

Stereotactic radiation therapy of a solitary lung tumor with on-line correction using Elekta Synergy®

Institution:	William Beaumont Hospital, USA
Patient:	72-year-old male
Diagnosis:	Non-small cell lung cancer
Plan:	Seven-field, coplanar and non-coplanar, unopposed beam arrangements
Image guidance:	Elekta VolumeView™ on-line correction
Positioning:	Elekta Stereotactic Body Frame®
Treatment:	Target – 12Gy daily (cumulative dose: 48Gy)

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Radiation Oncologists: **Inga S. Grills, MD, K. Kenneth Chao, MD.**
Medical Physicists: **Geoffrey D. Hugo, PhD, Jennifer L. Wloch, Di Yan, DSc.**

Patient diagnosis and history:

The patient is a 72-year-old male with a history of emphysema and American Joint Committee on Cancer (AJCC) stage IA adenocarcinoma involving the left upper lobe of the lung. The patient underwent a lobectomy and mediastinal lymph node dissection in 2000 and in February 2006 he presented with a new nodule in the right lung.

Thorough work-up including a CT scan of the chest, an F-18 fluoro-2-deoxyglucose (FDG) PET scan, routine blood work, and a brain MRI, revealed a 1.4cm solitary nodule in the right lower lobe with abnormal FDG uptake (standardized uptake value = 5.8) in the nodule and equivocal uptake in the mediastinum. A CT-guided biopsy of the lung nodule was positive for a high-grade adenocarcinoma. A mediastinoscopy with biopsy was negative for any mediastinal nodal disease.

The patient was evaluated by thoracic oncology, radiation oncology, and medical oncology. It was determined that he was only a candidate for a wedge resection of the lung due to his suboptimal pulmonary function and prior surgical resection. Given the significant risk of post-operative morbidity, the patient elected to proceed with a course of image-guided hypofractionated stereotactic radiation therapy on a phase II clinical trial.

Planned treatment

A seven-field, coplanar and noncoplanar, unopposed beam arrangement using 6MV photons was designed using Philips Pinnacle3[®] V7.4 and optimized with the Dynamic Machine Parameter Optimization™ module (figure 1). The prescription dose was 48Gy administered in 4 fractions of 12Gy each to the planning target volume (allowing up to 20% heterogeneity). The maximal dose to the spinal cord was 20.1 Gy (protocol limit = 20.5Gy). The volume of lung that received 10.8Gy was 8.9% (protocol limit = 15%). Maximal dose to other critical normal tissues included 0.6Gy to the brachial plexus (27Gy), 7.7Gy to the esophagus (30.5 Gy), 1.2Gy to the trachea (33.9Gy), 11.3Gy to the proximal bronchial tree (33.9Gy), and 7.1Gy to the heart (33.9Gy).

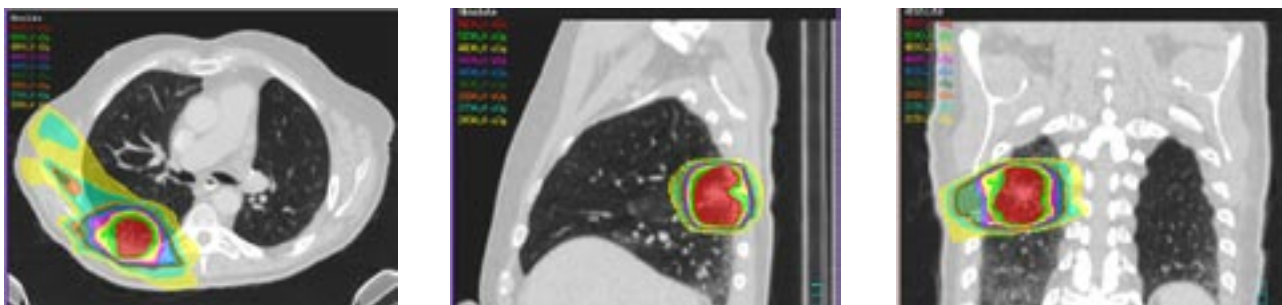


Figure 1: dose distribution of the seven-field stereotactic radiation therapy plan with conformal limits to spinal cord and pertinent mediastinal tissue structure.

Treatment using image guidance

The patient was immobilized using Elekta Stereotactic Body Frame® and this was used throughout imaging and treatment. A planning CT scan, as well as a planning PET scan, were used for treatment planning. A 3D Elekta VolumeView™ image was acquired using Elekta Synergy®. Image registration of the visible tumor was used to perform daily on-line translation-only position corrections. Pre-correction and post-correction images, compared to the initial planning data set, are shown in figure 2. The gentleman tolerated the treatment very well and completed the course without any delays.

Uncorrected

Corrected

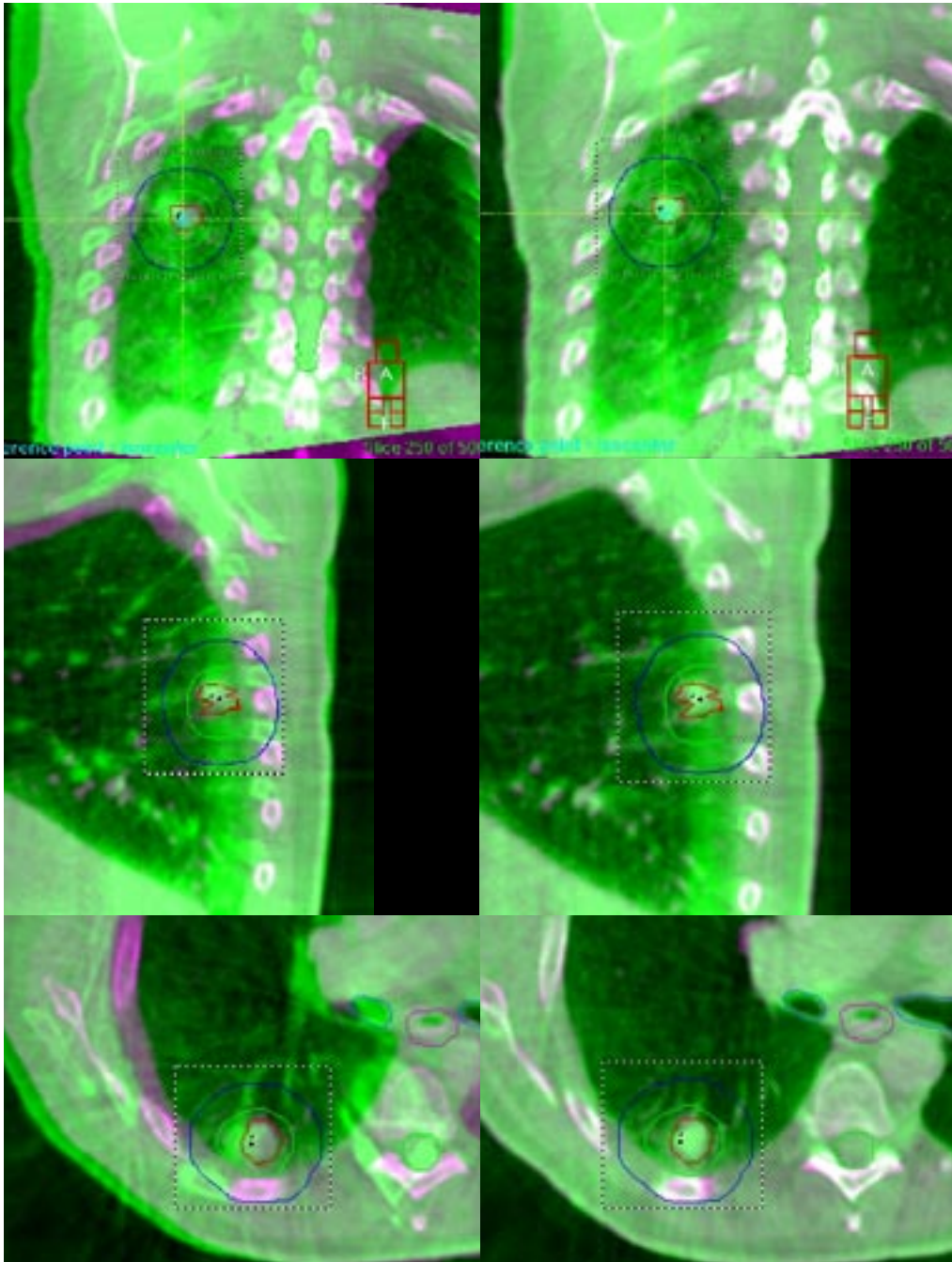


Figure 2. Elekta VolumeView™ images acquired using Elekta Synergy® show uncorrected (left) and corrected (right) positions. Daily VolumeView™ images were registered to the gross visible tumor from the pretreatment planning image. Translation-only position corrections were determined automatically using the X-ray volume imaging (XVI) software and verified by staff. (continued overleaf)

Treatment time = 30 to 45 minutes:

Using DMPO IMRT for stereotactic radiosurgery

8 to 12 mins.	– patient set-up
1 to 2 mins	– 1st VolumeView™ acquisition (<i>pre-correction</i>)
2 to 3 mins.	– 1st image registration using grey value auto-registration
1 min.	– position correction
1 to 2 mins	– 2nd VolumeView™ acquisition (<i>post correction</i>)
1 to 5 mins	– 2nd image registration/correction
10 to 14 mins.	– treatment

Dose exposure per VolumeView™ acquisition is approx. 2 to 3cGy to the skin

Outcome and follow-up

At the time of this case study composition, the patient's tumor is locally controlled and the patient has exhibited no signs of acute or subacute toxicity.

Discussion

Stereotactic radiation therapy of this lung tumor was optimized with daily on-line positional corrections using Elekta VolumeView™ cone beam CT. Accurate dose delivered to the tumor was ensured while unnecessary exposure of the spinal cord and other critical normal tissues was minimized.

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