3D Echo: Acquisition, cropping and display

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No Disclosures
1. Image Optimization

2. Acquisition Modes
   - Spatial vs temporal resolution
   - Gating artifacts

3. Rendering
   - Cropping
   - Thresholds

4. Final Image Display + Analysis

Which Image Will Result In Better 3DE?

A

B
Which Image Will Result In Better 3DE?

A

B

Acquisition: 2D Image Quality

• Before 3DE acquisition, the 2D image should be optimized
  – Poor 2D images, poor 3D images
Acquisition: Image Optimization
Biplane Imaging/Multi-View

Modes of Acquisition

Single-beat (high volume rate methods)
- Zoom
- Narrow volume/Live 3D
- Wide angle/Full volume
- Color Doppler

Multi-beat
Select Acquisition Mode

- Zoom
- Narrow Sector (Live)
- Wide Sector (Full Volume)

For each mode, there are different settings available:

- EPIQ:
  - Zoom: 3D Zoom
  - Narrow angle: Live 3D
  - Full volume: Full Volume

- iE33:
  - Zoom: 3D Zoom
  - Live 3D
  - Full Volume

- e9:
  - 4D Zoom Prepare
  - Birds View
  - Medium
  - Large

- e95:
  - 4D Zoom Prepare
  - Bird's View
  - Medium
  - Large
• Indications:
  – Valves
  – ASD
  – VSD
  – small, fast moving structures
• Beware of losing spatial orientation
Narrow Volume

- Useful for procedures

Wide Angle
Pyramidal size

4-Beat, 30 Hz  4-Beat, 20 Hz

What size to choose?

Narrow angle/Zoomed
- Valves
- Inter-atrial septum
- Inter-ventricular septum

Wide angle
- LV
- RV
- Whole heart
Single or Multi-beat?

Single-beat acquisition
– acquisition of multiple pyramidal data sets per second in a single heartbeat

ECG-triggered multiple-beat acquisition
What is the Problem?

a) Nothing
b) Low frame rate
c) Stitch artifact
d) LV is not centered

What is the Problem?

6 Hertz

a) Nothing
b) Low frame rate
c) Stitch artifact
d) LV is not centered
**Solution**

- Multi-beat or high volume rate mode

1-Beat, 6 Hertz  
4-Beat, 23 Hertz  
High Volume Rate, 23 Hertz

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**Single or Multi-beat?**

<table>
<thead>
<tr>
<th>Single Beat</th>
<th>Multi-beat</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantage</strong></td>
<td><strong>Advantage</strong></td>
</tr>
<tr>
<td>Overcomes limitations from rhythm disturbances and respiratory motion</td>
<td>Images with higher temporal resolution</td>
</tr>
<tr>
<td><strong>Disadvantage</strong></td>
<td><strong>Disadvantage</strong></td>
</tr>
<tr>
<td>Limited by poor temporal resolution</td>
<td>Gated images are susceptible to artifacts from respiratory motion or cardiac arrhythmias</td>
</tr>
</tbody>
</table>
### Vendor Dependent

<table>
<thead>
<tr>
<th></th>
<th>GE</th>
<th>Phillips</th>
<th>Siemens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Beat</td>
<td>X</td>
<td>X</td>
<td>X (High Volume)</td>
</tr>
<tr>
<td>Multi-beat</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>High Volume</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

![Images](image1.png)

Courtesy Drs Muraru and Badano

### What is the Problem?

a) Too bright  
b) Too zoomed  
c) Stitch artifact  
d) Nothing, it’s perfect

![Images](image2.png)
What is the Problem?

- a) Too bright
- b) Too zoomed
- c) Stitch artifact
- d) Nothing, it’s perfect

Stitch Artifact

- MUST examine the imaging planes perpendicular to the sweep plane
- Apical 4-chamber acquisition → check SAX/side
What Can Cause This Problem?

a) Motion
b) Arrhythmia
c) Early acquisition in multi-beat mode
d) a and b
Solutions

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution*</th>
</tr>
</thead>
</table>
| Motion     | • Stabilize probe  
             • Breath Hold  
             • Single beat acquisition |
| Arrhythmia | • Retrospective acquisition setting using freeze/cine play/trim  
             • Single beat/high volume rate acquisition |

*Always check ECG

Why Do We Have This Problem?

a) Motion  

b) Arrhythmia

c) Early acquisition in multi-beat mode

d) I still don’t think we have a problem
Why Do We Have This Problem?

a) Motion
b) Arrhythmia
c) Early acquisition in multi-beat mode
d) I still don’t think we have a problem

Solution:
Acquire on Multiplane View
Select Density

<table>
<thead>
<tr>
<th>Mode of Acquisition</th>
<th>High Density</th>
<th>Medium Density</th>
<th>Low Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrow angle</td>
<td>46° x 23°</td>
<td>58° x 29°</td>
<td>N/A</td>
</tr>
<tr>
<td>3D Zoom</td>
<td>30° x 30°</td>
<td>38° x 38°</td>
<td>45° x 45°</td>
</tr>
<tr>
<td>Multi-beat</td>
<td>62° x 56°</td>
<td>78° x 70°</td>
<td>93° x 84°</td>
</tr>
<tr>
<td>3D Color</td>
<td>28° x 28°</td>
<td>35° x 35°</td>
<td>42° x 42°</td>
</tr>
</tbody>
</table>

Density: Determines volume resolution and size

3DE color Doppler

Can be obtained with single beat or multi-beat
Cropping

• Can be performed before or after data acquisition
• Before acquisition allows better temporal and spatial resolution
• However if cropped image is stored, image may not be amenable to ‘uncropping’
• Wide data set can be acquired and then cropped, retains information but at expense of spatial and temporal resolution
Cut-Planes

• **Box Crop**
  – Auto Crop
  – Box Crop/Crop Tool

Cut-Planes

• **Arbitrary Crop**
  (Plane/View Crop)
Cut Planes – iCrop/
2-Click Crop/Parallel Crop

GE e9 (e95)
What is the Problem?

a) Too zoomed
b) Leaflet dropout
c) Too bright
d) Too smoothed
Solution: Larger acquisition box/less cropping

Acquire or Render and Crop

• Remember *rendering and cropping* can be adjusted after acquiring your 3D volume
Rendering

3D object ➔ 2D image

Gain
Compress
Vision
Smoothing
Brightness

Gain

“Snow”

Drop-out

GE 4D Active Mode
• effects are opposite
Smoothing

- Increase
- Decrease

GE Gamma
- affects only midtone values
- lower gamma brighter images
- Higher gamma darker image

Brightness

- Decrease
- Increase
**Colorization/Depth Color Maps**

- Predefined Chroma maps which are colorized post-processing setting applied to the image data to highlight the data
- 1-8

**Vision/Volume Opt**

- Menu of predefined combinations of contrast, transparency, lighting and compositing algorithms
- Affects the spatial filtering and depth of colorization seen
  - Ranges from A - H
GE- UD Clarity

- edge preserving speckle and noise reduction filter that reduces speckle while preserving or even enhancing significant boundaries in the volume data
- Affects cut-planes and the 3D volume

How Can You Fix This Problem?

a) Look at the 2D images
b) Adjust total gain
c) Adjust TGCs
d) All of the above
How Can You Fix This Problem?

a) Look at the 2D images  
b) Adjust total gain  
c) Adjust TGCs  
d) All of the above

Solutions

• Check 2D image
Solutions

• Check 2D image

Solutions

Over  Under
1. Overall gain

- "Snow"
- Drop-out

2. Regional gain

- Adjust TGCs
Acquisition & Presentation

Lang, Badano et al. EAE/ASE 3D Guidelines JASE 2012

MV Valve: Acquisition and Display
Ao Valve: Acquisition and Display

Display

Volume Rendering
Surface Rendering

Wire-Frame
2D Tomographic Slices
Tricuspid Valve

Display the tricuspid valve with the septum placed inferiorly in the six o'clock position, regardless if the valve is oriented as viewed from the left atrium or the left ventricle.

Ant = anterior, Post = posterior, IAS = interatrial septum, IVS = interventricular septum

Mitral Valve

Display the mitral valve with the aortic valve placed superiorly, regardless if the valve is oriented as viewed from the left atrium or the left ventricle.

AV = aortic valve, Lat = lateral left ventricle, PMVL = posterior mitral valve leaflet

Pulmonic Valve

Display the pulmonic valve with the anterior cusp at the 12 o'clock position, regardless if the valve is oriented as viewed from the pulmonary artery or the right ventricle outflow tract.

AC = anterior cusp, LA = left atrium

Aortic Valve

Display the aortic valve with the right coronary cusp located inferiorly at the six o'clock position, regardless if the valve is oriented as viewed from the aorta or the left ventricular outflow tract.

RCC = right coronary cusp

Lang, Badano et al. EAE/ASE 3D Guidelines JASE 2012.

Thank you for listening
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