

REVIEW

The role of PET scanning in the evaluation of lung carcinoma

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Abstract

The purpose of the review is to:

- provide information concerning the physiology of lung cancer imaging with fluorodeoxyglucose (FDG) positron emission tomography (PET);
- clarify the role of FDG–PET in the diagnosis of solitary pulmonary nodules;
- summarise the accuracy of PET scanning in the staging of lung cancer both in regard to mediastinal nodal staging and the staging of distant metastases.

Keywords: Lung neoplasm; PET; lung nodule.

Solitary pulmonary nodules

Positron emission tomography (PET) with F-18 2-fluoro-2-deoxy-D-glucose (FDG), a glucose analogue labelled with positron-emitting fluorine-18, is a useful imaging modality for evaluating patients with lung cancer. Most malignant tumours are characterised by increased glucose metabolism. Because tumours are metabolically active, tumour cells take up increased amounts of FDG relative to normal lung tissue. FDG is therefore highly sensitive in the identification of malignant tumours.

PET was previously available only in institutions with an on-site cyclotron. FDG is now distributed commercially, and PET imaging for lung cancer has been approved for reimbursement by most third-party payers.

PET with FDG has become an additional option for the evaluation of solitary pulmonary nodules and other focal lung lesions. Reported sensitivities for the detection of lung cancer have ranged in various reports between 83 and 100%, with specificities of 63–90% using standard

uptake values of equal to or greater than 2.5^[1,2]. False-negative studies, however, can occur in tumours with low metabolic activity, such as bronchioloalveolar carcinoma and carcinoid tumours, and in small nodules that are smaller than 1 cm in diameter^[3,4]. False-positive studies may occur in benign nodules or lesions with high metabolic rates, such as active inflammatory processes. These include infections such as infectious granulomas and sarcoidosis.

The negative predictive value of a PET study is clinically useful. Patients with focal lung lesions without significant FDG uptake can be followed because a negative finding is highly suggestive of a benign abnormality. The positive predictive value is lower, and such lesions frequently require biopsy; however the positive predictive value for FDG–PET is 90% in patients over 60 years of age. The FDG–PET scan should also be interpreted in conjunction with the clinical likelihood of lung cancer in a given patient and other

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radiologic features of focal lesions, such as growth rate, morphologic features, and the presence or absence of contrast enhancement.

Staging of lung cancer

PET has recently proved useful in the staging of lung carcinoma in the determination of the presence of nodal disease and distant metastases. In several studies, up to 18% of patients considered to be resectable have more advanced disease demonstrated by PET imaging.

Regarding nodal staging, the sensitivity of PET has been reported in the range of 76–100% and specificities range from 82 to 100%. Several studies have demonstrated the superiority of FDG–PET over CT scanning in the evaluation of nodal disease. In a meta-analysis comparing the value of PET in 514 patients studied from 1994 to 1998 to CT studies in 2226 patients studied in the same period, PET was more accurate than CT in demonstrating nodal metastases from non-small cell lung cancer. The mean sensitivity and specificity for PET was 79 and 91%; for CT scanning, it was 60 and 77%. Wahl *et al.*^[5] demonstrated a sensitivity of 82% and a specificity of 81% for PET in staging the mediastinum, as compared with a sensitivity of 64% and a specificity of 44% for CT scanning. The overall diagnostic accuracy of PET was 92 and 75% for CT scanning. Peterman *et al.*^[6] studied 102 patients with non-small cell lung cancer. The sensitivity for PET in the detection of mediastinal nodal metastases was 91%, with a specificity of 86%. Despite the superiority of PET over CT scanning for evaluation of mediastinal adenopathy, the resolution of PET makes determination of the extent of the tumour and involvement of individual lymph node groups difficult. CT is still required for anatomic correlation, and the combined use of CT scanning and PET to stage intrathoracic nodal metastases is clinically useful.

PET seems to improve the non-invasive detection of extrathoracic disease. Whole-body PET can stage intrathoracic and extrathoracic disease in a single examination, and has an overall greater accuracy than conventional imaging. Whole-body PET can detect unsuspected extrathoracic metastases in up to 10% of patients when CT scanning fails to detect them, and may also alter management in up to 40% of cases.

PET may be used to evaluate adrenal masses, with sensitivities and specificities of PET reported to be 100% and 80–100% respectively^[7]. The bones are another common site of metastatic disease. PET detects lesions not found on conventional studies. The accuracy,

sensitivity, and specificity of PET for bone metastases have been reported to be above 90%^[8]. There are, however, limitations in the PET evaluation of brain metastases. The normal brain has significant glucose uptake, and metastases may be difficult to detect on PET. Reports of low sensitivity (68%) have been reported in detecting brain metastases, and PET should not be used to replace CT or MR imaging. There are limitations of PET in the evaluation of non-small cell lung cancer. The positive predictive value of PET is lower in patients with inflammation (e.g. in post-obstructive pneumonia). The limited anatomic resolution of PET makes evaluation of the extent of the tumour less reliable than CT scanning or MR imaging.

Preliminary studies have also demonstrated the benefit of FDG–PET in measuring response to chemotherapy and radiation and also in the detection of recurrent disease^[9]. PET has been reported to have a sensitivity of 97–100% and a specificity of 62–100% in the detection of recurrent tumours. Scans are most reliable 6 months to 1 year after completion of therapy. Before that time, hypermetabolic inflammatory changes may result in false-positive studies.

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