Imaging During Radiation Therapy Captures Abrupt and Dramatic Changes

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A 53-year-old woman with non–small-cell lung cancer of the left upper lobe (LUL) was treated with radiation and concurrent chemotherapy. The initial baseline 18F-fluorodeoxyglucose positron emission tomography (FDG-PET) and computed tomography (CT) scans (Fig. 1, left panels) displayed an FDG-avid LUL mass, a positive left pretracheal node, atelectasis of the LUL, and minimal FDG activity in the esophagus. Repeat CT and PET scans (Fig. 1, middle panels) on day 39, after a 44 Gy tumor dose, revealed minimal activity in the pretracheal node, reduced LUL tumor activity and size, persistence of the LUL atelectasis, and increased esophageal activity. Three days later, an on-treatment cone beam CT (Fig. 1, upper right panel, CT3*) showed remarkable posterior-lateral translation of the primary

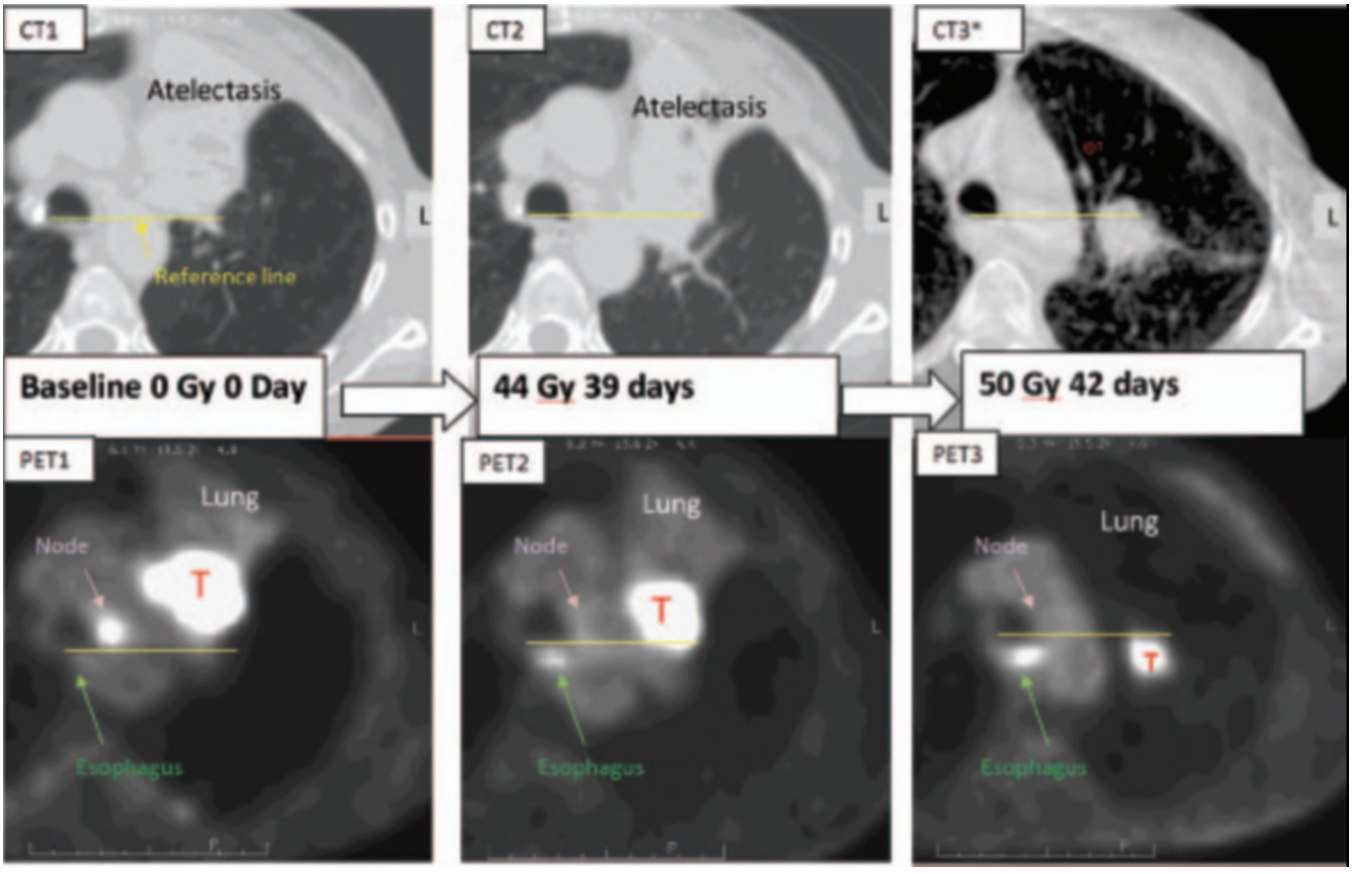

FIGURE 1. CT and 18-FDG PET images obtained at three time points during radiation therapy. CT, computed tomography; FDG PET, fluorodeoxyglucose positron emission tomography.

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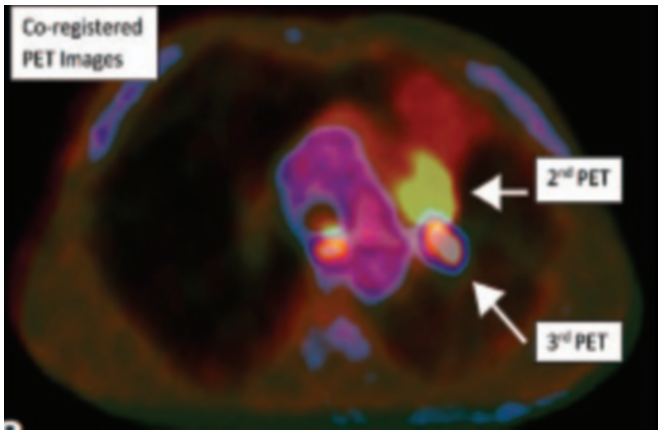

FIGURE 2. A composite image showing a fusion of the second and third PET images. PET, positron emission tomography.

tumor and complete resolution of the LUL atelectasis. Repeat CT (not shown) and PET (PET3) confirmed the cone beam CT findings and demonstrated increased esophageal activity consistent with clinical symptoms of radiation esophagitis. The abrupt resolution of atelectasis and dramatic tumor shift, demonstrated in the coregistered PET image showing a fusion of the second and third PET images (Fig. 2), mandated substantial changes to the treatment. Without adaptive planning, a highly conformal treatment plan would have missed a portion of the shifted target volume. With advanced radiation delivery methods and small treatment margins the possibility of a geometric miss because of such a shift is high. Similar tumor and anatomic remodeling may go undetected unless frequent imaging is performed during treatment, especially when the patient's normal anatomy is drastically altered by disease. In such cases a daily cone beam CT may be warranted. This finding provides further justification for the Radiation Therapy Oncology Group 1106/American College of Radiology Imaging Network 6697 trial, which will test whether during-treatment PET- and CT-based individualized adaptive radiation planning enables improved local regional tumor control in non–small-cell lung cancer.

