TRUS QA Workshop
Introduction

• The goals of using TRUS in prostate brachytherapy
  • Visualize the prostate
    • Need the US to penetrate deeply enough
    • Need sufficient grey scale resolution to be able to visualize the prostate from background
    • Need to be able to accurately measure the volume and linear dimensions of the prostate
  • Visualize the needles
    • Need sufficient resolution to see the needle
    • Need to be able to see the needle in both AX and SAG
  • Visualize the template
    • Electronic grid must be aligned with both physical grid and TPS grid

• The goal of TRUS QA is to ensure your system can do all of this accurately.
Equipment

- Ultrasound system
- TRUS probe
- Brachytherapy phantom (e.g. CIRS) (Check that phantom hasn’t changed)
- Stepper and stabilizer
- Template
- Bucket of water (plus adjuncts to bring SOS closer to 1540 m/s)
- Needles
- Baseline data
- Time: ~ 90 minutes
Tests – Element Drop-Out

- System turns on
- All crystals are functioning
  - Image a uniform phantom and look for non-uniformities
  - The figure illustrates element drop-out.
  - Further investigation warranted, requires service engineer.
Tests – Greyscale Visibility

• **Frequency**: Annual
• **Tolerance**: 2 steps or 10% of baseline length
• **Correction**: Re-calibrate monitor
• **Test**:
  • Locate greyscale strip in image
  • If discrete steps (left), count the number of steps you can see
  • If gradient (right), use calipers to measure length of visible gradient.
  • Record # of steps or length
Tests – Depth of Penetration

- **Frequency**: Annual
- **Tolerance**: change < 1cm from baseline
- **Test**:
  - Place probe on phantom
  - Image a relatively uniform region
  - Use usual frequency and consistent, high gain
  - Freeze image, record scan settings
  - Measure depth at which speckle is overwhelmed by electronic noise.
  - Repeat for orthogonal plane
  - Optional: repeat for other frequencies
Tests – Axial and Lateral Resolution

• Frequency: Annual
• Tolerance: change < 1mm from baseline
• Test:
  • Place probe on phantom
  • Image single filament targets at depth
  • Set focal depth to match depth at which measurement is to be taken
  • Set the gain to optimize visibility of targets
  • Freeze image, record scan settings
  • Measure the dimensions of the filament image in both axial and lateral planes
  • Repeat for orthogonal plane
  • Optional: repeat for other frequencies
Tests – Axial and Lateral Resolution

Axial resolution
Axial array

Lateral resolution
Axial array

Axial resolution
Longitudinal array

Lateral resolution
Longitudinal array
Tests – Axial and Lateral Distance Measurement

• **Frequency:** Annual

• **Tolerance:**
  - **Axial:** error ≤ 2mm or 2% from baseline (whichever is larger)
  - **Lateral:** error ≤ 3mm or 3% from baseline (whichever is larger)

• **Test:**
  - Use typical clinical scan parameters
  - Record scan settings
  - **For axial test:** align a column of filament targets in the centre of the image. If this is not possible, ensure you use the same set-up each time.
  - **For lateral test:** Image a row of targets.
  - Freeze the image.
  - **For axial test:** Measure vertical distance between most proximal and most distal targets.
  - **For lateral test:** Measure horizontal distance between left-most and right-most targets. Repeat for both distal and proximal pairs.
  - Compute absolute and relative difference between baseline and measured values
  - Repeat for orthogonal plane

• If high-contrast filaments are not available, regularly shaped targets of known dimension may be used.
Tests – Axial and Lateral Distance Measurement
Tests – Area and Volume Measurement Accuracy

• **Frequency**: Annual

• **Tolerance**: within 5% of nominal Area or Volume

• **Test Area**:
  • Use typical clinical scan parameters
  • Record scan settings
  • Scan an object with circular cross section of known size.
  • Freeze image.
  • Using appropriate tools on the scanner, trace the boundary of the object.
  • Record area and calculate % difference.

• **Test Volume**
  • Set up the phantom so that the probe can maintain good contact as it is stepped across the volume
  • Use typical scan settings
  • Record scan settings
  • Scan an egg-shaped object in axial cross section.
  • Locate the equivalent of the base and apex and zero the stepper at the base
  • Using the typical clinical procedure, translate the probe contouring the target at each step throughout the target
  • Record calculated volume and calculate % difference
Tests – Area and Volume Measurement Accuracy
Tests – Template/Electronic Grid Alignment

- **Frequency**: Annual, a vendor’s disposable templates should be checked periodically for consistency
- **Tolerance**: alignment should be within 3 mm
- **Test**:
  - Obtain a water container big enough to immerse the TRUS probe
  - Ensure water is room temperature and free of bubbles
  - Set the stepper with probe and needle template attached to be vertical and immerse the probe in the water.
  - Place needles at each corner of the template and one in the centre.
  - Verify that the location of the needle flashes in the image correspond to the physical location of the needles in the template
  - Adjust electronic grid as necessary

- **NOTE**: room temperature water has a SOS of 1480 m/s, which will introduce depth dependent distance errors. Adding 43 g of salt per litre of water will increase the SOS to ~1540 m/s. Consider using a probe cover in a saline solution.
Tests – Template/Electronic Grid Alignment
Tests – Treatment Planning Computer

- **Frequency**: Annual,

- **Tolerance**: Ultrasound and TPS should agree within 5%

- **Test**:
  - Perform a volume study of a 3D object in the prostate phantom
  - Import the volume study into the TPS
  - Contour the object in the TPS
  - Compare US and TPS volumes

Sutlief and Pfeifer, AAPM 2010