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9:10-9:40 AM

What I Have Learned from 3D Imaging of Heart Valve Disease



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Disclosures

- ◆ Core Lab Director for multiple tricuspid device trials for which I receive no direct compensation:
 - ◆ SCOUT Trial
 - ◆ Triluminate Trial
 - ◆ Tri-Repair Trial
- ◆ Speaker: Abbott Structural, GE, Philips, Boston Scientific
- ◆ Consultant: Gore&Associates, NaviGATE, Abbott Structural, GE, Philips

Lessons Learned From 3D

1. To understand 3D imaging, you need to understand Gross Anatomy
2. The more I use 3D, the more I learn about 2D imaging
3. The anatomy of the cardiac valves is incredibly variable

Mitral Valve



The heart is a 3-dimensional structure
with infinite individual variability!!

ASE/SCA GUIDELINES AND STANDARDS

Guidelines for Performing a Comprehensive Transesophageal Echocardiographic Examination: Recommendations from the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists

Rebecca T. Hahn, MD, FASE, Chair, Theodore Abraham, MD, FASE, Mark S. Adams, RDCS, FASE, Charles J. Bruce, MD, FASE, Kathryn E. Glas, MD, MBA, FASE, Roberto M. Lang, MD, FASE, Scott T. Reeves, MD, MBA, FASE, Jack S. Shanewise, MD, FASE, Samuel C. Siu, MD, FASE, William Stewart, MD, FASE, and Michael H. Picard, MD, FASE, *New York, New York; Baltimore, Maryland; Boston, Massachusetts; Rochester, Minnesota; Atlanta, Georgia; Chicago, Illinois; Charleston, South Carolina; London, Ontario, Canada; Cleveland, Ohio*

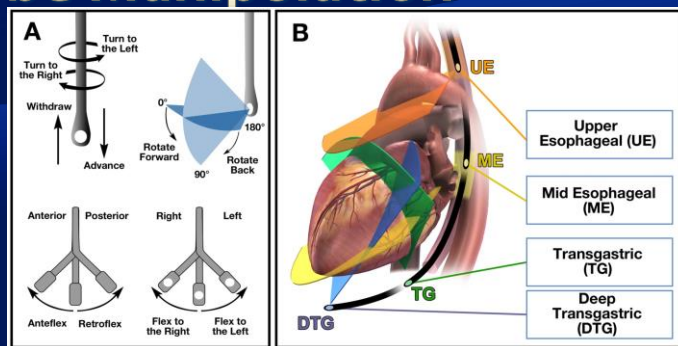
(J Am Soc Echocardiogr 2013;26:921-64.)

Keywords: Transesophageal echocardiography, Comprehensive examination

[http://www.onlinejase.com/article/So894-7317\(13\)00562-2/fulltext](http://www.onlinejase.com/article/So894-7317(13)00562-2/fulltext)

Hahn RT J Am Soc Echocardiogr 2013;26:921-64

Probe Manipulation

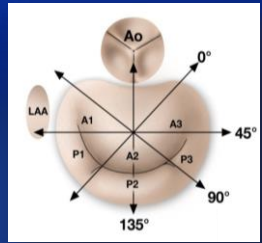
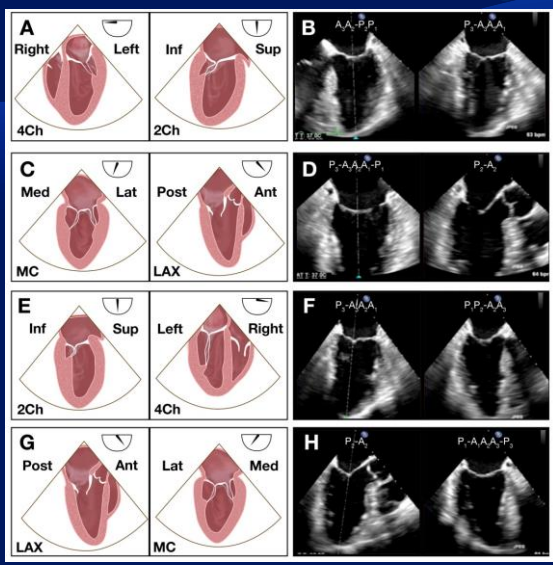


5 tools for optimizing imaging:

1. Advancing and withdrawing the probe
2. Turning probe (clockwise to the right chest, counter-clockwise to the left chest)
3. Anteflexion and retroflexion (large "wheel")
4. Right and left flexion (small "wheel")
5. Mechanical rotation of the multi-plane probe (0-180°)

Hahn RT J Am Soc Echocardiogr 2013;26:921-64

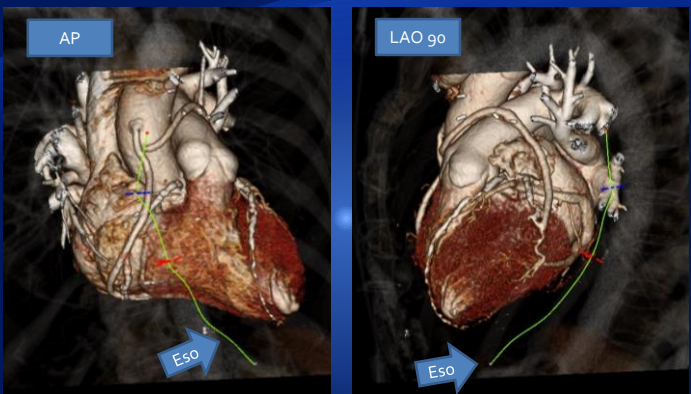
Simultaneous Multiplane Imaging



- Clues or orientation:
1. Coronary sinus is a posterior mitral annular structure
 2. LAA is a lateral structure
 3. The aortic root is an anterior structure

Hahn RT et al. J Am Soc Echocardiogr 2013;26:921-64

TEE Probe Manipulation



- Path of the esophagus
1. Advancing and withdrawing the probe

Courtesy of Thomas Smith, M.D., FACC

AT 0 DEGREES, ADVANCING PROBE MOVES FROM LATERAL TO MEDIAL

Lat

Med

Advance probe in esophagus

Normal Anatomy

- aortic root
- ascending aorta
- aortic arch
- aortic isthmus

HEARTWORKS

See important safety information referenced within.

AT 0 DEGREES, ADVANCING PROBE MOVES FROM LATERAL TO MEDIAL

1. Lateral Commissure A1/P1

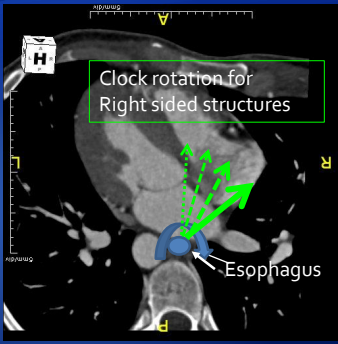
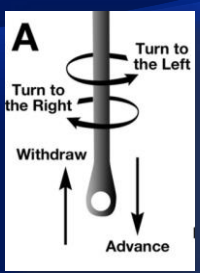
Continue to advance from A1/P1 (lateral) to A3/P3 (medial)

2. Lateral to midline of A2/P2

3. Medial to midline of A2/P2

4. Medial Commissure (A3/P3)

TEE Probe Manipulation



- Turning probe (clockwise to the right chest, counter-clockwise to the left chest)

Courtesy of Thomas Smith, M.D., FACC

INTER-COMMISSURAL (45-65 DEGREES) – P1/A2/P3
ROTATE PROBE FROM CLOCK TO COUNTER-CLOCK TO SWEEP FROM ANTERIOR TO POSTERIOR LEAFLET

Rotate probe counter-clockwise to move anterior to posterior

HEARTWORKS

See important safety information referenced within.

**FROM COMMISSURAL VIEW, ROTATING PROBE
ANTERIOR LEAFLET THROUGH POSTERIOR LEAFLET**

1. Aorto-mitral continuity

2. Commissural View with body of A2 leaflet

3. Commissural View with tip of A2 leaflet

4. Posterior Leaflet

See important safety information referenced within.

**LONG AXIS VIEW (120-140 DEGREES) –A2/P2
ROTATE PROBE FROM CLOCK TO COUNTERCLOCKWISE TO SWEEP FROM LATERAL TO MEDIAL COMMISSURES**

Sweep clockwise with probe to move L -> M

HEARTWORKS

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See important safety information referenced within.

ROTATE CLOCKWISE IN LONG-AXIS VIEW TO SWEEP LATERAL TO MEDIAL

1. Lateral Commissure A1/P1

2. Lateral to midline of A2/P2

3. Medial to midline of A2/P2

4. Medial Commissure (A3/P3)

Rotate probe clockwise to sweep lateral to medial across valve.

See important safety information referenced within.

Biplane Imaging: Scanning Across the Valve from Commissural View

RH2 TEE
X7.2t
56Hz
11cm
xPlane
45°
25%
50dB
P Off
Gen

111/50

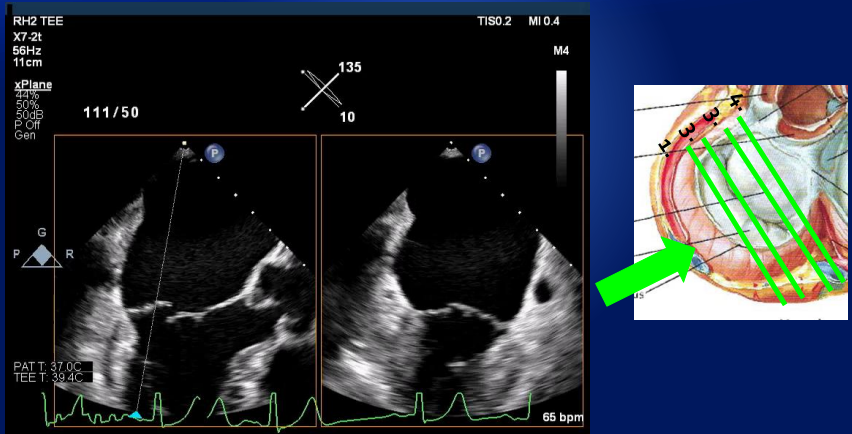
TISO.2 MI 0.4

M4

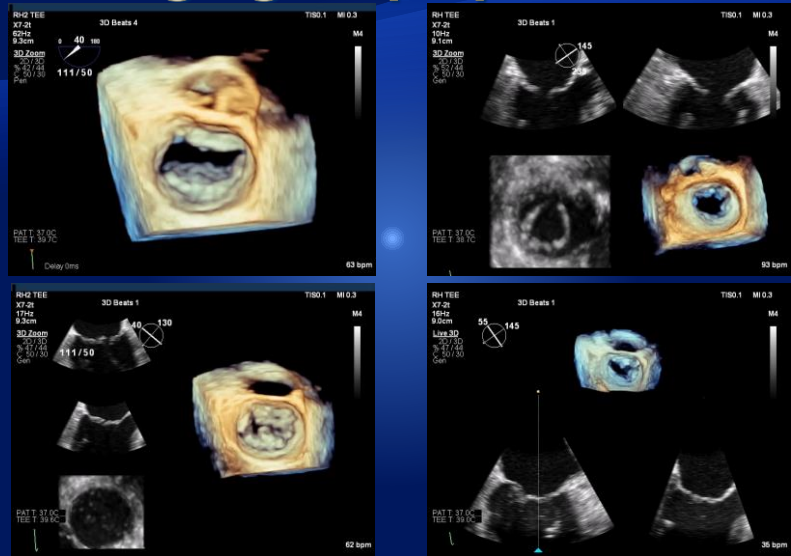
PAT T: 37.0C
TEE T: 33.0C

64 bpm

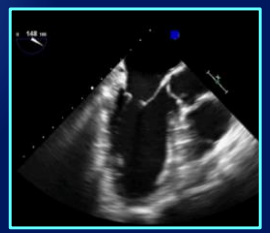
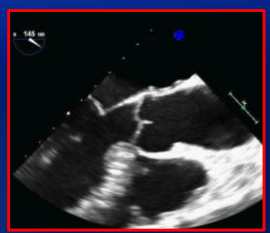
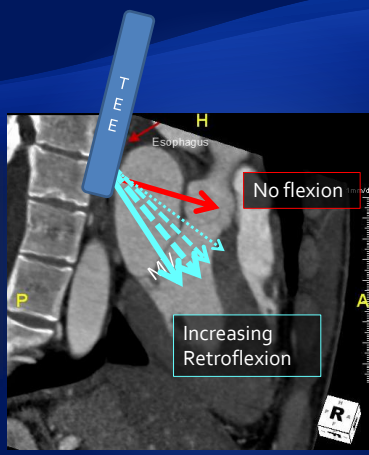
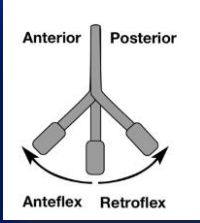
Biplane Imaging: Scanning Across the Valve from LAX View



3D Imaging Displays



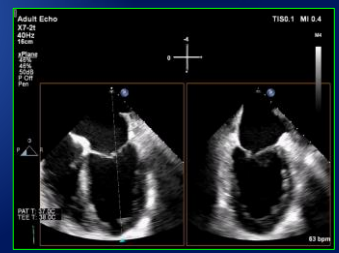
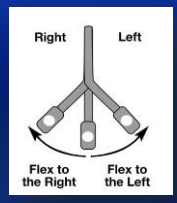
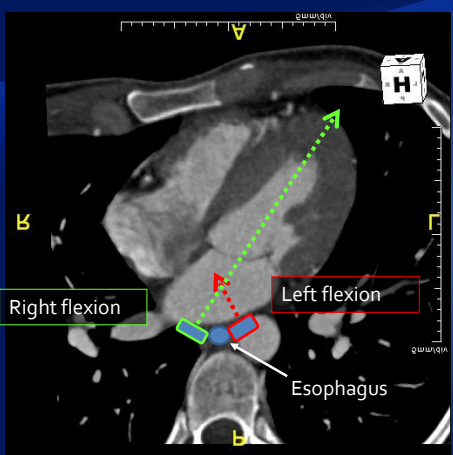
TEE Probe Manipulation



3. Anteflexion and retroflexion (large "wheel")

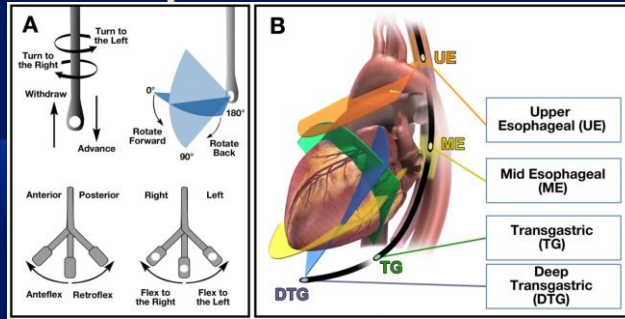
Courtesy of Thomas Smith, M.D., FACC

The Forgotten Manipulation



4. Right and left flexion (small "wheel")

Probe Manipulation



Four Levels of Imaging for the Tricuspid Valve:

1. Mid-esophageal
2. Deep-esophageal
3. Shallow Transgastric
4. Deep Transgastric

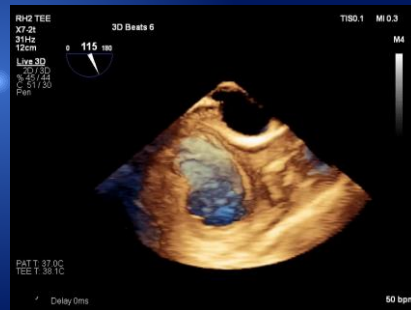
3D Modalities:

1. Simultaneous Multiplane
2. Real Time 3D
3. Full Volume 3D
4. Zoom 3D
5. Color 3D

Hahn RT et al. J Am Soc Echocardiogr 2013;26:921-64.

3D Bicaval View

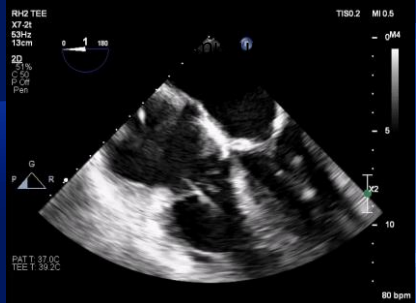
◆ Device Straddle and Steering



ME 4Ch View (0-40 degrees)

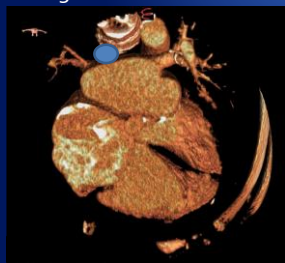
Grasping view for A-S

Grasping view for P-S

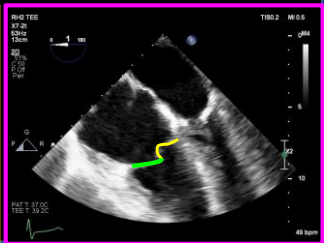
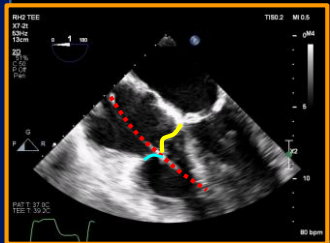
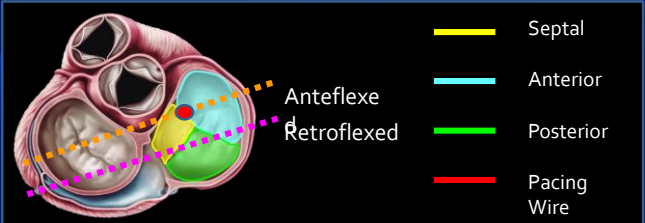


Slight ante-flexion

Slight retro-flexion



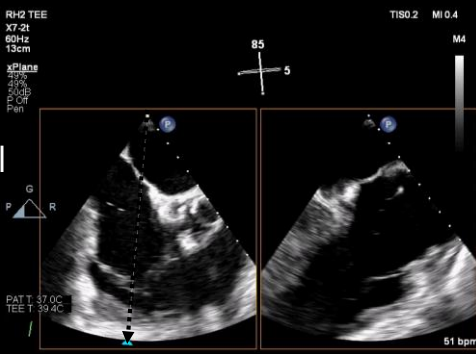
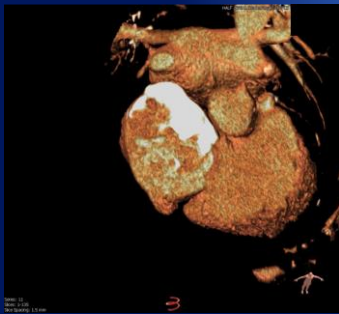
ME 4Ch View (0-40 degrees)



Pacing wire in A-S commissure

ME Short-Axis at Base/RV Inflow-outflow:

- Anterior and Posterior leaflets imaged (Septal Leaflet out-of-plane)



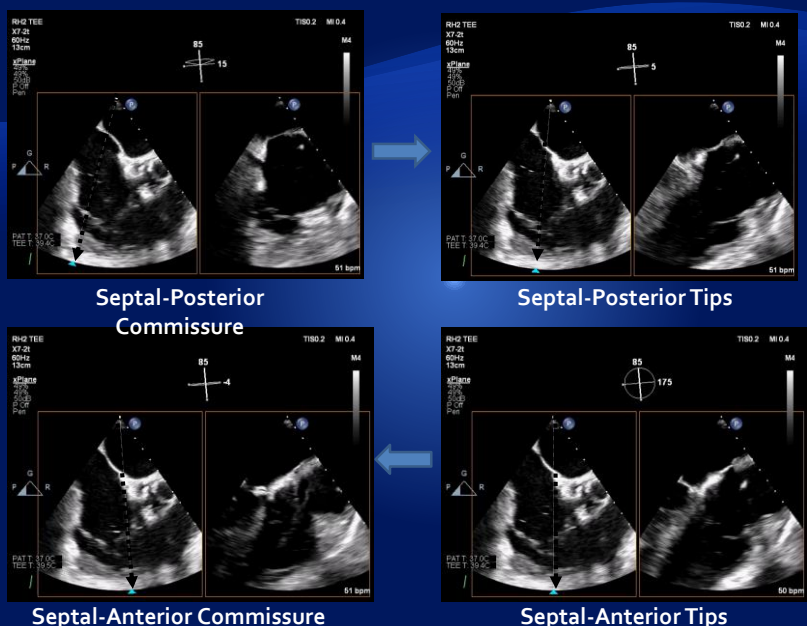
- ◆ Orthogonal Planes
 - ◆ Anterior-Septal Leaflet OR
 - ◆ Posterior-Septal Leaflet

ME Short-Axis at Base/RV Inflow-outflow:

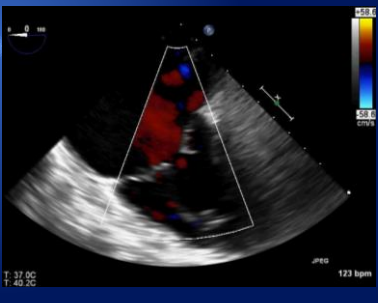
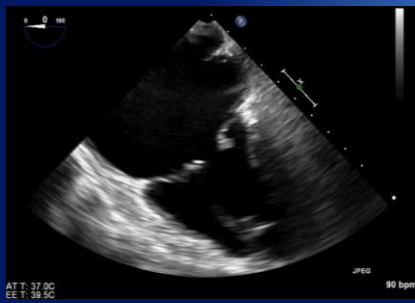
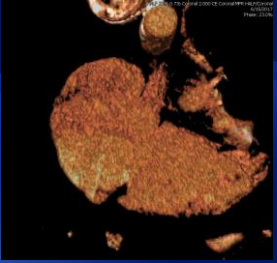
Anteflexe
 Retroflexed

- Septal
- Anterior
- Posterior
- Pacing Wire

ME Short-Axis at Base/RV Inflow-outflow SWEEP:

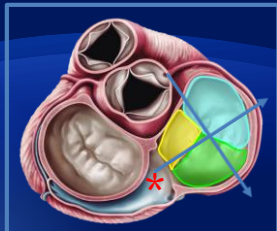


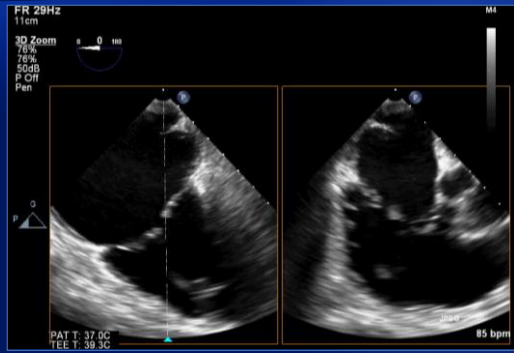
Deep Esophageal (GE junction)



1. Eliminates LA from view
2. Closer to TV

Lower-esophageal

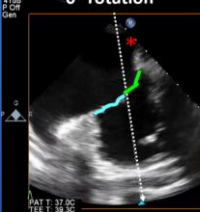





FR 29Hz
11cm
3D Zoom
75%
76%
SOB
P Off
Pen
PAT T: 37.0C
TEE T: 39.3C
85 bpm

GE Junction

0° rotation






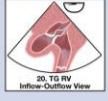
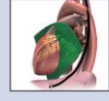

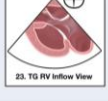
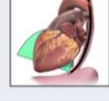

90° rotation




FR 29Hz
11cm
3D Zoom
75%
76%
SOB
P Off
Pen
PAT T: 37.0C
TEE T: 39.3C
91 bpm

- Septal
- Anterior
- Posterior

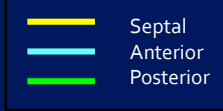
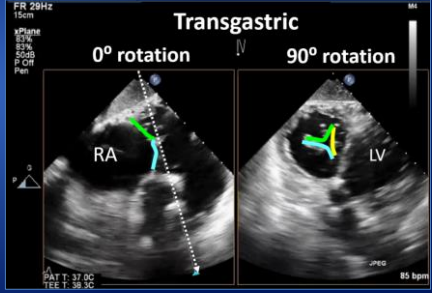
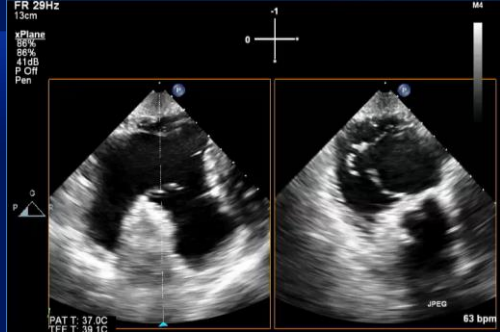
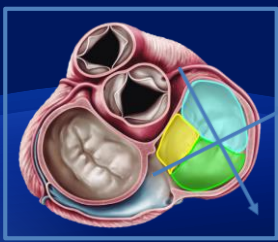
Transgastric Views of the RV and TV

Imaging Plane	3D Model	2D TEE Image	Acquisition Protocol	Structures Imaged
Transgastric Views				
 <small>19. TG RV Basal View</small>			Transducer Angle: ~ 0 - 20° Level: Transgastric Maneuver (from prior image): Anteflex	Left ventricle (mid) Right ventricle (mid) Right ventricular outflow tract Tricuspid Valve (SAX) Pulmonary Valve
 <small>20. TG RV Inflow-Outflow View</small>			Transducer Angle: ~ 0 - 20° Level: Transgastric Maneuver (from prior image): Right-flex	Right atrium Right ventricle Right ventricular outflow tract Pulmonary valve Tricuspid Valve
 <small>23. TG RV Inflow View</small>			Transducer Angle: ~ 90 - 110° Level: Transgastric Maneuver (from prior image): CW	Right ventricle Right atrium Tricuspid valve

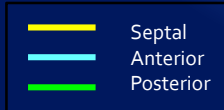
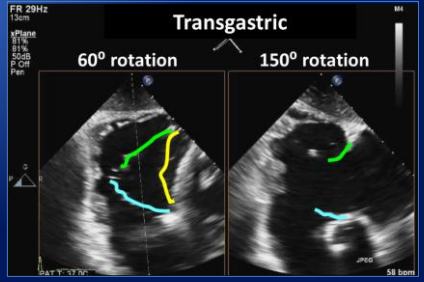
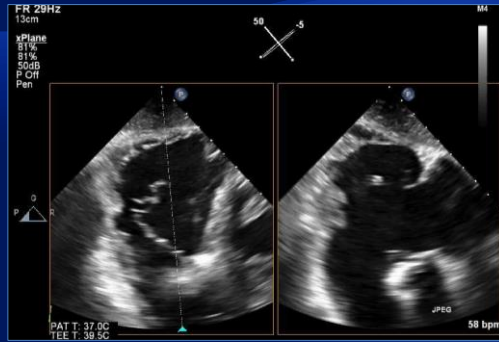
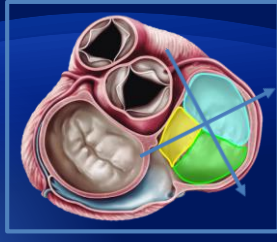


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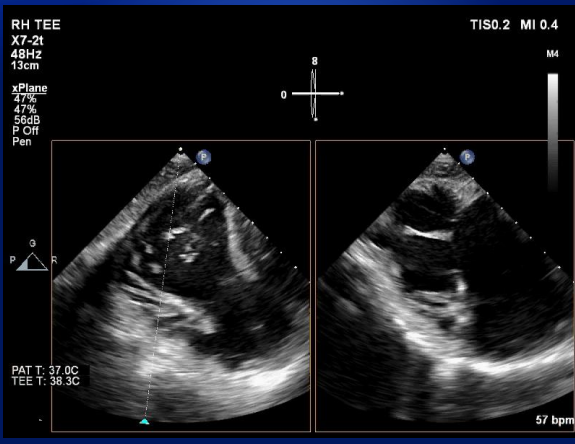
Transgastric



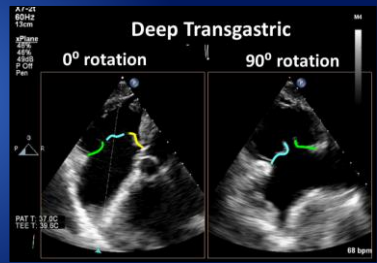
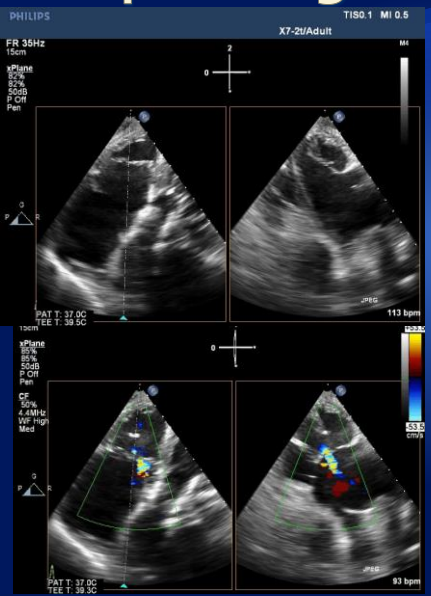
Transgastric



SWEEP of Posterior Leaflet



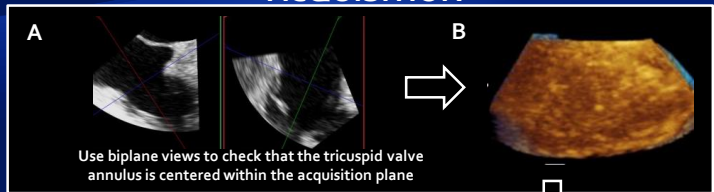
Deep Transgastric



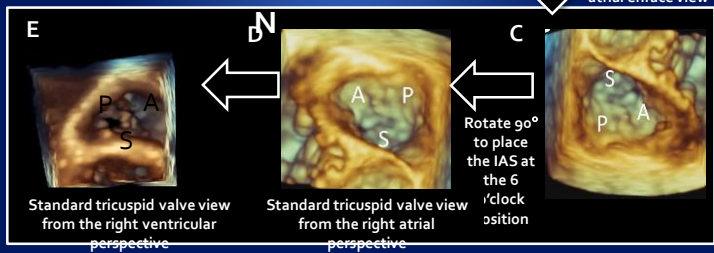
- Septal
- Anterior
- Posterior

3D TV ACQUISITION

ACQUISITION



PRESENTATION

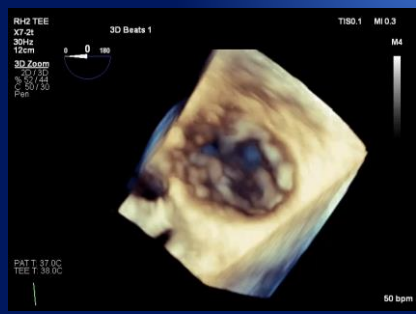


Caveat to Leaflet Identification



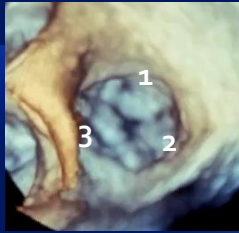
3D en face view

- ◆ KEY CAVEAT:
 - Three-dimensional valve
 - Highly variable anatomy

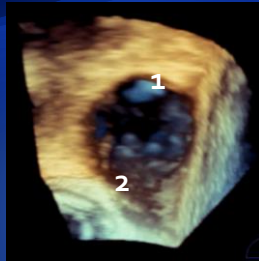


- Leaflet identification MUST be confirmed with 3D en face view

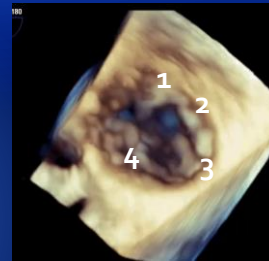
Variable Anatomy



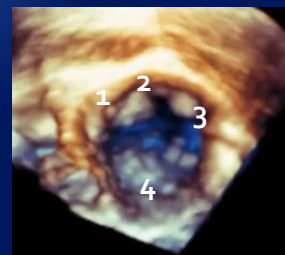
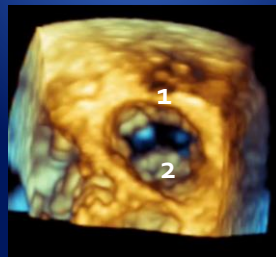
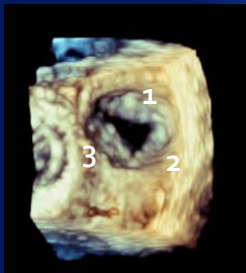
3 Leaflets



2 Leaflets



4 Leaflets



Lessons Learned From 3D

1. To understand 3D imaging, you need to understand Gross Anatomy
2. The more I use 3D, the more I learn about 2D imaging
3. The anatomy of the cardiac valves is incredibly variable which is why 3D Echo is so important

