SONOGRAPHER TIPS AND TOOLS FOR FETAL ARRYTHMIA EVALUATION

Objectives:

*** IDENTIFY ABNORMAL HEART RATES AND RHYTHMS**

*** CREATE A "TOOL BOX" FOR ARRYTHMIA ASSESSMENTS**

*** HELP SONOGRAPHERS OBTAIN DIAGNOSTIC IMAGES FOR INTERPRETATION**

Embryology

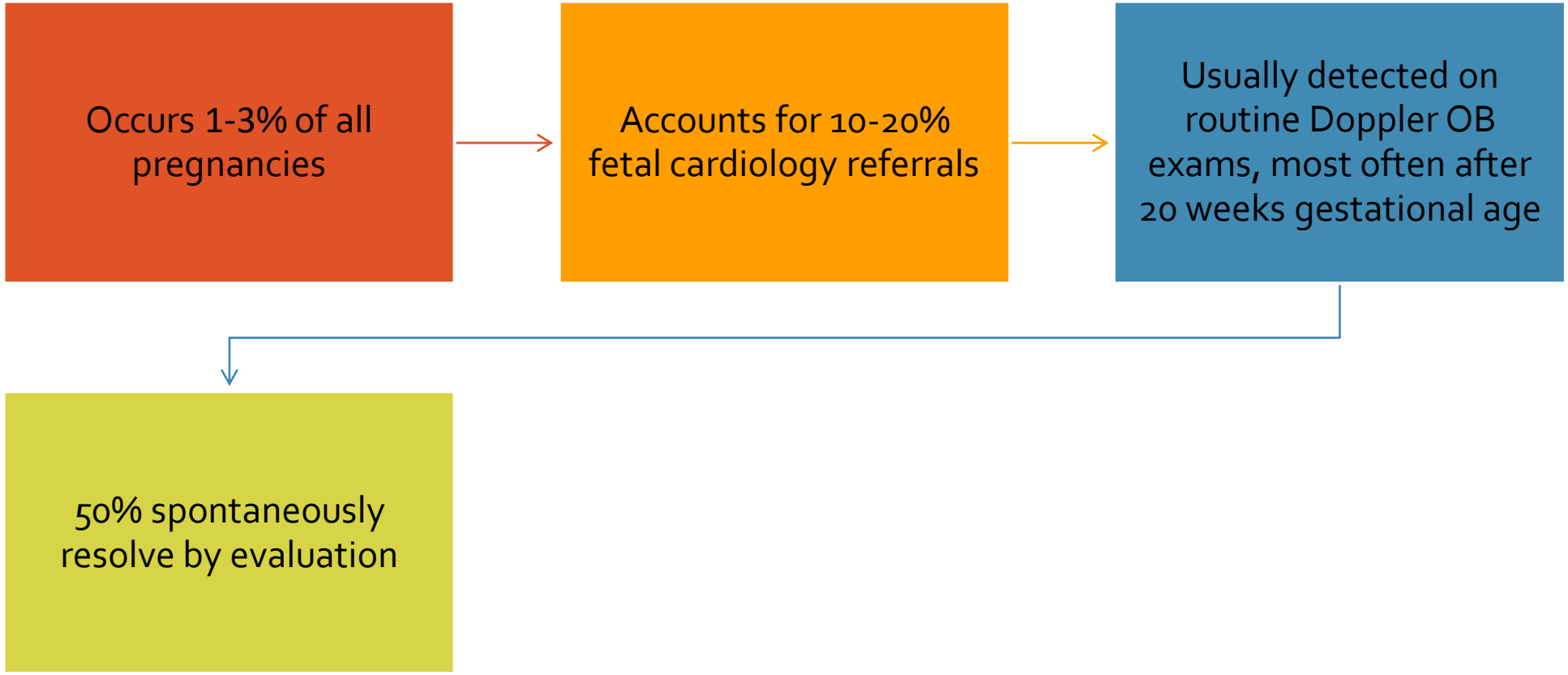
Heart beats as early as 12 days gestation!

By 6 weeks post conception, AV synchrony can be demonstrated

Normal fetal heart rates are age dependent

- 6 weeks- 100bpm
- 9 weeks- 170bpm
- 14 weeks- 150bpm
- 20 weeks- 140bpm (usually time at which we see them)
- Beat to beat variation may range 5-15bpm

Fetal Arrythmia Background



Mental preparation for sonogram:

Fetal well-being?

Structural defects/mother’s history?

Obtain information for diagnosis of rhythm

Fetal Well Being

- Hydrops present, pleural effusion/pericardial effusion?
- DV flow- retrograde flow seen?
- UV pulsations (not related to breathing)
- Good systolic ventricular function
- AVVR- TR?
- CT ratio increased?
- UA/MCA PI less than 1 (decreased CO)?

Structural Causes of Fetal Arrhythmias

Structurally normal heat

- SVT
- *PAC's, PVC's

Tumors or ventricular/atrial wall defects

- Rhabdomyoma
- Atrial septal aneurysm*- PAC’s

CHD

- Ebstein's anomaly-SVT
- Heterotaxy- all levels of SA/AV nodes tachyarrhythmias
- CCTGA-* CHB
- Left atrial isomerism *CHB
- Pulmonary Atresia
- Previous child with CHB

Autoimmune diseases/Viral Infections

Sjogrens syndrome- SSA/SSB+ (most common seen as arrythmias in category)

Myocarditis

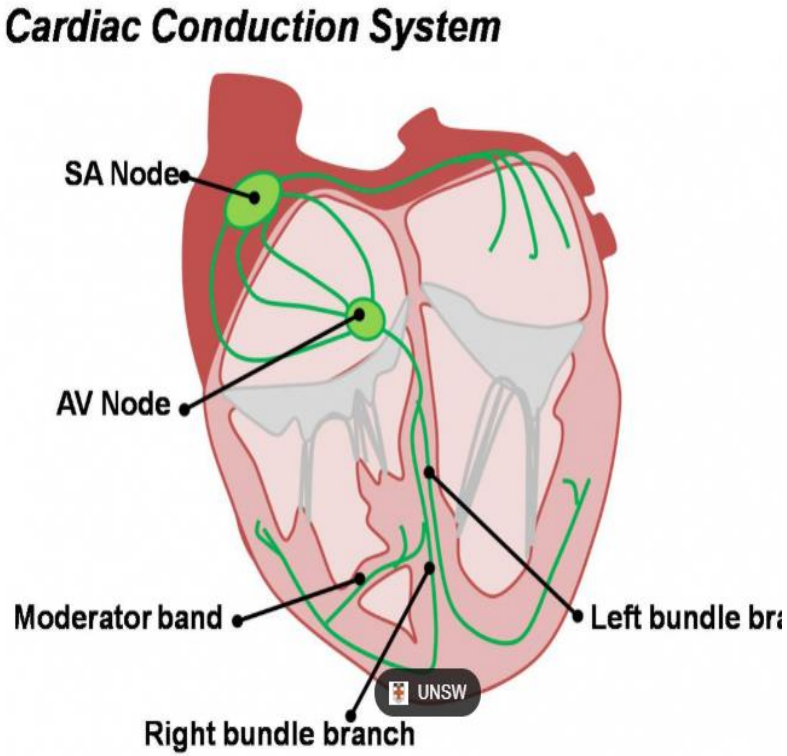
Thyrotoxicosis

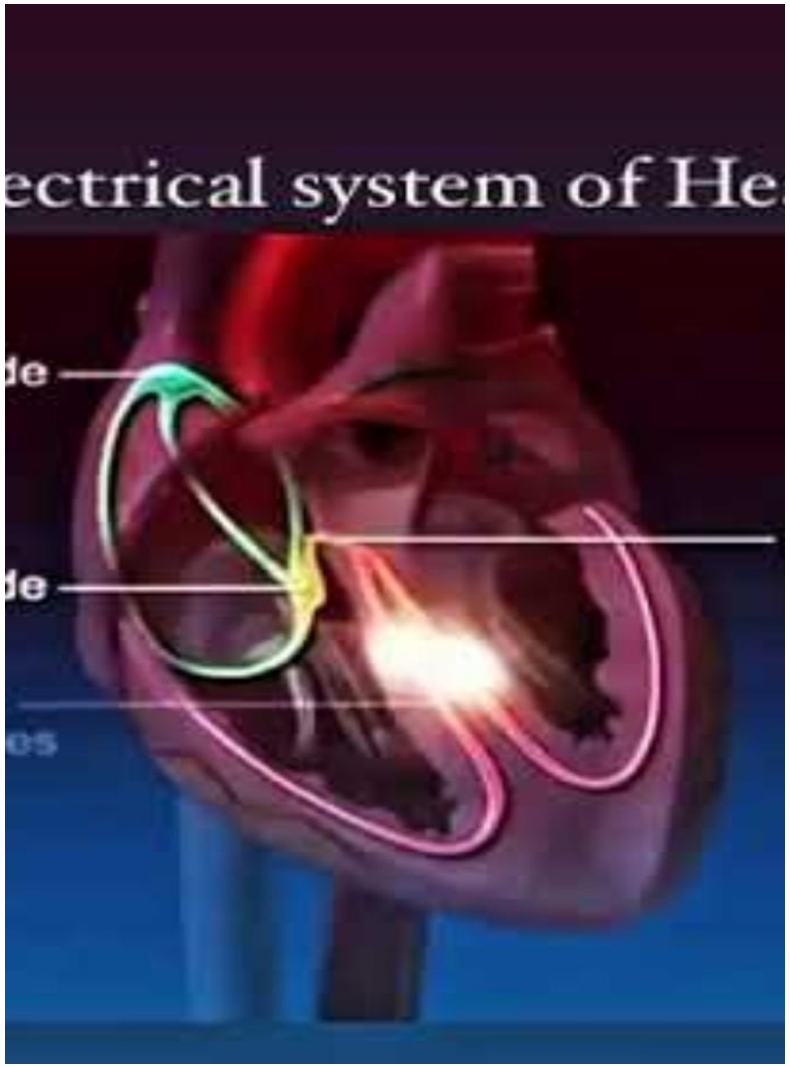
Phenylketonuria

Rubella

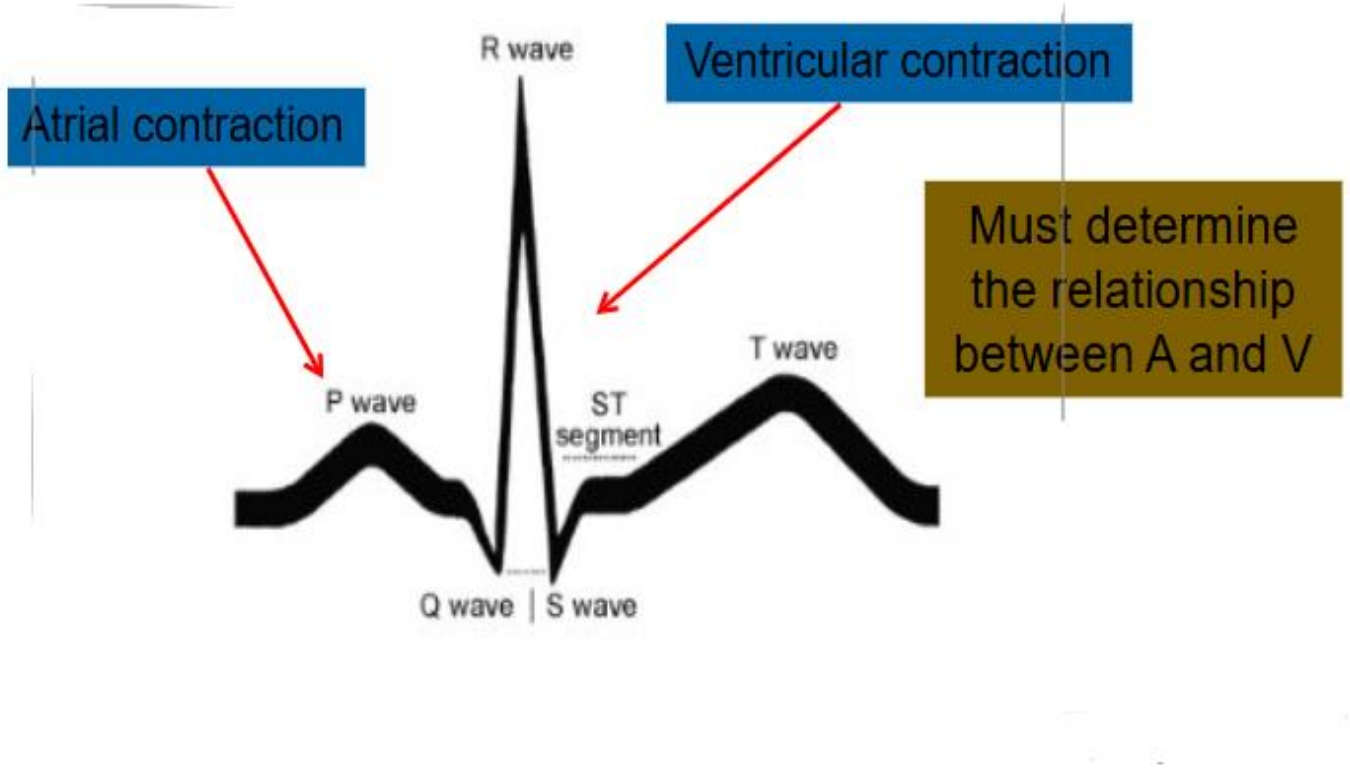
Inherited Channelopathy/Maternal Medications/diet

LQTS *
Short QT syndrome
Brugada syndrome
Catecholaminergic polymorphic ventricular tachycardia/CPVT
Beta-adrengeric blocking agents(propanalol,metroprolol)
Caffeine intake





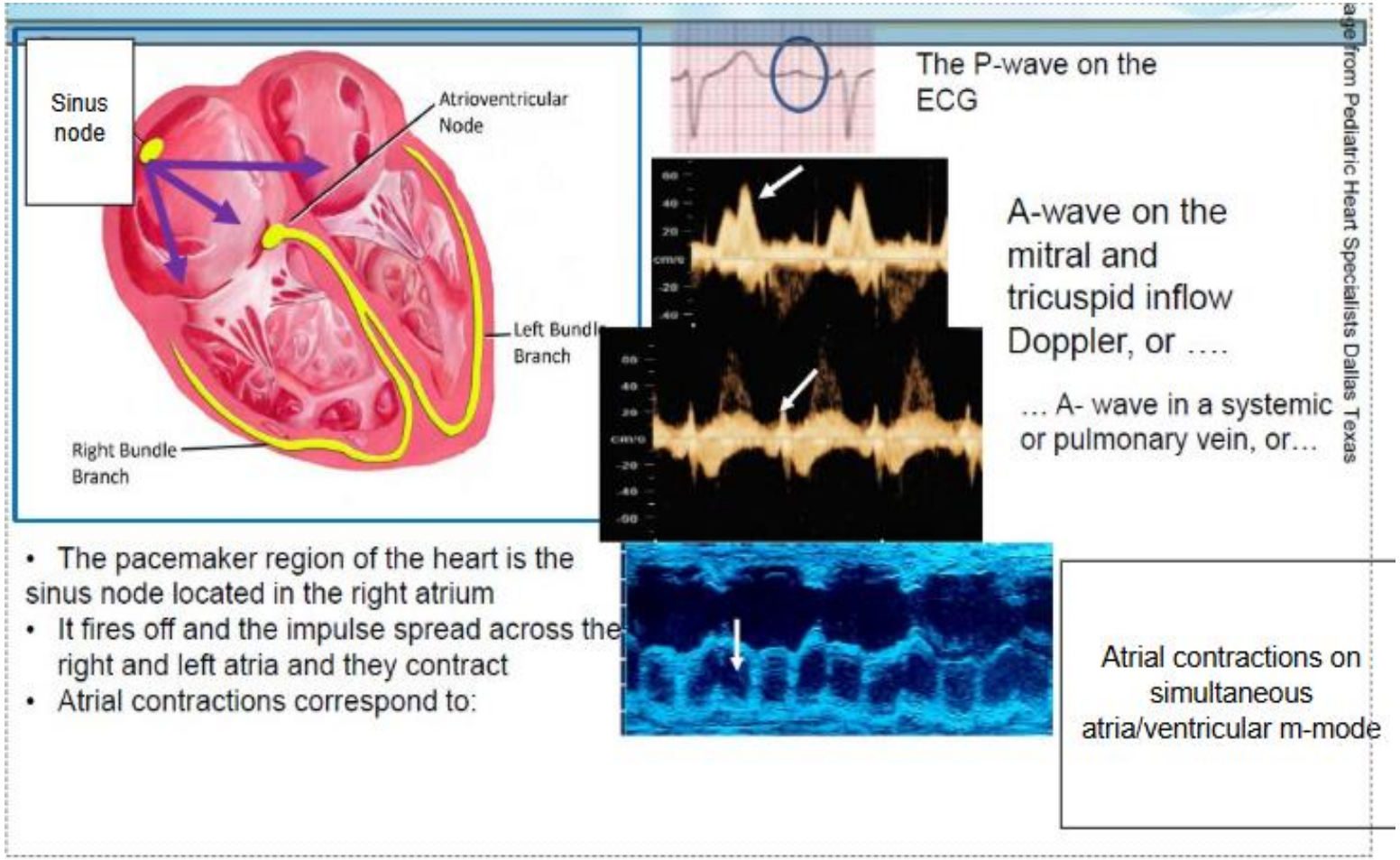
FETAL CONDUCTION SYSTEM



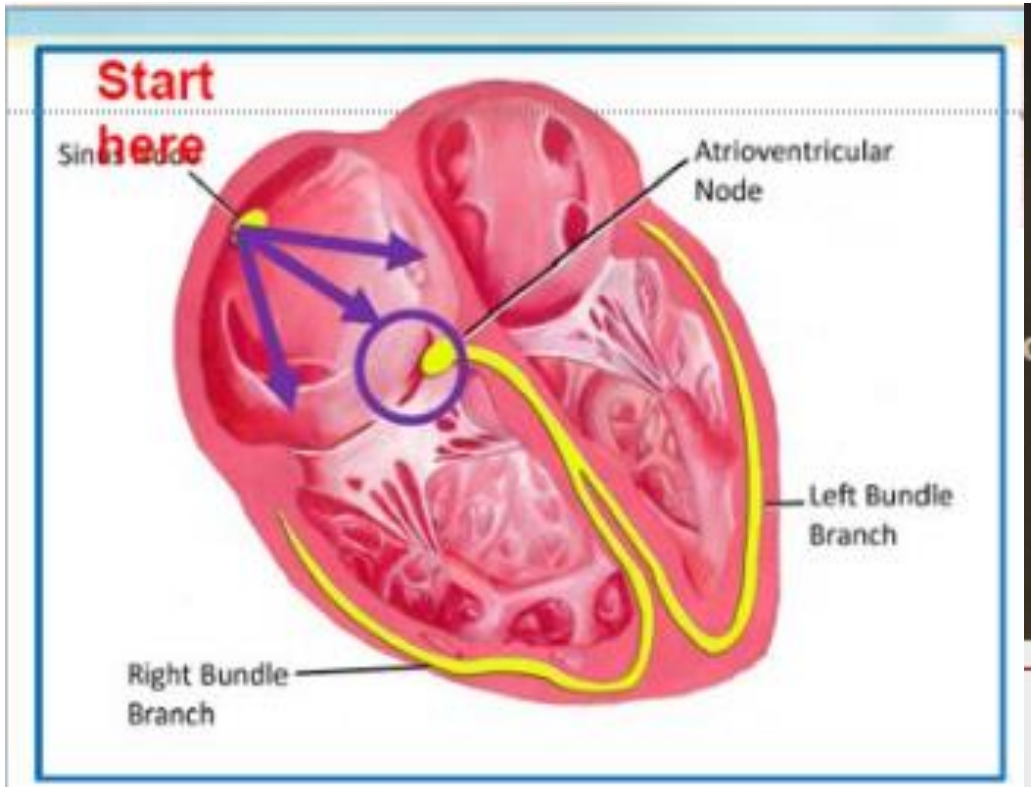
Fetal Arrhythmia Evaluation- No ECG!

- ECG is gold standard to assess direct measurement of electrical signals…. fetal echo is an indirect assessment by mechanical events-contractions associated with electrical signals

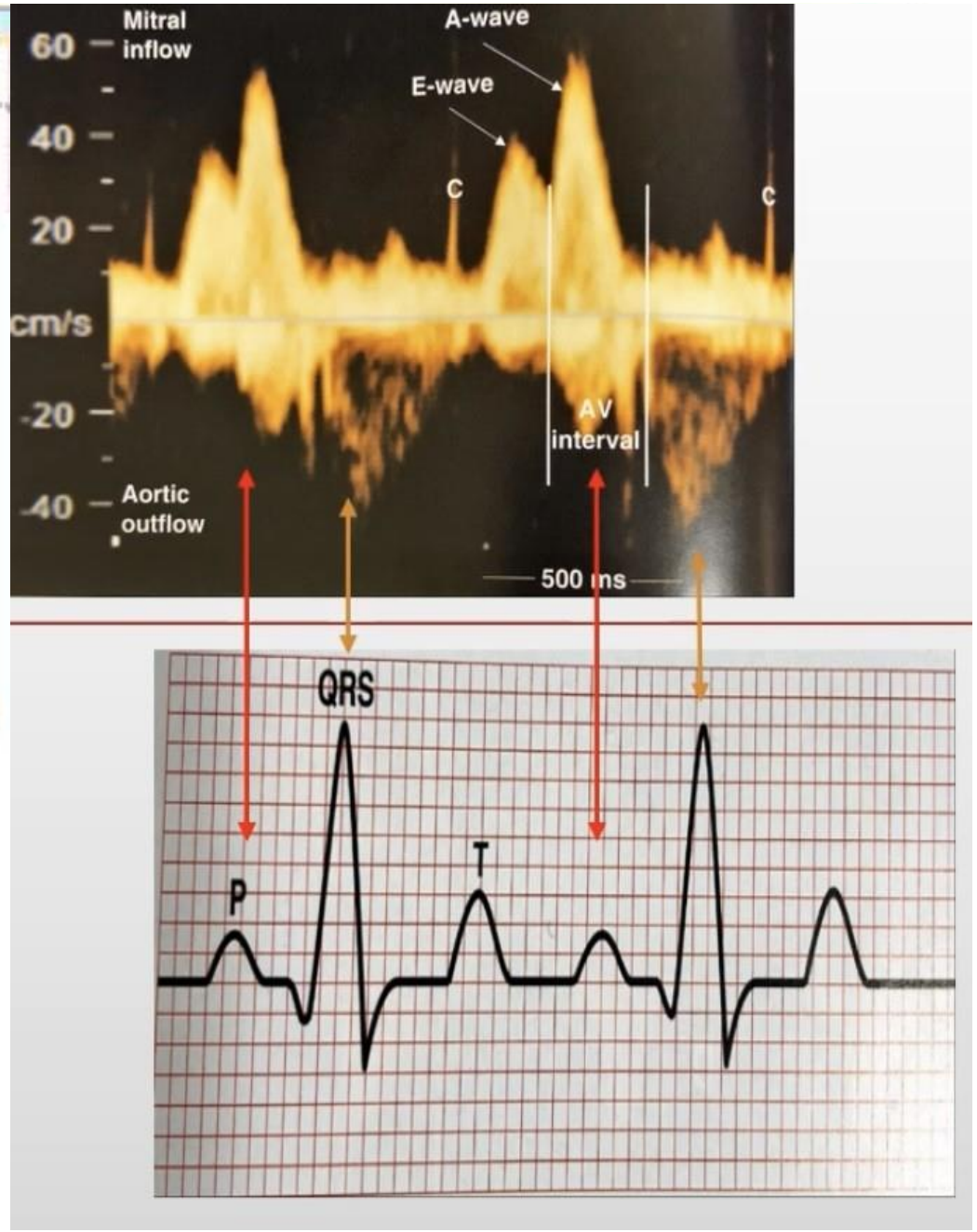
How to assess?



- 2D- visually categorize
- M-Mode and Doppler!
- M-Mode: through atria and ventricle
- PWD: LVOT inflow/outflow, SVC/AO, PA/PV



- The impulses are slowed at the AV node.
- This slowing corresponds to the PR or AV or mechanical PR interval
- If the AV node is abnormal, impulses are delayed (1° AV block), intermittently or not at all conducted (2° and 3° AV block



Step by Step

1st: What is the fetal HR (slow, fast, irregular

2nd: What is the atrial to ventricular relationship? (1:1 conduction or more atrial to ventricular or more ventricular to atrial contractions)

3rd: What are the AV/VA time intervals? (long, short, or all short, all long)

GA 31w0d
C9-2
88Hz
RS
2D
74%
Dyn R 50
P Low
HGen
M2
X2
8.4cm
*** bpm
P
R
2.5
5.0

M2
X2
R
5.0

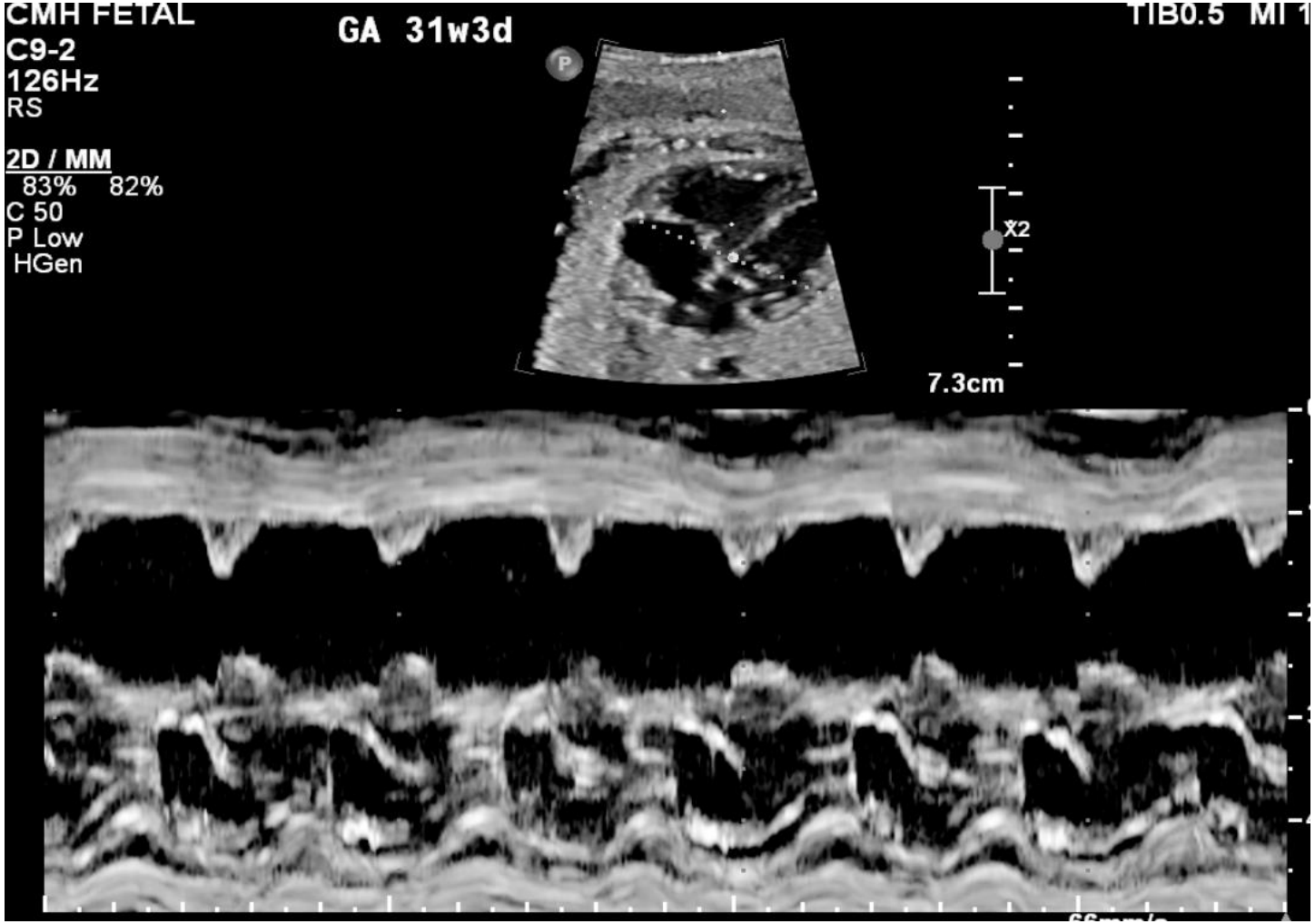
M2
X2
R
5.0

GA 31w5d
C5-1
80Hz
RS
2D
50%
CORDES
Dyn R 50
P Low
HGen
M2
X2
14cm
*** bpm
P
R
2.0
4.0

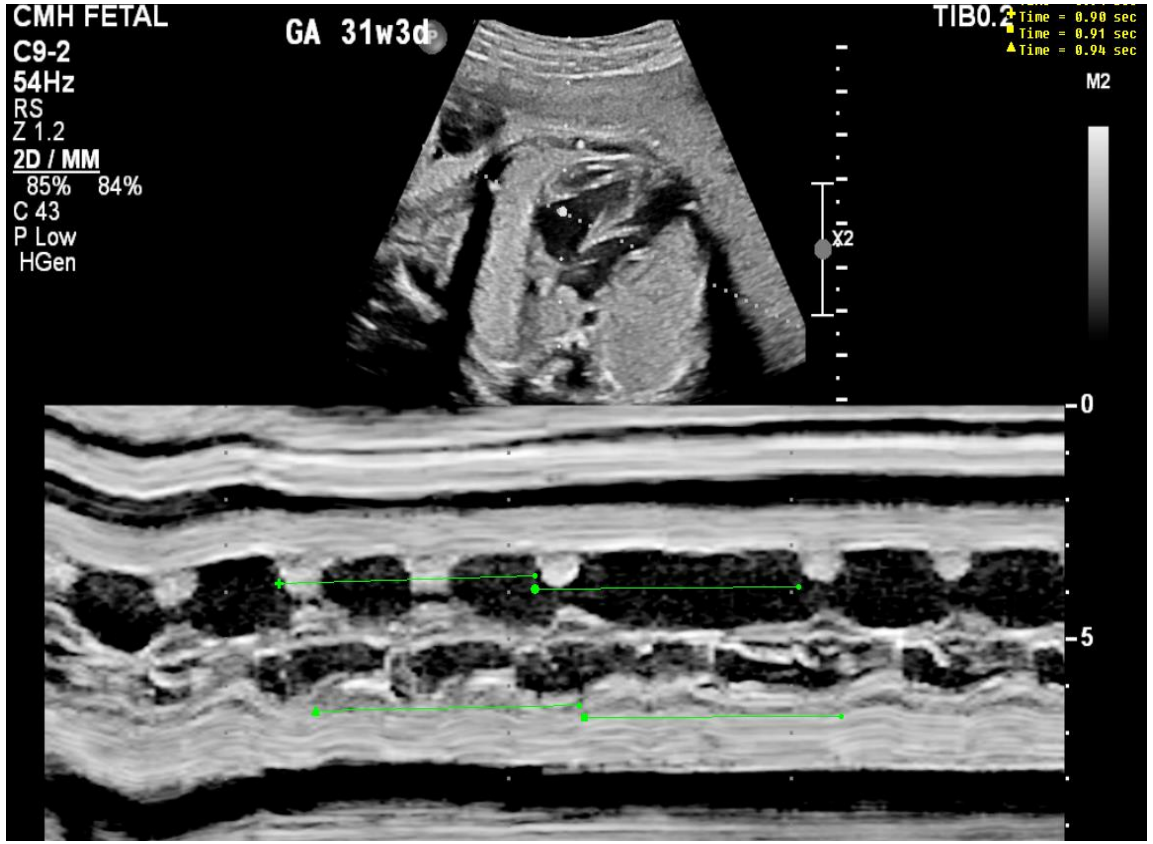
Step 2: Determining the A/V relationship by M-Mode

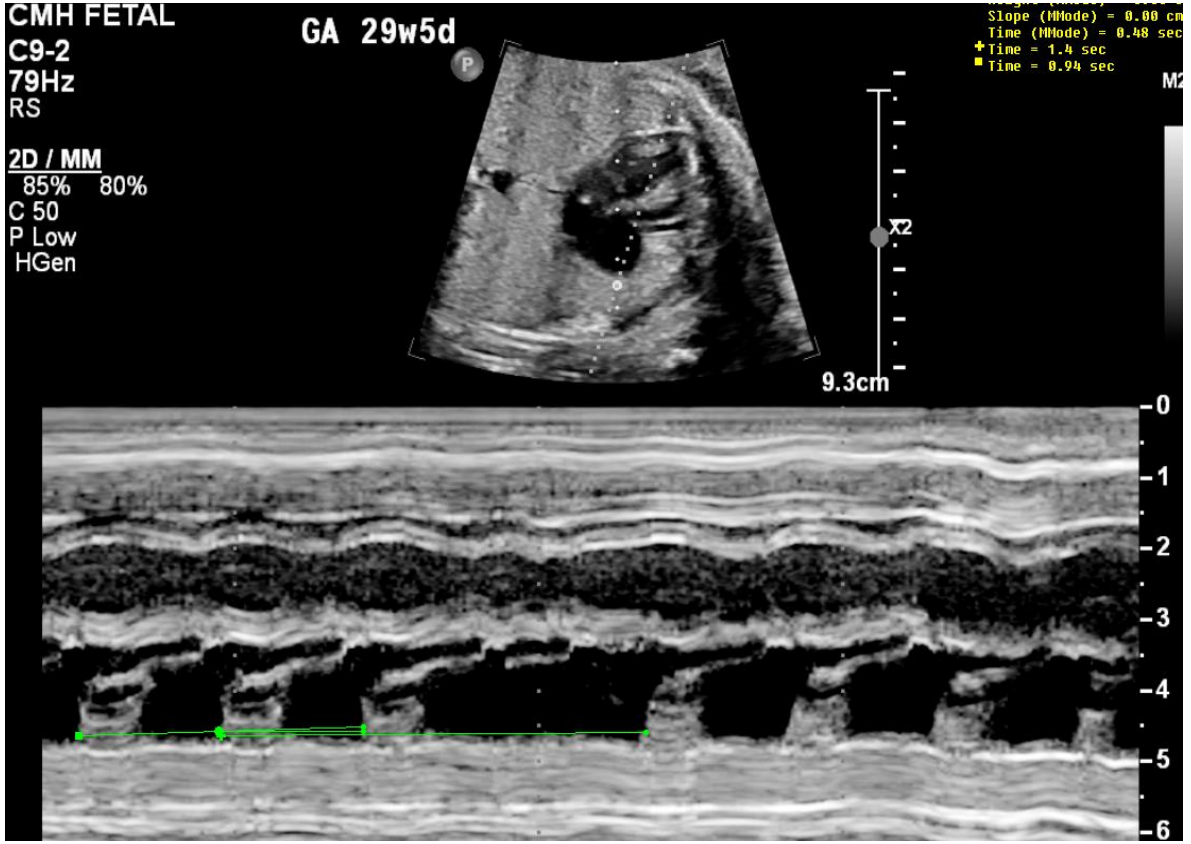
- AMM curser - RA wall tends to help with atrial assessment, so RA/LV
  - *Coronal view best, 4-Ch can be used, RA-RV in sagital view
  - There is a "dot" on the curser which helps the area of interest
  - Anatomical M-Mode is your friend- 45 degree angle is best
- Decrease sweep speed watch and leave it on to catch rhythm
- Can measure A-V time and V-A time, A-A rate V-V rate
- Limitations, fetal movement, breathing, hiccups, hydrops, & poor windows

Step 2: M-Mode

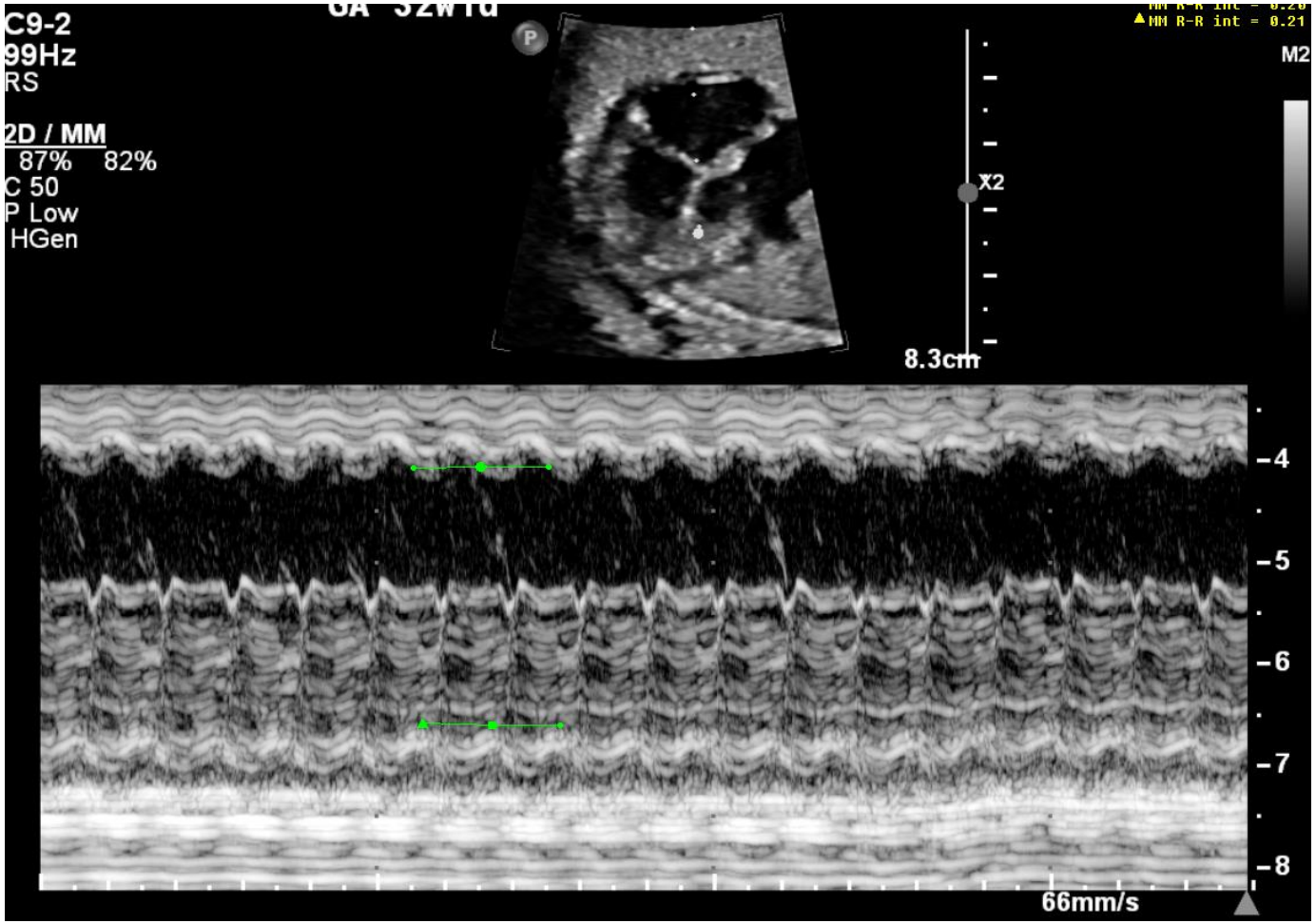

CMH FETAL
C9-2
126Hz
RS
2D / MM
83% 82%
C 50
P Low
HGen
GA 31w3d
TIB0.5
X2
7.3cm

M-Mode

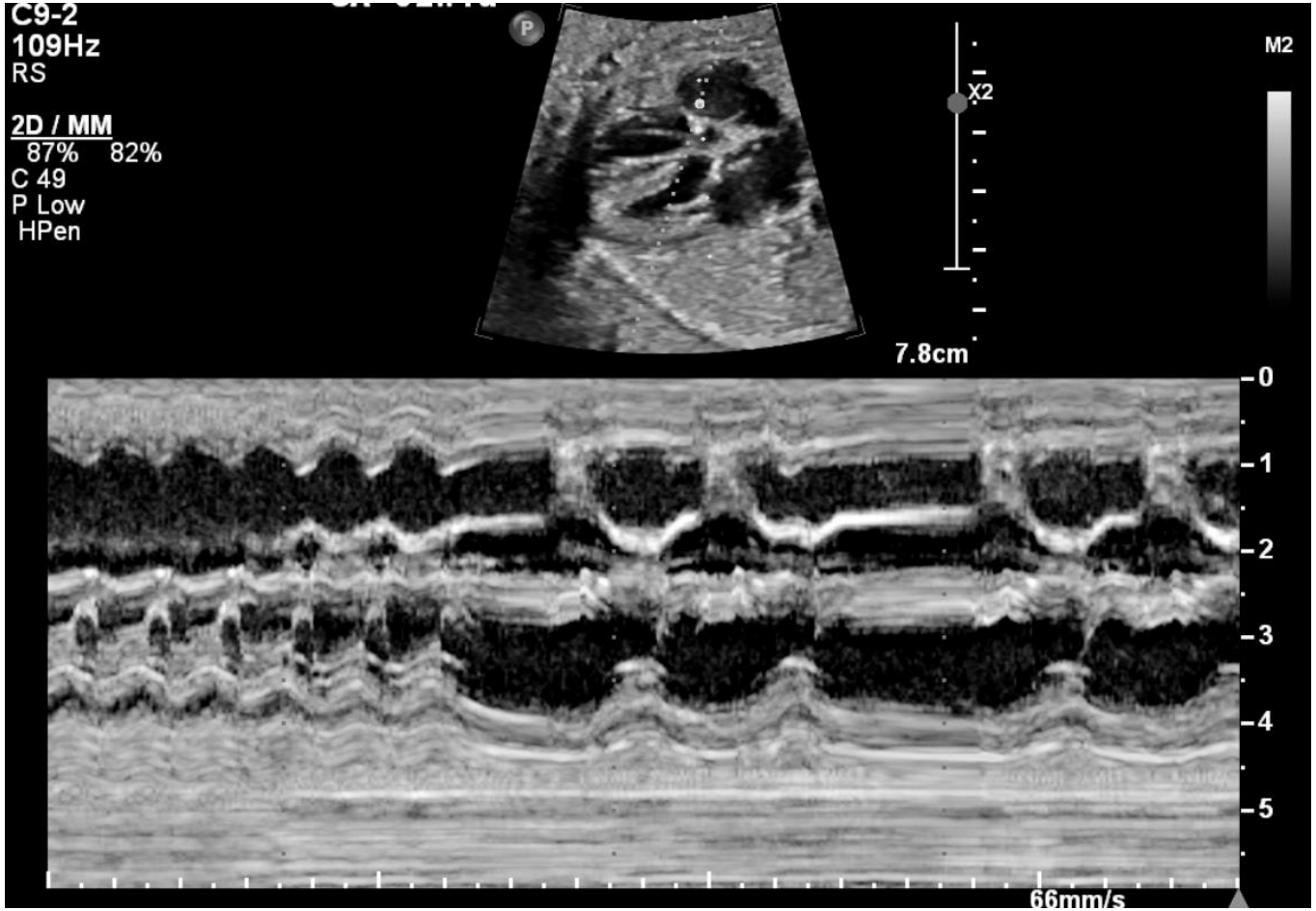

CMH FETAL
C9-2
54Hz
RS
Z 1.2
2D / MM
85% 84%
C 43
P Low
HGen
GA 31w3d
TIB0.2
Time = 0.90 sec
Time = 0.91 sec
Time = 0.94 sec
M2
X2
0
5


CMH FETAL
C9-2
79Hz
RS
2D / MM
85% 80%
C 50
P Low
HGen
GA 29w5d
Slope (MMode) = 0.00 cm
Time (MMode) = 0.48 sec
Time = 1.4 sec
Time = 0.94 sec
M2
X2
9.3cm
0
1
2
3
4
5
6

M-Mode


C9-2
99Hz
RS
2D / MM
87% 82%
C 50
P Low
HGen
MM R-R int = 0.21
M2
X2
8.3cm
-4
-5
-6
-7
-8
66mm/s

M-Mode



Step 3: Doppler assessment

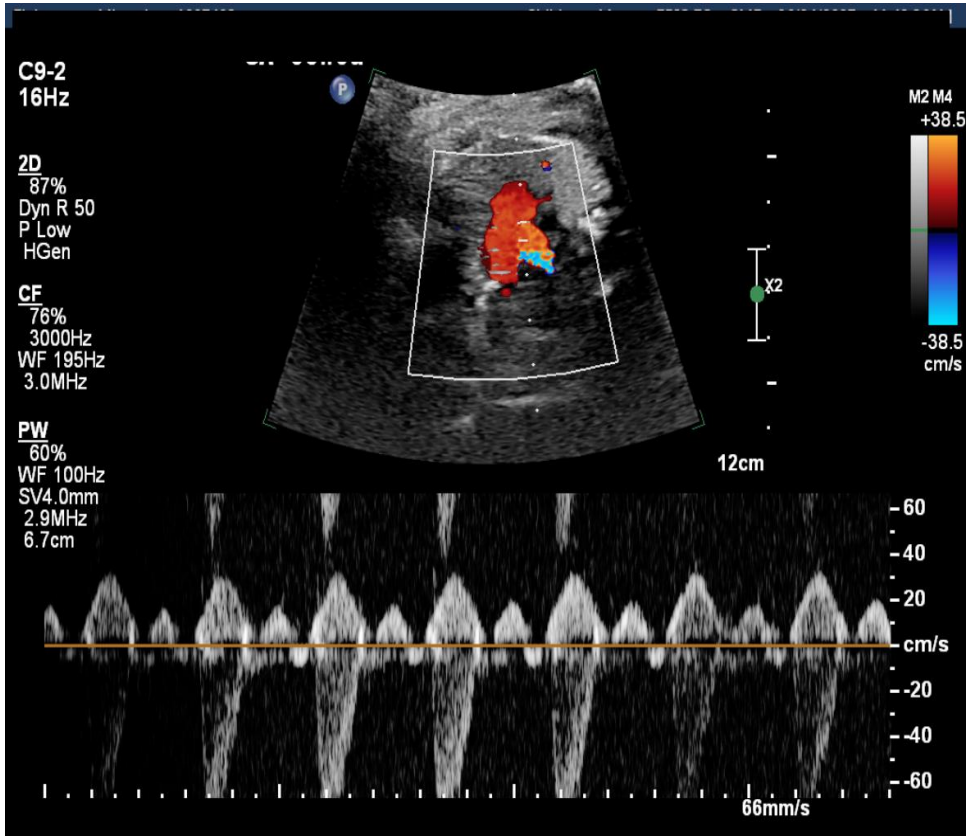
- SVC/AO interrogation
  - Increase sample gate- 4
  - wall filter around (120Hz)
- LVOT inflow /outflow interrogation
  - Increase sample gate
  - wall filter (120Hz)
- Pulmonary vein and Pulmonary artery interrogation

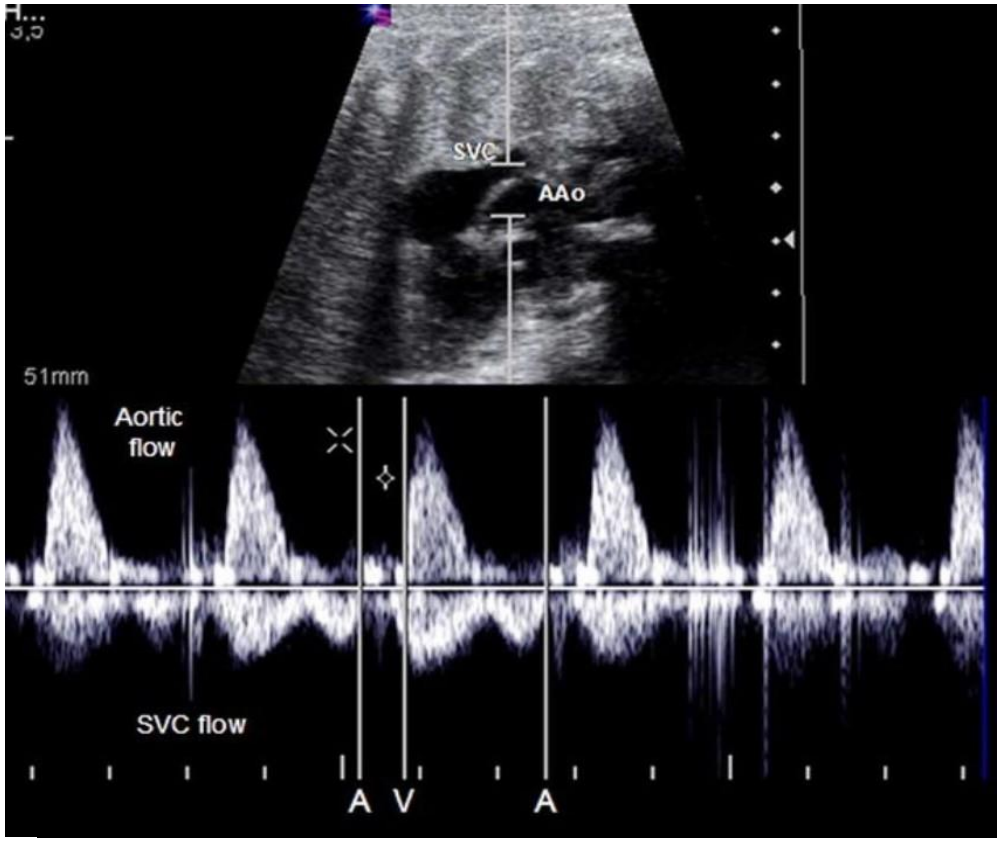
  - Show pics of SVC/AO and LVOT / PV/PA and ask what is being measured

SVC/Innominate/AO

Mechanical PR interval

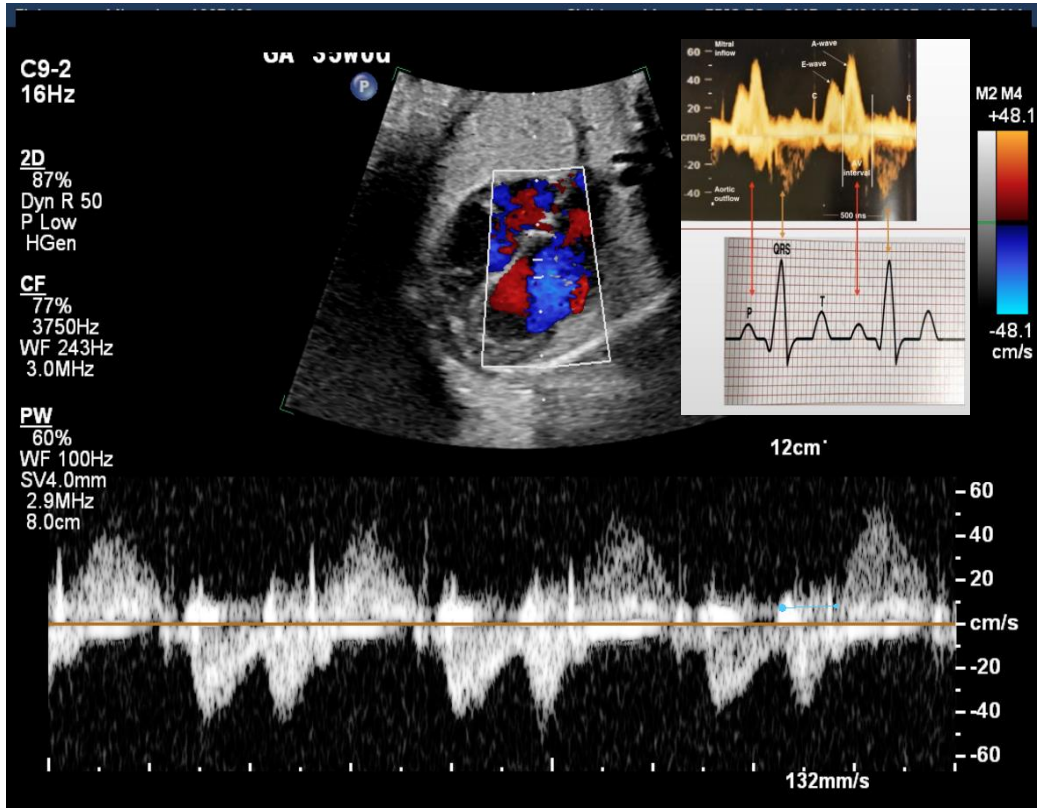
- 3V view and sagital view with Innominate Vein and Aorta

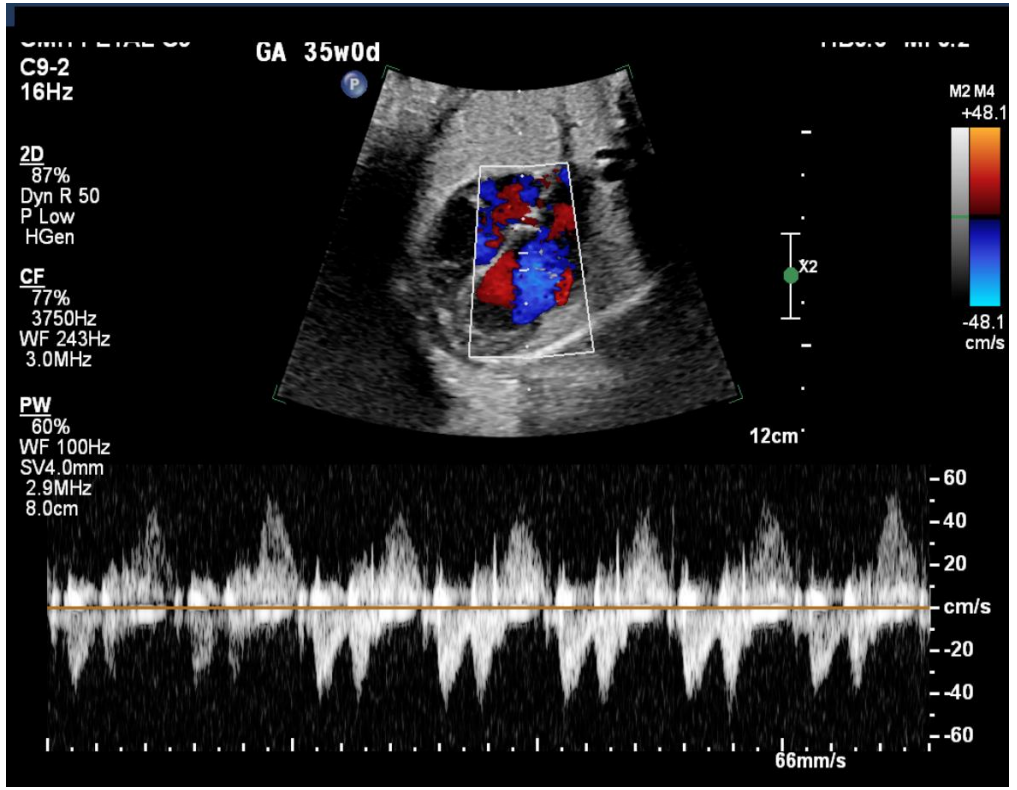




LVOT Inflow Outflow Doppler

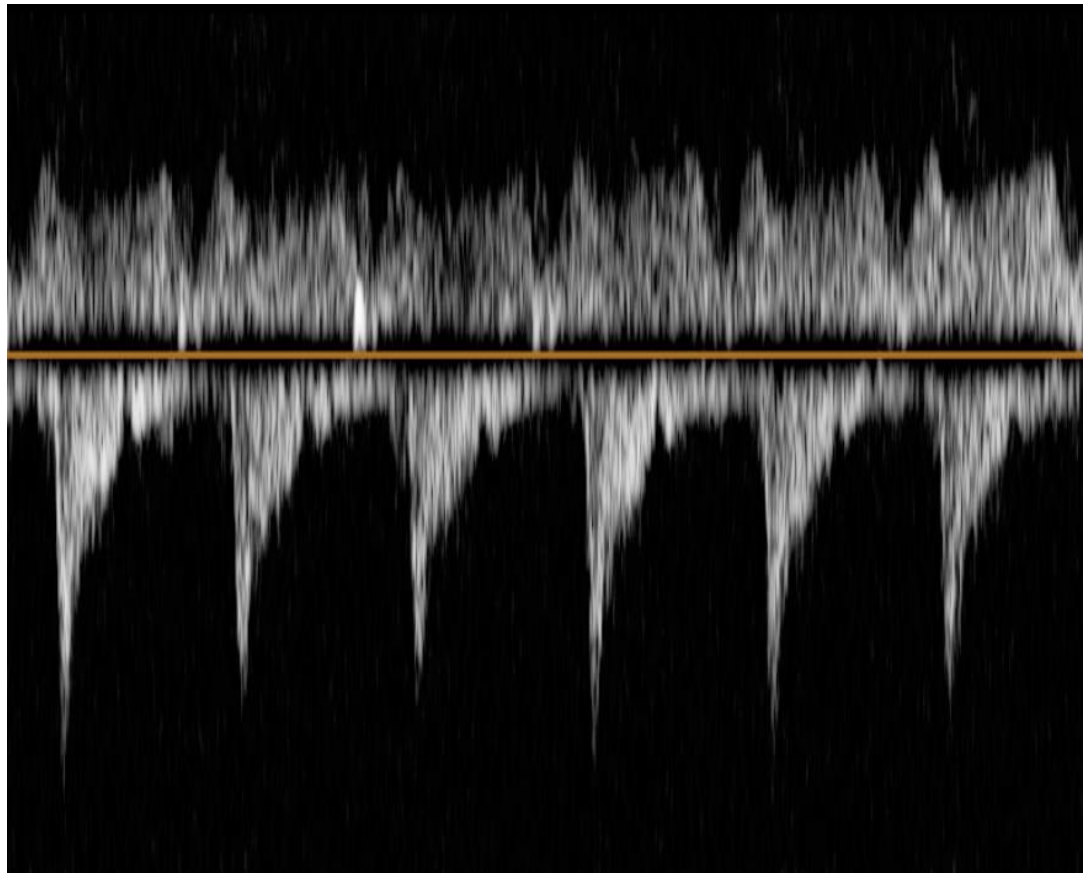
Mechanical PR interval

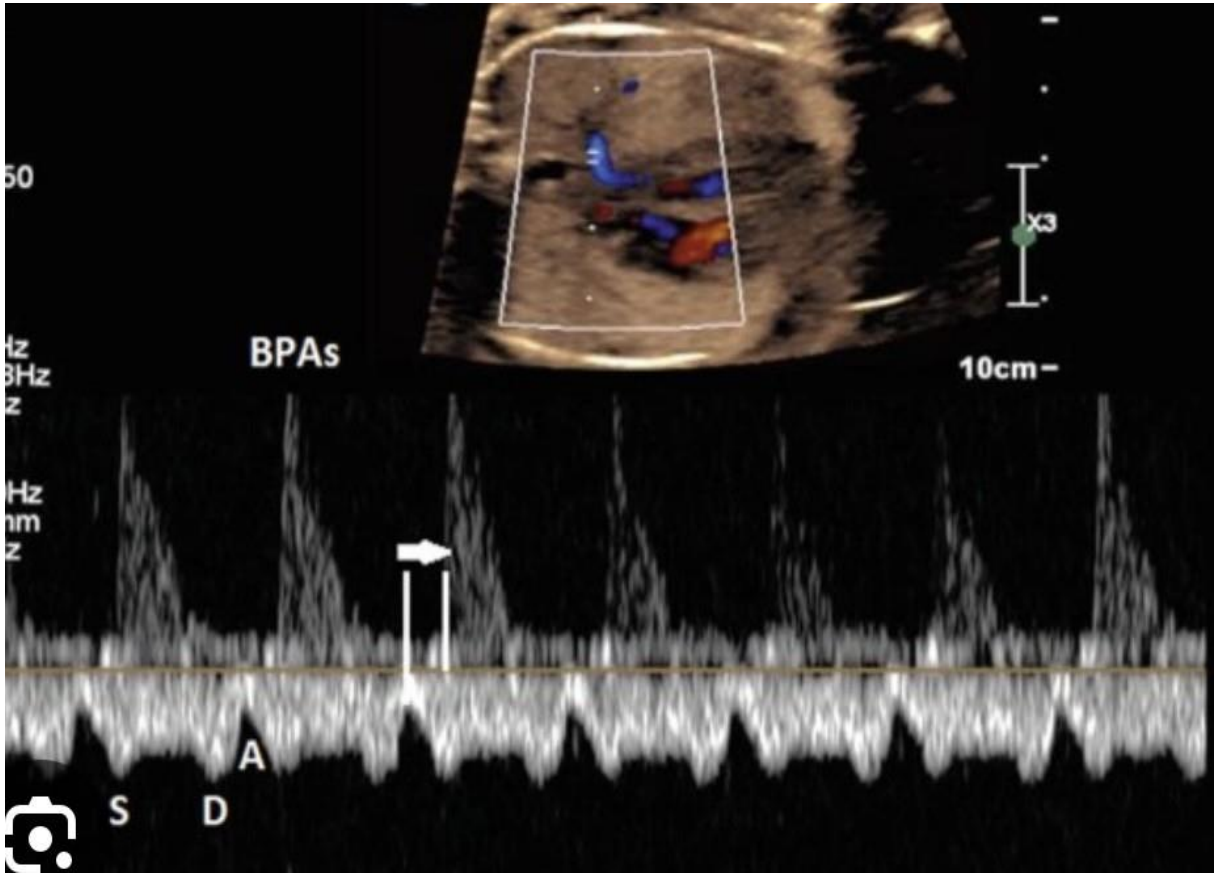




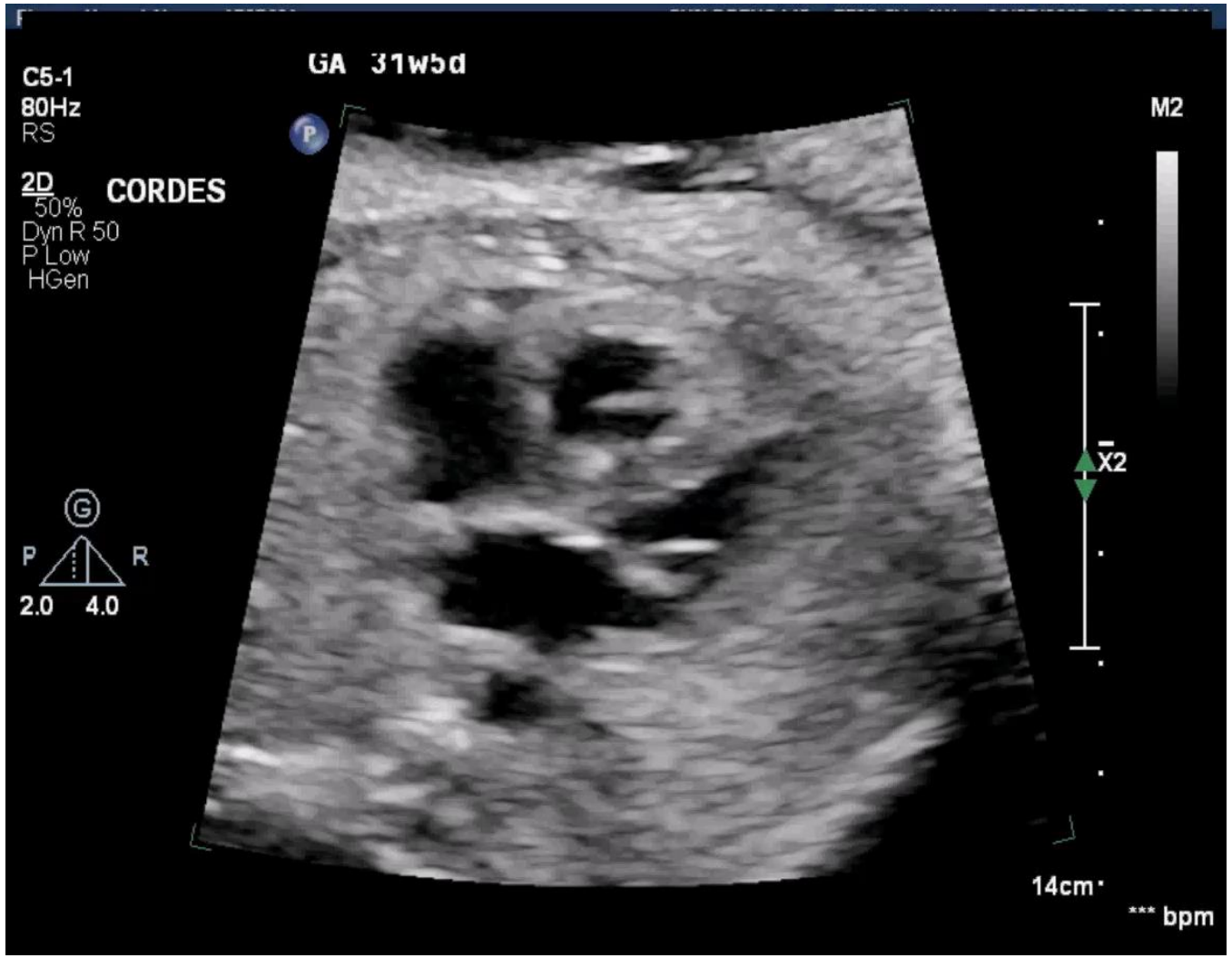
Pulmonary Vein/Pulmonary Artery-

Mechanical PR interval

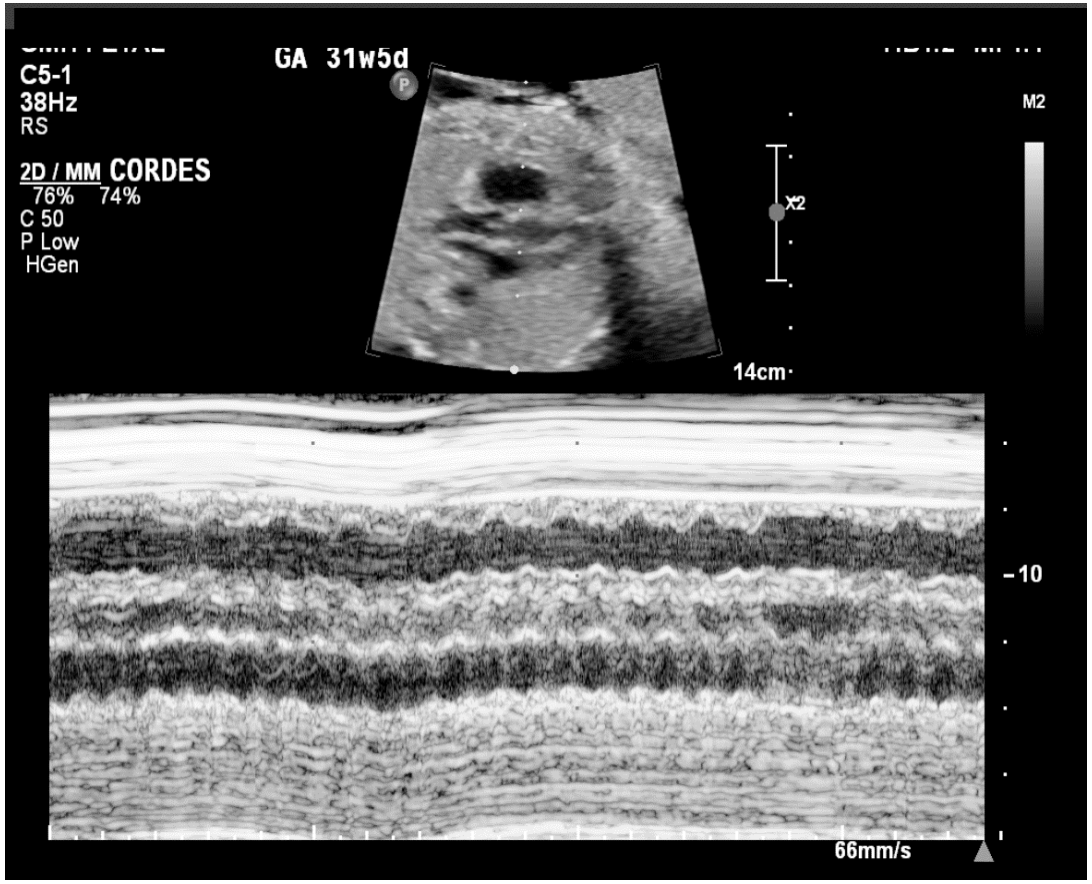


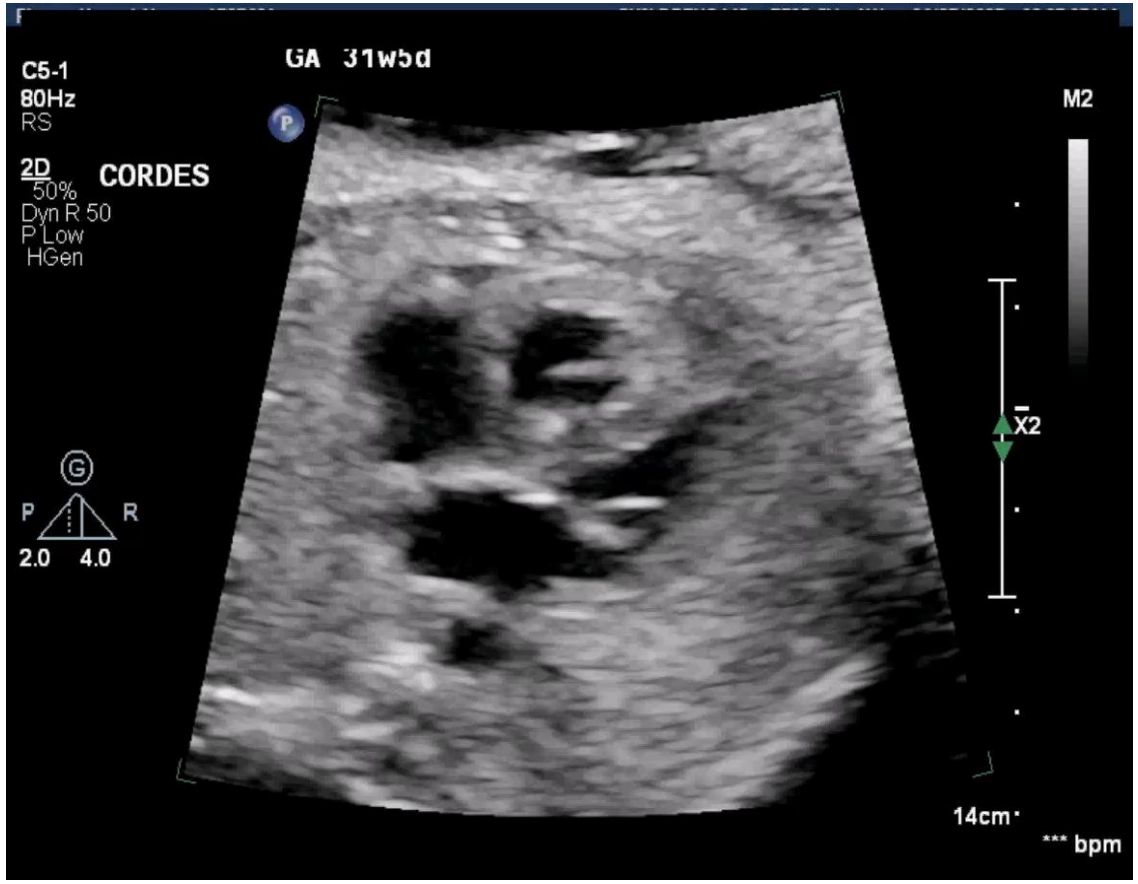


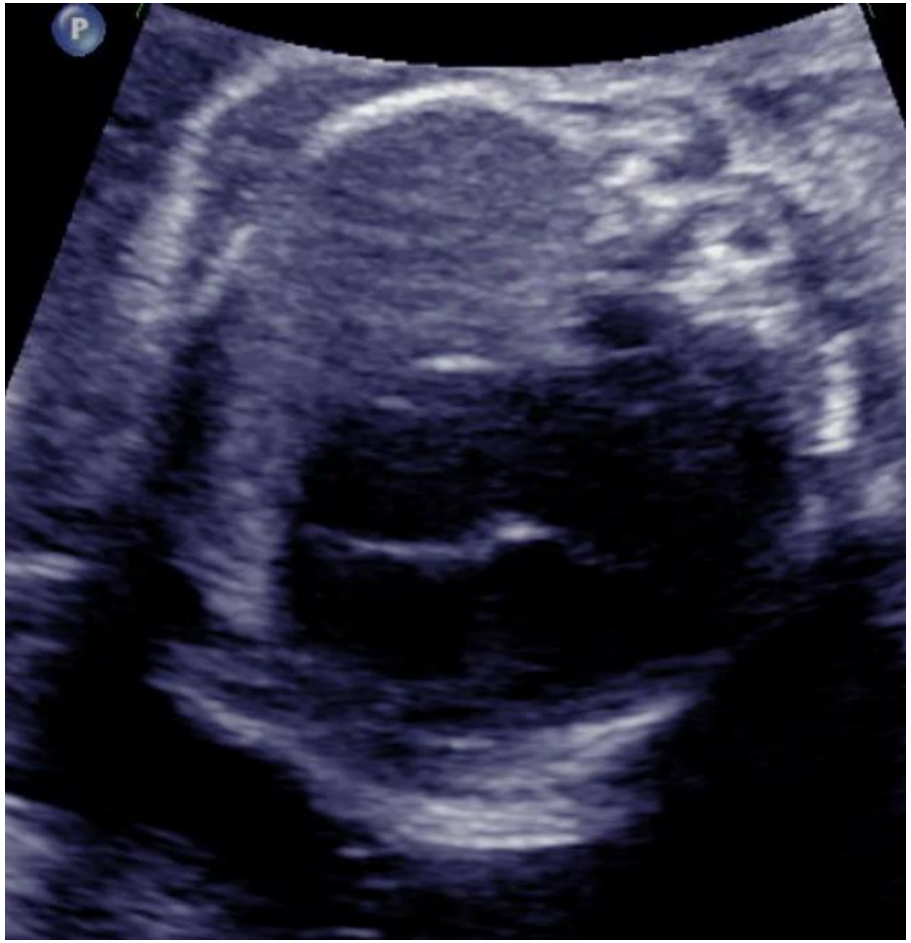
What Do You See? –2D Assessment

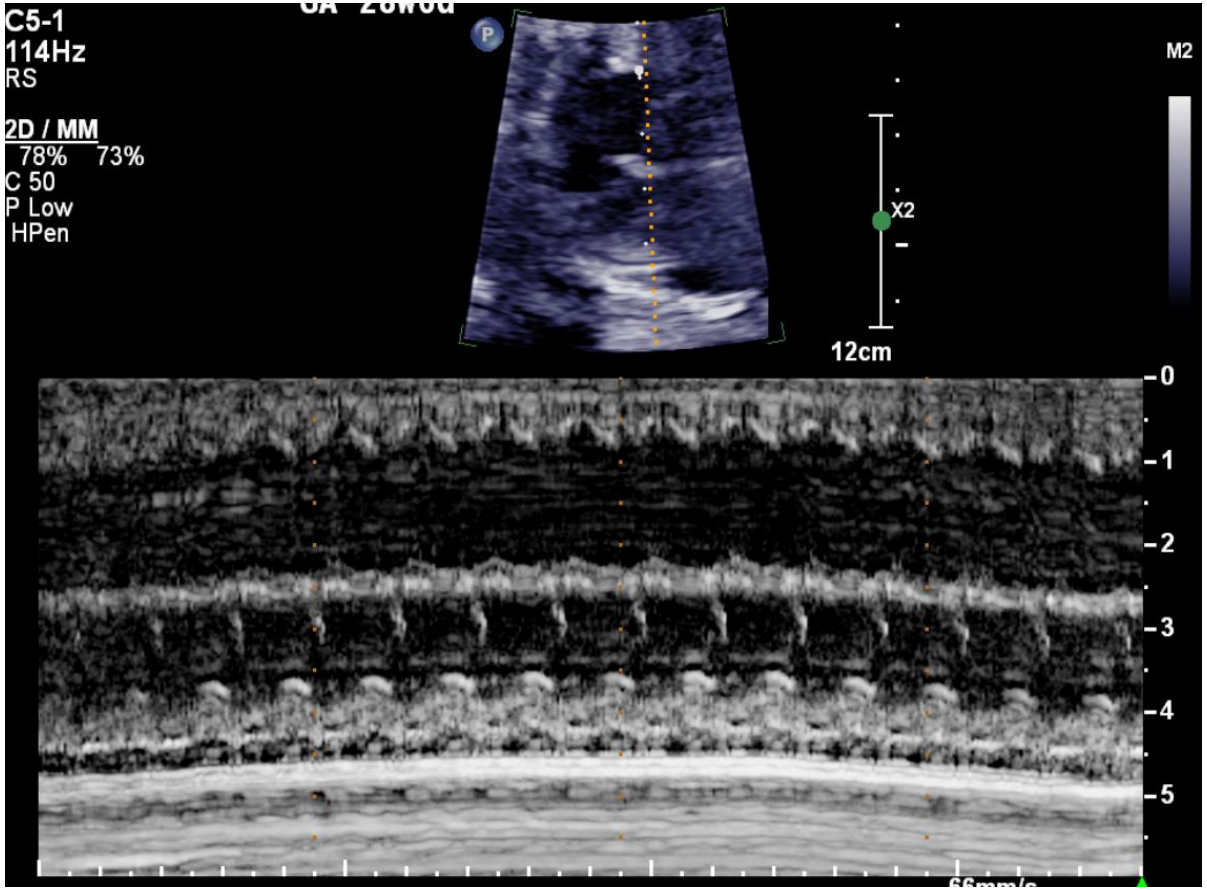


Atrial Flutter (close to 500)



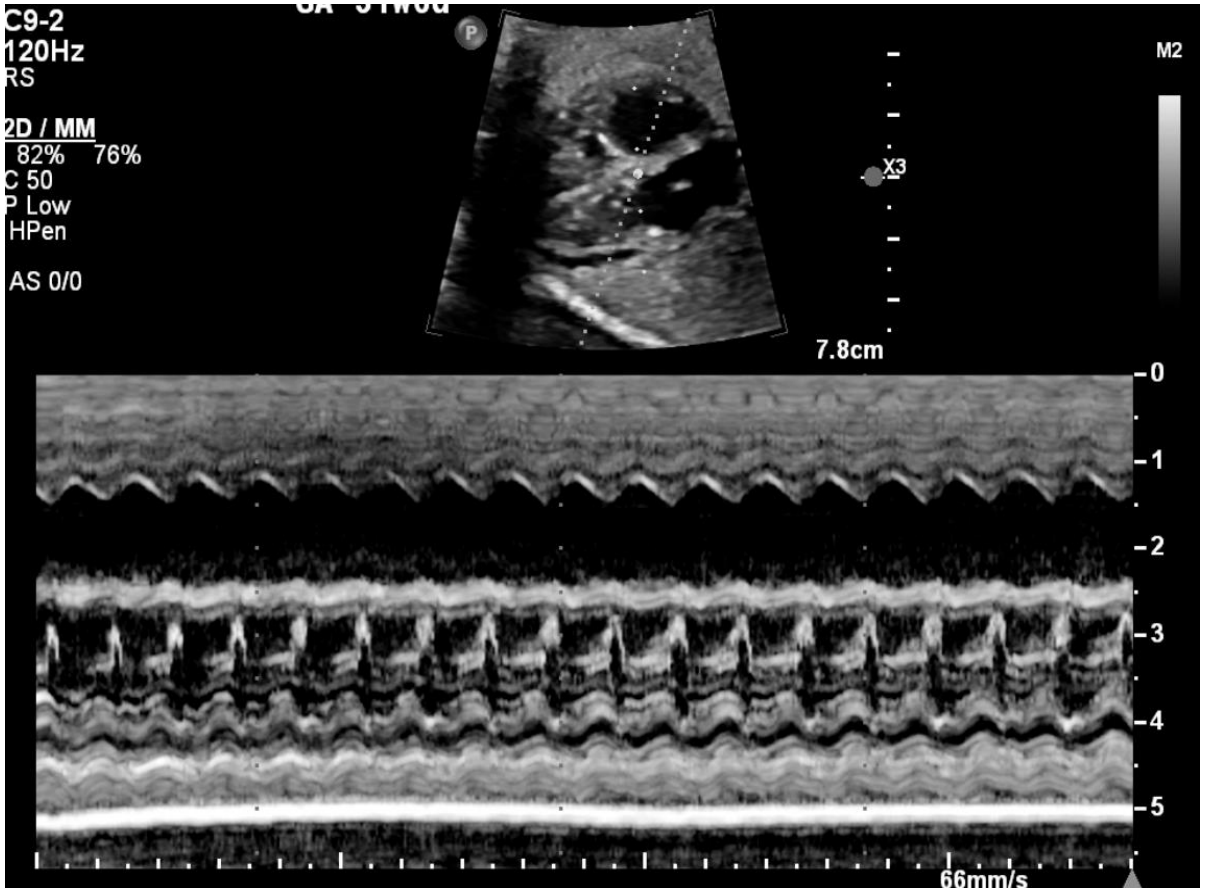





C5-1
114Hz
RS
2D / MM
78% 73%
C 50
P Low
HPen
M2
X2
12cm
0
1
2
3
4
5

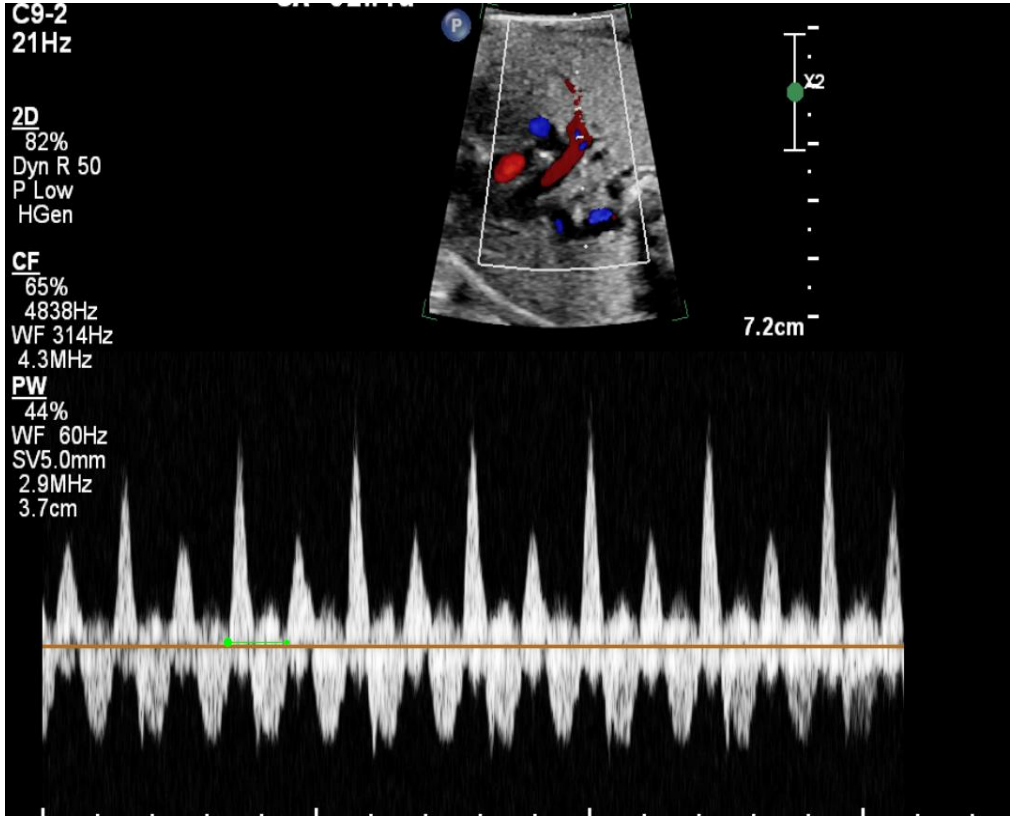
What Do You See?

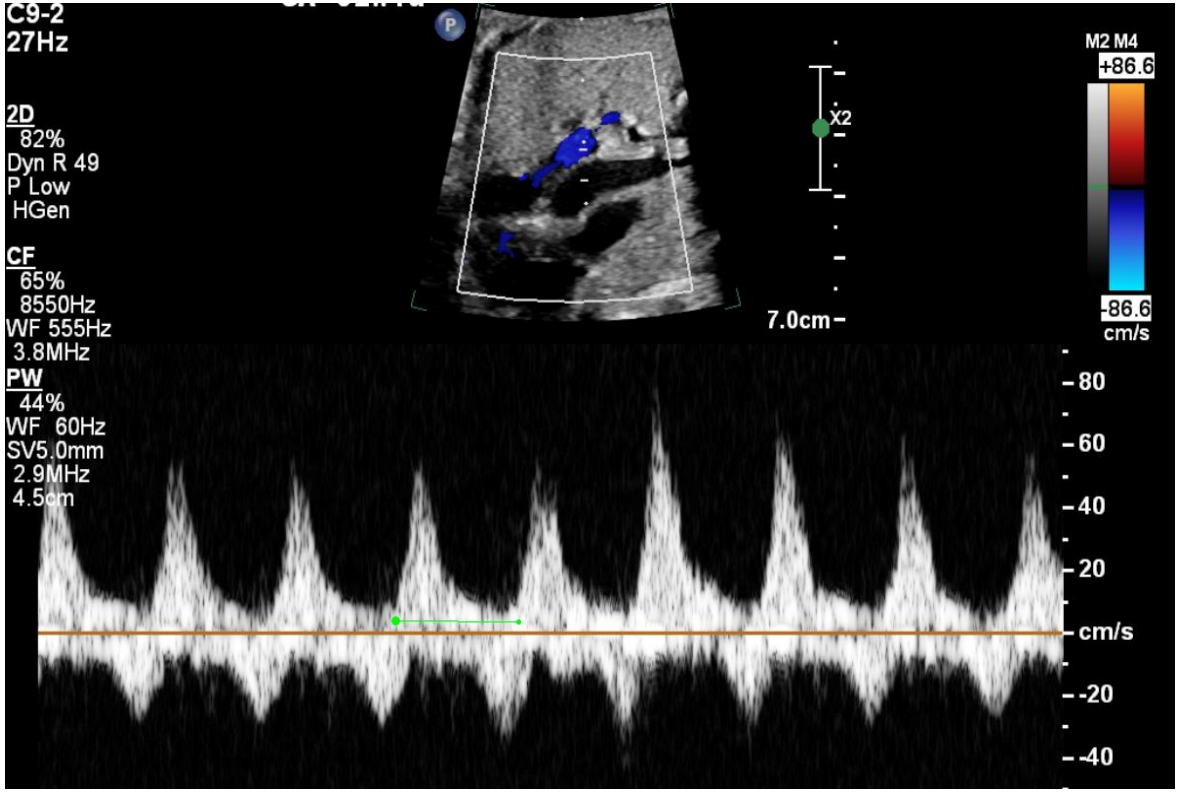
SVT


C9-2
120Hz
RS
2D / MM
82% 76%
C 50
P Low
HPen
AS 0/0
M2
X3
7.8cm
0
1
2
3
4
5
66mm/s

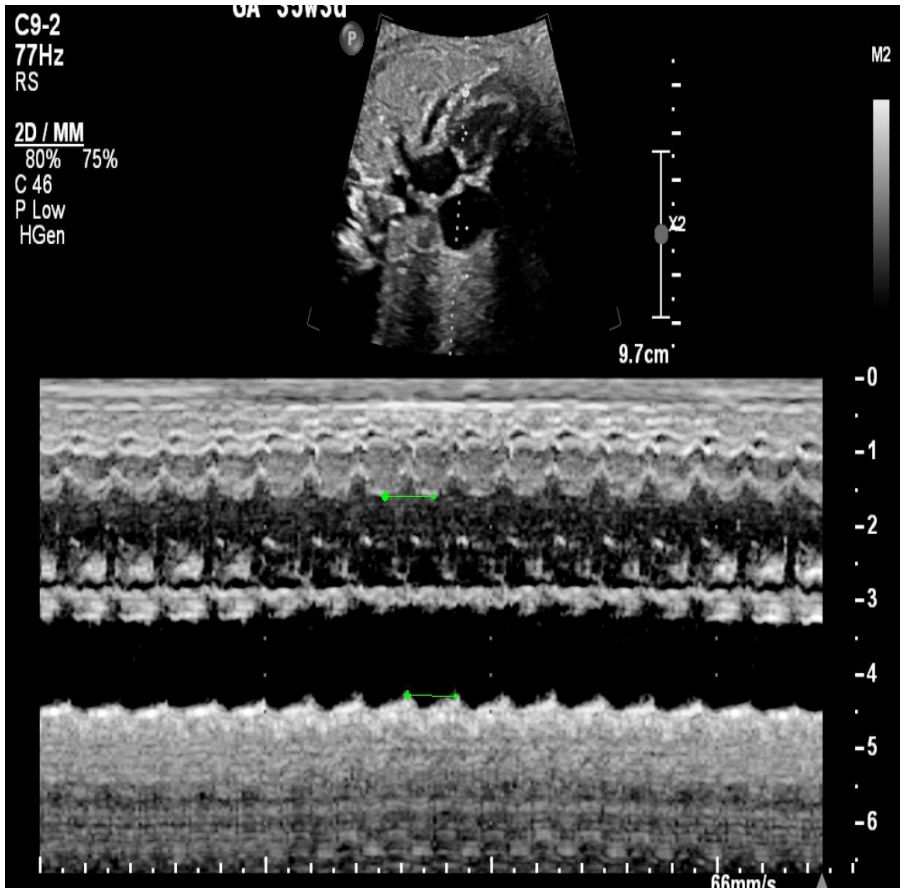
GA 31w6d
C9-2
79Hz
RS
2D
67%
Dyn R 48
P Low
HPen
AS 0/0
M2
X3
G
R
2.4
4.8
7.8cm
*** bpm

SVT

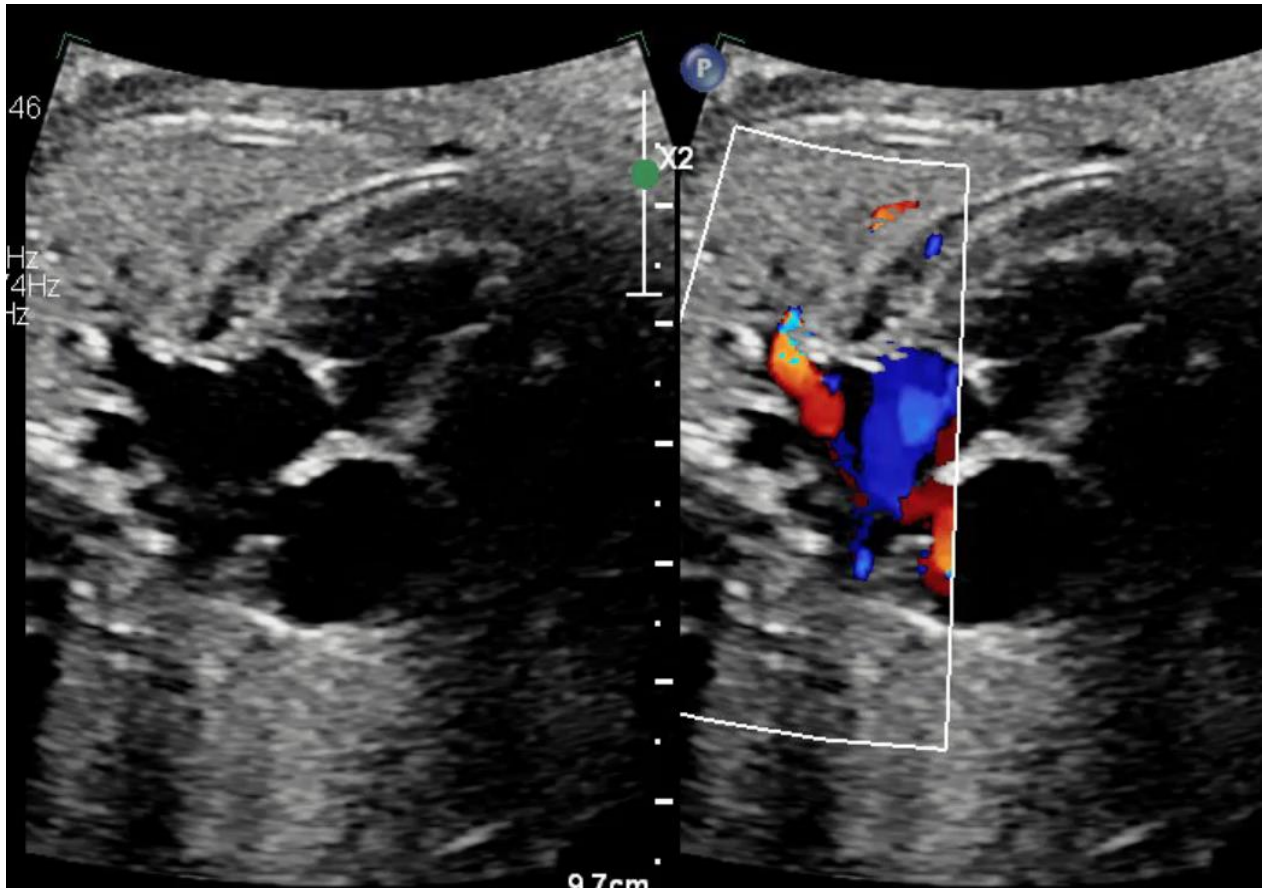

C9-2
21Hz
2D
82%
Dyn R 50
P Low
HGen
CF
65%
4838Hz
WF 314Hz
4.3MHz
PW
44%
WF 60Hz
SV5.0mm
2.9MHz
3.7cm
7.2cm

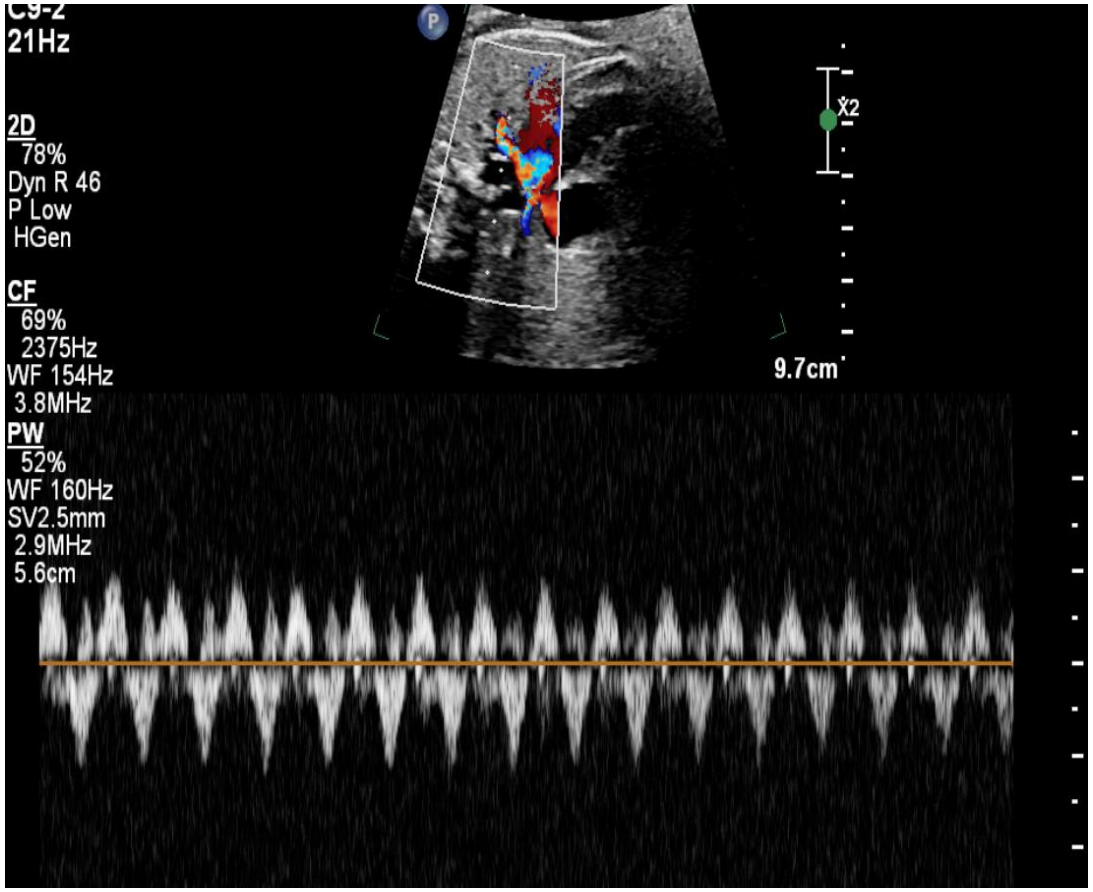

C9-2
27Hz
2D
82%
Dyn R 49
P Low
HGen
CF
65%
8550Hz
WF 555Hz
3.8MHz
PW
44%
WF 60Hz
SV5.0mm
2.9MHz
4.5cm
7.0cm
M2 M4
+86.6
-86.6
cm/s
80
60
40
20
cm/s
-20
-40

SVT



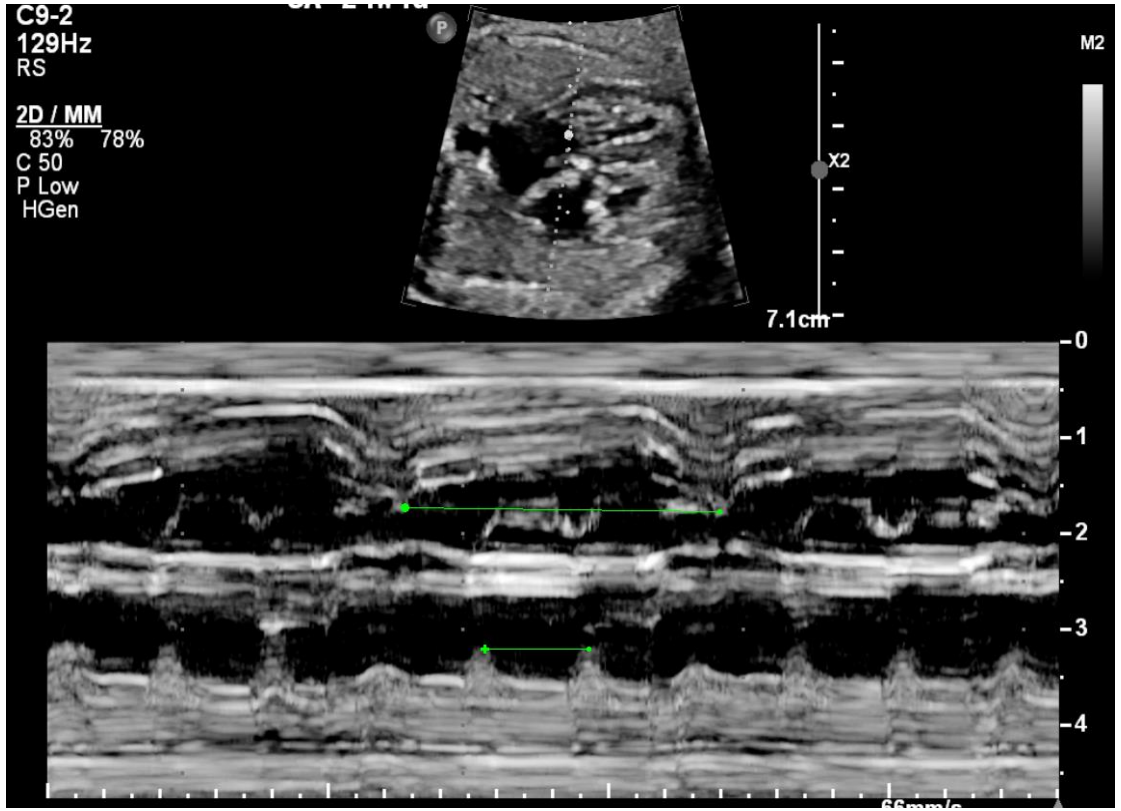
SVT

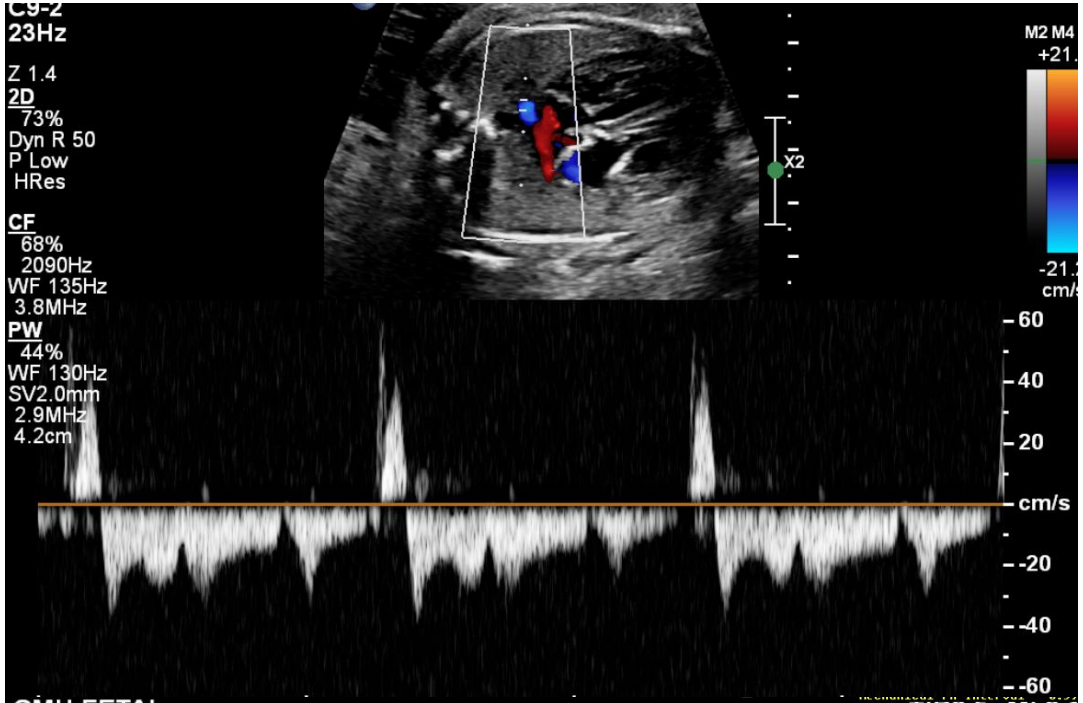

46
X2
9.7cm

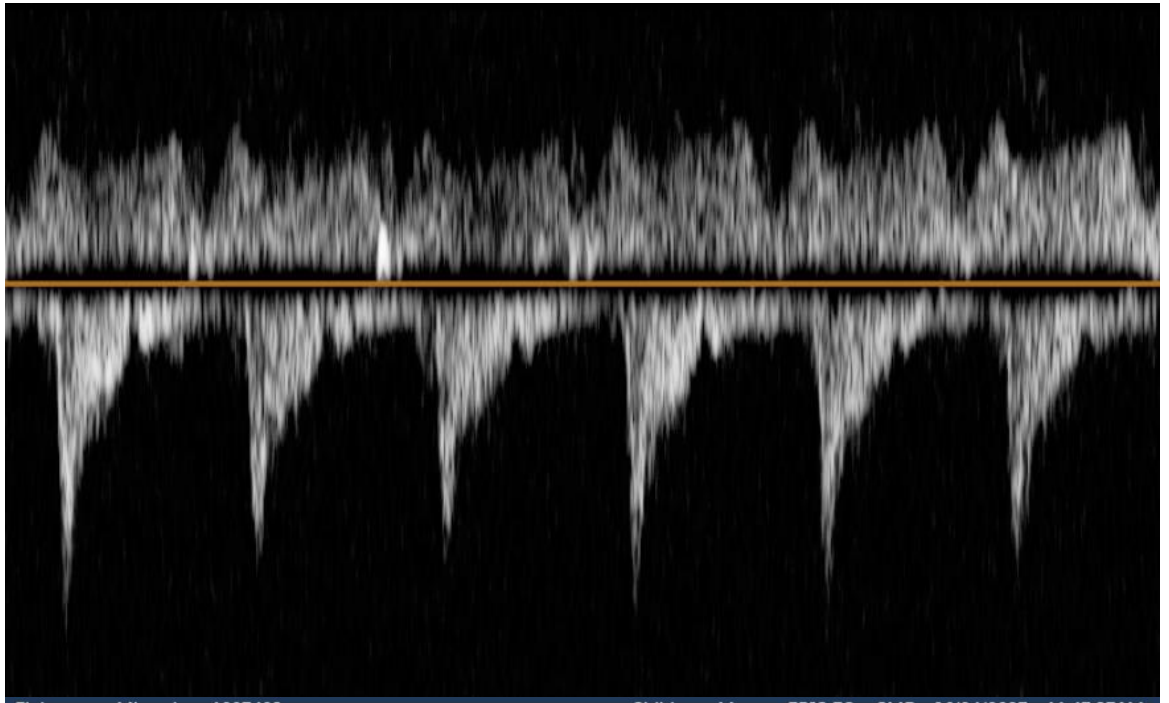

21Hz
2D
78%
Dyn R 46
P Low
HGen
CF
69%
2375Hz
WF 154Hz
3.8MHz
PW
52%
WF 160Hz
SV2.5mm
2.9MHz
5.6cm
X2
9.7cm

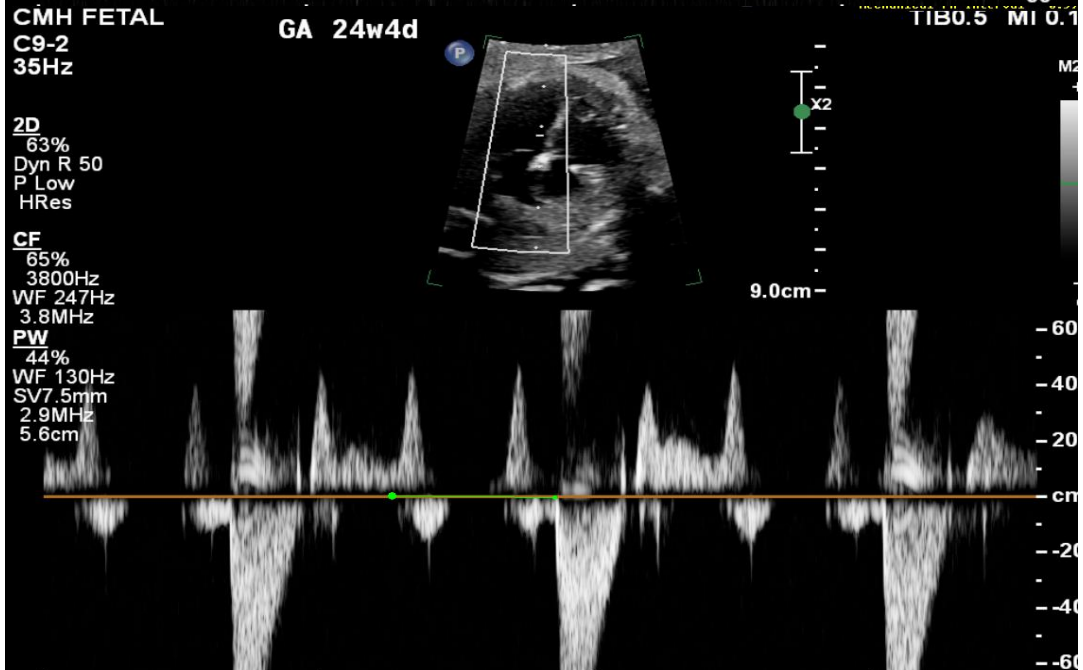
What Do You See?

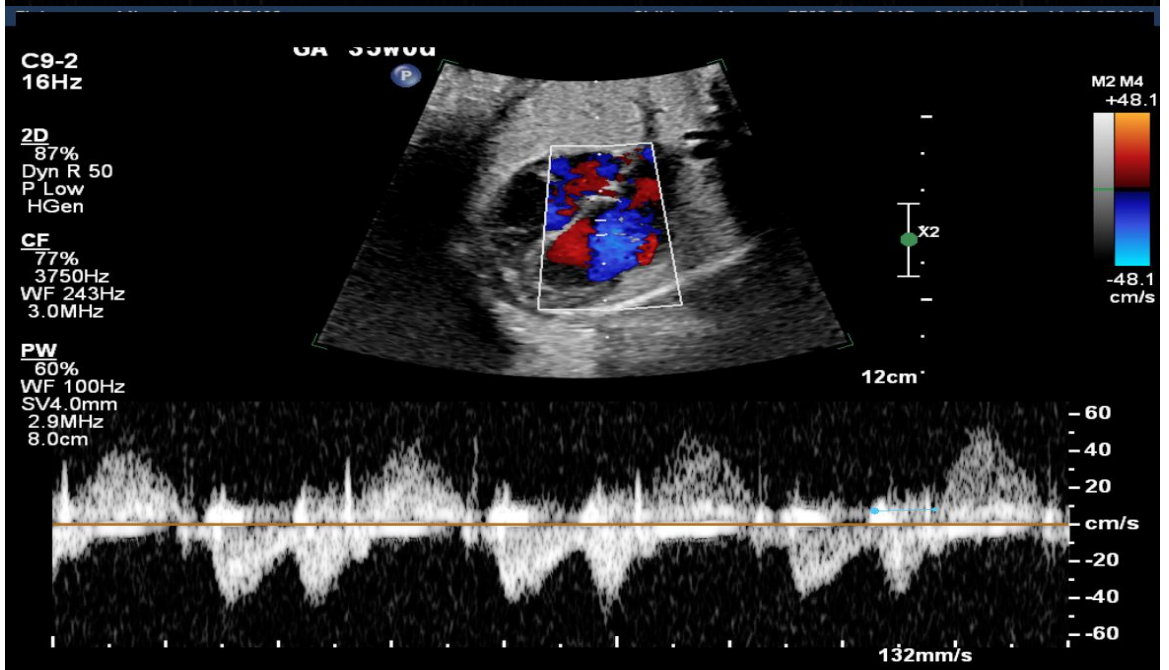
CHB



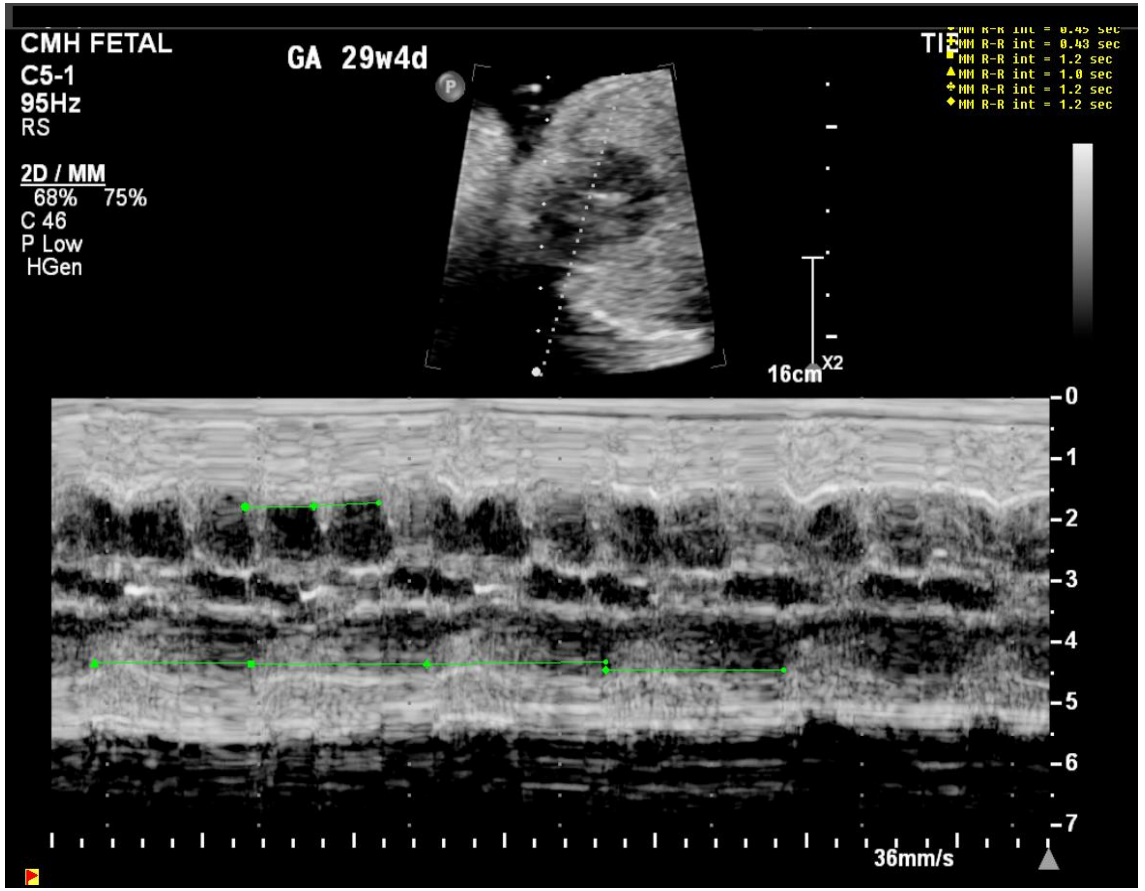

C9-2
23Hz
Z 1.4
2D
73%
Dyn R 50
P Low
HRes
CF
68%
2090Hz
WF 135Hz
3.8MHz
PW
44%
WF 130Hz
SV2.0mm
2.9MHz
4.2cm
M2 M4
X2
60
40
20
cm/s
-20
-40
-60



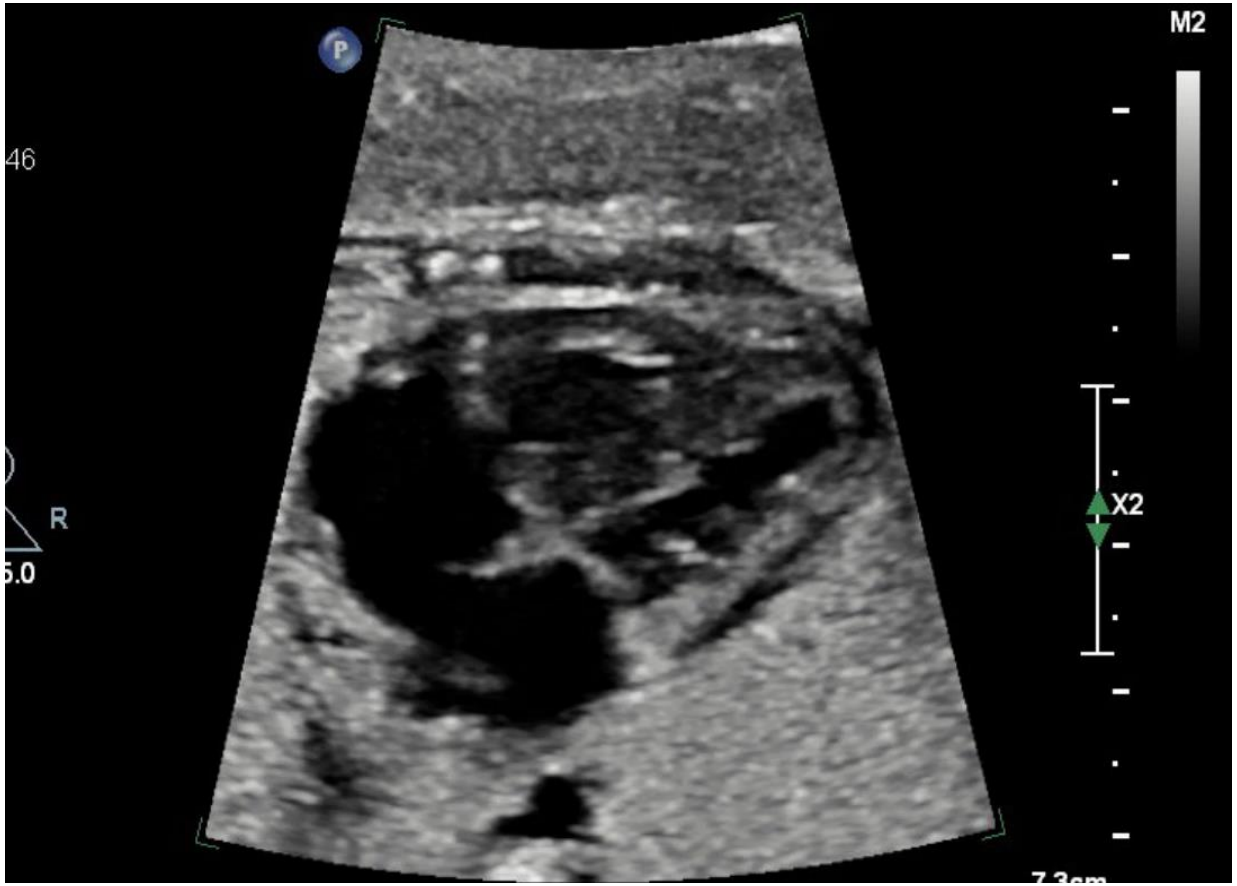

CMH FETAL
GA 24w4d
C9-2
35Hz
2D
63%
Dyn R 50
P Low
HRes
CF
65%
3800Hz
WF 247Hz
3.8MHz
PW
44%
WF 130Hz
SV7.5mm
2.9MHz
5.6cm
X2
9.0cm
60
40
20
-20
-40
-60

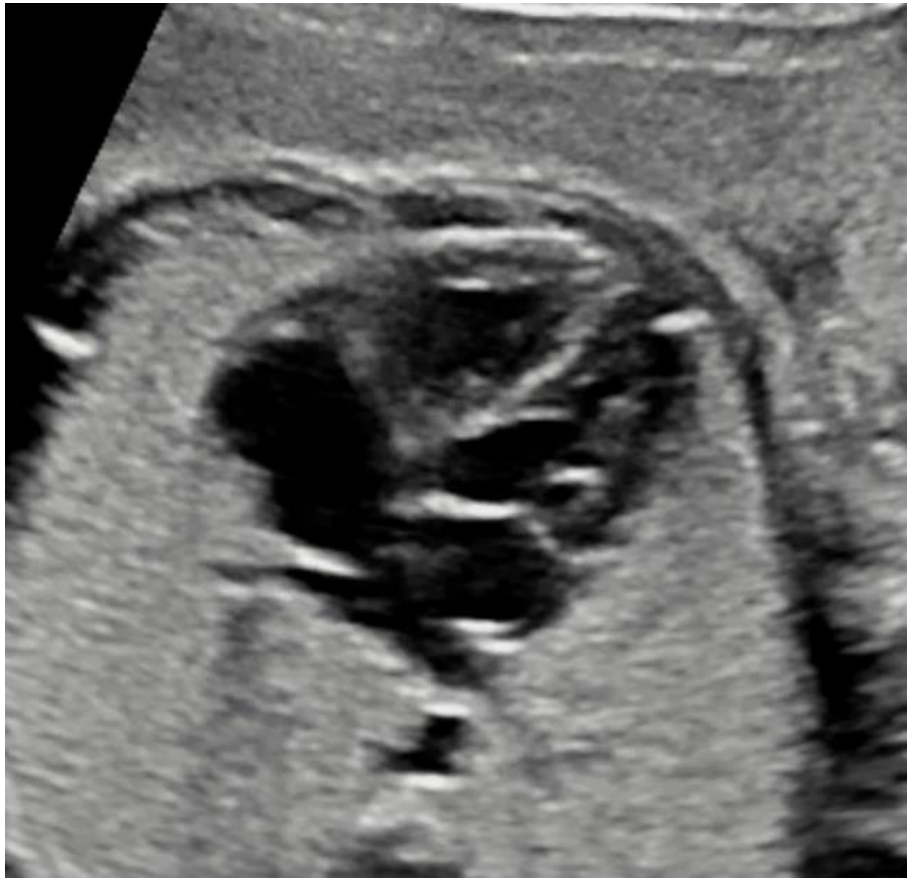

C9-2
16Hz
2D
87%
Dyn R 50
P Low
HGen
CF
77%
3750Hz
WF 243Hz
3.0MHz
PW
60%
WF 100Hz
SV4.0mm
2.9MHz
8.0cm
M2 M4
+48.1
-48.1
cm/s
X2
12cm
60
40
20
cm/s
-20
-40
-60
132mm/s

What do you see? (CHB)

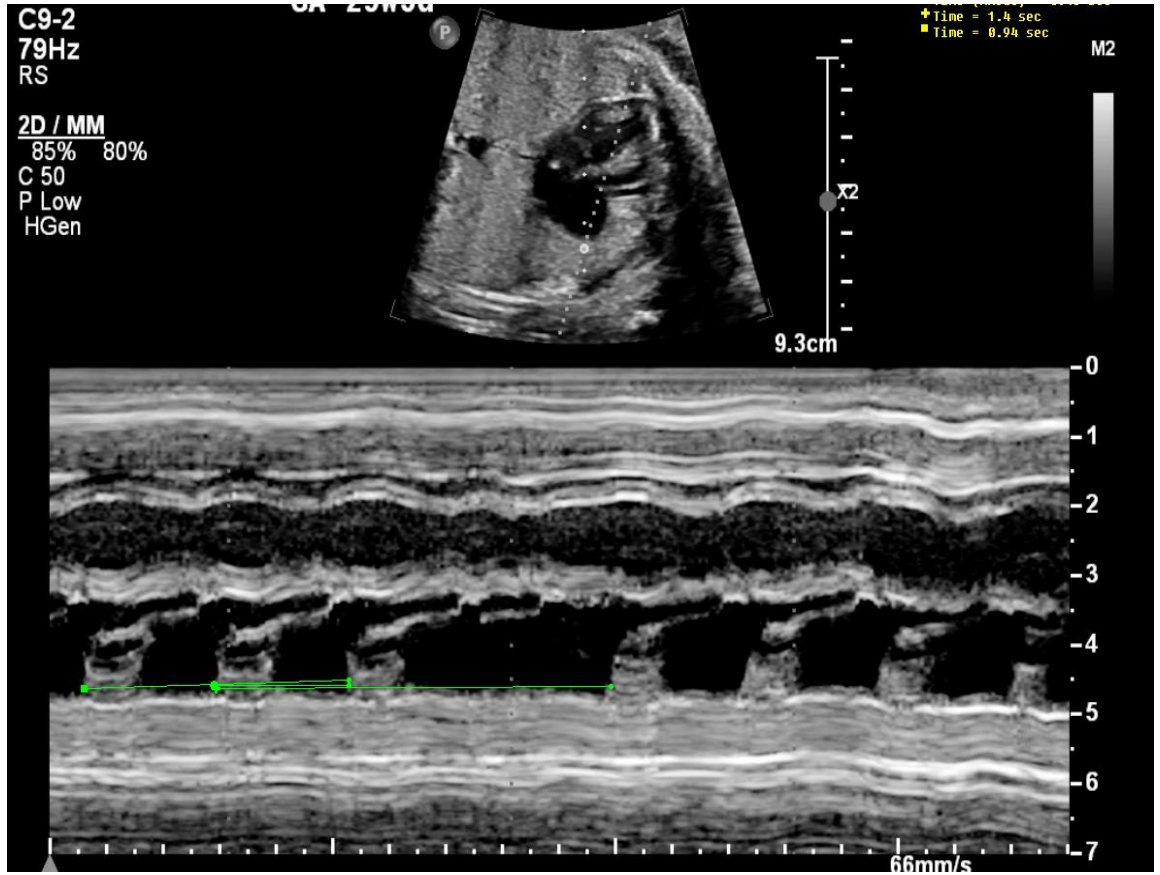


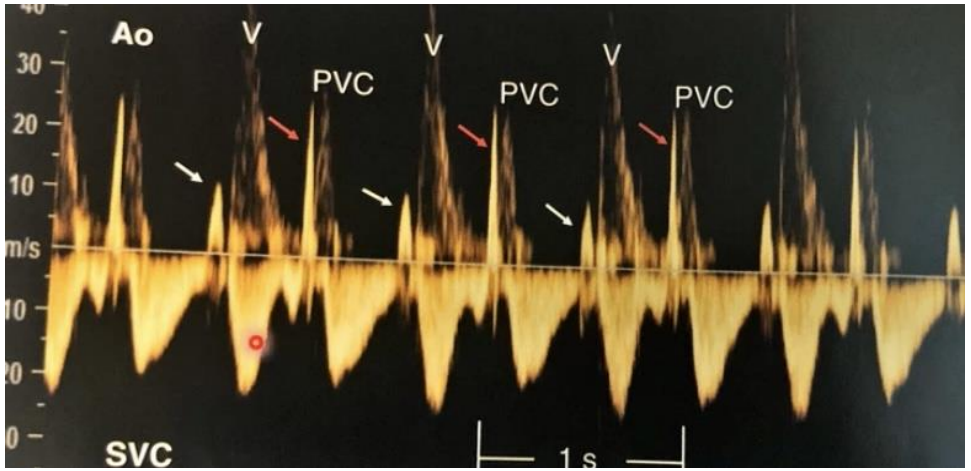
What Do You See?

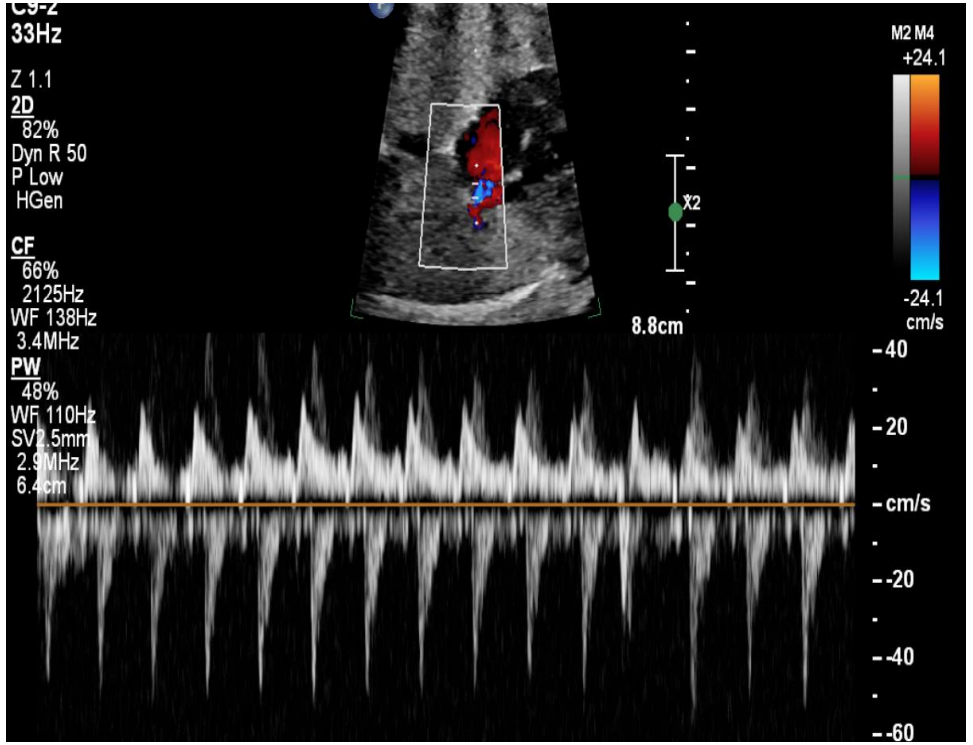




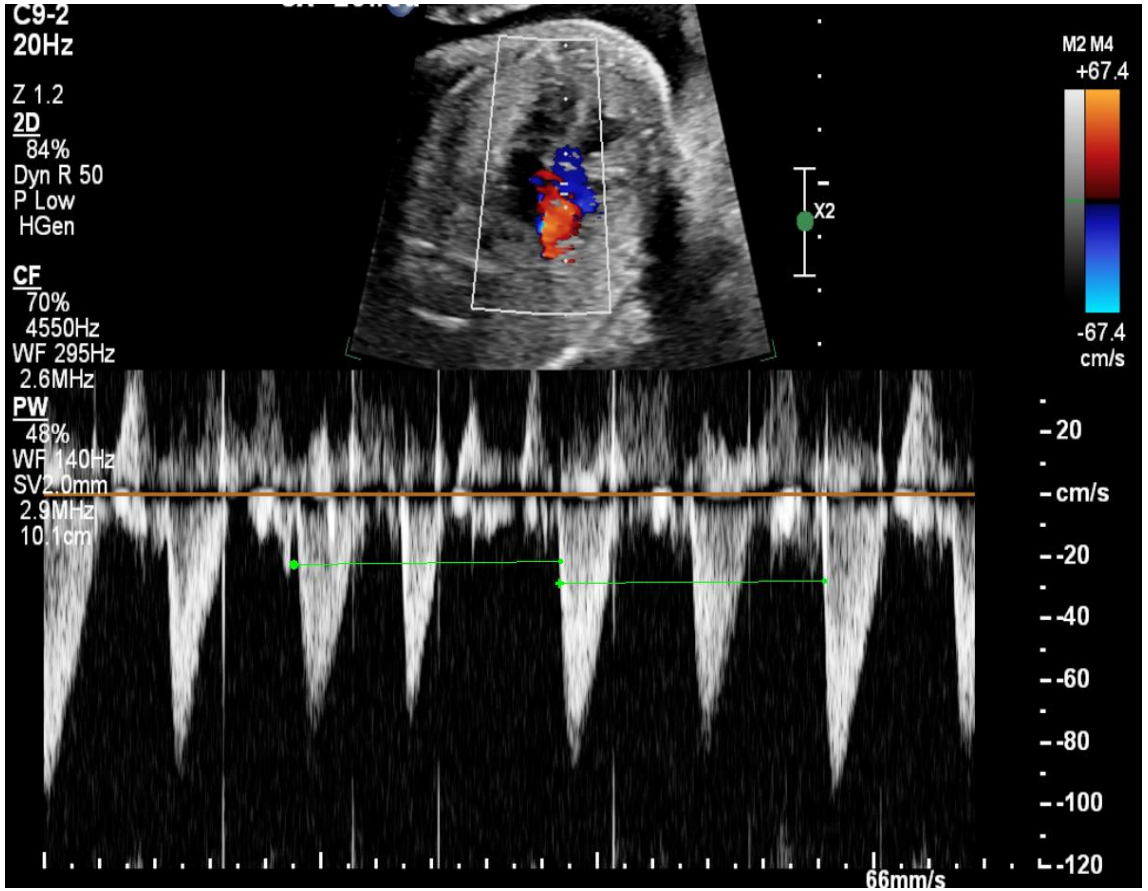
What do you see?

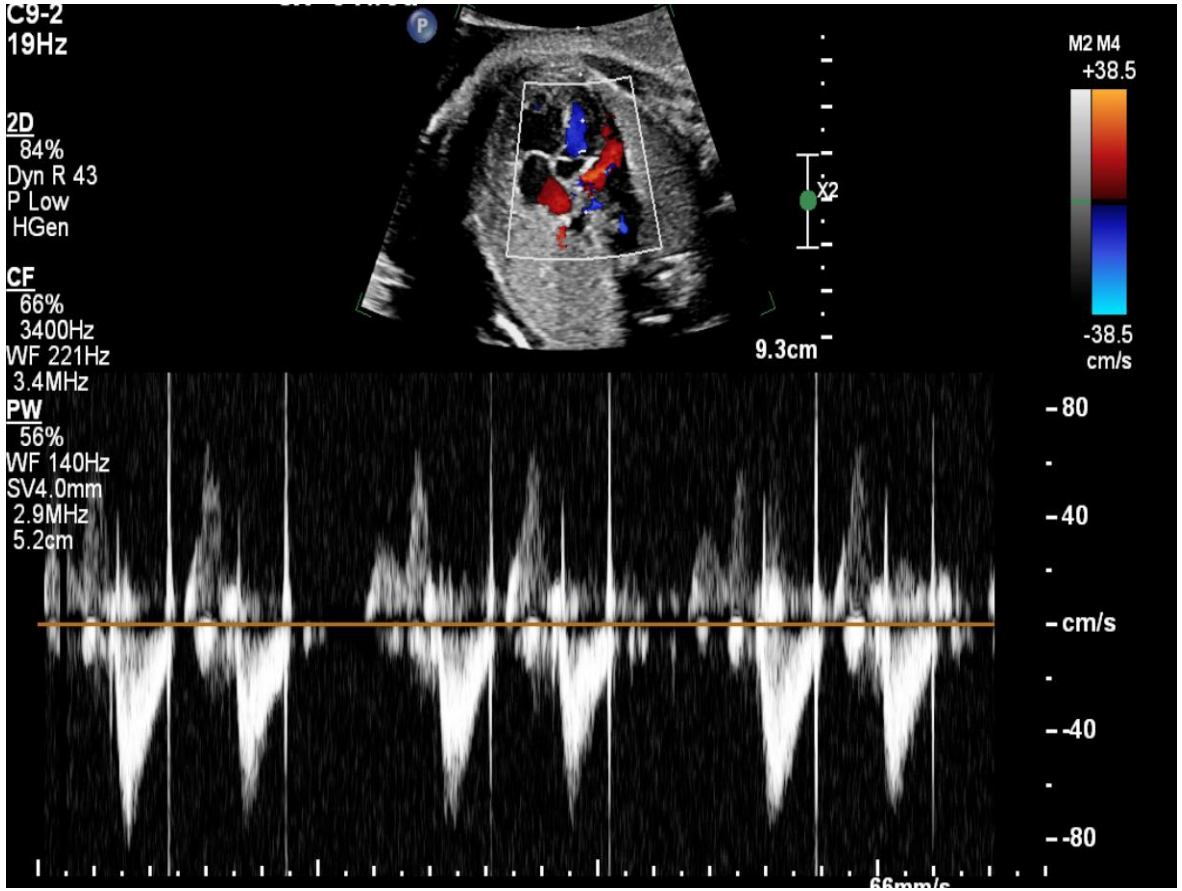




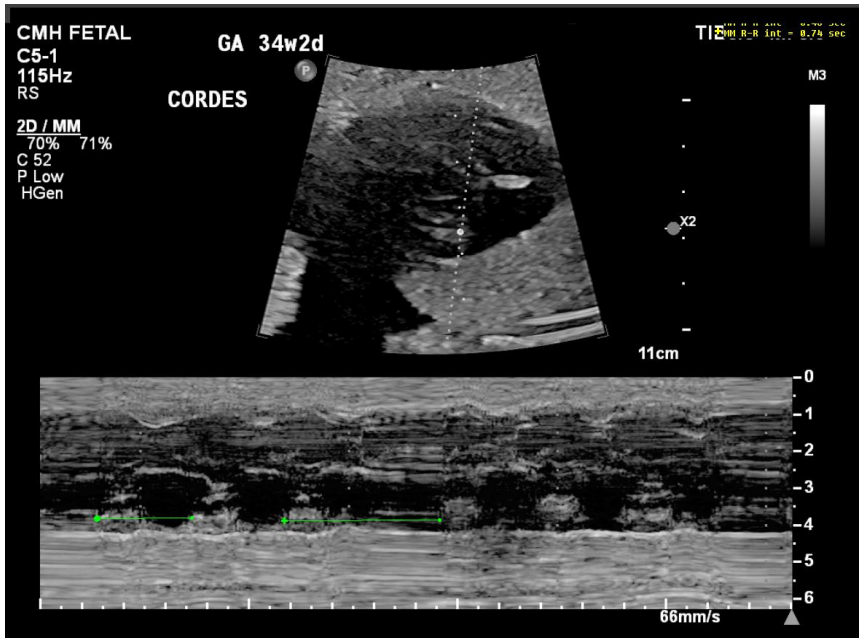


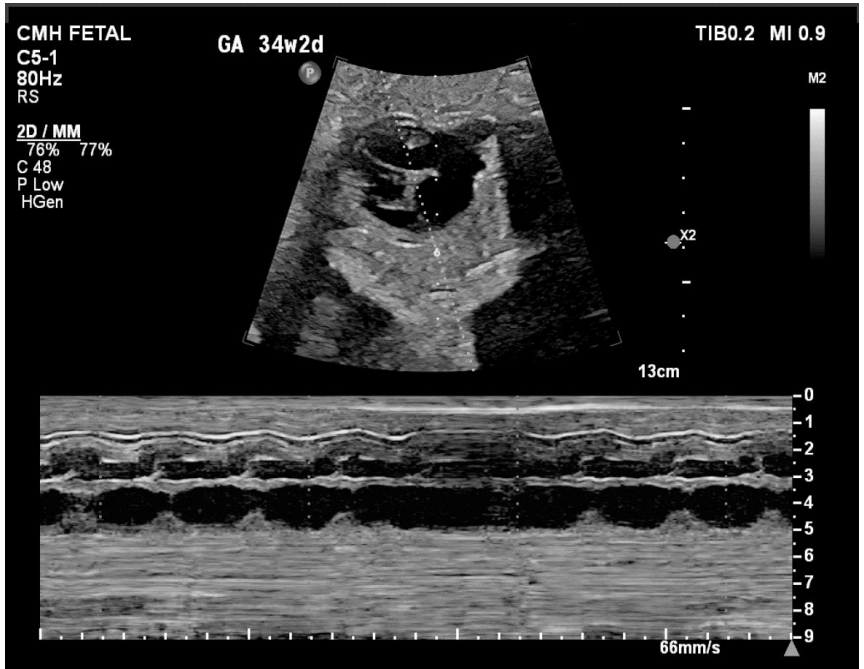
PVC's and possible Bigeminy



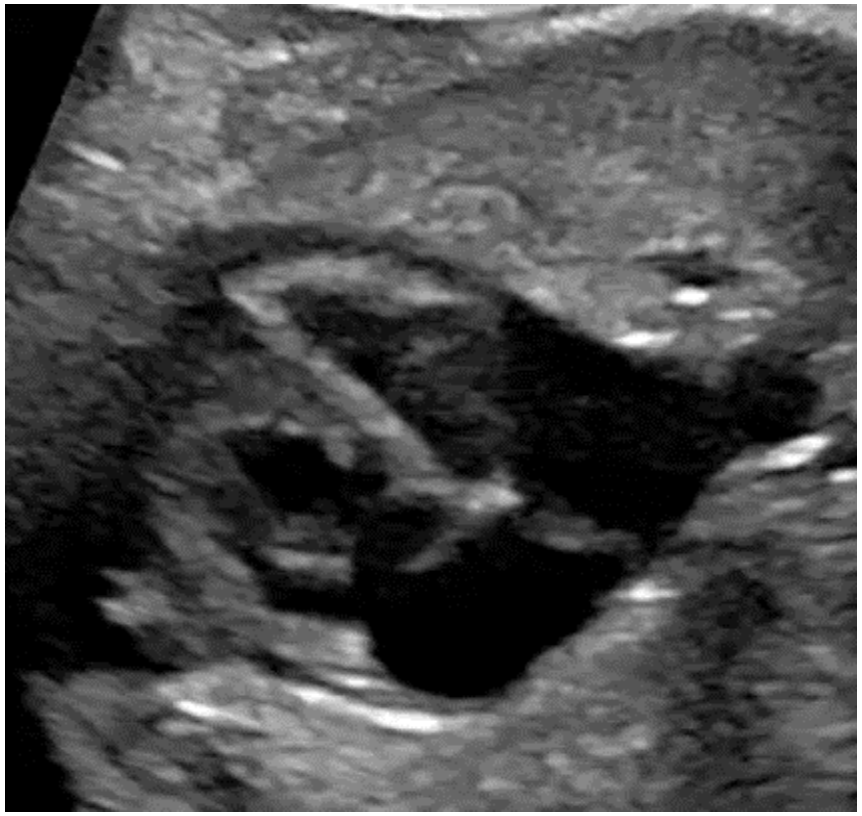


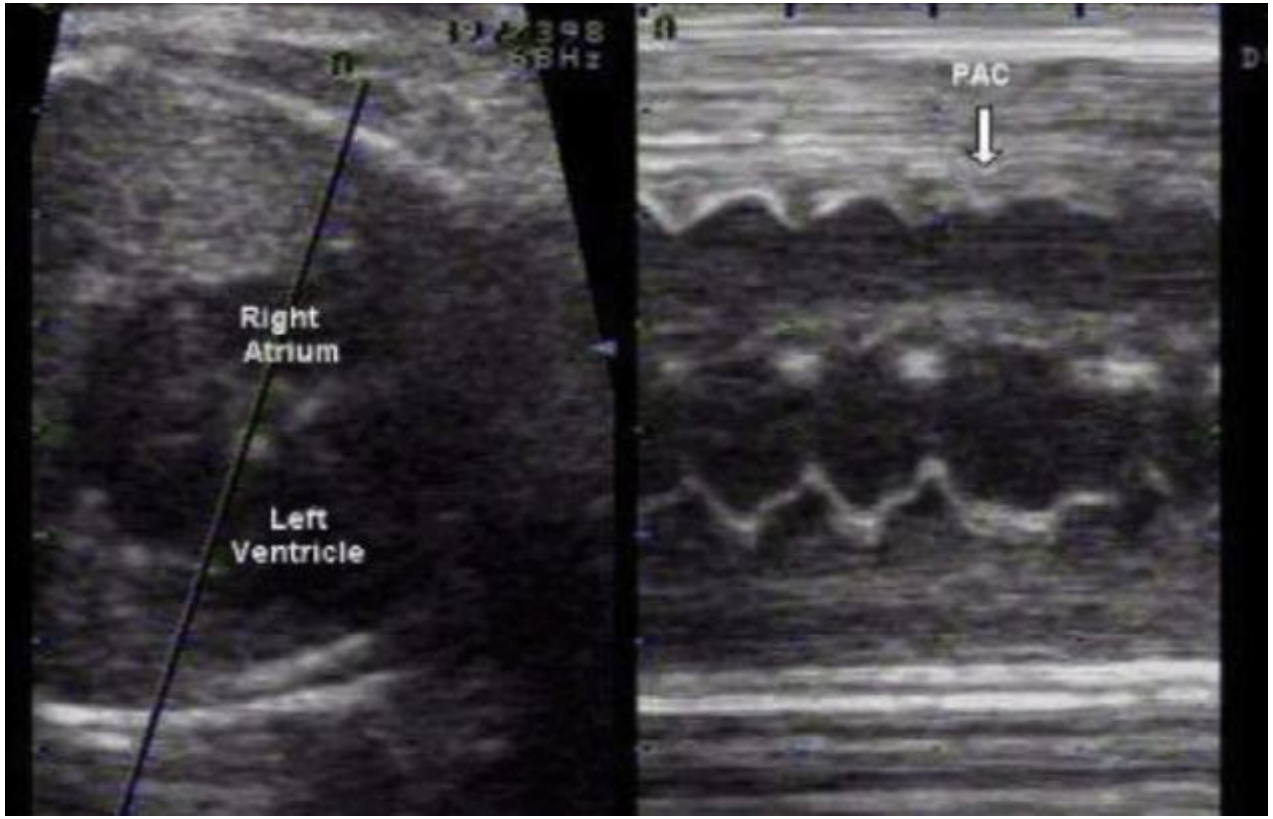
What do you see?



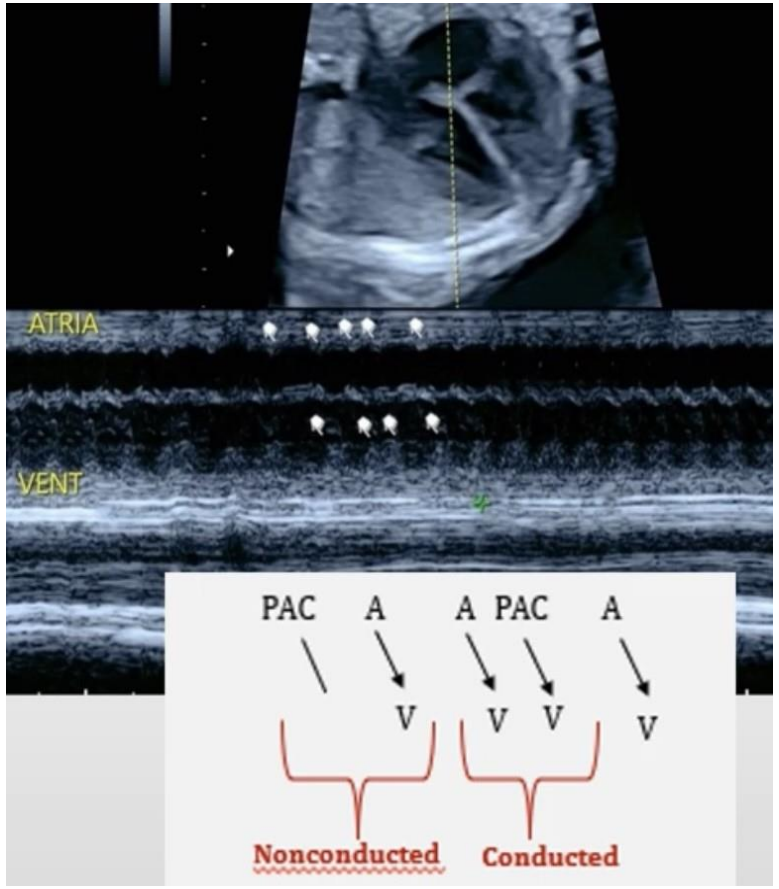


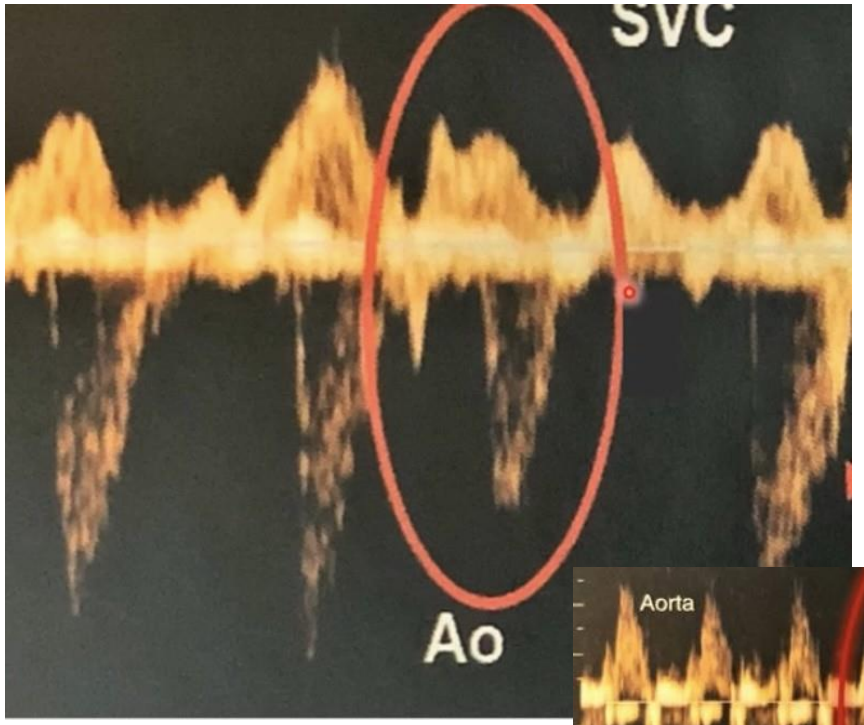
What Do You See? 2D Assessment:

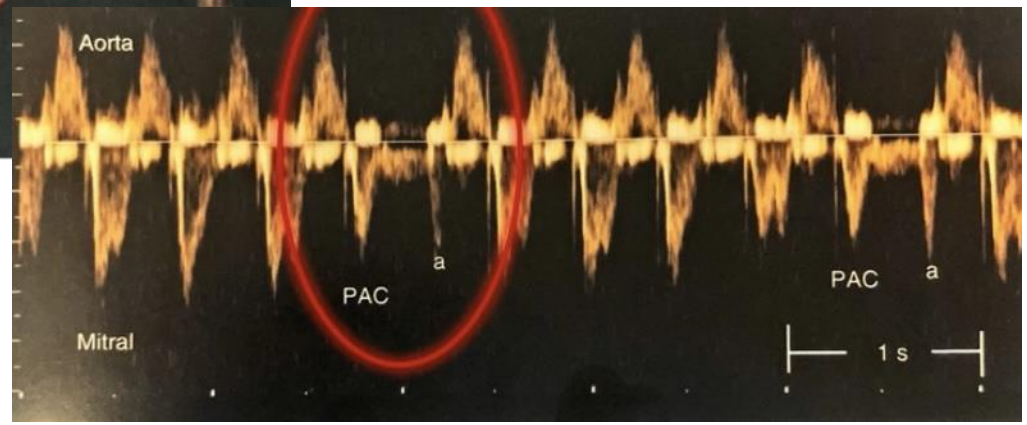




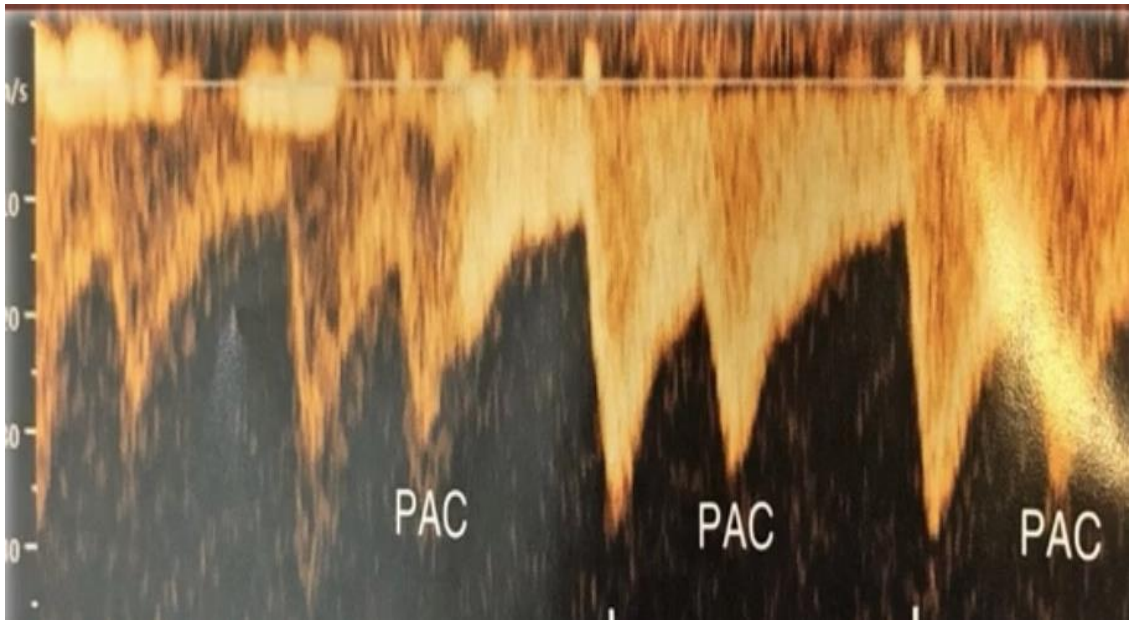
PAC's Non Conducted and Conducted

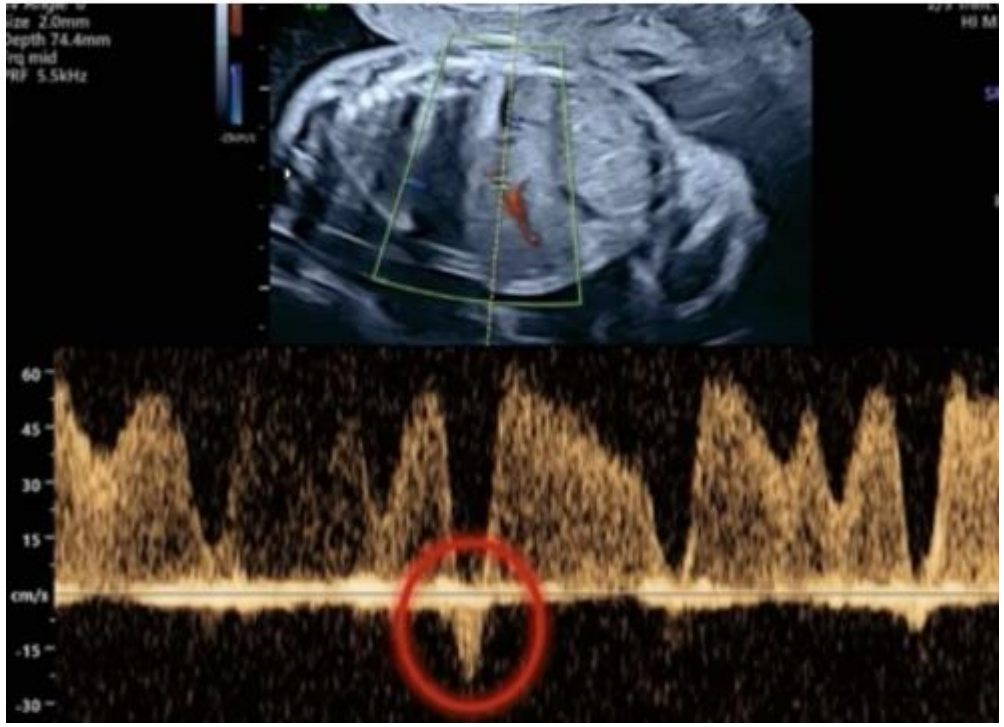






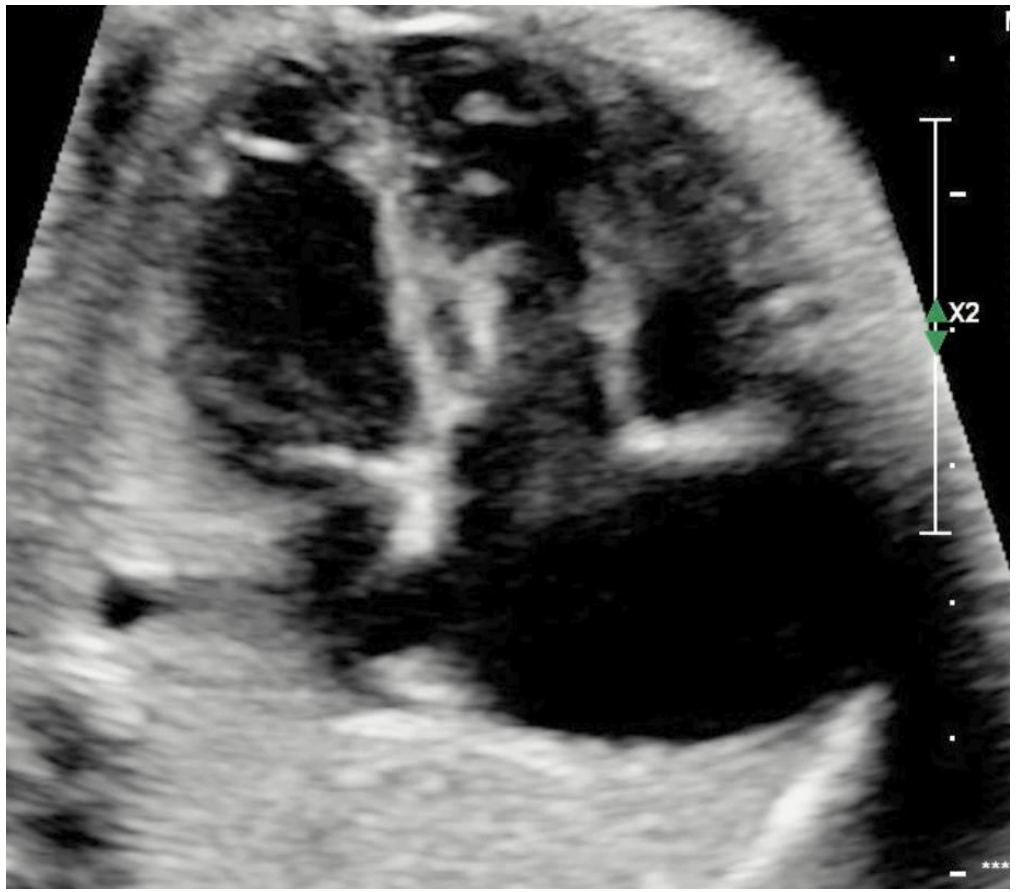
PAC's





Bonus points:

What arrythmia is most commonly seen in this video?



Summary

- Follow the routine 2D imaging standards
- Include M-Mode assessment of atrial and ventricular wall motion
- Include LVOT/AV Doppler for mechanical PR interval
- Sample a parallel artery/vein
- Stay calm, focus on one thing at a time!

Sources

- Fetal Cardiovascular Imaging, Jack Rychik, Zhiyun Tian
- Feb.bradyarrhythmias.AM.mp4
- Jan.tachyarrhythmias.NM.mp4

Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association

Circulation. 2014; 129:2183-2242

Diagnosis and Treatment of Fetal Cardiac Disease: A Scientific Statement From the American Heart Association

Mary T. Donofrio, Anita J. Moon-Grady, Lisa K. Hornberger, Joshua A. Copel, Mark S. Sklansky, Alfred Abuhamad, Bettina F. Cuneo, James C. Huhta, Richard A. Jonas, Anita Krishnan, Stephanie Lacey, Wesley Lee, Erik C. Michelfelder, Sr, Gwen R. Rempel, Norman H. Silverman, Thomas L. Spray, Janette F. Strasburger, Wayne Tworetzky and Jack Rychik
on behalf of the American Heart Association Adults With Congenital Heart Disease Joint Committee of the Council on Cardiovascular Disease in the Young and Council on Clinical Cardiology, Council on Cardiovascular Surgery and Anesthesia, and Council on Cardiovascular and Stroke Nursing

If this doesn't give your heart a smile and a little fast rhythm.... not sure what will. :)