Application of Small-Field Treatment: The Promises and Pitfalls of SBRT

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Disclosures

None
Learning Objectives

1. Learn special technical consideration in delivering SBRT treatments
2. Appreciate specific challenges of SBRT implementation
Promises
RTOG 0236: Lung SBRT

Timmerman et al. JAMA, 2010
Liver SBRT

Rusthoven et al. JCO 2009
Liver SBRT

Rusthoven et al. JCO 2009
Availability of SBRT

Pan et al. Cancer, 117, 4566 (2011)
## Availability of SBRT

### AAPM COMMITTEE TREE

Task Group No. 275 Strategies for Effective Physics Plan and Chart Review in Radiation Therapy

<table>
<thead>
<tr>
<th>Charge</th>
<th>1. To review existing data and recommendations that support the use of physics plan and chart review; and to review the current recommendations on the qualifications for performing these.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. To provide survey information on current practices in the community with respect to physics plan and chart review.</td>
</tr>
</tbody>
</table>

**Survey of physics practices**
## Availability of SBRT

What treatment modalities and techniques does your practice provide?

<table>
<thead>
<tr>
<th>Type</th>
<th>% respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photon</td>
<td>96%</td>
</tr>
<tr>
<td>IMRT</td>
<td>96%</td>
</tr>
<tr>
<td>VMAT</td>
<td>79%</td>
</tr>
<tr>
<td>SRS</td>
<td>67%</td>
</tr>
<tr>
<td>SBRT</td>
<td>81%</td>
</tr>
<tr>
<td>Brachytherapy</td>
<td>65%</td>
</tr>
<tr>
<td>IORT</td>
<td>15%</td>
</tr>
</tbody>
</table>

*TG275 survey*
Pitfalls
Pitfalls
Case Studies
Case Study #1

Simulation  Treatment
S-spine Hardware
Case Study #2: Wrong Tx Location

- Patient with metastatic melanoma undergoing Tx to R hilar mass
- 600 cGy x 5
- Physicist notes wrong isocenter on plan check
Isocenter

Centroid Calc Pt
Position patient such that lasers line up with patient marks.
Move the laser LIFT 0.73 cm (looking from feet of table.)
Move the table DOWN 0.73 cm.
Move the table OUT (away from the gantry) 0.06 cm.
centroid point (incorrect)

Isocenter point (correct)
Big effect (SBRT/small fields)

Volume

Dose (cGy)

PTV

Intended

With shift
Where Do Errors Originate?

Where Do Errors Originate?

Percentage of Reports (%)

- Patient Assessment
- Simulation
- Contouring
- Pre-treatment planning
- Treatment delivery
- Post-treatment review
- Equipment issues
- Other

Avrey Novak, Jing Zeng, et al. 2015
What do you need to do SBRT safely?
Special Article

Quality and safety considerations in stereotactic radiosurgery and stereotactic body radiation therapy: Executive summary

Timothy D. Solberg PhD, James M. Balter PhD, Stanley H. Benedict PhD, Benedick A. Fraass PhD, Brian Kavanagh MD, Curtis Miyamoto MD, Todd Pawlicki PhD, Louis Potters MD, Yoshiya Yamada MD

Received 4 May 2011; revised 14 June 2011; accepted 16 June 2011
What you need to do SBRT Safely

**IGRT**
- 3D
- Direct tumor visualization @ fraction
- Markers acceptable
- Respiratory management

**QA program**
- Formalized
- Periodically updated
What you need to do SBRT Safely

Personnel
- Special staffing needs
- SRS/SBRT-specific training per disease site
- SRS/SBRT-specific CME

Commissioning
Effects of Heterogeneity

Xiao et al. 2009
Effects of Heterogeneity

Xiao et al. 2009
What you need to do SBRT Safely

Commissioning
- Independent check of small field measurements
- End-to-end tests
- Independent check of TPS dose calc (IROC-H)
• Overdoses due to wrong output factor
• Factor of ~2
• 75 patients
IROC-H Phantom Family

- 2 prostate phantoms
- 33 lung phantoms
- 24 H&N phantoms
- 8 Spine phantoms
- 19 SRS phantoms
- 10 liver inserts

Courtesy: Dave Followill
## Phantom Results

Comparison between institution’s plan and delivered dose.

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<tr>
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<td>1880</td>
<td>143</td>
<td>950</td>
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<tr>
<td>Pass</td>
<td>1595 (85%)</td>
<td>105 (73%)</td>
<td>784 (82%)</td>
<td>474 (85%)</td>
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</tr>
<tr>
<td>Fail</td>
<td>285</td>
<td>38</td>
<td>166</td>
<td>82</td>
<td>71</td>
</tr>
<tr>
<td>Criteria</td>
<td>7%/4mm</td>
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*Courtesy: Dave Followill*
On-Site Dosimetry Review Audit

Discrepancies Discovered (Jan. ’05 – April ’13)

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<th>Discrepancies Regarding</th>
<th>Number of Institutions Receiving rec. (n = 206)</th>
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<tr>
<td>Review QA Program</td>
<td>152 (74%)</td>
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<tr>
<td><strong>Photon Field Size Dependence</strong></td>
<td>138 (67%)</td>
</tr>
<tr>
<td>Wedge Factor (WF)</td>
<td>66 (32%)</td>
</tr>
<tr>
<td>Off-axis Factors (OAF)/Beam symmetry</td>
<td>60 (29%)</td>
</tr>
<tr>
<td>Electron Calibration</td>
<td>35 (17%)</td>
</tr>
<tr>
<td>Photon Depth Dose</td>
<td>33 (16%)</td>
</tr>
<tr>
<td>Electron Depth Dose</td>
<td>25 (12%)</td>
</tr>
<tr>
<td>Photon Calibration</td>
<td>16 (8%)</td>
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This is a beam measurement issue and TPS beam modeling challenge.

Courtesy: Dave Followill
Conclusions

- Minor deviations – big effect
- Quality gap
- Commissioning and independent audit
Acknowledgments

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UW RAD ONC QUALITY TEAM