Mediastinal Lymph Node Sampling Following Positron Emission Tomography With Fluorodeoxyglucose Imaging in Lung Cancer Staging*

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Objectives: To evaluate the predictive accuracy as well as the rates of false-positive and false-negative results of CT and positron emission tomography (PET)-fluorodeoxyglucose (FDG) imaging in detecting the metastatic intrathoracic lymph nodes in patients with suspected or proven non-small cell lung cancer (NSCLC). Our other objective was to determine the need for routine invasive sampling procedure in confirming PET/CT staging results.

Methods: The results of CT and PET-FDG scanning in 77 patients with suspected or proven NSCLC were correlated with the histologic findings of hilar/mediastinal lymph node sampling using mediastinoscopy, open biopsy, thoracotomy, or thoracotomy with resection. Patients were then classified into resectable and unresectable groups based initially on PET results and compared to histologic findings.

Results: The sensitivity, specificity, and accuracy of CT and PET for detecting metastatic lymphadenopathy were 68%, 61%, 63%, and 87%, 91%, and 82%, respectively. A change of management with routine sampling following PET was seen in five of six patients (83%) with false-positive findings (13%) but in none of four patients (9%) with false-negative findings.

Conclusion: The false-positive findings of PET-FDG imaging affected selection of treatment in 83% of patients. However, false-negative results did not change management in any patient. This could potentially prevent unnecessary invasive thoracotomy, mediastinoscopy, or other sampling procedures in patients with negative PET results.

Key words: fluorodeoxyglucose; lung cancer; lymph node staging; positron emission tomography

Various diagnostic techniques and procedures are used for preoperative staging of lung cancer patients, including CT, bronchoscopy, mediastinoscopy, thoracoscopy, and positron emission tomography (PET). Among the noninvasive diagnostic methods, CT scanning is still considered the “gold standard” for staging of mediastinal disease in lung cancer. However, CT scanning is primarily a morphologic imaging test and suffers from limited sensitivity and specificity (55 to 65% and 65 to 75%, respectively). Several studies have shown that PET is superior to CT in staging mediastinal disease, with reported sensitivity and specificity of 82 to 100% and 81 to 100%, respectively. Whole-body PET imaging is also useful in detection of occult distant metastasis in as many as 10 to 25% of patients with lung cancer. While PET imaging may accurately establish lymph node staging in lung cancer patients, often mediastinoscopy/biopsy/thoracoscopy is still utilized

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Manuscript received August 11, 2000; revision accepted February 12, 2001.

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Lung cancer continues to be the most common cause of death by cancer in the United States, comprising 33% and 23% of the estimated cancer deaths in men and women, respectively. Non-small cell lung cancer (NSCLC) accounts for 80% of all lung cancers and has the potential for surgical cure once detected at an early stage. Optimum management of patients with NSCLC depends on accurate staging. Generally, stages I, II, and IIIA are considered surgically resectable with the potential for surgical cure, whereas stages IIIB and IV are considered nonresectable.
for decisions regarding unresectable status as to the presence of N2/N3 disease. Our objective in present study was to evaluate the need for such routine invasive sampling procedure in all cases to confirm findings of PET/CT scanning. We analyzed the data to determine the accuracy of PET/CT in identifying and classifying the presence of metastatic intrathoracic lymph nodes in lung cancer patients.

**Materials and Methods**

In this retrospective study, we included 111 consecutive patients with suspected or proven NSCLC who were referred for whole-body PET imaging for preoperative staging of lung cancer. None of the patients had received prior treatment for lung cancer. All patients underwent CT scanning of the chest within 4 weeks of the PET scanning for staging of lung cancer.

All 111 patients were considered as potential candidates for surgical resection. Seventy-three men and 45 women (ages, 35 to 84 years) were enrolled in this study after informed consent was obtained. Of these patients, 77 patients showed PET findings of a primary lung cancer with or without lymphadenopathy on PET/CT. Two patients with a primary tumor and negative PET and CT findings opted for no sampling procedure and underwent resection. Also, two patients with no primary tumor showed PET-positive mediastinal lymph nodes suspicious of malignancy and underwent mediastinoscopy. None of 34 patients with negative PET findings and benign histology underwent lymph node sampling. Seventy-seven of 111 patients underwent sampling of multiple mediastinal lymph nodes on mediastinoscopy or thoracotomy within 4 weeks following PET, and these 77 patients constitute the focus group in our study. In 77 patients, all accessible nodal stations were sampled and charted by the surgeon. The findings of the CT and PET scans were tabulated for presence of involved lymph nodes at different stations as published in American Thoracic Society (ATS) staging criteria.

The positive findings on PET and CT were labeled to identify the presence of N2/N3 disease. Our objective in present study was to evaluate the need for such routine invasive sampling procedure in all cases to confirm findings of PET/CT scanning. We analyzed the data to determine the accuracy of PET/CT in identifying and classifying the presence of metastatic intrathoracic lymph nodes in lung cancer patients.

The results of PET and CT and any other tests performed (such as bone scans) were available to the surgeon for staging. Patients considered stage 3A or lower, or patients with uncertain staging (eg, with discordant results on PET or CT) were candidates for mediastinoscopy or thoracotomy (n = 77). Mediastinoscopy was performed first if PET and CT gave different results. Other patients had sampling during thoracotomy or biopsy. Patients with unequivocal evidence of distant metastases (tissue diagnosis or concordant findings on multiple tests) or presence of N3 disease were not believed to be operative candidates and were not included in our study. Some patients underwent thoracotomy as part of surgical procedure following mediastinoscopy if found resectable based on mediastinoscopy findings.

**PET**

All patients were asked to fast for at least 4 hours prior to undergoing PET-fluorodeoxyglucose (FDG) study. PET-FDG imaging was performed using GE Advance Scanner (GE Medical Systems; Milwaukee, WI) of whole-body capability in the two-dimensional mode with an axial field of view of 14.6 cm. This scanner has a transaxial in-plane resolution of 4.7 mm. By performing five to six bed positions, PET imaging included the entire field of view from the neck to the pelvis floor. Emission scans were obtained with an acquisition time of 5 min per field of view 60 min after injection. Transmission scans were obtained for 10 min in each bed position using germanium-68 pin source.

All patients received 10 mCi of F-18 FDG, which was produced on site using GE Trace Cyclotron (GE Medical Systems). Serum glucose was < 150 mg/dL, at time of FDG injection. The acquired data were reconstructed using standard back-projection technique. Axial views and images were reoriented into coronal and sagittal views. Partial volume correction for lesions < 7 mm in size was not performed. This could potentially decrease sensitivity somewhat in smaller lymph node lesions.

**CT Imaging**

CT was performed using GE 9800 systems (GE Medical Systems). Most of the studies (> 75%) were performed after IV injection of 100 to 200 mL of contrast material. One-centimeter-thick contiguous image sections were obtained. All CT scans were read according to the criteria of Webb et al.3 Lymph nodes were considered abnormal if they were > 10 mm in short-axis diameter.

**Lymph Node Sampling**

Particular care was taken to ensure resection of all lymph nodes that were identifiable including but not limited to those preoperatively staged as positive. The surgeon charted the sites of sampled lymph nodes. The sites of these surgically sampled lymph nodes were matched to the abnormal lymph nodes identified on CT and PET. This was facilitated by reading CT and PET scans together in most of cases with the team of physicians’ before surgery. Additionally, we compared relative sensitivity and specificity of PET-FDG imaging in detection of malignancy in small vs large lymph node lesions. The lymph nodes from various stations sampled were also classified into different size groups: < 1 cm, 1 to 3 cm, and > 3 cm in diameter.

**Scan Interpretation**

All studies were interpreted prospectively independently, and findings were classified according to ATS staging. An experienced nuclear medicine physicians reviewed the PET scans. Interpretation of PET scans was often performed without knowledge of results of other imaging studies or other surgical results. Interpretation of the PET studies included review of the uncorrected and attenuation-corrected scans. A 5-point visual scoring system was used to interpret PET abnormalities: 1 = no detectable or very mild uptake, 2 = uptake less than mediastinal blood pool activity, 3 = uptake equal to mediastinal blood pool, 4 = uptake greater than blood pool, and 5 = uptake much greater in intensity than mediastinal blood pool activity. FDG uptake scores of 4 and 5 were classified as malignant and scores of 1, 2, and 3 were benign. If different opinions arose between the observers, mutual review and standard uptake values (SUVs) were considered to make the final decision. Quantification of FDG uptake was also performed using the region of interest analysis. A region of interest was carefully drawn over the “hottest” part of the lesion, and average and maximum SUVs were determined in equivocal cases only. Focal abnormality was defined as an area of increased FDG uptake as compared to the background and...
surrounding activity. Focal abnormality in the mediastinum was defined as an area of FDG uptake greater than background mediastinal uptake on attenuation-corrected images.

Findings of the PET scans were recorded following the review of nonattenuation-corrected as well as attenuation-corrected reformatted images. PET imaging studies were initially read without knowledge of CT scans or histology results and were reinterpreted (or reread) with the comparison of PET findings and CT scans.

**Results**

**Histology**

Final diagnosis was established based on the histologic examination of the tissue samples obtained by mediastinoscopy or surgery. In all, 77 pulmonary lesions were confirmed as malignant and 34 lesions were found to be benign: granuloma (n = 26), infection (n = 7), and fungal infection (n = 1). Lymph node sampling was performed using different invasive biopsy procedures based on various diagnostic tests and the patient’s presentation: mediastinoscopy (n = 18), thoracotomy/resection (n = 40) [lobectomy (n = 36) and pneumonectomy (n = 4)], thoracotomy without resection (n = 10) and open biopsy (n = 9). Patients with resectable disease on mediastinoscopy underwent further operative procedures.

Among the malignant group, the specific histologic subtypes included adenocarcinoma (n = 41), squamous cell cancer (n = 13), large cell or undifferentiated (n = 14), small cell cancer (n = 3), and others (n = 6). Final histology was available on 283 lymph nodes sampled in 77 patients on mediastinoscopy or surgery.

**CT Findings**

CT evidence of significant lymphadenopathy (> 1 cm in size on CT measurement) was seen in 59 patients. In all, 125 lymph nodes were enlarged on CT in 59 patients and considered metastatic. Of these, 125 lymph nodes were from N1, N2, and N3 areas. The sensitivity, specificity, and predictive accuracy of CT for detecting metastatic lymph nodes were 68%, 61%, and 63%, respectively. There were four lymph nodes > 3 cm in size but negative for tumor; the histology included granulomatous inflammation (n = 3) and anthracosis (n = 1). Of these, three lymph node lesions were PET negative and one lesion was also PET false-positive (granulomatous). CT missed detecting disease in 17 mediastinal lymph nodes that were < 1 cm in size on CT studies.

**PET-FDG Findings**

Overall, sensitivity, specificity, and accuracy of PET-FDG for staging mediastinal lymph nodes were 87%, 91%, and 82%, respectively (Table 1). PET showed significantly superior sensitivity, specificity, and accuracy for detecting lymph node metastases than CT scanning (p < 0.05, p < 0.01, p < 0.01, respectively using \( \chi^2 \) test). Positive and negative predictive values of PET-FDG imaging were 72% and 97%, respectively. PET-FDG staged lesions in 77 patients as stage I (n = 24; 31%), stage II (n = 26; 34%), stage IIIA (n = 18; 23%), and stage IIIB or IV (n = 9; 12%). PET found lesions in 68 of 77 patients (88%) to be resectable and in 9 of 77 patients (12%) to be unresectable.

**Pitfalls in PET Staging**

In our study, 25 of 283 lymph nodes were misclassified on PET. The false-negative rate was 8%, while the false-positive rate was 13%. There were seven false-negative PET node lesions in four patients. These lymph nodes ranged in size from 0.7 to 1.7 cm in maximum diameter (mean, 1.2 cm; Table 2). Three of these seven lymph nodes were < 1 cm in size and were also missed on CT. Three patients with stage IIIA disease were staged as IB, IIA, and IIA. One patient with stage IIA disease was staged as IA. However, PET correctly detected other (15 of 17) involved lymph nodes < 1 cm size that were missed on CT. There were 18 false-positive lymph nodes seen on correlation of PET and histology (Fig 1). The histologic causes (associated with increased uptake) of these false-positive lymph nodes were granulomatous inflammation and silicosis (Table 3). Silicosis was of chronic nature with macrophages. Eight of these 18 false-positive lymph nodes were < 1 cm in size, and only one false-positive lymph node was > 3 cm in size. The mean size of these lymph nodes was 1.4 cm (range, 0.5 to 6 cm). These 18 false-positive lymph nodes were seen in six patients with benign pulmonary histology with inflammatory disease processes, four of whom had noncaseating granulomas and two of whom had silicosis. Two patients with stage IIIB disease on PET were found to have no cancer (granuloma, silicosis). Another patient staged as IIIB was found to have stage II disease, while three other patients with N2 disease on PET were found to have no pathology (N0 disease), leading to a change of management in two of these three patients.

**Table 1—Lymph Node Detection by PET vs Pathology**

<table>
<thead>
<tr>
<th>Pathology Results</th>
<th>PET positive</th>
<th>PET negative</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>46</td>
<td>7</td>
<td>53</td>
</tr>
<tr>
<td>Negative</td>
<td>18</td>
<td>212</td>
<td>230</td>
</tr>
<tr>
<td>Total</td>
<td>64</td>
<td>219</td>
<td>283</td>
</tr>
</tbody>
</table>
PET-FDG imaging changed node staging in 25 patients with staging based on CT scanning. Lymph node staging was advanced in 14 patients and down-staged in 11 patients. Change of staging on PET was accurate in 21 of 25 patients who underwent biopsy. In 21 of 25 patients, PET results were in agreement with the "gold standard" of histology and were more reliable than CT in detecting involved lymph nodes \(p < 0.01\), McNemar’s test). In 15 of 283 lymph node lesions, PET found unsuspected disease, including 5 lesions with N3 involvement (Fig 2). In all, 43 lymph nodes of 1 to 3 cm in size and 4 lymph nodes of > 3 cm in size were false-positive on CT. In 36 enlarged lymph nodes on CT, PET findings were true-negative. These lymph nodes were considered to be metastatic based on CT. Additionally, PET detected node disease in 15 of 17 involved lymph nodes missed on CT (Table 4). All of these 15 lymph nodes were involved on histology. The accuracy of each test was calculated based on true-positive and true-negative lymph nodes (of the 283 lymph nodes sampled) by comparison with histology. PET missed lymph node involvement in seven lymph nodes seen in four patients. In six patients, PET false-positive findings were seen in 18 lymph nodes. In none of the patients with false-negative lymph nodes was the respectability status changed. In patients with false-negative PET findings, only N1 or N2 lymph nodes were missed that only understaged stage III patients as stage I or II \((n = 3)\) or stage II patient as stage I.

Perhaps the most important finding in our study is that in five of six patients \((83\%)\) with false-positive PET findings change of management occurred. Two patients believed to have bilateral metastatic lymph nodes were found to have no cancer, and no chemotherapy or radiation treatment was needed in these patients. One patient staged as unresectable on PET went on to have surgical resection. Two of three patients with N0 disease (wrongly staged as N2 disease) had their surgical procedure changed following tissue diagnosis.

**Table 2—False-Negative Results on PET**

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Lymph Nodes, No.</th>
<th>Size, cm</th>
<th>Pathology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.4 × 1</td>
<td>Large cell</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1 × 1.5</td>
<td>Adenocarcinoma</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1.4 × 1.6</td>
<td>Large cell</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>0.4 × 0.8</td>
<td>Large cell</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.6 × 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.8 × 1.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.4 × 1.7</td>
<td></td>
</tr>
</tbody>
</table>

**Table 3—False-Positive Results on PET**

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Lymph Nodes, No.</th>
<th>Size, cm</th>
<th>Pathology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.6 × 1</td>
<td>Silicosis</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>5 × 6</td>
<td>Silicosis</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>0.6 × 1</td>
<td>Silicosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.6 × 1.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.7 × 1.5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>0.6 × 1</td>
<td>Granuloma</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 × 1 ((n = 2))</td>
<td>Granuloma</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>1 × 1 ((n = 2))</td>
<td>Granuloma</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>0.5 × 1</td>
<td>Granuloma</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 × 1 ((n = 2))</td>
<td>Granuloma</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.5 × 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.8–1.2</td>
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Surgical resection remains the mainstay of therapy of lung cancer, especially for earlier stage malignancy. Some large series have demonstrated striking differences between clinical and pathologic staging, indicating inaccurate clinical staging. Most research in preoperative clinical staging has been focused toward evaluating the status of N staging, whether diagnosed by mediastinoscopy, CT scanning, or PET scanning. Radiologic staging has generally been found to be less accurate than mediastinoscopy at staging the mediastinum, and the 1-cm threshold is misleading at best. Nonetheless, oncologists and thoracic surgeons continue to use CT as radiologic “gold standard” for nodal staging.

Our results demonstrate that PET-FDG is an excellent modality for lymph node staging of patients with lung cancer. PET showed significantly superior sensitivity (p < 0.05, \( \chi^2 \) test), specificity (p < 0.001), and predictive accuracy (p < 0.01) for detecting mediastinal adenopathy than CT with statistical significant difference. Our results are consistent with similar efficacy of PET-FDG reported in the literature. Valk et al reported the relative accuracy of PET and CT as 91% and 70%, respectively, in 76 nodal sites confirmed on histology. Similarly Steiner et al also showed high sensitivity, specificity, and accuracy of 89%, 99%, and 96% with PET-FDG study in 599 nodes sampled in 47 patients. Some of the other investigators did not report to what extent the lymph node sampling was performed. This can affect the reported sensitivity and specificity if normal-sized lymph nodes with small tumor foci are not sampled. In our study, most of accessible lymph nodes were sampled (including contralateral lymph nodes in 52 of 77 patients) and underwent histopathologic analysis. In our study, PET revealed 21 unsuspected lymph node sites confirmed on histology.

By combining CT and PET, it is possible to significantly reduce the false-positive and false-negative results of detecting metastatic lymph nodes. Scott and associates reported an accuracy of 99% by comparing PET and CT scans. Others have similarly reported an accuracy of 90% and 93% with the combination of CT and PET scanning. Some of these lymph nodes can easily be “mislocalized” to a different station close to the vessels and airways. The superimposition of anatomic images with PET would define the relationship of the “hot spot” to the mediastinal structures.

PET-FDG is more sensitive than CT in detecting early metastatic disease in lymph nodes because of its ability to show increased tumor metabolism in normal-sized lymph nodes. This is primarily due to enhanced glucose metabolic rate in pulmonary neoplastic cells. The detectability of tumor site in normal-sized lymph nodes (< 1 cm on CT) is possibly due to the very high tumor uptake, with tumor to normal ratios as high as 5:1. These findings are consistent with in vitro results reported by other investigators. In our study, PET showed metastatic disease in 15 of 17 lymph nodes missed on CT. Our

<table>
<thead>
<tr>
<th>Pathology</th>
<th>CT</th>
<th>Positive</th>
<th>Negative</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>36</td>
<td>89</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>17</td>
<td>141</td>
<td>158</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>53</td>
<td>230</td>
<td>283</td>
<td></td>
</tr>
</tbody>
</table>
study demonstrated very low incidence of small involved lymph nodes (<1 cm in size) that were missed on PET imaging. However, it is likely that very early microscopic disease might be missed on PET.

Conventional criterion for an abnormal lymph node to be considered malignant is size of > 1 cm. Other investigators have also shown that a large fraction of enlarged lymph nodes on CT may not be metastatic, similar to our findings. Often, patients with enlarged lymph nodes on CT are presumed to have metastatic disease and are denied surgical resection of their primary tumor. In our study, seven patients with CT adenopathy showed no disease on PET and histology. Our study showed enlarged lymph nodes on CT with negative PET in 72 lesions with a false-positive rate of 39%, which is consistent with reports by other investigators.

Furthermore, our data represent one of the first reports of evaluating the need for routine lymph node sampling after PET and CT imaging. Our study showed very high negative predictive value of PET for mediastinal lymph nodes. In a 1998 study, Vasteenkiste et al. in a series of 690 lymph node stations sampled, also found PET studies, when interpreted using a 5-point visual analysis scale, to be highly reliable in detecting involved metastatic mediastinal lymph nodes with a high negative predictive value. In our study also, the false-negative results for detecting involved lymph nodes did not affect the surgical management in any patients with false-negative lymph node findings. It is possible that a larger series could show impact of false-negative lymph node findings on the resectability status in some patients.

Importantly, PET false-positive findings were also seen in six patients with false-positive CT results of enlarged lymph nodes. In five of these six patients, PET findings would have resulted in mismanagement if sampling were not performed to establish the histologic diagnosis. Some of these patients would have gone to unnecessary surgery or biopsy if we had not performed sampling.

The causes of increased FDG uptake encountered in cancer-free lymph nodes related to uptake in benign conditions have been described to some extent in various studies. In our study, six patients showed false-positive uptake. All these cases were related to the uptake in granulomatous inflammation and silicosis. False-positive conditions that have been described by other investigators have included histoplasmosis, tuberculosis, or some fungal inflammatory conditions. These are more likely to be found in patients with indeterminate solitary pulmonary nodule group rather than the lung cancer group. All lymph node abnormalities with false-positive uptake were also enlarged on CT and thus showed false-positive CT findings.

Mediastinoscopy is a surgical procedure that has been in use since 1959 for providing access to the superior mediastinum for lymph node sampling and direct observation of mediastinal involvement. Other procedures, including fiberoptic bronchoscopy, anterior mediastinotomy, video-assisted thoracoscopy and thoracotomy, and open-lung biopsy, may all be performed for sampling of lymph nodes for staging alone or during the biopsy of lung lesions. Most investigators would favor sampling in patients with suspected involved lymph nodes or in whom neoadjuvant therapy is planned for N2 or N3 disease. Our data indicate a definite need for sampling or biopsy when there are PET-positive lymph nodes. However no significant benefit was seen for routine biopsy with PET-negative lymph nodes in resectable lung cancer disease. Once confirmed in larger series, high negative predictive value of negative PET in predicting lymph node involvement should be helpful in preventing unnecessary sampling in a fraction of patients with resectable disease. This would minimize complication resulting from these invasive sampling procedures. Thus, invasive procedures may not be necessary in a patient with negative finding on PET in the mediastinum. Obviously, this decision may best be made on the individual patient. PET false-negative findings have been more frequently reported in bronchoalveolar lung cancer, and thus these patients may be carefully evaluated and managed with sampling whenever CT findings are suspicious or when lymph node involvement is suspected.

CONCLUSION

Our study demonstrates false-positive and false-negative rates of 13% and 9%, respectively, with PET-FDG imaging for detecting metastatic lymphadenopathy in lung cancer patients. PET-FDG showed superior efficacy over CT for lymph node staging. While false-positive findings affected selection of treatment and management in five of six patients (83%), false-negative results did not contribute to mismanagement of any patients. If further studies in larger groups of patients confirm these findings, routine mediastinal lymph node sampling is indicated to confirm all PET-positive lymph nodes, but is probably not necessary in patients with PET-negative lymph nodes.

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