SBRT TREATMENT PLANNING: TIPS + TRICKS

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OUTLINE

- Brief radiobiology review
- 3D CRT Tx Planning
- VMAT Tx Planning
- Protocols
- Other Sites
  - Oligometastases
  - Spine
  - Liver
  - Kidney
  - Adrenal Gland
  - HN
DISCLOSURES

- They make me plan with Varian Eclipse (version 13.6)
- All treatment planning systems everywhere are awesome
a) Single Dose vs. Multiple Dose fractionation
b) Normal Tissues vs. Tumor Tissues during multiple-fraction exposure

**RADIOBIOLOGY**

- **Serial Tissues**
  - Spinal cord
  - Esophagus
  - Bowels
  - Ducts
  - Vessels

- Severe damage to any segment yields catastrophic dysfunction
- If tumor abuts serial organ, SBRT is only of limited benefit

- **Parallel Tissues**
  - Peripheral lung
  - Peripheral liver
  - Peripheral kidney

- Catastrophic dysfunction depends on amount of tissue damaged.
- If volume can be limited with smaller margins, SBRT will be advantageous
RADIOBIOLOGY

- Cell Ablation
  - To interrupt clonogenicity, radiation damage to any of the genes is required
  - To interrupt cellular function, radiation must damage every single gene to disrupt cellular function

- Typical dose schedules in SBRT are ablative, as described above:
  - Most likely disrupting clonogenicity in every tumor cell, disrupting their cycles
  - More than likely also destroying tissue function

- Surrounding normal tissue just outside target will also be ablated
  - Similar to a surgeon’s knife
  - Leaves the tissues totally disabled both at point of contact and downstream
**SBRT + ABLATION**

- In surgery, if remove portion of serial organ (e.g. esophagus), would reconnect the ends
- In SBRT, if ablate portion of serial organ, cannot reconnect ends
- Therefore, ablative doses cannot be used near such organs
- Nerves and blood vessels very prone to ablation at high doses
- Ablative dose ranges = at least 10 Gy per Fx for 3 – 5 fractions
- Tumor control probabilities near 90% with ablative doses
DOUBLE TROUBLE

- Double-Trouble Effect
  - When comparing physical doses with prescription dose, fractionation (how physical dose is delivered in time) affects hot and cold spots.

- What gets hot, gets hotter biologically

- What gets cold, gets colder biologically.
SBRT STRATEGY

- To avoid such late effects, treat tumor while avoiding uninvolved tissues
  - Employing state-of-the-art technology

- Requires 4 factors:
  - prophylactic radiotherapy not required
  - tumor motion accounted for
  - rapid dose falloff to normal tissues
  - superior targeting accuracy
SBRT STRATEGY

- More difficult than Cranial SRS and SRT.
  - Motion
  - Special immobilization required
  - Special image-guidance required

- Requires 3D knowledge of target position during treatment.
3D - CRT vs VMAT

3D – CRT PROS

- Quicker treatment planning time?
- No fluence QA
- MD confidence?
- Increased exercise for RTTs

VMAT PROS

- Potentially faster tx time (FB)
- No PFs during treatment
- Better conformality
- NTO
- Inverse planning
- Less skin dose
- Potentially less rib dose
- Concave dose distribution
- Less treatment prep time
A Word about Respiratory Motion Management...

- Free-breathing
  - Easier on the patient
  - Only if 5mm or less movement
  - Both 3D + VMAT viable options

- Gating
  - Usu 30%-70% (typically during exhalation windows)
  - If 4 or more gating windows, VMAT becomes an option
  - Less than 4 gating windows, 3D CRT is preferred at RPCI

- Breath-hold (mDIBH)
  - Quicker treatment time than gating?
  - Both 3D + VMAT viable options
SBRT LUNG PROTOCOLS

- **Peripheral**: RTOG 0236
  - 60 Gy in 3 Fx
  - Normalization point in center of PTV

- **Peripheral**: RPCI I-124407
  - Normalization point in center of PTV
    - Arm 1: 60 Gy in 3 Fx
    - Arm 2: 30 Gy in 1 Fx

- **Central**: RTOG 0813
  - Normalization point in center of PTV
  - ~ 55 Gy in 5 Fx
3D - CRT Treatment Planning

- 7 – 11 Beams
  - Non-Coplanar
    - Gantry/ couch/ patient clearance
  - No POPs
  - No overlap on skin or just beneath
  - Min FS 3.5cm x 3.5cm
    - Challenge with small targets
  - No wedges
  - 6X.
    - Some high energy?
    - Shoot through healthy lung? Shoot through heart?

- Heterogeneity correction?
- Weighting of beams to achieve conformality
### 3D - CRT Treatment Planning

<table>
<thead>
<tr>
<th>Maximum PTV Dimension (cm)</th>
<th>Ratio of Prescription Isodose Volume to the PTV</th>
<th>Ratio of 50% Prescription Isodose Volume to the PTV, $R_{50%}$</th>
<th>Maximum Dose 2 cm from PTV in any Direction, $D_{2\mathrm{cm}}$ (Gy)</th>
<th>Percent of Lung receiving 20 Gy total or more, $V_{2\mathrm{Gy}}$ (%)</th>
<th>PTV Volume (cc)</th>
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**Note 1:** For values of PTV dimension or volume not specified, linear interpolation between table entries is required.

**Note 2:** Protocol deviations greater than listed here as ‘minor’ will be classified as ‘major’ for protocol compliance (See Section 6.7).
SKIN TOXICITY
3D - CRT Treatment Planning
3D - CRT Treatment Planning
VMATx PLANNING

- 3 or more partial arcs
- 6X.
  - Some high energy?
  - Shoot through healthy lung? Shoot through heart?
    - PARTIAL arcs
    - Non-coplanar?
- Heterogeneity correction ON
- Couch modeled
- Trick structures used for inverse planning
- NTO to control spillage outside of PTV
VMAT: Ray Ray's Tricks

- PTV sub GTV
- Smaller PTV sub GTV
- Overall hotspot control
- High dose spillage control
- Limit slices containing 2cm tissue constraint and HDS constraint
- If next to cord, make a dose limit ring – limit slices
PTV sub GTV
Smaller PTV sub GTV (1mm)
D2cm STRUCTURE
OVERALL HOTSPOT CONTROL
HDS CONTROL
USE AN EASY BUTTON
FINAL SBRT VMAT PLAN
**FINAL SBRT VMAT PLAN**

![Image of the final SBRT VMAT plan with detailed data on dose, organ at risk, and critical structures]
EXCELS SHEETS ARE SMART

<table>
<thead>
<tr>
<th>Max PTV Dimension</th>
<th>Ratio of RX ISODOSE Volume to PTV Volume</th>
<th>Ratio of 60% RX ISODOSE Volume to PTV Volume</th>
<th>Max Dose (% Rx Dose) in NT - (PTV + 2.0cm)</th>
<th>% Whole Lung V20</th>
<th>PTV Volume</th>
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INSTRUCTIONS TO CALCULATE DOSE LIMITS FOR PTV

1. Paste Data from row from table, above, with volume less than PTV volume.
2. Calculated values for this case will be transferred automatically to worksheet.
3. Paste Data from row from table, above, with volume greater than PTV volume.
SBRT VMAT CENTRAL LUNG
OLIGOMET: NRG-BR002 Review

- Lung – Peripheral
- Lung – Central
- Mediastinum/ Cervical LNs
- Liver METS
- Spinal
- Osseous
- Abdominal/ Pelvic

- Options: 1 Fx, 3 Fx, 5 Fx
Table 5-4

<table>
<thead>
<tr>
<th>Planning Parameter</th>
<th>Lung Central</th>
<th>Lung Peripheral</th>
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*Note: CTV = Clinical Target Volume, GTV = Gross Tumor Volume, PTV = Planning Target Volume.
NRG BR-002

- VMAT BABY!
  - Recommend 340 degree arcs
- If choose 3D, follow same recommendations as discussed earlier
- Normalization point at DMAX (should be in GTV)
- Heterogeneity correction ON
- HDS more strict than previous lung protocols
LIVER: Protocols

- RTOG 1112
  - Hepatocellular
- NRG BR-OO2
  - Mets
LIVER: Examples
ADRENAL
THANK YOU!