



# Weill Cornell Medicine

Hospital Medicine Point of Care Ultrasound  
(HM POCUS) Program

## Cardiac Image Optimization

Parasternal Long-Axis View (PLAx)



# Weill Cornell Medicine

Hospital Medicine Point of Care Ultrasound  
(HM POCUS) Program

*Author has no conflicts  
to declare*

# Acknowledgements

Dr. David Tierney, Abbott Northwestern Hospital, Minneapolis

Dr. Gigi Lou, Johns Hopkins

Dr. Gerard Salame, Denver Health

Dr. Ernest Fischer, Georgetown

Jina Bai and Dr. Tanping Wong, Cornell



# Image Optimization

- Equipment settings

# Image Optimization

- Equipment settings
- Probe position

# PLAx

1. Surveillance depth: descending aorta @ ~ middle of the screen
2. Study depth: Descending aorta visible at the bottom of the screen
3. Focus on LV. MV should be just to the right of the screen center
4. Obtain the image as high in the parasternal window as possible
5. Apex should not be visible, i.e. LV wall parallel to the septum
6. Largest LV cavity diameter – small tilt
7. Both aortic and mitral valve clearly visible in the same cut – medium tilt
8. 3 chambers (LA, LV, Aorta) + RVOT – large tilt

# Image Optimization

- Equipment settings
  - Gain adjustment so that blood within the heart appears anechoic *everywhere*. Do not over-gain!



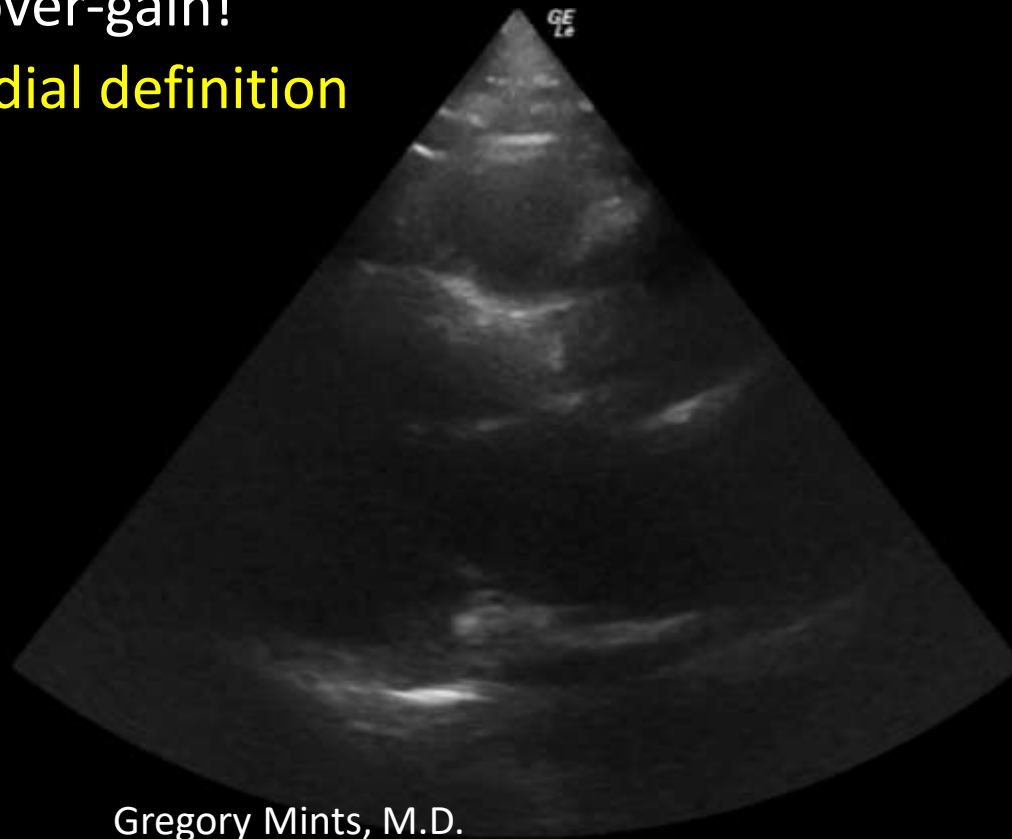
# Image Optimization

- **Equipment settings**
  - **Gain** adjustment so that blood within the heart appears anechoic *everywhere*.  
Do not over-gain!
  - **Endocardial definition**

# Image Optimization

- **Equipment settings**

- **Gain** adjustment so that blood within the heart appears anechoic *everywhere*.  
Do not over-gain!
- **Endocardial definition**



Gregory Mints, M.D.

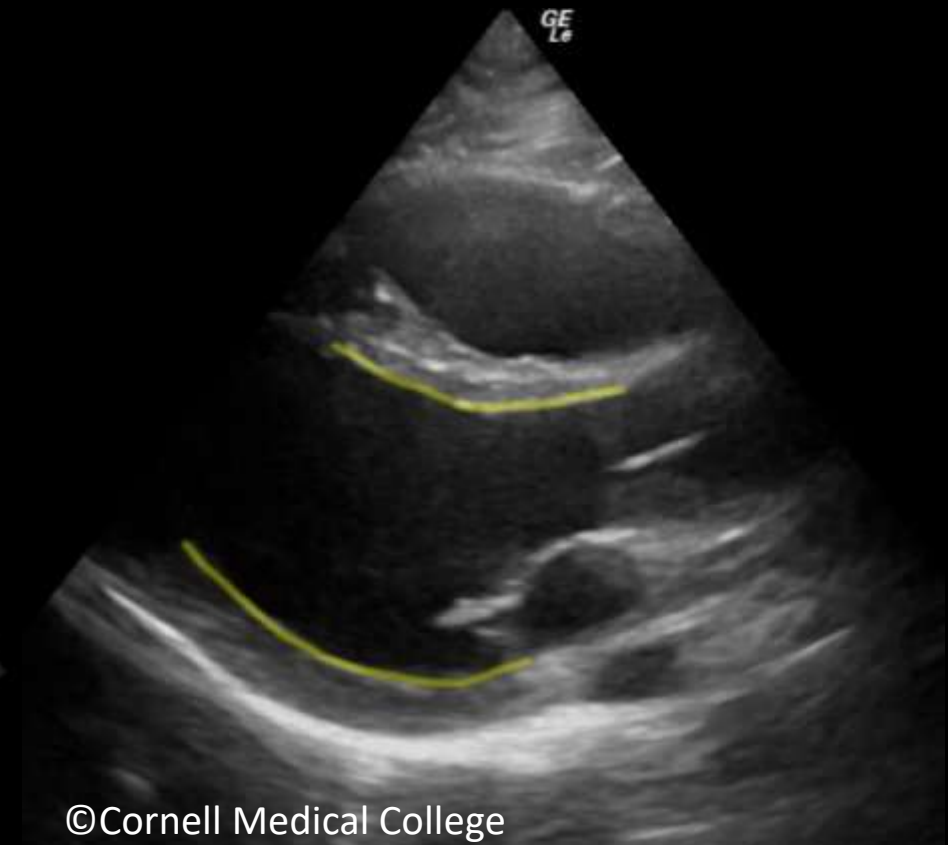
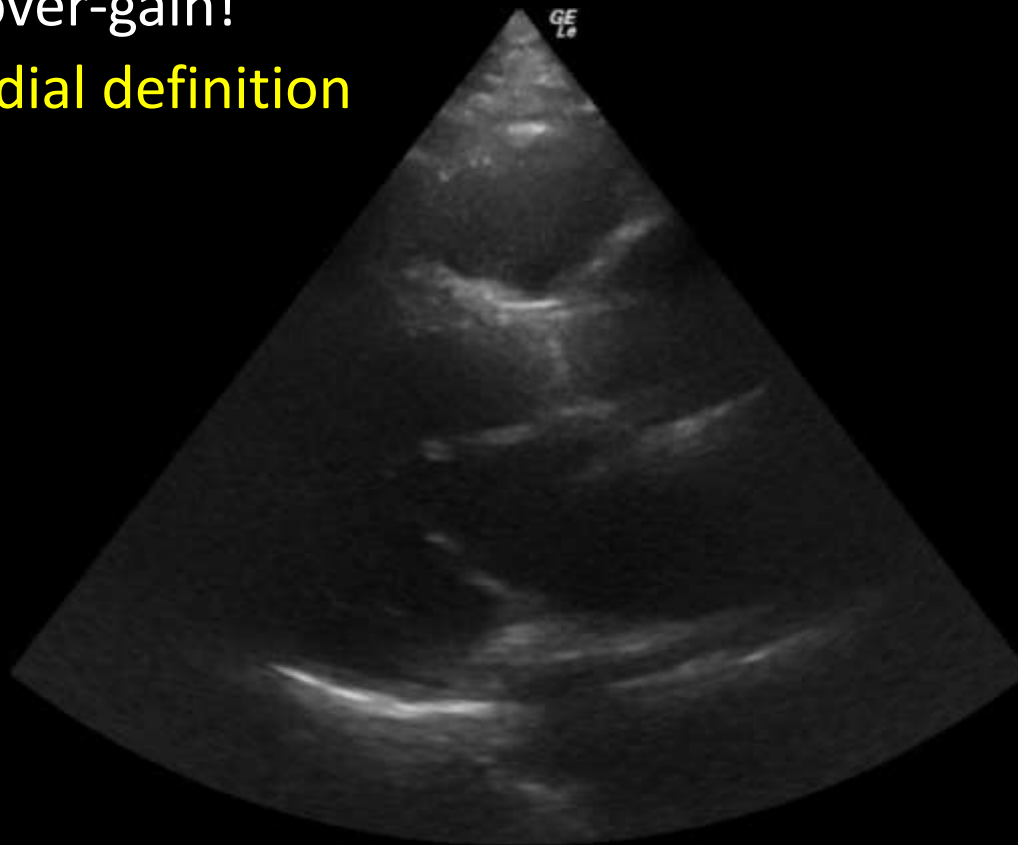


©Cornell Medical College

# Image Optimization

- **Equipment settings**

- **Gain** adjustment so that blood within the heart appears anechoic *everywhere*. Do not over-gain!
- **Endocardial definition**




# Image Optimization

- **Equipment settings**
  - Gain adjustment so that blood within the heart appears anechoic *everywhere*. Do not over-gain!
  - Endocardial definition
  - **Depth**

PLAx

depth



# PLAx

- depth
1. Surveillance depth: descending aorta @ ~ middle of the screen
  2. Study depth: Descending aorta visible at the bottom of the screen







# Image Optimization

- Equipment settings
- **Probe position**

Longs Axis

Short Axis

Vertical Axis

Longs Axis

Short Axis

Vertical Axis

TRANSLATIONAL

ROTATIONAL

Longs Axis

Short Axis

Vertical Axis

TRANSLATIONAL

SLIDING

SWEEPING

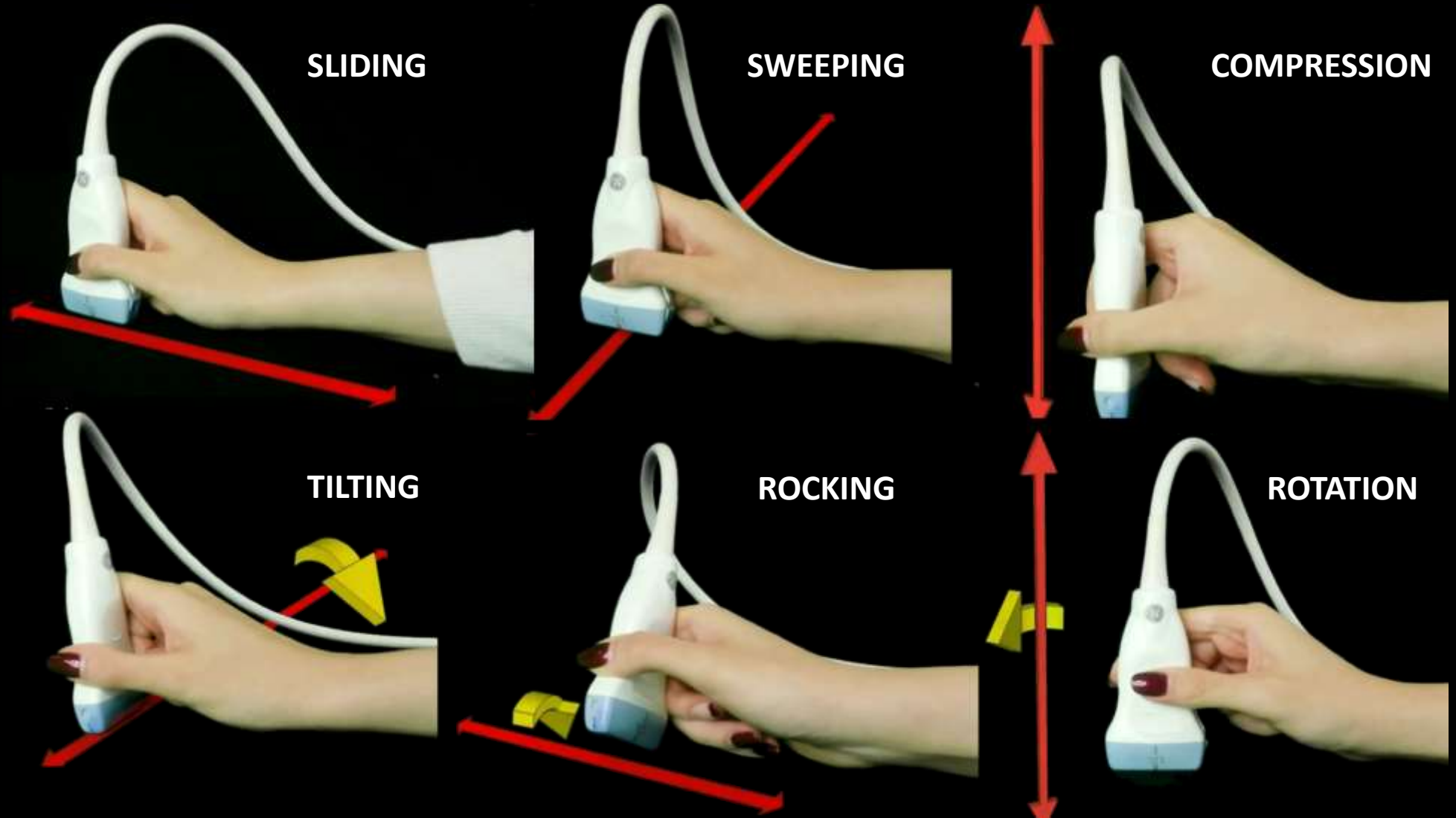
COMPRESSION

ROTATIONAL

TILTING

ROCKING

ROTATION



Longs Axis

Short Axis

Vertical Axis

SLIDING

SWEEPING

COMPRESSION

TRANSLATIONAL



TILTING

ROCKING

ROTATION

ROTATIONAL



Longs Axis

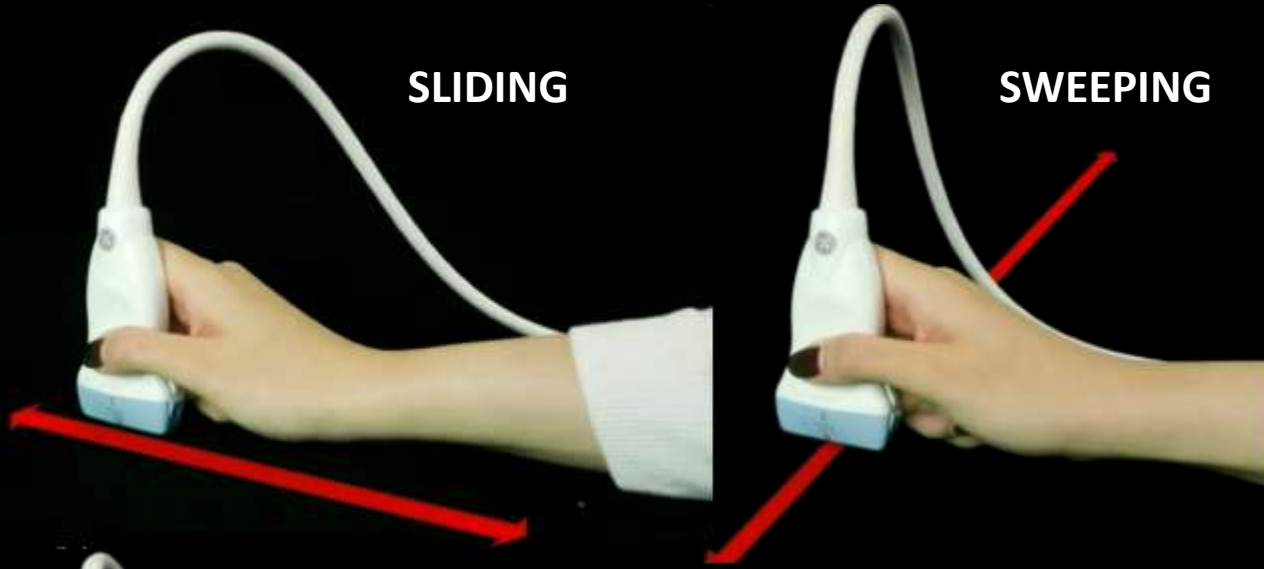
Short Axis

Vertical Axis

SLIDING

SWEEPING

TRANSLATIONAL



TILTING

ROCKING

ROTATIONAL



Longs Axis

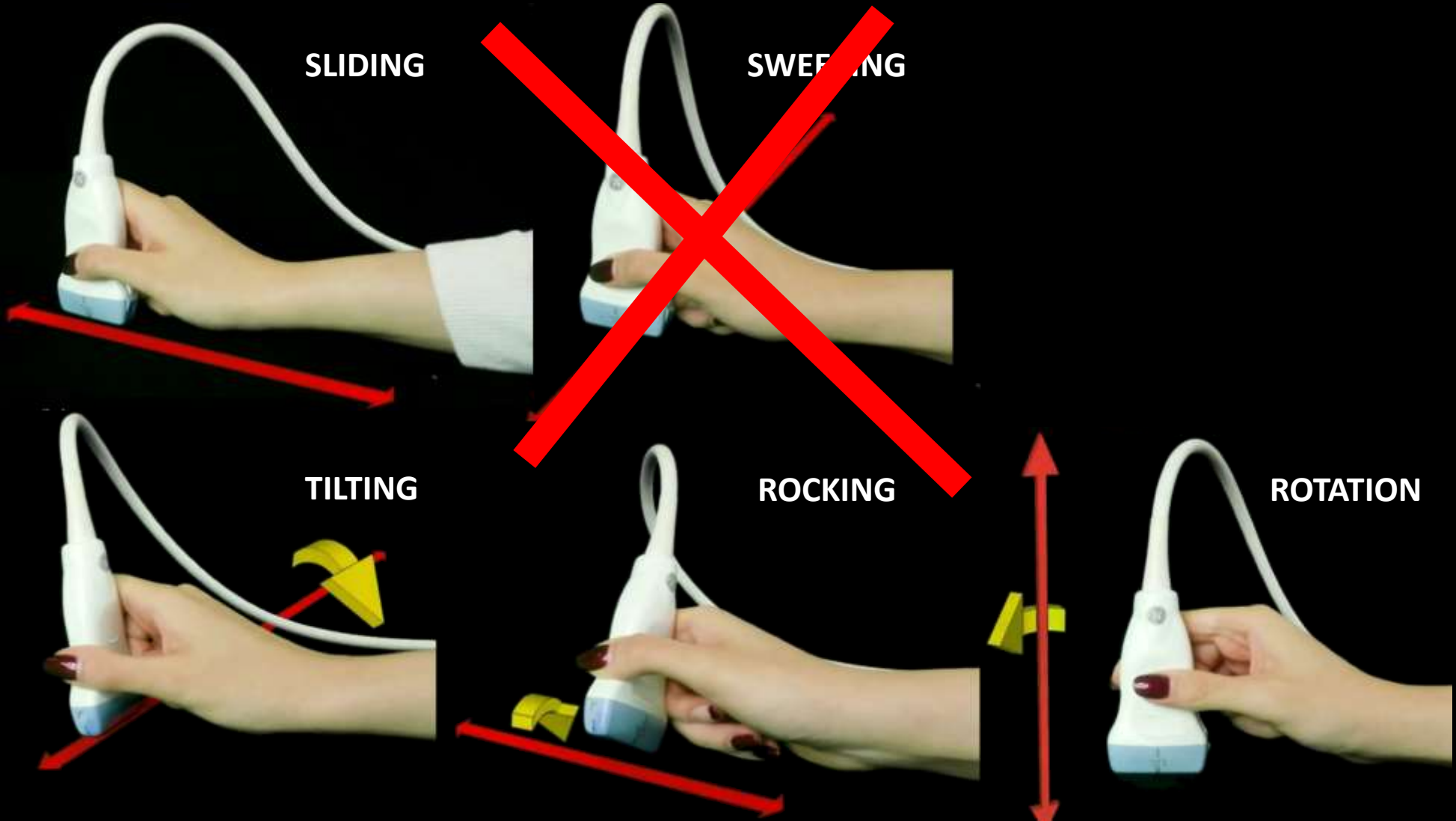
Short Axis

Vertical Axis

TRANSLATIONAL

SLIDING

~~SWEEPING~~



ROTATIONAL

TILTING

ROCKING

ROTATION

Longs Axis

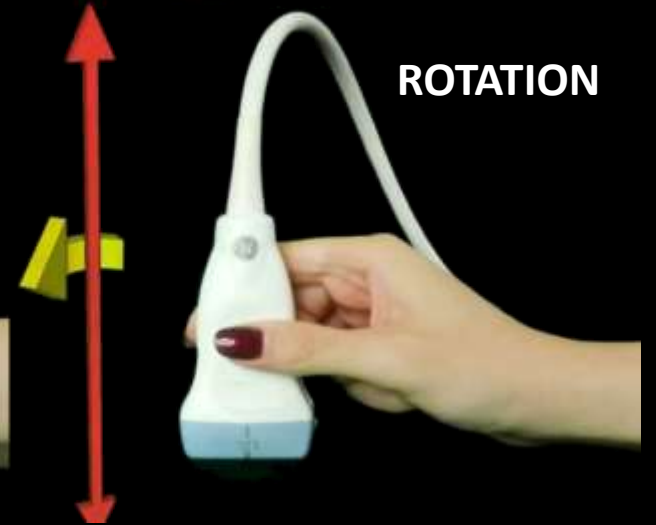
Short Axis

Vertical Axis

TRANSLATIONAL



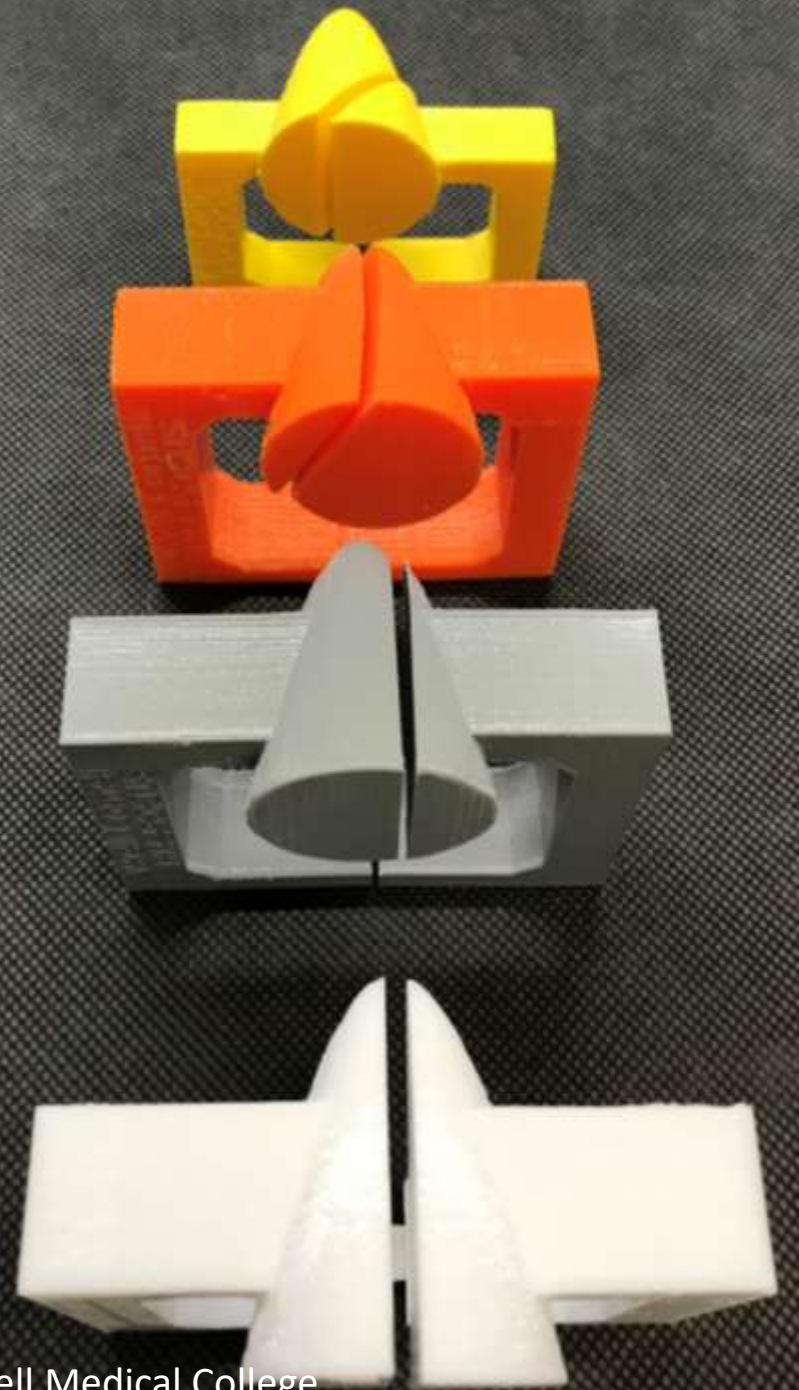
ROTATIONAL





# Exercise 1

This squid-like shape, a paraboloid, represents an LV



# Exercise 1

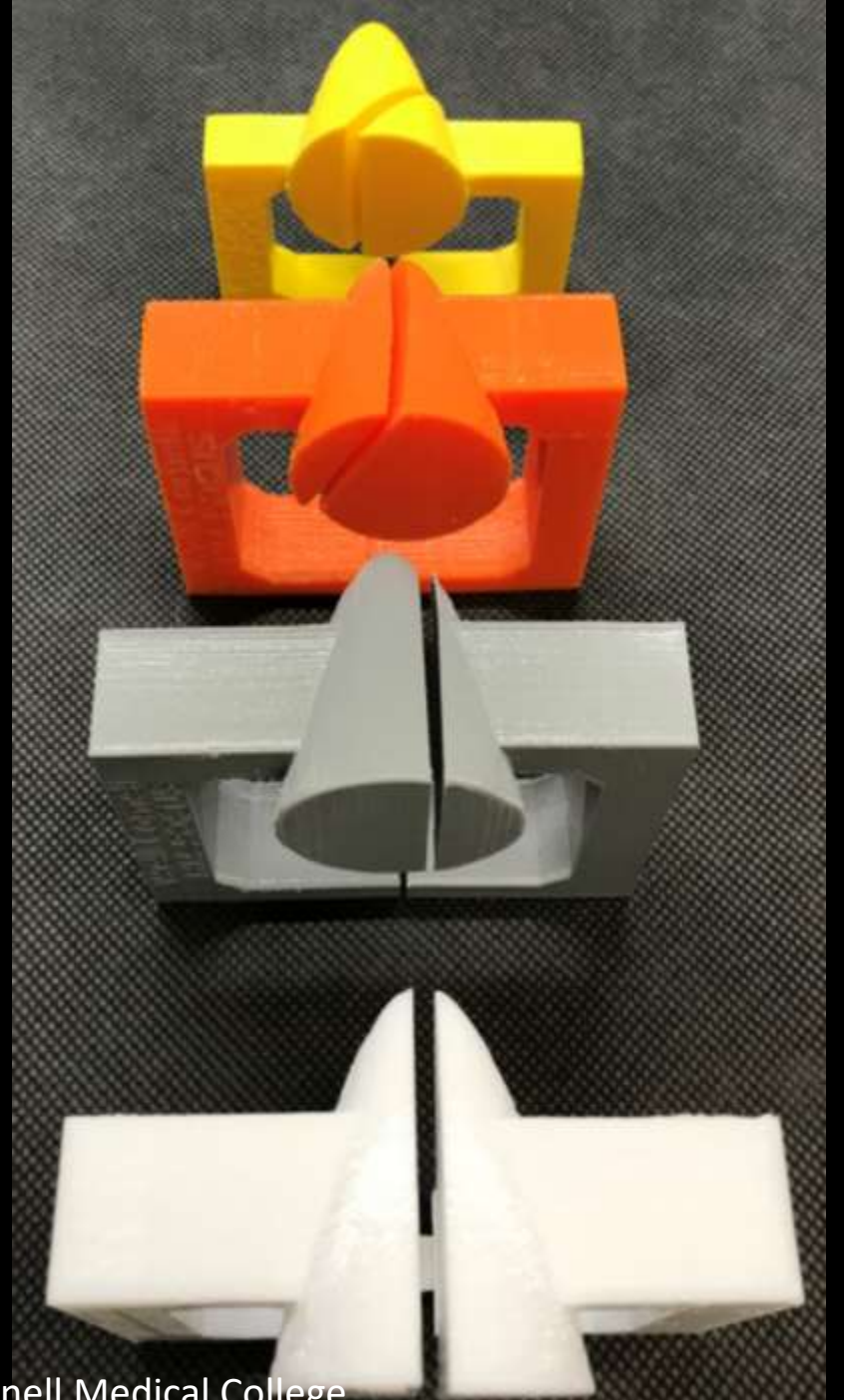
This squid-like shape, a paraboloid, represents an LV



Open a phantom  
with a greenish-  
blue lid



Gregory Mints, M.D.



©Cornell Medical College

# Exercise 1

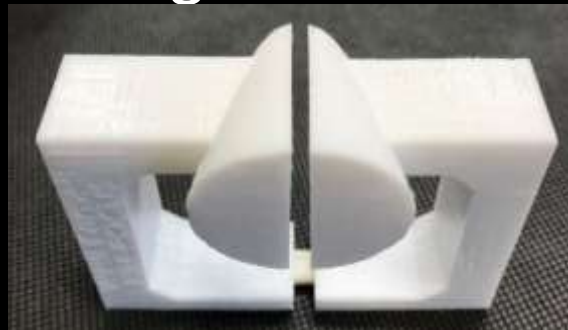
- Find a shape showing a longitudinal cut of the largest diameter.

# Exercise 1

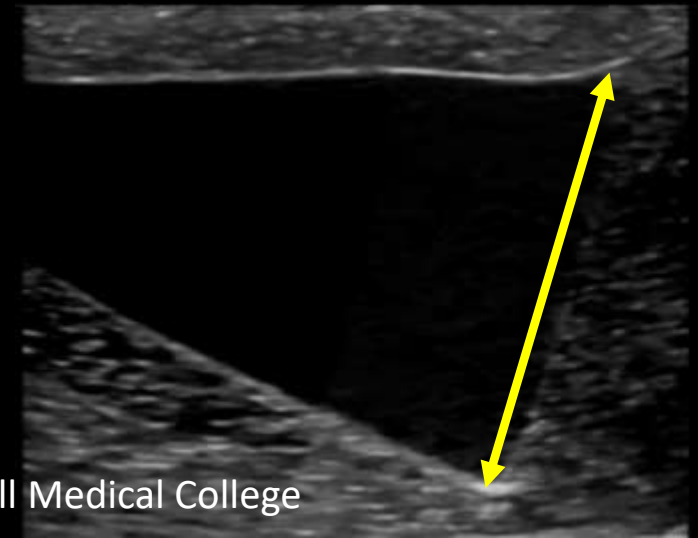
- Find a shape showing a longitudinal cut of the largest diameter.
- Scan the phantom. Orient the probe marker towards the dot on the container
- Use a lot of gel
- Obtain the largest diameter longitudinal cut.

# Exercise 1

- Find a shape showing a longitudinal cut of the largest diameter.



- Scan the phantom. Orient the probe marker towards the dot on the container
- Use a lot of gel
- Obtain the largest diameter longitudinal cut.



# Exercise 2a

Excluding compression, there are 2 movements of the probe which will distort *neither shape nor form* of the scanned object.

# Exercise 2a

Excluding compression, there are 2 movements of the probe which will distort *neither shape nor form* of the scanned object.

Demonstrate one of these scanning movements on the phantom

# Exercise 2b

Switch scanners.

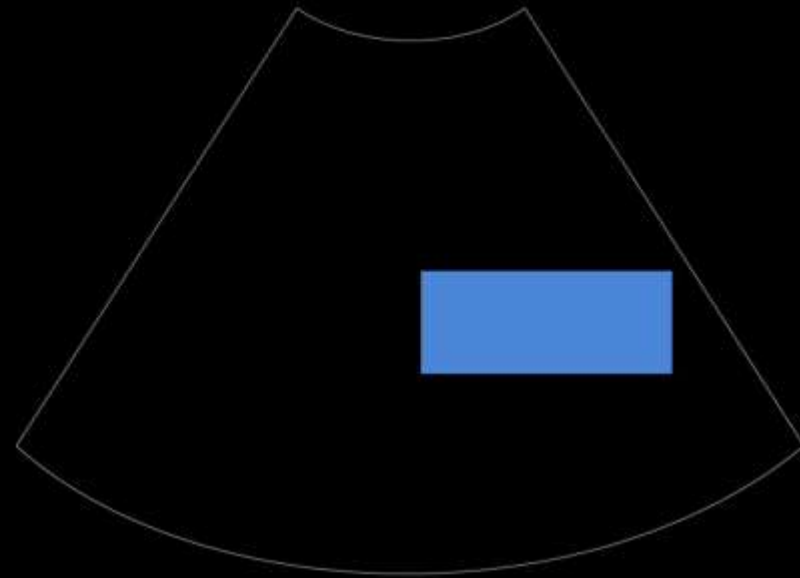
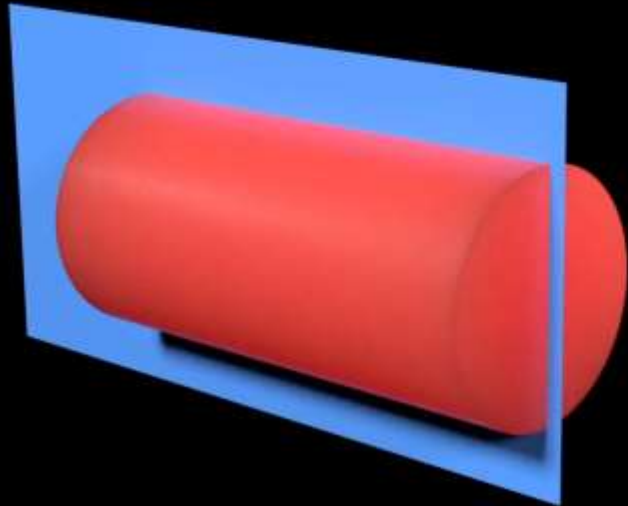


# Exercise 2b

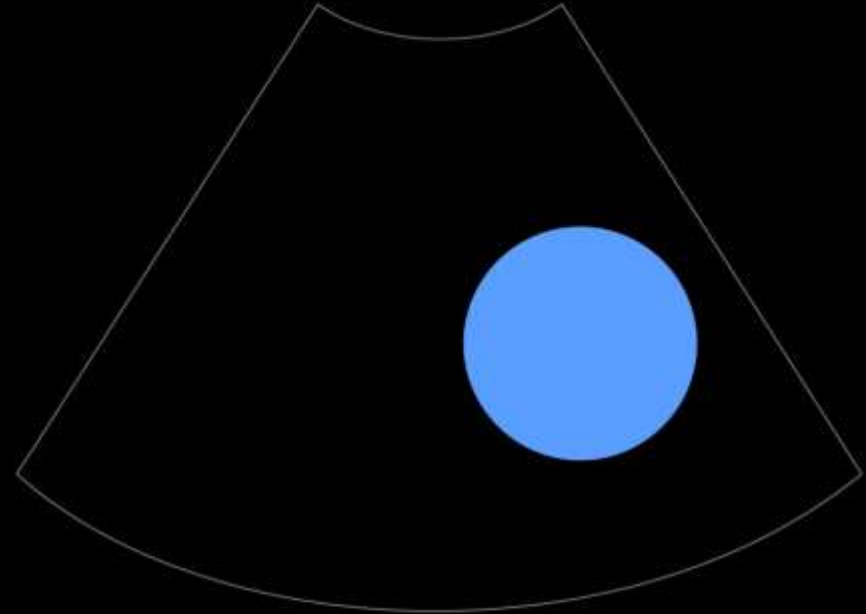
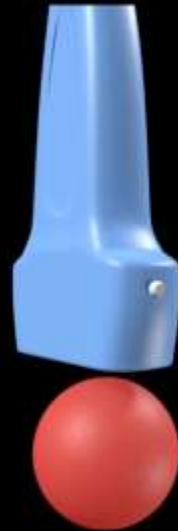
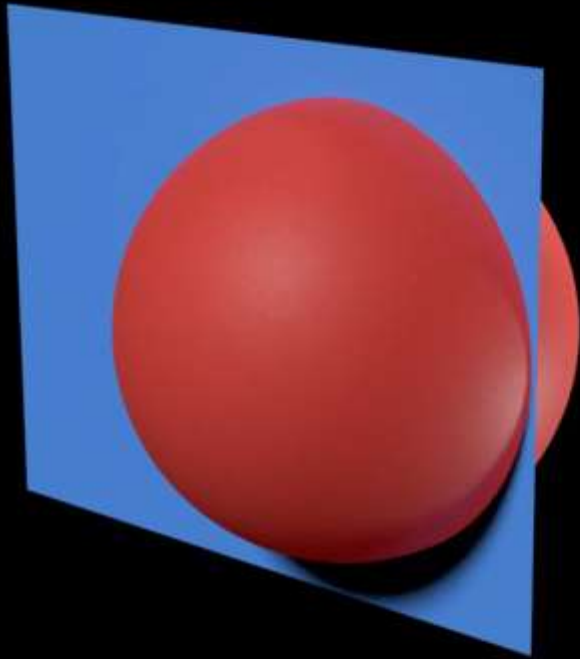
Switch scanners.

On the phantom demonstrate the other scanning movement which would not distort *neither shape nor form* of the shape

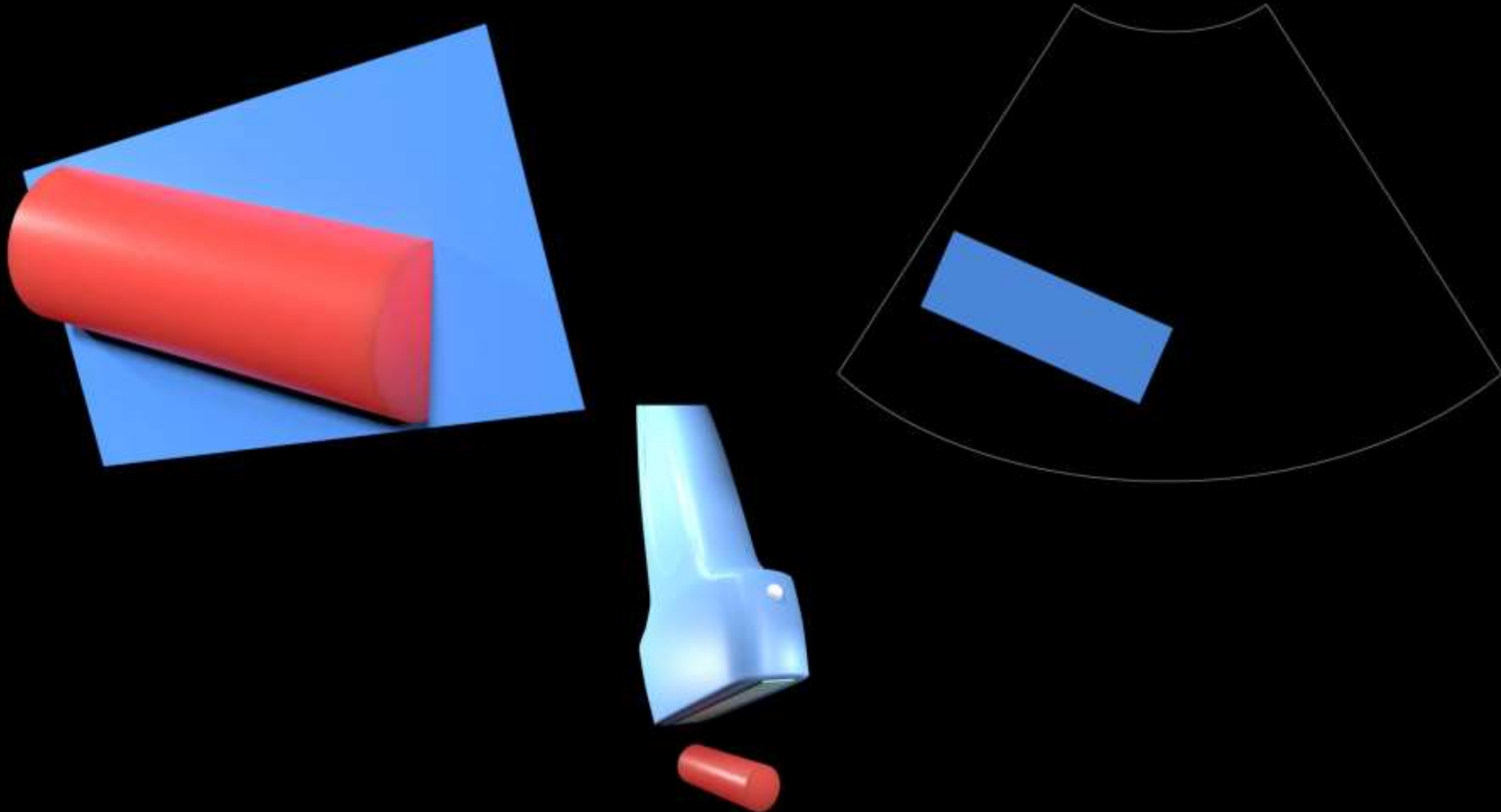
# Exercise 2: Sliding and Rocking preserve shape and size



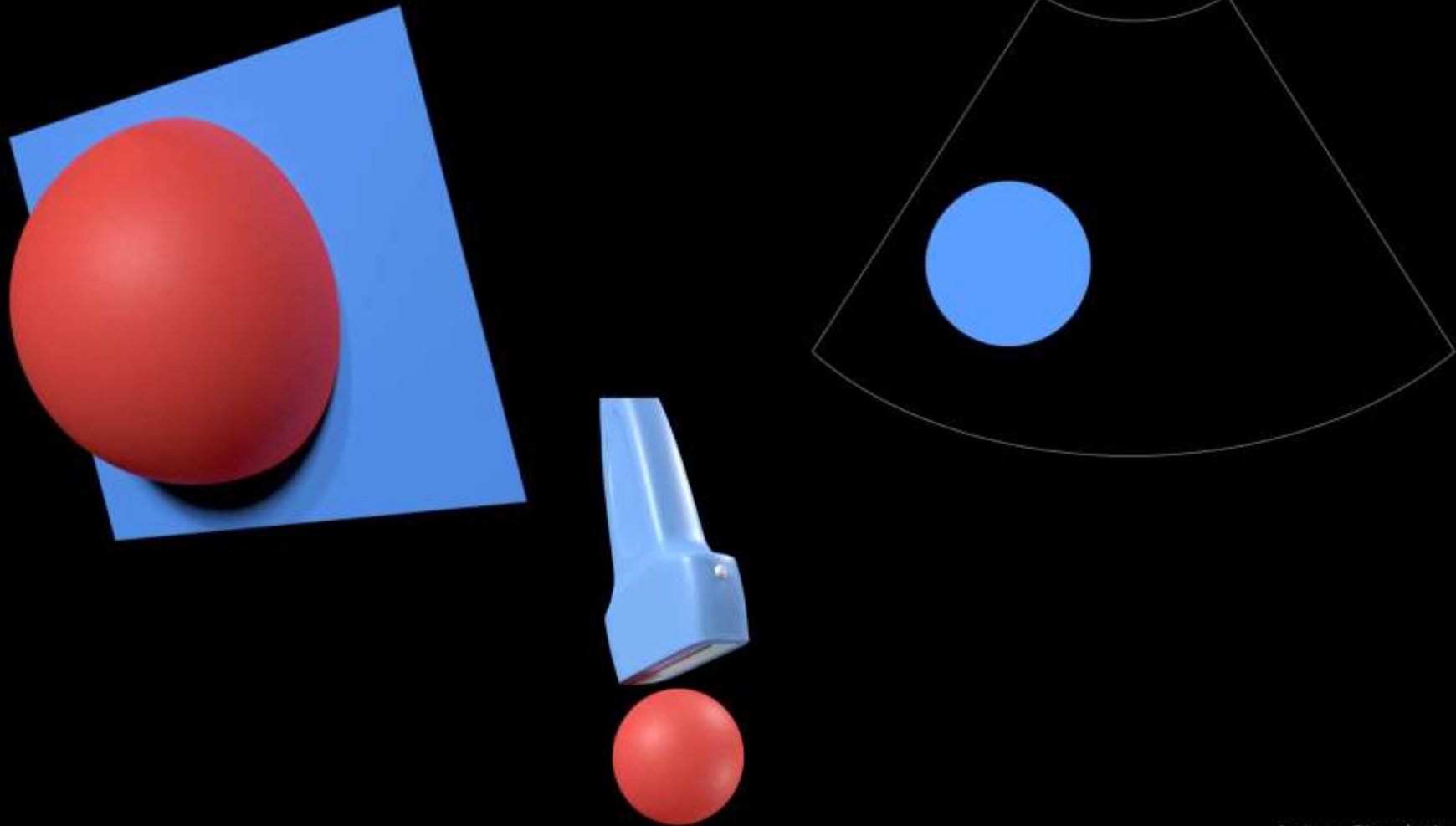
# Exercise 2: Sliding and Rocking preserve shape and size



# Exercise 2: Sliding and Rocking preserve shape and size



# Exercise 2: Sliding and Rocking preserve shape and size

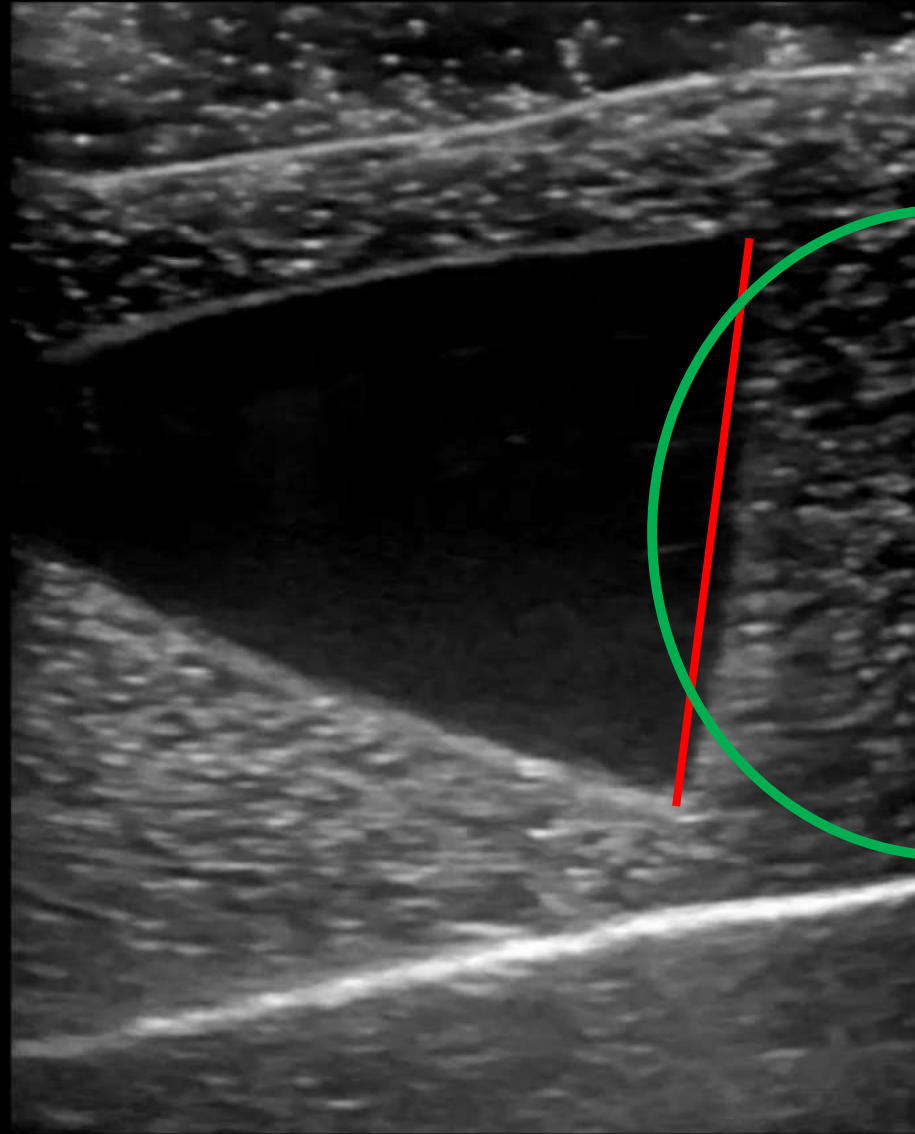


# Sliding and Rocking

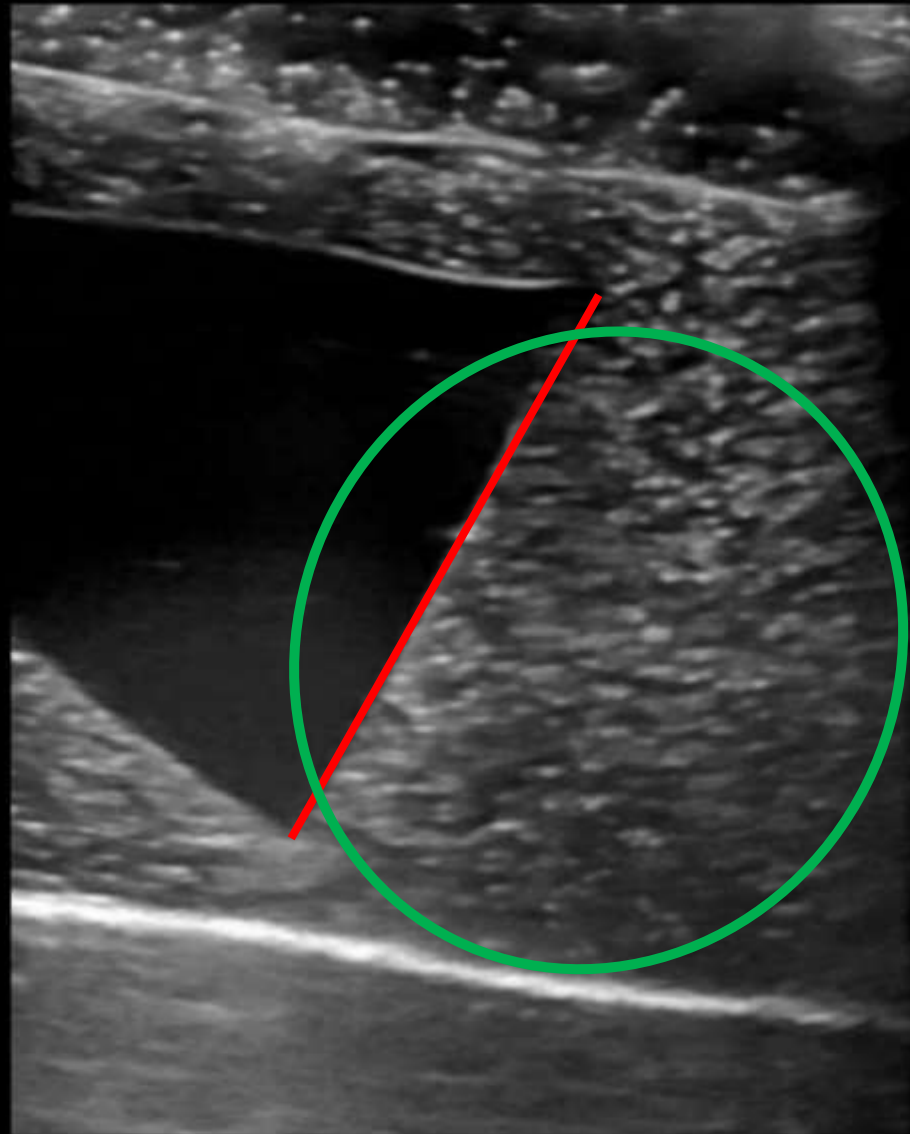
However:

Note the variable position of the base on the sono screen

# Rocking

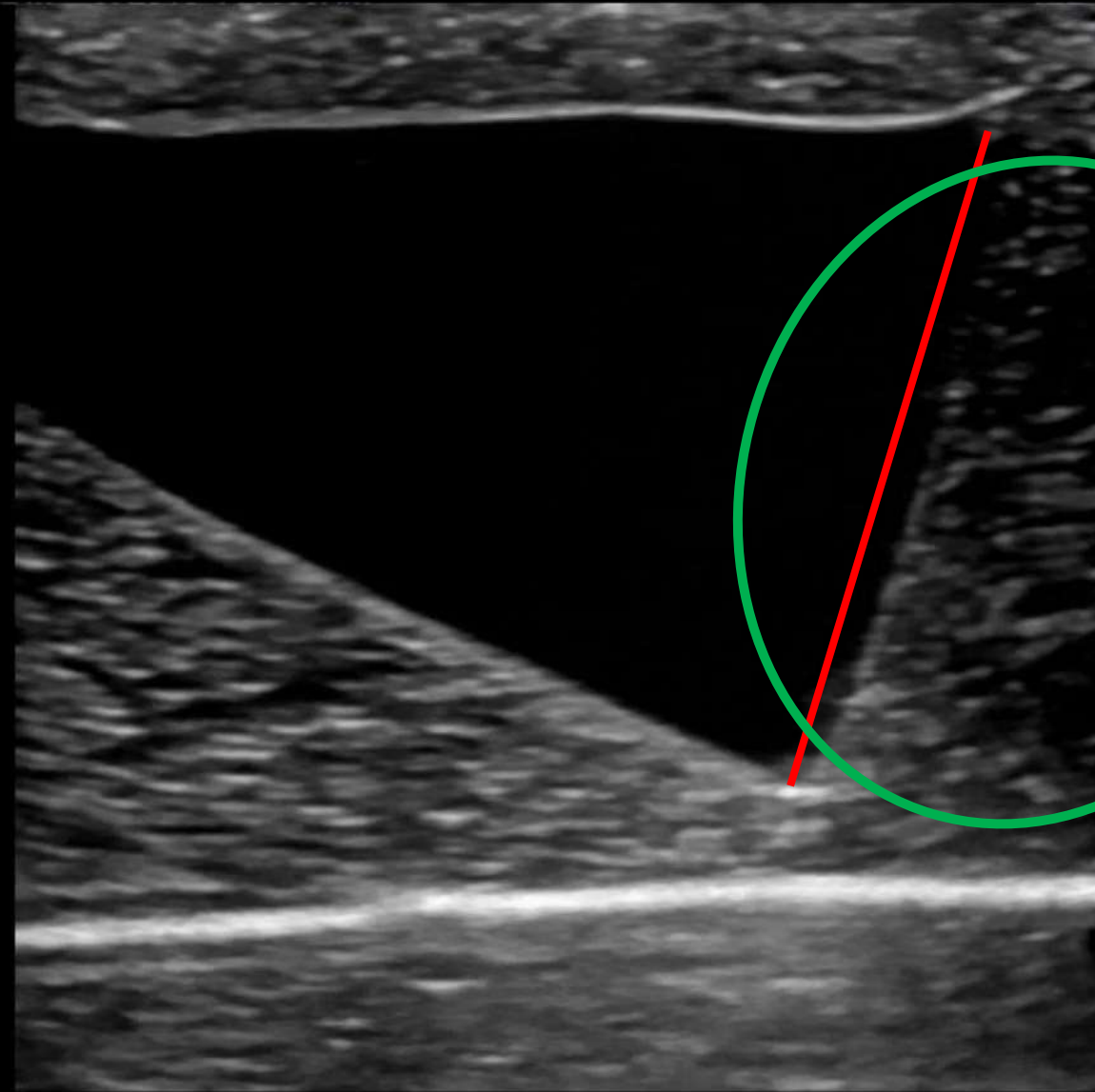


# Rocking

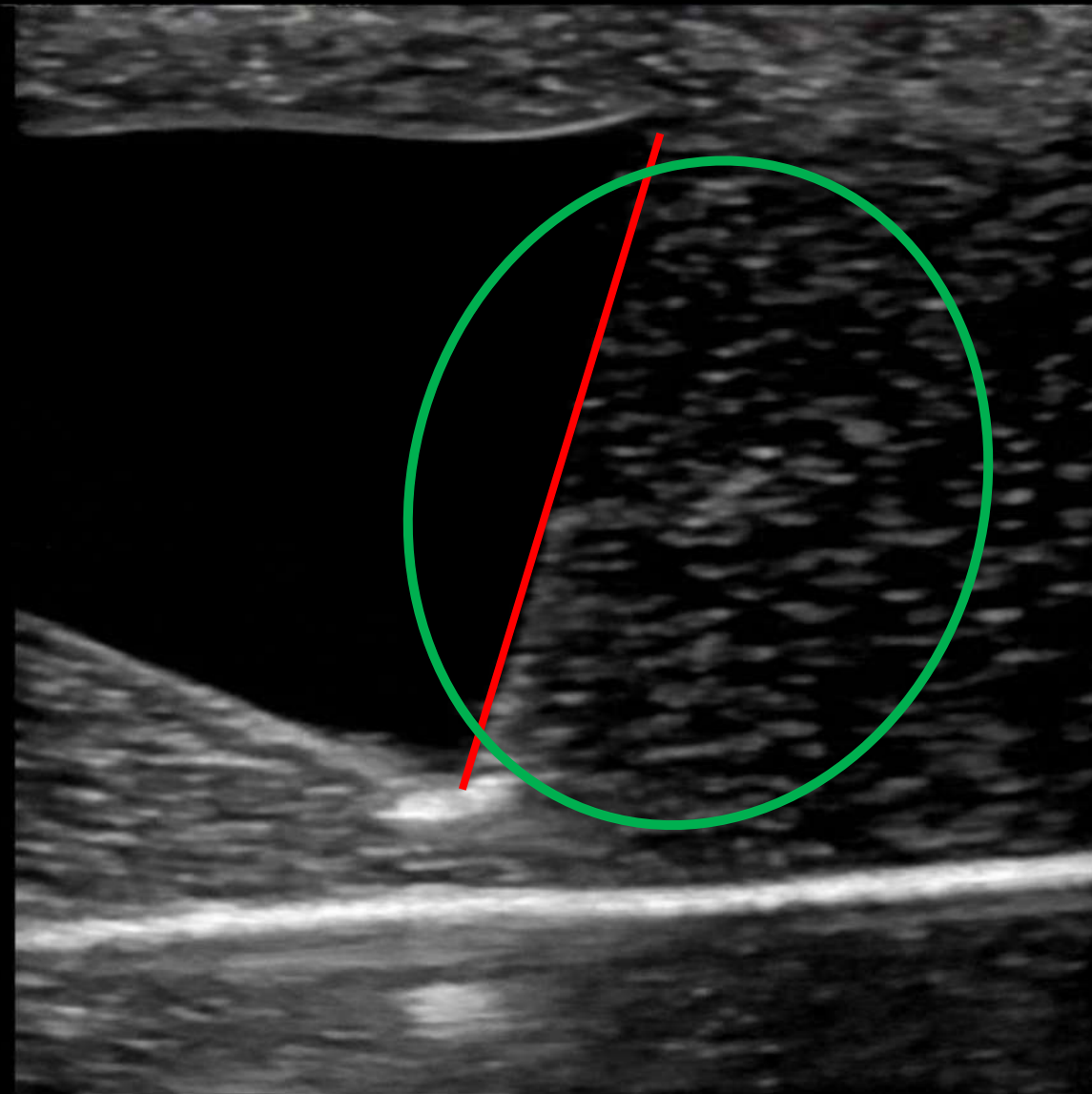




Sliding



# Sliding



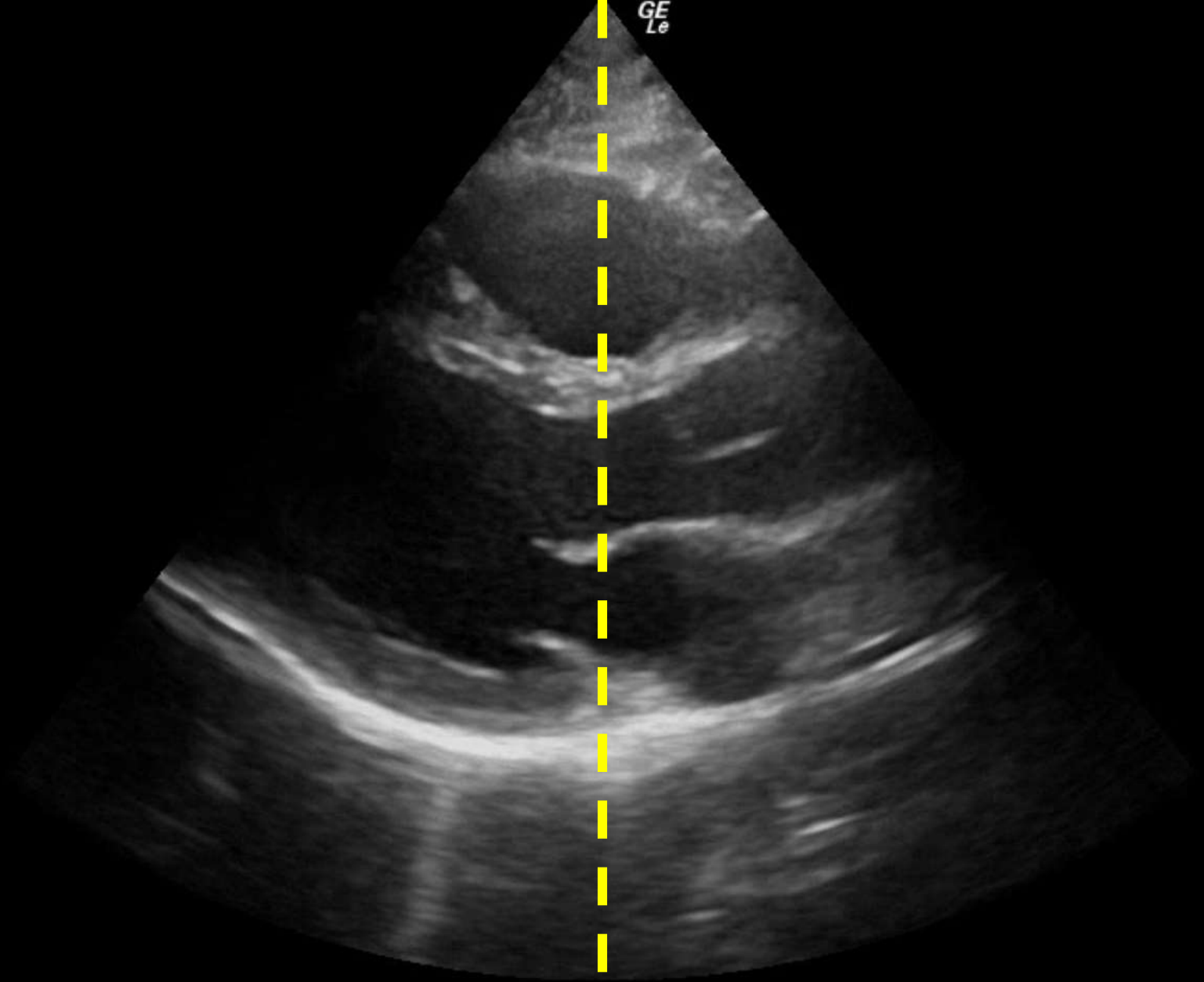
# Sliding and Rocking

- Preserve shape and size

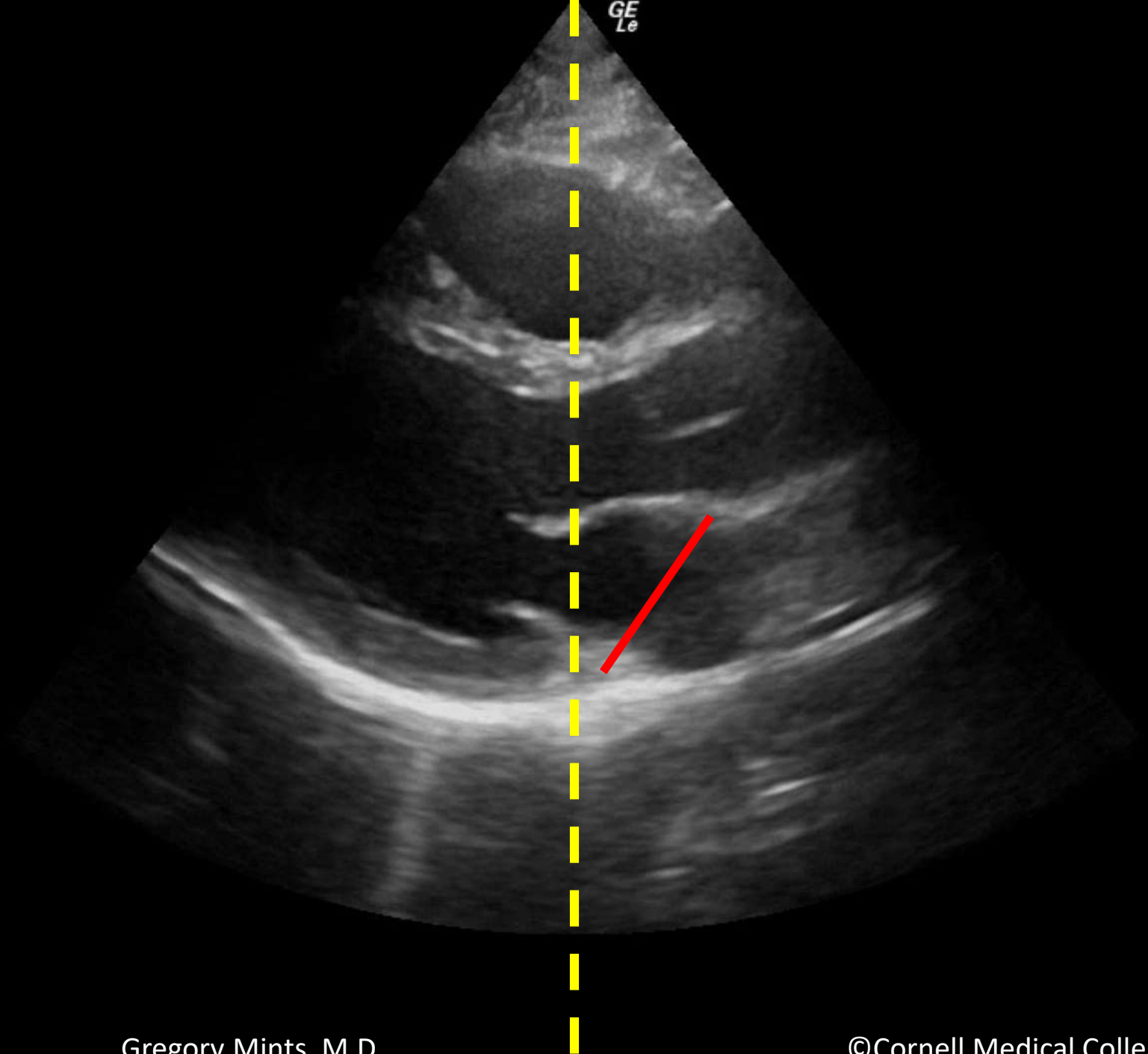
# Sliding and Rocking

- Preserve shape and size
- Alter position of structures on screen

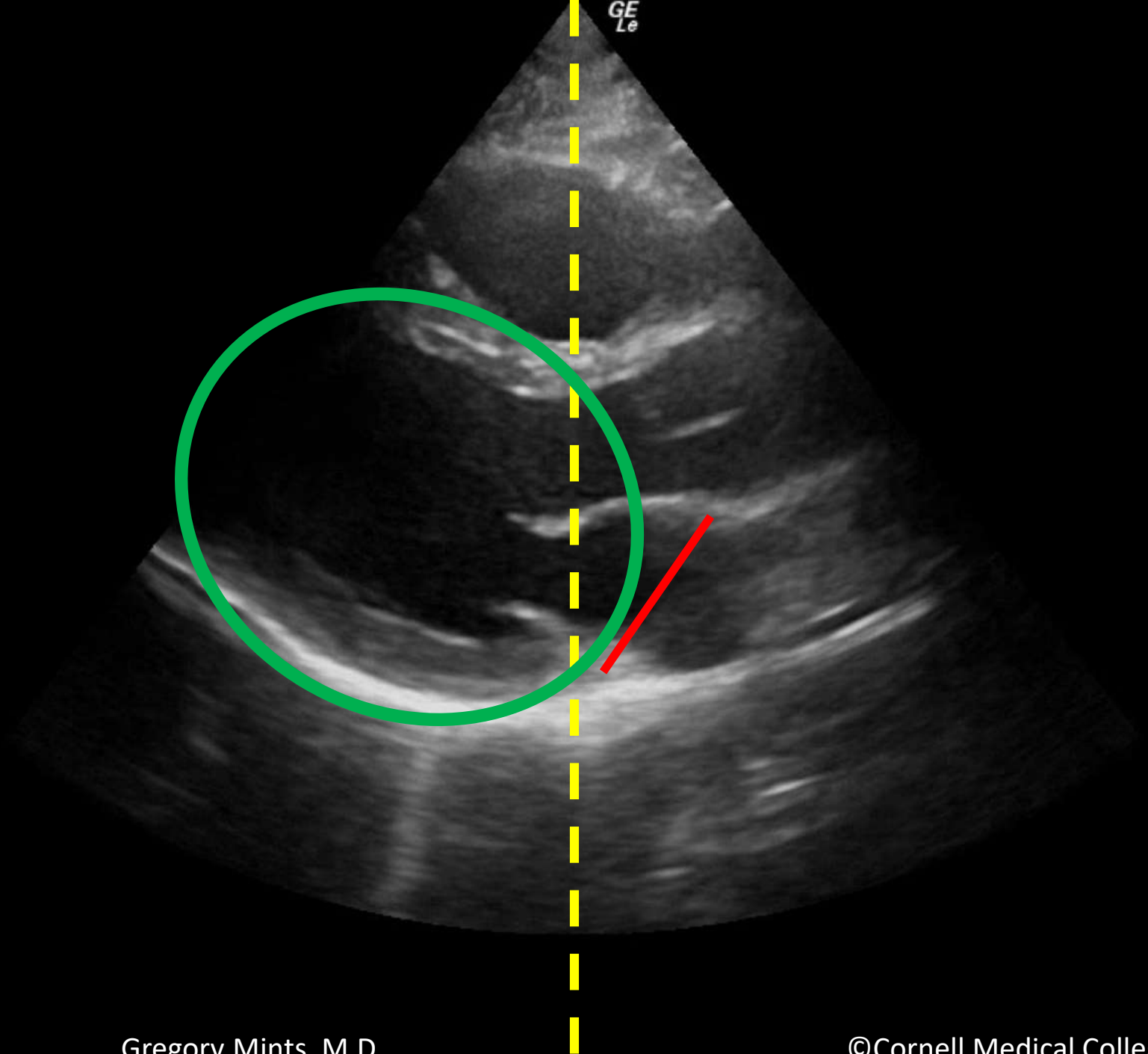




GE  
Le



GE  
Le



GE  
Le



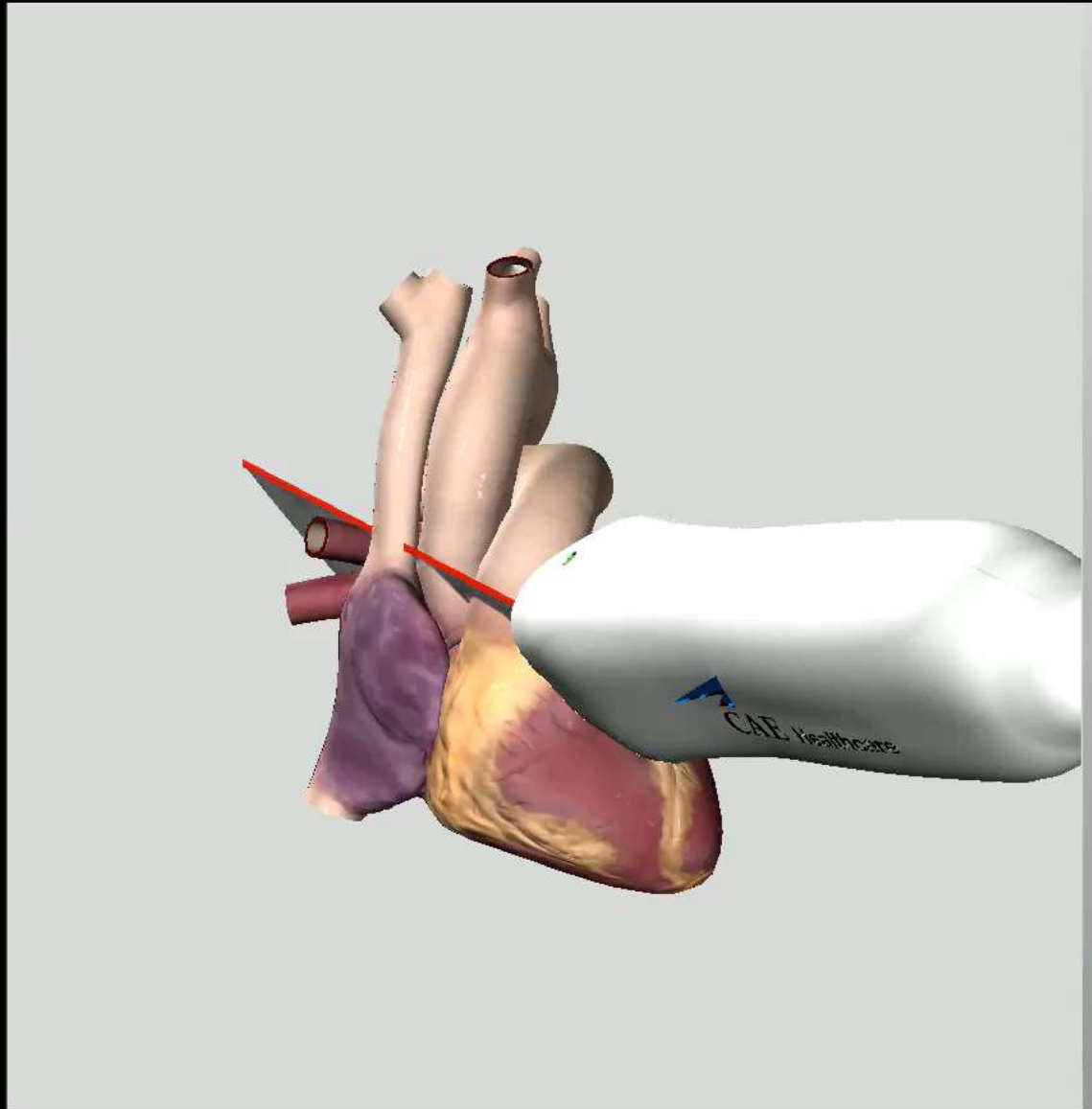
# PLAx

- depth
1. Surveillance depth: descending aorta @ ~ middle of the screen
  2. Study depth: Descending aorta visible at the bottom of the screen
  3. Focus on LV. MV should be just to the right of the screen center

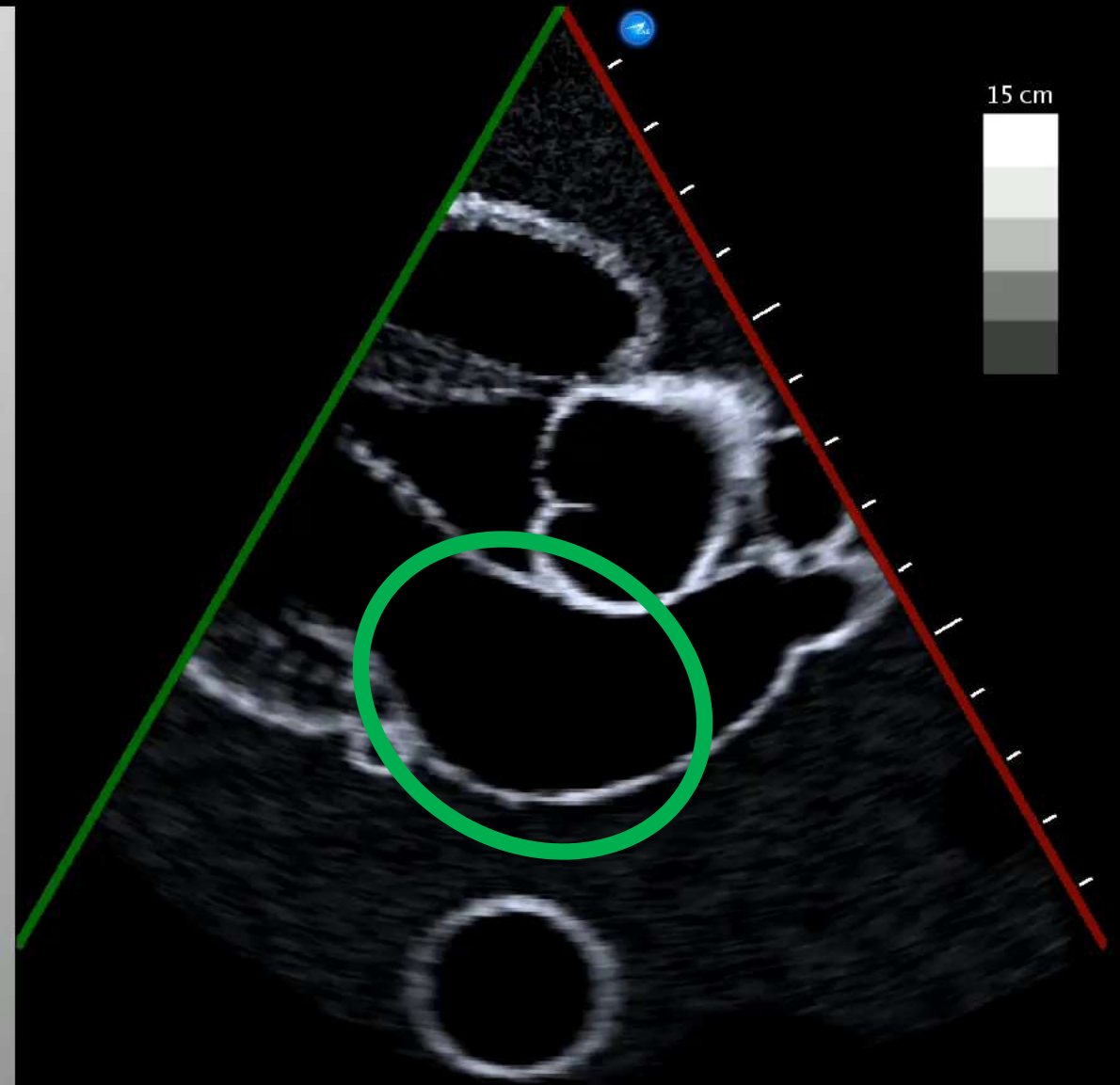
# PLAx

- depth {
1. Surveillance depth: descending aorta @ ~ middle of the screen
  2. Study depth: Descending aorta visible at the bottom of the screen
- Rock/  
Slide
3. **Focus on LV. MV should be just to the right of the screen center**

# Sliding

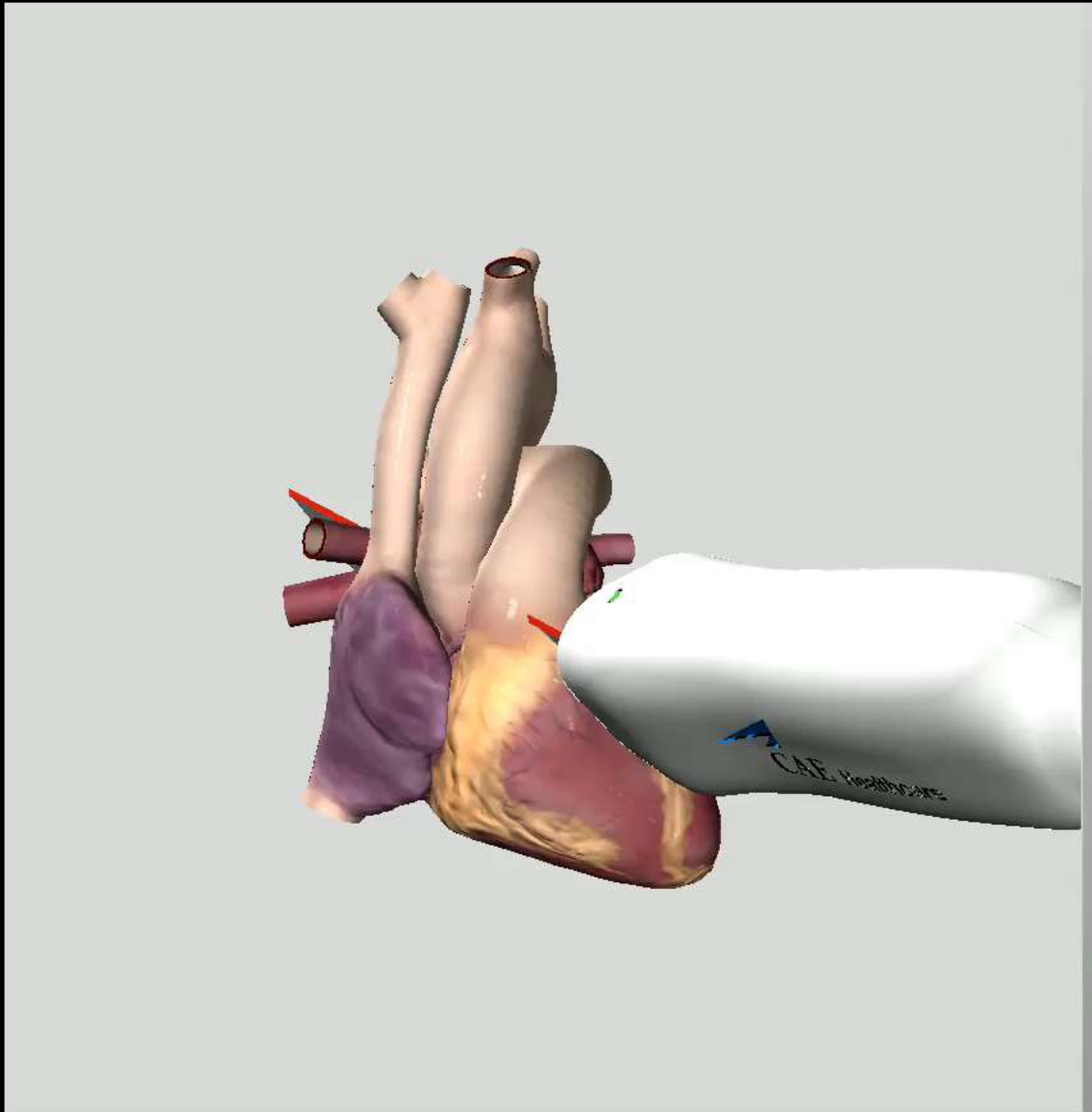


Gregory Mints, M.D., Gigi Lui, M.D.

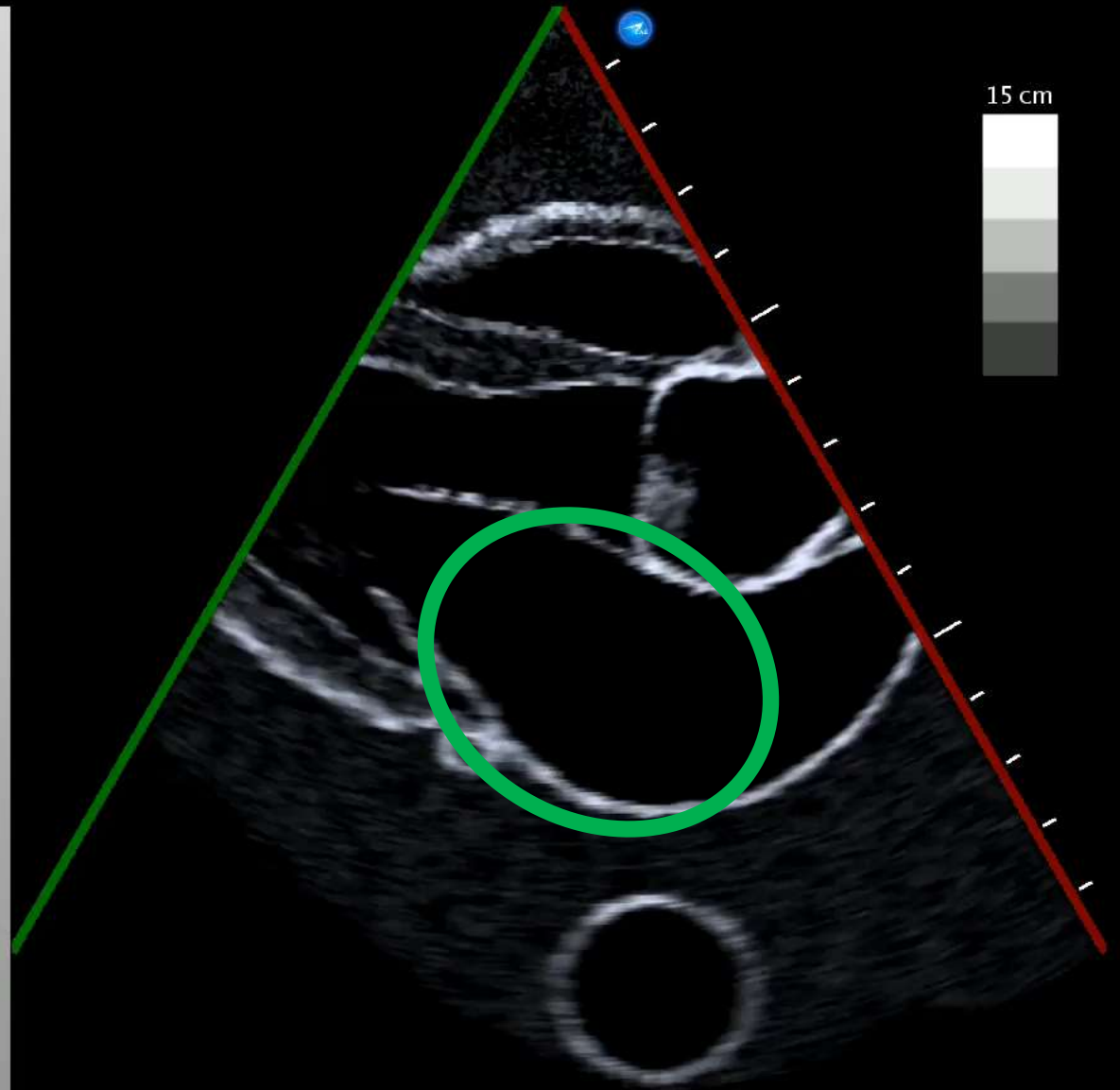


©Cornell Medical College, Johns Hopkins

# Rocking

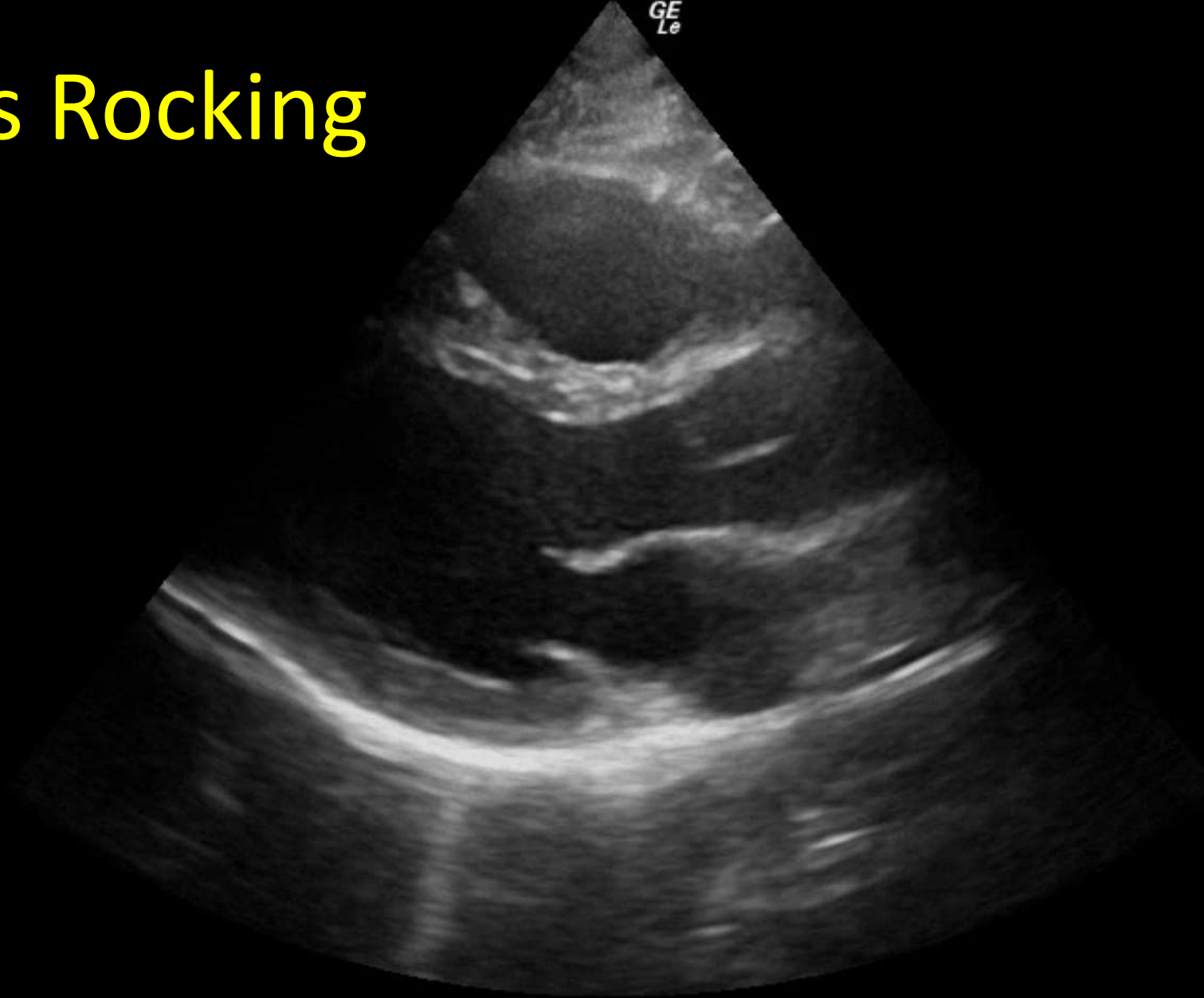


Gregory Mints, M.D., Gigi Lui, M.D.



©Cornell Medical College, Johns Hopkins

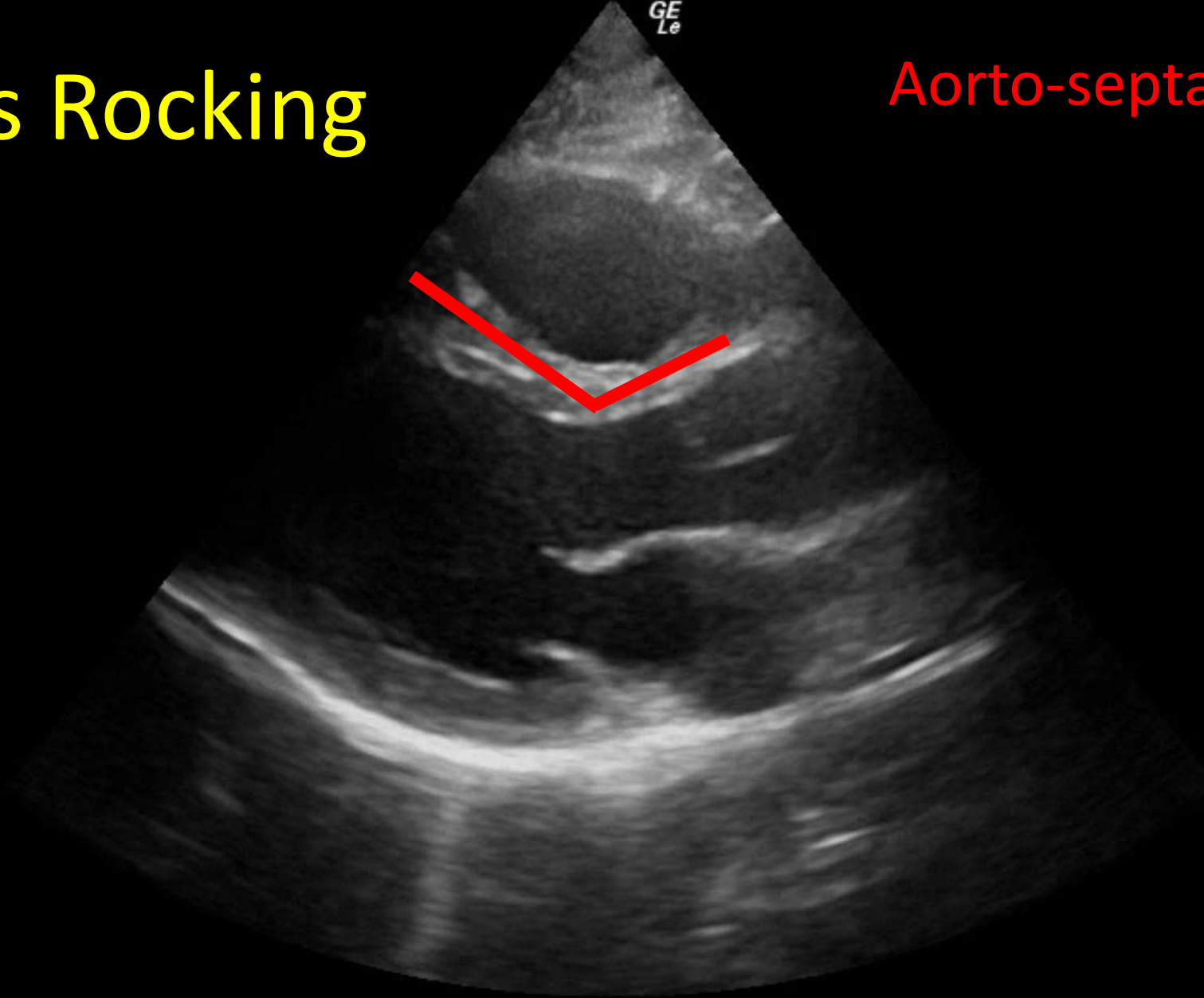
# Sliding vs Rocking



Good quality PLAx

# Sliding vs Rocking

Aorto-septal angle

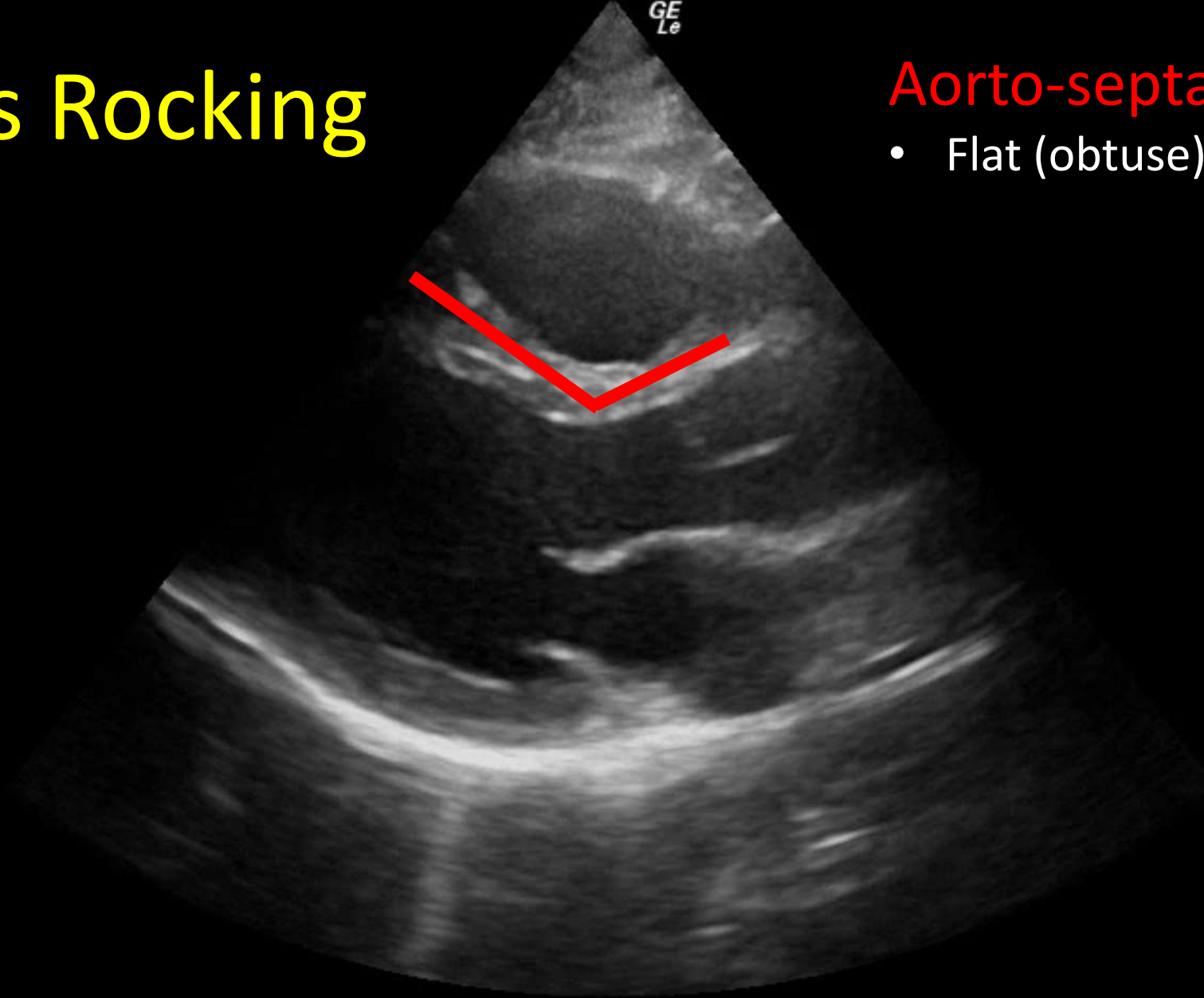


Good quality PLAx

# Sliding vs Rocking

## Aorto-septal angle

- Flat (obtuse)

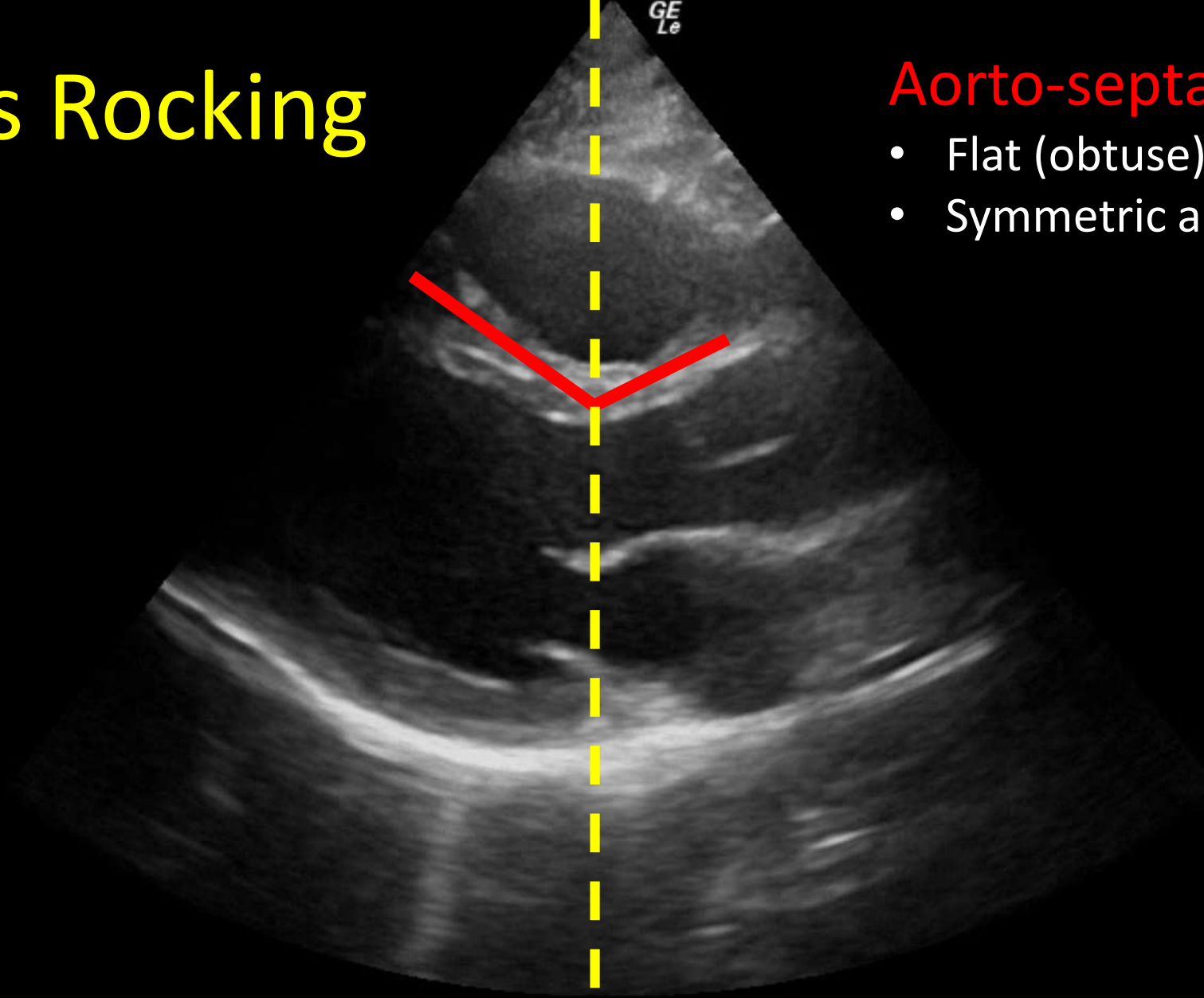


Good quality PLAx

# Sliding vs Rocking

## Aorto-septal angle

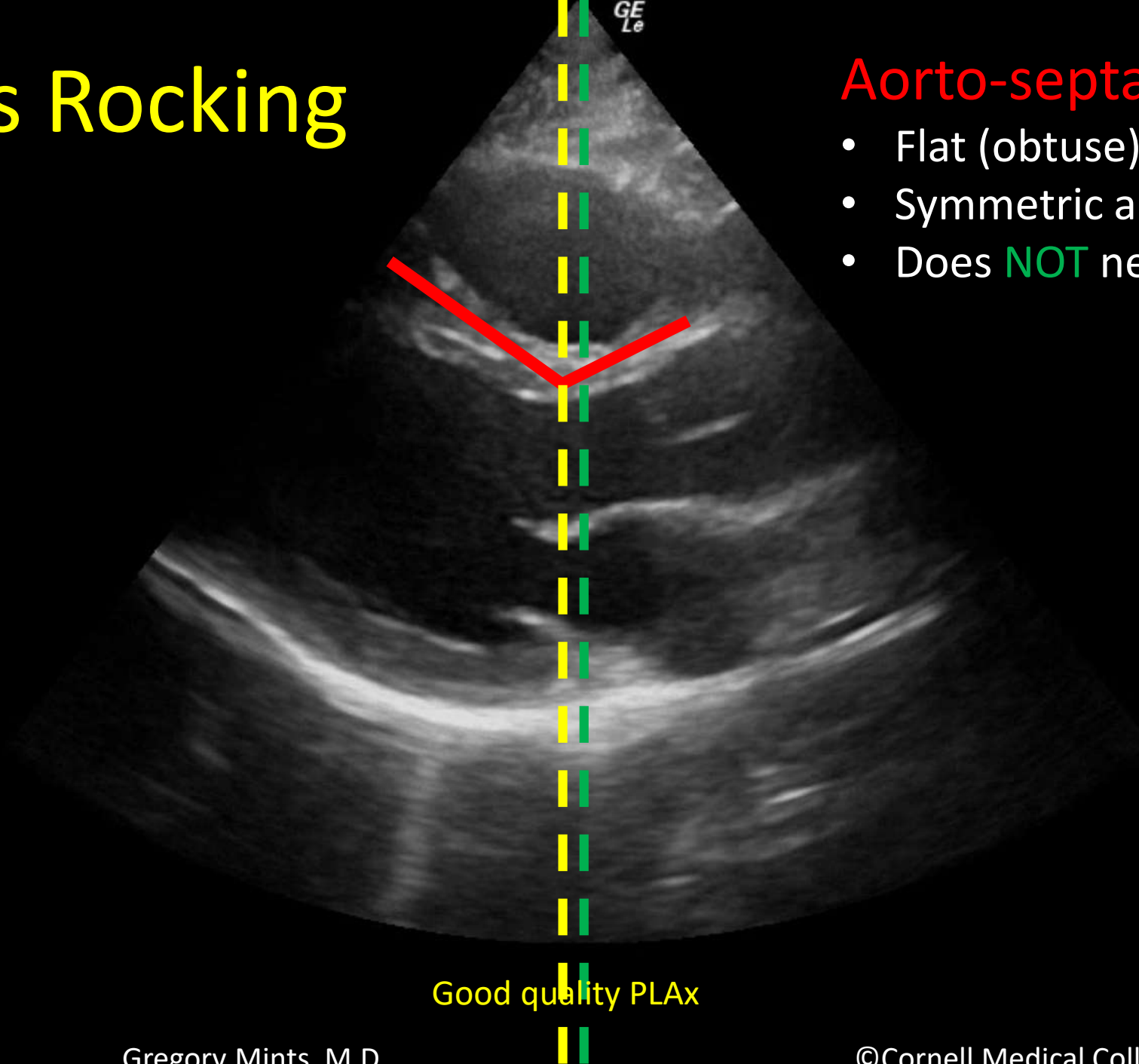
- Flat (obtuse)
- Symmetric around a vertical



Good quality PLAx



# Sliding vs Rocking



## Aorto-septal angle

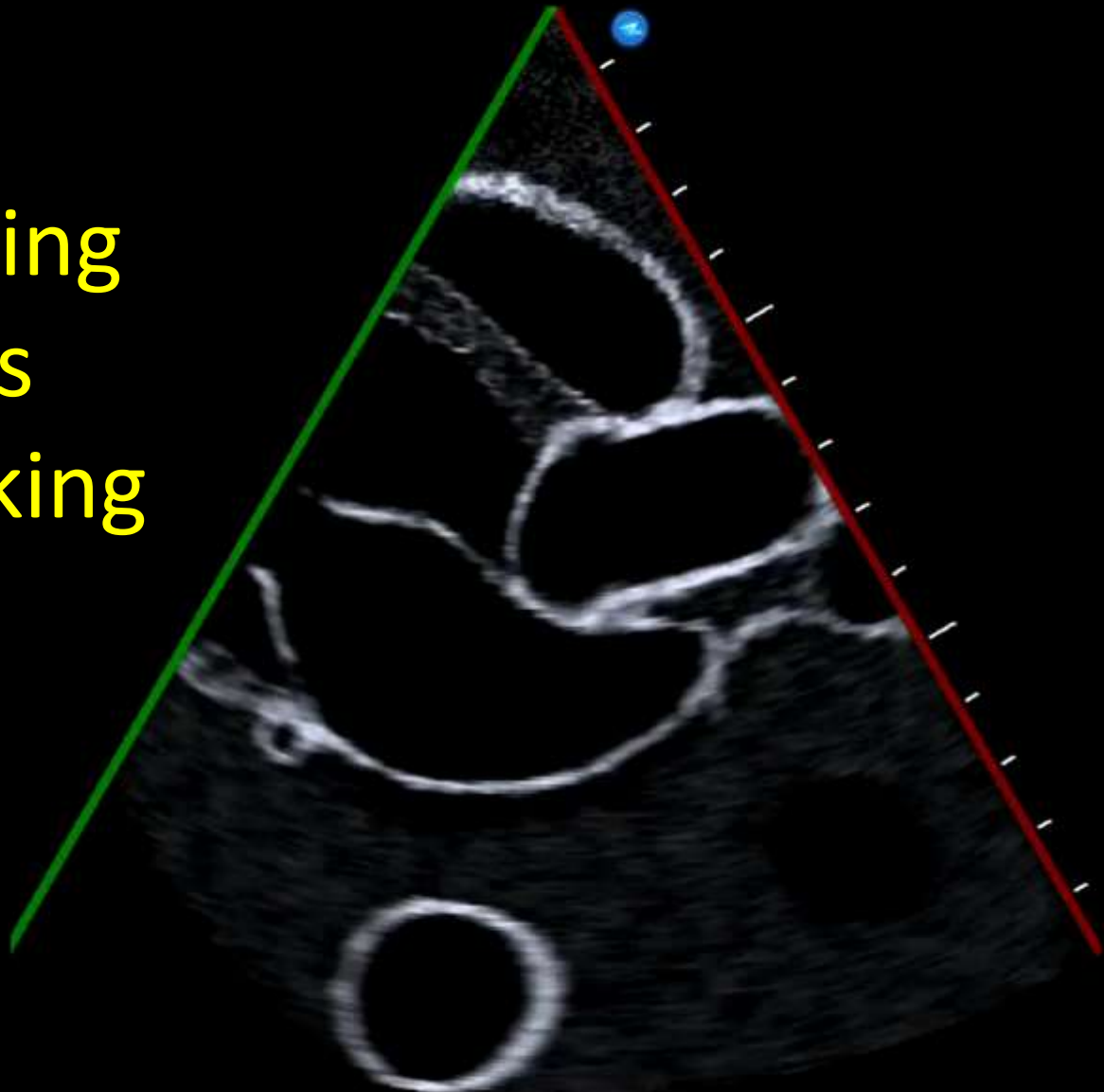
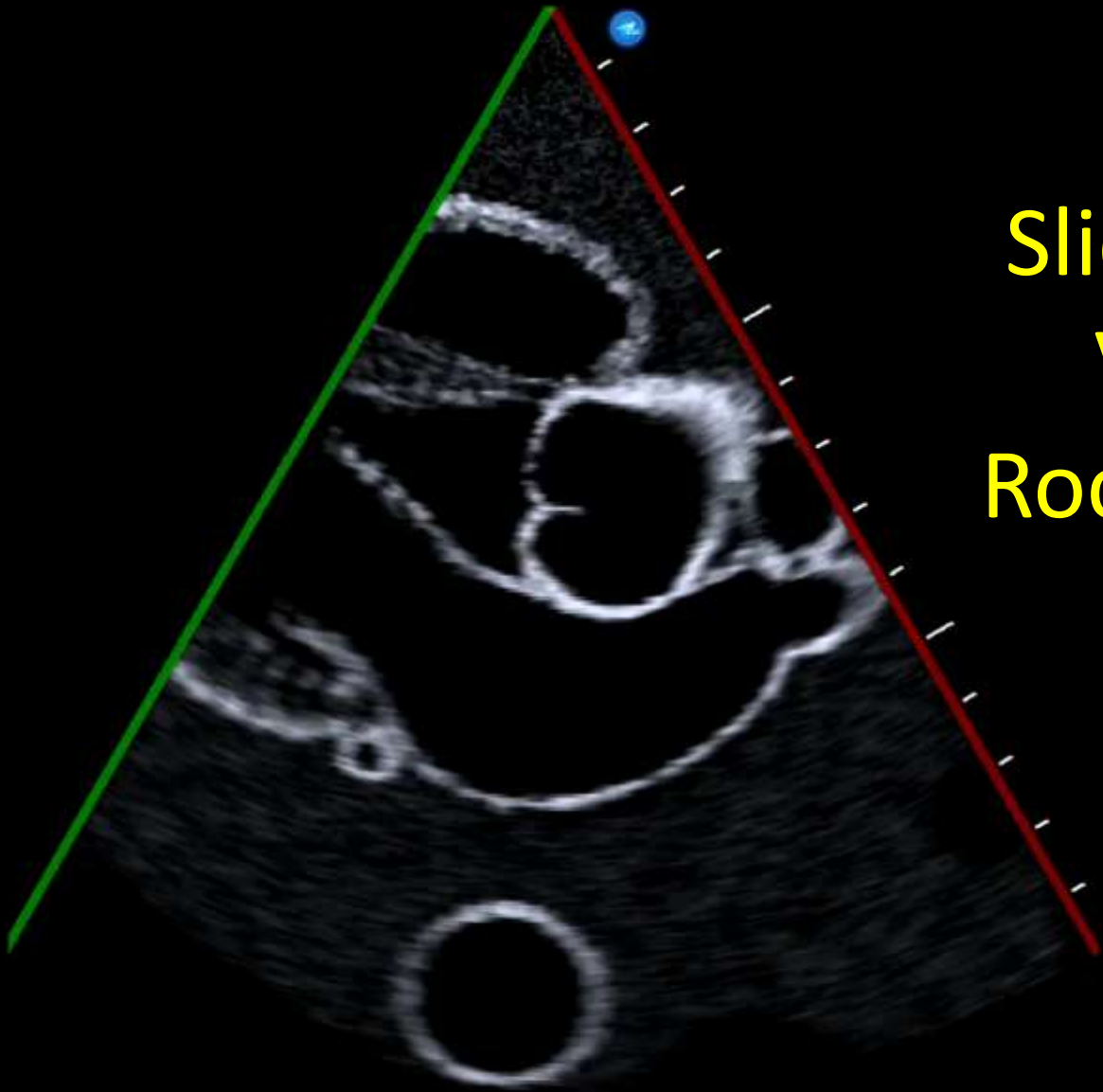
- Flat (obtuse)
- Symmetric around a vertical
- Does **NOT** need to be centered

Good quality PLAx

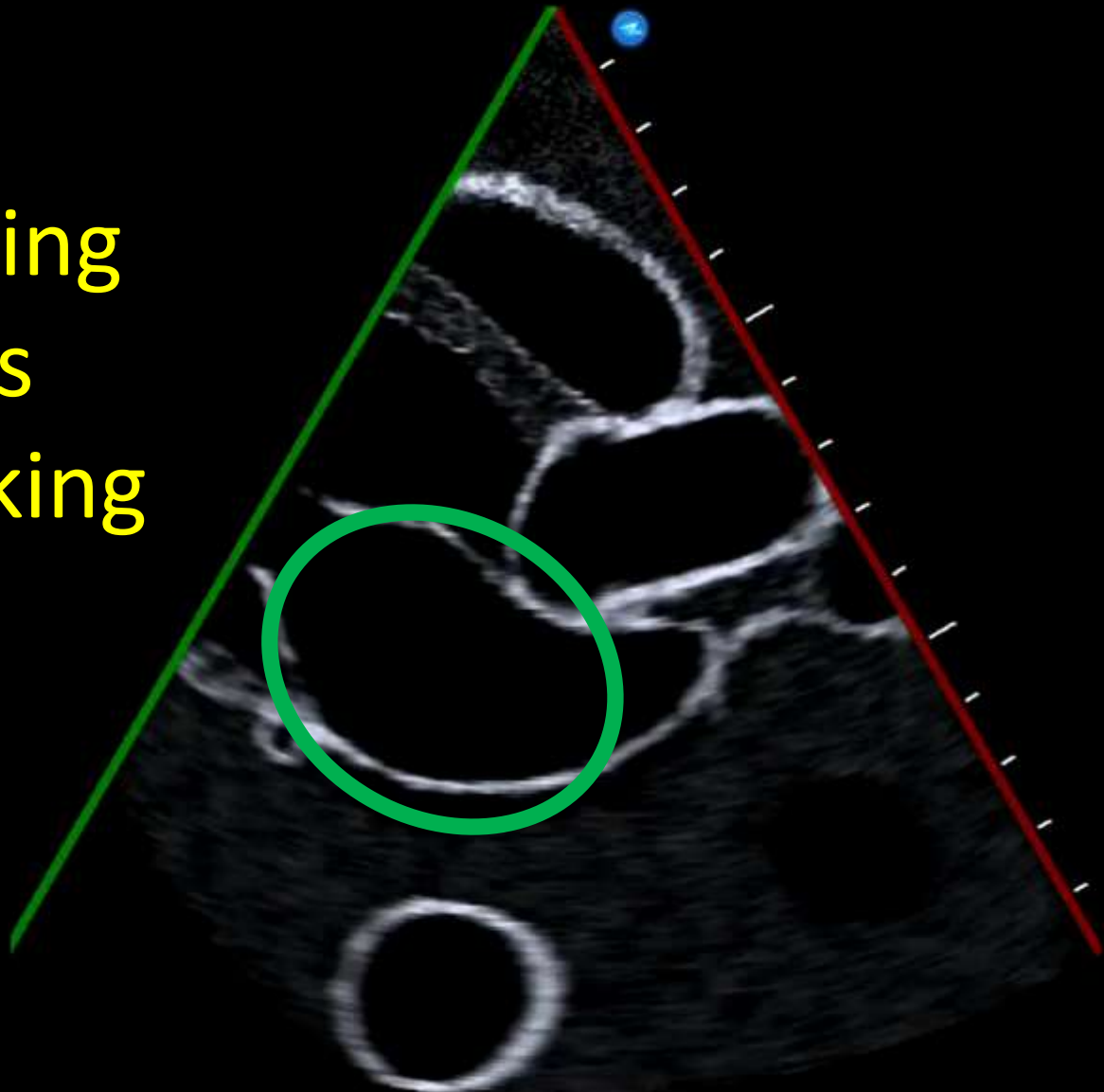
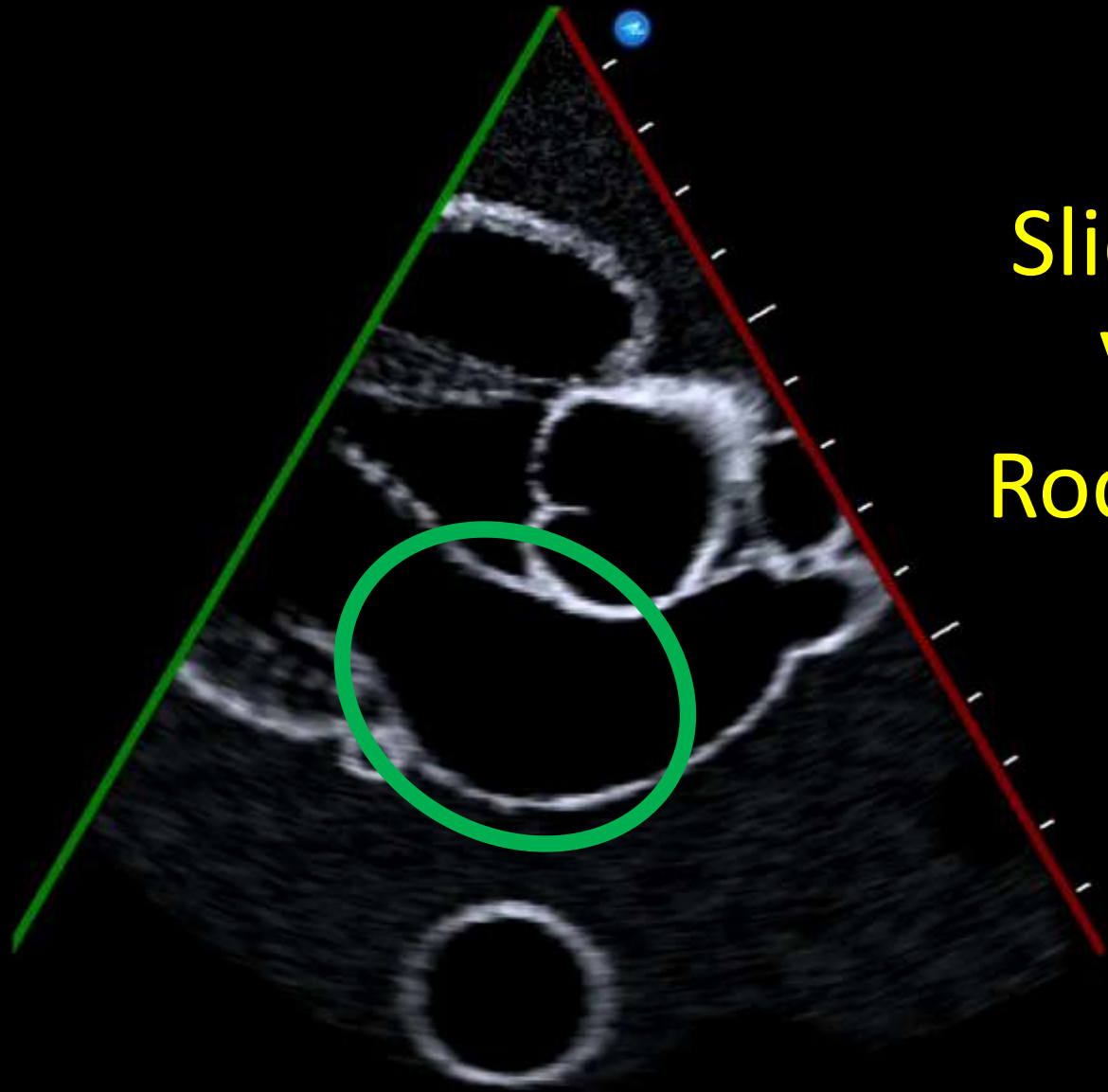
# PLAx

- depth {
1. Surveillance depth: descending aorta @ ~ middle of the screen
  2. Study depth: Descending aorta visible at the bottom of the screen
- Rock/  
Slide
3. Focus on LV. MV should be just to the right of the screen center
  4. **Aorto-septal angle: flat and symmetric**

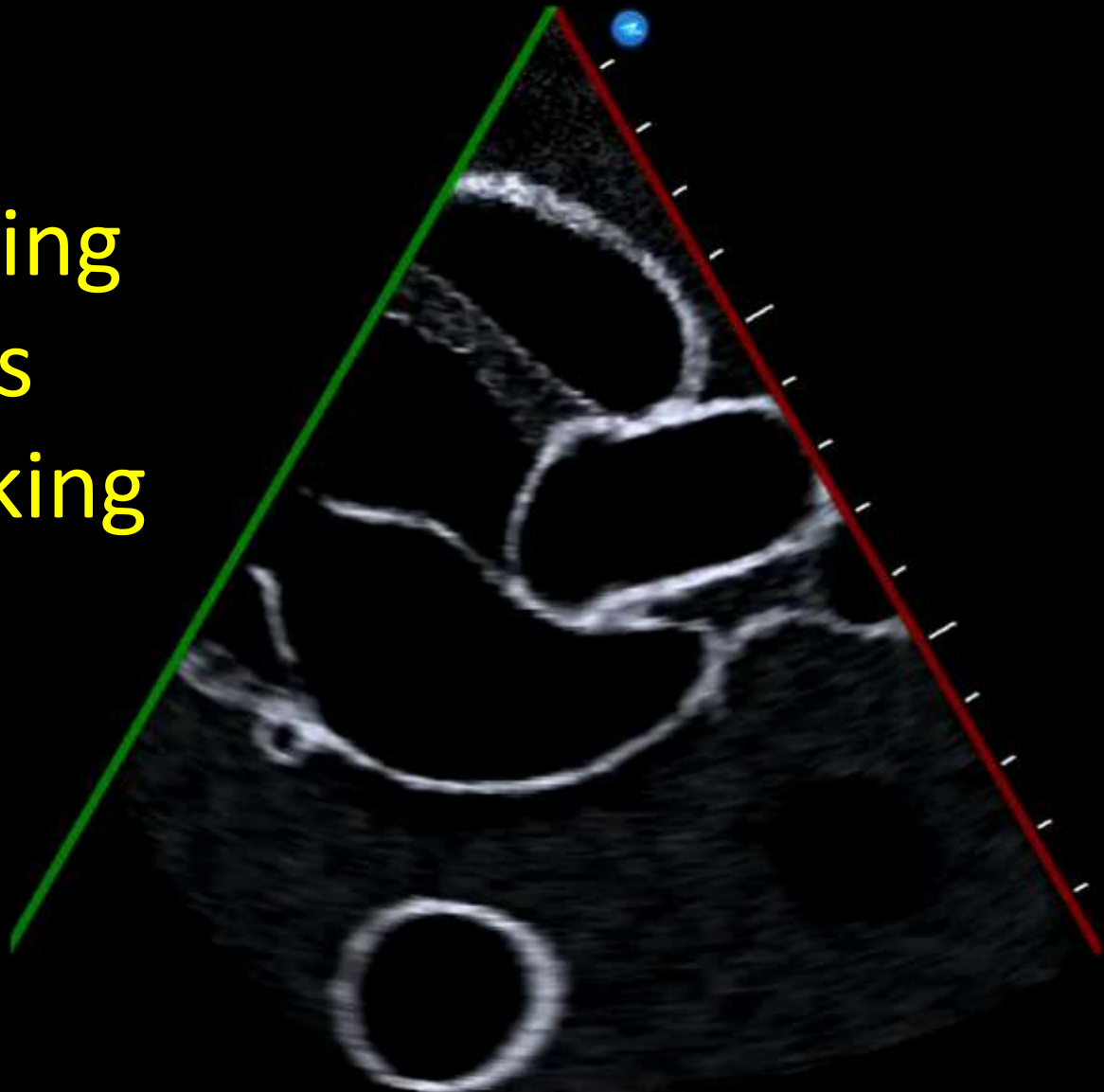
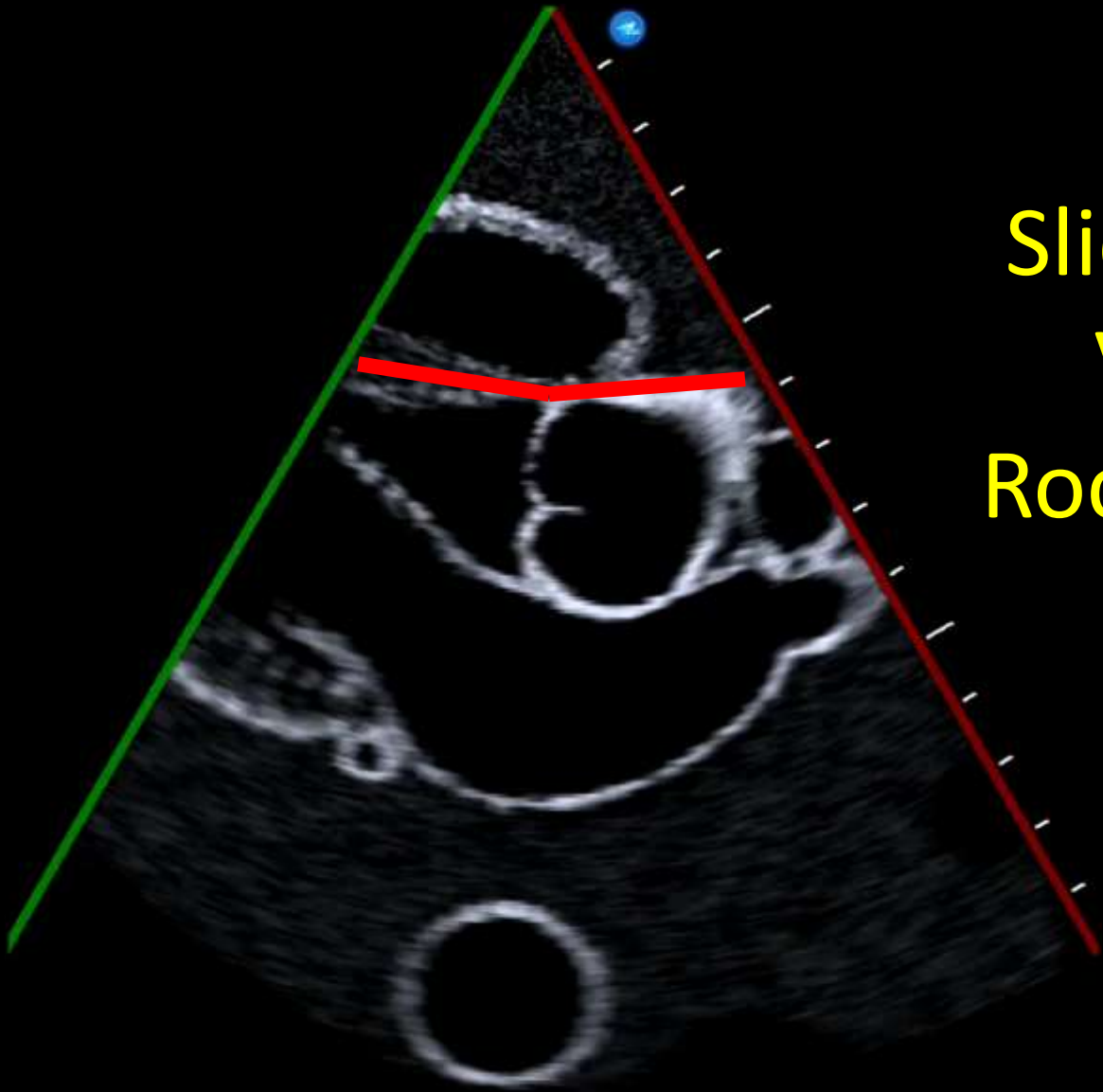
Sliding  
Vs  
Rocking



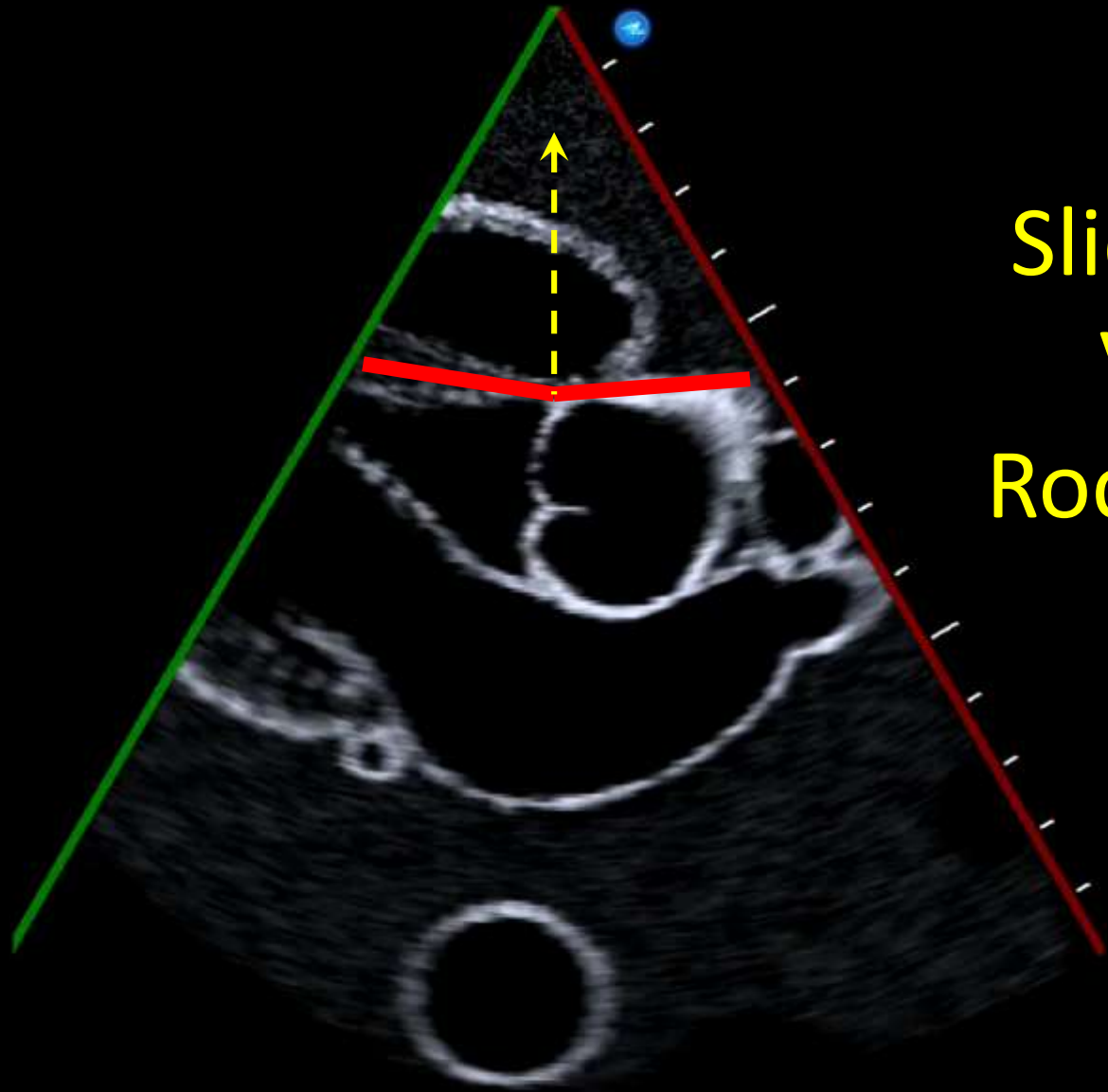
Sliding  
Vs  
Rocking



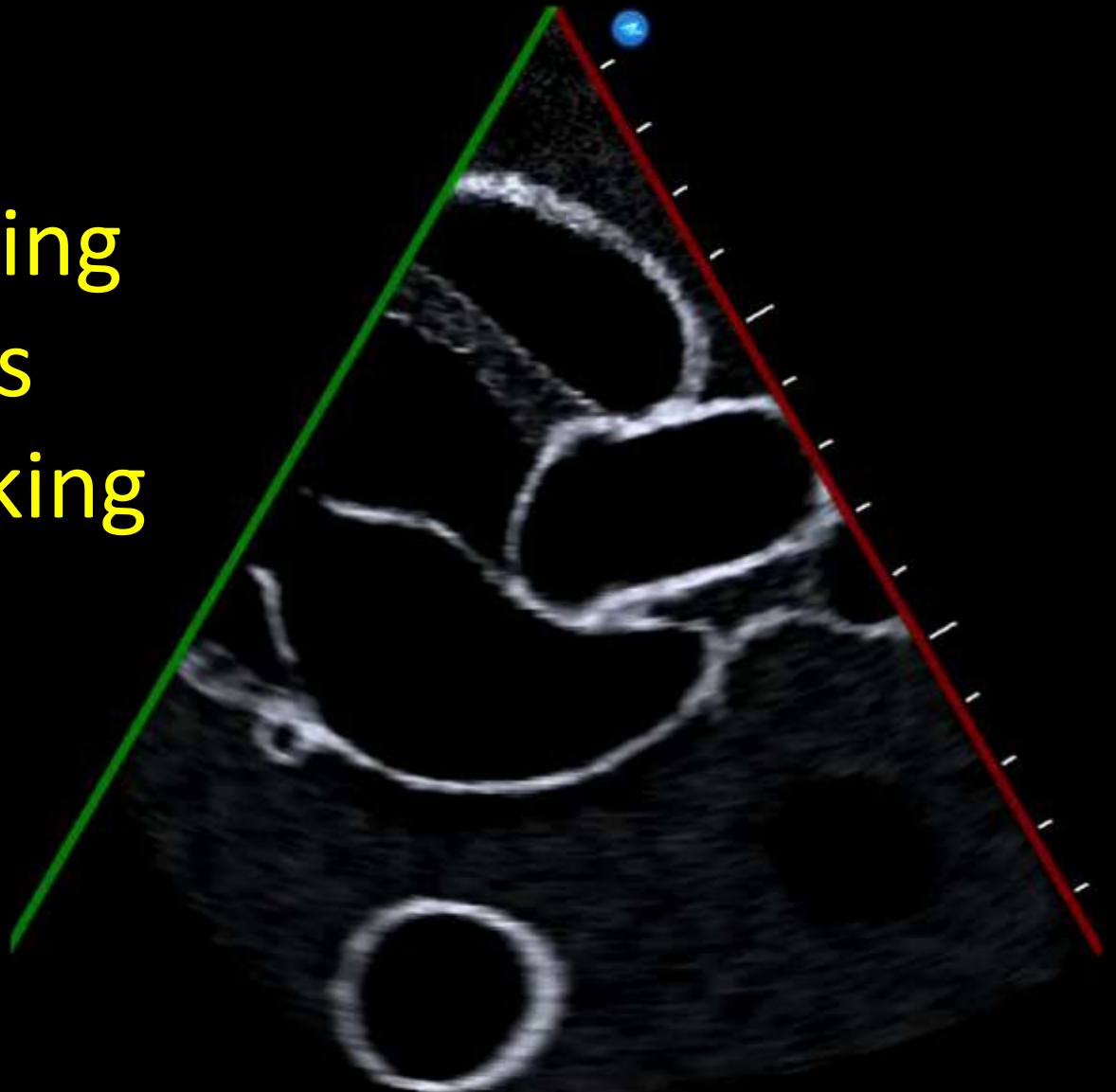
Sliding  
Vs  
Rocking







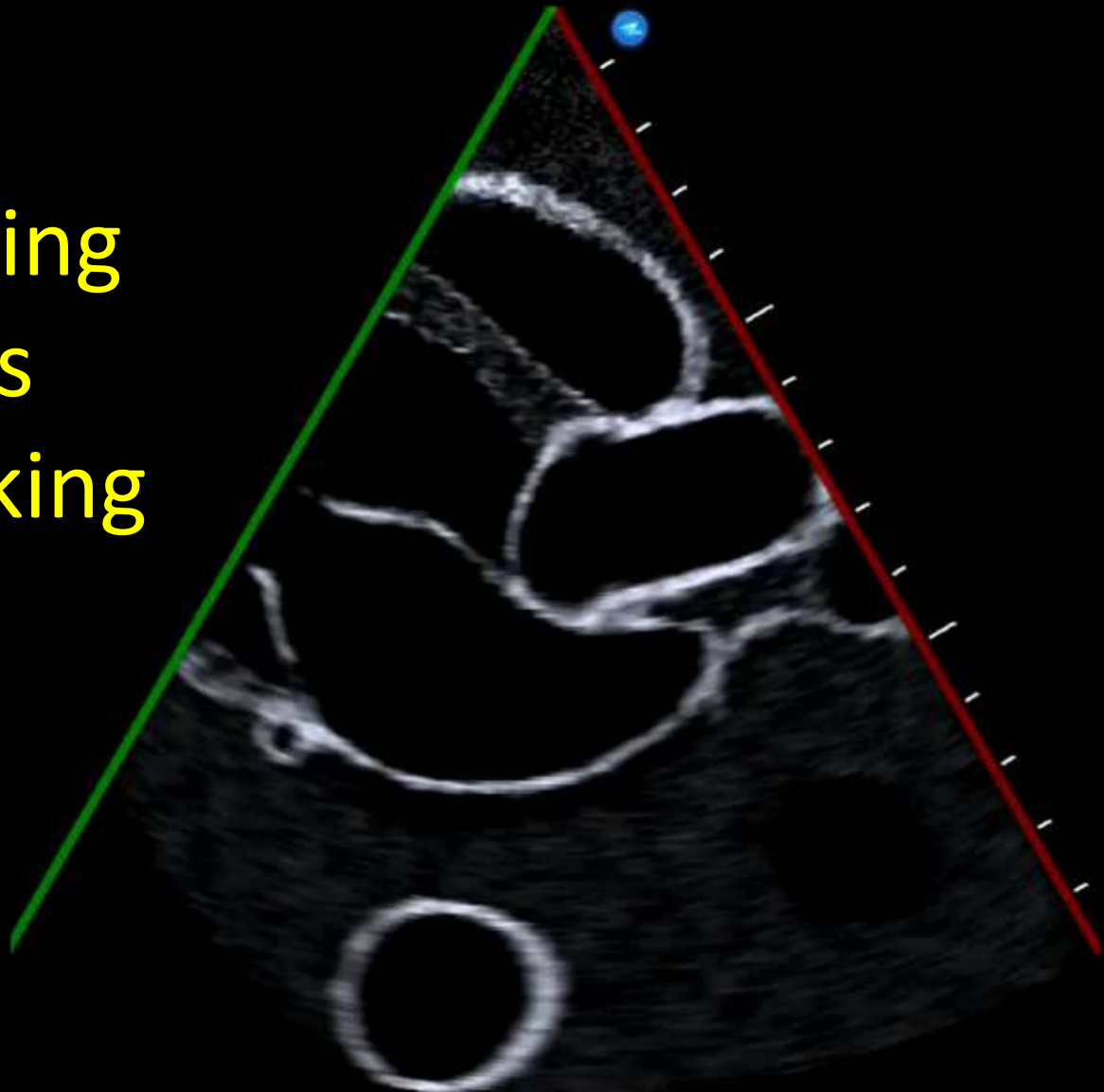
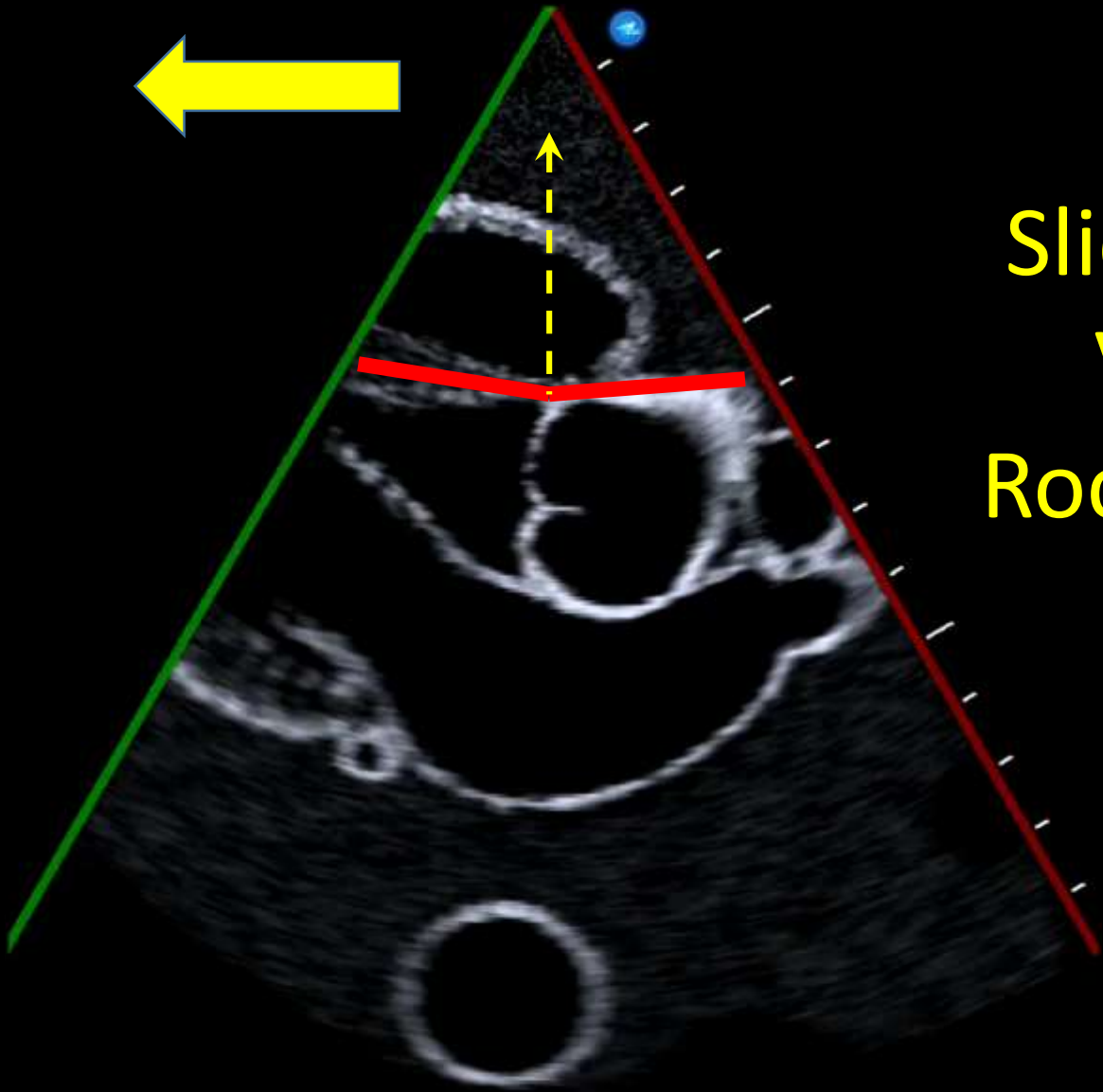
Sliding  
Vs  
Rocking



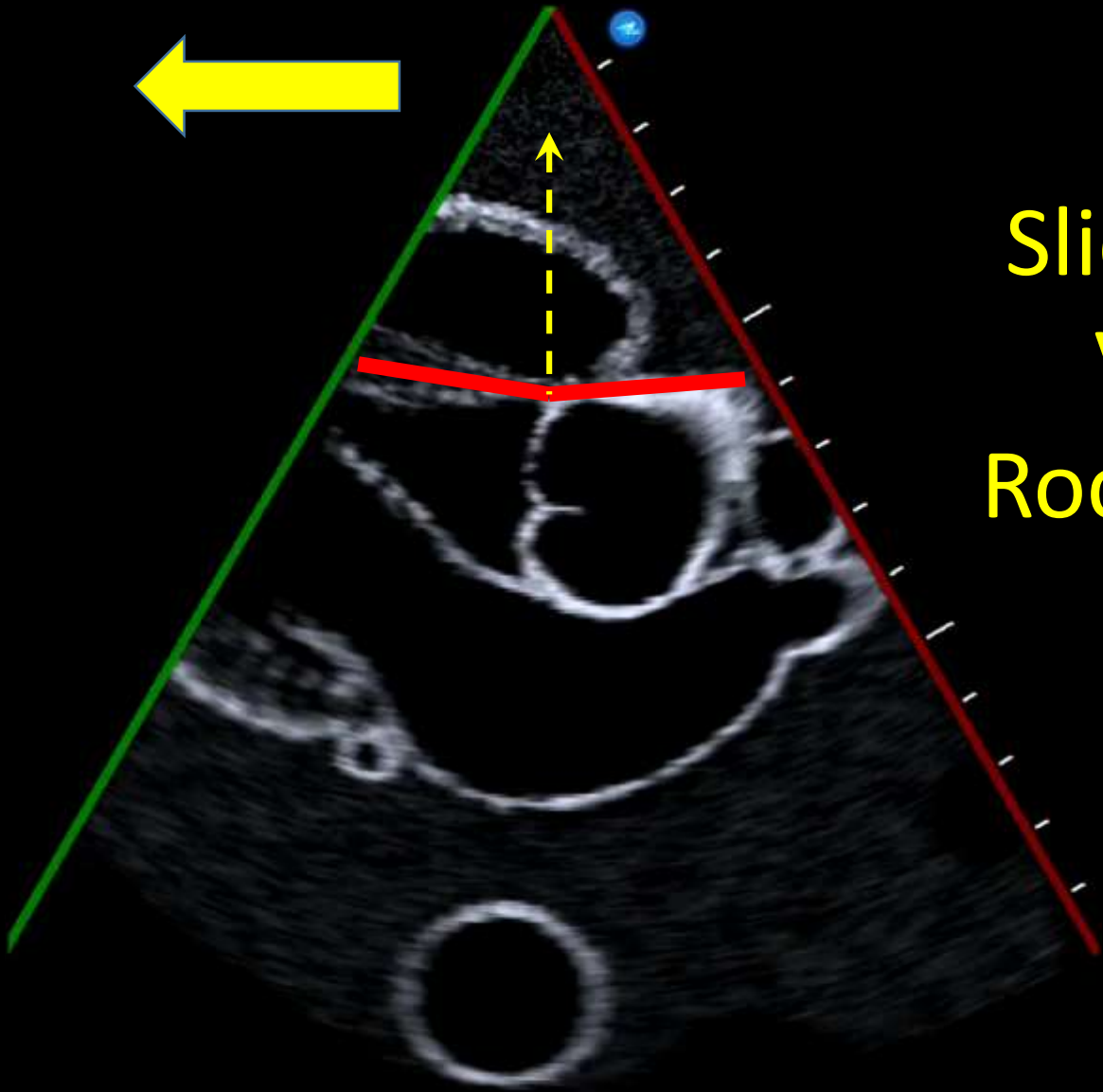
Normal aorto-septal angle –  
Need to slide towards the apex



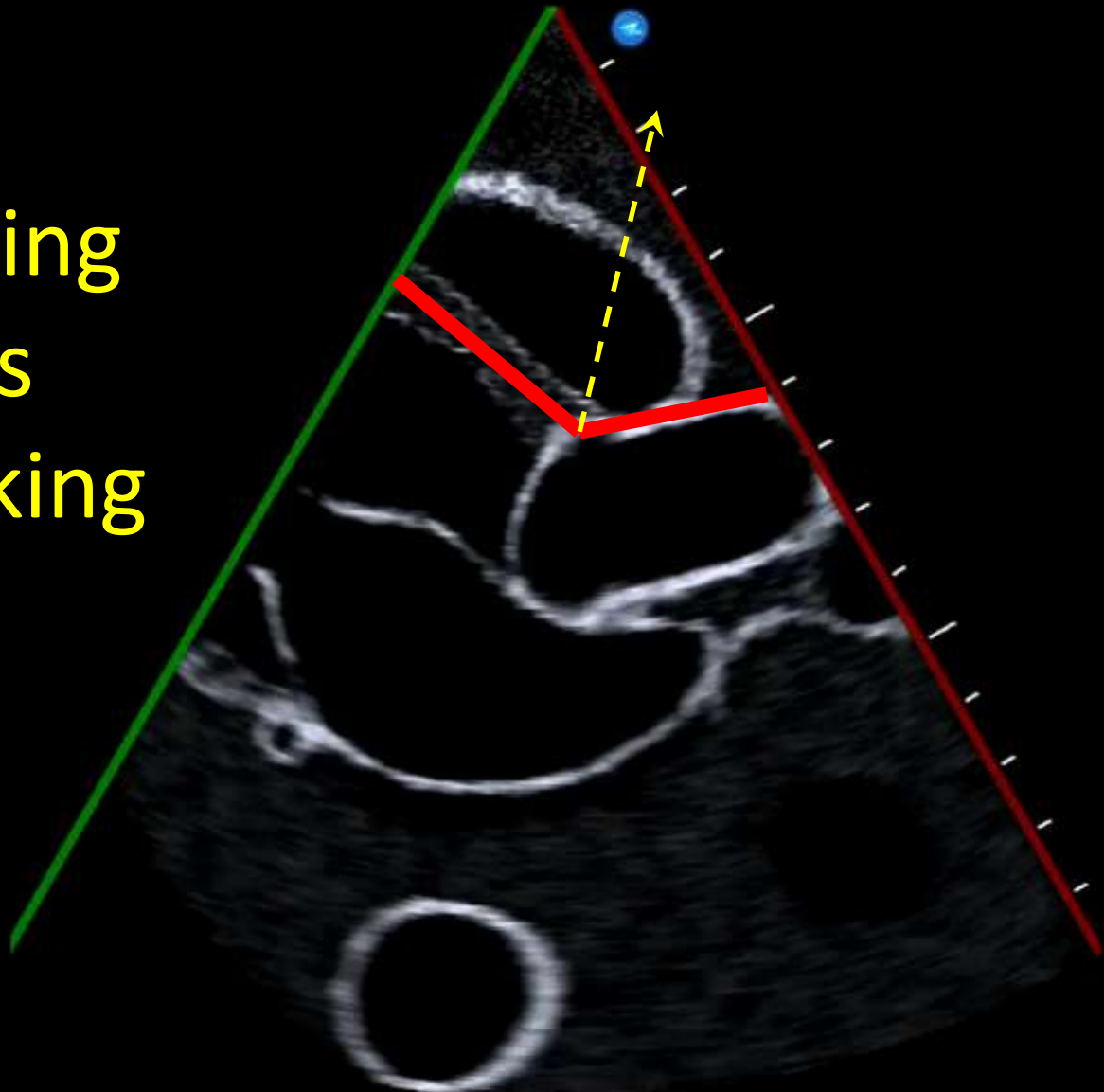
Sliding  
Vs  
Rocking



Normal aorto-septal angle –  
Need to slide towards the apex



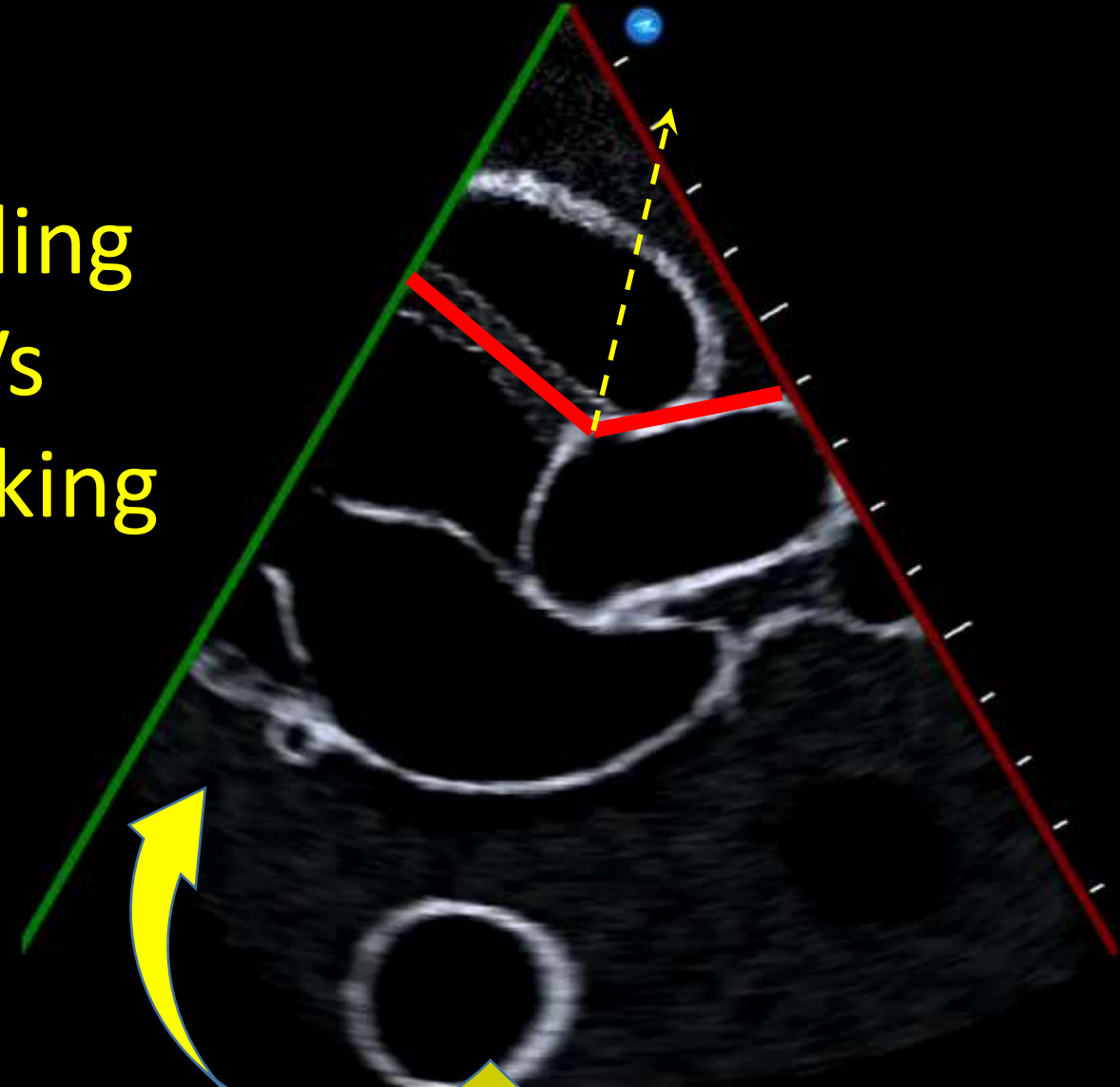
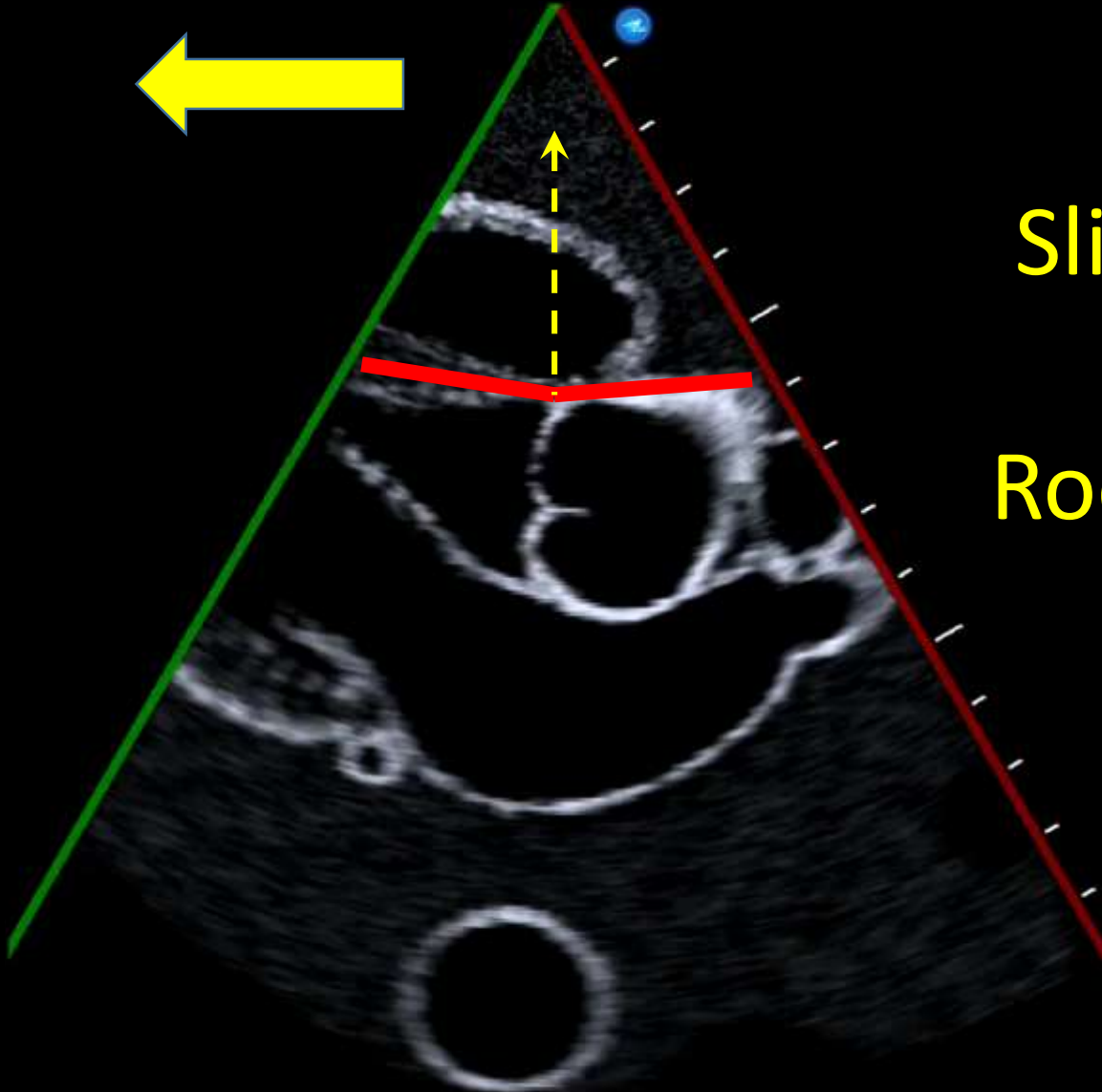
Sliding  
Vs  
Rocking



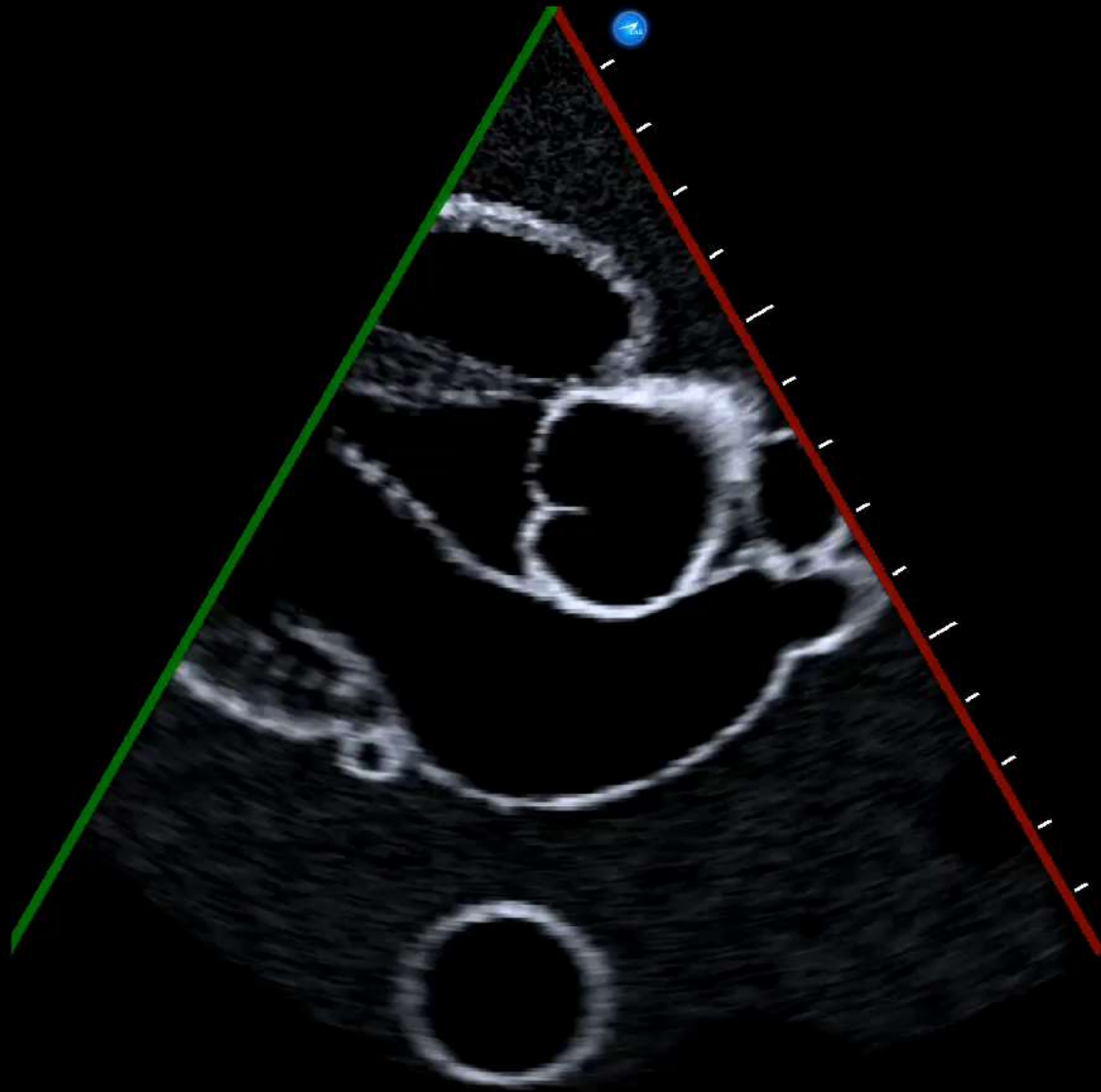


Normal aorto-septal angle –  
Need to **slide** towards the apex

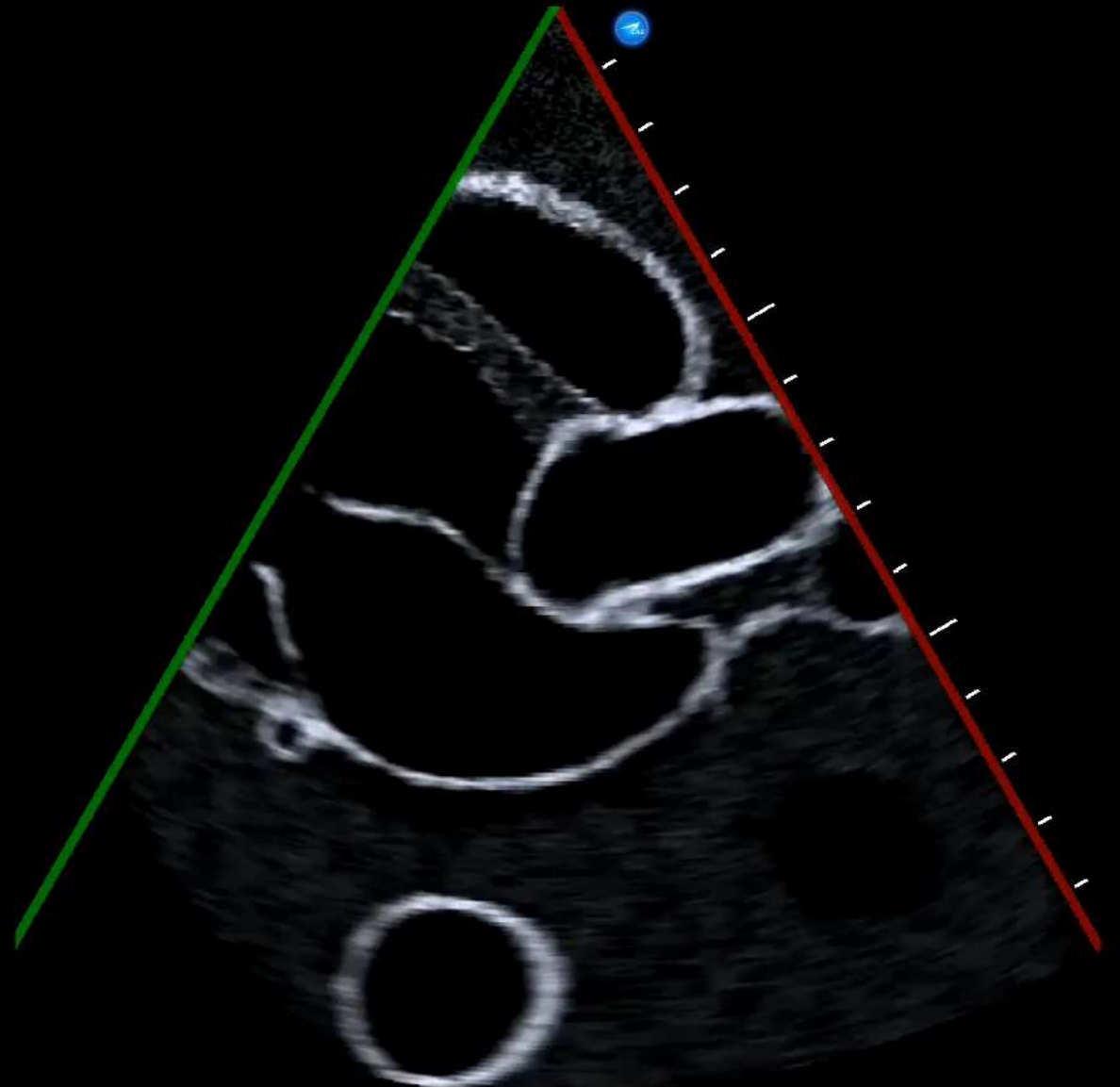
Aorto-septal angle is **rotated** –  
Need to **rock** towards the apex



Sliding  
Vs  
Rocking

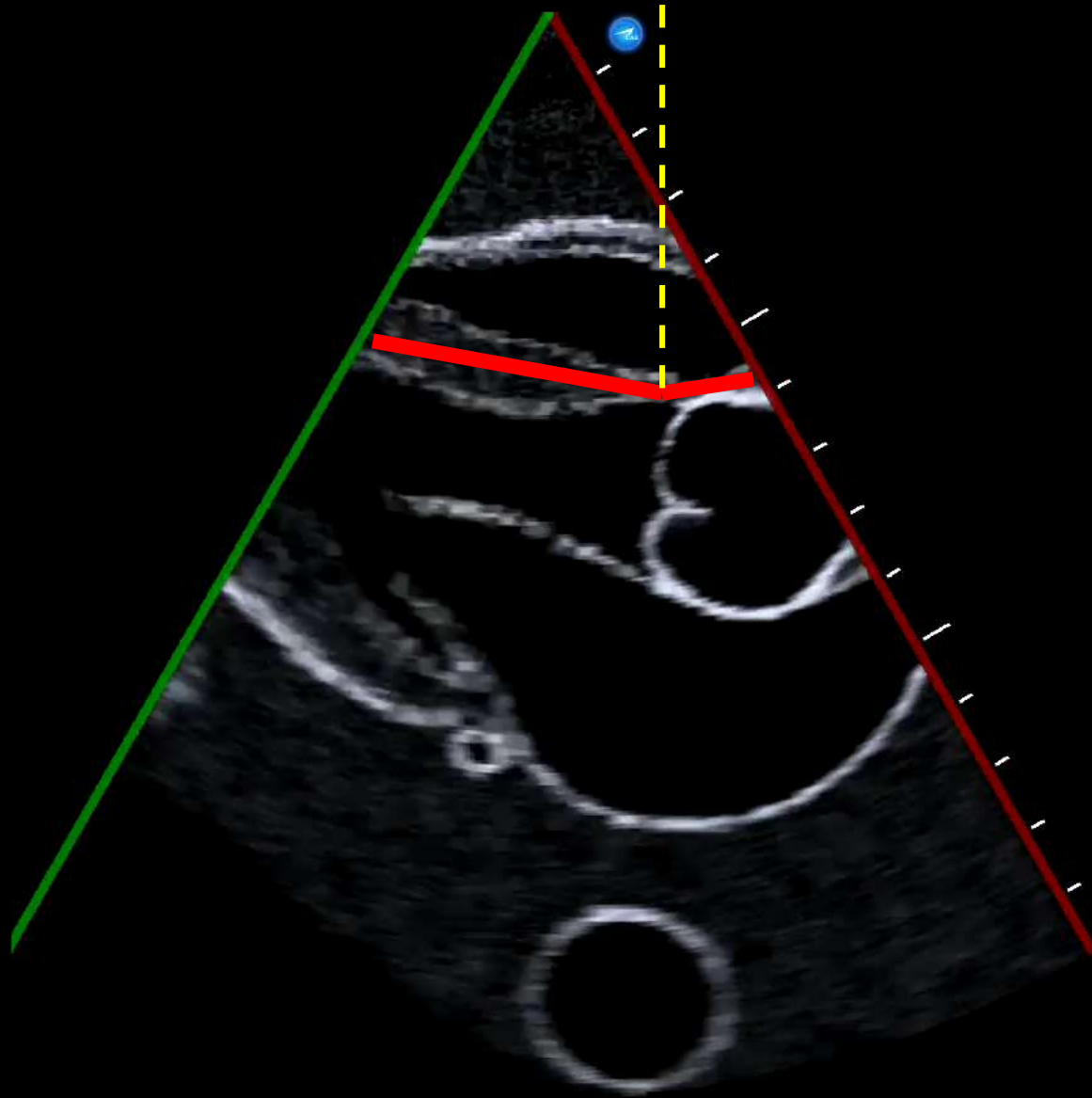


Gregory Mints, M.D., Gigi Lui, M.D.



©Cornell Medical College, Johns Hopkins

SLIDE

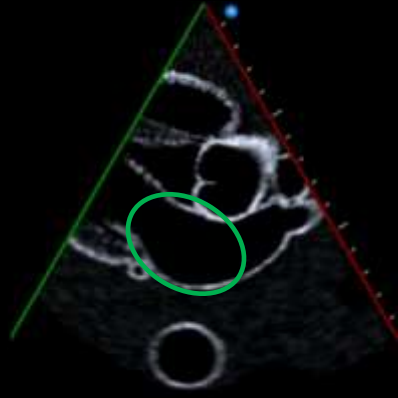


Gregory Mints, M.D.

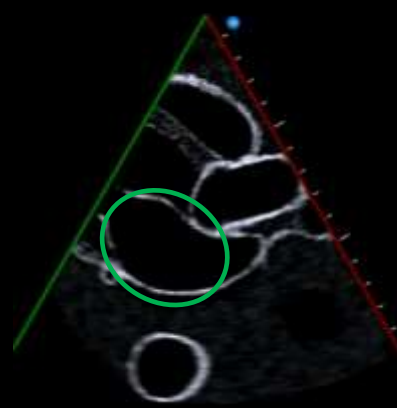
ROCK

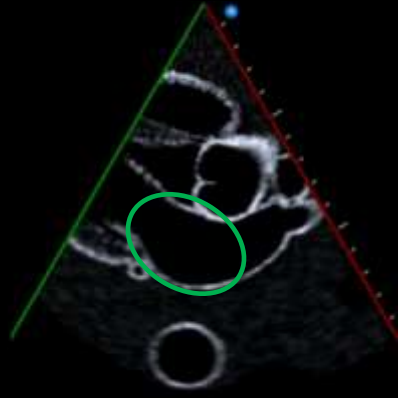


©Cornell Medical College

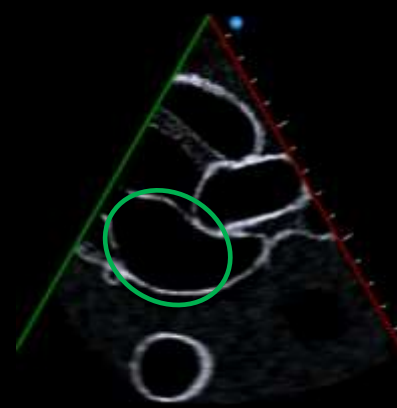


Atrium in the Center

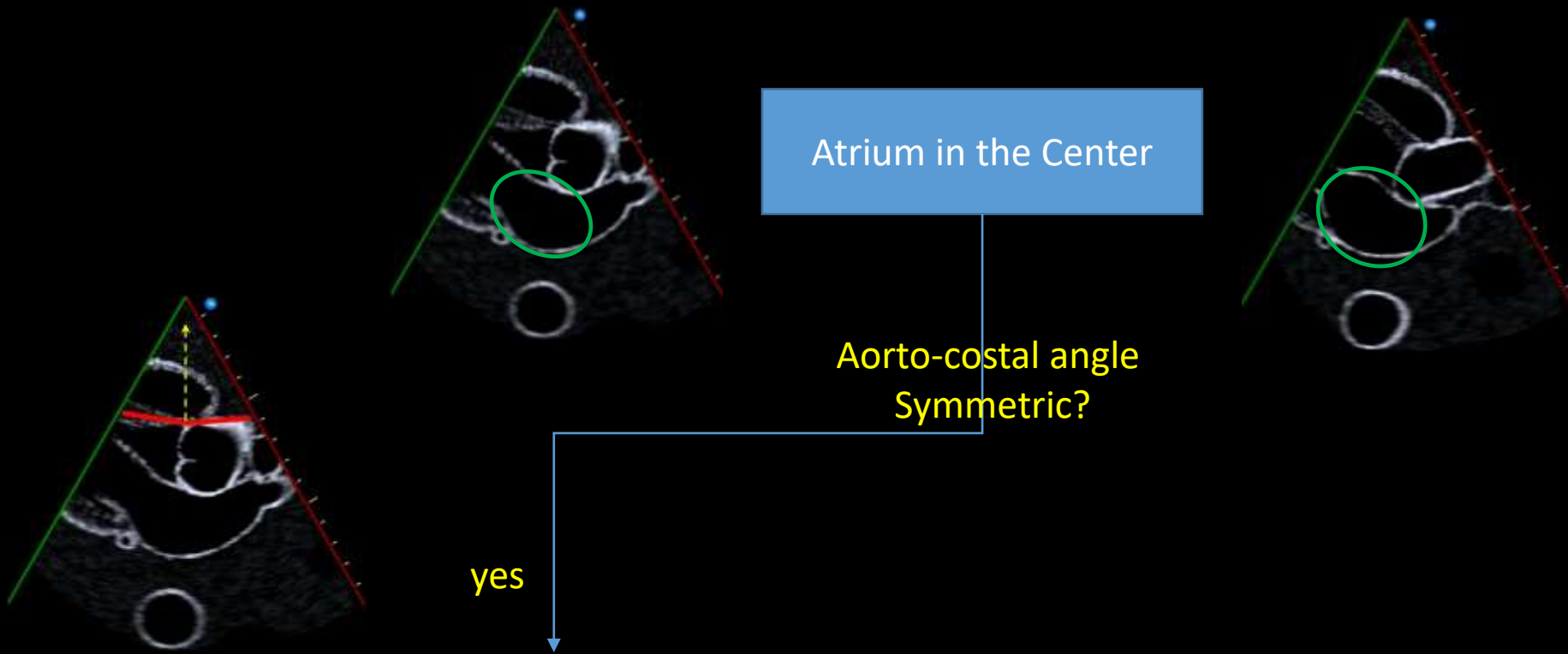


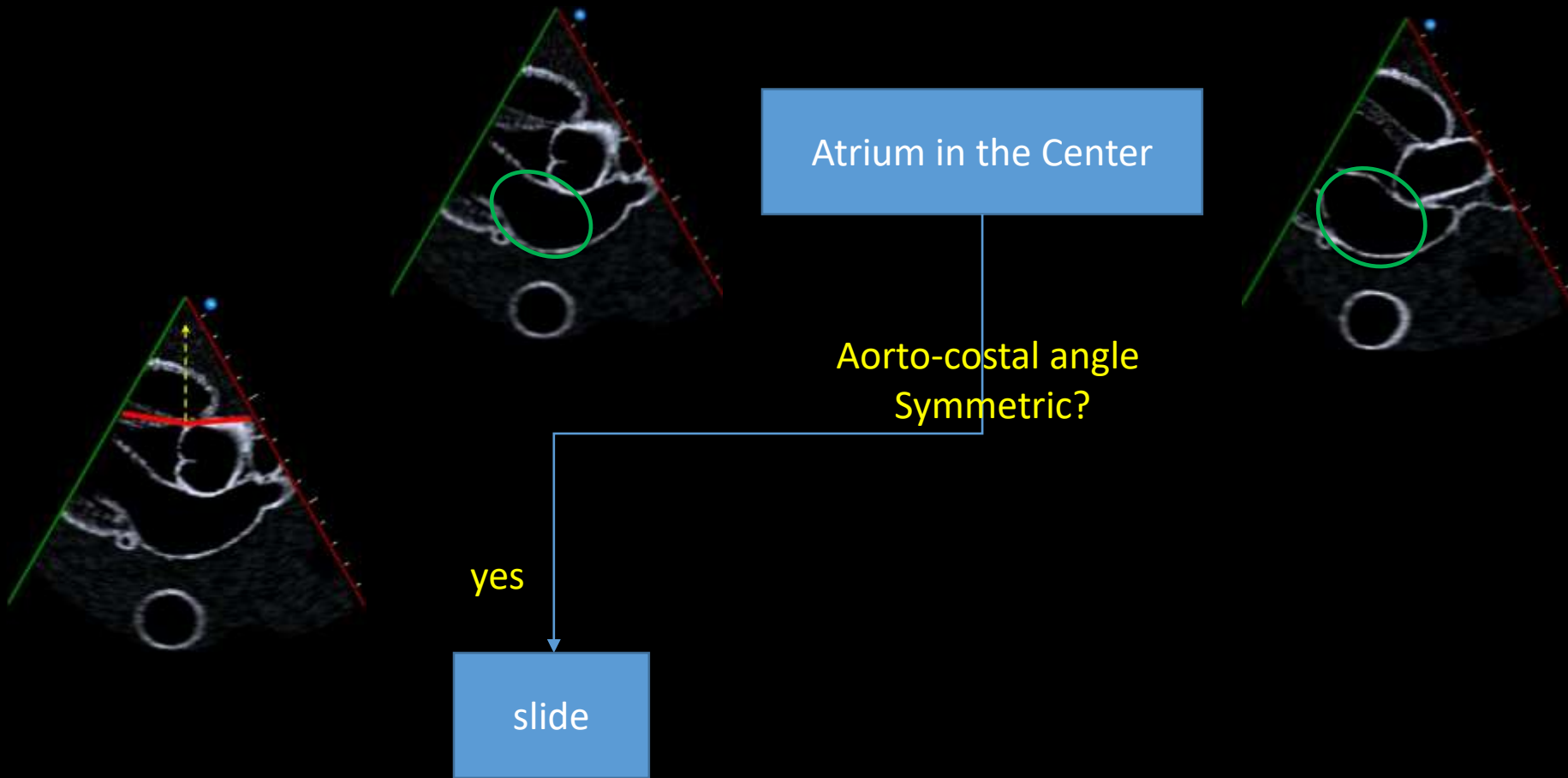


Atrium in the Center



Aorto-costal angle  
Symmetric?







Atrium in the Center

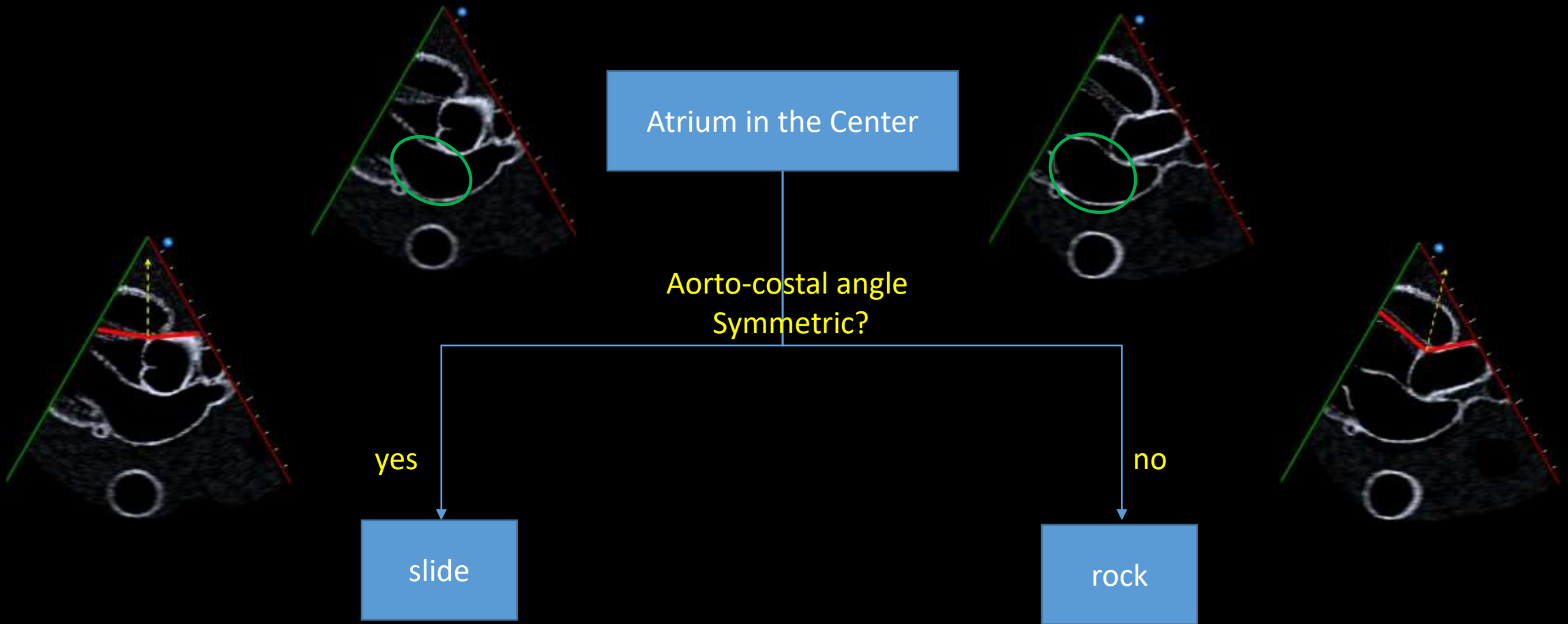
Aorto-costal angle  
Symmetric?

yes

slide

no

rock





# PLAx

- depth {
  1. Surveillance depth: descending aorta @ ~ middle of the screen
  2. Study depth: Descending aorta visible at the bottom of the screen
- Rock/  
Slide {
  3. Focus on LV. MV should be just to the right of the screen center
  4. **Aorto-septal angle: flat and symmetric**

# PLAx

- depth {
1. Surveillance depth: descending aorta @ ~ middle of the screen
  2. Study depth: Descending aorta visible at the bottom of the screen
- Slide 3. Focus on LV. MV should be just to the right of the screen center

# PLAx

- depth {
1. Surveillance depth: descending aorta @ ~ middle of the screen
  2. Study depth: Descending aorta visible at the bottom of the screen
- Slide 3. Focus on LV. MV should be just to the right of the screen center
- Rock • **Aorto-septal angle: flat and symmetric**

# PLAx

- depth { 1. Surveillance depth: descending aorta @ ~ middle of the screen
- 2. Study depth: Descending aorta visible at the bottom of the screen
- Slide 3. Focus on LV. MV should be just to the right of the screen center
- Rock
  - Aorto-septal angle: flat and symmetric
- 4. **Aorto-septal angle: flat and symmetric**

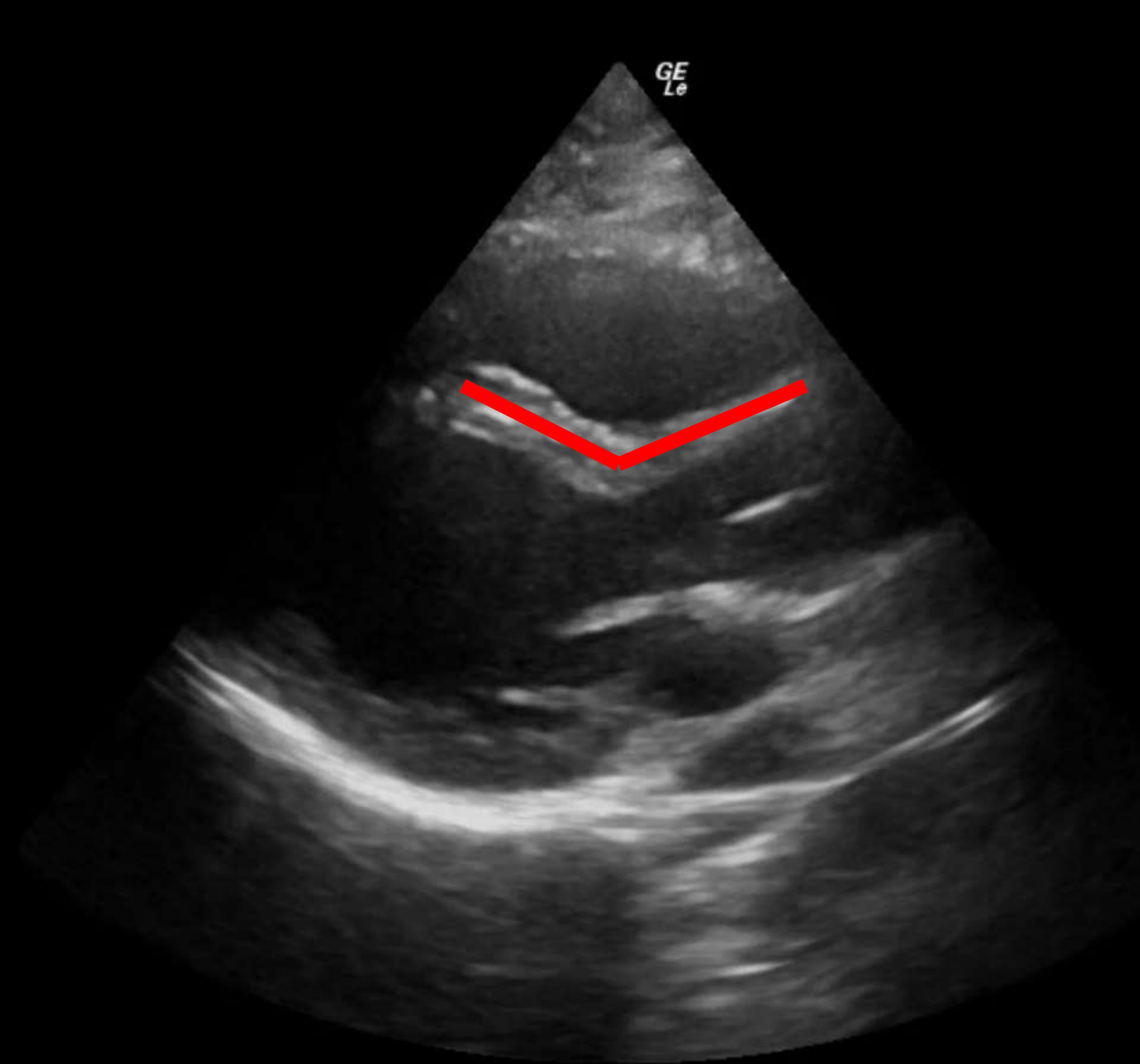


**Standard PLAx**

Gregory Mints, M.D.



©Cornell Medical College

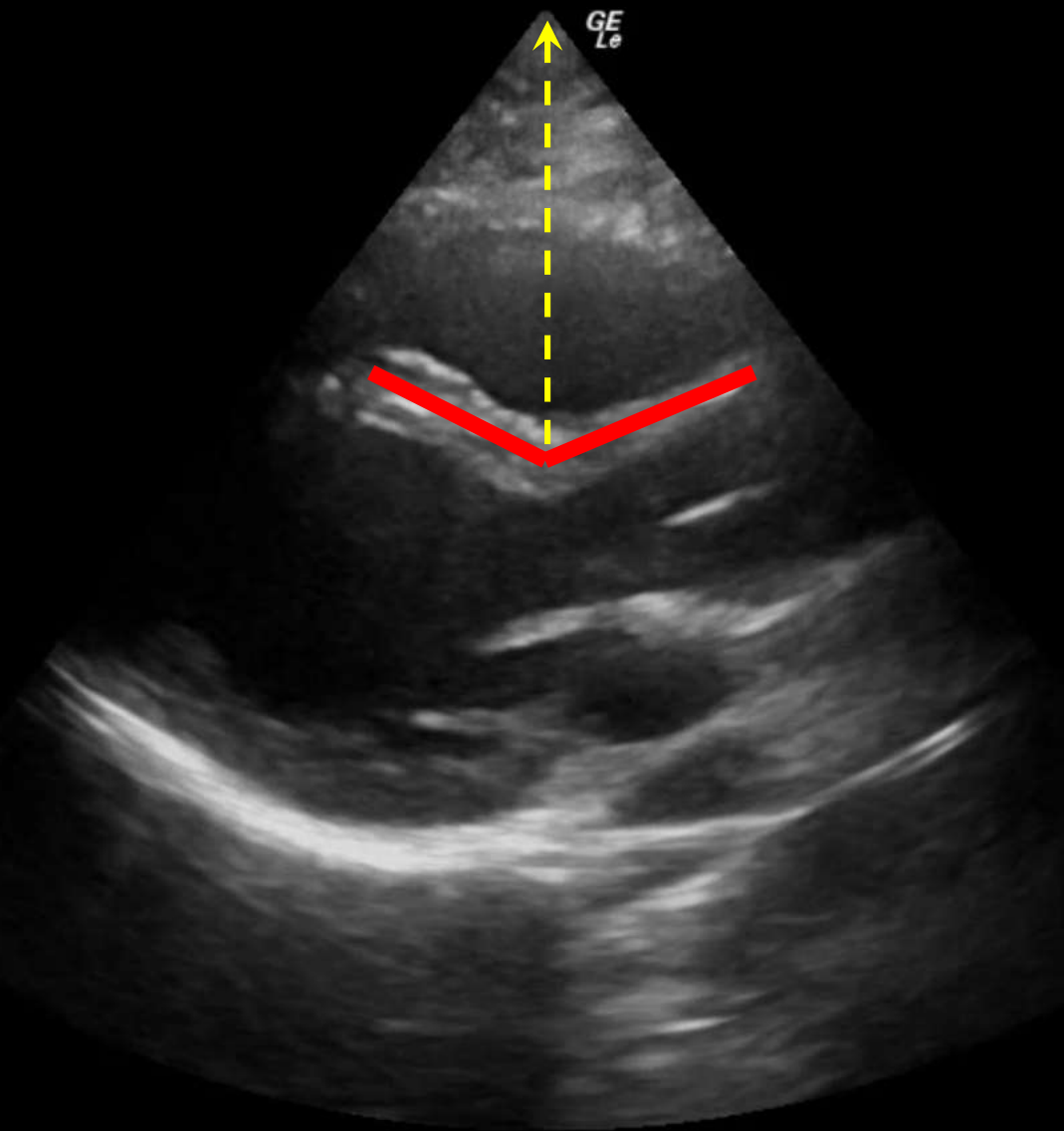


Standard PLAx

Gregory Mints, M.D.

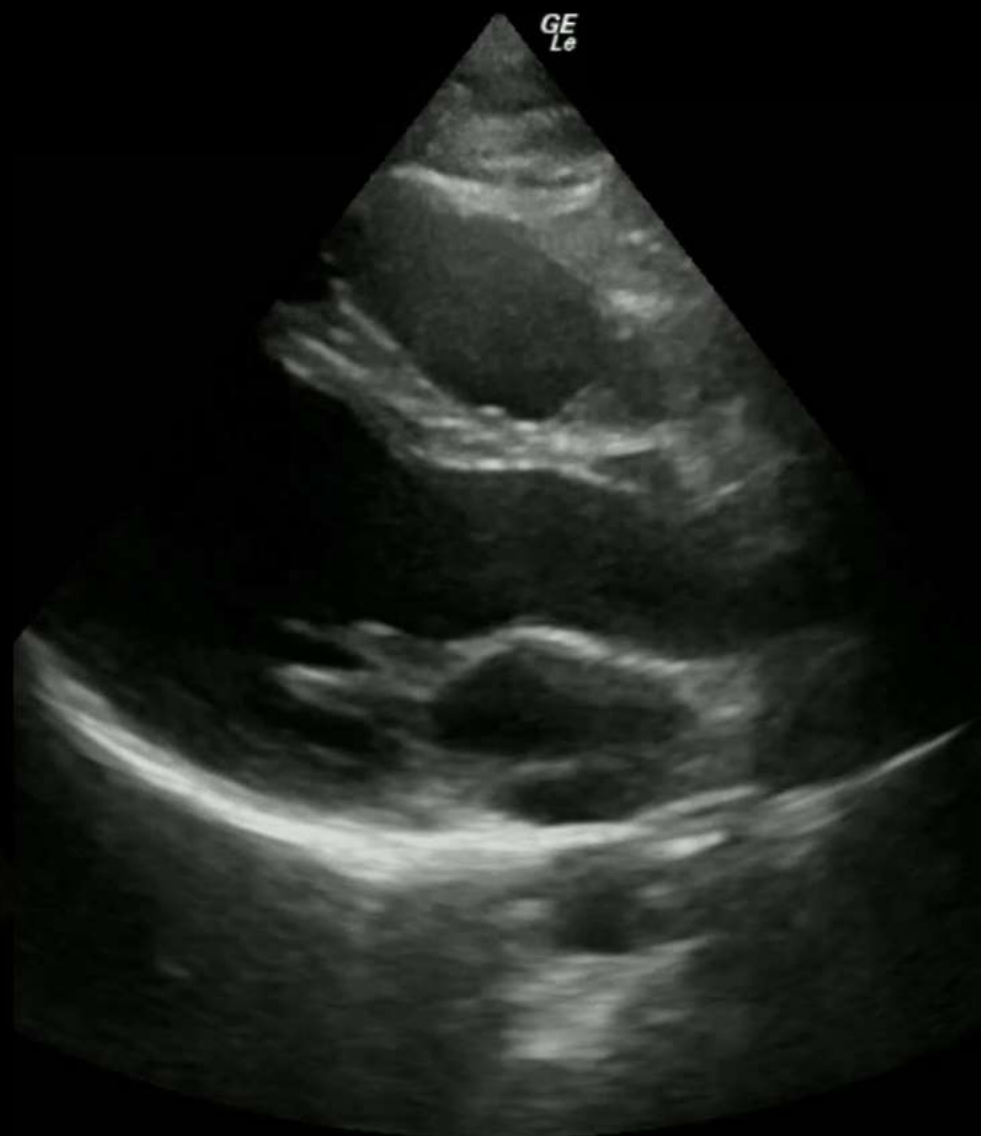


©Cornell Medical College

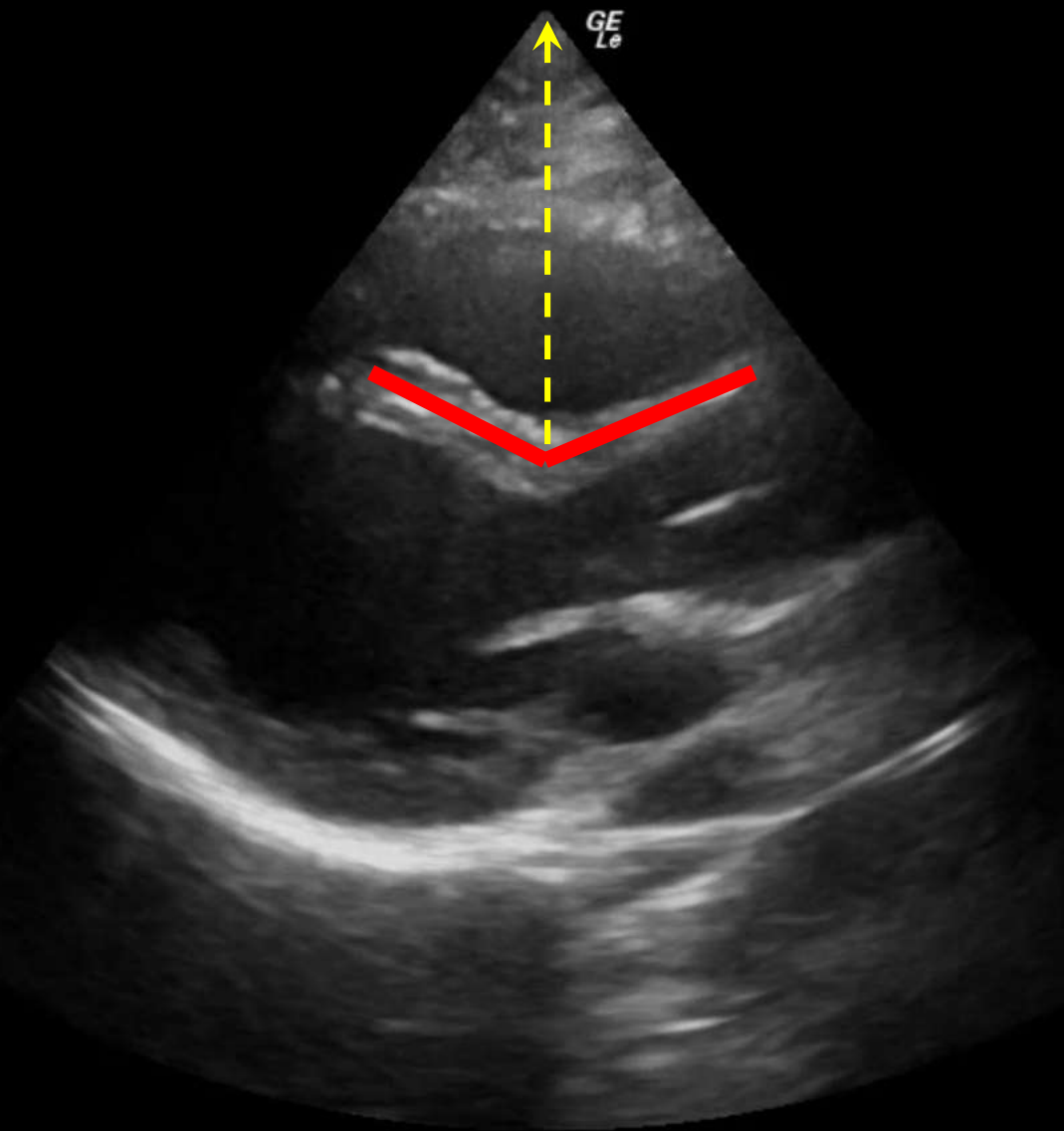


Standard PLAx

Gregory Mints, M.D.

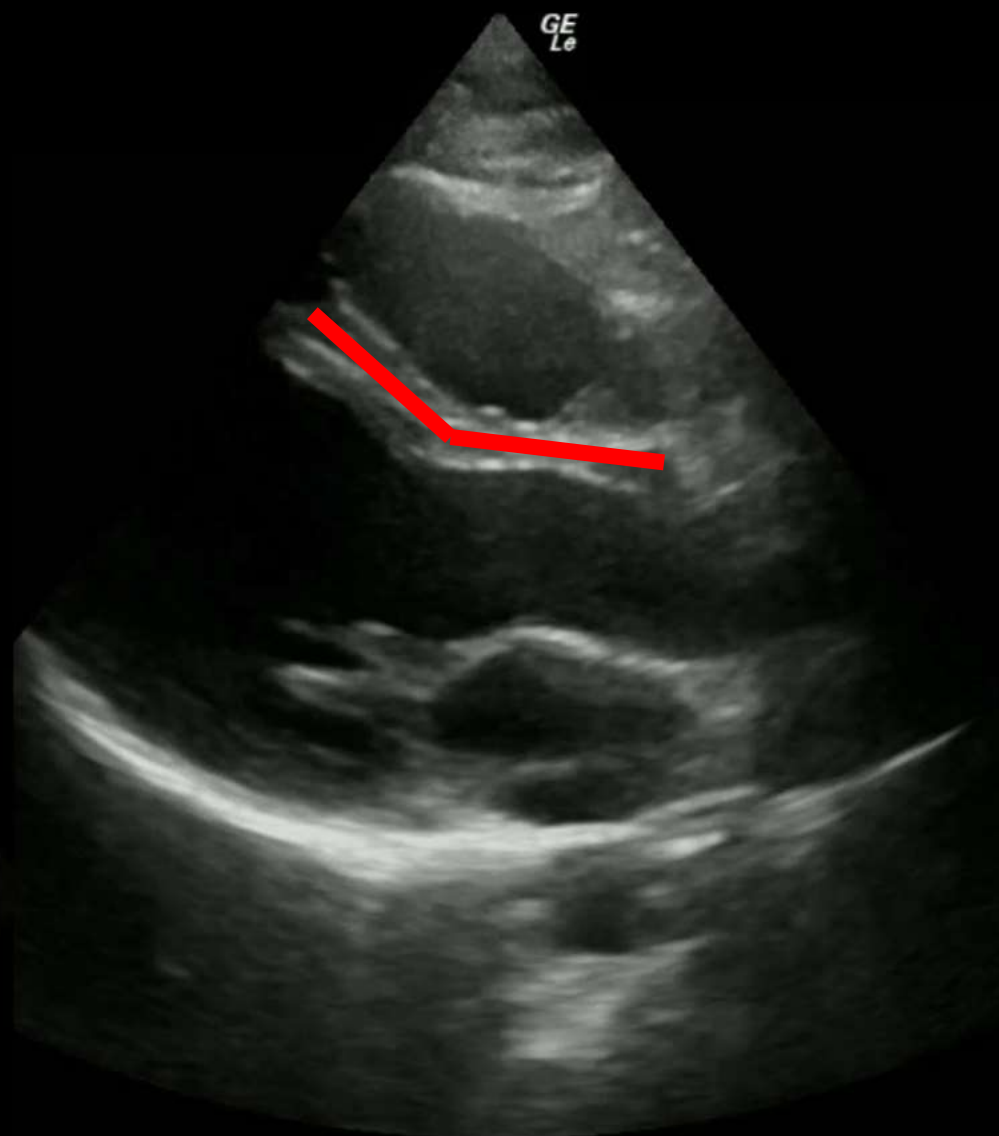


©Cornell Medical College



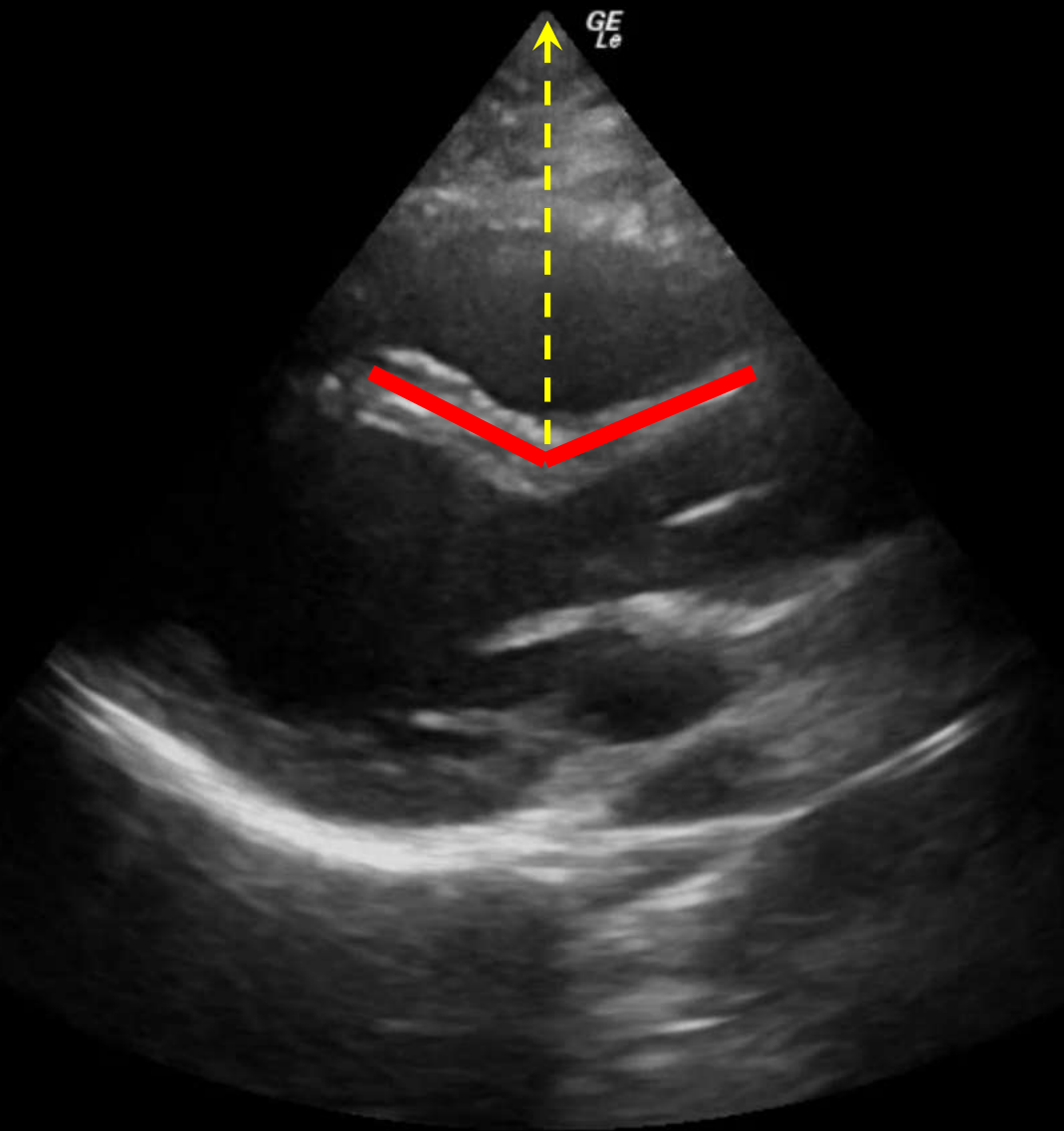
Standard PLAx

Gregory Mints, M.D.



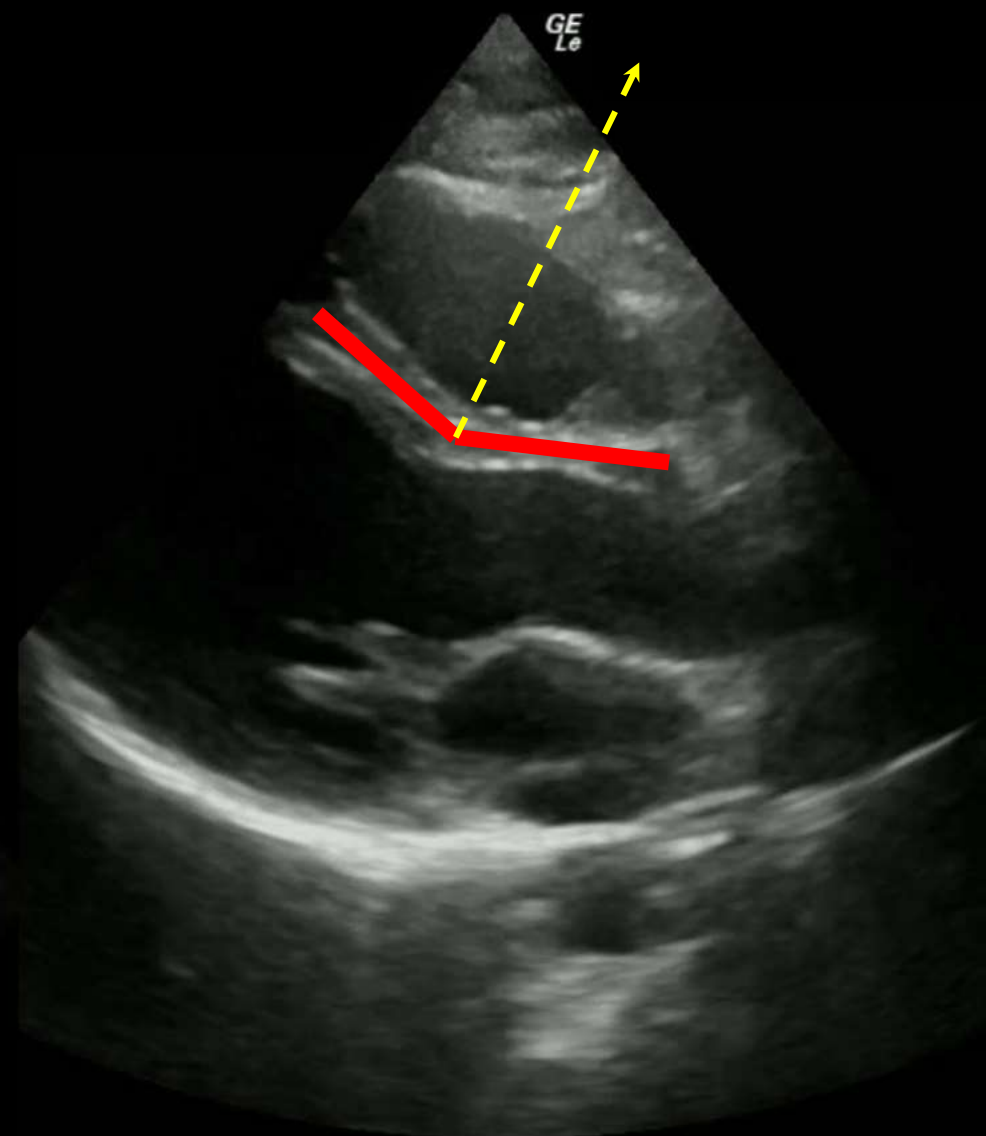
©Cornell Medical College



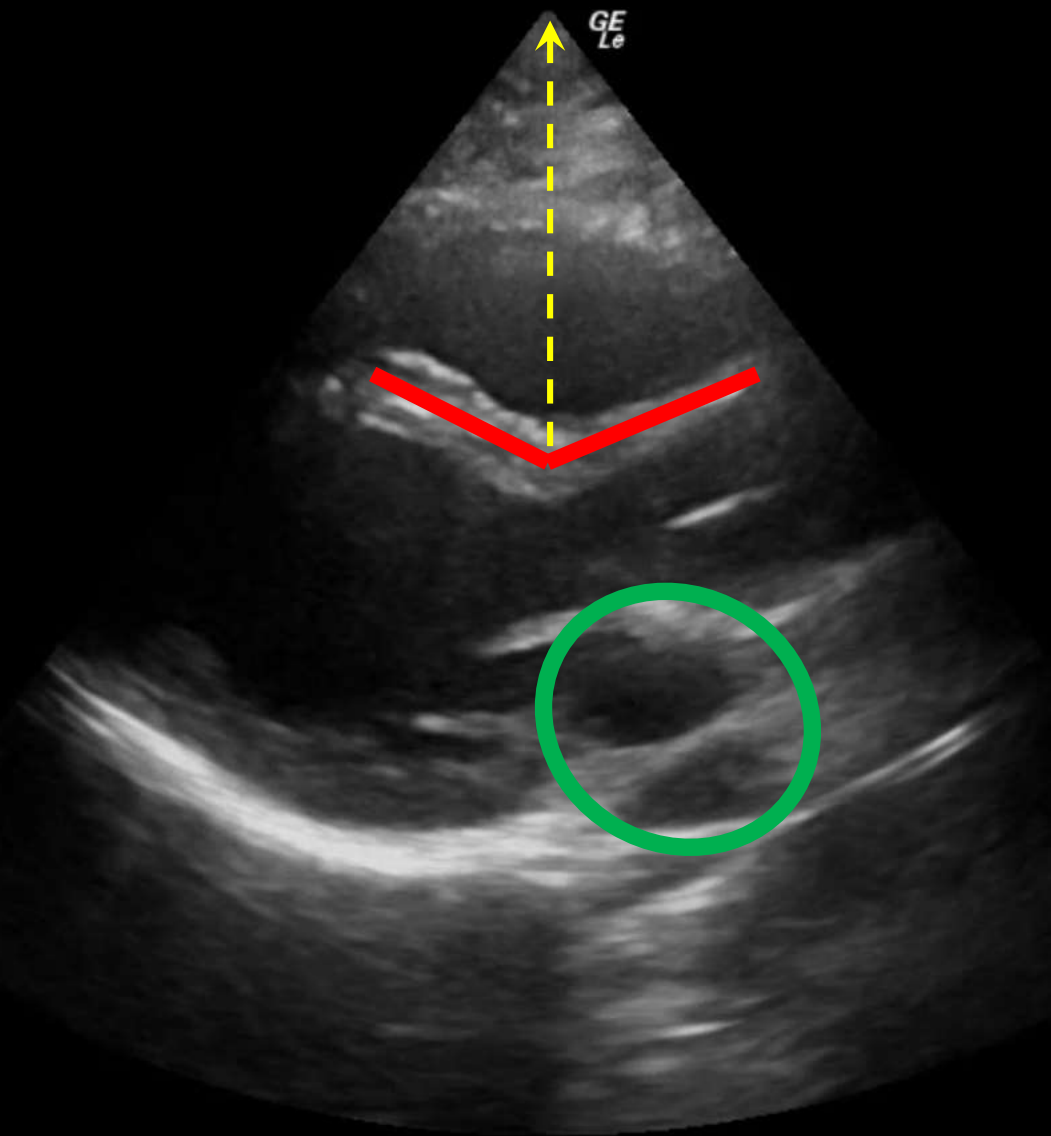


Standard PLAx

Gregory Mints, M.D.

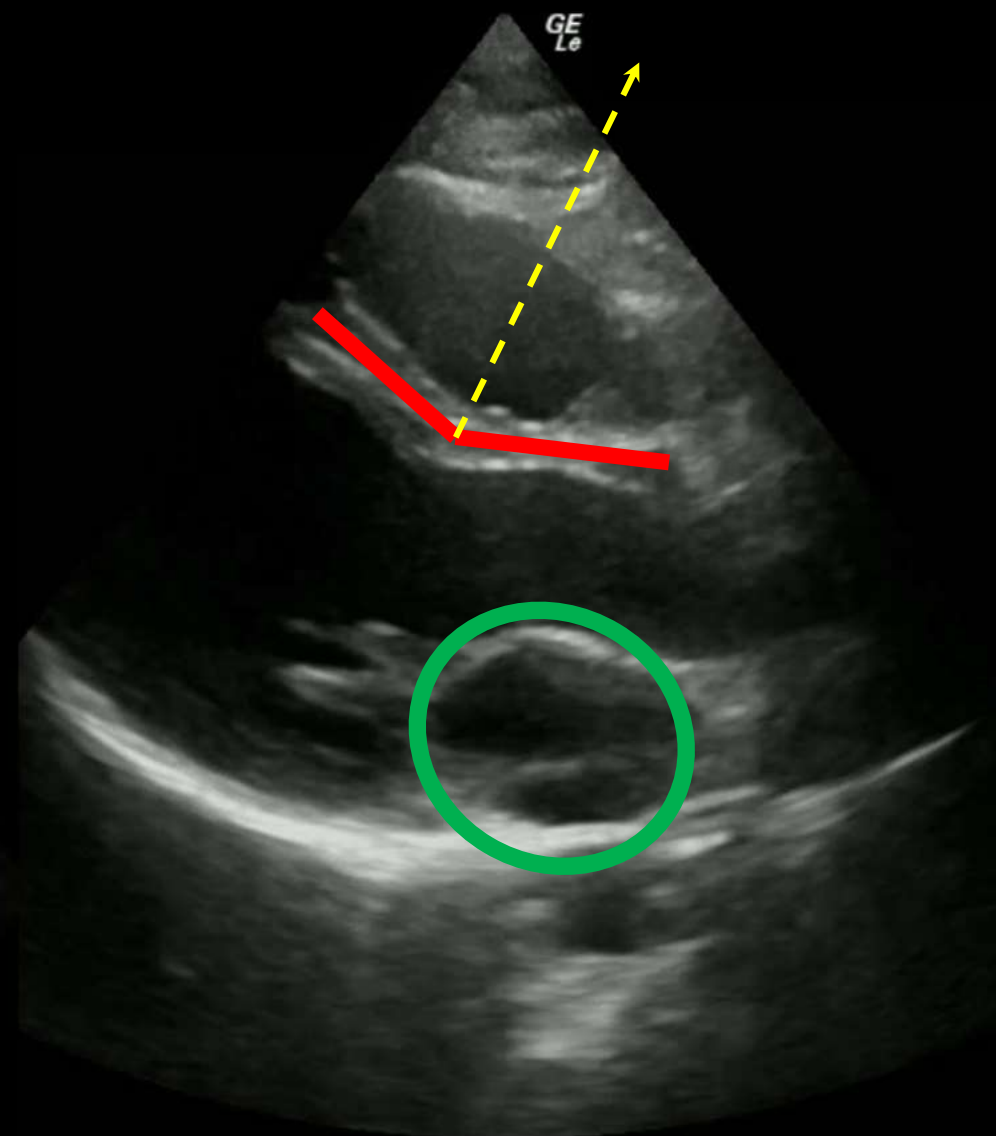


©Cornell Medical College

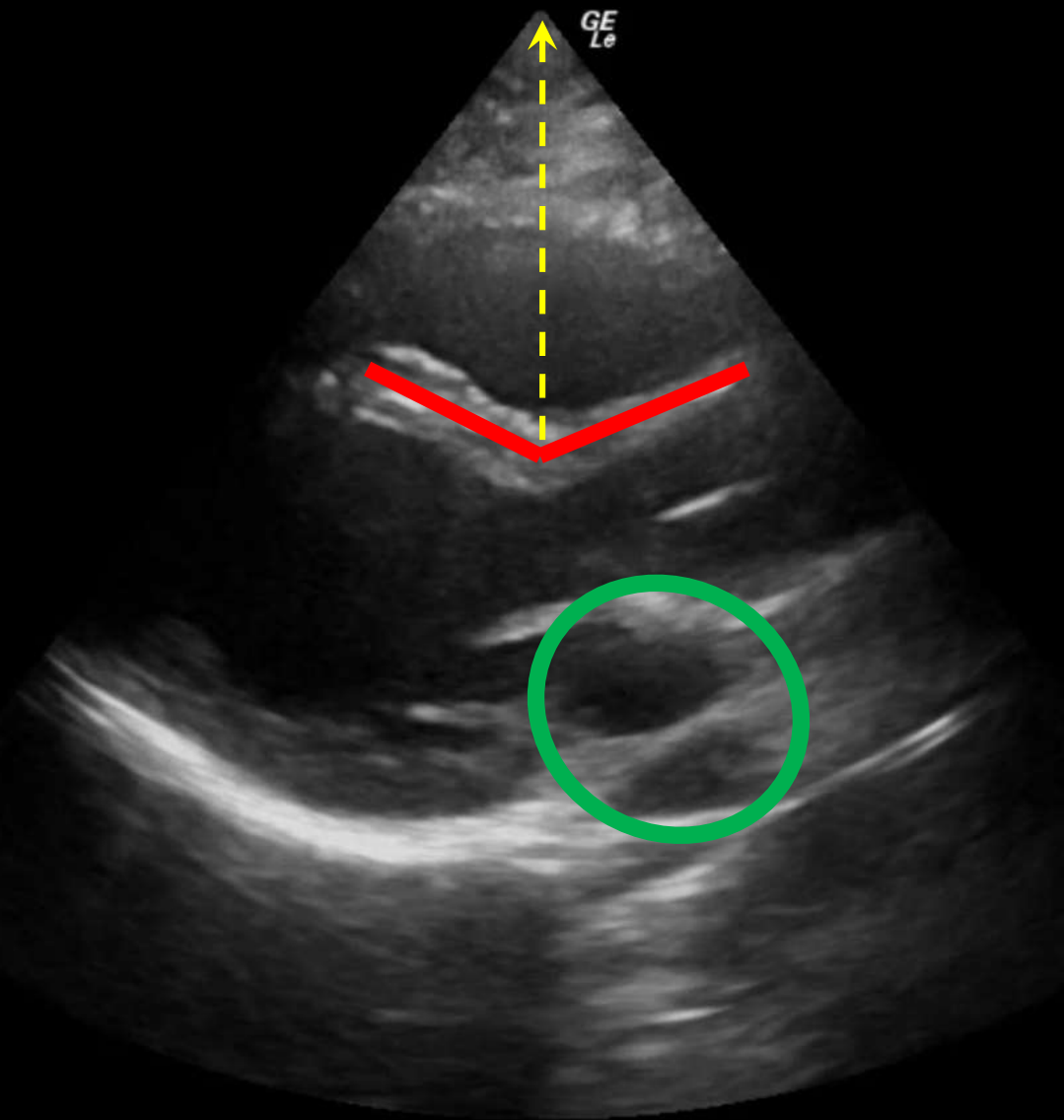


Standard PLAx

Gregory Mints, M.D.

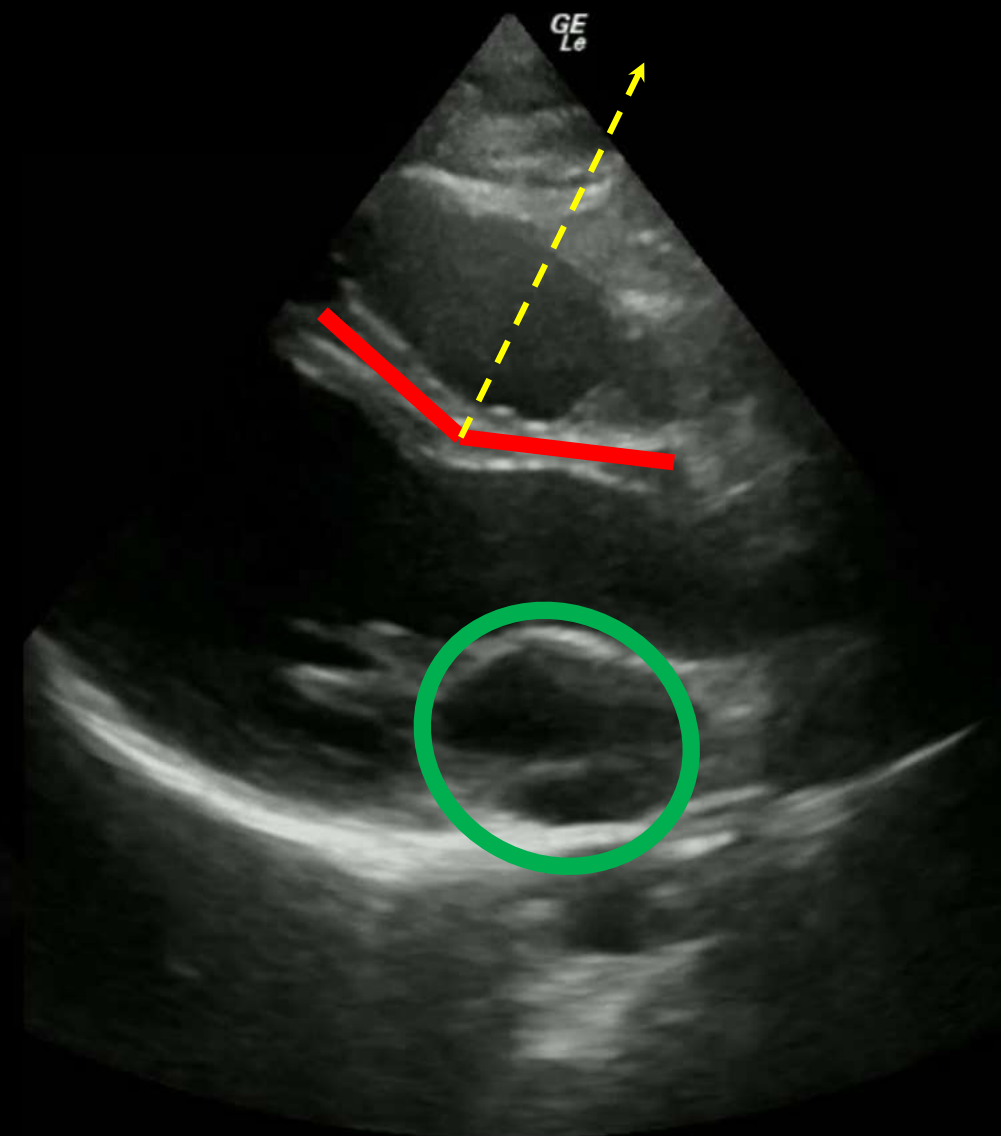


©Cornell Medical College



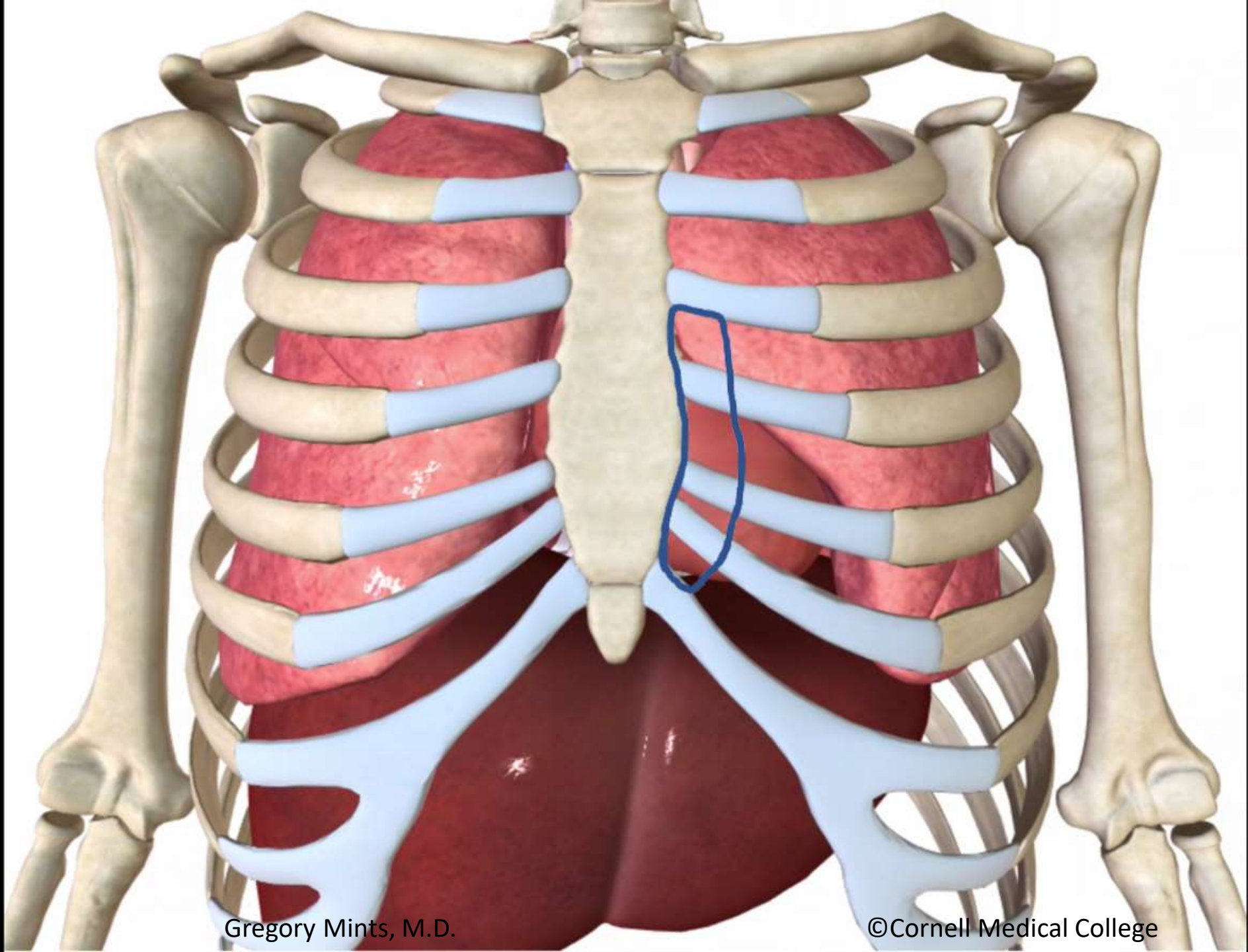
Standard PLAx

Gregory Mints, M.D.

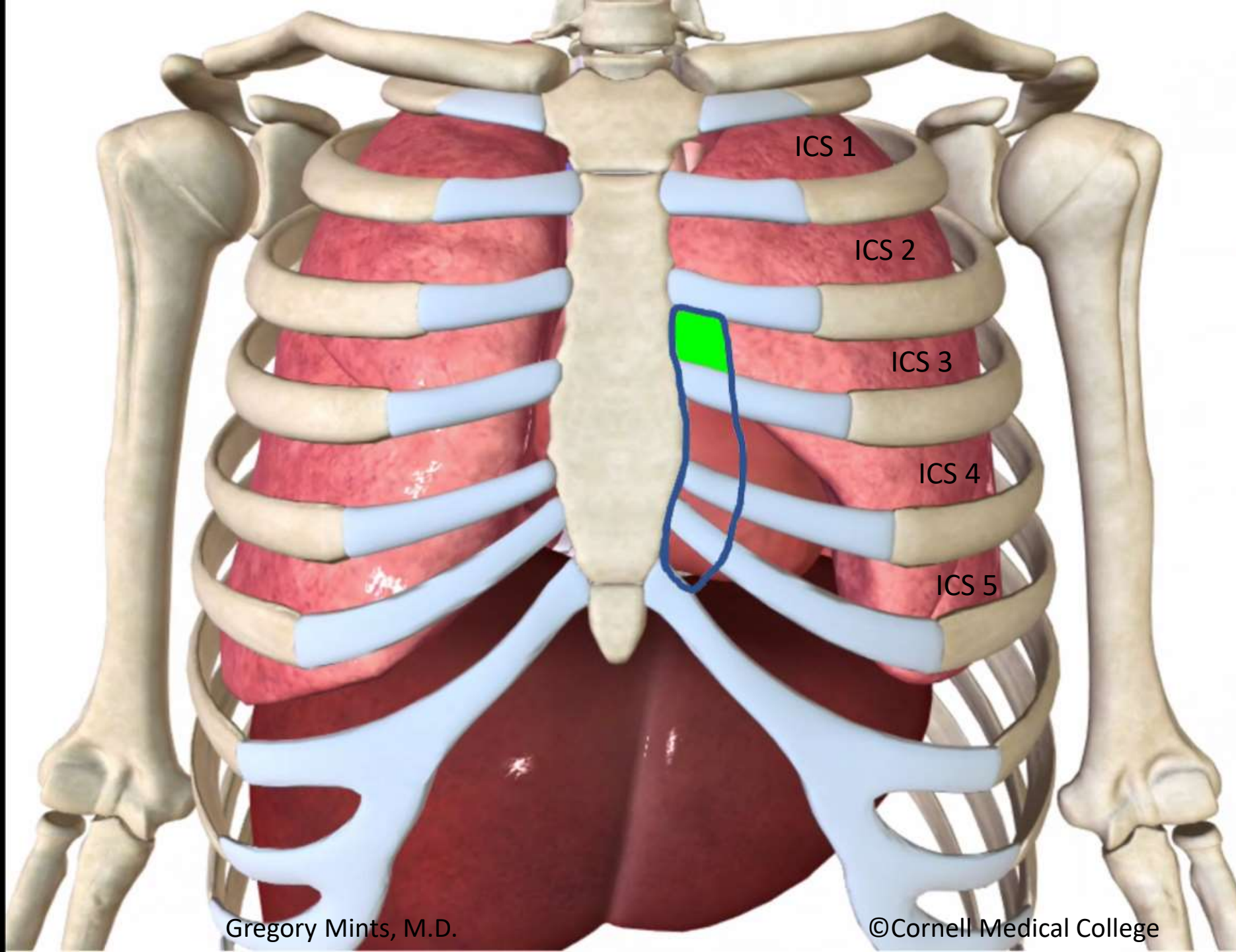


Low PLAx

©Cornell Medical College







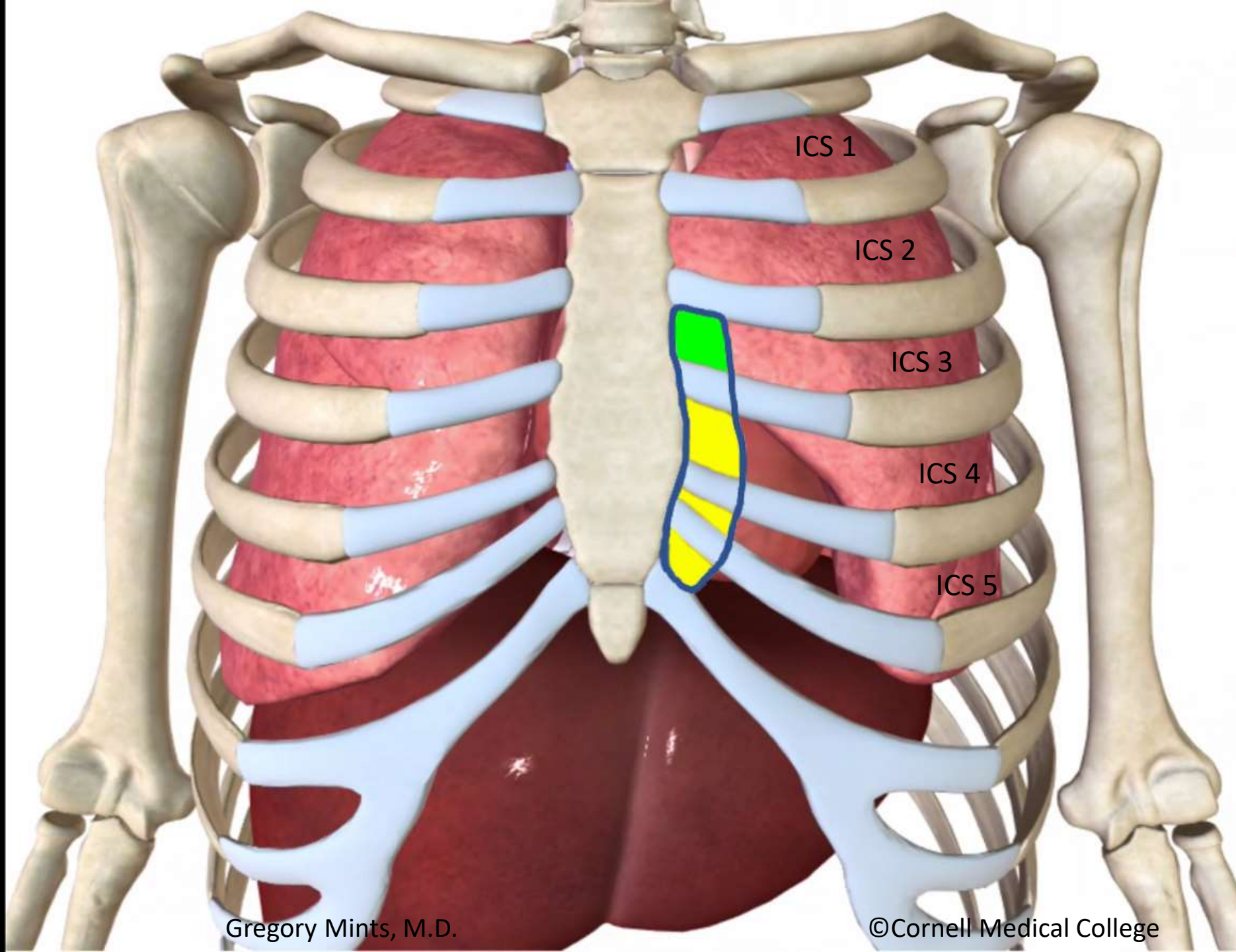
ICS 1

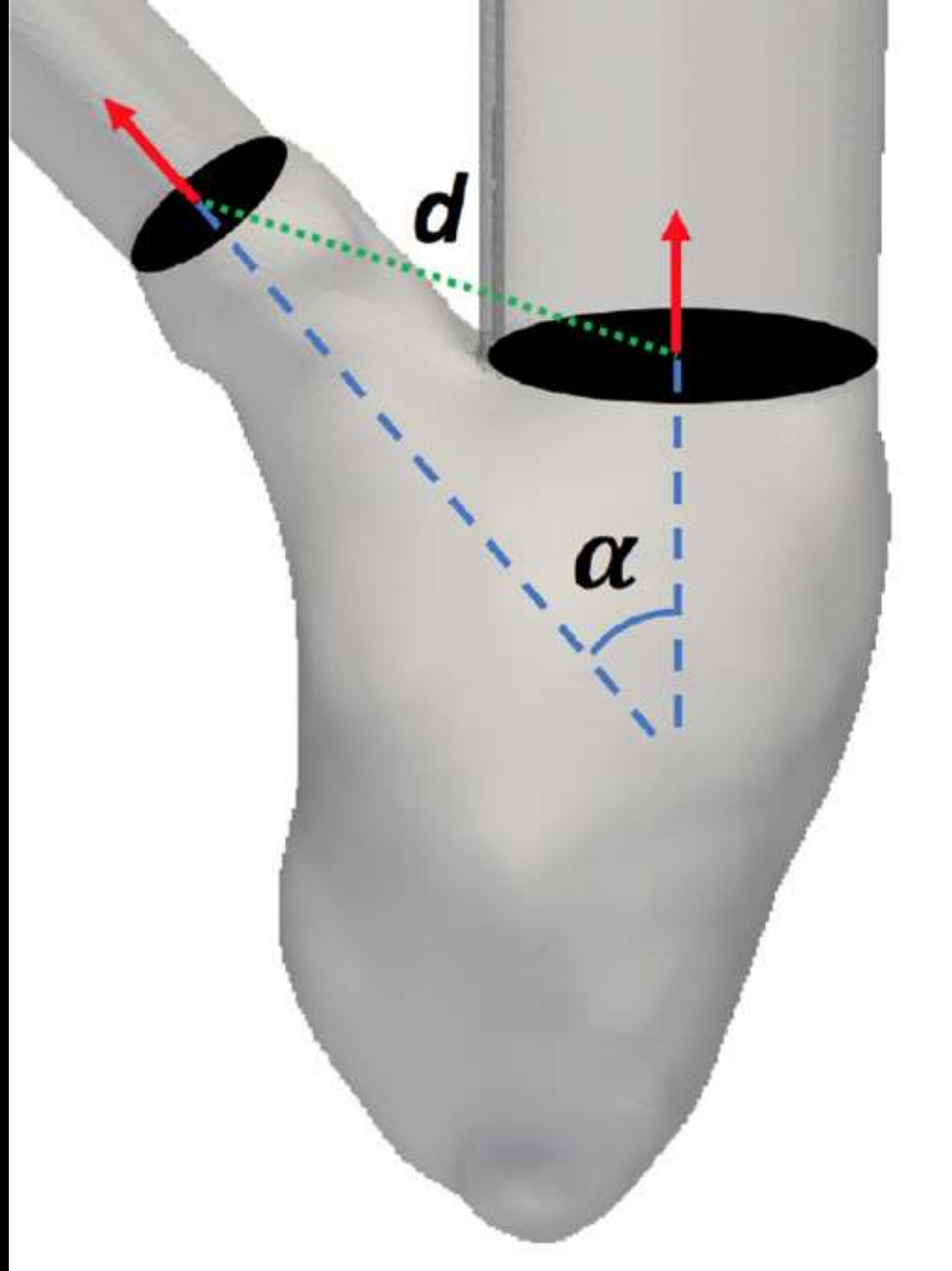
ICS 2

ICS 3

ICS 4

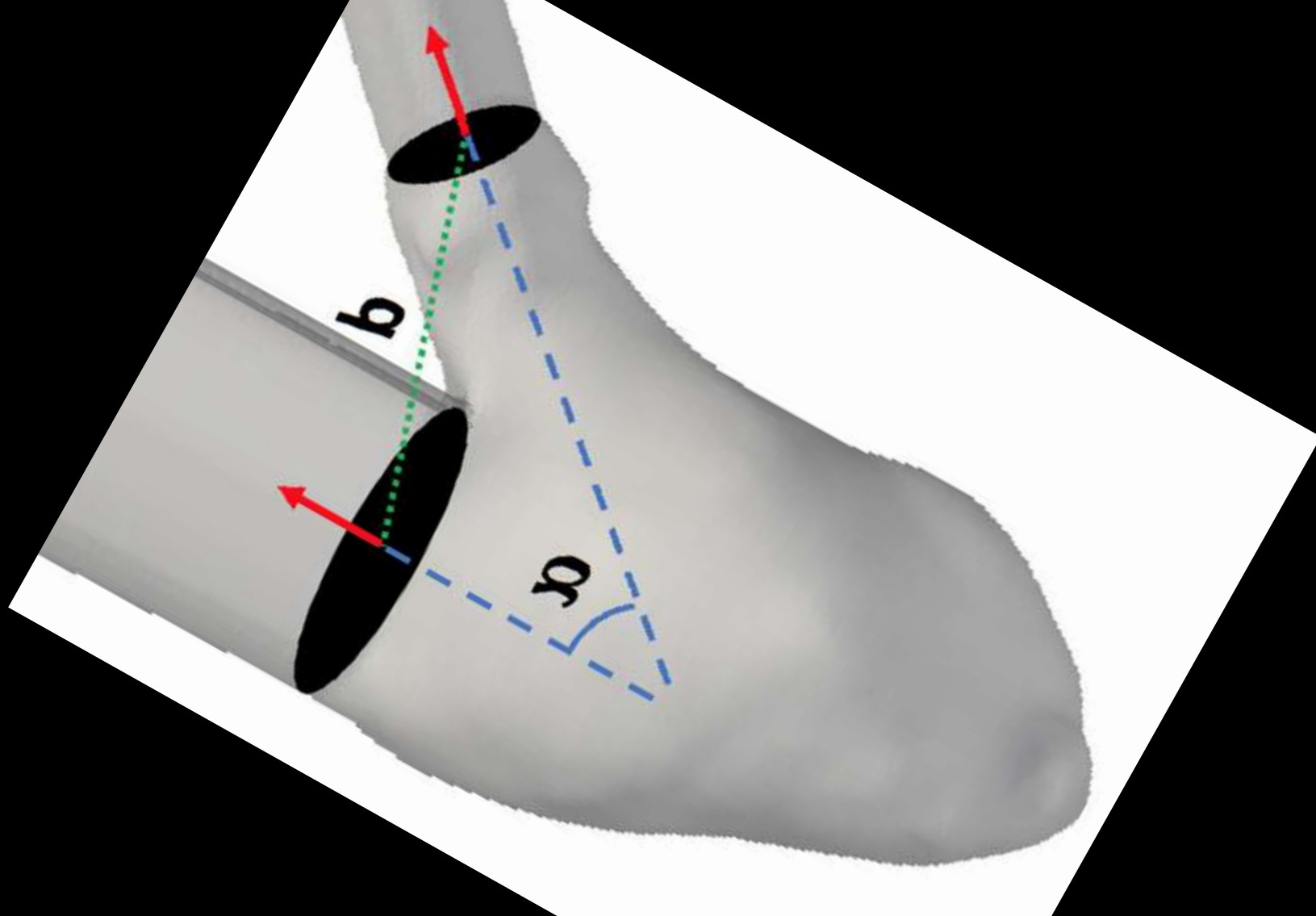
ICS 5





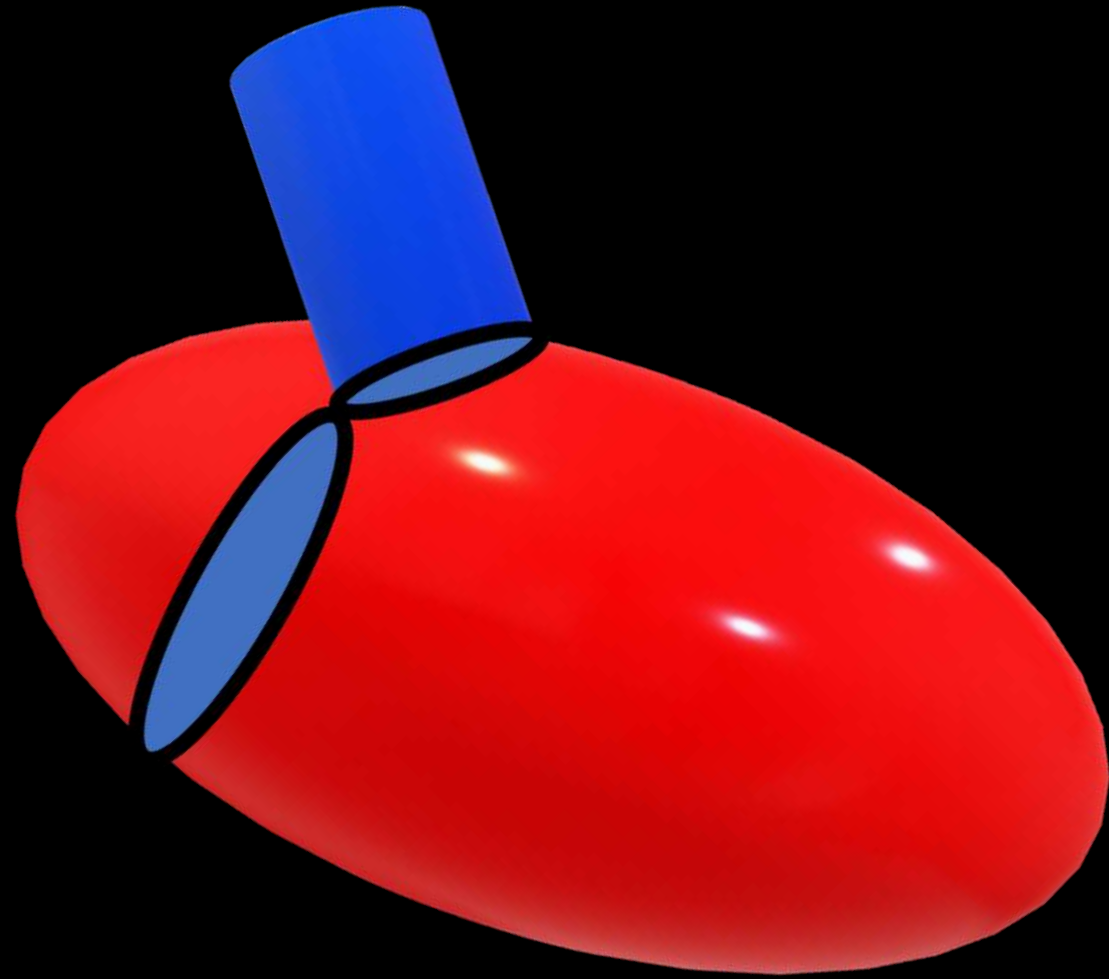
Sacco F., et al. (2018) Left Ventricular Trabeculations Decrease the Wall Shear Stress and Increase the Intra-Ventricular Pressure Drop in CFD Simulations. *Front. Physiol.* 9:458. doi: 10.3389/fphys.2018.00458

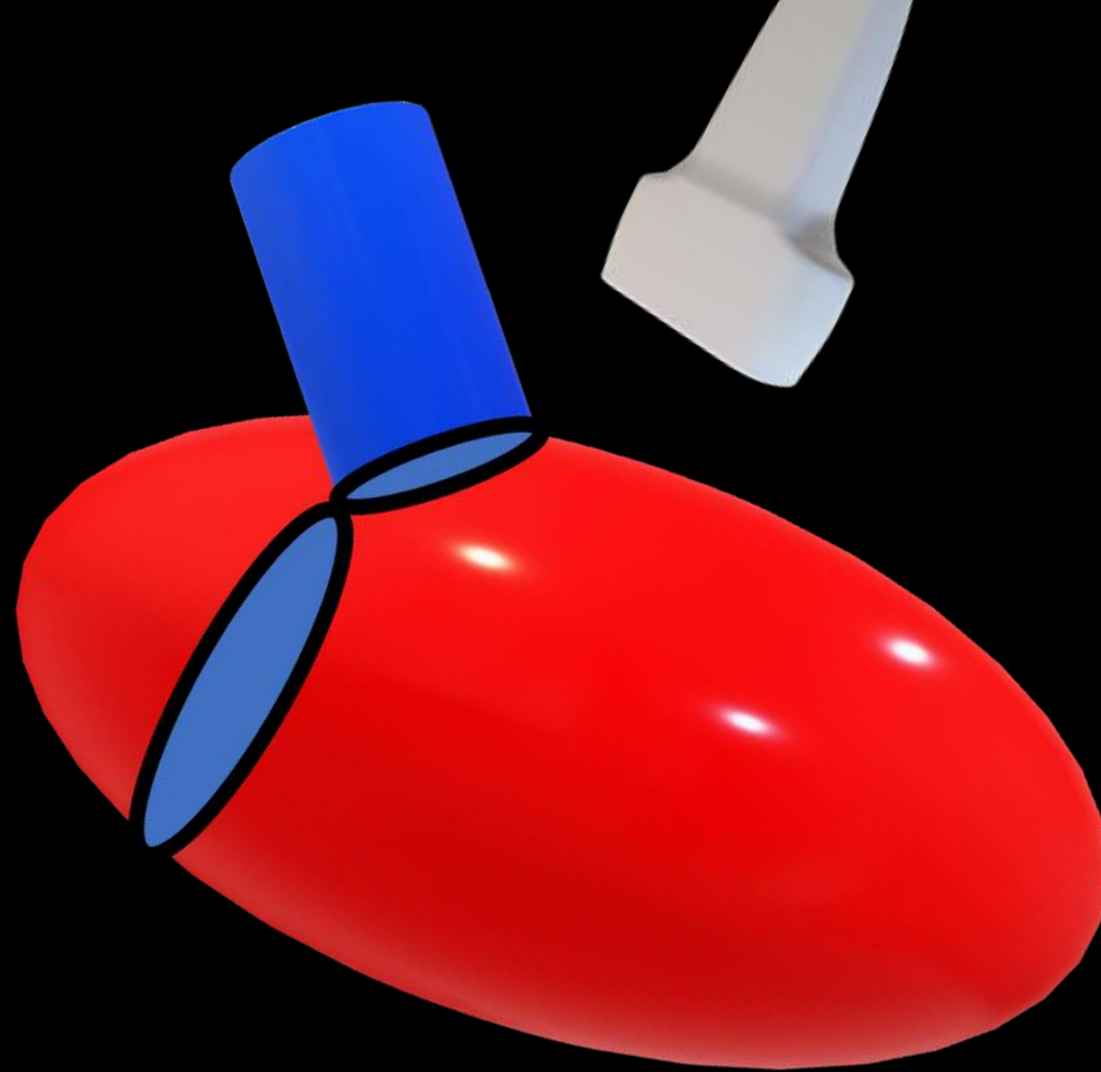


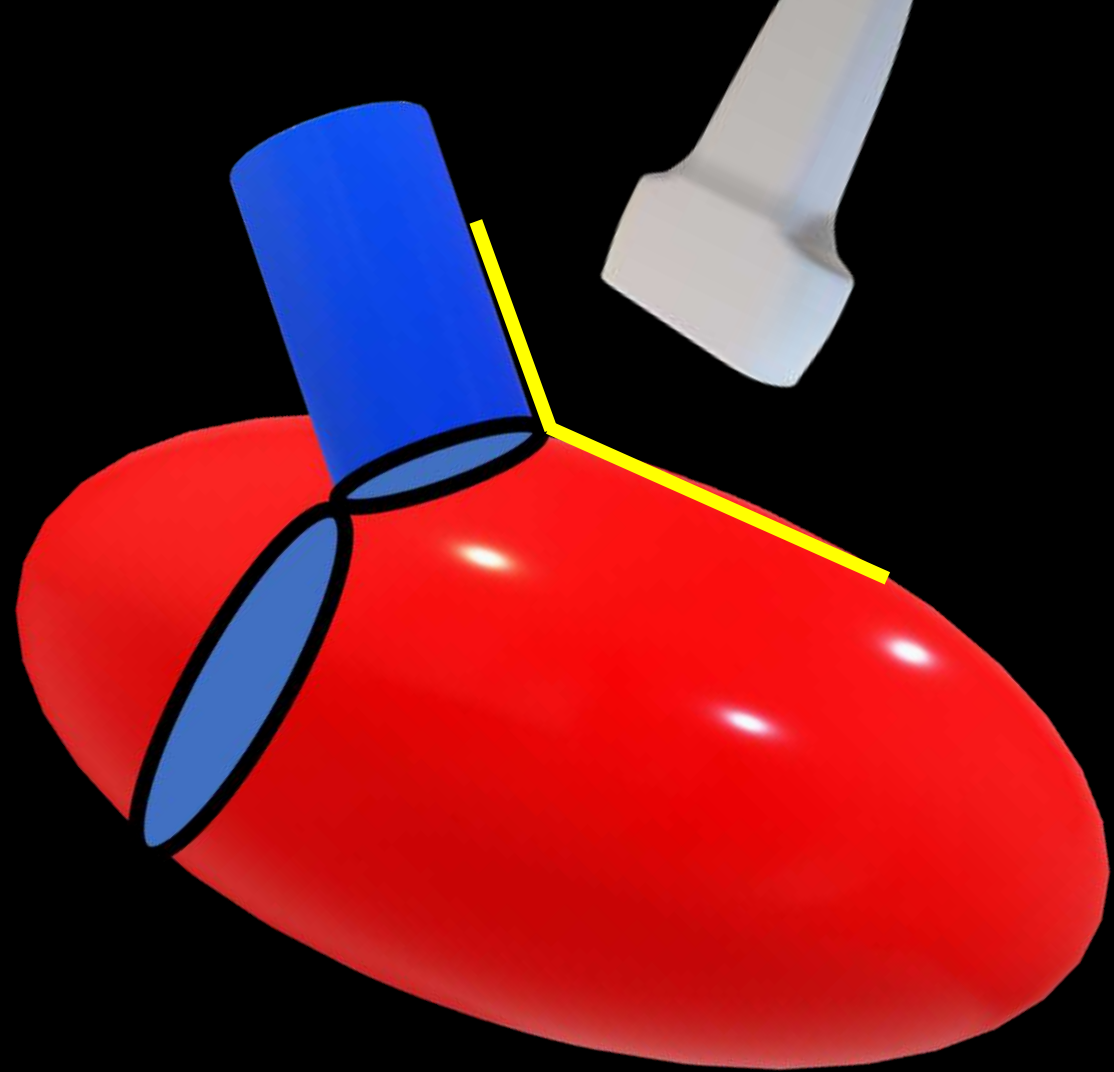


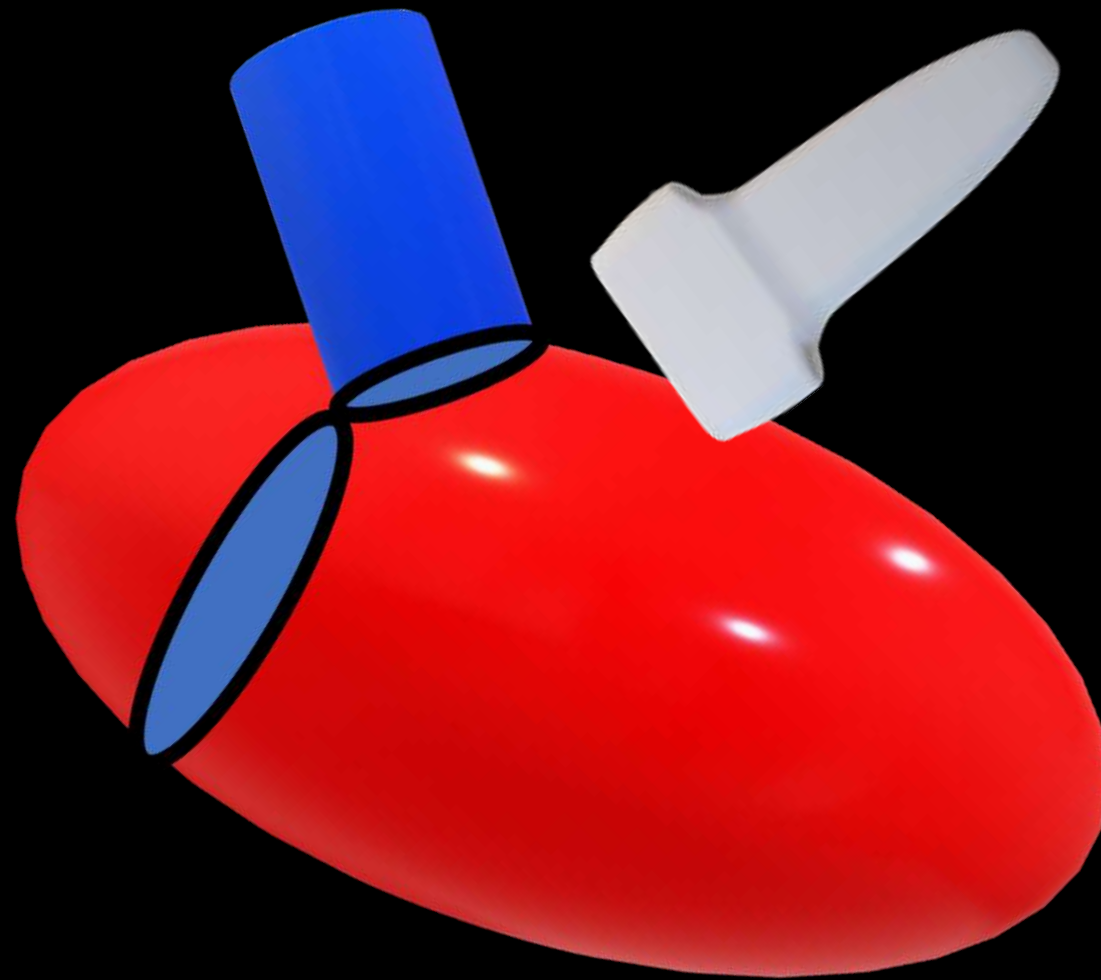
Sacco F., et al. (2018) Left Ventricular Trabeculations Decrease the Wall Shear Stress and Increase the Intra-Ventricular Pressure Drop in CFD Simulations. *Front. Physiol.* 9:458. doi: 10.3389/fphys.2018.00458

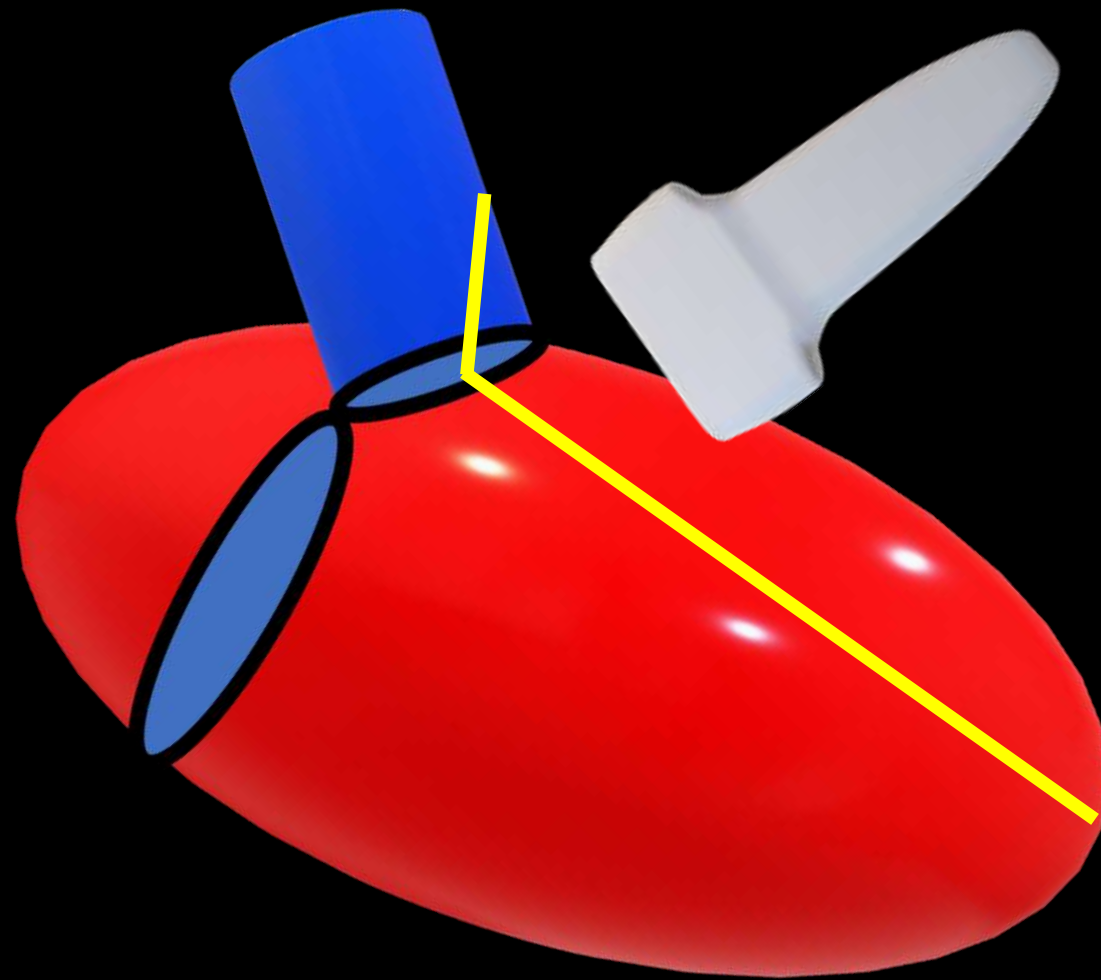


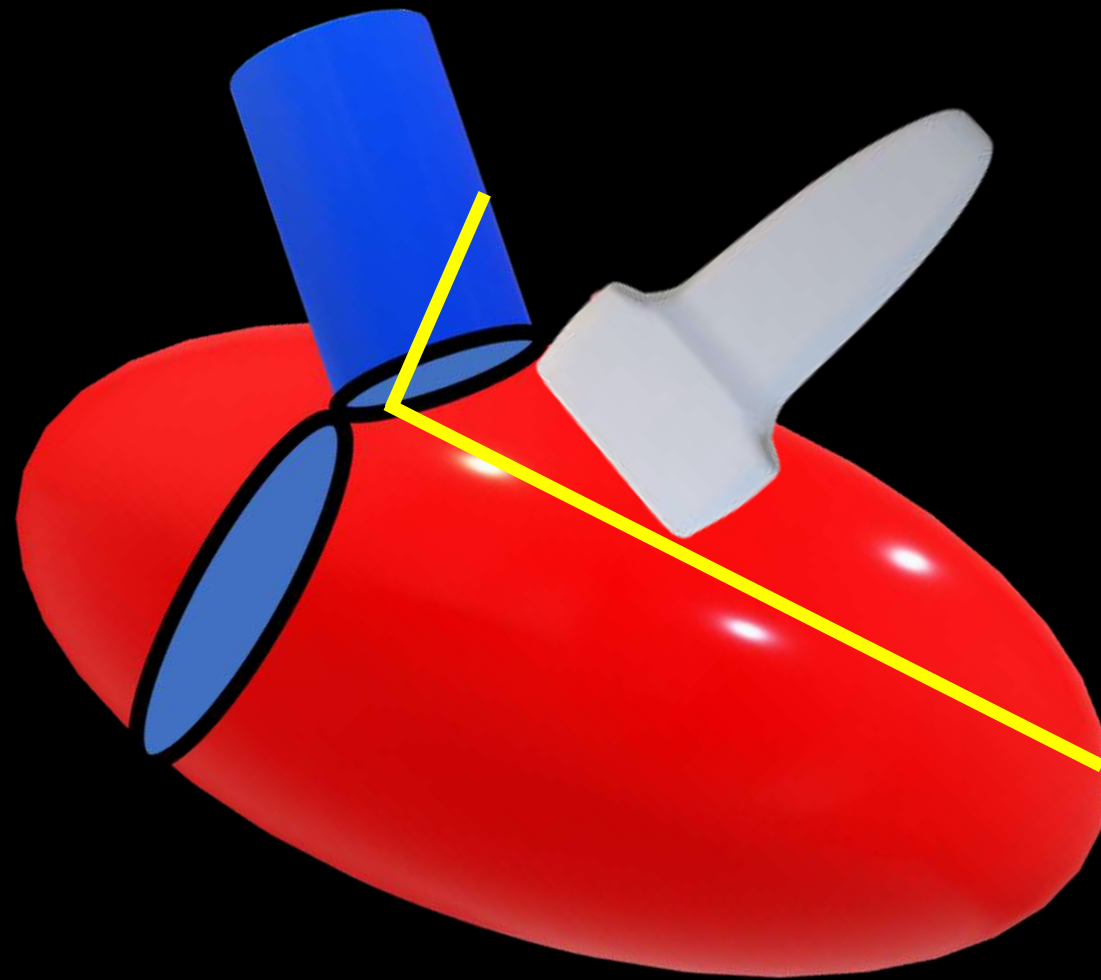


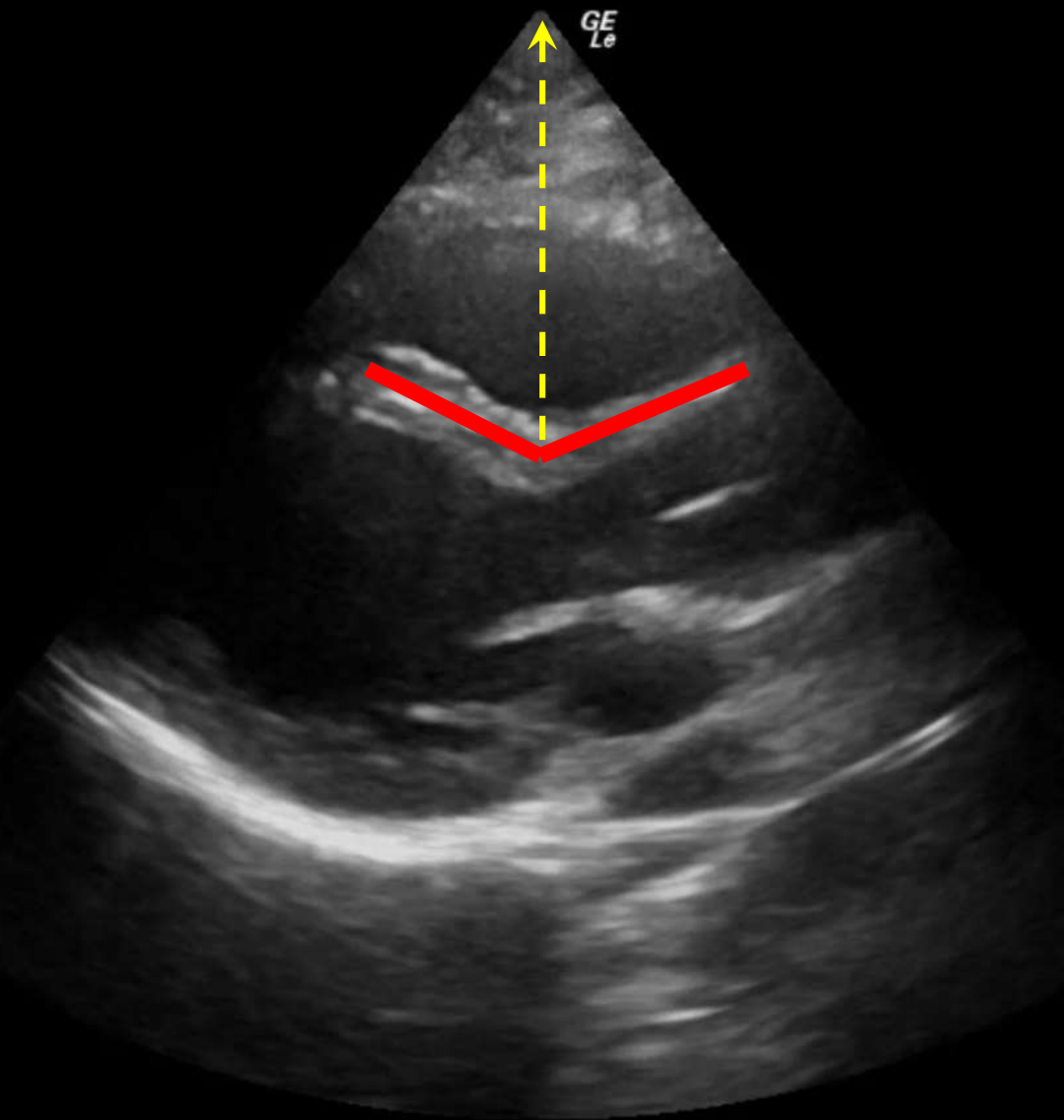






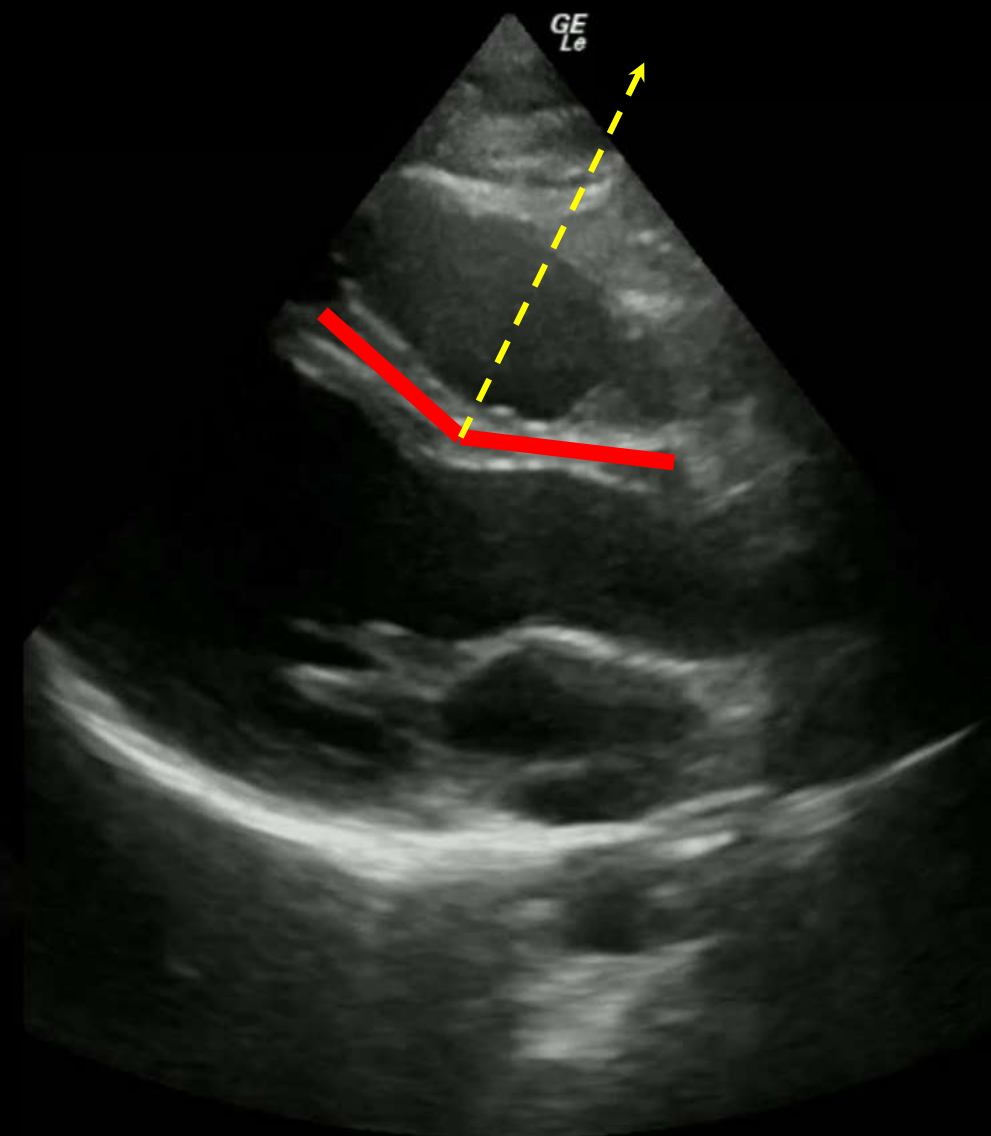






Standard PLAx

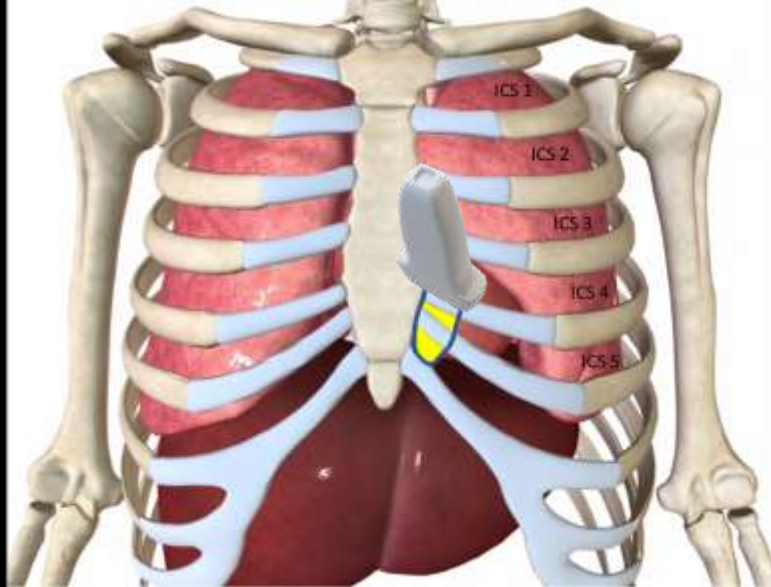
Gregory Mints, M.D.



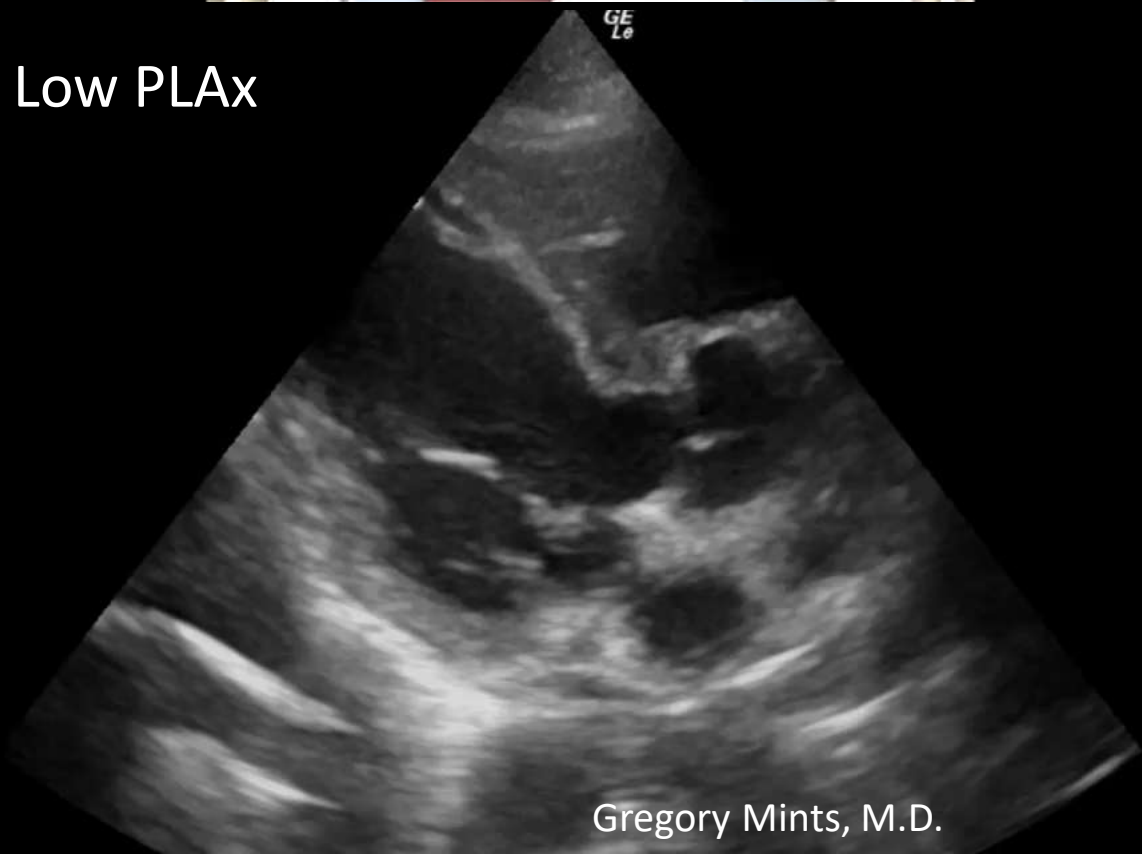
Low PLAx

©Cornell Medical College

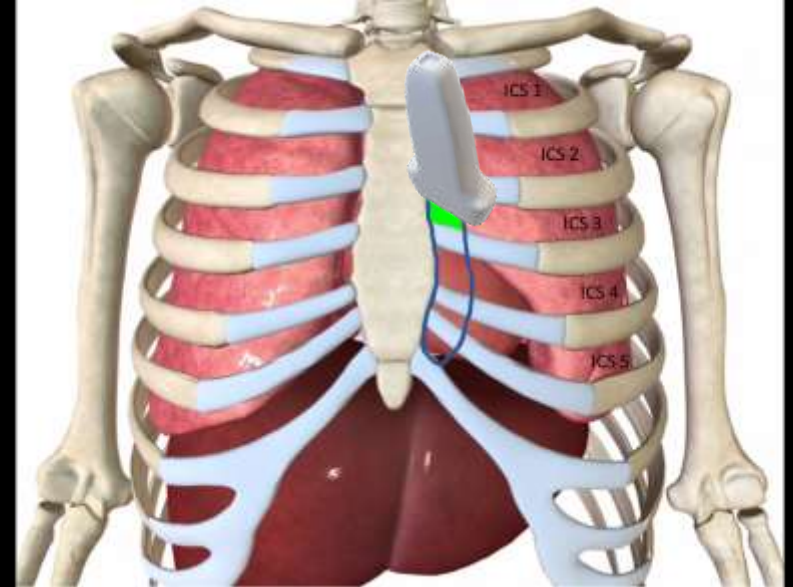




Low PLAX



Gregory Mints, M.D.



Standard PLAX



©Cornell Medical College



Structures in wrong place on screen

+

Aorto-septal angle sharp and/or asymmetric

} rotation

Structures in wrong place on screen

+

Aorto-septal angle sharp and/or asymmetric

} rotation

Structures in wrong place on screen

+

Aorto-septal angle normal

} sliding

Structures in wrong place on screen

+

Aorto-septal angle sharp and/or asymmetric

rotation

Structures in wrong place on screen

+

Aorto-septal angle normal

sliding

Structures in correct place

+

Aorto-septal angle sharp and/or asymmetric

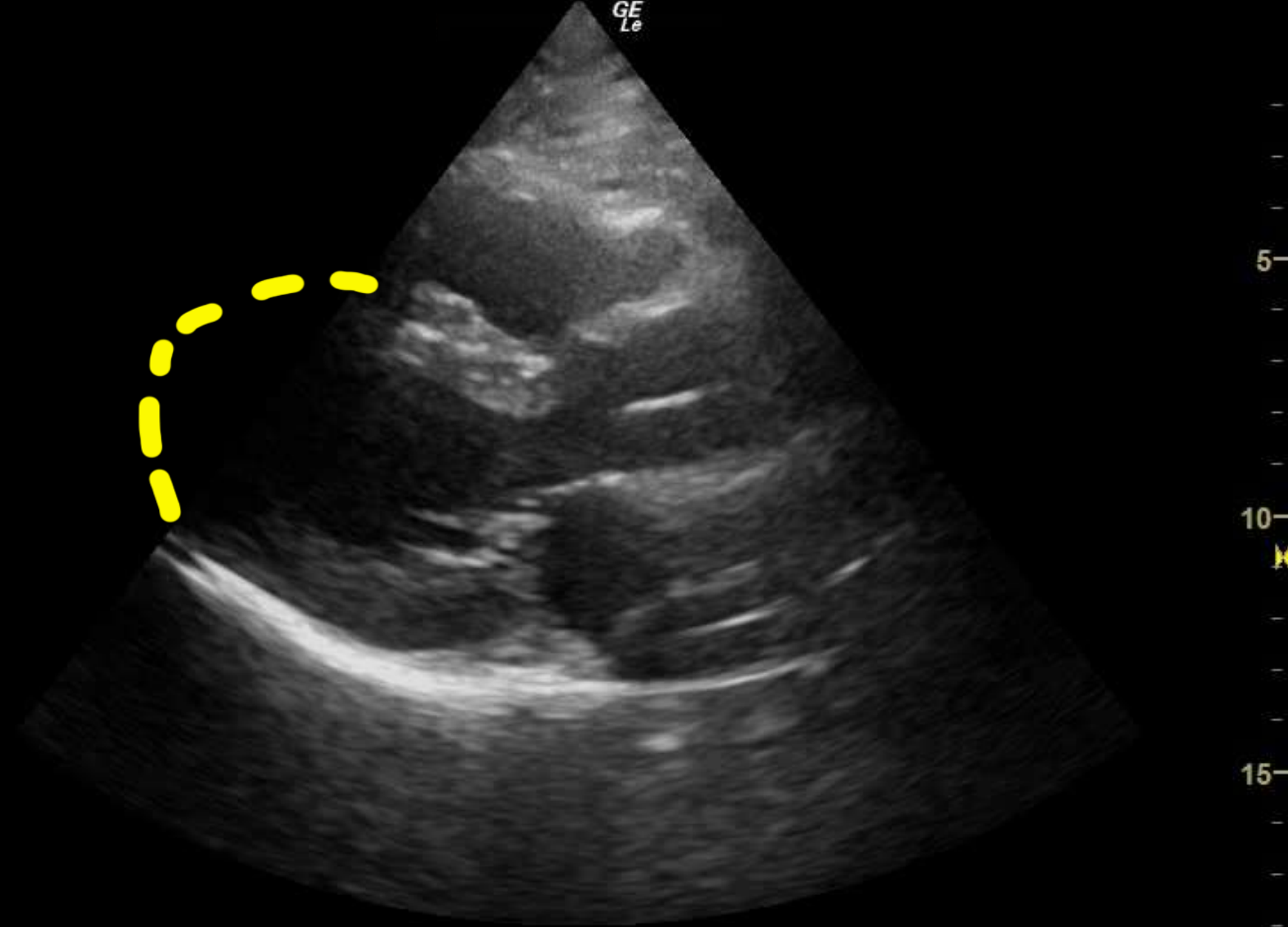
Low PLAx

# PLAx

- depth {
  1. Surveillance depth: descending aorta @ ~ middle of the screen
  2. Study depth: Descending aorta visible at the bottom of the screen
- Slide 3. Focus on LV. MV should be just to the right of the screen center
- Rock
  - Aorto-septal angle: flat and symmetric
- as high as possible 4. **Aorto-septal angle: flat and symmetric**

# PLAx

- depth {
  1. Surveillance depth: descending aorta @ ~ middle of the screen
  2. Study depth: Descending aorta visible at the bottom of the screen
- Slide 3. Focus on LV. MV should be just to the right of the screen center
  - Aorto-septal angle: flat and symmetric
- Rock
- as high as possible 4. Aorto-septal angle: flat and symmetric
- 5. Apex should not be visible, i.e. LV wall parallel to the septum



5-

10-

15-

# Exercise 3

Switch scanners.

# Exercise 3

Switch scanners.

While keeping the center of the wide part of the paraboloid in the scan section, rotate the probe.



# Exercise 3

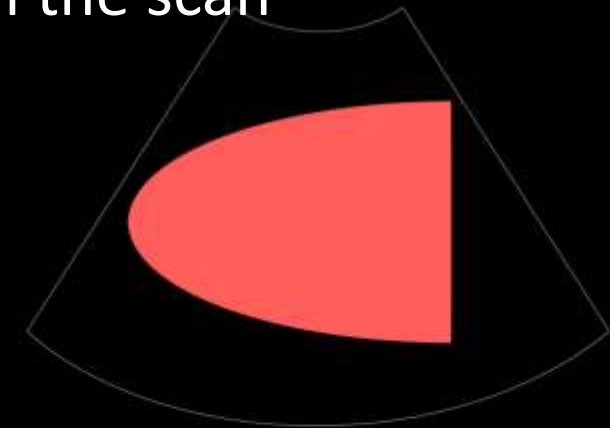
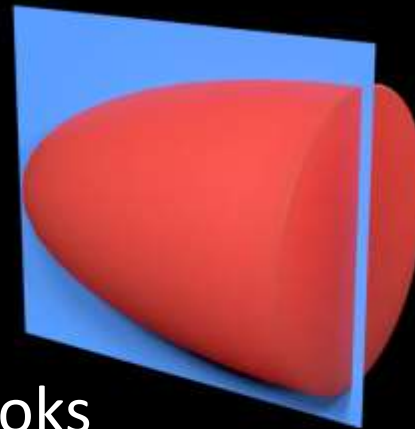
Find the corresponding shape

Switch scanners.

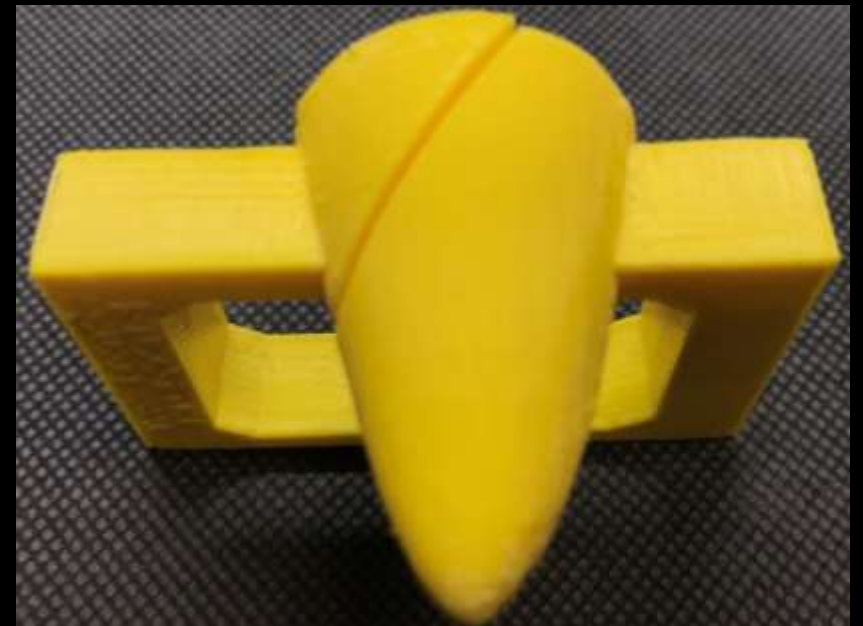
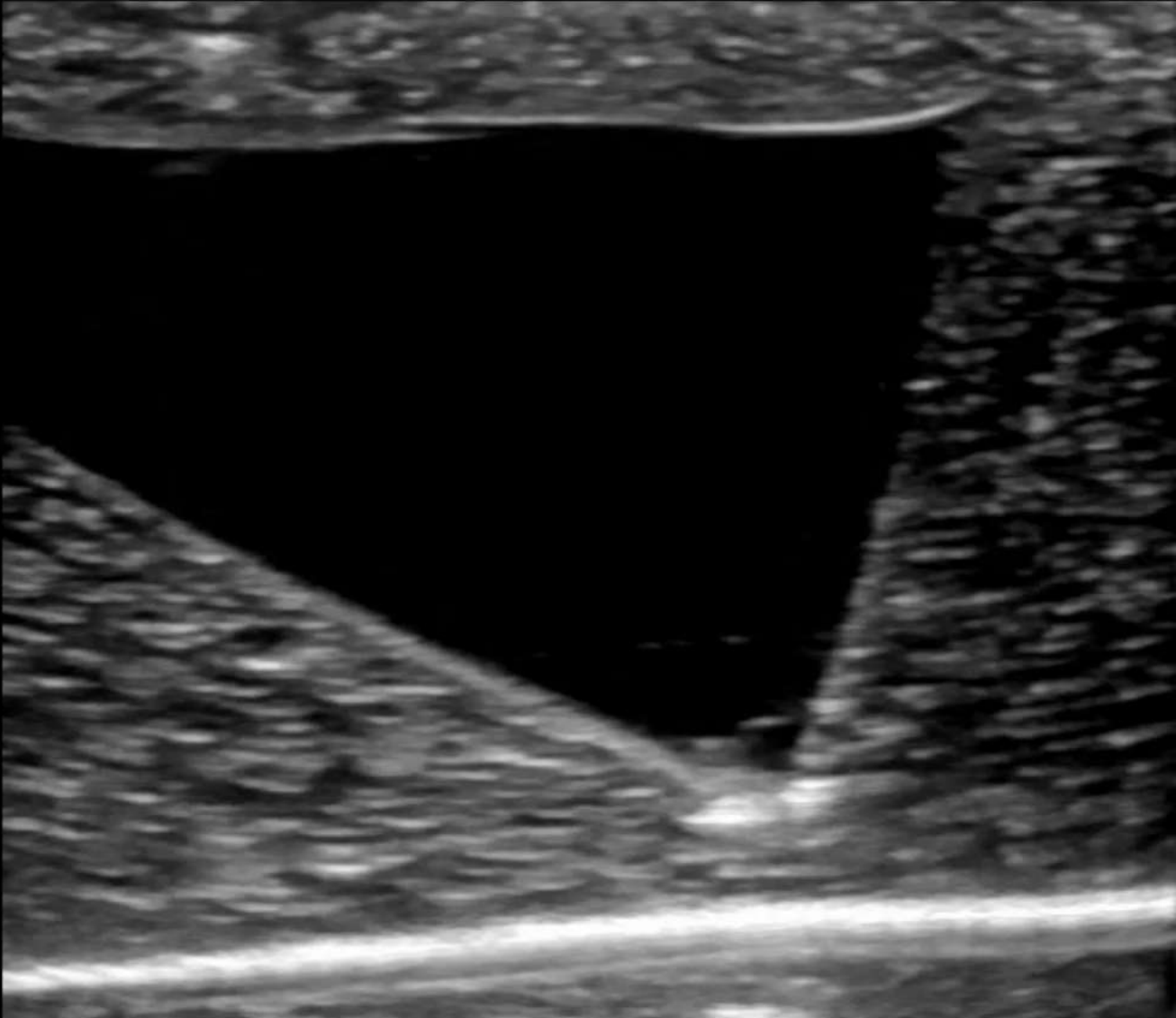
While keeping the center of the wide part of the paraboloid in the scan section, rotate the probe.

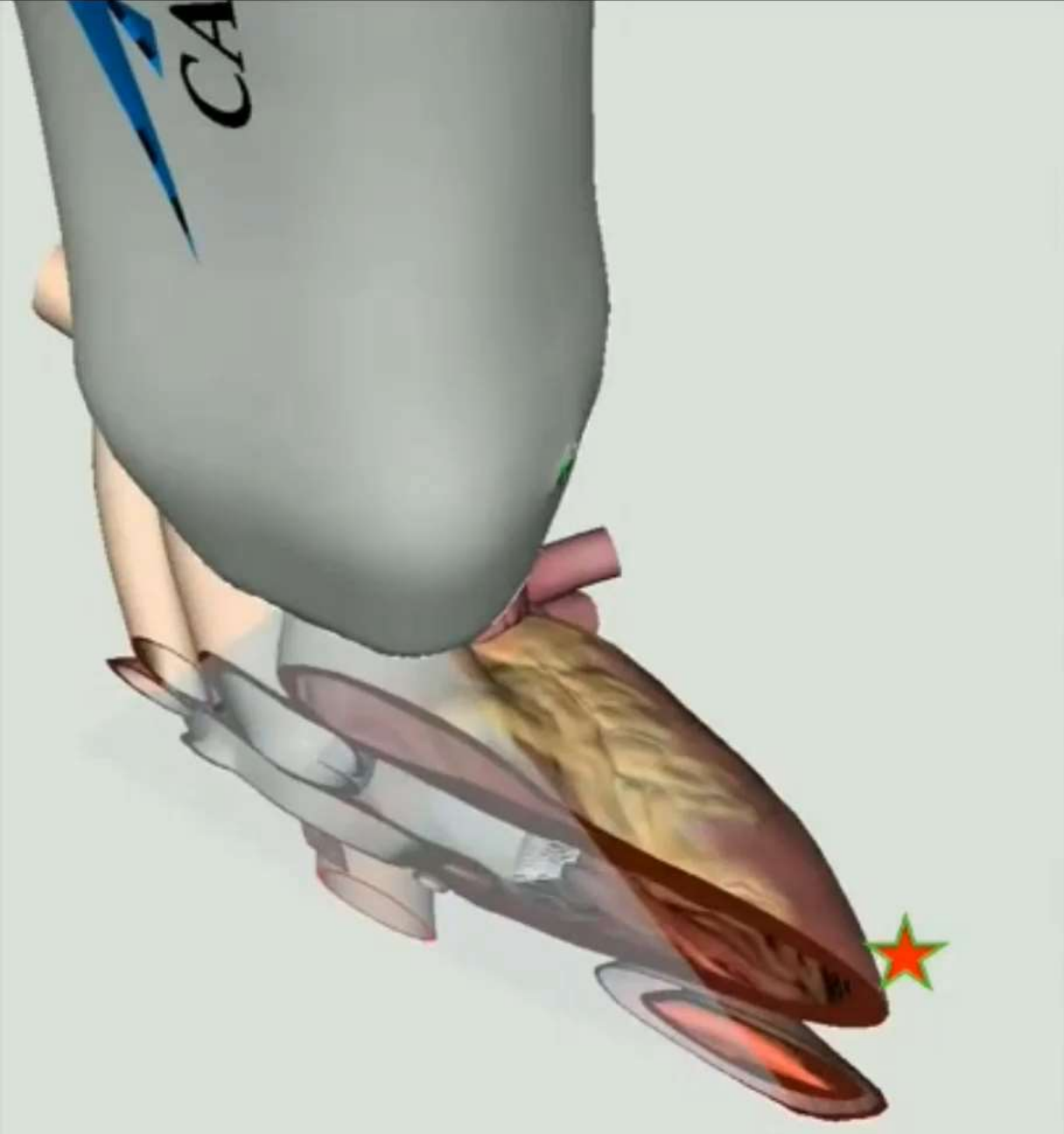
**Note:** the resulting cross-section still looks like a heart.

The “apex” seen is not a true apex, but is “capping”.



# Exercise 3: Rotation -> capping





**NOT QUITE RIGHT**

c/o Dr. David Tierney, Abbott Northwestern Hospital, Minneapolis



# PLAx

- depth { 1. Surveillance depth: descending aorta @ ~ middle of the screen
- 2. Study depth: Descending aorta visible at the bottom of the screen
- Slide 3. Focus on LV. MV should be just to the right of the screen center
  - Rock • Aorto-septal angle: flat and symmetric
- as high as possible 4. Aorto-septal angle: flat and symmetric
- 5. Apex should not be visible, i.e. LV wall parallel to the septum

# PLAx

- depth { 1. Surveillance depth: descending aorta @ ~ middle of the screen
- 2. Study depth: Descending aorta visible at the bottom of the screen
- Slide 3. Focus on LV. MV should be just to the right of the screen center
  - Rock • Aorto-septal angle: flat and symmetric
- as high as possible 4. Aorto-septal angle: flat and symmetric
- Rotate 5. Apex should not be visible, i.e. LV wall parallel to the septum

# Exercise 4

Switch scanners

# Exercise 4

## Switch scanners

There are 2 movements of the probe which will result in smaller estimated diameter of the cavity. One of them is **sweeping**.



# Exercise 4

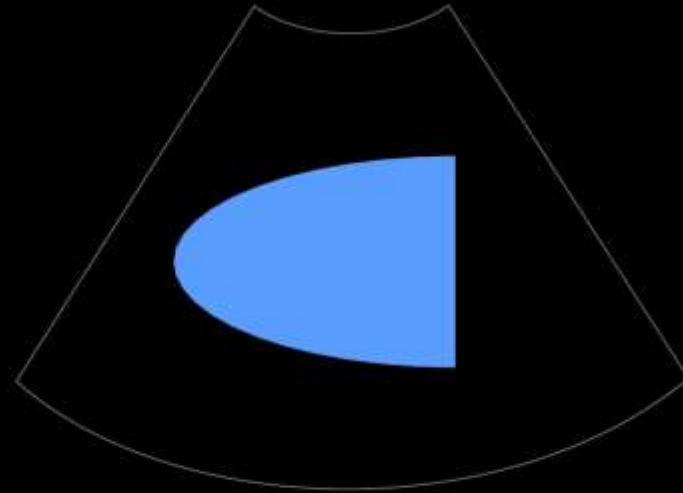
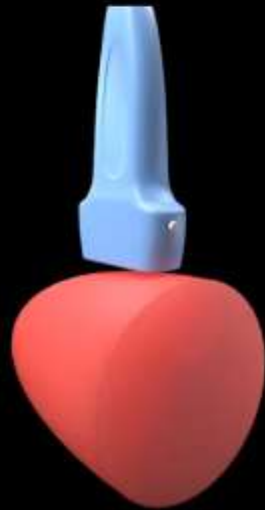
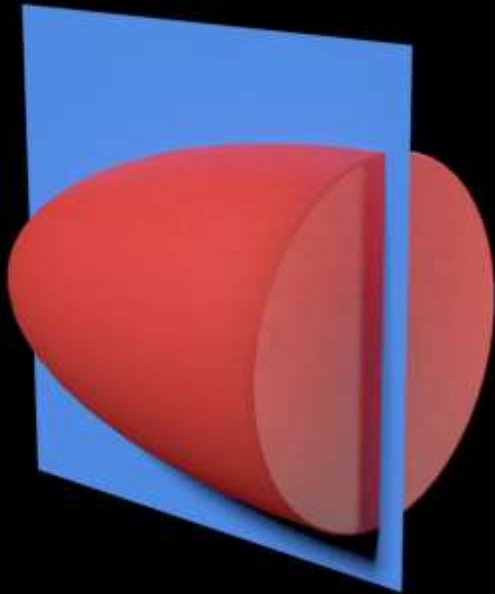
## Switch scanners

There are 2 movements of the probe which will result in smaller estimated diameter of the cavity. One of them is **sweeping**.

- Find a corresponding shape
- Demonstrate sweeping on the phantom

# Exercise 4: sweeping –

usually not an issue in PLAx



# Exercise 5

Switch scanners.

# Exercise 5

Switch scanners.

There are 2 movements of the probe which will result in smaller estimated diameter of the cavity. One of them is sweeping. **What is the other?**

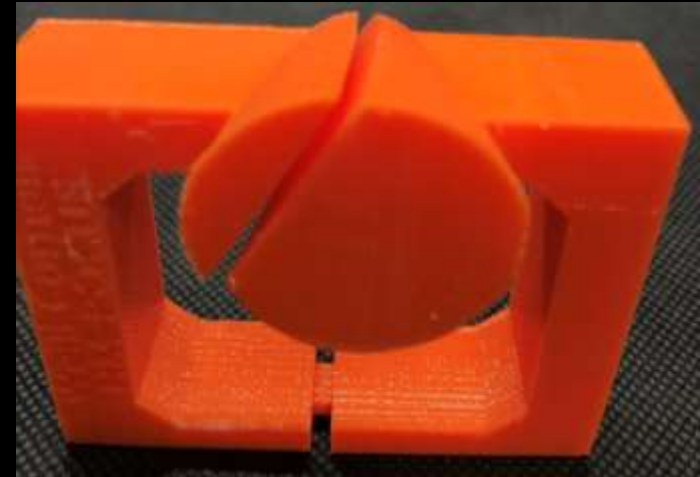
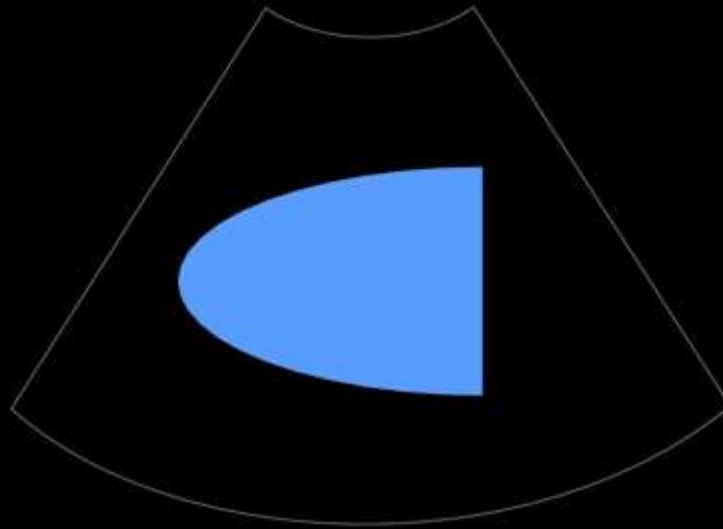
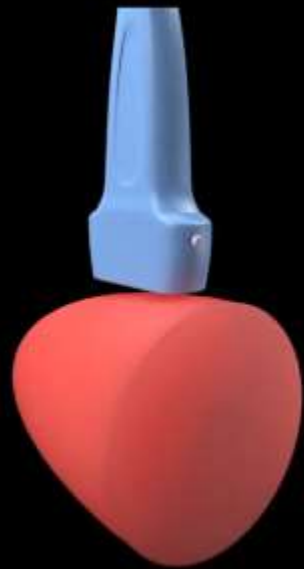
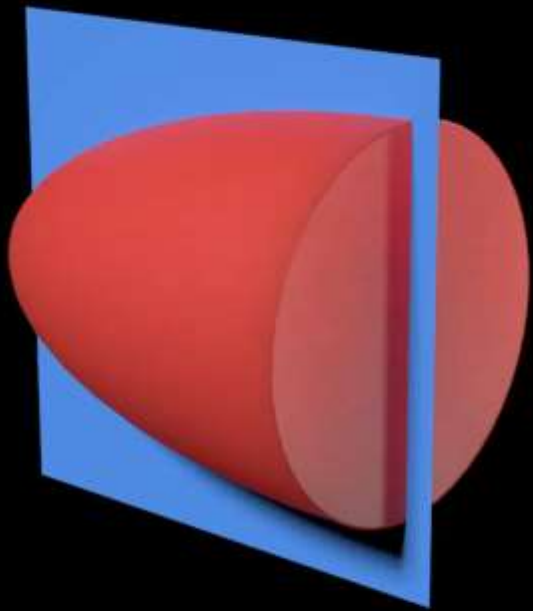
# Exercise 5

Switch scanners.

There are 2 movements of the probe which will result in smaller estimated diameter of the cavity. One of them is sweeping. **What is the other?**

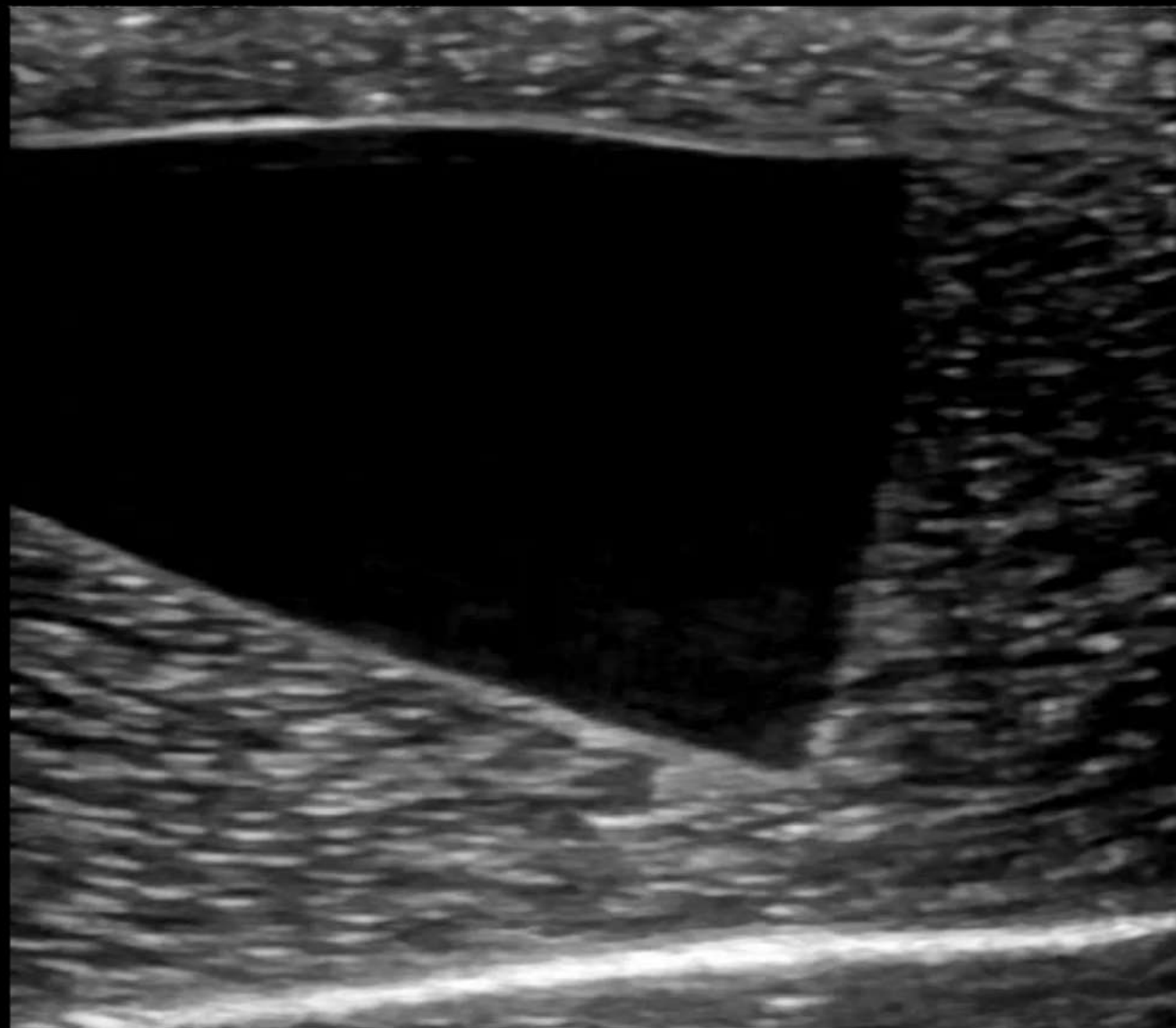
- Find a shape corresponding to that other movement
- Demonstrate that movement on the phantom

# Exercise 4: Tilting



Weill-Cornell HM-POCUS

Anima Simulations



# Tilt: max the diameter



c/o Dr. David Tierney, Abbott Northwestern Hospital, Minneapolis



# PLAx

- depth {
  1. Surveillance depth: descending aorta @ ~ middle of the screen
  2. Study depth: Descending aorta visible at the bottom of the screen
- Slide 3. Focus on LV. MV should be just to the right of the screen center
- Rock
  - Aorto-septal angle: flat and symmetric
- as high as possible 4. Aorto-septal angle: flat and symmetric
- Rotate 5. Apex should not be visible, i.e. LV wall parallel to the septum
- tilt {

# PLAx

- depth {
  1. Surveillance depth: descending aorta @ ~ middle of the screen
  2. Study depth: Descending aorta visible at the bottom of the screen
- Slide {
  3. Focus on LV. MV should be just to the right of the screen center
    - Aorto-septal angle: flat and symmetric
- Rock {
  4. Aorto-septal angle: flat and symmetric
- as high as possible {
  5. Apex should not be visible, i.e. LV wall parallel to the septum
- Rotate {
  6. Largest LV cavity diameter
- tilt {

# PLAx

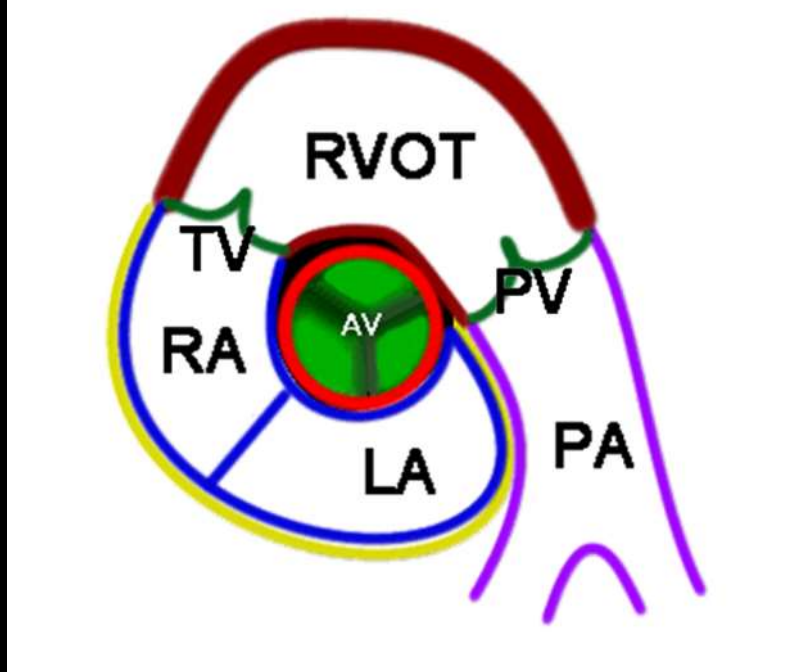
- depth {
  1. Surveillance depth: descending aorta @ ~ middle of the screen
  2. Study depth: Descending aorta visible at the bottom of the screen
- Slide {
  3. Focus on LV. MV should be just to the right of the screen center
    - Aorto-septal angle: flat and symmetric
- Rock {
  4. Aorto-septal angle: flat and symmetric
- as high as possible {
  5. Apex should not be visible, i.e. LV wall parallel to the septum
- Rotate {
  6. Largest LV cavity diameter
  7. Both aortic and mitral valve clearly visible in the same cut
- tilt {

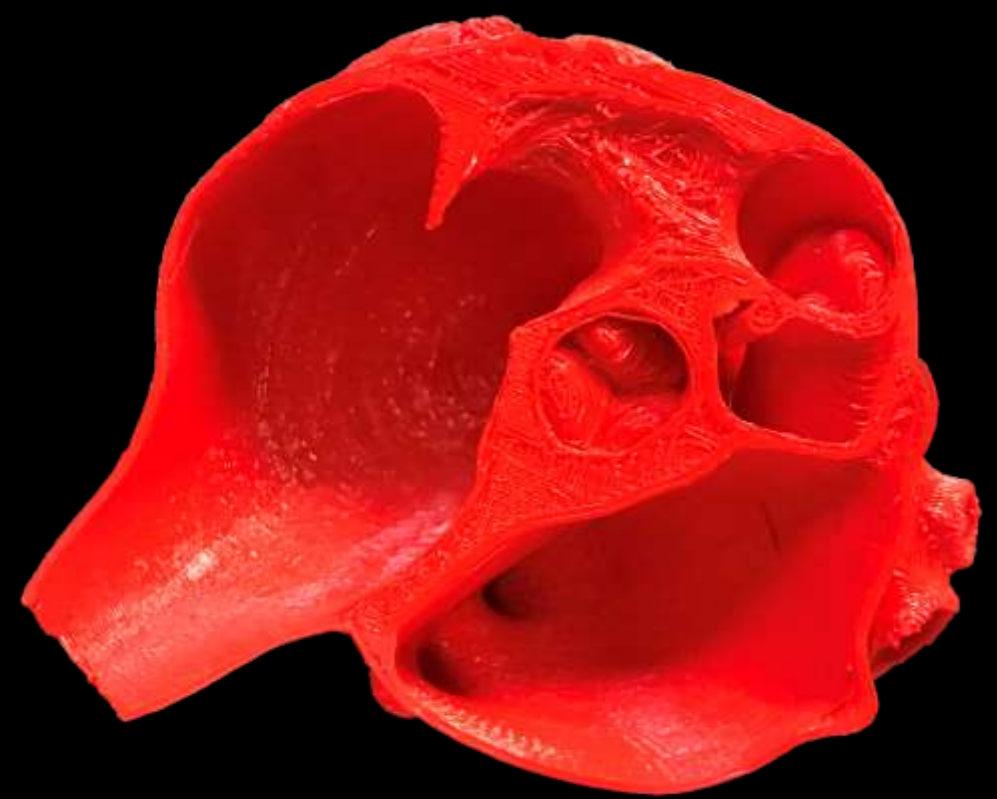
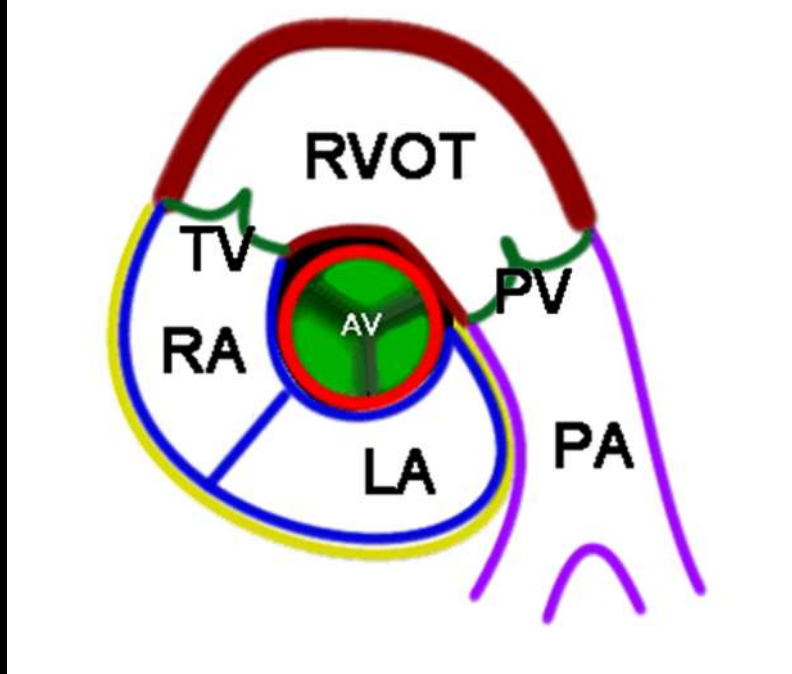
# PLAx

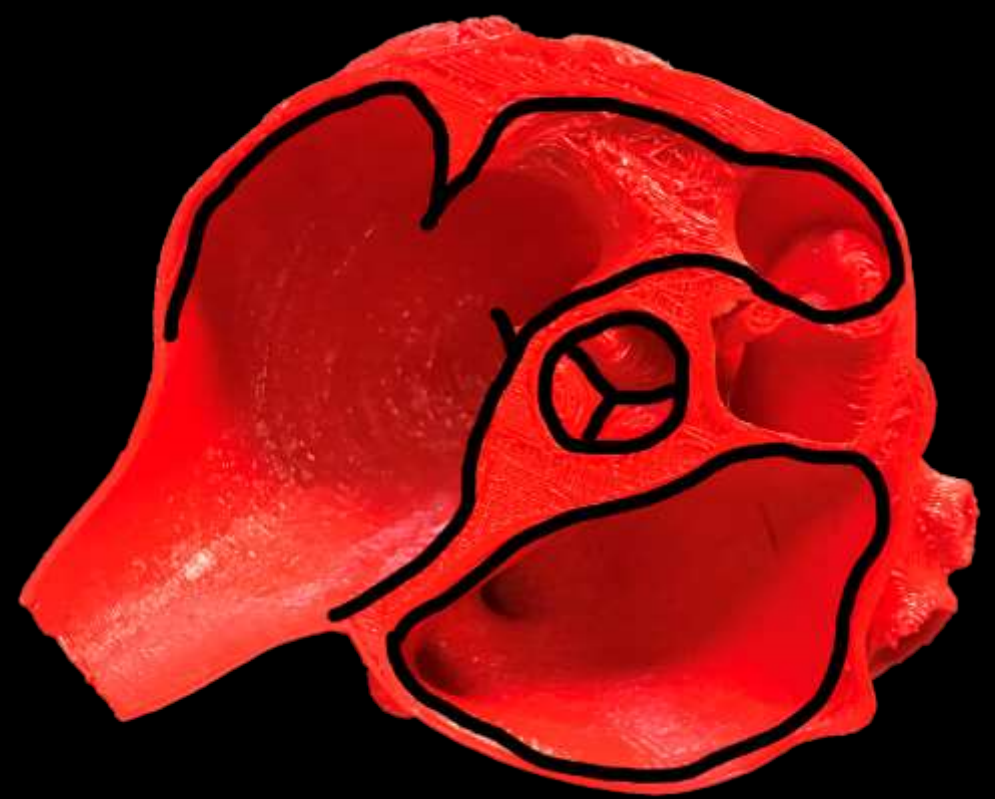
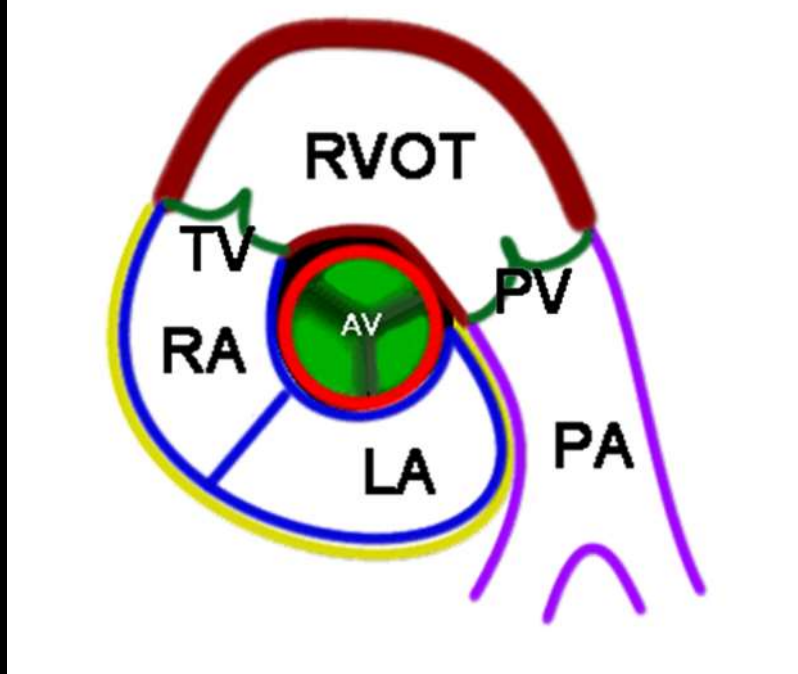
- depth {
  1. Surveillance depth: descending aorta @ ~ middle of the screen
  2. Study depth: Descending aorta visible at the bottom of the screen
- Slide 3. Focus on LV. MV should be just to the right of the screen center
- Rock
  - Aorto-septal angle: flat and symmetric
- as high as possible 4. Aorto-septal angle: flat and symmetric
- Rotate 5. Apex should not be visible, i.e. LV wall parallel to the septum
- tilt {
  6. Largest LV cavity diameter – small tilt
  7. Both aortic and mitral valve clearly visible in the same cut

# PLAx

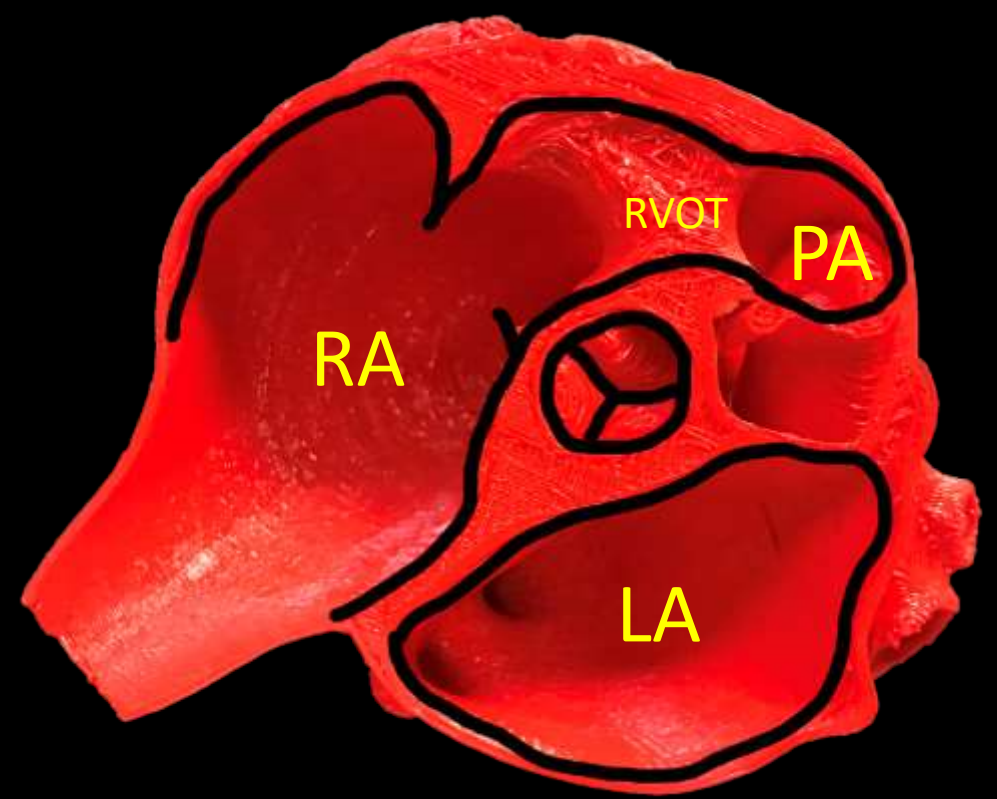
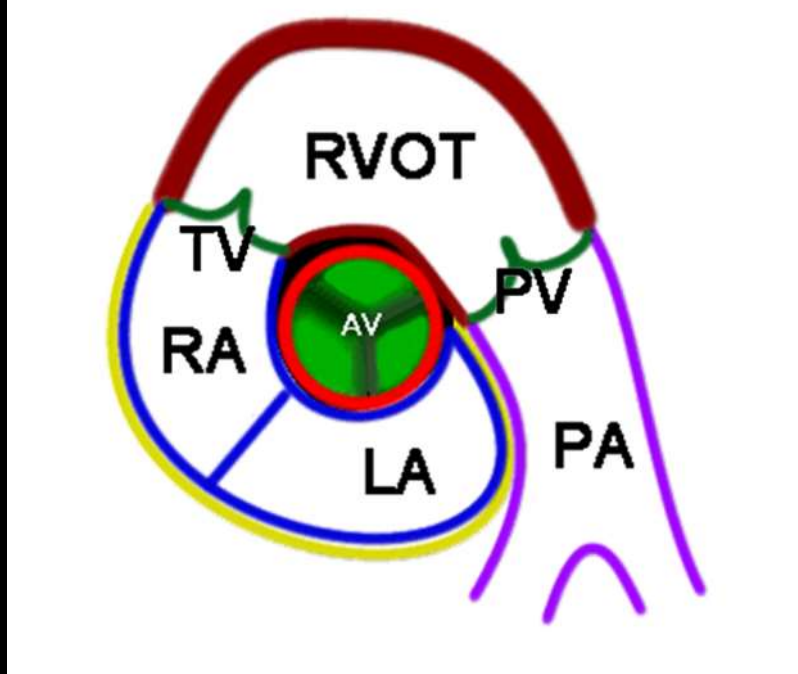
- depth {
  1. Surveillance depth: descending aorta @ ~ middle of the screen
  2. Study depth: Descending aorta visible at the bottom of the screen
- Slide {
  3. Focus on LV. MV should be just to the right of the screen center
    - Aorto-septal angle: flat and symmetric
- Rock {
  4. Aorto-septal angle: flat and symmetric
- as high as possible {
  5. Apex should not be visible, i.e. LV wall parallel to the septum
- Rotate {
  6. Largest LV cavity diameter – small tilt
  7. Both aortic and mitral valve clearly visible in the same cut – medium tilt

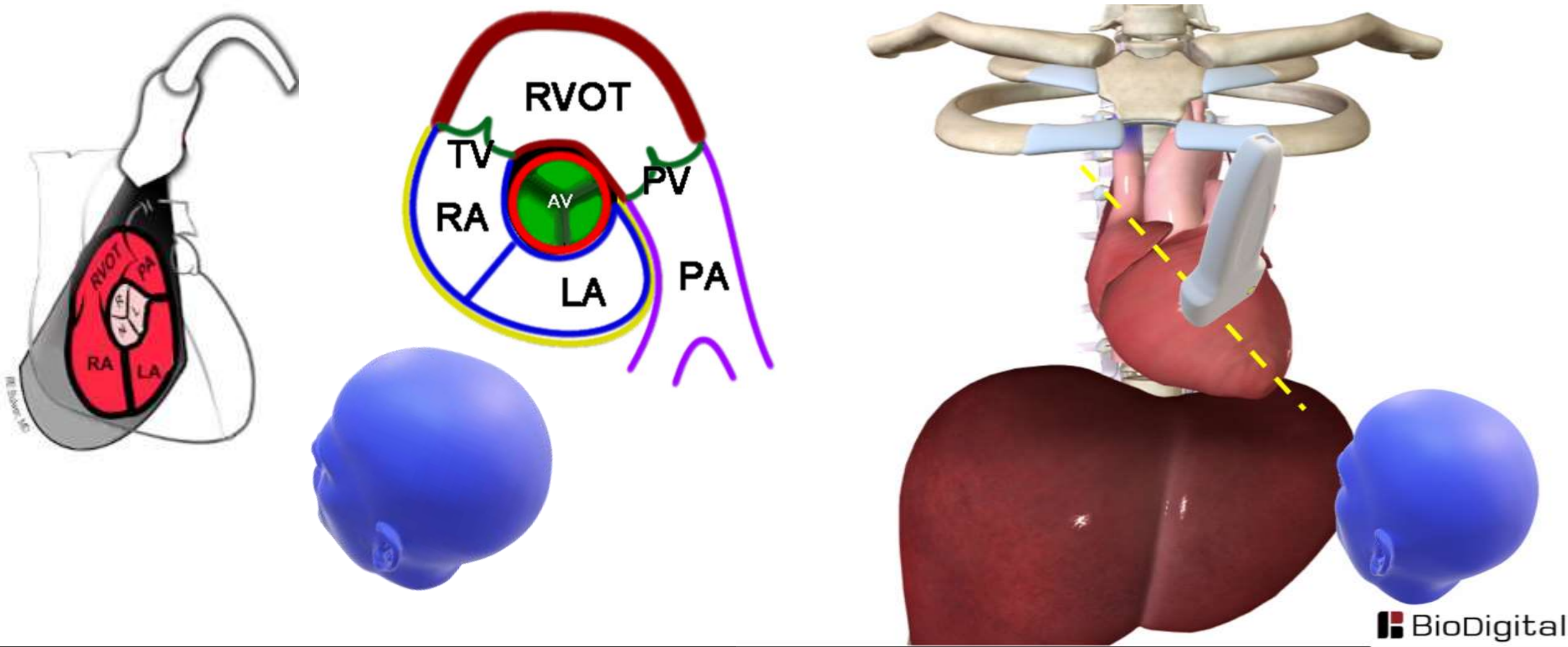




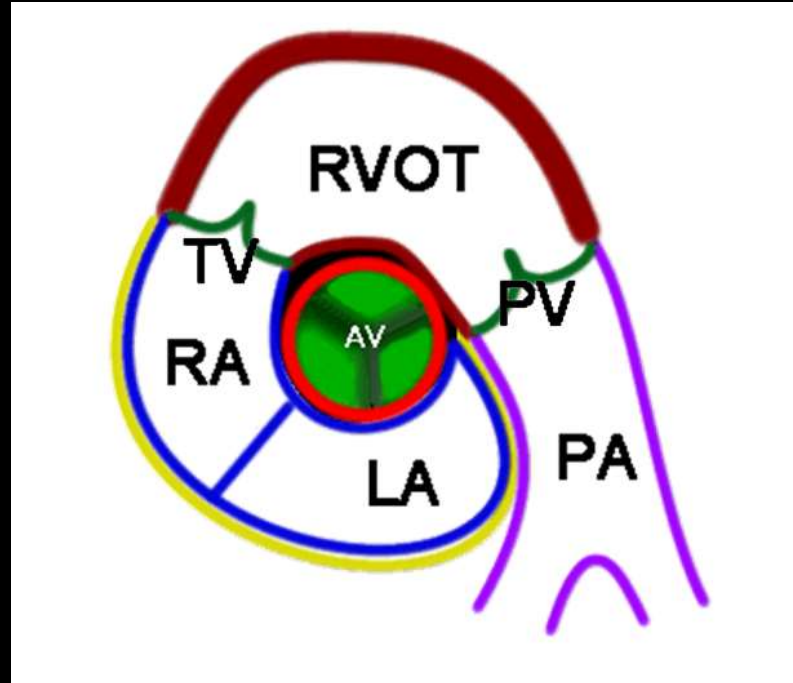
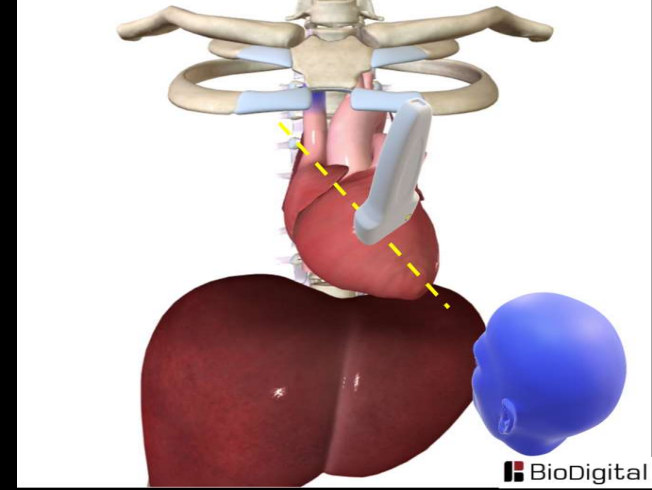




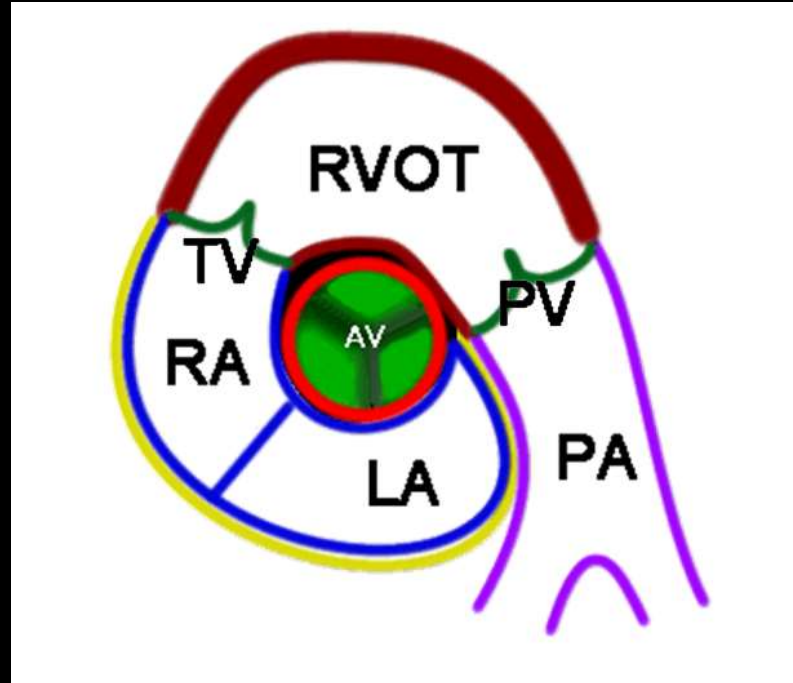
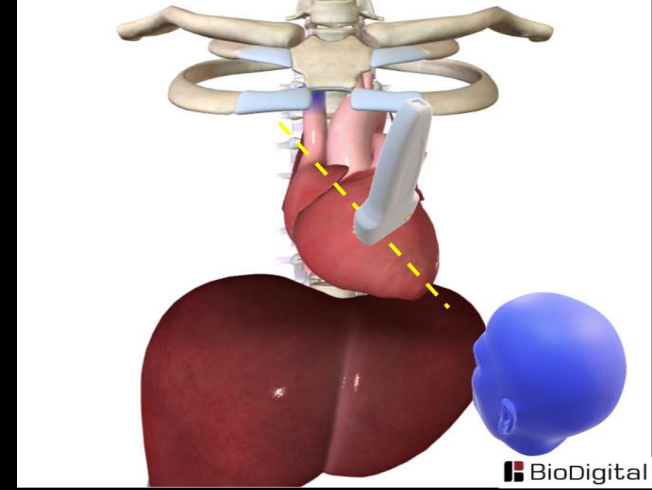




## PSAx (AoV level) Simulated view: from the apex

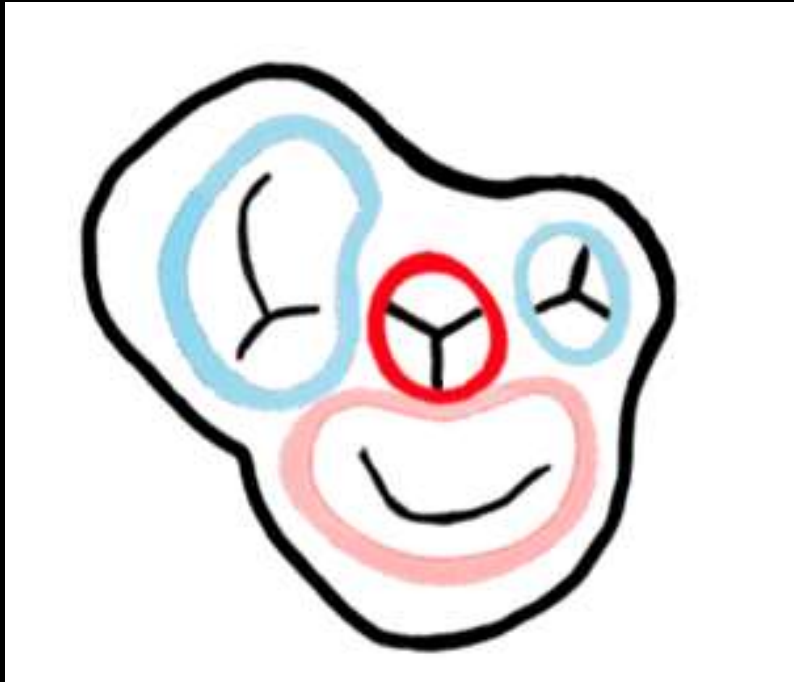


PSAx (AoV level) Simulated view: from the apex

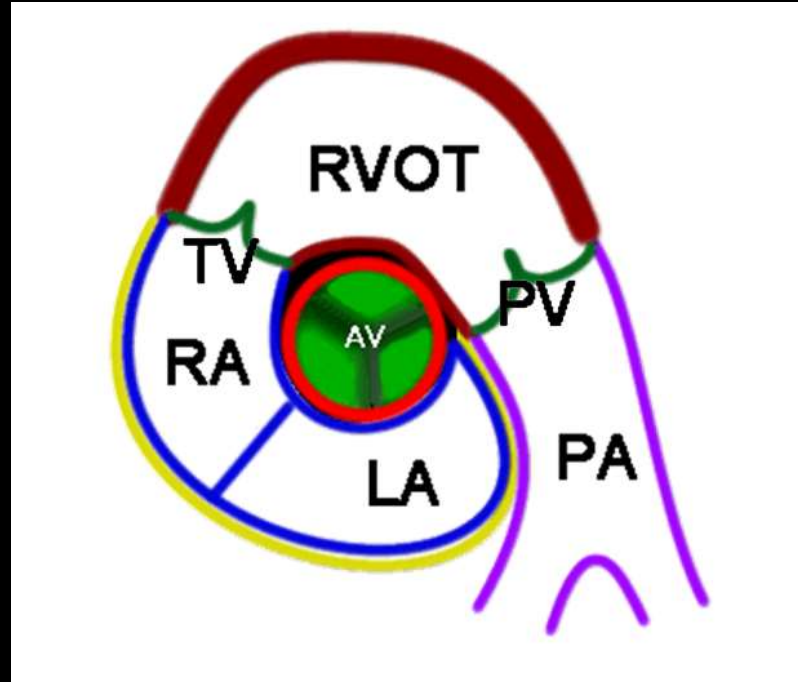


Sonographic Cut

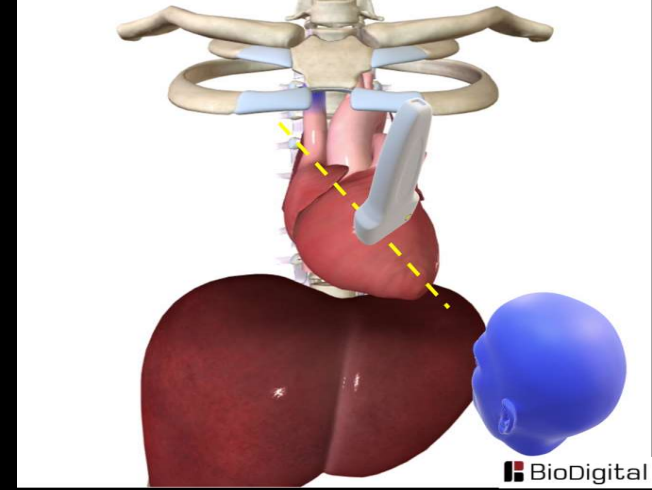
## View from the apex



Anatomic Cut

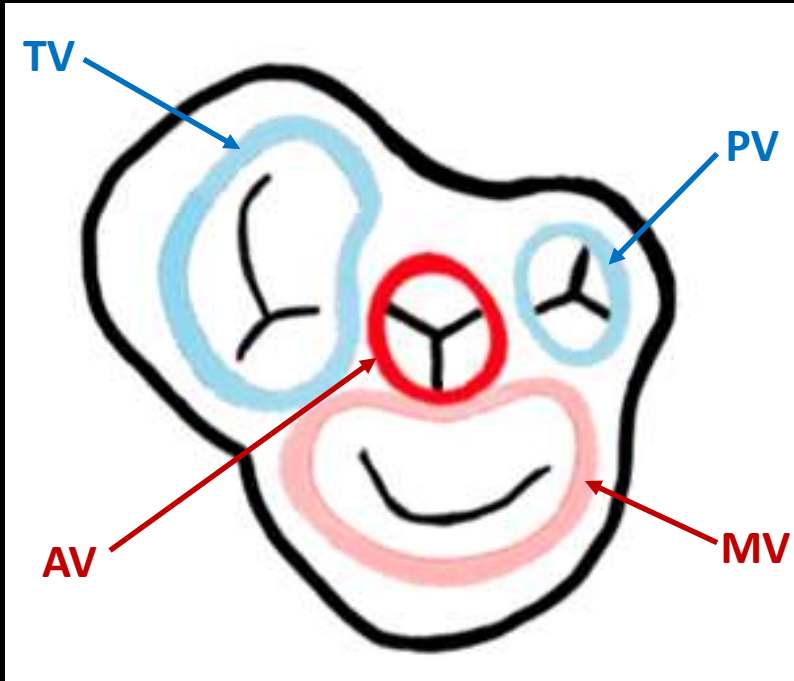


Sonographic Cut

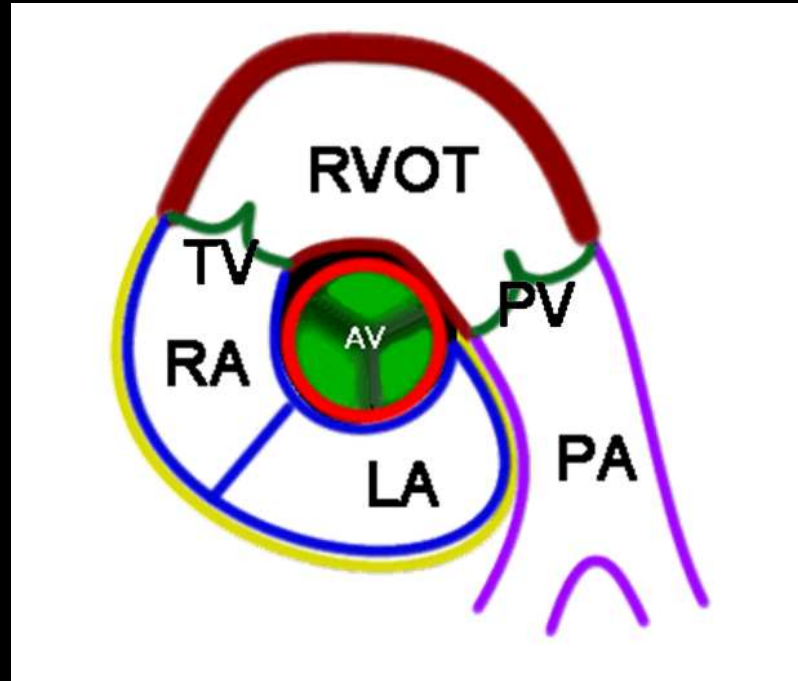


View from the apex

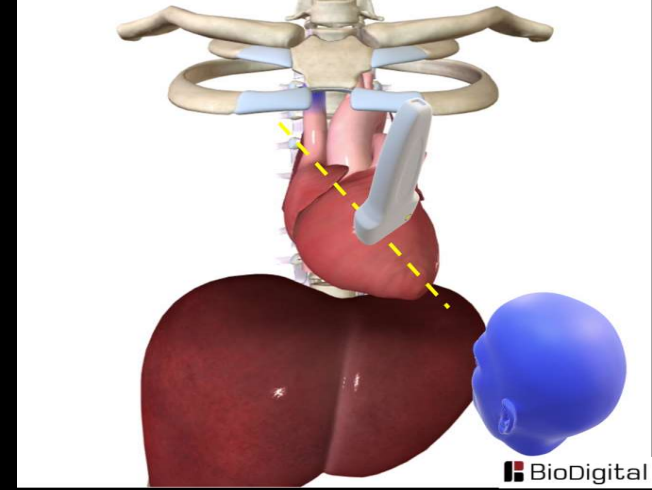




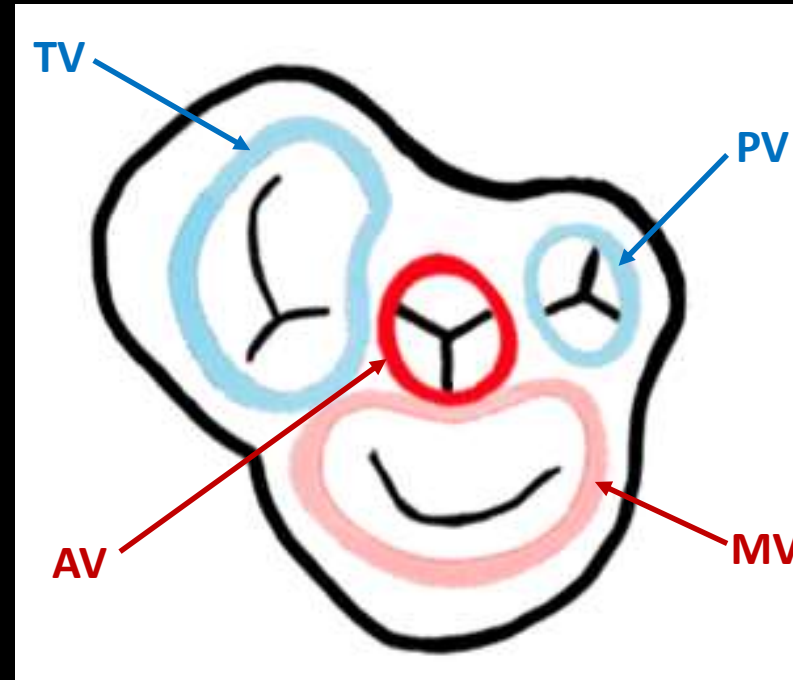
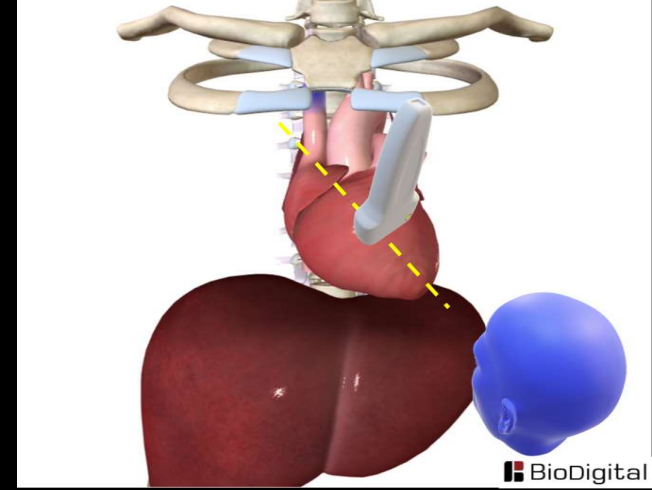
Anatomic Cut



Sonographic Cut

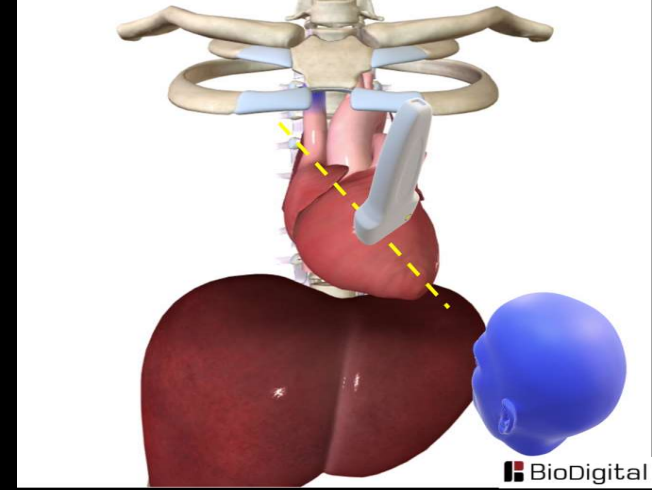


View from the apex

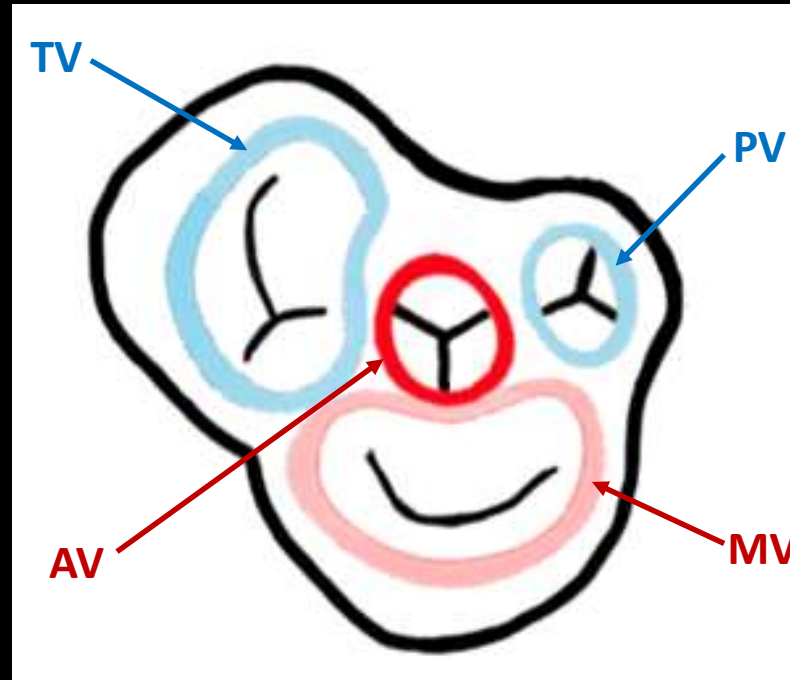


View from the apex

Anterior



Inferior



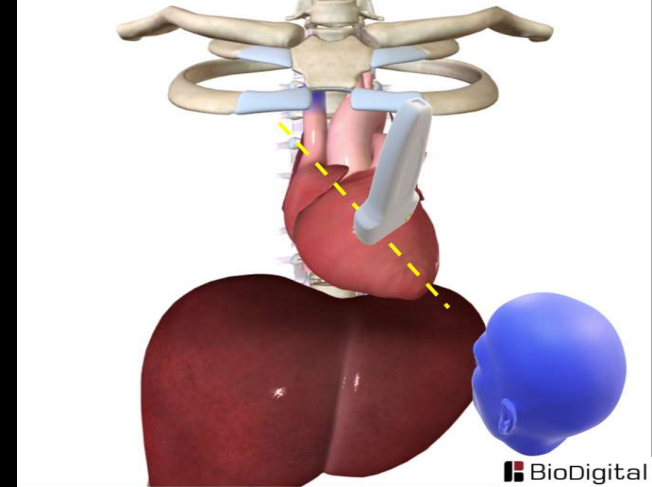
Superior

Posterior

View from the apex



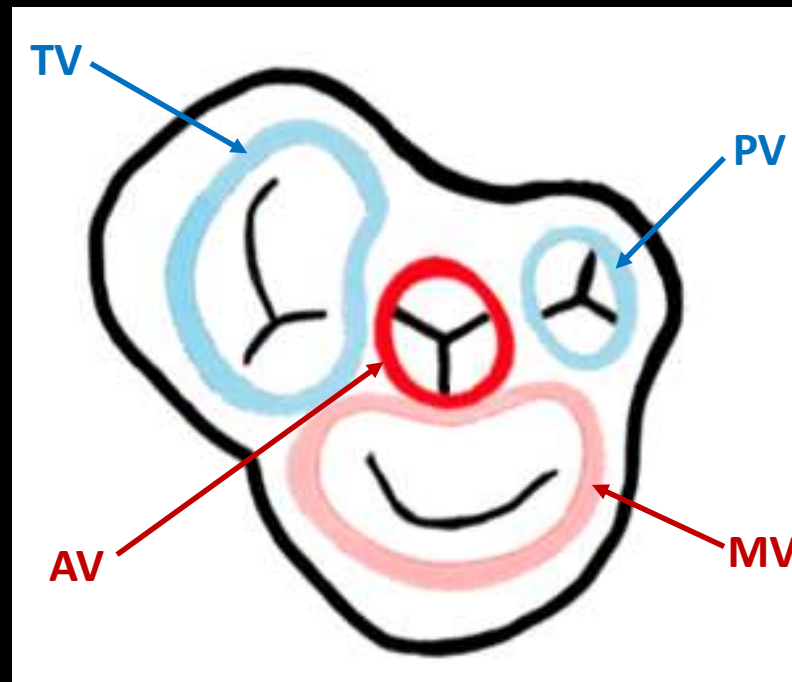
Anterior



RIBS



Inferior



Superior

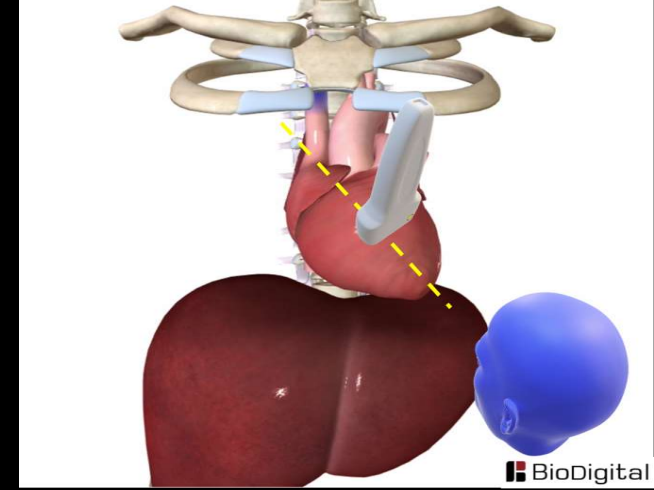
Posterior

View from the apex

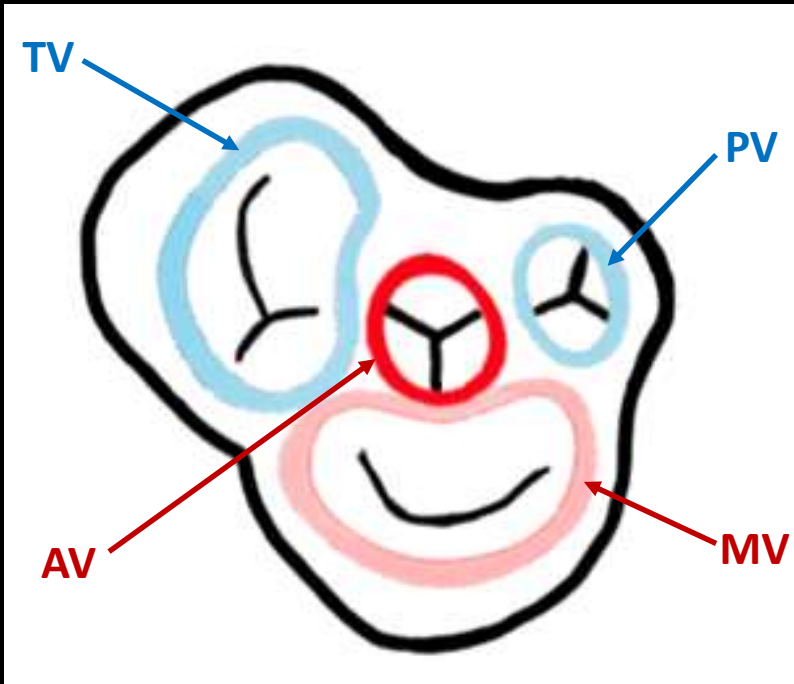
Anterior

3<sup>rd</sup>  
ICS

RIBS



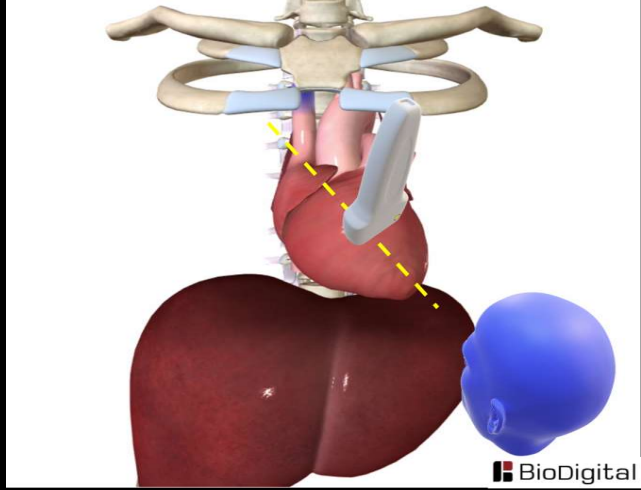
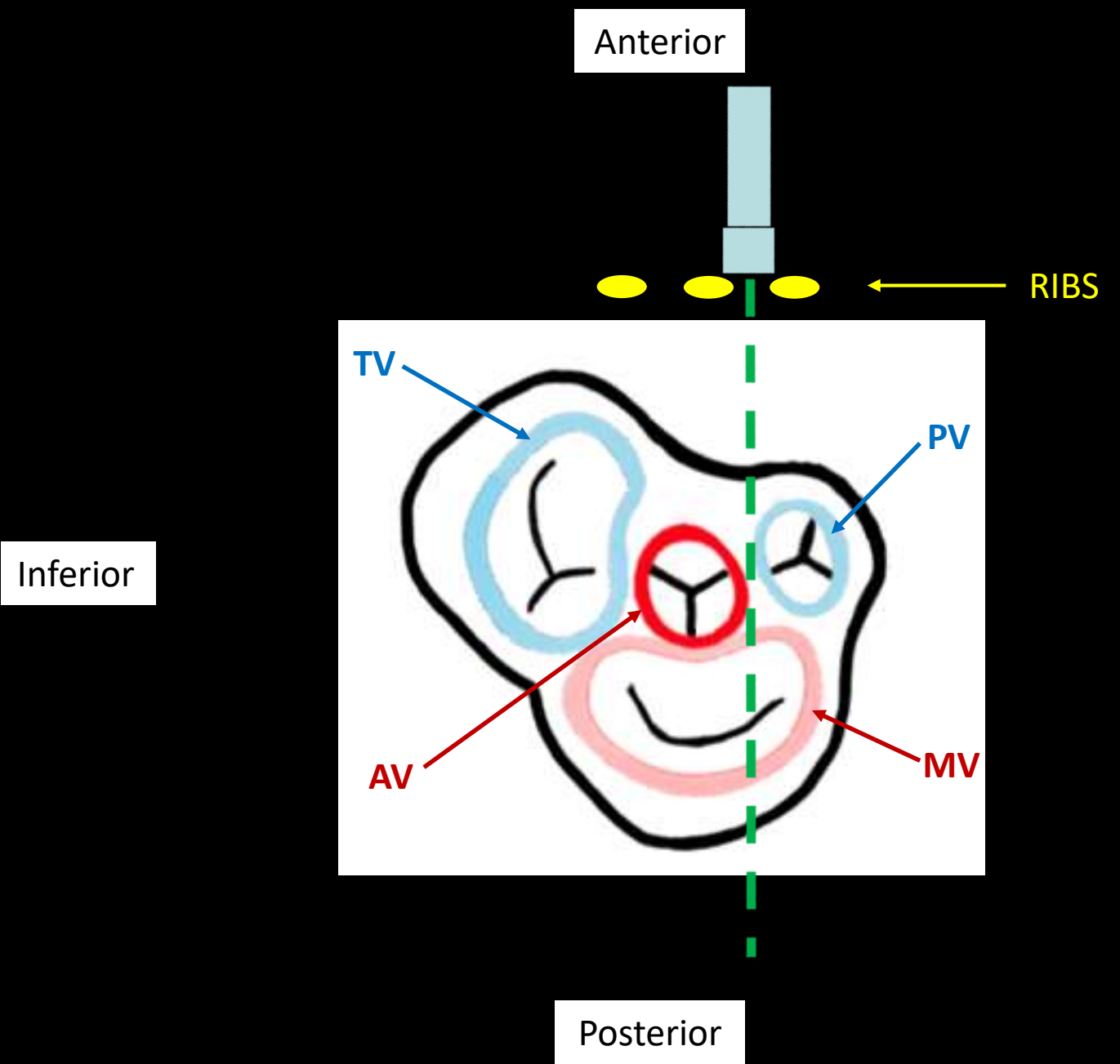
Inferior



Superior

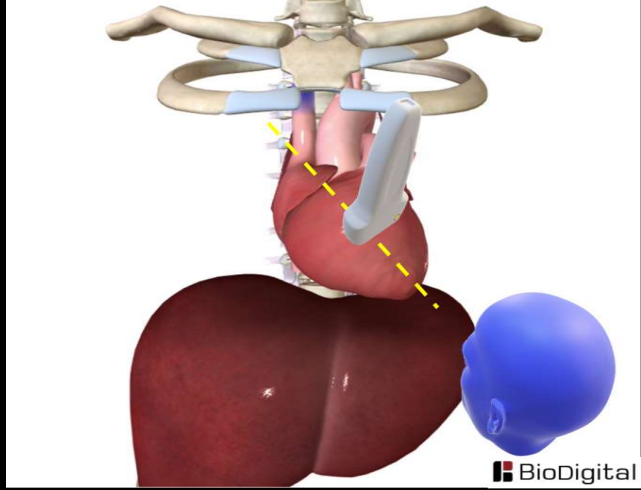
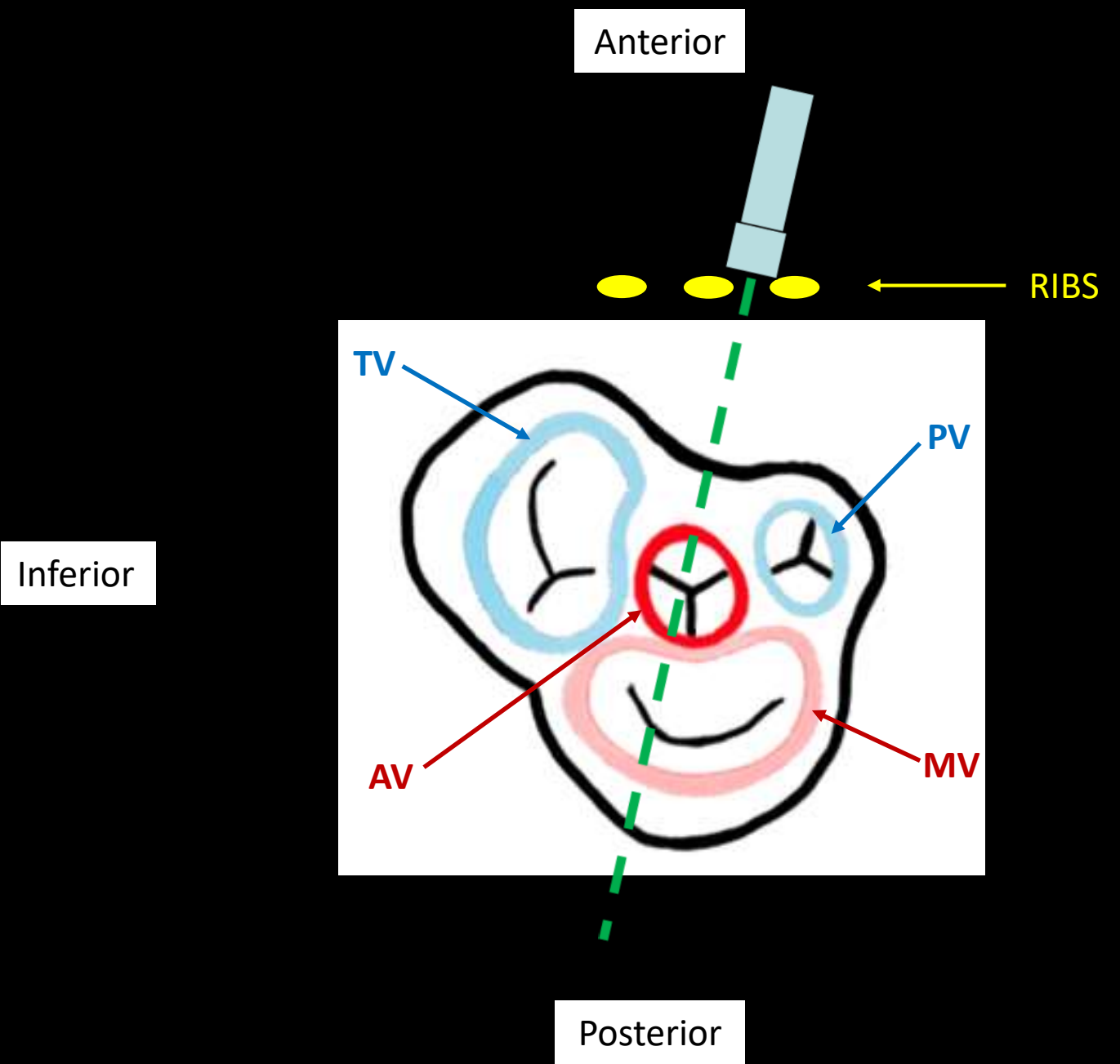
Posterior

View from the apex

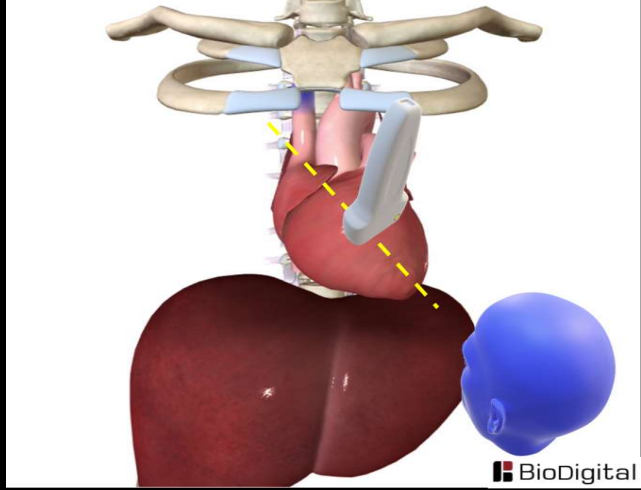
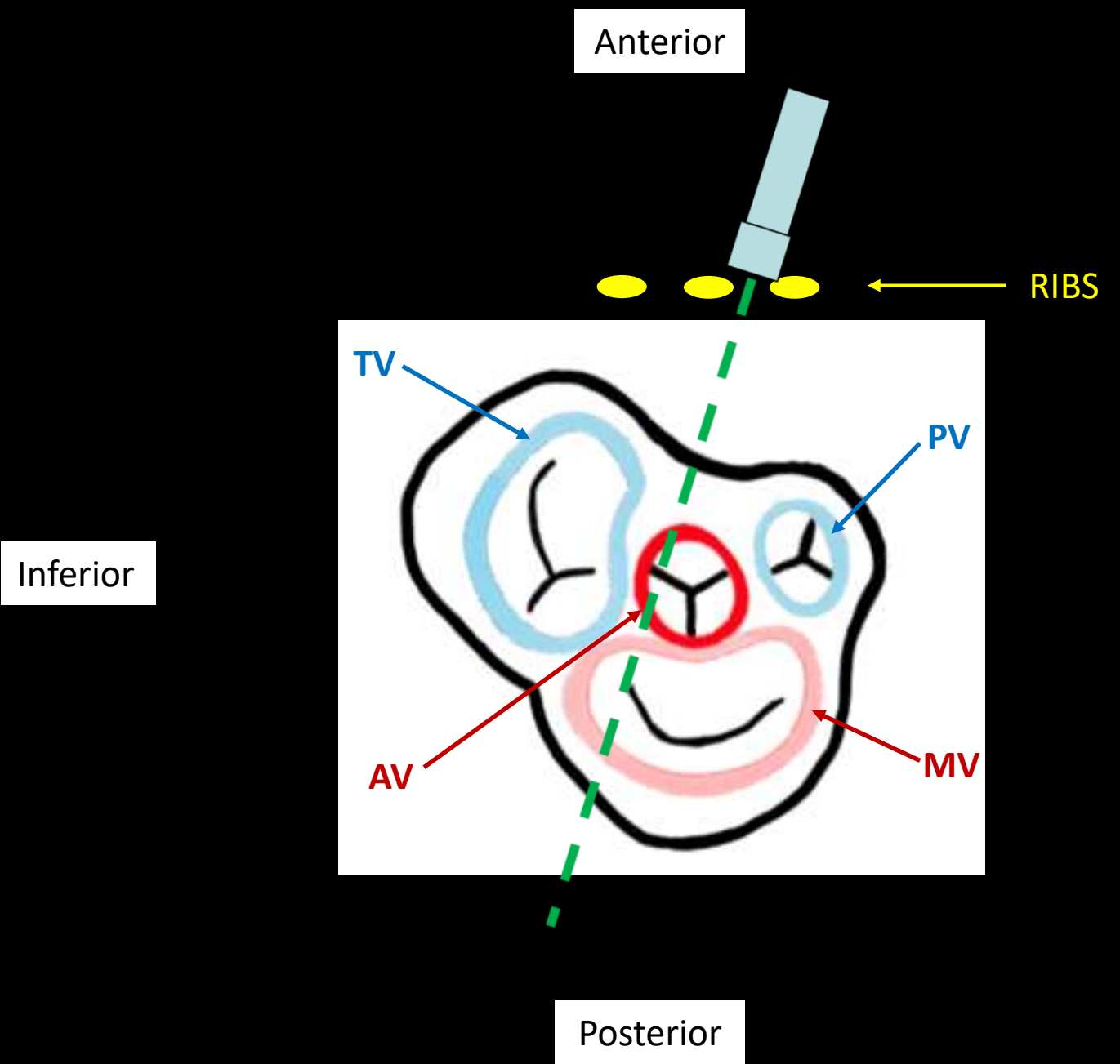


Superior

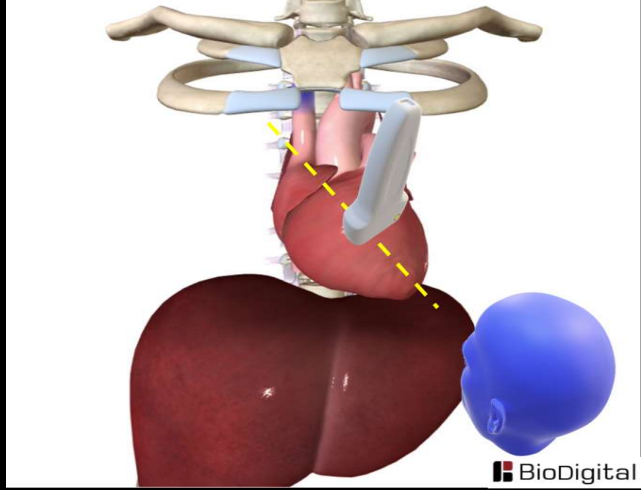
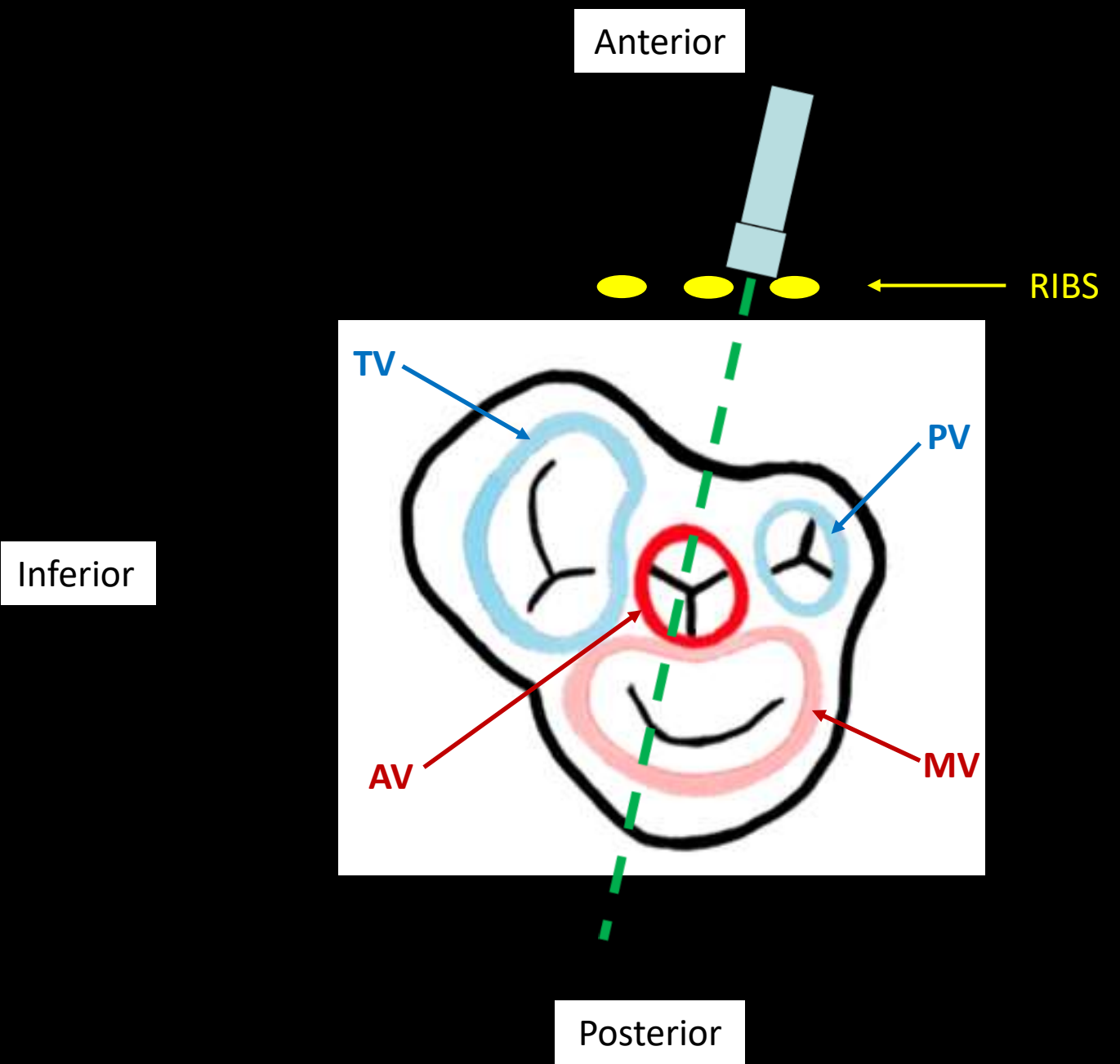
View from the apex



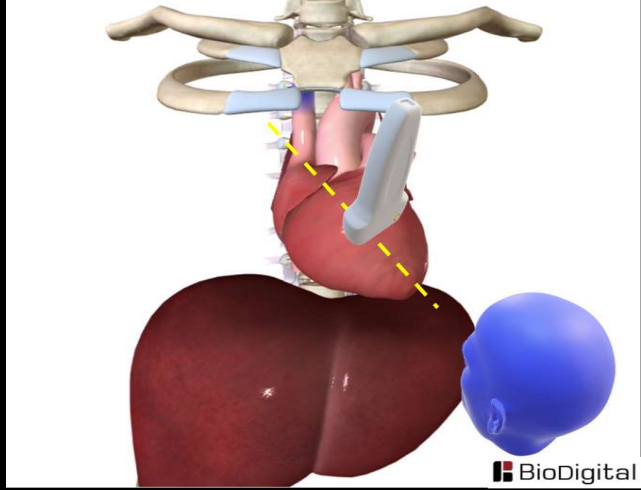
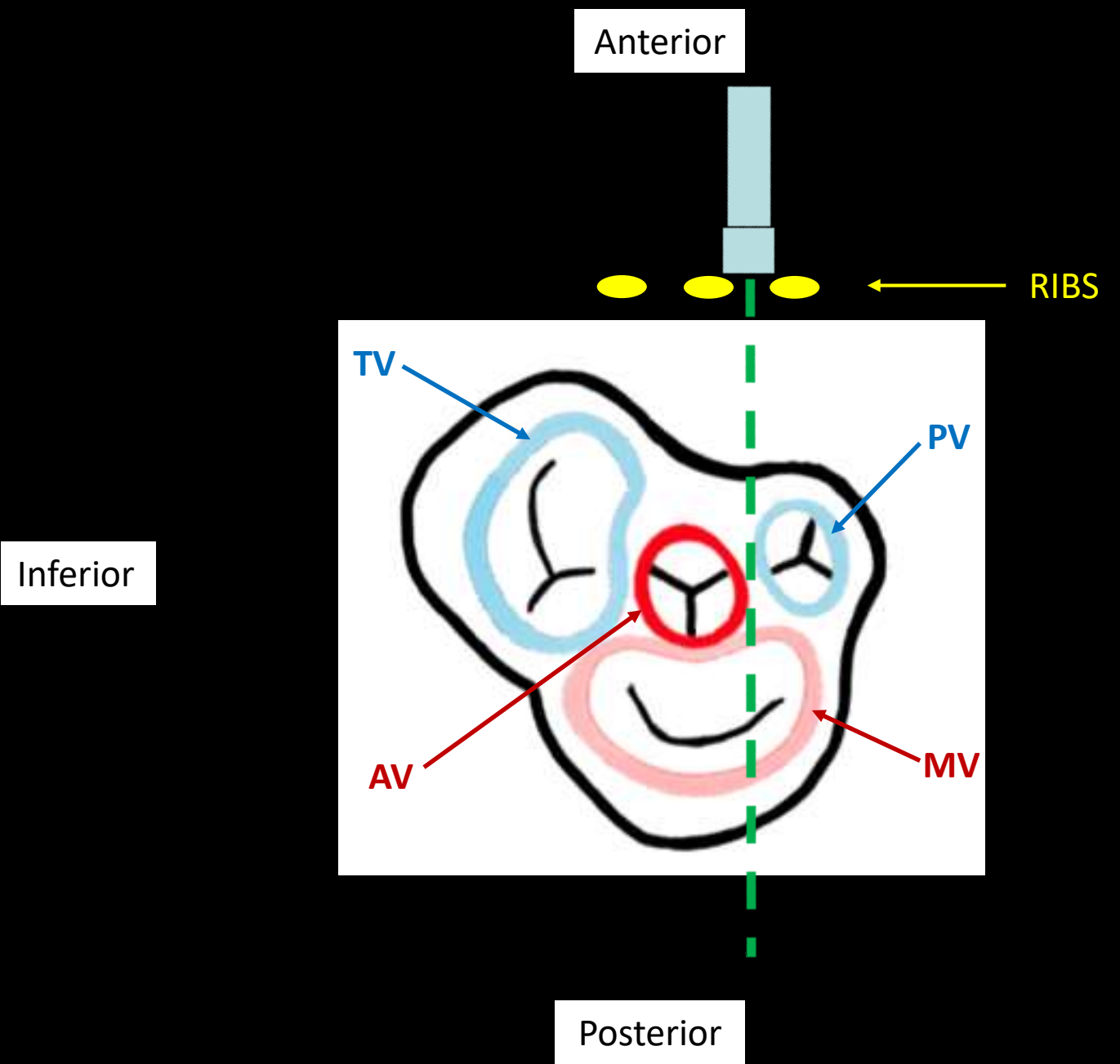
View from the apex



View from the apex

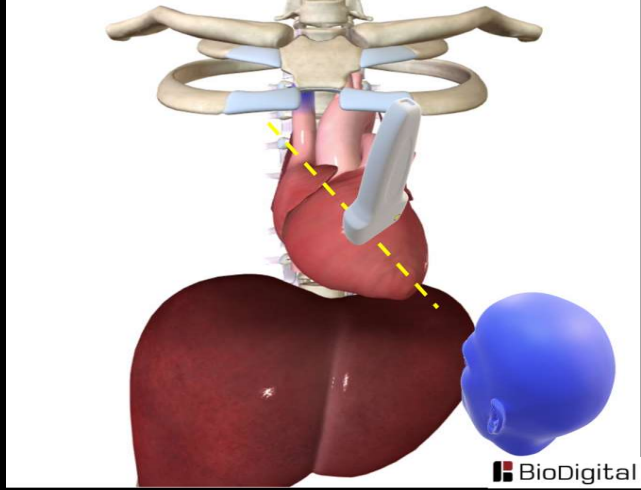
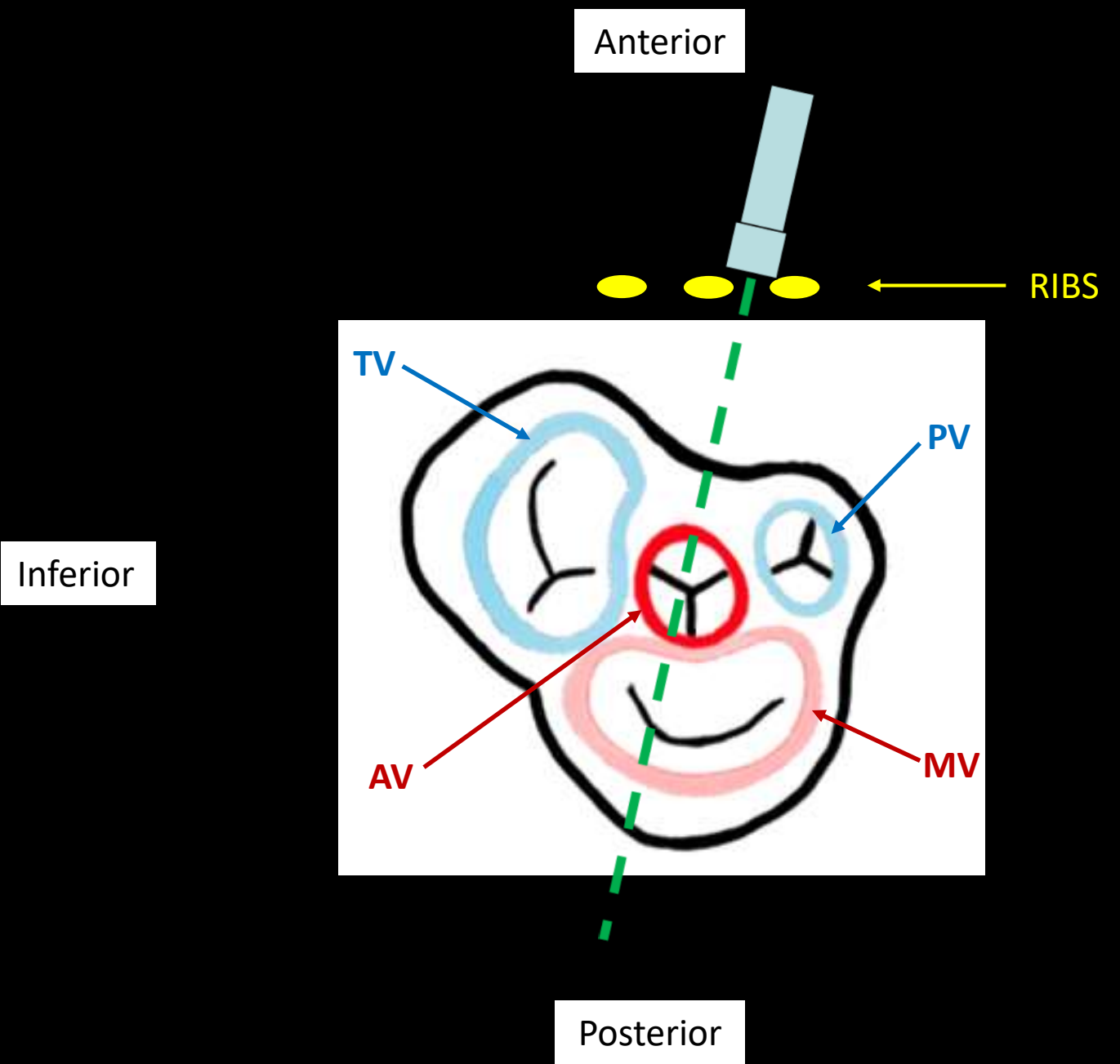


View from the apex



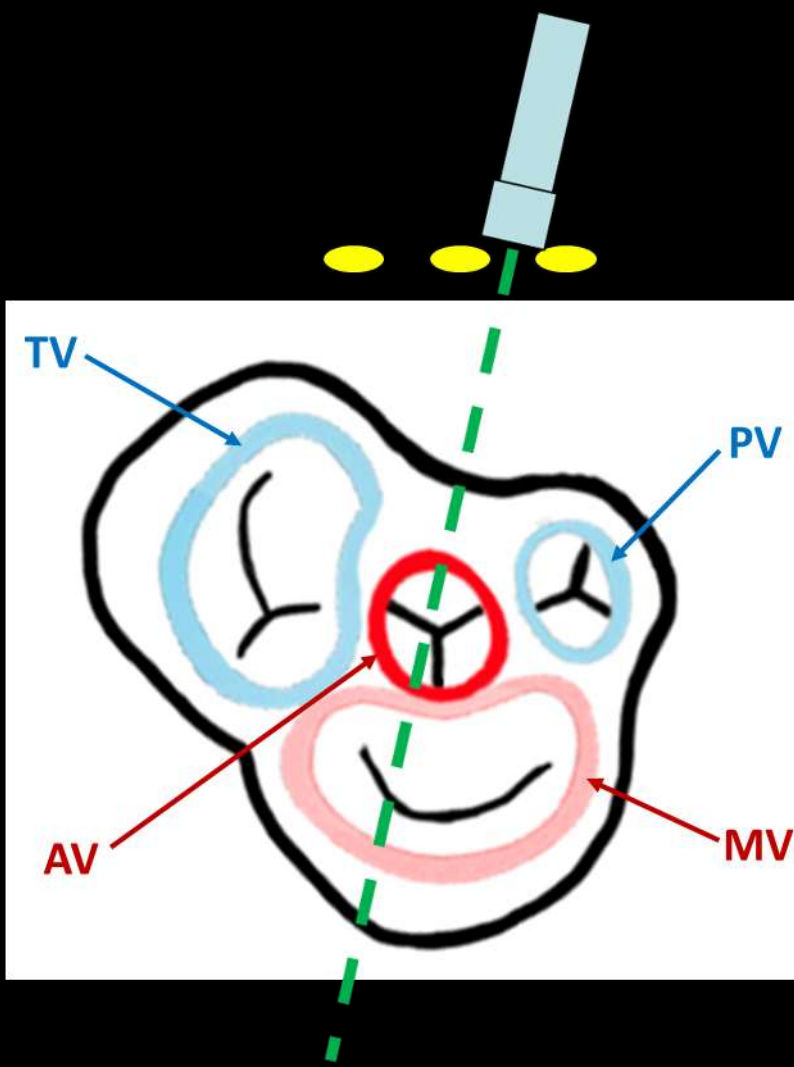
Superior

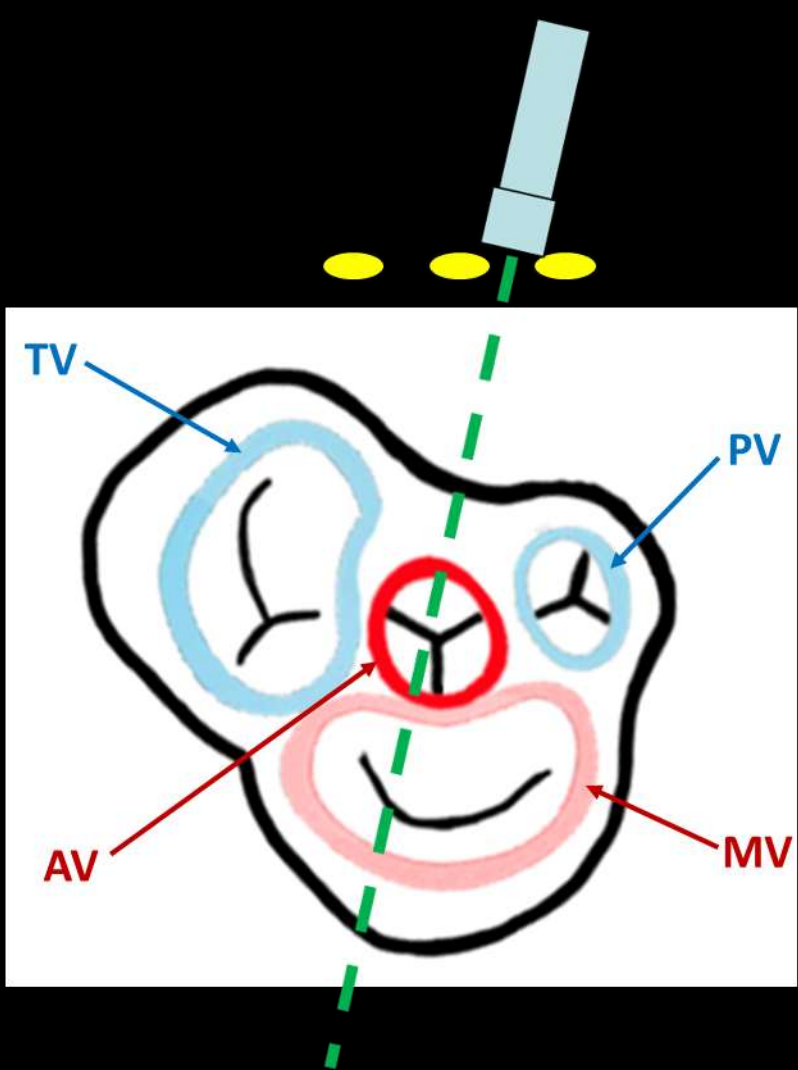
View from the apex



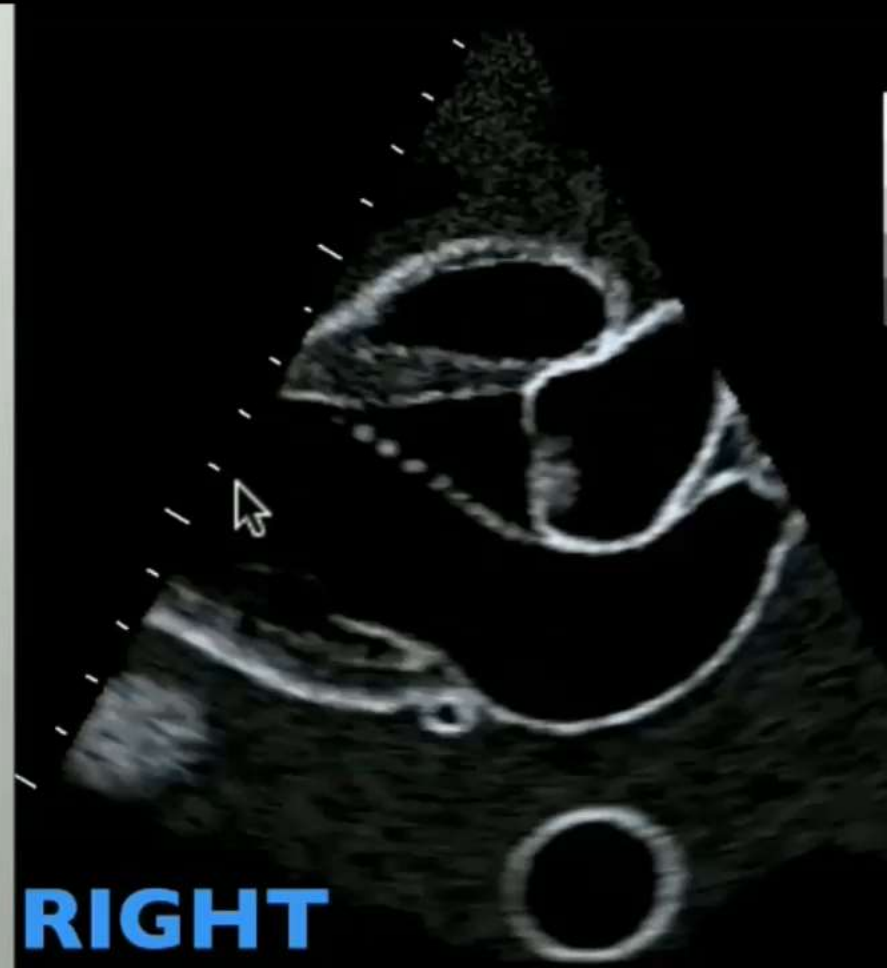
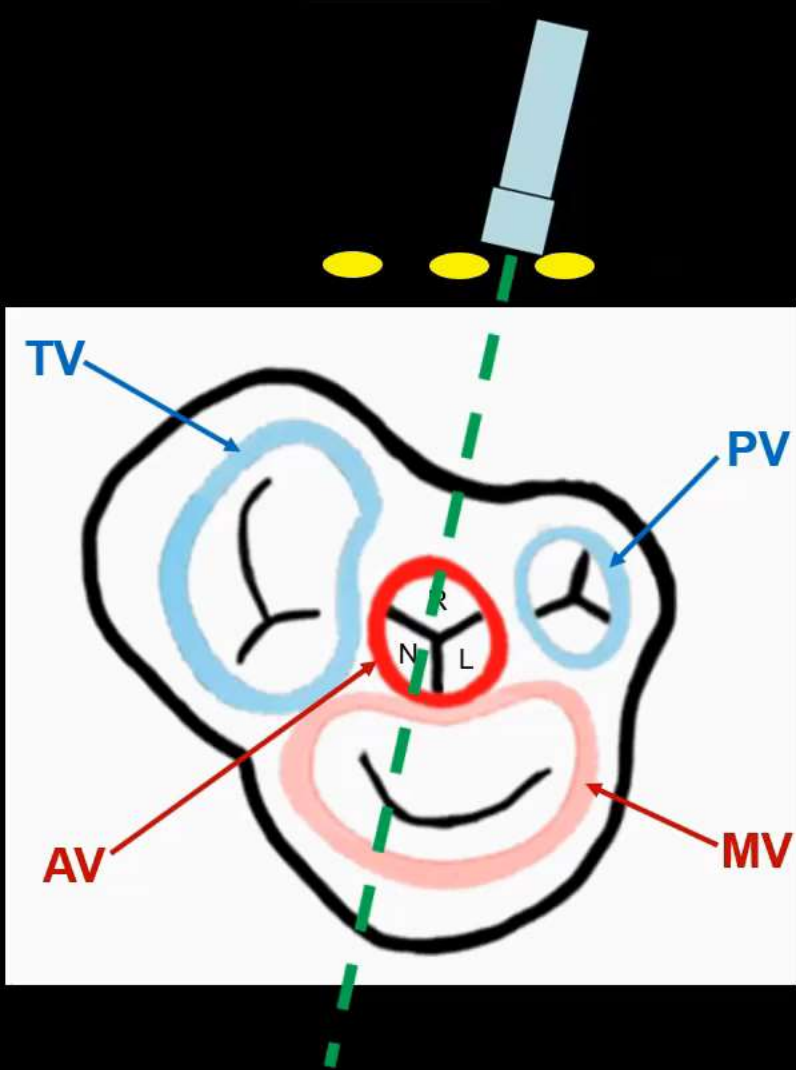
View from the apex







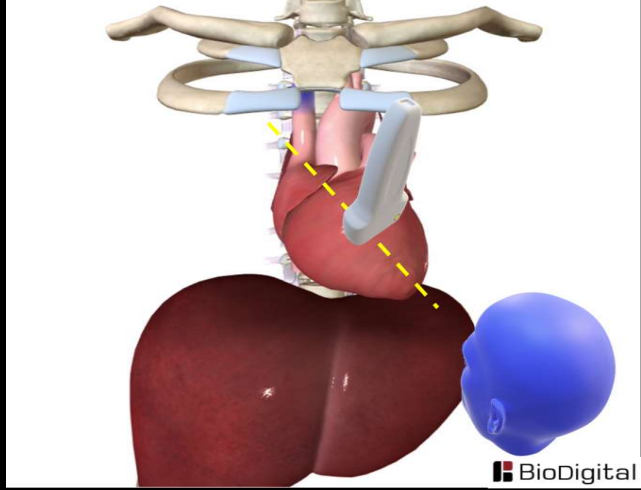
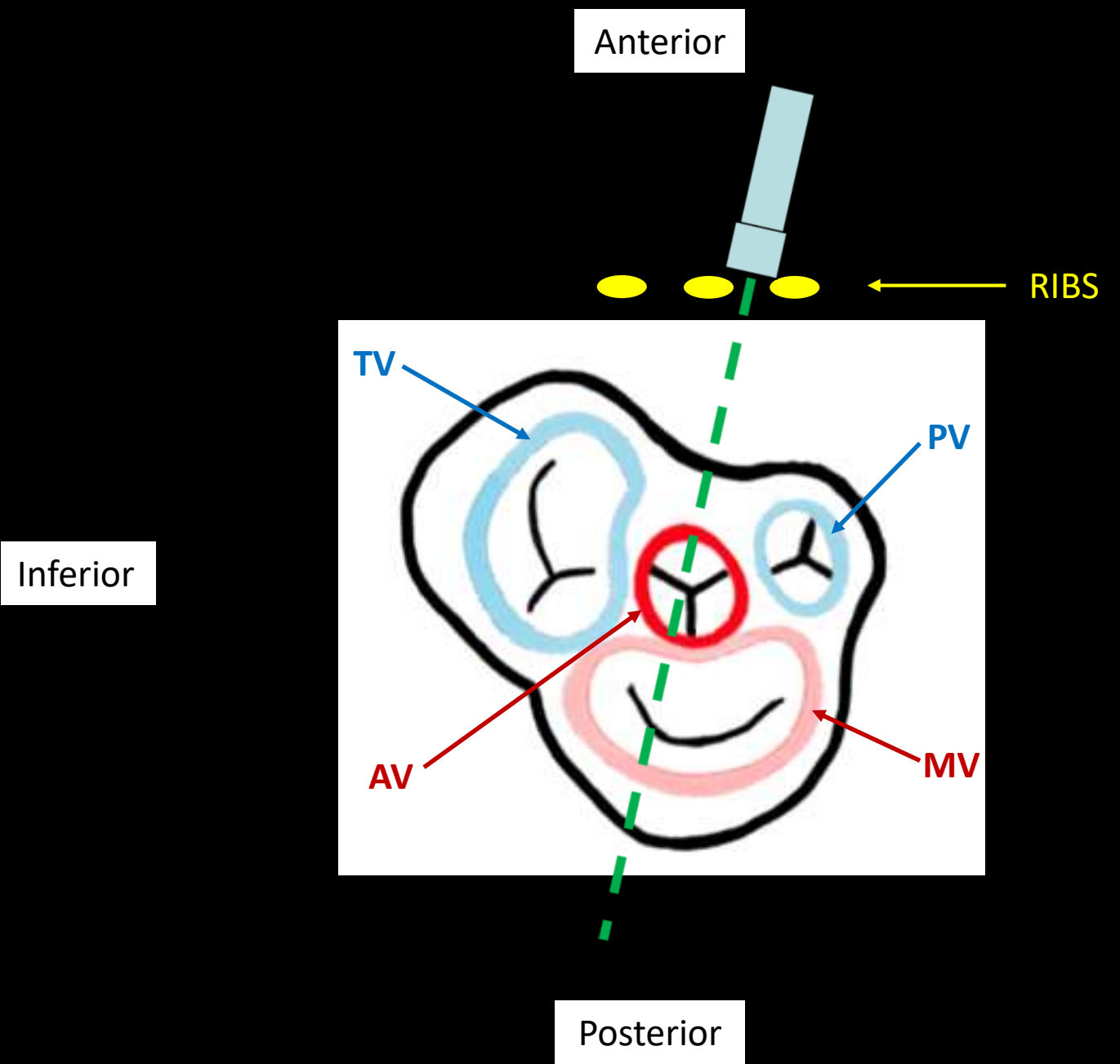
# Tilt: Medium – loss of a valve



**NOT QUITE RIGHT**

# PLAx

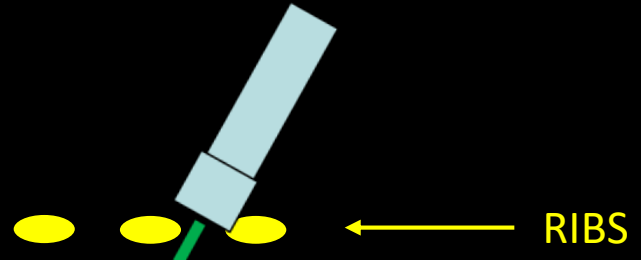
- depth { 1. Surveillance depth: descending aorta @ ~ middle of the screen
- 2. Study depth: Descending aorta visible at the bottom of the screen
- Rock/Slide { 3. Focus on LV. MV should be just to the right of the screen center
- sweep { 4. Obtain the image as high in the parasternal window as possible
- rotation { 5. Apex should not be visible, i.e. LV wall parallel to the septum
- tilt { 6. Largest LV cavity diameter – small tilt
- 7. Both aortic and mitral valve clearly visible in the same cut – medium tilt
- 8. 3 chambers (LA, LV, Aorta) + RVOT – large tilt



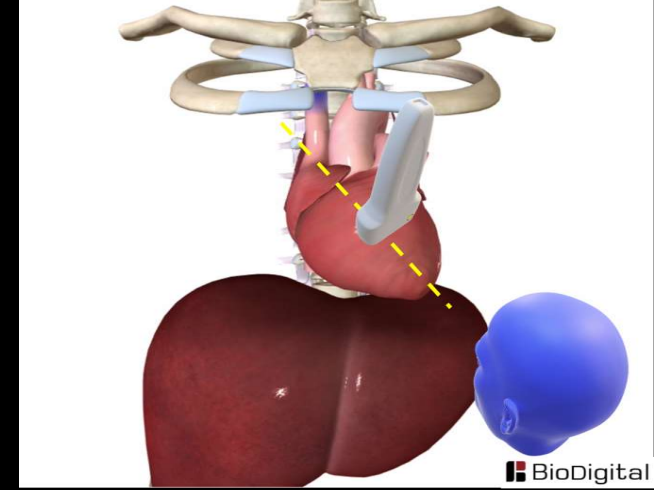
Superior

View from the apex

Anterior

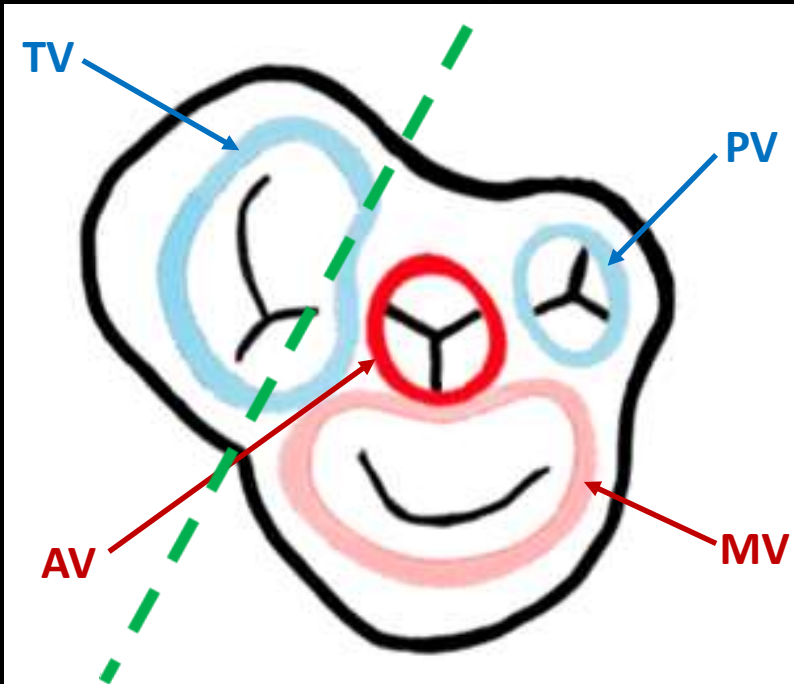


RIBS



BioDigital

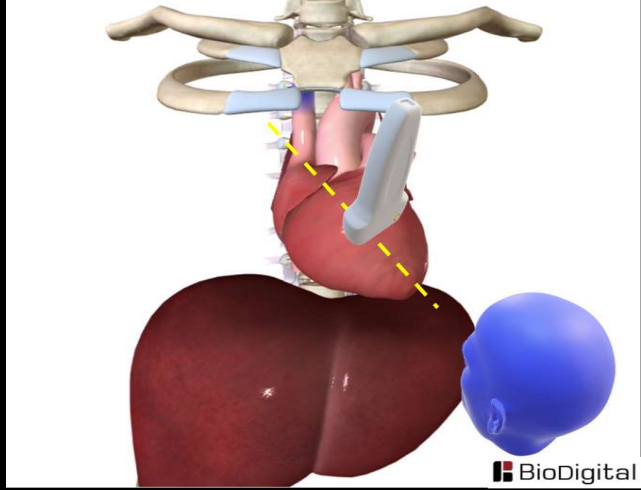
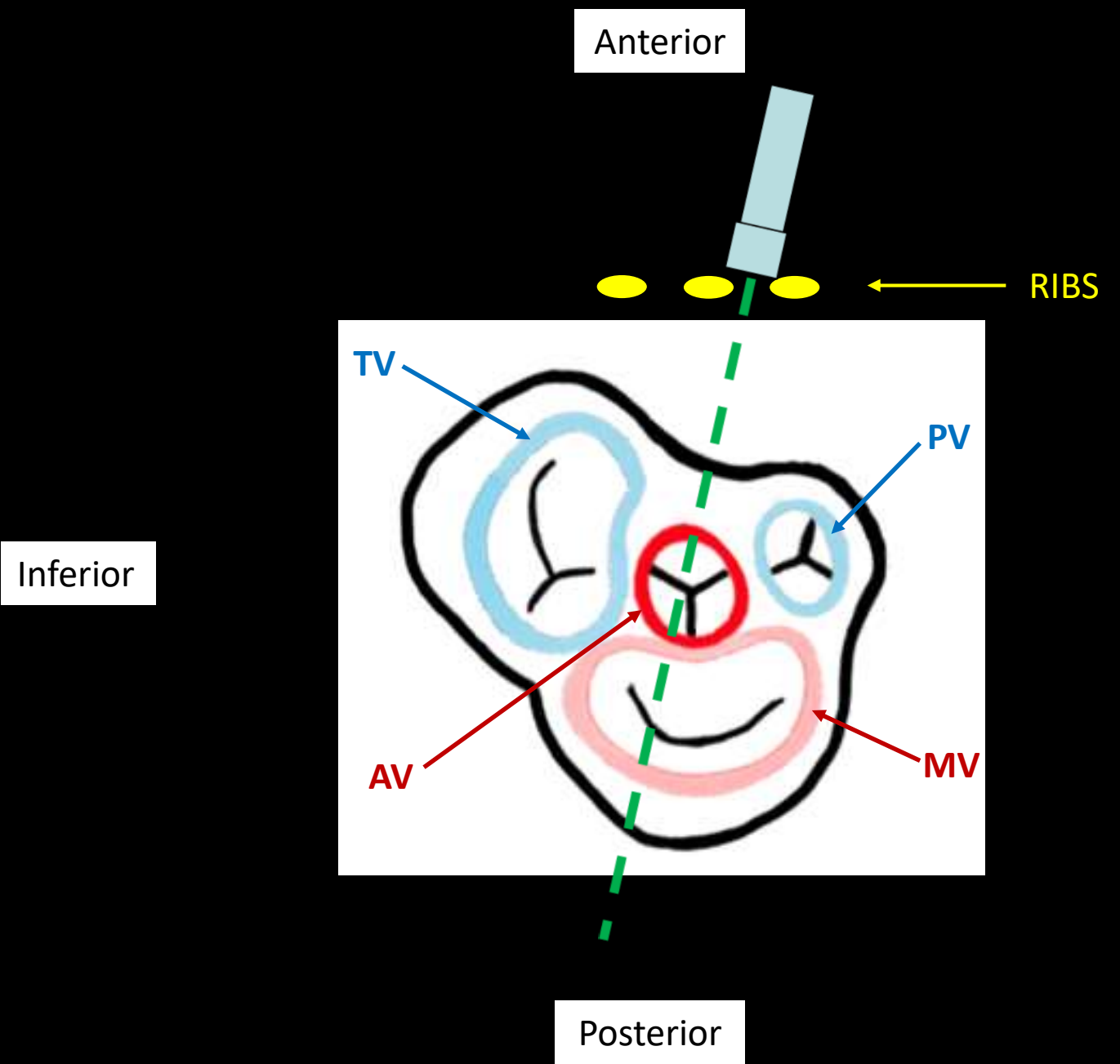
Inferior



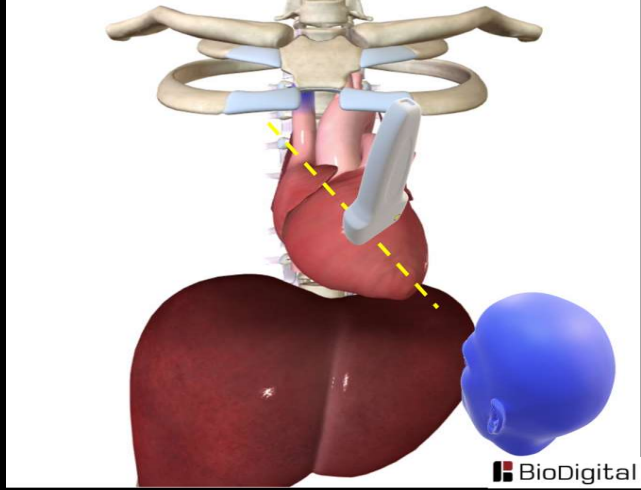
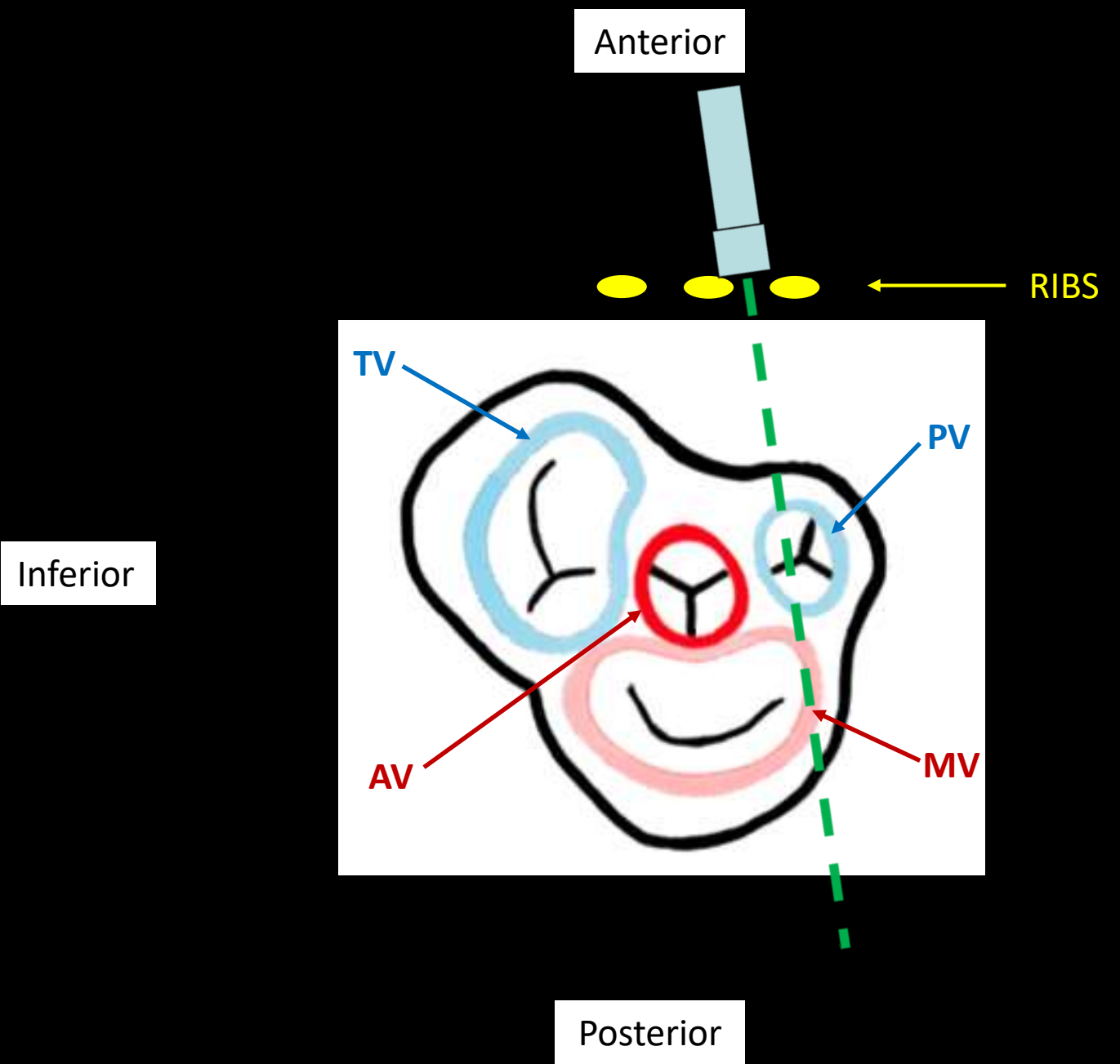
Superior

Posterior

View from the apex



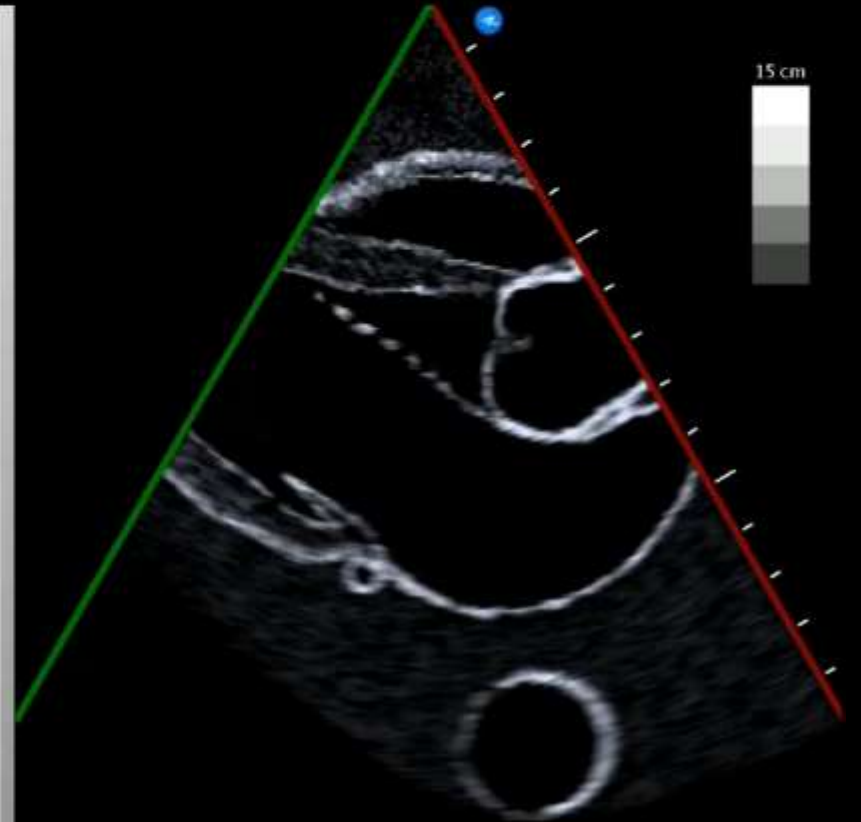
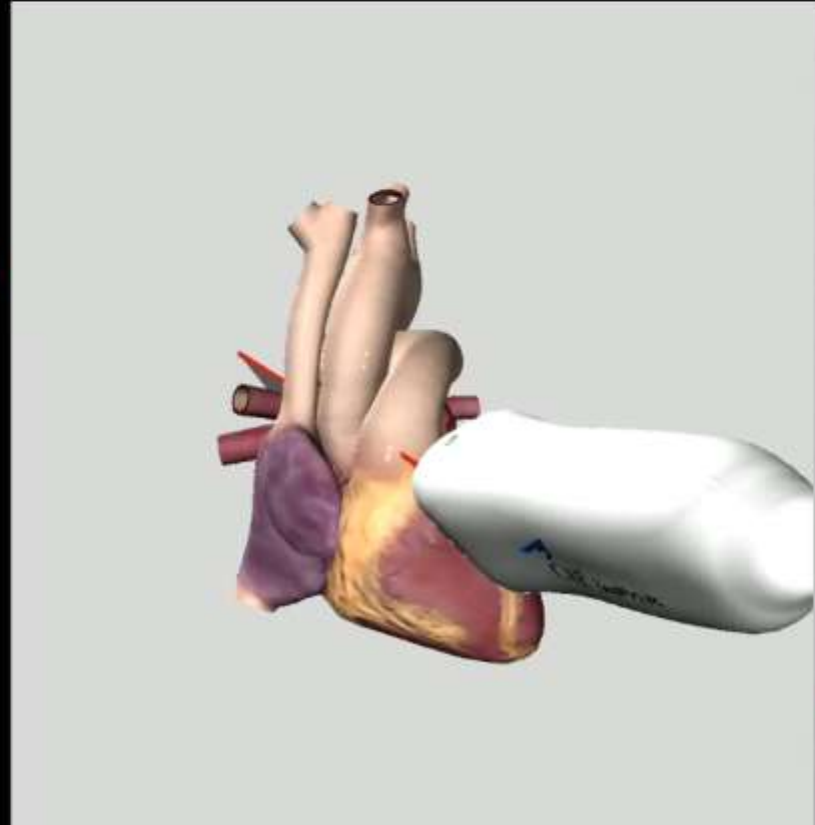
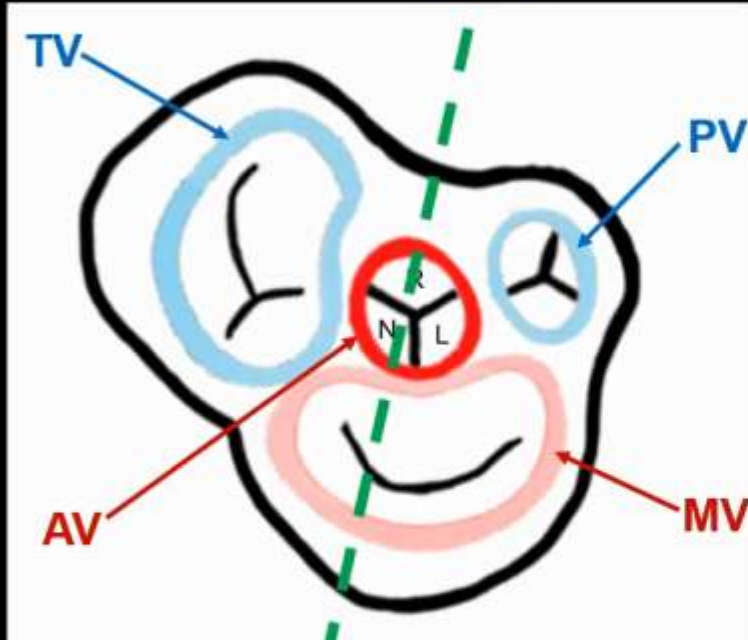
View from the apex



View from the apex

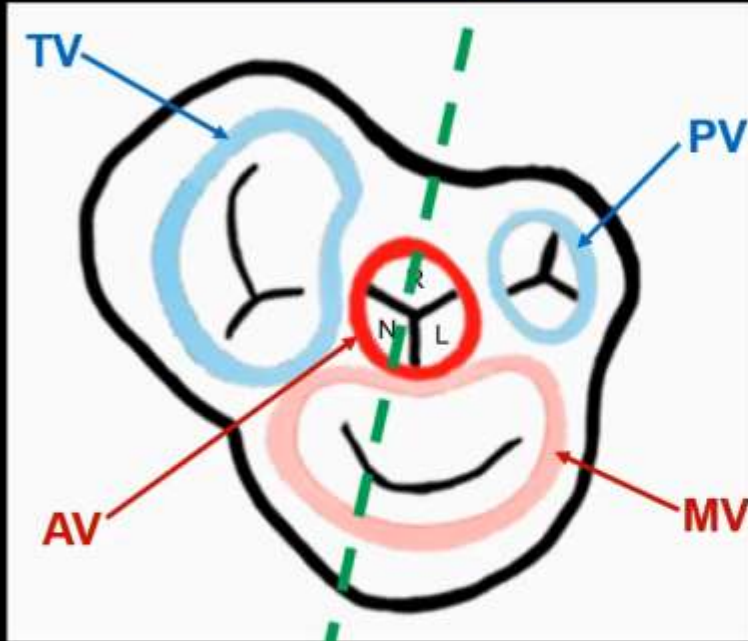


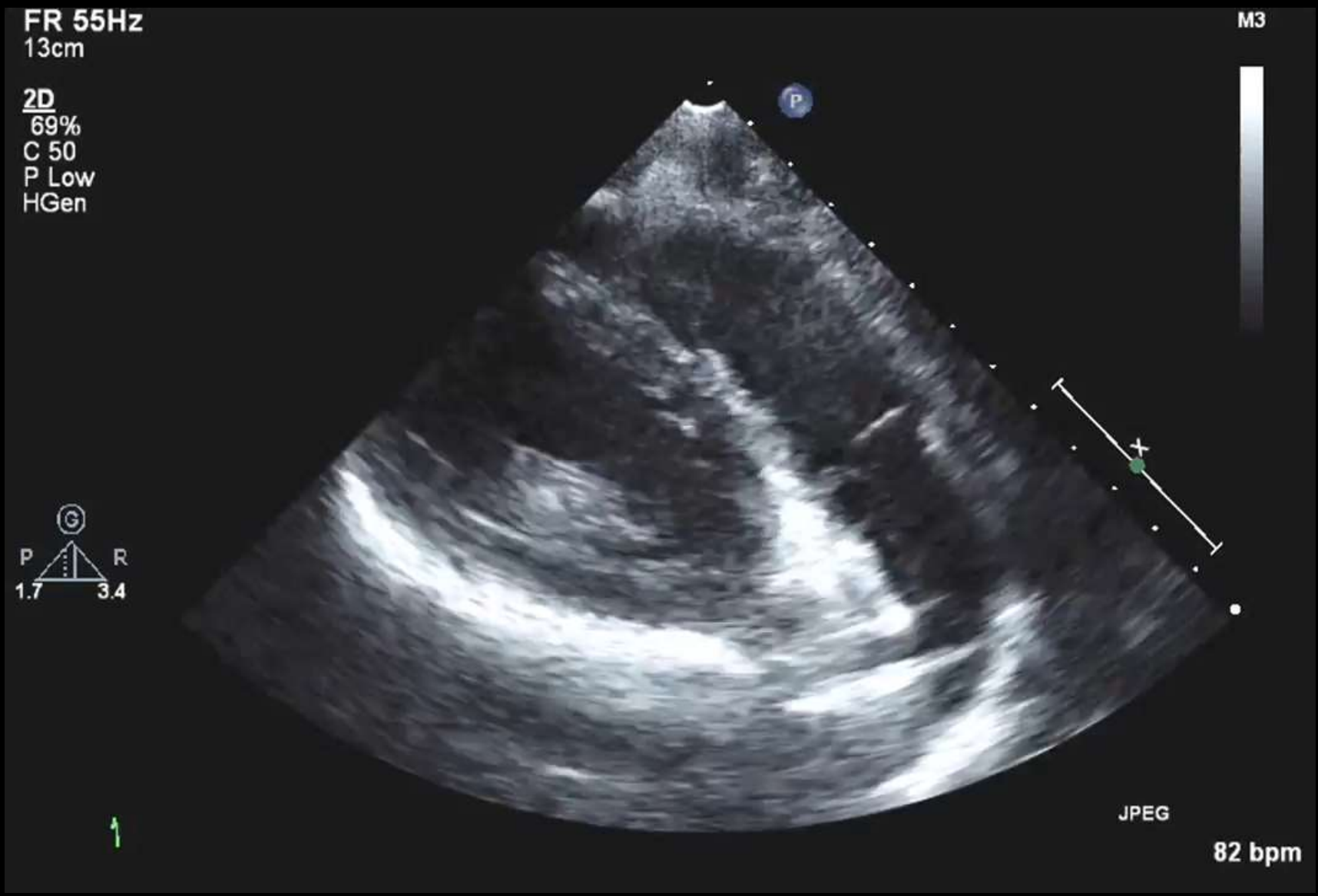
# Tilt: Large – RV inflow





# Tilt: Large – RV outflow





	Problem	Possible Cause	Solution
1	Missed pleural effusion. Which effusion: pericardial or pleural?	Surveillance depth too shallow	Increase the depth
2	Too much LA (too little LV), Aorto-septal angle OK	Probe is too far to the base	Slide towards the apex
3	Too much LA (too little LV), Aorto-septal angle asymmetric	Probe points too far to the base	Rock towards the apex
4	Aorto-septal angle is asymmetric +/- sharp(er), but LA is in correct position	Low parasternal window	Get as high of a window as possible.
5	“Apex” is visible	“Capping” - off axis cut	Rotate
8	Small(er) LV cavity	Off center cut	Tilt to obtain the largest LV diameter
6	Only one valve seen	Off axis imaging	Tilt
7	Only 2 chambers visible	Inferior cut = RV inflow view Superior cut = RV outflow view	Tilt to get 3 chambers + RVOT