



Artifacts and misinterpretation in MSUS

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Artifact

- Definition:
 - An accidental effect that causes incorrect results
(Meriam-Webster)
- Artefact (British – not commonly used)
- Artifact (American – more commonly used)



Artifact in ultrasonography

Definition:

- Any structure in an ultrasound image that does not have a corresponding anatomic tissue structure.
- Echoes on the sonographic image that do not correspond to actual interfaces in tissues.



- Artifacts may cause
 - Structures to appear in an image that are not present anatomically, or
 - A structure that is present anatomically may be missing from the image
 - US artifacts may also show structures as present but incorrect in location, size, or brightness

Kremkau FW. Diagnostic ultrasound principles and instruments. 5th ed. Philadelphia, Pa: Saunders, 1998; 147–157, 377–436



- Understanding is important to avoid misinterpretation or false results.
- Predictable phenomena that can sometimes be minimized.
- A pitfall ? (hidden or unsuspected danger or difficulty occurring during acquisition or interpretation of an image)



Assumptions that are not met during examination and processing

US image processing assumes that:		US artifacts are secondary to errors of:
1. The detected echoes are originated from the main ultrasound beam	However, in clinical sonography, these assumptions usually are not maintained.	Beam characteristics
2. The energy in an ultrasound field is uniformly attenuated		Attenuation
3. An echo returns to the transducer after a single reflection		Multiple echo paths
4. The depth of an object is directly related to the amount of time for an ultrasound pulse to return to the transducer		
5. The speed of US propagation is constant in human tissue		Velocity
6. The sound beam and its echo travel in a straight path		

B-mode ultrasound artifacts. I. Abreu et. al.



Classification of artifacts

Beam Characteristics	<ul style="list-style-type: none">• Side lobe and beam width• Anisotropy
Attenuation	<ul style="list-style-type: none">• Posterior acoustic shadowing• Posterior acoustic enhancement
Multiple echo paths	<ul style="list-style-type: none">• Posterior reverberation• Mirror image• Ring down and comet tail
Velocity	<ul style="list-style-type: none">• Refraction



Classification of artifacts

Site of origin		
I- Equipment or error	II-Between transducer and skin	III-Within tissues

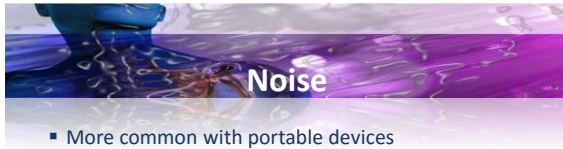
Pitfalls of Gray-Scale Artifacts. Laszlo Irsay, Peter Mandl, Peter V. Ballint. *Essential Applications of Musculoskeletal Ultrasound in Rheumatology*.



Classification of artifacts

1. Pitfalls due to GS artifacts	Due to transducer position Due to interaction of US beam to the tissues	Anisotropy Bone pseudodeflect Attenuation Enhancement through transmission Associated with velocity errors	- Shadowing Reverberation Mirror Side lobe/grating lobe Cartilage interface -
2. Pitfalls due to Doppler artifacts	Mirror Reverberation	-	-
3. Pitfalls due to human error (GS and Doppler)	Drop out Machine incorrect adjustment Transducer incorrect handling Insufficient anatomy knowledge	-	-
4. Pitfalls due to machine error (GS and Doppler)	Piezoelectric crystals damage Transducer's fibers damage	-	-

Violeta Vlad,
Pitfalls in
Musculoskeletal
Ultrasound
Y. El Miedany (ed.),
*Musculoskeletal
Ultrasonography in
Rheumatic Diseases*



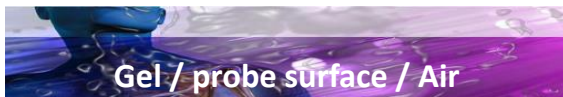
- More common with portable devices
- Not enough insulation or grounding

Acoustic

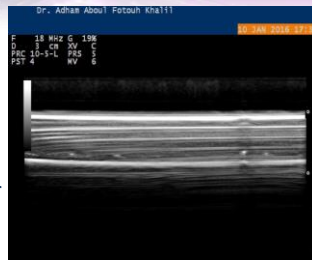
- Reflection of beams from other sources
- Larger and harder to avoid

Electronic

- Innate characteristic of all electronic devices

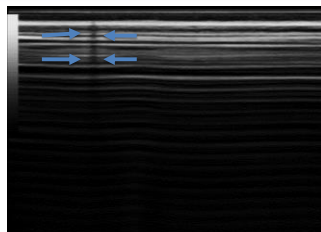


- **Gel:** Hypoechoic inhomogeneous area
- **Rubber:** Hyperechoic line
- **Air:** Strong reflector



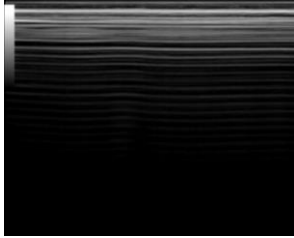


- Vertical anechoic lines
- DD skin conditions:
 - Tip: remove the probe

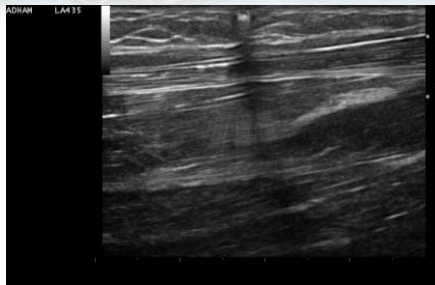


Reverberation from the probe

- Hyperechoic parallel lines.
- Upper part of image
- Intensity decreases with distance.
- Strong reflectors (air)
- Examination starts.



Metallic objects



Ring finger, female, married





- Air artifact
- Image drop out
- Insufficient contact
- Diseases: plaques, wounds, tumors
- Correction: more gel



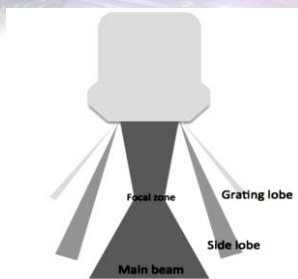


1. Axial and lateral resolution

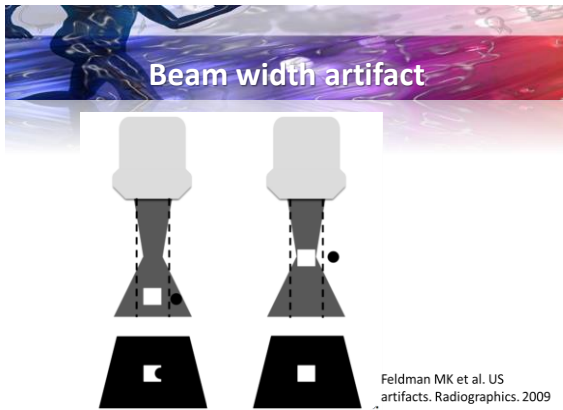
- Resolution: 2 point discrimination
- Axial: vertical to US path
- Lateral: horizontal line
- Leads to loss of details, 2 adjacent structures appear as one

2. Slice thickness

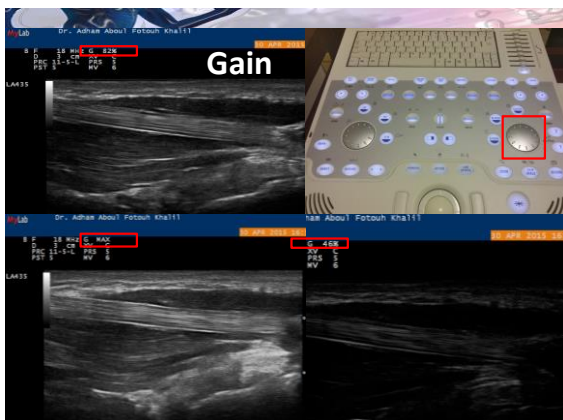
- 3D compression to 2D
- Use multiple focal zones



Feldman MK et al. US artifacts. Radiographics. 2009







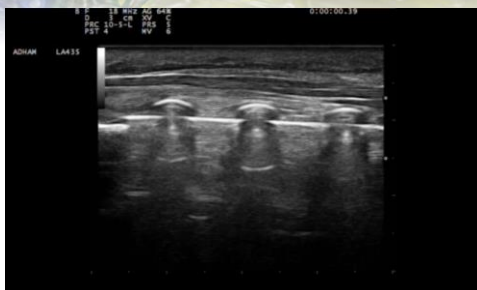
Artifacts originating within tissues

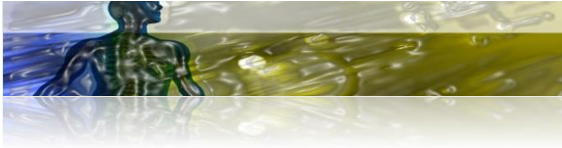
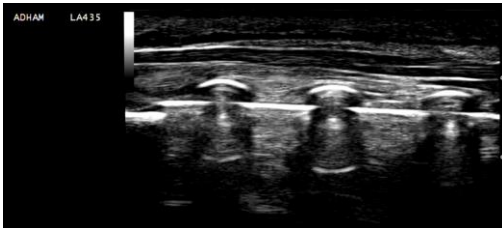
Reverberation

- Sound bouncing back and forth between tissue boundaries
- Minimized by avoiding perpendicular angle
- Orthopedic metals and needles
- Erroneously placed at increased distance from the transducer
- Equidistantly spaced linear reflections

Reverberation

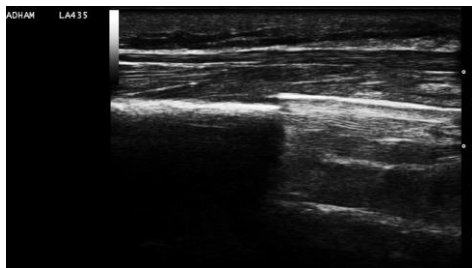








Reverberation





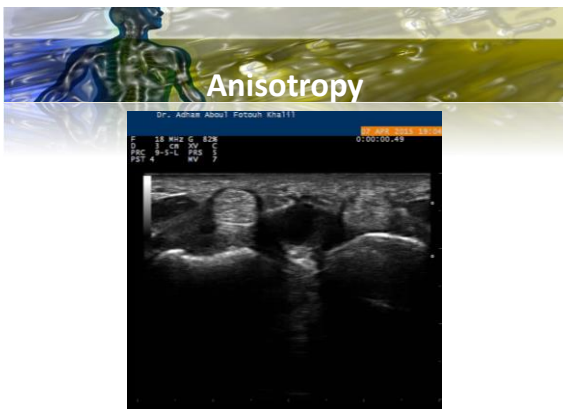
Anisotropy

- Directionally dependent
- Multibeam compound imaging
- Long. and trans.



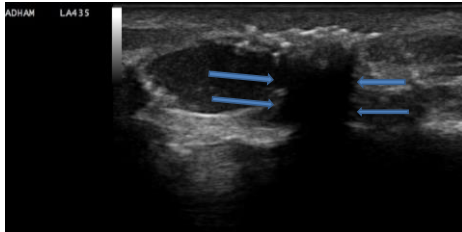


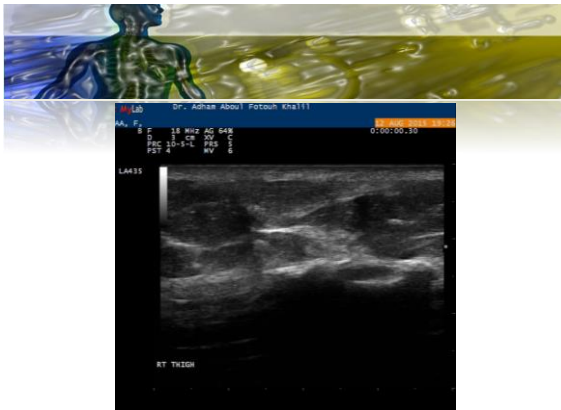




Acoustic shadowing

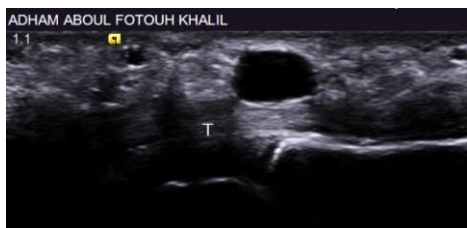
Acoustic shadowing (arrows) is caused by calcification

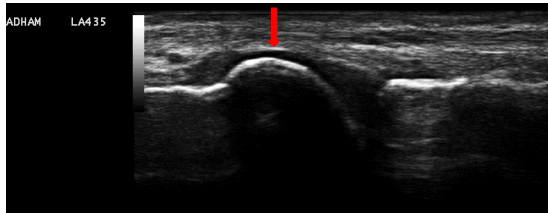


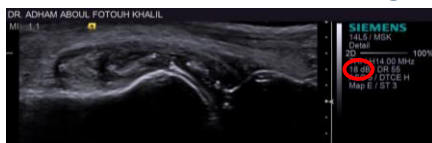
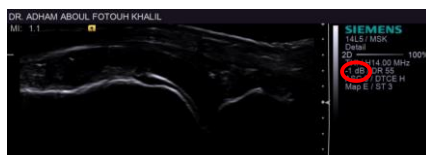


Acoustic enhancement

Transmission through fluid









- Machine settings
 - e.g. Focus
- Human error
 - e.g. Compression







- Artifact are now understandable, so know them well and be ware.
- Understand how they are produced.
- Use what you can from them to improve your image outcome.
- Make sure you know different machine settings and options as well.
- Work on your technique under supervision.



Thank you

This presentation contained videos. Please don't hesitate to contact me for any assistance.
Adham

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