CASE STUDY

METACHRONOUS STAGE I NON-SMALL CELL LUNG CARCINOMA

Georgetown University Hospital
MedStar Health

Georgetown University Hospital CyberKnife Team:

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CyberKnife Center:

Georgetown University Hospital
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METACHRONOUS STAGE I NSCLC

DEMOGRAPHICS:

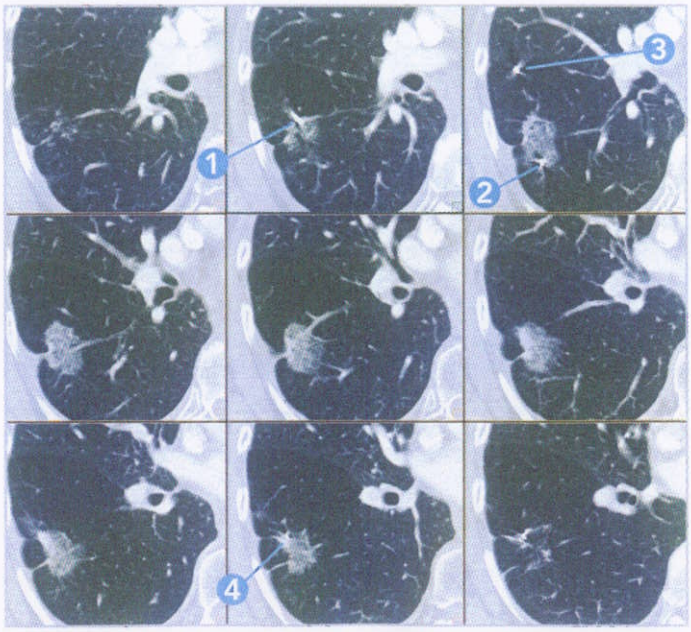
Sex: F
Age: 64
Histology: Pulmonary adenocarcinoma, bronchoalveolar type.
Treat Date(s): 10/25/04 – 11/02/04

CLINICAL HISTORY:

Referred by: Pulmonologist

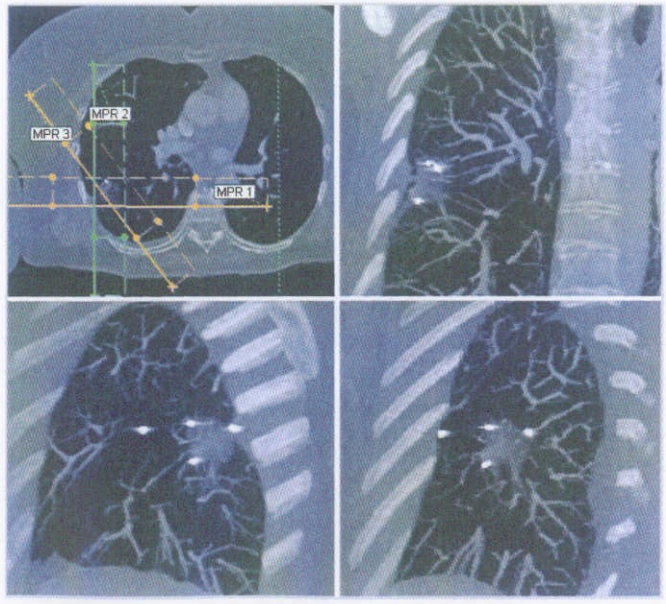
Past Medical History: Stage III non-small cell lung cancer (NSCLC) of the left upper lobe diagnosed in 1999, Chronic Obstructive Pulmonary Disease (COPD), smoker

Case History:
A 64-year-old female ex-heavy smoker with severe COPD and a history of Stage III NSCLC in the left upper lobe, treated with conventional radiation and chemotherapy in 1999, presented with a new 3-cm right lower lobe (RLL) ground glass opacity. CT-guided needle biopsy completed in July 2004 confirmed well-differentiated pulmonary adenocarcinoma of the bronchoalveolar type. Given this patient's complete response to treatment for her poorly differentiated adenocarcinoma five years prior, this new RLL adenocarcinoma was classified as a metachronous Stage I lung cancer. The patient's COPD had progressed since her prior radical conventional chemoradiation treatment in 1999, with a current forced expiratory volume in one second (FEV_1) of 1.13 liters.



Pretreatment diagnostic 3.0-mm CT sections showing the tumor and 4 implanted fiducials.

CyberKnife Treatment Rationale:
Stage I NSCLC is typically treated by primary surgical resection (lobectomy or more limited resections, such as wedge resections).[1-2] Conventional radiation has been reserved for patients who refuse surgery or are deemed medically inoperable because of associated co-morbidities.[3] This patient's severe COPD made her a poor surgical candidate.[2] Her significant pulmonary disease and prior conventional radiation increased the risks of treatment by conventional radiation.[3] Furthermore, pretreatment fluoroscopic exam revealed substantial tumor excursion with respiration (longitudinal motion with an amplitude of 3 cm). Accounting for this degree of tumor motion would require large margins of normal tissue to be irradiated, further increasing the risks of radiation pneumonitis.[3] To minimize morbidity for this high-risk patient, a viable treatment would have to target the tumor precisely and maximally spare normal lung tissue. The CyberKnife® equipped with the Synchrony® Respiratory Tracking System allows the accurate delivery of high-dose radiation to moving lung tumors, thereby minimizing harmful effects to normal surrounding tissue.[4]



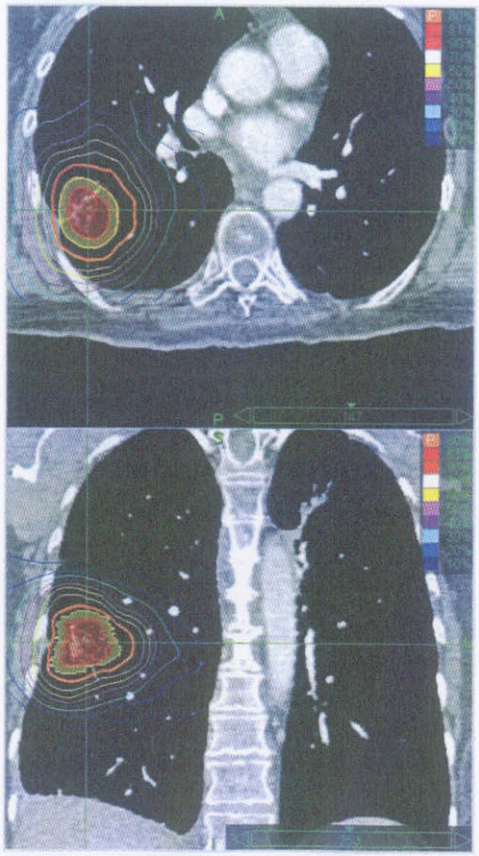
Coronal, sagittal and oblique multiplanar reformations taken from 1.0-mm planning CT showing placement of fiducials near the tumor.

METACHRONOUS STAGE I NSCLC

TREATMENT DETAILS:

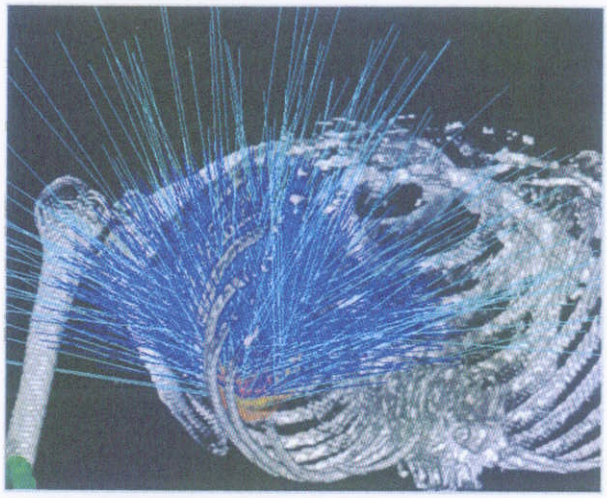
Tumor Volume:	11.84 cm^3	**Fractions / Treatment Time:**	3 / 97 min average per fraction
Imaging Technique(s):	CT	**Path Template:**	3 path 900_1000 mm
Rx Dose & Isodose:	54 Gy to 80%	**Tracking Method:**	Synchrony with 4 Fiducials
Conformality Index:	1.97	**Collimator(s):**	30 mm
Tumor Coverage:	99%	**Number of Beams:**	172

Planning Process and Goals:
The patient was prepared for treatment planning by placing 4 fiducials near the RLL tumor percutaneously under CT guidance. A planning CT was obtained 7 days later. Fiducials were identified and the lesion was outlined on the scan, resulting in a target volume of 11.84 cm^3. A treatment plan was developed using the MultiPlan™ treatment planning system. The final plan was created to deliver 54 Gy in 3 fractions to the 80% isodose line, with 5-mm tumor margins, using a 30-mm collimator. The V_{20} (volume of lung receiving greater than 20 Gy) was less than 10%.

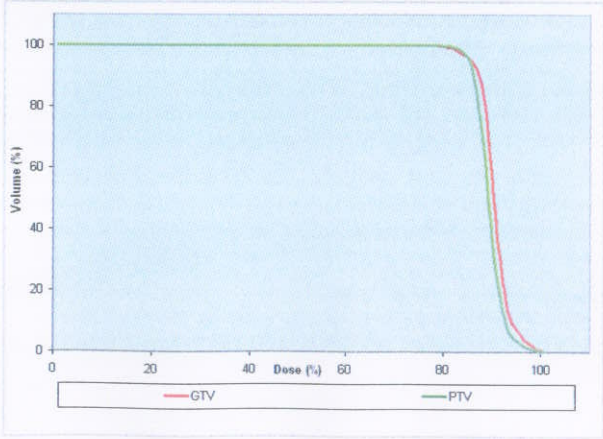


Axial and coronal planning images showing gross tumor volume (GTV) in red and planning tumor volume in yellow. The 80% isodose line (representing a prescription dose of 54 Gy) is shown in orange.

Treatment Delivery:
The patient underwent CyberKnife treatment using 172 beams. The prescribed dose covered 99% of the planning target volume (PTV) with a homogeneity index of 1.25 and a conformality index of 1.97. The amount of surrounding normal lung parenchyma was maximally spared and the patient tolerated the procedure well.



3D rendering of bony anatomy and CyberKnife beam positions to the RLL tumor.



Dose Volume Histograms (DVH) for GTV (red) and PTV (green).