Quality Assurance

Chapter 21

Quality Assurance

• The routine and periodic evaluation of ultrasound systems to assure optimal image quality
• QA programs include
  • assessment of system components
  • system repairs
  • PM
  • and of course the hated paper work problem of record keeping

Goals

• Assure proper operation of the system and its components
• detect gradual changes
• reduce critical down time
• decrease the number of equipment produced poor quality exams
• minimize repeat imaging due to system problems

Types of devices used

• AIUM 100 mm test object
• Tissue Equivalent Phantoms

AIUM 100mm Test Object

• Fluid fill with strategically placed pins
• the fluid should be that of normal soft tissue
• there is not attenuation properties of the fluid
• designed to evaluate the accuracy and performance characteristics of the system
AIUM 100mm Test Object

- Axial resolution evaluated when the pins are parallel to the sound main beam axis
- The smallest distance in which 2 pins parallel to the primary beam are displayed as separate objects

A Dead Zone
E vertical registration

B Lateral resolution when transducer is on oblique corner
B Axial resolution. If transducer is on top
C Lateral resolution when transducer is on side
C Axial resolution if transducer is on top
D Horizontal registration

AIUM 100mm Test Object

- Lateral resolution is evaluated by measuring the size of the pins located perpendicular to the sound beam
- Minimum distance two side by side rods are displayed as separate entities (scan side B)

AIUM 100mm Test Object

- Electronic caliper accuracy of the system compares the system measurements against a phantom standard

AIUM 100mm Test Object

- The ability of the system to echo’s in the correct position with differing orientations
- Vertical depth calibration means the system places the pins at the correct depth when located parallel to the beam
- If irregularities occur between scan and pin location causes may be system malfunction or sound speed in phantom is different than 1,450 m/s

AIUM 100mm Test Object

- Horizontal calibration is similar to vertical but the pins are located perpendicular to the beam

AIUM 100mm Test Object

- Dead Zone is evaluated by imaging the pins located superficially in the phantom and determining the minimum depth a pin can be resolved creating a meaningful reflection
**AIUM 100mm Test Object**

- **Dead Zone** is evaluated by imaging the pins located superficially in the phantom and determining the minimum depth a pin can be resolved creating a meaningful reflection.
- With a tissue equivalent phantom this zone is the shallowest depth in which uniform tissue texture appears.

**Focal Zone** is a point where the beam is the narrowest and the beams intensity is the greatest.
- Lateral resolution is very good and the beam is narrow.
- Array transducers are user controlled and should be carefully evaluated.
- Dynamic receive focusing should produce narrow reflections through a wide range of depths.

**Uniformity**

- The system's ability to display similar reflectors throughout the phantom with equal brightness and regardless of the depth.
- The same TGC and depth should be used from test to test.

**Solid and Cystic Uniformity**

- With a tissue equivalent phantom solid masses should appear uniform.
- Cystic masses should be anechoic.

**Tissue Equivalent Phantoms**

- Mimics the features of normal soft tissue.
- Evaluates characteristics in modern systems:
  - Gray scale
  - Tissue texture
  - Multi-focus
  - Adjustable focus found in phased array transducers.

- Phantom has the following soft tissue associations:
  - Speed of sound
  - Attenuation
  - Scattering characteristics
  - Echogenicity

- Evaluates gray scale by viewing hollow and solid cysts within the phantom.
Doppler Phantom

- Used to assess characteristics of all Doppler systems including Pulsed, CW and Power
- Uses motion from a string moving belt or fluid flow phantom

Slice Thickness Phantoms

- Used to determine the systems elevation resolution
- Measures the beam geometry perpendicular to the imaging plane
- The phantom contains a diffuse scattering plane at an angle to the primary beam
- The imaging plane is thicker than the beam width or the pulse length so slice thickness is most likely to degrade image quality

Sensitivity

- Is the ability of the system to resolve low level echo’s and display them.
- There are three types
  - minimum
  - normal
  - maximum

Minimum Sensitivity

- Assesses the weakest sonographic echo intensity that can be accurately displayed from the far field
- Start by setting the TGC flat then increase the system gain from the minimal setting to just when the deep rods appear
- There should be no variance from test to test over time

Normal Sensitivity

- A setting at which all pins in the phantom can be displayed
- Output power, TGC, and amplification are set to establish normals
- Normal sensitivity is at a higher gain than minimum.
- All subsequent QA tests are then made at this normal setting
- There should be no variance from test to test over time

Maximum Sensitivity

- A evaluation of power output and amplification with the system set to the maximum practical levels.
- A tissue equivalent phantom is then imaged using these settings.
- The depth of the tissue mimicking texture is determined.
- The max. visualization depth is then assessed
- There should be no variance from test to test over time