Stereotactic Radiotherapy for Solitary Lung Tumors

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Disclosures

• Varian education program
Surgery for Lung Cancer

- **anatomic lobectomy** along with the N1 lymph nodes that are within the visceral pleural envelope

- Sampling or formal **lymphadenectomy** of the central mediastinal N2 lymph nodes
Medical Comorbidities and Early Stage Lung Cancer

- Coexisting medical conditions can preclude surgery in some patients
  - COPD
  - Cardiac disease
  - Other medical comorbidities
  - Poor functional status
Treatment Options for Stage I NSCLC 
(T1/T2 N0 M0)

• **Surgical Resection**
  – Lobectomy
  – Sublobar Resection (+/- adjuvant radiation)
    • Segmentectomy
    • Wedge Resection

• **Nonsurgical Therapy**
  – Ablative techniques
    • Stereotactic Radiosurgery
    • Radiofrequency Ablation
  – Radiation Therapy

• **No Treatment**
### Lobectomy versus Sublobar Resection

<table>
<thead>
<tr>
<th>Type of Resection:</th>
<th>Lobectomy</th>
<th>Sublobar Resection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Local Control</strong></td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><strong>Survival</strong></td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><strong>Lung Function</strong></td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>
Varian
Local Control: Lobectomy vs Sublobar Resection

• Ginsberg RJ, Rubinstein LV. Randomized Trial of Lobectomy versus limited Resection for T1N0 NSCLC. *Annals of Thoracic Surgery* 1995. 60(3):615.

• Local recurrence
  – 21/122 (17%) sublobar resection
  – 8/125 (6%) lobectomy
Local Control: Lobectomy vs sublobar resection


- 70 patients with segmentectomy
- No local recurrences
Local Control: Lobectomy vs sublobar resection


- 55 patients Stage IA NSCLC underwent segmentectomy
- One local recurrence
Survival: Lobectomy vs sublobar resection

- LCSG

- Limited resection associated with 30% increase in overall death rate and 50% increase in death with cancer
Survival: Lobectomy vs sublobar resection

- 5 year survival 87.1% with segmentectomy
- Better survival for tumor 2 cm or less
- No difference in survival for lobectomy vs segmentectomy for tumor 2cm or less
5 year survival after resection
Okada et al

<table>
<thead>
<tr>
<th>Tumor size</th>
<th>Lobectomy</th>
<th>Segmental resection</th>
<th>Wedge resection</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 mm or less</td>
<td>96.7%</td>
<td>92.4%</td>
<td>85.7%</td>
</tr>
<tr>
<td>21 to 30 mm</td>
<td>87.4%</td>
<td>84.6%</td>
<td>39.4%</td>
</tr>
<tr>
<td>Greater than 30 mm</td>
<td>81.3%</td>
<td>62.9%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Stereotactic radiation: everyone’s doing it!
Conventional XRT for Stage I Lung Cancer

- Poor long term survival and poor local control
Conventional Radiotherapy

- **Standard approach** 45 – 66 Gy total dose in 1.8 to 2 Gy fractions
- 5 year survival rates 10 – 30%
Stereotactic Radiotherapy (SRT)

- Three dimensional conformal planning techniques
- Stereotactic targeting with image guidance
- Systems to decrease the effect of lung motion
Tumor targeting

- Ablative doses to the tumor
- Limit radiation to normal tissue to prevent toxicity
FIDUCIAL PLACEMENT
Compensating for Respiratory Motion

- Tumor tracking
- Gating
- Respiratory inhibition
Dosimetry

• Potent dose which confidently hits the target while having a very sharp fall off dose gradient outside the region of the tumor

• Multiple beam paths from multiple directions
CyberKnife
Varian
Radiosurgery Results

• Central tumor predictor of toxicity

• Large tumor predictor of toxicity
Outcomes with current Regimen

• 20 Gy X 3 peripheral tumors
• 12 Gy X 4 central tumors

• Minimal toxicity / no change in PFTs
• Local control rates 85 to 90 %
Phase II Trial SBRT peripheral tumors

- Timmerman et al. JAMA 2010
- Phase II North American Multicenter trial SBRT for T1T2N0 NSCLC (<5cm) peripheral medically inoperable
- 18 Gy x 3, 3 year F/U
- 55 patients (44T1, 11T2)
Timmerman et al.

- 51% complete response rate at 6.5 months post Rx
- Complete or partial response in 89% patients
Timmerman et al

- 1/55 patients had recurrence at treated site
- 3 year primary control rate 98%
- 3/55 patients had recurrence within the involved lobe
- 3 year primary tumor and involved lobe control rate 91%
Timmerman et al.

- 2/55 regional nodal failures (33 and 36 months)
- 3 year local/regional control rate 87%
- 11/55 metastatic disease
SBRT vs Surgery

- Crabtree et al. JTCVS 2010

- 462 surgical patients F/U 31 months
  - 49 wedge, 16 seg, 375 lobe, 22 pneum
- 76 SBRT patients F/U 19 months

- Staged with CT and PET/CT
- Surgical patients younger, lower comorbidity scores, better pulmonary function
<table>
<thead>
<tr>
<th>Method</th>
<th>Overall Survival</th>
<th>Cancer Specific Survival</th>
<th>Local Control</th>
</tr>
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<tbody>
<tr>
<td>surgery</td>
<td>68%</td>
<td>82%</td>
<td>96%</td>
</tr>
<tr>
<td>SBRT</td>
<td>32%</td>
<td>82%</td>
<td>89%</td>
</tr>
</tbody>
</table>

3 year follow-up
Crabtree et al.

- Propensity matching to find 2 similar groups wrt age, clinical stage and comorbidity
- No difference in overall survival, cancer specific survival, or local control
- In high risk group operative mortality 7% with 44% complication rate (27% pneumonia or resp failure)
Conclusions

• SBRT has excellent local control and better than expected regional control
• Long term recurrences may be underestimated due to high non-cancer deaths in patient population studied
• Results of SBRT in operative candidates pending
• Optimal dose regimen for central tumors forthcoming (RTOG trial)
How I Do IT

• Weekly clinic with radiation oncologist (new patients and F/U patients)
• Contouring the patients
• Treatment delivery supervision for 1 fraction
CPT Code

- Tumor delineation
- Confirm of target at time of treatment delivery in non-fiducial tracking systems
Reimbursement

- Tumor delineation
- Patient evaluation and consultation
- Fiducial placement
- Surgical / endoscopic staging (mediastinoscopy / VATS / EBUS)
Thank You

Lung Ablation Techniques, University of Pittsburgh