ICARO2 eContouring: Lung Cancer

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Learning Objectives

• Strengthen hands-on contouring skills
• Practice contouring techniques
• Compare contours with instructor
• Learn key IMRT/SABR plan review principles
Outline

• Introductory comments
• Set-up
• Tumor contouring
• Normal anatomy contouring
• Normal tissue dose constraints
• Plan review
Introductory comments

- Cases intended to illustrate principles, *NOT* to be used as templates for treatment
- Useful reference for contouring definitions and dose constraints: NRG Oncology lung protocols (rtog.org); NCCN NSCLC 2017 Guidelines (nccn.org)
- Standardized naming: Santanam et al., IJROBP 2012 83:1344
Set-up

• Position – esp. upper extremity positioning
  – Based on tumor location
  – Arms up vs. down
  – Patient comfort!!

• Immobilization

• Breathing regularity assessment

• FDG-PET

• CT contrast
  – Oral and/or IV
GTV contouring

- **CT:**
  - Contrast to distinguish vessels from nodes
  - Lung window for contouring parenchymal portion
  - Soft tissue window for contouring mediastinum

- **FDG-PET**
  - Include hypermetabolic nodes
  - Controversy: exclude CT+/PET- nodes?
  - Exclude atelectasis

- **4-D CT**
  - Define motion management strategy, ITV

- **Controversy:** CTV & Elective nodal irradiation
GTV contouring – windowing

Soft tissue mediastinal window
GTV contouring – windowing

Pulmonary window
GTV contouring – windowing

Pulmonary window
GTV contouring – windowing

Soft tissue/mediastinal window
GTV contouring

Include spicules in GTV?
GTV contouring
GTV contouring – contrast

Non-contrast CT
GTV contouring – contrast

Impact of CT contrast
Treatment planning PET-CT

CT-based PTV
Treatment planning PET-CT

PET-CT-based PTV
IASLC Nodal Stations


• Nodal CTV guidelines (esp. for PORT):
Normal organ contouring
Spinal cord contouring

- C1-L3 vertebral levels
- Bony limits of spinal canal vs. cord proper
Esophagus contouring

- Entire length: bottom of cricoid to GE junction
- Entire thickness of wall to adventitia
- Oral contrast helpful, especially behind heart
Proximal bronchial tree

- Entire or distal trachea to lobar level bronchi
- Entire thickness of wall
- Very useful as landmark on DRRs
Proximal bronchial tree
Proximal bronchial tree
Heart contouring

- From origin of coronary arteries to apex
- Include pericardium
- Alternate: include entire pericardium to bottom of aortic arch
- May contour course of left coronary artery
Lung contouring

- Contour all lung parenchyma including atelectasis
- Exclude GTV
- Exclude effusion and central airways
Brachial plexus contouring

- C5 to T1 nerve roots (5 nerve roots)
- Last 2 nerve roots span first rib
- Splits anterior and middle scalene muscles
- Main trunks course posterior and superior to subclavian artery
- Subclavian vessels may not be adequate surrogate, esp. when treating apical tumors
Brachial plexus contouring
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Brachial plexus contouring
### Normal tissue constraints – CFRT

<table>
<thead>
<tr>
<th>Dose limit RTOG L-0117</th>
<th>Dose limit RTOG 0617</th>
<th>Actual in RTOG L-0117*</th>
<th>Actual in RTOG 0617**</th>
<th>Sample dose limit (conservative)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total lung V20 &lt;30%</td>
<td>Total lung V20 &lt;37%, Mean ≤20 Gy</td>
<td>V20 23.9 ± 6.1% MLD 15 ± 3.6 Gy</td>
<td>V20 28.7% (60 Gy) V20 30.9% (74 Gy)</td>
<td>Total lung V5 &lt;60%; V10 &lt;40% V20 &lt;30%; V30 &lt;20% Mean &lt;18 Gy; Ipsi lung V20 &lt;50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>V50&lt;30% Mean &lt;25 Gy</td>
</tr>
<tr>
<td>V55 &lt; 30% Mean &lt;34 Gy</td>
<td>Mean &lt;34 Gy; Calculate V60</td>
<td>MED 22 ± 6.4 Gy</td>
<td>MED 24.7 Gy V60 15% (60 Gy) MED 29.8 Gy V60 25.6% (74 Gy)</td>
<td>V44&lt;1 cc</td>
</tr>
<tr>
<td>Max &lt; 45 Gy</td>
<td>Max ≤50.5 Gy</td>
<td></td>
<td></td>
<td>Mean &lt;30 Gy</td>
</tr>
<tr>
<td>Whole organ &lt;40 Gy</td>
<td>60 Gy&lt;1/3 45 Gy&lt;2/3 40 Gy&lt;100%</td>
<td>V50 7% (60 Gy) V50 11% (74 Gy)</td>
<td></td>
<td>Max &lt;55 Gy Mean &lt;40 Gy</td>
</tr>
<tr>
<td>LAD</td>
<td>N/A</td>
<td></td>
<td></td>
<td>Max &lt;66 Gy</td>
</tr>
<tr>
<td>N/A</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N/A</td>
<td>Max &lt;66 Gy</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Normal tissue constraints – SABR

### Table 3. Normal Tissue Dose-Volume Constraints for SABR*

<table>
<thead>
<tr>
<th>OAR</th>
<th>1 Fraction</th>
<th>3 Fractions</th>
<th>4 Fractions</th>
<th>5 Fractions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinal Cord</td>
<td>14 Gy</td>
<td>18 Gy (6 Gy/fx)</td>
<td>26 Gy (6.5 Gy/fx)</td>
<td>30 Gy (6 Gy/fx)</td>
</tr>
<tr>
<td>Esophagus</td>
<td>15.4 Gy</td>
<td>30 Gy (10 Gy/fx)</td>
<td>30 Gy (7.5 Gy/fx)</td>
<td>32.5 Gy (6.5 Gy/fx)</td>
</tr>
<tr>
<td>Brachial Plexus</td>
<td>17.5 Gy</td>
<td>21 Gy (7 Gy/fx)</td>
<td>27.2 Gy (6.8 Gy/fx)</td>
<td>30 Gy (6 Gy/fx)</td>
</tr>
<tr>
<td>Heart/Pericardium</td>
<td>22 Gy</td>
<td>30 Gy (10 Gy/fx)</td>
<td>34 Gy (8.5 Gy/fx)</td>
<td>35 Gy (7 Gy/fx)</td>
</tr>
<tr>
<td>Great Vessels</td>
<td>37 Gy</td>
<td>39 Gy (13 Gy/fx)</td>
<td>49 Gy (12.25 Gy/fx)</td>
<td>55 Gy (11 Gy/fx)</td>
</tr>
<tr>
<td>Trachea &amp; Proximal Bronchi</td>
<td>20.2 Gy</td>
<td>30 Gy (10 Gy/fx)</td>
<td>34.8 Gy (8.7 Gy/fx)</td>
<td>32.5 Gy (6.5 Gy/fx)</td>
</tr>
<tr>
<td>Rib</td>
<td>30 Gy</td>
<td>30 Gy (10 Gy/fx)</td>
<td>31.2 Gy (7.5 Gy/fx)</td>
<td>32.5 Gy (6.5 Gy/fx)</td>
</tr>
<tr>
<td>Skin</td>
<td>26 Gy</td>
<td>30 Gy (10 Gy/fx)</td>
<td>36 Gy (9 Gy/fx)</td>
<td>40 Gy (8 Gy/fx)</td>
</tr>
<tr>
<td>Stomach</td>
<td>12.4 Gy</td>
<td>27 Gy (9 Gy/fx)</td>
<td>30 Gy (7.5 Gy/fx)</td>
<td>35 Gy (7 Gy/fx)</td>
</tr>
</tbody>
</table>

*NCCN NSCLC Guidelines 2014, based on RTOG protocols*
Thank you!

On to interactive contouring...

Patient #1: 70 yo woman with past smoking history, diagnosed with adenocarcinoma involving the RUL, with hilar and R paratracheal lymphadenopathy on PET-CT confirmed by bronchial ultrasound guided biopsy. Plan: concurrent chemoradiotherapy.
4-D CT Contouring
4-D CT, MIP, Ave IP, ITV
4-D CT, MIP, Ave IP, ITV
4-D CT, MIP, Ave IP, ITV
4-D CT, MIP, Ave IP, ITV
4-D CT, MIP, Ave IP, ITV
4-D CT, MIP, Ave IP, ITV
4-D CT, MIP, Ave IP, ITV
Internal margin design for gating

PHASE 90
Internal margin design for gating

PHASE 90
IMRT/SABR Plan Review

Technical
- Beam orientation and energy
- Dose calculation algorithm / heterogeneity correction
- Motion management

Target coverage
- Prescription point / plan normalization

Conformity / hot spots / high dose spillage

Intermediate dose conformity

Normal tissue doses / DVHs
Interpreting Prescription Doses – SABR

<table>
<thead>
<tr>
<th>Nominal dose</th>
<th>Prescription point</th>
<th>Calculation</th>
<th>Equivalent dose (approximate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 Gy/3 fx</td>
<td>95% of PTV</td>
<td>No HC</td>
<td>&gt;72 Gy at isocenter</td>
</tr>
<tr>
<td>RTOG 0236, Xiao 2009</td>
<td></td>
<td></td>
<td>54 Gy at periphery</td>
</tr>
<tr>
<td>48 Gy / 4 fx</td>
<td>Isocenter</td>
<td>HC PB algorithm</td>
<td>&lt;40 Gy at periphery</td>
</tr>
<tr>
<td>JCOG 0403, Matsuo 2007</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 Gy / 4 fx</td>
<td>75-90% IDL to PTV</td>
<td>HC ? algorithm</td>
<td>56-67 Gy Max</td>
</tr>
<tr>
<td>Chang 2008</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45 Gy / 3 fx</td>
<td>67% IDL at periphery</td>
<td>HC PB algorithm</td>
<td>&lt;66 Gy at isocenter</td>
</tr>
<tr>
<td>aumann 2009</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
SABR Plan Review – Example
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Thank you!

Tumor Stereotactic Ablative Radiotherapy (LT-SABR)