Fully automated planning and delivery for hippocampal-sparing whole brain irradiation

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INTRODUCTION

• Phase III NRG-Oncology CC001 trial confirmed that hippocampal sparing whole-brain irradiation (HS-WBRT) plays a significant role in preserving patient’s neurocognitive performance while achieving comparable intracranial control.
• Sparing the hippocampus while uniformly irradiating the whole brain involves complex treatment planning and requires substantial planner training.

AIM

To fully automate the treatment planning and delivery process of HS-WBRT by combining HyperArc technology (Varian Medical System) and RapidPlan knowledge-based planning model (Varian Medical System).

METHOD

• HyperArc (HA) provides automatic isocenter placement, a standard set of non-coplanar beams (full arc at couch 0°, half arcs at couch 315°, 45°, and 270°) with optimized collimator rotation and allows automated delivery on the machine.
• The RapidPlan (RP) model automatically generates optimization objectives based on dose-volume histogram (DVH) estimates.
• Nine patients previously treated with HS-WBRT were re-planned using HA geometry and RP optimization objectives (HA-RP).
• Planning target volumes (PTV) and organs at risk (OAR) outlined following NRG-CC001 guidelines
• No pseudo-structures were created by the planner.
• HA-RP plans were compared with conventional RP plans.

RESULTS

• All HA-RP plans were generated in < 30 minutes.
• In general, HA-RP plans were equivalent or better than RP plans.
• Table 1 shows the NRG-CC001 protocol compliance criteria and the dosimetric parameters analyzed.
• Target coverage, dose homogeneity and OAR constraints “per protocol” with no plan being in the “variation acceptable” range.
• HA-RP performed better (mean ± St Dev) for target dose homogeneity (D2%/D98% divided by prescription dose) compared to RP plans (0.14±0.02 vs 0.19±0.01, p<0.01).
• The volume of PTV receiving prescription dose was comparable between the two treatment planning modalities (p=0.16).
• D98% was superior for HA-RP compared to RP (p<0.01).
• D2% showed no significant difference (p=0.23).
• Hippocampi’s maximum dose was equivalent between the two planning modalities (p=0.14).
• D100% of hippocampi was slightly higher (p=0.03) for the HA-RP vs. RP plans, but significantly lower compared to the 9Gy allowed per protocol.
• Dose to the optic apparatus was considerably lower than protocol guidelines for both modalities.
• Standardization of plan quality was achieved and effective planning time was minimized.

Table 1: Protocol compliance criteria and dosimetric parameters

<table>
<thead>
<tr>
<th>Dosimetric Parameter</th>
<th>Protocol</th>
<th>HA-RP</th>
<th>RP</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>V95% [cm³]</td>
<td>Mean ± St Dev</td>
<td>95.82 ± 0.81</td>
<td>95.26 ± 0.97</td>
<td>p = 0.16</td>
</tr>
<tr>
<td>D2%(Gy)</td>
<td>≥ 25</td>
<td>28.74 ± 0.58</td>
<td>27.29 ± 0.94</td>
<td>p = 0.01</td>
</tr>
<tr>
<td>D98%(Gy)</td>
<td>≤ 37.5</td>
<td>33.00 ± 0.11</td>
<td>32.90 ± 0.19</td>
<td>p = 0.23</td>
</tr>
<tr>
<td>Hippocampi (Gy)</td>
<td>≤ 9</td>
<td>7.96 ± 0.19</td>
<td>7.77 ± 0.25</td>
<td>p = 0.03</td>
</tr>
<tr>
<td></td>
<td>≤ 16</td>
<td>12.92 ± 0.66</td>
<td>12.54 ± 0.59</td>
<td>p = 0.14</td>
</tr>
</tbody>
</table>

CONCLUSIONS

HA technology combined with RP model allows:
• Fully automated planning and delivery for HS-WBRT.
• Highly conformal and homogenous dose distribution for the PTV with lower doses to OARs.
• All NRG-CC001 protocol constraints to be met.
• Increased planning efficiency with very limited user input.
• Standardized planning process and improved consistency of plan quality.
• Automated delivery allows a complex treatment to be delivered safely in a shorter time.

REFERENCES

1. A randomized phase III trial of memantine and whole-brain radiotherapy with or without hippocampal avoidance in patients with brain metastases, NRG oncology, NRG-CC001

CONTACT INFORMATION

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