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No Disclosure

Objectives

- Understand the concepts of 3D imaging
- Clinical applications of 3D echocardiography
- 3D image acquisition and optimization
3D Technology

- New generation Piezoelectric crystals (PureWave Crystals)
- Microelectronics

**3D Probe**

- The 3D probe provides all conventional modalities, such as 2D imaging, M-mode, pulse and continuous wave Doppler, and color Doppler imaging.

- X-Plane technology

**Clinical applications of 3D echocardiography**

- Chamber quantification
- Valvular heart disease
  - Native and prosthetic valves
- Intracardiac masses
- Congenital heart defects
  - Anatomic assessment and procedural guidance
- Interventional cardiac procedures
  - TAVR, MitraClip, LAA occlusion devices
- Stress echo
Chamber Quantification and Function

- **2D method**
  - Subjective
  - Experience dependent
  - Large inter- and intra-observer variability

- **3D method**
  - No geometric assumption
  - Avoid foreshortening
  - Reproducible
  - Excellent correlation with CMR

Valvular heart disease

- Assessment of mitral valve anatomy
- LVOT and aortic annulus sizing
- Valve area measurement via direct planimeter in mitral and aortic valve stenosis
- Regurgitant orifice measurement via vena contracta in regurgitant lesions
- Evaluation of prosthetic valve malfunction and paravalvular leak

Mor Avi V, Lang RM et al., Circulation 2004. 110: 1814-1818
54 M with new onset AF ...!
54 M with new onset AF ...!

LA en face view of MV

71 M with severe MR due to MSSA IE, s/p bioprosthetic MVR
71 M with severe MR due to MSSA IE, s/p bioprosthetic MVR

71 M with severe MR due to MSSA IE s/p bioprosthetic MVR
Cardiac masses

Lambl’s excrescences

Papillary fibroelastoma

Interventional cardiac procedures

MitraClip

LAA occlusion device
3D Imaging Acquisition, Display and Processing

GUIDELINES AND STANDARDS

EAE/ASE Recommendations for Image Acquisition and Display Using Three-Dimensional Echocardiography

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Keywords: Echocardiography, Two-dimensional, Three-dimensional, Transesophageal, Transfemoral

Steps of Acquisition

1. 2D Image
2. Mode of Acquisition
3. Rendering
4. Image Acquisition and Display
5. Final Image

- Live 3D
- 3D Zoom
- Full Volume
- Single vs multi-beat
- Color Doppler
- Cropping
Imaging Acquisition

- Real-time (live) acquisition
  - Live 3D narrow volume
- 3D zoom

Full-volume (ECG-gated)
**Imaging Acquisition**

- **Full-Volume**
  - A pyramidal volume of 60 x 60 up to 100 x 100
  - Large cardiac volume
  - Require ECG gating
  - Full volume is constructed by merging 2-6 narrow segments of the pyramidal database

- **Full-Volume 3D with Color Doppler**

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**Which 3D mode to use ..?**

- LV, LA or RV quantification
  - Full Volume

- Structural or congenital heart defects
  - Live 3D + Color 3D Zoom, Full Volume

- Interventional Guidance
  - Live 3D 3D Zoom
3D Zoom Acquisition of Mitral Valve

1) Initial view in 3D zoom is a biplane preview

2) X and Y planes and elevation width (Z axis) to include entire structure of interest

3) Press 3D zoom again will generates a pyramid of 3D volume (X,Y, Z)

4) En Face MV view, tilt 3D volume down 90 degree, then rotate clockwise or counter-clock to position the aortic valve at 12 clock

5) Decrease gain

IAS at 90 degree
Acquisition and presentation of cardiac valves

1D0

Aortic Valve

Mitral Valve

Pulmonic Valve

Tricuspid Valve

3D presentation of cardiac structures

Left Ventricle

Right Ventricle

Interatrial Septum

Left Atrial Appendage

AR, Ao, Mitral Valve, AV, Pulmonic Valve

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4/19/2021
3D image optimization

- Optimize 2D image
- Adjust the gain
- Zoom on the ROI
- Adjust focus depth
- Choose small sector

Quality 3D images always start with a good 2D image

Imaging Rendering Process

- Cropping
- Gain
- Compression
- Brightness
- Smoothing
- Color-Map vision
Gain

- Removes noise from structures

Compression

- High values of compression add “soft” echos, making objects appear more opaque and larger

- Lower compression values are preferred, 2-4 on scale of 0-10
**Brightness**

- To avoid under-illumination or over-illumination, a medium level of brightness ranging from 40-50 (scan 0-100) should be used.

**Smoothing**

- Removes subtle roughness of the surface.

- Medium values 6-8 on a scale 0-10 allows precise definition of structure.
Color-Map Vision

- Grayscale shades or dual-color mapping for depth perception

Advantages of 3D Echo

- Evaluation of cardiac chamber volumes and mass
- Assessment of regional left ventricular wall motion and quantification of systolic dyssynchrony
- Presentation of realistic views of heart valves
- Volumetric evaluation of regurgitant lesions and shunts with 3DE color Doppler imaging
Disadvantages of 3D Echo

- Time consuming
- Requires training in 3D analysis
- Accuracy varies with expertise and vendors
- Temporal resolution
- Relies on good 2D image

Everything in nature is 3D …!