Original Article

DOI: 10.14235/bas.galenos.2021.4751
Bezmialem Science 2022;10(2):212-8

Role of Positron Emission Tomography in Staging Lymph Nodes in Non-small Cell Lung Cancer

Pozitron Emisyon Tomografisinin Küçük Hücreli Dışı Akciğer Kanserinde Lenf Nodu Evrelemesindeki Rolü

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ABSTRACT

Objective: Lung cancer is in the cancer group with high mortality, and early diagnosis and accurate staging prolongs survival. Positron emission tomography (PET) is routinely in use for staging of non-small cell lung cancer. Since there were still controversies, we aimed to investigate the reliability of PET especially in mediastinal lymph node (MLN) staging.

Methods: A total of 141 surgical procedures were performed on 133 patients with non-small cell lung cancer clinically suitable for surgery. With PET, lymph nodes having a standart uptake value-SUV_{max} >2.5 were noted. With the results, the stations reached by mediastinal examination in 25 patients and direct thoracotomy in 8 patients were sampled. With the results, a total of 123 patients underwent resection, and 13 patients were referred to oncology clinics. In staging of MLN, tomography and PET were compared in terms of sensitivity and specificity, and also the relationship of PET with type, localization and size of tumor was investigated.

Results: For mediastinal staging, sensitivity of PET in squamous cell lung cancer was 100%, while specificity 88%, positive predictivity 50%, negative predictivity 100%, and accuracy 89.5%. Hilar, intrapulmonary and mediastinal lymph nodes were analyzed and the same parameters were 64.5%, 80%, 80%, 64.5% and 74.4%, respectively. PET-SUV_{max} values were found to be statistically significantly associated with tumor size, central location, epidermoid histology and especially lymph node 7. The accuracy of PET in evaluating this lymph node station seemed to be higher.

ÖZ

Amaç: Akciğer kanseri mortalitesi yüksek kanser grubunda olup erken tanı ve doğru evreleme sağkalımı uzatmaktadır. Pozitron emisyon tomografisi (PET) küçük hücreli dışı akciğer kanserinde tanı ve evreleme yöntemi olarak rutin kullanılmaktadır. Halen tartışmalı durumlar olduğundan özellikle mediyastinal lenf nodu (MLN) evrelemesinde PET'nin güvenilirliğini araştırmayı amaçladık.

Yöntemler: Klinik olarak operasyona uygun küçük hücreli dışı akciğer kanseri tanılı 133 hastaya 141 cerrahi işlem uygulandı. Bu yöntem ile metastaz olduğu belirtilen (standart uptake değeri-SUD_{maks} >2,5) lenf nodları kaydedildi. Sonuçlarla 25 hastada mediasten incelemesi, 8 hastada direkt torakotomi yapılarak ulaşılan istasyonlar örneklendi. Sonuçlarla toplamda 123 hastaya rezeksiyon uygulandı, 13 olgu onkoloji kliniklerine yönlendirildi. MLN tutulumu açısından tomografi ile PET'nin duyarlılık ve özgüllük sonuçları karşılaştırılarak, PET'nin tümör tipi, lokalizasyonu ve boyutu ile ilişkisiaraştırıldı.

Bulgular: Skuamöz hücreli karsinomun mediyastinal evrelemesinde PET'nin duyarlılığı %100, özgüllüğü %88, pozitif prediktivite değeri %50, negatif prediktivite değeri %100 ve doğruluğu %89,5 olarak bulundu. Hiler, intrapulmoner ve MLN istasyonları çalışmaya alınarak yapılan değerlendirmede ise aynı değerler sırası ile %64,5, %80 %80, %64,5 ve %74,4 olarak hesaplandı. PET-SUV_{maks} değerleri tümör büyüklüğü, santral yerleşim, epidermoid histoloji ve özellikle 7 nolu lenf nodu ile istatistiksel olarak ilişkili bulundu.

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Received: 04.06.2020
Accepted: 13.01.2021

Cite this article as: Akgül AG, Temel U. Role of Positron Emission Tomography in Staging Lymph Nodes in Non-small Cell Lung Cancer. Bezmialem Science 2022;10(2):212-8

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Conclusion: PET gives statistically significant results when we evaluate the MLN stations one by one. In addition, PET results should be confirmed, especially in the centrally located adenocarcinoma subgroup. If PET can provide more reliable results in staging with advancing technology in medicine, it will perhaps take its place as the gold standard in lung cancer as a non-invasive technique.

Keywords: Lung cancer, mediastinal staging, PET

PET'nin özellikle bu lenf nodu istasyonunu değerlendirmedeki doğruluğu daha yüksek görünmektedir.

Sonuç: MLN istasyonlarını tek tek değerlendirdiğimizde, PET istatistiksel anlamlılık vermektedir. Bunun yanında, özellikle de santral yerleşimli adenokarsinom alt grubunda PET sonuçları doğrulanmalıdır. Tıpta ilerleyen teknoloji ile PET, evrelemede daha güvenilir sonuçlar verebilirse non-invazif teknik olarak akciğer kanserinde belki de altın standart olarak yerini alacaktır.

Anahtar Sözcükler: Akciğer kanseri, mediastinal evreleme, PET

Introduction

Lung cancer is one of the most common malignancies and its frequency is increasing all over the world. In the early diagnosis of the tumor, computerized tomography (CT), sputum cytology and bronchoscopy can increase the number of patients suitable for surgery. Mediastinal lymph node (MLN) staging is the most important factor in determining both the treatment method and the prognosis (1,2).

Staging is mainly based on imaging techniques. CT is the most commonly used method for non-invasive staging of lung cancer, especially for lymph nodes. Evaluation on CT for lymph nodes is based on shape and size. Usually, the diameter over 1 cm is in favor of the enlarged lymph node; however, in histological examinations, metastasis can be detected in lymph nodes below 1 cm, and some lymphadenopathies (LAP) may be due to reactive hyperplasia or other benign causes (3). For this reason, mediastinoscopy is required for the majority of patients for mediastinal staging and is still considered the gold standard. Today, positron emission tomography (PET), which shows the biological activities of tumor cells, has been shown to be superior to thorax CT in the mediastinal staging of patients diagnosed as having non-small cell lung cancer (NSCLC). Therefore, PET, which is the noninvasive method for detecting MLN metastasis, has been reported to replace invasive mediastinoscopy (4-7).

In this study, we aimed to compare the histopathological results of mediastinal lymph nodes with non-invasive methods such as thorax CT and CT integrated PET for patients diagnosed as having NSCLC in our clinic.

Method

Within 4 years, 141 surgical procedures were applied to 133 patients who were admitted to our clinic, diagnosed as having NSCLC by tissue biopsy, and were found to be eligible for surgical treatment. More than one surgical procedures were applied to 5 patients. All patients were evaluated with contrast thorax CT and PET examinations, which were performed within 30 days maximum before the operation, retrospectively and prospectively.

As laboratory tests, all patients underwent routine blood tests, arterial blood gas and related blood tests in those with additional diseases. Routinely, pulmonary function tests, electrocardiograms, echocardiography -to evaluate cardiac functions more detailed- and other related examinations were also performed. Radiological examinations including postero-anterior and lateral direct chest X-rays and thorax CT which were performed to evaluate the localization and size of the tumor, lymph nodes and resectability of the tumor, were applied in all patients. Thorax multislice CT imaging was performed by delivering nonionic iodized contrast agent intravenously with an automatic injector pump. All thorax was scanned from upper clavicle level to upper surge at both lower adrenal gland image area and the raw data obtained were reconstructed without gap. Five-mm-thick axial images in multislice CT were evaluated in mediastinal window. In defining localization, tumors related to mediastinal pleura were defined centrally and others peripherally in 1/3 of the hemithorax. In the evaluation of mediastinal lymph nodes by using thorax CT, the lymph nodes with a short diameter greater than 1 cm were suspiciously considered pathological with probability of metastasis.

For the histopathological diagnosis of the lesion, bronchoscopic biopsy, transbronchial needle aspiration biopsy, transthoracic needle aspiration or tru-cut biopsy was performed. In patients with non-diagnostic results, thoracoscopy, and finally thoracotomy and frozen-section tissue examination were performed.

PET imaging was performed following 4-6 hours of fasting and a good hydration. If the blood glucose level was measured within normal limits, 10-15 mCi 18-fluorodeoxyglucose (FDG) injection was administered in the patient, and after waiting for 60 minutes images were gathered with integrated PET/CT camera. Examination for mediastinal lymphatic metastasis was evaluated visually first. In visual evaluation, mediastinal foci with increased uptake compared to the back-ground and surrounding tissue activity with normal biodistributionwere interpreted as suspicious for malignancy, and in cases where measurement was possible, the maximum standard uptake value (SUV_{max}) higher than 2.5 was interpreted in favor of malignancy.

In the identification of MLN, in accordance with the Mountain (8) classification, the records were created. After imaging MLN with PET as areas with high SUV_{max}, standart cervical mediastinoscopy for lymph nodes 2, 4, 7, anterior mediastinotomy for 5 and 6, and VATS for 8 were performed in 15 days for verification. After examining the pathology of the samples, patients with metastases were re-evaluated and directed to oncology clinics for neoadjuvant or non-surgical treatment. Appropriate resection and systematic mediastinal lymphatic sampling with thoracotomy or VATS were

performed in patients in whom metastasis was not detected in lymph node examinations.

The histopathological diagnosis obtained as a result of interventions for lymph nodes and lesions has been accepted as the gold standard. It was aimed to compare histopathological diagnosis with imaging methods. Thorax CT, PET, mediastinoscopy, anterior mediastinotomy, VATS and thoracotomy results were recorded. In accordance with the definitions below, true positive, true negative, false positive, false negative rates were determined, and sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy rates were compared.

Statistical Analysis

Excel and SPSS (Statistical Package for Social Sciences) 16 for Windows statistics program were used. In comparison of parameters, Fisher verification test, chi-square test and Student's t-test were used. As a result of the analyzes, "p" values that were less than 0.05 were considered significant.

Results

Ninety-nine (74.4%) of the patients were male and 34 of them (25.6%) were female. Their ages ranged from 24 to 83, with the mean of 60.7. In the histopathological differentiation of malignant tumors, squamous cell carcinoma (SCC) was detected in 48 (34%), adenocarcinoma in 45 (32%), sarcoma in 8 (5.7%), and adenosquamous carcinoma in 5 (3.5%) patients. Other histologies were metastatic carcinoma (n=4), large cell carcinoma (n=2), lymphoma (n=2), and the rest were pleomorphic carcinoma, carcinoid tumor, mesenchymal tumor and anaplastic carcinoma.

Localization of 141 tumors in 133 patients was right lung in 75 (53.2%) patients and left in 66 (46.8%) patients. Seventy four (52.5%) tumor lesions were located peripherally and 67 (47.5%) centrally. Enlarged lymph node was observed with 33 (23.4%) tumors in thorax CT evaluation. After surgery, 17 (51.5%) of the patients were not detected as having malignant tumor, while 6 (6%) of 108 patients that were not suspicious for malignancy in CT, were detected as having malignant tumor (Table 1).

Mediastinal LN involvement was detected in 33 (23.4%) patients on PET. Lymph nodes were evaluated by applying mediastinoscopy, mediastinotomy, VATS and thoracotomy. Eight patients were taken directly to thoracotomy, 2 of them were diagnosed as having lymphoma with wedge resections, N2 was detected in 2 patients (positive lymph nodes were 5 and 6 in one patient, and a different node from PET; no=9, was positive in other patient). Four patients were taken directly to thoracotomy after neoadjuvant. In 12 patients who were performed preoperative invasive lymph node evaluation, malignancy was found, while 8 patients had no tumor metastasis, and 5 patients had benign disease. Thirteen patients (with 1 patient added from PET negative group, but mediastinoscopy was applied because of the brain metastasis and it was found positive) with LNM were referred to oncology clinic for the purpose of neoadjuvant or adjuvant therapy. Mediastinal LN dissection was conducted on patients who underwent thoracotomy with a negative lymph node. In all patient groups, lobectomy and bilobectomy were performed in 80 (56.7%) patients, wedge resection in 32 (22.7%), pneumonectomy in 11 (7.8%), and mediastinal staging in 18 (12.8%). The tumors were localized at upper lobes in 84 (68.3%) of the resections, at lower lobes in 33 (27%), and hilar in 6 (4.7%).

In 1 patient, who underwent preoperative invasive evaluation (mediastinoscopy for no=7 positivity) and was not detected as having mediastinal metastasis, was found as having N2 (no=8 lymph node) positivity (16.6%). In this patient, the histopathology of the tumor was adenocarcinoma and it was located in the right lower lobe. N2 or N3 lymph nodes were found positive in 12 of 25 patients who underwent preoperative invasive staging with mediastinoscopy after detecting positivity with PET. Sensitivity and specificity could not be calculated because thoracotomy was performed only in patients with N2 negative results in mediastinoscopy.

From 108 patients who did not have metastases in MLN, 1 patient with solitary brain metastasis was examined, and histopathological evaluation revealed N2 (no=6) despite PET negativity and referred also to oncology. And N2 was detected in 5 patients also, who were directly resected and dissected with thoracotomy.

Table 1. PET and CT evaluation between each-other and for various parameters

	Sensitivity %	Specificity %	PPV %	NPV %	Accuracy %
CT	67	83	42	93	80.3
PET	70	85	45	94	82.5
PET SCC mediasten	100	88	50	100	89.5
PET adenocarcinoma mediasten	54	81.5	58	78.5	72.5
PET central	81	78	54	93	79
PET peripheric	40	90	25	95	86
PET hilar LN	23	88	39	78	72.4
PET paranchimal LN	-	98	-	89	87.4
PET all LN	64.5	80	64.5	80	74.4

PPV: Positive predictive value, NPV: Negative predictive value, CT: Computed tomography, PET: Positron emission tomography, SCC: Squamous cell carcinoma, LN: Lymph node

Of the patients with false positive results, 29% (n=5) had adenocarcinoma, 65% (n=11) squamous cell carcinoma, and 1 (6%) pleomorphic carcinoma. In 9 (53%) patients, the tumor was localized in the right lung and in 13 (76.4%) in the upper lobe. Tissue diagnosis was adenocarcinoma in all 6 patients with false negative results with PET. Four (66.6%) of the tumors localized in the upper lobe, were in the left lung and 2 (33.4%) in the right.

In measuring the accuracy of mediastinal lymph nodes evaluated by using PET, according to histopathological subtypes, statistical evaluation was made and the rates in SCC and adenocarcinoma were examined (Table 1). As a result of comparing the two histopathological types of tumors, the likelihood-ratio, which was found to be 8.9 in SCC, was significantly higher than the value of 2.9 in adenocarcinoma. When we looked at the differences in sensitivity, a significant difference was observed again. With these data, a statistically significant difference was observed between the two histopathologies in terms of the reliability of PET in MLN staging. In addition, all lymph node stations were included in the study and PET results were evaluated (Table 1).

The sensitivity of PET results in terms of MLN in centrally located tumors was found to be significantly high (Table 1). The relationship between the high value of SUV_{max} measured for the MLN and the central location was statistically significant.

In the examination of hilar lymph nodes (no=10 and 11), metastasis was detected in 18 patients by using PET examination. While positivity was found at 7 (38.8%) of 18 stations evaluated by surgical staging, metastasis was not observed in 11 (61.2%). In the examination of 105 patients without any involvement in the hilar region, metastatic lymph node was detected in 23 (22%) patients after surgical staging (Table 1).

In the statistical evaluation, the high value of SUV_{max} for hilar lymph nodes and no=9 mediastinal node was found to be related with tumor size (>1.5 cm) and gender (male). In the examination of the parenchymal lymph nodes (no=12-14) with PET screening, metastasis was detected in 2 patients. While metastasis was not detected in these 2 patients after staging with surgery, 14 (11.2%) positivities were detected among 125 stations which were indicated to have no metastasis in PET. Since both patients with lymph nodes detected in the parenchyma were found to be negative in pathological evaluation, the sensitivity could not be determined (Table 1).

The SUV_{max} values measured for MLN were compared with pathology results of lymph node stations and examined individually. In the statistical evaluation, a significant relationship was observed between a high SUV_{max} value of meanly 12.4 (7.3-19), and the positive pathology results of the stations numbered 4, 7, 8 and 9.

In the evaluation of lymph nodes considering the final stages of the patients with the histopathological results determined after all surgical interventions, 83 (63%) patients had N0, 27 (20.6%) N1, and 21 (16.4%) N2. Ten patients were exceptional of staging because of having lymphoma, sarcoma, metastatic tumors, and carsinoids. According to these results, N1 was found in 15 of the patients and N2 in 4 which were found as N0 in PET. N2 was found in 2 of 14 patients, and N0 in 9 which were found as N1 in PET. N1 in 9 and N0 in 8 were detected which were found as N2 in PET (Table 2).

When a comparison was made between the two groups, the N2 rate was 4.3% higher in patients who had N0 with PET examination, and the N2 rate was 14.3% higher after histopathological diagnosis in patients who were detected as having N1 with PET. These results should be taken into consideration in clinical evaluation, as it showed that the probability of N2 was higher in patients with N1 detected with PET compared to those with N0.

Clinical staging with PET performed by evaluating MLN was compared to histopathological staging achieved after surgical methods. While compatibility with the initial stage was found in 88 (62.4%) patients, a regression in the stage was observed in 31 (22%), and a progress in stage was observed in 22 (15.6%).

Comparing the final stages determined according to histopathological diagnoses and clinical staging, it was found that the stage was confirmed in 61% of 1A group, 60% of 1B group, 0% of 2A group, 60% of 2B group, 50% of 3A group, and 100% of 3B and 4 groups. When statistical analysis was performed, no significant difference was found between tumor diameter and histology and the first- last stage change, but it was determined that left sided and centrally localized tumors had a statistically significant. It was also determined that the "p" value calculated in relation to the SUV_{max} of the mass was at the limit (p=0.05). This may give an idea that tumors of left lung and centrally localized tumors with tumor size of greater than 2 cm and having high SUV_{max} have a greater risk of malignancy correlance.

Of 17 false positive results obtained withMLN, 1 was detected as reactive hyperplasia, 2 as granulomatous reaction, 2 as sarcoidosis, 2 as sinus histiocytosis, 3 as anthracosis, and 7 as tuberculosiswith PET. The SUV_{max} calculated for lymph nodes ranged from 2.7 to 10.8. Nine of them had also positivity in the form of lymphadenopathy in thorax CT.

Tumor was localized in the left lung in 8, right lung in 9 in the upper lobes in 13, and centrally in 11 patients. Of the lymph nodes with false positive results with PET, 10 were lower right paratracheal (no=4R), 5 subcarinal (no=7), 3 right upper paratracheal (no=2R), 2 left lower paratracheal (no=4L), 2 subaortic (no=5), 1 wasleft upper paratracheal (no=2L), 1 wasparaaortic (no=6), and 1 was right paraesophageal (no=8R) lymph nodes.

Table 2. Comparison of PET and histopathology for mediastinal staging

Histopathology				
		N0	N1	N2
PET	N0	66	15	4
	N1	9	3	2
	N2	8	9	15

PET: Positron emission tomography

Seven of the mediastinal lymph nodes evaluated by using PET were identified as false negative. Histopathological diagnosis was adenocarcinoma in all of them. Three were identified as LAP in CT. Tumor was located in upper lobes in all of them and it was localized in the left lung in 4 patients, and centrally in 3. Of false negative results in PET, 3 were detected in lymph station 5, 2 in lymph node station 6, and 2 in lymph node station 4R.

Discussion

In a patient with diagnosis of lung cancer, the research steps include clinical evaluation, risk factors, and CT image in the first step. Possible diagnosis, cell type and stage are determined. In the second step, diagnosis and staging are confirmed by using advanced radiological and invasive techniques. In the last step, the treatment option is determined. The choice of treatment and prognosis in a patient with lung cancer are closely related to the stage at the time of diagnosis. The main purpose of the intrathoracic staging of NSCLC is to investigate the involvement of MLN. It is divided into imaging and sampling magnetic resonance and PET are used in staging together with thorax CT. The most important indication of screening is to decide surgery or chemotherapy and/or radiotherapy by separating potentially resectable early stage cancers from nonresectable advanced ones (5,9).

Pathological sampling can be performed via transthoracic fine needle aspiration, transbronchial fine needle aspiration, endoscopic ultrasound, Endobronchial ultrasound-guided, mediastinoscopy, mediastinotomy, thoracoscopy and thoracotomy. Thorax CT detects a pathologic lymph node, but is unable to distinguish benign disease-related enlargements from metastasis. In studies, it has been reported that metastases can not be detected in 40% mediastinal lymphadenopaties at thorax CT, while metastases are detected in 15-20% of lymph nodes that do not reach the pathological size. In MLN staging, the sensitivity of CT with approximate values is reported as 65%, specificity as 76%, and accuracy as 73% (9-12). While the results we obtained in our study were found to be within the range specified in the literature, it was decided that CT would not be sufficient for mediastinal staging alone.

None of today's methods seems ideal in mediastinal staging alone for NSCLC. Various combinations of these methods are used for reliable mediastinal staging. Given all this, PET has been introduced as a promising method. Comparative studies of CT-PET efficacy including early periods showed that PET was superior in MLN staging (5,13,14). PET is thought to be a non-invasive method that can replace mediastinoscopy with high accuracy rates. However, the studies in the following years were not as satisfactory as the positive results we achieved in the early period. In the study of Gonzalez-Stawinski et al. (15) including 202 patients, PET sensitivity was calculated as 64%, specificity 77%, PPV 44%, and NPV 88% in MLN staging.

Toloza et al. (5) reported sensitivity, specificity, PPV and NPV of mediastinoscopy as 81%, 100%, 100%, and 91%, respectively in the study, which included 14 series involving 5,687 patients. In an invasive guide-study of Detterbeck et al. (16), sensitivity and specificity of mediastinoscopy were found as 78% and 100%, respectively in the examination of the results of 19 series containing a total of 6505 patients. The disadvantage of the procedure is being an invasive method that requires general anesthesia and having risks of morbidity and mortality.

By some authors, it is argued that mediastinoscopy can be neglected in patients with a peripherally localized tumor in small diameter without suspicion of N2 with screening while some others believe that it is mandatory in every patient (6,13,16,17). In our study, mediastinoscopy was not performed in patients who were not considered to be N2 clinically and radiologically. Twenty five patients with high FDG uptake in MLN according to PET, underwent mediastinal staging and 8 patients without metastasis underwent thoracotomy. When the last pathologies of the lymph nodes were examined, 7 patients had no lymph node involvement in the mediastinum, while 1 (16.6%) patient had a false negative result. With this result, the accuracy rate of mediastinoscopy was calculated as 83.4%. However, mediastinoscopy was performed for lymph node 7, which was indicated as positive in PET, and pathology result was learned as negative. After the thoracotomy, it was the lymph node station number 8, which was found to be positive. Therefore it may not be correct to define the result of mediastinoscopy as false negativity. In addition, the fact that there may be problems in the correct definition of anatomical structures with PET examination should not be ignored in this patient.

In determining mediastinal metastases, many studies were conducted to compare PET and other conventional imaging methods, and sensitivity, specificity, PPV and NPV were calculated. In the report of Birim et al. (18) in 2005, CT and PET were compared by evaluating 17 series. Consecutive CT and PET sensitivities were 59% and 83%, and their specificities were 78% and 92%, respectively. In more comprehensive and detailed studies, PET was not found to be a 100% reliable method (10,19). In the study published by Ebihara et al. (20), it was stated that besides detecting N1, PET could be superior for especially upper mediastinal lymph nodes. The accuracy of PET was also investigated in different series including high patient numbers and it was stated that PET was not significant in diagnosis, staging and prognosis evaluation in tumors smaller than 2 cm (9,10).

In the light of the statistical results we reached in our study, the sensitivity and specificity of CT and PET were compared in terms of MLN. The comparison of the SUV_{max} measured by the PET scan especially at no=7 station and number 4, 8 and 9 lymph node stations, was found statistically significant.

In some studies, FDG uptake in PET was found to be lower in adenocarcinoma, bronchoalveolary carcinoma and carcinoid tumors due to false negativity, whereas some did not support this (21,22). In our study, PET's sensitivity in MLN detection was found high for 48 patients diagnosed as having SCC. However, 45 patients diagnosed as having adenocarcinoma were found to have lower rates of detecting MLN (Table 1). When comparing

the two histopathological tumor types, the high difference between them in terms of PET sensitivity and specificity and accuracy rate was found statistically significant. A significant relationship was determined also between the high SUV_{max} of the mass and the SCC.

The most important problem in PET is that FDG uptake may increase in some benign pathologies other than tumor as well as malignant tumor tissue. Granulomatous lesions such as tuberculosis- seen frequently in our country- sarcoidosis, aspergillosis, coccidioidomycosis, histoplasmosis and reactive hyperplasias that may develop secondary to pneumonia can give misleading results between 16-55% as stated in the literature (23,24).

In our study, statistical analyses were made for the lymph nodes, besides, false positive results were obtained in 15 (10.6%) patients after histopathological examination for lung lesions also. Final diagnoses after surgical procedures were tuberculosis in 7 (46.6%) patients, suture granuloma in 3 (20%), Bronchiolitis obliterans organized pneumonia in 2 (13.3%), and aspergilloma in 1, sarcoidosis in 1, and sequestration in 1 (6.7%). SUV_{max} had a median value of 4.82 (2.5-15). When the tumor diameter (>2 cm) and the SUV_{max} of the tumor were compared, a significant relationship was determined.

Study Limitations

It is reported by some authors that PET is not sufficient to detect small-size metastatic lymph nodes (3,25). In our study, 14 (42.4%) of 33 patients with MLN detected in CT, were also confirmed pathologically. In 3 (21.4%) of the same 14 patients, there was no involvement in the MLN with PET. This result suggests that in patients with a lymph node detected with CT, it is necessary to verify it by using invasive methods even if PET is negative. In our study, relationship between central and peripheric tumor locations and PET accuracy was statistically significant. Similarly, a significant correlation was found between the SUV_{max} measured for mediastinal lymph nodes and central location. Likewise, the correlation of localization of the upper lobe with the SUV_{max} was also significant, but this significance was controversial due to the apparent numerical superiority of tumors localized to the upper lobe in our study.

Conclusion

The use of PET has an important place in the staging of intrathoracic malignancies today. Although the PET's efficacy is generally low in MLN staging compared to mediastinoscopy, the question of whether it may have the potential to replace mediastinoscopy in some specific patients based on our study with considering developing technology, is still open to debate.

As a result of our study;

PET seems to be sufficient in terms of MLN staging, especially in peripherally located squamous cell lung cancer.

The reliability of PET is low in adenocarcinoma, especially in those located centrally, so preoperative invasive staging should be done.

PET results only seem reliable at the subcarinal lymph node station (no=7), in cases of single-station positivity.

PET results are not reliable in lesions smaller than 1 cm. Clinical correlation should be considered as false negative results can be encountered.

Considering the rate of false negativity in patients with negative PET involvement who have mediastinal lymphadenopathy detected in thorax CT, it will be appropriate to perform invasive staging for mediasten in radiologically N2 patients.

In clinical evaluation, final results should be taken into consideration as it shows that the probability of N2 is higher in patients with N1 detected with PET compared to those with N0.

Ethics

Ethics Committee Approval: The ethical committee approval was obtained from Marmara University Medical Faculty, with approval number of 21.07.2006- B.30.2.MAR.0.01.00.02/ AEK-275

Informed Consent: An informed consent form was obtained from all participants.

Peer-review: Externally peer reviewed.

Authorship Contributions

Surgical and Medical Practices: A.G.A., U.T., Concept: A.G.A., Design: A.G.A., U.T., Data Collection or Processing: A.G.A., U.T., Analysis or Interpretation: A.G.A., U.T., Literature Search: A.G.A., U.T., Writing: A.G.A., U.T.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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