Optimizing Immobilization and IGRT schedule for decreasing PTV margins for supine Cranio-spinal irradiation

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Background
Craniospinal irradiation (CSI) is critical in achieving long-term control in embryonal brain tumours like medulloblastoma. As per our previous institutional experience, PTV margins for cranium and spine of 5 and 8 mm were found to be safe for supine CSI, which is quite comparable to international experience as well [1,2]. This was achieved using four clamp orfit for head and neck and did not improve with use of whole body VACLOC. Recently with availability of universal baseplate, we started using dual orfit. One at head neck and second at abdomen. Daily CBCT were taken for both cranium and lower spine for all patients during the course of treatment as per institutional policy.

Objectives
The setup errors for patients treated with supine craniospinal irradiation (CSI) using dual immobilisation (head-neck and pelvic thermoplast) with universal baseplate were reviewed to identify optimal image guidance (IG) schedule with with least planning target volume margins (PTV).

Methods
- 398 on-board daily volumetric CT images
- 2 sets of images for matching per patient
  - Cranial (C)
  - Spinal (S)
- 13 consecutive patients (TrueBeam / Trilogy / Tomotherapy machines)
- Systematic (S) and random error (σ) were calculated in three axes (mediolateral:x, craniocaudal:y, anteroposterior:z)
- Three no-action-level (NAL) and action-level (AL:2mm) offline protocols were tested:
  - Set-up errors of the first three (PF3:NAL, AL)
  - Five fractions (PF5:NAL, AL) averaged and implemented for the remaining fractions,
  - Post PFS daily errors implemented for C alone (PF5B:NAL, AL)
- The PTV margins were determined by the Van Herk (H) and stroom’s (St)
- Optimal IG is determined based on least margins with minimum IG utilization.

Results

PTV Margins for various IGRT Schedules

<table>
<thead>
<tr>
<th>PTV (H/St; mm)</th>
<th>NO-IGRT</th>
<th>PF3</th>
<th>PF5</th>
<th>PF5B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NAL</td>
<td>AL</td>
<td>NAL</td>
<td>AL</td>
</tr>
<tr>
<td>Brain</td>
<td>3/2/2.8</td>
<td>7/6/6.3</td>
<td>4.5/3.7</td>
<td>6.2/5.3</td>
</tr>
<tr>
<td>Spine</td>
<td>5/4.4</td>
<td>6.4/4.3</td>
<td>5.1/4.4</td>
<td>4.8/4.1</td>
</tr>
<tr>
<td>Mediolateral:x</td>
<td>3.2/2.8</td>
<td>6.9/5.9</td>
<td>4.9/4.1</td>
<td>4.8/4.7</td>
</tr>
<tr>
<td>Craniocaudal:y</td>
<td>5.8/4.9</td>
<td>6.8/5.7</td>
<td>4.6/4.4</td>
<td>5.3/4.4</td>
</tr>
<tr>
<td>Anteroposterior:z</td>
<td>3.2/2.8</td>
<td>6.9/5.9</td>
<td>4.9/4.1</td>
<td>4.8/4.7</td>
</tr>
</tbody>
</table>

If the current margin for Cranial PTV reduced from 5mm → 3mm and that for spinal PTV is reduced from 8mm → 5mm

Concentration
- Dual immobilization system resulted in smaller PTV margins
- Five fractions (PF5:NAL, AL:2mm) averaged and implemented for the remaining fractions, is reasonably better IGRT schedule
- Reduction in margin leads to considerable reduction in planning target volume

References