Challenges and Opportunities of TRUS Based Prostate HDR Brachytherapy

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High Dose Rate Prostate Brachytherapy

Single High Activity Source
Precise Flexible Dosimetry
Hypofractionation
Clinical Results
Image Guided Prostate HDR Brachytherapy

- TRUS Guided Catheter Insertion
- CT Based Treatment Planning
- HDR Treatment
Image Guided Prostate HDR Brachytherapy

- TRUS Guided Catheter Insertion
- TRUS Based Treatment Planning
- HDR Treatment
Potential Advantages of US Based Planning

Small foot print, available in OR
- ”Real-Time”

Potential for a much quicker turn around if all done in the radiation department

Avoid needle migration

Improved visualization of CTV?
Prostate brachytherapy

HDR prostate monotherapy — Dosimetric effects of implant deformation due to posture change between TRUS- and CT-imaging

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PlanUS2CT compared to planUS

<table>
<thead>
<tr>
<th></th>
<th>Patient 1</th>
<th>Patient 2</th>
<th>Patient 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTV coverage TRUS/CT</td>
<td>28%</td>
<td>6%</td>
<td>10%</td>
</tr>
<tr>
<td>Urethra max</td>
<td>13%</td>
<td>=</td>
<td>2%</td>
</tr>
<tr>
<td>Urethra volume</td>
<td>8%</td>
<td>=</td>
<td>82%</td>
</tr>
<tr>
<td>Rectum max</td>
<td>18%</td>
<td>12%</td>
<td>1%</td>
</tr>
<tr>
<td>TRUS Prostate volume</td>
<td>31 cc</td>
<td>36 cc</td>
<td>35 cc</td>
</tr>
<tr>
<td>CT Prostate volume</td>
<td>52 cc</td>
<td>32 cc</td>
<td>51 cc</td>
</tr>
</tbody>
</table>

Fig. 4. Summarized effect of changes (PlanUS2CT compared to PlanUS) in dose distribution due to posture changes on DVHs. In the planUS all dose constraints were met.
1. Conclusions - Positioning

One plan, One fraction
  Re-plan each time for multiple fractions
US should be in position during treatment
  minimize deformation change
Patient needs to be same position plan/tx
  cystoscopy (high vs low lithotomy)
Imaging of implant needles for real-time HDR-brachytherapy prostate treatment using biplane ultrasound transducers

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37c  water tank

D1 = 13 mm
D4 = 43 mm
D7 = 73 mm

BK-Medical US/Probe
Falcon 2101 / Type 8658
ProFocus 2202 / Type 8658
ProFocus 2202 / Type 8848

Varian Medical
Trocar point stainless steel needle

1. Different probe position
2. Integrated Optical Density
3. Users
2. Conclusions - Hardware/Software

**Tip was more distal**
This is always underestimated (0.8-3.1 mm)
Depending on the probe and frequency
Not distance dependent (test range 13-43 mm)

**Image on sagittal better than transverse**
Mean difference 2.6 vs 1.8 mm
Probe dependent (0.1-1.8 mm)
Not frequency depending within each probes tested
Integrated Optical Density (IOD) vs Trocar Tip

Different users use different echo characteristics for localization IOD depending on gain & lower IOD -> less error
lowest when z = 0
User interpretation differences (0.08-0.16 mm)
Static vs. dynamic
A novel method for accurate needle-tip identification in trans-rectal ultrasound-based high-dose-rate prostate brachytherapy

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Probe Position

Template Position

Zheng, Brachytherapy 10: 455-73, 2011
3. Results/Conclusions

**TRUS Method**
- Error in water: 0.7-2.3 mm
- Error in phantom: 0.9-13.2 mm

**Physical Measure Method**
- Error in water: 0.6-0.8 mm
- Error in phantom: 0.3-0.9 mm

**Best method?**
Test needs to be done in phantom
(not just water)

include artifacts
Effect of using different U/S probe Standoff materials in image geometry for interventional procedures: the example of prostate

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