Ultrasound Principles and Instrumentation: Concepts in Image and Doppler Management

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Introduction

• YOUR images provide the basis for the interpretation. The interpretation provides information which allows for appropriate treatment and care.

• We continue to evolve our diagnostic measurements and calculations, and due to the sheer volume of data we may sometimes provide less effort in achieving exceptional images.
Topics of Discussion

• Basic ultrasound physics and instrumentation
• Why is frame rate important and how can I maximize it?
• Transducer frequency and image field depth to grayscale and color Doppler image resolution
• Image artifacts
Important concepts in basic ultrasound physics and instrumentation

• Think of sound waves as compression waves (which they are) rather than longitudinal waves (which they aren’t).
Important concepts in basic ultrasound physics and instrumentation

• Understand the relationship between amplitude (strength) and frequency (quality).

• Remember that the time our transducer is producing pulses (duty factor) determines how much time it can “listen”, which directly affects how we can resolve images at depth.
Important concepts in basic ultrasound physics and instrumentation

• Understand the difference between PRE-processing (settings which cannot affect the image after it is acquired) and POST-processing (those which can change after image is stored)

  – Pre-processing:
    • Depth, focus, output power, overall gain, TGCs, compression, edge enhancement, package size, etc.

  – Post-processing:
    • Grayscale or color curves, color invert
Why is frame rate important and how can I maximize it?

• In imaging, it’s ALL about resolution!
• Axial, lateral, and slice thickness deal with the quality of the image on any one frame.
• Temporal resolution deals with the quality of the image presented over time.
• If too much time elapses between images (even with exceptional axial, etc resolution), our cine loops appear choppy and potentially impactful information may not be seen.
Why is frame rate important and how can I maximize it?

- Remember the basics...frequency, field depth, grayscale and color sector sizes, and focal depth.
- Limit use of controls which “smooth” the image. Frame averaging (or persistence) doesn’t add new information, it simply “connects the dots”.
- Remember that post-processing modalities don’t affect frame rate. It won’t hurt to try them before you compromise frame rate in other ways.
Image artifacts

• Reflection, refraction, absorption, attenuation, and transmission are properties which not only affect quality of images, but also enable return signals that create image artifacts.

• Most image artifacts are “near field occurrences”
  – Reflection off of adjacent interface structures such as ribs OR attenuation due to density changes on interfaces

• Most artifacts can be improved or “cured” using harmonics, depth, gain, focal zone, and transducer repositioning.
Mirror Image Artifact
Side Lobe Artifact
Reverberation Artifact
Ringdown Artifact
Key take-away's regarding artifacts...

• We want to show the ACTUAL anatomy, not anatomy derived via artifacts (i.e. false dissections/thrombus)

• Remember that harmonics eliminate or reduce near most near field artifacts (except hard attenuators)

• Adjust initial settings in the same order every time.
  1. Depth
  2. Focus
  3. TGC