Gynecologic Vaginal Brachytherapy
(Mostly Post-Op Endometrial)

D. Jeffrey Demanes M.D. FACRO, FACR, FASTRO
Director Brachytherapy
UCLA David Geffen School of Medicine
Manual Source Loading – Should be Phased Out

Live Sources
- Nursing restrictions
- Radiation safety

Applicator deficiencies
- Poor fixation
- Packing compresses

Robotic Brachytherapy

Stage I Endometrial Cancer

Surgery

Pathology

VBT Only

EBRT Only

EBRT + VBT

Vaginal BT Only
 Assumes negative LNs
 Avoids SBO and Lymphedema
 Risks: vaginal, rectal, bladder
Radiation Sources: must be closer to the target than to adjacent normal organs

Vaginal Brachytherapy

Be sure vagina apex healed **BEFORE** BrachyRx – do a pelvic exam!

*2-3 fx per week* (not just 1 – unless during EBRT)

Usual target – *4-5 cm upper vagina* (or about ½ way from apex to urethral meatus)
Prescription Dose and Fractionation

VBT only:
Calif. Endocurietherapy 5-6 Gy x 5-6
3 fx (PORTEC 2) 7 Gy x 3
3 fx (PORTEC 4) 3Gy x 3

EBRT only 45-50 Gy

EBRT + VBT 39.6 - 45 central
5-6 Gy x 3

Vaginal Brachytherapy – Equipment
Vaginal Applicators
Single Channel Cylinder
Multi-Channel Cylinder
Ovoid and Cylinder

Important considerations:

Cylinder size: Best fit & source to vag surface distance
Distribution of sources: in relation to target and OARs

Single-channel applicators = limited dosimetry control
Multi-Channel Applicators

Prescribe Dose 2-5 mm from surface including tip!

Multichannel: bladder and rectal dose reduction approx. 15%

Demanes et al IJROBP 1999 v44 n1 p211

Single vs. Multi-channel Dosimetry

Unnecessary
Multi-channel Cylinders

Diameter: 2.6 cm
Length: 10 cm

CET

Miami

CET Multichannel Cylinder Dosimetry
Nucletron multi-channel VC – with curved tip channels

Capri Multi-Channel Inflatable VC Applicator

Diameter: 3.4 – 4.3 cm
Length: 10 cm
**Target Dose**

<table>
<thead>
<tr>
<th></th>
<th>V100, V150, D90, Dmean</th>
<th>Why?</th>
</tr>
</thead>
<tbody>
<tr>
<td>5mm</td>
<td>No diff with various channel permutations</td>
<td>Dose normalized to 5mm</td>
</tr>
<tr>
<td>Surface</td>
<td>All different except V150</td>
<td>V150 is within cylinder vol</td>
</tr>
</tbody>
</table>

**OARs**

<table>
<thead>
<tr>
<th></th>
<th>R23 = R123</th>
<th>R1</th>
</tr>
</thead>
<tbody>
<tr>
<td>5mm</td>
<td>lowest</td>
<td>highest</td>
</tr>
<tr>
<td>Surface</td>
<td>lowest</td>
<td>highest</td>
</tr>
</tbody>
</table>

R1 not needed when using R23
R2 not optimally distributed for independent use

Park et al IJRBP 2013 v87n4p840

**Where to Calculate the Dose?**

Radial and Tip:
- **Single Channel:** 0-5mm from applicator surface
- **Multi-Channel:** 2 - 4mm from surface

Longitudinal
- Multiple points along applicator
- Bladder wall (or balloon or both)
- Rectal wall along length of applicator
Ovoid and Cylinder
Treatment of vaginal apex and parametria

Ovoid and Cylinder Dosimetry

Cylinder (OD = 2.2 cm, L = 5 cm)
Ovoids (R = 1.8 cm, L = 2.5 cm)
Electronic Brachytherapy (50 kVp)

- Diameters: 20, 25, 30, and 35 cm
- Applicator Length: 10 cm
- Clinical Target: 3-5 cm of vagina
- Prescription: 6 Gy x 5 to cylinder surface or 7 Gy x 3 to 5 mm depth

Xoft Single Channel Vaginal Cylinder

- Diameters: 2.0, 2.5, 3.0, and 3.5 cm
- Applicator Length: 10 cm
- Clinical Target: 3-5 cm of vagina
- Prescription: 6 Gy x 5 to cylinder surface or 7 Gy x 3 to 5 mm depth
Single Channel Xoft vs. HDR Vaginal Cylinder

100% Rx at Cylinder Surface

E-Brachy vs. HDR: when 100% isodose at VC surface (vaginal mucosa)

Target tissue and OAR are ≈ 5mm from cylinder surface

Distance from source (cm)
E-Brachy vs. HDR: 100% at 5mm depth (also OAR)

Target tissue and OAR are ≈ 5mm from cylinder surface

![Graph showing isodose lines for E-Brachy and HDR]

Postop vaginal cuff E-Brachy

N=16 (13 Endometrial and 3 Cervix)
Mean fu 21 mo

5 E-Brachy only (mean 6Gy x 5 or 30Gy)
8 E-Brachy 9-20 Gy (2-4 fx) + EBRT (45 Gy)

LRC 94% OS 88%

Toxicity Grade 2 or 3?
E-Brachy alone: (n = 0) – Why?

E-Brachy + EBRT: (n = 4) Gyn 4, GU 3, GI 0
*2 cases Gyn G3 = V_{150} 75% vs. 34% (all other cases)

Kamrava et al Brachytherapy 2013 v12p141
### EBRT with Brachytherapy

<table>
<thead>
<tr>
<th>Author/Reference</th>
<th>N</th>
<th>Treatment</th>
<th>5-y NSS</th>
<th>5-y OS</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lybeert et al. (27)</td>
<td>291</td>
<td>Postop</td>
<td>40 GY EBRT + 5 GY x 4 at 0.5 cm (HDR)</td>
<td>2.7</td>
<td>No, Grade 3/4</td>
</tr>
<tr>
<td>Neri et al. (28)</td>
<td>300</td>
<td></td>
<td>40 GY EBRT = 7 Gy x 3 at 0.5 cm (HDR)</td>
<td>3.0</td>
<td>No, Grade 3/4</td>
</tr>
<tr>
<td>Algan et al. (29)</td>
<td>81</td>
<td></td>
<td>45 Gy EBRT = 4 Gy x 3 at 0.5 cm (HDR) or 30 Gy surface (LDR)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cannan et al. (30)</td>
<td>50</td>
<td></td>
<td>45-51 Gy EBRT = 5 GY x 2 at 0.5 cm (HDR)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fayed et al. (31)</td>
<td>1179</td>
<td></td>
<td>40 Gy EBRT + 6 Gy at 0.5 cm (HDR) or 60-7 Gy total at 0.5 cm (LDR)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Aalders et al. (25)</td>
<td>263</td>
<td></td>
<td>40 Gy EBRT 60 Gy at 0.5 cm (HDR)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Vaginal EBRT + Brachytherapy

<table>
<thead>
<tr>
<th>Author/Reference</th>
<th>N</th>
<th>Treatment</th>
<th>5-y NSS</th>
<th>5-y OS</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aalders et al. (25)</td>
<td>263</td>
<td></td>
<td>40 Gy EBRT 60 Gy at 0.5 cm (HDR)</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

### Brachytherapy without EBRT

<table>
<thead>
<tr>
<th>Author/Reference</th>
<th>N</th>
<th>Treatment</th>
<th>Total pelvic recurrences (%)</th>
<th>Vaginal recurrences (%)</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serbe and Snoes (5)</td>
<td>404</td>
<td></td>
<td>5-y OS, 92%</td>
<td>0.7</td>
<td>0.9</td>
</tr>
<tr>
<td>Noyes et al. (6)</td>
<td>63</td>
<td>16.2 Gy x 2 outside at surface</td>
<td>OS, 98.5%</td>
<td>0</td>
<td>No, Grade 3/4</td>
</tr>
<tr>
<td>Forrester et al. (7)</td>
<td>60</td>
<td>7 Gy x 3 at 0.5 cm</td>
<td>3-y NED, 100%</td>
<td>0</td>
<td>No, Grade 3/4</td>
</tr>
<tr>
<td>Kooiker et al. (8)</td>
<td>108</td>
<td>10 Gy x 4 to 0.5 cm or 1.0 cm</td>
<td>3-y OS, 96%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hong et al. (9)</td>
<td>44</td>
<td>7 Gy x 3 at 0.5 cm</td>
<td>5-y DNR, 92%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MacLeod et al. (10)</td>
<td>141</td>
<td>8.5 Gy x 4 at surface</td>
<td>3-y OS, 99%</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Weiss et al. (11)</td>
<td>122</td>
<td>7 Gy x 3 at surface</td>
<td>5-y NED, 94%</td>
<td>1.6</td>
<td>No, Grade 3/4</td>
</tr>
<tr>
<td>Paternit et al. (12)</td>
<td>191</td>
<td>16.2 Gy x 2 outside at surface</td>
<td>4-y OS, 95%</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Cintra et al. (13)</td>
<td>58</td>
<td>7 Gy x 3 at 0.5 cm</td>
<td>5-y OS, 99%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Enzshoiko et al. (14)</td>
<td>352</td>
<td>30 Gy at 0.5 cm (LDR)</td>
<td>5-y DNR, 93.9%</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Anderson et al. (15)</td>
<td>105</td>
<td>5 Gy x 3 at 0.5 cm</td>
<td>5-y OS, 84%</td>
<td>1.0</td>
<td>No, Grade 3/4</td>
</tr>
<tr>
<td>Horovitz et al. (16)</td>
<td>364</td>
<td>7 Gy x 3 at 0.5 cm</td>
<td>5-y OS, 87%</td>
<td>1.0</td>
<td>No, Grade 3/4</td>
</tr>
<tr>
<td>Ritter et al. (17)</td>
<td>53</td>
<td>5 Gy x 3 at 0.5 cm</td>
<td>5-y OS, 91%</td>
<td>0</td>
<td>No, Grade 3/4</td>
</tr>
<tr>
<td>Jolly et al. (18)</td>
<td>50</td>
<td>5 Gy x 3 at 0.5 cm</td>
<td>4-y OS, 97%</td>
<td>2</td>
<td>No, Grade 3/4</td>
</tr>
<tr>
<td>Aalders et al. (9)</td>
<td>382</td>
<td>7 Gy x 3 at 0.5 cm</td>
<td>5-y OS, 99%</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Vaginal Brachytherapy Alone: Results Endometrial Cancer

<table>
<thead>
<tr>
<th>Author/Reference</th>
<th>N</th>
<th>Treatment</th>
<th>Total pelvic recurrences (%)</th>
<th>Vaginal recurrences (%)</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seibert et al. (20)</td>
<td>100</td>
<td>7 Gy x 3 at 0.5 cm</td>
<td>3-y OS, 97.9%</td>
<td>0</td>
<td>No, Grade 3/4</td>
</tr>
<tr>
<td>Cormie et al. (21)</td>
<td>31</td>
<td>7 Gy x 3 at 0.5 cm (HDR) or 70 Gy at surface (LDR)</td>
<td>5-y OS, 91%</td>
<td>0</td>
<td>No, Grade 3/4</td>
</tr>
<tr>
<td>Atah et al. (22)</td>
<td>128</td>
<td>5 Gy x 5 at 0.5 cm</td>
<td>5-y OS, 96%</td>
<td>0</td>
<td>No, Grade 3/4</td>
</tr>
<tr>
<td>Lin et al. (23)</td>
<td>42</td>
<td>7 Gy x 3 at 0.5 cm (HDR) at surface, 30 Gy at 0.5 cm (LDR)</td>
<td>5-y OS, 96%</td>
<td>0</td>
<td>No, Grade 3/4</td>
</tr>
<tr>
<td>McCloskey et al. (24)</td>
<td>75</td>
<td>7 Gy x 3 at 0.5 cm</td>
<td>5-y OS, 97%</td>
<td>0</td>
<td>No, Grade 3/4</td>
</tr>
<tr>
<td>Aalders et al. (25)</td>
<td>277</td>
<td>60 Gy at surface (LDR)</td>
<td>5-y OS, 89%</td>
<td>0.9</td>
<td>1.3</td>
</tr>
<tr>
<td>Knoxor et al. (26)</td>
<td>325</td>
<td>8.5 Gy x 4–5 with intravaginal 3 Gy x 2 cm</td>
<td>5-y OS, 97%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PORTEC-2 (3)</td>
<td>213</td>
<td>7 Gy x 3 at 0.5 cm (HDR) 30 Gy at 0.5 cm (LDR)</td>
<td>5-y OS, 96%</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Conclusions: Vaginal Brachytherapy

Prevents LR in interm. Risk endometrial Ca (LN-)
Low morbidity (esp. monotherapy) – limited dose to OAR
HDR: convenient, radiation safe, better dosimetry than LDR
Multi-channel or custom app > better dosimetry than single channels
E-Brachy is valid alternative, but higher mucosal dose than HDR
HDR multi-channel: best therapeutic index (Target vs. OAR dose)