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CASE STUDY

SYNCHRONOUS BILATERAL STAGE IA NON-SMALL CELL CARCINOMA

Georgetown University Hospital
MedStar Health

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DEMOGRAPHICS

Sex:	Female
Age:	63
Histology:	Poorly differentiated squamous cell carcinoma

CLINICAL HISTORY

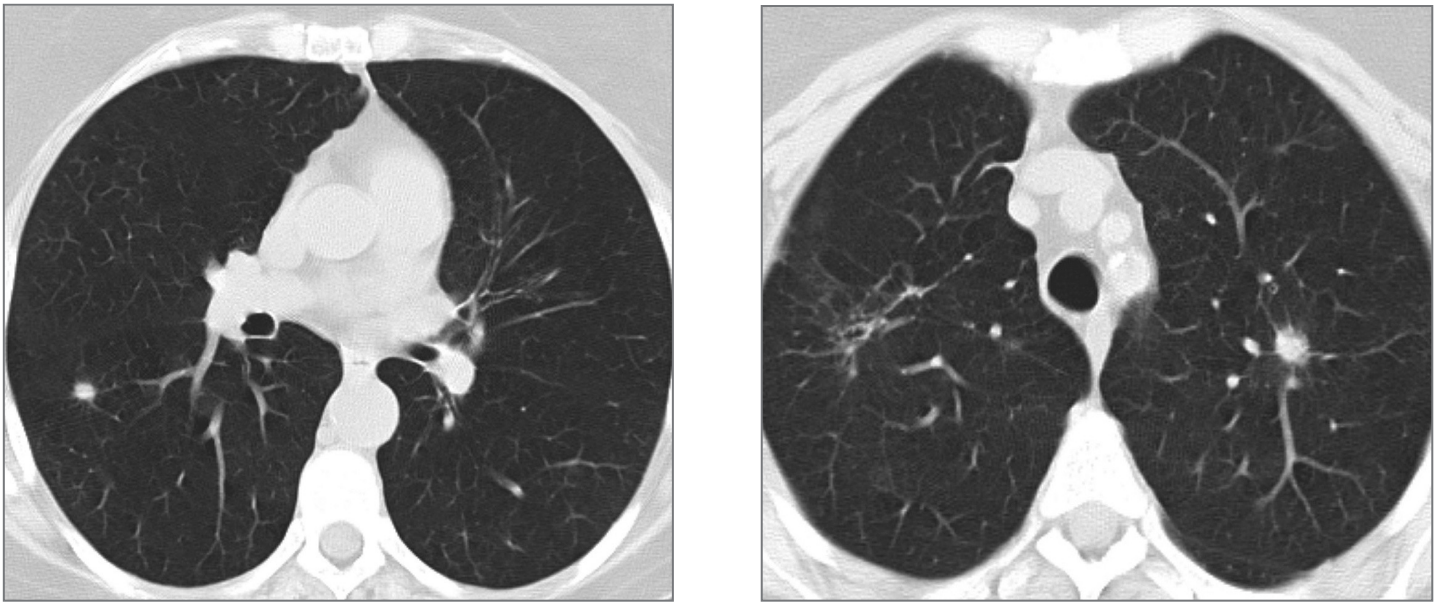
Referred by:	Thoracic Surgeon
Past Medical History:	COPD (chronic obstructive pulmonary disease), smoker

Case History

A 63-year-old female smoker with a history of COPD presented with bilateral pulmonary nodules noted on chest X-ray. PET-CT scanning demonstrated a 1.5 x 1.0 cm left upper lobe (LUL) nodule and a 1.0 x 1.0 cm right lower lobe (RLL) nodule, both with increased standardized uptake value (SUV) suspicious for malignancy. LUL biopsy confirmed poorly differentiated squamous cell carcinoma. These findings and the clinical presentation left open the question of whether the correct diagnosis was bilateral synchronous primary Stage I non-small cell lung carcinoma (NSCLC) or metastatic disease. Given the patient's excellent functional status, the patient underwent a RLL video-assisted thoracoscopic (VATS) lobectomy two months after PET-CT scanning. Microscopic evaluation confirmed Stage IA primary adenocarcinoma. The patient's post-operative course was difficult and she had a significant decline in her pulmonary function. Her forced expiratory volume in 1 min (FEV1) was 1.06 (45% o f predicted) and her carbon monoxide diffusing capacity (DLCO) was 50% of predicted. Follow-up imaging, 5 months after her initial diagnosis, demonstrated stability of the LUL lesion with persistent high SUV uptake.

CyberKnife® Treatment Rationale

When possible, Stage I NSCLC is treated by primary surgical resection (lobectomy or segmentectomy).[1,2] Conventional radiation therapy and chemotherapy have been treatments reserved for patients who refuse surgery or who are deemed medically inoperable because of associated co-morbidities. In recent years improved tumor control with relatively few complications has been achieved using high-dose, hypofractionated stereotactic radiation delivery.[3-5] The patient was offered a second thoracotomy and LUL lobectomy, but was also informed that her decreased post-operative pulmonary function tests (PFTs) and history of COPD made her a borderline surgical candidate. She was unwilling to undergo a second thoracotomy, and instead chose to receive CyberKnife® treatment of the lesion with concurrent chemotherapy. The CyberKnife System with the Synchrony® Respiratory Tracking System delivers high-dose radiation to lung tumors while minimizing deleterious effects to normal surrounding tissue by tracking and correcting for tumor movement throughout the respiratory cycle.[6-9]



Pre-treatment diagnostic CT imaging demonstrating right lower lobe 1.0 x 1.0 cm and left upper lobe 1.5 x 1.0 cm pulmonary nodules.

TREATMENT DETAILS

Gross Tumor Volume:	1.27 cm^3	**Fractions:**	3
Imaging Technique(s):	CT	**Tracking Method:**	Synchrony with fiducials
Rx Dose & Isodose:	60 Gy to 80% isodose	**Collimator(s):**	20 mm
Conformality Index:	2.0	**Homogeneity Index:**	1.25
Tumor Coverage:	100%		
Number of Beams:	126 beams/fraction		

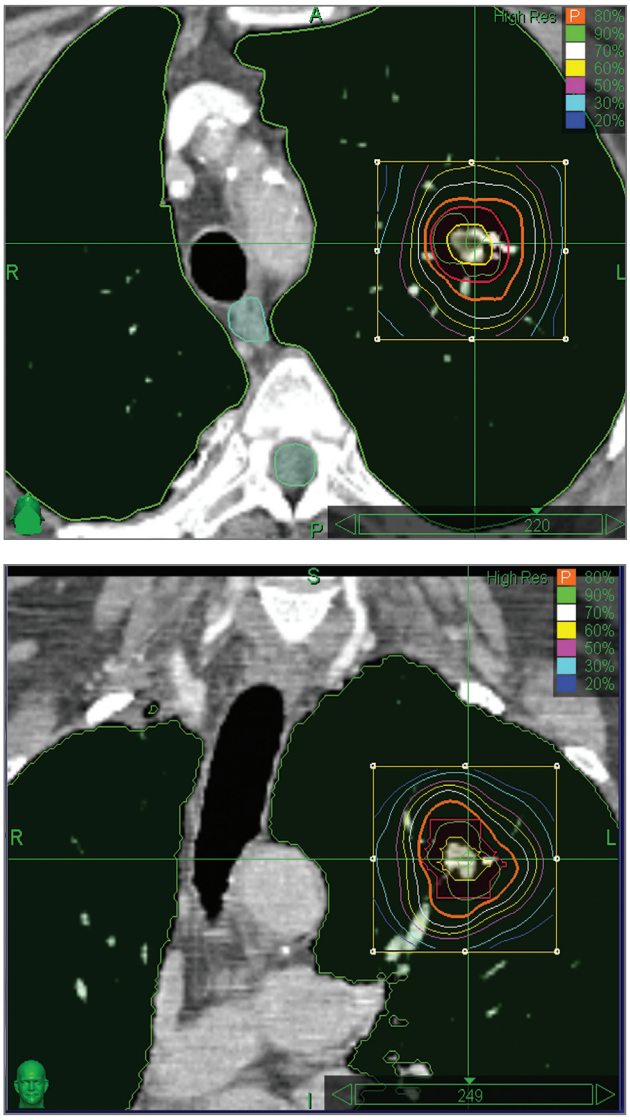
Planning Process

The patient was prepared for treatment planning by implanting four fiducials in close proximity to the LUL tumor percutaneously under CT guidance. A planning CT image was obtained 7 days later. Fiducials were identified and the lesion was outlined on the scans resulting in a gross tumor volume of 1.27 cm^3. A treatment plan was created to deliver 60 Gy in 3 fractions to the 80% isodose line with 5-mm tumor margins, using the 20-mm collimator.

CT imaging 5 months after initial diagnosis demonstrating stability of the left upper lobe lesion.

Treatment Delivery

The patient underwent CyberKnife® treatment using 126 beams/fraction. The prescribed dose covered 100% of the tumor target with a homogeneity index of 1.25 and a conformality index of 2.0 for the PTV. The patient tolerated the procedure well.



Axial and coronal treatment planning images showing gross tumor volume (GTV, yellow isodose line) and planning tumor volume (PTV, red). The 80% prescription isodose line is shown in orange.

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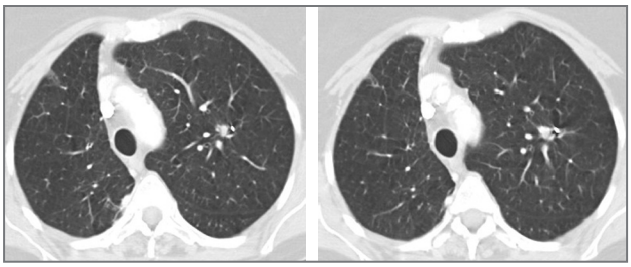
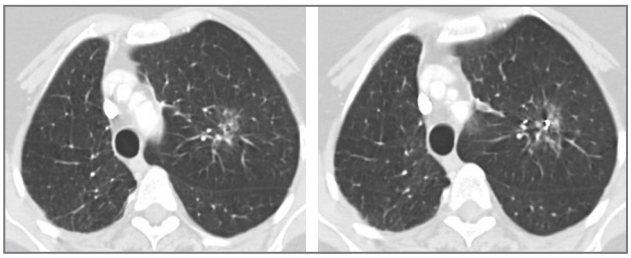
Outcome and Follow-Up:

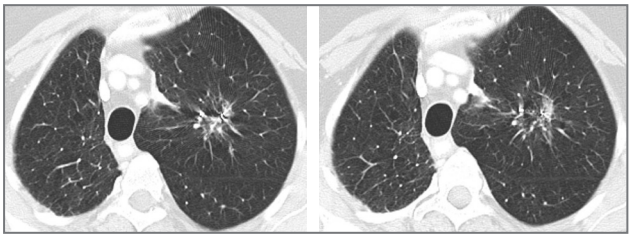
- Two months after CyberKnife® treatment CT imaging revealed an interval decrease in the size of the LUL lesion, which measured 0.91 x 0.8 cm – the patient complained of mild dyspnea on exertion but imaging revealed no infiltrates or findings consistent with radiation pneumonitis or pneumonia; the patient was managed conservatively



- Ten months after CyberKnife treatment the patient's PET-CT scan revealed further interval decrease in the size of the LUL lesion (0.8 x 0.5 cm) – this lesion had been PET positive prior to treatment by SUV criteria, but was now PET negative; the patient's dyspnea, noted at the previous follow-up, had completely resolved – the patient's PFTs were equal to pre-treatment values



- Eighteen months after CyberKnife treatment CT imaging revealed findings consistent with residual scarring – no tumor was noted; the patient remains stable with no reported radiation-induced toxicities and without evidence of disease



Conclusion and CyberKnife Advantages:

- This patient had an excellent initial outcome with the CyberKnife System with Synchrony® Respiratory Tracking in the treatment of a LUL lung tumor; normal lung parenchyma was preserved and pre-treatment lung function and performance status were maintained
- The CyberKnife System can deliver complex treatment plans to lesions within the lung while minimizing irradiation to the surrounding healthy tissue, thereby decreasing the risk of complications, such as radiation pneumonitis
- The CyberKnife System is an excellent treatment option for patients with lung tumors who refuse surgery or who are deemed medically inoperable because of co-morbidities and poor functional status

GEORGETOWN UNIVERSITY HOPSITAL (www.georgetownuniversityhospital.org)

Georgetown University Hospital's (GUH) CyberKnife Robotic Radiosurgery System, installed in 2002, was the first system on the East Coast. The Synchrony Respiratory Tracking System was added in 2004 and Xsight® Spine Tracking in 2006. The CyberKnife System allows GUH physicians to provide a targeted, minimally invasive alternative to open surgery and a treatment option for certain tumors that are otherwise untreatable. GUH physicians and the Radiation Oncology Department have created a multi-disciplinary approach to provide their patients with the most comprehensive diagnosis and treatment possible. Over 400 patients were treated in 2006, with a clinical workload of 45% intracranial, 20% spine and 35% extracranial non-CNS.

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