**IMRT site-specific procedure: Prostate (CHHiP)**

**Scope:** To provide site specific instructions for the planning of CHHIP IMRT patients

**Responsible:** Radiotherapy Physicists, HPC Registered Therapy Radiographers  
(Pre-Treatment), Clinical Oncologists

**Definitions:**  
IMRT – Intensity Modulated Radiotherapy  
OARs – Organs at Risk  
VOIs – Volumes of Interest  
GTV – Gross Tumour Volume  
CTV – Clinical Target Volume  
PTV – Planning Target Volume  
CHHiP – Conventional or Hypofractionated High Dose Intensity  
Modulated Radiotherapy for Prostate Cancer

**Documentation:**  
IMRT Contouring  
CHHiP IMRT Contouring form  
IMRT planning  
IMRT plan write-up  
IMRT preparation for patient-specific QC

1. **Context**

This work instruction describes the parts of the IMRT planning and QC process that are specific to CHHIP IMRT plans. It should be read in conjunction with the documents ‘IMRT contouring’, ‘IMRT planning’, ‘IMRT: Plan write-up’ and ‘IMRT: Preparation for QC’.

2. **ProSoma**

2.1 Table 1 identifies the volumes which require contouring on ProSoma and indicates who should perform the contouring. The relevant volumes should have already been outlined in Prosoma by the Dr and Phys/Rad and exported to Image Server.

Volumes are listed in Table 1.
<table>
<thead>
<tr>
<th>VOI name</th>
<th>VOI type</th>
<th>Contoured by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bladder</td>
<td>ORGAN</td>
<td>Phys/Rad</td>
</tr>
<tr>
<td>Bowel (IMRT)</td>
<td>ORGAN</td>
<td>Phys</td>
</tr>
<tr>
<td>GTV1 (Prostate)</td>
<td>GTV</td>
<td>Dr</td>
</tr>
<tr>
<td>GTV2 (Prostate + SV)</td>
<td>GTV</td>
<td>Dr</td>
</tr>
<tr>
<td>L Femoral Head</td>
<td>ORGAN</td>
<td>Phys/Rad</td>
</tr>
<tr>
<td>R Femoral Head</td>
<td>ORGAN</td>
<td>Phys/Rad</td>
</tr>
<tr>
<td>Rectum (IMRT)</td>
<td>ORGAN</td>
<td>Phys</td>
</tr>
<tr>
<td>Urethral Bulb</td>
<td>ORGAN</td>
<td>Dr</td>
</tr>
</tbody>
</table>

Table 1: Volumes for contouring on ProSoma

2.2 Check the bladder volume falls within the range 200 – 400cc. If outside this range, investigate. For very small bladder volumes (approx less than 185cc), the patient will need to drink more water and be rescanned. A large bladder volume may not be comfortably reproducible.

2.3 When contouring the femoral heads, check that the shape is smooth in each orthogonal plane and edit any spikes.

2.4 When drawing rectum, the CHHiP trial requires it to start at the anus and be contoured up to the recto-sigmoid junction (the junction between rectum and bowel). This is usually where the organ turns anteriorly and to the left. The rectum is typically 10-12cm long.

2.5 All loops of bowel should be included, with bowel being contoured at least 2cm sup of the PTV1 (3cm sup of GTV2). This can be started on ProSoma but must be finished on OMP.

2.6 OMP after the final margin growing.

a. The clinician must check the Clinical Data form and the patient’s risk group before drawing the appropriate CTV/GTVs.

2.7 After the GTV1 (Prostate) has been contoured, select ‘Copy VOI’. Double click on the copied VOI and choose the name GTV2 (Prostate and SV) from the list. This will ensure that the prostate part of the GTVs is identical.

2.8 Record all data onto the CHHiP contouring form, save the structure set and send to OMP.
3. Contouring on OMP

3.1 After the CT slices and RT Structure set are imported into OMP, additional VOIs (for example planning PTVs and pseudo structures) are created from the relevant template. See the general IMRT Contouring procedure.

3.2 Need to outline the body contour in OMP.

3.3 Approve any structures grown by the Dr to prevent any unintentional editing. After editing any OARs to avoid overlap with the CTV/GTVs, grow appropriate PTVs according to Table 2 below. Use the Boolean operator to create PTV1-PTV2 and PTV2-PTV3, (ie: PTV1 “Sub” PTV2) Use the Boolean operator with post-processing (0.5cm³) on PTV1-PTV2 to clean the VOI. Check that no significant area of this structure is removed.

<table>
<thead>
<tr>
<th>Final VOI</th>
<th>Grow from VOI</th>
<th>Margin</th>
</tr>
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<tbody>
<tr>
<td>PTV3</td>
<td>GTV1</td>
<td>0.5cm 3D, 0 margin POST, <strong>avoid rectum</strong></td>
</tr>
<tr>
<td>PTV2</td>
<td>PTV3</td>
<td>0.5cm 3D</td>
</tr>
<tr>
<td>PTV1</td>
<td>GTV2</td>
<td>1cm 3D</td>
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</table>

Table 2: Margins for CHHiP Patients

3.4 Observe the rectal distortion if the patient is in the CHHiP trial. Refer to the CHHiP Trial Protocol. If the distortion is moderate to large, discuss with the clinician on which slices a variable margin is to be used for PTV2. Make a note in the comments box on the contouring form.

3.5 Use the Boolean operator with post-processing (0.5cm³) on PTV1-PTV2 to clean the VOI. Check that no significant area of this structure is removed.

3.6 Record the final OMP volumes on the CHHiP Trial Contouring form, with the clinician’s signature and date. All volumes are to be checked by another physicist.

3.2 It is good practice to create “planning volumes” to which the user constraints are applied. Create a **Pseudo PTV1-PTV2**, **Pseudo PTV2-PTV3** and **Pseudo PTV3** (do not use Planner initials). Then click on PTV1-PTV2, **Copy Structure** and **Paste Structure Over Structure** onto Pseudo PTV1-PTV2. Similarly for Pseudo PTV2-PTV3 and Pseudo PTV3.

3.3 Also create a **Pseudo Rectum**, **Pseudo Bladder** and **Pseudo Bowel** using the Crop Structure option. These pseudo OAR volumes should be cropped to 0.5 cm from the PTVs.
4 Planning

4.1 Before inserting the beam template, move the User Origin to align with the tattoos on the central \((Z = 0.00)\) slice. The isocentre should be positioned to coincide with the reference marks unless this would place it outside the PTV; in this situation it should be moved by a whole number of cm, ideally in one direction only, to place it within the PTV.

A 5-field coplanar plan is used - the approved plan template IMRT CHHIP will automatically add the appropriate fields. Select PTV3 as the target volume.

4.2 In some cases it may be advantageous to adjust the angle of the posterior obliques to best match the shape of the PTV volume at the posterior edge. Look at the BEV for each field and ensure good coverage of the PTVs.

4.3 Typical starting DVH constraints are as given in Table 3 (assuming 74Gy/37\# to PTV3):

<table>
<thead>
<tr>
<th>Organ</th>
<th>Constraint type</th>
<th>Volume (%)</th>
<th>Dose (cGy)</th>
<th>Priority</th>
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<tr>
<td>Pseudo PTV1-PTV2</td>
<td>Lower</td>
<td>100</td>
<td>5630</td>
<td>70</td>
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<tr>
<td></td>
<td>Upper*</td>
<td>50</td>
<td>5930</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Upper</td>
<td>0</td>
<td>6740</td>
<td>70</td>
</tr>
<tr>
<td>Pseudo PTV2-PTV3</td>
<td>Lower</td>
<td>100</td>
<td>6740</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Upper</td>
<td>50</td>
<td>7120</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Upper</td>
<td>10</td>
<td>7100</td>
<td>70</td>
</tr>
<tr>
<td>Pseudo PTV3</td>
<td>Lower</td>
<td>100</td>
<td>7100</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Upper</td>
<td>50</td>
<td>7400</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Upper</td>
<td>0</td>
<td>7500</td>
<td>70</td>
</tr>
<tr>
<td>(Pseudo) Rectum</td>
<td>Upper</td>
<td>0</td>
<td>7400</td>
<td>20</td>
</tr>
<tr>
<td>(Pseudo) Bowel</td>
<td>Upper</td>
<td>0</td>
<td>5500</td>
<td>20</td>
</tr>
<tr>
<td>(Pseudo) Bladder</td>
<td>Upper</td>
<td>0</td>
<td>7400</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 3: Starting DVH constraints for CHHiP patients

* In some cases, the plan will tend to deliver a low median dose to PTV1; in this case, this constraint should be set as a lower constraint.

The optimisation should initially be run concentrating on PTV coverage/homogeneity. If necessary, modifications to the Pseudo PTVs should be made to improve coverage. To optimise, click on Planning – Optimise. In the optimisation window, ensure that the Normal Tissue Objective Parameters has the distance from target border set to 0.5 cm. The Priority is set to 150, Smoothing Values \(X=60\) and \(Y=60\). Minimise Dose = 0, Fixed Jaws UNTICKED and Field Weight = 1.0. Click OK then start with the values given in Table 3.
4.4 Usually get an acceptable distribution after about 25 iterations. Then only turn on the DVHs of interest to get a better overview of how the algorithm is performing. When DVHs are acceptable, click on OK.

4.7 Then go to Planning – Plan Normalisation - % of Target Volume (100% covers 50% of Target volume) – OK.

4.8 Once the PTV doses are acceptable, the optimisation should be paused and line constraints drawn for Pseudo Bowel, Pseudo Bladder and Pseudo Rectum, initially following the current DVH of these structures (note: it may be preferable to use pseudo structures which exclude the PTV). These line constraints can then be gradually dragged across to the left as the optimisation proceeds to improve OAR sparing.

4.9 Plans should be assessed to ensure they fulfil the dose-volume criteria on the CHHIP plan assessment form. Additionally, the dose distribution should be carefully examined to ensure there are no hotspots outside PTVs (remember ICRU recommendations), that there are no areas of significant dose (>80%) at beam entry points and that the high dose regions conform well to the PTVs.

4.10 Also observe the fluences for each field to ensure there are no regions of high and low dose immediately adjacent to each other and that no “bands” of high dose are visible. Some Fluence Editing may be necessary to reduce the required number of MUs for the plan.

4.11 If the fluences are satisfactory then run the MLC “movie” to gauge whether most MU delivery corresponds to a large Average Leaf Pair Opening.

4 Plan write-up

a. DRRs should be generated as follows:
   i. For patients without implanted markers, use the bones.dps parameter set.
   ii. For patients with markers, use the IGRT markers.dps parameter set. It may be necessary to adjust the weights of the two sets of parameters used in the DRR generation in order to best visualise the markers.
   iii. Set the field size to encompass an adequate amount of the pelvis for accurate EPI matching (see Fig. 1)
5. QC plan preparation

a. When setting up the phantom QC plan, the isocentre and chamber depths will generally be 9cm deep, and it is usually unnecessary to shift the isocentre from the phantom centre.

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<table>
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<th>Issue Date:</th>
<th>Document No:</th>
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References:

Document seen and agreed by

Lead Clinical Oncologist
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Dated.................................

Radiotherapy Services Manager
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Dated.................................

Head of Radiotherapy Physics
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