Craniospinal Irradiation Treatment Planning Study for Spot Scanning Proton Therapy

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Planning Criteria

• 18 Patients (8 under 10 yo)
• Prescription:
  ➢ 3600cGy in 20 fx
  ➢ 2340 in 13
• Normalization:
  ➢ 98% of CTV receives 100% Rx dose
Study of Two Targets

All patients

Thecal sac + brain to 2340cGy

Patients under 10 yo

Thecal sac + brain to 2340cGy

Vertebral bodies to 2100cGy
Matching the fields

• Match area achieved by stepping down dose over 9cm.
Without Robust IMPT

This is the lower spine portion of a CSI treatment. The Blue is the CTV (thecal sac), the orange are the OTVs. There is an OTV_inf_100% (the larger orange), OTV_inf_90% (the small orange segment next to OTV_inf_100%), OTV_inf_80% etc. The purple is the STV for the inferior spine field, STV_inf. There would be a corresponding “STV_mid” with OTV_mid_xx%. The STV_mid and STV_inf would overlap along with the OTVs to make a smooth gradient.
Beam Arrangement

**Posterior Beams**

- 1 posterior beam per isocenter

**Oblique Beams**

- 2 posterior oblique beams per isocenter
- 45 degree obliques used when possible
- 1 side would be treated per day
  - Alternating schema: left side one day, right side the next
Bolus / Range Shifter

- Lowest energy protons we get from synchrotron: 72MeV (4cm deep in water)
- We need to pull back the protons for our shallower target.

- 4.5cm range shifter in tx nozzle
- 5cm thick slab of bolus under the patient
Large Tails have a major influence on the dose distribution.
Robustness Considerations

• 3mm shift of all isocenters
  ➢ x, y, and z shifts each considered independently
• 3% range uncertainty
  ➢ 3% increase in HU applied to each pixel
    ▪ Makes tissue more dense, protons won’t travel as far
  ➢ 3% decrease in HU applied to each pixel
    ▪ Makes tissue less dense, protons will travel farther
Robustness Plots 101

Structure: Right Retina
Plan type: Range Shifter, Vertebral bodies, Obliques
Uncertainty: 3mm translation in z direction
Robustness Plots 101

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Mean of all the original plans, robustness not considered
Robustness Plots 101

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1 standard deviation from the mean of all original plans
Robustness Plots 101

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1 standard deviation of original plan with shift z + 3mm
Robustness Plots 101

Structure: Right Retina
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Mean of all the original plans, robustness not considered
1 standard deviation from the mean of all original plans
1 standard deviation of original plan with shift z + 3mm
1 standard deviation of original plan with shift z - 3mm

Thanks to Erik Tryggestad, T.J. Whitaker
DVH’s - Esophagus

Thecal Sac Plans

Vertebral Body Plans

Mean DVH for ROI: esophagus

- BTP +/- 1sig; N=18
- BTO +/- 1sig; N=18
- RTO +/- 1sig; N=18
- CSI Photon 2340 +/- 1sig; N=11

Mean DVH for ROI: esophagus

- BVP +/- 1sig; N=6
- BVO +/- 1sig; N=6
- RVO +/- 1sig; N=6
- CSI Photon 2340 +/- 1sig; N=11
# Mean Doses
(2 field bolus plans)

<table>
<thead>
<tr>
<th></th>
<th>Mean Doses (cGy)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean (SD)</td>
</tr>
<tr>
<td><strong>CTV</strong></td>
<td>3682 (15)</td>
</tr>
<tr>
<td><strong>Retina</strong></td>
<td>231 (142)</td>
</tr>
<tr>
<td><strong>Cochlea</strong></td>
<td>2286 (174)</td>
</tr>
<tr>
<td><strong>Scalp</strong></td>
<td>2661 (423)</td>
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</tbody>
</table>
CTV
Cochlea
Retina
Thank you for your time.

Questions?