ECHOCARDIOGRAM BASICS

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Disclosures:

I have no disclosures
Welcome to the virtual conference...

Thanks to the Iowa Chapter of the ACC CV Team
Upon completion of this presentation the learner will:

1. Understand the different views in transthoracic echocardiograms
2. Identify basic structures of the heart on transthoracic echocardiograms
Outline

I. Basic ultrasound imaging principles
II. Sonographic terminology
III. Windows, scan planes, color and spectral Doppler
   A. Parasternal window
      1. Long axis – standard, RV inflow, RVOT
      2. Short axis – base, mitral valve, mid LV
   B. Apical window
      1. 4 chamber
      2. 5 chamber
      3. 2 chamber
      4. 3 chamber (long axis)
   C. Subcostal
      1. 4 chamber
      2. IVC
      3. Aorta
   D. Suprasternal notch
      1. Aortic arch
      2. Descending aorta
      3. SVC
IV. Summary
Basic Ultrasound Imaging Principles

Pulse-echo technique

• US sent into body, reflects off structures and returns to the transducer

• Instrument/computer processes the reflections into an image

• Pulsing provides time/depth information

Animation courtesy of Dr. Dan Russell, Kettering University
Basic Ultrasound Imaging Principles

Scan Lines

Displayed reflections

Intensities based on the intensity of the returning echo
Locations corresponding to the direction of the beam sent out
Depth based on return time of reflections

Beam is moved through the body in a sweeping action producing real-time

Animation courtesy of Dr. Dan Russell, Kettering University
Basic Ultrasound Imaging Principles

Transducers
- Low Frequency has poor spatial resolution
- Small footprint
  - Phased array
  - Vector (Siemens)

Frame Rate
- High (>40 Hz) for temporal resolution
- Narrow sector
- Color is always a lower frame rate
Basic Ultrasound Imaging Principles

B color/Colorize

- Eye may be more sensitive to color than black/white
- Colorization can help bring out subtle aspects of the image
  - Peak velocities
  - Thrombus
  - Walls/endocardium
- Colorization is used to help demonstrate depth in 3D imaging
Basic Ultrasound Imaging Principles

Doppler Effect

- Change in frequency when there is motion between the source and receiver
- Medical ultrasound it’s motion of a reflector
  - Toward is above the baseline and red
  - Away is below the baseline and blue

Bushong 1991
Basic Ultrasound Imaging Principles

Doppler Angle
- Parallel to flow is best
- Perpendicular to flow has limited flow detection
- Angle of more than 20 degrees will result in slower calculated velocity
Sonographic Terminology

- Echogenic – having echoes, white
- Anechoic/Sonolucent – without echoes, black
- Hyperechoic – having more echoes when compared to adjacent structure
- Hypoechoic – having less echoes when compared to adjacent structure
- Isoechoic – having the same echogenicity as adjacent structure
2D Windows and Scan Planes

Windows – improve the angle to anatomy and flow
1. Left parasternal
2. Apical
3. Subcostal
4. Suprasternal notch

Hagen-Ansert, 2018
2D Windows and Scan Planes

Scan Planes – must see all walls in two planes, 17 segments
- Long axis
- Short axis
- 4 chamber
- Variations of these

Long

Short

4 chamber

Hagen-Ansert, 2018
2D Windows and Scan Planes

Left Parasternal Long Axis
2D Windows and Scan Planes

Left Parasternal – Long Axis
- Pleural effusion
- Pericardial effusion
Doppler Imaging

Left Parasternal – Long Axis
- Long axis zoom for valves
  - Mitral regurgitation
  - Aortic insufficiency

Normal

Aortic Insufficiency
2D Windows and Scan Planes

Left Parasternal
- Right ventricular (RV) inflow for tricuspid valve (TV)
- Right ventricular outflow tract (RVOT) for pulmonic valve

Hagen-Ansert, 2018

https://thoracickey.com/right-heart/
2D Windows and Scan Planes

Left Parasternal Short Axis
- Base
- Mitral valve
- Mid ventricle

Hagen-Ansert, 2018
2D Windows and Scan Planes

Left Parasternal - Short Axis
- Aortic stenosis
- Atrial septal defect

This patient also has a pacemaker in, see RA through TV into RV
2D Windows and Scan Planes

Apical 4 chamber
2D Windows and Scan Planes

Apical - 4 chamber
- Poor ejection fraction with apical thrombus
- Dilated right atrium
  - Pacer wire with thrombus
2D Windows and Scan Planes

Apical – 4 chamber
- Mitral valve
- Tricuspid valve
2D Windows and Scan Planes

Apical – 4 chamber
- Tricuspid regurgitation
  - Increased RV pressure
  - Pressure Gradient = \(4(V_{\text{max}})^2\)
  - Pulmonary hypertension

TR Vel(max) approx. 3.5 m/s
RV to RA PG = \(4(3.5\text{m/s})^2\) = 49 mmHg
Est RV pressure >= 52 mmHg dependent on RA pressure
Pitfall – varying velocities, need multiple measurements
2D Windows and Scan Planes

Apical
- 5 chamber - Left ventricular outflow tract (LVOT)
- 3 chamber (long axis)
- 2 chamber
2D Windows and Scan Planes

Apical – 5 chamber
- Stroke volume
2D Windows and Scan Planes

- Apical – 3 chamber
- Aortic stenosis
- Aortic insufficiency

$V_{\text{max}} = 4.5 \text{ m/s}$

Est. peak PG 81 mmHg
2D Windows and Scan Planes

- Subcostal
  - 4 chamber
  - IVC with sniff
  - Abdominal aorta

Hagen-Ansert, 2018

Anderson, B, 2007
2D Windows and Scan Planes

Subcostal – IVC
- IVC normal collapse
- IVC plethora

Increased central venous pressure
2D Windows and Scan Planes

Suprasternal Notch
- Long axis aortic arch
- Long axis descending thoracic aorta
- Short axis aortic arch
2D Windows and Scan Planes

Suprasternal Notch
- Normal flow in descending thoracic aorta
2D Windows and Scan Planes

Suprasternal Notch
- Coarctation

\[ V_{\text{max}} = 5 \text{ m/s} \]
Estimated peak PG 100 mmHg
This and That…

Agitated Saline (bubble study)
- ASD
- PFO
- Transpulmonic shunt (pulmonary arteriovenous fistula)
- Persistent left superior vena cava

Negative

Positive – Secundum ASD
This and That...

Image enhancing agent (contrast)
- Endocardial delineation
- Ejection fraction
- Wall motion abnormalities
- Thrombus
- Non-compaction
1. Understand the different views in transthoracic echocardiograms
   A. Left parasternal window
      • Long axis
      • Short axis
   B. Apical window
      • 4 chamber
      • 5 chamber
      • 3 chamber
      • 2 chamber
   C. Subcostal
      • 4 chamber
      • IVC long axis
   D. Suprasternal notch
      • Aortic arch long axis
      • Descending aorta
      • Aortic arch short axis
Summary

2. Identify basic structures of the heart on transthoracic echocardiograms
   A. Pericardium
   B. Chambers
   C. Valves
   D. Aorta and Pulmonary arteries
   E. Flow characteristics

References
Thank You

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