Background:
FDG-PET/CT has become an integral component of non-small cell lung carcinoma staging because it improves the detection of nodal and distant metastases and frequently alters patient management (1). PET is more sensitive than CT for staging of many malignancies, including non-small cell lung carcinoma, as well as for differentiating lung malignancy from benign lung findings, such as post-obstructive atelectasis (2).

The use of radiation therapy for curative treatment of lung cancer is limited by the radiosensitivity of surrounding normal structures, by difficulty in delineating the extent of malignancy using conventional imaging techniques and by the identification of distant metastatic disease (3).

3-DCRT and IMRT have improved the accuracy of radiation delivery leading to improved locoregional control with reduced morbidity by facilitating delivery of higher radiation dose to tumor while increasing normal tissue sparing (2,4).

Case Example 1:
Case Example 1. a. CT image showing primary lung cancer in the left upper lobe. The red line defines the GTV and the yellow line defines the CTV. b. PET reveals pathological FDG uptake (purple and green area) in the left upper lobe at the same level as the CT image in a. c. The fusion image documents that FDG uptake is also present in the subcarinal region, indicating metastatic lymph node extension not visible on CT. The red line defines the GTV and the yellow line defines the CTV. In this image a part of the treatment field of radiotherapy planning is seen (yellow wedges). D. 3D conformal treatment planning was performed, choosing the volume based on FDG uptake, which encompassed lymph node disease. This figure clearly reveals the increase in GTV (red volume) and the consequent increase in CTV (yellow volume) due to inclusion of lymph nodes in the subcarinal region. (5)
Functional imaging is increasingly being utilized for treatment planning for patients with cancer at several anatomic sites (6). PET/CT simulation for radiation therapy treatment planning requires that the patient be aligned using the same setup that will be utilized during radiation therapy. 4D CT respiratory gating can also be utilized (7).

Ashamalla, et al, determined that PET/CT planning is a valuable tool for refining traditional treatment volumes (8). Macapinlac concluded that the incorporation of FDG PET images into radiation therapy treatment planning resulted in a 15% - 60% increase or decrease in treated volumes (1). Bradley et al reported that in 30-60% of patients treated with definitive radiotherapy, PET simulation enhanced precision in coverage of the GTV (6).

Overall, there has been limited evaluation of incorporation of FDG PET/CT images into radiation therapy treatment plans. Thresholding needs to be further studied, as do new technologies such as PET gating and average CT techniques. Ultimately, improvement in outcomes will determine the widespread use of FDG PET/CT in radiation therapy treatment planning.

References

Case Example 2: This patient presented with right upper lobe atelectasis. The FDG-PET images helped to (1) differentiate the primary tumor (red arrow) from atelectasis (yellow arrow) within the right upper lobe and (2) delineate abnormal-sized upper paratracheal node on CT, but showing avid FDG uptake on the PET scan (white arrow). (6)