RADIOThERAPY PROTOCOL

Document Title: Stereotactic Body Radiotherapy for Non-Small Cell Lung Cancer (54-60 Gy in 3-8 fractions)

Document Type: Clinical Guideline

Subject: Standard Care Plan

Approved by: Neil Bayman

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Author(s): 

Standard care plan for stereotactic body radiotherapy for non-small-cell lung cancer

References


Stereotactic Body Radiation Therapy (SBRT) for Patients with Early Stage Non-small Cell Lung Cancer: A Resource. UK SBRT Consortium, September 2009


Patient group
- Early stage NSCLC not suitable for surgery
- Clinical stages of: T1N0M0, T2 (≤5cm) N0M0 or T3 (≤5cm) N0M0

Indications
- Early stage NSCLC not suitable for surgery (see above)
- Lesion not within a previous radical radiotherapy field
- Any histological subtype of NSCLC
- MDT consensus of NSCLC if not able to confirm histologically
- ECOG PS 0-2 (selected cases with PS 3)
- Radiotherapy target volume is likely to be within radiotherapy planning constraints as judged by a clinical oncologist
- The UK SBRT consortium currently recommends that treatment should be reserved for peripheral lesions outside a 2cm radius of main airways and proximal bronchial tree. However there is emerging data that proximal tumours can be safely treated with minimal toxicity using 8 fractions (see Lagerwaard paper), and such tumours may be treated in the future.

Cautions
- Adequate lung function (typically FEV1 >40% predicted and KCO >40% predicted). However, the evidence for correlation of lung function with respiratory toxicity is poor, hence these parameters serve only as a guide. Therefore, radical treatment is not precluded with lung function below these arbitrary levels with careful patient consent and consideration of anticipated PTV and V20.

Evidence
Regimes recommended by the UK SBRT consortium for SBRT treatment of NSCLC in the UK are 54Gy in 3 fractions, 60Gy in 5 fractions and 60Gy in 8 fractions. There are many retrospective data supporting excellent outcomes with these dose and fractions.

Outcome
Retrospective data gives local control of 80-95% at 3 years which is superior to standard conformal external beam radical radiotherapy, and comparable local control to surgery. 2 year overall survival ranges from 65% to 90%, again superior to
the predicted 45% 2 year overall survival from radical external beam radiotherapy (see table 1).

**Toxicity**

Atelectasis ≥ Grade 2 occurs in less than 5%, pneumonitis ≥ Grade 2 occurs in about 5%, rib fractures occur in 5-20%. These figures however include data from RTOG 0236 which included treatment of proximal tumours, and treated tumours in contact with chest wall with 3 fractions. Our practice excludes proximal tumours and we treat tumours in contact with chest wall with 5 fractions, and we expect lower toxicities.

1. **Initial investigations and work up prior to start of treatment**

   1.1. **Diagnostic review and work up should usually include:**

   - Pathology/Cytology confirmed diagnosis of NSCLC (MDT consensus of NSCLC diagnosis if not able to confirm histologically)
   - Stage of disease determined and documented
     - CT Abdomen/thorax
     - Bronchoscopy
     - PETCT
     - EBUS/mediastinoscopy if radiologically suspicious mediastinal lymph nodes
     - Biopsy of supraclavicular lymph node if radiologically suspicious of malignancy
   - Clinical assessment and documentation of current disease related symptoms
   - Performance status recorded
   - Co-morbidities recorded
   - Smoking status recorded
   - FH recorded
   - Concomitant medications recorded and stopped if necessary
   - Lung function test desirable
• Patient consented for aims, practicalities and toxicity of radical external-beam radiotherapy

1.2. **MDT meeting**

Case must have been through the relevant diagnostic MDT prior to commencing treatment.

2. **Stereotactic Body Radiotherapy Technique for NSCLC**


Please also refer to the UK SBRT consortium guidelines.

2.1. **Patient treatment position and set-up**

Supine, breathing normally using an external immobilisation device with arms immobilised above the head in most cases. Exceptionally, for patients with limited arm movement or apical cancer, arms may be positioned by the patients’ side and consideration should be given to a 5 pt shell fixation to aid stability.

Set up should be by reference to anterior and lateral tattoos on stable areas of skin and bony anatomical landmarks.

2.2. **Patient data acquisition**

More consideration needs to be given to patient comfort as well as their positional stability and the reproducibility of their set-up.

Patients should be placed supine in a comfortable and reproducible position, with their arms above their heads, although alternative positions may be required for individual patients.

Devices such as customized vacuum bags can be used to achieve patient comfort and stability.

Custom immobilisation devices can also be used for immobilisation and to facilitate abdominal compression. The immobilization device should allow for patient and tumour imaging as necessary using CT, CBCT and/or fluoroscopy, and not interfere with dose calculation or treatment delivery.

In addition, analgesics +/- mild sedatives and oxygen can be considered to help the patient maintain the treatment position during each fraction.

Once the patient has been appropriately positioned, 4DCT is used to assess tumour motion.

2.3. **Target volume delineation**

Treatment will be planned based on information from bronchoscopy, PET-CT scan if available and mediastinoscopy or thoracotomy, if performed in addition to CT
findings. Target volume delineation will be done using both the mediastinal and lung windows.

Gross Tumour Volume (GTV) = The GTV is defined as the radiologically visible tumour in the lung, contoured using lung settings. Mediastinal windows may be suitable for defining tumours proximal to the chest wall. Where available information from PET/CT will be incorporated into delineating the GTV.

Clinical Target Volume (CTV) = The CTV is the GTV with no margin for microscopic disease extension. This is the accepted standard in the majority of SBRT trials.

Internal Target Volume (ITV) = tumour volume obtained using a 4DCT scan. This is defined as tumour contoured using either the (i) maximum intensity projection scan, (ii) maximum inspiratory and expiratory scans or (iii) as contoured on all 10 phases of a 4DCT scan.

Planning Target Volume (PTV) = ITV expanded by isotropic margins of 5mm.

2.4. Organs at risk (delineation and dose constraints)

It is recommended that the following organs at risk are delineated on the CT planning dataset.

- **Spinal cord**
  The spinal cord should be contoured on all slices based on the bony limits of the spinal canal.

- **Oesophagus**
  The oesophagus will be contoured using mediastinal windowing on CT to correspond to the mucosal, submucosa, and all muscular layers out to the fatty adventitia.

- **Brachial Plexus**
  The brachial plexus will be contoured using the subclavian and axillary vessels as a surrogate. This neurovascular complex will be contoured starting proximally at the bifurcation of the brachiophepalic trunk into the jugular/subclavian veins (or carotid/subclavian arteries), and following along the route of the subclavian vein to the axillary vein ending after the neurovascular structures cross the 2nd rib.

- **Heart**
  The heart will be contoured along with the pericardial sac. The superior aspect (or base) for purposes of contouring is defined as the superior aspect of pulmonary artery (as seen in a coronal reconstruction of the CT scan) and extended inferiorly to the apex of the heart.

- **Trachea and proximal bronchial tree**
  The trachea and bronchial tree will be contoured as two separate structures using lung windows. For this purpose, the trachea will be divided into two sections: the proximal trachea and the distal 2 cm of trachea. The proximal trachea will be contoured as one structure, and the distal 2 cm of trachea will be included in the structure identified as proximal bronchial tree. Differentiating these structures in this fashion will facilitate the eligibility requirement for excluding patients with tumours within 2 cm of the proximal bronchial tree.

*Proximal trachea*
Contours should begin 10cm superior to superior extent of PTV or 5cm superior to the carina (whichever is the more superior) and continue inferiorly to the superior aspect of the proximal bronchial tree.

**Proximal bronchial tree**
This will include the most inferior distal 2cm of trachea and the proximal airways on both sides. The following airways will be included: distal 2cm trachea, carina, right and left mainstem bronchi, right and left upper lobe bronchi, the bronchus intermedius, right middle lobe bronchus, lingular bronchus, and the right and left lower lobe bronchi.

**Whole lung**
Both lungs should be contoured as one structure using pulmonary windows. All inflated and collapsed lung should be included. However, GTV and trachea/ipsilateral bronchus as defined above should not be included. The Lungs-GTV should be kept at V20< 10%, and V12.5<15%.

### 2.5. Dose prescription

The dose prescription will be chosen such that 95% of the target volume (PTV) receives at least the nominal fraction dose.

Radical Radiotherapy doses: 54Gy in 3 fractions or 60Gy in 5-8 fractions. It is recommended that the inter-fraction interval be at least 40 hours, with a maximum interval of ideally 4 days between treatment fractions.

### 2.6. Verification:

Standard procedure involves an online cone beam CT correction strategy outlined below.
2.7. Treatment Delays:

- Every effort should be made to deliver the prescribed dose of radiotherapy within the standard timeframe. If unavoidable delays occur, patient will be treated on the next available treatment date. The consultant will need to be notified. It is aimed that despite potential delays all treatment will complete within 4 weeks. As overall treatment time will be less than 4 weeks, there is no need for compensation for tumour repopulation.
3. On treatment assessments

3.1. Clinical assessment by medical team with every fraction including
- Graded documentation of toxicity
- Assessment of disease related symptoms
- Performance status recorded

3.2. Management of treatment related toxicity

3.2.1 Radiation oesophagitis
- Grade 2 oesophagitis – optimise analgesia (consider sucralfate suspension, paracetamol mucilage, codeine phosphate liquid, oromorph, fentanyl patch). Advise soft diet/oral dietary supplements if required
- Grade 3 oesophagitis - treat as for grade 2 oesophagitis but also consider admission to The Christie/dietician input/parenteral nutrition if required. Every effort should be made to continue radiotherapy. Avoid placement of nasogastric tubes
- Grade 4 oesophagitis – As for grade 3 oesophagitis but radiotherapy should be stopped.

3.2.2 Radiation Pneumonitis
- Grade 2 pneumonitis - Consider oral steroids/antibiotics/antifungals
- Grade 3 pneumonitis – consider admission to The Christie for high dose IV steroids/oxygen/antibiotics/antifungals. Alert critical care team. Consider stopping radiotherapy
- Grade 4 pneumonitis – as for grade 3 but will require admission to critical care and consider ventilatory support if appropriate. Stop radiotherapy.

3.2.3 Radiation dermatitis
- Topical treatment with aqueous cream/1% hydrocortisone cream if required
Post treatment follow-up

- 2 week and 4 week post-treatment review with clinical assessment for residual treatment related toxicity and appropriate investigations at discretion of clinician.
- Further follow-up as outlined below:

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## Appendices

### ECOG PERFORMANCE STATUS*

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<thead>
<tr>
<th>Grade</th>
<th>ECOG</th>
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<tbody>
<tr>
<td>0</td>
<td>Fully active, able to carry on all pre-disease performance without restriction</td>
</tr>
<tr>
<td>1</td>
<td>Restricted in physically strenuous activity but ambulatory and able to carry out work of a light or sedentary nature, e.g., light house work, office work</td>
</tr>
<tr>
<td>2</td>
<td>Ambulatory and capable of all selfcare but unable to carry out any work activities. Up and about more than 50% of waking hours</td>
</tr>
<tr>
<td>3</td>
<td>Capable of only limited selfcare, confined to bed or chair more than 50% of waking hours</td>
</tr>
<tr>
<td>4</td>
<td>Completely disabled. Cannot carry on any selfcare. Totally confined to bed or chair</td>
</tr>
<tr>
<td>5</td>
<td>Dead</td>
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### CTCAE v4.0 Skin and Subcutaneous Tissue Disorders

<table>
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<tr>
<th>Adverse Event</th>
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<tbody>
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<td><strong>Oesophagitis</strong></td>
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<tr>
<td>Grade</td>
<td>1</td>
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<tr>
<td>Asymptomatic; clinical or diagnostic observations only; intervention not indicated</td>
<td>Symptomatic; altered eating/swallowing; oral supplements indicated</td>
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<tr>
<td><strong>Pneumonitis</strong></td>
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<tr>
<td>Grade</td>
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</tr>
<tr>
<td>Asymptomatic; clinical or diagnostic observations only; intervention not indicated</td>
<td>Symptomatic; medical intervention indicated; limiting instrumental ADL</td>
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<tr>
<td><strong>Rash: dermatitis associated with radiation</strong></td>
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<td>Grade</td>
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<td>Faint erythema or dry desquamation</td>
<td>Moderate to brisk erythema; patchy moist desquamation, mostly confined to skin folds and creases; moderate oedema</td>
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<td><strong>Dyspnoea</strong></td>
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<td>Grade</td>
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<td>Shortness of breath with moderate exertion</td>
<td>Shortness of breath with minimal exertion; limiting instrumental ADL</td>
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<td><strong>Fatigue</strong></td>
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<td>Fatigue relieved by rest</td>
<td>Fatigue not relieved by rest; limiting instrumental ADL</td>
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<td><strong>Chest wall pain</strong></td>
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<td>Grade</td>
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<tr>
<td>Mild pain</td>
<td>Moderate pain; limiting instrumental ADL</td>
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<tr>
<td>Cough</td>
<td>Mild symptoms; nonprescription intervention indicated</td>
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<td>---------------</td>
<td>------------------------------------------------------</td>
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