Stereotactic Body Radiotherapy for Lung Cancer

Haidy Lee MD
Disclosures

None
What is it?

- Stereotactic Body Radiotherapy (SBRT)
  - Extracranial radiosurgery
- Very large doses of extremely precise ionizing radiation
- A highly specialized form of image-guided radiotherapy (IGRT)
- Given in 1-5 fractions
Why do it?

<table>
<thead>
<tr>
<th>Total Dose</th>
<th>Reference</th>
<th>BED Gy10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional fractionation</td>
<td>—</td>
<td>(Fig. 1.1)</td>
</tr>
<tr>
<td>60 Gy, 30 fractions</td>
<td>—</td>
<td>72</td>
</tr>
<tr>
<td>70 Gy, 35 fractions</td>
<td>—</td>
<td>84</td>
</tr>
<tr>
<td>SBRT</td>
<td>(6)</td>
<td></td>
</tr>
<tr>
<td>48 Gy, 4 fractions</td>
<td>(2)</td>
<td>106</td>
</tr>
<tr>
<td>45 Gy, 3 fractions</td>
<td>(2)</td>
<td>113</td>
</tr>
<tr>
<td>48 Gy, 3 fractions</td>
<td>(2)</td>
<td>125</td>
</tr>
<tr>
<td>60 Gy, 5 fractions</td>
<td>(12)</td>
<td>132</td>
</tr>
<tr>
<td>60 Gy, 3 fractions</td>
<td>(3)</td>
<td>180</td>
</tr>
<tr>
<td>69 Gy, 3 fractions</td>
<td>(33)</td>
<td>228</td>
</tr>
</tbody>
</table>


SBRT is biologically more potent
Who do we treat?

• Early stage non-small cell lung cancer
  – Medically inoperable
    • COPD
  – Refuse surgery

• Oligometastatic disease with reasonable survival
  – Lung, Liver, Spine, Kidney
Tumors in serial organ structures are not always candidates for SBRT due to risk of downstream injury.

Small, peripheral tumors are best!
Excessive Toxicity When Treating Central Tumors in a Phase II Study of Stereotactic Body Radiation Therapy for Medically Inoperable Early-Stage Lung Cancer

Robert Timmerman, Ronald McGarry, Constantin Yiannoutsos, Lech Papiez, Kathy Tuáor, Jill DeLuca, Marvene Ewing, Ramzi Abdulrahman, Colleen DesRosiers, Mark Williams, and James Fletcher
Does it work?

The North American Experience with Stereotactic Body Radiation Therapy in Non-small Cell Lung Cancer

Robert D. Timmerman, MD,* Clint Park, MD,* and Brian D. Kavanagh, MD, MPH†


<table>
<thead>
<tr>
<th>Author</th>
<th>Treatment</th>
<th>Primary Tumor Control</th>
<th>Single Fraction Equivalent Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>North America/Europe</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timmerman, 2006</td>
<td>20-22 Gy X 3</td>
<td>95% (2+ years)</td>
<td>56 – 62 Gy</td>
</tr>
<tr>
<td>Bauman, 2006</td>
<td>15 Gy X 3</td>
<td>80% (3 years)</td>
<td>41 Gy</td>
</tr>
<tr>
<td>Fritz, 2006</td>
<td>30 Gy X 1</td>
<td>80% (3 years)</td>
<td>30 Gy</td>
</tr>
<tr>
<td>Nyman, 2006</td>
<td>15 Gy X 3</td>
<td>80% (crude)</td>
<td>41 Gy</td>
</tr>
<tr>
<td>Zimmermann, 2005</td>
<td>12.5 Gy X 3</td>
<td>87% (3 years)</td>
<td>43.5 Gy</td>
</tr>
</tbody>
</table>
Outcomes After Stereotactic Lung Radiotherapy or Wedge Resection for Stage I Non–Small-Cell Lung Cancer

Inga S. Grills, Victor S. Mangona, Robert Welsh, Gary Chmielewski, Erika McInerney, Shannon Martin, Jennifer Wloch, Hong Ye, and Larry L. Kestin

Conclusion
Both lung SBRT and wedge resection are reasonable treatment options for stage I NSCLC patients ineligible for anatomic lobectomy. SBRT reduced LR, RR, and LRR. In this nonrandomized population of patients selected for surgery versus SBRT (medically inoperable) at physician discretion, OS was higher in surgical patients. SBRT and surgery, however, had identical CSS.
How do we treat?

• Simulation (Treatment Set-up)
  – Immobilization
  – 4D CT scan
  – Respiratory control

• Treatment planning

• Treatment delivery with image-guidance
  – 3-5 fractions
Patient Immobilization

Body Pro-Lock System with respiratory compression belt
4D CT scan

Assess tumor motion for treatment planning
Respiratory Control

- Abdominal compression
- Respiratory gating
Respiratory Gating

Slide courtesy of P. Keall, VCU
Respiratory Gating
Treatment Planning

- **Arc Therapy (VMAT)**
  - Beam on while rotating around tumor
  - Faster treatment time
  - Decreased patient motion
  - Increased accuracy
Treatment Delivery
Treatment Delivery

- X-ray and CT scan on treatment couch
- Visualize tumor and align anatomy
- Monitor patient and tumor movement
Treatment Delivery
Follow Up

• 3 month post-treatment CT scan
• Regular follow up CT scan
  – Initially 3-4 months
  – 6 months
  – Yearly
• PET/CT for possible progression
Follow Up
Easy

Pre  3 months  18 months
Follow Up

Difficult

Pre 3 months 14 months

A: 13.1mm
B: 10.8mm
Future Directions

• Different fractionation schemes
  – Single fraction

• Surgical candidates
  – SBRT as primary treatment with surgical salvage