Back to Basics: Common Errors In Quantitation In Everyday Practice

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ASE: Echo Florida
10/9/2017

BACK TO BASICS: COMMON ERRORS IN QUANTITATION IN EVERYDAY PRACTICE

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Director of Interventional Echocardiography
Professor of Medicine
Columbia University

Imaging Approach to Aortic Stenosis

- Asses Valve anatomy, etiology of stenosis (Congenital, Rheumatic, Calcific)
- Exclude other causes of left ventricular outflow obstruction (subvalvular, supravalvular)
- Assess Stenosis severity
  - AS peak jet velocity
  - Mean transvalvular pressure gradient
  - Aortic valve area by continuity equation

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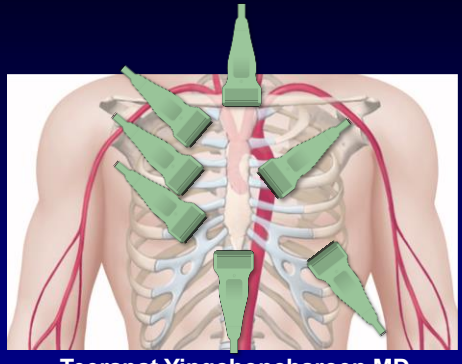
Multiple Acoustic Windows



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Teerapat Yingchoncharoen MD

vii. For aortic stenosis, the systolic velocity must be evaluated from multiple transducer positions (e.g., apical, suprasternal and right parasternal). This must include interrogation from multiple views with a dedicated non-imaging continuous wave Doppler transducer (at least one clear envelope must be obtained)

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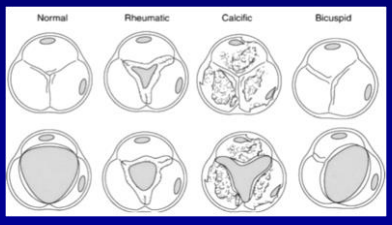
Assess Valve Morphology

- Identify number of cusps in systole, raphe
- Assess cusp mobiltiy, commissural fusion
- Assess valve calcification



JASE 2017;30:372-392

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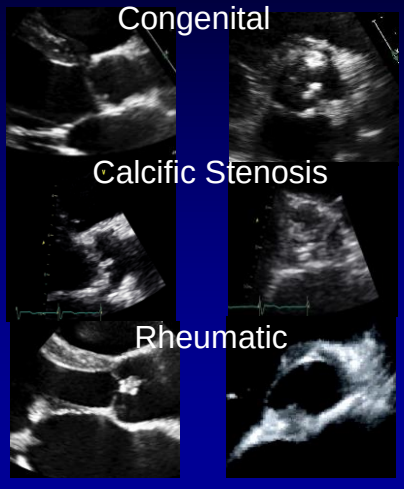
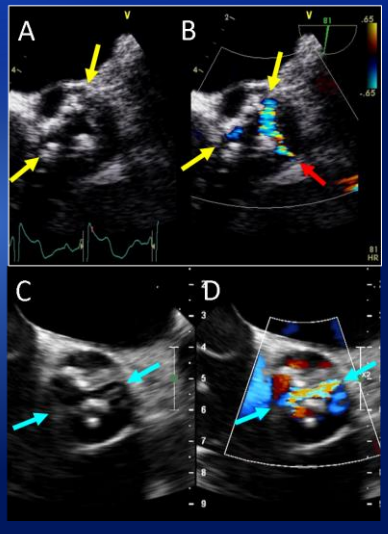
PLAX SAX



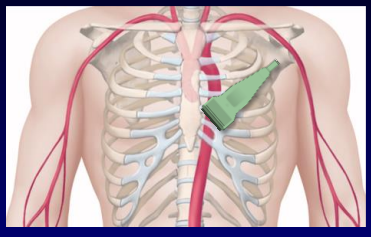
Trileaflet vs Bileaflet Valve

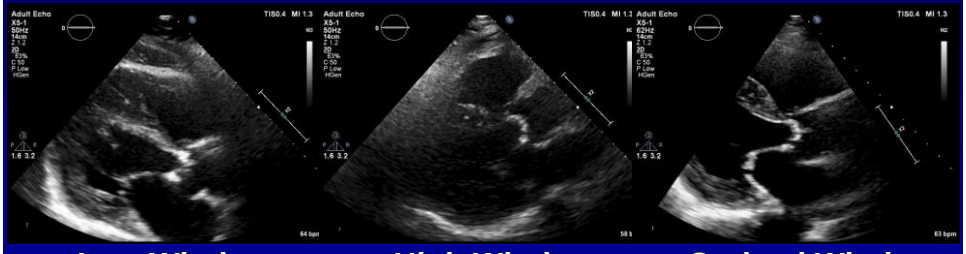
- *Submitted for review: bicuspid valve suspected on CT scan*
- *Color Doppler: clear imaging of flow into 3 commissures*



Hahn RT. Color Doppler to Differentiate Trileaflet From Bicuspid Aortic Stenosis. http://www.acc.org. Aug 31, 2016.

Optimize PLAX Window





Low Window | High Window | Optimal Window

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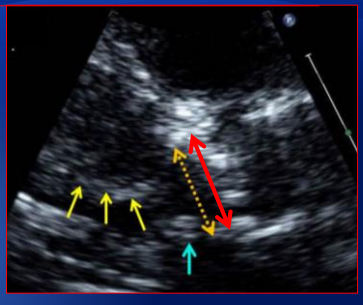
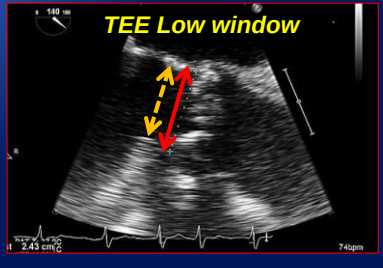
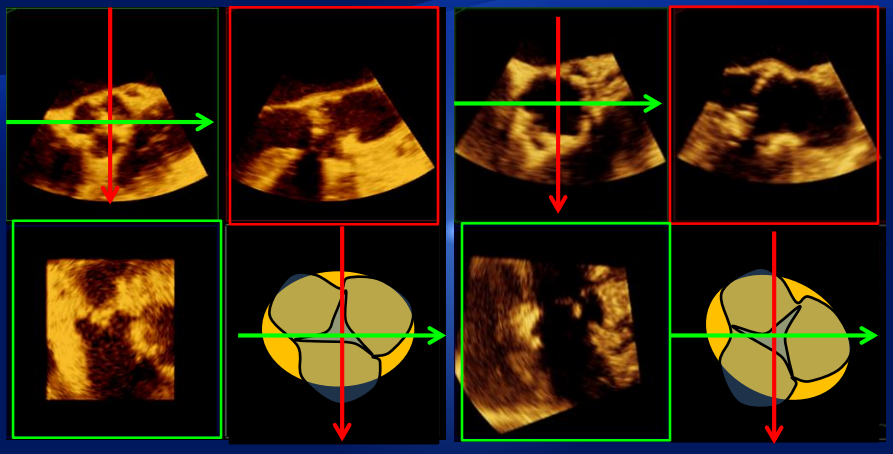
LVOT & Annular Measurement

- The largest systolic diameter LVOT measurement should be used in calculating the aortic valve area
  - **Avoid measuring basal septal hypertrophy (yellow arrows)**
  - **Measure LVOT (dashed arrow) just apical to the annulus (red arrow)**
- In the setting of acoustic shadowing of the distal annulus, **a lower or higher window** can be used to better image the entire plane of the annulus
- Avoid measuring the calcification of the MV as the border of the LVOT (blue arrow)





Low Window



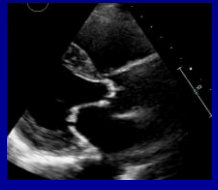
Sagittal Plane

Coronal Plane

Approximates the Mean Diameter

LVOT Diameter

- 2D PLAX acquire multiple cardiac cycles
- Zoom mode
- Adust gain to optimize the blood tissue interface
- Measure
  - Inner edge to inner edge septal endocardium and anterior mitral valve leaflet
  - Mid – systole at the same time in cardiac cycle as maximum LVOT velocitiy
  - Parallel and adjacent to AV or at site of velocity measurement
  - Diameter is used to calculate a circular CSA



Mid - Systole

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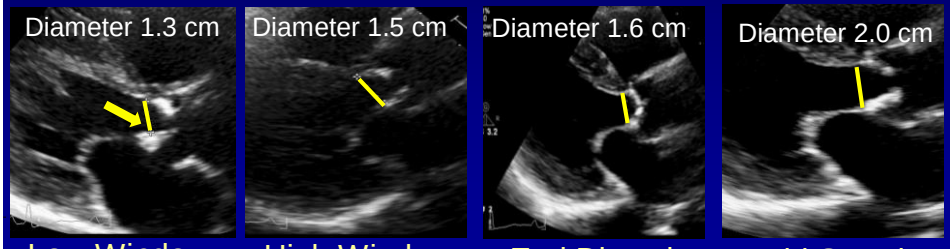
LVOT Diameter Pitfalls

- Oblique images
- Calcification protruding into LVOT
- Timing of cardiac cycle
- Error can under/overestimate AVA



Low Window | High Window | End Diastole | Mid Systole

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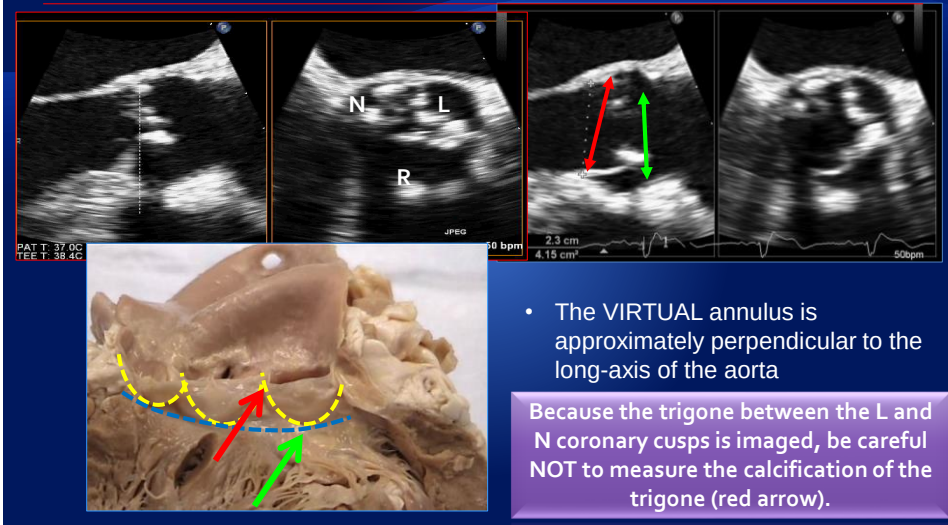
Aortic Valve Annular Dimensions: Biplane TEE



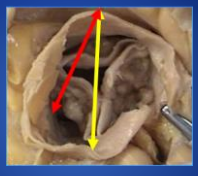
- The VIRTUAL annulus is approximately perpendicular to the long-axis of the aorta

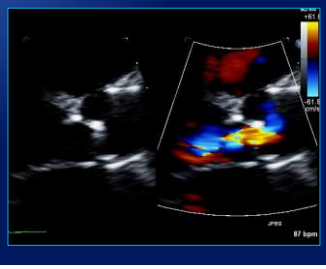
Because the trigone between the L and N coronary cusps is imaged, be careful NOT to measure the calcification of the trigone (red arrow).

Use of biplane imaging to align the annulus

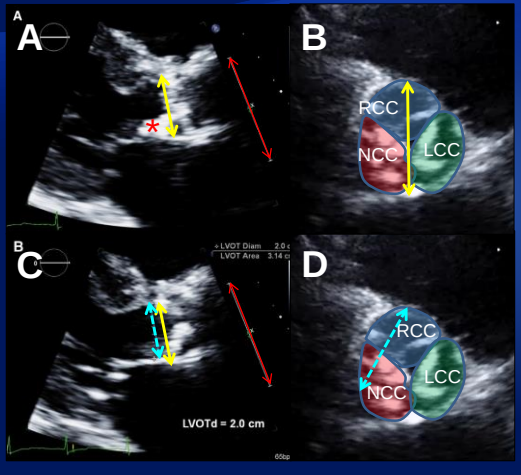
LVOT and Annular Measurement Pearls

- Short-axis (SAX) views may help ensure alignment of the LAX view perpendicular to the largest LVOT diameter





Editorial Comment

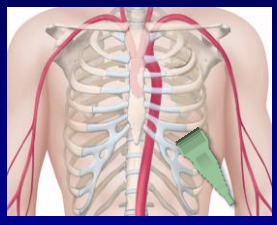


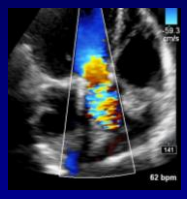
Hahn and Pibarot JASE 2017

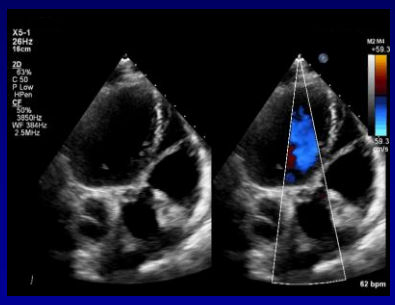
- The maximum diameter of the annulus bisects a trigone on one side, and a cusp on the other side (**Yellow arrow**)
- When equal cusps are imaged in LAX view the LVOT and annular diameters may be underestimated (**Blue arrow**)

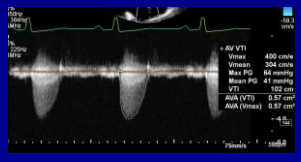
AS Jet Velocity

- On axis apical 5 and 3 chamber views
- Assess for flow acceleration with CFM
- Line CW Doppler cursor parallel with flow
- Acquire at least 3 cardiac cycles in NSR, > 6 with AFib









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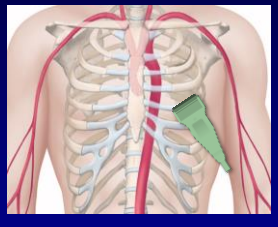
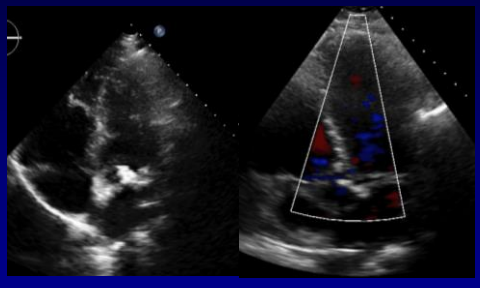
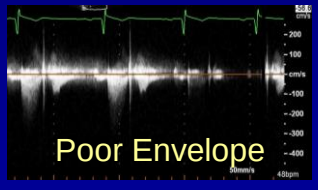
Pitfalls of AS Jet Velocity

- Foreshortened Image
  - Underestimated peak velocity





Poor Flow Acceleration



Poor Envelope

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Transesophageal Echocardiographic Evaluation of Native Aortic Valve Area: Utility of the Double-Envelope Technique

Andrew D. Maslow, MD, John Mashikian, MD, J. Michael Haering, MD, Stephanie Heindel, MD, Pamela Douglas, MD, and Robert Levine, MD

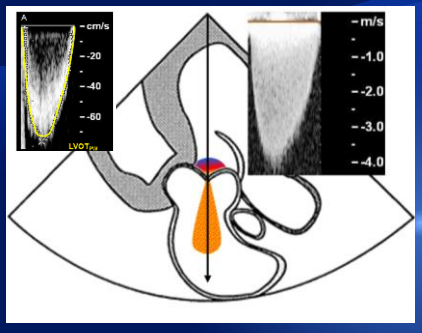
Fig 1. Measurement of aortic valve area (AVA) using planimetry and the double-envelope technique in a patient with sinus rhythm. Aortic valve measurement using planimetry (AVA, 0.99 cm²) (A). The double-envelope technique obtained using continuous-wave Doppler (AVA, 0.91 cm²) (B). Pulsed-wave Doppler of the left ventricular outflow tract (C). Note the similarity between pulsed-wave and continuous-wave Doppler in measuring the left ventricular outflow tract flow velocity (76.5 cm/sec *v* 78.0 cm/sec).

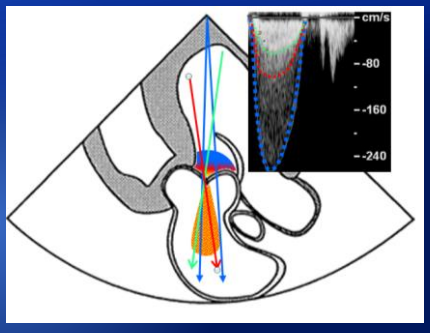
Assumption: the inner envelope is generated from the immediate subvalvular location

TEE evaluation of native AVA using the DE technique is feasible and in good agreement with that obtained by C/TTE and G/CATH.

J Cardiothorac Vasc Anesth 2001;15:293-299

Double Envelop Pitfalls



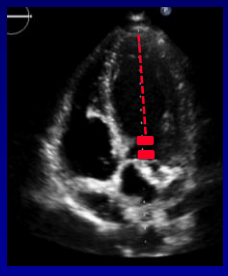


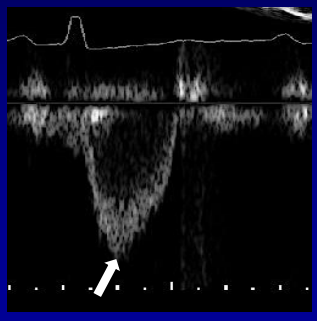
- AVA_{DE} overestimates AVA_{CE} by 0.17± 0.23 cm² ($p < 0.001$) which may be clinically-significant for pre-procedural as well as intra-procedural decision-making.

Teo E…Hahn RT et al (submitted)

LVOT Velocity

- Align PW Doppler cursor parallel to flow in apical long- axis or five- chamber views
- PW Doppler SV length (3 – 5 mm) position on the LV side of AV proximal to region of flow acceleration into jet
- May be necessary to move SV 0.5 – 1.0 cm for laminar flow





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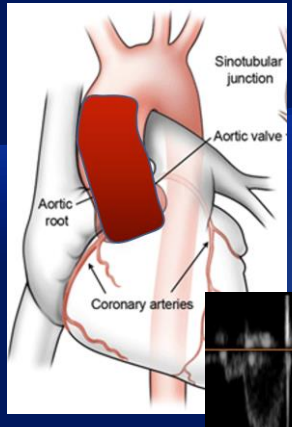
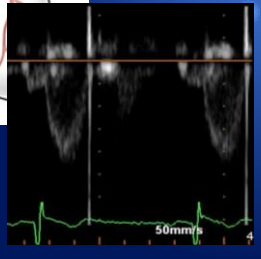
Non-stenotic Aortic Valve

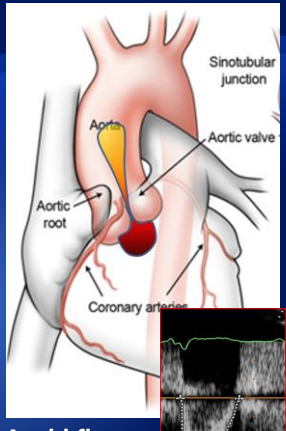


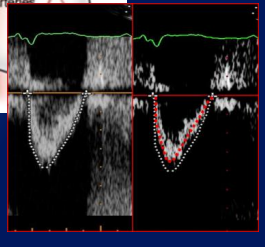


No flow convergence

Look for Closure Click: you WANT to cross the valve in systole and NOT in diastole

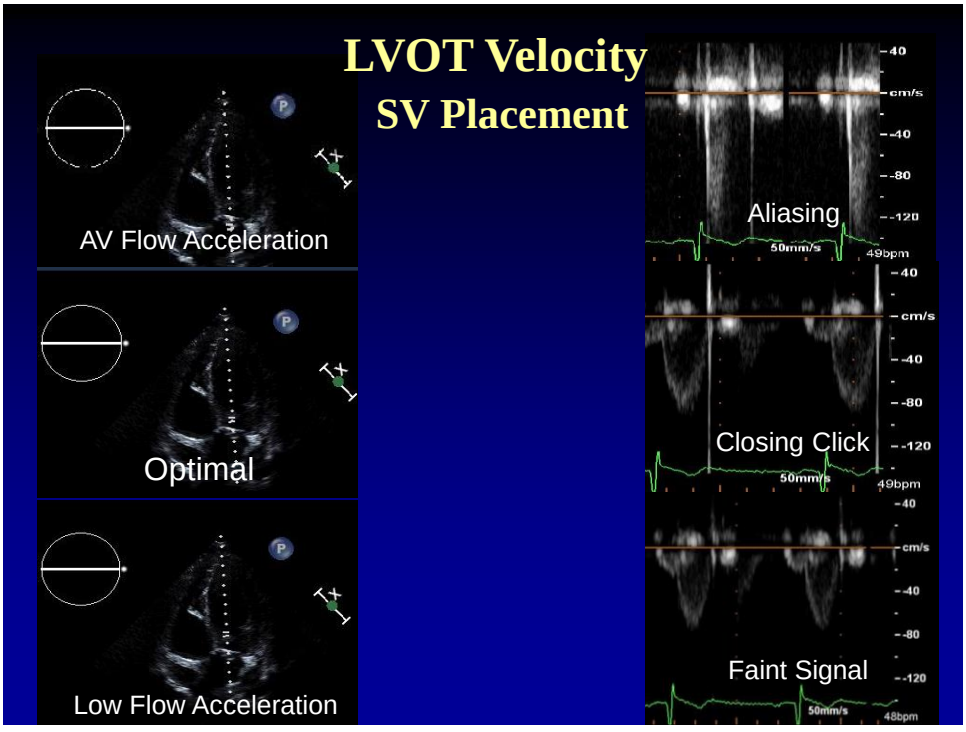
Stenotic Aortic Valve

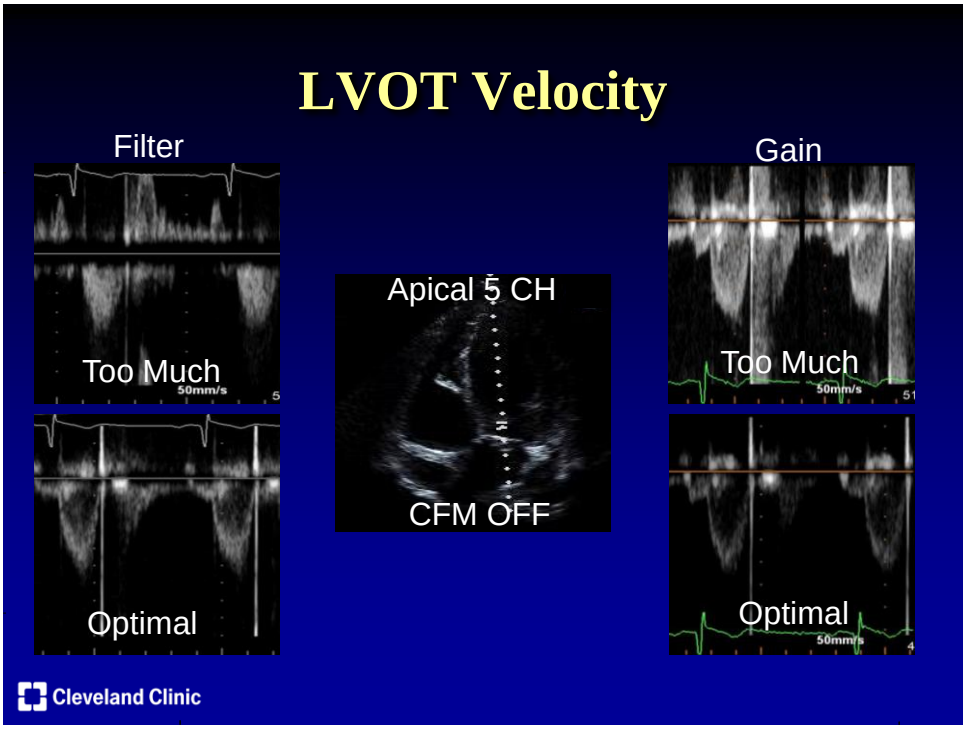




Avoid flow convergence

Do not cross the valve in systole thus no valve closure click and look for Modal Velocity (no spectal broadening)


LVOT Velocity
SV Placement
AV Flow Acceleration
Optimal
Low Flow Acceleration
Aliasing
Closing Click
Faint Signal


LVOT Velocity
Filter
Too Much
Optimal
Apical 5 CH
CFM OFF
Gain
Too Much
Optimal
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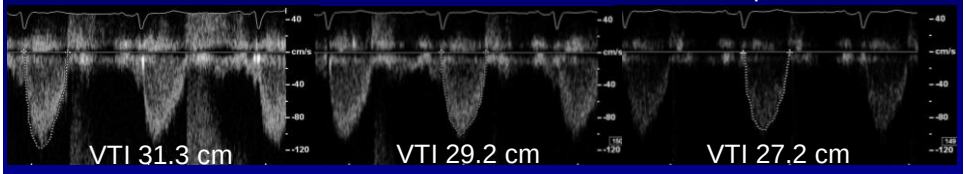
LVOT Velocity

- Measure maximum velocity
  - Peak of dense velocity curve
- VTI traced from modal velocity

Over estimated

Optimal



Sweep Speed 100 ms.

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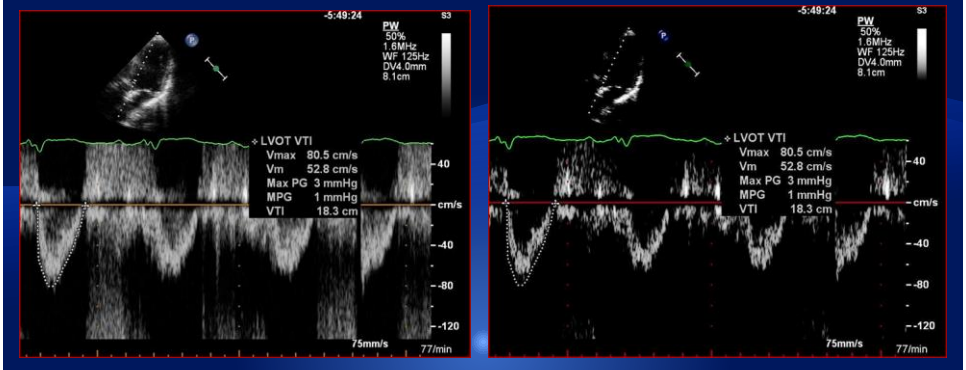
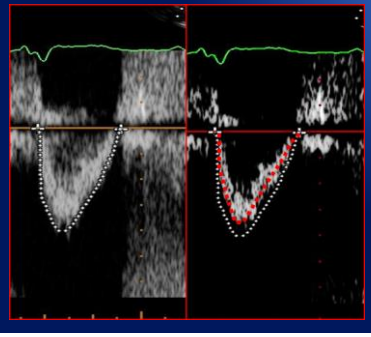
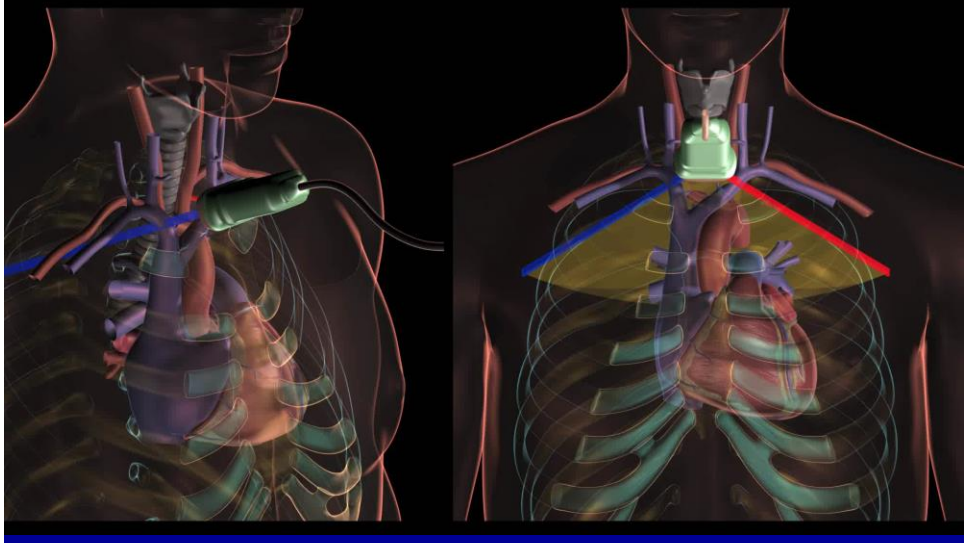




- *MODAL velocity*
  - *Not the maximum velocities of a few blood cells*
  - *Rather the most frequent value in a distribution*
    - *Lower gain and/or increase reject*

SSN Window



Aortic Stenosis

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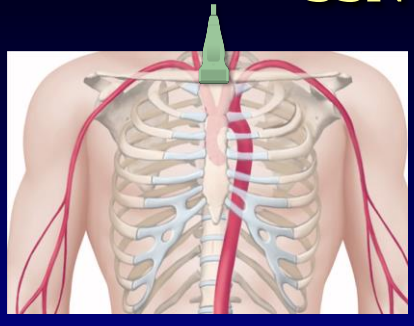
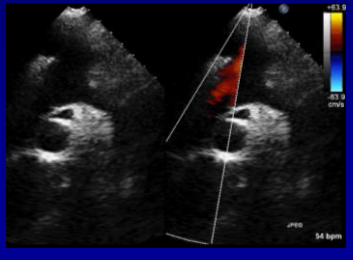
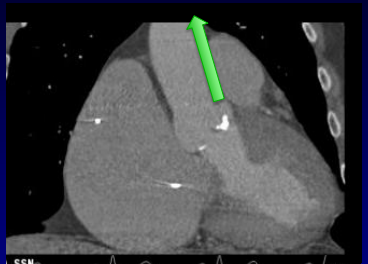
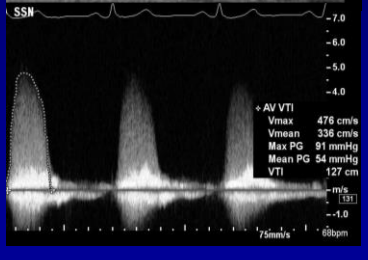
SSN Window









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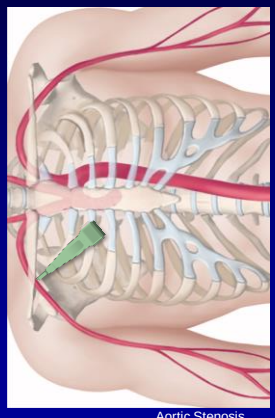
RSB Positioning

- Positioning is key
- Use CFM to line up parallel with flow
- Change to Pedoff (stand alone) probe
- Listen for the strongest flow velocity



Aortic Stenosis

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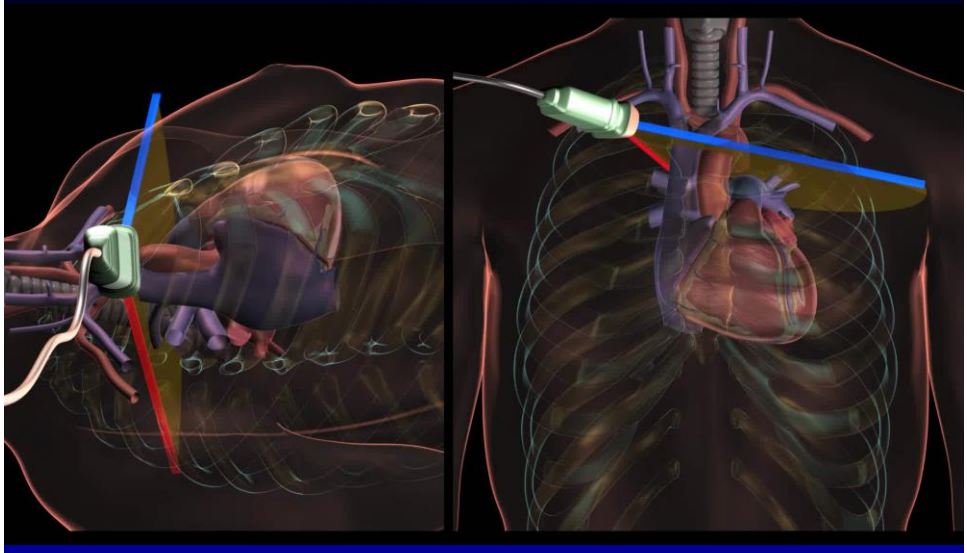
RSB Window



Aortic Stenosis

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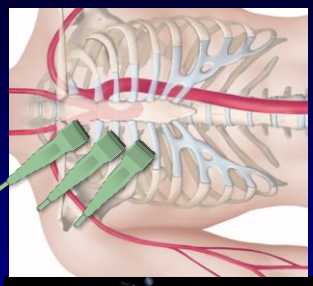
Poor Alignment With RSB Flow



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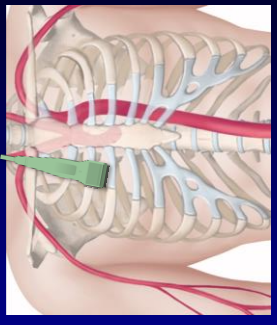
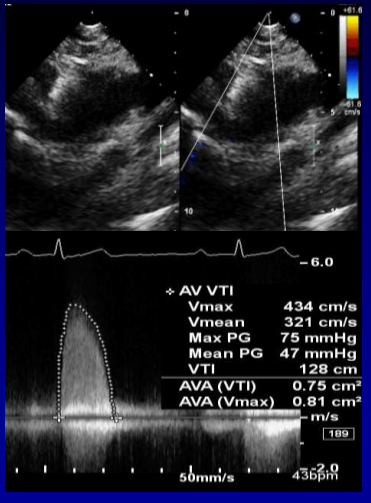
Proper Alignment With RSB Flow





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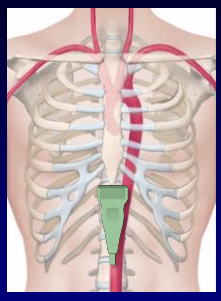
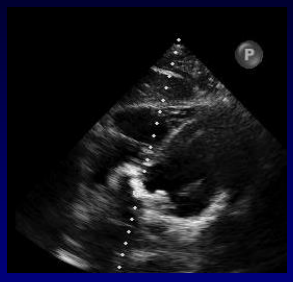
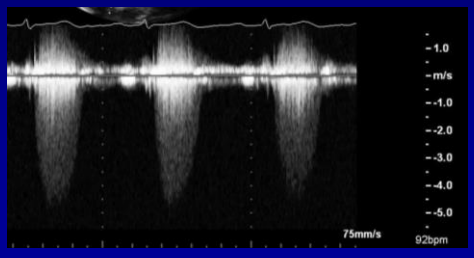
Subcostal Window







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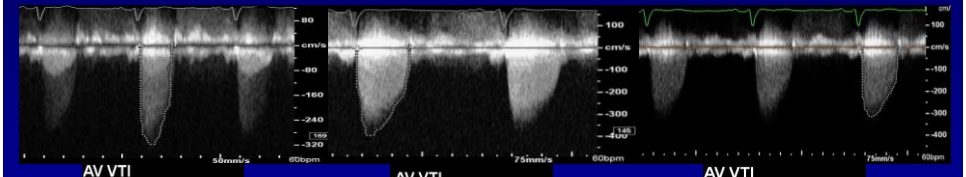
AS Jet Velocity

- Measure maximum velocity
  - Peak of dense velocity curve
  - Avoid noise and fine linear signals
- VTI traced from outer edge of dense signal curve
- Mean gradient calculated from traced velocity curve



AV VTI	
Vmax	319 cm/s
Vmean	251 cm/s
Max PG	41 mmHg
Mean PG	28 mmHg
VTI	84.2 cm

AV VTI	
Vmax	398 cm/s
Vmean	296 cm/s
Max PG	63 mmHg
Mean PG	38 mmHg
VTI	105 cm

AV VTI	
Vmax	315 cm/s
Vmean	228 cm/s
Max PG	40 mmHg
Mean PG	24 mmHg
VTI	84.0 cm

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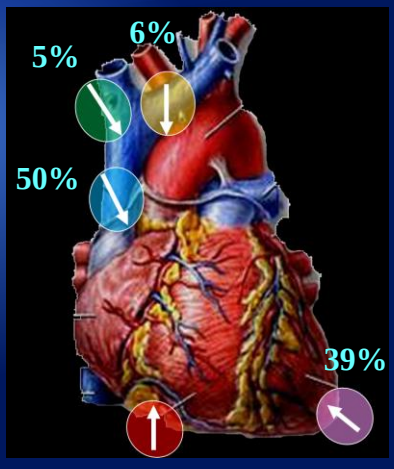
Doppler Imaging in Aortic Stenosis: The Importance of the Nonapical Imaging Windows to Determine Severity in a Contemporary Cohort

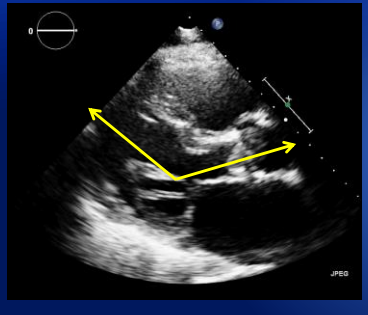
Jeremy J. Thaden, MD, Vuyisile T. Nkomo, MD, MPH, Kwang Je Lee, MD, PhD, and Jae K. Oh, MD, *Rochester, Minnesota and Seoul, Korea*

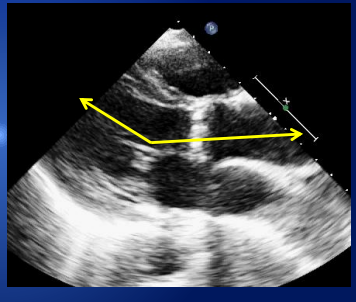
- V_{max}
  - RPS window in 50%,
  - apex in 39%,
  - suprasternal notch in 6%,
  - right supraclavicular in 5%



J Am Soc Echocardiogr 2015;28:780-5.

Non-apical Imaging Windows

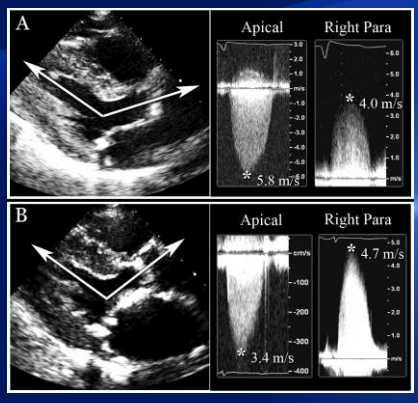




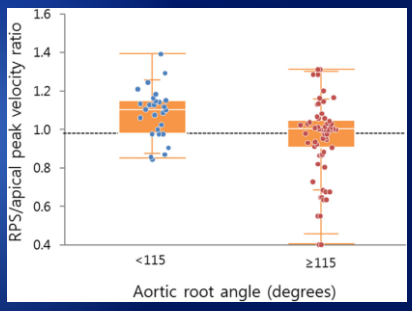
- Age >75 was associated with
  - More acute LVOT angle (116±7.7° vs 120±6.7°, p=0.006).

Thadden et al. J Am Soc Echocardiogr 2015;28:780-5.

Optimal Doppler Velocity Location Depends on Aortic Root Angulation



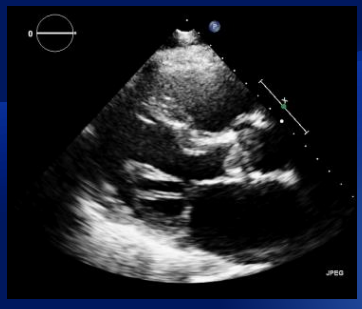
J. Thaden and J. Oh et al

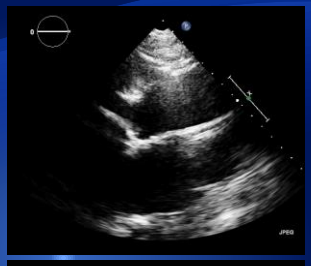


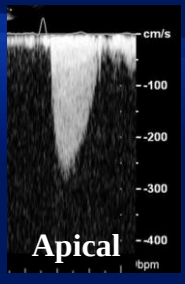
- Overall, the highest AV velocity comes from RPS in 50%
- If the angle<115 degree, it is from RPS in 67%
- AS is underestimated in 15% if only apex is used

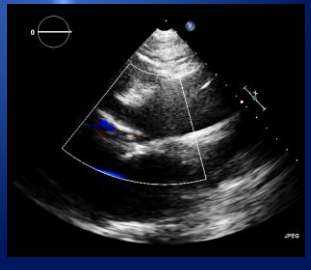
Thadden et al. J Am Soc Echocardiogr 2015;28:780-5.

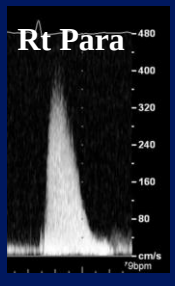
Right Parasternal Window







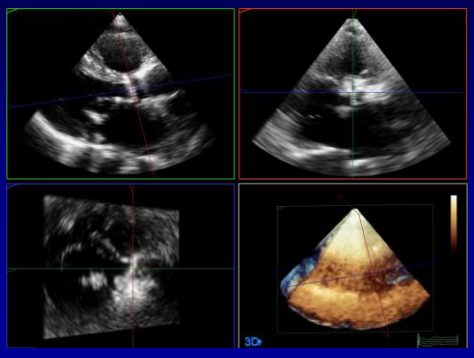




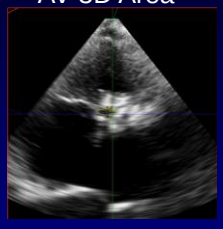
- Use color Doppler to help determine if right parasternal view is most appropriate

3D AV

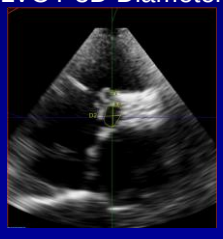
PLAX 3D Acquisition



AV 3D Area



LVOT 3D Diameter



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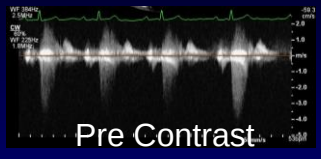
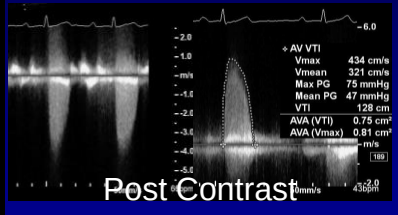
Contrast Enhancement



Pre Contrast



Post Contrast

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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

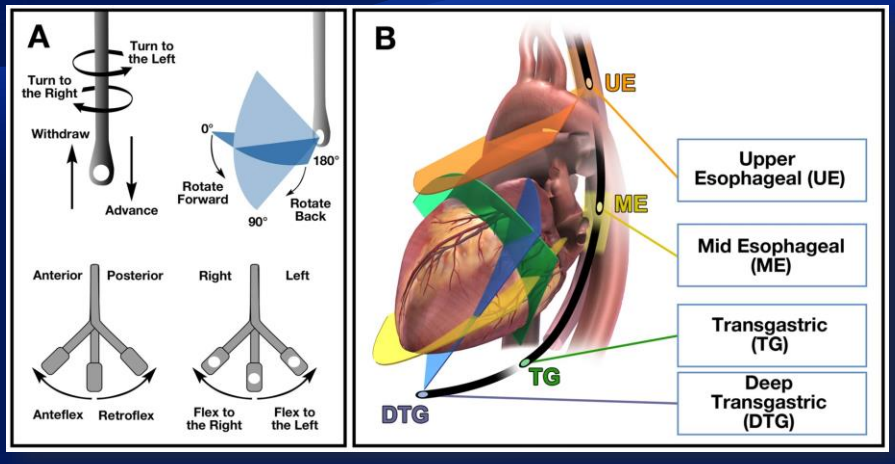
Rebecca T. Hahn, MD, FASE, Chair, Theodore Abraham, MD, FASE, Mark S. Adams, RDCS, FASE, Charles J. Bruce, MD, FASE, Kathryn E. Glas, MD, MBA, FASE, Roberto M. Lang, MD, FASE, Scott T. Reeves, MD, MBA, FASE, Jack S. Shanewise, MD, FASE, Samuel C. Siu, MD, FASE, William Stewart, MD, FASE, and Michael 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.)

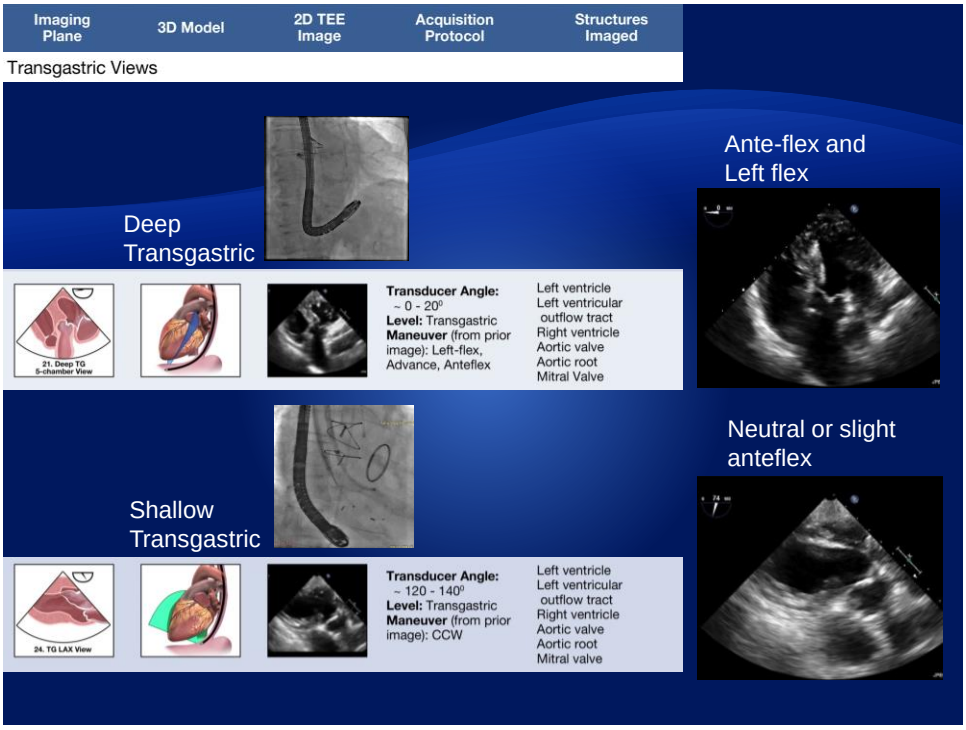
Keywords: Transesophageal echocardiography, Comprehensive examination

http://www.onlinejase.com/article/S0894-7317(13)00562-2/fulltext

Probe Manipulation



Hahn, RT et al. JASE 2013;26:921-64



Serial Measurements

- **Make sure that aortic jet velocity is recorded from the same window with the same quality (always report the window where highest velocities can be recorded).**
- **When AVA changes, look for changes in the different components incorporated in the equation. LVOT size rarely changes over time in adults. Severity of stenosis does not decrease.**

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EACVI/ASE CLINICAL RECOMMENDATIONS

Recommendations on the Echocardiographic Assessment of Aortic Valve Stenosis: A Focused Update from the European Association of Cardiovascular Imaging and the American Society of Echocardiography

Helmut Baumgartner, MD, FESC, (Chair), Judy Hung, MD, FASE, (Co-Chair), Javier Bermejo, MD, PhD, John B. Chambers, MB BChir, FESC, Thor Edvardsen, MD, PhD, FESC, Steven Goldstein, MD, FASE, Patrizio Lancellotti, MD, PhD, FESC, Melissa LeFevre, RDCS, Fletcher Miller Jr., MD, FASE, and Catherine M. Otto, MD, FESC, *Muenster, Germany; Boston, Massachusetts; Madrid, Spain; London, United Kingdom; Oslo, Norway; Washington, District of Columbia; Liège, Belgium; Bari, Italy; Durham, North Carolina; Rochester, Minnesota; and Seattle, Washington*

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Conclusion

- With the advent of percantaneous AV implantations, assessment is key to planning of intervention and prosthesis size
- Technical perfection is required
- Do not get discouraged with Pedoff probe
- Practice makes perfect !!!!!!!!

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Thank you

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