



Diagnosing Heart Failure With Echocardiography

Dr. Alison Duncan

MB BS BSc PhD FRCP FESC

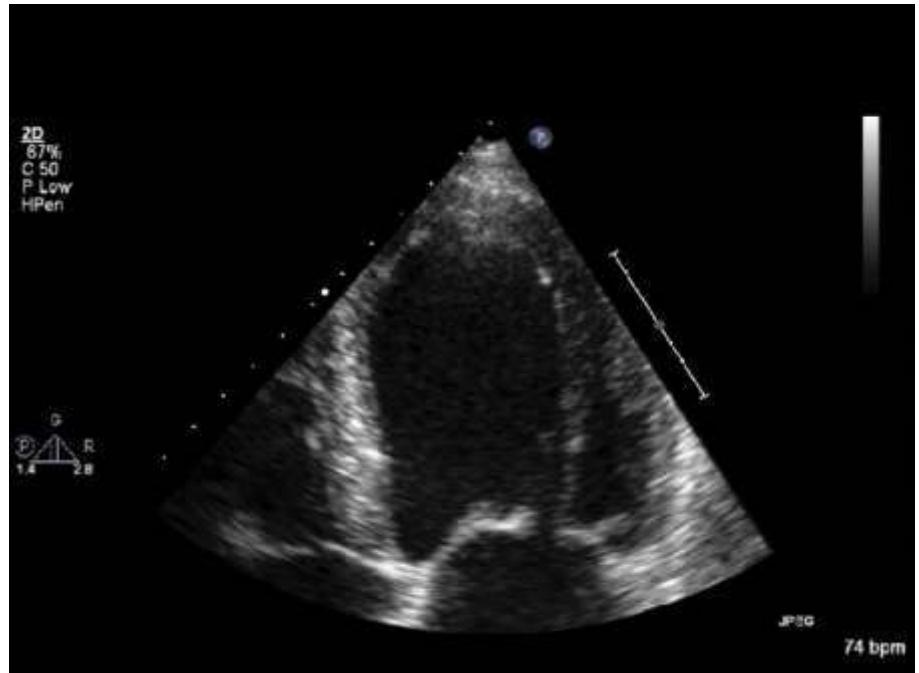
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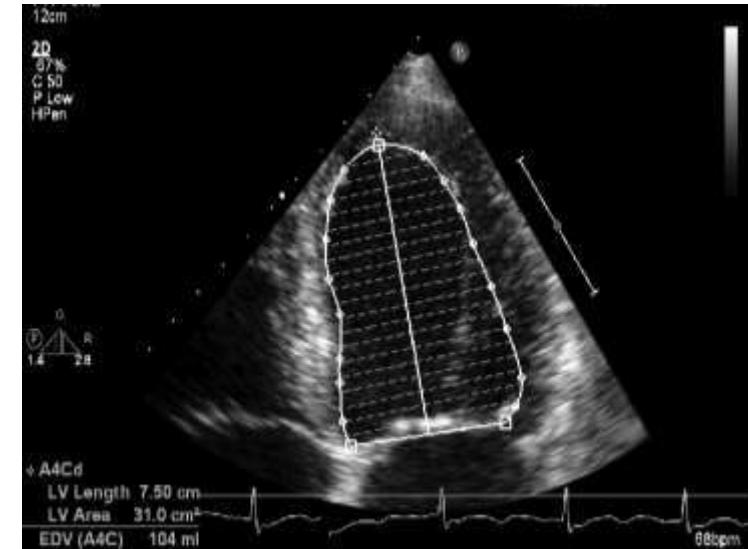


Measuring LVEF with 2D Echo



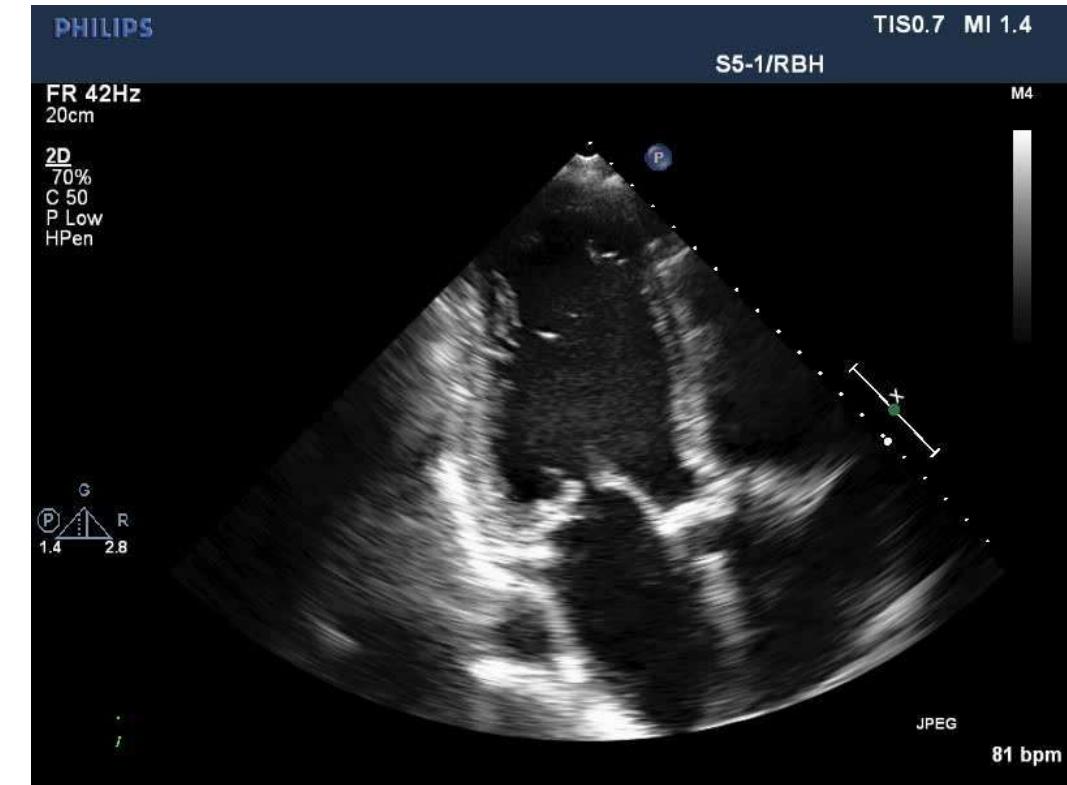
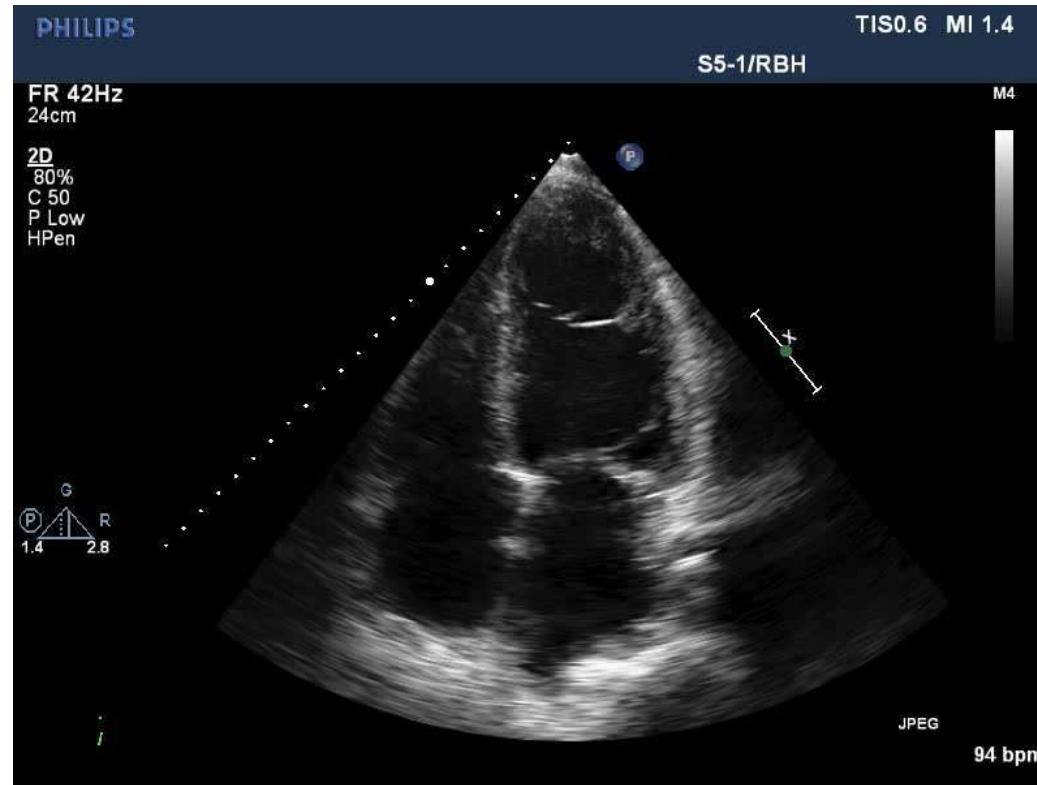
- Modified biplane Simpson's rule
- Measures EDV and ESV (ml)
- Calculated EF (%) = $EDV - ESV * 100$

EDV



HFrEF <40%

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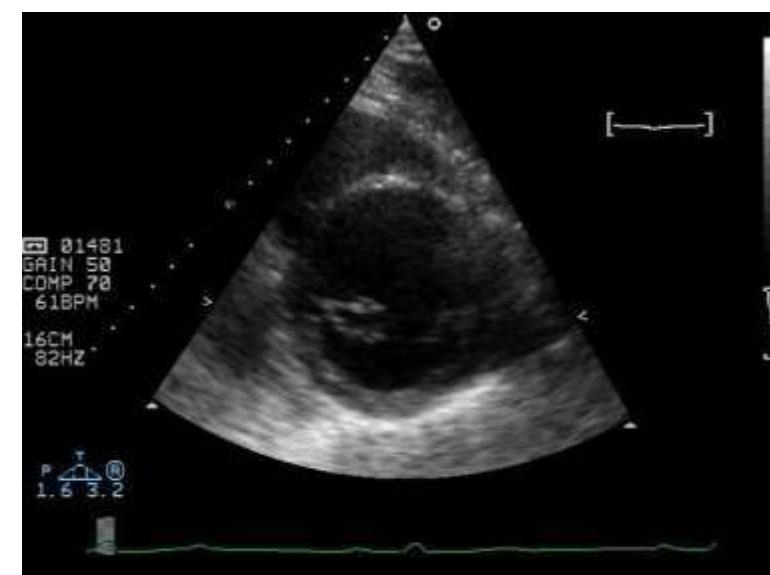
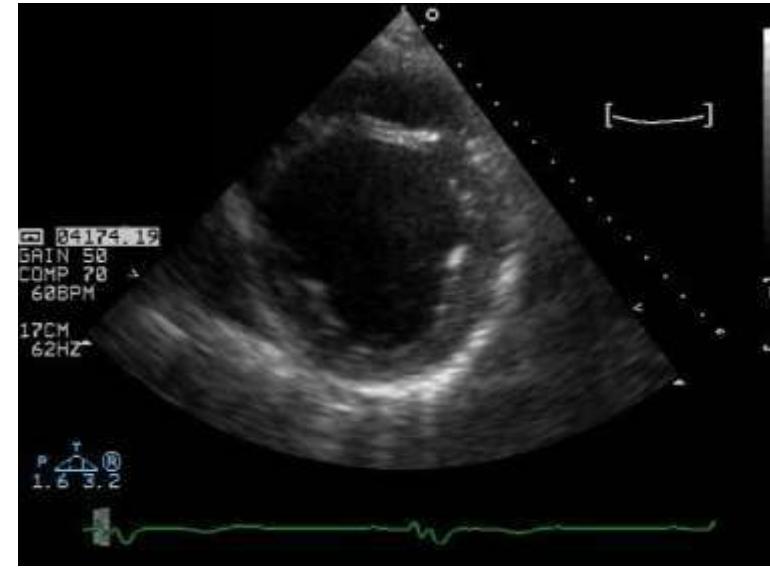
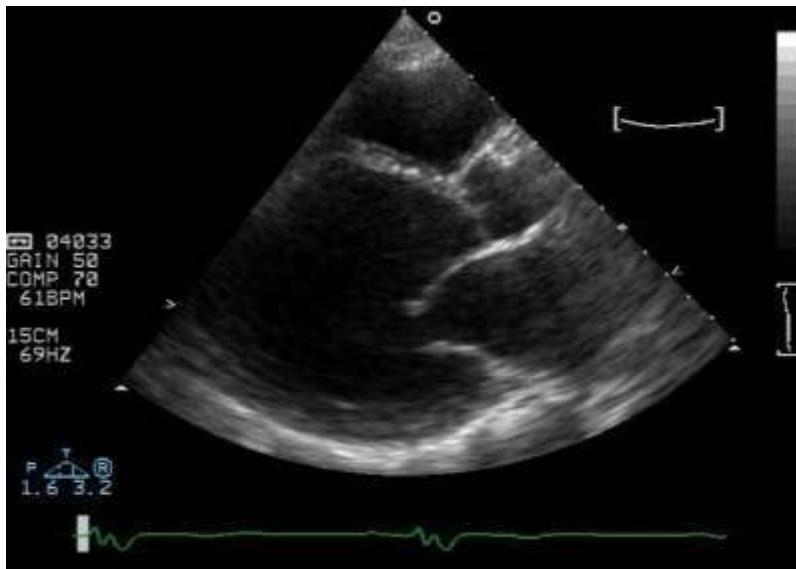
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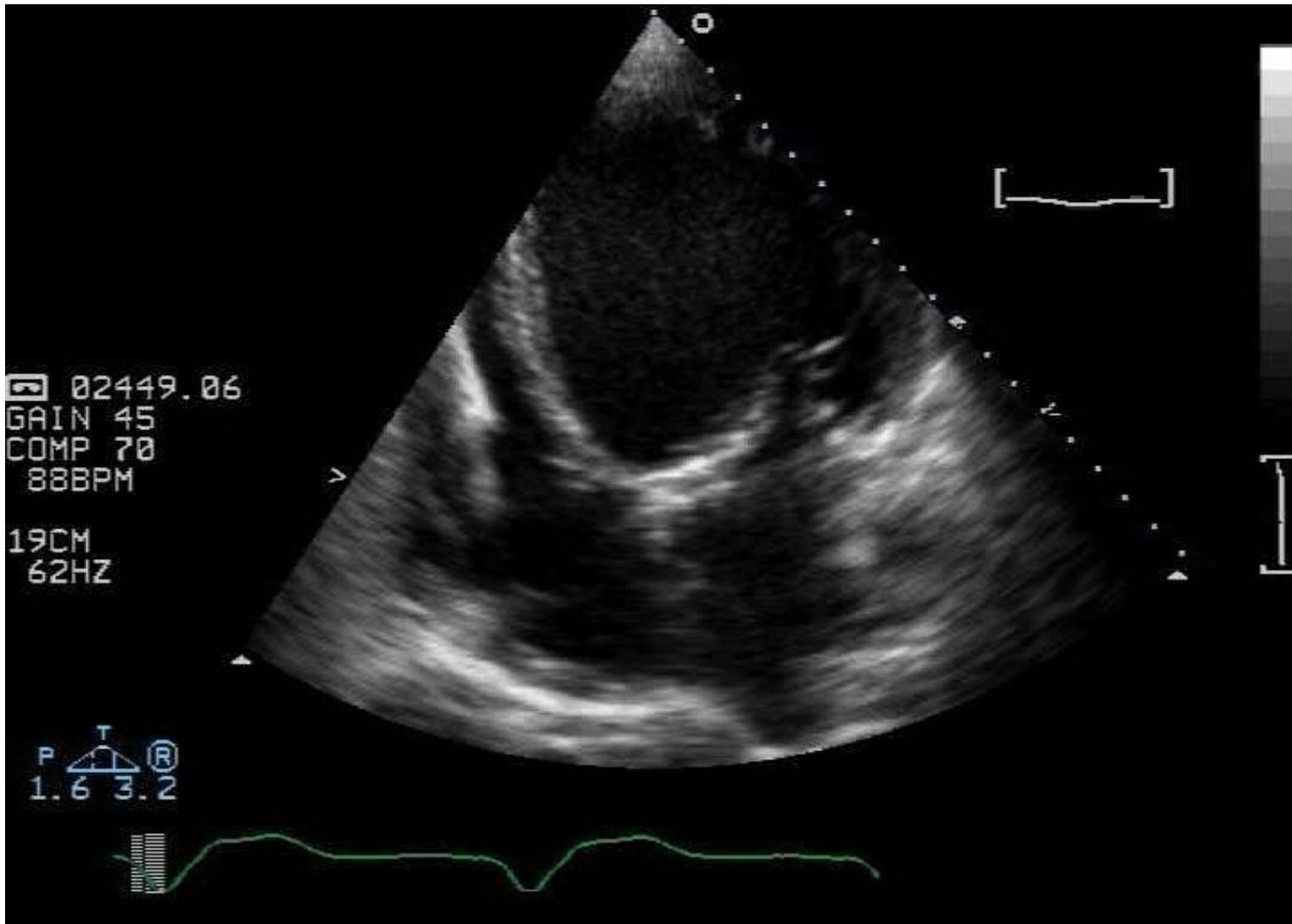


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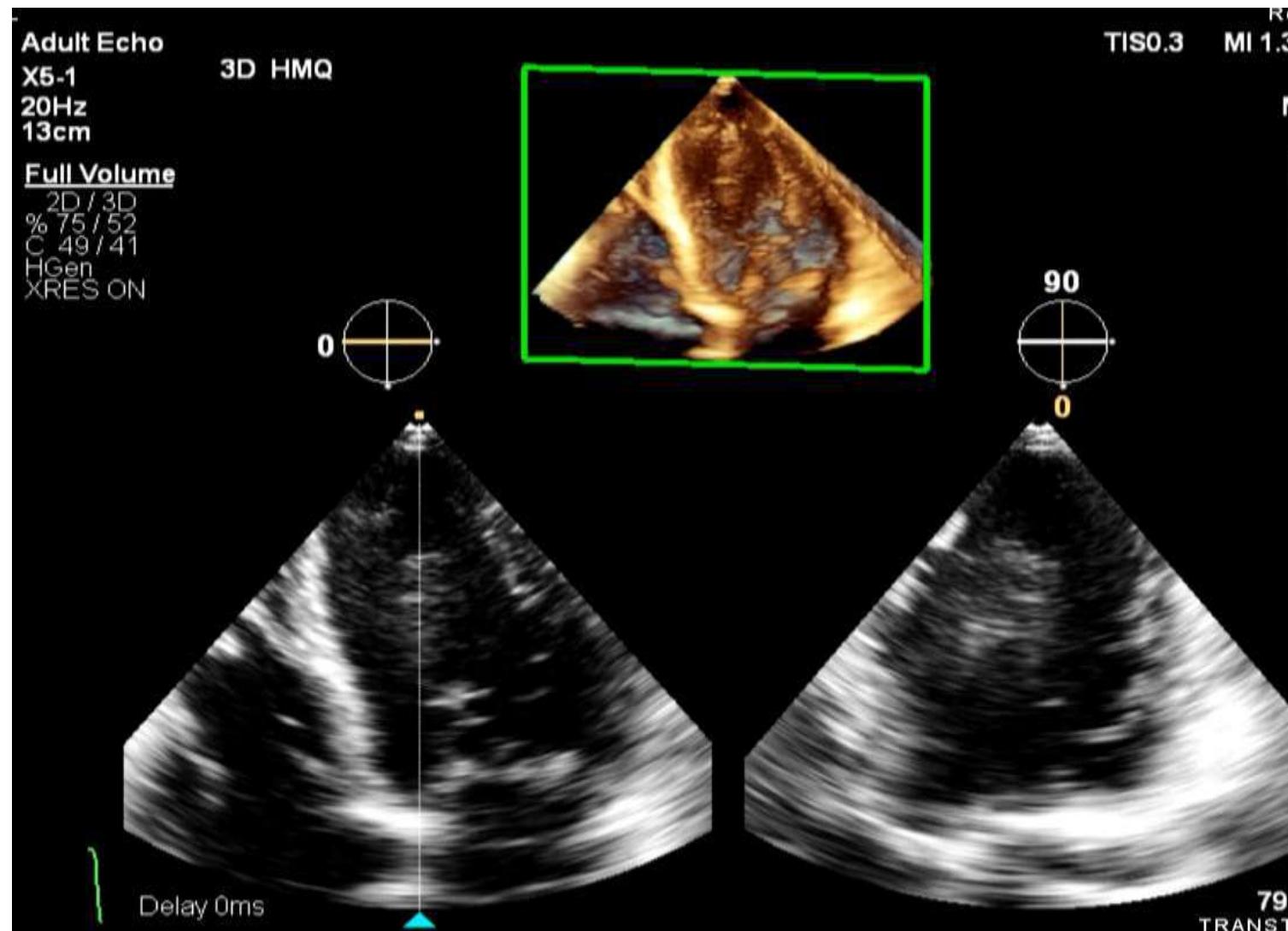


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Diagnosing HF with 3D Echo

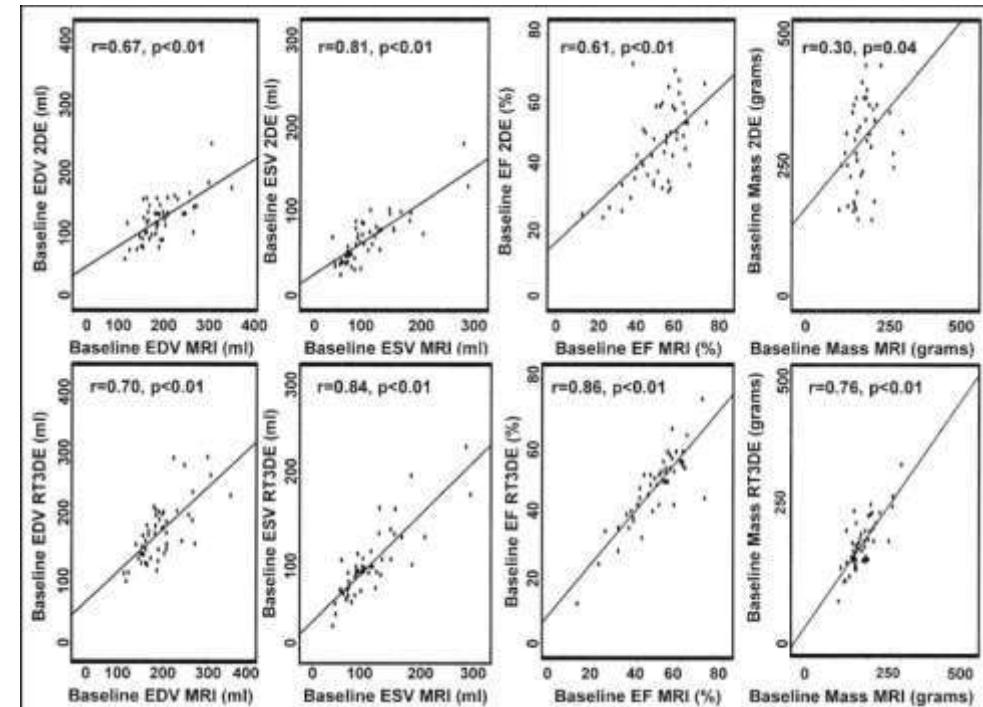
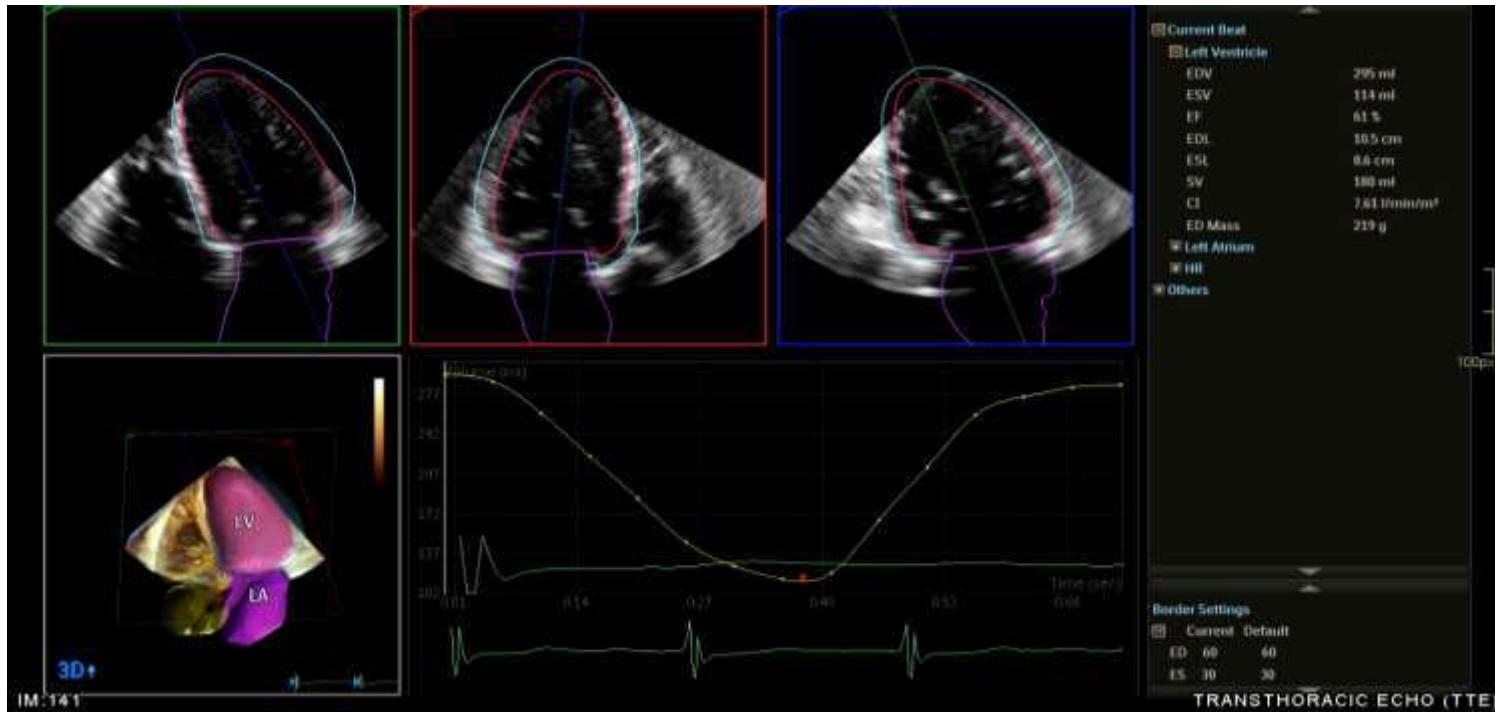
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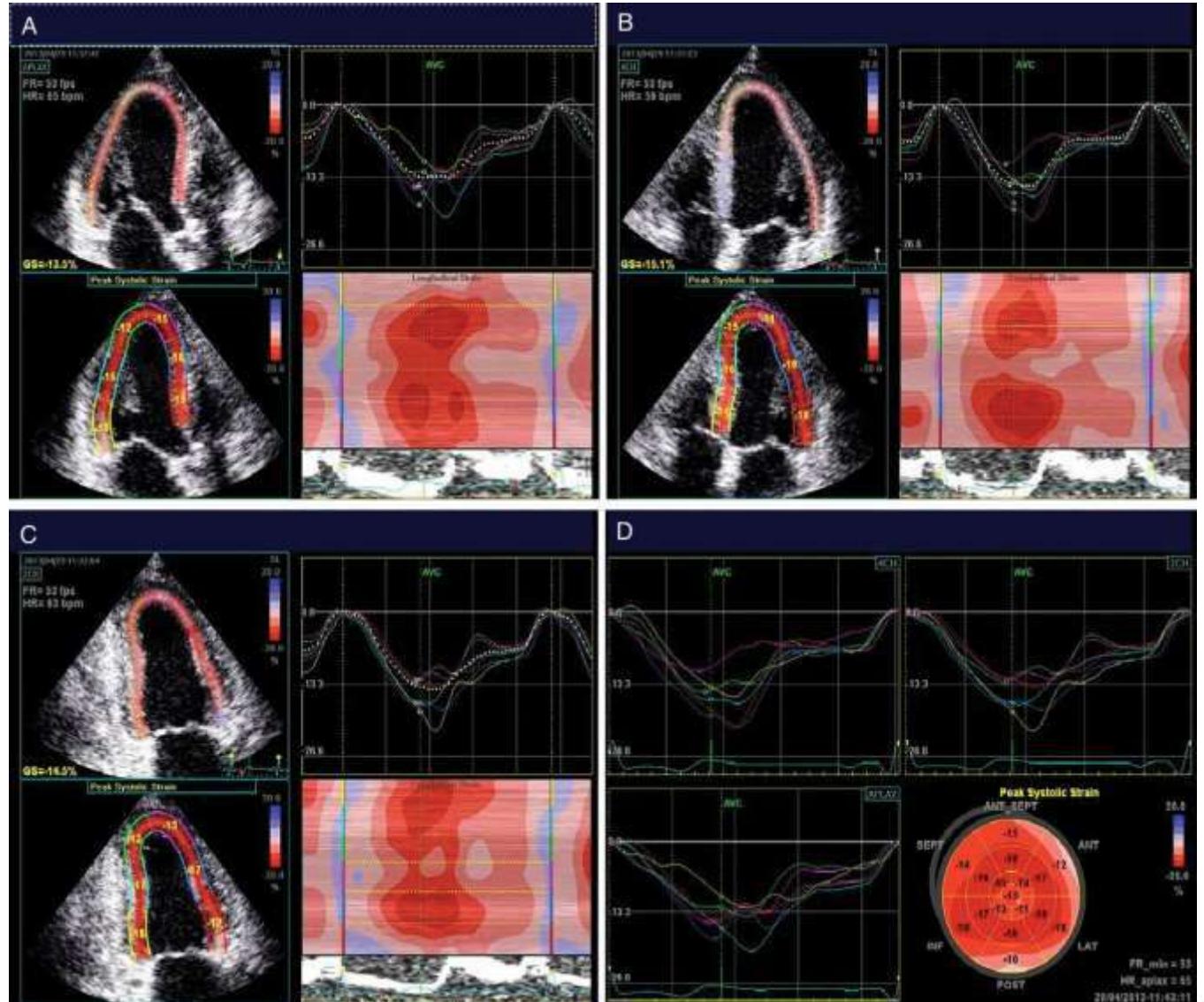


Diagnosing HF with 3D Echo



Detecting subclinical LV disease: GLS

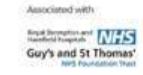
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Diagnosing HF preserved LVEF

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1. LVEF: >50%

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1. LVEF: >50%
2. Diastolic dysfunction: E/e' >9.0 suggest raised LV filling pressures

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Diagnosing HF preserved LVEF

1. LVEF: >50%
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3. LA enlargement: LA volume >34mL/m² (> 40mL/m² in AF)

Diagnosing HF preserved LVEF

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4. LVH: LV mass index >115g/m² men, >95g/m² women

Diagnosing HF preserved LVEF

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6. PHT: PASP >35mmHg

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7. GLS: Less negative than -16%

Diagnosing HF preserved LVEF

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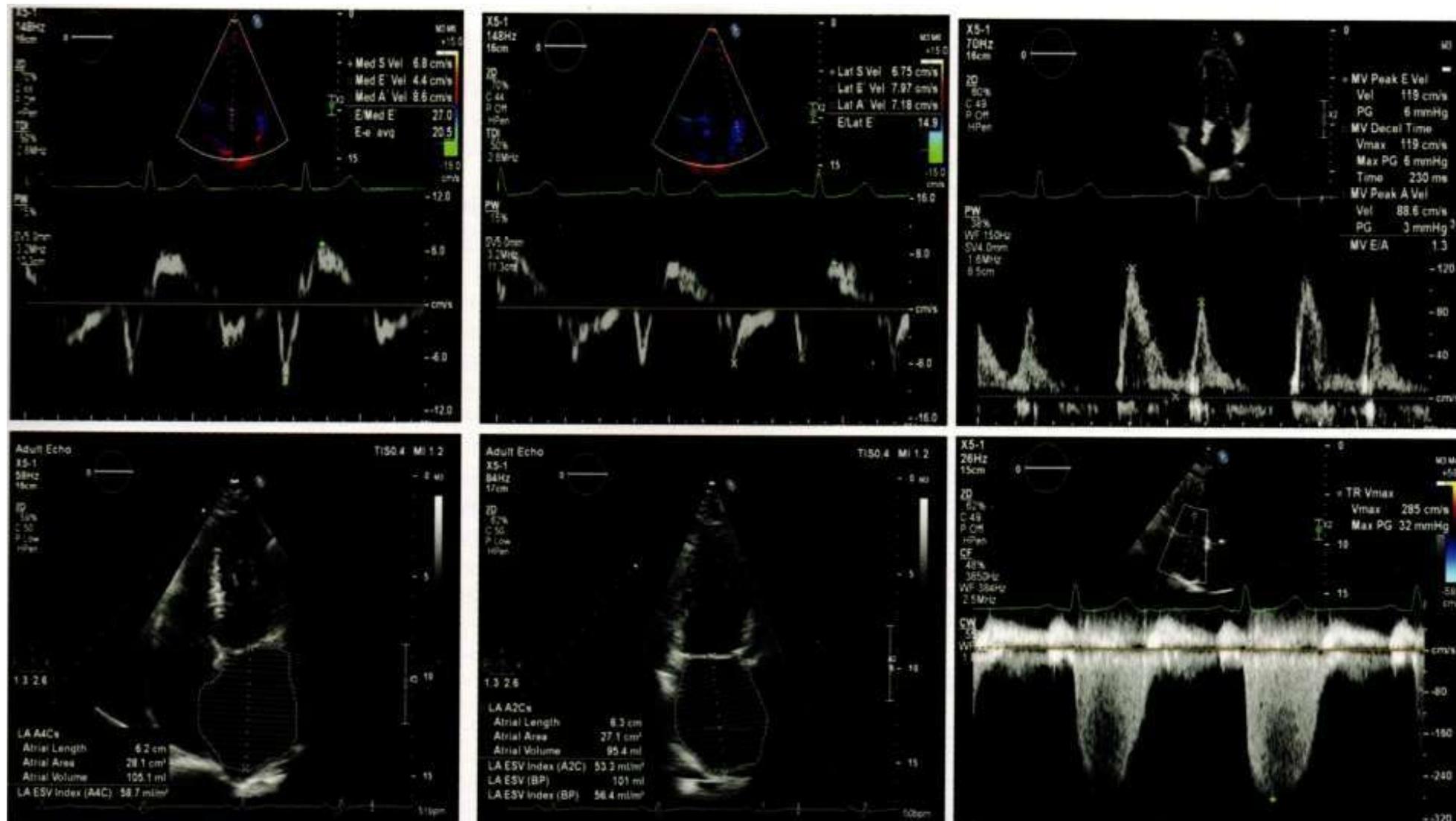
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HF2PEF Score HFA-PEFF Score

Diagnosing HF preserved LVEF

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When to suspect HFrEF

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Common comorbidities associated with HFrEF



high blood pressure



AF



COPD



chronic kidney disease

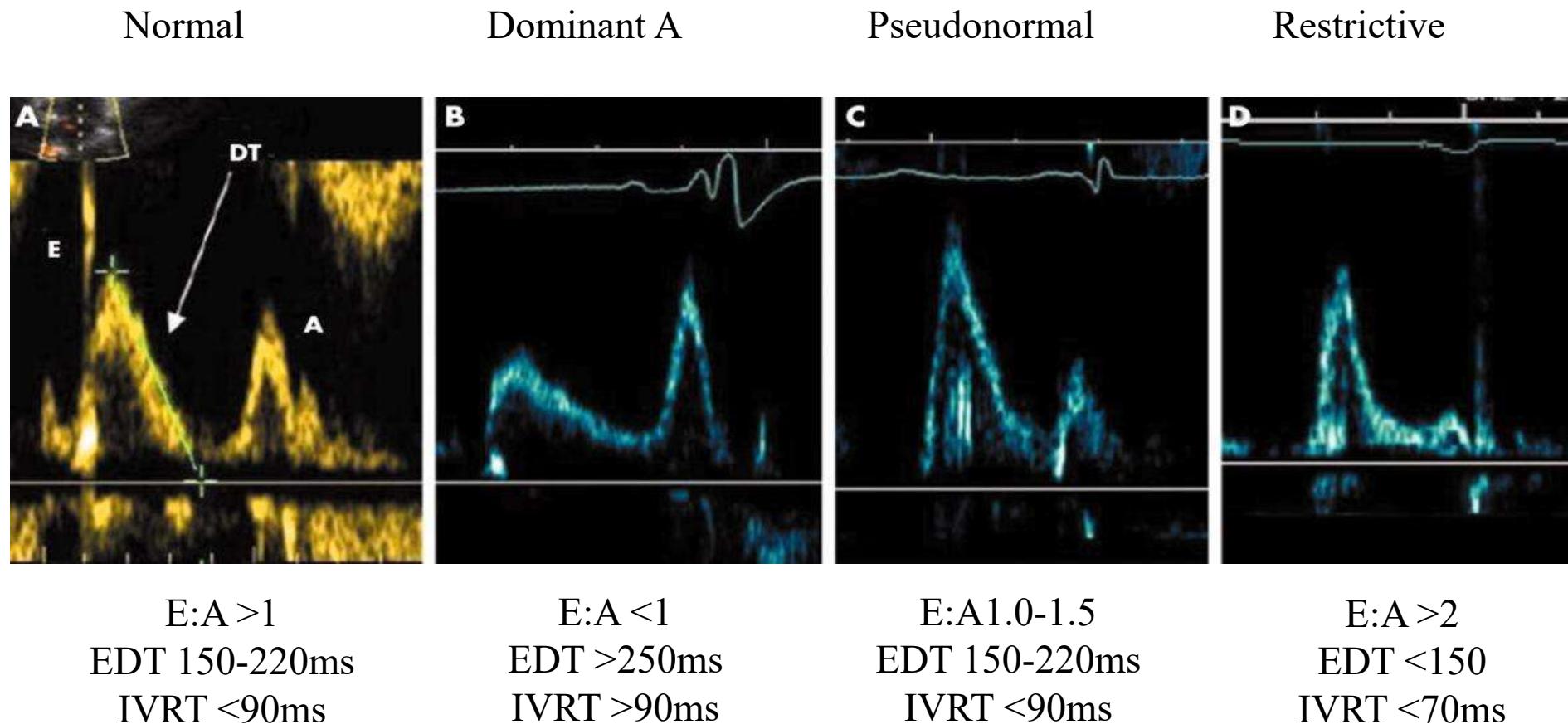
obesity and diabetes



Echocardiographic findings that may support diagnosis of HFrEF

- LA dilatation (LAVi > 34ml/m²)
- LV hypertrophy, normal LV volumes
- Abnormal LV strain
- Increased TR velocity > 2.8m/s
- No significant left sided valve disease
- AF

Diagnosing HF preserved LVEF



So far.... So easy....

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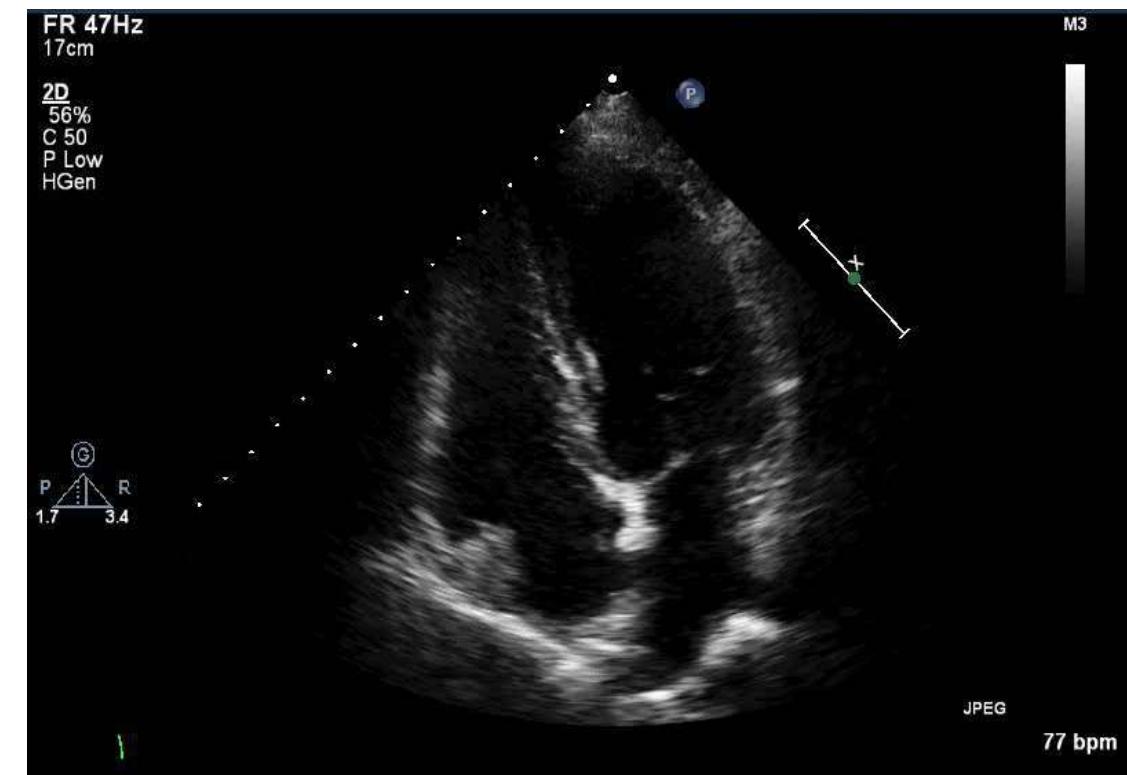
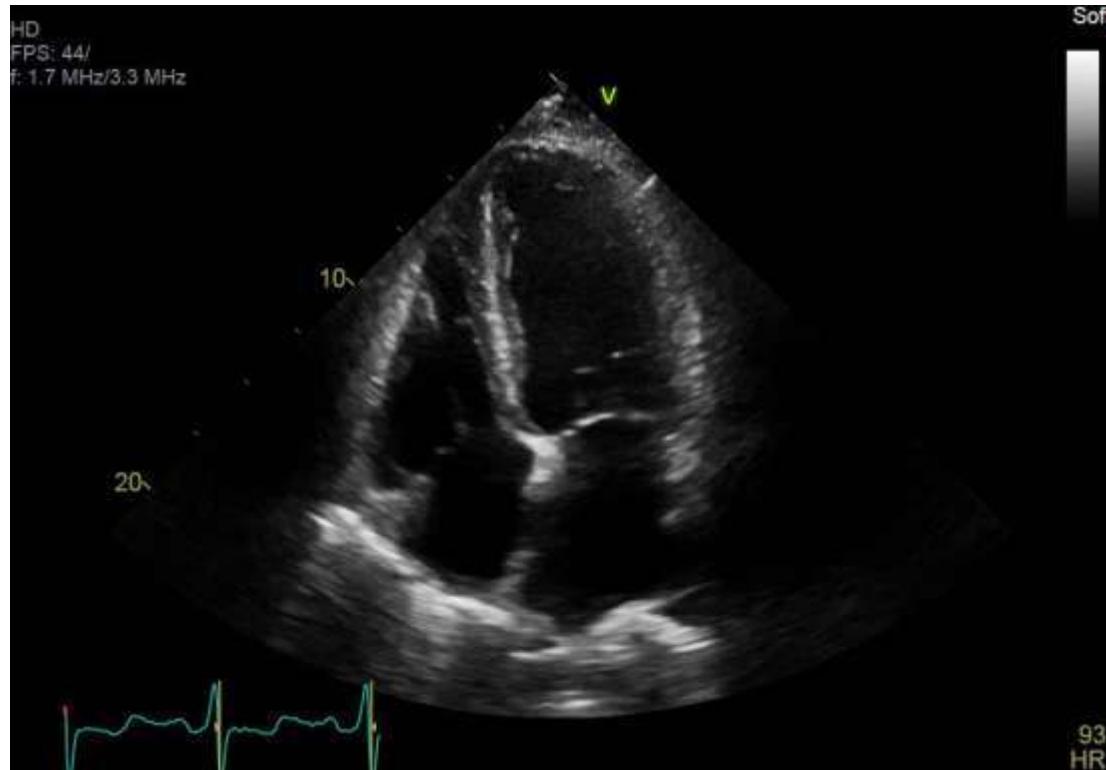
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LVEF in presence of severe AS

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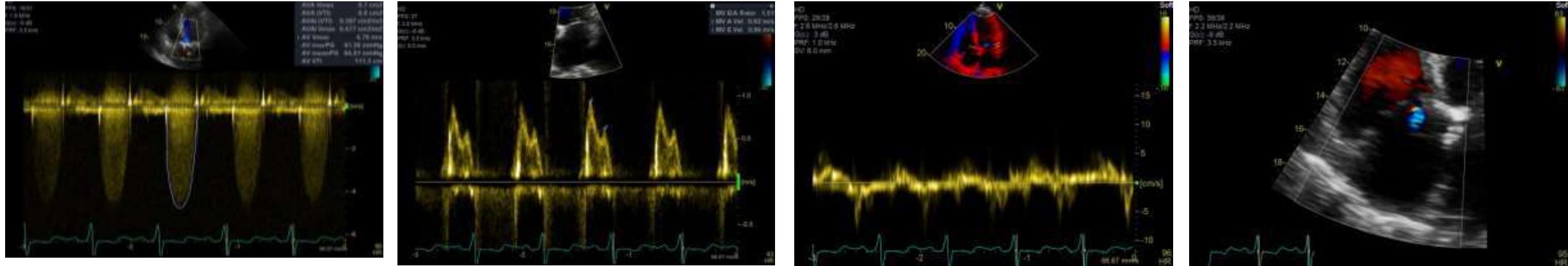
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Physiology of Heart Failure

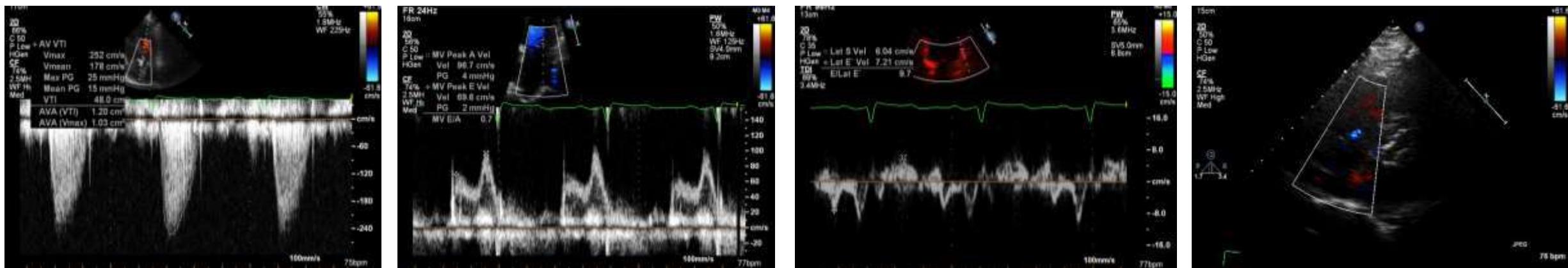
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Before TAVR



8 weeks after TAVR



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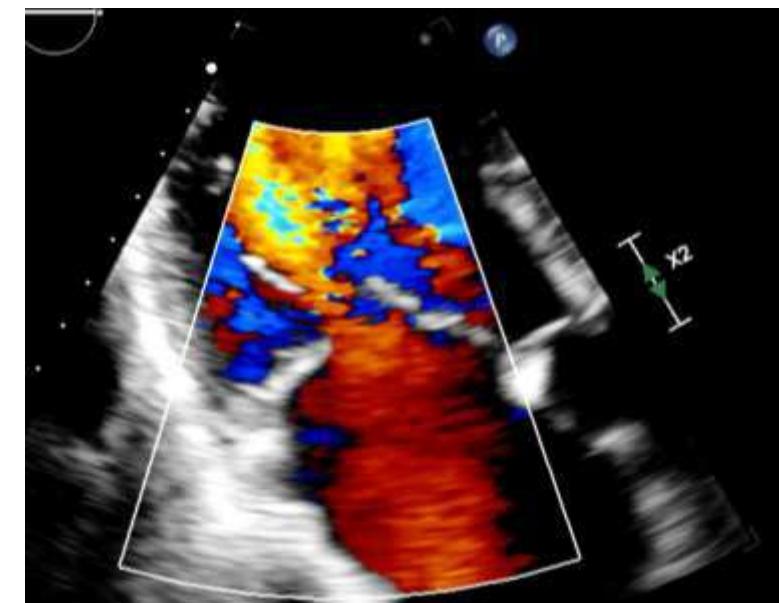
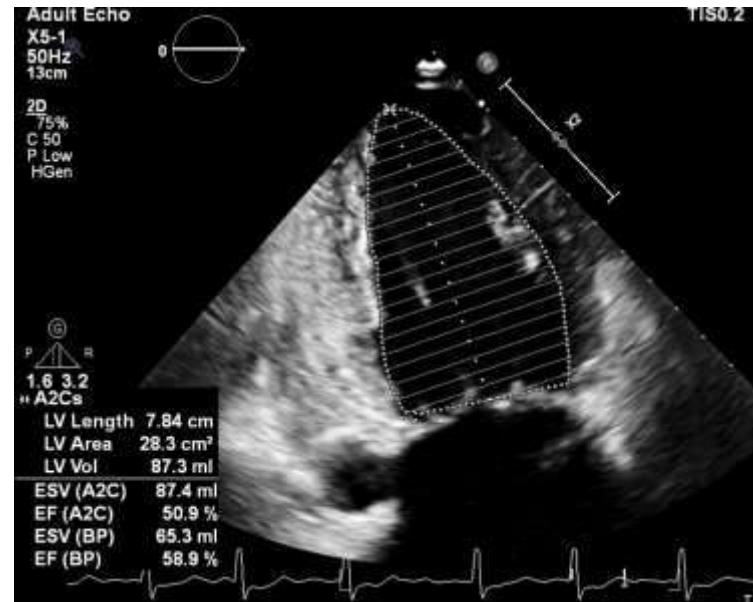
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LVEF in presence of severe MR

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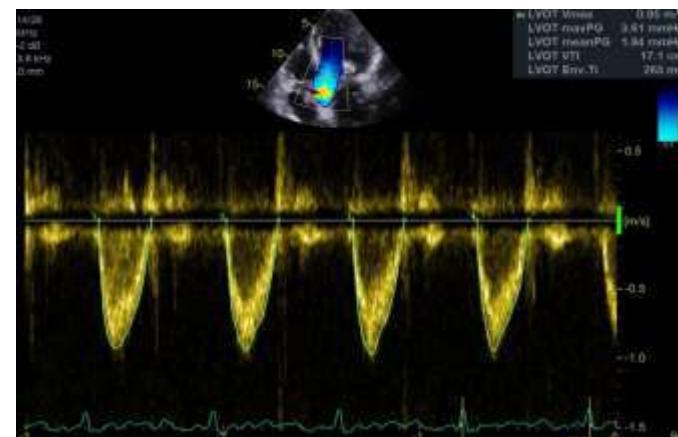
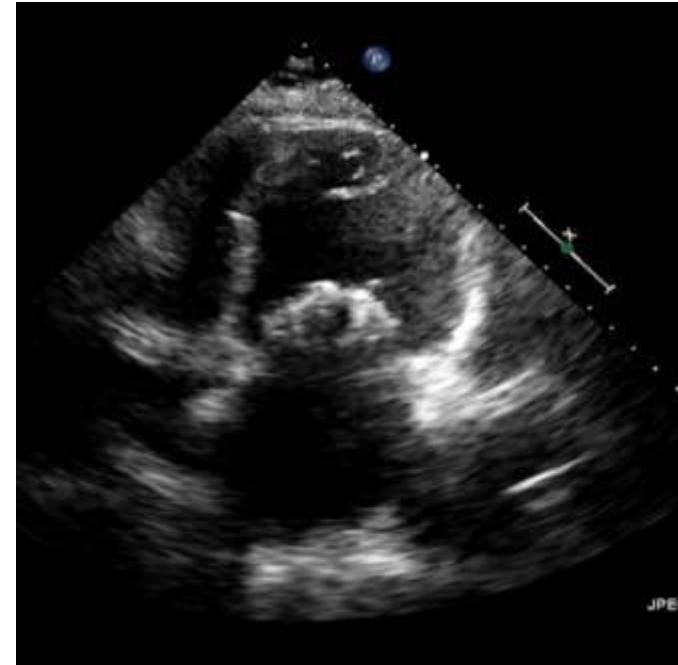
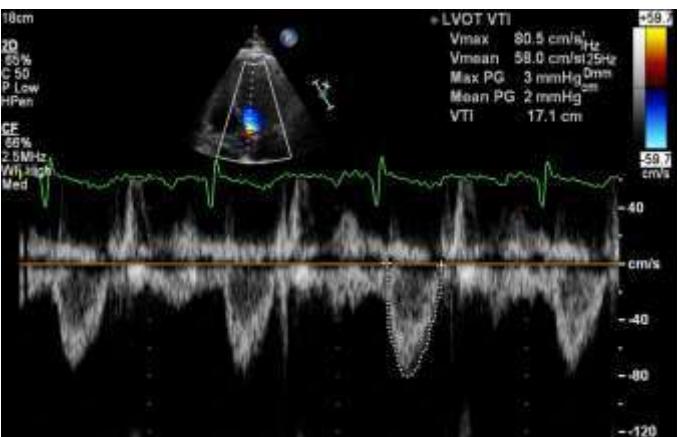
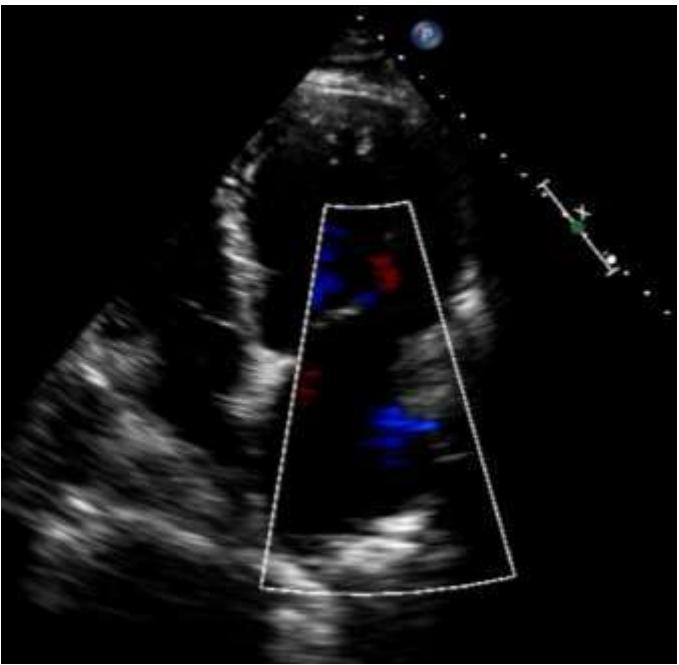
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LVEF before and after TMVR

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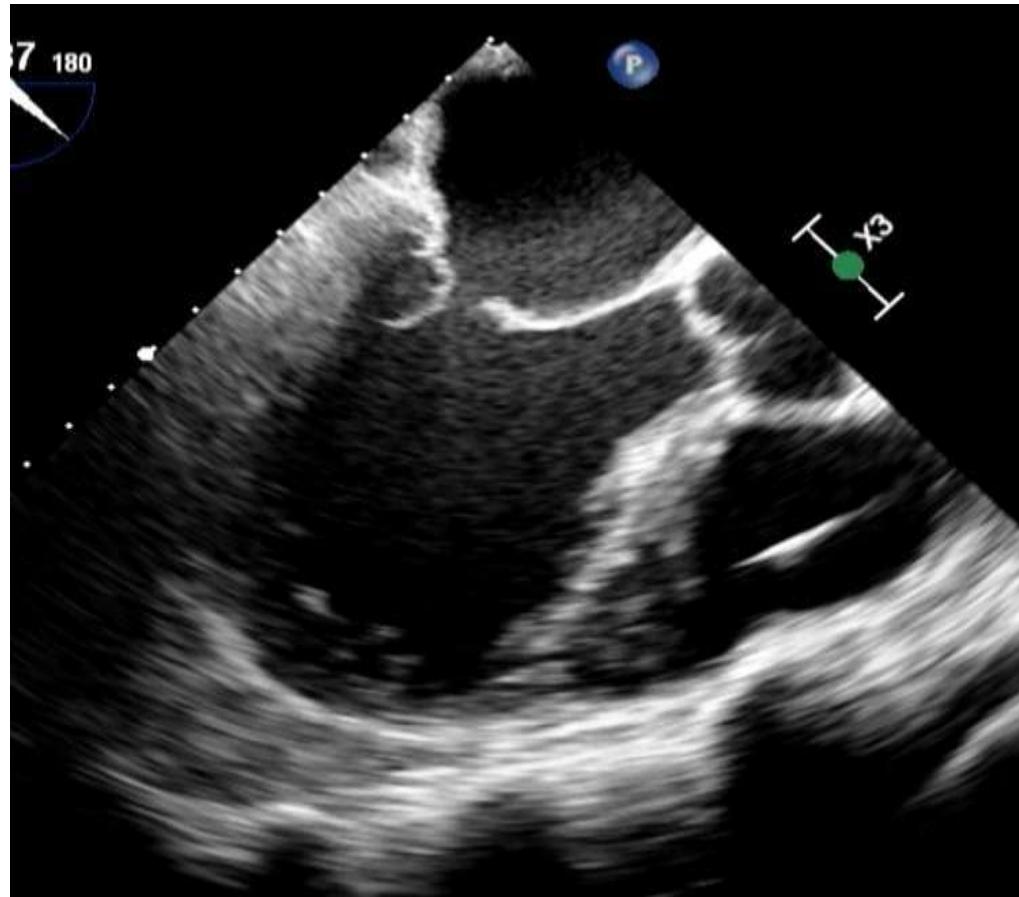
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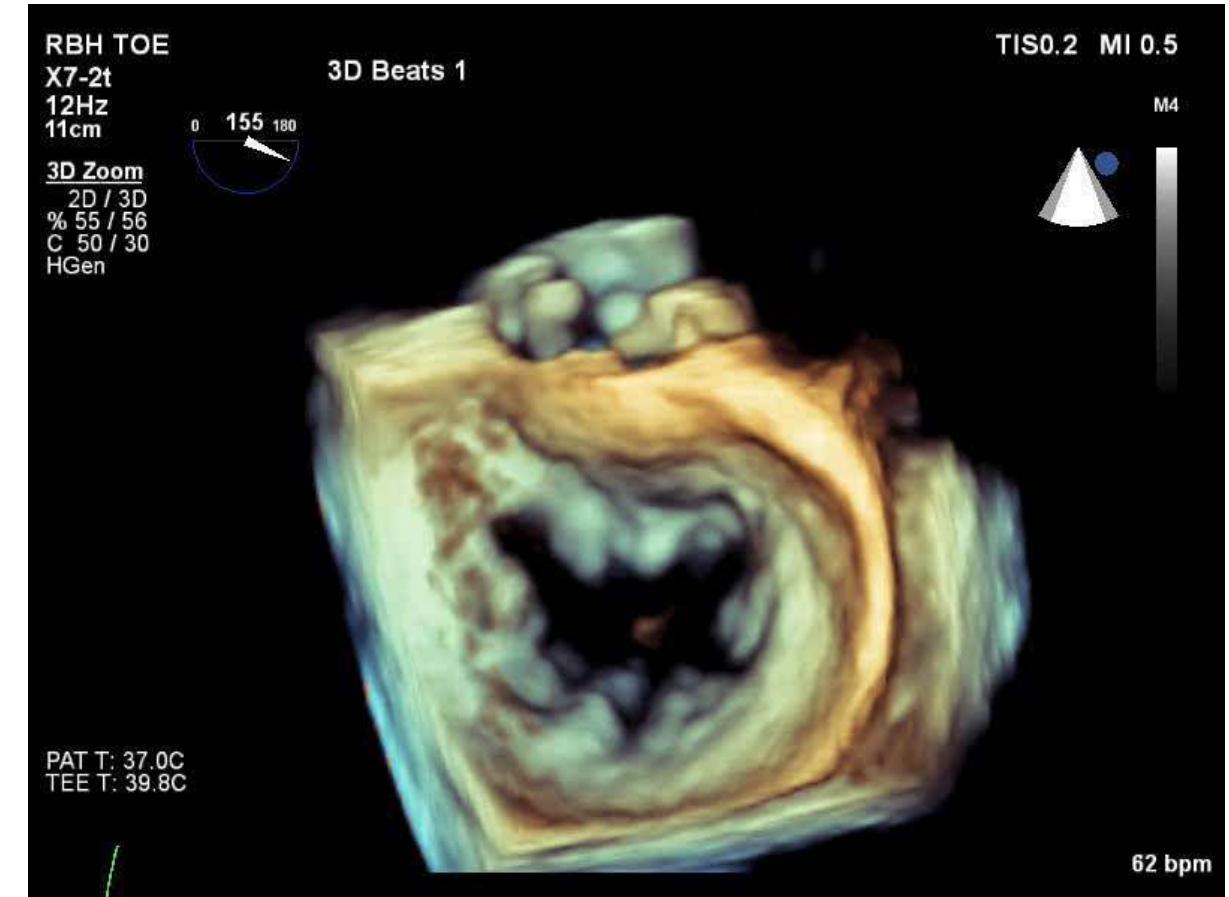


Secondary MR

2D

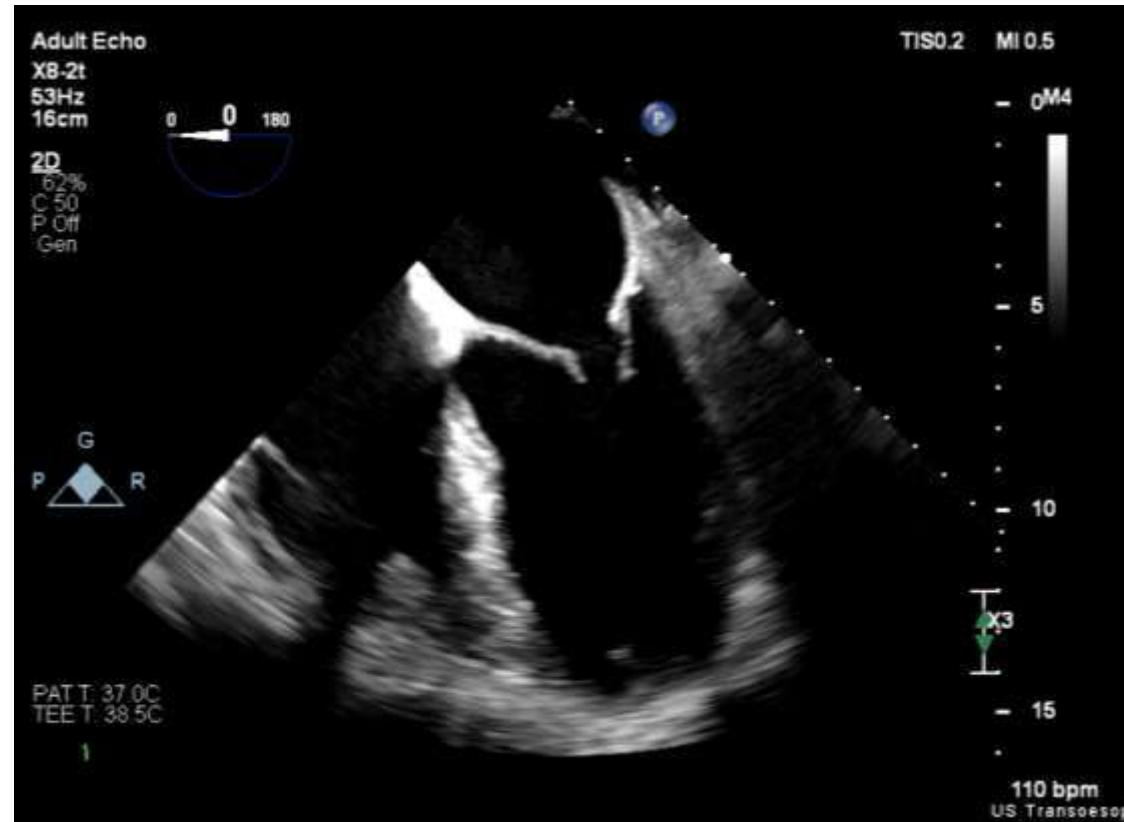


3D

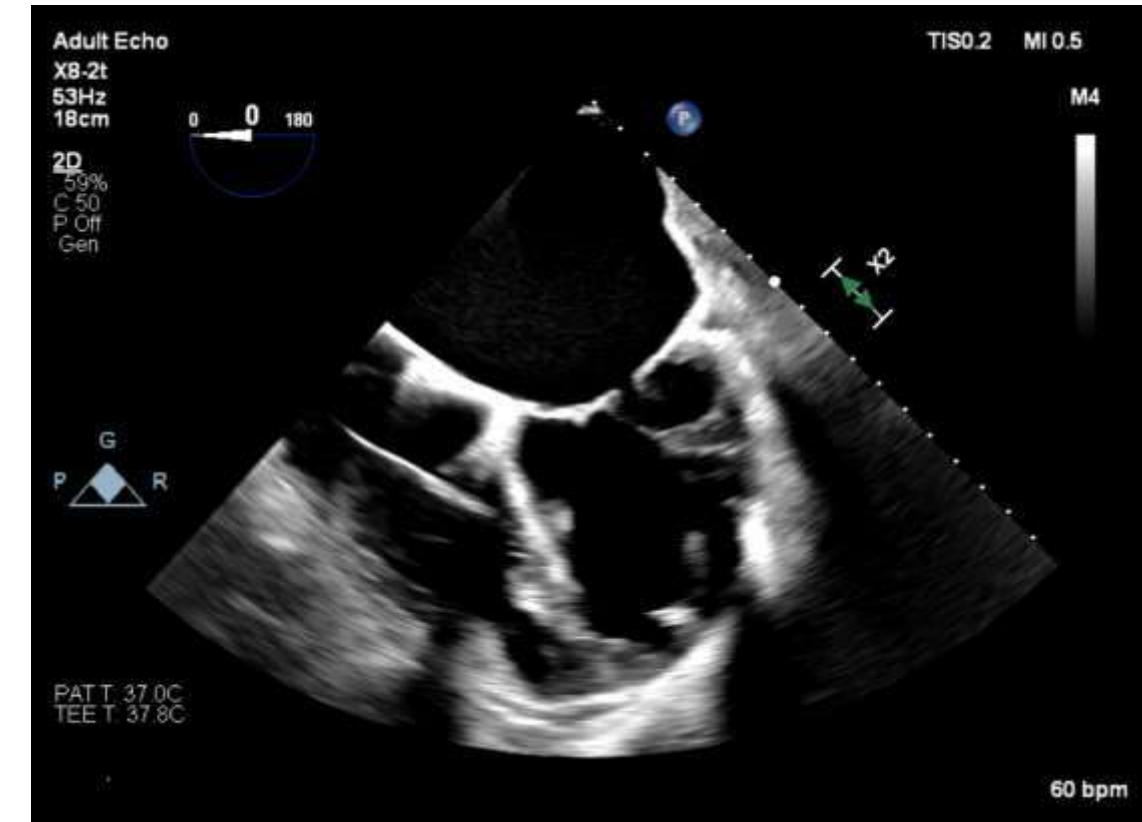




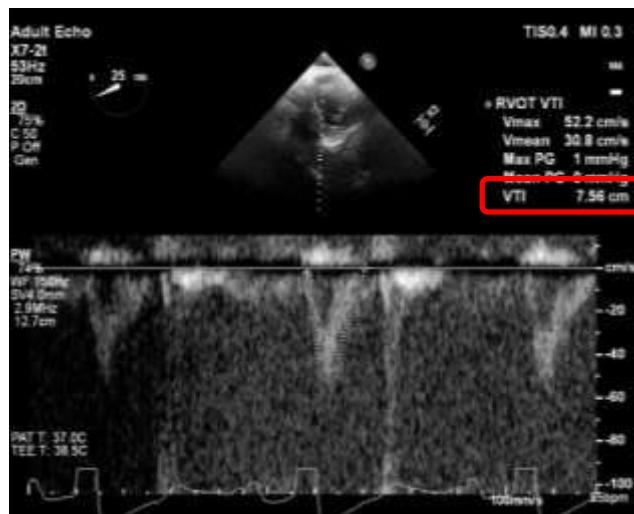
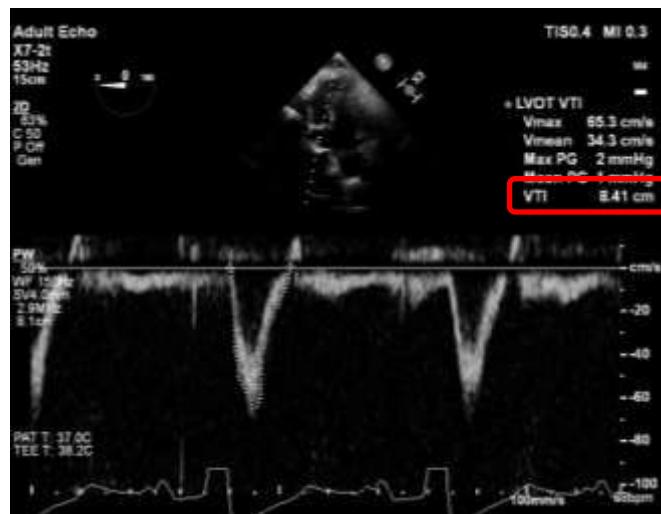
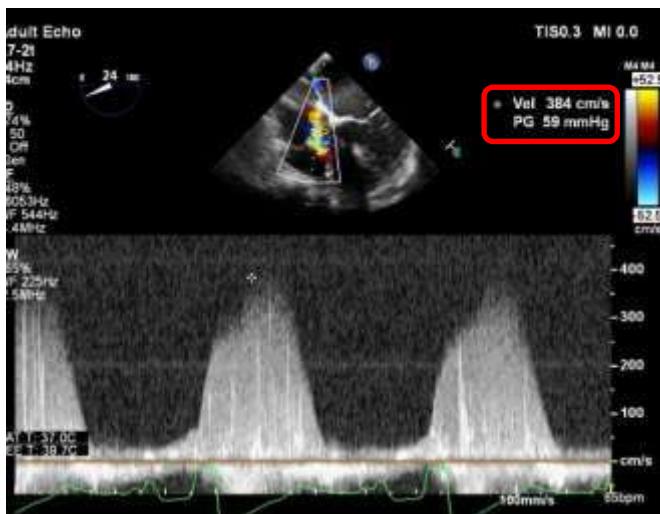
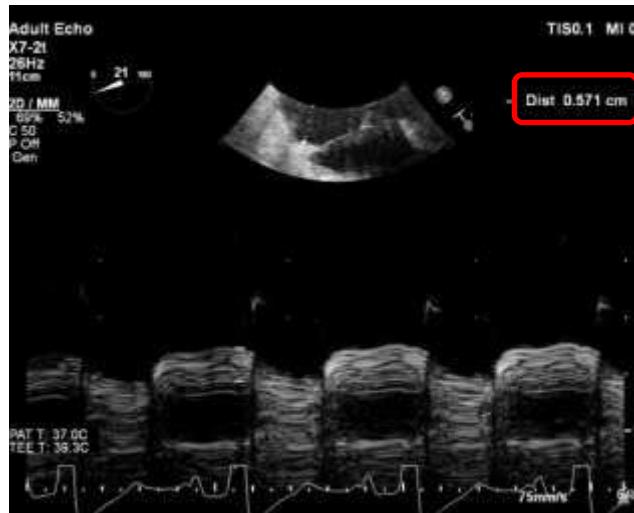
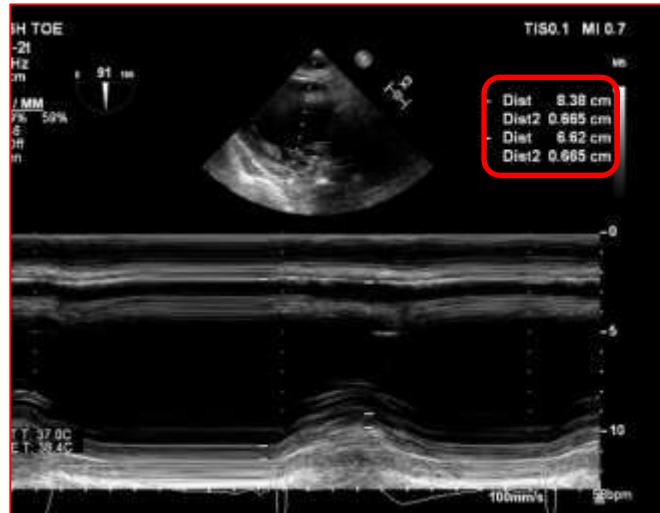
Secondary ventricular MR



Secondary atrial MR



SMR physiology in Heart Failure

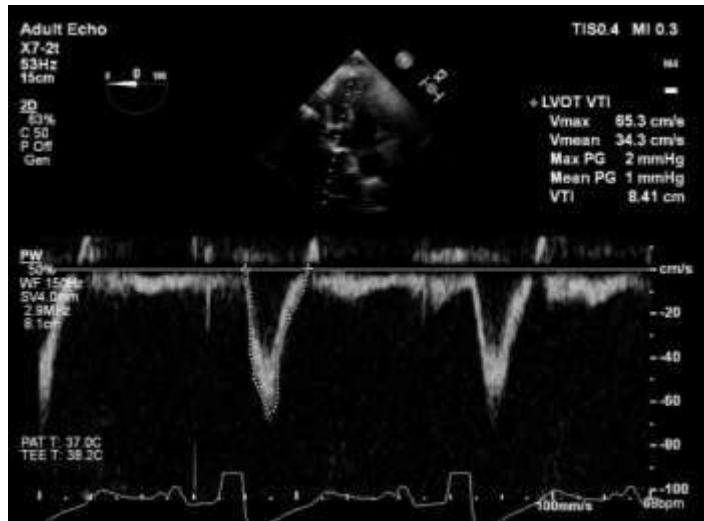


SMR physiology in Heart Failure

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SV 29ml, CO 2.0L/min. CI 0.93



Add dobutamine

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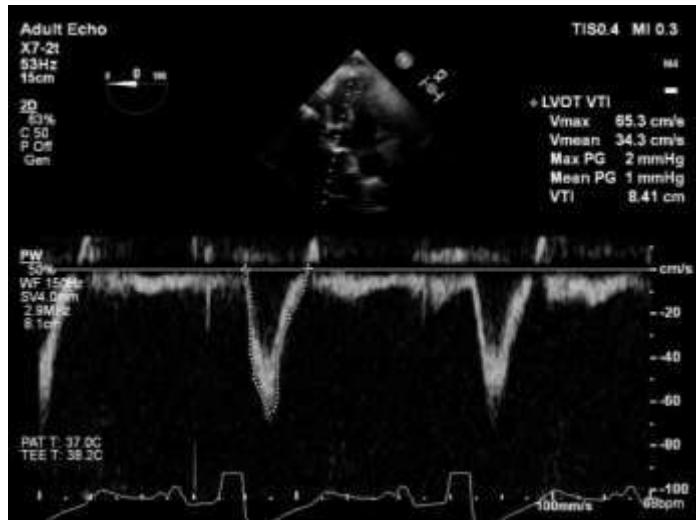
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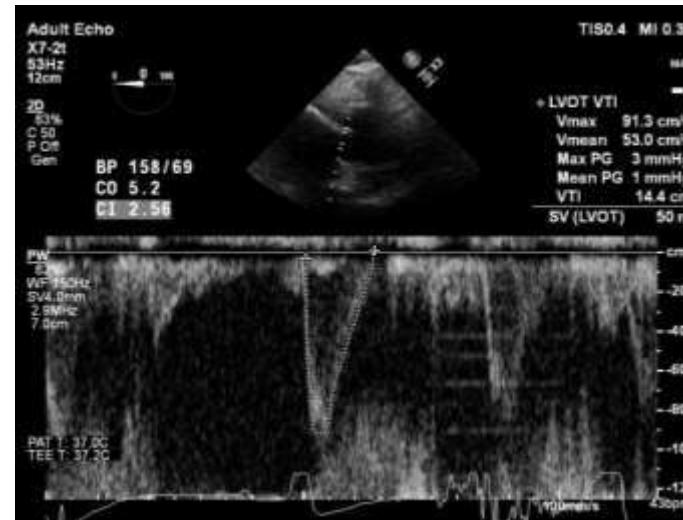
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SV 50ml, CO 2.1L/min, CI 0.97



Add dobutamine

Increase pacing rate

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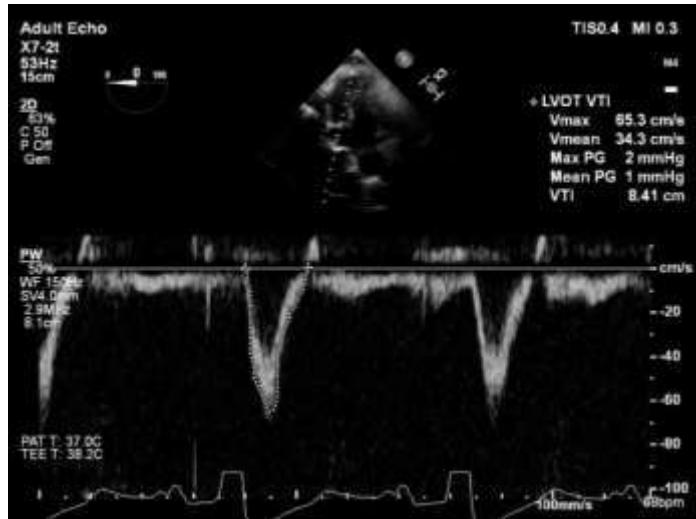


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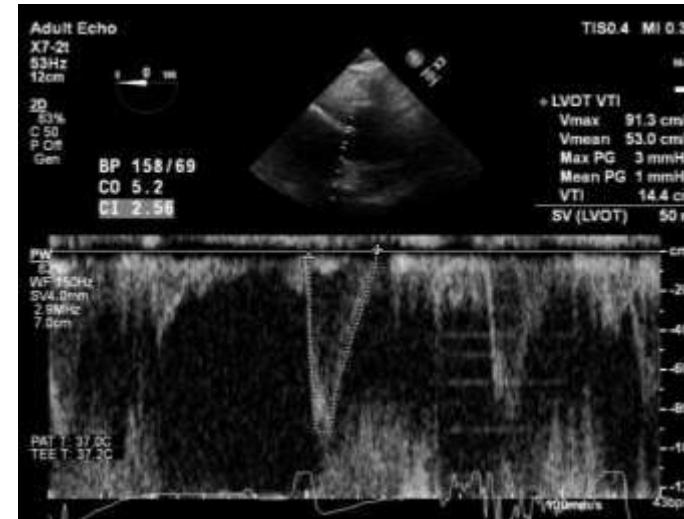
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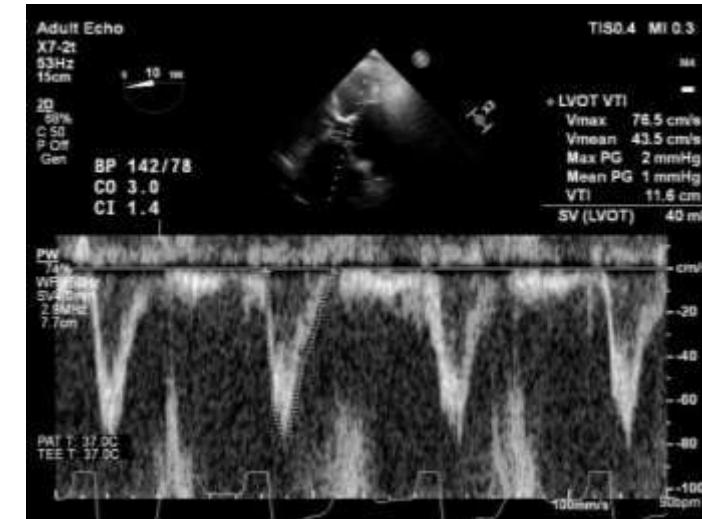
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SV 40ml, CO 3.6L/min, CI 1.67



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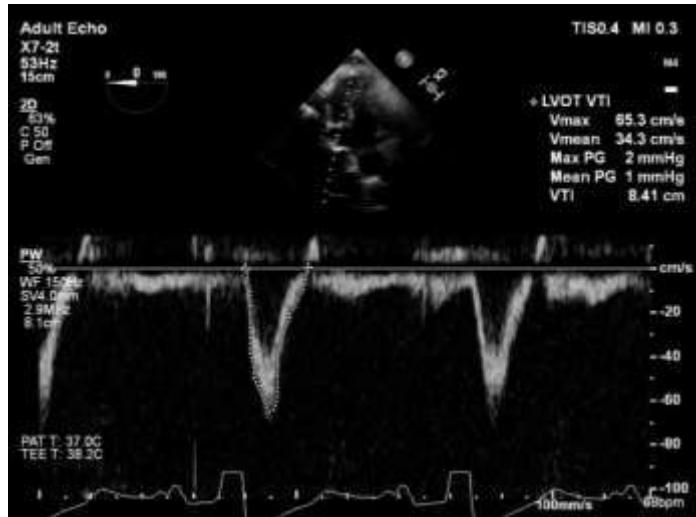
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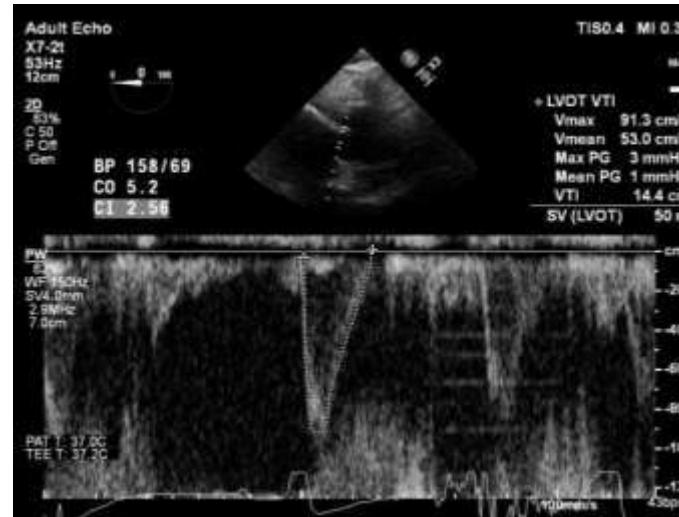
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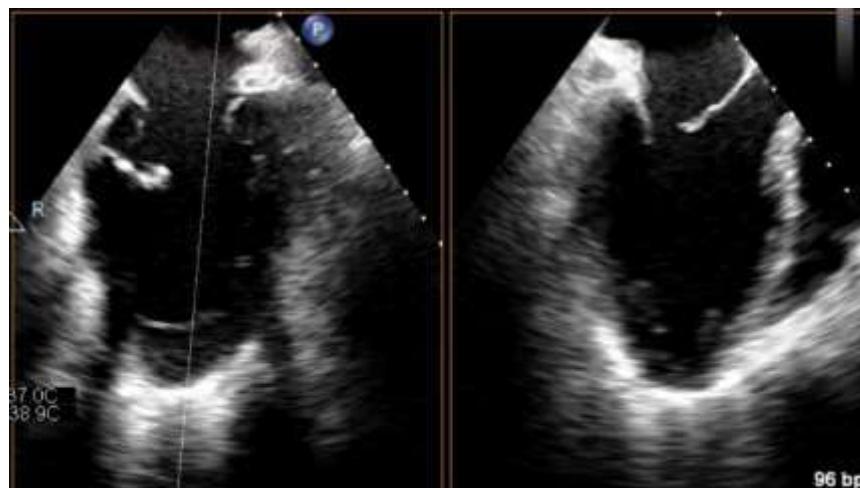
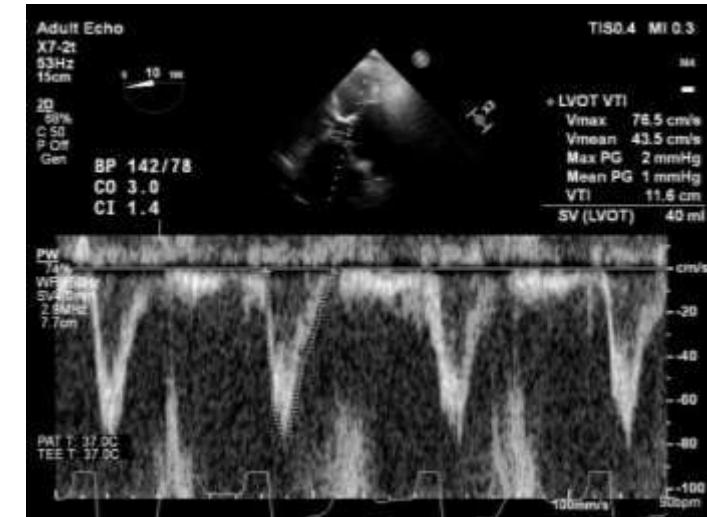
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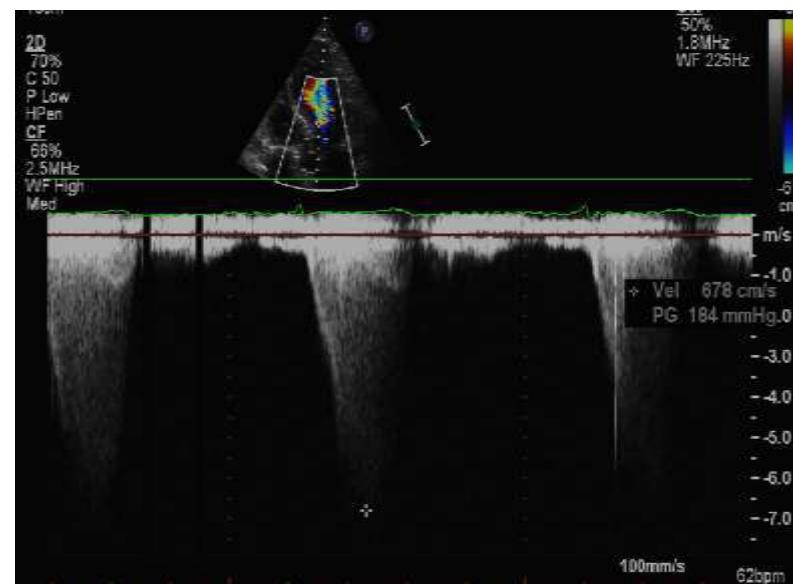
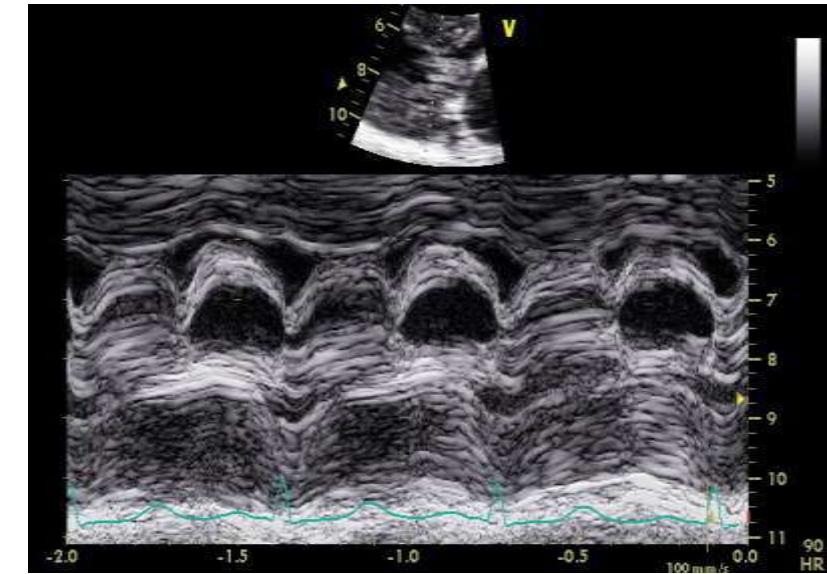
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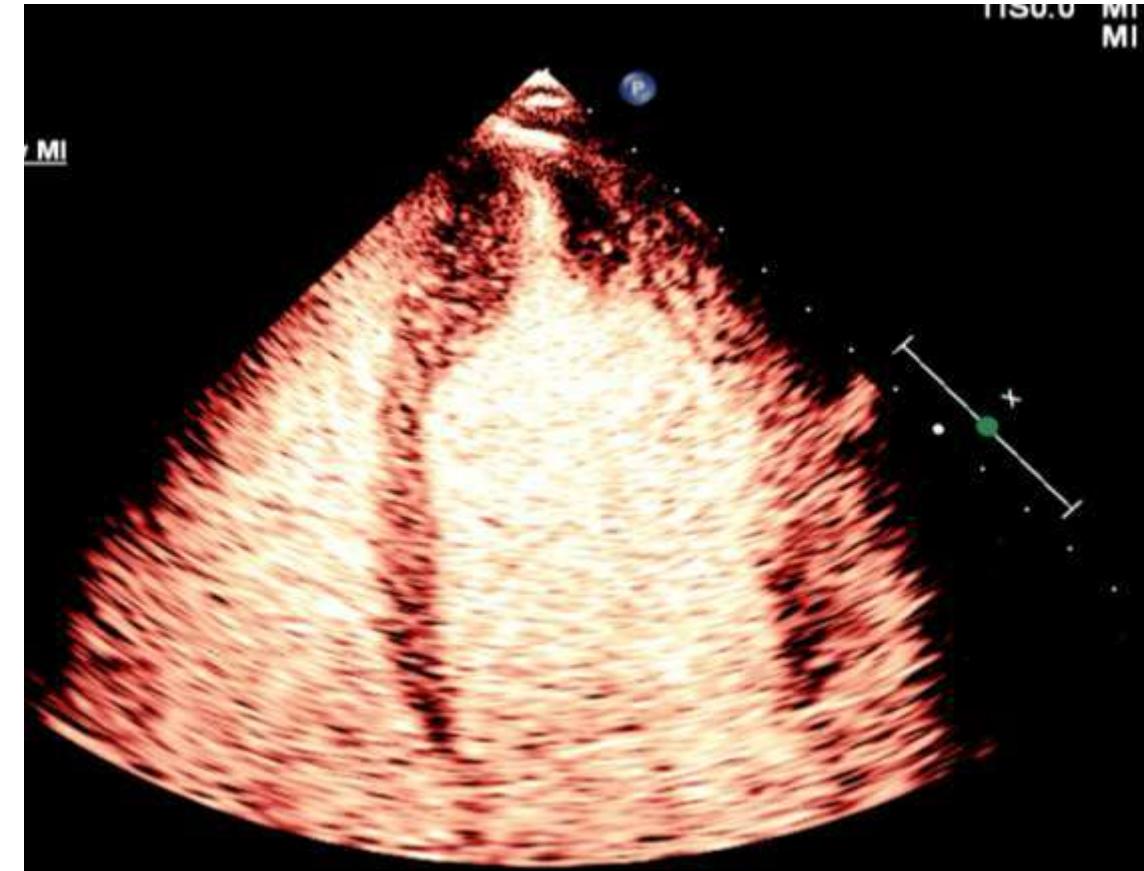
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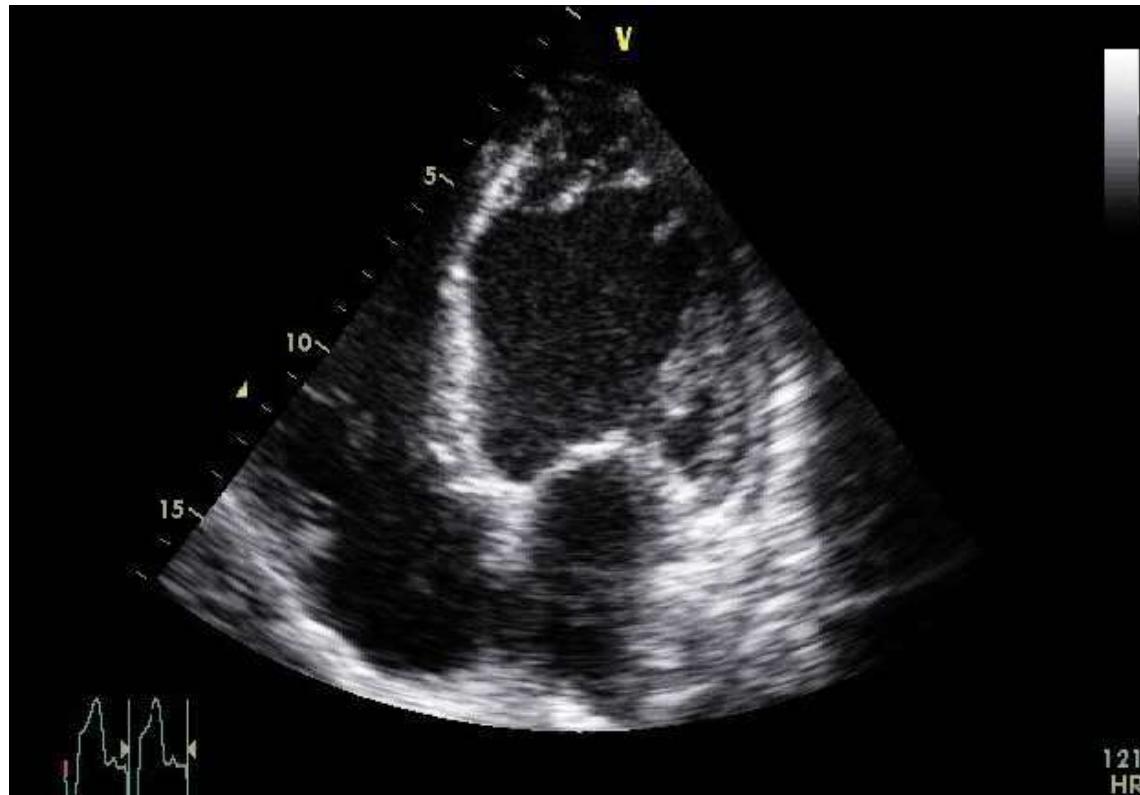
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Non-Compaction LV

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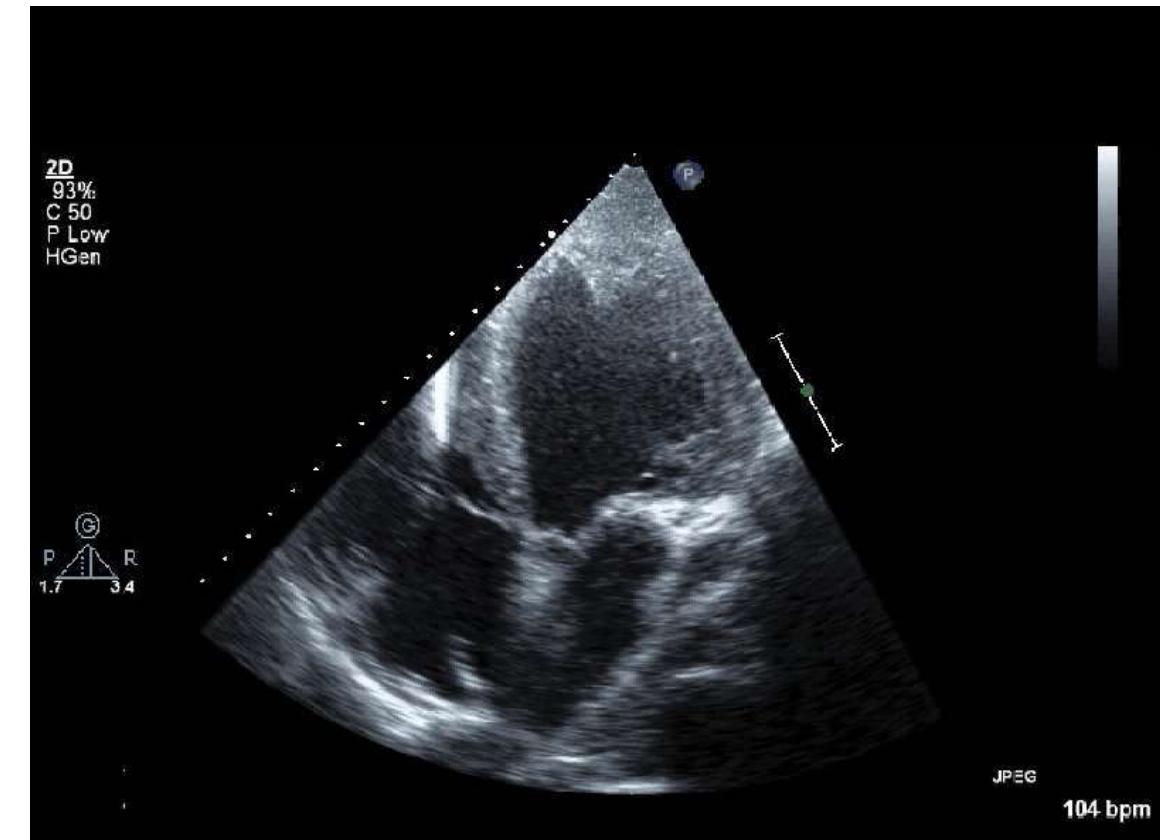
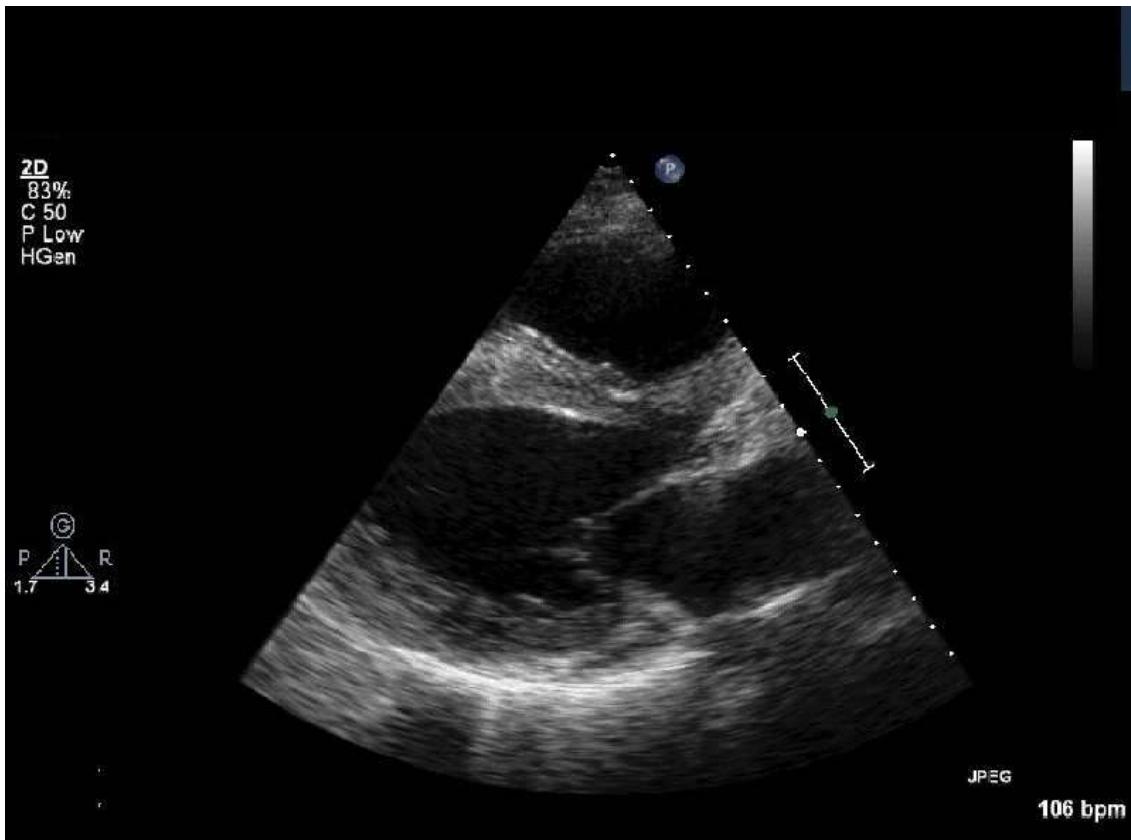
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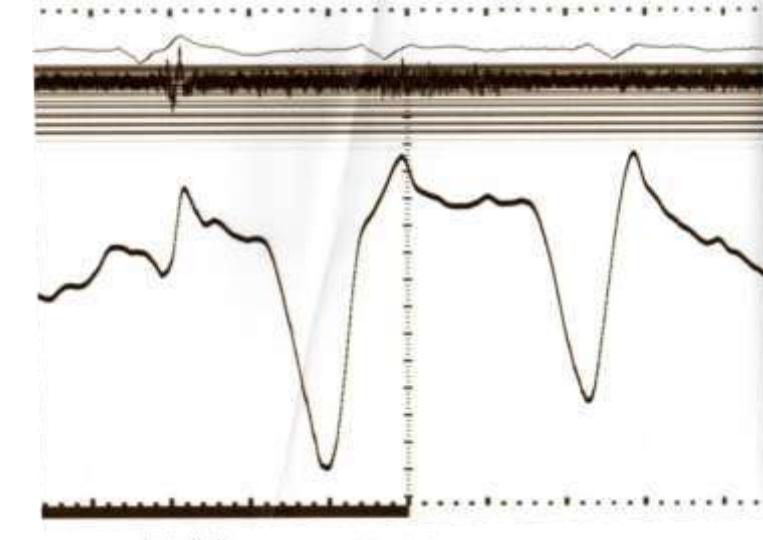
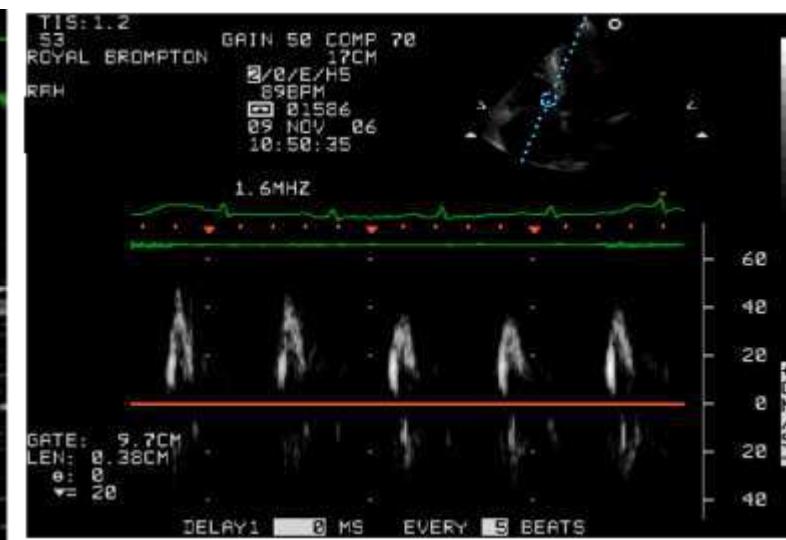
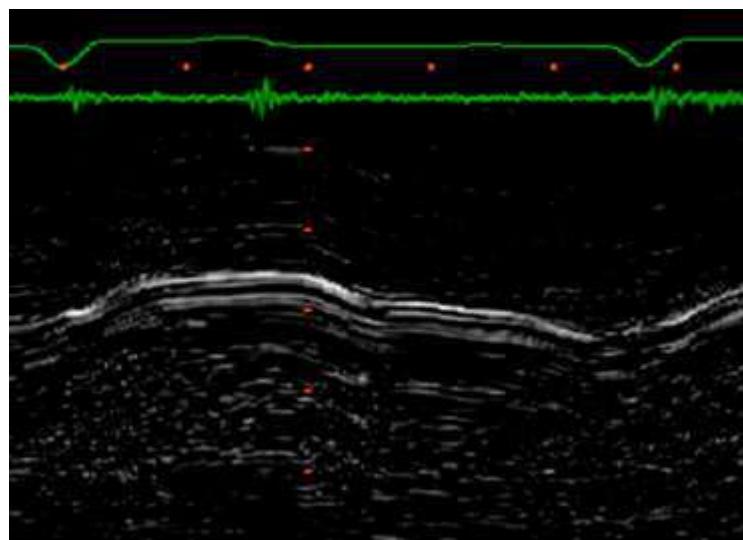
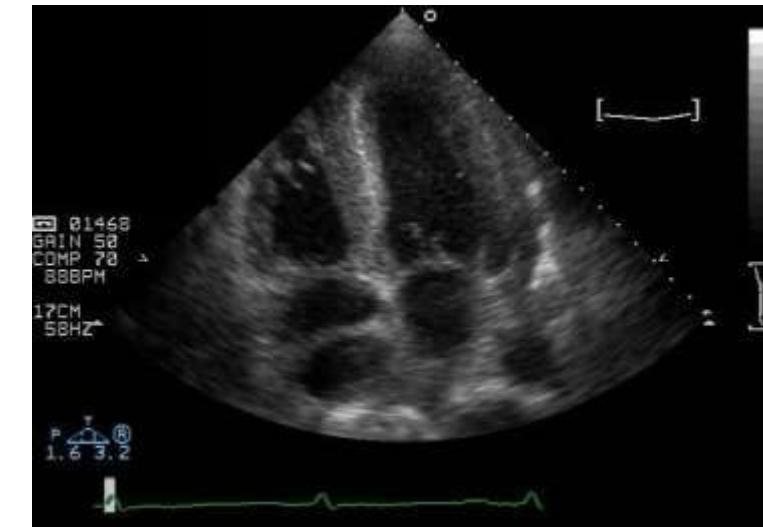
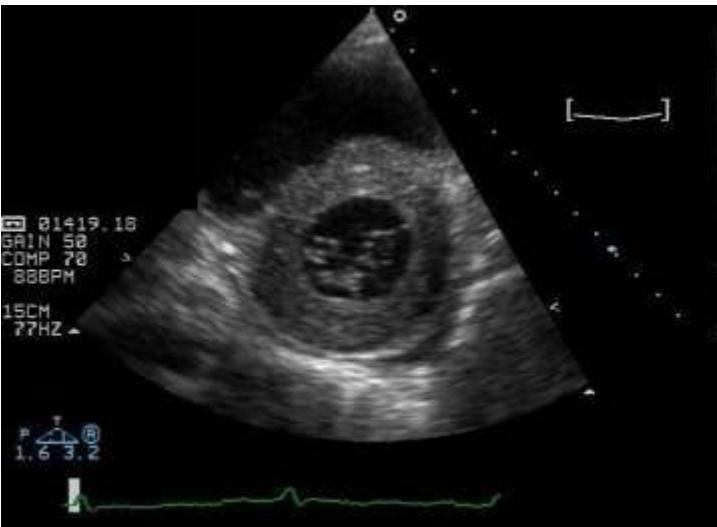
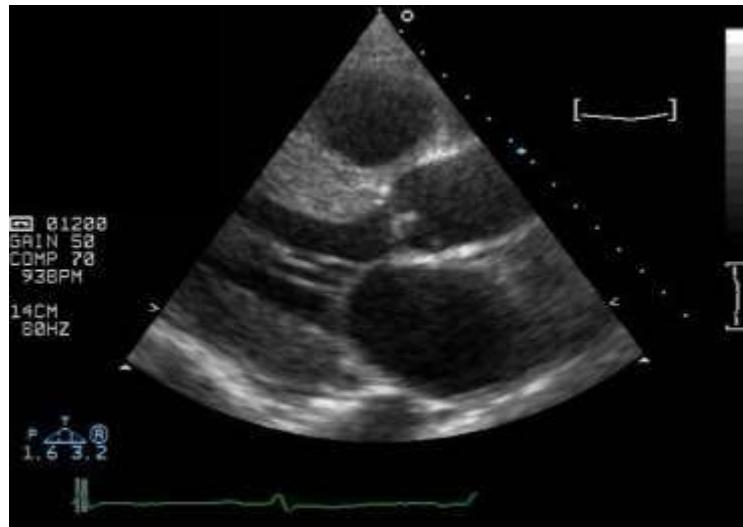
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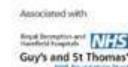
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Restrictive Cardiomyopathy

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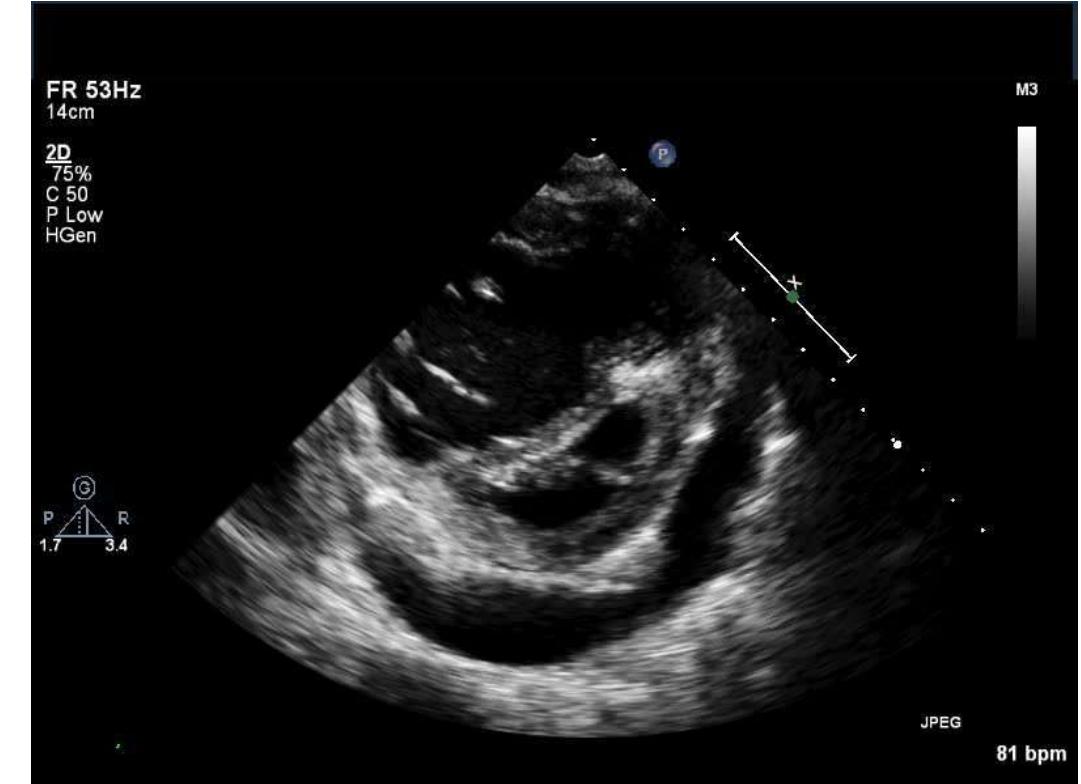
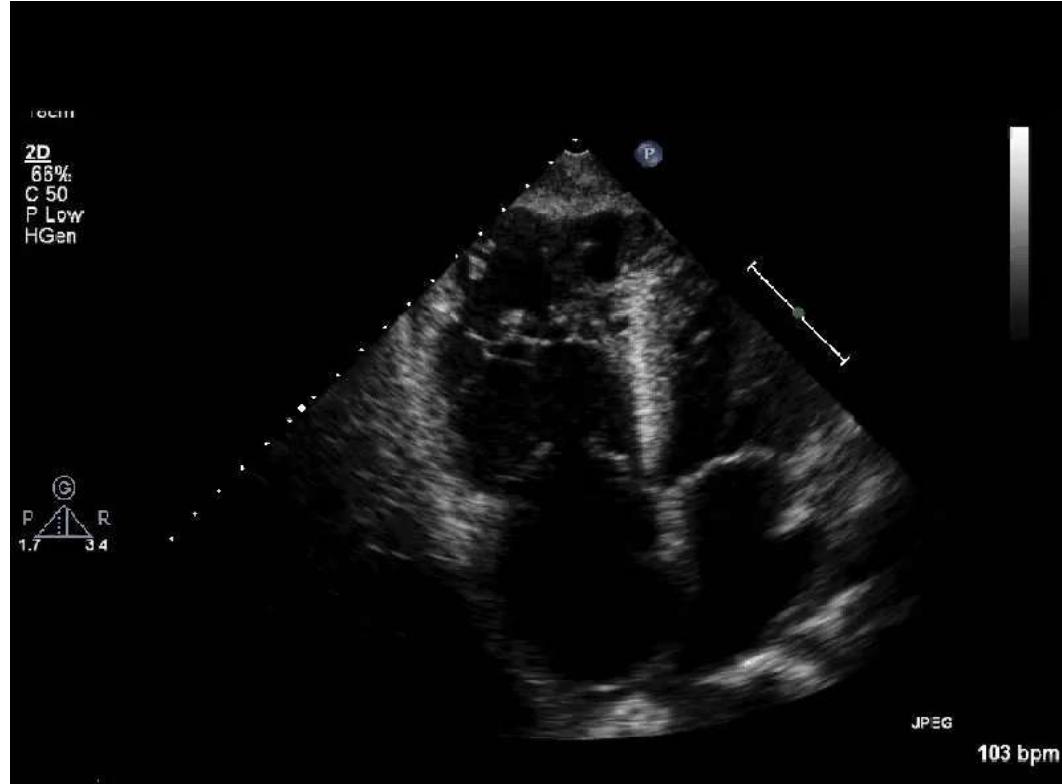


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Right heart dilatation and failure

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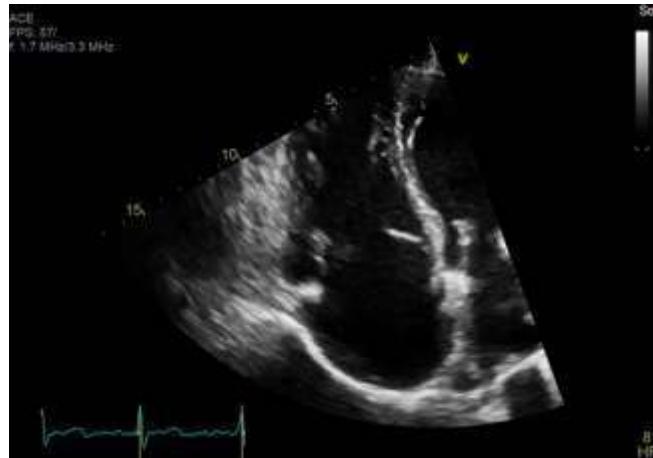
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Mechanisms of TR

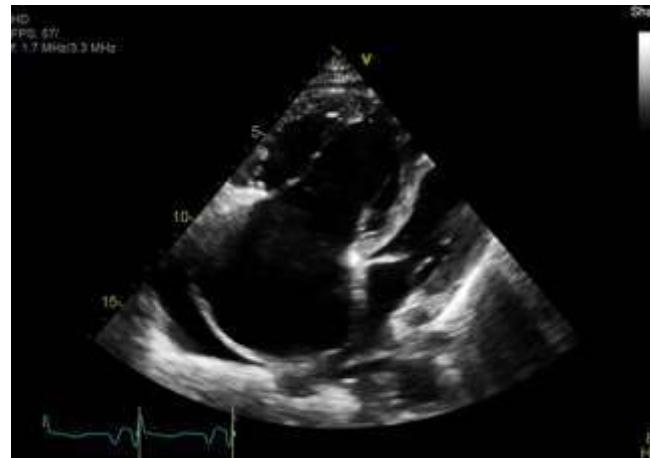
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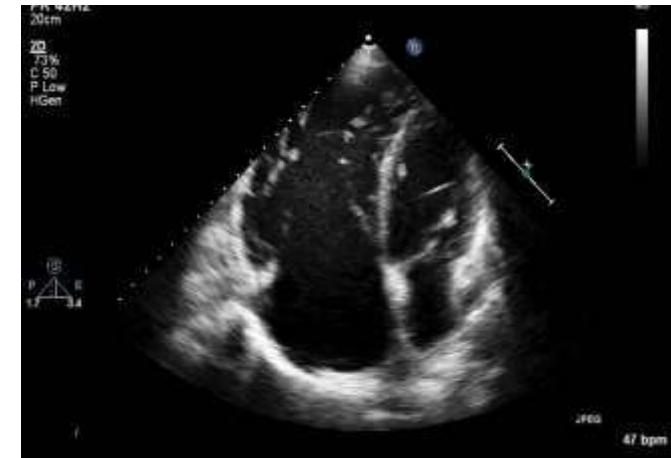
Primary TR



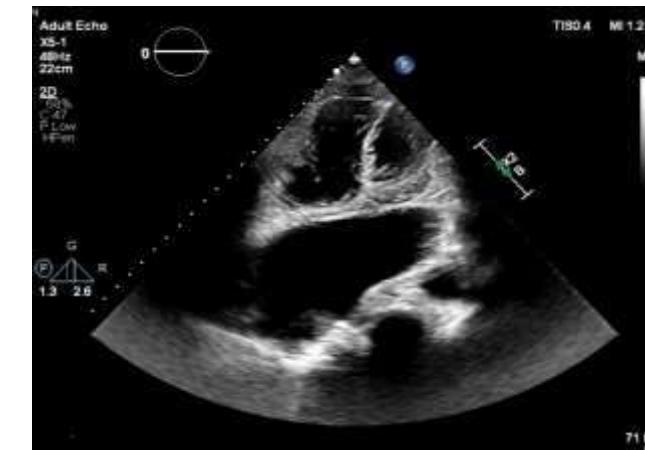
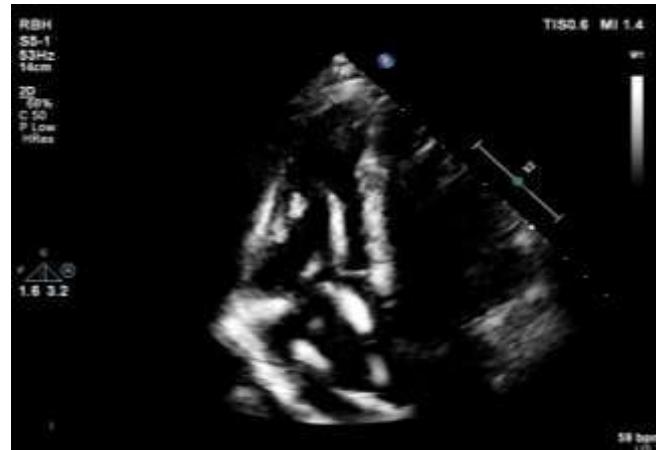
Secondary Atrial TR



Secondary Ventricular TRv



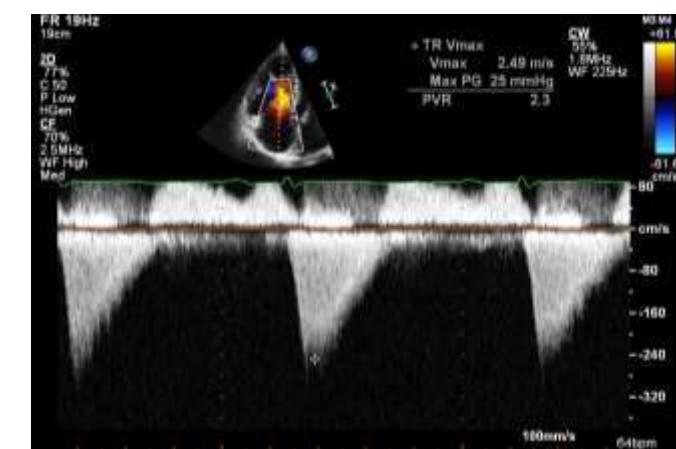
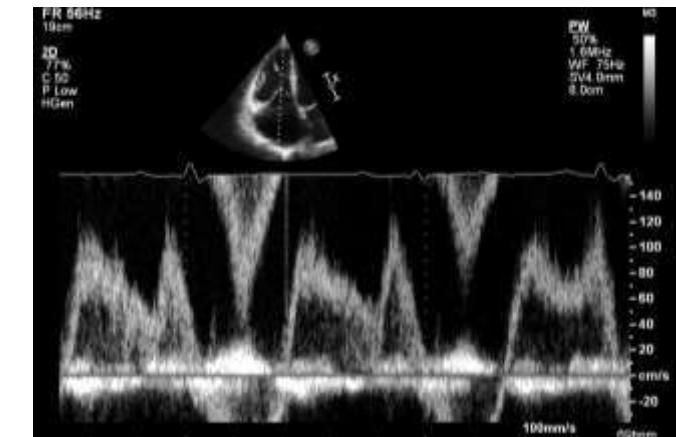
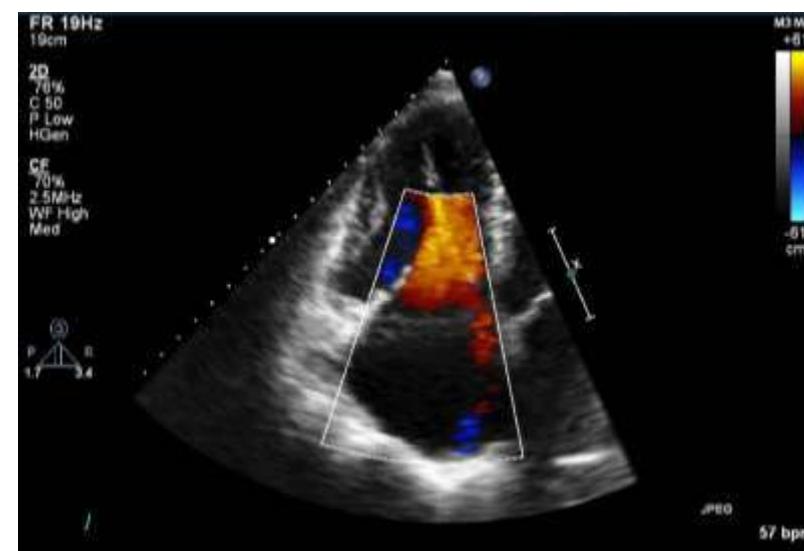
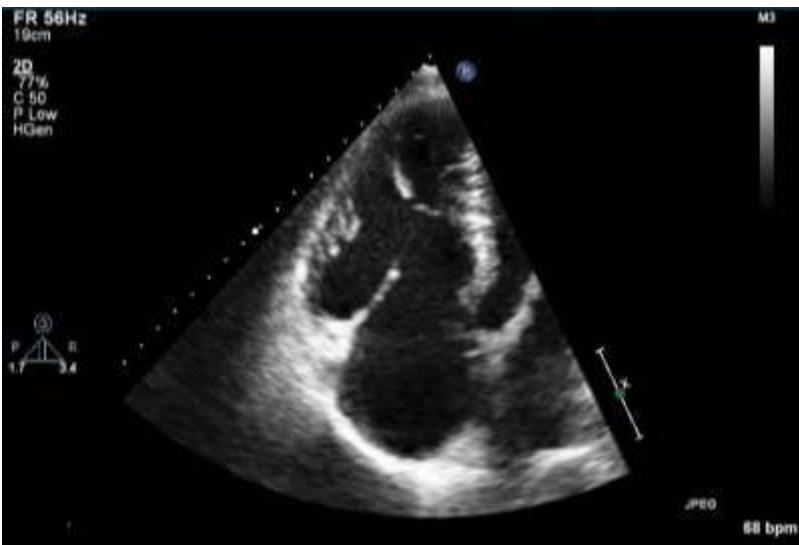
CEID TR



Persistent SVC,
dilated CS

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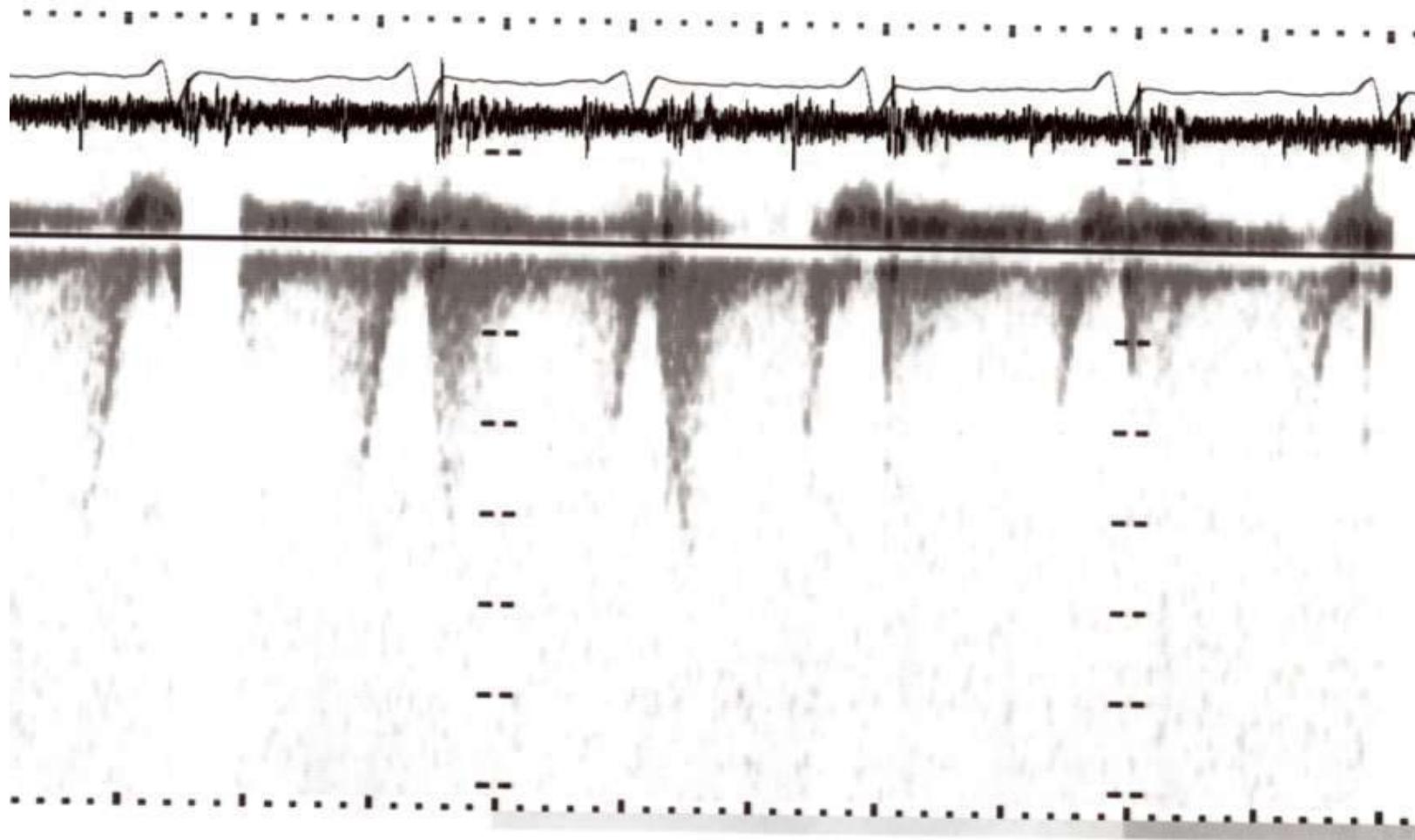
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Short RR interval
Normal systolic time (MR)
No time for LV filling

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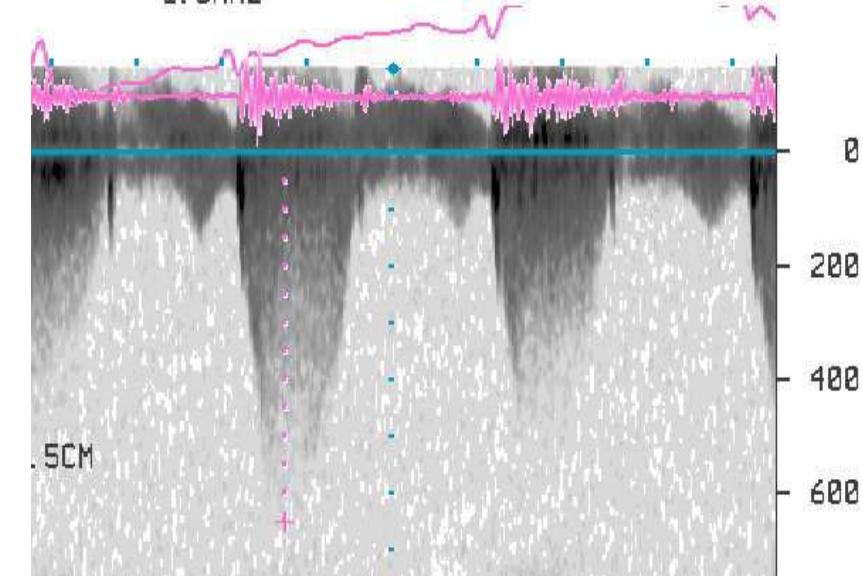
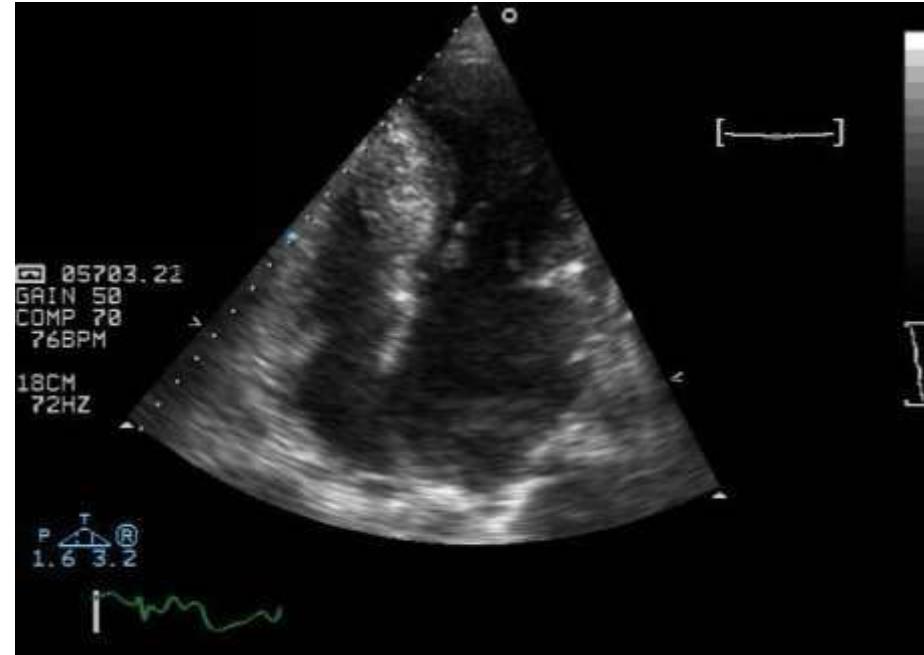
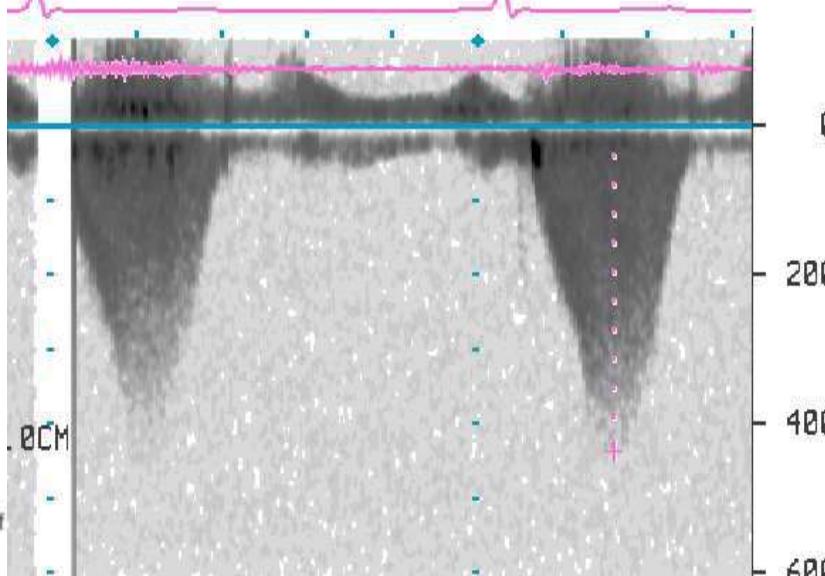


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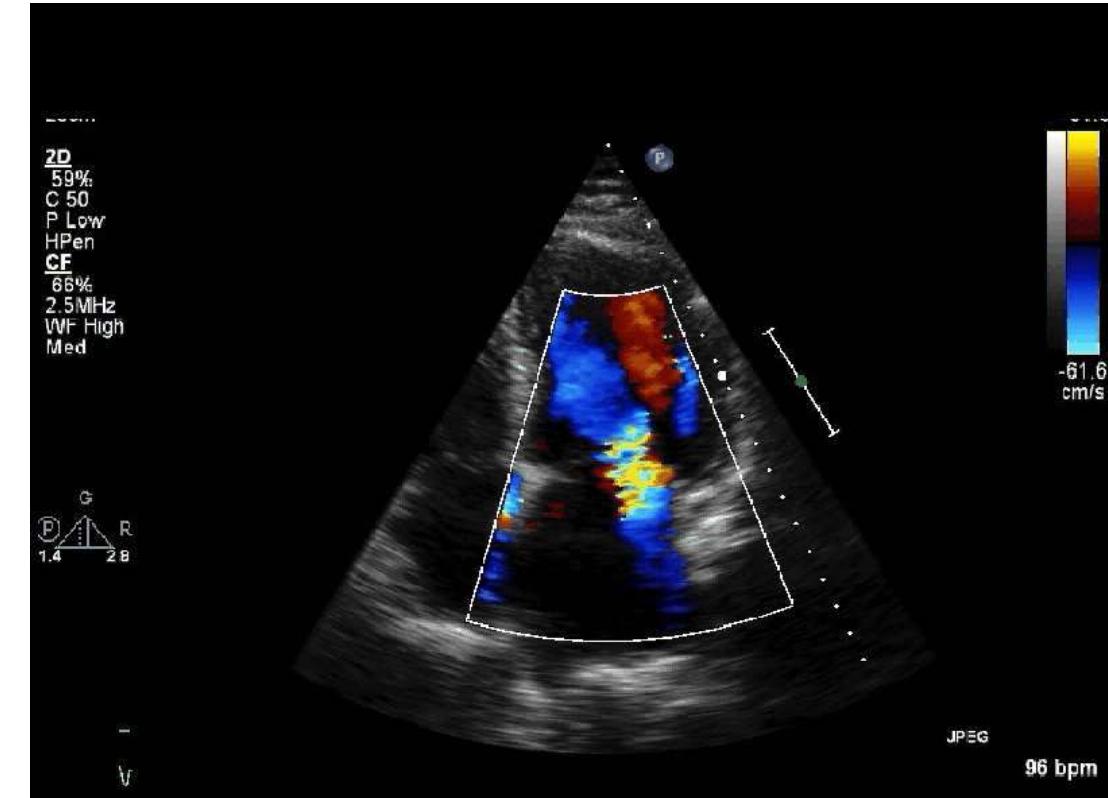
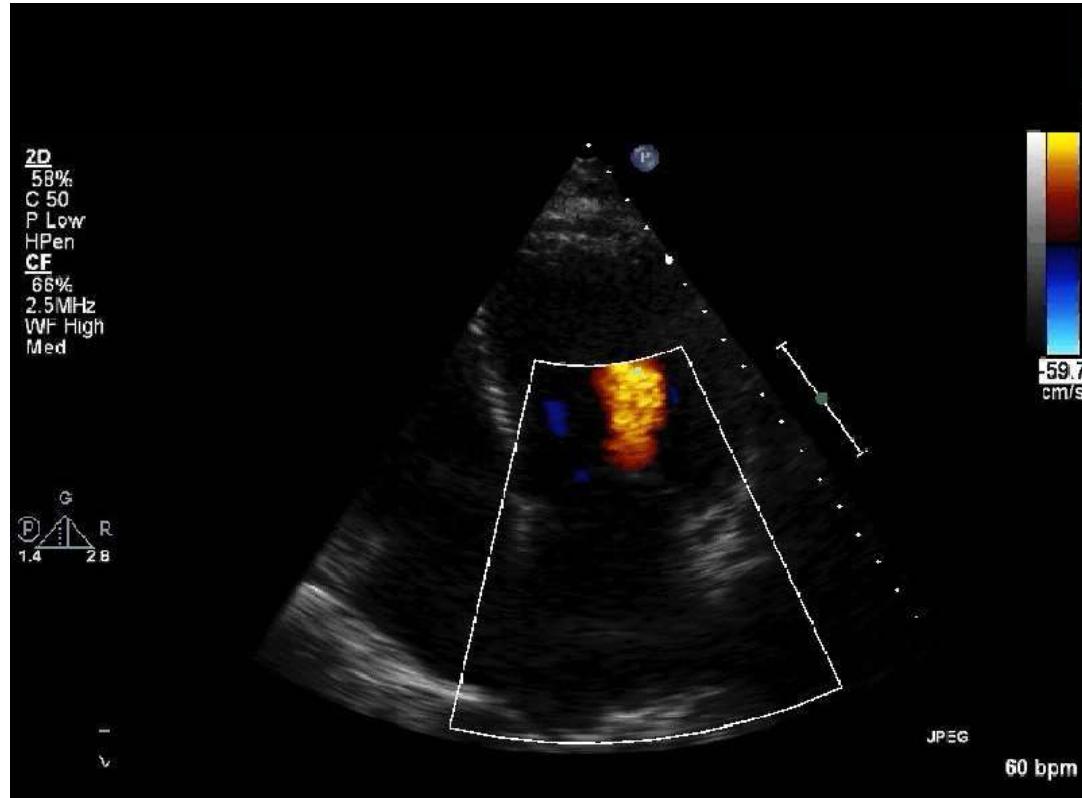
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Exercise Echo: Stress-induced MR

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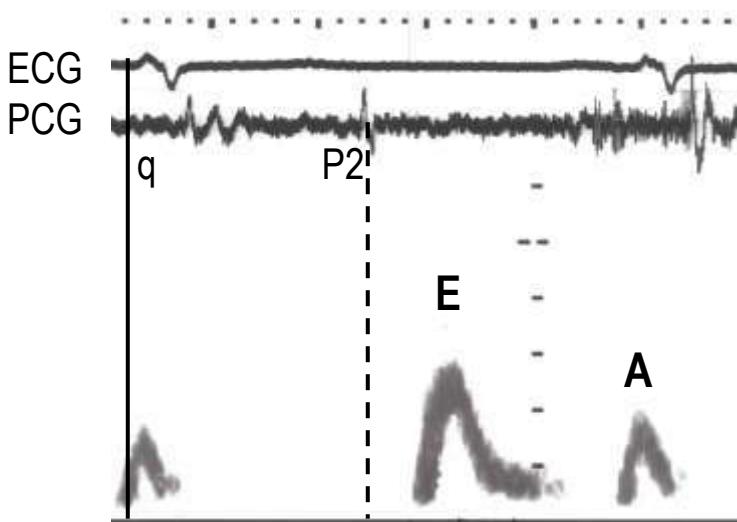
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Importance of Restrictive Filling

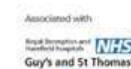
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REST



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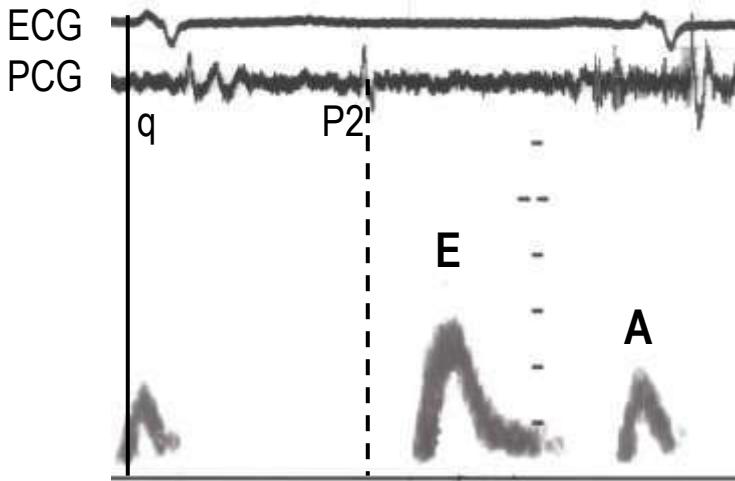


Importance of Restrictive Filling

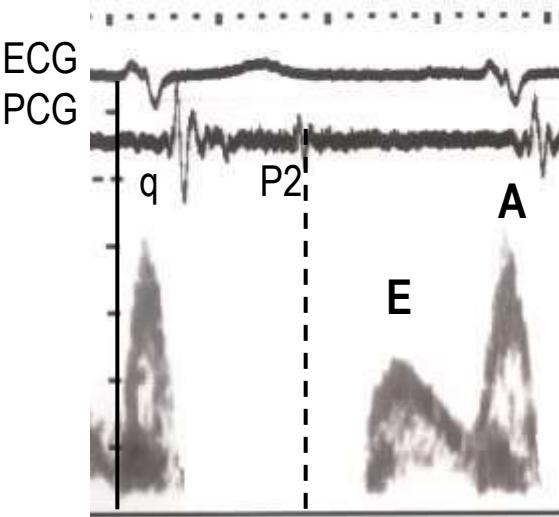
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REST



STRESS



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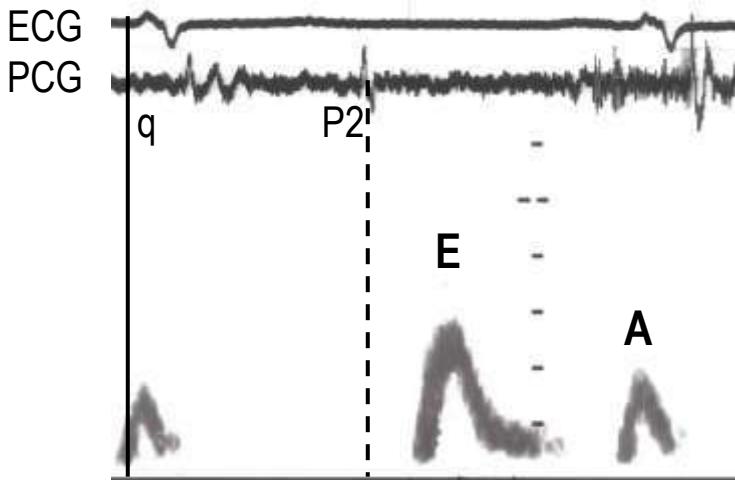
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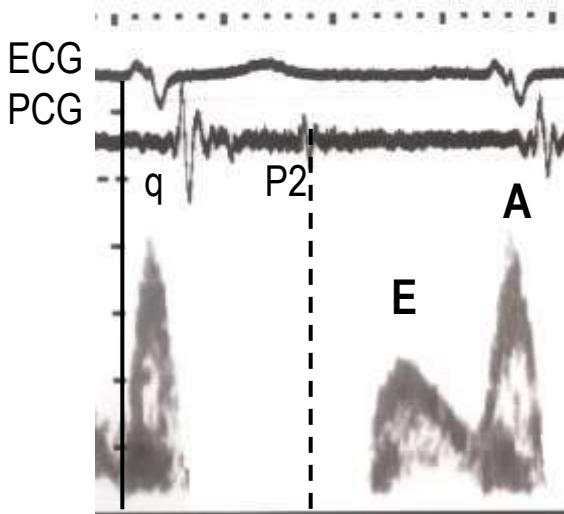
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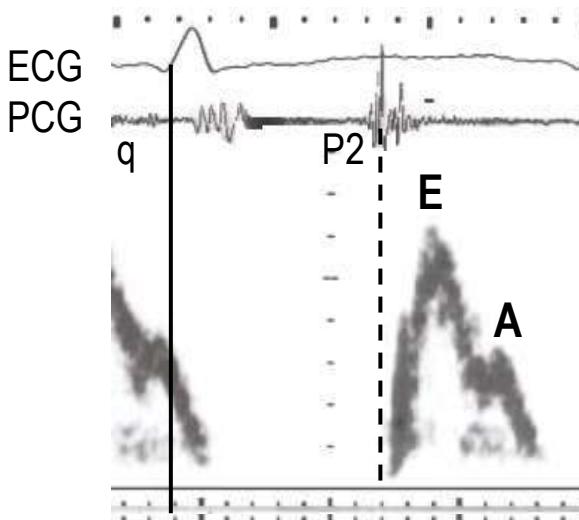
REST



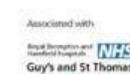
STRESS

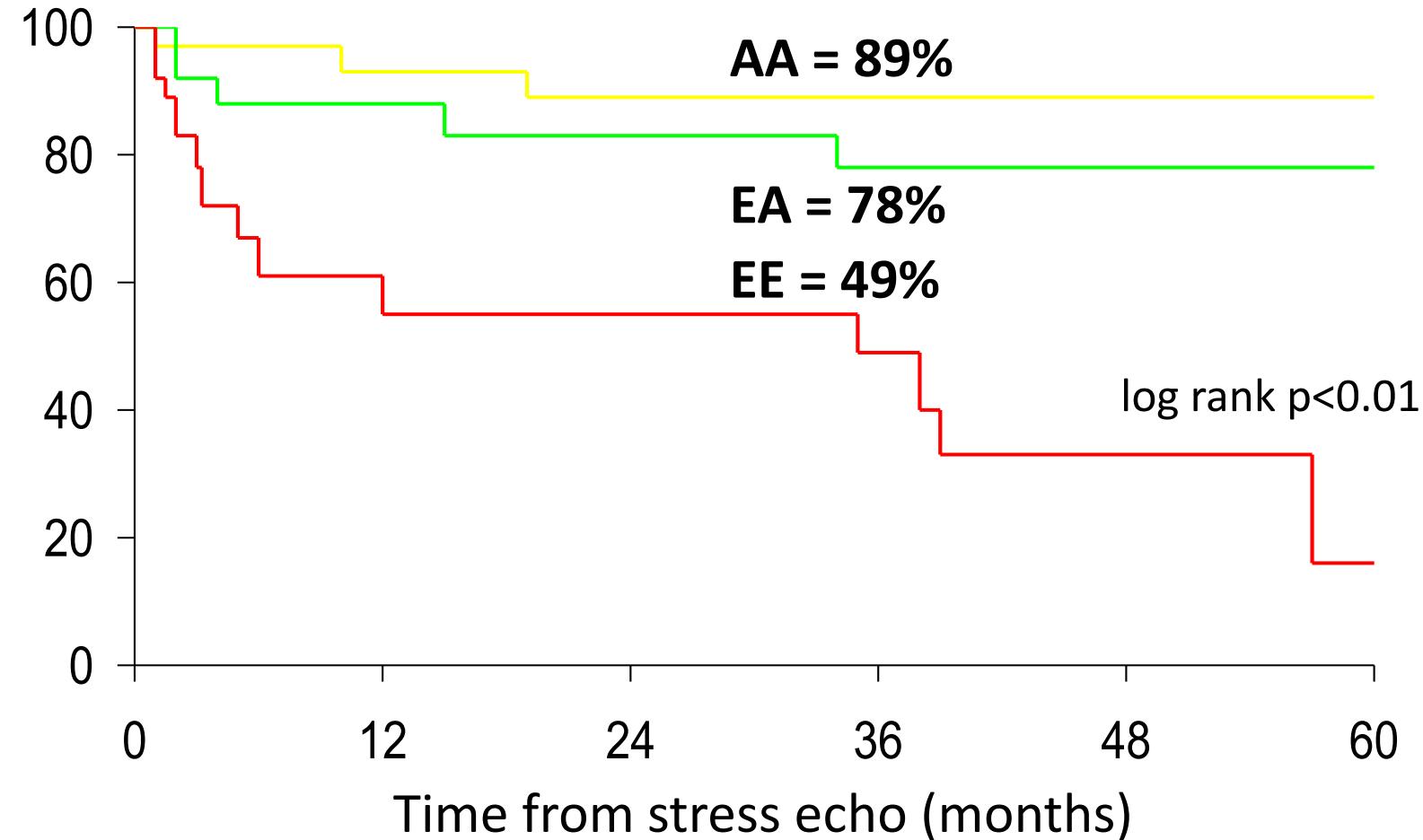


STRESS



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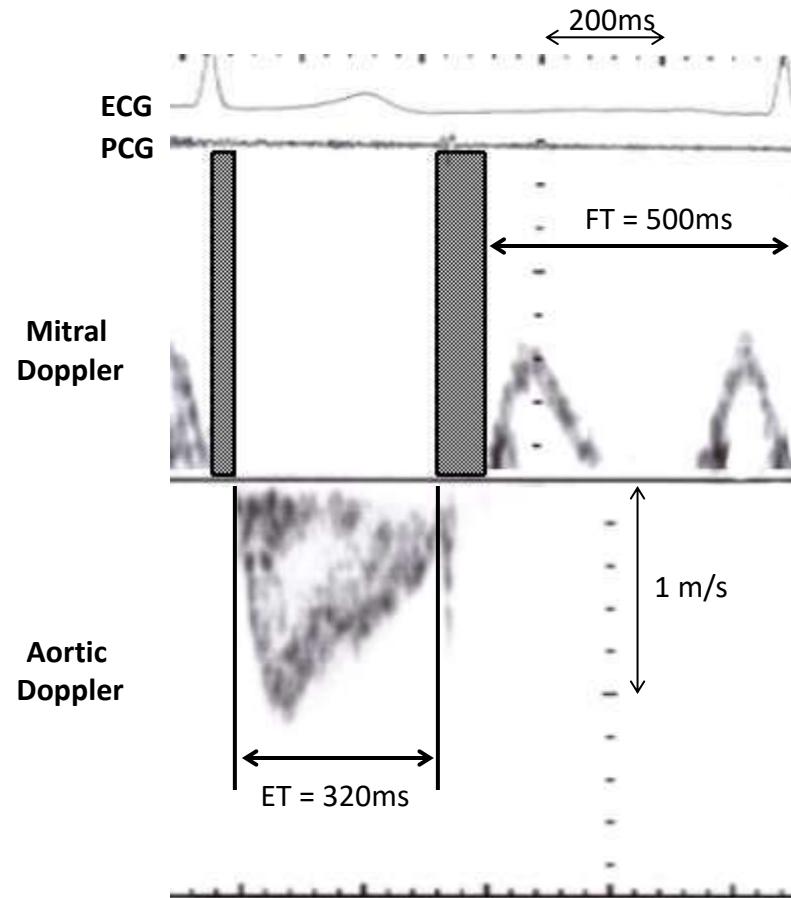


Hazard ratio compared with AA

EE = 9.5, $p<0.001$ (95%CI 4.3-14.7)
EA = 1.9, $p=NS$ (95% CI -4.2-+8.1)

Duncan et al. JACC 2005

Total Isovolumic Time

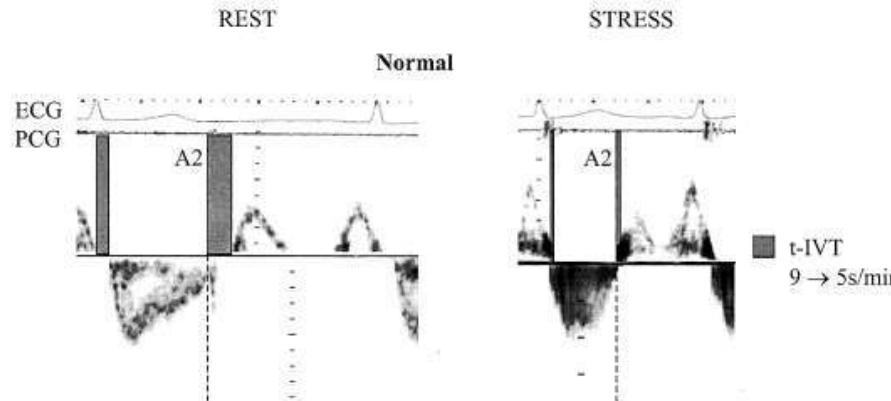


$$\begin{aligned} \text{HR} &= 63 \text{ bpm} \\ \text{ET} &= 320 \text{ ms or } 0.32 \times 63 = 20 \text{ s/min} \\ \text{FT} &= 500 \text{ ms or } 0.50 \times 63 = 32 \text{ s/min} \\ \blacksquare \text{ T-IVT} &= 60 - (20+32) = 8 \text{ s/min} \end{aligned}$$

Duncan et al. JACC 2003

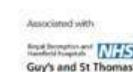
Total isovolumic Time with Stress

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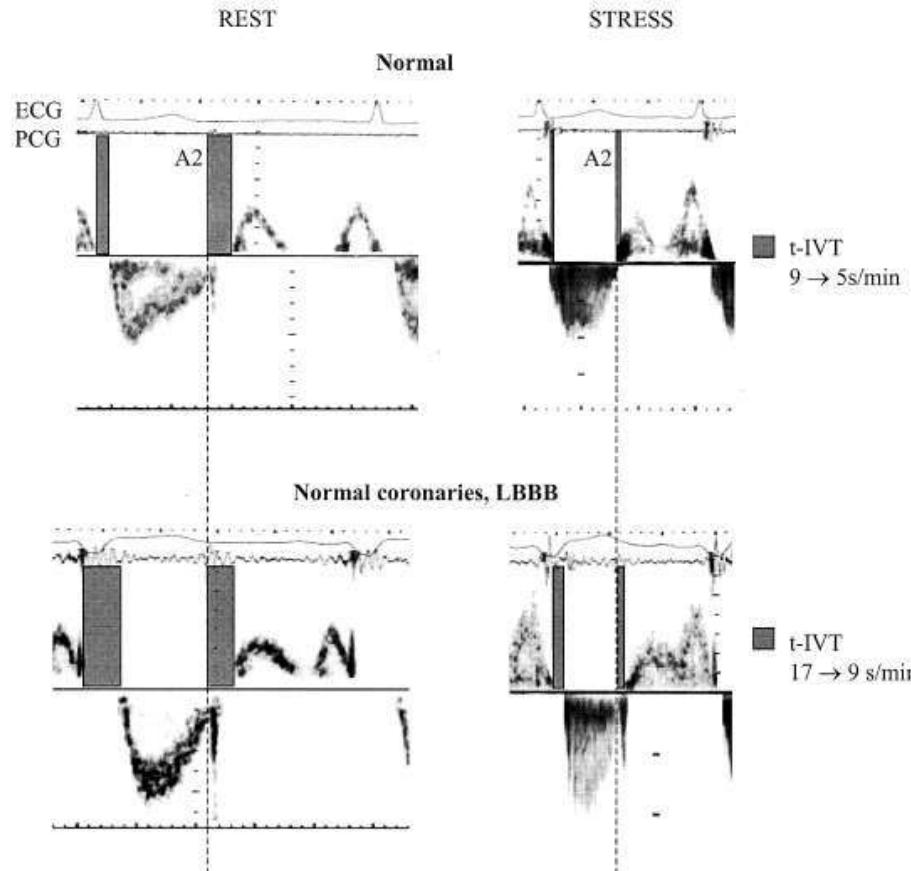
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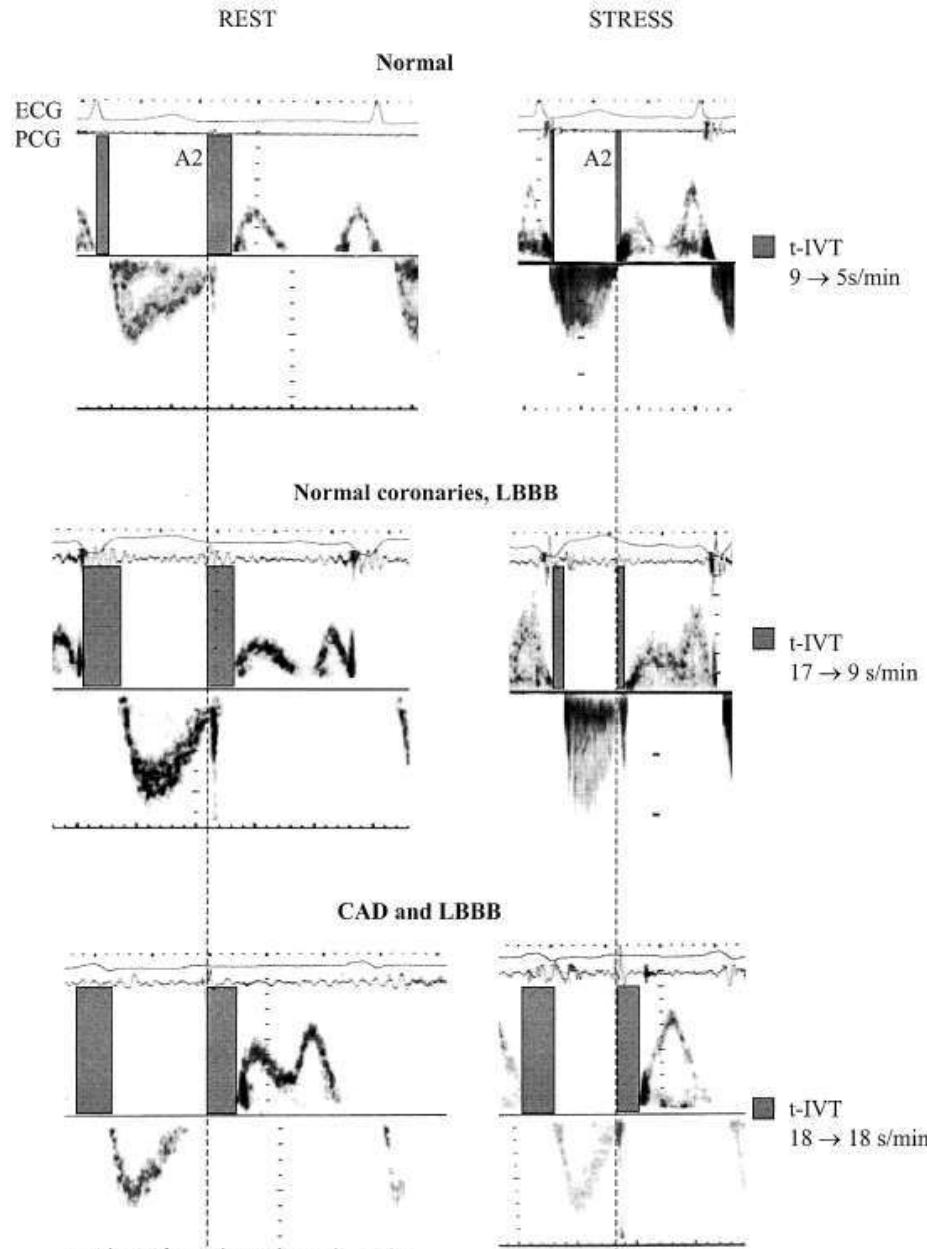
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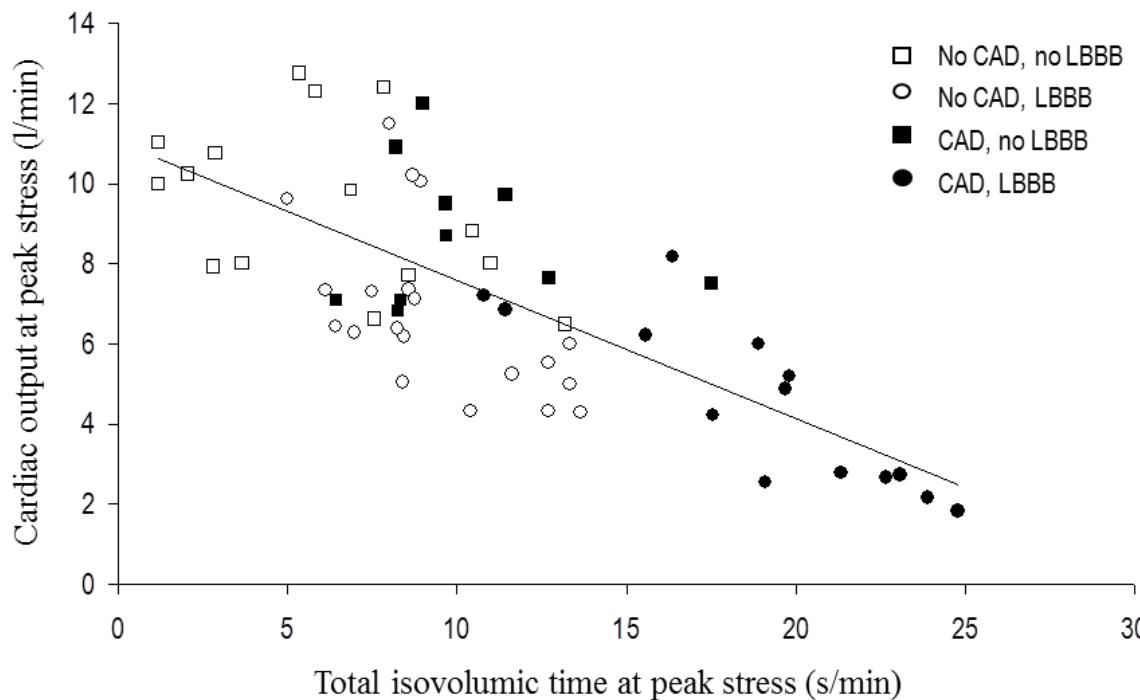
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Correlation between peak stress total isovolumic time and peak stress cardiac output



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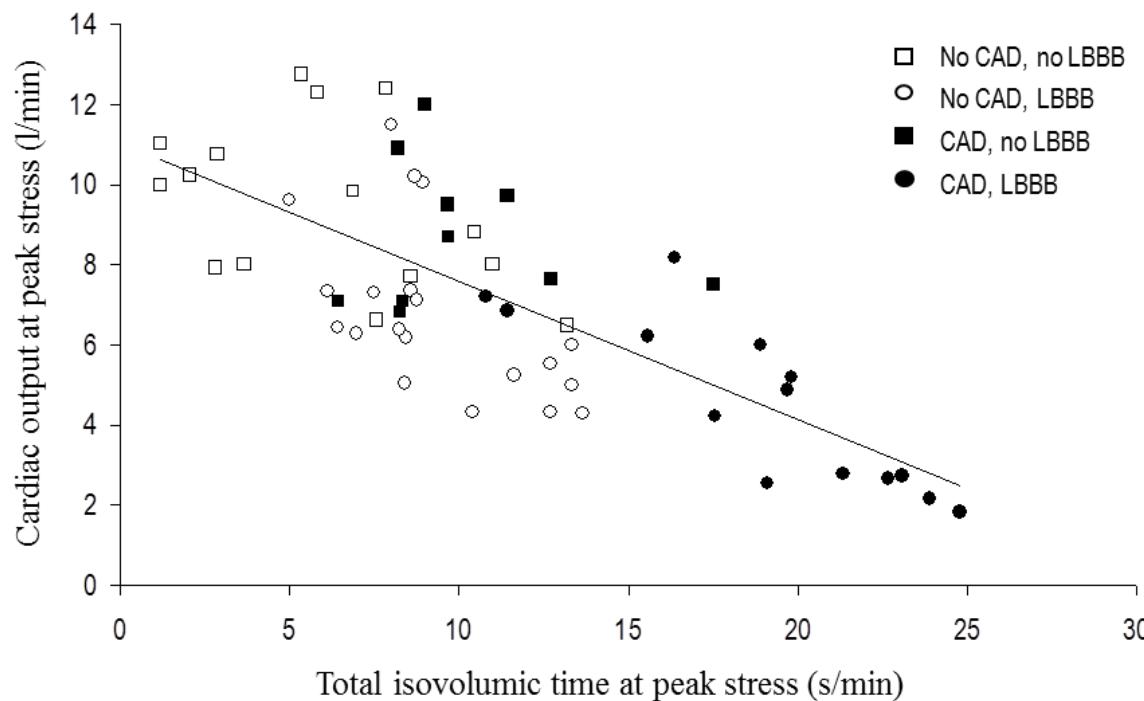
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Total Isovolumic Time

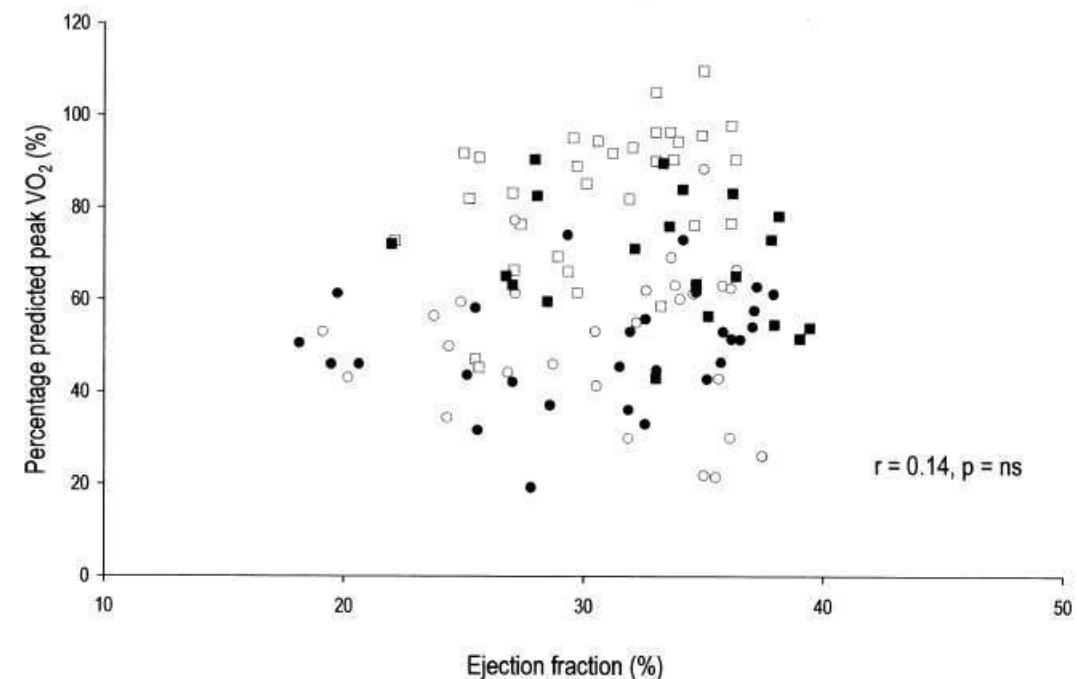


Correlation between peak stress total isovolumic time and peak stress cardiac output



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No correlation between peak stress total isovolumic time and peak LVEF

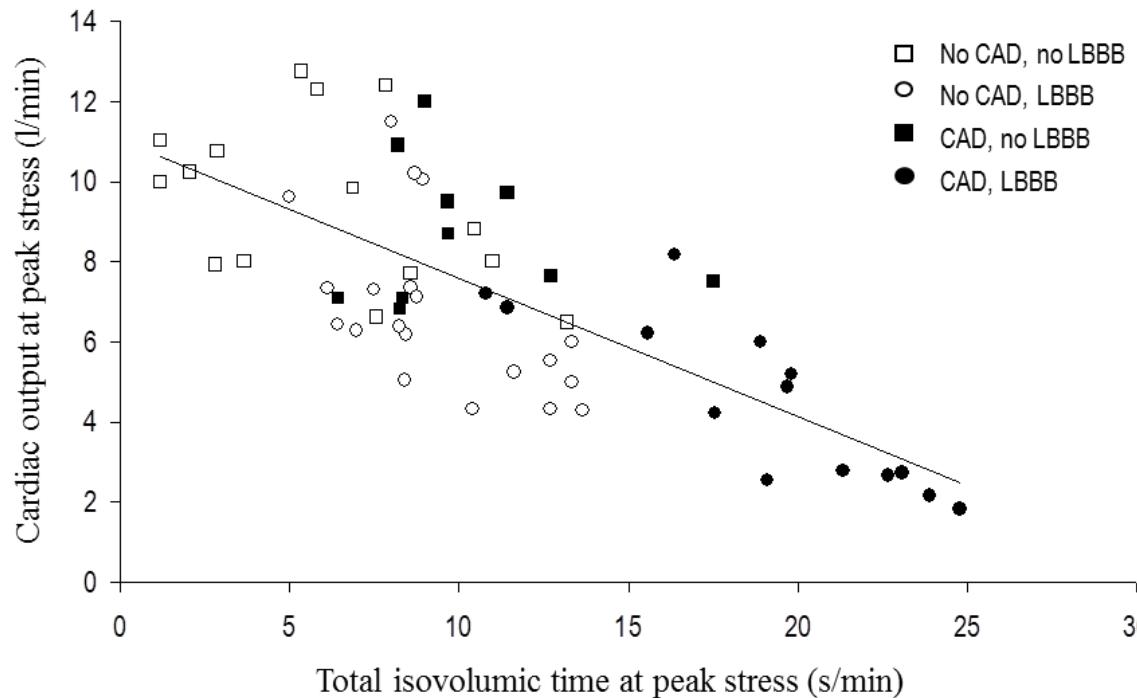


Duncan et al. JACC 2004

Total Isovolumic Time

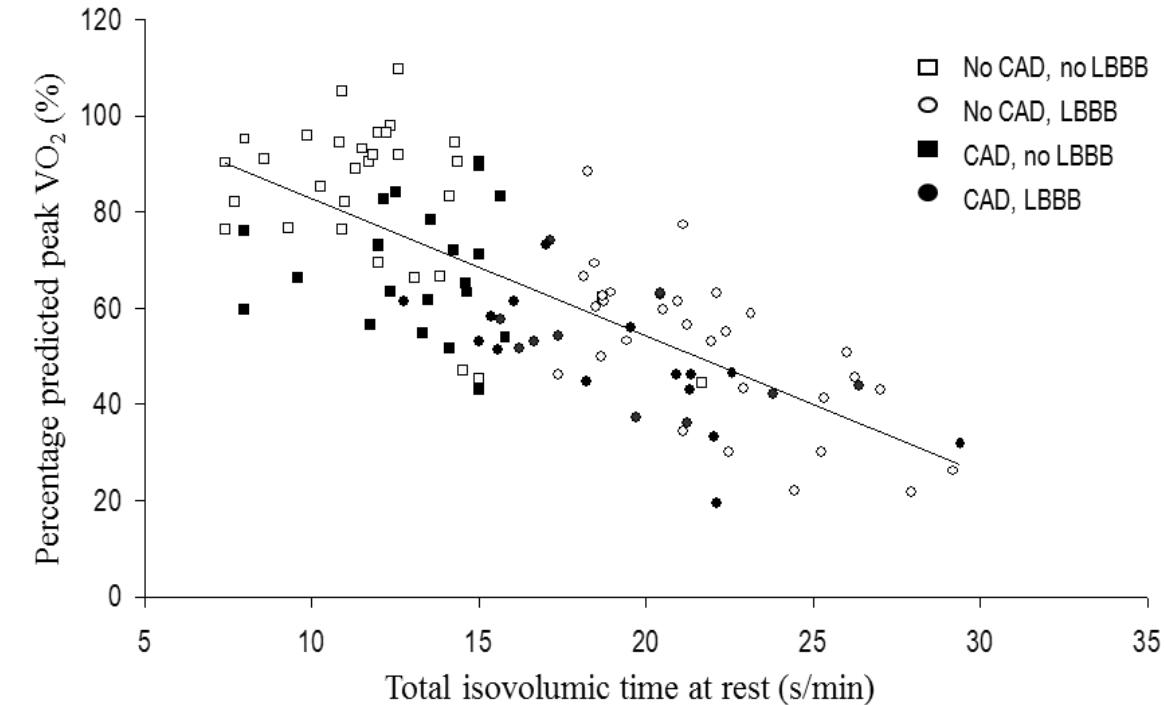


Correlation between peak stress total isovolumic time and peak stress cardiac output



Duncan et al. JACC 2003

Correlation between resting total isovolumic time and peak exercise capacity



Duncan et al. JACC 2004



Diagnosing Heart Failure With Echocardiography

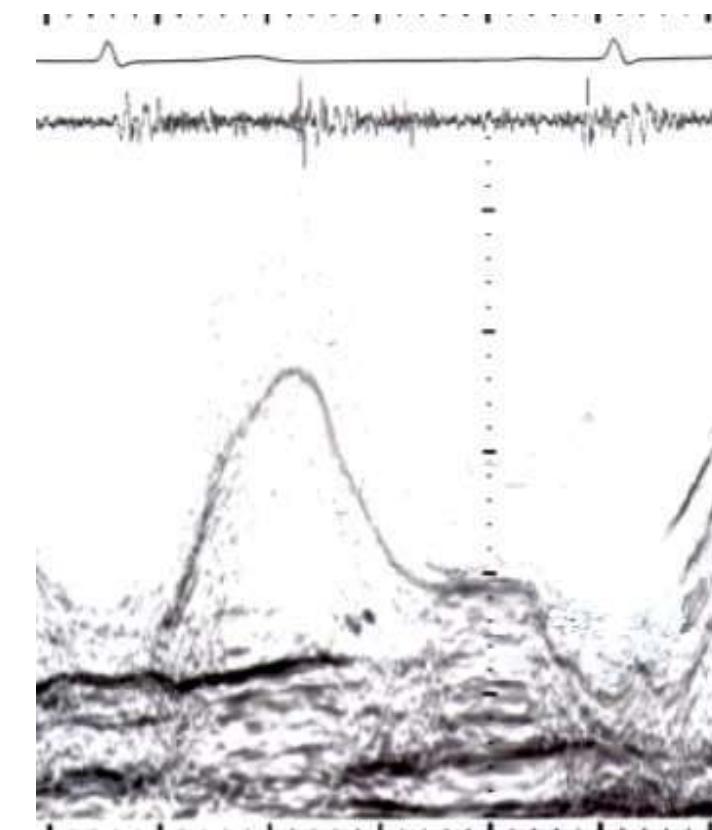
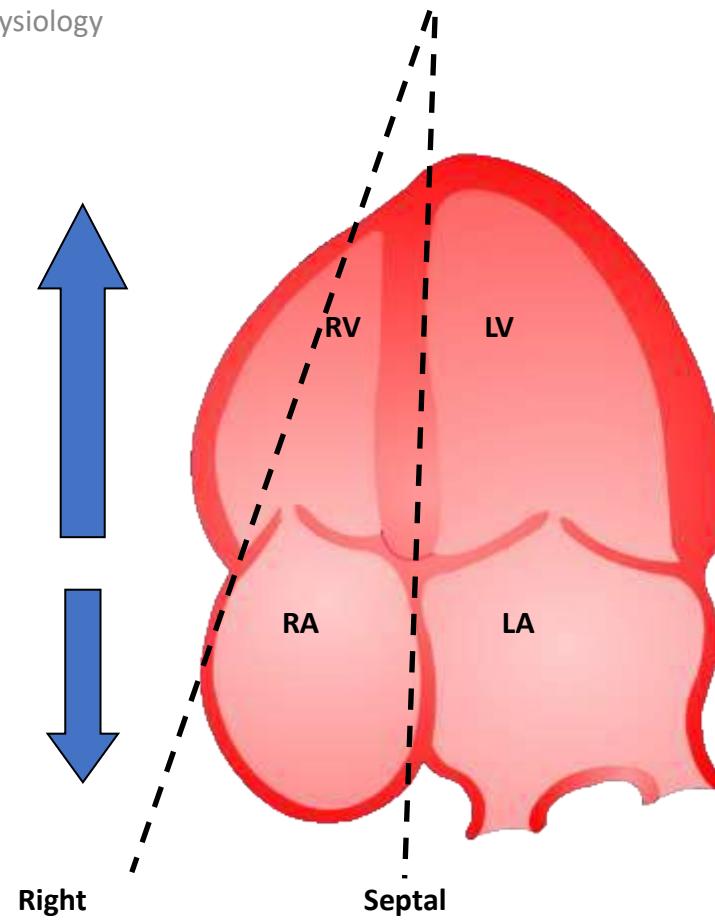
Can you take any more ?

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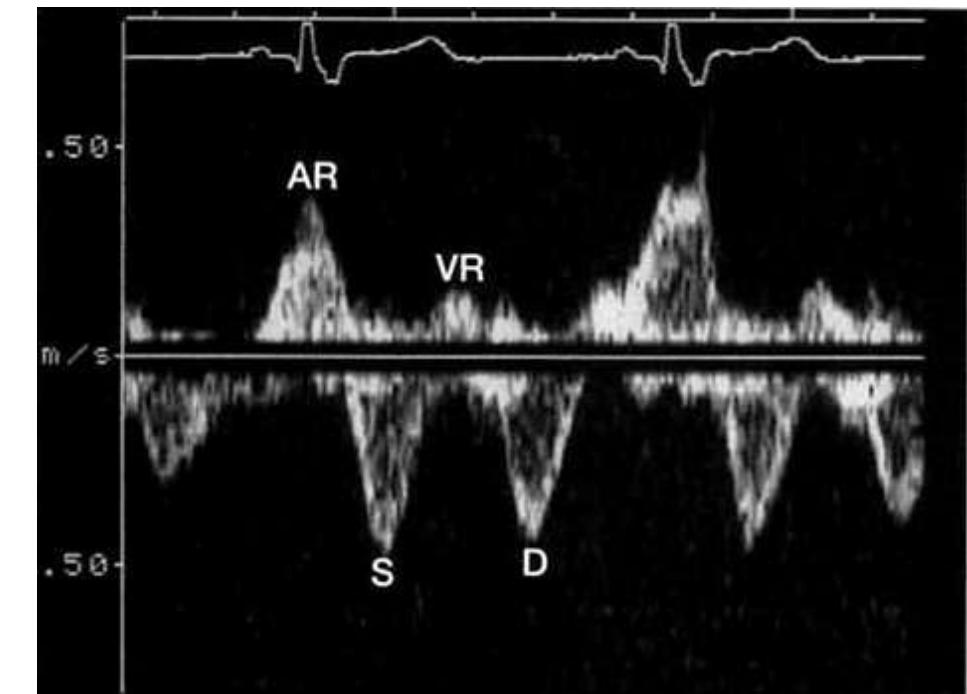
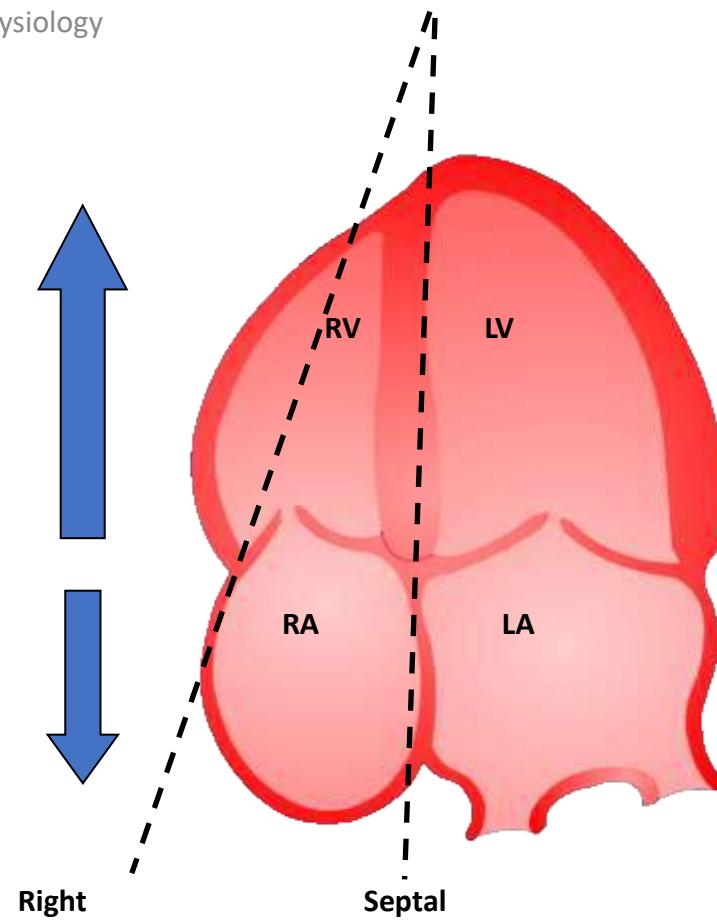
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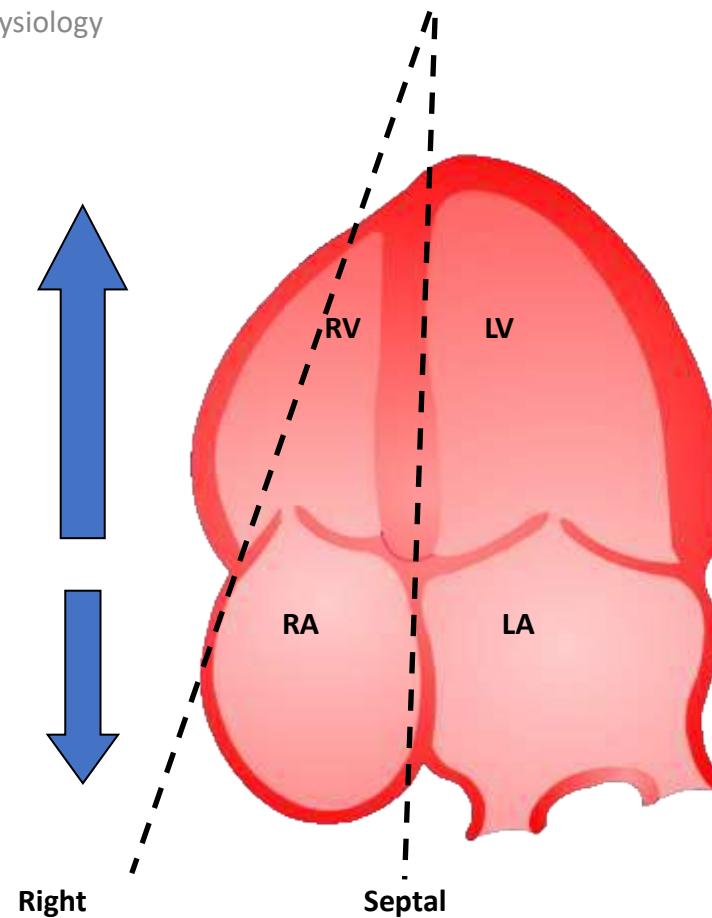
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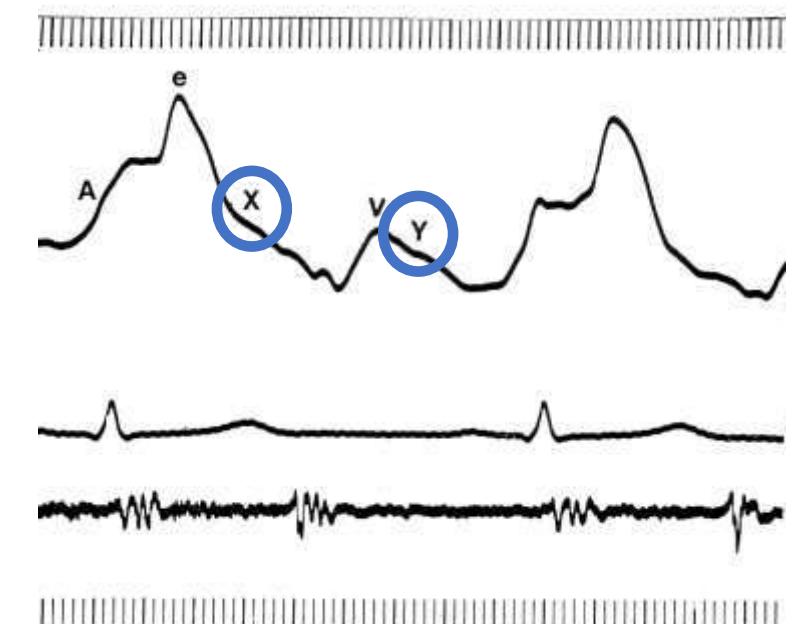
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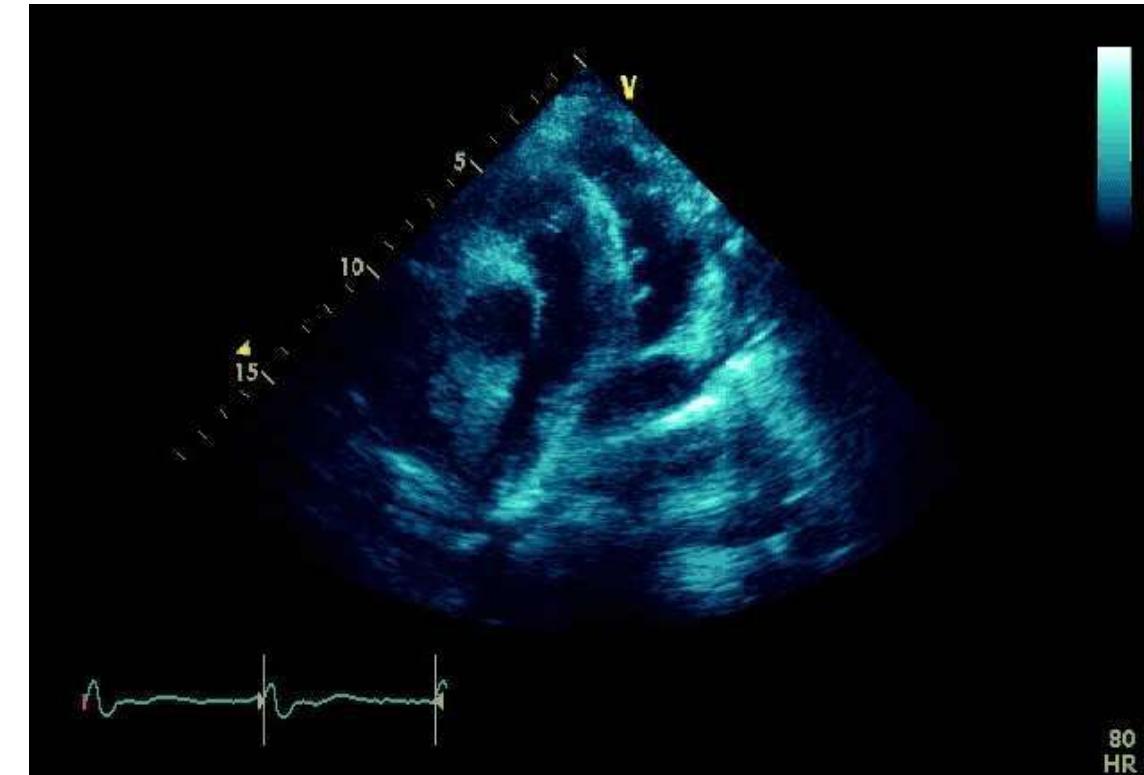
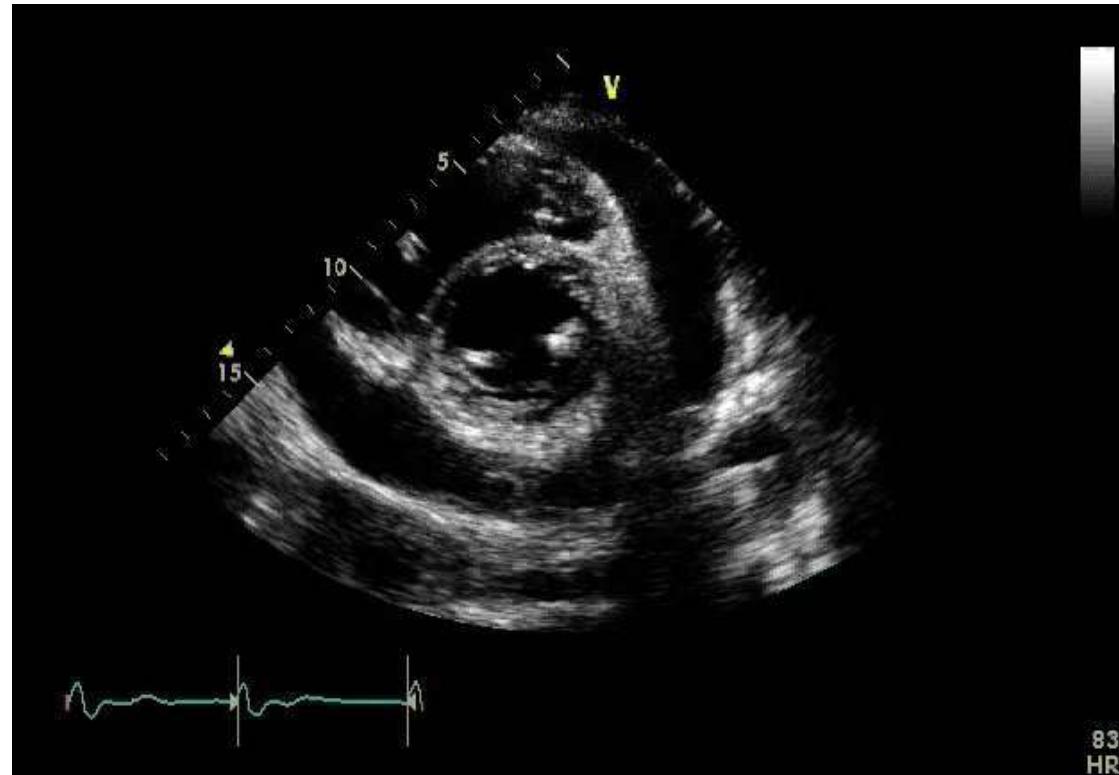


Normal JVP



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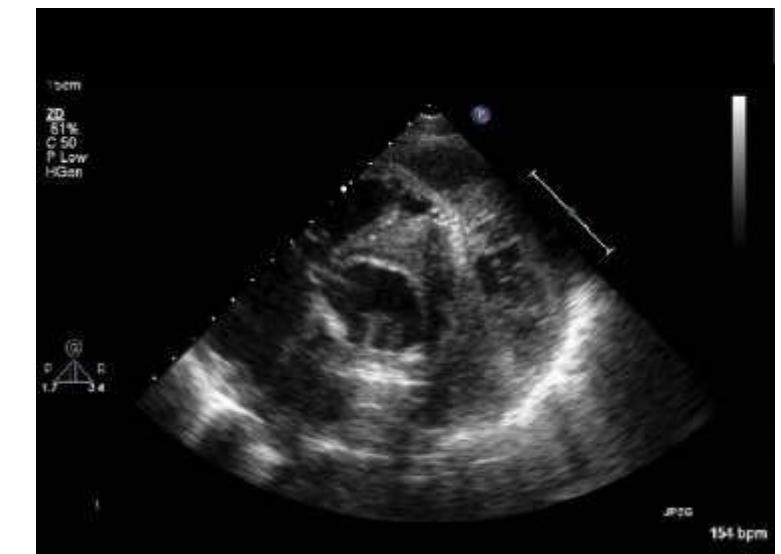
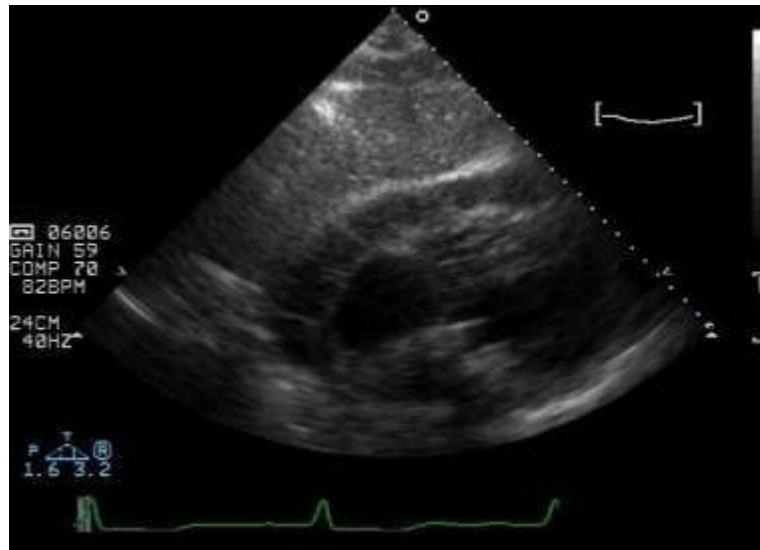
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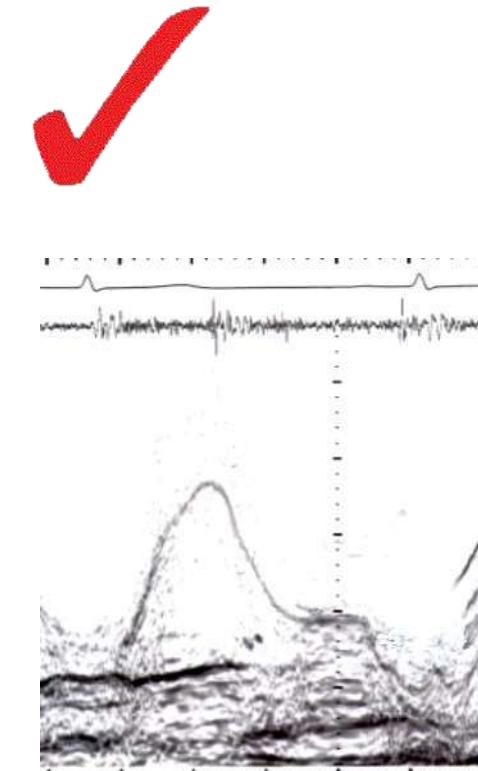
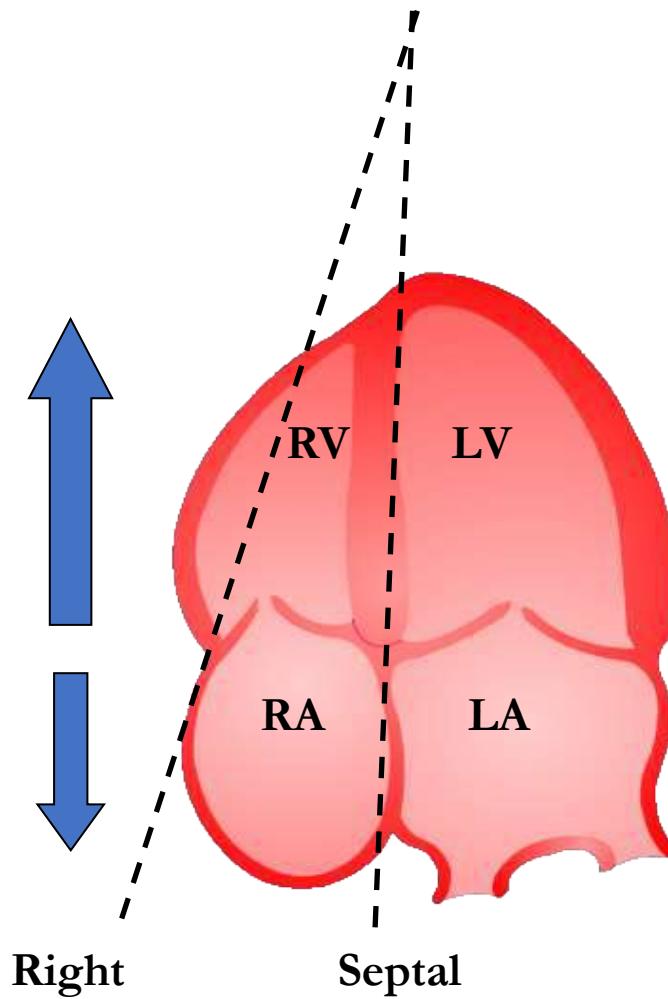
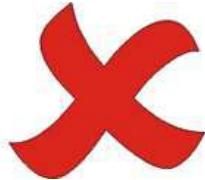
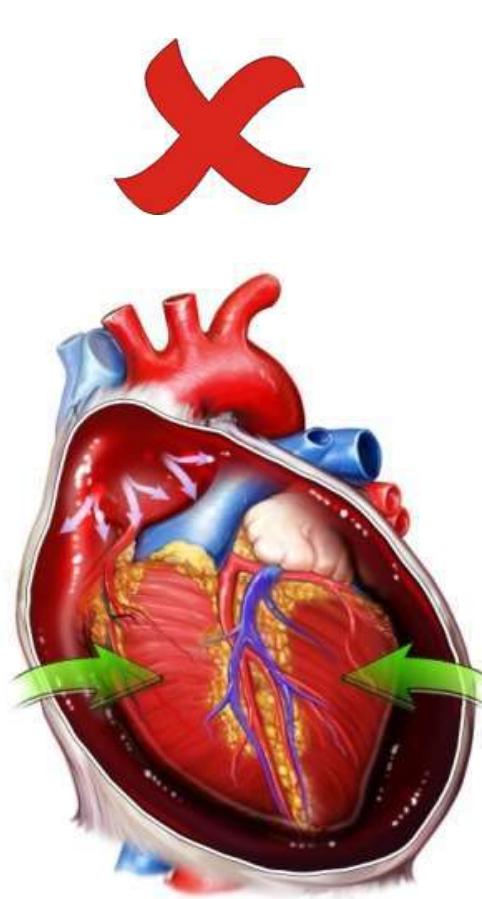
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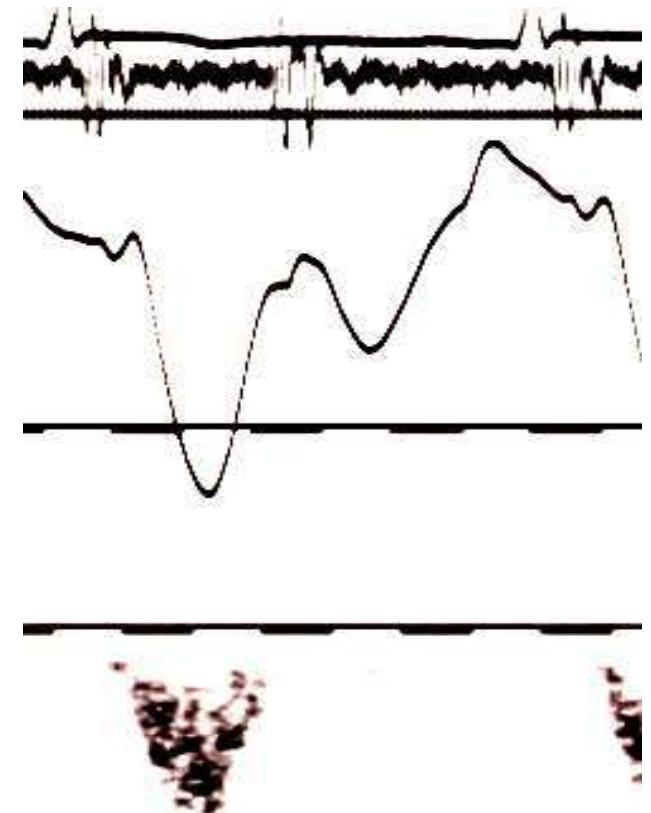
Pathophysiology Pericardial Constriction

Systole:

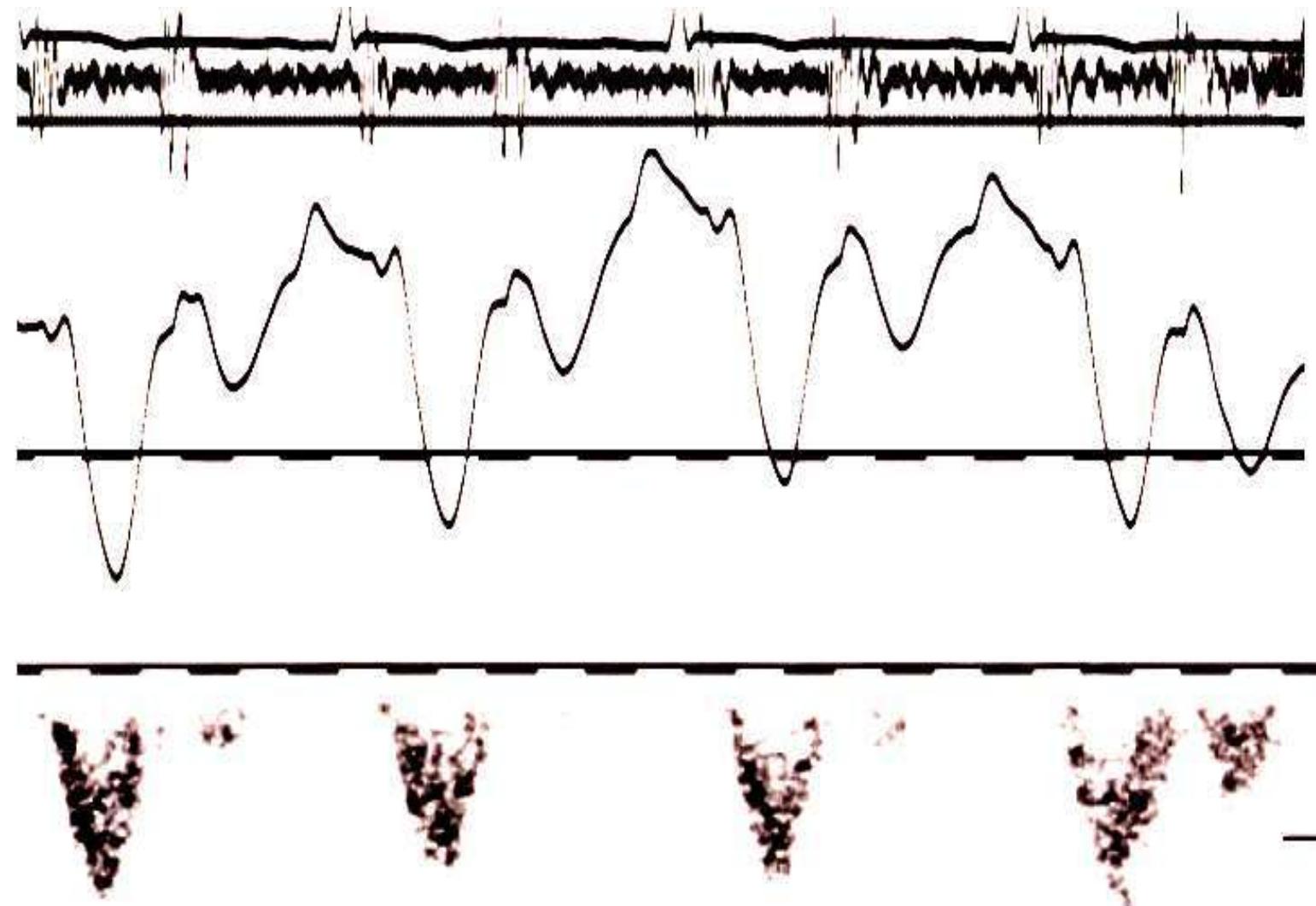
- preserved RV long axis systolic motion
- So dominant X descent on JVP is preserved
- Associated with dominant systolic wave on SVC flow

Diastole

- tricuspid valve opens
- Y descent on JVP
- diastolic wave on SVC flow
- Y descent < X descent as intrapericardial pressure higher during diastole

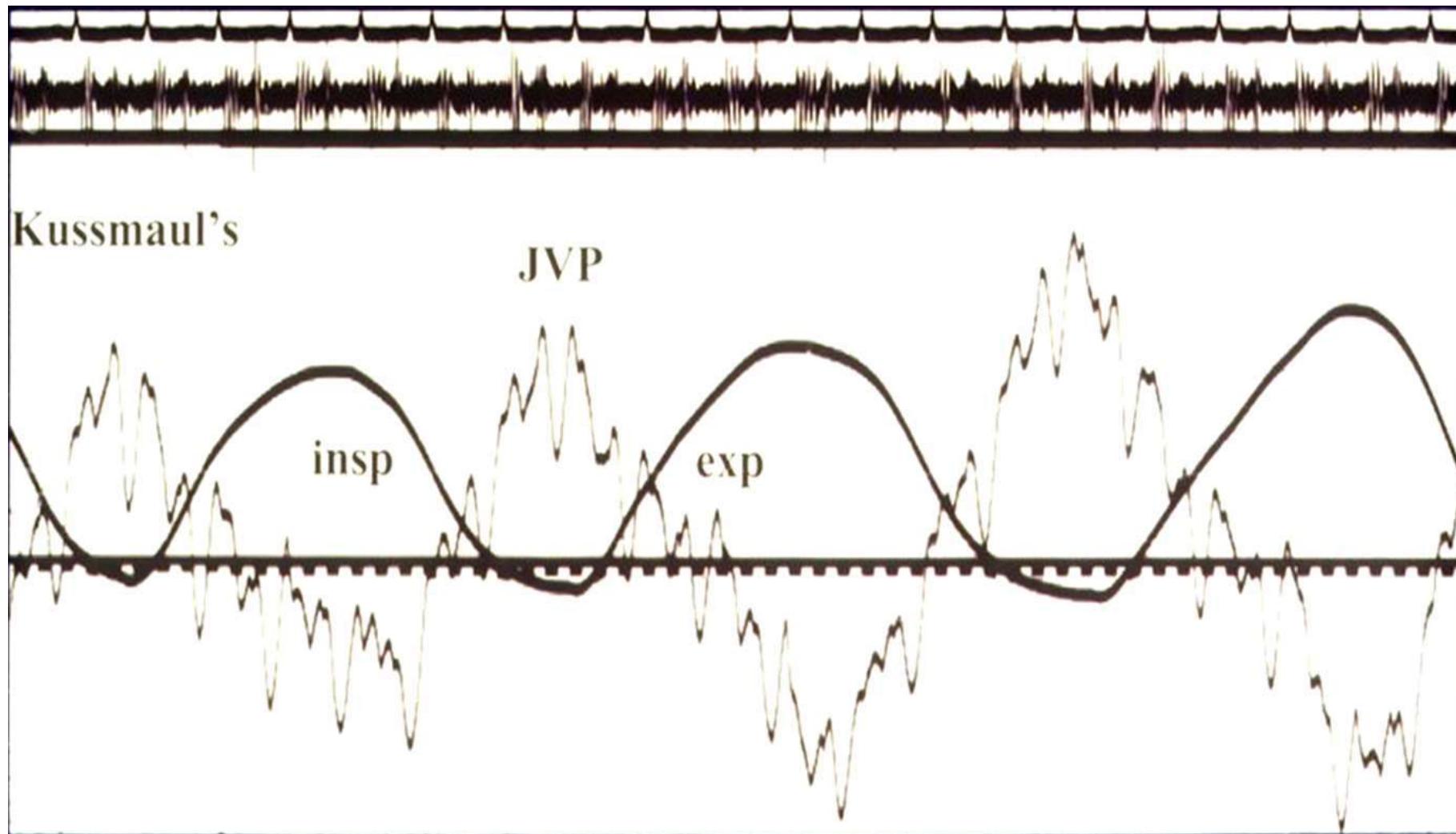


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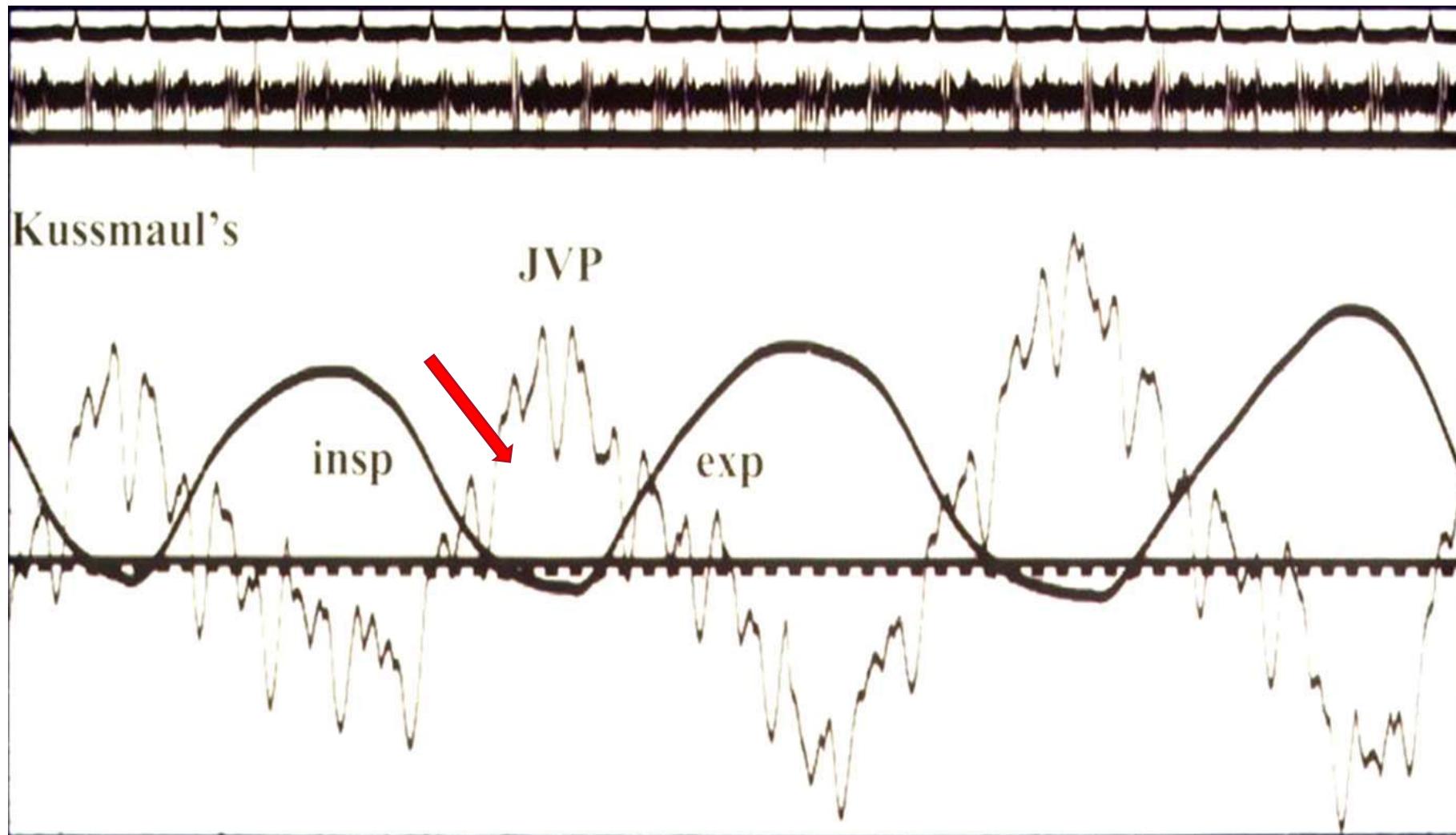


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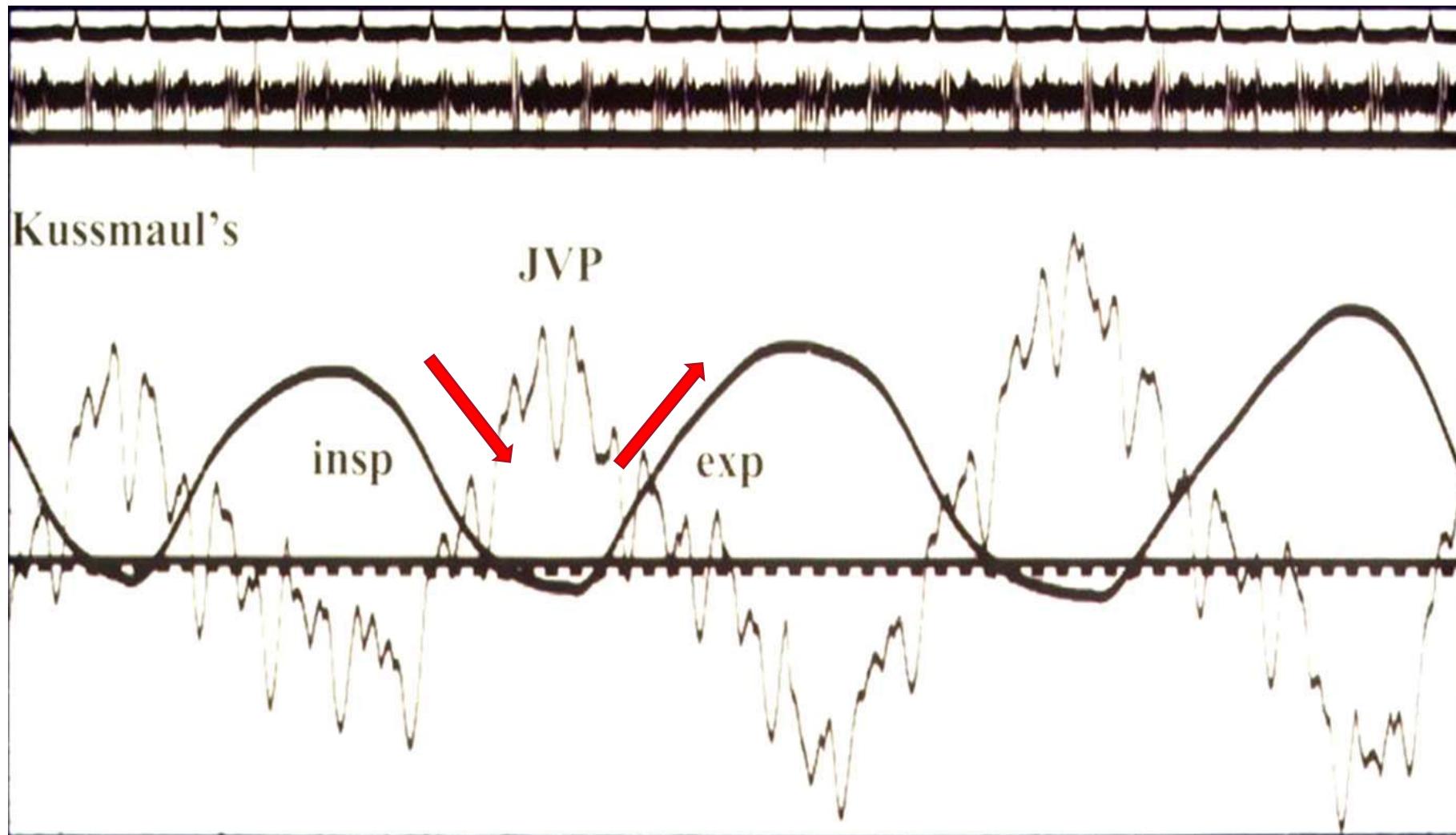
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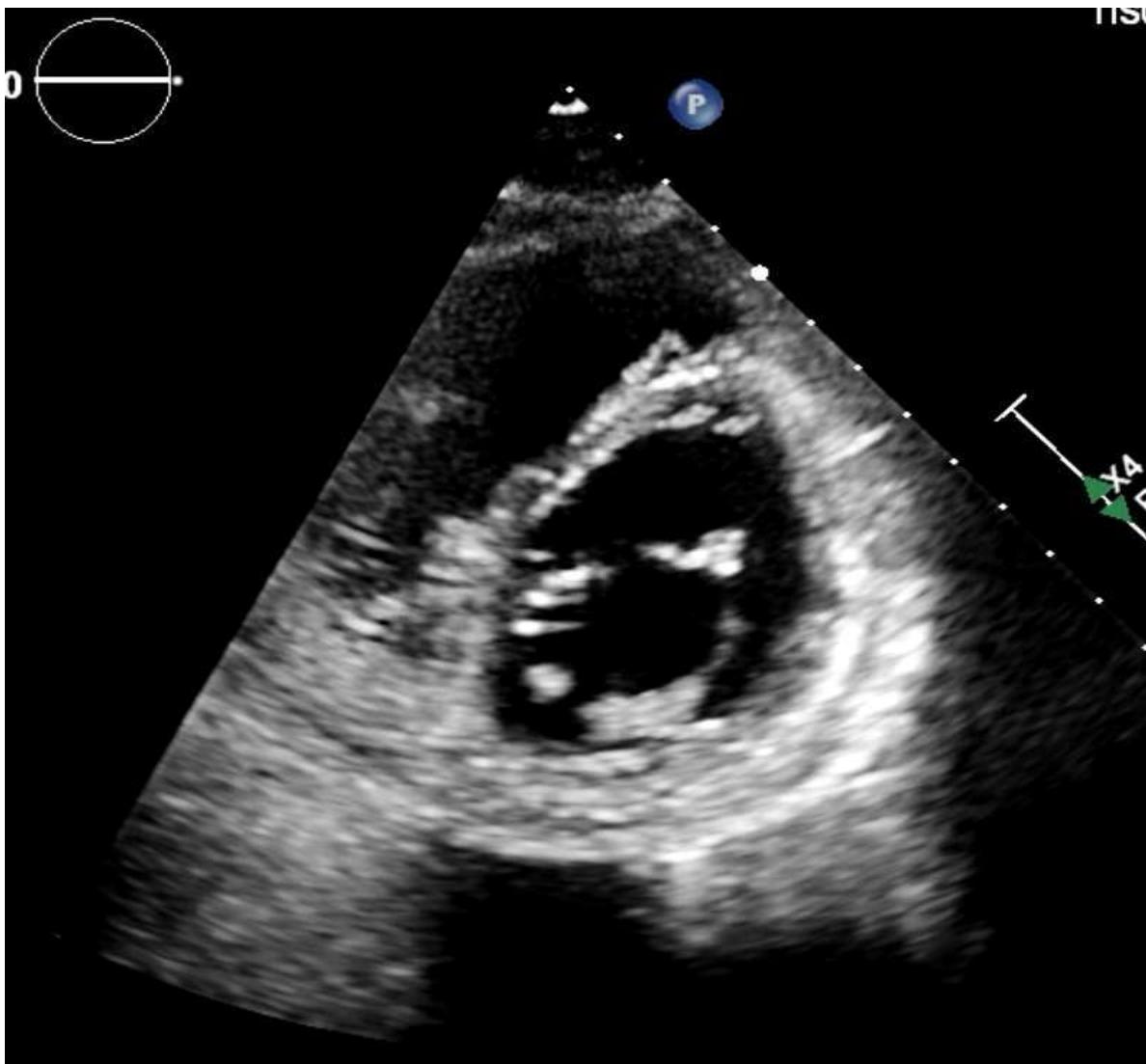
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Ventricular Interdependence with Respiration



↑ pericardial pressure > CVP and PV pressure, filling influenced by variation in intrathoracic pressures

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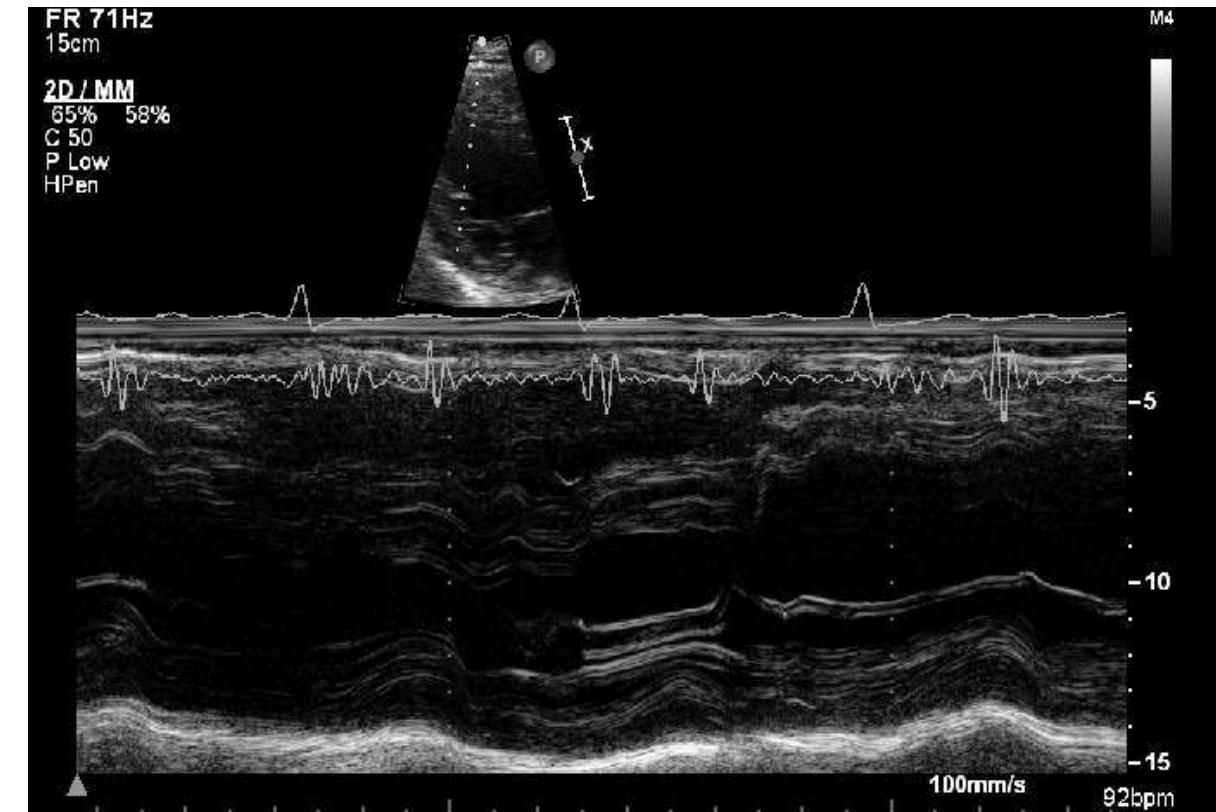
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↑ pericardial pressure > CVP and PV pressure, filling influenced by variation in intrathoracic pressures

Inspiration

- -ve intra-thoracic pressure → ↑ flow into RV
- IVS bulge towards LV
- Pooling blood pulmonary veins
- ↓se LV filling
- Pulsus paradoxus



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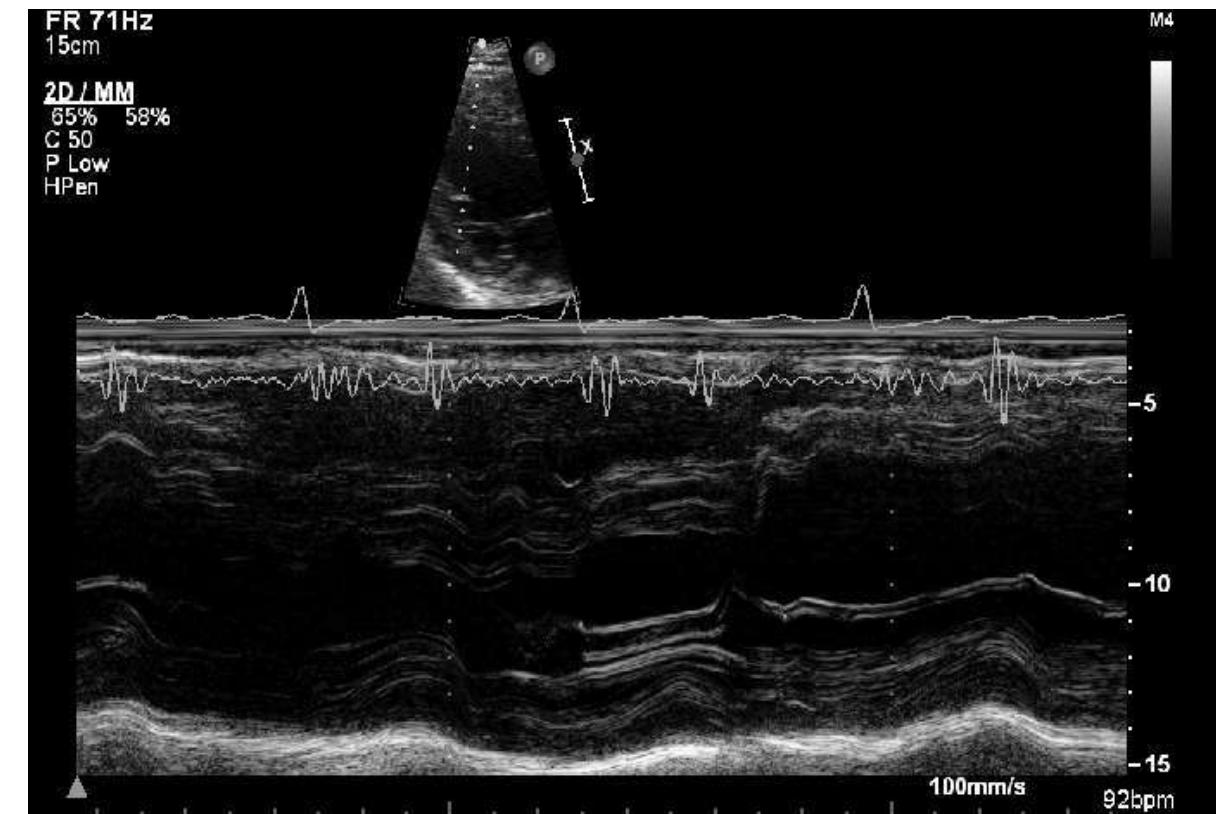
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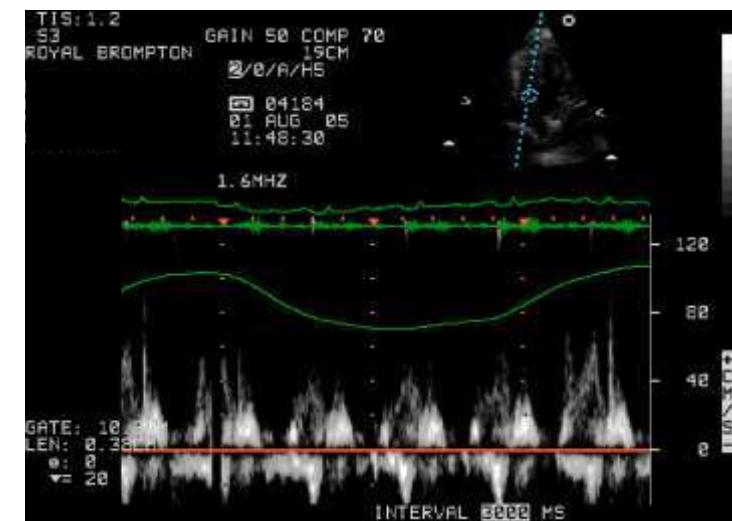
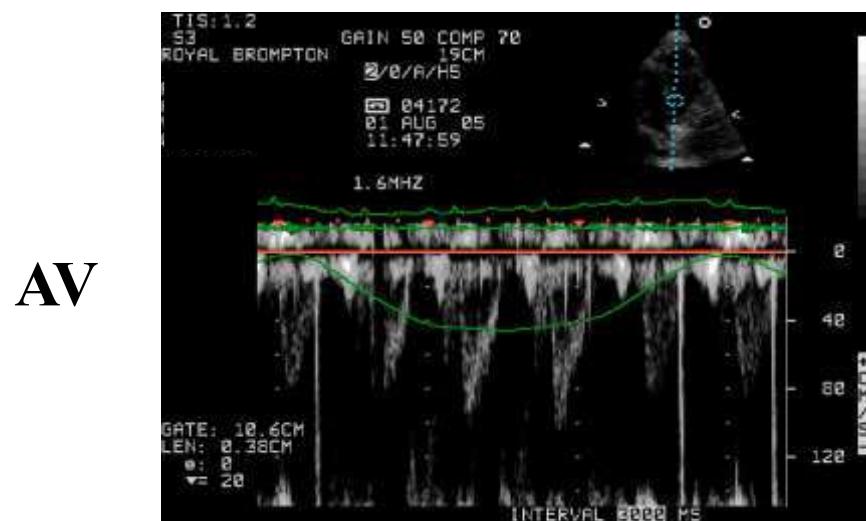
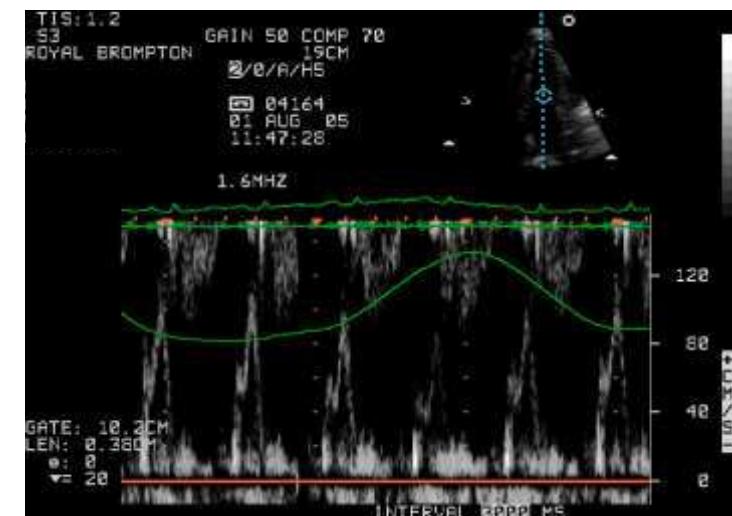
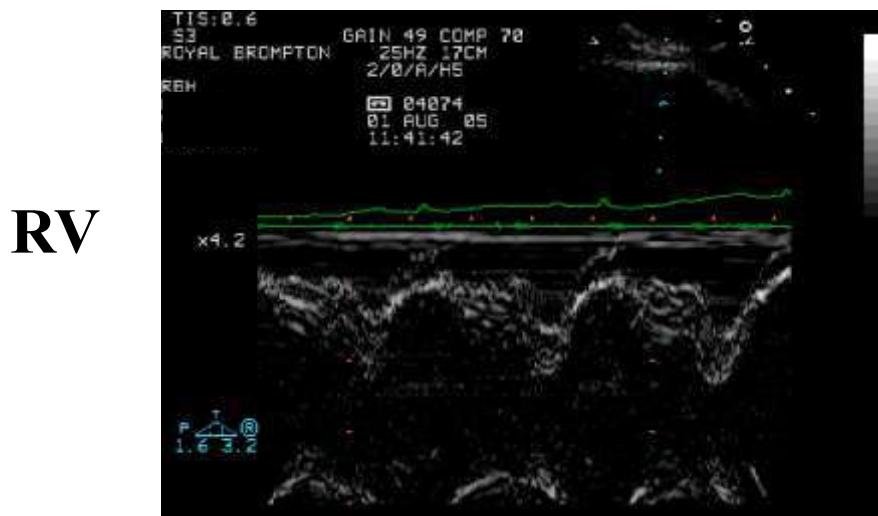
Expiration

- Intra-thoracic pressure increases
- Less blood from vena cava enters RV
- IVS bulge towards RV
- Increased PV flow
- ↑se LV filling



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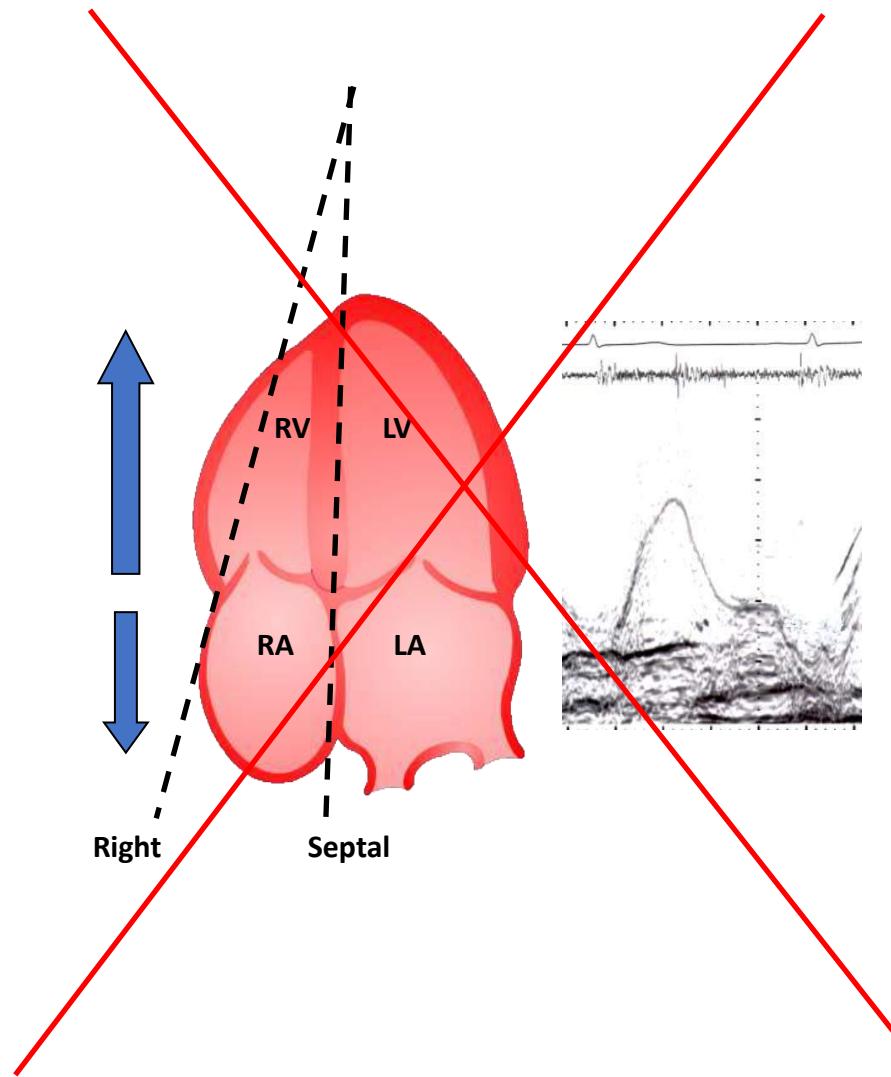


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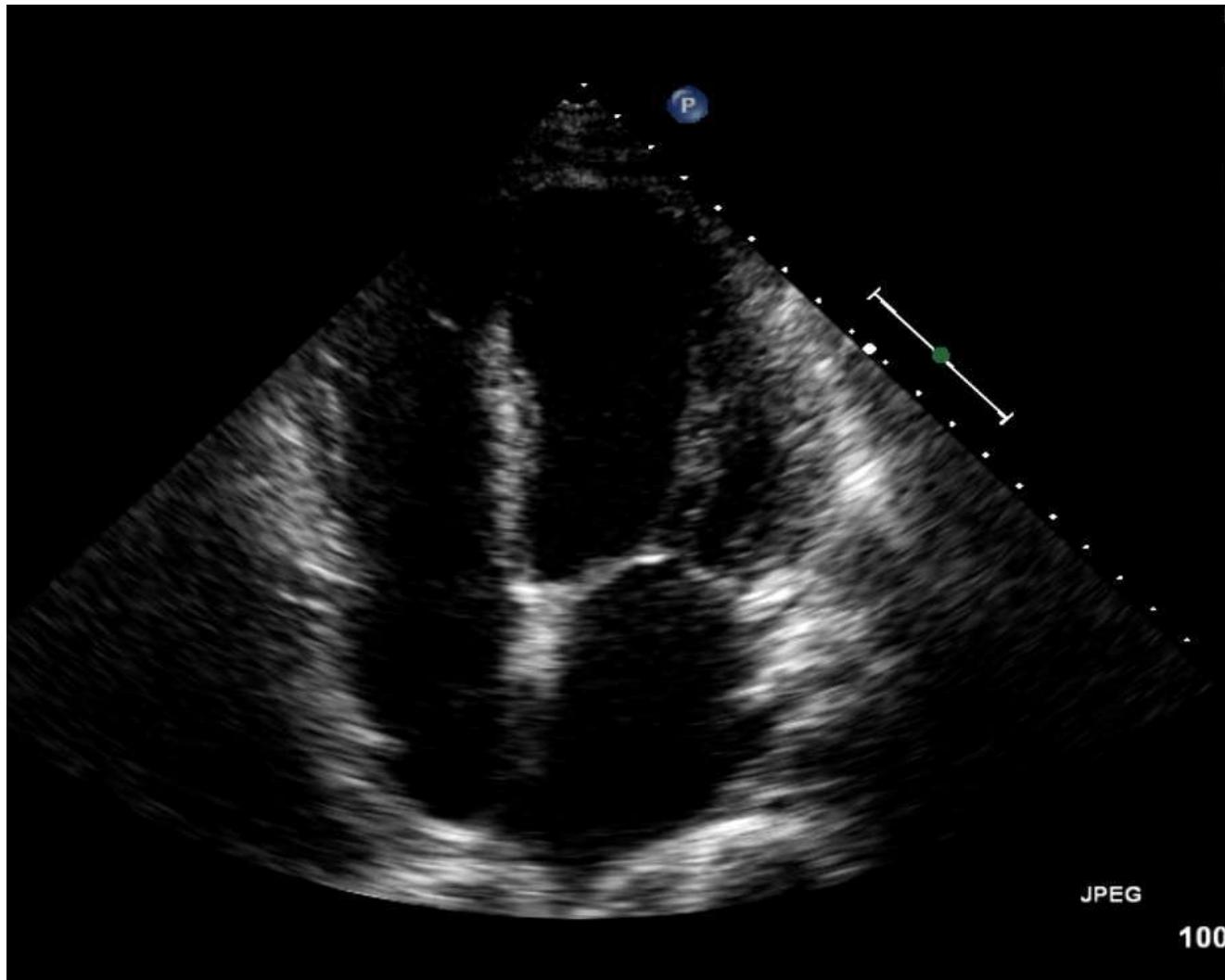
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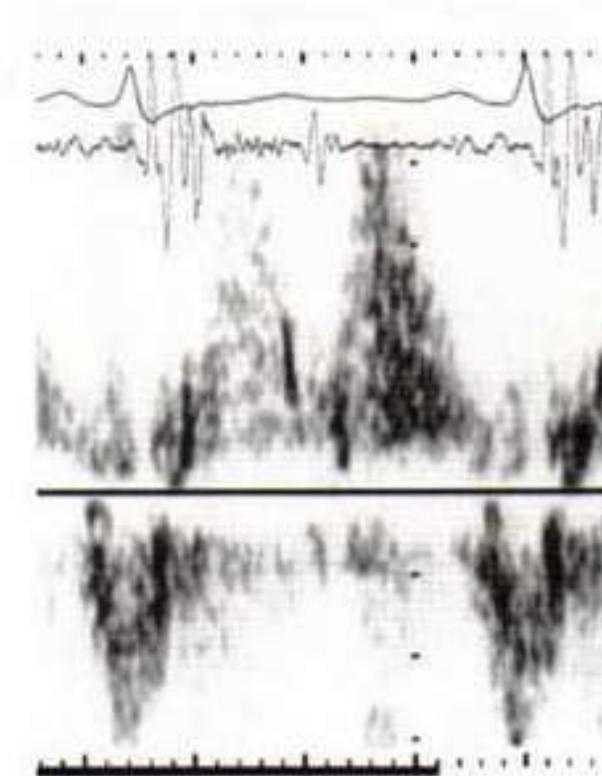
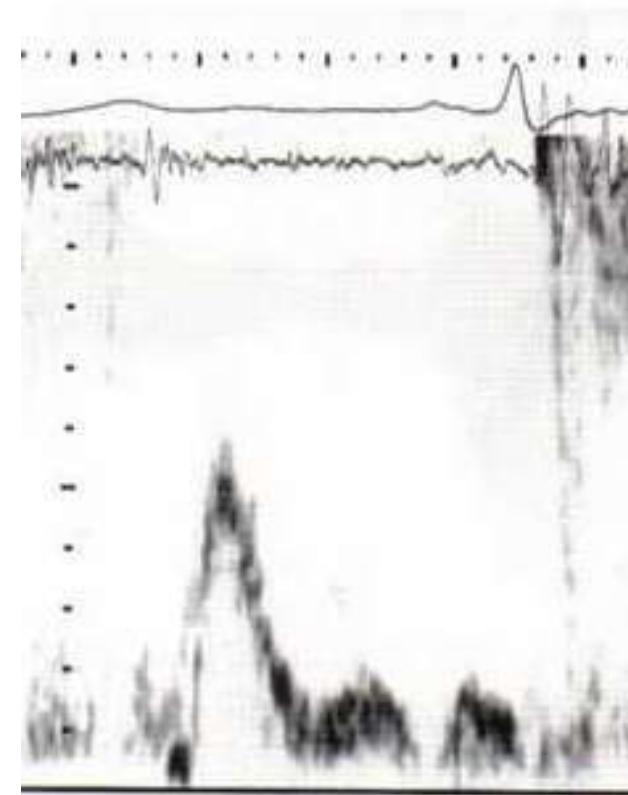
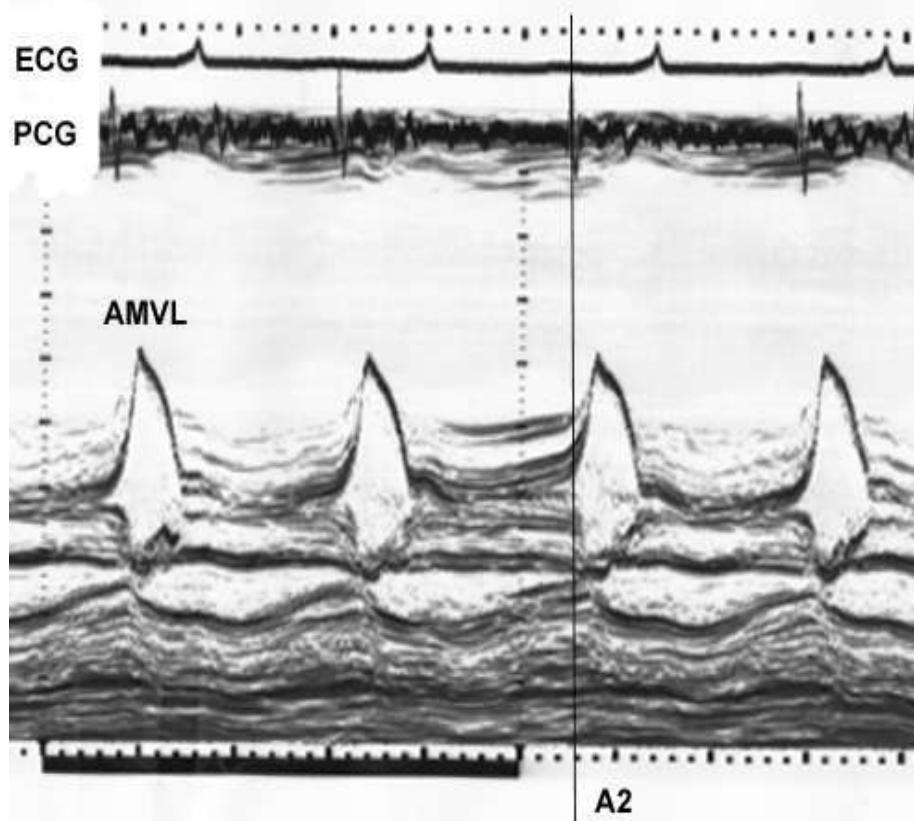
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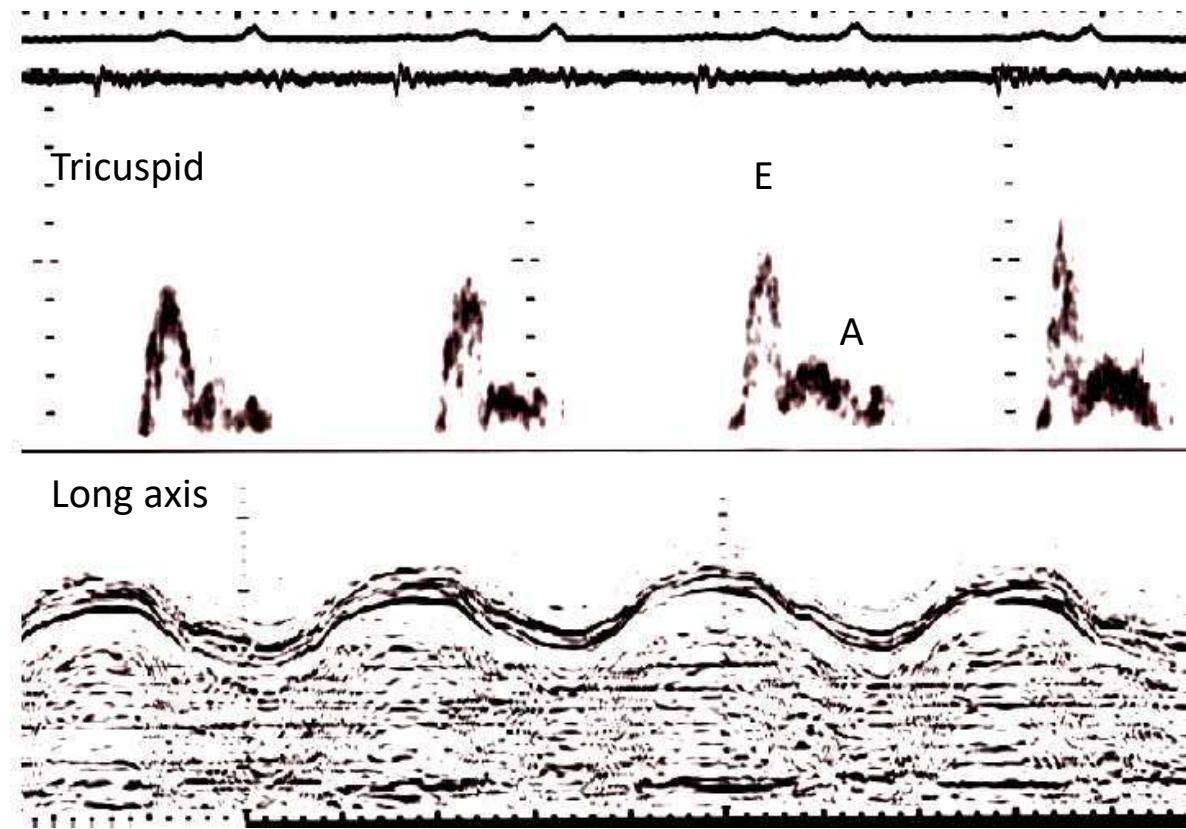
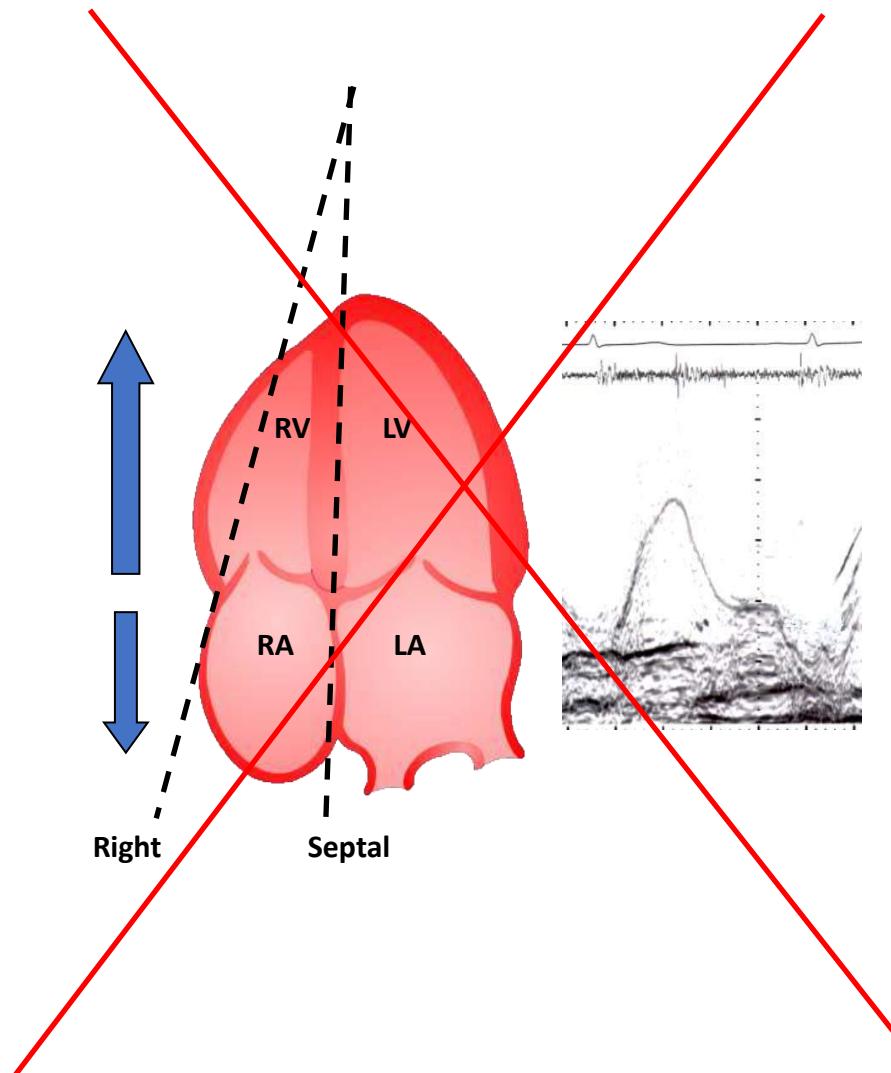
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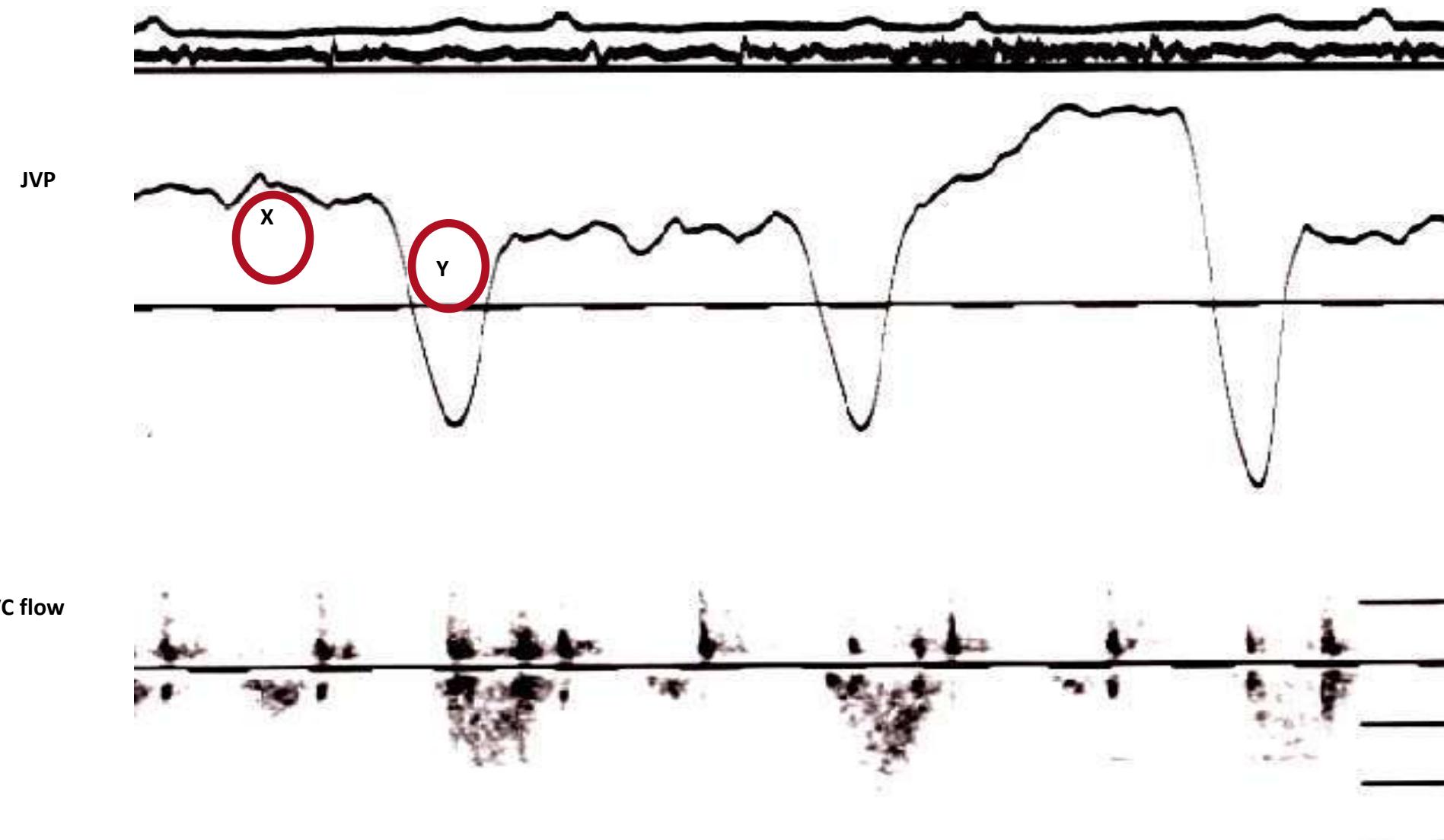
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Dominant Y in JVP: diastolic flow in SVC

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Multiple Uses Echo in Heart Failure

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