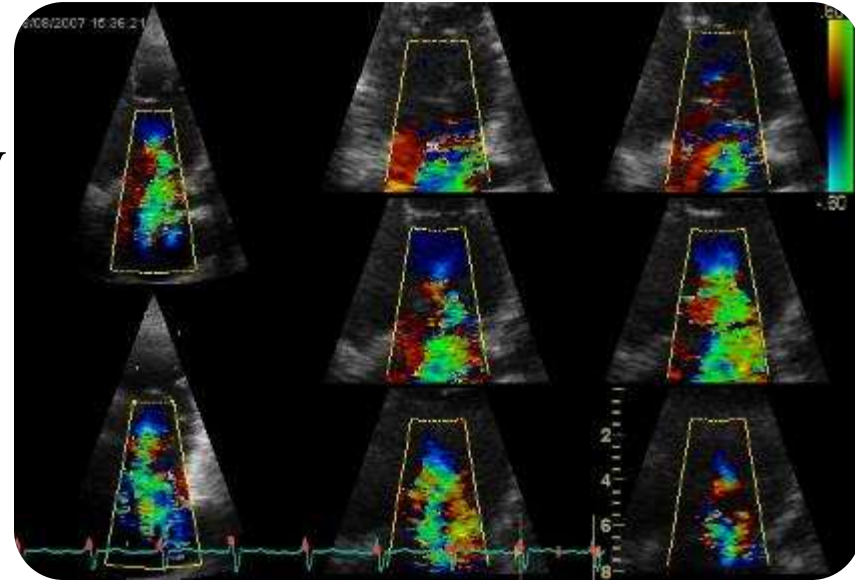


# Mitral Regurgitation

# What to Expect

## Review

- Specific Signs of Severity
- Supportive Signs of Severity
- Qualitative Parameters
  - Structural
  - Doppler
- Quantitative Parameters
  - Vena Contracta Width
  - Regurgitant Volume (mL/beat)
  - Regurgitant Fraction (%)
  - Effective Regurgitant Orifice Area (EROA – cm<sup>2</sup>)
- Cases – implement what you learned!



# Specific Signs



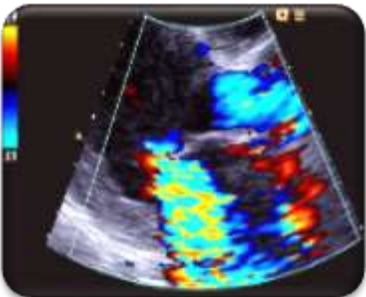
## Mild

- Small central jet  $<4 \text{ cm}^2$  or  $<20\%$  of LA
- Vena contracta width  $<0.3\text{cm}$
- No or minimal flow convergence



## Moderate

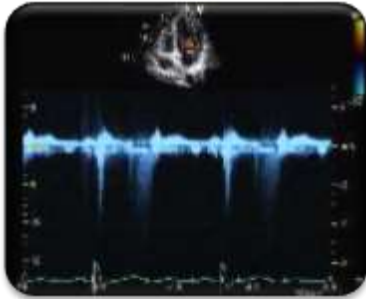
- Signs of MR  $>$  Mild but no criteria for severe MR



## Severe

- Vena contracta width  $\geq 0.7\text{cm}$
- Large flow convergence
- Systolic reversal in pulmonary veins
- Prominent flail MV leaflet of ruptured papillary muscle

# Supportive Signs



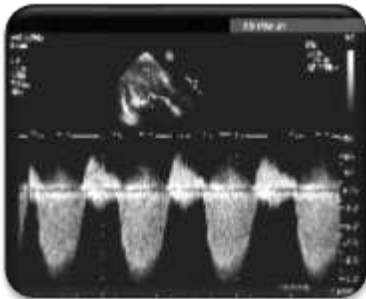
## Mild

- Systolic dominant flow in pulmonary veins
- A-wave dominant mitral inflow
- Soft density, parabolic CW Doppler MR signal
- Normal LV size



## Moderate

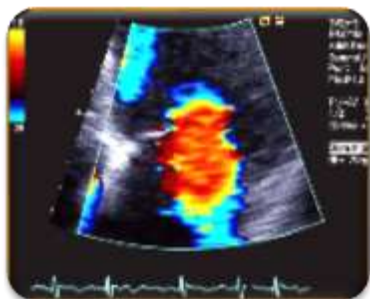
- Intermediate signs/findings



## Severe

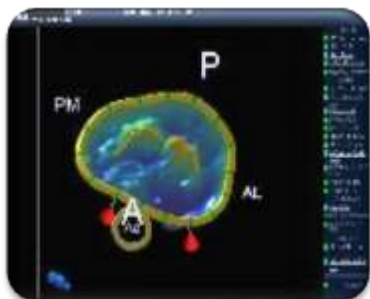
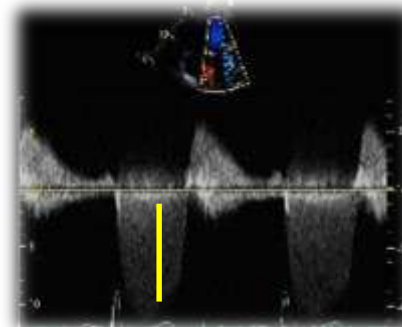
- Dense, triangular CW Doppler MR jet (early peaking)
- E-wave dominant mitral inflow ( $E > 1.2$  m/s)
- Enlarged LV
- Enlarged LA

# Quantitative Parameters



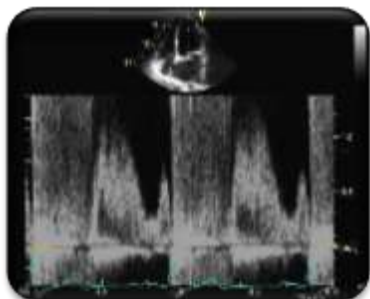
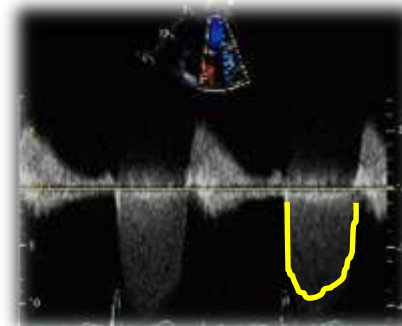
## EROA (cm<sup>2</sup>)

- Mild <math><0.20</math>
- Mild-Mod 0.20-0.29
- Mod-Sev 0.30-0.39
- Severe  $\geq 0.40$



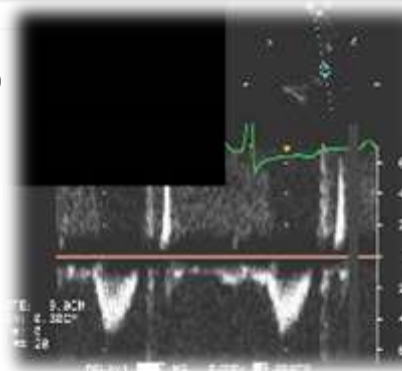
## R Vol (mL/beat)

- Mild: <math><30</math>
- Mild-Mod 30-44
- Mod-Sev 45-59
- Severe  $\geq 60$



## Regurgitant Fraction % (RF)

- Mild <math><30</math>
- Mild-Mod 30-39
- Mod-Sev 40-49
- Severe  $\geq 50$



# Grading MR

## Qualitative/Supportive Methods

Parameters	Mild	Moderate	Severe
Color jet area	4cm <sup>2</sup> or 10% LA	Variable	>10cm <sup>2</sup> or 40% LA
CW	Faint/parabolic	Dense/para	Dense/early peak
Pvein flow	Sys. dominance	Sys. Blunting	Systolic reversal
MV Inflow	Dominant A wave		Dominant E >1.2

## Quantitative Methods

Parameters	Mild	Moderate	Severe
Vena Contracta	<0.3	0.3-0.69	<u>≥</u> 0.7
Reg. Volume	< 30	30-59	<u>≥</u> 60
Reg. Fraction	< 30	30-49	<u>≥</u> 50
EROA (cm <sup>2</sup> )	<0.2	0.2-0.39	<u>≥</u> 0.40

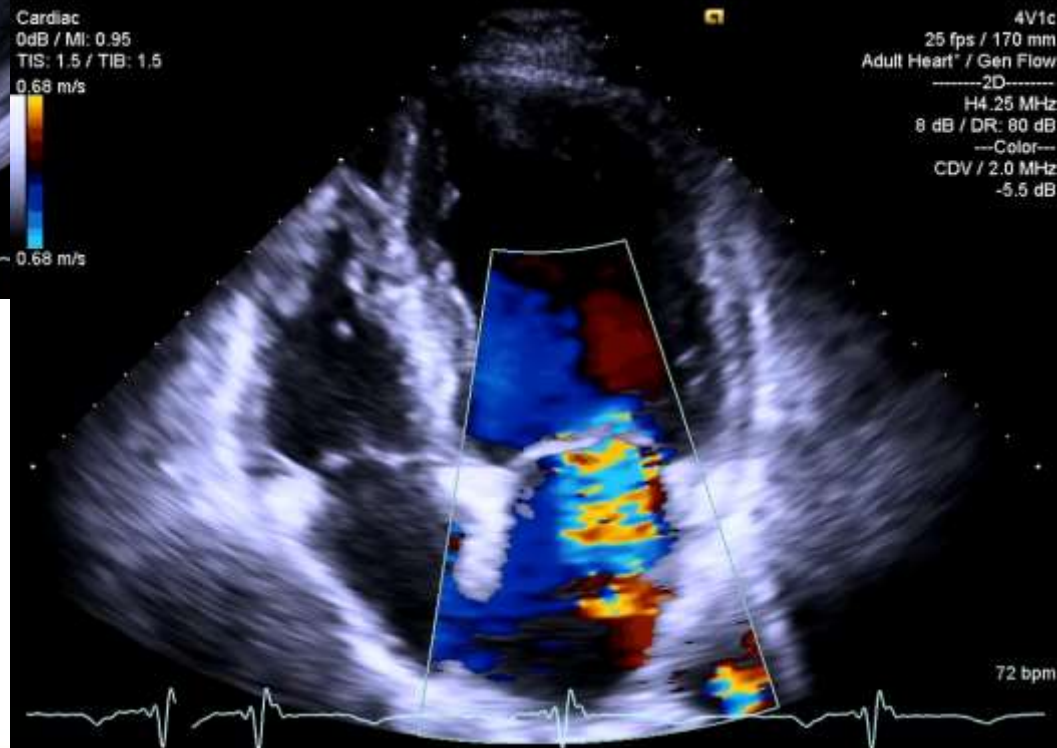
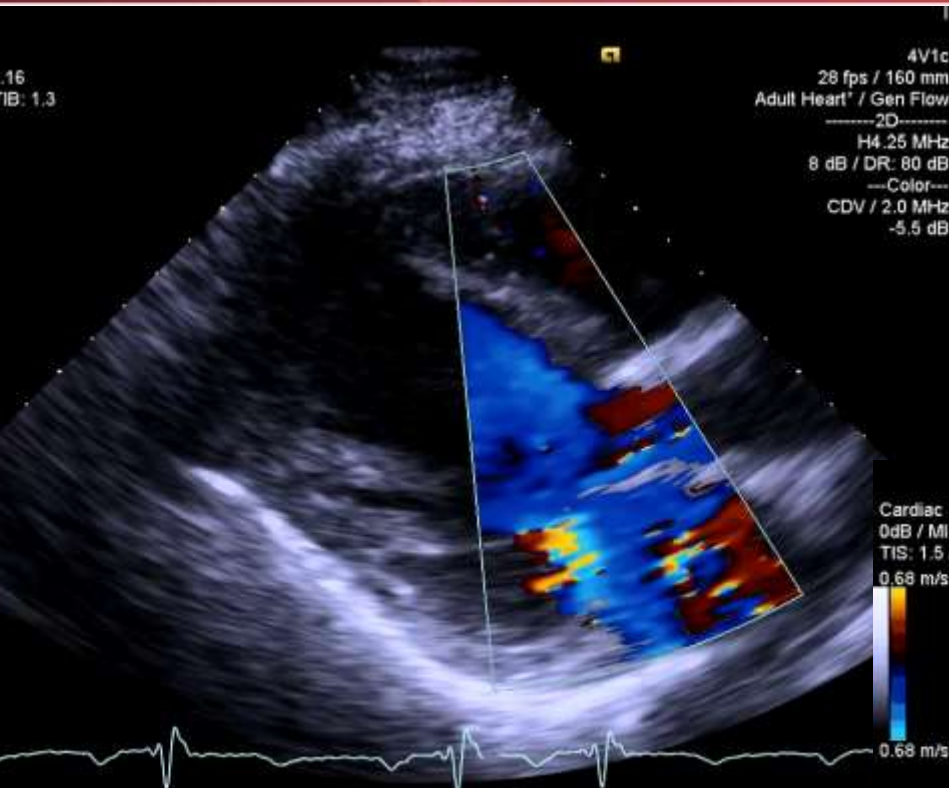
WELCOME TO  
CAPE DISAPPOINTMENT  
STATE PARK



LEWIS AND CLARK NATIONAL PARK



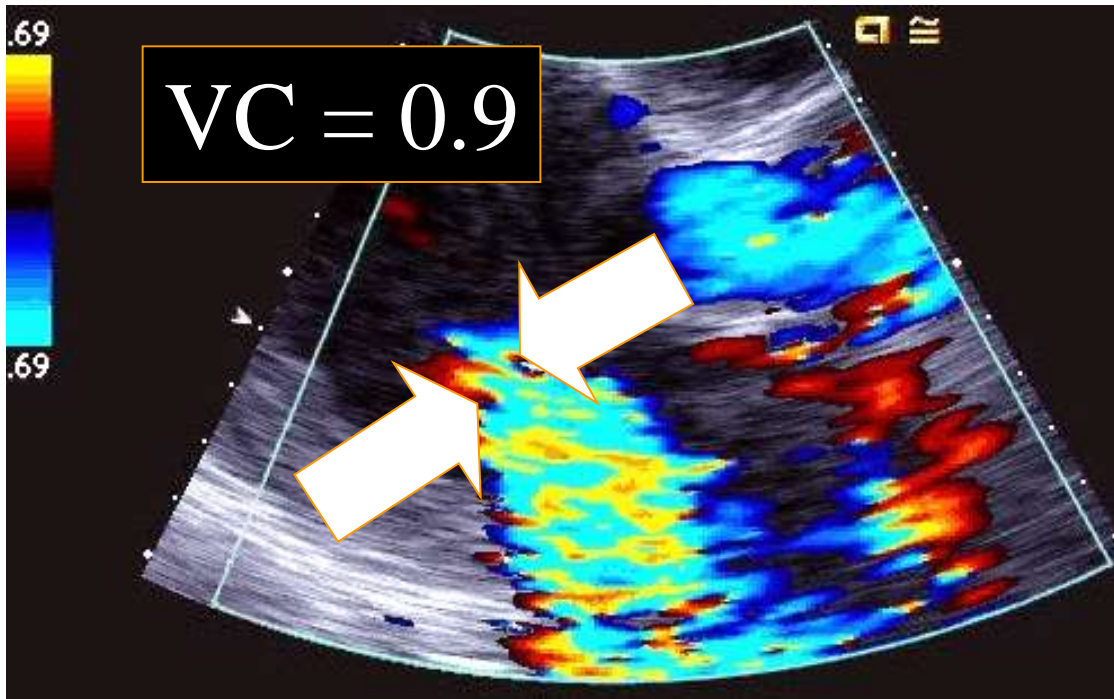
# Mitral Regurgitation





# Vena Contracta

Measurement at the narrowest portion of neck during mitral regurgitation.



- Optimize jet in PLAX
- Zoom or RES
- Look for flow across the valve with a neck

*Measurement of the vena contracta is a quick and accurate quantitative technique when properly applied. It works best on single central MR jets, but is also valuable in assessing an eccentric jet.*

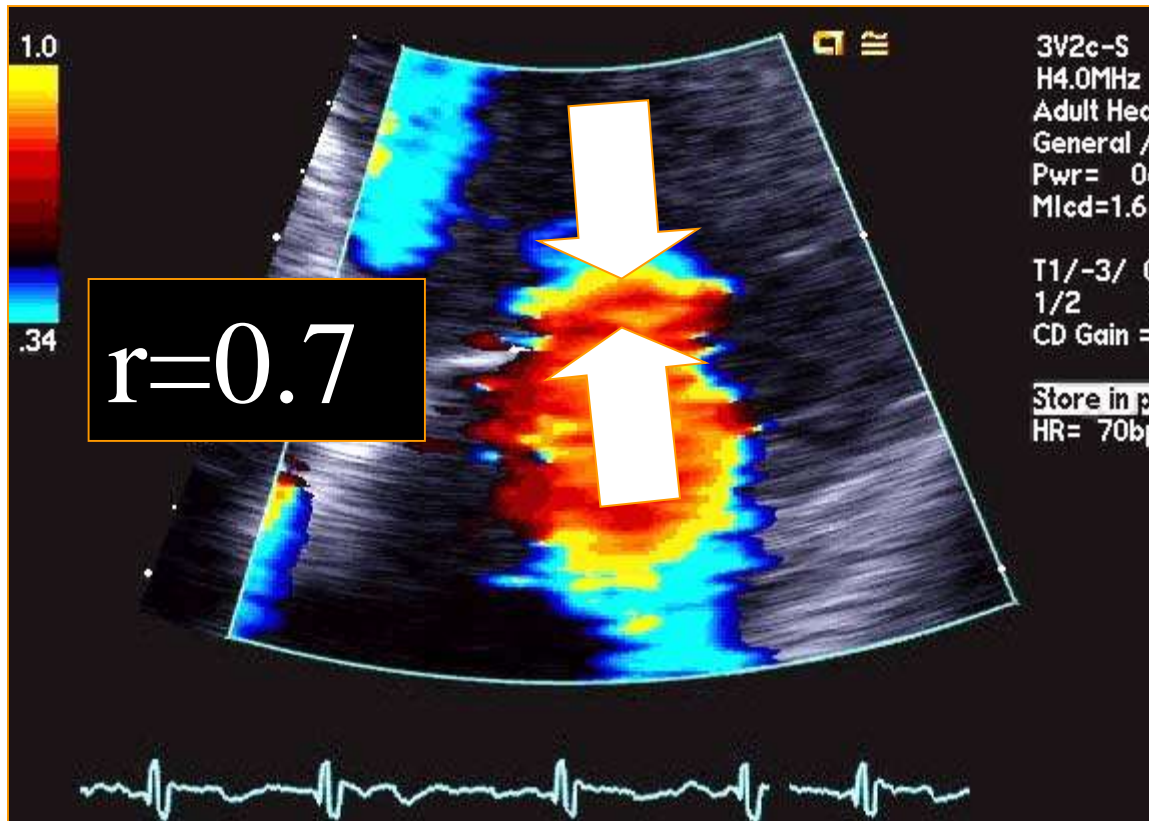
*Roberts, B and Grayburn, P. Vena Contracta: Practical Approach. J Am Soc Echocardiogr 2003;16:1002-6.)*

# PISA Method

Volume Flow Rate (VFR) =  $2 \times \Pi \times r^2 \times V_r$

Effective Reg Orifice Area =  $VFR/V_{MAX}$

Regurgitant Volume (rVol) =  $ERO \times VTI$



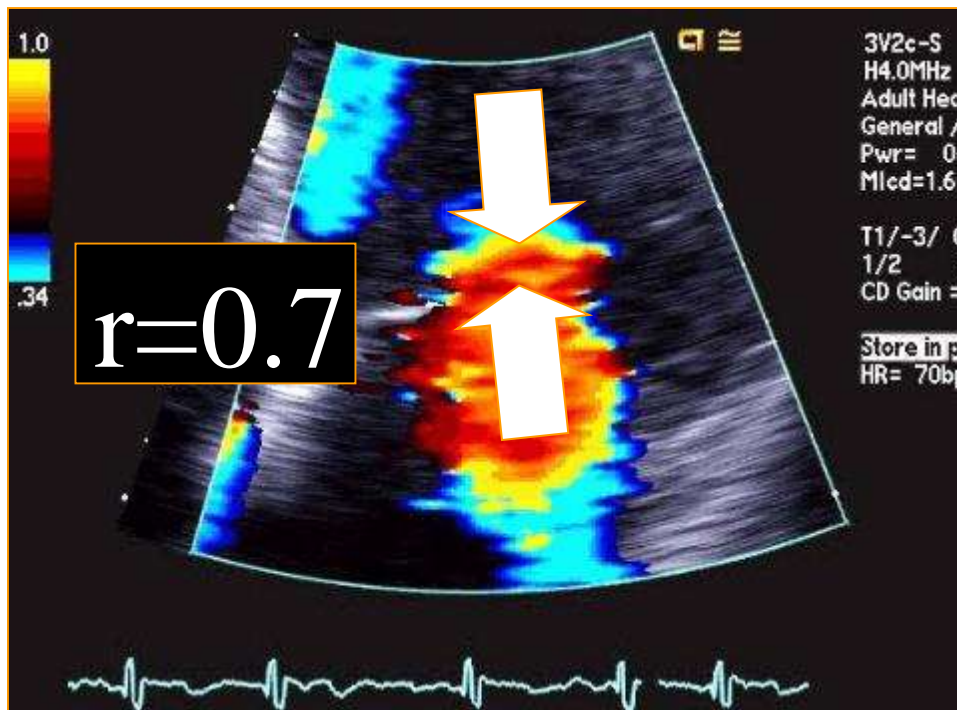
- Adjust baseline
- Scroll to mid-systole
- Locate vena contracta
- Measure from vena contracta to 1<sup>st</sup> color shift change

# PISA Method

$$\text{Volume Flow Rate (VFR)} = 2 \times \pi \times \underline{r}^2 \times \underline{V}_r$$

$$\text{Effective Reg Orifice (ERO)} = \text{VFR} / \underline{V}_{\text{MAX}}$$

$$\text{Regurgitant Volume (RVol)} = \text{ERO} \times \underline{\text{VTI}}$$



$$\text{VFR} = 6.28 \times .49 \times 34$$

$$\text{VFR} = 105\text{cc/s}$$

$$\text{ERO} = \text{VFR} / V_{\text{MAX}}$$

$$\text{ERO} = 105 / 417.4$$

$$\text{ERO} = 0.25\text{cm}^2$$

$$\text{RVol} = \text{ERO} \times \text{VTI}$$

$$\text{RVol} = 0.25 \times 130$$

$$\text{Rvol} = 32\text{mL}$$

# Grading MR

## Qualitative Methods

Parameters	Mild	Moderate	Severe
Color jet area	4cm <sup>2</sup> or 10% LA	Variable	>10cm <sup>2</sup> or 40% LA
CW	Faint/parabolic	Dense/para	Dense/early peak
Pvein flow	Sys. dominance	Sys. Blunting	Systolic reversal
MV Inflow	Dominant A wave		Dominant E >1.2

## Quantitative Methods

Parameters	Mild	Moderate	Severe
Vena Contracta	<0.3	0.3-0.69	<u>≥0.7</u>
Reg. Volume	< 30	<u>30-59</u>	<u>≥60</u>
Reg. Fraction	< 30	30-49	<u>≥50</u>
EROA (cm <sup>2</sup> )	<0.2	<u>0.2-0.39</u>	<u>≥0.40</u>

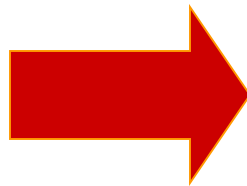
# Easy PISA?

If aliasing velocity  $30 \pm 5$  cm/sec and the velocity is around 500 cm/sec

$$\frac{6.28 \times r^2 \times 30 \text{ cm/sec}}{500 \text{ cm/sec}}$$

- $ERO = \frac{6.28 \times r^2 \times 30 \text{ cm/sec}}{500 \text{ cm/sec}}$
- $ERO = 0.38 \times r^2$

$$r=0.7$$



$$ERO = 0.38 \times (0.7)^2$$

$$ERO = 0.38 \times 0.49$$

$$ERO = 0.19 \text{ cm}^2$$

# Left Atrial Pressure

$$LAP = SBP - 4 \times MRV^2$$

$$SBP = 140$$

$$MRV = 5 \text{ m/s}$$

$$LAP = 140 - 4 \times 25$$

$$LAP = 140 - 100$$

$$LAP = 40$$

$$LAP = SBP - 4 \times MRV^2$$

$$SBP = 140$$

$$MRV = 4 \text{ m/s}$$

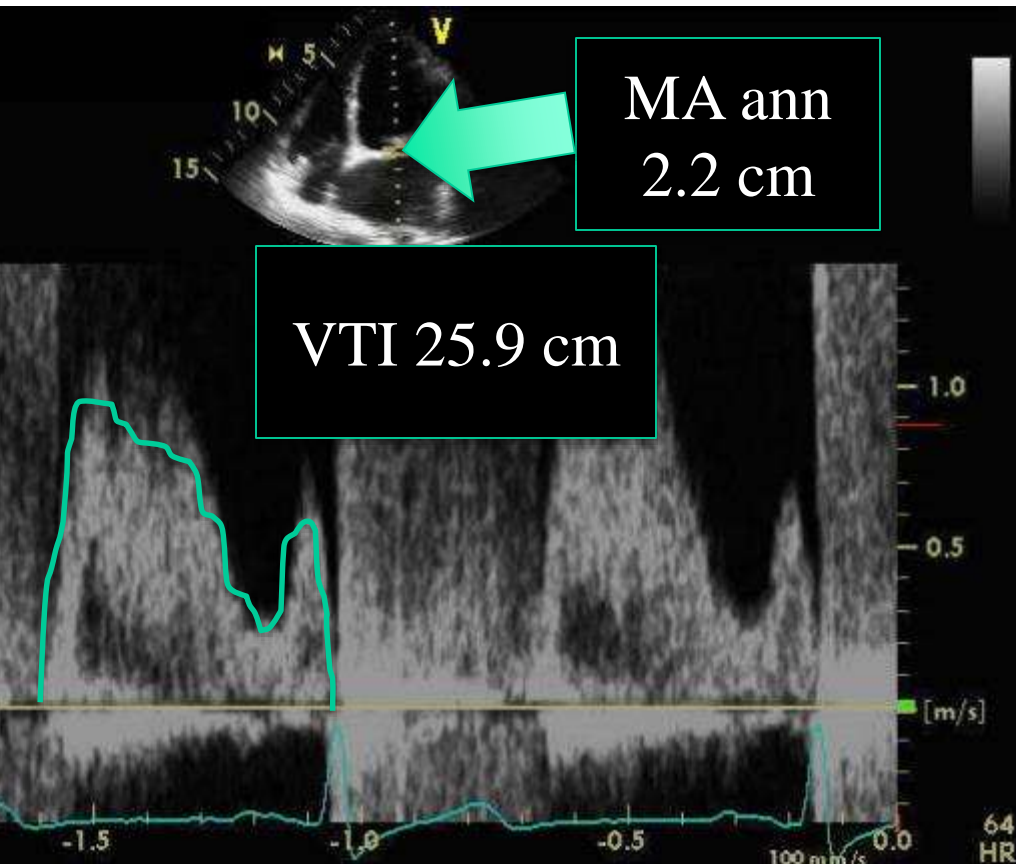
$$LAP = 140 - 4 \times 16$$

$$LAP = 140 - 64$$

$$LAP = 76$$

# Regurgitant Fraction %

$$RF\% = SV (\text{Valve}) - SV (\text{Systemic}) / SV (\text{Valve})$$



$$MA SV = D^2 \times .785 \times VTI$$

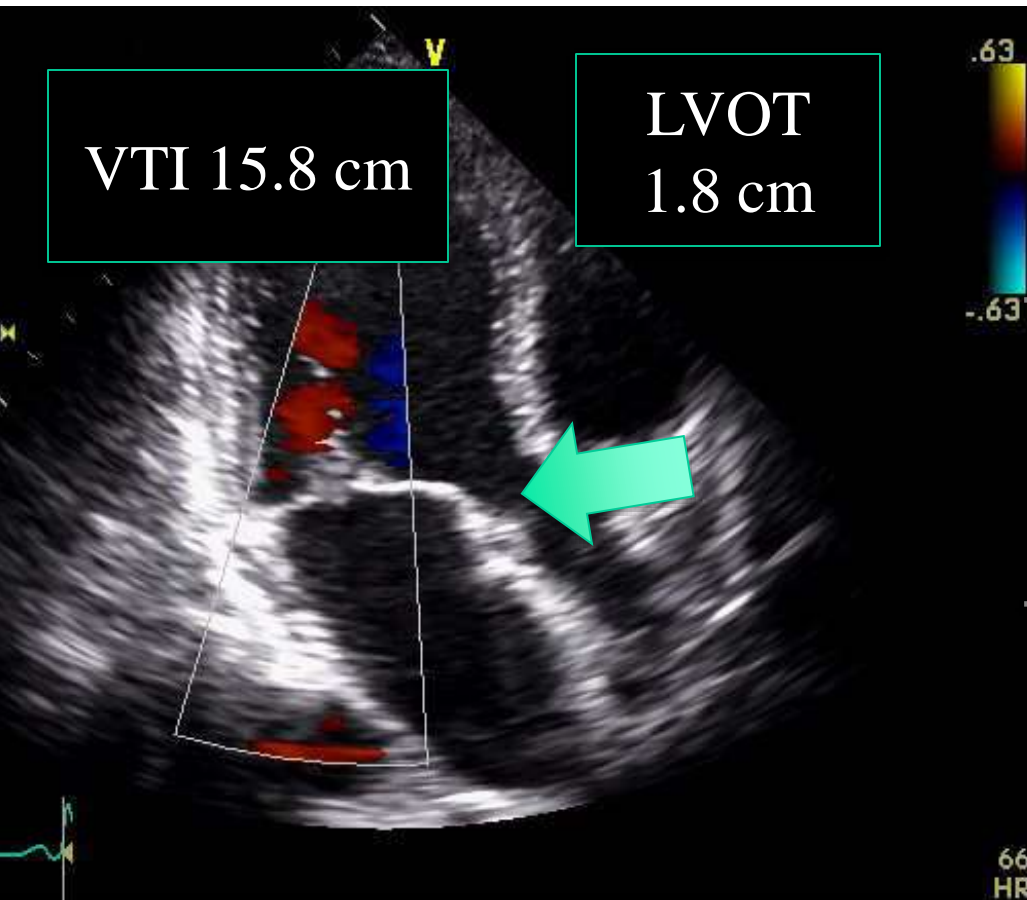
$$MA SV = 2.2 \times .785 \times 25.9$$

$$MA SV = 98.4 \text{ ml}$$

$$LVOT SV = D^2 \times .785 \times VTI$$

# Regurgitant Fraction %

$$RF\% = SV (\text{Valve}) - SV (\text{Systemic}) / SV (\text{Valve})$$



$$MA\ SV = D^2 \times .785 \times VTI$$

$$MA\ SV = 2.2 \times .785 \times 25.9$$

$$MA\ SV = 98.4\ \text{ml}$$

$$LVOT\ SV = D^2 \times .785 \times VTI$$

$$LVOT\ SV = 3.24 \times .785 \times 15.8$$

$$LVOT\ SV = 40.2\ \text{ml}$$

$$RF\% = MA_{SV} - LV_{SV} / MA_{SV}$$

$$RF\% = 98.4 - 40.2 / 98.4$$

$$RF\% = 59\%$$



# Grading MR

## Qualitative Methods

Parameters	Mild	Moderate	Severe
Color jet area	4cm <sup>2</sup> or 10% LA	Variable	>10cm <sup>2</sup> or 40% LA
CW	Faint/parabolic	Dense/para	Dense/early peak
Pvein flow	Sys. dominance	Sys. Blunting	Systolic reversal
MV Inflow	Dominant A wave		Dominant E >1.2

## Quantitative Methods

Parameters	Mild	Moderate	Severe
Vena Contracta	<0.3	0.3-0.69	<u>≥0.7</u>
Reg. Volume	< 30	30-59	<u>≥60</u>
Reg. Fraction	< 30	30-49	<u>&gt;50</u>
EROA (cm <sup>2</sup> )	<0.2	0.2-0.39	<u>≥0.40</u>

# Case 175,425,421<sub>en</sub>

- 32 y/o Vietnamese Female
- 5'2"
- 97 lb
- B/P 105/51
- HR 68
- Prior MV Repair



# Case 175,425,421<sub>cn</sub>



# Case 175,425,421<sub>cn</sub>



# Case 175,425,421<sub>cn</sub>

## What kind of MV surgery?



- a) No surgery
- b) Ring repair
- c) Mitral Clip
- d) Replacement

# Case 175,425,421<sub>cn</sub>

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# Case 175,425,421<sub>cn</sub>



# Case 175,425,421<sub>cn</sub>

Based on info so far, what is severity?



- a) Mild
- b) Moderate
- c) Severe
- d) Low Nyquist



# Case 175,425,421<sub>cn</sub>

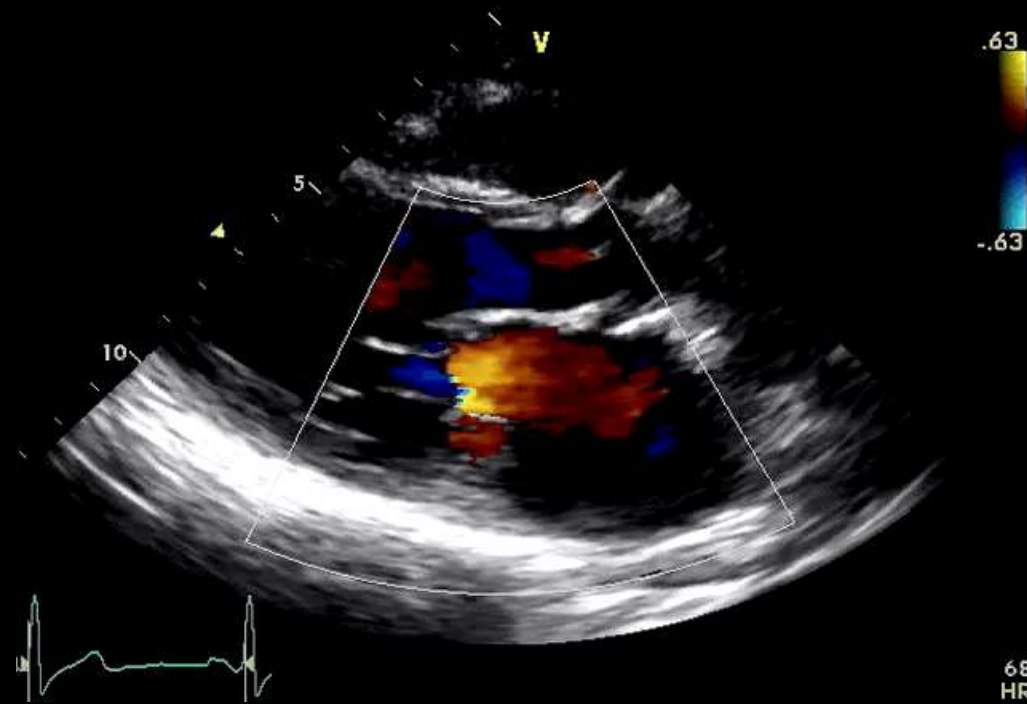
Based on info so far, what is severity?



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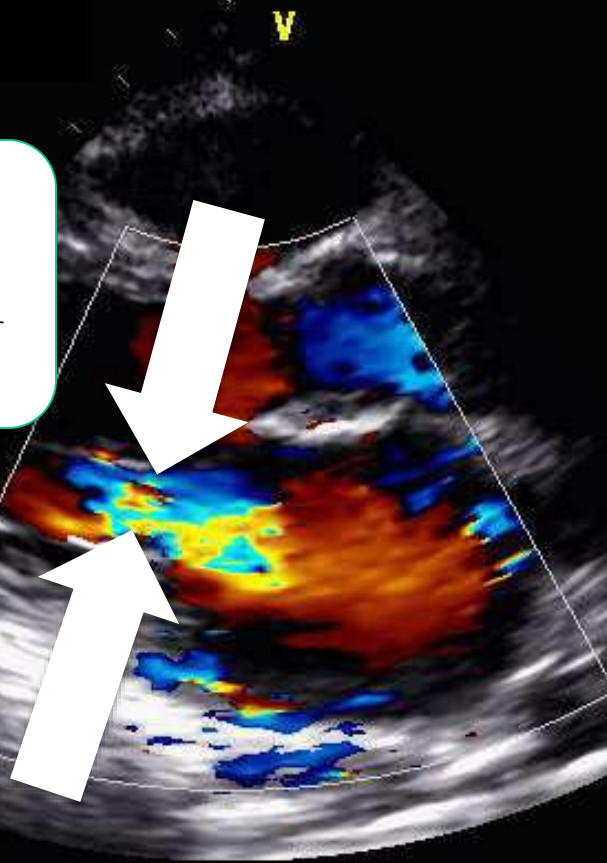
What is the estimated vena contracta?



- a)  $<0.30$
- b)  $0.30-0.69$
- c)  $>0.70$
- d) Poor image

## What is the estimated vena contracta?

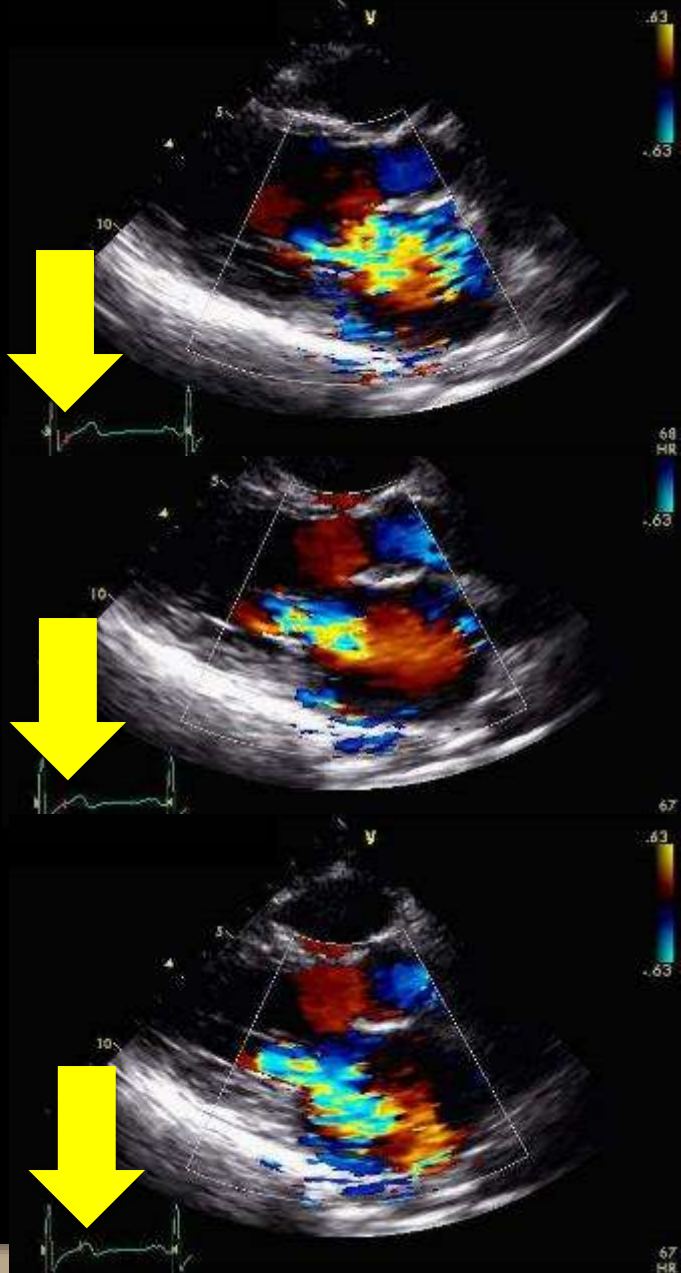
0.9cm



- a)  $<0.30$
- b)  $0.30-0.69$
- c)  $>0.70$
- d) Poor image



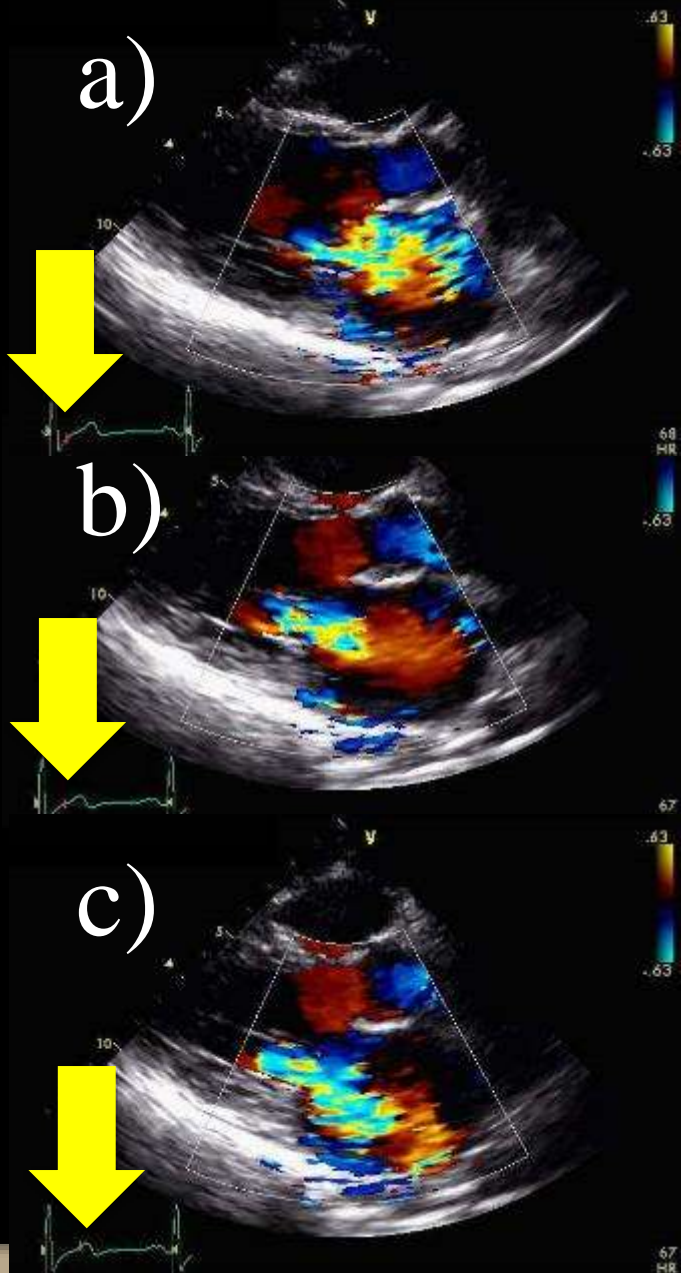
# Case 175,425,421<sub>cn</sub>



When do you measure?

- a) Early sys 0.5
- b) Mid sys 0.9
- c) Late sys 1.1

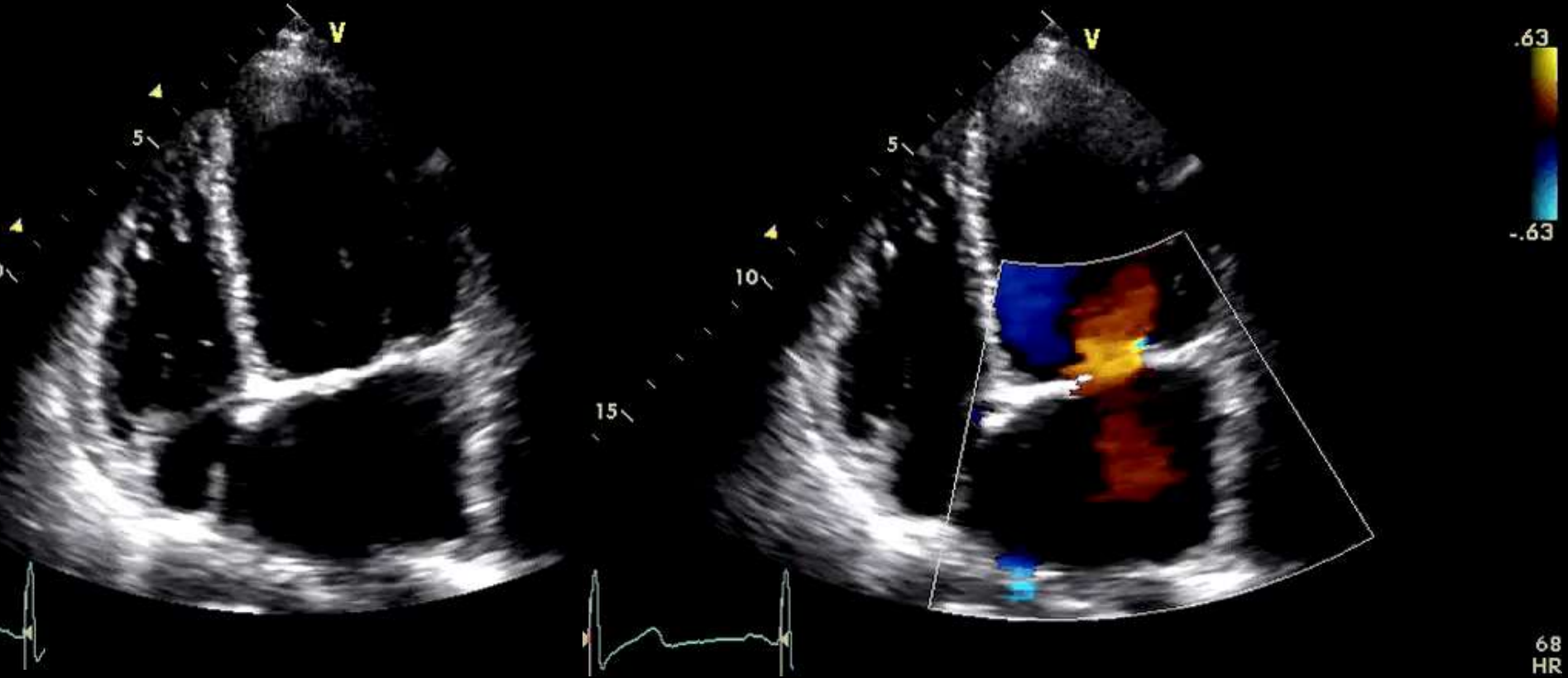
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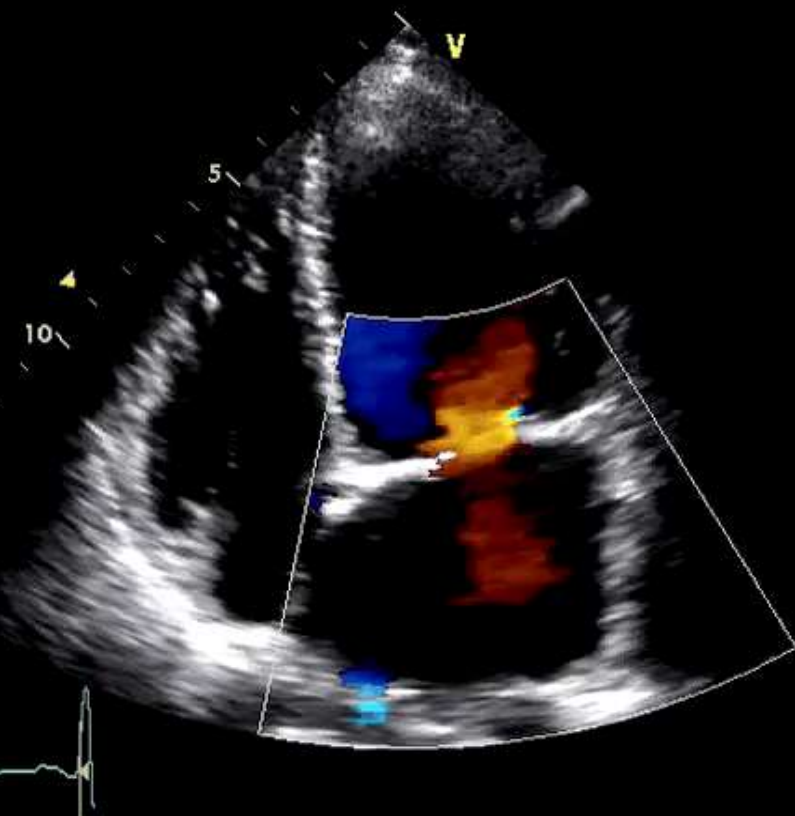
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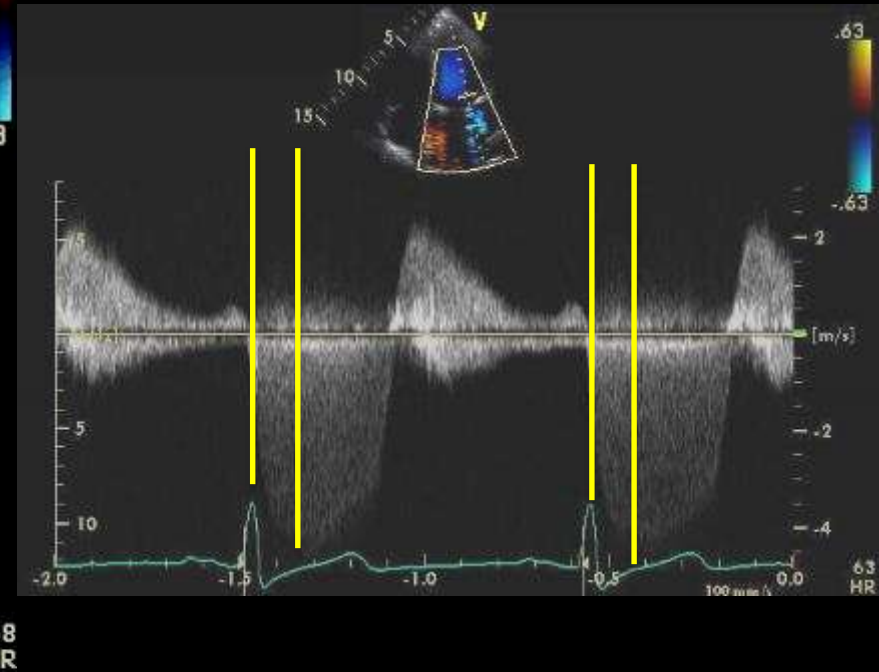
# Case 175,425,421<sub>cn</sub>



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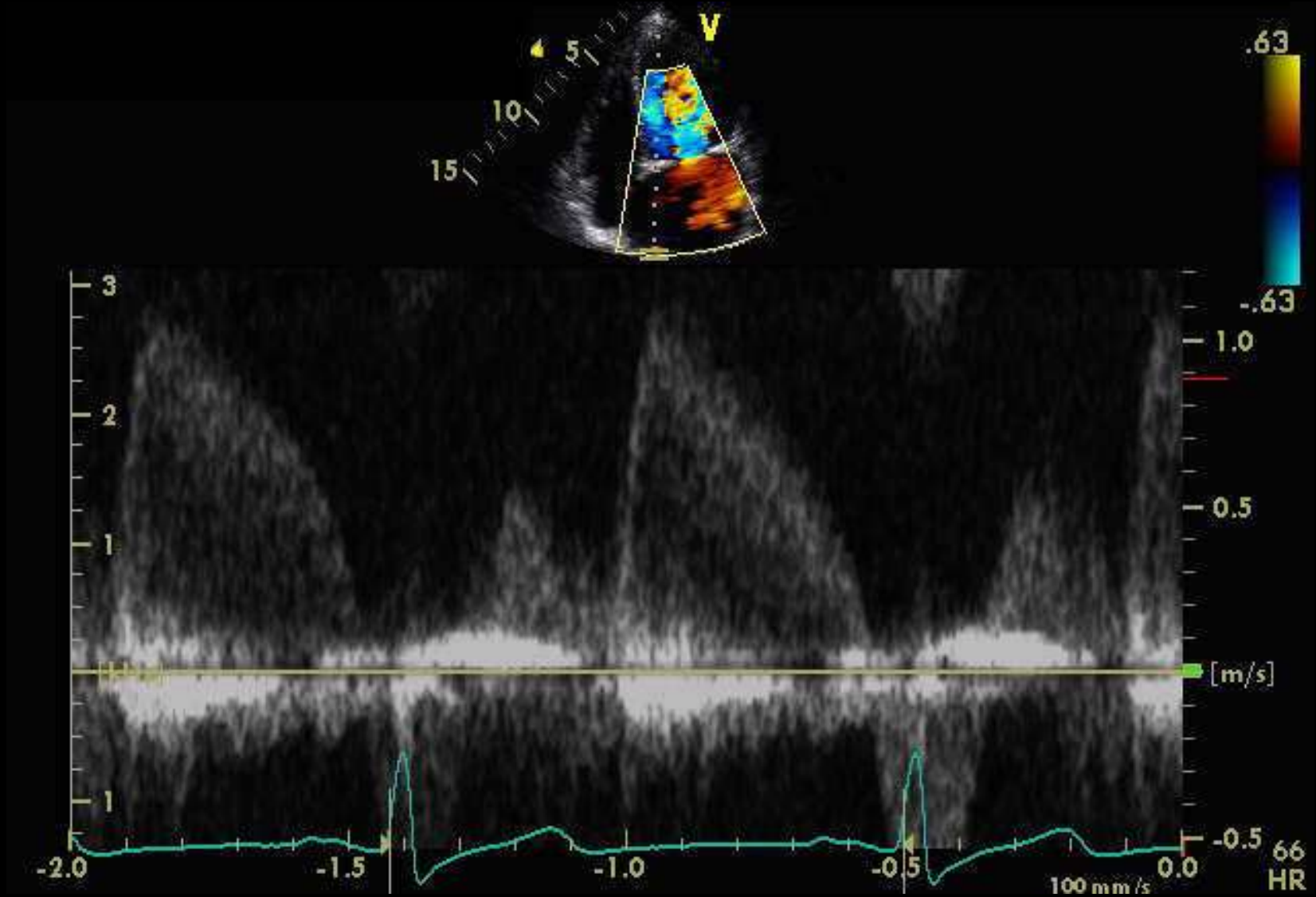


What size is the LA?  
**130.7ml**



What about density and shape of Doppler?

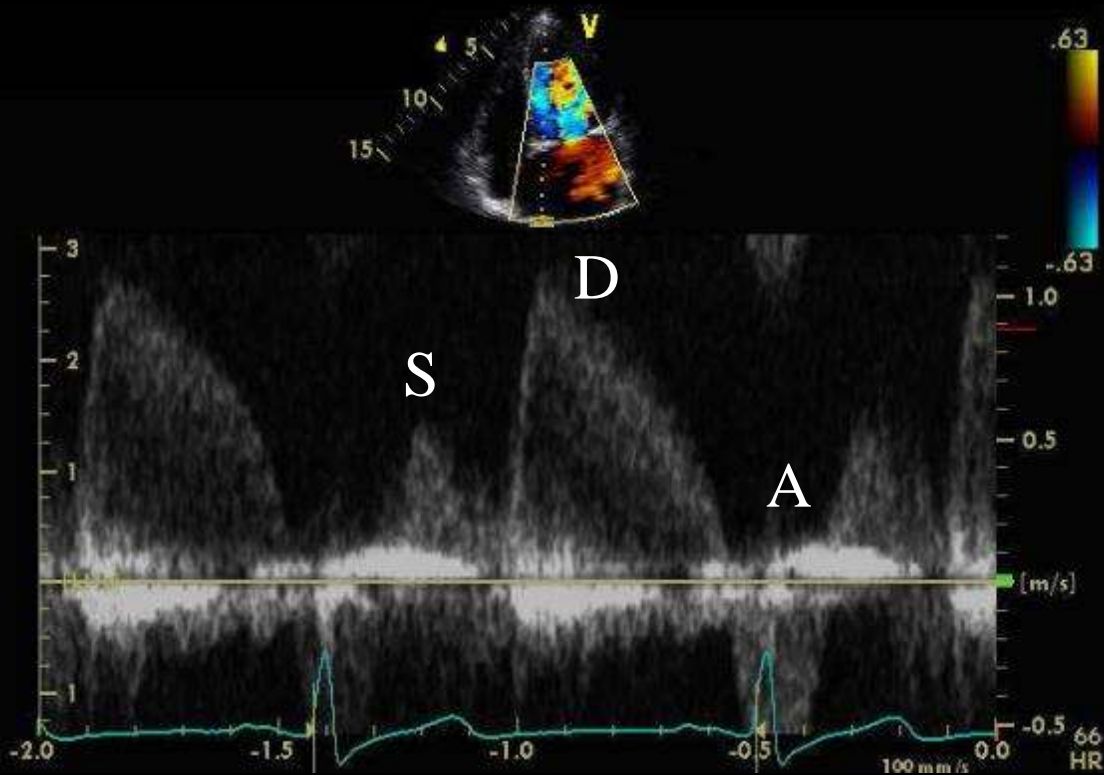
# Case 175,425,421<sub>cn</sub>





# Case 175,425,421<sub>en</sub>

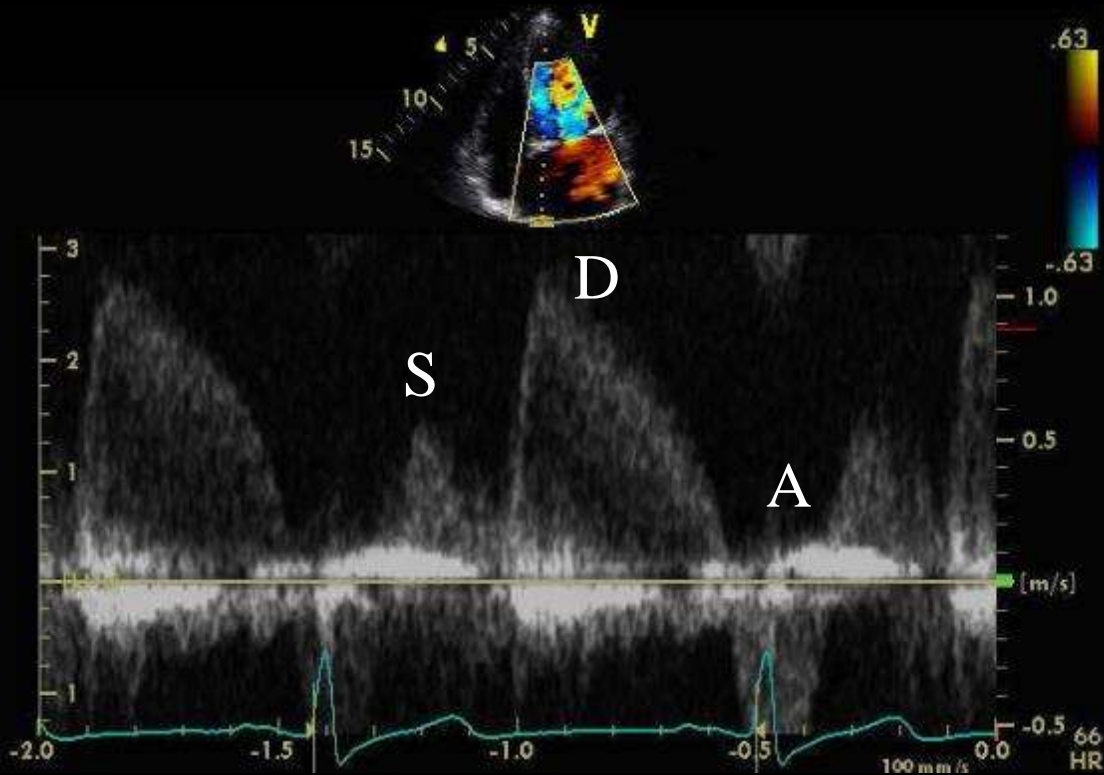
What supportive sign is noted in pulmonary vein flow for significant MR?



- a) Dominant D wave
- b) Dominant S wave
- c) Dominant A wave
- d) All of the above

# Case 175,425,421<sub>en</sub>

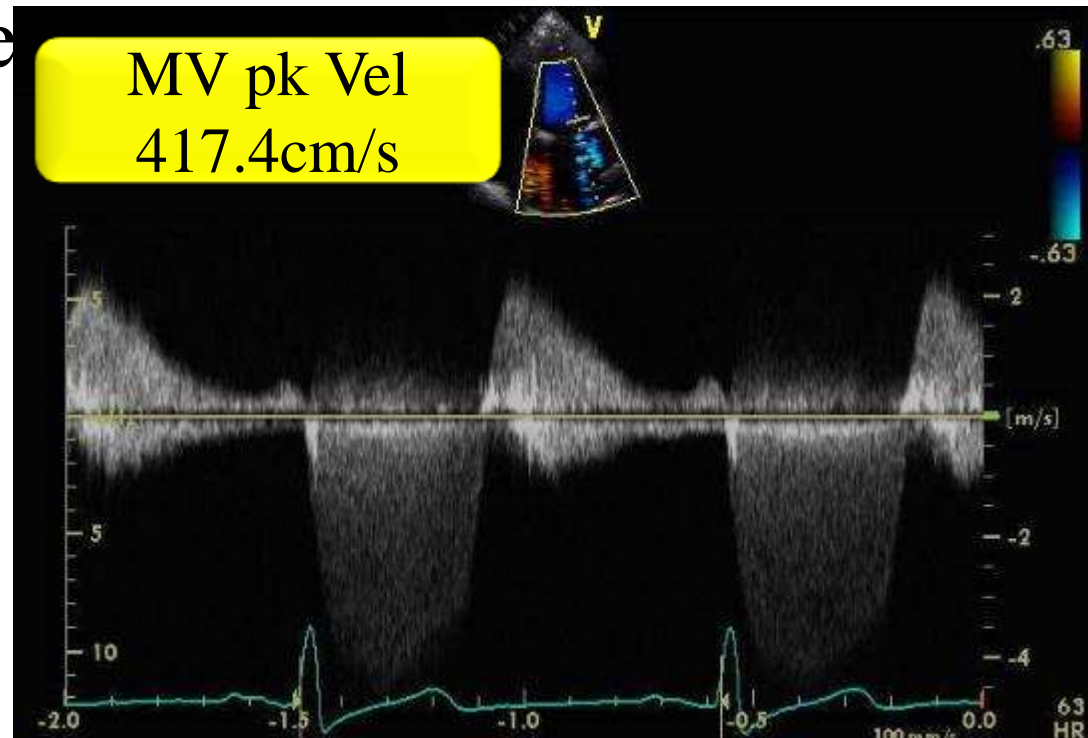
What supportive sign is noted in pulmonary vein flow for significant MR?



- a) Dominant D wave
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- d) All of the above

## What is the LA pressure?

- 32 y/o Vietnamese
- 5'2"
- 97 lb
- **B/P 105/51**
- HR 68
- Prior MV Repair



# Left Atrial Pressure

$$LAP = SBP - 4 \times MRV^2$$

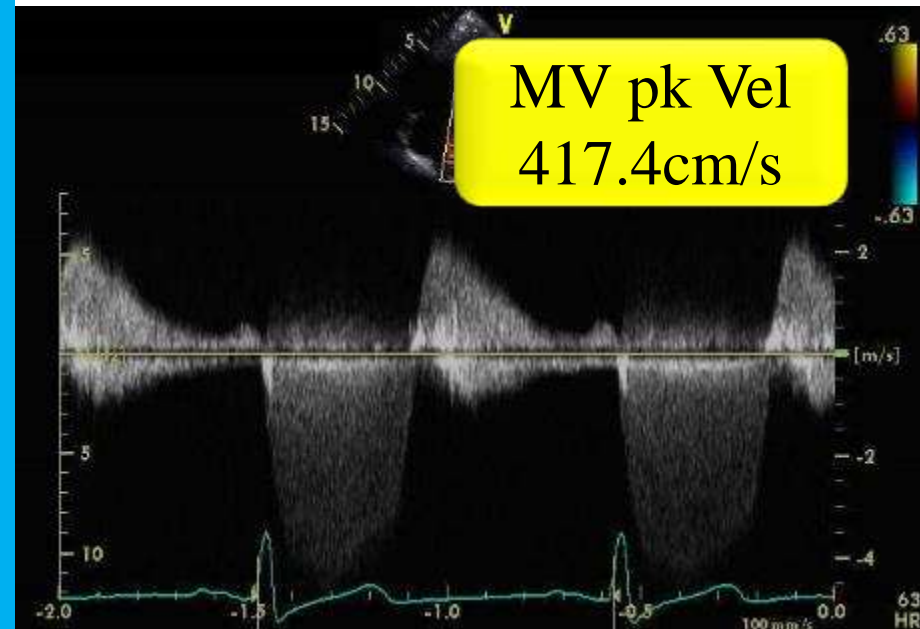
$$SBP = 105$$

$$MRV = 4.2 \text{ m/s}$$

$$LAP = 105 - 4 \times 17.64$$

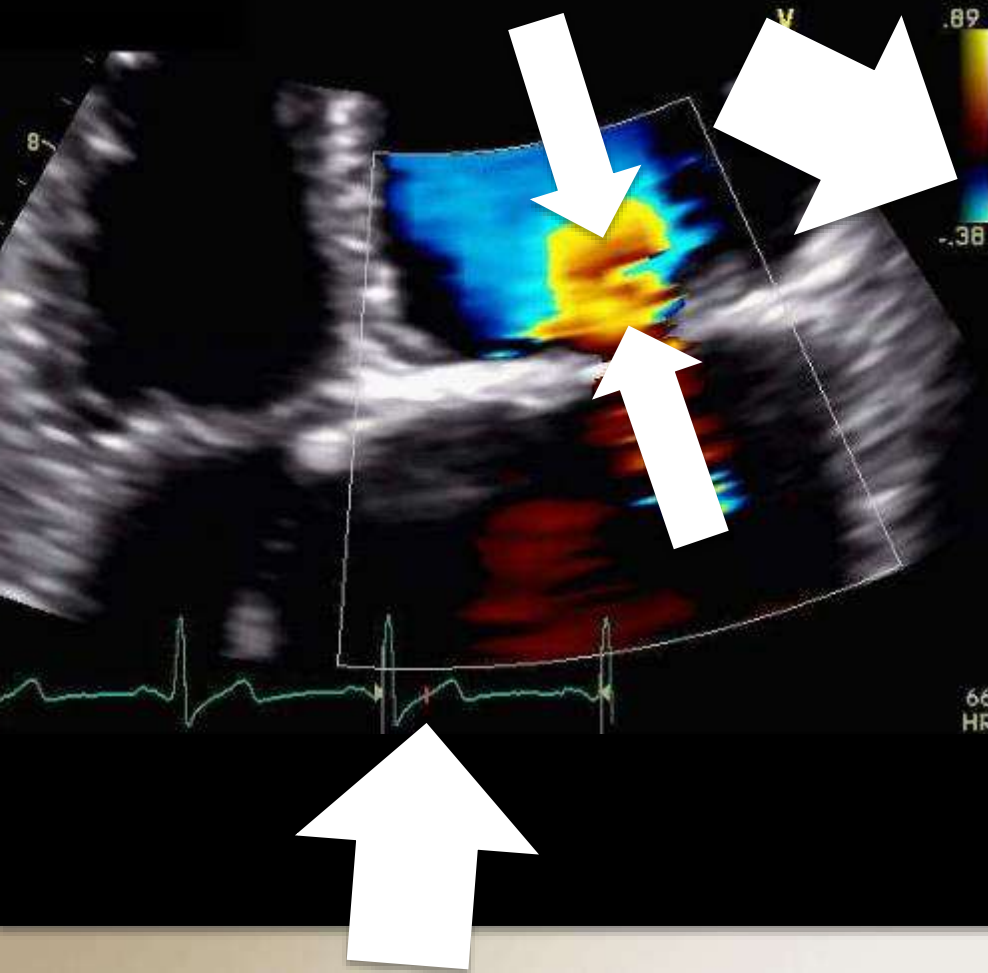
$$LAP = 105 - 70.56$$

$$LAP = 34.44$$



$$SBP = 105$$

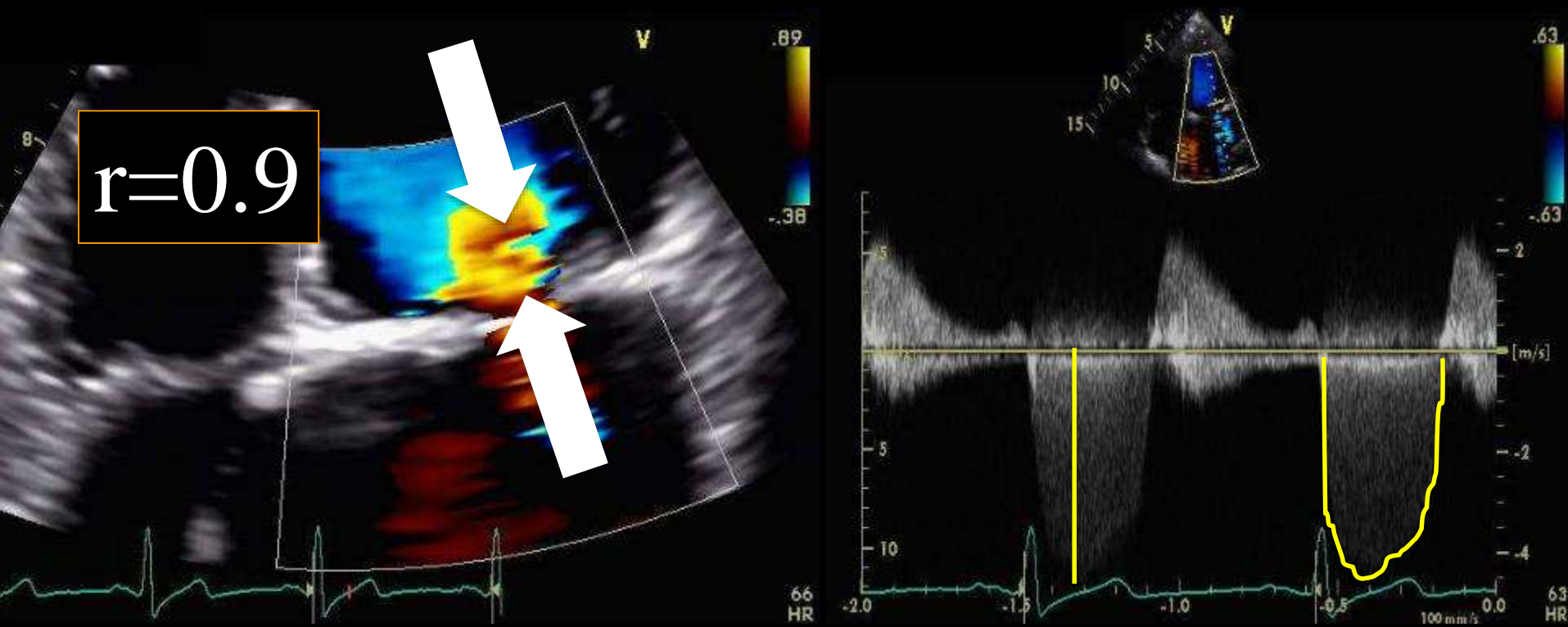
## Tips for measuring flow convergence (PISA)



1. Leaflet to 1<sup>st</sup> color shift
2. Mid systole
3. Baseline shift
4. Zoom
5. Do often

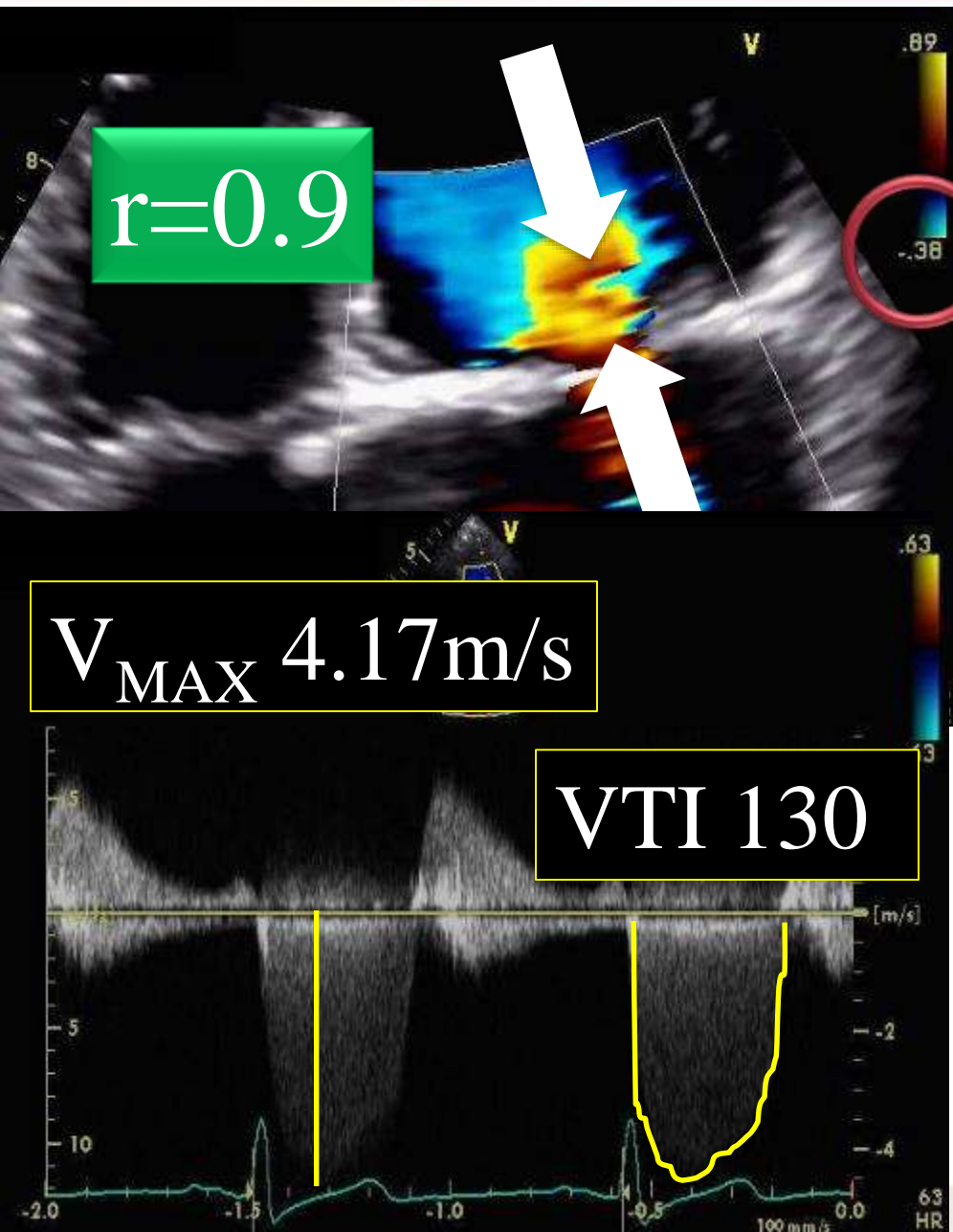
# PISA Method - 4 Numbers

$r = 0.9$       MR pk Vel = 417 cm/s  
 $V_r = 38$  cm/s      MR TVI = 130 cm



**ERO and RVol**

# PISA Method - 4 Numbers



$$VFR = 2 \times \pi \times r^2 \times V_r$$

$$VFR = 6.28 \times .81 \times 38$$

$$VFR = 193cc/s$$

$$ERO = VFR/V_{MAX}$$

$$ERO = 193/417.4$$

$$ERO = 0.46cm^2$$

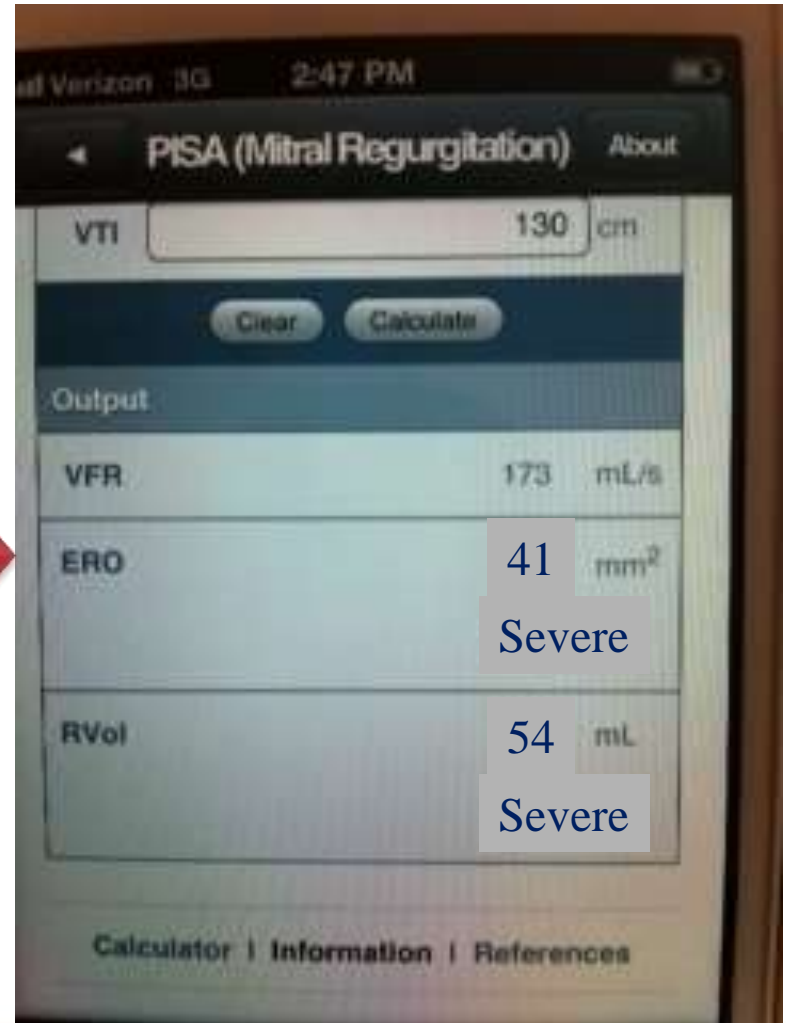
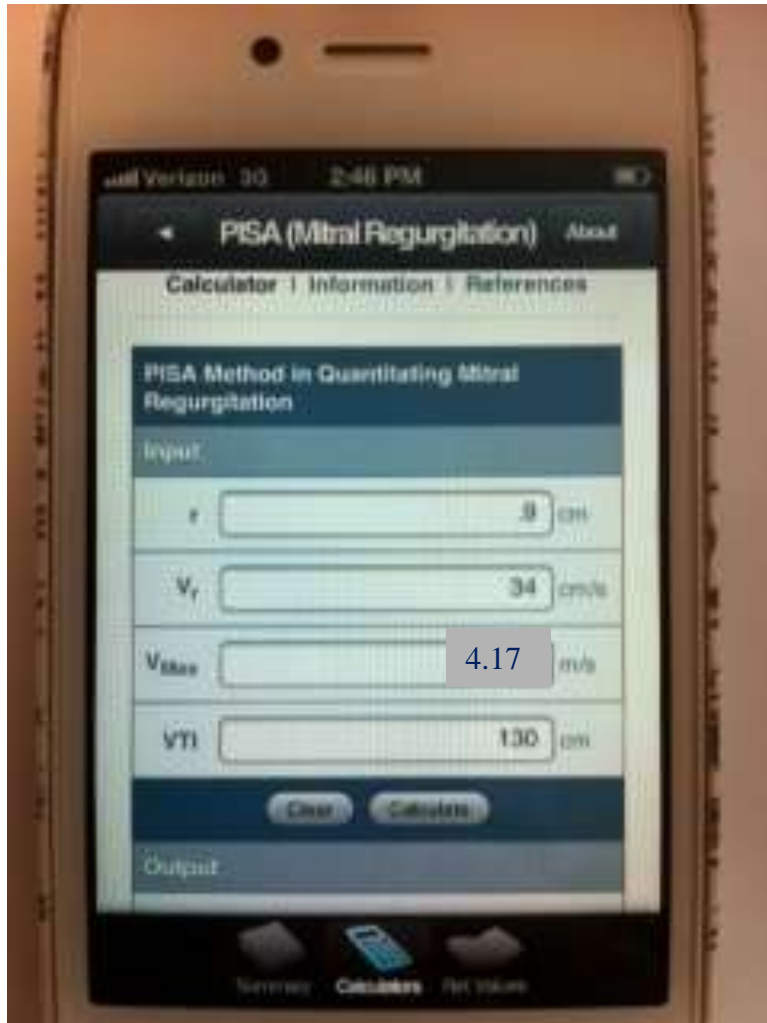
$$RVol = ERO \times VTI$$

$$RVol = 0.46 \times 130$$

$$Rvol = 59.8 mL$$

# Case 175,425,421<sub>cn</sub>

## iASE app





# Grading MR

## Qualitative Methods

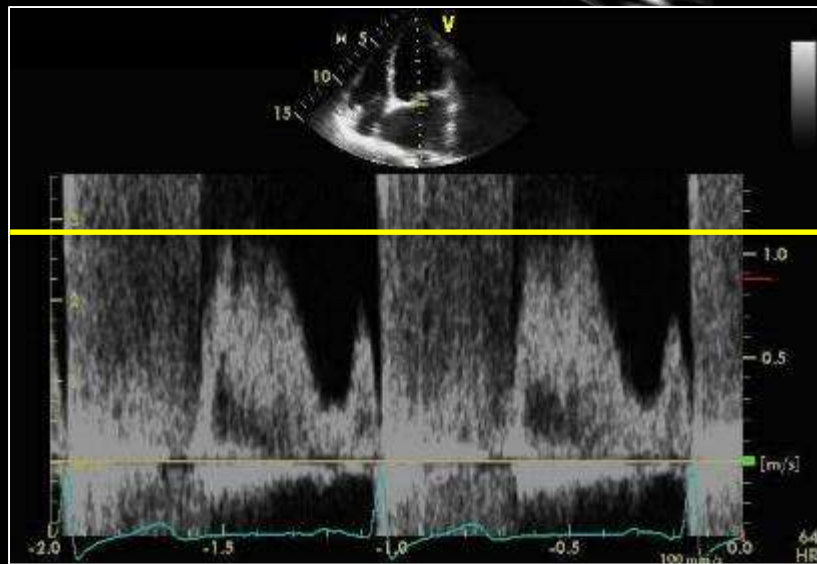
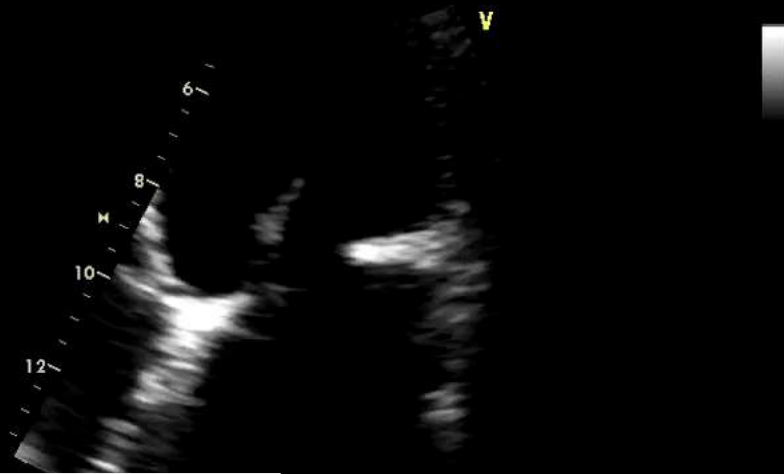
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Reg. Volume	< 30	30-59	≥60
Reg. Fraction	< 30	30-49	≥50
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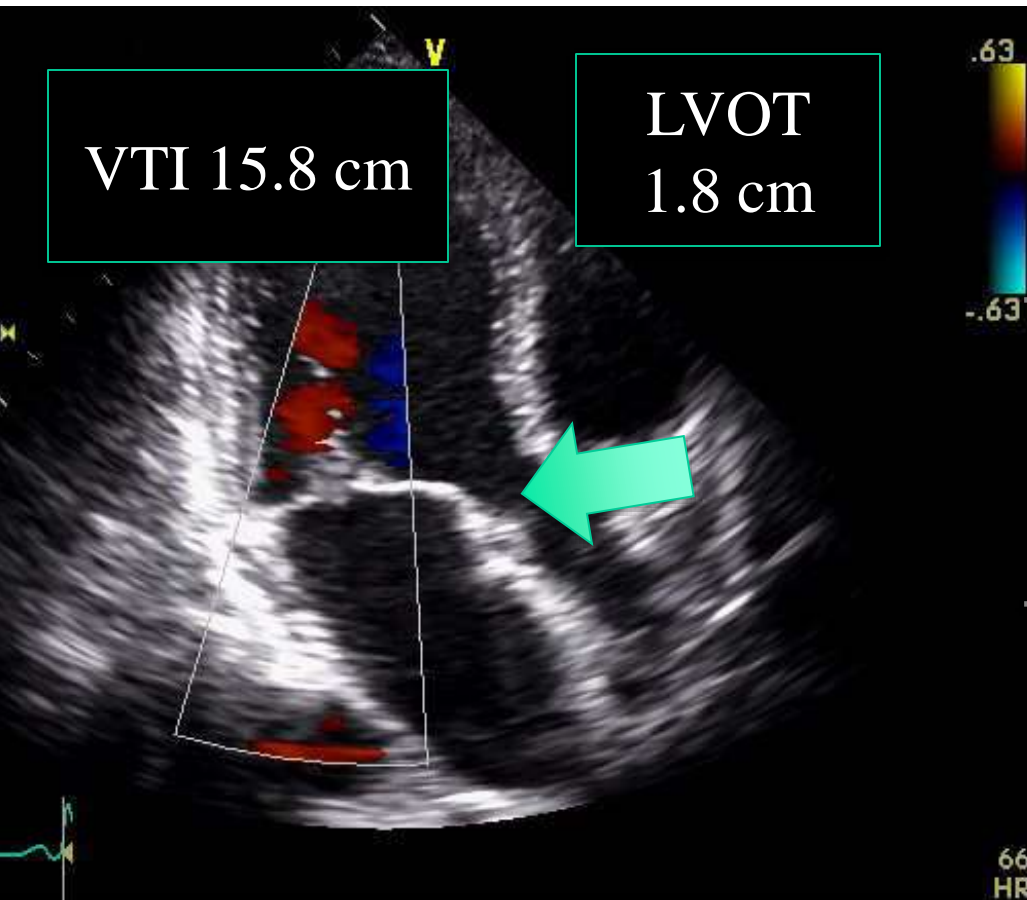
Case 175,425,421<sub>cn</sub>

# MA Stroke Volume & CO



# Regurgitant Fraction %

$$RF\% = SV \text{ (Valve)} - SV \text{ (Systemic)} / SV \text{ (Valve)}$$



$$MA \text{ SV} = D^2 \times .785 \times VTI$$

$$MA \text{ SV} = 2.2 \times .785 \times 25.9$$

$$MA \text{ SV} = 98.4 \text{ ml}$$

$$LVOT \text{ SV} = D^2 \times .785 \times VTI$$

$$LVOT \text{ SV} = 3.24 \times .785 \times 15.8$$

$$LVOT \text{ SV} = 40.2 \text{ ml}$$

$$RF\% = MA_{SV} - LV_{SV} / MA_{SV}$$

$$RF\% = 98.4 - 40.2 / 98.4$$

$$RF\% = 59\%$$

# Grading MR

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Pvein flow	Sys. dominance	Sys. Blunting	Systolic reversal

## Quantitative Methods

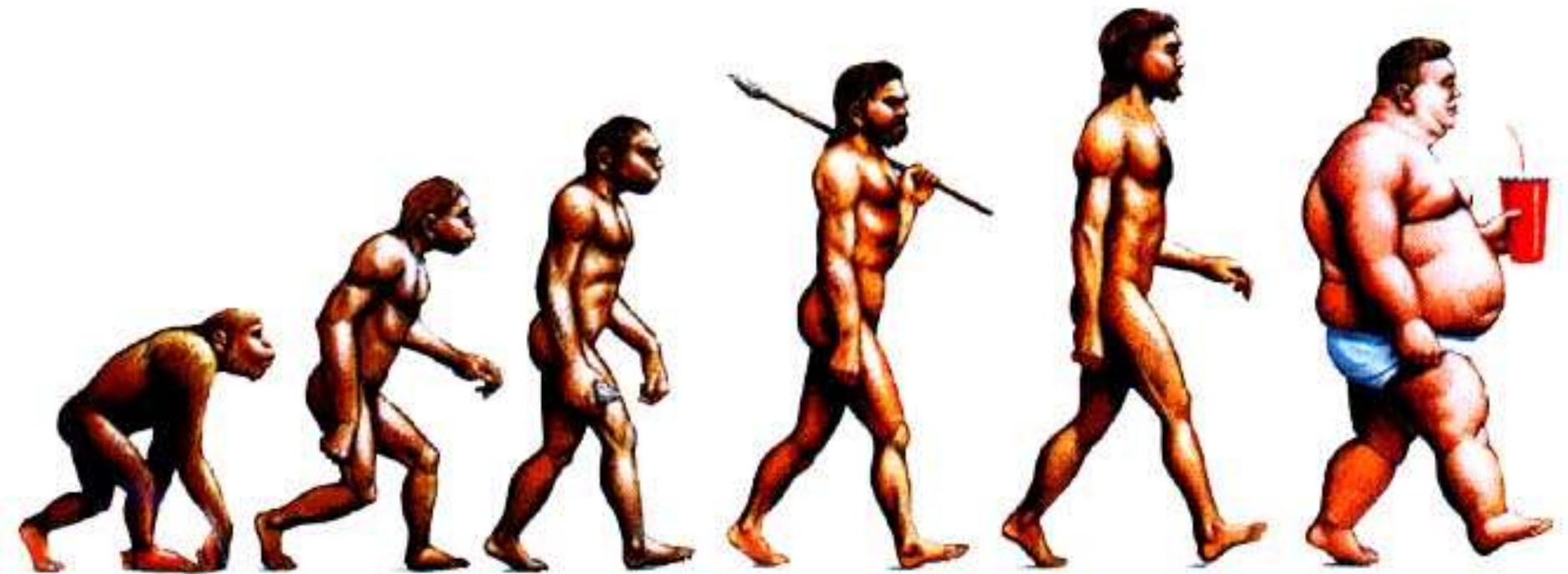
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EROA (cm <sup>2</sup> )	<0.2	0.2-0.39	>0.40

# Case 175,425,421<sub>en</sub>

## Findings for the 32 y/o Vietnamese Female

- LV function normal
- RV normal
- LA Severely enlarged
- RA normal
- AV trace AI
- MV thickened leaflets, surgical ring, severe regurgitation with RF of 59% and estimated Rvol of 58 mL.





# Case 176,298,521<sub>JH</sub>

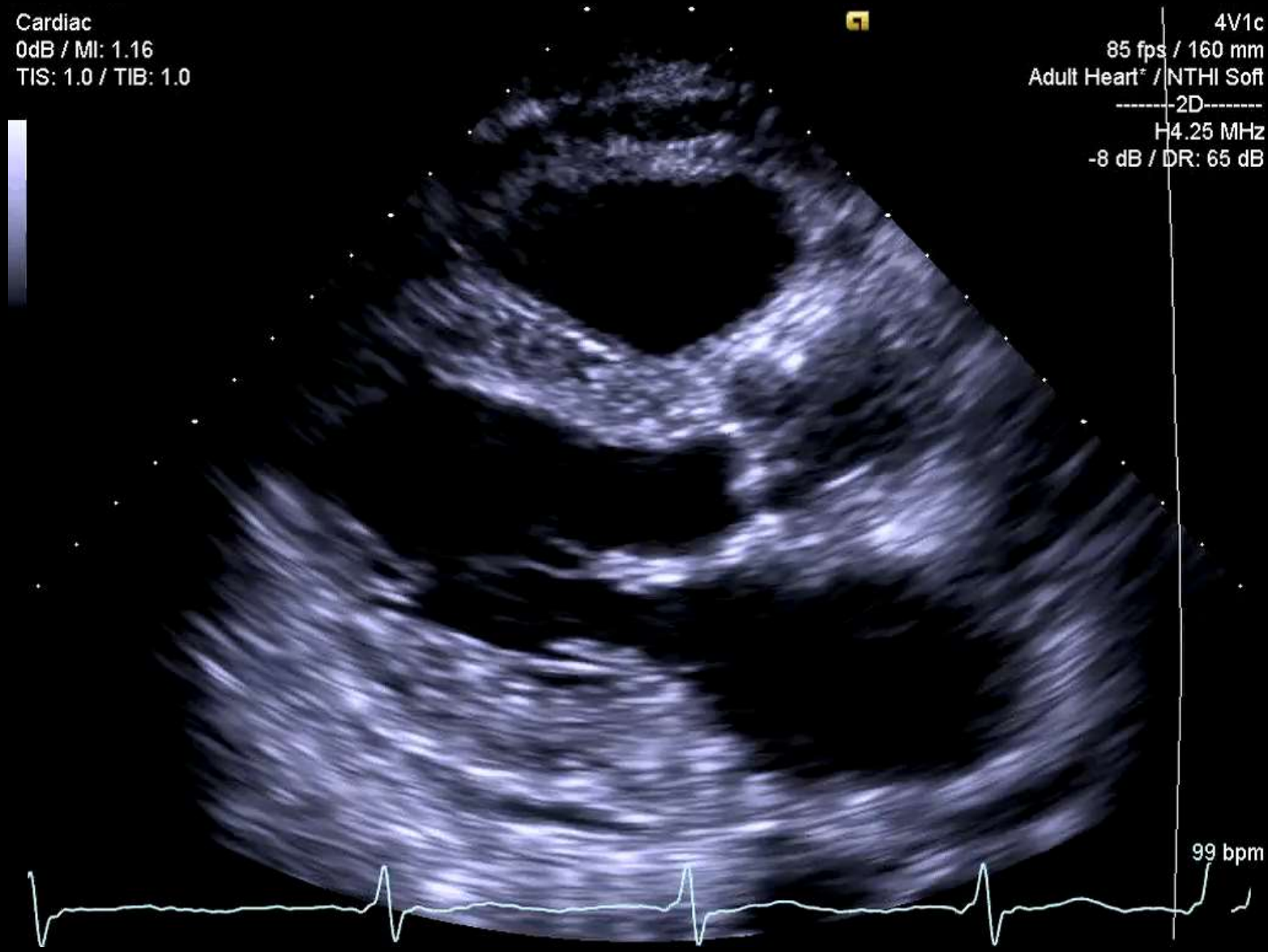
- 68 y/o Female
- 5'7"
- 148.9 lb
- BSA 1.79 m<sup>2</sup>
- Primary indication – Atrial Fibrillation



# Case 176,298,521<sub>JH</sub>

Cardiac  
0dB / MI: 1.16  
TIS: 1.0 / TIB: 1.0

4V1c  
85 fps / 160 mm  
Adult Heart\* / NTHI Soft  
-----2D-----  
H4.25 MHz  
-8 dB / DR: 65 dB



99 bpm



# Case 176,298,521<sub>JH</sub>

Cardiac  
0dB / MI: 1.15  
TIS: 1.0 / TIB: 1.0

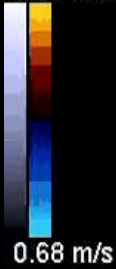
4V1c  
99 fps R 44.4 mm  
Adult Heart\* / NTHI Soft  
-----2D-----  
H4.25 MHz  
-8 dB / DR: 65 dB

132 bpm

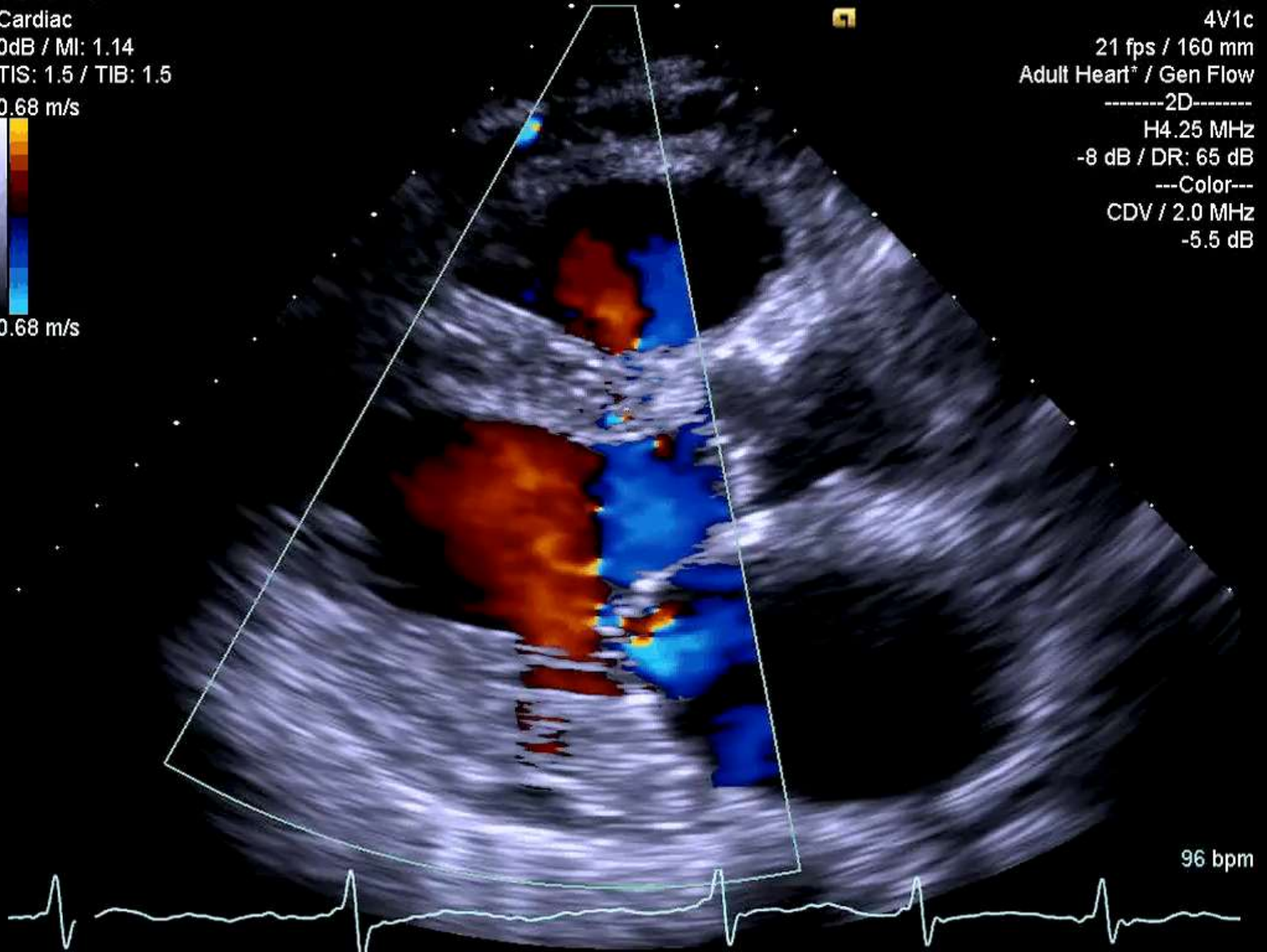


# Case 176,298,521<sub>JH</sub>

Cardiac  
0dB / MI: 1.14  
TIS: 1.5 / TIB: 1.5  
0.68 m/s



4V1c  
21 fps / 160 mm  
Adult Heart\* / Gen Flow  
-----2D-----  
H4.25 MHz  
-8 dB / DR: 65 dB  
---Color---  
CDV / 2.0 MHz  
-5.5 dB



# Case 176,298,521<sub>JH</sub>

Based on information so far, what degree is the MR?



- a) Mild
- b) Mild to Moderate
- c) Moderate
- d) Severe

# Case 176,298,521<sub>JH</sub>

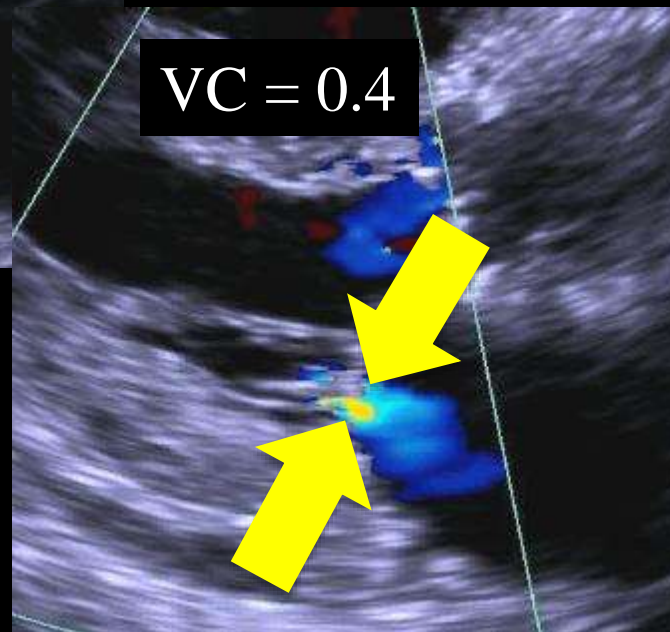
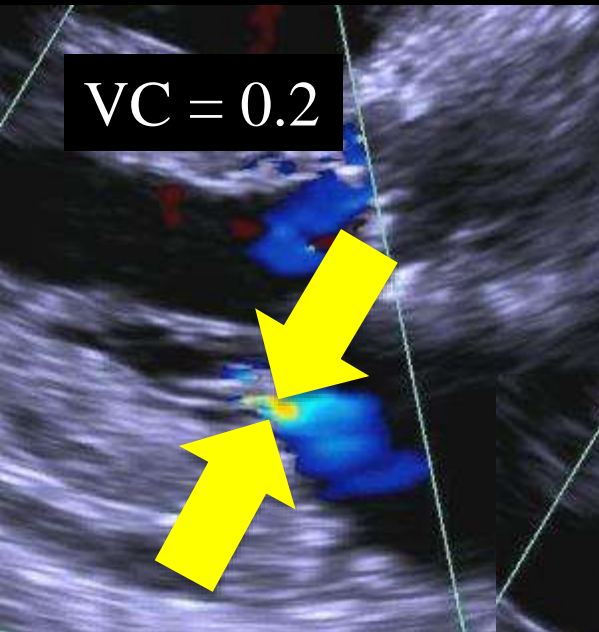
Based on information so far, what degree is the MR?



- a) Mild
- b) Mild to Moderate
- c) Moderate
- ~~d) Severe~~

# Case 176,298,521<sub>TH</sub>

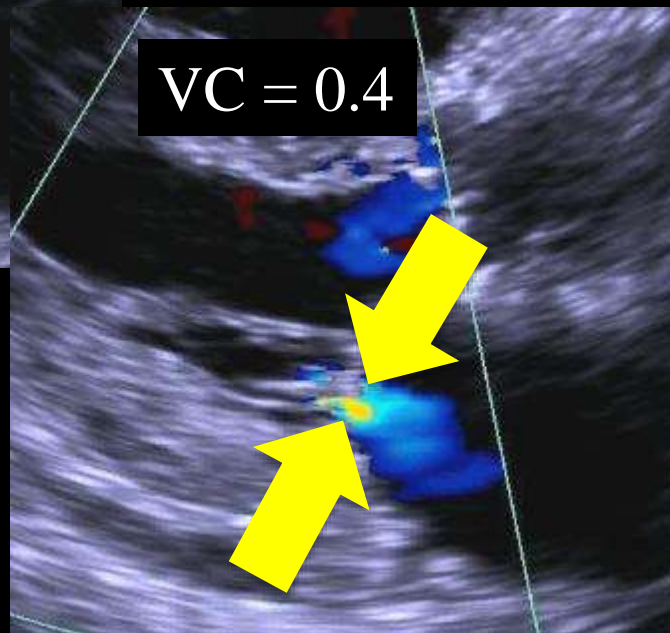
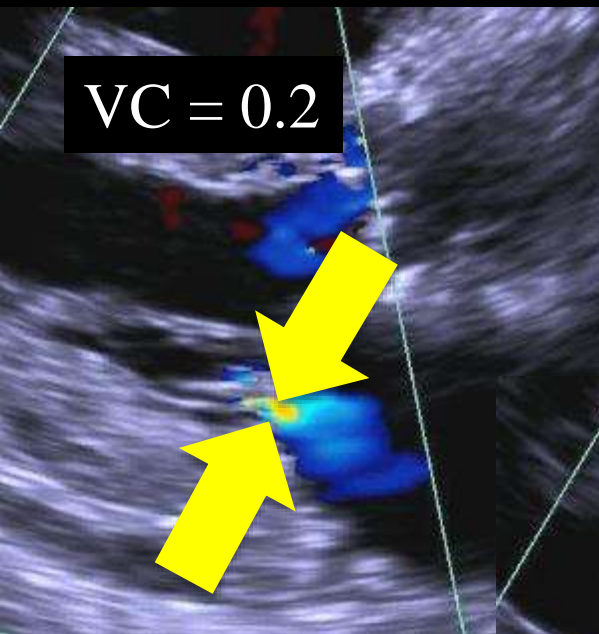
Based on vena contracta what is the degree of MR?



- a) Mild
- b) Mild to Moderate
- c) Moderate
- d) Severe

# Case 176,298,521<sub>JH</sub>

Based on vena contracta what is the degree of MR?



- a) Mild
- b) Mild to Moderate
- c) Moderate
- d) Severe

# Grading MR

## Qualitative Methods

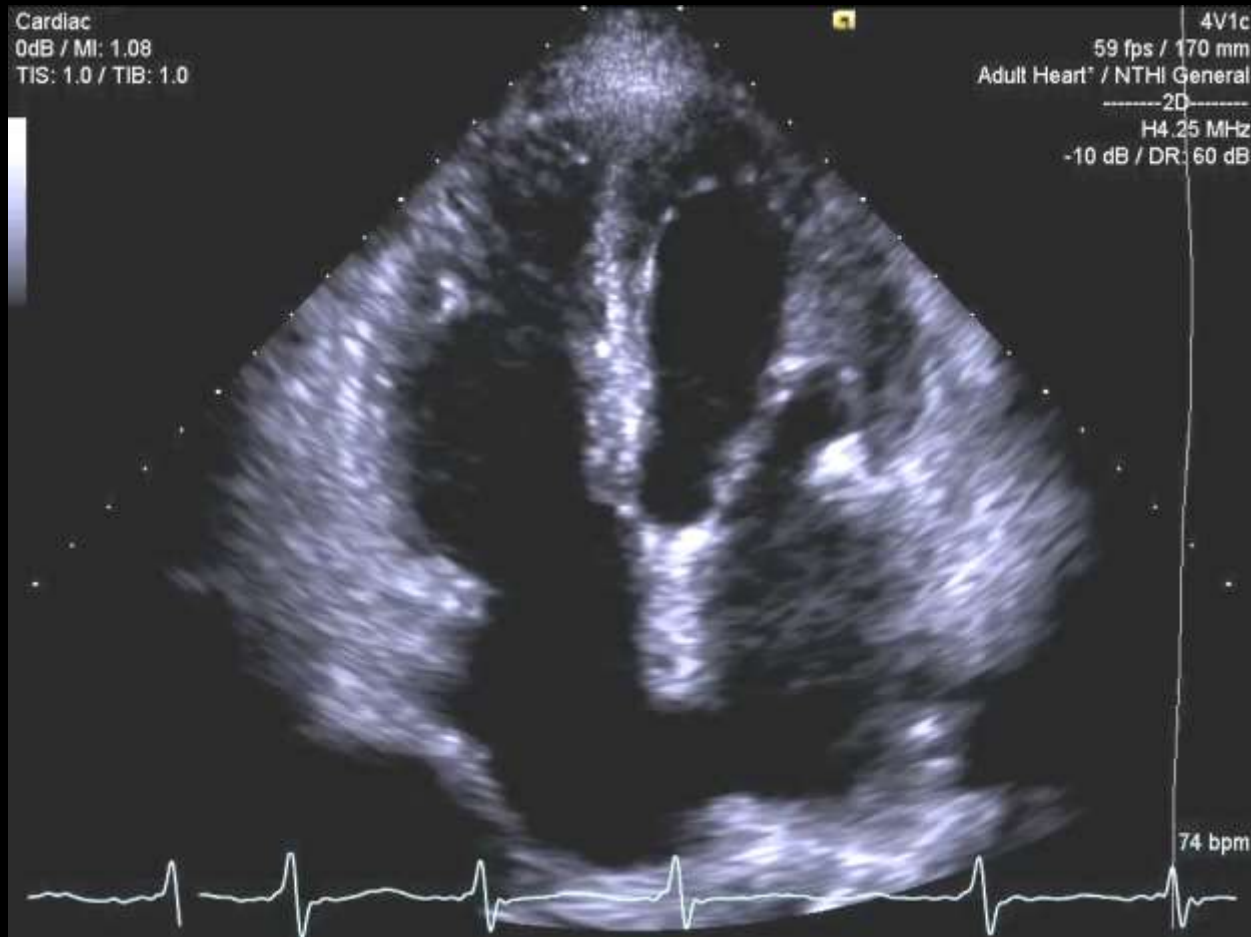
Parameters	Mild	Moderate	Severe
Color jet area	4cm <sup>2</sup> or 10% LA	Variable	>10cm <sup>2</sup> or 40% LA
CW	Faint/parabolic	Dense/para	Dense/early peak
Pvein flow	Sys. dominance	Sys. Blunting	Systolic reversal
MV Inflow	Dominant A wave		Dominant E >1.2

## Quantitative Methods

Parameters	Mild	Moderate	Severe
Vena Contracta	<0.3	0.3-0.69	≥0.7
Reg. Volume	< 30	30-59	≥60
Reg. Fraction	< 30	30-49	≥50
EROA (cm <sup>2</sup> )	<0.2	0.2-0.39	≥0.40

# Case 176,298,521<sub>JH</sub>

## What size is the LA?

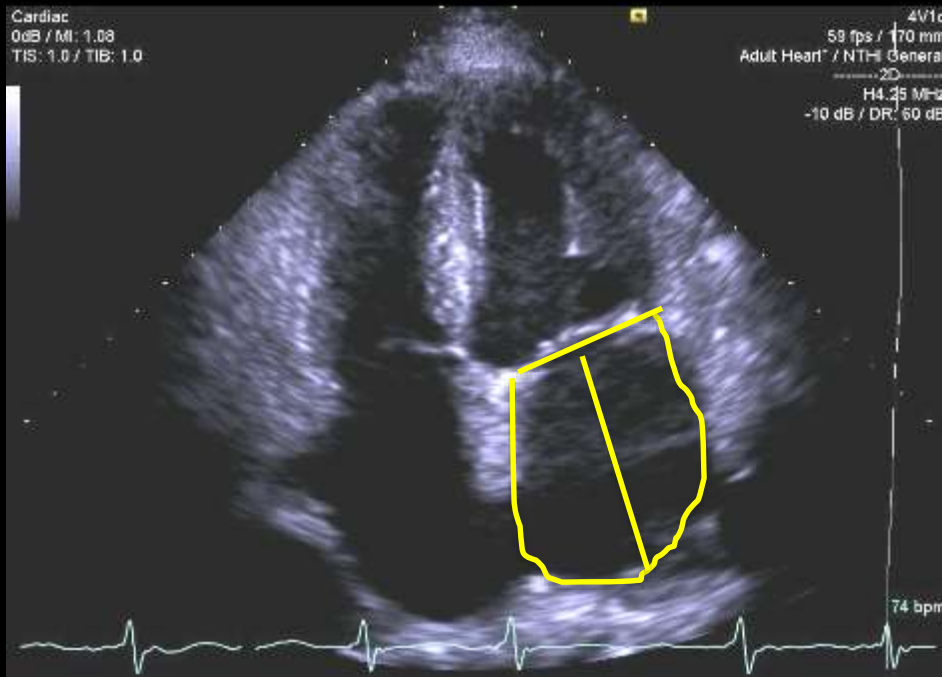




# Case 176,298,521<sub>JH</sub>

## What size is the LA?

71.7 ml

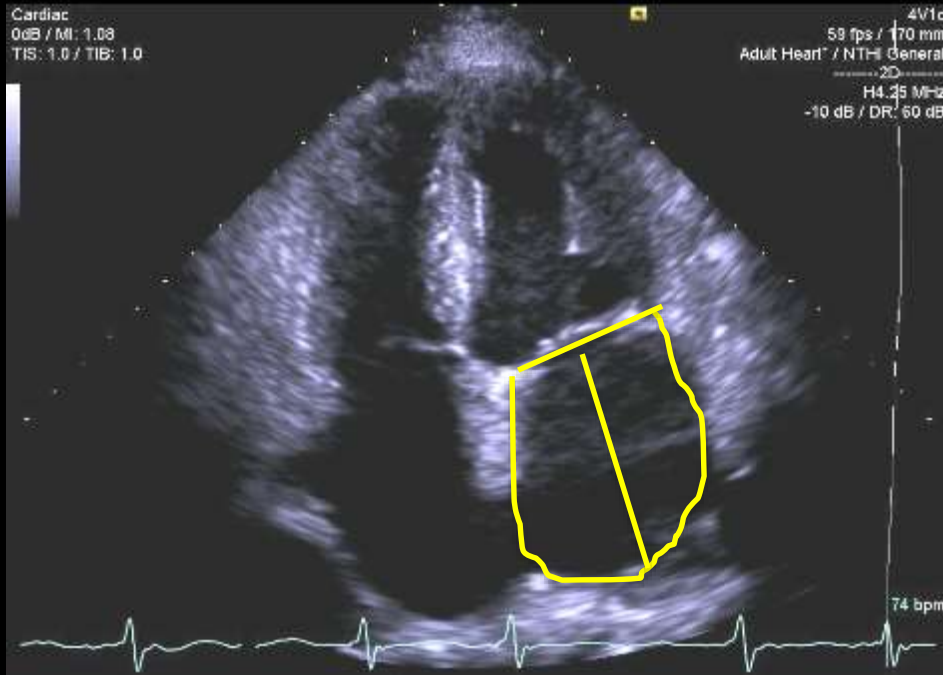
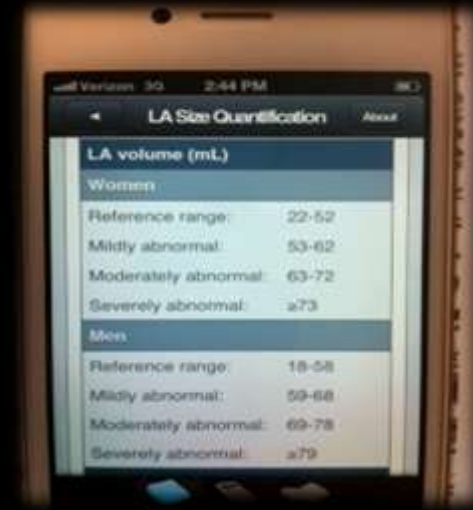


- a) Normal
- b) Mildly enlarged
- c) Moderately big
- d) Severely enlarged

# Case 176,298,521<sub>JH</sub>

## What size is the LA?

71.7 ml



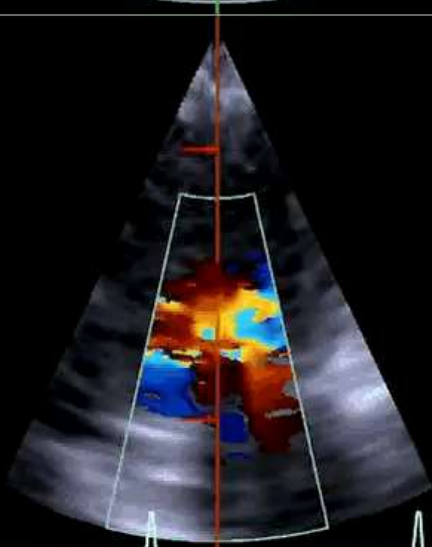
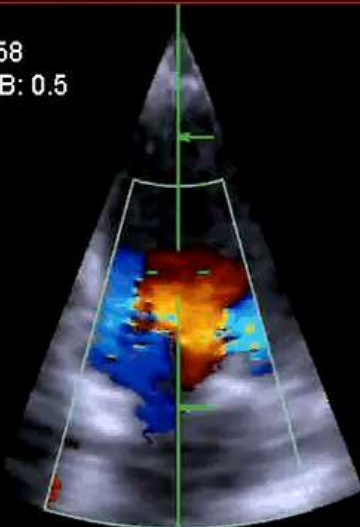
- a) Normal
- b) Mildly enlarged
- c) Moderately big
- d) Severely enlarged

# Case 176,298,521<sub>JH</sub>

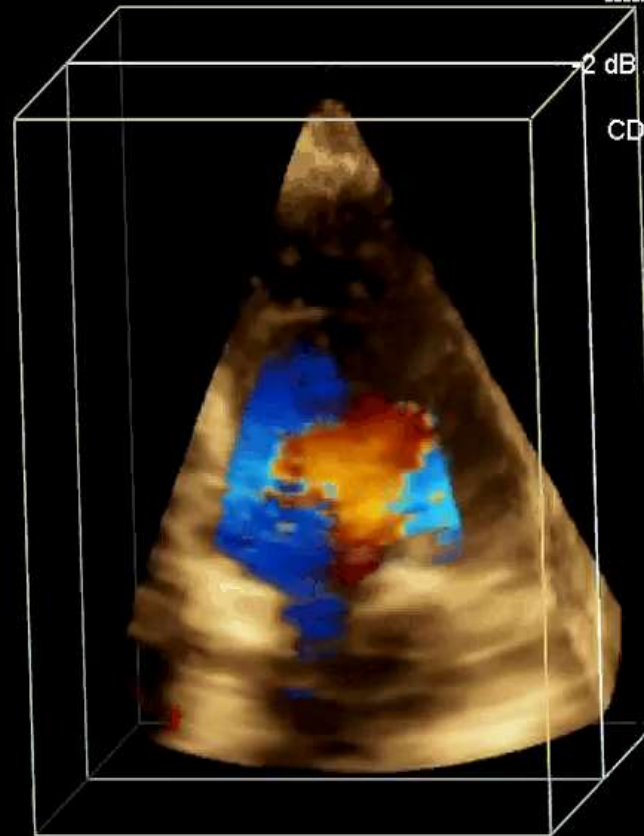
Cardiac  
0dB / MI: 0.58  
TIS: 0.5 / TIB: 0.5  
0.66 m/s

0.66 m/s

0.66 m/s




4Z1c  
22 vps / 130 mm  
Adult Heart\* / Gen Flow  
-----4D-----  
2.8 MHz  
2 dB / DR: 55 dB  
---Color---  
CDV / 2.5 MHz  
2 dB



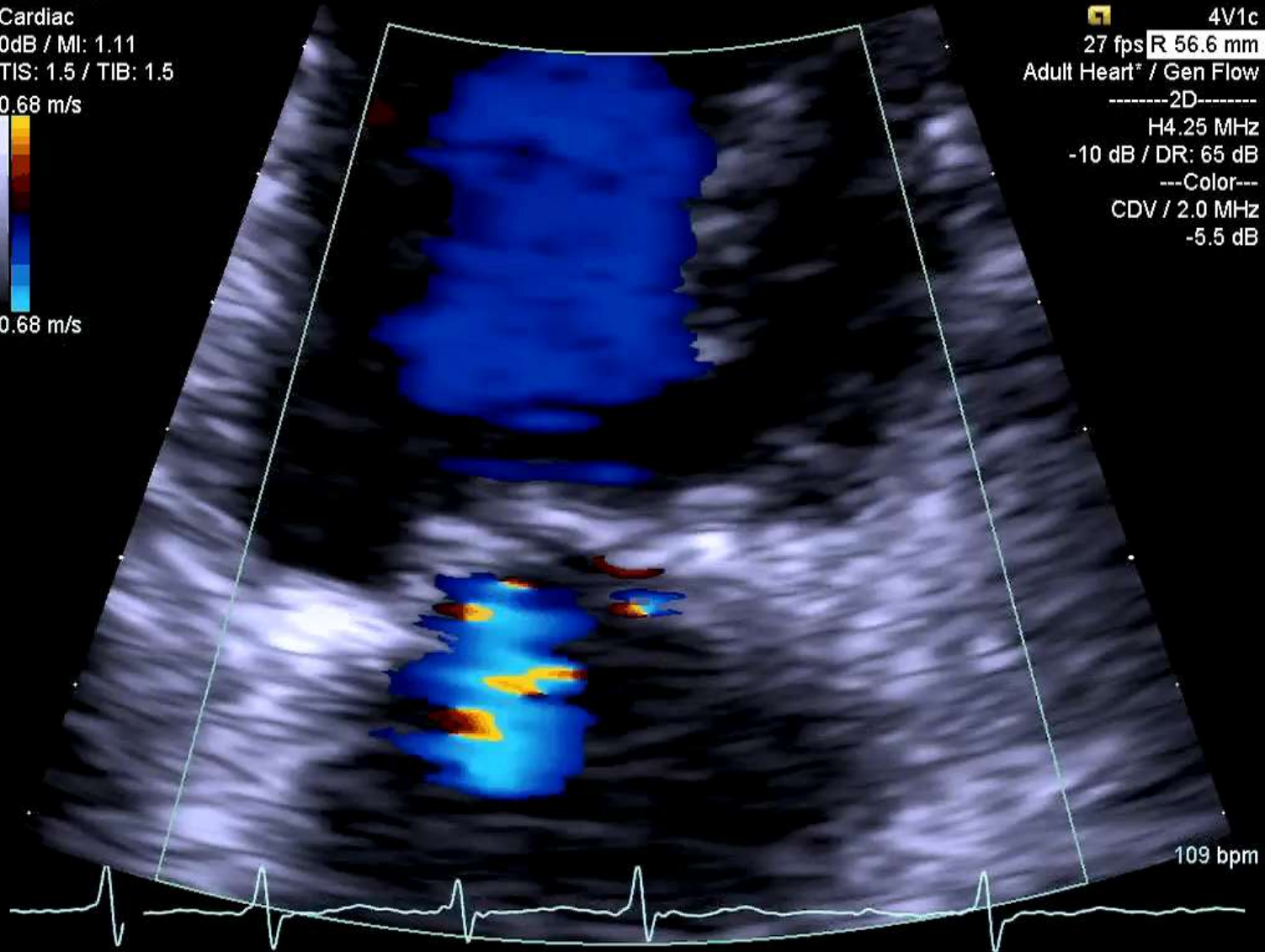
114 bpm



# Case 176,298,521<sub>JH</sub>

Cardiac  
0dB / MI: 1.11  
TIS: 1.5 / TIB: 1.5  
0.68 m/s  
  
0.68 m/s

 4V1c  
27 fps **R 56.6 mm**  
Adult Heart\* / Gen Flow  
-----2D-----  
H4.25 MHz  
-10 dB / DR: 65 dB  
---Color---  
CDV / 2.0 MHz  
-5.5 dB



# Case 176,298,521<sub>JH</sub>

How many MR jets are there??



- a) one
- b) two
- c) three
- d) What MR?

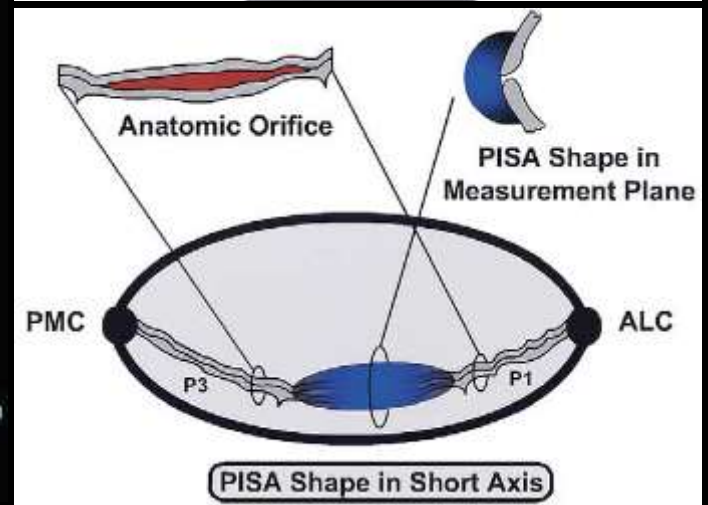
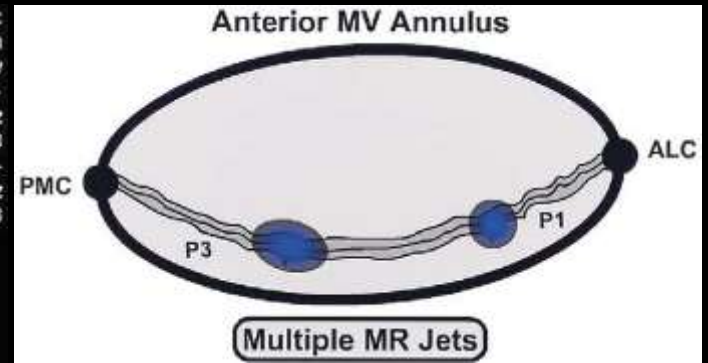
# Case 176,298,521<sub>JH</sub>

## How many MR jets are there??

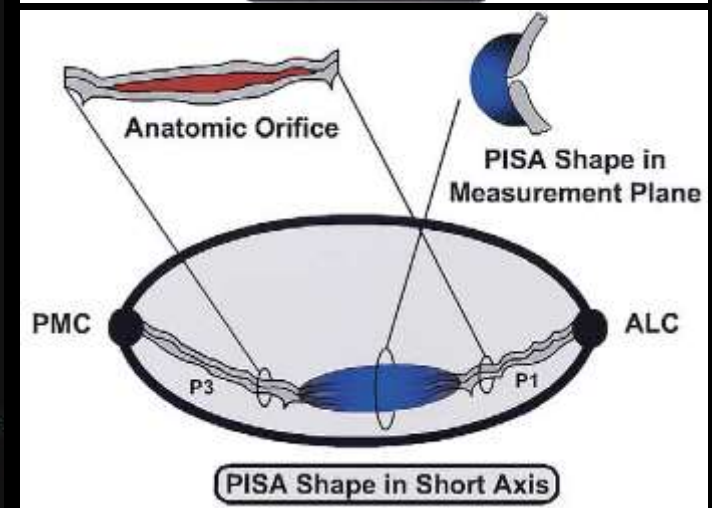
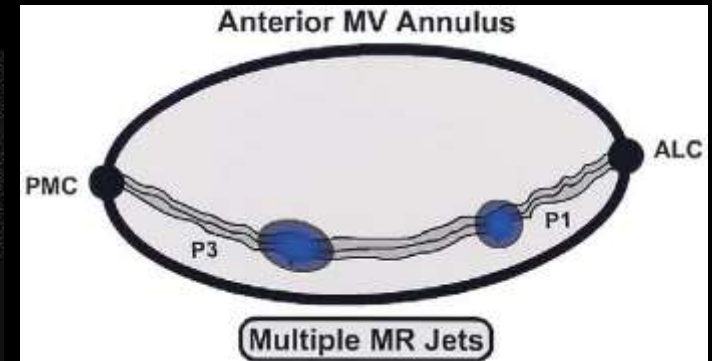


- a) one
- b) two
- c) three
- d) What MR?

# Case 176,298,521<sub>JH</sub>



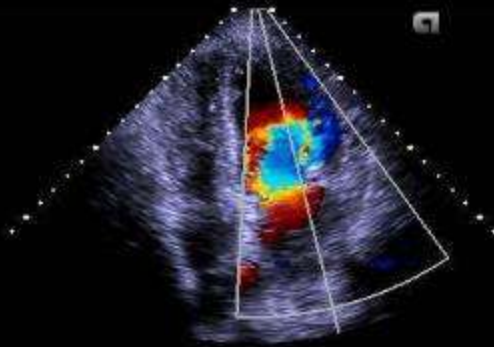
# Case 176,298,521<sub>JH</sub>



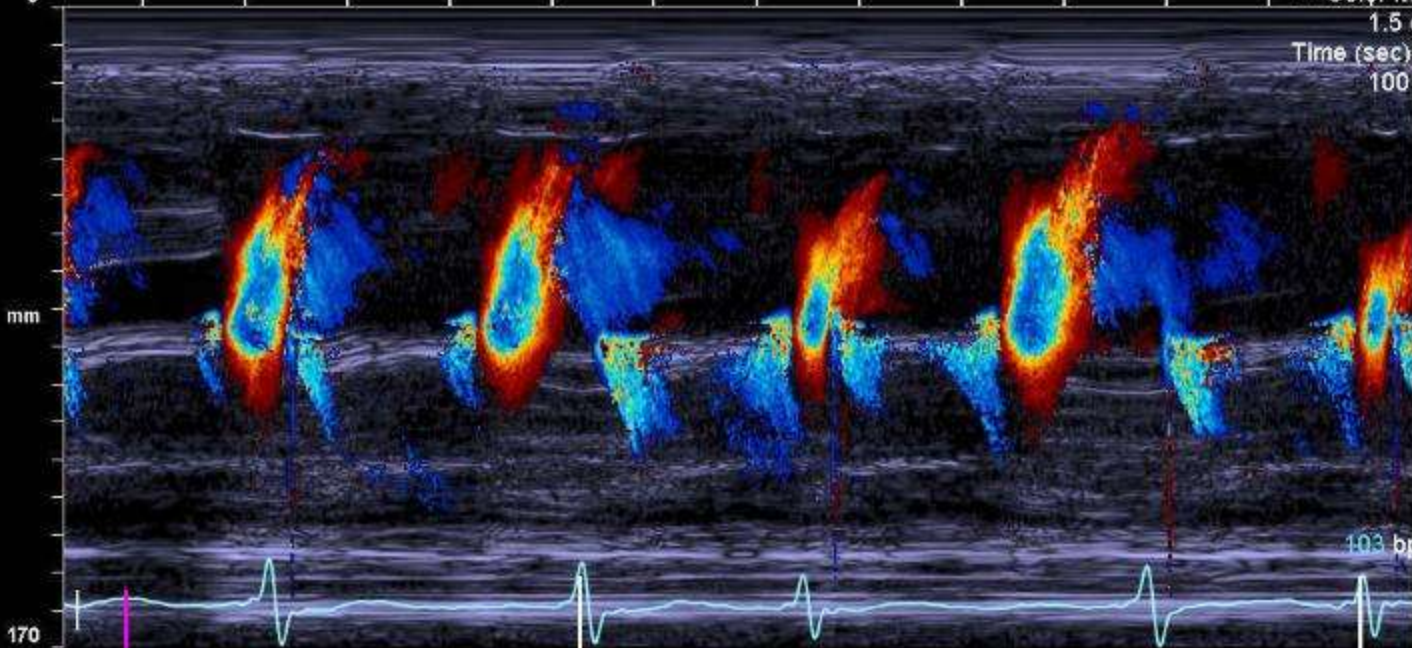


# Case 176,298,521<sub>JH</sub>

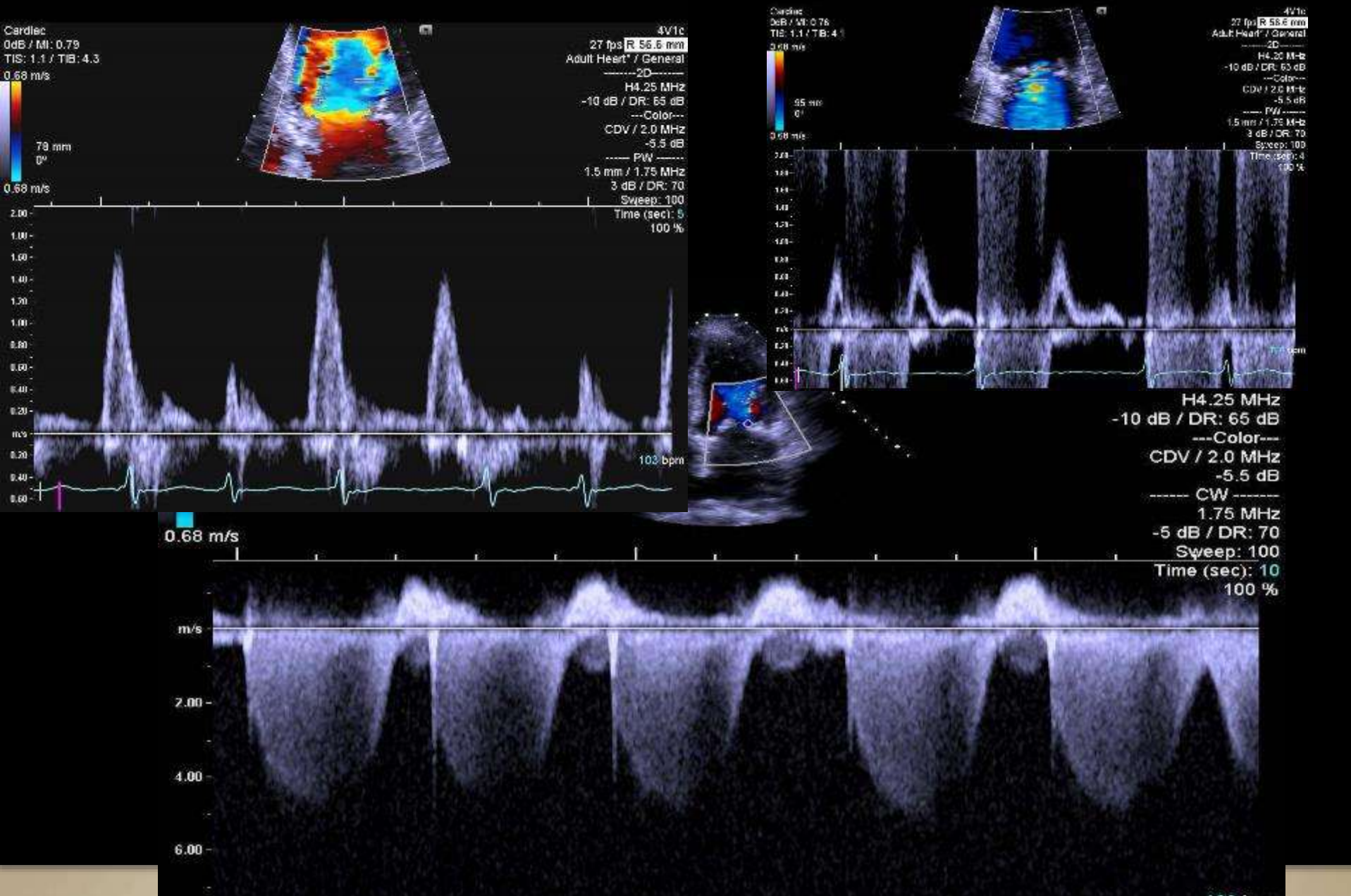
Cardiac  
0dB / MI: 1.35  
TIS: 0.8 / TIB: 3.4  
0.68 m/s



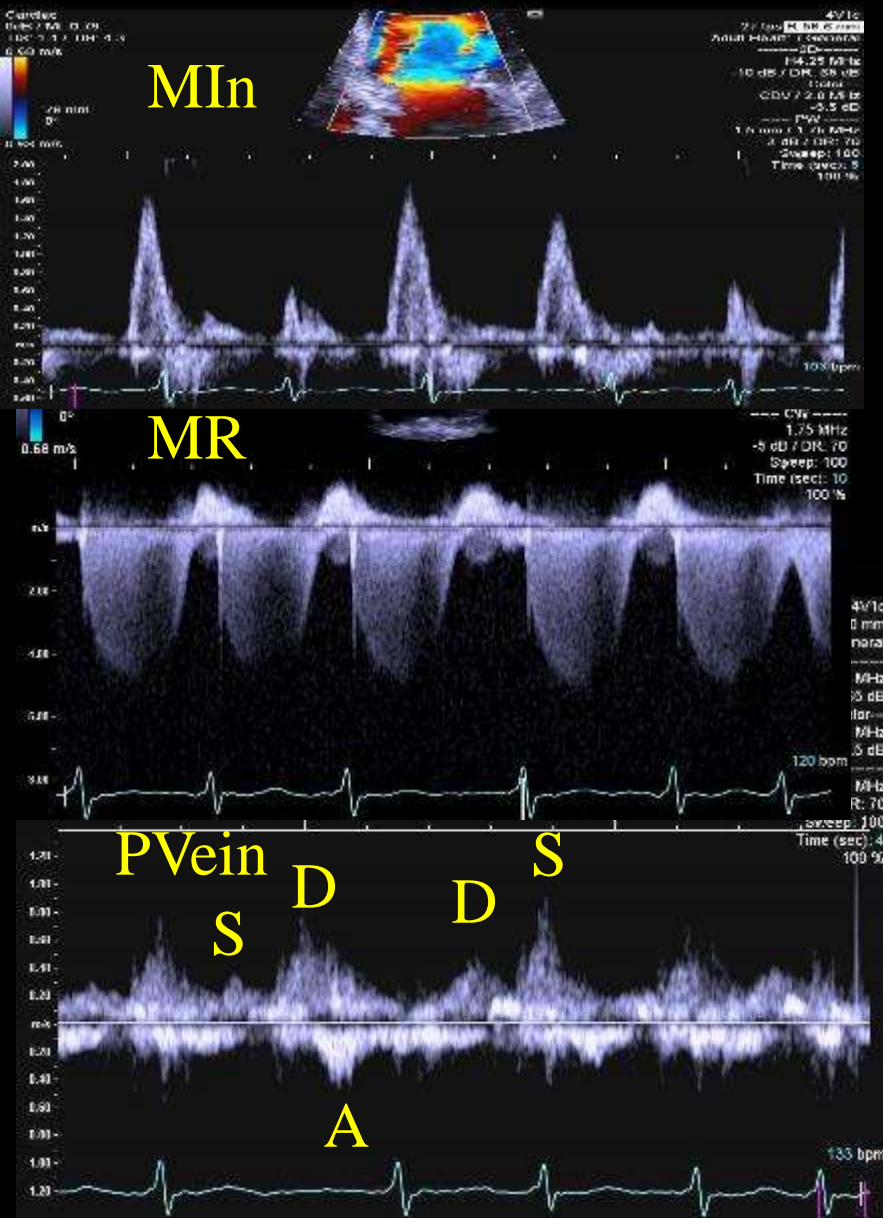
4V1c  
21 fps / 170 mm  
Adult Heart\* / High Flow  
-----2D-----  
H4.25 MHz  
-10 dB / DR: 65 dB  
----M----  
0 dB / DR: 55 dB  
Sweep: 100  
---Color---  
CDV / 2.0 MHz  
-5.5 dB  
---Color M---  
1.5 dB  
Time (sec): 2  
100 %



# Case 176,298,521<sub>JH</sub>



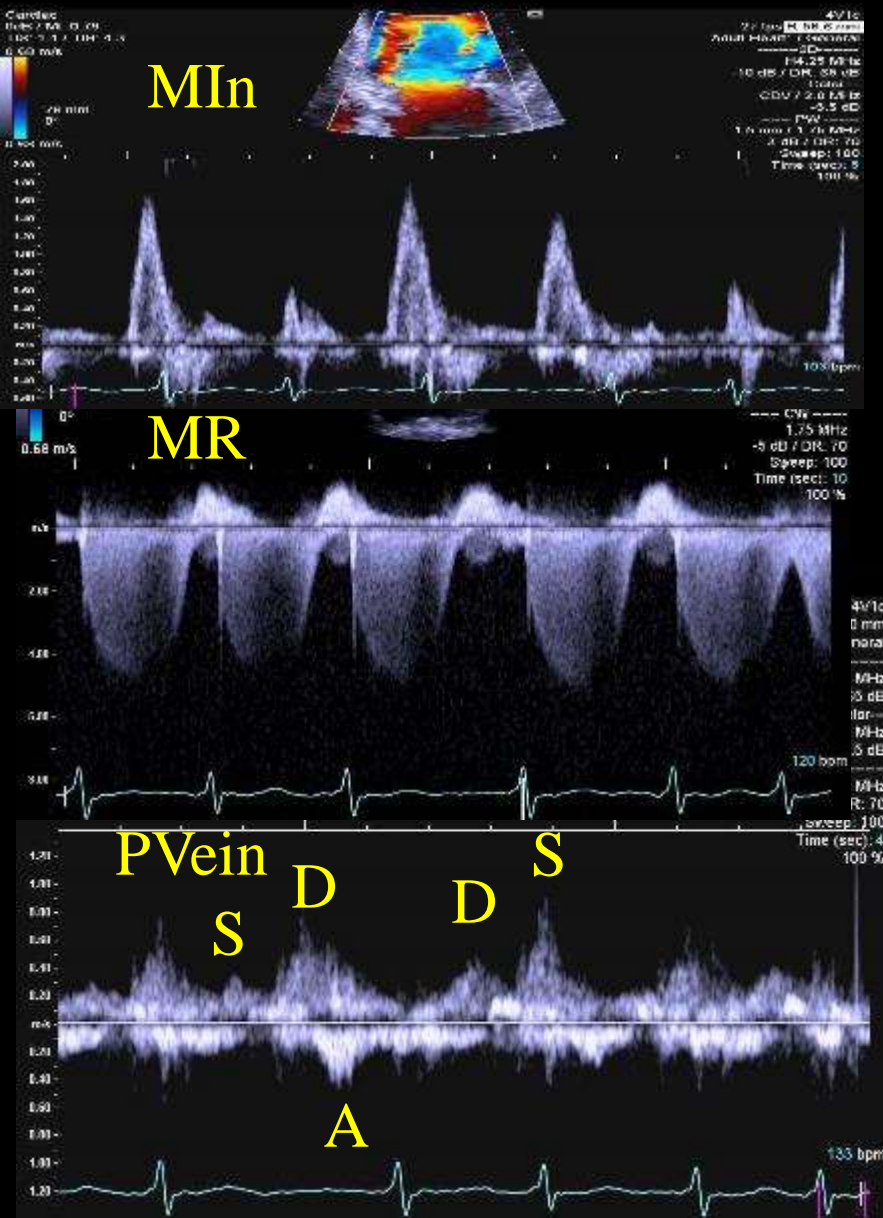
# Case 176,298,521<sub>JH</sub>



Supportive signs include...

- a) Dominant E
- b) Dense parabolic Doppler
- c) None of the above
- d) A & B

# Case 176,298,521<sub>JH</sub>



Supportive signs include...

- a) Dominant E
- b) Dense parabolic Doppler
- c) None of the above
- d) A & B

# Grading MR

## Qualitative/Supportive Methods

Parameters	Mild	Moderate	Severe
Color jet area	4cm <sup>2</sup> or 10% LA	Variable	>10cm <sup>2</sup> or 40% LA
CW	Faint/parabolic	Dense/para	Dense/early peak
Pvein flow	Sys. dominance	Sys. Blunting	Systolic reversal
MV Inflow	Dominant A wave		Dominant E >1.2

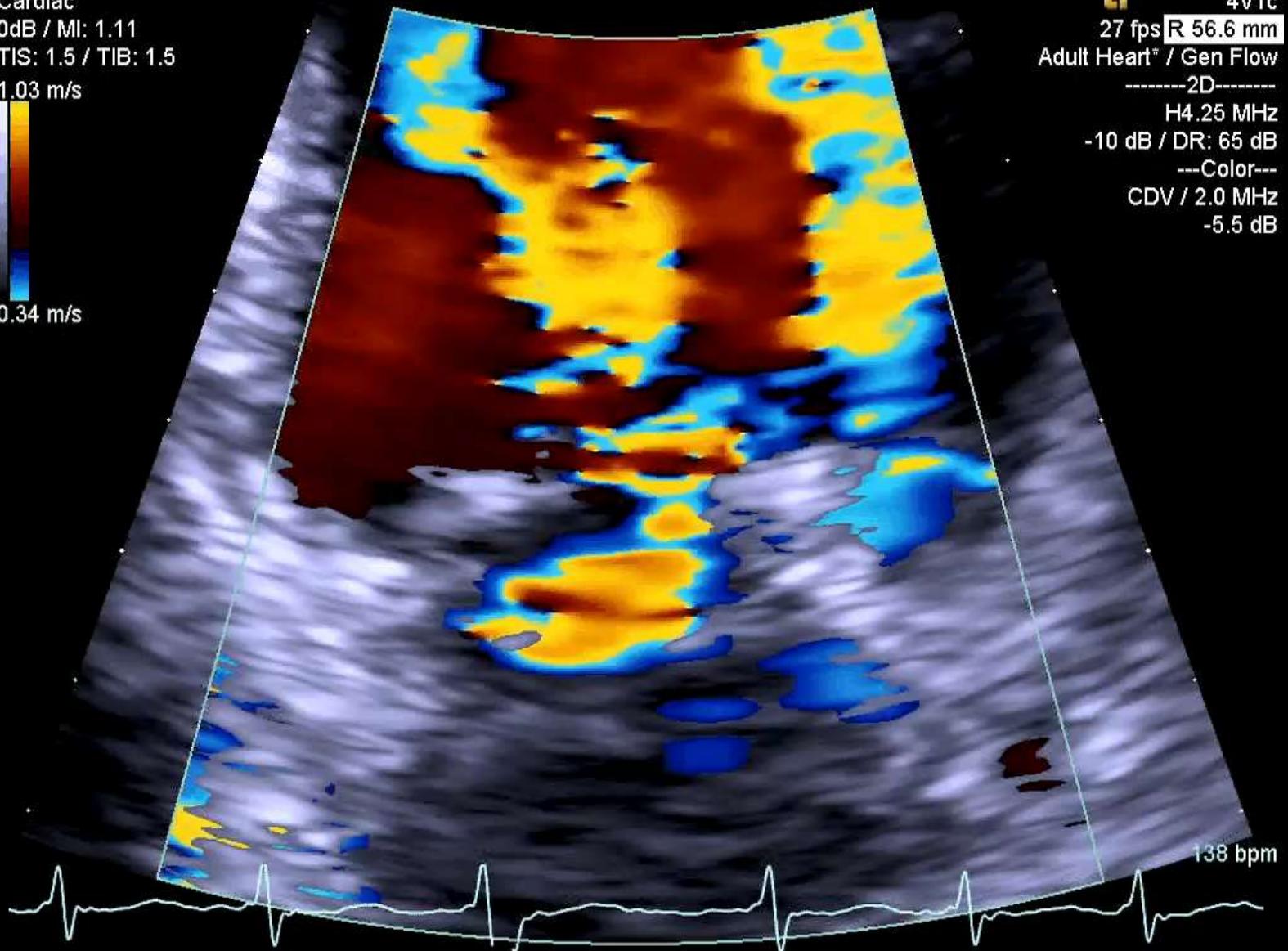
## Quantitative Methods

Parameters	Mild	Moderate	Severe
Vena Contracta	<0.3	0.3-0.69	≥0.7
Reg. Volume	< 30	30-59	≥60
Reg. Fraction	< 30	30-49	≥50
EROA (cm <sup>2</sup> )	<0.2	0.2-0.39	≥0.40

# Case 176,298,521<sub>JH</sub>

Cardiac  
0dB / MI: 1.11  
TIS: 1.5 / TIB: 1.5  
1.03 m/s  
0.34 m/s

4V1c  
27 fps R 56.6 mm  
Adult Heart<sup>®</sup> / Gen Flow  
-----2D-----  
H4.25 MHz  
-10 dB / DR: 65 dB  
---Color---  
CDV / 2.0 MHz  
-5.5 dB



# Case 176,298,521<sub>JH</sub>

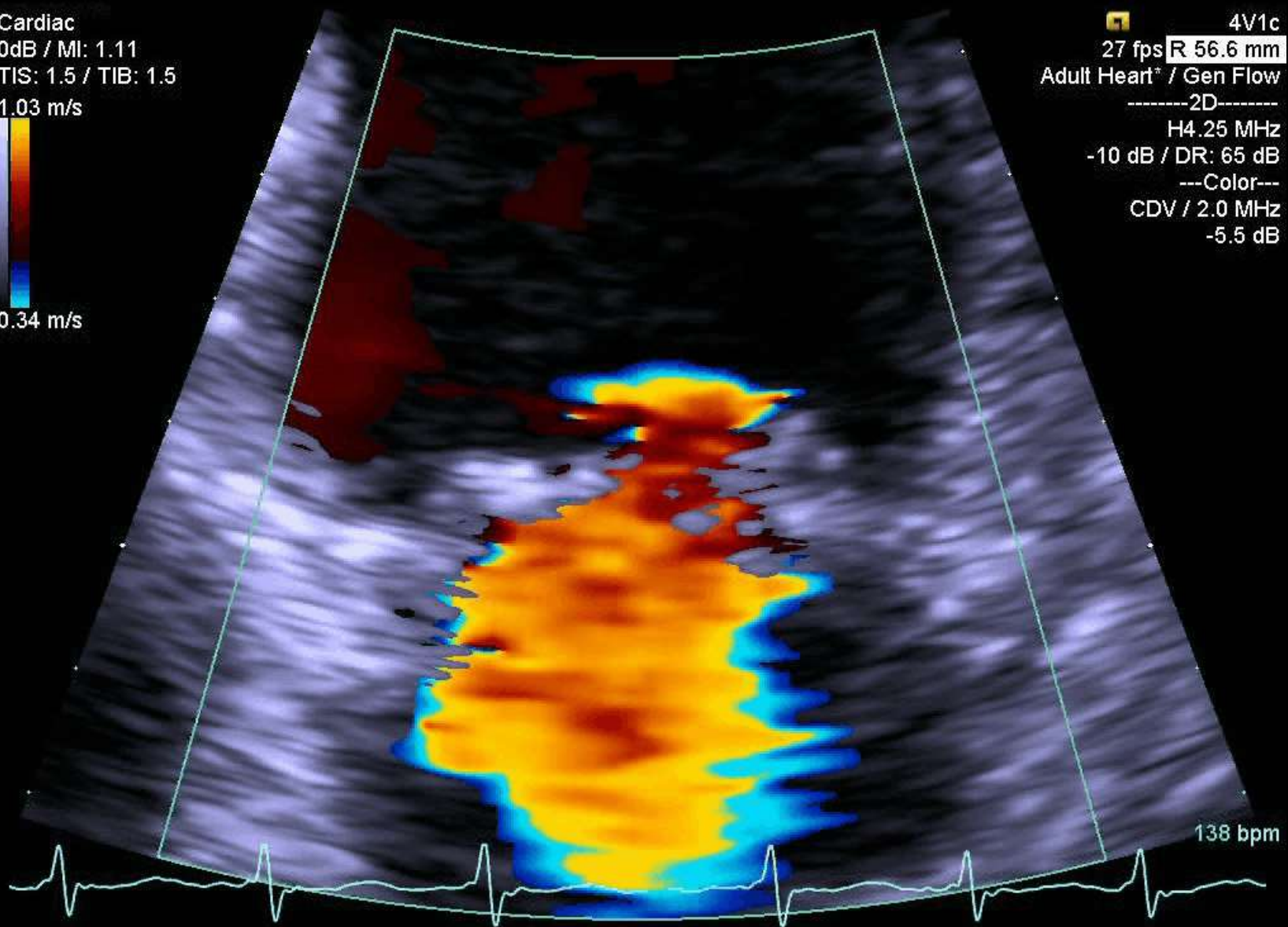
Cardiac  
0dB / MI: 1.11  
TIS: 1.5 / TIB: 1.5

1.03 m/s



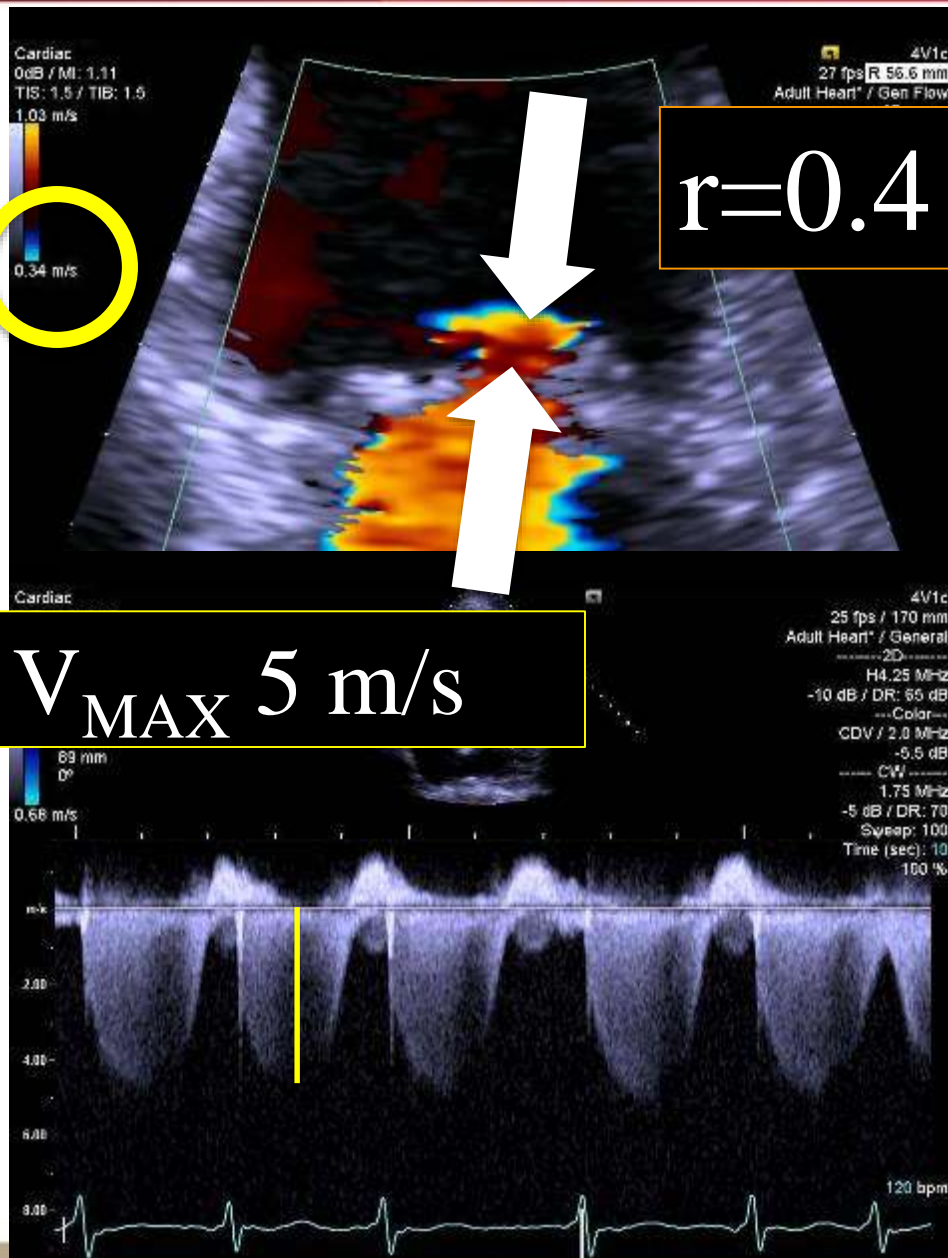
0.34 m/s

4V1c  
27 fps R 56.6 mm  
Adult Heart\* / Gen Flow  
-----2D-----  
H4.25 MHz  
-10 dB / DR: 65 dB  
---Color---  
CDV / 2.0 MHz  
-5.5 dB



138 bpm

# PISA Method - 4 Numbers



$$VFR = 2 \times \pi \times r^2 \times V_r$$

$$VFR = 6.28 \times .16 \times 34$$

$$VFR = 34 \text{ cc/s}$$

$$ERO = VFR / V_{MAX}$$

$$ERO = 34 / 500$$

$$ERO = 0.068 \text{ cm}^2$$

$$\text{Easy PISA} = 0.38 \times r^2$$

$$ERO = 0.38 \times 0.16$$

$$ERO = 0.06 \text{ cm}^2$$



# Grading MR

## Qualitative Methods

Parameters	Mild	Moderate	Severe
Color jet area	4cm <sup>2</sup> or 10% LA	Variable	>10cm <sup>2</sup> or 40% LA
CW	Faint/parabolic	Dense/para	Dense/early peak
Pvein flow	Sys. dominance	Sys. Blunting	Systolic reversal
MV Inflow	Dominant A wave		Dominant E >1.2

## Quantitative Methods

Parameters	Mild	Moderate	Severe
Vena Contracta	<0.3	0.3-0.69	≥0.7
Reg. Volume	< 30	30-59	≥60
Reg. Fraction	< 30	30-49	≥50
EROA (cm <sup>2</sup> )	<0.2	0.2-0.39	≥0.40

# Case 176,298,521<sub>JH</sub>

## Findings for the 68 y/o female

- LV size normal, mild/mod LVH, fx lower limits of normal
- RV size normal and mildly depressed
- LA mod to severely enlarged
- RA mildly enlarged
- Small PE
- AV mild calcification with trace AI
- MV no structural abnormalities with mild to moderate regurgitation



# Case 185,425,421<sub>ej</sub>

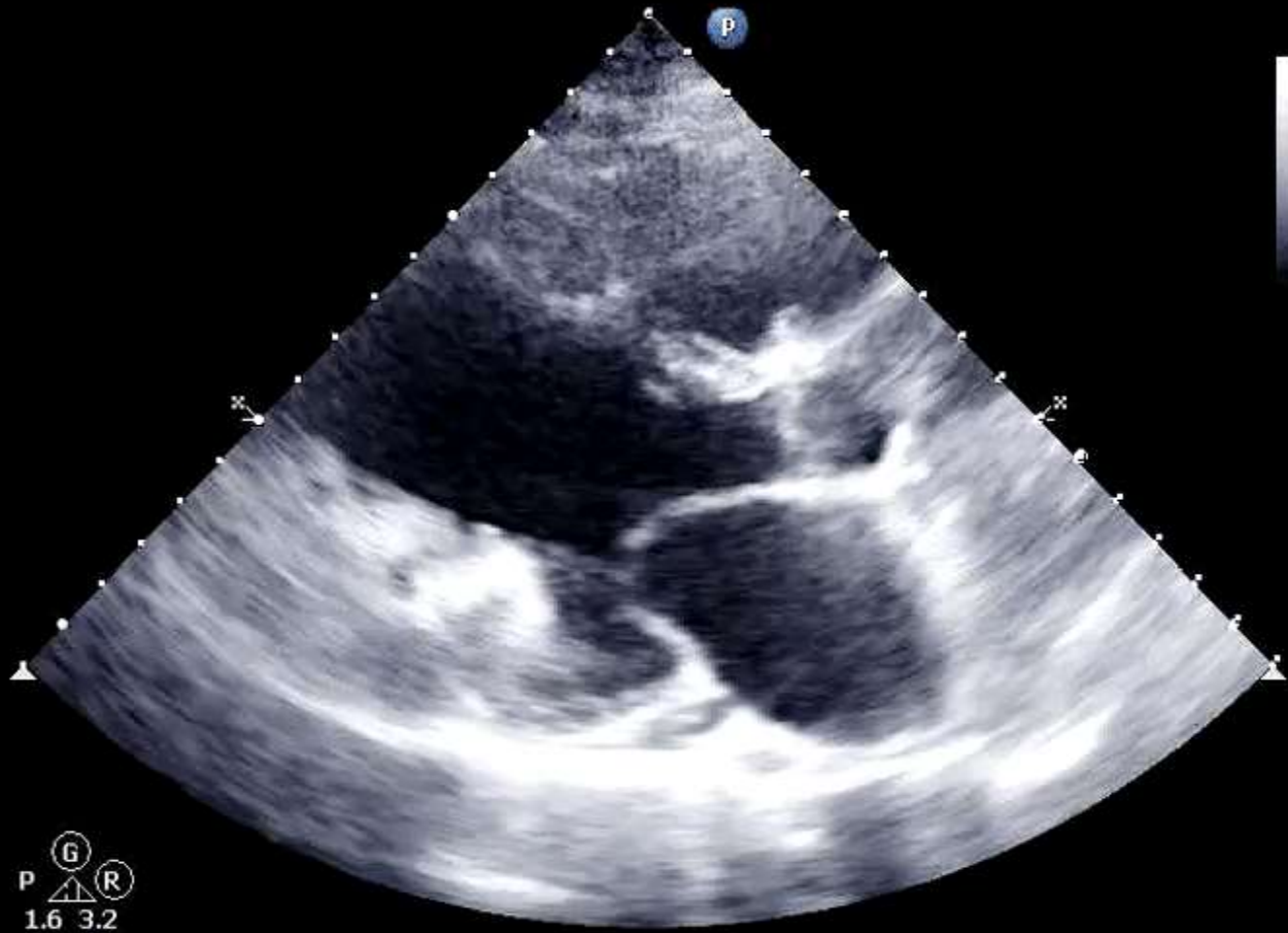
- 59 y/o female
- Primary diagnosis CHF
- 5'8"
- 173 lb
- BSA 1.92
- B/P 70/00



# Case 185,425,421<sub>cj</sub>

ECHO  
S5-1  
60Hz  
16cm

2D  
HGen-HRes  
Gn 48  
C 50  
2/4/2  
100 mm/s

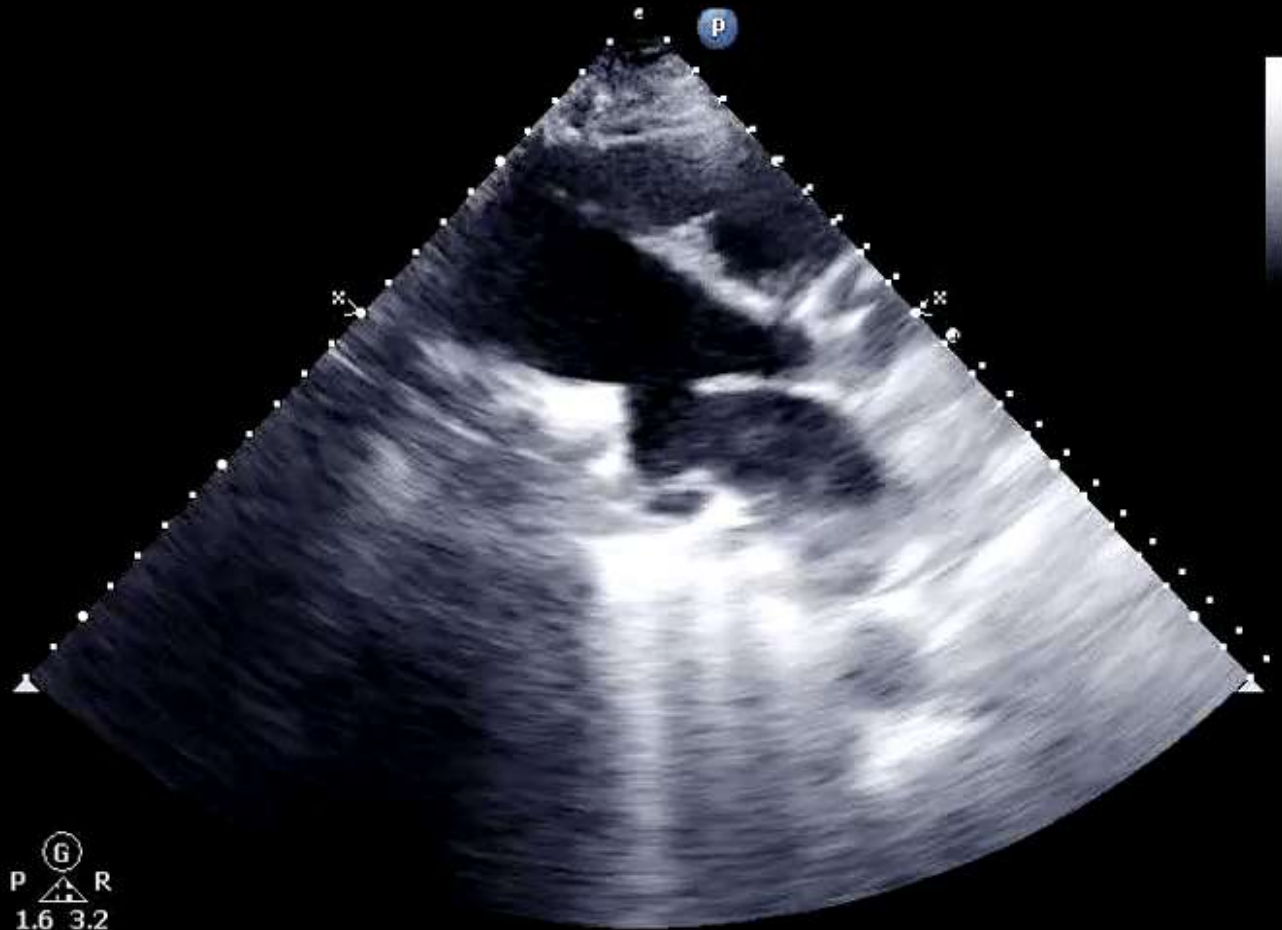


75  
BPM

# Case 185,425,421<sub>cj</sub>

ECHO  
S5-1  
32Hz  
22cm

2D  
HGen  
Gn 48  
C 50  
2/4/2  
100 mm/s



71  
BPM

# Case 185,425,421<sub>cj</sub>

## What do you think about the valves?

ECHO  
S5-1  
60Hz  
Zoom

2D  
HGen-HRes  
Gn 40  
C 50  
2/4/2  
100 mm/s



P  $\text{\textcircled{G}}$   $\text{\textcircled{R}}$   
1.6 3.2

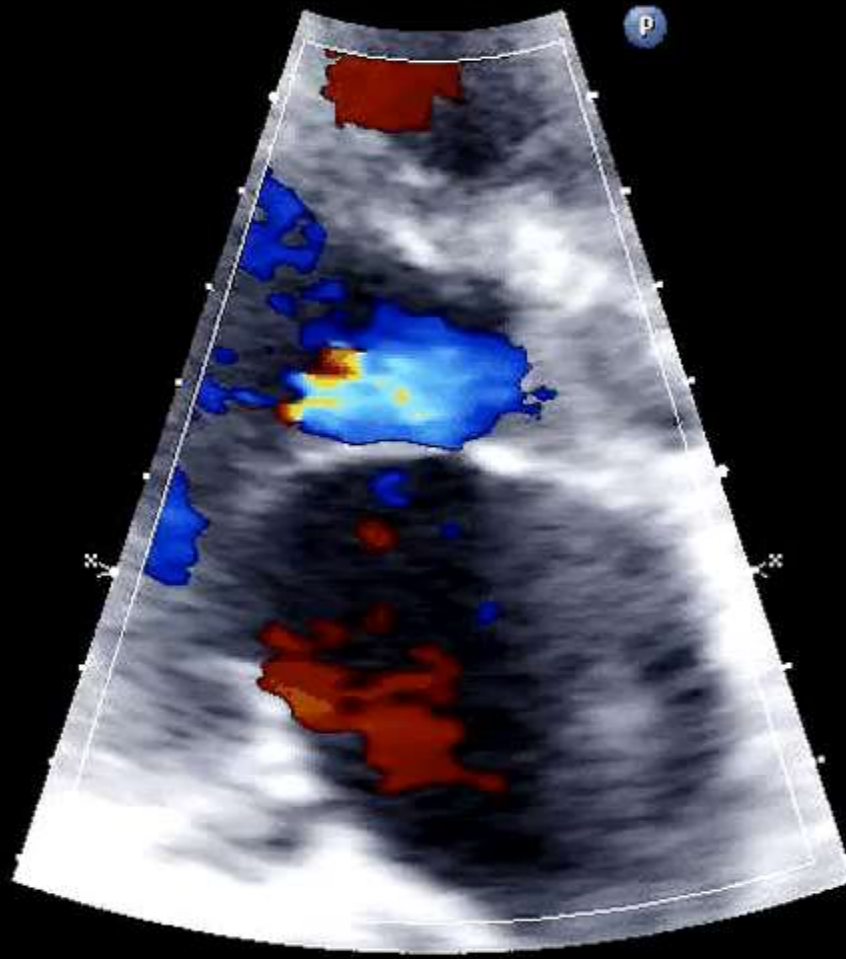
68  
BPM

# Case 185,425,421

ECHO  
S5-1  
17Hz  
Zoom

2D  
HGen-HRes  
Gn 40  
C 50  
2/4/2  
100 mm/s

Color  
2.5 MHz  
Gn 47  
4/5/1  
Fltr Med



G  
P R  
1.6 3.2

71  
BPM

# Case 185,425,421

ECHO  
S5-1  
40Hz  
16cm

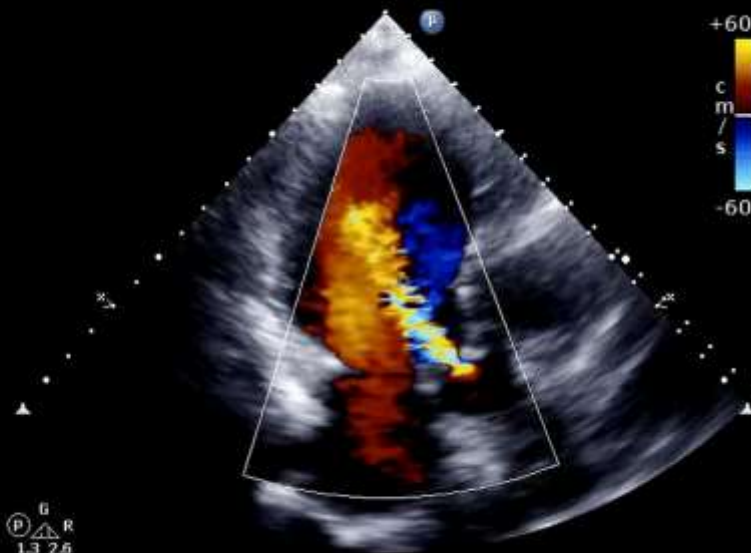
2D  
HPen  
Gn 30  
C 50  
2/4/2  
100 mm/s



ECHO  
S5-1  
15Hz  
16cm

2D  
HPen  
Gn 20  
C 46  
2/4/2  
100 mm/s

Color  
2.2 MHz  
Gn 39  
4/5/1  
Fltr Med



+60  
cm/s  
-60

G  
P R  
1.3 2.6



74  
BPM

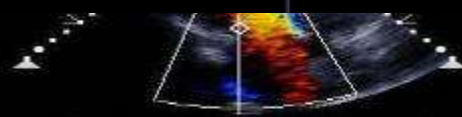
G  
P R  
1.3 2.6



68  
BPM

2D  
HPen  
Gn 20  
C 46  
2/4/2

G  
P R  
1.3 2.6

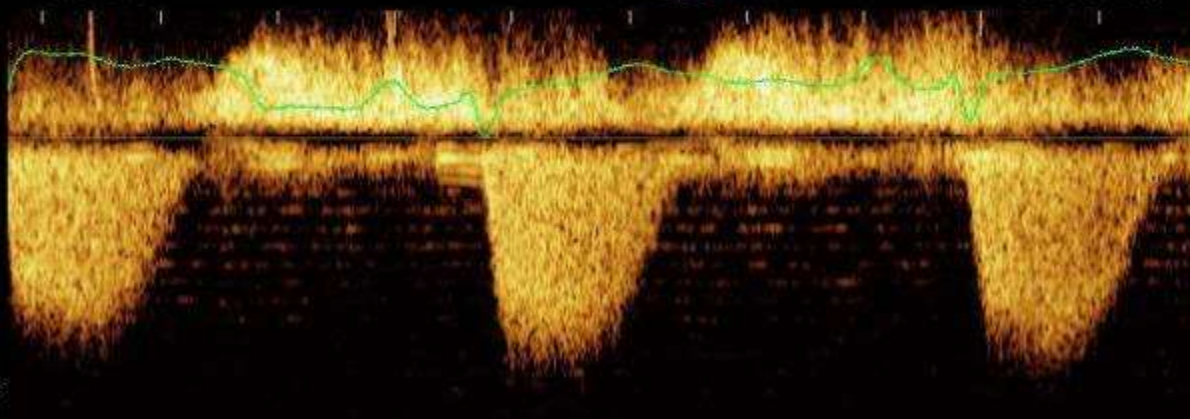


72  
BPM

m/s  
-60

Color  
2.2 MHz  
Gn 39  
4/5/1  
Fltr Med

CW  
1.7 MHz  
Gn 50  
9.2 cm  
Angle 0°  
Fltr 600HZ  
100 mm/s



100  
0  
100m/s  
200  
300



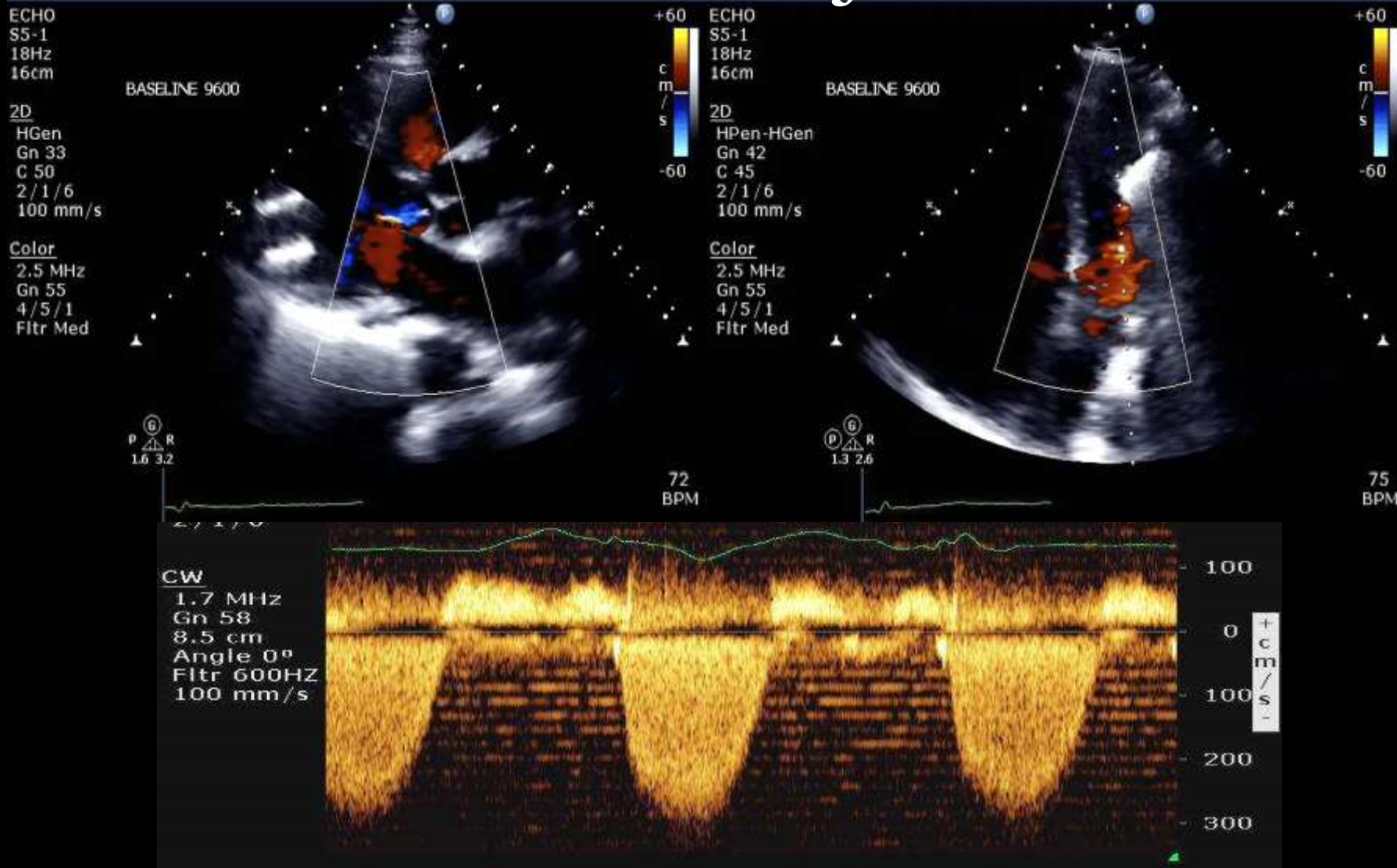
# Case 185,425,421<sub>ej</sub>

- 59 y/o female
- Primary diagnosis CHF
- 5'8"
- 173 lb
- BSA 1.92
- B/P 70/00
- **Heartmate II LVAD insertion 9/28/2010**
- **LVAD misalignment**



# Case 185,425,421

## After LVAD adjustment



# Case 185,425,421



**Berlin Heart Incor**



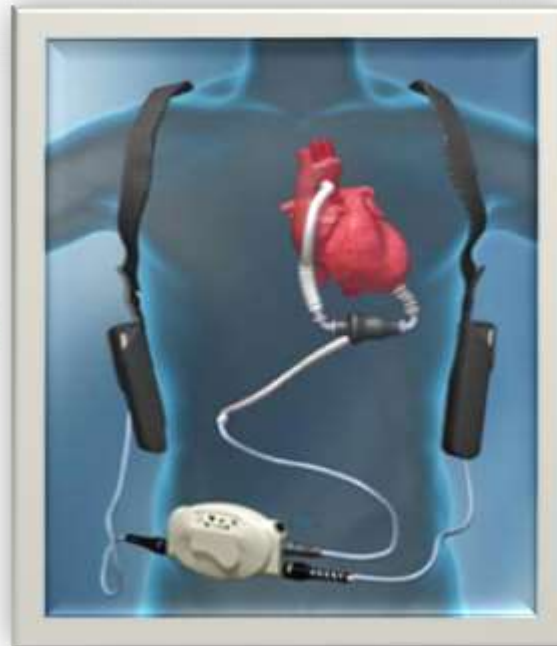
**Heartmate II**



**Ventracor VentrAssist**



**HeartWare**



# Case 546,222,333<sub>RR</sub>

- 57 y/o female
- Primary diagnosis mitral regurgitation
- 65 in
- 113 lb
- BSA 1.55
- B/P 110/77

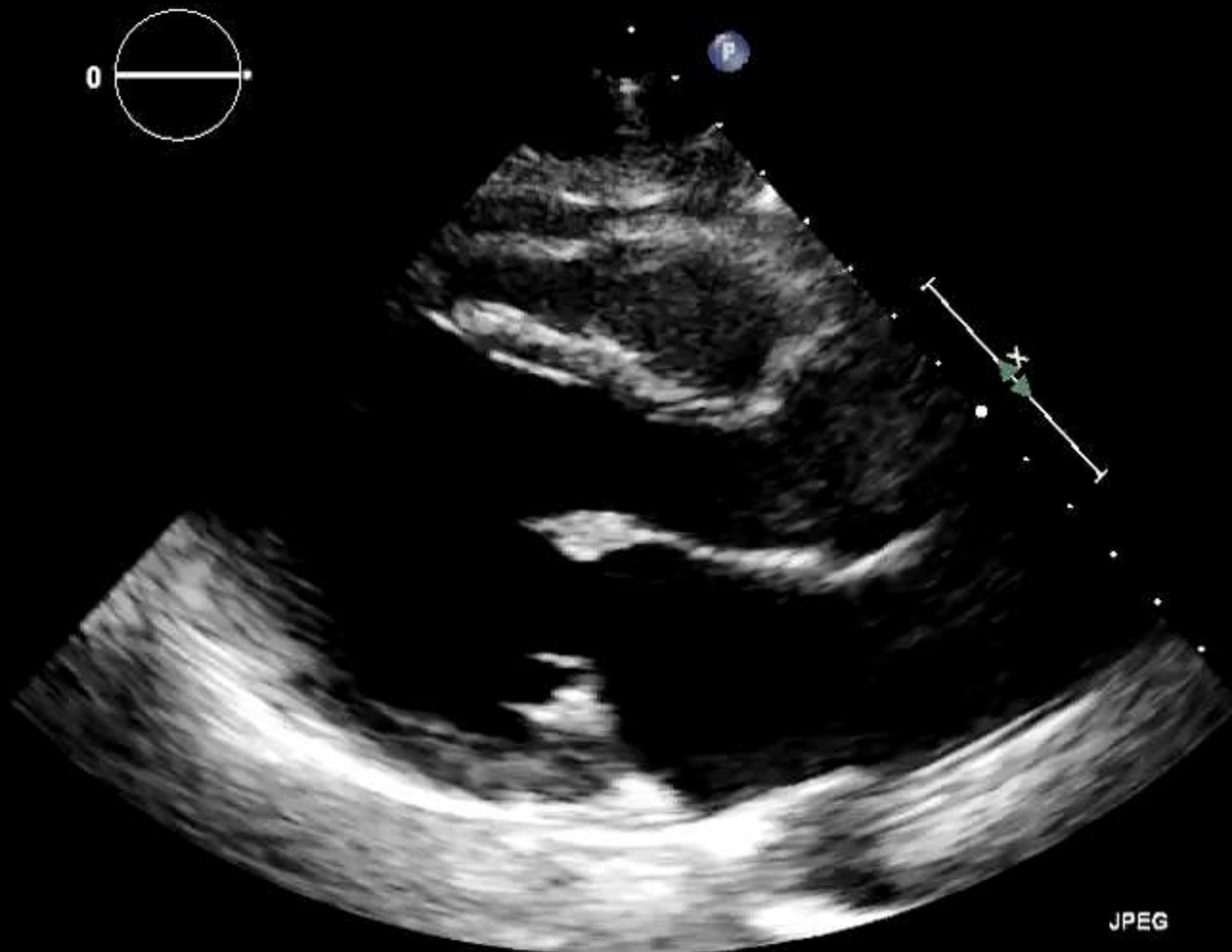


# Case 546,222,333<sub>RR</sub>

FR 50Hz  
14cm

M3

2D  
49%  
C 50  
P Low  
HPen



JPEG

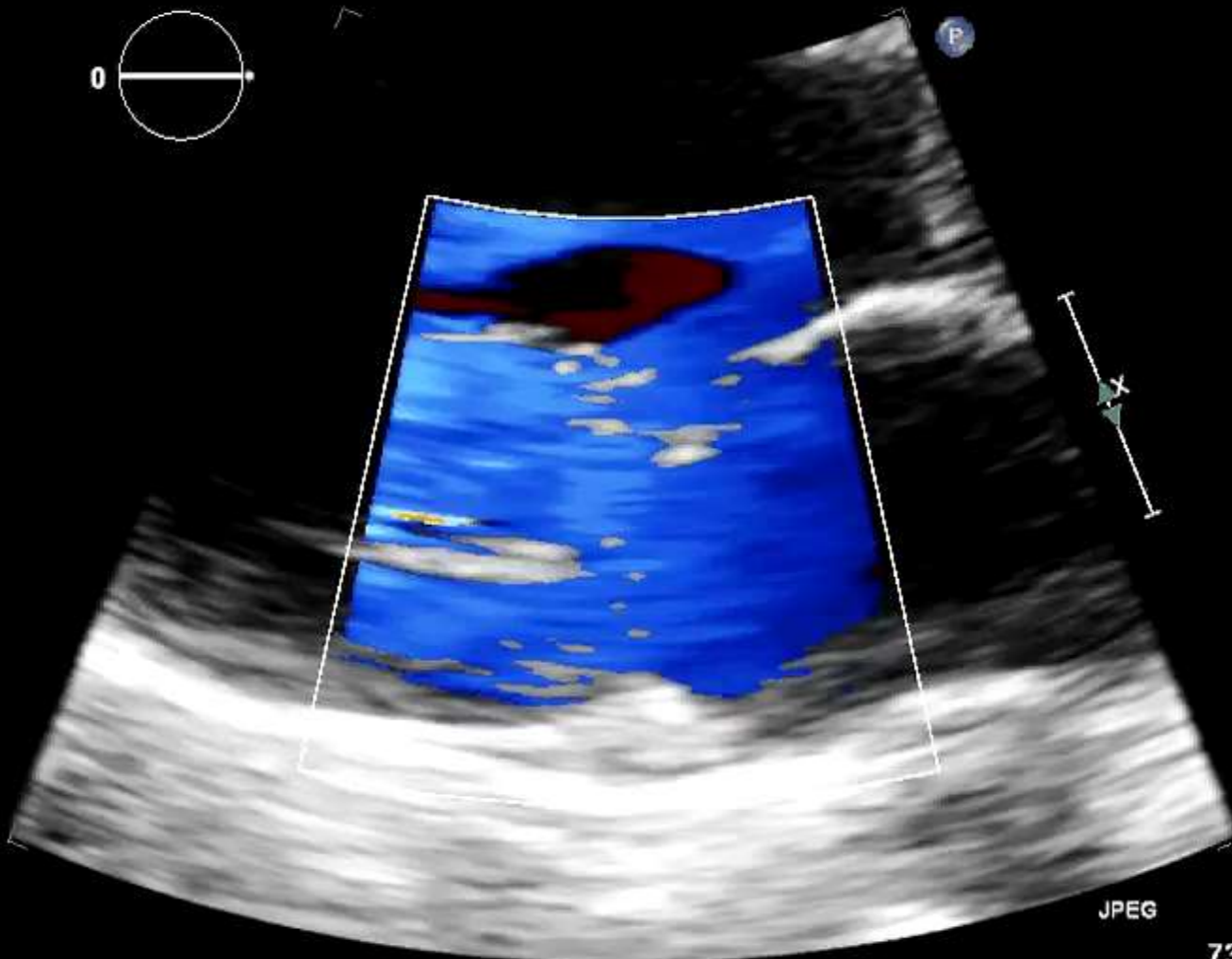
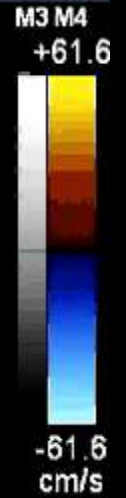
77 bpm

# Case 546,222,333<sub>RR</sub>

FR 22Hz  
14cm

2D  
52%  
C 50  
P Low  
HPen

CF  
63%  
2.5MHz  
WF High  
Med



JPEG

73 bpm

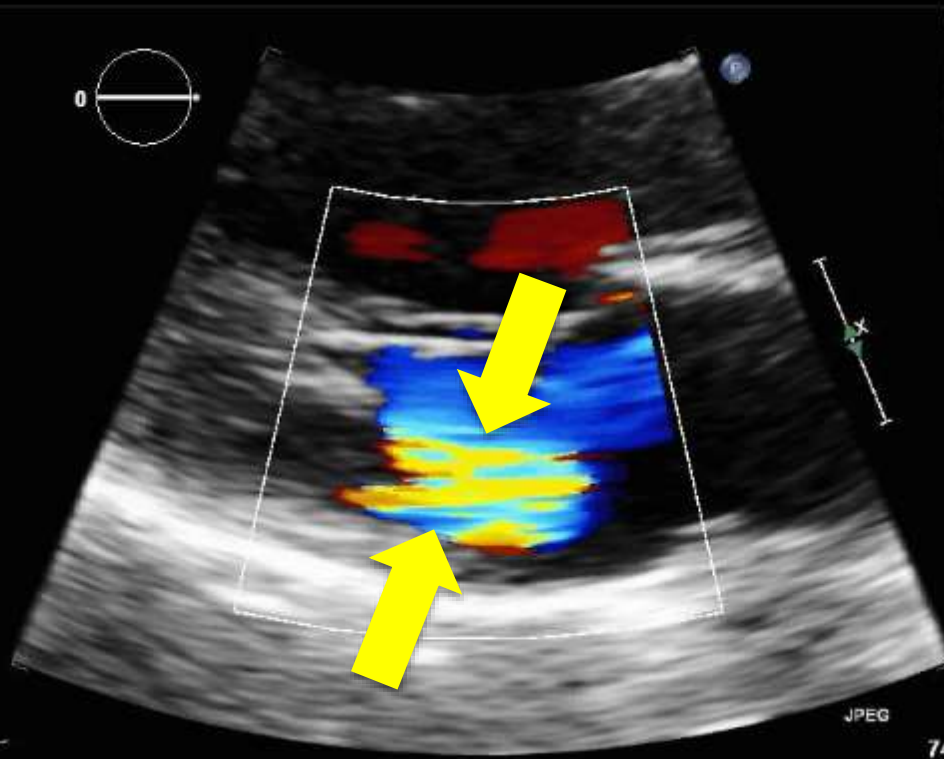
## What is the estimated vena contracta?

FR 22Hz  
14cm

2D  
52%  
C 50  
P Low  
HPen

CF  
63%  
2.5MHz  
WF High  
Med

G  
P R  
3 26



- a)  $<0.30$
- b)  $0.30-0.69$
- c)  $>0.70$
- d) Too eccentric to estimate

## What is the estimated vena contracta?

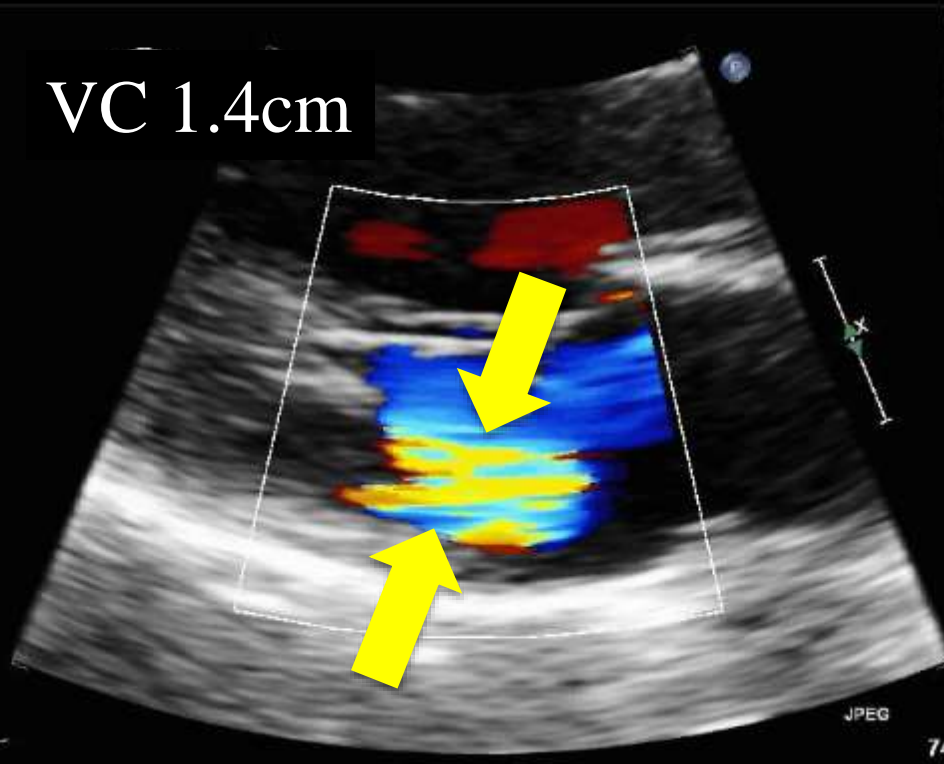
FR 22Hz  
14cm

2D  
52%  
C 50  
P Low  
HPen

CF  
63%  
2.5MHz  
WF High  
Med

G  
P R  
3 26

VC 1.4cm



M3 M4  
+61.6  
-61.6  
cm/s

- a)  $<0.30$
- b)  $0.30-0.69$
- c)  $>0.70$
- d) Too eccentric to estimate



# Grading MR

## Qualitative/Supportive Methods

Parameters	Mild	Moderate	Severe
Color jet area	4cm <sup>2</sup> or 10% LA	Variable	>10cm <sup>2</sup> or 40% LA
CW	Faint/parabolic	Dense/para	Dense/early peak
Pvein flow	Sys. dominance	Sys. Blunting	Systolic reversal
MV Inflow	Dominant A wave		Dominant E >1.2

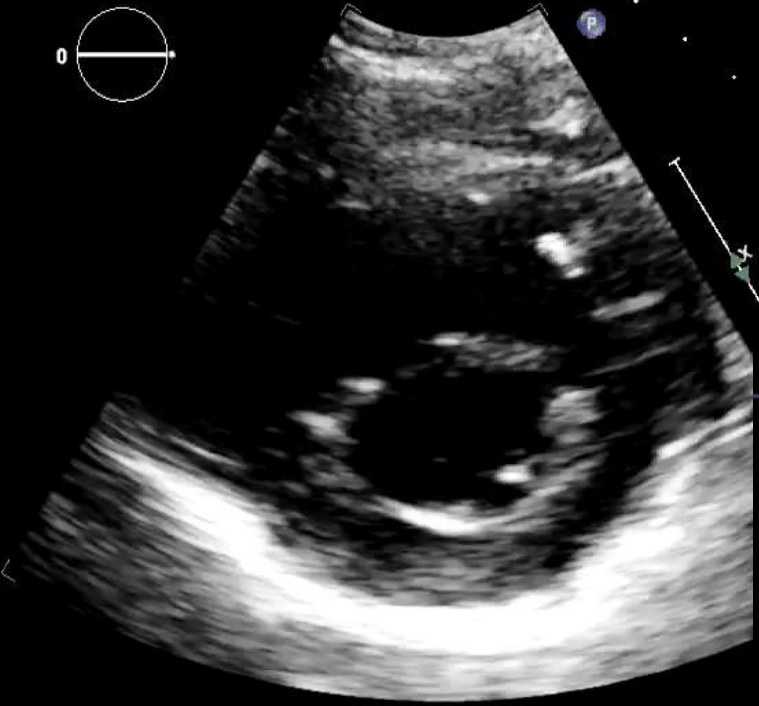
## Quantitative Methods

Parameters	Mild	Moderate	Severe
Vena Contracta	<0.3	0.3-0.69	<u>≥0.7</u>
Reg. Volume	< 30	30-59	<u>≥60</u>
Reg. Fraction	< 30	30-49	<u>≥50</u>
EROA (cm <sup>2</sup> )	<0.2	0.2-0.39	<u>≥0.40</u>

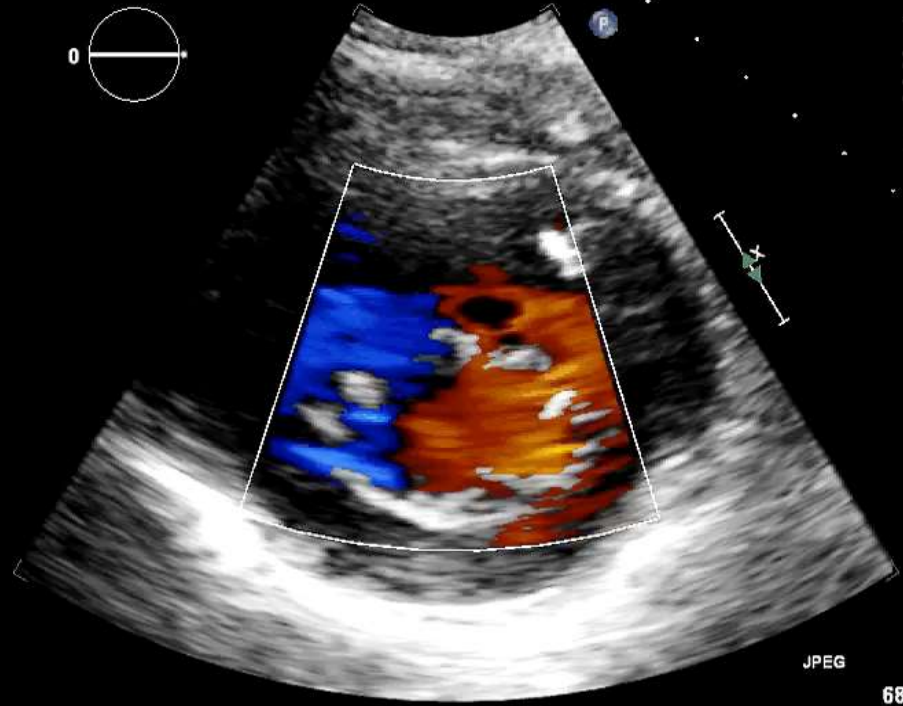
# Case 546,222,333<sub>RR</sub>

lz

M3



FR 16Hz  
13cm  
**2D**  
56%  
C 50  
P Low  
HPen  
**CF**  
63%  
2.5MHz  
WF High  
Med

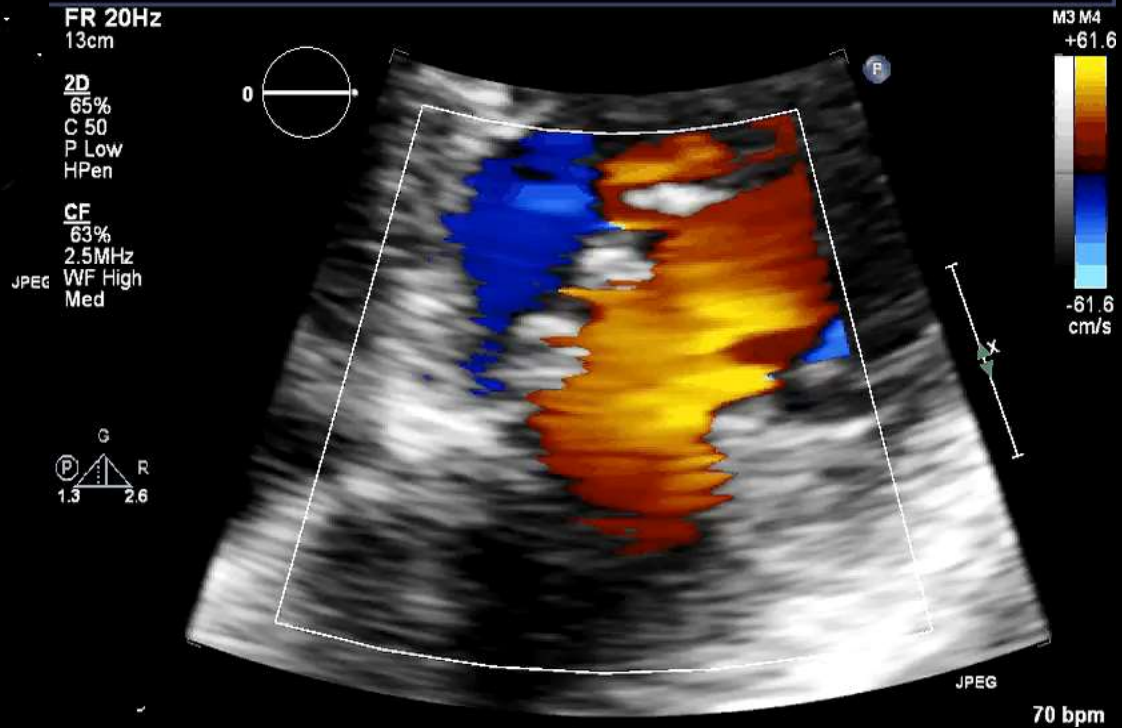
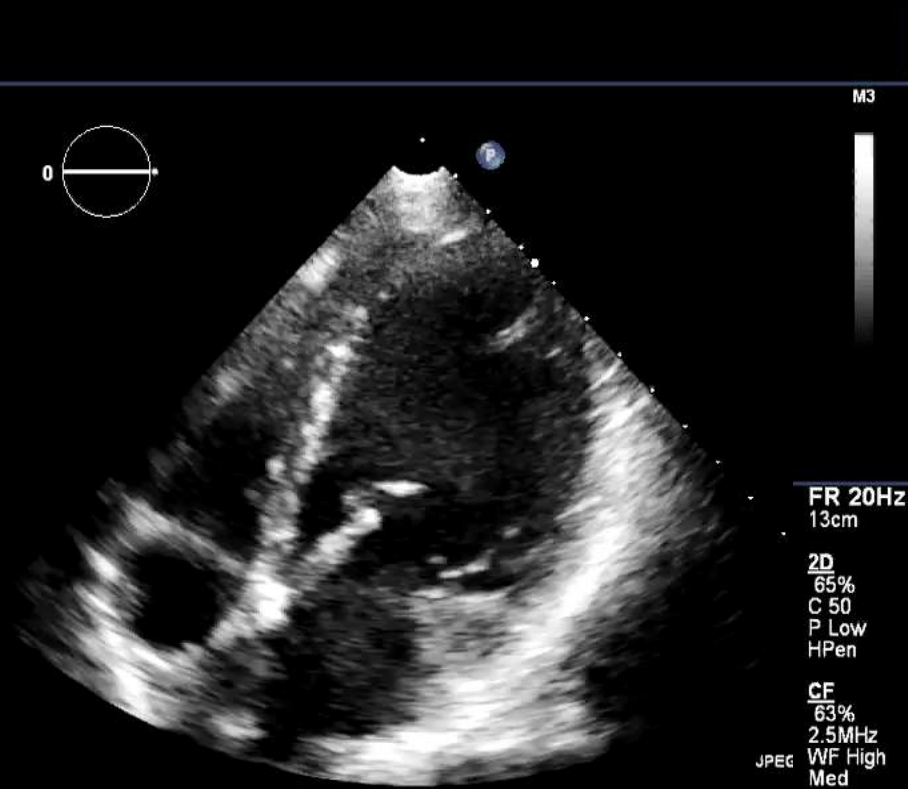


M3 M4  
+61.6  
-61.6  
cm/s

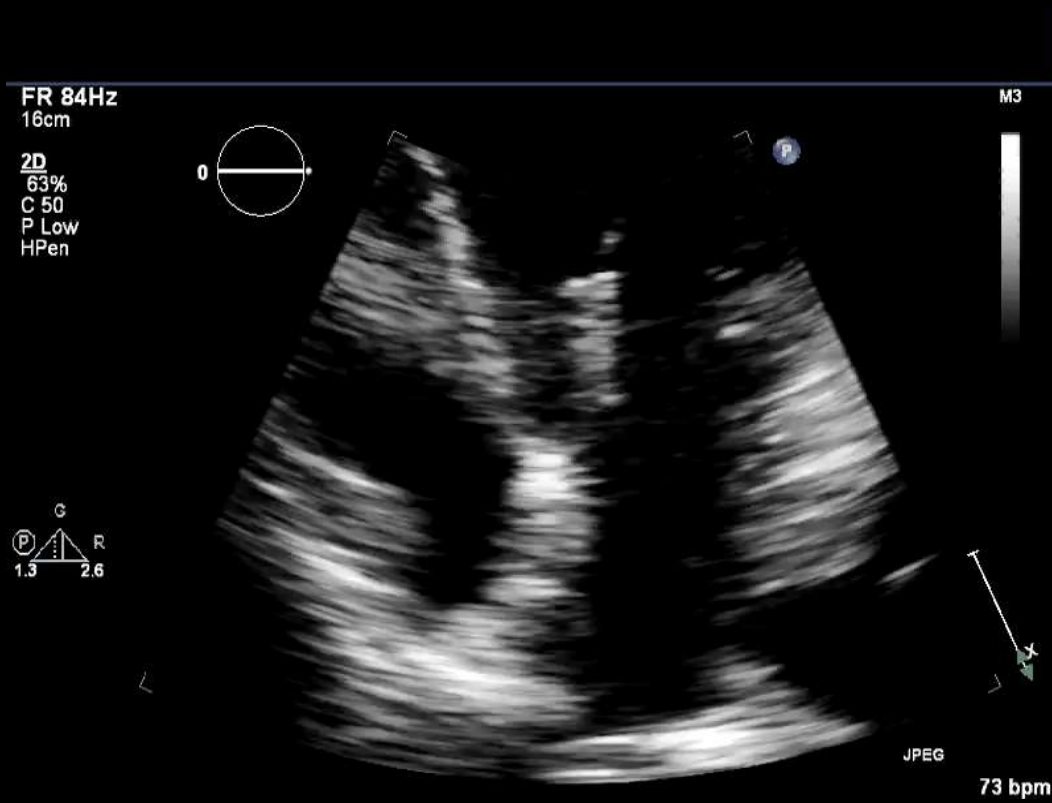
JPEG

68 bpm

# Case 546,222,333<sub>RR</sub>



## What size is the LA?

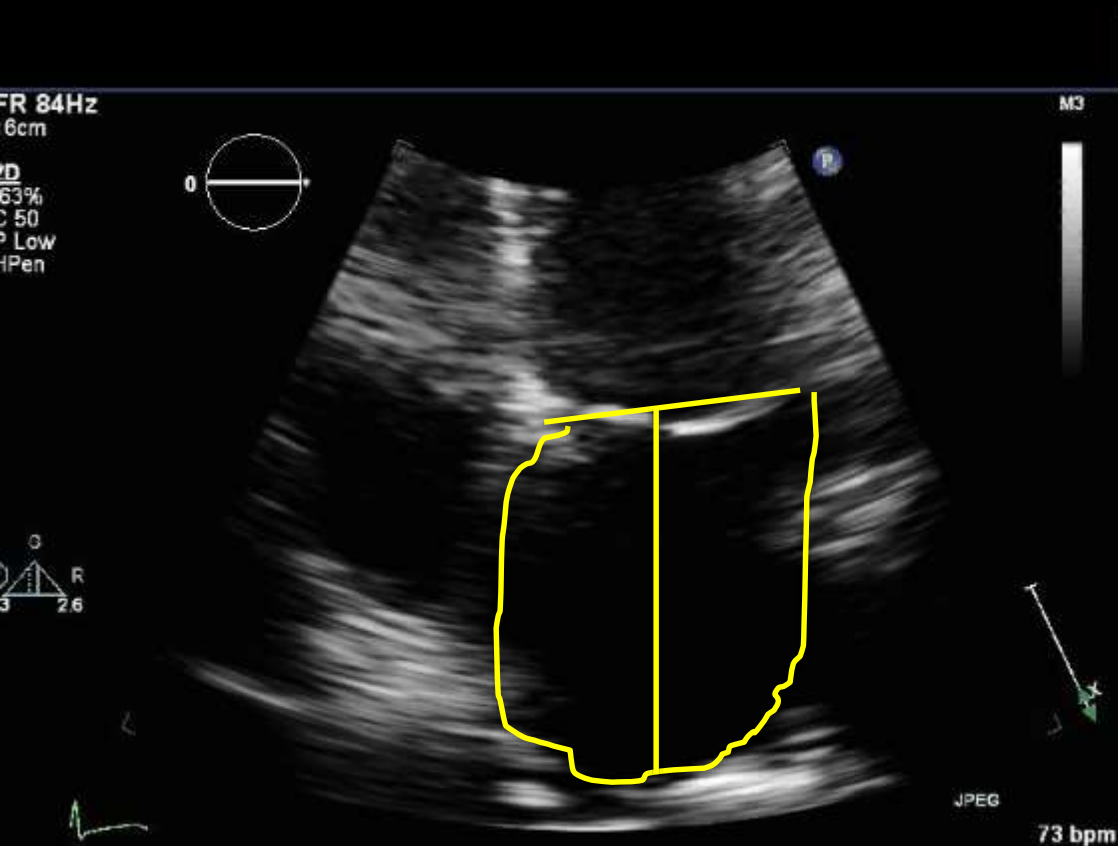


- a) Normal
- b) Mildly enlarged
- c) Moderately big
- d) Severely enlarged

# Case 546,222,333<sub>RR</sub>

What size is the LA?

LA Vol = 89.6 ml

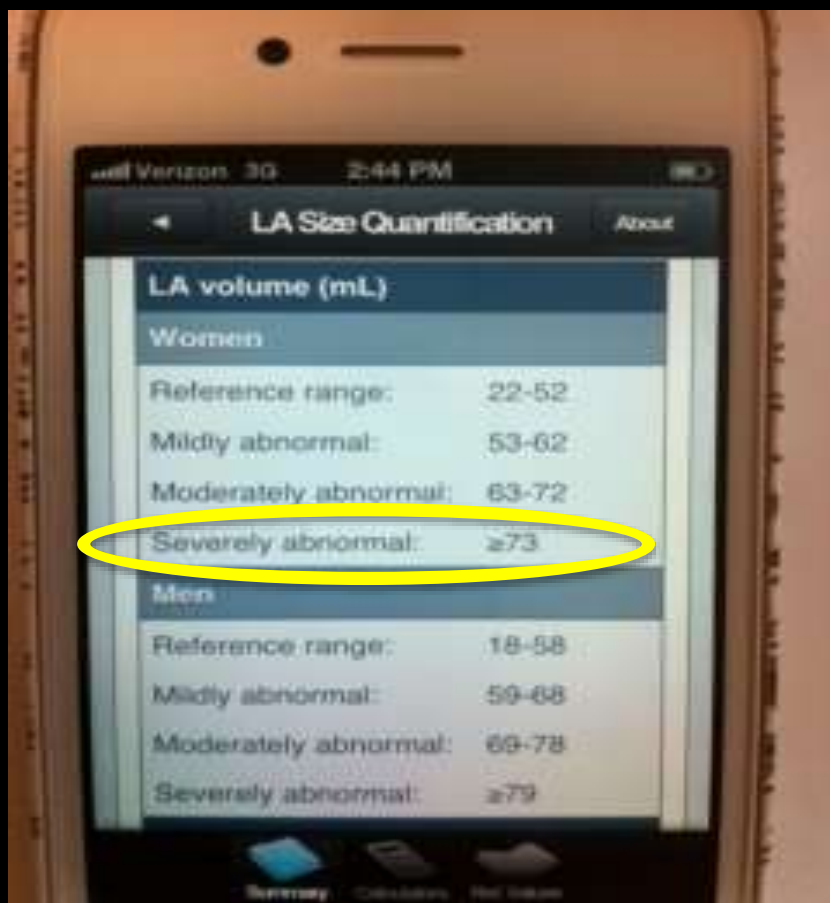


- a) Normal
- b) Mildly enlarged
- c) Moderately big
- d) Severely enlarged

# Case 546,222,333<sub>RR</sub>

## What size is the LA?

LA Vol = 89.6 ml



- a) Normal
- b) Mildly enlarged
- c) Moderately big
- d) Severely enlarged

# Case 546,222,333<sub>RR</sub>



M3

FR 16Hz  
13cm

2D  
64%  
C 50  
P Low  
HPen

CF  
63%  
2.5MHz  
WF High  
Med

G  
P R  
1.3 2.6



M3 M4  
+61.6

-61.6  
cm/s

JPEG

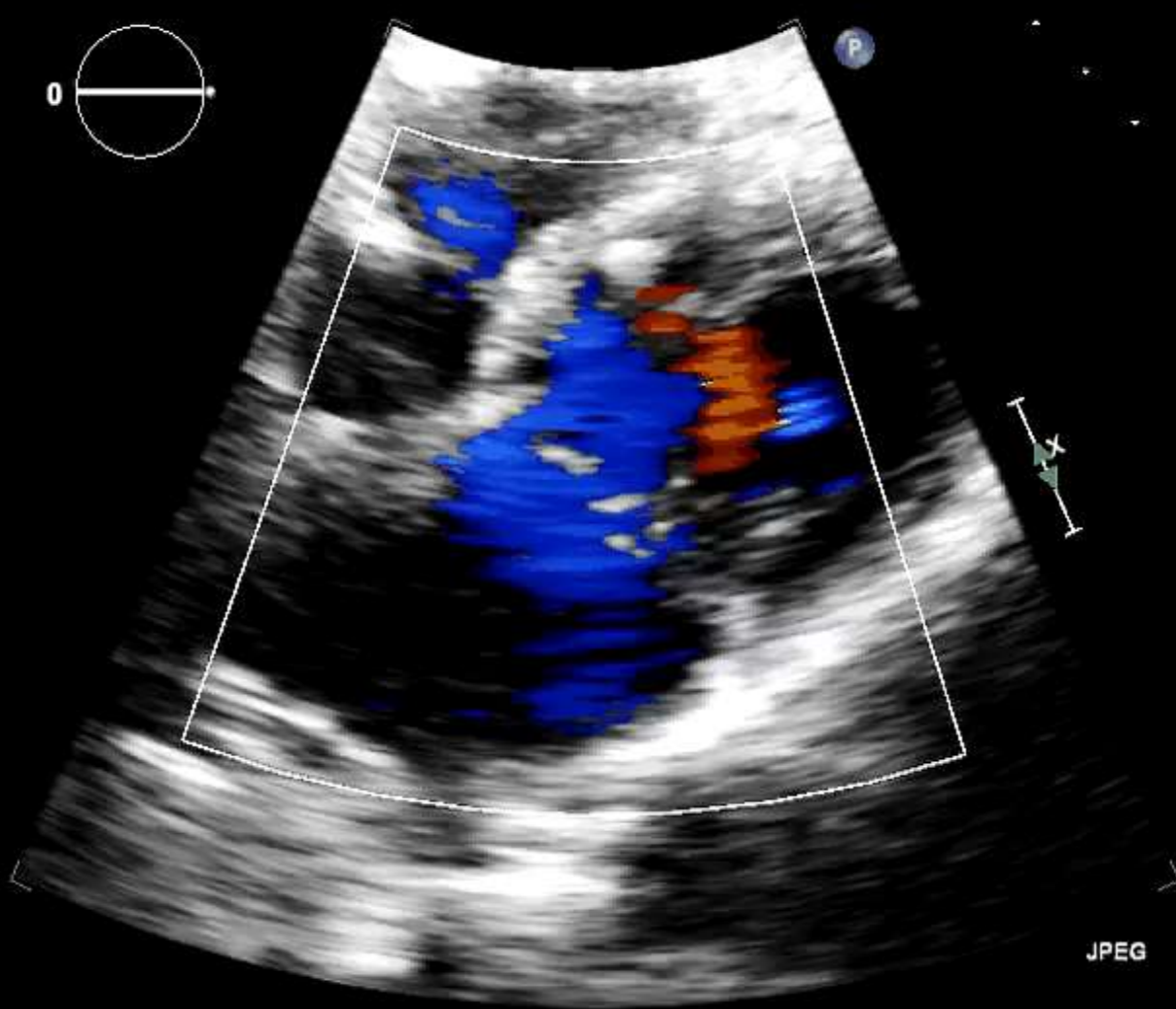
71 bpm

# Case 546,222,333<sub>RR</sub>

FR 15Hz  
20cm

2D  
69%  
C 50  
P Low  
HPen

CF  
63%  
2.5MHz  
WF High  
Med

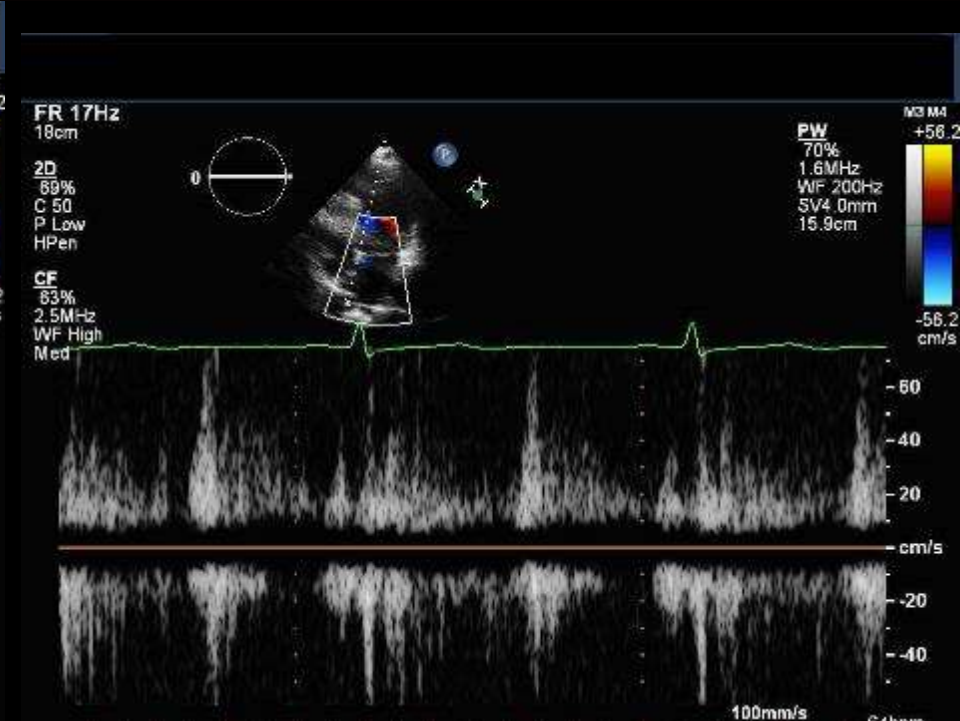
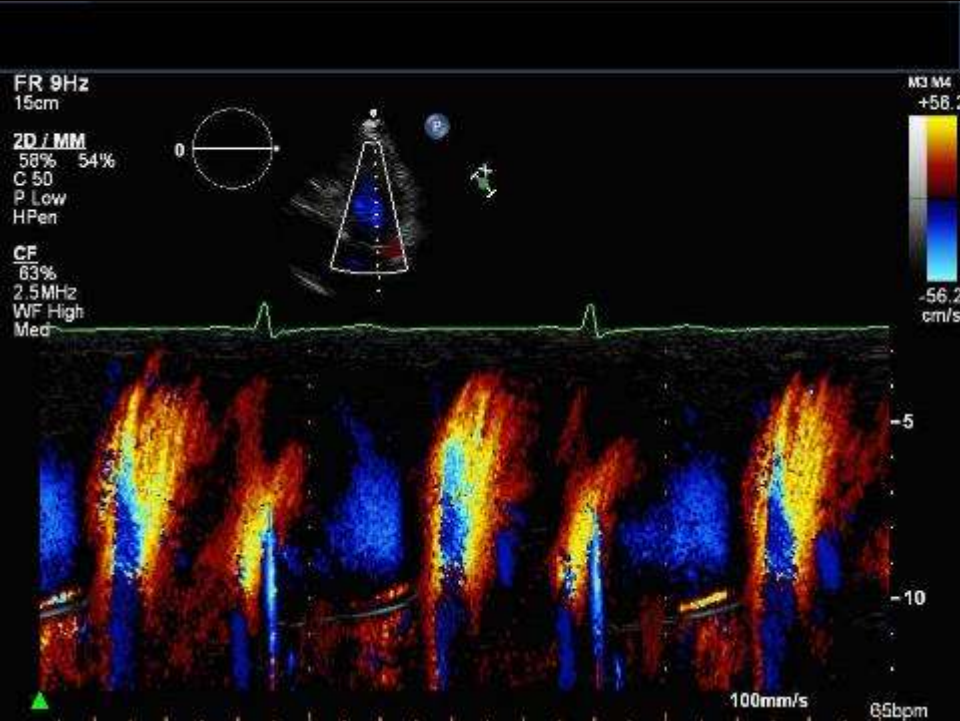


JPEG

68 bpm

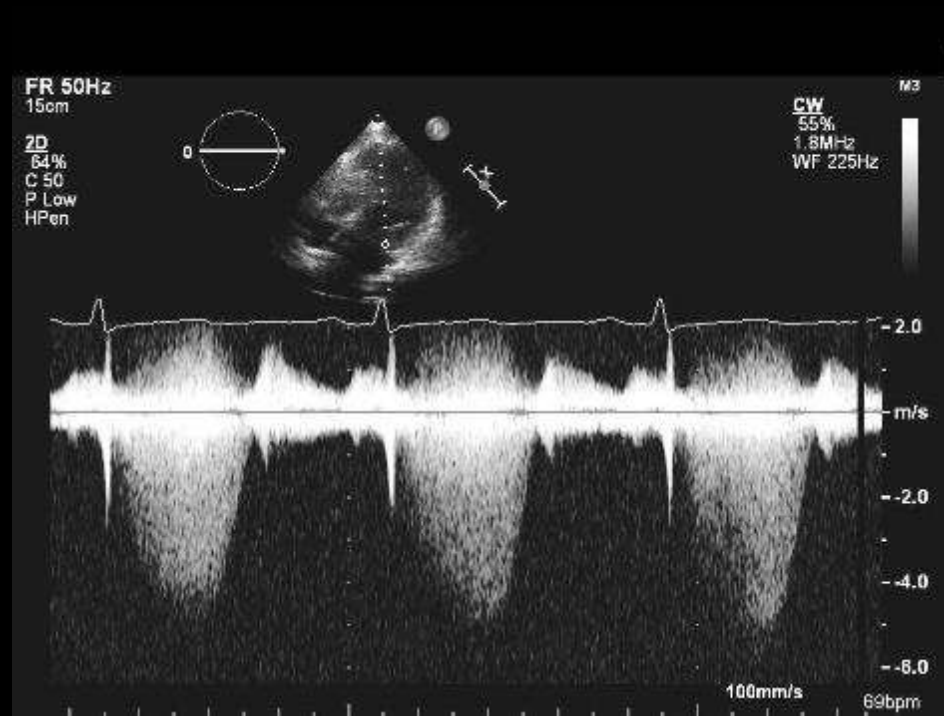
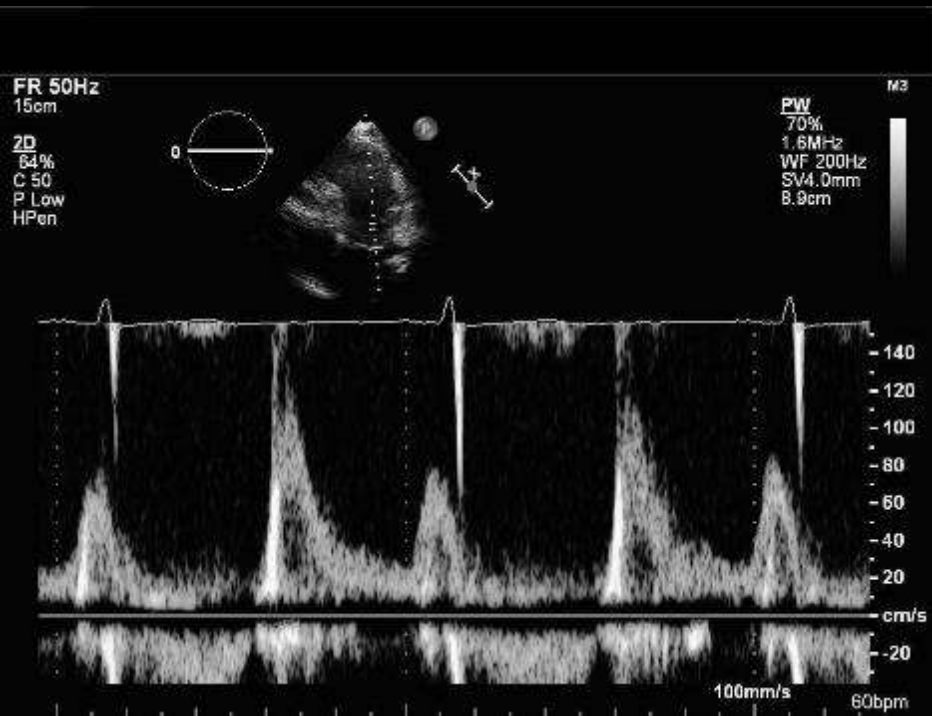


# Case 546,222,333<sub>RR</sub>



What do you think about these Doppler tracings?

# Case 546,222,333<sub>RR</sub>



What do you think about these  
Doppler tracings?

# Grading MR

## Qualitative/Supportive Methods

Parameters	Mild	Moderate	Severe
Color jet area	4cm <sup>2</sup> or 10% LA	Variable	>10cm <sup>2</sup> or 40% LA
CW	Faint/parabolic	Dense/para	Dense/early peak
Pvein flow	Sys. dominance	Sys. Blunting	Systolic reversal
MV Inflow	Dominant A wave		Dominant E >1.2

## Quantitative Methods

Parameters	Mild	Moderate	Severe
Vena Contracta	<0.3	0.3-0.69	<u>≥0.7</u>
Reg. Volume	< 30	30-59	<u>≥60</u>
Reg. Fraction	< 30	30-49	<u>≥50</u>
EROA (cm <sup>2</sup> )	<0.2	0.2-0.39	<u>≥0.40</u>

# Specific Signs



## Mild

- Small central jet  $<4 \text{ cm}^2$  or  $<20\%$  of LA
- Vena contracta width  $<0.3\text{cm}$
- No or minimal flow convergence



## Moderate

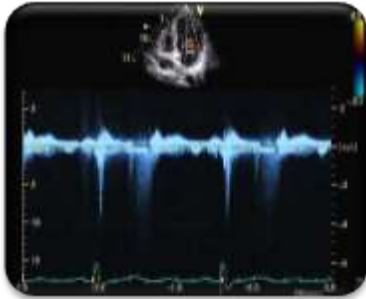
- Signs of MR  $>$  Mild but no criteria for severe MR



## Severe

- Vena contracta width  $\geq 0.7\text{cm}$
- Large flow convergence
- Systolic reversal in pulmonary veins
- Prominent flail MV leaflet of ruptured papillary muscle

# Supportive Signs



## Mild

- Systolic dominant flow in pulmonary veins
- A-wave dominant mitral inflow
- Soft density, parabolic CW Doppler MR signal
- Normal LV size



## Moderate

- Intermediate signs/findings

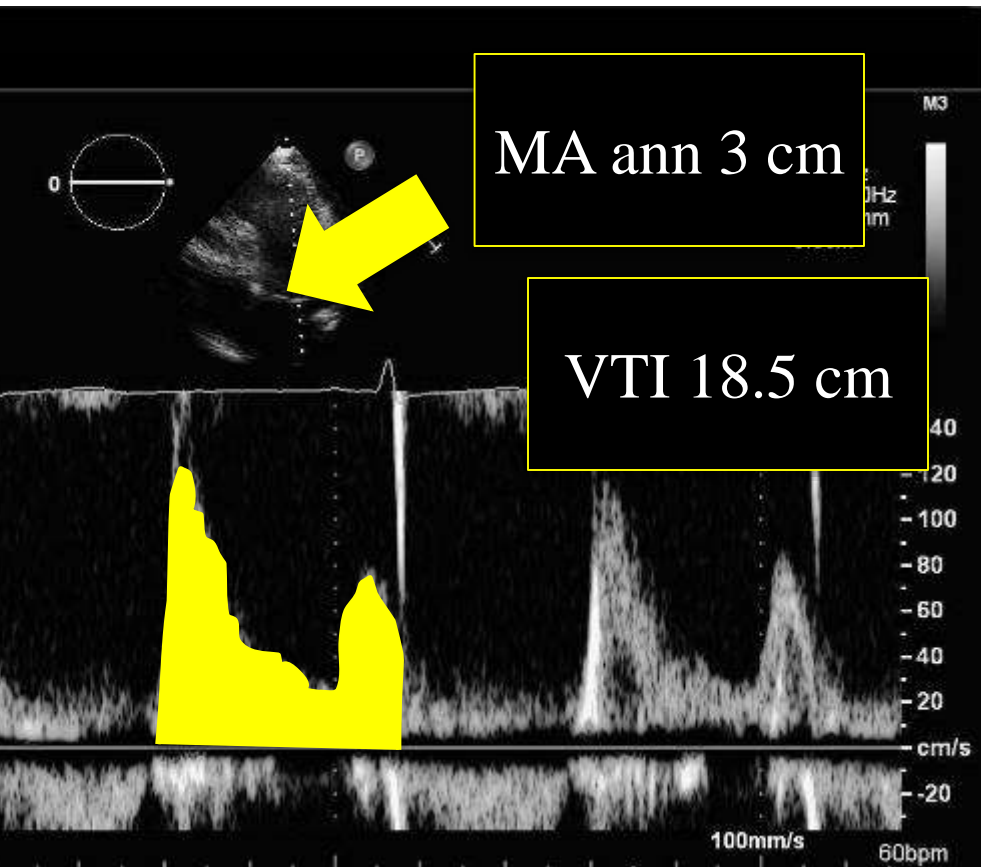


## Severe

- Dense, triangular CW Doppler MR jet (early peaking)
- E-wave dominant mitral inflow ( $E > 1.2$  m/s)
- Enlarged LV
- Enlarged LA

# Regurgitant Fraction %

$$RF\% = \frac{SV(\text{Valve}) - SV(\text{Systemic})}{SV(\text{Valve})}$$



$$MA\ SV = D^2 \times .785 \times VTI$$

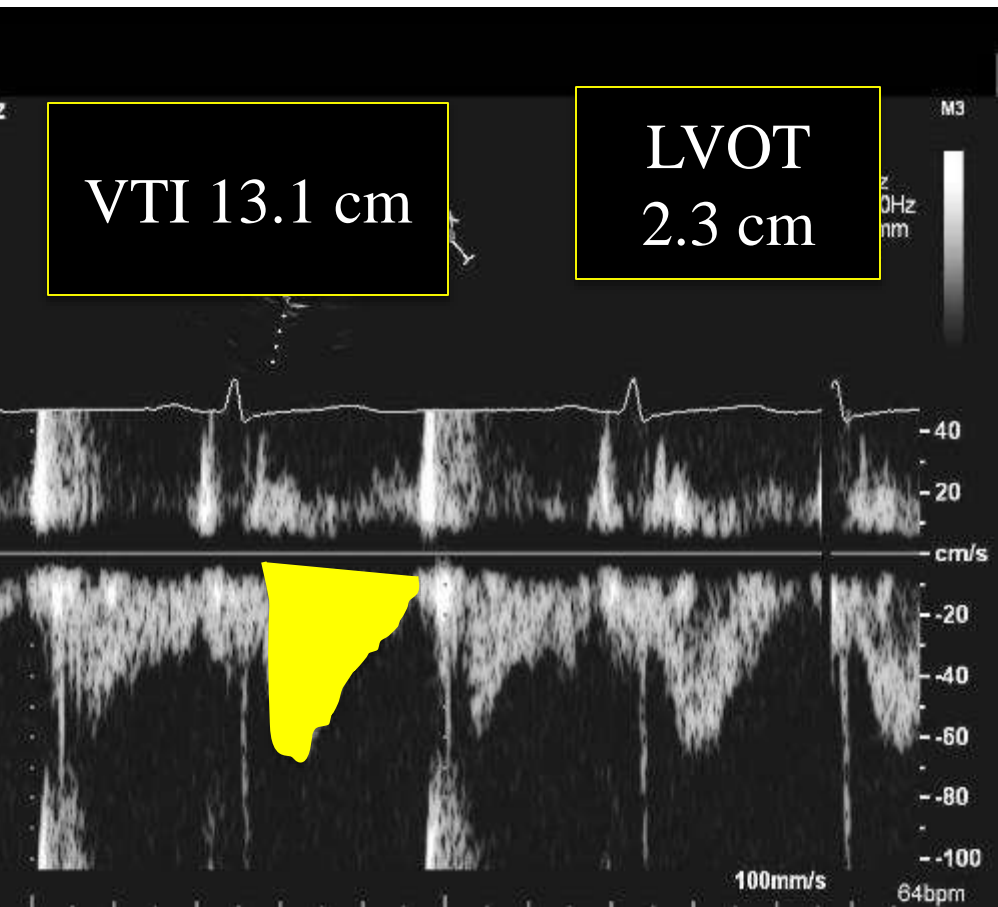
$$MA\ SV = 9 \times .785 \times 18.5$$

$$MA\ SV = 130.7\ \text{ml}$$

$$LVOT\ SV = D^2 \times .785 \times VTI$$

# Regurgitant Fraction %

$$RF\% = SV \text{ (Valve)} - SV \text{ (Systemic)} / SV \text{ (Valve)}$$



$$MA \text{ SV} = D^2 \times .785 \times VTI$$

$$MA \text{ SV} = 9 \times .785 \times 18.5$$

$$MA \text{ SV} = 130 \text{ ml}$$

$$LVOT \text{ SV} = D^2 \times .785 \times VTI$$

$$LVOT \text{ SV} = 5.3 \times .785 \times 13.1$$

$$LVOT \text{ SV} = 54.5 \text{ ml}$$

$$RF\% = MA_{SV} - LV_{SV} / MA_{SV}$$

$$RF\% = 130 - 54.5 / 130$$

$$RF\% = 58\%$$

$$RVol = 130 - 54 = 76 \text{ ml}$$

# Grading MR

## Qualitative/Supportive Methods

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## Findings

- LV size is enlarged, overall fx normal
- RV size is normal with normal fx
- LA severely enlarged
- RA normal
- MV barlows and prolapsed. Severe regurgitation with an estimated RF of 58% and a Rvol of 76ml.



# Test Time

What are the 2 views/images needed for PISA?

- a) Subcostal and parasternal
- b) Zoom color 4 chamber and MR cw Doppler
- c) Parasternal and color M-Mode
- d) Zoom color 4 chamber and MR cw Doppler

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- a) Subcostal and parasternal
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- c) Parasternal and color M-Mode
- d) Zoom color 4 chamber and MR cw Doppler

# Test Time

What 4 #/measurements do you need for PISA?

- a) Baseline shift, lvot vel, lvot TVI, prox flow convergence
- b) Baseline shift, pulm vein flow, lvot TVI, prox flow convergence
- c) Baseline shift, MR vel, MR TVI, prox flow convergence
- d) Lvot diam, lvot vel, lvot TVI, prox flow convergence

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What 4 #/measurements do you need for PISA?

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# Test Time

Which of the following best describes the vena contracta?

- a) The vena contracta is too hard to do on a daily basis to accurately define MR
- b) The vena contracta is relatively simple and accurate for identifying mild and severe MR
- c) The vena contracta is a vasospasm in the descending vein of marshal and not related to MR
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# Pearls and Pitfalls

- Practice, Practice, Practice
  - Are you really good at something you only do every now and then?
- Specific signs in conjunction with the supportive signs renders a  $\geq 90\%$  specificity
- Nyquist limit must be greater than 54cm/s
- The process of grading MR should be comprehensive, using clues and and measurements by Doppler echocardiography



# Thank you!



# Texas Medical Center



- ✓ 5 million pt's
- ✓ Pre-stress test

