

Supraclavicular Lymph Node Metastasis from Various Malignancies: Assessment with ^{18}F -Fluorodeoxyglucose Positron Emission Tomography/CT, Contrast-Enhanced CT and Ultrasound

다양한 원발암으로부터의 쇄골상림프절 전이: ^{18}F -Fluorodeoxyglucose Positron Emission Tomography/CT, 조영증강 CT 그리고 초음파 간의 평가

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Purpose: The purpose of this study is to compare the usefulness of ^{18}F -fluorodeoxyglucose positron emission tomography (^{18}F -FDG PET)/CT, contrast-enhanced CT and ultrasound (US) for diagnosing metastatic supraclavicular lymph nodes.

Materials and Methods: This study included 53 supraclavicular lymph nodes of 48 consecutive patients with various malignancies observed on ^{18}F -FDG PET/CT, contrast-enhanced CT and US. Detection of supraclavicular lymph nodes was determined by ^{18}F -FDG PET/CT where uptake was greater than that of surrounding tissue and contrast-enhanced CT with a node short-axis diameter of 5 mm or more. On US, we classified the supraclavicular lymph node as benign or malignant by sonographic criteria. The diagnostic values of these modalities were compared in the detection of metastatic supraclavicular lymph nodes.

Results: Metastatic supraclavicular lymph nodes were diagnosed cytologically in 44 (83%) of 53 lesions. In the detection of metastatic supraclavicular lymph nodes, the diagnostic accuracies of ^{18}F -FDG PET/CT, contrast-enhanced CT, and US were 92%, 89%, and 91%, respectively. The specificity (67%) and negative predictive value (86%) of ^{18}F -FDG PET/CT were higher than those of contrast-enhanced CT and US.

Conclusion: ^{18}F -FDG PET/CT is more useful for detecting and characterizing supraclavicular lymph nodes in patients with cancer, because of its high specificity and negative predictive value.

Index terms

Lymph Node
Metastasis
Positron Emission Tomography/CT
Malignancy

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INTRODUCTION

The supraclavicular lymph nodes comprise a final common pathway of metastatic nodal involvement from various malignancies. These lymph nodes are easily accessible by palpation and their enlargement may be the first sign of a metastatic tumor, mostly from lung, head and neck, breast, esophageal, gastric, pancreatic, gynecologic, and prostate cancers (1).

Examination of the supraclavicular lymph node has traditionally been performed by palpation; however, this method has been found to be unreliable in the literature (2-5). These investigators have suggested that noninvasive imaging tech-

niques such as CT and ultrasound (US) can be used to improve the detection of lymph node metastasis. Several studies have reported on CT and US methods for assessing supraclavicular lymphadenopathy (1, 2, 6-11).

^{18}F -fluorodeoxyglucose positron emission tomography (^{18}F -FDG PET) is a noninvasive method that plays an important role in the evaluation of lymph node metastasis in patients with various malignancies. Moreover, ^{18}F -FDG PET is more accurate than CT for detecting or excluding nodal disease (12-16). However, some limitations exist for the use of ^{18}F -FDG PET alone. In combining functional PET data and morphologic CT data, ^{18}F -FDG PET/CT studies have produced promising initial

oncologic imaging results (17-19). To our knowledge, the usefulness of ^{18}F -FDG PET/CT in the characterization and detection of supraclavicular lymph node metastases from various malignancies has not yet been reported.

Accordingly, the purpose of this study is to compare the usefulness of ^{18}F -FDG PET/CT, contrast-enhanced CT (CECT), and US in the diagnosis of metastatic supraclavicular lymph nodes.

MATERIALS AND METHODS

Patients

From January 2008 to September 2009, 158 consecutive patients with suspected or proven malignancy underwent US, CECT, and ^{18}F -FDG PET/CT examinations. Our institutional review board approved our research study and did not require informed consent from the patients for this retrospective study. We excluded patients who had undergone chemotherapy or radiation therapy, patients who had not undergone pathologic evaluation, and who had no supraclavicular lymph node enlargement. This retrospective study included 53 supraclavicular lymph nodes in 48 patients with a proven malignancy. The histopathological diagnosis of a primary malignancy was confirmed by surgery in 38 cases, by percutaneous needle aspiration biopsy of the primary mass in 12 cases, and by bronchoscopic biopsy in three cases. The final status of the supraclavicular lymph nodes was established by US-guided fine-needle aspiration biopsy (FNAB) or by surgical excision biopsy. All patients underwent US examination of the supraclavicular region, CECT of the neck or chest that included the supraclavicular region, and ^{18}F -FDG PET/CT of the whole body. The mean interval between US and ^{18}F -FDG PET/CT was 4.9 days (range, 0-18 days). The mean interval between CECT and ^{18}F -FDG PET/CT was 5.2 days (range, 0-20 days).

^{18}F -FDG PET/CT Acquisition and Imaging Interpretation

All patients fasted for at least 6 hours and had a serum glucose level lower than 140 mg/dL before the IV injection of ^{18}F -FDG. Scanning was performed 60 minutes after ^{18}F -FDG administration. Scans were acquired using PET/CT system (CTI, Knoxville, TN, USA), consisting of a full-ring PET scanner and a dual-detector-row spiral CT scanner (Somatom Emotion Duo, Biograph, Erlangen, Germany). CT was performed

from the head to the pelvic floor according to a standard protocol with the following settings: 130 kVp; 30 mA; tube rotation time, 0.8 seconds per rotation; pitch, 6; section thickness, 5 mm to match the PET section thickness. Immediately after non-enhanced CT, PET was performed in the identical transverse field of view. PET data sets were obtained with an iterative reconstruction and an ordered subset expectation maximization algorithm was performed by the application of segmented attenuation correction (two iterations, 28 subsets) to the CT data. Co-registered scans were displayed with software that enabled image fusion and analysis.

^{18}F -FDG PET/CT data sets were prospectively evaluated by one nuclear medicine physician. The physician was unaware of the CT findings or any clinical information except that the patients had primary malignancy. For imaging interpretation, positive FDG uptake in supraclavicular lymph nodes was considered when glucose uptake of the lesion was greater than the surrounding tissue. Further, the maximum standardized uptake value (SUV) adjusted for the patient's body weight, was recorded.

CECT Acquisition and Imaging Interpretation

CT scans were acquired using a helical technique, which was performed with a Somatom Plus-4 (Siemens Medical Solutions, Erlangen, Germany) or a Somatom Sensation 64 (Siemens Medical Solutions, Erlangen, Germany) scanner. Chest CT scanning was performed from the lower part of the neck to the middle portion of the kidneys. In neck CT, scanning was performed from the skull base to the level of the aortic arch. All scanning was performed after IV administration of contrast medium (100 mL of iopromide, Redisence 300, Accuzen, Seoul, Korea) at a rate of 2 mL/s with a power injector (Mallinckrodt, Tyco and Vistron CT, Medrad, Pittsburgh, PA, USA). The scanning parameters were as follows: 120 kVp; chest CT, 90 mA; neck CT, 150 mA; beam width, 2.5 mm; and a table speed of 15 mm per rotation in the chest CT and 13.8 mm per rotation in the neck CT. Data were interfaced directly to a picture archiving and communication system, which displayed all imaging data on monitors (two monitors, 1,536 × 2,048 image matrices, 8-bit viewable gray scale, 60-foot-lambert luminance). Scans were viewed with both mediastinal (window width, 400 H; window level, 20 H) and lung (window width, 1,500 H; window level, -700 H) window settings.

Two experienced radiologists, who were blinded to any clinical information except that the patients had a primary malignancy prospectively read all of the CT scans. The supraclavicular nodal area was defined as the region that lies above the manubrium on the same image as the clavicle, lateral to the medial edge of the common carotid artery and medial to the clavicle and the lateral rib margin (20, 21). Metastatic supraclavicular lymph nodes were defined as having a short-axis diameter ≥ 5 mm on CECT (1, 2, 6, 11). The long-axis diameter and its ratio with the short-axis diameter of the supraclavicular lymph nodes were also recorded.

High-Resolution Thyroid Sonography and US-Guided Aspiration Biopsy

A sonographic examination was performed using a 5 to 12-MHz linear array transducer (iU22, Philips Medical Systems, Bothell, WA, USA) for the evaluation of the thyroid gland and neck in all patients. Before US-guided FNAB was performed, real-time sonography was performed by one of five radiologists in the thyroid imaging department; this radiologist was unaware of any clinical information except that the patients had a primary malignancy. All US-guided FNABs in our series were performed by one radiologist. Transverse and sagittal images were obtained from the submandibular gland to the acromioclavicular joint.

Interpretations of sonography were performed prospectively. The radiologist was unaware of the CT findings or of any clinical information except that the patients had a primary malignancy. For imaging interpretation, several criteria were used for differentiating malignant from benign lymph nodes: long-axis diameter to short-axis diameter ratio ≤ 2 ; absence of a nodal hilum; and the presence of a nodal cortex abnormality, such as eccentric nodal thickening. The definition of ultrasonic malignancy criteria was based on previous literature (11, 22). The sonography results, grouped into metastatic and benign, were compared with those of the final cytopathological reports for assessing the value of the test in diagnosing malignancy.

After the sonographic evaluation of the thyroid gland, US-guided FNABs were performed by one radiologist for re-evaluating the cervical lymph nodes. The procedure was conducted using a 23-gauge needle attached to a 10 mL disposable plastic syringe. Specimens obtained from the aspiration biopsy

were expelled onto glass slides and smeared. Additional cytological sampling was performed if a specimen was inadequate for diagnosis.

Statistical Analysis

Statistical analysis was performed with commercially available software (SAS 8.2, SAS Institute, Cary, NC, USA). The accuracy, sensitivity, specificity, and positive and negative predictive values of US (long-axis diameter to short-axis diameter ratio, absence of a nodal hilum, and presence of a nodal cortex abnormality), CECT (short-axis diameter), and ^{18}F -FDG PET/CT (increased FDG uptake greater than that of surrounding tissue) in the detection of metastatic supraclavicular lymph nodes were calculated using a generalized estimating equation. McNemar's test was used to compare the diagnostic accuracy, sensitivity, and specificity of the imaging modalities. The positive and negative predictive values of these methods were also compared. The Mann-Whitney test, Fisher's exact test, and Student's *t*-test were used for various measurements comparing the presence versus absence of supraclavicular lymph node metastasis. The maximum SUV of each supraclavicular lymph node was retrospectively calculated to indicate the presence of metastasis on ^{18}F -FDG PET/CT. *p* values < 0.05 were considered to indicate statistically significant differences.

RESULTS

Characteristics of Supraclavicular Lymph Nodes

The characteristics of patients with various malignancies are shown in Table 1. Fifty-three supraclavicular lymph nodes were found on CECT, US, and ^{18}F -FDG PET/CT in 48 patients; five of whom had bilateral supraclavicular lymph nodes. Aspiration cytological examination confirmed the presence of supraclavicular lymph node metastasis in 43 (81%) of the 53 lymph nodes from the following cancer types: lung, 24; stomach, 10; thyroid, six; esophagus, four; colon, two; uterine cervix, one; breast, one; kidney, one; hypopharynx, one; and prostate, one. Surgical excision confirmed the presence of supraclavicular lymph node metastasis from lung cancer in one (2%) of the 53 lymph nodes, while the other nine (17%) lymph nodes proved to be benign. The finding was made at the aspiration cytological examination in all benign lymph nodes.

Diagnostic Efficacy of ¹⁸F-FDG PET/CT, CECT, and US

The accuracy, sensitivity, specificity, and positive and negative predictive values of ¹⁸F-FDG PET/CT, CECT, and US in the detection of supraclavicular lymph node metastasis are

Table 1. Characteristics of Patients with Malignancies

Characteristics	Value	
Sex (n = 48)		
Men	35	
Women	13	
Mean age (y)		
All patient	62 (39-85)	
Men	65 (41-85)	
Women	59 (39-68)	
Primary malignancy site (n = 53)*	Right SCN	Left SCN
Lung [†]	14	11
Abdomen & Pelvis		
Stomach	4	6
Colon	0	2
Kidney	0	1
Uterine cervix	1	1
Prostate	0	1
Esophagus [‡]	2	2
Thyroid [§]	4	2
Breast	0	1
Hypopharynx	1	0

Note.—Values in parentheses are ranges.

*Number of supraclavicular lymphnodes.

[†]Bilateral supraclavicular lymphnodes in two patients.

[‡]Bilateral supraclavicular lymphnodes in one patient.

[§]Bilateral supraclavicular lymphnodes in two patients.

SCN = supraclavicular lymphnode

shown in Table 2. The sensitivities ($p = 1.000$) and specificities ($p = 0.183$) of ¹⁸F-FDG PET/CT and CECT did not differ significantly. In addition, the sensitivities ($p = 0.337$) and specificities ($p = 0.190$) of ¹⁸F-FDG PET/CT and US did not differ significantly. The diagnostic accuracy was not significantly different between ¹⁸F-FDG PET/CT and CECT ($p = 0.300$) or ¹⁸F-FDG PET/CT and US ($p = 1.200$). The positive predictive values ($p = 1.265$) and negative predictive values ($p = 0.090$) were not significantly different between ¹⁸F-FDG PET/CT and CECT. Likewise, the positive predictive values ($p = 2.500$) and negative predictive values ($p = 0.107$) did not differ significantly between ¹⁸F-FDG PET/CT and US. However, ¹⁸F-FDG PET/CT had a higher specificity and negative predictive value than CECT and had a higher specificity than US.

Correlation between Maximum SUV and Nodal Size

The statistical assessment of variable measurements on ¹⁸F-FDG PET/CT and CECT according to the presence of metastasis in the supraclavicular lymph node is shown in Table 3. No significant correlation was observed between long-axis diameter to short-axis diameter ratio on CECT and maximum SUV on ¹⁸F-FDG PET/CT ($p = 0.198$). However, significant differences were observed between the metastatic and benign groups of supraclavicular lymph node in terms of the maximum SUV of supraclavicular lymph nodes ($p = 0.002$), the nodal short-axis diameter on CECT ($p = 0.001$), and the nodal long-

Table 2. Diagnostic Efficacy of ¹⁸F-FDG PET/CT, CECT, and US

Finding	Accuracy (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
¹⁸ F-FDG uptake on PET/CT	92	98	67	93	86
Short-axis diameter ≥ 5 mm on CECT	89	98	44	90	80
Malignant lymph node on US	91	98	56	91	83

Note.—CECT = contrast-enhanced CT, ¹⁸F-FDG PET/CT = 18F-fluorodeoxyglucose positron emission tomography, NPV = negative predictive value, PPV = positive predictive value, US = ultrasound

Table 3. Statistical Assessment of Measurements on ¹⁸F-FDG PET/CT and CECT According to the Presence of Metastatic SCN

Variable Measurement	Metastatic SCN		p value
	Present	Absent	
Maximum SUV of SCN on ¹⁸ F-FDG PET/CT	5.13 ± 2.26	1.87 ± 1.10	0.002*
Size on CECT (mm)			
Short axis diameter	1.25 ± 0.51	0.60 ± 0.21	0.001 [†]
Long axis diameter	1.72 ± 0.60	0.95 ± 0.29	0.003*
Long-axis/short-axis	1.46 ± 0.39	1.65 ± 0.48	0.198*

Note.—*Mann-Whitney test.

[†]Student's t test.

CECT = contrast-enhanced CT, ¹⁸F-FDG PET/CT = 18F-fluorodeoxyglucose positron emission tomography, SCN = supraclavicular lymphnode, SUV = standardized uptake value

axis diameter on CECT ($p = 0.003$).

False-Positive and False-Negative Interpretations on ^{18}F -FDG PET/CT, CECT, and US

False-positive interpretations of metastatic lymph nodes were made on ^{18}F -FDG PET/CT in three cases, on CECT in five cases, and on US in five cases. Three of these cases were interpreted as being false-positive on all modalities. One patient with stomach cancer had a false-positive finding for a right supraclavicular lymph node metastasis. On US, the long-axis diameter to short-axis diameter ratio was 1.46 with no fatty hilum. The short-axis diameter was 7 mm on CECT, and a FDG uptake in the supraclavicular area with a maximum SUV of 3.89 was observed on PET/CT. However, lymphocytes and fibrous tissues were observed on aspiration cytological examination, and surgical excision of the lymph node confirmed the presence of tuberculous caseating granuloma (Fig. 1).

One patient with left thyroid cancer had a false-positive finding of left supraclavicular lymph node metastasis. On US, the long-axis diameter to short-axis diameter ratio was 1.2 with no fatty hilum. The short-axis diameter was 10 mm on CECT, and FDG uptake in the supraclavicular area with a maximum SUV of 2.79 was observed on PET/CT. However, the result of aspiration cytological examination was found to be a benign reactive lymph node.

One patient with uterine cervical cancer had a false-positive finding of right supraclavicular lymph node metastasis. On US, the long-axis diameter to short-axis diameter ratio was 1.43 with no fatty hilum. The short-axis diameter was 7 mm on CECT, and FDG uptake in the supraclavicular area with a maximum SUV of 3.01 was observed on PET/CT. However, the diagnosis of an aspiration cytological examination was a benign reactive lymph node. Two false-positive interpretations were made on CECT, and the mean short-axis di-

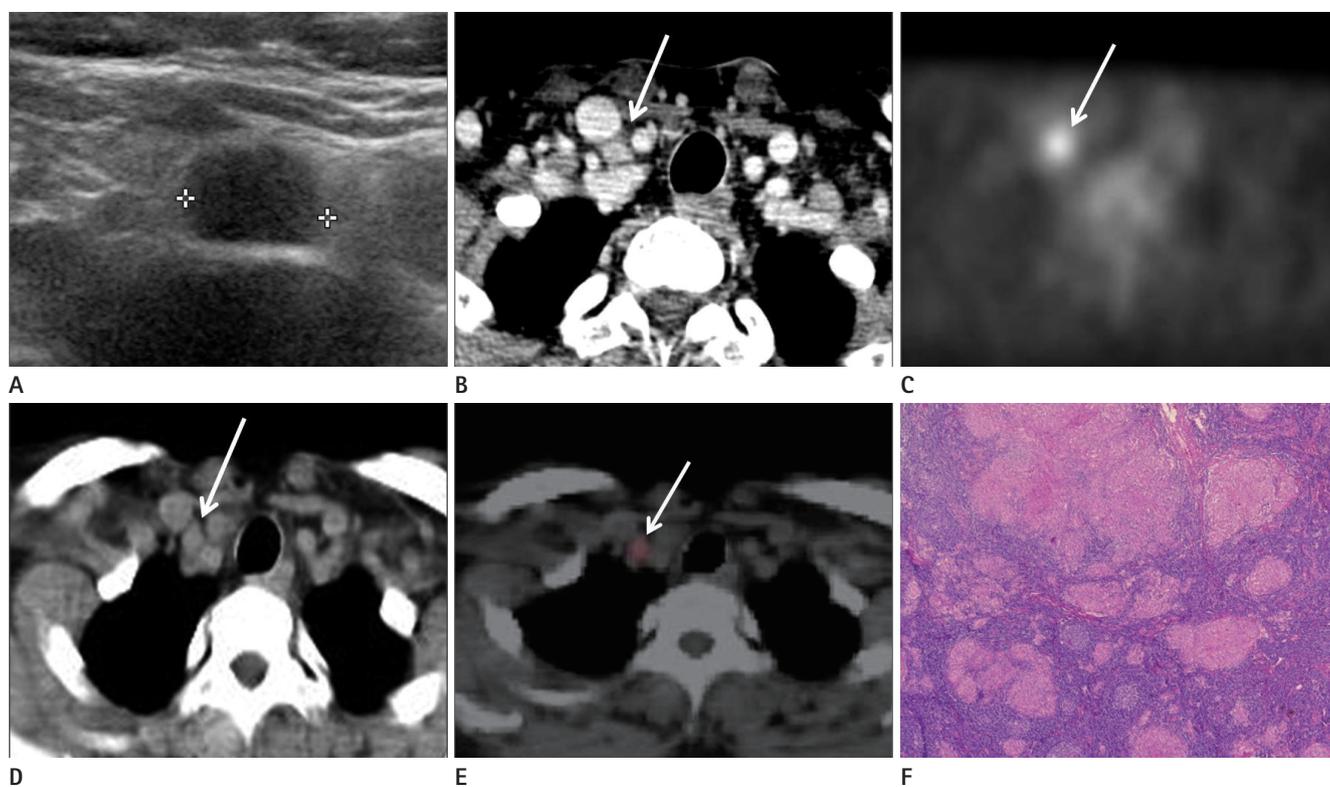


Fig. 1. A 49-year-old woman with stomach cancer and false-positive interpretation at US, contrast-enhanced CT, and ^{18}F -FDG PET/CT.

A. US examination shows round supraclavicular lymph node without fatty hilum.

B. Contrast-enhanced CT scan shows right supraclavicular lymph node (arrow) with a short-axis diameter of 7 mm.

C-E. PET (**C**), CT (**D**), and PET/CT (**E**) show increased FDG uptake (arrow) in the right supraclavicular lymph node with a maximum SUV of 3.89.

F. Photomicrograph of lymph node biopsy specimen shows chronic granulomatous inflammation with caseation necrosis suggestive of tuberculosis (H&E, $\times 40$).

Note. — ^{18}F -FDG PET/CT = ^{18}F -fluorodeoxyglucose positron emission tomography, SUV = standardized uptake value, US = ultrasound

iameter of the supraclavicular lymph nodes was 7.5 mm (7 mm and 8 mm). Two false-positive interpretations were made on US, and the mean long-axis diameter to short-axis diameter ratio of the supraclavicular lymph nodes was 1.53 (1.95 and 1.1).

False-negative interpretations of metastatic supraclavicular lymph nodes were made on two patients. One patient with right thyroid cancer had a false-negative finding on ¹⁸F-FDG PET/CT, while another patient with left breast cancer had a false-negative interpretation on both CECT and US. The patient with right thyroid cancer had a false-negative finding on ¹⁸F-FDG PET/CT. A metastatic right supraclavicular lymph node with a long-axis diameter to short-axis diameter ratio of 1.94 with no fatty hilum on US and a short-axis diameter of 5.6 mm on CECT did not show significant FDG uptake (Fig. 2) in the same area on ¹⁸F-FDG PET/CT. The other patient with left breast can-

cer showed FDG uptake of left supraclavicular lymph node on PET/CT with a maximum SUV of 2.31, but had a short-axis diameter of 4.2 mm on CECT and a long-axis diameter to short-axis diameter ratio of 2.42 with a fatty hilum on US.

DISCUSSION

Accurate staging is mandatory to ensure the selection of appropriate therapy in patients with malignancy. The supraclavicular lymph nodes are an important component of lymphatic drainage and are involved in various malignancies. Therefore, the assessment of supraclavicular lymph nodes by using physical palpation, US, CECT, or ¹⁸F-FDG PET/CT without unnecessary invasive procedures in patients with malignancy is important.

In several studies, examination of the supraclavicular lymph

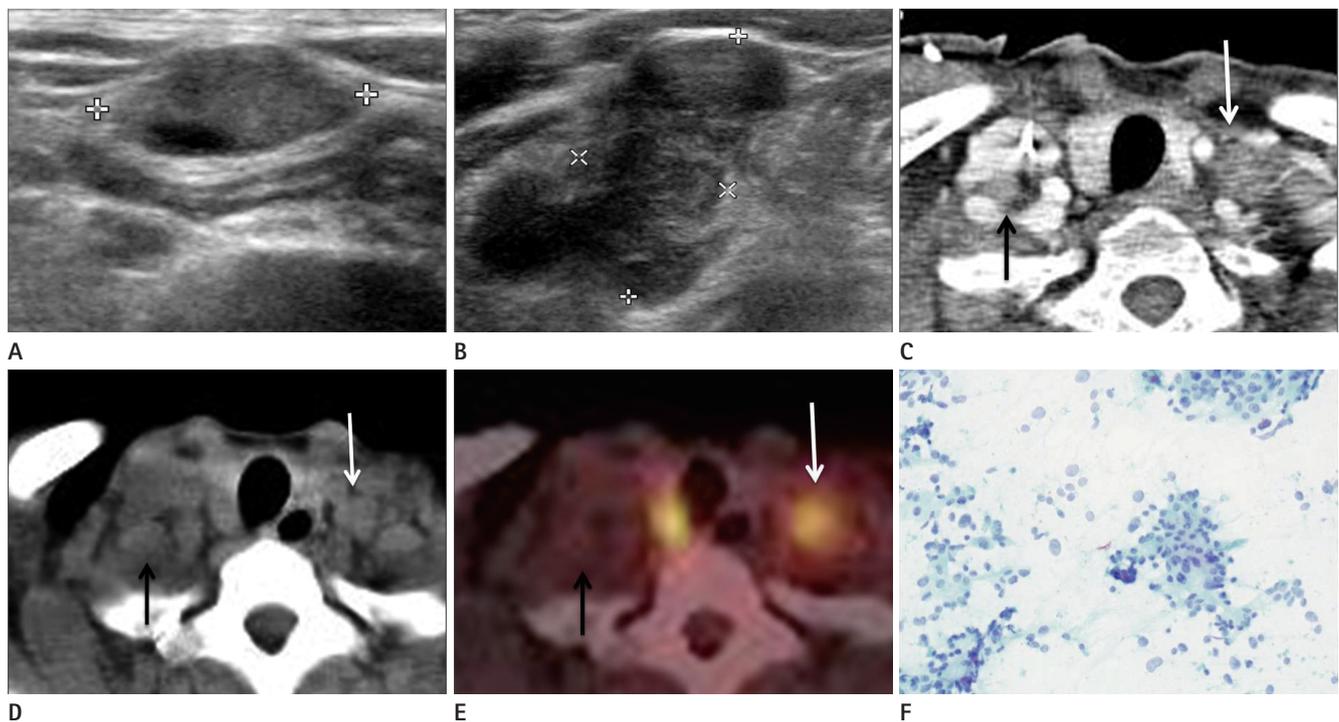


Fig. 2. A 52-year-old woman with thyroid cancer and false negative interpretation at ¹⁸F-FDG PET/CT.
A. US examination of the right supraclavicular area reveals an ovoid lymph node without fatty hilum.
B. US examination of the left supraclavicular area shows a taller than wide lymph node (long-axis to short-axis diameter ratio < 2) without fatty hilum.
C. Contrast-enhanced CT scan shows right supraclavicular lymph node (black arrow) with a short-axis diameter of 5.6 mm and a left supraclavicular lymph node (white arrow) with a short-axis diameter of 7.6 mm.
D, E. CT (**D**) and PET/CT (**E**) show increased FDG uptake (white arrow) only in the left supraclavicular lymph node with maximum SUV of 4.57. There is no FDG uptake in right supraclavicular area. Note the right thyroid show increased FDG uptake consistent with thyroid cancer.
F. Photomicrograph specimen from a sonographically-guided aspiration biopsy shows malignant cells suggestive of papillary cell carcinoma (H&E, x 200).

Note. — ¹⁸F-FDG PET/CT = 18F-fluorodeoxyglucose positron emission tomography, US = ultrasound

nodes by palpation has been found to be unreliable (2-5). In various malignancies, such as head and neck cancer (5), melanoma (3), esophageal cancer (4), US and US-guided fine-needle aspiration cytological analysis have proved to be superior to palpation for the detection and characterization of supraclavicular lymph node metastasis. On US, a long-axis diameter to short-axis diameter ratio ≤ 2 , absence of a nodal hilum, and nodal cortex abnormality are reliable criteria for differentiating malignant from benign lymph nodes (11, 22). In the application of these criteria as malignant lymph nodes, the following diagnostic characteristics were obtained: accuracy, 91%; sensitivity, 98%; specificity, 56%; positive predictive value, 91%; and negative predictive value, 83%.

There are also reports of the successful use of CT for assessing supraclavicular lymph node metastasis in patients with lung cancer (2, 6) and esophageal cancer (23). These investigators obtained satisfactory sensitivity (82-85%) for supraclavicular lymph node metastasis on CT with the use of short-axis diameter criteria for the presence of metastases greater than or equal to 5 mm. In our study, CECT had 89% accuracy, 98% sensitivity, 44% specificity, a 90% positive predictive value, and an 80% negative predictive value.

In this study, several false-positive and false-negative interpretations on CECT were observed. The possible causes of these include the following: presence of normal-sized (short-axis diameter < 5 mm) metastatic lymph nodes; lymph node enlargement (short-axis diameter ≥ 5 mm) due to benign process; inaccurate measurements of short-axis diameter of supraclavicular lymph nodes on axial CT scan; various interpretation with measurement error of borderline-size lymph nodes around 5 mm. These problems were partially solved in this study through the use of US and ^{18}F -FDG PET/CT.

Several reports indicate that FDG PET is more accurate than CT for detecting or excluding nodal disease (12-16). These findings indicated that FDG PET was more sensitive for the detection of metastasis by increased metabolic activity. However, its limitations include failure to depict anatomic landmarks and limited spatial resolution. In that regard, ^{18}F -FDG PET/CT results in improved sensitivity, specificity, and accuracy for the detection of malignant lymph nodes compared with FDG PET and CT (17).

In our study, the positive uptake of supraclavicular lymph

nodes was defined as having a FDG uptake greater than that of the surrounding tissue, and ^{18}F -FDG PET/CT had 92% accuracy, 98% sensitivity, 67% specificity, a 93% positive predictive value, and an 86% negative predictive value for the detection of supraclavicular lymph node metastasis. Although the differences were not statistically different among imaging modalities, ^{18}F -FDG PET/CT had higher specificity than US, and had higher specificity and negative predictive value than CECT. In one report (24), ^{18}F -FDG PET/CT had higher sensitivity and negative predictive value than CECT in lung cancer with nonpalpable supraclavicular lymph nodes. In addition, no significant differences were observed in the report.

Although ^{18}F -FDG PET/CT has the advantage of whole-body imaging for metastasis detection, one well-known limitation is the differentiation from the inflammatory process. This can be problematic in countries with high endemic rates of tuberculosis, because reactive hyperplasia or inflammation due to granulomatous diseases such as tuberculosis shows increased FDG uptake. In our study, there was a false-positive interpretation of supraclavicular lymph node metastasis with a maximum SUV of 3.89 on ^{18}F -FDG PET/CT and this case was confirmed by tuberculous caseating granuloma. Consideration of lymphatic drainage pathways and review of pre-contrast CT imaging for high density lymph nodes may be helpful in determining granulomatous lymphadenopathy.

Malignancies originating in the pelvis or abdomen are more likely to metastasize to the left supraclavicular lymph node (25). In the present case, all abdominal and pelvic malignancies metastasized to the left supraclavicular area. Right and left lower lung cancers had a tendency to metastasize to the right supraclavicular area. Moreover, we can predict the metastasis site by considering the location of the primary malignancy. Therefore if we consider the characteristics of lymphatic drainage, we could reduce the number of false-positive cases in all imaging modalities.

Other possible causes of false-positive results are physiologic muscle uptake and brown fat (26, 27). However, these patterns are typically bilateral, symmetric, fusiform, or elongated and are often confused with malignancy (28). In some cases, atherosclerotic plaques exhibit focal increased FDG uptake and manifest as malignancy (29, 30). However, these problems can be overcome with the use of ^{18}F -FDG PET/CT.

In most instances, the FDG uptake of metastatic lesion is proportional to that of primary lesion. Therefore, if the FDG uptake of the primary lesion is low, then the metastatic lesion might show low or no FDG uptake. In addition, FDG uptake is related to lesion size, cell density, and metabolic activity. These are the main cause of false-negative results in ^{18}F -FDG PET/CT.

Our study did have a limitation. Because patients who did not undergo cytological confirmation, US, CECT, or ^{18}F -FDG PET/CT were excluded, the diagnostic efficacies of all imaging modalities may have been underestimated in the detection of supraclavicular lymph node metastasis.

In conclusion, the presence of supraclavicular lymph node metastasis in various malignancies is important for accurate staging and appropriate therapy. ^{18}F -FDG PET/CT is a more useful modality than the other abovementioned techniques for the detection and characterization of supraclavicular lymph node metastasis in various malignancies, because of its higher specificity and negative predictive value.

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다양한 원발암으로부터의 쇄골상림프절 전이: 18F-Fluorodeoxyglucose Positron Emission Tomography/CT, 조영증강 CT 그리고 초음파 간의 평가

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목적: 전이성 쇄골상림프절의 진단에 있어서 18F-fluorodeoxyglucose positron emission/CT (이하 ^{18}F -FDG PET/CT), 조영증강 CT 그리고 초음파의 유용성을 비교하여 알아보려고 하였다.

대상과 방법: 다양한 원발암을 진단받은 환자 중에서 쇄골상림프절이 발견된 환자를 대상으로 연구를 시행하였다. 모든 환자는 ^{18}F -FDG PET/CT, 조영증강 CT, 그리고 초음파 검사를 시행하였고 최종적으로 48명의 환자에서 53개의 쇄골상림프절을 평가하였다. 쇄골상림프절 발견은 ^{18}F -FDG PET/CT에서 주위 조직보다 FDG 섭취 증가가 있을 경우로 정의하였고, 조영증강 CT에서는 림프절의 단축 직경이 5 mm보다 큰 경우로, 그리고 초음파에서는 림프절의 단축 직경에 대한 장축 직경의 비, 림프절 문, 림프절 겉질의 이상 유무로 정의하였다. 전이성 쇄골상림프절 발견에 있어 각각의 검사법 종류에 대한 진단적 가치에 대해 비교하였다.

결과: 전이성 쇄골상림프절은 조직학적 검사를 통해 53개에서 44개(83%)가 진단되었다. 전이성 쇄골상림프절 발견에 있어서, ^{18}F -FDG PET/CT, 조영증강 CT, 그리고 초음파의 진단 정확도는 각각 92%, 89%, 91%였다. ^{18}F -FDG PET/CT의 특이도(67%)와 음성 예측도(86%)가 조영증강 CT와 초음파의 것보다 높은 값을 나타냈다.

결론: 다양한 암환자에서 쇄골상림프절 전이 발견과 특성화에 있어서 ^{18}F -FDG PET/CT가 높은 특이도와 음성 예측도를 나타내기 때문에 더욱 유용하다고 할 수 있다.

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