Hands-On Ultrasound Physics and Quality Control Workshop

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Sponsored by AAPM Ultrasound Committee

Outline

• Why ultrasound quality control is important to you?
• Recommendations from national organizations
  – ACR
  – AAPM
  – AIUM
• Ultrasound phantoms, testing, and rejuvenation
• Ultrasound QC identified deficiencies
• Conclusions, questions, and hands-on session
ACR Ultrasound Accreditation Program

www.acr.org

- Breast Ultrasound Accreditation Program
  (including Ultrasound-guided Breast Biopsy)
- Ultrasound Accreditation Program
  - Obstetrical
  - Gynecological
  - General
  - Vascular
  - Combination of the above

ACR Recommended Semi-Annual QC Tests for Breast Ultrasound Accreditation

- Maximum depth of visualization
- Distance accuracy (vertical and horizontal)
- Uniformity
- Electrical-mechanical cleanliness condition
- Anechoic void perception
- Ring down
- Lateral resolution
- Quality Control Checklist
**ACR Recommended Technologist’s QC Tests for Breast Ultrasound Accreditation**

- Adherence to universal infection control procedures for each biopsy
- All transducers should be cleaned between patients
- Distance calibration - quarterly
- Gray scale photography - quarterly

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**ACR Required Semi-Annual QC Tests for Ultrasound Accreditation**

- Vertical and horizontal distance accuracy (only recommended when the program is initiated)
- System sensitivity and/or penetration capability
- Image uniformity
- Photography and other hard copy recording
- Low contrast object detectability (optional)
- Assurance of electrical and mechanical safety
Report of AAPM Ultrasound Task Group No. 1


“Real-time B-mode ultrasound quality control test procedures”


Report of the American Institute of Ultrasound in Medicine (AIUM)

“Quality Assurance Manual for Gray Scale Ultrasound Scanners (Stage 2)”

edited by E. Madsen et al

AIUM, Laurel, MD, 1995
Ultrasound QC Phantoms

B-mode:
1. Multi-purpose or General Purpose Tissue/Cyst Phantom
2. Low Contrast Ultrasound Phantom
3. Prostate QC phantom

Doppler-mode:
1. Doppler phantom/flow control system

Ultrasound Phantom Rejuvenation

• Monitoring Desiccation (moisture loss)
  – Monitor phantom weight loss regularly
    • Rejuvenation requirements provided by manufacturer
    • Rejuvenation recommended usually after a 10 - 15 gram weight loss
  – Rejuvenation accomplished by injecting a water-alcohol fluid through the polyurethane scanning surface

• Rejuvenation Procedures and Hints
  – Follow manufacture’s recommended rejuvenation procedures
  – Remember: 1 gram = 1 cc = 1 ml
  – Remove air bubbles from syringe prior to injection
  – Pick a remote location for injection - seal with super glue
Ultrasound QC Testing

- Scans of a general-purpose ultrasound phantom can reveal deficiencies in:
  - distance accuracy,
  - image uniformity,
  - maximum depth of visualization,
  - anechoic void,
  - perception,
  - ring down,
  - spatial resolution (axial and lateral)

Ultrasound QC Testing

- Scans of a low contrast ultrasound phantom can reveal the low contrast object detectability which is an optional test on the ACR semi-annual QC test list for general ultrasound accreditation
Ultrasound QC Testing

- Doppler QC tests include
  - Doppler signal sensitivity,
  - Doppler angle accuracy,
  - Color display and Gray-scale image congruency,
  - Range-gate accuracy,
  - Flow readout accuracy

Ultrasound QC Testing

- Image Display Fidelity
  - The shades of gray, weak, and strong echo texture should be optimized and consistent between the image display on the ultrasound scanner and the photographic hard copies or soft copy displays on the workstation in the reading room
  - Use the SMPTE test pattern and other patterns if they are available on the ultrasound scanner
  - For quick follow-up testing, the Gray-scale bar pattern on the clinical image display can be used
  - Film processor QC needs to be done daily
  - Workstation monitor display should be included in QC tests
### QC Identified Deficiencies (95’-98’)

#### Probe Problems
- 20.5%
- Cracks
- Air intrusion
- Connector malfunction
- Scan line orientation
- No image
- Cut in the cable

#### Physical & Visual Inspection
- 6.9%
- Buttons not lit
- Sticky tracking ball
- Malfunction in toggle switch
- Loose parts
- Dusty

#### Image Uniformity
- 11.1%

#### Penetration
- 6.8%

### QC Identified Deficiencies (95’-98’)

#### Image Display and Hard Copy
- 17.9%
- Gray-scale adjustment
- Printer non-operational
- Raster line appearance
- Frame cut-off
- Geometric distortion
- Flickering display

#### Software
- 7.7%
- Presets

#### Image quality
- 26.5%

#### Doppler related
- 2.6%
Conclusion

- Multiple tissue-mimicking phantoms are used for a comprehensive QC program to evaluate the performance of an ultrasound scanner.
  - There is currently no ACR standard ultrasound phantom.
- Through visual inspection and a simple phantom scan, many deficiencies can be revealed, such as
  - deficiencies in image uniformity,
  - deficiencies in penetration,
  - mechanical and electrical flaws

Questions?

Please start hands-on session!