ARTIFACTS: THEORY AND ILLUSTRATIVE EXAMPLES

Robert A. Levine, M.D.
Marielle Scherrer-Crosbie, M.D.
Eric M. Isselbacher, M.D.

No conflicts of interest

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

Philippe 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 Vendervoort, 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!
NAME THAT MASS:

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

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

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?
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
Reverberations

Reverberation Artifacts: Adjacent Cavities

Aorta  LA

2d  d
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

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What is behind the Heart?

MIRROING

LV

LA
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
The Challenge of the LA Appendage
Contrast to enhance visualization of thrombus

TAKE HOME LESSONS

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

• More distant than the object
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• Same distance as the object
  – 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
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This patient shows:

1. Biventricular wires
2. Reverberation
3. Mirror image
4. Side lobes
Side lobes: Laterally directed ultrasound energy arising from transducer edges

Side lobe energy returning to transducer is displayed as if originating centrally
Generation of Side Lobe Artifacts

Echo Map of True Object and Side Lobe Artifacts
This patient shows:

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

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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
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

Para LAX  Apical 4
Test: Real MR or Pseudo-MR?

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

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
Abnormal Wall Motion despite Normal Thickening = “Pseudodyskinesis”

Wall Motion Abnormality?
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
TR max PG = 52 mmHg
TR max PG = 27 mmHg
Take Home Message:

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

Thank you!