

ARTIFACTS: THEORY AND ILLUSTRATIVE EXAMPLES

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No conflicts of interest

Fact or Artifact in Two-Dimensional Echocardiography:
Avoiding Misdiagnosis and Missed Diagnosis

Philippe B. Bertrand, MD, MSc, Robert A. Levine, MD, Eric M. Isselbacher, MD, MSc,
and Pieter M. Vandervoort, MD, *Genk and Hasselt, Belgium; and Boston, Massachusetts*

Philippe Bertrand, Pieter
Vandervoort, Hasselt and
Genk, Belgium, JASE 2016

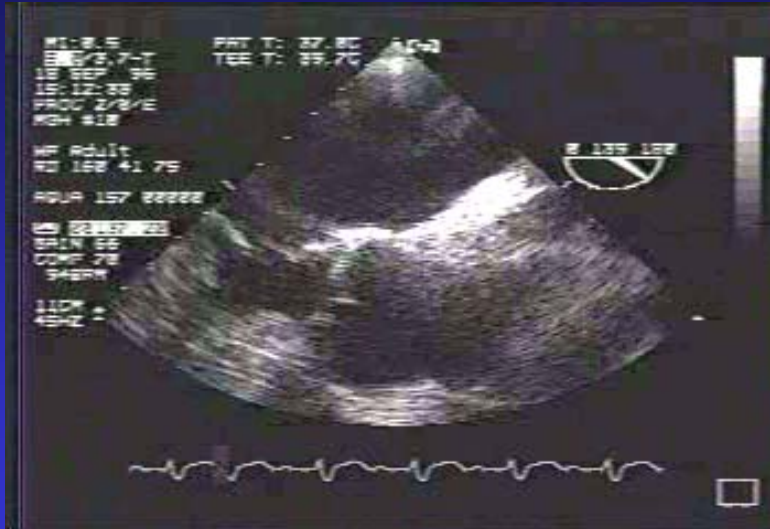
**The danger of a noninvasive
test lies in its *interpretation***

**Life-threatening artifacts:
dissection, vegetation**

**60 year old man
Cardiac source of embolus?**

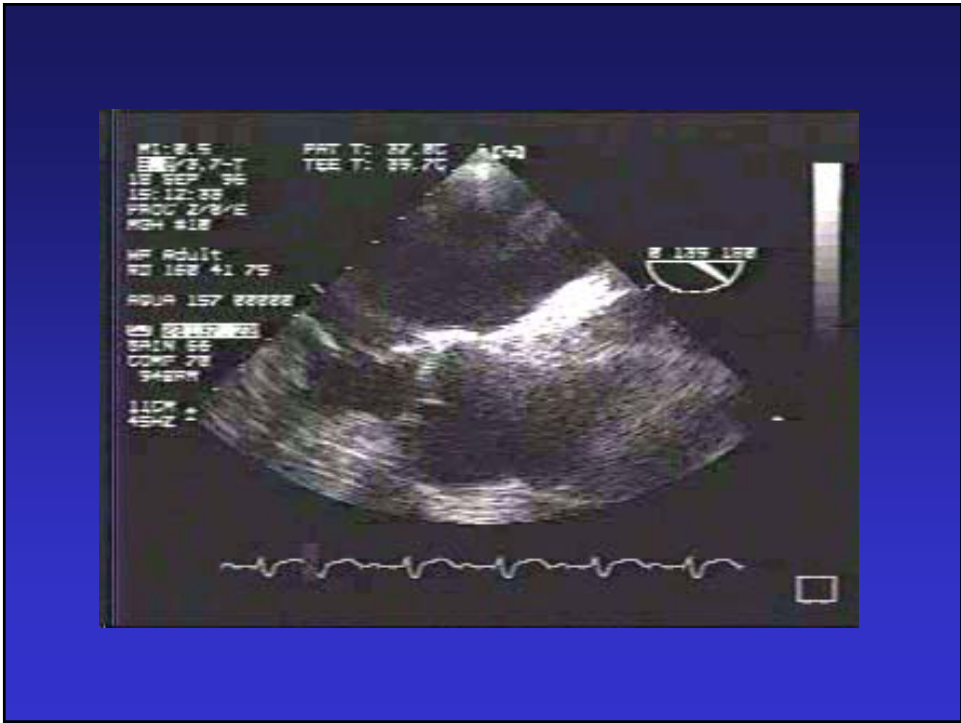
NAME THAT MASS!

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NAME THAT MASS:

1. Left atrial myxoma
2. Left atrial thrombus
3. Sinus of Valsalva aneurysm
4. Atrial septal aneurysm (bulging)



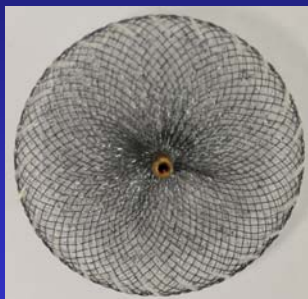
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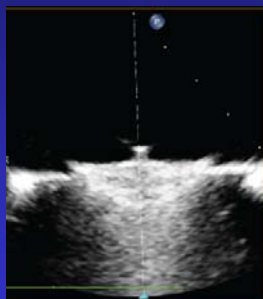
Take Home Lesson:

Look at a perpendicular view: a mass will appear solid in both views.

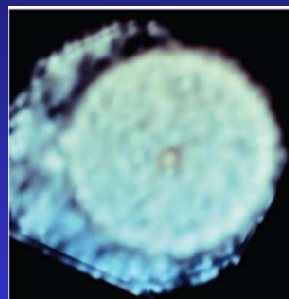
LA APPENDAGE CLOSURE DEVICES



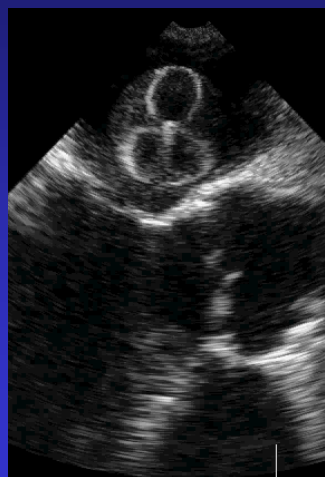
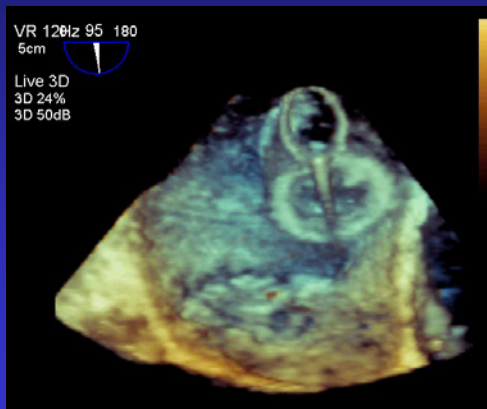
AMPLATZER



3D ECHO FRONTAL VIEW



Apical TTE and TEE: What type of device?



ECHOCARDIOGRAPHY IN LA APPENDAGE CLOSURE

Etiology and Relevance of the Figure-of-Eight Artifact on Echocardiography after Percutaneous Left Atrial Appendage Closure with the Amplatzer Cardiac Plug

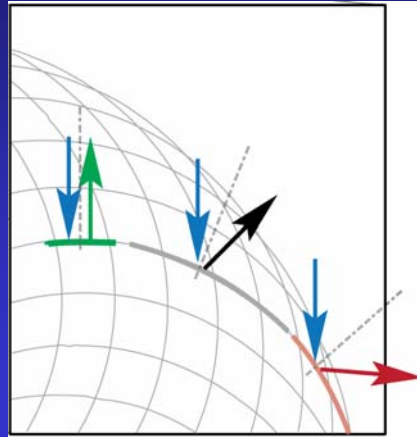
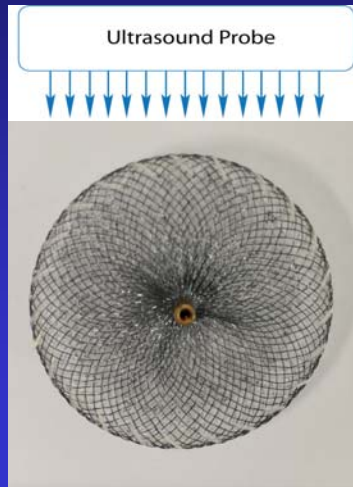
Philippe B. Bertrand, MD, MSc, Lars Grieten, MSc, PhD, Pieter De Meester, MD, Frederik H. Verbrugge, MD, Wilfried Mullens, MD, PhD, David Verhaert, MD, Maximo Rivero-Ayerza, MD, PhD, Werner Budts, MD, PhD, and Pieter M. Vandervoort, MD, *Genk, Hasselt, and Leuven, Belgium*

JASE 2014; 27:323-8

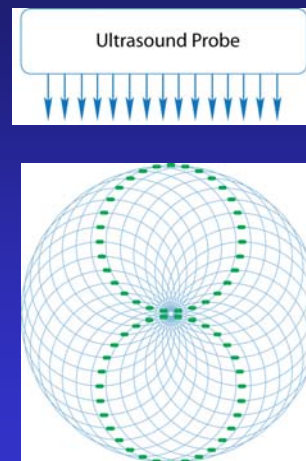
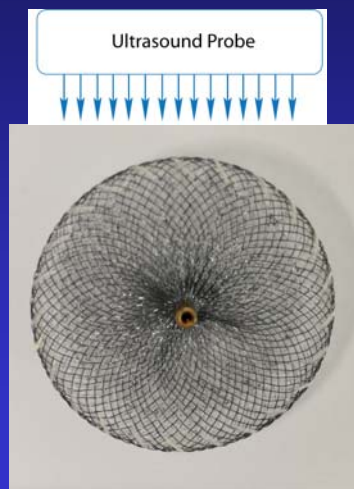
This change in apparent shape is caused by which physical effect?

- 1. Scattering**
- 2. Refraction**
- 3. Reflection**
- 4. Acoustic shadowing**

Physics principle: Angle of reflection = angle of incidence for a specular reflector



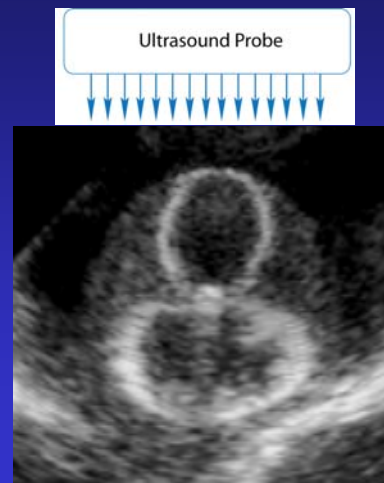
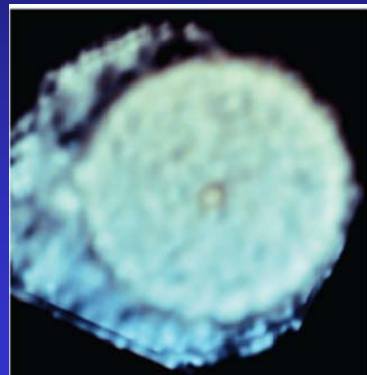
Result: Figure-of-8 artifact



This change in apparent shape is caused by which physical effect?

1. Scattering
2. Refraction
3. Reflection
4. Acoustic shadowing

Result: Figure-of-8 artifact versus true shape when beam views device en face

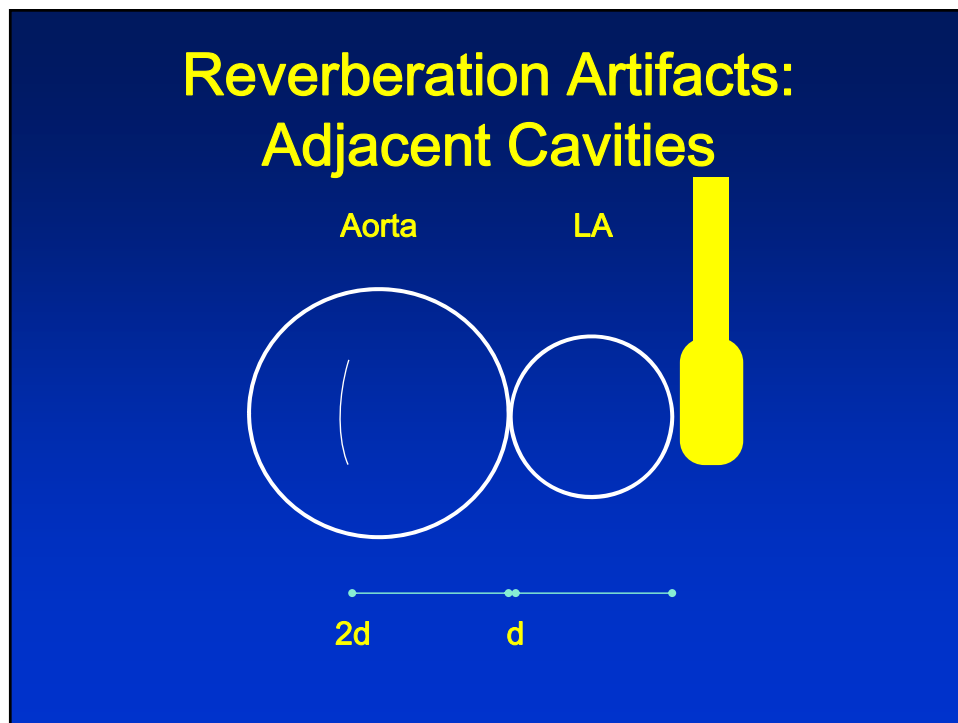
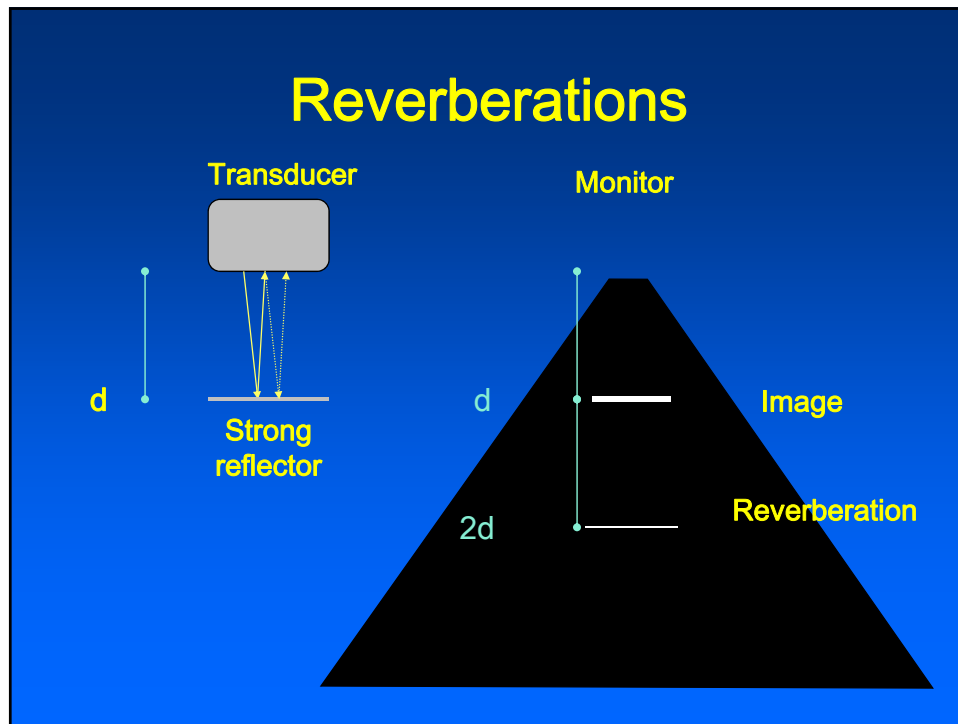


TYPES OF ARTIFACTS

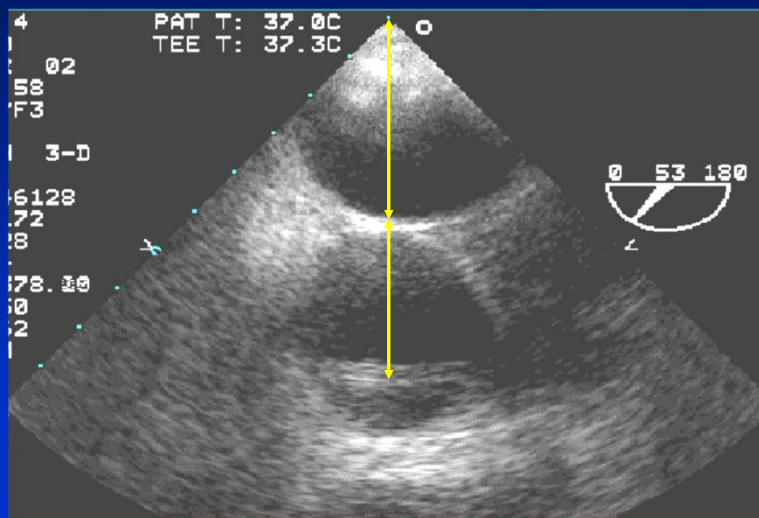
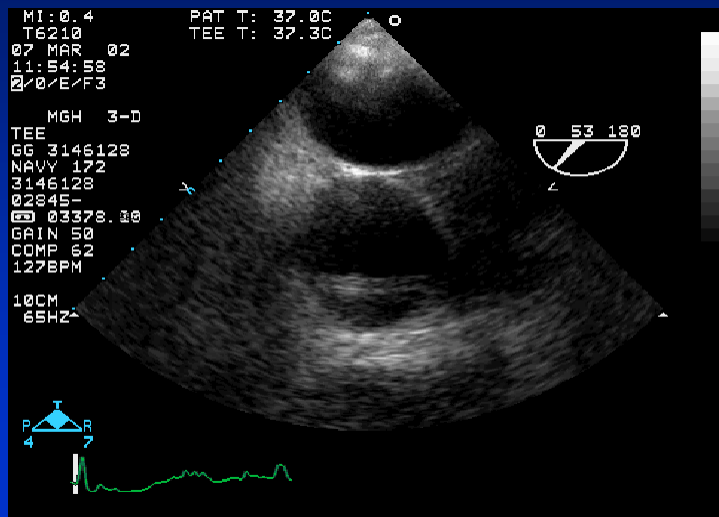
- More distant than the object
 - Parallel motion: Reverberation
 - Opposite motion: Mirror image
- Same distance as the object
 - Beam width
 - Side lobe

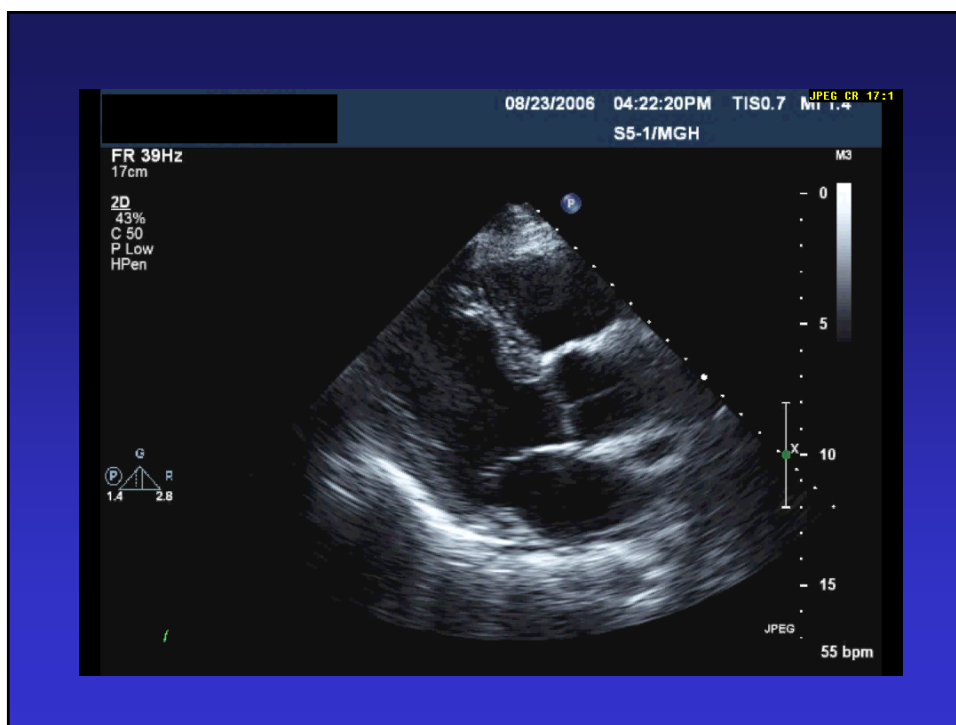
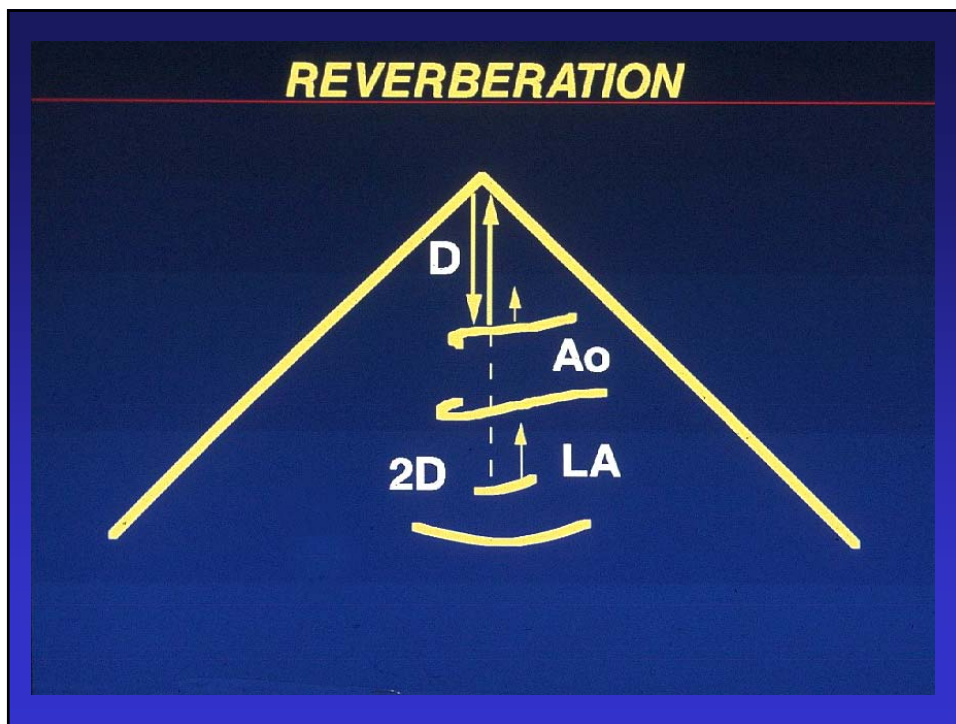
BASIC PRINCIPLES OF ARTIFACTS

- The machine displays all returning echoes in the direction of the beam
- The distance to an echoed object is determined from the time it takes for sound to return to the transducer

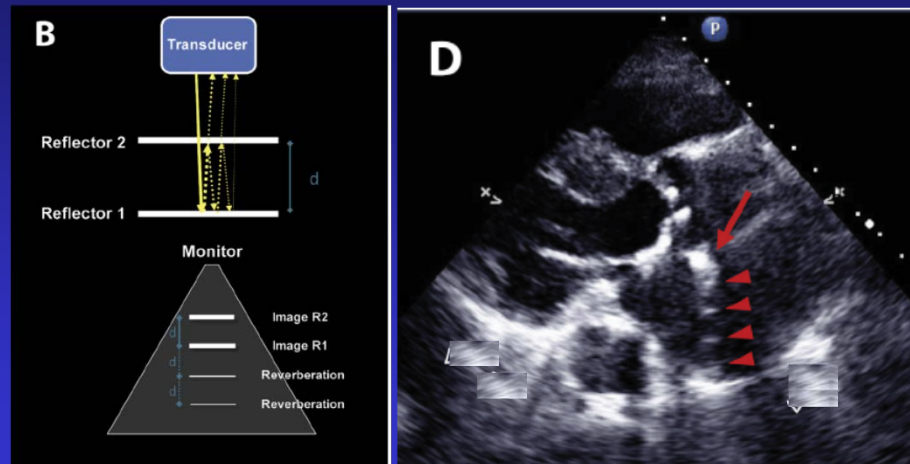


Reverberation Artifact: Ascending Aorta in Short Axis





MULTIPLE REVERBERATIONS



If an object is an artifact, color flow signal:

1. Passes through it
2. Demonstrates flow reversal near the artifact
3. Does not become turbulent in its vicinity

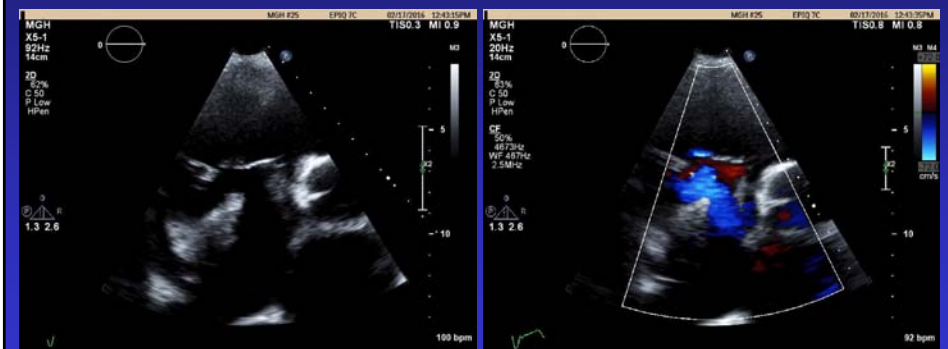
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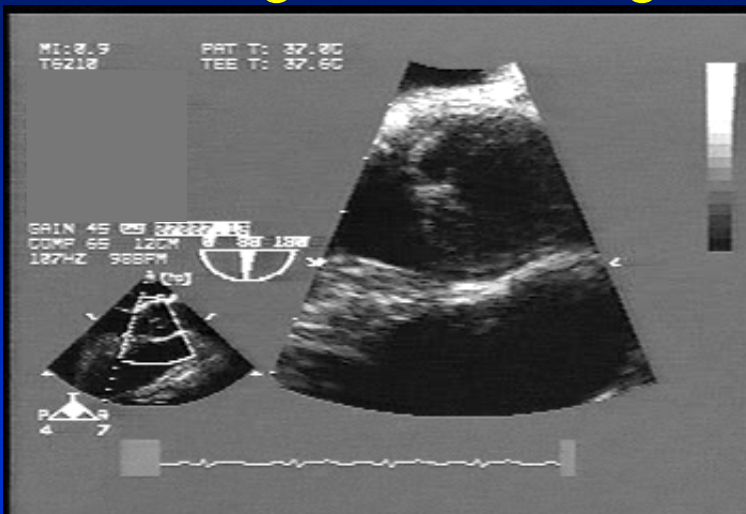
If an object is an artifact, color flow signal:

**May or may not pass through it –
Tissue priority algorithm**

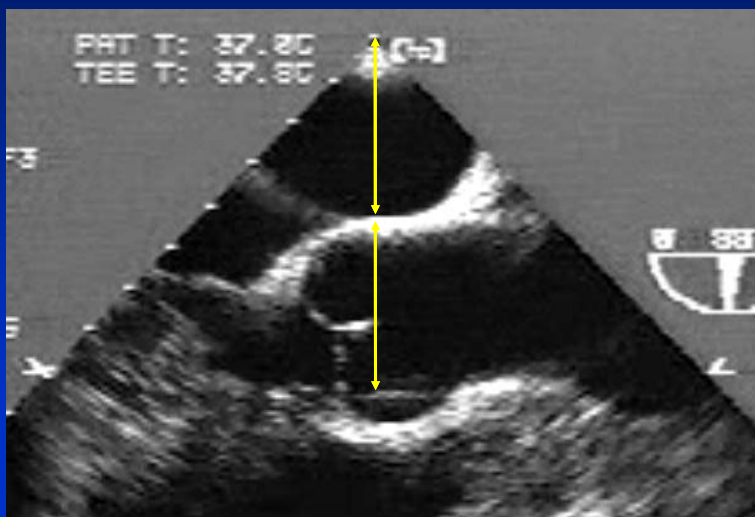
Tissue priority algorithm



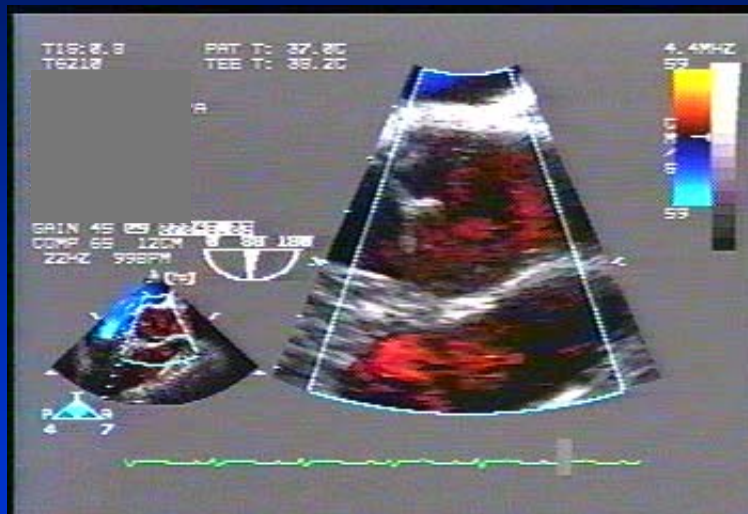
Reverberation Artifact: Ascending Aorta in Long Axis



Reverberation Artifact: Ascending Aorta in Long Axis



Color Doppler: Ascending Aorta in Long Axis



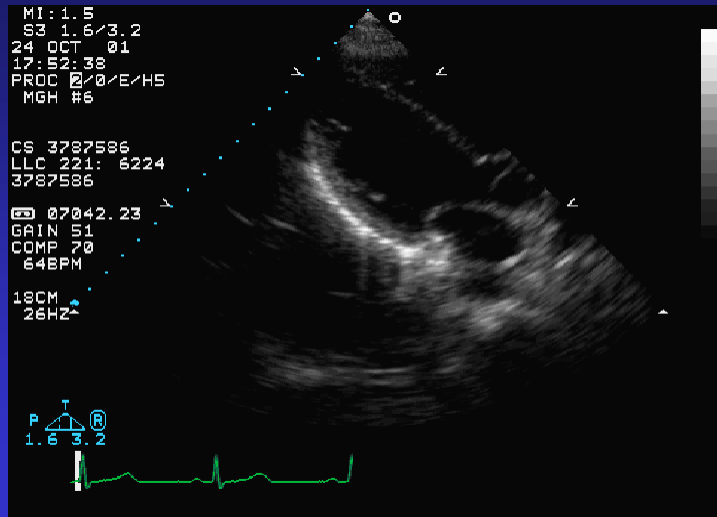
Take Home Lessons

- Beware of linear structures in the ascending aorta on TEE
- Always confirm the anatomy of linear structures in multiple views and with color flow
- Take your time in drawing a conclusion

TYPES OF ARTIFACTS

- More distant than the object
 - Parallel motion: Reverberation
 - Opposite motion: Mirror image
- Same distance as the object
 - Beam width
 - Side lobe

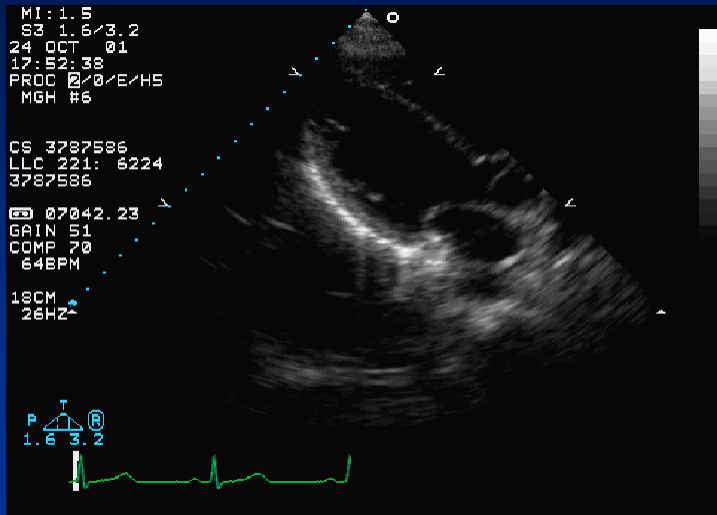
What is behind the Heart?



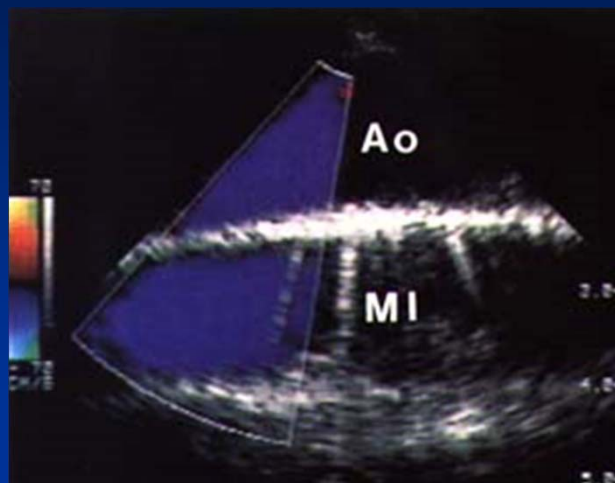
MIRRORING

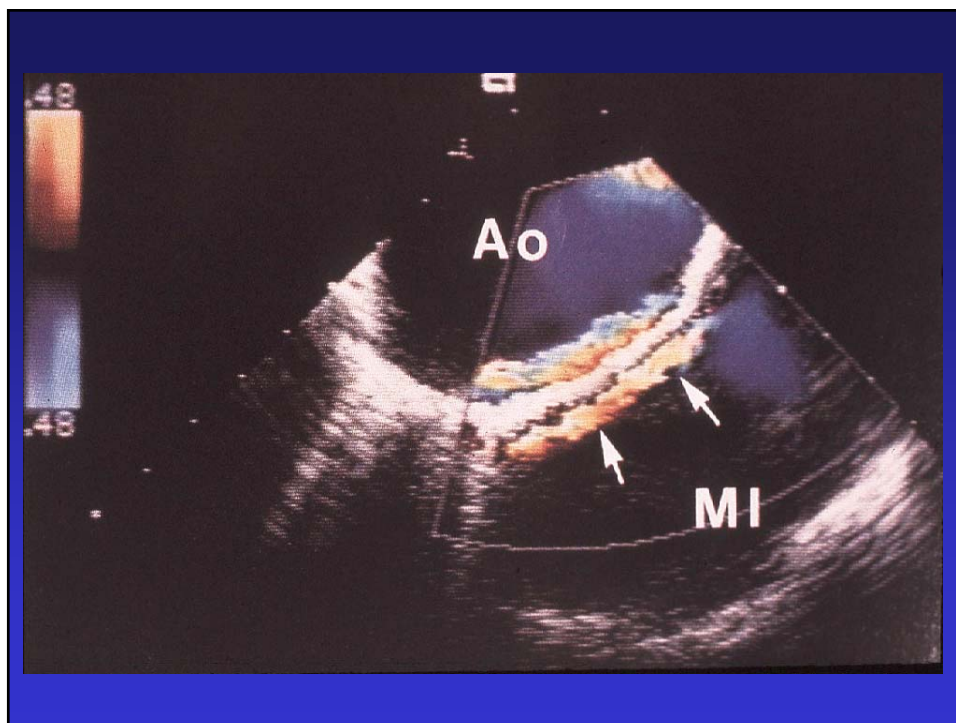
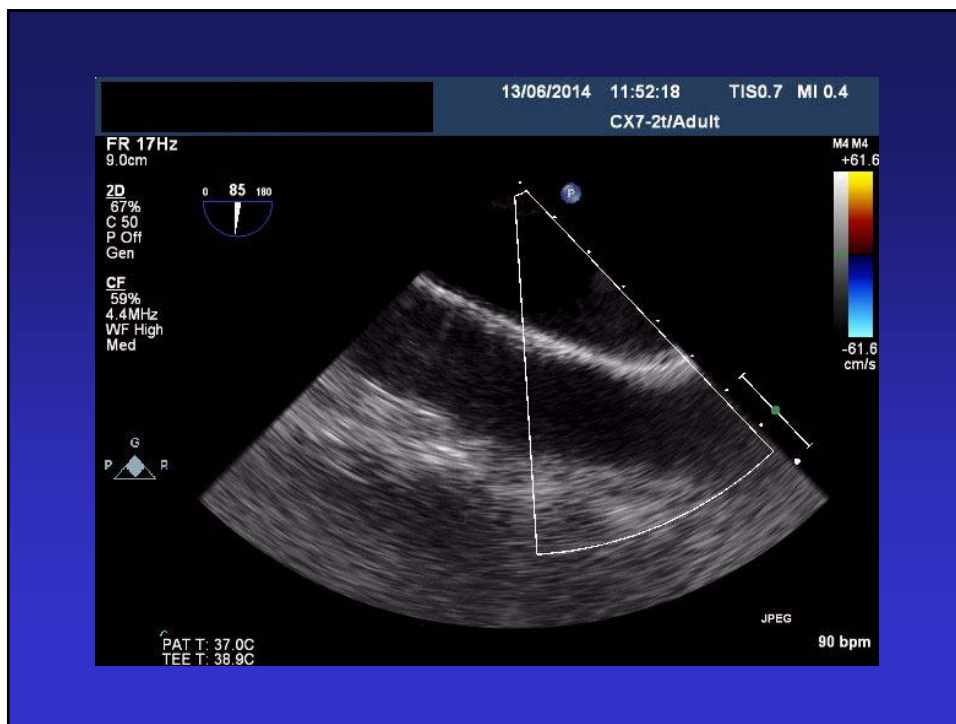


What is behind the Heart?



Mirror Image of Descending Thoracic Aorta

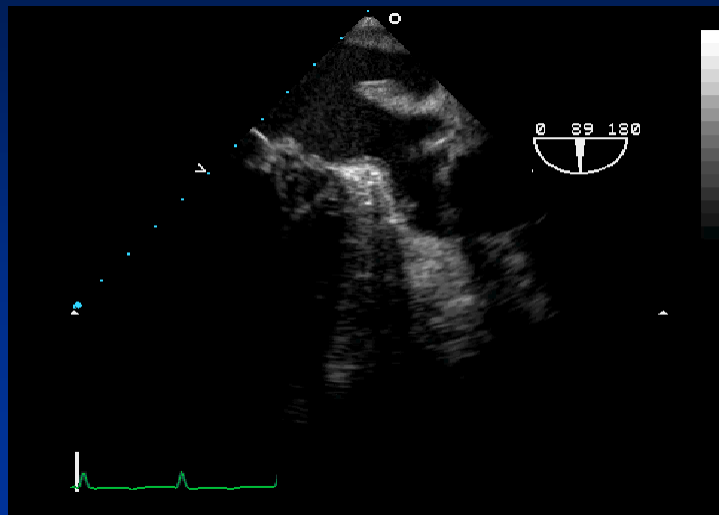




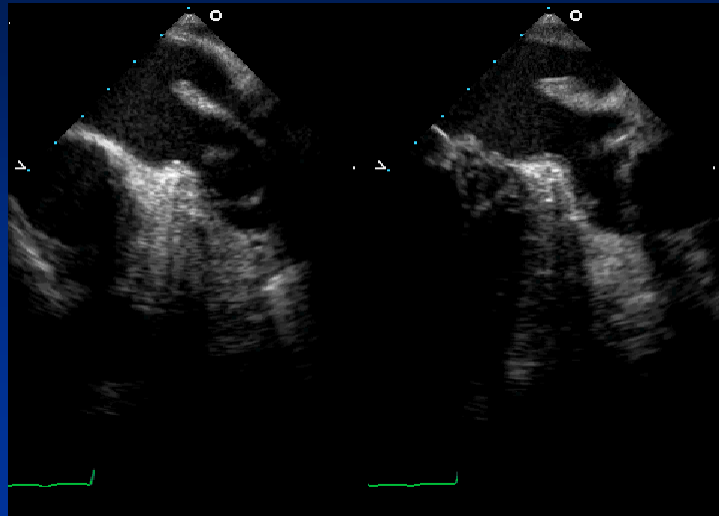
CASE

- 52 male with AFib for 1 month
- Sent for cardioversion (TEE)
- You must decide right now:
Shock or not?

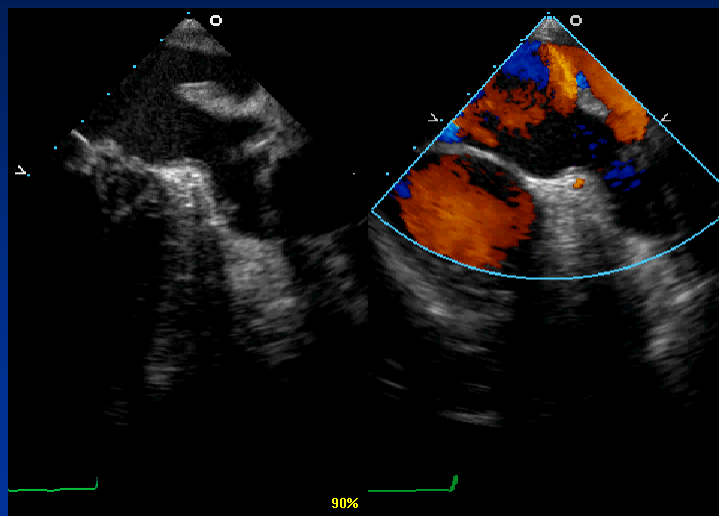
The Challenge of the LA Appendage

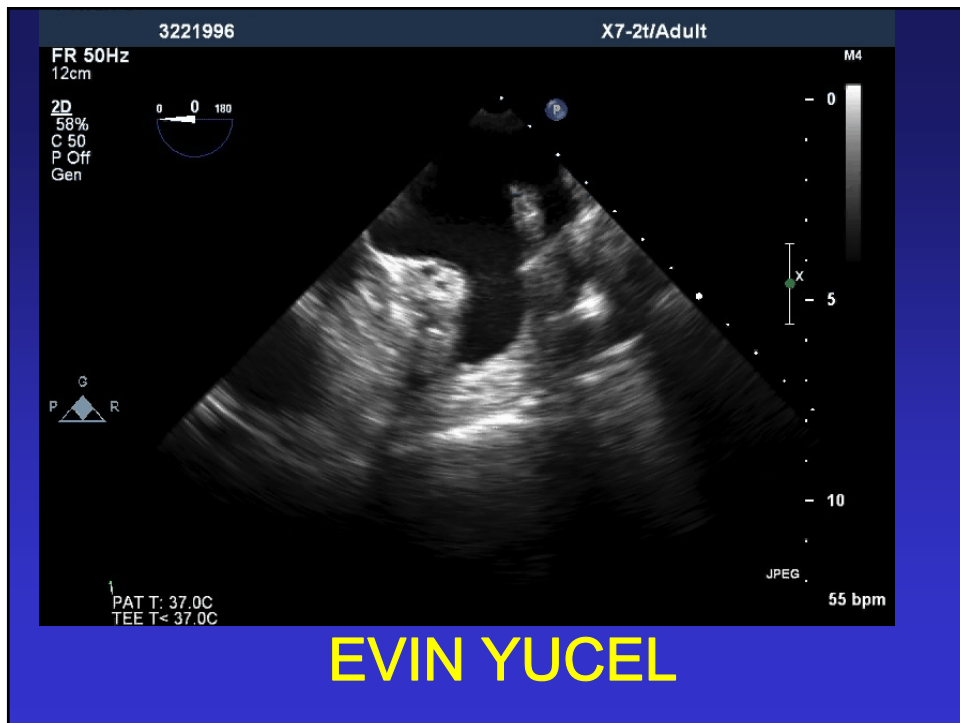
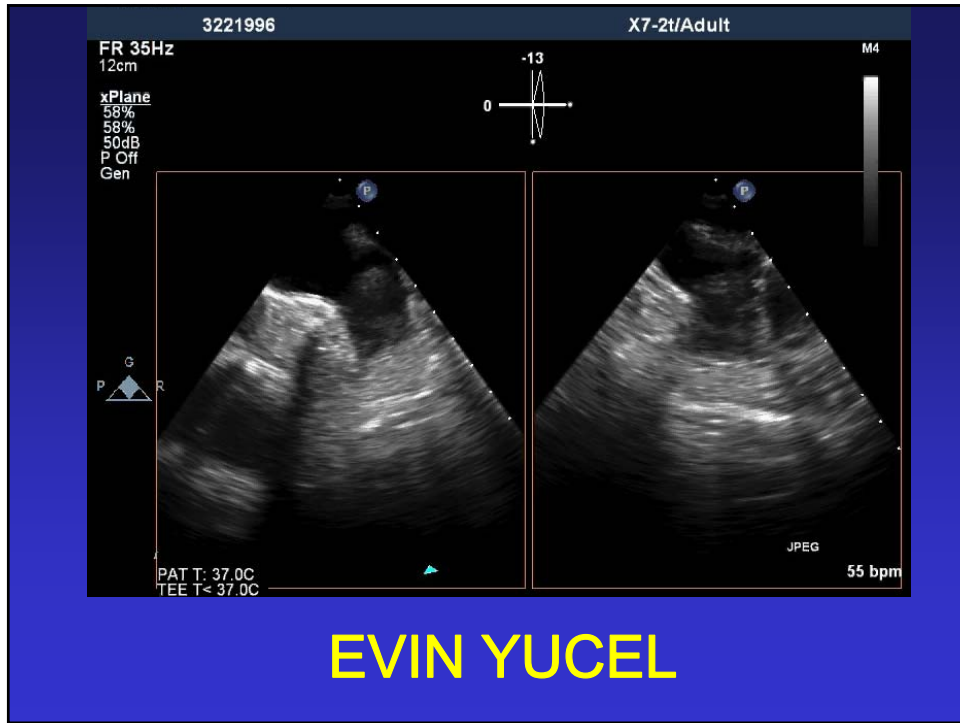


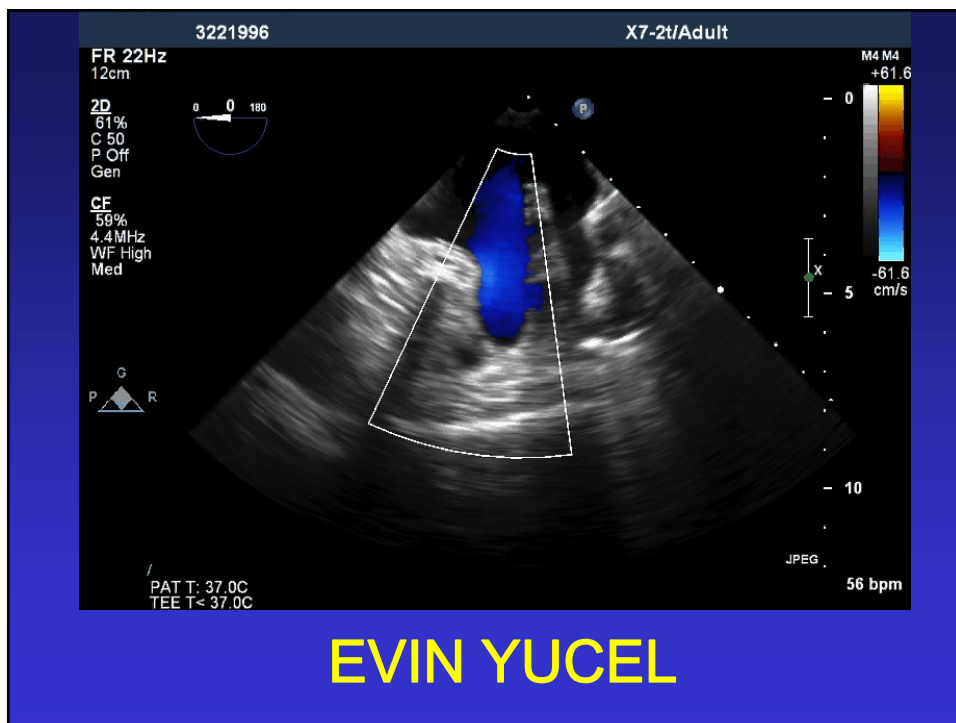
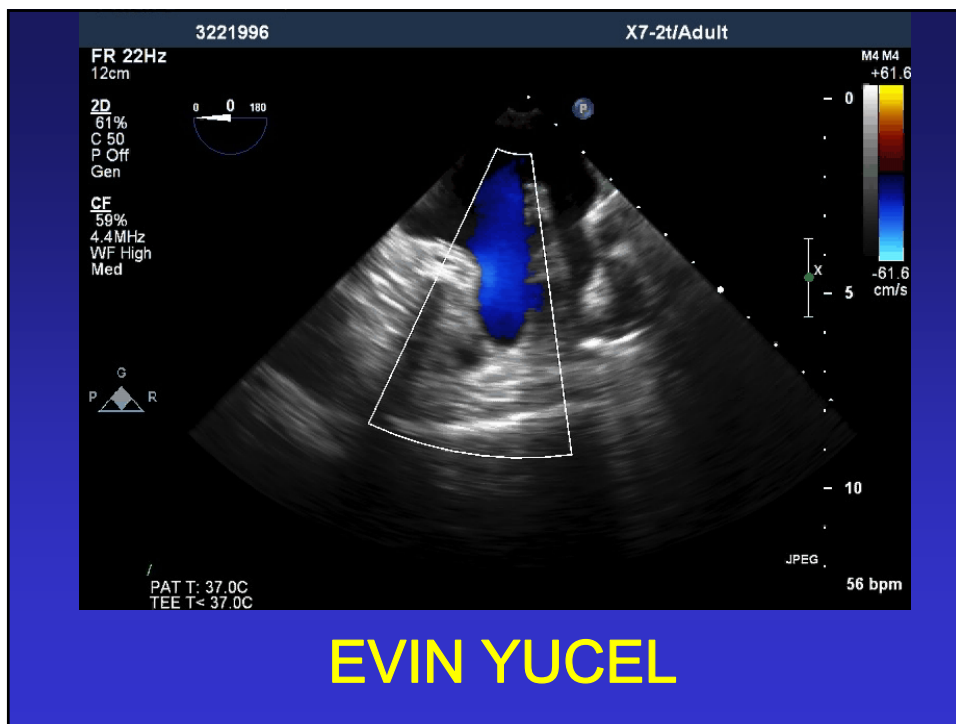
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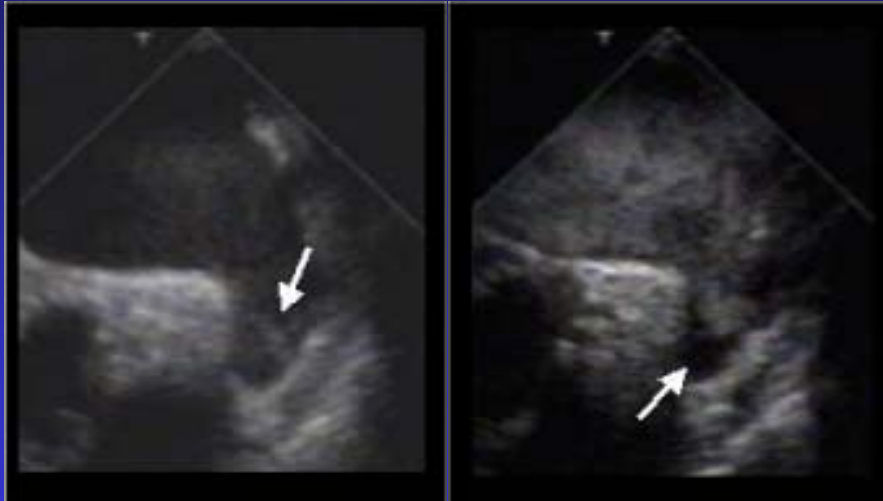
The Challenge of the LA Appendage







Contrast to enhance visualization of thrombus



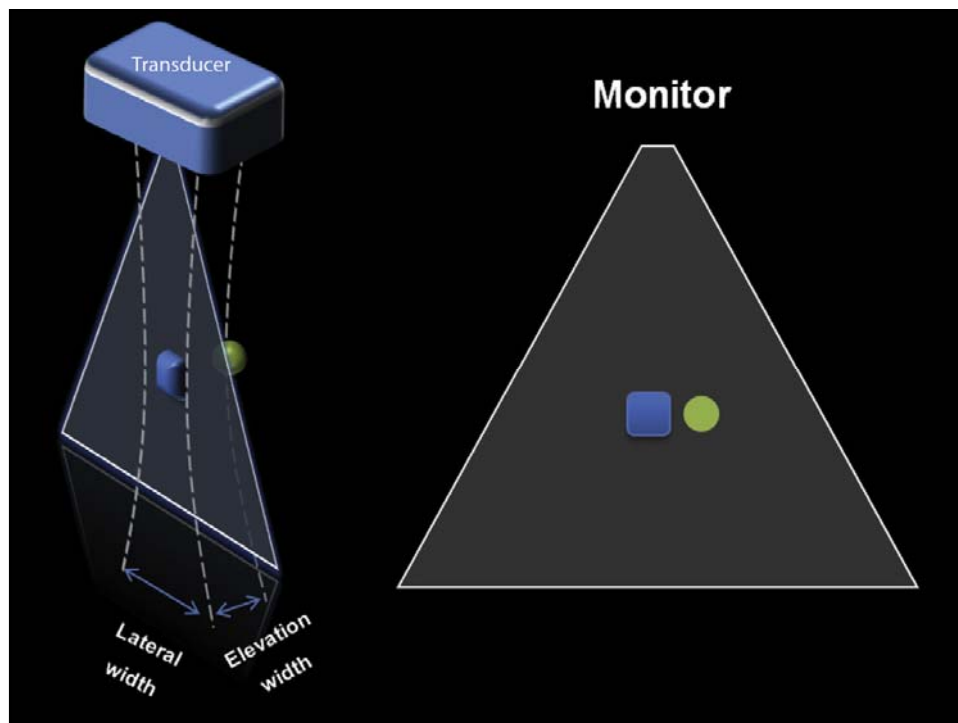
EVIN YUCEL

TAKE HOME LESSONS

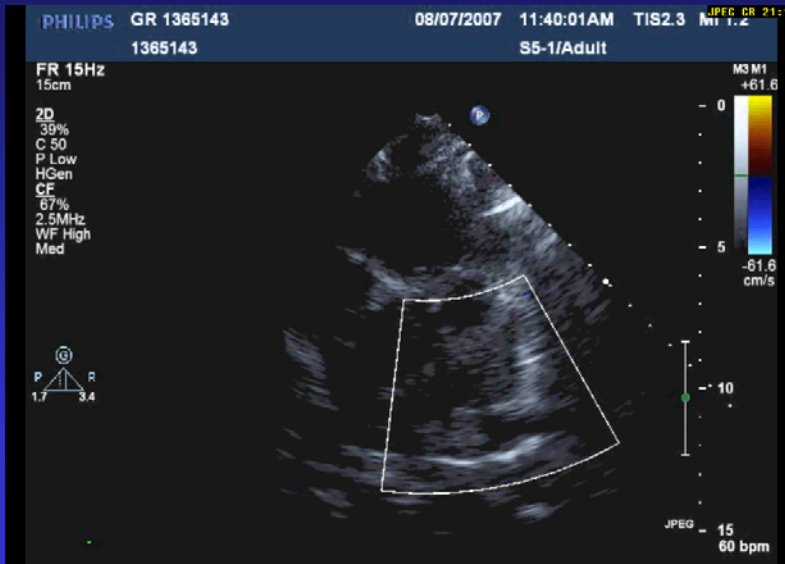
- Beware of artifacts in the LA appendage
- Reverberations, side lobes, and pectinate muscles – common
- Practice looking at normals

TYPES OF ARTIFACTS

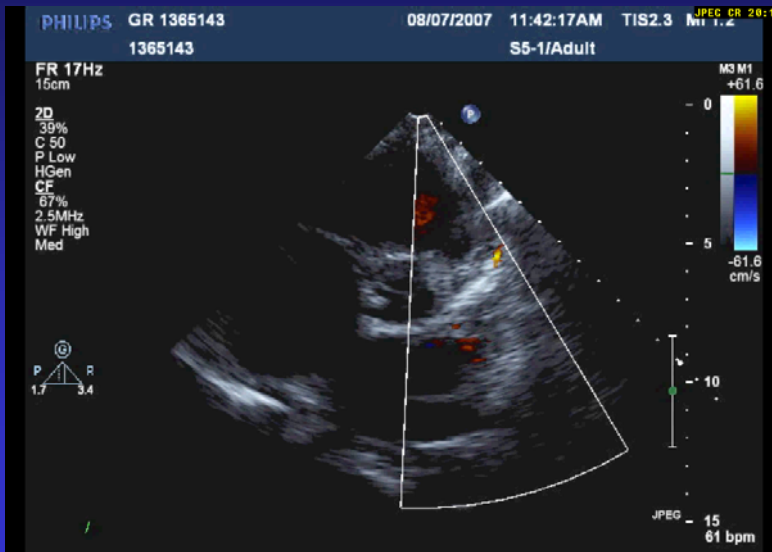
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 - Beam width
 - Side lobe
 - Refraction (lens)



What is the flow in the PA?



MR from out of the plane!



Take Home Message:

Doppler detects flow within the full width of the beam, in and out of the plane.

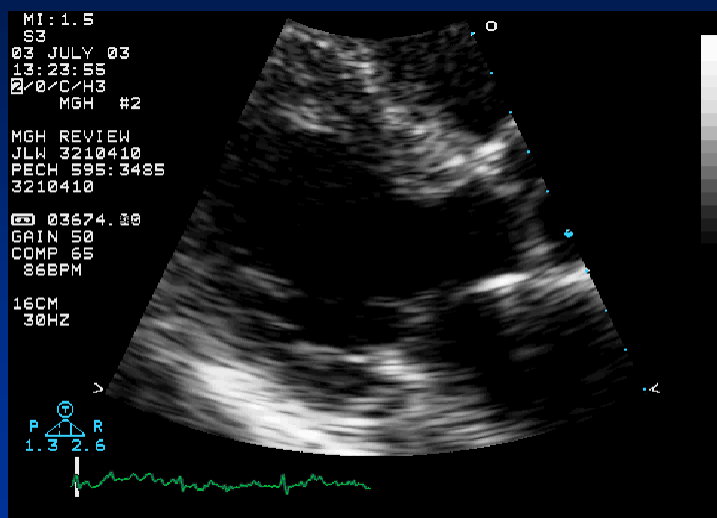
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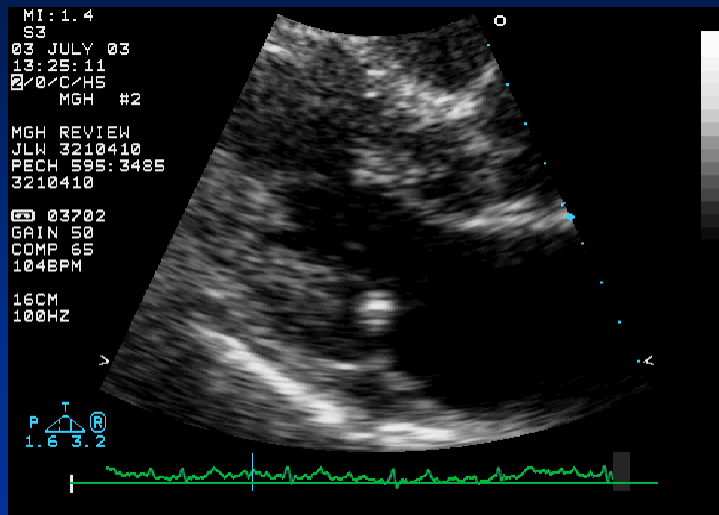
Case

- 51 year old female with fevers and one blood culture bottle positive for gram positive cocci in clusters
- TTE to rule out endocarditis

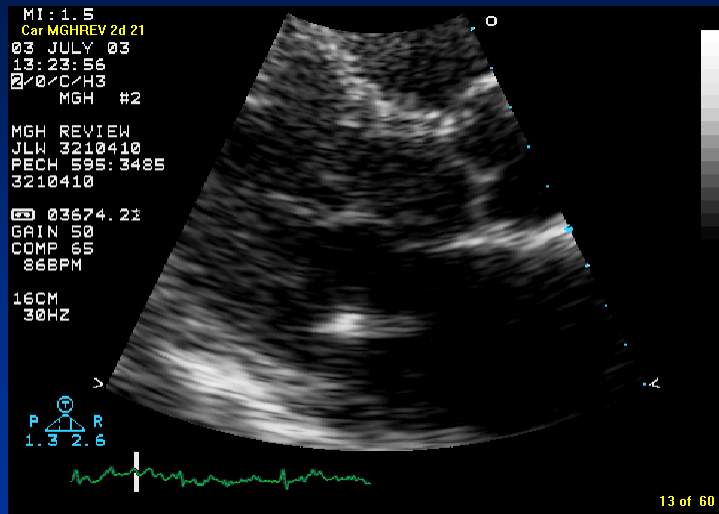
Case: Rule out SBE



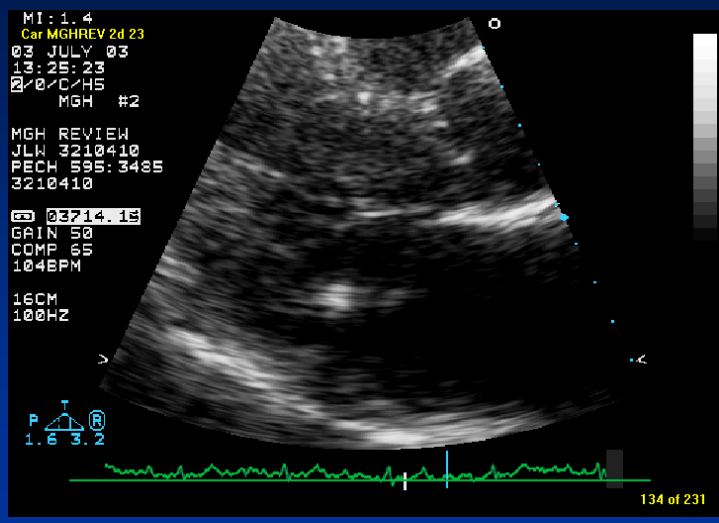
Case: Rule out SBE



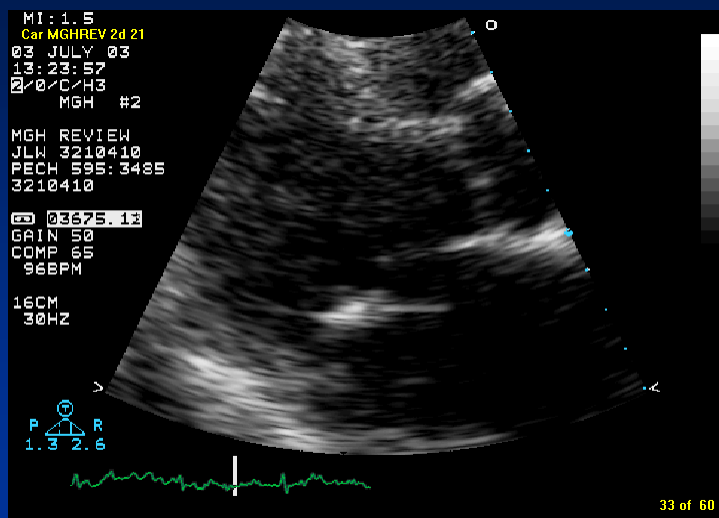
Case: Rule out SBE



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Case: Rule out SBE

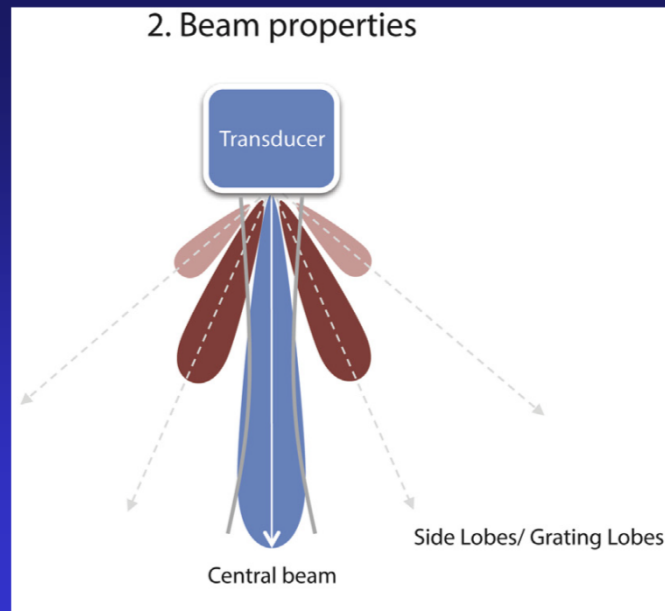


This patient shows:

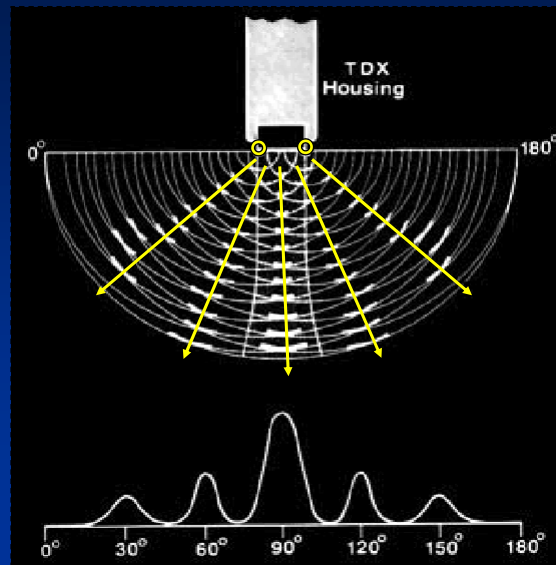
1. Biventricular wires
2. Reverberation
3. Mirror image
4. Side lobes



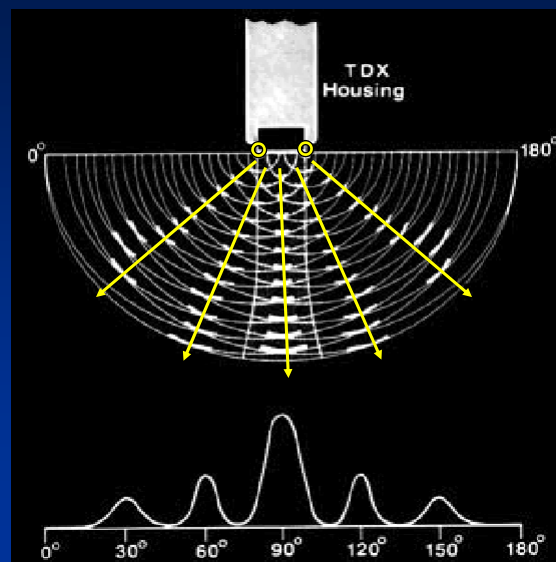
2. Beam properties

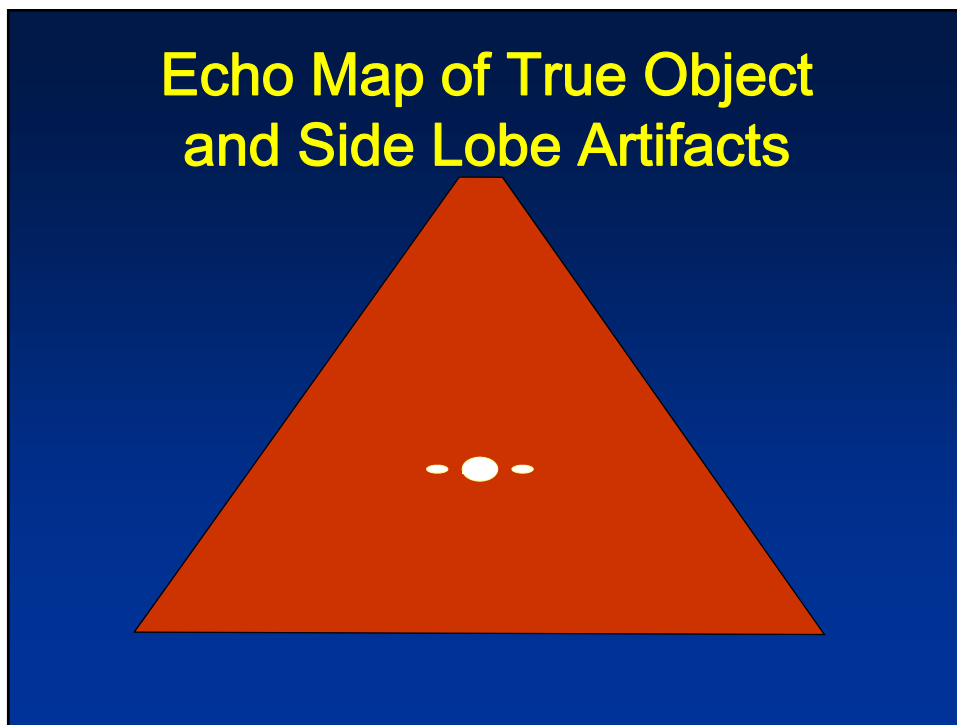
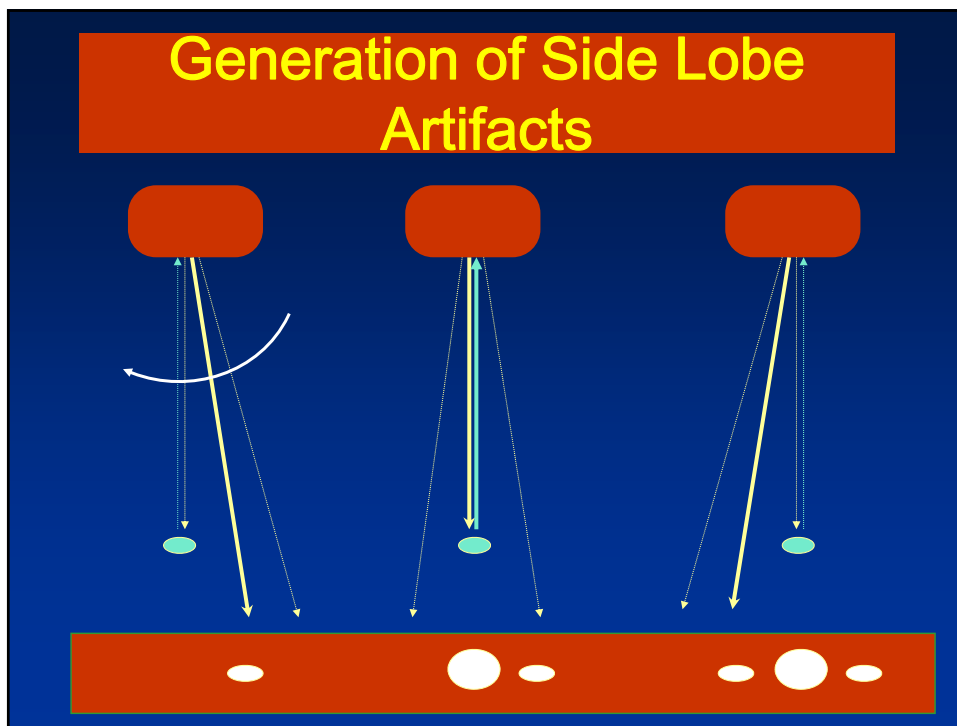


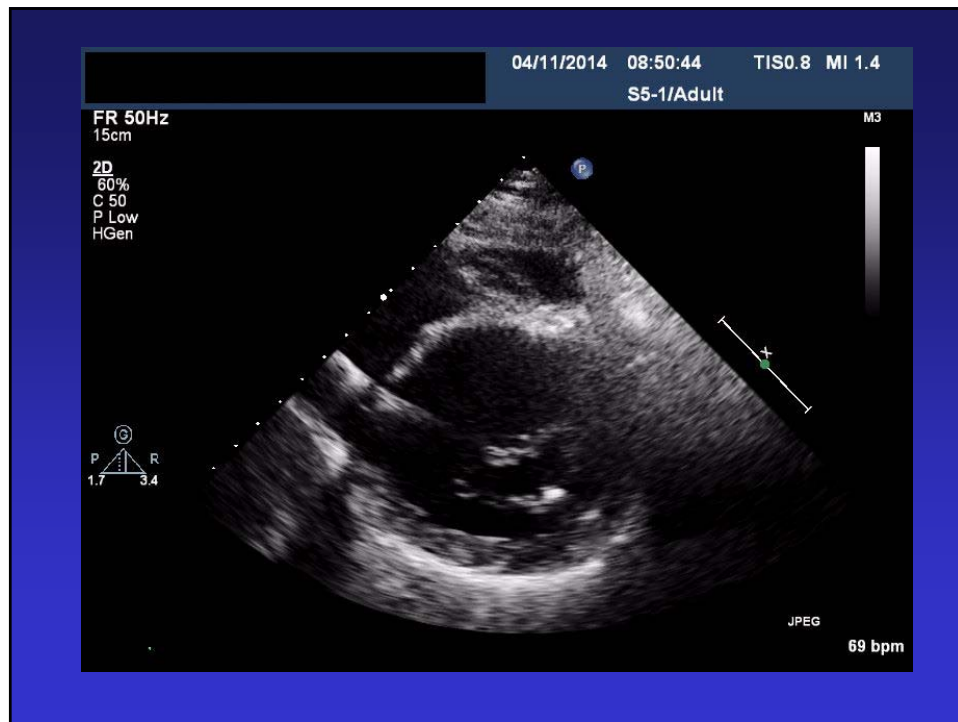
Side lobes: Laterally directed ultrasound energy arising from transducer edges



Side lobe energy returning to transducer is displayed as if originating centrally





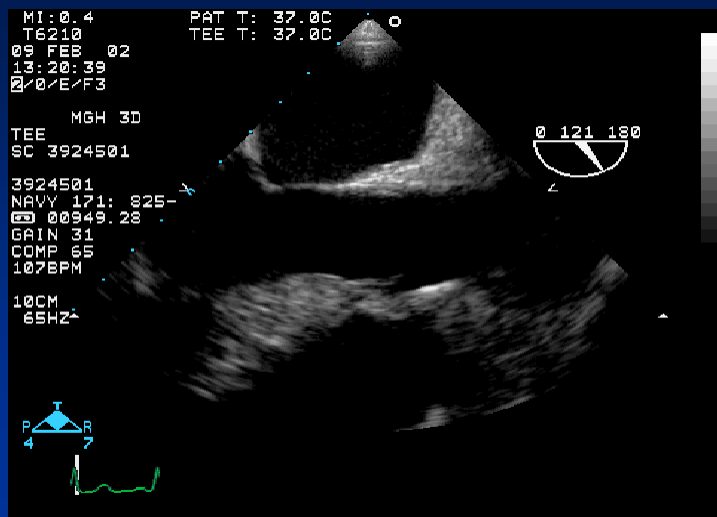


This patient shows:

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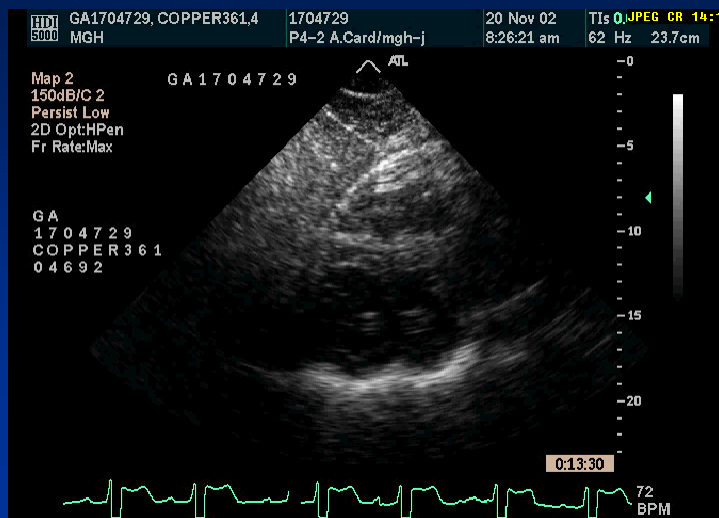
TEE: Aortic Dissection or Not?



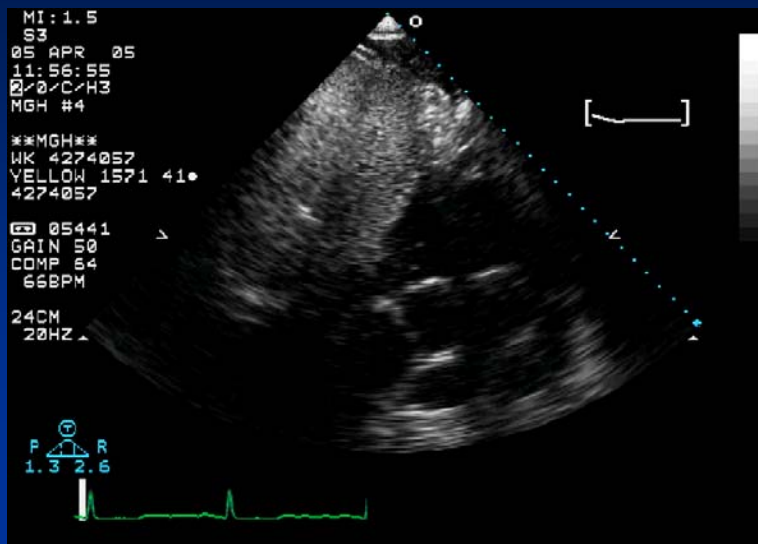
Case

- Another common finding on TTE that you may never have noticed

How Many Left Ventricles Does He Have?



How Many Aortas Does He Have?



TYPES OF ARTIFACTS

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Lens Artifact Creating Twin Images

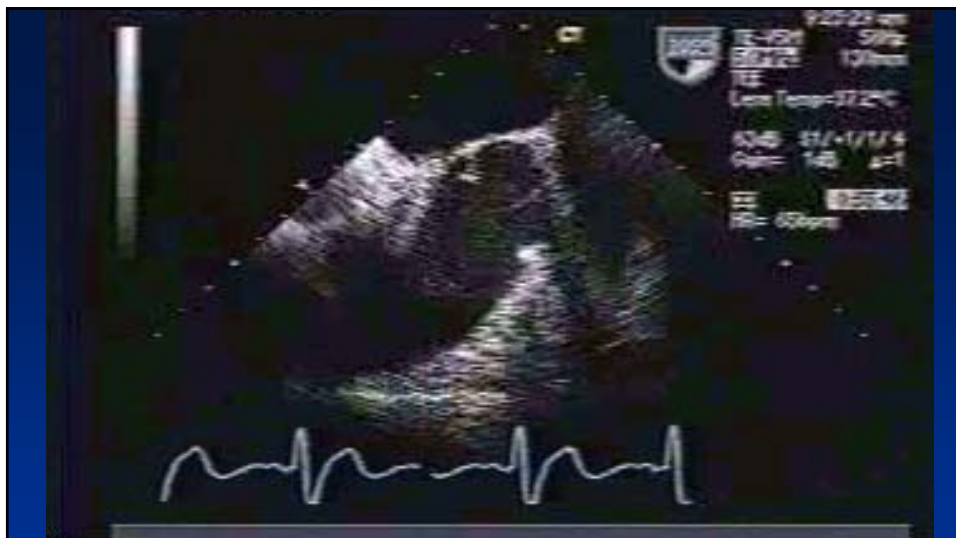


Case

- 75 M underwent TEE for question of dissection of the ascending aorta
- Referred to our hospital to repair the dissection

DISSECTION FLAPS

- Independent mobility (unless hematoma)
- Cannot pass through a wall
- Attached, not free-floating
- Act as flow dividers
- Not always: Occur in dilated aorta (IRAD: 1/5 of acute type B not so J Vasc Surg 2012)



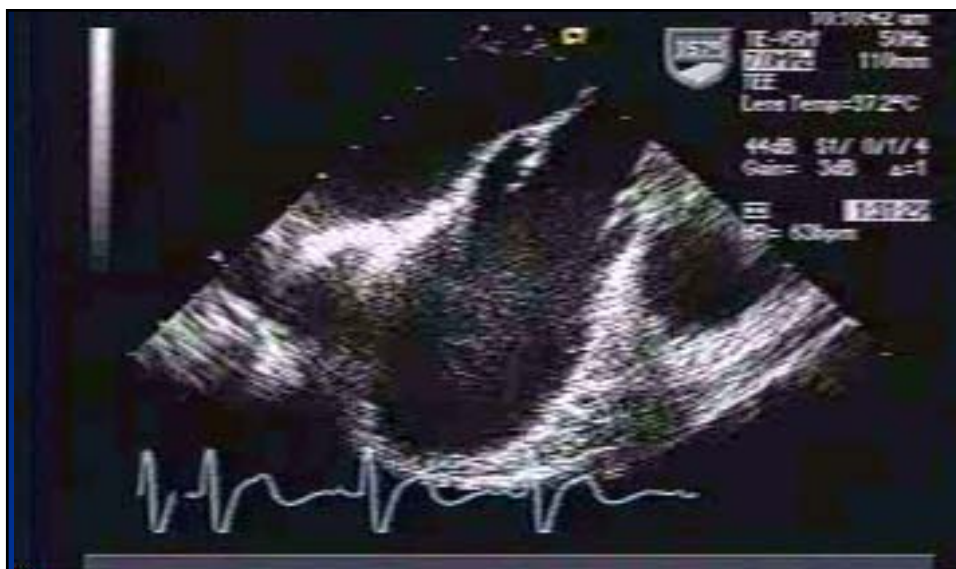
Case: Referral for Surgery for Aortic Dissection



Case: Referral for Surgery for Aortic Dissection

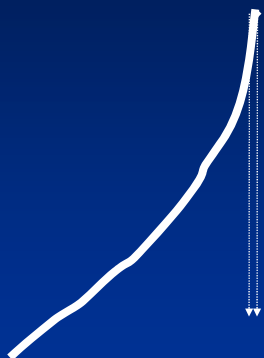


Case: Referral for Surgery for Aortic Dissection

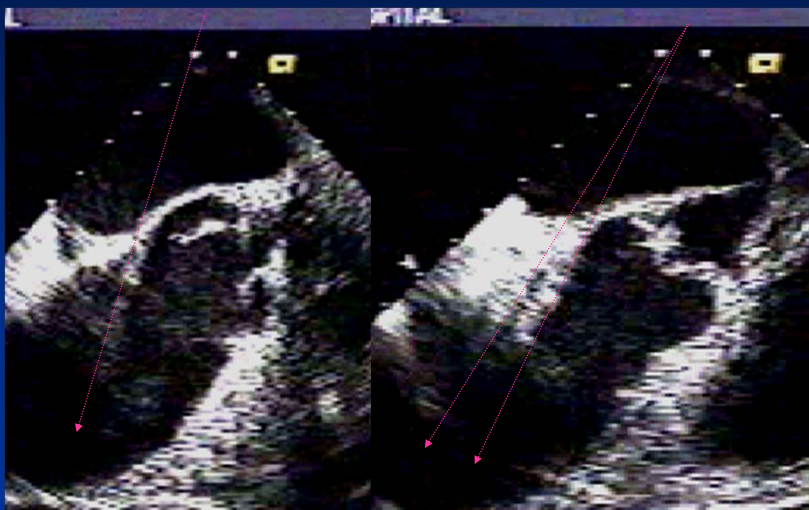


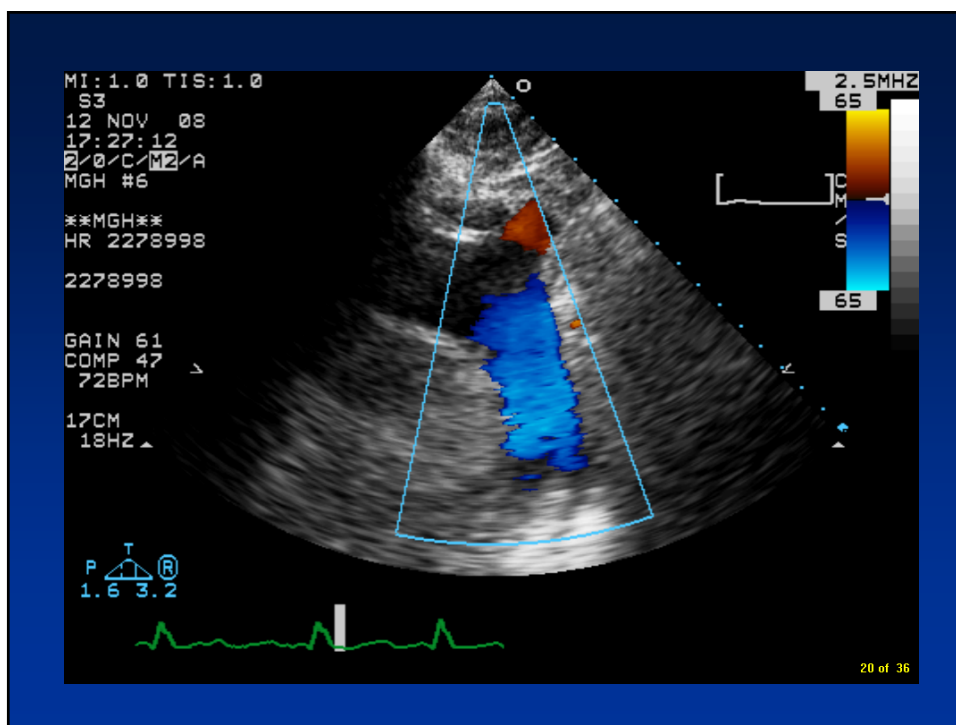
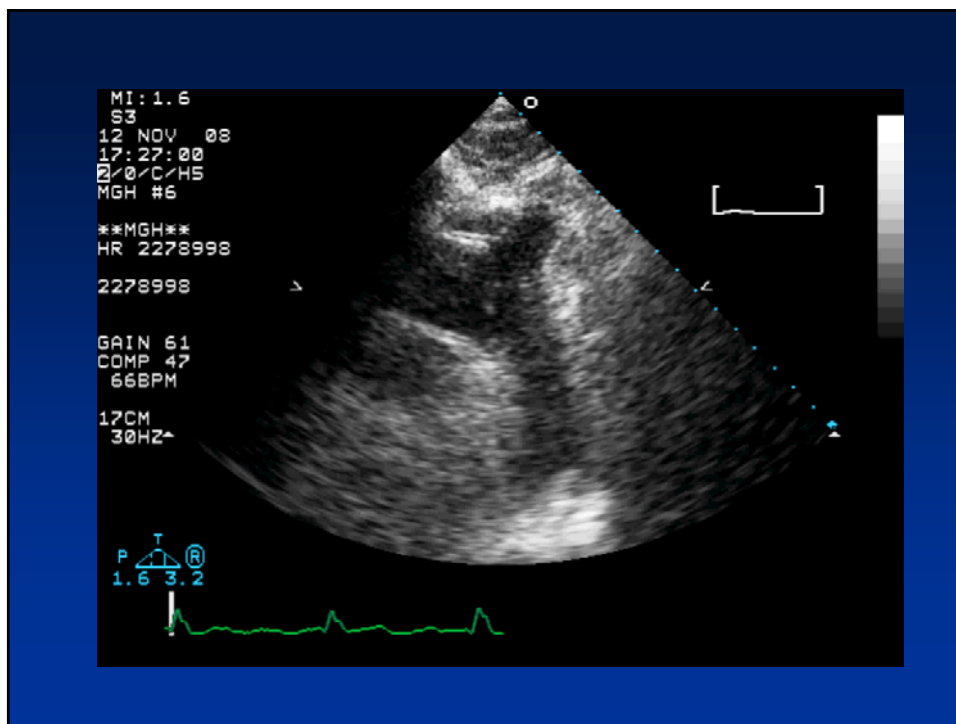
Case: Referral for Surgery for Aortic Dissection

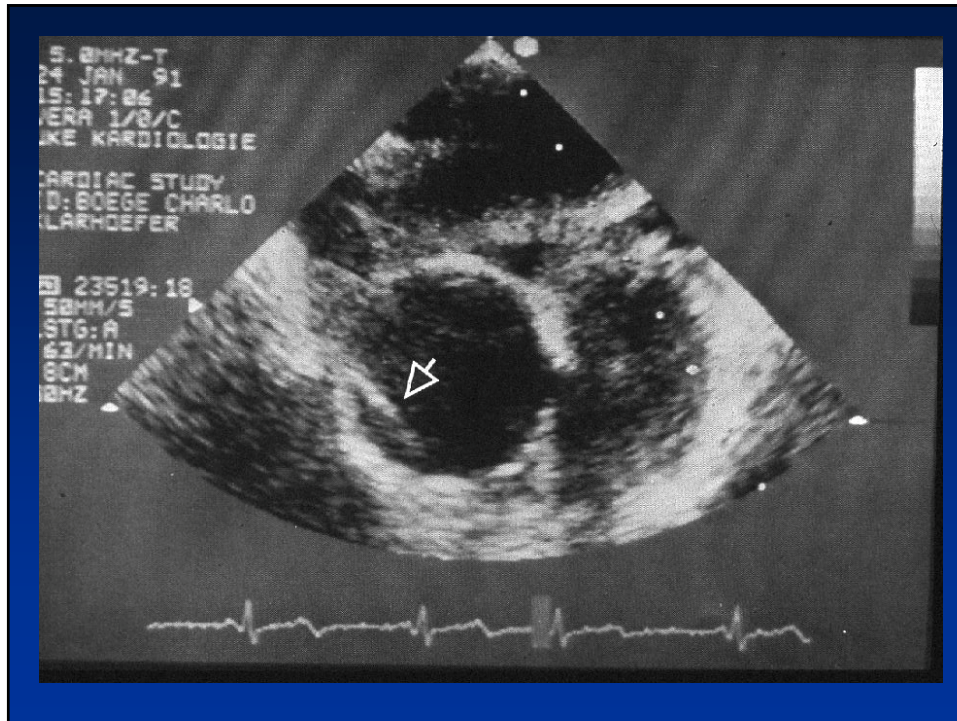
Reverberations Within an Object: Linear Structures Struck En Face by Beam



Linear Artifacts from Reverberations







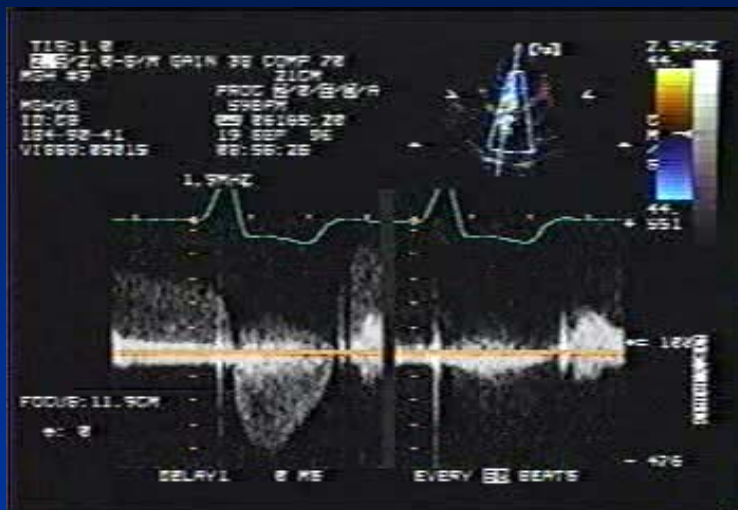
Case

- Patient with St. Jude mitral valve for 8 years
- Also has aortic stenosis
- New shortness of breath and systolic murmur
- ? Severe AS
- ? Prosthetic MR

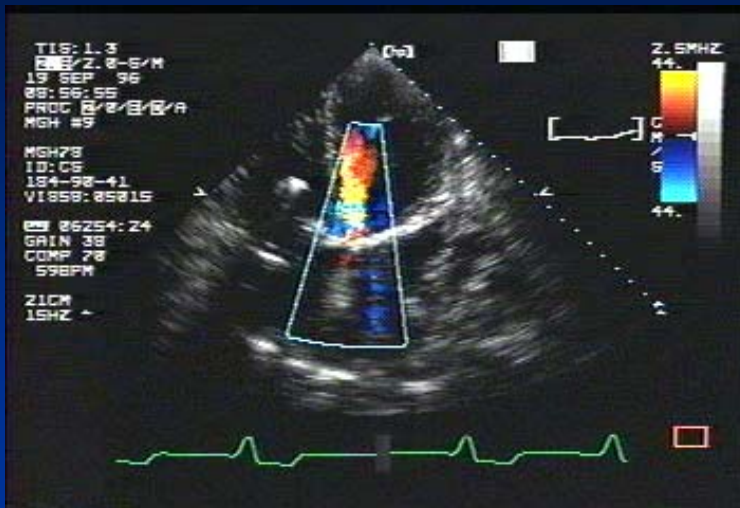
Case: St. Jude MVR, ?MR



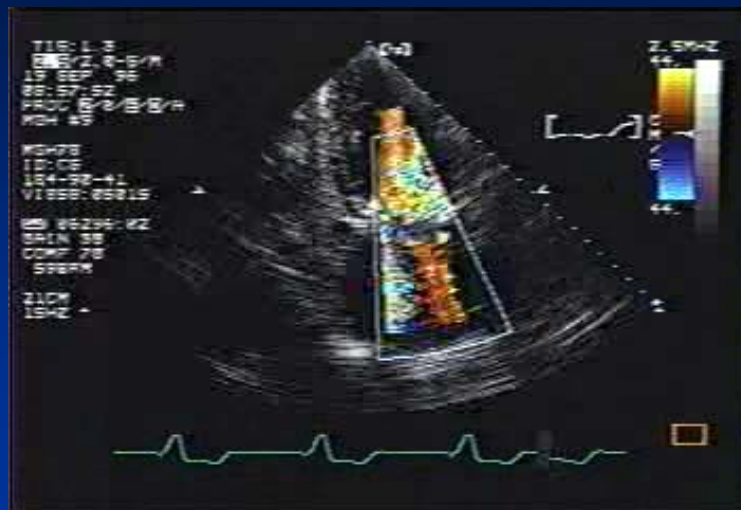
Case: St. Jude MVR, ?MR



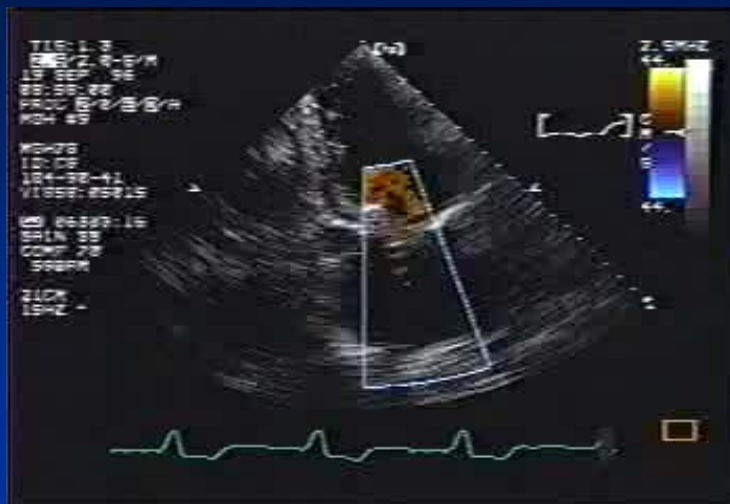
Pseudo MR



Case: St. Jude MVR, ?MR

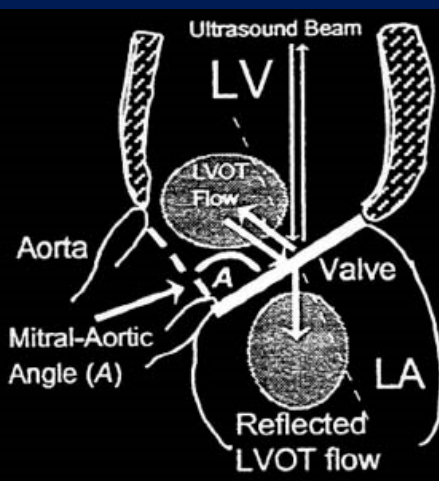


Case: St. Jude MVR, ?MR



Pseudo-MR: Principles

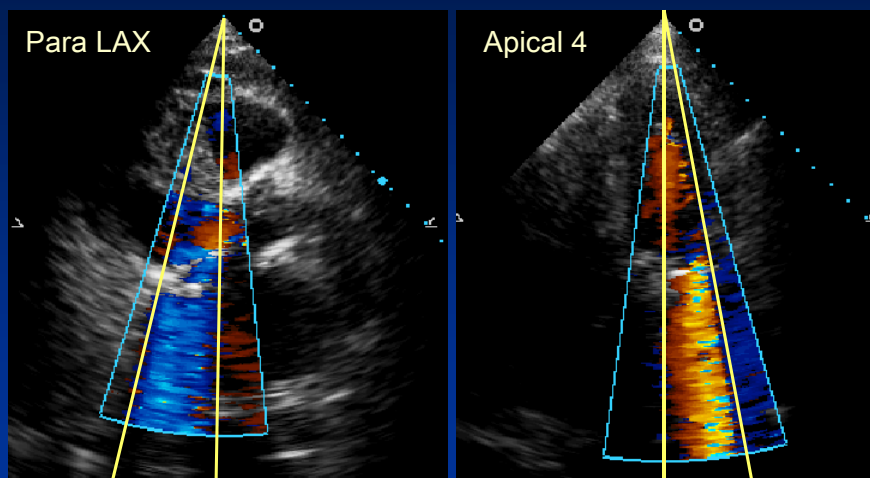
- The metallic prosthesis acts as an acoustic mirror
- The timing of the color in the left atrium matches that in the LVOT
- PISA on the LV side of the valve is absent



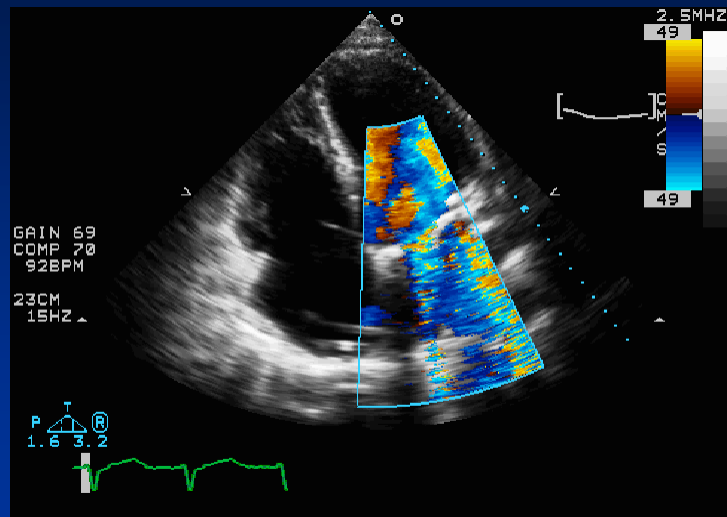
Recognizing Pseudo-MR



Prosthetic reverberations



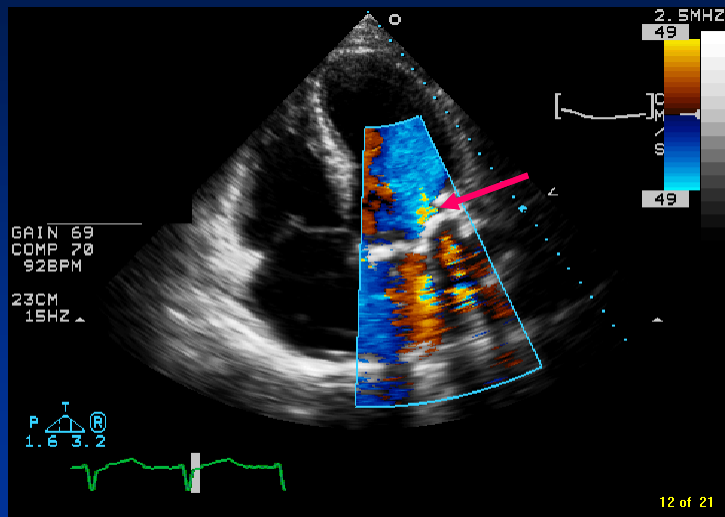
Test: Real MR or Pseudo-MR?



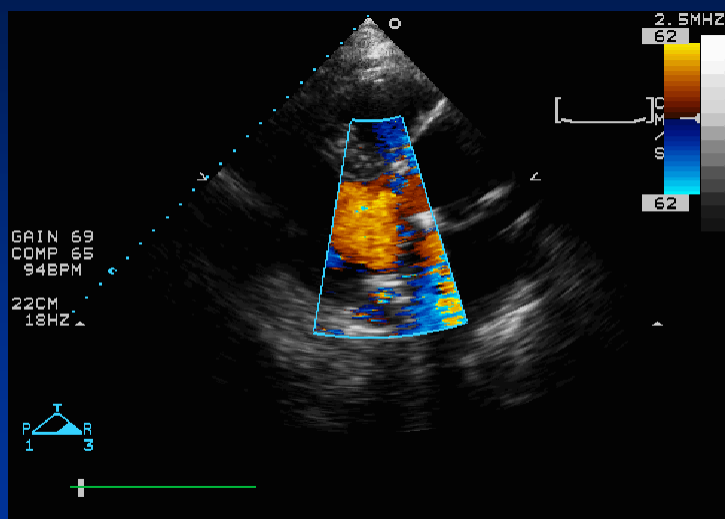
Test: Real MR or Pseudo-MR?

- A. Pseudo-MR
- B. Trace physiologic MR
- C. Significant MR

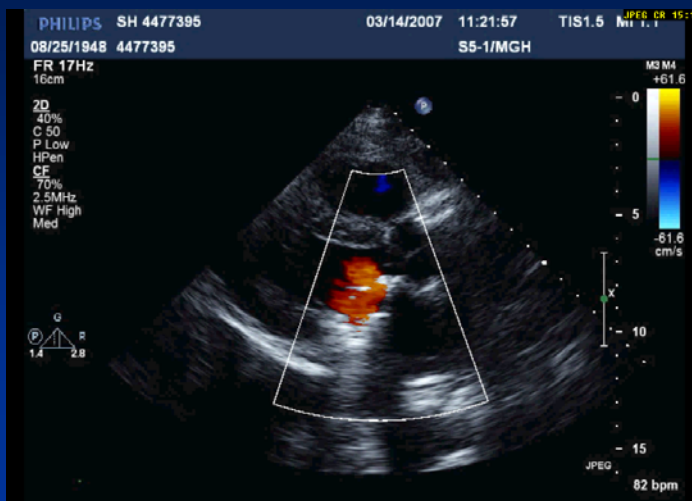
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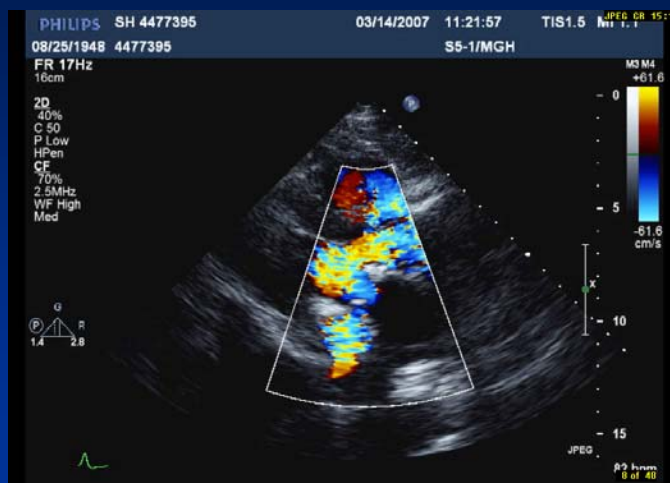
Test: Real MR or Pseudo-MR?



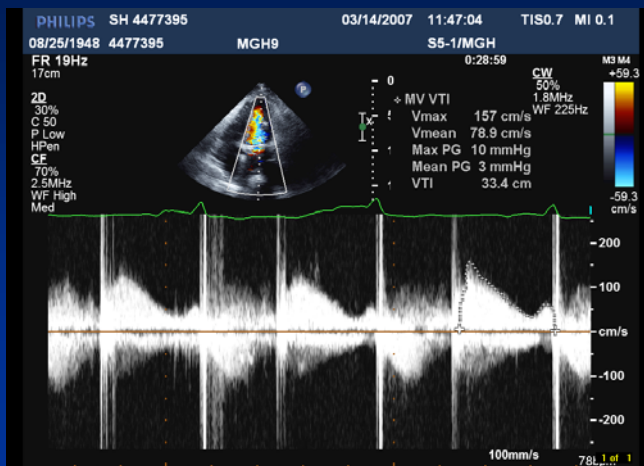
Test: Real MR or Pseudo-MR?



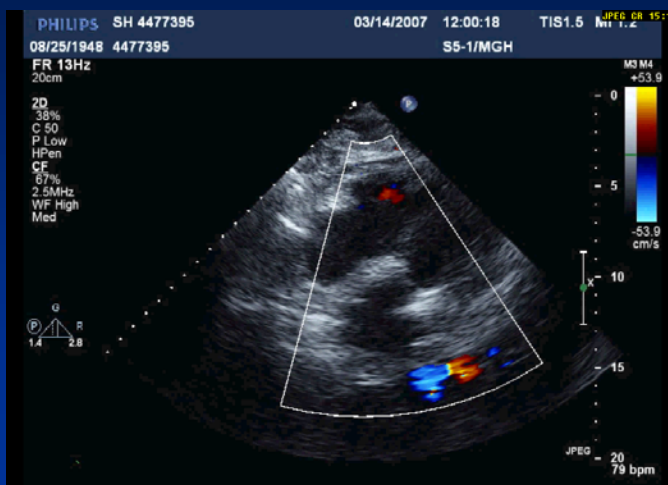
Test: Real MR or Pseudo-MR?



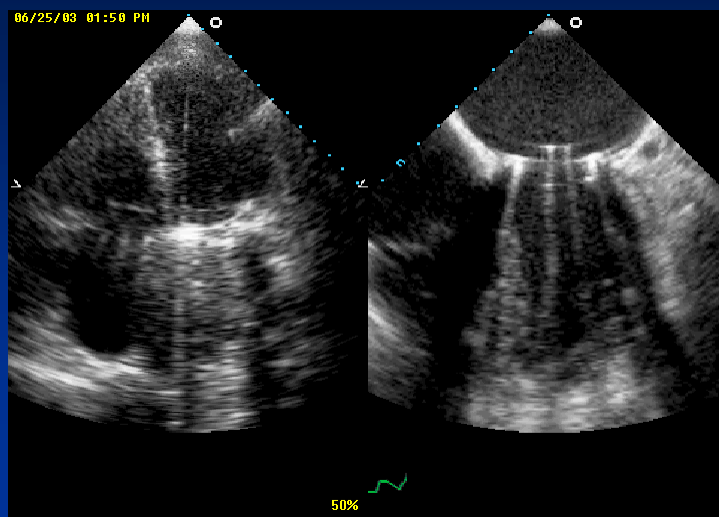
Test: Real MR or Pseudo-MR?



Test: Real MR or Pseudo-MR?



Additional Mechanical Prosthetic Valve Artifacts



**PROBLEMS WITH
INTERPRETATION**

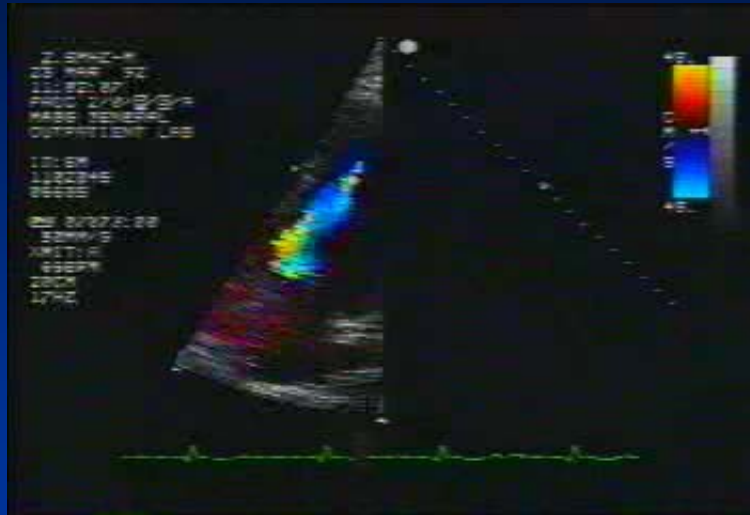
Case

- 48 M with shortness of breath and PVC's on monitor
- Abnormal EKG
- TTE to assess LV

Assess LV Function



Assess LV Function



Assess LV Function



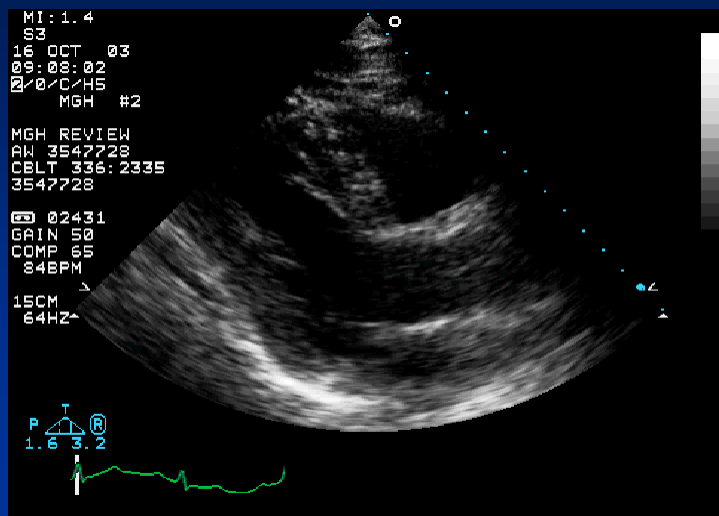
Take Home Lessons

- Don't be fooled by lack of epicardial motion, especially at the apex
- Use color as a contrast agent to define the endocardial borders
- If color is ineffective, use IV echo-contrast agent

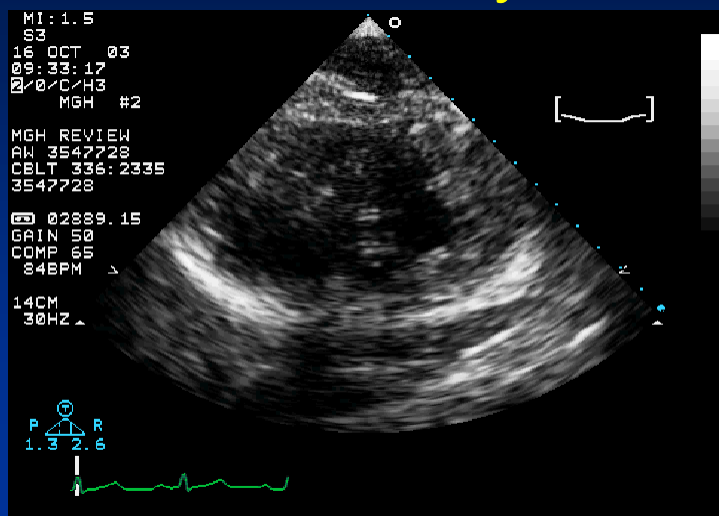
Case

- 64 M with HTN presents with mild pulmonary edema
- CPK negative, troponin-T borderline
- Echo to assess LV function

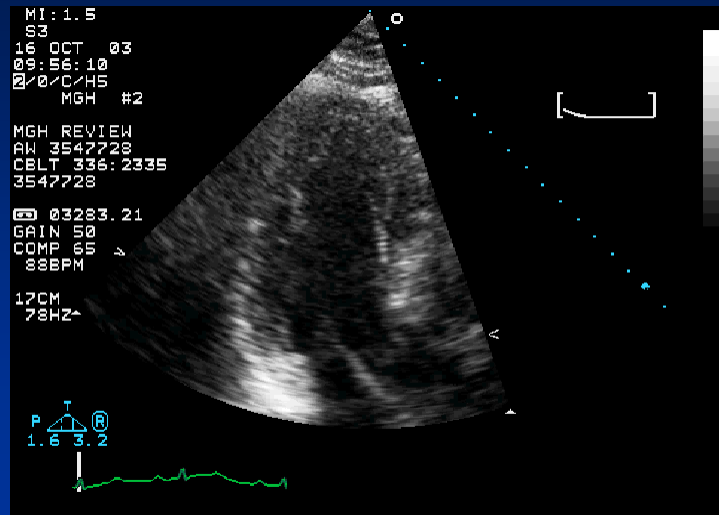
Case: Name the Wall Motion Abnormality



Case: Name the Wall Motion Abnormality



Case: Name the Wall Motion Abnormality



Test: Recognizing segmental LV dysfunction

- A. Posterior dyskinesis
- B. Posterior dyssynergy
- C. Normal posterior wall motion
- D. Normal posterior wall contraction

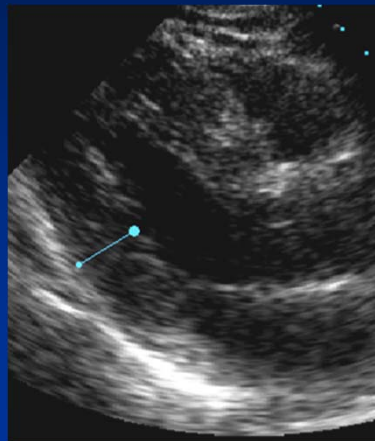
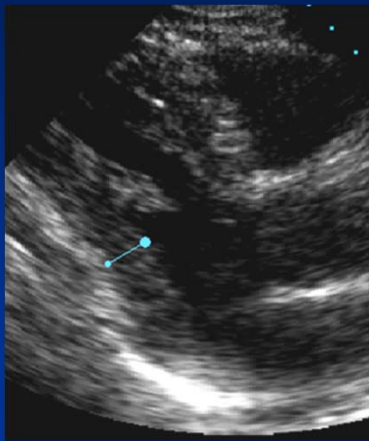
Test: Recognizing segmental LV dysfunction

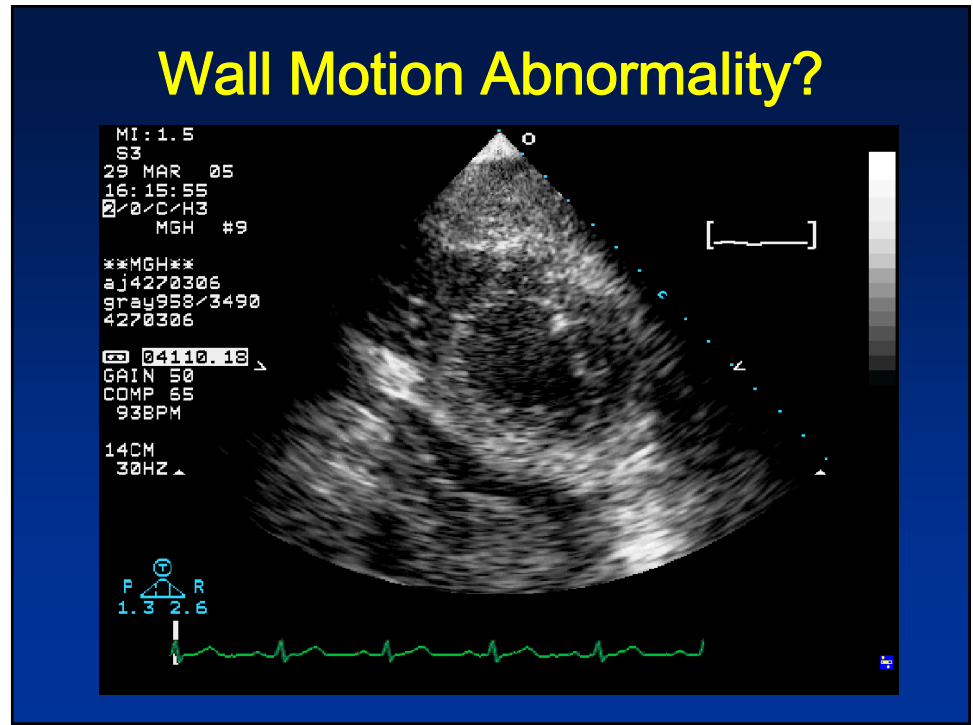
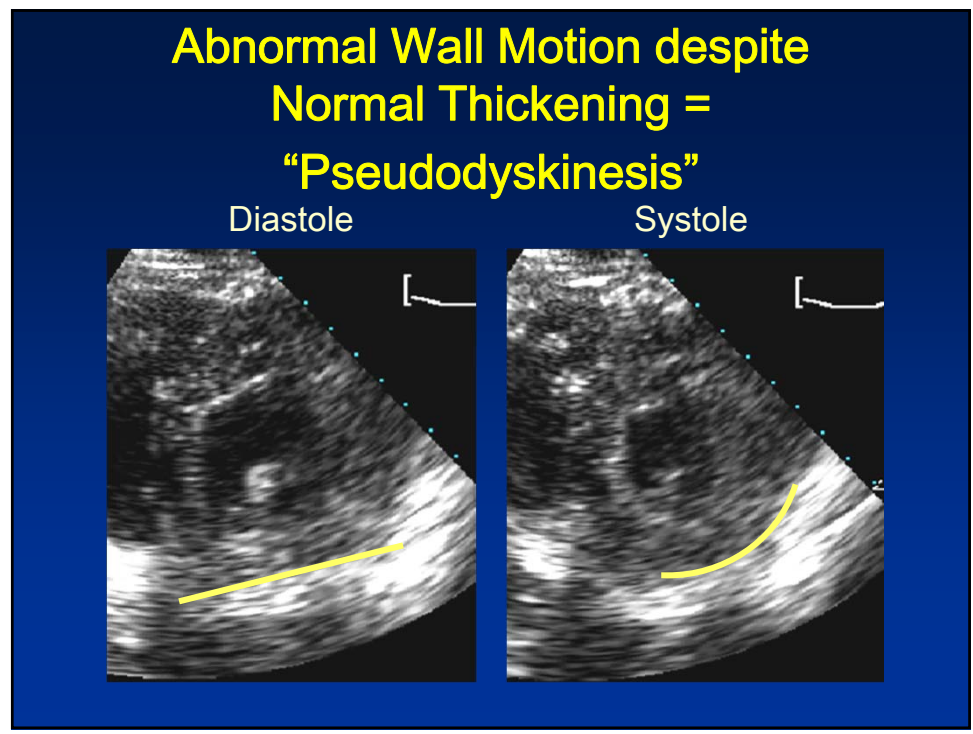
1. Posterior dyskinesis
2. Posterior dyssynergy
3. Normal posterior wall motion
4. Normal posterior wall contraction

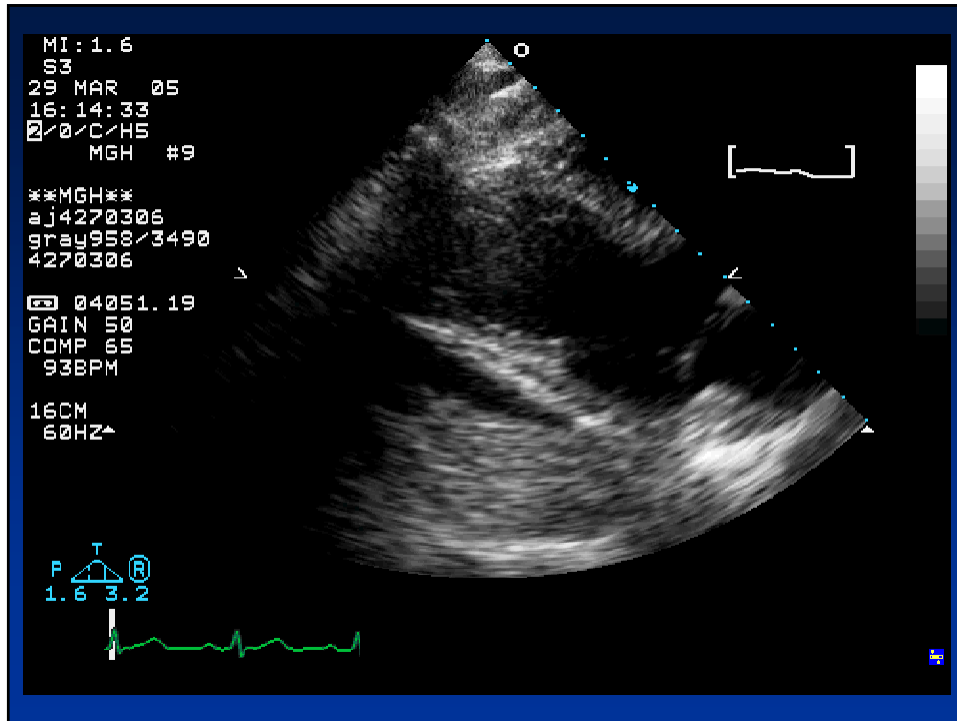
Wall Motion vs. Wall Thickening

Diastole

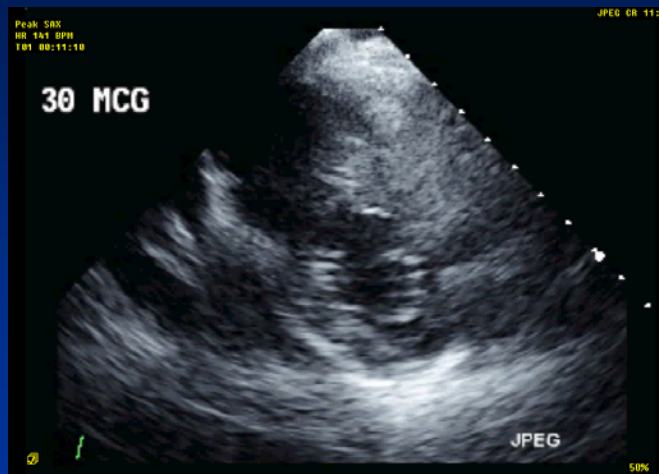
Systole







Wall Motion Abnormality?



**Endocardial motion does
not equal LV thickening**

Take Home Message

- **Look closely at wall thickening;
don't get distracted by the motion**
- **Abnormal thickening is what
indicates myocardial dysfunction,
not abnormal motion**

Clues to the Presence of An Artifact

- Artifacts are often linear, lack well-demarcated borders
- Artifacts may appear to pass through other solid structures
- Motion identical to a real structure
 - Parallel or mirror image
- May not be reproduced in a perpendicular view
- Color flow not affected by it
- Does not have clear attachments

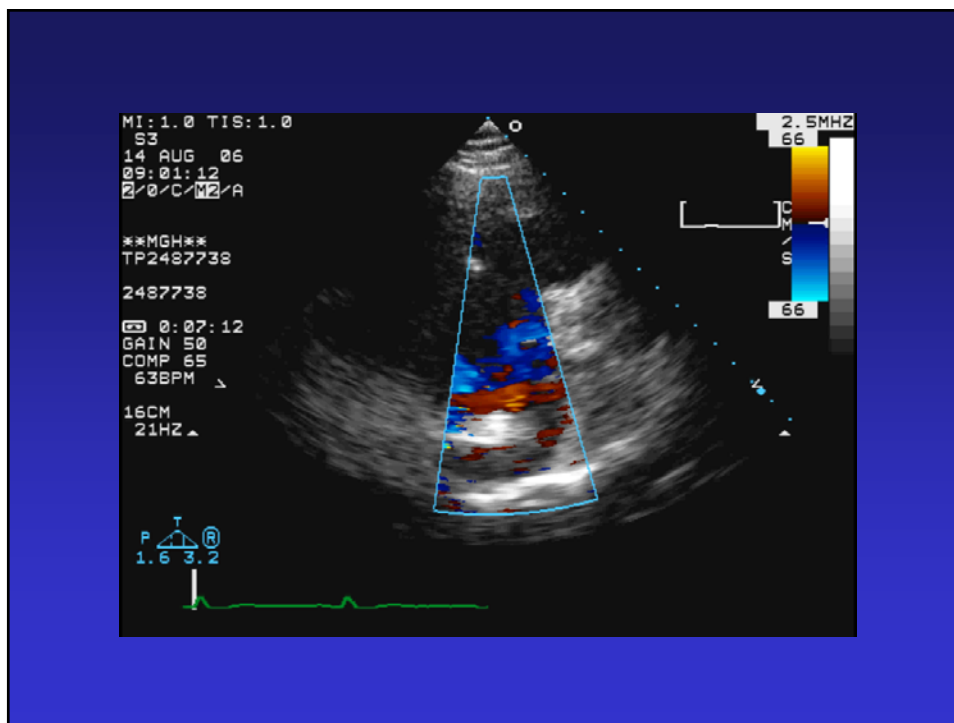
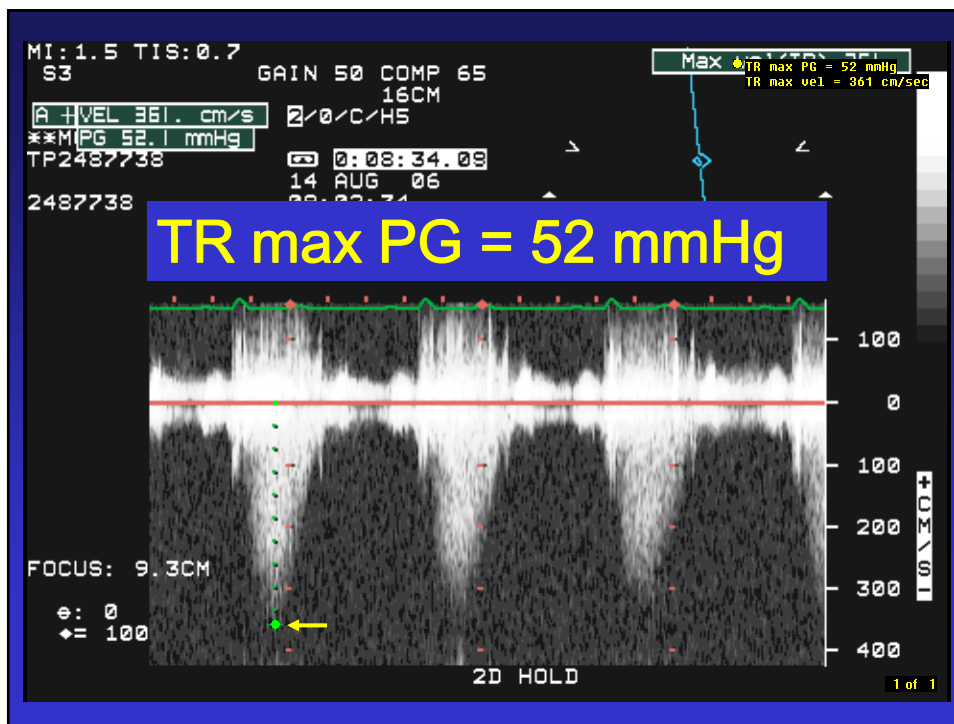
Clues to Real Structures

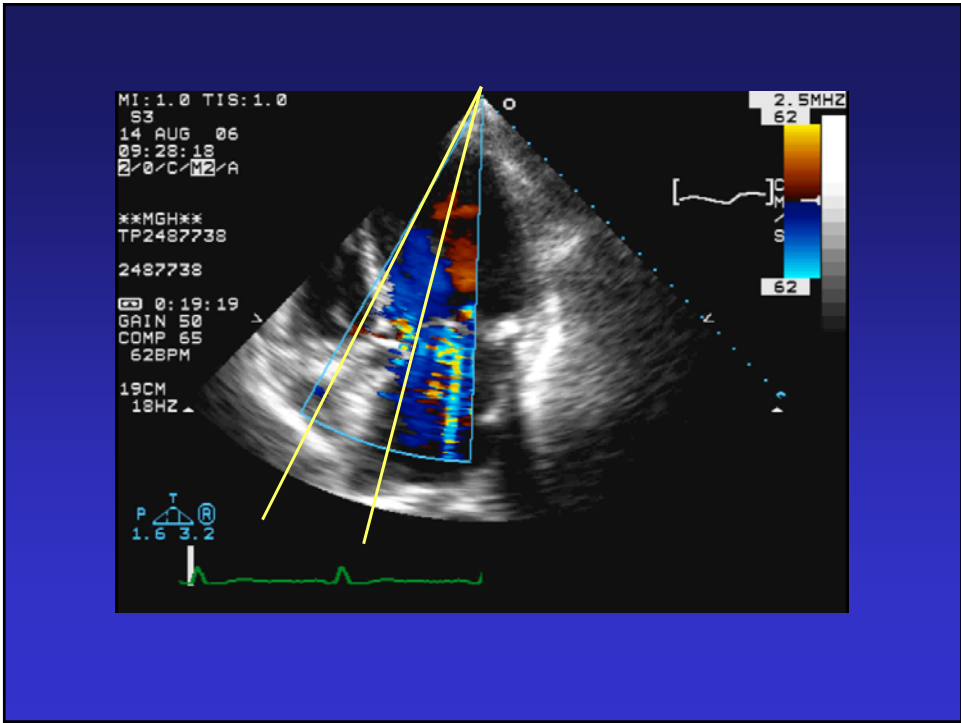
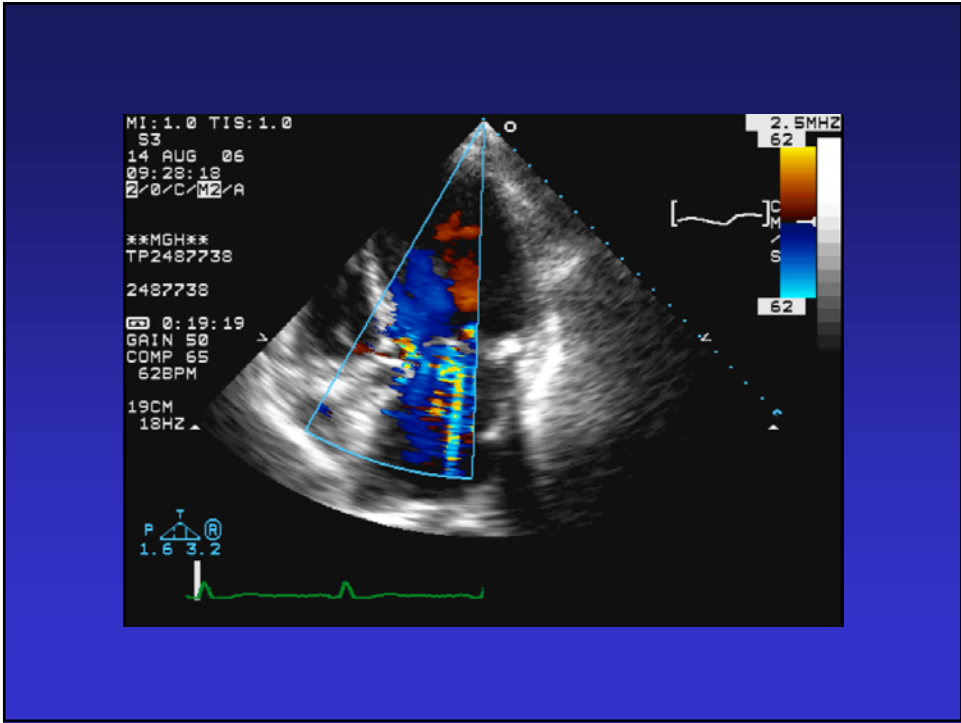
- Distinct edges (unless thrombus)
- Independent motion
- Seen consistently in multiple views
- Color flow affected by structures
- Attached to other structures
- Usually have logical anatomic relationships

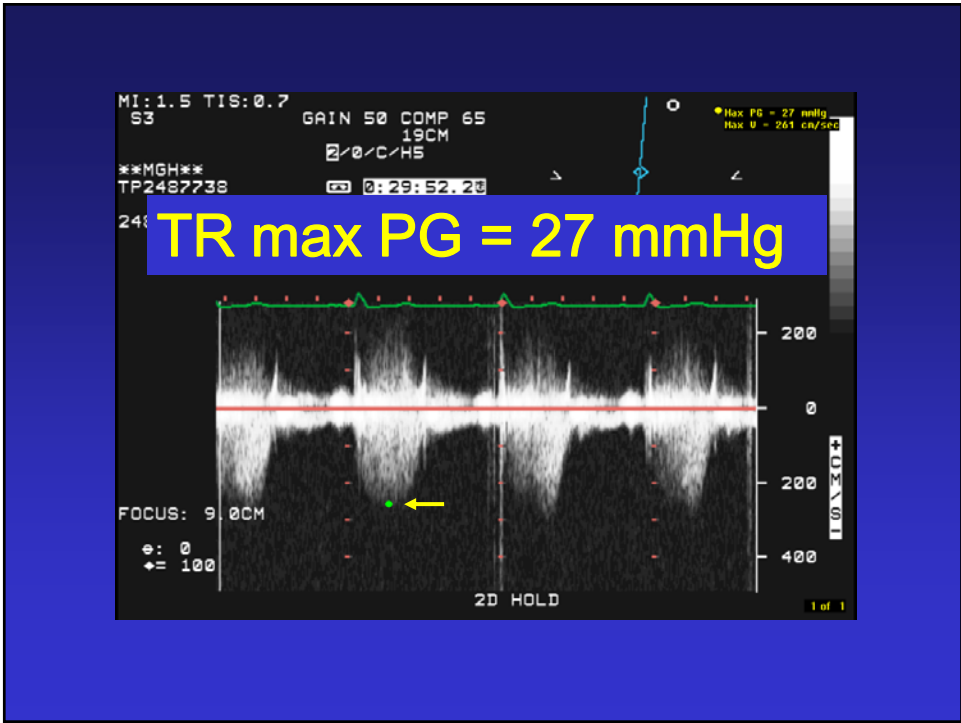
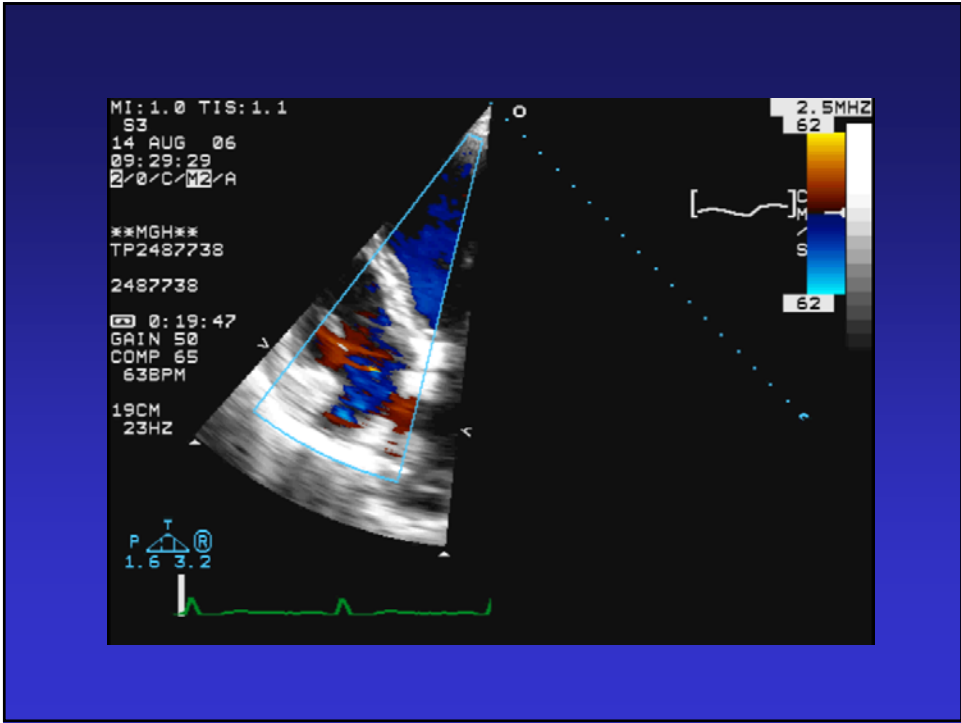


Bonus Case

- 55 year old professor with MVP and MR referred for surgery for the indication of PHTN
- Request for second opinion







Take Home Message:

Doppler detects flow within the full width of the beam, in and out of the plane.

Thank you!