LDR prostate workshop

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Learning Objectives

• Be able to define and create the target volume from the prostate
• Be able to express and achieve dosimetric goals in the plan
• Modify the plan by tracking needle deposition in real time
• Determine dosimetry in a CT post implant study set
Treatment planning considerations
What is the target volume?

- Prostate only — or less
  - Biochemical outcome will be no better than surgery
- Prostate plus dosimetric margin
  - Inconsistent in interpretation and application
- Explicit Planning Target Volume (PTV)
  - Clearly documents your planning goals
  - May produce incrementally better bNED results
  - Treatment margin may be the best predictor of success in implants with "good" dosimetry
Can brachytherapy treat extraprostatic disease?

- Prostate capsule
- 5 mm margin
- 2 mm EPE
How much margin is necessary?

- **Mayo Clinic**: Davis *et al.*, Cancer, 85:2630-2637, 1999
  - EPE (extra prostatic extension) in 28% of 376 patients
  - 5 mm margin encompasses 99% of locally confined EPE
- **Cleveland Clinic**: Soyhada *et al.*, Urol, 55:382-386, 2000
  - EPE in 35% of 265 patients
  - 5 mm = 90th percentile distance
- **Wm Beaumont**: Chao *et al.*, IJROBP, 65:999-1007, 2006
  - EPE in 33% of 371 patients
  - 5 mm = 90th percentile distance
  - EPE occurrence and distance increased with PSA and Gleason score
Select the patient and study set

- Double click the VariSeed icon on your desktop
- Click on *Patient ABS, Planning Test, ID 17-xxx*
- In the Study box, double click on Name “ABS Planning Test”
Create a PTV

- Select Contour on the menu bar

- Select Margin Structure on the lower right
Set Independent margins to 5 mm left and right lateral, anterior, and superior and 1 mm posterior

Originating structure = Prostate and Result = PTV
Select source type Pd-103
(Even if you usually plan with I-125)

- Select Source Placement on the menu bar
- Click Study on top menu bar and click Select Source Type
  - Choose Pd-103 (Mod 200) — “OK”
  - Choose “Yes” to edit the activity list
  - Enter 3.1 U in strength box
Modify prescription dose and quality alerts

- Modify Rx dose to 125 Gy
  - Select isodoses displayed
- Click Study on top menu
  - Choose “Edit Dosimetric Quality Alerts” – Add
    - PTV V100 > 99.9%
    - PTV D90 110-135%
    - Ureth V150 < 10%
Plan with explicit dosimetric thresholds and ranges and stick with them

<table>
<thead>
<tr>
<th>Evaluated quantity</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient specific needs</td>
<td>PTV, TURP, etc.</td>
<td>Primary importance</td>
</tr>
<tr>
<td>Planning volume coverage</td>
<td>$V_{100}$</td>
<td>&gt; 99.9% volume</td>
</tr>
<tr>
<td>Planning volume dose</td>
<td>$D_{90}$</td>
<td>125% ± 10% RxDose</td>
</tr>
<tr>
<td>Urethral volume coverage</td>
<td>Urethral $V_{100}$</td>
<td>= 100% volume</td>
</tr>
<tr>
<td></td>
<td>Urethral $V_{150}$</td>
<td>&lt; 10% volume</td>
</tr>
<tr>
<td>Homogeneity</td>
<td>$V_{150}$</td>
<td>30% – 45% plan vol, $^{125}$I</td>
</tr>
<tr>
<td></td>
<td></td>
<td>55% – 70% plan vol, $^{103}$Pd</td>
</tr>
<tr>
<td>High dose volume</td>
<td>$V_{200}$</td>
<td>&lt; 15% plan volume, $^{125}$I</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt; 30% plan volume, $^{103}$Pd</td>
</tr>
<tr>
<td>Target volume / US volume</td>
<td>Ratio</td>
<td>1.85 ± 0.35 *</td>
</tr>
</tbody>
</table>

* PTV/US volume ratio is size and risk dependent
Day 0 CT dosimetry at Schiffler Cancer Center
Adequacy defined as $D_{90} > 100\%$ and $V_{100} > 90\%$
Jan 2006 – Jun 2014, $n = 1,260$

Mean $V_{100} = 97.7\% \pm 2.0\%$
Mean $D_{90} = 121\% \pm 9\%$
Create uniform loading beginning on Image 1, $z = 0.0$ cm

- Right click coordinate $c, 1.5$
- Select Add Alternating Seeds
  - 5 Seed Needle
- Move to midgland slice, Image 5
- Right click on existing needle to Edit/Copy
- Right click on each lowercase column, half integer row to paste (type “P”)
  - Do not paste coordinates more than 5 mm outside PTV
Remove seeds more than 5 mm outside PTV

- Left click seeds on Image 1 (Base) to remove individual seeds
  - We leave seeds at a,1.5 and f,1.5 to boost seminal vesicles
- Left click seeds on Image 9 (Apex) to remove individual seeds
Remove selected seeds on Image 5 for urethral sparing

- Remove the seed that lowers urethral dose the most
- Remove 4 seeds in a zigzag pattern
Use the reverse zigzag pattern of seed removal on Image 3 and 7
Add several needles to boost peripheral dose

- Needles and seeds should be on even integer rows
  - Columns may be upper or lower case
  - For this plan, seeds on coordinates B,4.0 and F, 4.0 on Images 2, 4 and 6 work well

- One more round of urethral seed removal
  - Remove hottest contributor on Image 3 and 7
  - Correct cold spot on Image 7 by adding 1 or 2 seeds far from the urethra (e, 2.5 and b,3.5)
Review plan quality

- Dosimetric alerts for PTV V100 and D90 and urethra V150 should be clear
- View DVH for All Regions
  - Prostate is cooler than the PTV
Intraoperative 2 mm needle shifts to create urethral and rectal sparing (PTV, urethra and 150% isodose volume shown)
DVHs of the plan with and without 2 mm needle shifts
Biochemical failure by NCCN risk group: 2,234 men implanted 1995-2010

(AV Taira et al., J Contemp BTx, 5:215-221, 2013)
High quality implants to the prostate plus margins result in very low PSAs

Wheeling implants from 1995-2010, n = 2,234

Follow-up

- < 3 yrs
- 3 - 6 yrs
- 6 - 9 yrs
- 9 - 12 yrs
- 12 - 15 yrs
- > 15 yrs
Switch to I-125 seeds

- Click Study on top menu
  - Select Source Type
  - I-125 (6711)
- Enter 0.55 U
  - Delete Selection
  - Add Current – OK
  - Yes to reassign
- Change Rx dose to 145 Gy
Same plan (88 seeds, 24 needles) but with I-125 seeds
Post implant evaluation

When should the post-implant dosimetric imaging be performed?
TG-137 gives the optimum time for post implant dosimetry

- The physics optimum is 10-14 days for $^{131}\text{Cs}$, 15-21 days for $^{103}\text{Pd}$, and 35-45 days for $^{125}\text{I}$
  - This encourages procrastination
- The clinical optimum is day 0 or day 1
  - Logistically favorable for patient and staff
  - Early feedback allows timely response to under- or overdose
  - Edema makes implants appear cooler, but CT may be repeated later if day 0 dosimetry is inadequate
  - Prompt closure of the learning loop while memory is still fresh will aid future patients
Open a post implant study

- Select *File/Open* to access Patient Manager
- Click on *Patient ABS, Planning Test, ID 17-000”*
- In the Study box, double click on Name “post implant”
Select Variation “Seed Finder”

- Click on Seed Finder in lower right screen
- Adjust green rectangular search region to encompass the PTV with a 1 cm margin
- Change Expected source Count to 108
  - Source type and strength = Pd-103, 2.190 U
Click on Find Seeds, then OK

- Many seeds found in bony pubic arch
Manual placement via 4-slice view and shadow cursor