Thames Valley and Wessex Radiotherapy Network

Radiotherapy Protocols

Soft Tissue Sarcoma, Bone Sarcoma, Chondrosarcoma Chordoma and Fibromatosis

This document is the standardised Thames Valley and Wessex Radiotherapy Network Sarcoma treatment protocol developed collaboratively by the Sarcoma Protocol Working Group:

Trust	Clinician	Physicist	Radiographer
Oxford University Hospitals NHS Foundation Trust	Dr Sally Trent Dr David Cutter	Dr Helen Winter Maxwell Robinson	Sharon Duxbury Louise Drummond Elizabeth Lewis
University Hospital Southampton NHS Foundation Trust	Dr Carolyn Macfarlane		

Document History

Date of Issue	Version Number	Date Approved	Responsible for Change	Nature of Change	Ratification/ Approval
26.5.2021	1.0	26.5.2021	Sarcoma Protocol WG	Alignment of OUH and UHS protocols	
31.5.2023	2.0	01.6.2023	Sarcoma Protocol WG	Update in line with the latest clinical evidence	

Table of Contents

1. Pre-Radiotherapy

Pre-radiotherapy investigations:
- Chest and abdo pelvis CT or PET/CT
- Pre-operative MRI must be available at time of planning
- Histopathology report
- For post-operative radiotherapy surgical note must be available

Immobilisation/position :
- As sarcomas are very heterogeneous in type and site, immobilisation and positioning is very dependent on location. Site-specific guidance may be given by clinician on the planning request *Therefore, where ever possible a member of either the limb team or treatment team, should see the immobilisation positioning for each patient.*
- Immobilisation must be indexed or referenced to the couch.
- In principle an immobilising shell should be used whenever possible.
- *If the patient requires bolus, clear instructions must be given on the planning set up note.*

CT-Scanning:
Planning CT is undertaken following **the Centre own local policies.**

- Planning CT to encompass the tumour bed with slices at least 10cm above and below the tumour, including the whole length of bone
- If the whole compartment is to be treated it must be specified on the Radiotherapy planning request form to ensure adequate CT slices are taken
- CT slice intervals should be 0.2-0.3cm
- For post-operative radiotherapy the scar and drain sites must be wired.
- IV contrast is recommended (follow the Centre own local guidelines)

For CT scanning and immobilisation of extremities/limbs, **follow the Centre own local policies** for:

- Pre-Treatment - Radical Limb Planning
- Pre-Treatment: Thigh and Groin/ Pelvis Planning Flowchart
- Pre-treatment: Limb Scanning Entitlement
- Pre-treatment Upper Limb Planning Flowchart

Image Fusion:

Image fusion with pre-operative images is strongly recommended. This may not be possible because of change in patient contour and limb position (follow the Centre own local guidelines).

2. Soft Tissue Sarcoma

Indications:

Low grade: Consider radiotherapy after local recurrence or in selected cases if complete excision is impossible.
Marginal excision if salvage surgery would not be possible.

High grade: Tumours superficial to the fascia and greater than 3-5cm
Deep tumours all sizes.

<u>Extremity Soft Tissue Sarcoma</u>
Target Volume and dose prescription:

Preoperative Radiotherapy [2, 3]
Define GTV using Gd enhanced MRI on T1 weighted images

CTV_{50} = GTV + 2cm radially, *taking intact* bone, *skin and* fascial *boundaries into account*. *Add a 0.5cm margin over bone* or fascial boundaries. *A more generous 3cm axial margin is used for histologies known to be associated with high local recurrence rates (myxofibrosarcoma, malignant peripheral nerve sheath tumour (MPNST)).*
+ 3cm margin *longitudinally (proximally and distally)*, *but* do not extend the CTV beyond the *muscle* compartment.

Care should be taken not to taper the CTV longitudinally.
Confirm that any peritumoural increase in T2 signal is included in the CTV. This may require a greater than 3cm margin. For tumours deep to the fascia the CTV does not include the skin surface unless the biopsy site will not be excised at time of surgery. This may be included for superficial tumours.

Preoperative Radiotherapy for Subcutaneous Tumours

CTV_{50} = GTV + 3-4cm circumferential margin, taking intact bone, skin and fascial boundaries into account. Add a 0.5cm margin into underlying muscle, bone or fascial boundaries. Confirm that any peritumoural increase in T2 signal is included in the CTV. [7]

PTV_{50} = CTV_{50} + 0.7cm

Dose 50Gy in 25x 2Gy fractions x5/week (IMRT or Conformal)

MRI at 4 weeks after completion of radiotherapy
Aim for surgery at 6 weeks after completion of radiotherapy.

Adjuvant Radiotherapy [4]

GTV Pre-operative tumour volume
Reconstruct using pre-operative imaging, surgical notes and pathology report
Do not use post-operative seroma as a surrogate for GTV.

If adjuvant radical radiotherapy is prescribed for locally recurrent sarcomas not previously irradiated, the CTV is based on the combined tumour bed from first diagnosis and time of recurrence.

$CTV_{52.2}$ = GTV and includes biopsy site, drain site, seroma, surgical clips and surgical scar.
$CTV_{52.2}$ remains within the skin surface unless a clinical decision is made to include the skin, in which case the CT planning scan should be done with bolus.
+ 5cm margin sup/inf, or scar +1cm, and entire seroma.
+2cm axially unless there is an intact fascia or bony boundary, *where the margin should be 0.5cm over these boundaries.*
A more generous 3cm margin is used for histologies known to be associated with high local recurrence rates (myxofibrosarcoma, malignant peripheral nerve sheath tumour (MPNST)).
If facial plane violated consider margin >2cm.
Care should be taken not to taper the CTV longitudinally.
Confirm that any peritumoural increase in T2 signal is included in the $CTV_{52.5}$. This may require a greater than 5cm margin. For tumours deep to the fascia the CTV does not include the skin surface unless the biopsy site will not be excised at time of surgery. This may be included for superficial tumours.

Post-operative cases with flap reconstruction: consideration needs to be taken as to how much flap to include in the CTV; the flap is not part of the CTV.

For non limb sites $CTV_{52.2}$ = GTV +2cm sup/inf and axially depending on site and individual patient anatomy.

$PTV_{52.2}$ = $CTV_{52.2}$ + 0.7cm

CTV_{60} = GTV + 2cm sup/inf, and 2cm axially, keep the same axial margin as $CTV_{52.2}$
CTV_{60} remains within the skin surface unless a clinical decision is made to include the skin, in which case the CT planning scan should be done with bolus.

For non limb sites CTV_{60} if possible, reduce volume to spare normal tissue.

Postoperative Radiotherapy for Subcutaneous Tumours

$CTV_{52.2}$ = GTV + 3-4cm circumferential margin, taking intact bone, skin and fascial boundaries into account. Add a 0.5cm margin into underlying muscle, bone or fascial boundaries and surgical bed, scar and drain istes. Confirm that any peritumoural increase in T2 signal is included in the CTV. [7]

CTV_{60} = GTV + 1.5-2cm circumferential margin, taking intact bone, skin and fascial boundaries into account. Add a 0.5cm margin into underlying muscle, bone or fascial boundaries and surgical bed, scar and drain istes.[7]

PTV_{60} = CTV_{60} + 0.7cm

Dose

Clear surgical margins	60Gy in 30x 2Gy fractions to PTV_{60} x5/week
	52.2Gy in 30x 1.74Gy fractions to $PTV_{52.2}$ x5/week
Positive surgical margins	66Gy in 33x 2Gy/fractions to PTV_{66} x5/week
	53.46Gy in 33x 1.62Gy/fractions to $PTV_{53.46}$ x5/week

The PTVs should be edited to 0.3cm inside the patient surface, including the scar where this is part of the CTV.

These doses may be modified if spinal cord, brachial or lumbar plexus are within the PTV.
50.4Gy in 28 x1.8Gy/# x5/week as a single phase
45Gy in 25x 1.8Gy/# x5/week followed be a boost of 5.4Gy in 3 x1.8Gy/#
59.4Gy in 33 x1.8Gy/# x5/week as a single phase

Definitive Radical Radiotherapy
66Gy in 33 x 2Gy/# x5/week

In some patients, medical suitability for resection will need to be assessed during "pre op" radiotherapy. If patient is not fit for resection they will continue with a phase II volume, this will be planned with the phase I.

Phase I	50Gy in 25x2Gy fractions x5/week
Phase II	16Gy in 8x2Gy fractions if patient not for surgery

<u>Intra-cavity Sarcoma [6]:</u>

Pre-operative Radiotherapy:

Assess patient prior to recommending radiotherapy.
The patient must be fit enough for surgery.
The tumour must be assessed as resectable with negative macroscopic margins.
There should be absence of symptoms requiring immediate resection.

CT Simulation – additional information supplementing section 1:
For tumours above the iliac crest assessment of motion must be considered.
Identify GTV using available imaging.

Target Volume if 4D motion is assessed:

ITV = GTV incorporating 4D motion
CTV = ITV +1.5cm
Edit ITV at interfaces:
Retroperitoneal compartment, bone, kidney, liver; 0.5cm
Bowel and air cavity; 0.5cm
Under skin surface; 0.3-0.5cm
If tumour extends into the inguinal canal expand CTV by 3cm inferiorly

PTV = CTV + 0.5cm
Change in volume of the GTV will require re-planning.

Target Volume if 4D motion is not assessed (majority of tumour is below the pelvic brim)

CTV = GTV + 1.5cm
Edit CTV at interfaces:
Retroperitoneal compartment, bone, kidney, liver; 0.5cm
Bowel and air cavity; 0.5cm
Under skin surface; 0.3-0.5cm
If tumour extends into the inguinal canal expand GTV by 3cm inferiorly

PTV = CTV + 0.5cm
Change in volume of the GTV will require re-planning

Dose 50Gy in 25 x2Gy fractions 5x/week
Or 50.4Gy in 28x 1.8Gy fractions x5/week (if significant small bowel in PTV)

Post-operative Radiotherapy

Post-operative radiotherapy in retroperitoneal sarcoma can be challenging to deliver due to normal tissue tolerance. There are no international guidelines. Several small retrospective series have suggested that patients receiving post-operative radiotherapy have a reduced local failure rate. These series have suggested that local control was increased in patients who received greater than 50Gy. Post-operative radiotherapy can be facilitated by the use of spacers placed at the time of surgery.

GTV = Reconstruct pre-operative tumour volume using pre-operative imaging, surgical notes and path report. Consider image fusion. Modify the volume to account for organ movement following resection of sarcoma.

Use the voluming guidelines for pre-operative radiotherapy to construct CTV and PTV.

$CTV_{50.4}$ = GTV +1-1.5cm
$PTV_{50.4}$= $CTV_{50.4}$ + 0.5cm

Dose for intra-cavity sarcoma: 50.4Gy in 28x 1.8Gy fractions x5/week

Consider a Simultaneous Integrated Boost of 56Gy 28# if possible, to keep within OAR tolerances.

CTV_{56} = GTV + 0.2-0.5cm
PTV_{56} = CTV_{56} + 0.5cm

Dose for intra-cavity sarcoma SIB: 56Gy in 28x 2Gy fractions x5/week

Tolerances doses; as per the Quantec data.

If irradiating the upper abdomen, outline the spleen as an OAR. If the mean dose >10Gy consent patient for risk overwhelming post splenectomy infection (OPSI). Please see the Centre local asplenia guidelines.

3. Ewing Sarcoma

Reference should be made to current trial protocol (Euro Ewing 2012)

Indications:

- **Pre-operative Radiotherapy:**
    - If resection is expected to be marginal
    - If radiotherapy is expected to be indicated for another indication (below) and there is a technical advantage to give radiotherapy prior to surgery

- **Post-operative Radiotherapy should be considered:**
    - *Positive surgical margins, (or <0.1cm) if further surgery not possible*
    - *Poor histological response, ≤ 90% necrosis, to pre op* chemotherapy
    - *If* all tissue involved by the original pre chemotherapy tumour volume *has not been excised*
    - Displaced pathological fracture *of bone* at primary site
    - Sites where local control is *felt to be* more difficult *to achieve*
        - Spine and paraspinal sites
        - Pelvis and sacrum
        - Rib tumours *when* presenting with a pleural effusion

- **Definitive Radiotherapy** - For tumours where complete resection is not possible without unacceptable morbidity

- **Whole lung** - Patients with pulmonary and/or pleural metastatic disease
  (NB – Never in combination with Bu-Mel (Busulfan plus Melphalan) high dose chemotherapy

Target volume and dose definition:
The planning CT scan must include the whole tumour and involved bone, the tumour bed, the scar (for post-operative patients) and entire lung volume for thoracic spine tumours. Pelvis, sacral, paraspinal and spinal tumours may protrude into pelvic, abdominal or thoracic cavity at presentation, and may regress with treatment. This needs to be taken into account when delineating GTV and CTV. Consider tissue spacer and/or bladder filling for pelvic tumours.

Pre-operative and definitive radiotherapy
Define GTV using Gd enhanced MRI on T1 weighted images at its maximal extent prior to any chemotherapy or surgery.

- GTV = the visible tumour on imaging at its maximal extent (using CT, PET, bone and MRI scans, as available) prior to any chemotherapy or surgery. For tumours with 'pushing' margins extending into body cavities (e.g. abdomen, thorax), GTV may require modification to exclude normal tissues.
- CTV = GTV +1.5 - 2cm taking into account anatomical barriers to tumour spread such as fascial boundaries and bone. Do not extend more than 0.5cm into bone, or beyond intact fascial barrier or skin
  It does not include the skin surface unless involved or where the biopsy site will not be excised at time of surgery. Confirm that any peritumoural increase in T2 signal is included in the CTV. This may require a greater than 2cm margin. Do not extend the CTV beyond the compartment.
- PTV = CTV + 0.7cm (may be modified by site)

Post-operative radiotherapy

Pre-operative tumour volume at its maximal extent prior to any chemotherapy or surgery. Reconstruct using pre-operative imaging, surgical notes and pathology report. Do not use post-operative seroma as a surrogate for GTV

$CTV_{46.2}$ = GTV + 1.5 - 2cm. Extend further to include all areas of potential microscopic spread or contamination (including metallic prostheses, spinal rods and screws, drain sites and surgical scars, if feasible) taking into account anatomical barriers to tumour spread such as fascial boundaries and bone. CTV for spinal/paraspinal tumours should include one unaffected vertebra above and below the affected vertebra. The CTV does not include the skin surface unless a clinical decision is made to include the skin, in which case the CT planning scan should be done with bolus.

CTV_{54} = Should encompass the GTV and surrounding site of potential microscopic extension of tumour and should be no less than GTV +1-2cm margin in all directions. It should take in to account anatomical barriers to tumour spread. Do not extend more than 0.5cm into bone, or beyond intact fascial barrier or skin

$PTV_{46.2/54}$ = $CTV_{46.2/54}$ + 0.7cm (may be modified by site).

Dose for Ewing sarcoma:

Pre-operative: 50.4Gy in 28x 1.8Gy fractions x5/week.
This may be reduced to 45Gy in 25x 1.8Gy fractions if there is concern about organ tolerance or wound healing.

Post-operative: $PTV_{46.2}$ 46.2Gy in 30x 1.54Gy/# x5/week
PTV_{54} 54Gy in 30x 1.8Gy/# x5/week

Definitive: 54Gy in 30x 1.8Gy fractions x5/week
With SIB 58.6Gy in 30 x 1.95Gy/# to macroscopic disease if able to keep within normal tissue constraints

Paraspinal Tumours: 50.4Gy in *30* x *1.68*Gy/# x5/week as a single phase or an initial phase of 45Gy in 25x 1.8Gy/# x5/week followed be a boost of 5.4Gy in 3 x1.8Gy/#

In some patients, the best plan is achieved with Conformal RT rather than IMRT. In these cases, the following doses should be prescribed:

Phase I	45Gy in 25x1.8Gy fractions x5/week (to PTV 1 = $PTV_{46.2}$)
Phase II	9Gy in 5x1.8Gy fractions x5/week (to PTV 2 = $PTV_{54)}$

Whole lung radiotherapy:

CTV = Entire pleural cavity and lungs (defined using 4DCT)
PTV = CTV + 1cm

Dose: <14 years of age = 15Gy in 10x 1.5Gy fractions x5/week
≥14 years of age = 18Gy in 12x 1.5Gy fractions x5/week

4. Primary Non-Ewing Sarcoma of Spine/ Pelvis

Target volume and dose definition:

The planning CT scan should include the whole tumour and involved bone, the tumour bed (for post-operative patients) and entire lung volume for thoracic spine tumours. Consider tissue spacer and/or bladder filling for pelvic tumours.
Volume definition will be guided by pretreatment imaging, operative findings and clinical information. Image fusion should be performed.

Definitive radiotherapy;

GTV = the visible tumour on the planning CT with reference to diagnostic imaging prior to chemotherapy, if given.

CTV = GTV with a margin for suspected sub-clinical microscopic disease.
2-3cm margin in all directions, taking patterns of spread and intact skin, bone cortex and fascial barriers into account. Do not extend more than 0.5cm into bone, or beyond intact fascial barrier or skin
For spinal tumours margins will be smaller and individualised. If the bone cortex is breached a CTV margin will need to be added. Where the cortex of the bone is not breached but the central part of the bone is involved, the CTV can be restricted to the intact cortex. The CTV may need to be modified around critical structures
A shrinking volume technique with more than one dose level within the plan may be required if normal tissue tolerance constraints are difficult to meet.

Post-operative radiotherapy;

The GTV should be reconstructed using pre-operative imaging to aid the delineation of the CTV. The operation report and pathology report are required to reconstruct the GTV. For chordoma this is usually based on the T1-contrast enhancing tumour and abnormal bone on CT bony windows.

CTV = GTV with a margin for suspected sub clinical microscopic disease.
2-3cm margin in all directions, taking patterns of spread and intact skin, bone cortex and fascial barriers into account. Do not extend more than 0.5cm into bone, or beyond intact fascial barrier or skin
For spinal tumours, margins will be smaller and individualised. If the bone cortex is breached a CTV margin will need to be added. The CTV may need to be modified around critical structures.
A shrinking volume technique with more than one dose level within the plan may be required if normal tissue tolerance constraints are difficult to meet.
PTV = CTV + 0.5cm

Dose for primary non-Ewing sarcoma of spine/ pelvis:

Definitive radiotherapy: 60-70Gy to PTV in 30-38x 1.8-2Gy fractions x5/week

Post-operative radiotherapy: 60Gy to PTV in 30-34x 1.8-2Gy fractions x5/week

Post-operative radiotherapy (chordoma): Aim for 70Gy to PTV in 35-38 fractions in 1.8-2Gy fractions x5/week

5. Aggressive Fibromatosis (Extra Abdominal Desmoid)

Fibromatosis is locally aggressive tumour with no known potential for metastatic spread. They have a high rate of recurrence even after complete resection. They have an unpredictable clinical course and close observation is often recommended. Radiotherapy may be used when surgical morbidity would be unacceptable.

Definitive Radiotherapy

Define GTV using Gd enhanced MRI on T1 and T2 weighted images fused with planning CT

CTV56 = GTV + 2cm radially, taking intact bone, skin and fascial boundaries into account. Add a 0.5cm margin over bone or fascial boundaries.
+ 3cm margin longitudinally (proximally and distally), but do not extend the CTV beyond the muscle compartment.
Care should be taken not to taper the CTV longitudinally.

PTV56 = CTV56 + 0.7cm

Dose 56Gy in 28x 2Gy fractions x5/week (IMRT or Conformal)

6. Volume Definitions

Target volumes labelled GTV, CTV1, CTV2, PTV1, PTV2 are provided for the clinician in the structure template of the treatment planning system. These will be re-labelled by the clinician to include the appropriate prescription dose e.g. PTV1 will be re-labelled PTV52.2 and PTV2 will be re-labelled PTV60 (if there is a boost volume).

IMRT/VMAT cases:
The planner will copy each PTV into a new structure with _DVH added to the structure name and edited so that there are no overlapping volumes. Starting with the highest dose prescription PTV, the Boolean operator tool will be used to subtract any lower dose prescription PTV from it. The planner must also ensure that the PTV is cropped back from the skin by 0.3cm e.g. for limb cases.

Organs at risk will be contoured by the clinician where appropriate.

All volumes must be approved by the clinician.

7. Treatment Planning

Where possible a conformal plan or hybrid conformal plan with VMAT will be used for pre-operative cases. In addition, there may also be some instances where a conformal plan has been identified as the best option by the planner/clinician, such as treating at extended FSD. For all other cases, IMRT or VMAT will be used. Plans will be normalised as per the Eclipse Normalization and Algorithm Policy.

Extremities:

For extremities avoid beams entering through the contralateral limb. For VMAT, this can be achieved with partial arcs and/or avoidance sectors. For IMRT, 5-7 fields should be sufficient. Hybrid plans (conformal and IMRT/VMAT) may also be considered.

A longitudinal corridor with minimum diameter of 2cm should be excluded from the treatment volume to reduce the risk of lymphoedema. The planner will define a corridor, and this will be checked by the clinician at plan approval. When treating with conformal RT the corridor dose should be minimised with a significant proportion not exceeding 20Gy in the fully optimized treatment plan.

Target Dose Constraints for IMRT/VMAT

PTV_DVH Volume	Dose to PTV_DVH
98%	>90%
95%	>95%
50% (median)	100% +/- 0.5Gy
5%	<105% (as low as possible)
2%	<107% (as low as possible)

8. Normal Tissue Tolerances

All relevant organs at risk should be outlined and conventional dose constraints adhered to as per QUANTEC data (5)**

OAR	Dose Constraint
Weight bearing bone in treatment field*	V50Gy ≤50%
Weight bearing bone - whole bone	Mean dose ≤ 40Gy V40Gy ≤ 64%
Femoral head/neck	Mean dose ≤40Gy
Joint	V50Gy ≤50%
Soft tissue outside PTV (corridor)	V20Gy <50%
Brachial plexus	D_{Max} (<0.1cc) <60Gy
Spinal canal	Max (0.1cm^3) ≤48Gy 1cm^3 ≤46Gy
Spinal canal+0.3cm	Max (0.1cm^3) ≤50Gy 1cm^3 ≤48Gy
Spleen	If mean dose >10Gy consent patient for risk of infection V10Gy record
Peritoneal space	V45Gy <195cm3
Rectum	V50Gy ≤50% V60Gy ≤ 35% V65Gy ≤ 25% V70Gy ≤ 20%
Kidneys	V12Gy ≤ 55% V20Gy ≤ 32% V28Gy ≤ 20% Mean dose ≤18Gy
If mean dose to 1 kidney >18Gy	V6Gy (remaining kidney) <30%
Bladder	V65Gy ≤ 50% V70Gy ≤ 35%
Lung	V20Gy ≤ 30-35% Mean lung dose ≤ 20-23Gy
Cauda equina	Max 60Gy
Testis	V3 <50% (if patient wishes to preserve fertility)
Ovary	Mean dose <5Gy Max dose 10Gy

OAR	Dose Constraint
Liver (partial irradiation)	Mean dose < 30Gy V30Gy < 50% V40Gy < 30% V50Gy < 15%
Heart	V40Gy ≤ 30% V25Gy ≤ 50%

*Weight bearing bone: these constraints do not apply where the tumour invades the bone, where the planned surgery will include resection of that section of bone or where part of the bone circumference is enclosed by the tumour.

** PTV coverage should be compromised in order not to exceed OAR constraints for the following organs;
Cord PRV, Brachial plexus, Kidneys, Other OAR in discussion with clinician

9. Palliative Dose Options

8Gy 1#
20Gy 5x 4Gy/# x5/week
40Gy 15x 2.67Gy/# x5/week
6Gy weekly fraction up to a maximum of 5 fractions, to be reviewed prior to each fraction.
46-50Gy 23-25# 2Gy/# x 5/week to spinal metastases in low grade sarcoma with good PS and good prognosis
30Gy 10# 3Gy/# x5/week
45Gy 15# 3Gy/# x5/week

GTV: Tumour that is considered to be causing the main symptoms. It is not always necessary to treat all known tumour.
Field size: A 1- 2cm margin is sufficient depending on site and proximity to OARS

10. Review on Treatment

Review by Review Radiographer or Radiotherapy Specialist Nurse weekly from week 1 plus physician review during final week of treatment.

11. Treatment Delivery

Radiotherapy will be undertaken in accordance with the department policy.

Patients shall be postioned as per setup instructions

For VMAT plans, the couch longitudinal value when at the isocentre must not be equal to or greater than 158cm as gantry movement for treatment is prevented.

For all fractions of VMAT treatments, Radiographers treating MUST ensure the gantry will not collide with the patient or couch during the treatment.

TROUBLESHOOTING FOR EXTREMITY PATIENTS

TREATMENT

- If there is any difficulty with the set-up at fraction 1, the team leader who saw the patients set up at the scanning stage should be contacted for advice as soon as possible to prevent delays.

- If a Perspex board is used as part of the set-up equipment and the current indexing holes are not appropriate, the position of new, suitable indexing holes must be determined on fraction 1 and drilled preferably before the next treatment.

- If extra travel is required on the treatment couch the perspex board, or limb board can overhang the couch by up to approximately 15cm. Extra care must be taken to ensure there is no collision risk. If the equipment is unable to be physically indexed, the not slip matt should always be used.

- If the treatment site requires bolus, clear instructions must be given on the planning set up document. A discussion with physics must take place prior to the patient's first fraction, if any points are unclear and the set-up notes amended accordingly.

IMAGING

- If there is a rotational displacement outside the tolerance which is unable to be corrected with a re-set-up, priority should be given to anatomy at the level of the GTV
- In the event that there is a collision risk, an MV / kV pair should be considered.
- For CBCT:

  Where Longitudinal offsets cannot be achieved due to bed limitations (e.g., couch long158cm) the PTV should be covered as much as possible.

  On an iX linac, where Lateral Offsets are too large (> +/-7cm) the CBCT system is unable to automatically centre the couch for CBCT acquisition. In these cases, the couch will need to be moved manually, both before and after the CBCT is acquired. Example: Note the lateral couch position, start the CBCT process on the OBI station at the 4DTC, go back into the treatment room & manually move the couch laterally, using the motors to 0. After the CBCT is acquired, move the couch back manually in the treatment room.

Category
Sarcoma category 2. Patients receiving pre op radiotherapy (50Gy 25#) should be prioritised and their start date should not be delayed

In the event of an unscheduled break in treatment, compensation for the break should occur as per the Centre own local policy.

12. Treatment Verification

Verification images shall be acquired and assessed in line with the Centre own local policies.

13. Follow Up

- Post treatment review at 4-6 weeks
- For Soft Tissue Sarcoma:

Low grade	year 1-2	4 monthly with CXR
	year 3-10	annually with CXR
High grade	baseline MRI and CT chest at 3 months post surgery/ RT	
	year 1-2	3 monthly with CXR
		CT chest at 12 months
	year 3-5	6 monthly with CXR
	year 5-10	annually with CXR

- Individual for other tumour types (e.g. as per trial protocol)

14. Re Irradiation

In very select circumstances re irradiation can be considered. It depends on the expected prognosis and there being no suitable alternative treatment including SABR. The risks and benefits need to discussed and documented within a peer group and discussed fully with the patient.
Time elapsed from previous treatment, the use of chemotherapy, previous surgery, associated comorbidities, BED to points of interest and evidence of radiation sequelae are all important in any decision. Consider chemotherapy initially to reduce volume if appropriate.
If not suitable for re irradiation with SABR then doses and dose constraints as per the rectal re irradiation protocol have been used.

Ensure at least 6 months post previous radiotherapy treatment.

14. Proton Beam Therapy

Certain patients may be suitable for referral for proton beam therapy in the UK or abroad as part of the NHS Commissioning of Highly Specialised Services and should be individually assessed as per the clinical commissioning policy [6]

Potential indications:
- Chondrosarcoma – Skull base, spinal and paraspinal tumours
- Chordoma – Skull base and spinal tumours
- Spinal and paraspinal bone and soft-tissue sarcomas

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Appendix 1: The CTOC and EORTC-STBSG guidelines for radiotherapy target volume delineation

Radiotherapy target volume delineation for soft tissue sarcomas of the extremity: the CTOS and EORTC-STBSG guidelines.

R.L.M. Haas

Department of Radiotherapy

The Netherlands Cancer Institute – Antoni van Leeuwenhoek Hospital, Amsterdam.

Task Force Members:

Th. F. DeLaney (Massachusetts General Hospital, Boston, MA, USA), **B. O'Sullivan** (Princess Margaret Hospital, Toronto, Canada)
R.B. Keus (Arnhems Radiotherapeutisch Instituut, Arnhem, The Netherlands), **C. Le Pechoux** (Institut Gustave-Roussy, Paris, France)
P. Olmi (Istituto Nazionale per lo studio e la cura dei Tumori, Milan, Italy), **J.P. Poulsen** (The Norwegian Radium Hospital, Oslo, Norway)
B. Seddon (University College London Hospitals, London, UK), **D. Wang** (Medical College of Wisconsin, Milwaukee, WY, USA)

BACKGROUND

Guidelines for radiotherapy target volume delineation in extremity soft tissue sarcomas are lacking. A group of 9 radiation oncologists, members of CTOS and/or the EORTC STBSG, have joined forces over the last years to produce these guidelines and finalize a consensus.

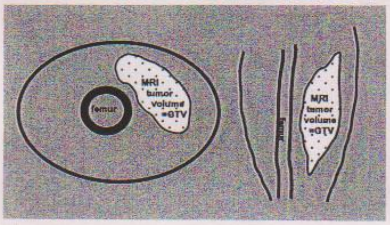
RECOMMENDATIONS

Stable and reproducible patient positioning is essential in high precision radiotherapy. Immobilization of the treated limb on an individual patient basis with customized immobilization devices to provide reproducible daily set-up is strongly recommended.

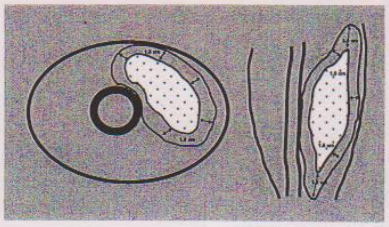
CAUTION

The CTOS / EORTC Task Force has produced these guidelines as an aid for radiation oncologists.
The Task Force does NOT accept any liabilities nor responsibilities concerning individual patients.

PREOPERATIVE RADIOTHERAPY

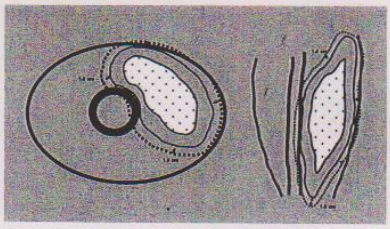


The GTV is defined by the volume of the tumor as visualized by contrast enhanced MRI. Preferably the MRI and planning CT scans are matched with the patient in the same treatment position.



The CTV is constructed by expanding the GTV in all directions with 1.5 cm, except
- o longitudinally; 3 cm in this direction
- o laterally in the directions of bones and fasciae, where the volume is expanded onto the surface of those bones and fasciae, unless these structures are involved.

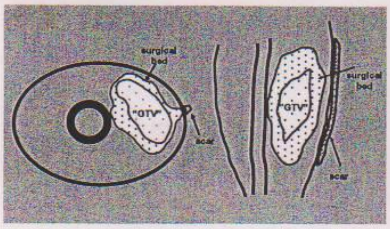
Note that the tumor surrounding edema is covered in all directions by the CTV (not necessarily by the GTV).



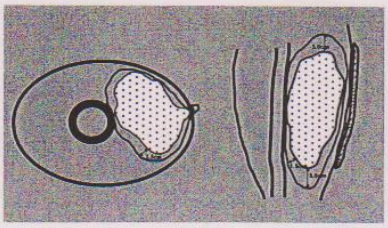
The PTV is produced by expanding the CTV with 1.0 cm in all directions, without exceptions.

Caution: CTV to PTV margins are dependent upon immobilization, image guidance, the reproducibility of the treatment setup and should therefore be based upon local institutional protocol according to the setup variability seen at that institution.

POSTOPERATIVE RADIOTHERAPY

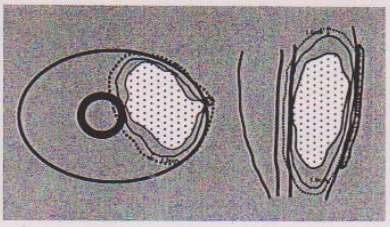


Obviously, a GTV cannot be defined in the postoperative setting, since the tumor is removed. Only a CTV can be constructed. Hereto, it is advised to reconstruct the original tumor extensions (the resected GTV) into the planning CT scan, and apply the same extensions to CTV as for the preoperative CTV delineation. CTV will have to be adjusted, if necessary, based on the extent of the operation field including all visible clips, and length of the surgical scar.



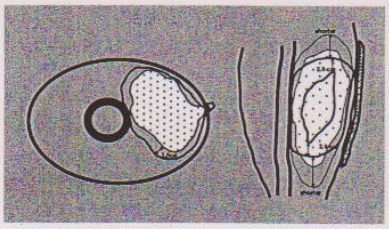
The **CTV-elective** is produced by delineating the entire surgical area with a 1.5 cm margin in all directions, except
- o longitudinally; 3 cm in this direction
- o laterally unto the surface of bones and fasciae

Note that the CTV remains inside the skin surface

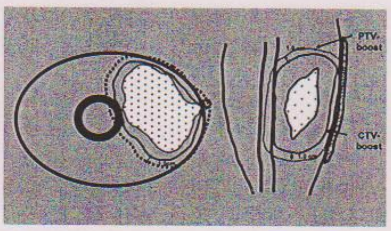


The **PTV-elective** is produced by expanding the CTV-elective with 1.0 cm in all directions, without exceptions.

For remarks on CTV to PTV margins: see above



The **CTV-boost** is the same volume as the CTV-elective except in the longitudinal direction: it is defined by the reconstructed GTV plus a 2 cm margin. In other words: the CTV-boost is shorter in the longitudinal plane, but it is not smaller in the transverse plane.



The **PTV-boost** is produced by expanding the CTV-boost with 1.0 cm in all directions, without exceptions.

For remarks on CTV to PTV margins: see above

*Correspondence: **r.haas@nki.nl***