LONDON CANCER
NORTH AND EAST

London Cancer

Radiotherapy Guidelines for Treatment of Lung Cancer

June 2014

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1. Non-Small Cell Lung cancer

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4	Radical	Cyberknife T1/T2 < 3 cm tumours
5	Radical	Stage IIB /IIIA (some stage IIIB) chemo-radiation or radiation only dependent on PS, size of PTV
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7	Palliative	Symptomatic metastases i.e. bone, brain, nodes, skin

Adapted from Malthus Project Decision Tree: NSCLC, March 2013

NSCLC	Stage I	Surgery	Complete resection	No radiotherapy
			Positive margins	Radical radiotherapy
		No surgery - medically inoperable		Radical radiotherapy
	Stage II	Surgery	Complete resection	No radiotherapy
			Positive margins	Radical radiotherapy
		No surgery - medically inoperable	Radical radiotherapy	
	Stage IIIA	Surgery [non bulky nodal disease]	N0-1	No radiotherapy
			Positive margin, ≥N2	Radical radiotherapy
		No surgery	Definitive radical radiotherapy Concurrent chemo-radiotherapy	
			Palliative radiotherapy	
	Stage IIIB	Good performance status	Radiotherapy or sequential chemo-radiation High dose palliative radiotherapy	
		Poor Performance Status	Palliative chemotherapy Palliative radiotherapy	
	Stage IV	Focal symptoms	Palliative chemotherapy /biological treatment Palliative radiotherapy	
		No focal symptoms	No radiotherapy	

<table>
<tr><td rowspan="8">Non Small Cell Lung Cancer</td><td rowspan="3">Stage 1
16% (ECRIC, LUCADA)</td><td rowspan="2">Surgery
80% Malthus consensus</td><td>Complete resection</td><td>No radiotherapy[27] ECRIC 93%</td></tr>
<tr><td>Positive margins</td><td>Radiotherapy ECRIC 7%
60 Gy*30#
55 Gy20#
66Gy 33#</td></tr>
<tr><td colspan="2">No surgery - medically inoperable 20%</td><td>Radiotherapy 60-66 Gy /30-33# ,55 Gy/20# CHART*[14,15,21] 54 Gy/36#/12d, T1-2 ≤5 cms
SBRT[1,11] [Stereotactic Body Radio-Therapy] 54Gy/3# over 2 weeks > 40 hours apart, < 8 days apart
ECRIC RT 57%/
ECRIC 43% no treatment</td></tr>
<tr><td rowspan="3">Stage 2
7% LUCADA, 8% ECRIC</td><td rowspan="2">Surgery 80%</td><td>Complete resection</td><td>No radiotherapy[27] ECRIC 79%</td></tr>
<tr><td>Positive margins[2]</td><td>Radiotherapy
60* Gy/30-33# ECRIC 21%
55 Gy/20#</td></tr>
<tr><td>No surgery - medically inoperable 20%</td><td colspan="2">Radiotherapy 60-66* Gy /30-33# ,55 Gy/20#
CHART[14,15,21] 54 Gy/36#/12d, ECRIC 55% RT, 45% no Tx
T1-2 ≤5 cms
SBRT[1,11][Stereotactic Body Radio-Therapy] 54Gy/3# over 2 weeks > 40 hours apart, < 8 days apart
If stage 2 concurrent CT/RT[13,26]</td></tr>
<tr><td rowspan="3">Stage 3a
10%
LUCADA
Normalised</td><td rowspan="2">Surgery 10%
[non bulky nodal disease]</td><td>N0-1</td><td>No Radiotherapy ECRIC 71%</td></tr>
<tr><td>Positive margin, ≥N2[2,27]</td><td>Radiotherapy ECRIC 29% 55/20#, 60* Gy/30# if +ve margin 50/20 ≥ N2 disease
Lung ART 54/30#</td></tr>
<tr><td>No surgery 90%</td><td colspan="2">Definitive RT 40%
Concurrent chemo-radiotherapy[13,26] 60-66* Gy in 30-33#, 55 Gy/20#
If unable to have chemotherapy consider CHART[14,15,21] 54 Gy/36#/12
otherwise 66/33# or 55/20# Superior sulcus tumour consider preop crt 45 Gy/25# then surgery.</td></tr>
<tr><td colspan="3">Palliative radiotherapy 60%
high dose palliative 36 Gy /12#, 30 Gy/10#[24]
Poor performance status focal symptoms – palliative 20 Gy/5#, 16Gy/2, 10Gy/1 #Thoracic radiotherapy</td></tr>
</table>

	Stage 3b 19% LUCADA Normalised	Good performance status 50%	20% Radiotherapy – Concurrent CT/RT[13,26] 66G*y in 30#, 55Gy/20# over 4/52 ECRIC no treatment or surgery 37% 10%If unable to have chemotherapy consider CHART[14, 15, 21] 54Gy/36#/12d or 55/20# or 66/33#. 20 %-May consider chemo first and then sequential radical radiotherapy if reduced bulk. If excellent performance status and very large tumour [curative dose not possible as not encompasable] – 50% of patients are palliative High dose palliative 39/13#, 36 Gy/12#*, 30 Gy/10#[24] Palliative RT to chest if symptoms – 20 Gy/5#, 17*[16] Gy/2#16*[16] Gy/2#, 10Gy/1#
		Poor performance status 50%	25% Palliative chemo 75% Palliative RT 20Gy 5#, 16-17Gy 2#, 10Gy single#
	Stage 4 48% Lucada, 40% ECRIC	Focal symptoms 50%	Give chemotherapy /biological treatment. Palliative Radiotherapy to chest ECRIC RT 50 % 39/13#*, 36 Gy/12#[16] [very good performance status] 30 Gy/10#[24] ,20Gy/5#, 16-27Gy/2[16], 10Gy/1# Bone metastases 20 Gy/5#, 8Gy/1*# QUARTZ trial 20 Gy/5# vs no RT Brain 20 Gy/5# - If metastasis resected consider 30 Gy/10#
		No focal symptoms 50%	No radiotherapy ECRIC RT 50 %

Figures in red are clinical estimates : Malthus Project NSCLC Radiotherapy decision tree March 2013

LUCADA : National Lung Cancer Audit Programme

ECRIC : Eastern Cancer Registration and Information Centre

1.2. Post-operative treatment (adjuvant)

Radiotherapy is not recommended in completely resected N0-1 disease.

Where there has been incomplete resection or unexpected N2 disease radiotherapy may be offered as it has been shown to reduce local recurrence.

Performance status and residual lung function needs to be taken into account. FEV1 > 0.8 L/min. Case should be reviewed at MDT with surgical input and target volume should be identifiable by clips and encompassed by a simple volume.

Dose is dependent on whether the residual disease is macroscopic or microscopic.

- Macroscopic: 55Gy in 20 fractions over 4 weeks using 6 MV photons in a single phase.
- Microscopic: 50Gy in 20 fractions over 4 weeks using 6 MV photons in a single phase.

NB in certain situations e g tumour close to the spinal cord or in Pancoast tumours it may be preferable to use lower dose-per-fractions regimens e g 66Gy/33F for macroscopic tumour and 60Gy/30F for microscopic tumour.

1.3. Early Stage Disease : T1/T2 and N0 (or proximal N1) External beam 3D conformal radiotherapy or IMRT

Information required

- Referral form indicating RA/IMRT or 4D CT as applicable
- Healthcare records including copy of MDT decision
- Cytology/histology report including EBUS if available.
- Bronchoscopy report and pulmonary function tests
- Staging CXR/CT chest/abdomen, PET if performed- imaging and reports
- Chemotherapy investigations if appropriate including FBC, U+E, LFTs, EDTA
- Consent

Dose : Either is acceptable
55 Gy in 20 F using 6MV photons over 4 weeks in a single phase
Or 64-66 Gy in 32-33 F using 6MV photons over 6 ½ weeks in a single phase

Planning and treatment technique

Radical radiotherapy technique: Linear Accelerator: 6 – 10 MV photons

Patient treatment position	Supine, with arms above head. Immobilisation using chest board and fixed arm position. The patient should be breathing normally.
Patient data acquisition	A planning CT scan should be performed in the treatment position, whilst the patient undertakes a normal respiration, using 2 - 3 mm slices through the entire target volume and 5 cm margins in the superior/inferior direction. The whole lung (apex to diaphragm) should be covered using at least 2 cm slices to allow dose-volume histograms to be calculated. For all cases suitable for radical radiotherapy, every effort should be made to obtain PET/CT scan to enable the clinician to delineate between tumour and collapsed lung/consolidation and positive lymph nodes. Further information may be available from EBUS. Intravenous contrast should be used, when patient renal function permits and where central disease should be distinguished from vasculature. Where possible 4D CT scanning should take place to identify the complete tumour movement during respiration. Where uncertainty exists in delineating gross tumour volume (GTV) attempts should be made to discuss all images with diagnostic radiologist and experienced lung clinical oncologist to define extent of active tumour and possible involved lymph nodes either at lung MDT or at specific meeting with radiologist and clinical oncologist.
GTV – CTV – PTV Margins Planning target volume (PTV)	Peripheral tumours: Use Lung Window settings and outline tumour to include spicules as CTV. Enlarge to PTV by 1.5 cm superior / inferiorly and by 1.0 cm laterally. For central and mediastinal tumours / nodes : use mediastinal window settings for GTV. Add 0.5 cm in all directions for CTV then enlarge accordingly 1.5 cm superior / inferiorly and 1.0 cm laterally. This is a guide and for larger tumour volumes, discussion should take place with experienced consultant for alternative settings. Majority of lung tumours in the lower lobes in proximity to the diaphragm may show greater excursion during respiration than tumours located in the upper lobes. 4D CT scanning will eventually help demonstrate the full excursion of tumour during normal respiration and will help reduce margins.

	Where it is difficult to achieve coverage with the 95% isodose on the end slices, a slightly lower minimum dose will be accepted in preference to a clinically inappropriate increase in field length. Prophylactic nodal irradiation should not be employed.
Normal Tissues and Organs at Risk (OAR)	The spinal cord, both lungs, heart and oesophagus should be outlined. No more than 10 cm oesophagus should be included in PTV. The spinal cord position must be identified throughout the PTV. Maximum radiation dose to 10 cm spinal cord should not exceed 44 Gy in 2 Gy per fraction or 36Gy in 2.75 Gy fraction size. Every effort should be made to exclude normal lung tissue. Less than 35% of 'normal' lung (i.e. whole lung excluding Gross Tumour Volume) should receive a radiation dose of ≥ 20 Gy i.e. V20 < 35% but <30% preferable. The heart can receive the total dose (TD) to < 30% of its volume. For > 50% of cardiac volume, dose < 50% of TD is recommended.
Treatment planning	One or two phases may be used, depending on usual considerations regarding radiation tolerance of spinal cord, normal lung tissue and heart. Use of 3D conformal radiotherapy is required unless 4D planning is employed. Beams eye views may be useful in the design of individual shielding. 4D planning may be used for suitable tumours if the participating centre is able to do. Isodose distribution must be provided at the central plane. Dose volume histograms (DVH) for the PTV and normal lung will be calculated in order to obtain full knowledge of the 3D dose distribution.
Simulation	A simulation check is required for all treatment fields and the position of blocks used should be indicated on the simulator films.
Dose specification and fractionation	The PTV should receive 55 Gy in 20 daily fractions of 2.75 Gy over a period of 28 days. Alternative schedules are 64-66 Gy in 32-33 daily fractions over 6 ½ weeks. This may also allow for 2 phases for larger PTV coming off some mediastinal lymph nodes, when some uncertainty might exist on positivity of some PET warm lymph nodes.

	The dose will be specified at the ICRU reference point and fully corrected for heterogeneity. The dose distribution within the PTV should ideally be within ± 5% of the prescribed dose, and no more than ± 7% of the prescribed dose. In some situations it may not be possible to meet the above inhomogeneity requirements. If this is the case, a dose range of 107% - 90% will be accepted if the participating clinician confirms that this is the best achievable dose distribution and the area receiving less than 95% is not regarded as critical.
Treatment delays	Every effort should be made to deliver the prescribed dose of radiotherapy in the prescribed time. If unavoidable delays occur, that could increase the overall treatment time, e.g. due to machine breakdown, compensation should if possible be made by one of the following mechanisms: giving two fractions on a subsequent day, with a minimum interval of six hours between fractions, or treating on a weekend day, or adjusting fraction size to deliver the total prescribed dose within the allotted time. If the radiation schedule is interrupted for more than 1 week due to intercurrent illness consideration should be given to discontinuing treatment. Further treatment will depend upon the clinical situation and is at the discretion of the responsible clinician. Interruptions for < 1 week due to intercurrent illness or radiation toxicity will be recorded and treatment should be completed as planned.

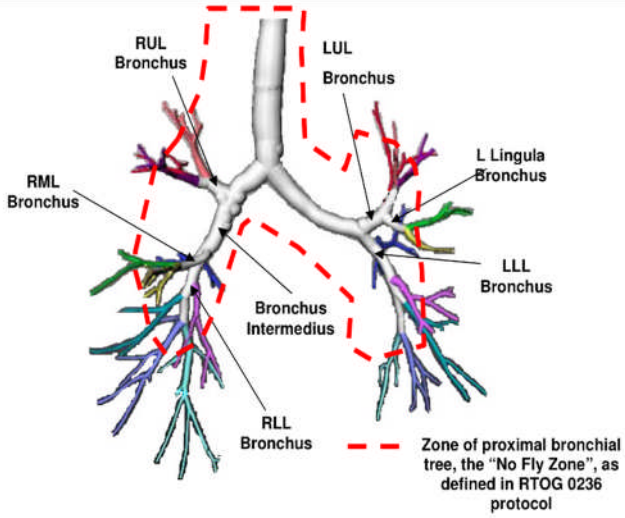
1.4. Stereotactic Ablative Radiotherapy or Stereotactic Body Radiotherapy

Stereotactic Ablative Radiotherapy (SABR) or Stereotactic Body Radiotherapy (SBRT) should only be performed in specialist centres with dedicated MDT and team with experience of > 25 cases /year. Dose schedule to be determined as per national SBRT group. [See SABR UK Consortium Version 4.0 January 2013]

Inclusion Criteria	• MDT diagnosis of NSCLC based on findings of positive histology, positive PET scan or growth on serial CT scan • Clinical stages of T1 N0 M0 or T2 (≤5cm) N0 M0 or T3 (≤5cm) N0 M0 • [radiologically N2 (CT or PET), patients only eligible if possible nodal disease is subsequently confirmed as histologically negative with mediastinoscopy or endoscopic bronchial or oesophageal ultra-sound biopsy]

	• Not suitable for surgery because of medical co-morbidity, lesion is technically inoperable or patient declines surgery after surgical assessment (or option of assessment) • WHO performance status 0-2 • Peripheral lesions outside a 2cm radius of main airways and proximal bronchial tree. This is defined as 2cm from the bifurcation of the second order bronchus e.g. where the right upper lobe bronchus splits (See bronchial tree diagram) • Age ≥ 18 years
Exclusion Criteria	• NSCLC patients with T2 or T3 primary tumours > 5cm • T3 primary NSCLC tumours involving the mediastinal structures or central T3 primary tumours. • Metastatic lung tumours • Any tumour that is not clinically definable on the treatment planning CT scan e.g. surrounded by consolidation or atelectasis. • If tumour has respiratory motion ≥ 1cm despite using techniques to reduce tumour motion, only proceed with treatment if target delineation is reliable and suggested normal tissue and tumour planning constraints can be achieved. • Tumours within 2cm radius of main airways and proximal bronchial tree (figure II.1). • Primary NSCLC tumours with clinical evidence of regional or distant metastasis after appropriate staging studies. • Previous radiotherapy within the planned treatment volume Presence of pulmonary fibrosis (unless the increased risk of SABR has been fully considered and the patient has been appropriately consented) • Chemotherapy administered within 6 weeks prior to study entry or planned for < 6 weeks following SABR. See diagram bronchial tree and exclusion zones:
Tumour Delineation	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 SABR 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.
Organs at Risks (OAR)	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 defined ipsilateral brachial plexus originates from the spinal nerves exiting the neural foramina on the involved side from around C5 to T2. However, for the purposes of this protocol only the major trunks of the brachial plexus will be contoured using the subclavian and axillary vessels as a surrogate for identifying the location of the brachial plexus. This neurovascular complex will be contoured starting proximally at the bifurcation of the brachiocephalic 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
Planning Dose Constraints	See table II2 SABR UK Consortium Version 4.0
Tumour Dose Schedules	18 Gy x 3 fractions 12 Gy x 5 fraction 11 Gy x 5 fraction

	ideally 2-4 days between fractions
Diagram of exclusion zone	

1.5. Cyberknife available at St Bartholomew's Hospital and Mount Vernon Hospital

Accuray Cyberknife, as a specialist form of Stereotactic Ablative Body Radiotherapy (SABR), has been recommended by the National Cancer Action Team : National Radiotherapy

Implementation Group Report 2011, as the "Standard of Care" for Stage I NSCLC : Suitable for peripheral lung cancers less than 3 cm size. T1 N0 M0

All other stages : Recommended as a Clinical Trial

Referral to Barts Stereotactic MDT or Mount Vernon MDT

1.6. Radical Chemo-Radiation or Radical Radiotherapy alone for locally advanced NSCLC.

Good PS locally advanced stage IIB, IIIA, some IIIB, small volume PTV.

Care should be taken to identify those patients who have stage III disease, with N2 or some N3 disease, who are of good performance status and have a small PTV that allows for radical external beam radiotherapy and for lung V20 to remain less than 35% (preferably less than 30%).

Dose: 55 Gy in 20 F over 4 weeks or 64-66 Gy in 32-33 F over 6 ½ weeks.

For those of excellent performance status, also consider chemo-radiotherapy.

Either sequential or Concurrent, for details see later.

Concurrent Chemo-Radiation: Suggested schedule for 4 week RT with concurrent chemotherapy Cisplatin/Vinorelbine

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Week 1	RT #1	RT #2	RT #3	RT #4	RT #5		
	Vin						
	Cis						
Week 2	RT #6	RT #7	RT #8	RT #9	RT #10		
	Vin						
Week 3	RT #11	RT #12	RT #13	RT #14	RT #15		
					Vin		
Week 4	RT #16	RT #17	RT #18	RT #19	RT #20		
					Vin		
	Cis	Cis	Cis	Cis			

RT # = Fraction of radiotherapy
Vin = Vinorelbine iv 15mg/m2, NB alternative :oral Vinorelbine 60mg/m2
Cis = Cisplatin iv 20 mg/m2
Radiotherapy to be delivered within 6 hours of chemotherapy.
Radical Radiotherapy technique as above.

Those patients who have lower performance status : consider sequential chemo-radiation or radical radiation alone.

IDEAL –CRT : Clinical Trial
Isotoxic Dose Escalation and Acceleration in Lung Cancer ChemoRadiotherapy: A phase I/II trial of concurrent chemoradiation with dose-escalated radiotherapy in patients with cisplatin and vinorelbine on Days 1 and 8 (vin only), and days 29 and 36 (vin only). 63 Gy in 30 Fractions minimum before dose escalation depending on toxicity.

- Histologically confirmed NSCLC
- Stages II, IIIA and IIIB
- FEV1 $\geq$ 40% of predicted or $\geq$ 1 L
- DLCO $\geq$ 40% of predicted

1.7. Palliative Settings

Indications
The main purpose is to palliate symptoms, although in some patients of good performance status, higher doses of radiotherapy have been shown to result in a modest improvement in survival.

In the case of patients with advanced disease, but who are not symptomatic, the use of radiotherapy is controversial. Several studies have shown no apparent benefit in survival in the use of immediate radiotherapy versus delayed radiotherapy and no difference in

symptom control or quality of life. Therefore, in this group, there should be a discussion with the Clinical Oncologist regarding the options of using palliative radiotherapy upfront or withholding radiotherapy until symptoms arise.

Palliation of chest symptoms: Historically, there have been many different types of radiotherapy schedules for palliation. The aim is to relieve the symptoms of cough, haemoptysis, chest pain, breathlessness or venous compression.

Information required

- Referral Form indicating diagnosis , stage and intent.
- Healthcare records including copy of MDT decision
- Cytology/ histology report including EBUS if available.
- If histology not conclusive, MDT decision required stating clinical and/or radiological diagnosis of bronchogenic carcinoma
- Bronchoscopy report
- Staging CXR/CT chest/abdomen, PET if performed- imaging and reports
- Consent

Immobilisation
Head Rest, Knee fix, Vacbag

Orientation
The patient must be able to lie flat for a period of at least 20 minutes for accurate radiotherapy planning to take place. An initial assessment should be carried out by the Clinical Oncologist regarding the WHO clinical performance status (CPS) of the patient and their ability to comply and lie flat.

Supine, arms above head fixed or by side if not possible

Localisation
3D conformal planning using CT data with IV contrast if requested
Planning CT scan with 2.5mm helical slices
Scan from thoracic inlet to 2.0cm below diaphragm (ensuring coverage of both lungs)

Target Definition
GTV: Primary tumour and involved LNs
CTV: GTV and margin to cover sub clinical disease
PTV: CTV plus margin Normally in the range of:
0.8cm-1.0cm Right /Left and Anterior/Posterior
1.0cm-1.5cm margin Superior/Inferior

Technique
A parallel opposed field technique, using Megavoltage photons from linear accelerator. The field should include the primary tumour and ipsilateral nodal disease at the mediastinum and immediate drainage lymph nodes where practically possible with a margin for movement and set-up error. For those patients with better clinical performance status and locally advanced disease within the thorax (but no metastases outside the thorax), a higher

palliative radiotherapy dose has been shown to result in a modest improvement in survival. In poorer performance patients and those with distant metastases (stage IV), a single fraction or two fractions are sufficient for symptom control [MRC lung cancer working group studies 1992, 1996]. The rate of symptom control is approximately 55%-65% using external beam radiotherapy.

The following table may be used as a guideline to palliative radiotherapy dose schedules:

Stage	WHO Clinical Performance Status (CPS)	Radiotherapy Dose Prescription
Locally advanced disease, not suitable for radical radiotherapy	0-1	36Gy in 12 #, maintaining cord tolerance 30 Gy in 10 # over 2 wks 20Gy in 5 # over 1 wk 17Gy in 2 # over 8 days
	2	10Gy single #
	3	10Gy single #
Metastatic disease outside thorax	0-3	8 or 10Gy single #
Any stage	4	8 or 10Gy single # or consider no radiotherapy but use symptomatic and supportive care

Side effects of treatment

Immediate: 6-12 hours: nausea, vomiting and chest discomfort occasionally seen, particularly after larger radiotherapy fractions. This may be alleviated with Paracetamol, Domperidone/Metoclopramide and Dexamethasone tablets 4mg bd x 1 day.

Intermediate: 2–4 weeks: radiation induced oesophagitis: may be managed with medication such as Gaviscon, Sucralfate or simple analgesia such as soluble paracetamol. Occasionally, candidiasis may be responsible and treated using Fluconazole tabs 50mg x 7 days or equivalent.

Delayed: 6–12 weeks or longer: radiation pneumonitis may be noted. This may be treated with a course of steroids for 4-6 weeks: Prednisolone 20mg od x 2 weeks, then slowly reduce to zero.

2. Small Cell Lung Cancer

2.1. Palliative Radiotherapy

Schedules are similar in technique and fractionation to those used in non-small cell lung cancer .

Consolidation thoracic radiation has been shown to improve absolute three year survival (from 8.9% to 15.3%) and improves local control in those with limited disease who have had a complete response to chemotherapy (Warde 1995).

2.2. Radical Radiotherapy

Standard three field radical radiotherapy techniques should be used if possible. There is evidence now that when radical radiotherapy is used with chemotherapy, for limited stage SCLC, the timing of the radiotherapy should be no later than after cycle 2 of chemotherapy

- Patient lies supine with arms above head
- CT Planning scan carried out for localisation of Gross Tumour Volume (GTV) and any relevant lymph nodes
- CTV and PTV must be delineated by Clinical Oncologist at Consultant level or experienced SpR (part I FRCR or year 3+) then checked by a Consultant Clinical Oncologist.
- Conformal Radiotherapy technique to be used where available.
- Computerised isocentric plan made by Physicist and approved by Clinical Oncologist
- Three or four field technique is often used to maximise high homogeneous dose to Clinical Target Volume whilst keeping radiation dose to normal tissue to a minimum.
- Gross Tumour Volume : GTV is delineated using mediastinal window settings on CT planning Scan.
- Clinical Target Volume CTV comprises the GTV with 0.5 cm margin in all directions.
- If lung window setting used, visible disease and spiculations is CTV.
- Planning Targit Volume PTV: is the CTV with 1.5 cm margin in all directions

Planning CT scan should therefore be undertaken after cycle 1 of chemotherapy, so that radiation may start after cycle 2 of chemotherapy. Chemotherapy is suspended until radiation is completed.

Organs at Risk OAR
Both lungs are delineated
Spinal Cord is delineated, within thoracic cavity
Oesophagus is delineated

Dose limiting tissues include spinal cord : A 10 cm length of spinal cord should not receive more than 45 Gy in 2 Gy # or equivalent. In special circumstances the dose to the spinal cord may receive 45 Gy if 1.8 Gy fractions used and length of spinal cord irradiated is less than 10 cm.

Radical Radiotherapy should start within 4 weeks of consultation with Clinical Oncologist (Royal College of Radiologist recommendation for category I type tumour)

Dose:

45 Gy in 30 Fractions twice daily (given concurrently with cisplatin/etoposide) over 3 weeks [31] : considered standard in some USA / European centres. But further results awaited from CONVERT Study

55 Gy in 20 Fractions over 4 weeks: (Smaller Target Volume)
40.05 Gy in 15 Fractions over 3 weeks: (Larger Target Volume)

In situations where there is residual small cell lung cancer disease in the mediastinum, which cannot easily be encompassed with three field technique, is to use an anterior and posterior opposed fields and treat to 40 Gy in 15 fractions. Lead shielding is used for the posterior field so that maximum dose to spinal cord is 35Gy (shield posterior field for last 4 fractions).

Consideration should be given to enter patient into CONVERT Trial : A 2-arm randomised trial comparing:

a) 45Gy in 30 fractions BD radiotherapy schedule (given concurrently with cisplatin/etoposide)
b) 66Gy in 33 fractions OD radiotherapy schedule (given concurrently with cisplatin/etoposide)

2.3. CONVERT Study Planning target volume (PTV)

The CT data will be transferred to the planning system.

- The GTV (gross tumour volume) will be contoured by a qualified radiation oncologist specialised in thoracic malignancies. The contouring should be carried out using the mediastinal and the lung windows. The GTV is defined as identifiable tumour and involved lymph nodes (nodal involvement on CT scan is defined as nodes $\geq$ 1 cm in short axis). If PET scan is available for staging, the GTV should include PET positive lymph nodes.

- The CTV (clinical target volume) comprises the GTV with a 0.5 cm margin of radiologically normal tissue in all directions. It will take into account microscopic spread. Manual adjustment of CTV is permitted to reduce dose to the spinal cord for example, when disease is adjacent to a structure such as a vertebra but is not thought to invade the structure

- The PTV comprises the CTV with a 1 cm margin superiorly and inferiorly, and 0.8 cm margin laterally, at the 95% isodose. The CTV to PTV expansion should not be reduced as it is allowing for set up errors and organ motion.

Prophylactic nodal irradiation should not be employed.

Prophylactic cranial irradiation (PCI)
PCI may improve three year survival from 8.9% to 15.3% in patients with limited disease a complete response to chemotherapy (Auperin 1999) and should be considered after discussion with patient. A parallel pair technique is used with 6 MV photons and treatment dose is 25 Gy in 10 fractions to the mid plane. This should be no later than 6 weeks after the final dose of chemotherapy.

PCI is also recommended for patients with Extensive Stage Small Cell, whose disease has responded well to first line chemotherapy.

3. References

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