

Long Term Clinical Experience Using Ultrasound Alignment

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Overview

- Discuss various technique, and patient related, image quality issues.
- Present a technique to improve alignment quality and consistency.
- Is the prostate displaced during transabdominal ultrasound?
(Heisenberg Uncertainty Principle)

Ultrasound Alignment Experience at Fox Chase

- FCCC and Cleveland Clinic first BAT™ sites in 1998.
- Since then 50-60 patients per day.
- Over 100,000 procedures to date.
- Very few patients non-imageable.
- Extreme shifts (>2cm) verified by CT.

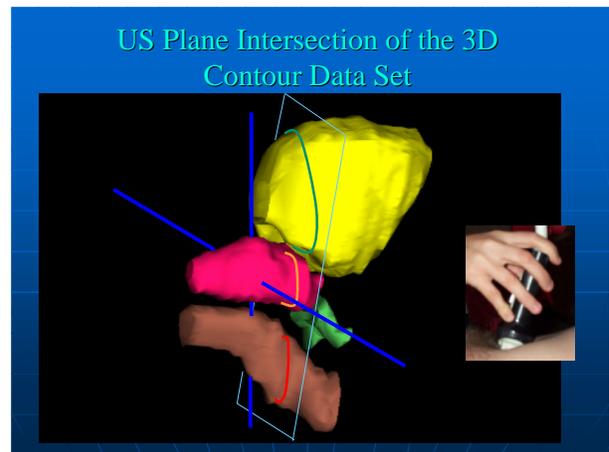
Commercial Ultrasound Positioning Systems



ZMED -SonArray

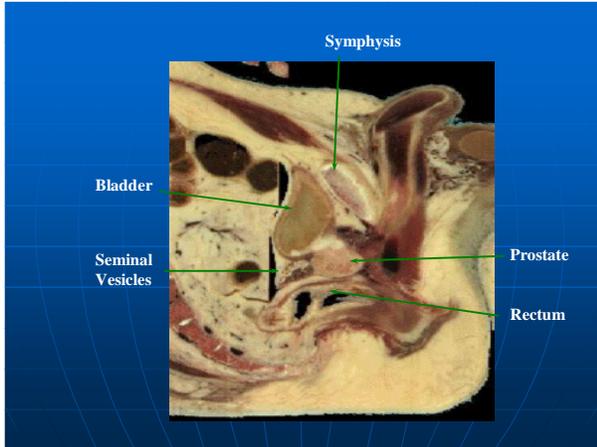


CMS - I-Beam



- ### Ultrasound Alignment Quality
- The key to a good alignment starts with decent imaging.
 - Imaging through a mostly full bladder improves prostate visualization.
 - US image quality is not always desirable
 - Large patients – greater distance / decreased resolution
 - Empty bladder – degrades prostate visualization
 - Poor image – US procedure is skipped
 - Use skin marks

- ### Ultrasound Alignment Quality
- Operators must have proper training!
 - Most common problem is therapists try to image too close to symphysis
 - Symphysis shields US energy and degrades image quality.
 - Instruct therapists to move superior & angle probe to image through the bladder.
 - At FCCC, each alignment reviewed by physician during OTV.
 - Therapists receive feedback on alignment quality for each procedure



Ultrasound Alignment Quality

- Some other issues that can improve or degrade image quality.
 - Increased probe pressure usually helps.
 - Imaging through surgical scars degrades.
 - Sometimes moving lateral to midline will improve quality.
 - Making sure proper US parameters are used.

A Technique to Improve Daily Alignment Quality and Consistency

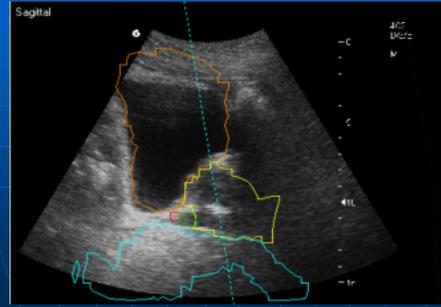
The Problem

- Noticed therapists were having some trouble aligning Sup/Inf
- CTV is commonly outlined with proximal SVs.
 - SVs are typically easily imaged with US.
- Also, Nomos designed BAT so users capture an axial image before the sagittal

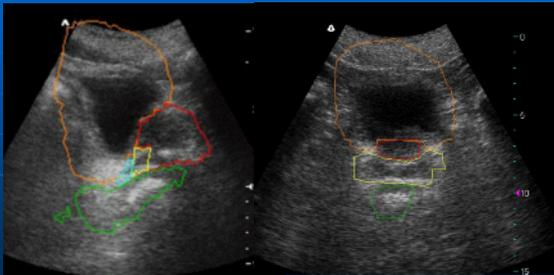
Procedural Changes

- Start with acquisition in sagittal plane.
 - Superior image of prostate/rectum interface.
 - Allows correction of largest shifts first
 - Better feel for patient anatomy
- Separated SVs into two structures – Proximal and Distal.

Procedural Changes



Proximal and Distal SVs



Procedural Changes

- Start the axial scan at base & scan through proximal SVs.
 - If SV/prostate transition makes sense it's a good bet the SI & AP alignment is accurate.
- The only shift remaining should only be a small L/R shift.

Results

- Alignment printouts were reviewed before and after the technique was implemented
 - 10 patients each
 - 303 scans before, 310 after.
 - Noted for physician comment of substandard alignment
 - Reviewed by same physician

Results

- Before
 - 15.1% comment rate
- After
 - 3.5% comment rate
 - ($p=0.006$)
- Needless to say, this is our standard procedure now.

Prostate Displacement During Transabdominal Ultrasound

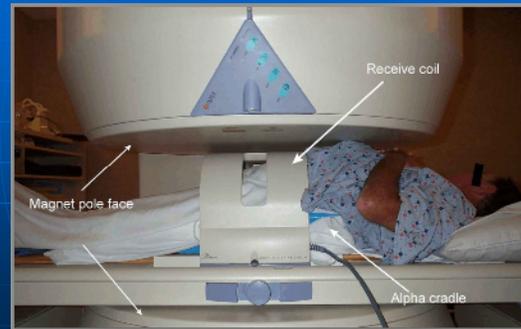
Objective

- Determine if transabdominal ultrasound displaces the prostate.
- Duplicate the probe position during image acquisition.
- Image the prostate during the simulated ultrasound.
- If there is a displacement, the position of the prostate during imaging is not the actual treatment position.

Method

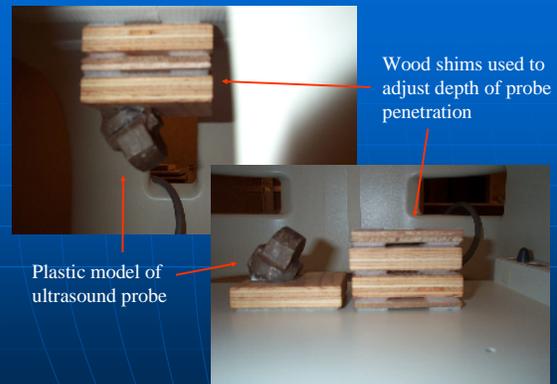
- Utilize the department's 0.23T Philips MRI.
- Patients placed in an alpha cradle cast and aligned to treatment position.
- Pelvic coil placed around patient.
- Scanned once for treatment and again with probe.
 - T2 FSE 3D Tr-3000mS Te-140mS 256x256

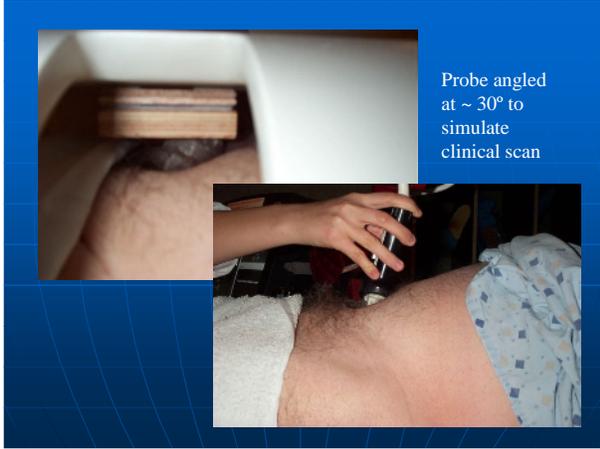
Philips 0.23T Open MRI



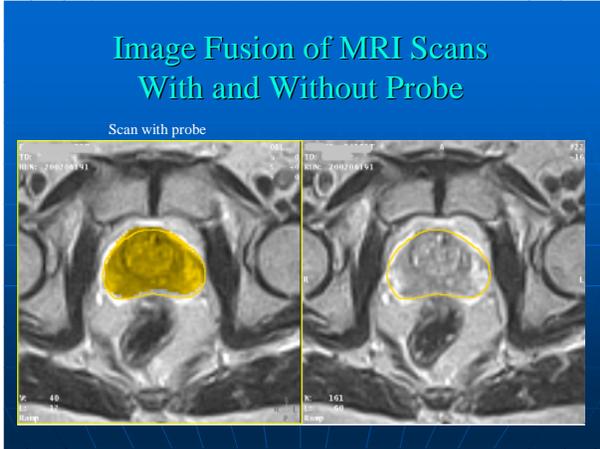
Method

- Simulate the ultrasound procedure during imaging.
 - Plastic mold of ultrasound probe from wax cast
 - Attached to bottom of pelvic coil
 - Angled at 30°
 - Adjust patient penetration using wood shims



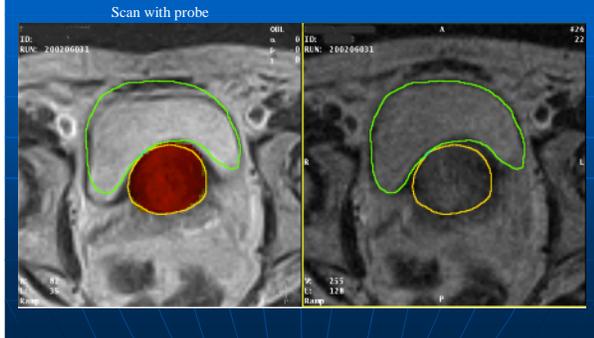


- ### Method
- Depth of probe determined by clinical experience.
 - Amount of pressure varies by patient
 - Active portion of probe must view prostate
 - Prostates contoured on each MRI data set by same physician.
 - Fuse MRI images for each patient.
 - Determine the center of volume shifts from each patient's scan set.

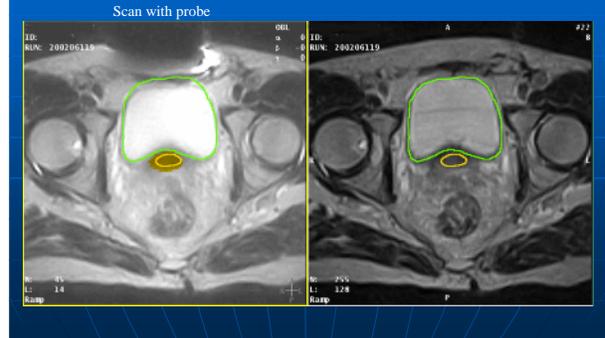


- ### Results
- 16 patients imaged
- | Prostate Shifts (mm) | | | |
|----------------------|---------------------|---------------------|---------------------|
| | A/P _(P±) | Lat _(L±) | S/I _(S±) |
| Avg. Shift | -1.5 | 0.2 | 0.9 |
| Std. Error | 0.5 | 0.3 | 0.4 |
- Average percent difference of prostate volumes = 5.7%

Example Images



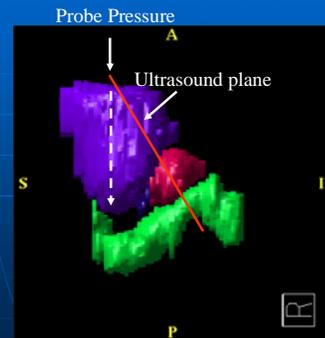
Example Images



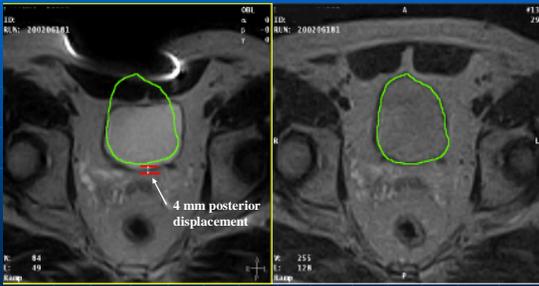
Discussion

- Suprapubic ultrasound shows minimal effect on prostate position.
- Probe placed superior to prostate and angled cephalo caudad.
- Tissue directly posterior to probe may show 3-5 mm posterior displacement depending on patient.

Lateral Prostate View



Tissue Displacement Superior to Prostate



In Conclusion

- Discussed some ideas on how to improve image quality from an operator's point of view.
- Presented a simple procedural change which improved alignment quality.
- Examined some of the potential systematic errors involved with transabdominal ultrasound.