The management of gynecological cancers

Physics considerations

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Most errors associated with GYN brachytherapy are:

1. Due to poor imaging  
   e.g. “I can’t see the catheter...”

2. Dose calculation errors  
   e.g. You say mRe, I say mCi.

3. Geometrical errors  
   e.g. Treatment of wrong area.

4. Brachytherapy is a simple application in GYN patients with very few errors.
A: Most errors associated with GYN brachytherapy are:

1. Due to poor imaging:
   - usually associated with “relatively” small deviations and geometrical uncertainties

2. Dose calculation errors:
   - these are slowly going away as HDR is becoming a standard modality

3. Geometrical errors:
   - With common use of HDR afterloaders, GYN related medical events listed on the NRC web site are mostly geometric misses.

4. Brachytherapy is a simple application in GYN patients with very few errors.
The challenge:

• involves multiple services

• additional treatments (cervix, interstitial implants)

• added complexity / transition to image guided BT

If it’s not forbidden, it will happen. (p=1)
OBJECTIVES (with focus on brachytherapy):

- Review of commonly used applicators
- Applicator commissioning
- Applicator reconstruction
- Image guided planning
- Briefly mention some EBRT considerations
Intravaginal cylinders/stump applicators

- Critical structures
- Applicator diameter (std dia. 2-4cm)
- Rx line/pt
- Applicator material

- CT based planning can achieve everything atlas or film planning do
- Segmented applicators
- Multi-channel
- Non standard treatments
CT compatible interstitial template kits:
Syed (right), MAC (bottom)
LDR (Cs-137) applicators for Cervix Ca
Utrecht (a) and Vienna (b) applicators: CT and MR compatible

Note:
MR compatible vs MR conditional (latter contains metal components)
Tandem & Ring (Titanium) with smit sleeves

- CT compatible
- MR conditional

- Fixed applicator
- Ring diameter
- Tandem length
Point A definition:
Applied new HDR applicators, remains 2cm from the cap.
Tandem & Ovoids (LDR Cs-137) vs Tandem & Ring (HDR/CT)

- Where is the pear shape distribution
- Simulate T&O loading
- Use of point dose calcs / line optimization
- Use std points: A, B, Cx, Vs, Vd
- But with CT can evaluate DVH of OARs
ABS recommendations:

<table>
<thead>
<tr>
<th>Dose specified to</th>
<th>Radiographs</th>
<th>3D imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point A</td>
<td>$5 \times 5 - 6 \text{ Gy}$</td>
<td>Variable</td>
</tr>
<tr>
<td>$D_{90}$</td>
<td></td>
<td>$\geq 80 - \leq 90 \text{ Gy EQD2}$</td>
</tr>
<tr>
<td>ICRU point bladder</td>
<td>$5 \times \leq 3.7 \text{ Gy}$</td>
<td></td>
</tr>
<tr>
<td>ICRU point rectum</td>
<td>$5 \times \leq 3.7 \text{ Gy}$</td>
<td></td>
</tr>
<tr>
<td>$D_{2cc}$ bladder</td>
<td></td>
<td>$\leq 90 \text{ Gy EQD2}$</td>
</tr>
<tr>
<td>$D_{2cc}$ rectum</td>
<td></td>
<td>$\leq 75 \text{ Gy EQD2}$</td>
</tr>
<tr>
<td>$D_{2cc}$ sigmoid</td>
<td></td>
<td>$\leq 75 \text{ Gy EQD2}$</td>
</tr>
</tbody>
</table>

EQD2 = normalized therapy dose; 3D = three dimensional.
Why CT planning?

Standard plan with prescription to Pt A

Dose to critical structures: bladder, rectum, RS, bowel.

T&R Titanium version can flex thus close but not fixed geometry.
Independent Plan Check:
This is your time out--Please take the time to do it

• program reads after-loader data file
• automatically determines applicator type
• fixed applicator geometry is built-in along with applicator reference points
  - e.g. Pt A typically within 3%
  - Indicative of deviations in geometry
• facilitate efficient check of interstitial implants (for simple implants can use excel worksheet as well)
• independently calculate dwell positions and point coordinates in order to verify geometry
3D imaging:

What you see is not necessarily what you get
Commissioning of applicators (pre clinical):
• physical measurements; applicator integrity
• imaging: modality, orientation, resolution (slice thickness, FOV)
• source position verification auto-radiographs
• MRI: preferred sequence; metal artifacts. Fusion of CT and MRI
• accounting for slack in curved applicator (Gammamed, Varian)
Challenges w/ reconstruction (CT)

- Applicator template vs. direct tracing
- rendered vs. native image set
- slice thickness ; pixel size
- inhomogeneity correction
MRI compatible Tandem and Ring applicator
Titanium T&O and T&R applicators scanned in phantom

- CT/MR
- ~7mm distortion of tandem tip in superior direction (T2); ~2mm (T1)
- Depends on sequence used. View applicator vs view anatomy.

Yusung et al IJROBP (80) 2011.
GEC-ESTRO Recommendations

Recommendations from Gynaecological (GYN) GEC-ESTRO Working Group (IV): Basic principles and parameters for MR imaging within the frame of image based adaptive cervix cancer brachytherapy

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Conventional EBRT field size definition vs IMRT/IMRT with dose painting
REFERENCES:


• ICRU REPORT 38: Dose and Volume Specification for Reporting Intracavitary Therapy in Gynecology
REFERENCES:


• Refer to manufacturer IFU and CTBs