^{18}F-FDG PET/CT Findings in Endometrial Cancer Patients: The Correlation between SUVmax and Clinicopathologic Features

Trirat Boonya-ussadorn MD*, Woo Hee Choi MD**,
Joo Hyun O MD**, Sung Hoon Kim MD**,
Soo Kyo Chung MD**, Ie Ryung Yoo MD**

** Division of Nuclear Medicine, Department of Radiology, Phramongkutklao Hospital, Bangkok, Thailand*
*** Department of Radiology, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, South Korea*

Objective: *To study ^{18}F-FDG PET/CT findings in endometrial cancer patients, to analyze the correlation between the maximum standardized uptake value (SUVmax) and clinicopathologic tumor characteristics.*
Material and Method: *Retrospective study included 33 endometrial cancer patients who underwent pre-operative ^{18}F-FDG PET/CT and abdominal CT or MRI from June 2005 to October 2009. Pattern of FDG uptake was classified as focal and diffuse uptake. SUVmax was measured at primary tumor in endometrial cavity and correlated with maximum tumor size, menopausal state, histological grade, depth of myometrial invasion and nodal metastasis. The diagnostic performance of ^{18}F-FDG PET/CT was assessed for primary tumor and lymph node metastasis and correlated with those of CT/MRI.*
Results: *Sensitivity of ^{18}F-FDG PET/CT in primary tumor detection was slightly higher, without significant difference, than that of either CT or MRI (93.9 % vs. 87.9%, p = 0.625). The overall SUVmax mean of the primary tumor was 8.24±5.38. The focal FDG uptake pattern was more common than the diffuse uptake pattern (71.0% and 29.0%, respectively), but the SUVmax was higher in the diffuse uptake pattern (diffuse pattern 12.10±7.47 vs. focal pattern 6.66±3.33, p = 0.008). There was significant association between the SUVmax of the primary tumor and maximum tumor size (p = 0.001), but not between the SUVmax of the primary tumor and menopause state, histological grade, depth of myometrial invasion and nodal metastasis (p = 0.522, 0.622, 0.694 and 0.601, respectively). For lymph node detection, the sensitivity of ^{18}F-FDG PET/CT were also higher, without statistically significant difference, than those of CT/MRI (on patient basis; 80.0% vs. 40.0%, p = 0.500; on nodal basis 64.7% vs. 47.1%, p = 0.453, respectively).*
Conclusion: *^{18}F-FDG PET/CT had slightly higher diagnostic sensitivity than CT/MRI in both primary tumor and lymph node detection. The finding focal uptake pattern is more common, but the diffuse uptake pattern shows higher FDG uptake. The SUVmax of primary tumors was associated with the maximum tumor size, but not associated with menopause state, histologic grade, depth of myometrial invasion and nodal metastasis.*

Keywords: *Endometrial cancer, ^{18}F-FDG, PET/CT, Maximum standardized uptake value*

J Med Assoc Thai 2014; 97 (Suppl. 2): S115-S122
Full text. e-Journal: *http://www.jmatonline.com*

Gynecologic malignancy consists of cervical, ovarian, endometrial and vulvar cancer. Endometrial cancer refers to several types of malignancies that arise from the endometrium, or lining, of the uterus. The incidence of endometrial cancer is about 142,000 cases per year worldwide[1]; however, there is regional variation. In the United States, it is the most common gynecologic malignancy, with an estimated 43,470 new cases diagnosed in 2010[2,3]. The incidence is lower in Asian population. For instance, it is the third most common gynecologic cancer following cervical and ovarian cancer in Korea[4] and Thailand. Thai Gynecologic Cancer Society reported incidence 2.8 cases/100,000 female population in 2009[5].

The first recommended modality for diagnosis of endometrial cancer following physical examination is a transvaginal ultrasound. It is used to evaluate the endometrial layer or other abnormalities in the pelvic cavity[1]. Then, for initial staging, CT and MRI have been useful to evaluate tumor extension and metastasis

Correspondence to:
Boonya-ussadorn T, Division of Nuclear Medicine, Department of Radiology, Phramongkutklao Hospital, Bangkok 10400, Thailand.
Phone & Fax: 0-2354-7632
E-mail: triratsa@hotmail.com

of pelvis, abdomen and chest[6,7].

Nowadays, the use of PET/CT with ^{18}F-fluorodeoxyglucose (^{18}F-FDG) has been rapidly increasing. It is a well-known diagnostic tool to survey various malignancies and inflammatory disease. Most literature has reported the usefulness of ^{18}F-FDG PET/CT in various malignancies; however, the role of ^{18}F-FDG PET/CT in endometrial cancer is still less defined due to a lack of supporting data in the literature.

Some researches show high FDG uptake at primary tumor of endometrial cancer. For instance, Kitajima K et al reported mean SUV of endometrium in 40 endometrial cancer patients between 2.0-25.6, with a mean value of 11.2[8]. Nowadays, pattern of FDG uptake at primary tumor of endometrium has never been classified. Besides correlation between the maximum standardized uptake value (SUVmax) and clinicopathologic features is controversial.

The purposes of this research were to assess diagnostic performance of ^{18}F-FDG PET/CT in endometrial cancer for primary tumor and nodal metastasis detection, to study finding of ^{18}F-FDG PET/CT in endometrial cancer and to analyze the correlation between the SUVmax and clinicopathologic features.

Material and Method

Patients

Thirty-three pathological proved endometrial cancer patients from Seoul St. Mary's Hospital, College of Medicine, the Catholic University of Korea were retrospectively reviewed. All of them underwent pre-operative ^{18}F-FDG PET/CT from June 2005 to October 2009. Thirty-two cases underwent pre-operative pelvic MRI and only one underwent an abdominal CT. All of these studies were performed within 2 weeks of surgical staging for carcinoma of endometrium.

^{18}F-FDG PET/CT imaging protocol

The patients were instructed to fast at least 6 hours prior to undergoing ^{18}F-FDG PET/CT. In the day of the examination, the serum glucose levels of all patients measured before ^{18}F-FDG injections were less than 130 mg/dl. After 370-555 MBq of ^{18}F-FDG was injected intravenously, the patient rested lying and scanning began 60 min later. No intravenous contrast agent was used. Two combined PET/CT in-line system (Biograph DUO, BiographTruepoint; Siemens Medical Solutions, Knoxville, TN, USA) were used to acquire all data. CT scan was performed from the orbitometal line to upper thighs (30 mA s, 130 kV, 5-mm slice thickness; 80 mA s, 130 kV, 5-mm slice thickness). PET followed immediately over the same body region. There were 6-8 bed positions, and the acquisition time was 2-3 min per bed position. The CT data were used for attenuation correction, and images were reconstructed using a standard ordered-subset expectation maximization algorithm.

Data analysis

Each ^{18}F-FDG PET/CT study was reviewed by a nuclear medicine physician and CT/MRI was reviewed by a radiologist. All studies were assessed for the primary tumor, regional nodal status and distant metastasis.

For primary tumor detection of PET/CT, perceptible increased FDG uptake in uterine endometrium was classified as positive for tumor detection. The pattern of FDG uptake was classified as focal and diffuse uptake pattern. The term focal uptake means a localized FDG uptake in uterine cavity, including large endometrial mass, which occupied entire or nearly entire uterus, while the diffuse uptake means generalized uptake of uterine endometrium. Sensitivity of ^{18}F-FDG PET/CT and CT/MRI were compared with those of postoperative pathological results.

The standardized uptake value (SUV) represents the ^{18}F-FDG accumulation in the tumor. It is calculated as the following formula:

$$SUV = \frac{\text{Mean ROI activity (mCi/mL)}}{\text{Activity administered (mCi)/body weight (grams)}}$$

ROI = Region of interest

SUVmax (a maximum standardized uptake value in each ROI) was measured at uterine endometrium and correlated with maximum tumor size, menopausal state, histologic grade, depth of myometrial invasion and nodal metastasis by using independent t-test and one-way ANOVA.

For nodal metastasis, the increased FDG uptake lymph node was reported as positive for nodal metastasis. The diagnostic sensitivity, specificity and accuracy of ^{18}F-FDG PET/CT and CT/MRI were compared with those of postoperative pathological results.

Differences in assessment between both procedures in primary tumor and lymph node detections were tested for significance. A *p*-value less than 0.05 was statistically significant using STATA/MP 12.

Results

Patient characteristics are shown in Table 1.

Table 1. Patient characteristics

Characteristic	No. of patients (%) (n = 33)
Age (year), mean ± SD	53.7±8.6
Menopause state	
Premenopausal	8 (24.2)
Postmenopausal	25 (75.8)
Tumor maximum size (cm), mean ± SD	3.4±2.6
Histology	
Endometrioid adenocarcinoma	31 (93.94)
Well-differentiated	14 (42.42)
Moderate-differentiated	14 (42.42)
Poor-differentiated	3 (9.10)
Serous adenocarcinoma	1 (3.03)
Malignant mixed mullerian tumor (carcinosarcoma)	1 (3.03)
Lymph node status by pathology	
Negative	28 (84.8)
Positive	5 (15.2)

Thirty-three patients were included with mean age 53.7±8.6 years. Eight of them were in premenopausal women; the remaining were postmenopausal women. Mean of tumor maximum size was 3.4±2.6 cm. Histological reports reviewed 31 of endometrioid adenocarcinoma (14 of well differentiated, 14 of moderate-differentiated and 3 of poor-differentiated type). The remaining two patients were serous adenocarcinoma and malignant mixed mullerian tumor.

Regarding locoregional involvement, the histology revealed four cases with endocervical involvement, two with cervical stroma and two with adnexal involvement. No serosal or vaginal involvement including distant metastasis was detected in these patients. There were 6 cases of coincidental leiomyomas, 5 of adenomyosis and 3 of both leiomyomas and adenomyosis.

By ^{18}F-FDG PET/CT imaging, two of 33 cases showed no perceptible FDG uptake in the primary tumor and these tumors were measured 0.3 and 0.4 cm in post-operative pathology respectively. Both of them were postmenopausal women with endometrioid adenocarcinoma, moderate and well differentiation, respectively. Therefore, the sensitivity of ^{18}F-FDG PET/CT for primary tumor was 93.9%. On the other hand, CT/MRI showed undetectable primary endometrial tumor in 4 cases (sensitivity 87.9%). There was no significant difference between sensitivity of ^{18}F-FDG PET/CT and CT/MRI for primary tumor detection (p = 0.625).

The ^{18}F-FDG PET/CT of the remaining 31 cases were positive for a primary tumor, with an overall

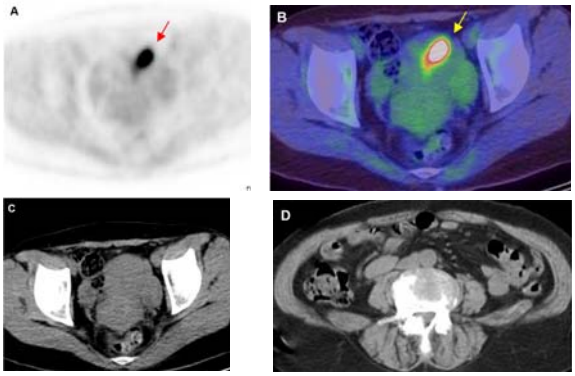

Fig. 1 A 36-year-old premenopausal endometrioid adenocarcinoma woman. A-C)^{18}F-FDG PET, Fusion PET/CT and CT images show intense focal FDG uptake pattern (SUVmax 10.4) in uterine endometrium (arrow). D) MRI T2W shows irregular intermediate signal intensity in the left side of uterine fundus with junctional zone invasion (open arrow).

mean SUVmax was of 8.24±5.38. We found focal uptake (as Fig. 1) in 22 cases (71.0%) and diffuse uptake (as Fig. 2) in 9 cases (29.0%). The mean SUVmax was significantly higher in primary tumors with diffuse FDG uptake than with focal uptake (12.10±7.47 vs. 6.66±3.33, p = 0.008). The results are shown in Table 2.

The maximum tumor size was associated with SUVmax. The value of SUVmax in tumors sized at least 4 cm was significantly higher than those of tumors smaller than 4 cm (mean SUVmax 12.17±6.39 vs. 6.07±3.22, p = 0.001). Regarding menopause state (p =

0.522), histological grade (p = 0.622), depth of myometrial invasion (p = 0.694) and nodal metastasis (p = 0.601), these factors were not associated with SUVmax of primary lesion (Table 3).

By histological review, thirty-two nodal metastases were detected from 1,435 pelvic lymph node sampling (17 in 394 nodal groups). Nodal metastases were detected in 5 cases (15.2%) and negative in 28 cases (84.8%). In patient-based analysis, sensitivity of ^{18}F-FDG PET/CT was higher, without statistically significant difference, than that of CT/MRI (80.0% vs. 40.0%, p = 0.500), Fig. 3. Of the five positive cases, pathology detected 17 positive nodal groups. Based on nodal groups, ^{18}F-FDG PET/CT found 11, while CT/MRI found 8 true positive cases. Each ^{18}F-FDG PET/CT and CT/MRI showed one false positive case. Therefore, sensitivity, specificity and accuracy of ^{18}F-FDG PET/CT are 64.7% (95% CI 41.30-82.69), 99.7% (95% CI 98.51-99.95) and 98.2% respectively, meanwhile those of CT/MRI are 47.1% (95% CI 26.17-69.04), 99.7% (95% CI 98.51-99.95) and 97.5%, respectively (Table 4). Although the sensitivity of ^{18}F-FDG PET/CT was higher than that of CT/MRI, there was no significant difference in statistical analysis (64.7% vs. 47.1%, p = 0.453).

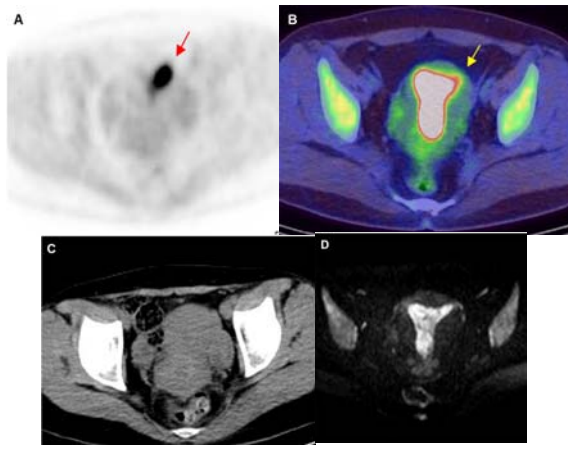

Fig. 2 28-year-old premenopausal woman with endometrioid adenocarcinoma.A-C, ^{18}F-FDG PET, Fusion PET/CT and CT images show markedly intense diffuse FDG uptake pattern (SUVmax 29.3) along uterine endometrium (arrow); and D, MRI T2W fat suppression demonstrates soft tissue lesion in uterine endometrium, resulting in widening of endometrial cavity.

Discussion

In the presented study, sensitivity of ^{18}F-FDG PET/CT in primary tumor detection was slightly higher, without significant difference, than that of CT/MRI (93.9% vs. 87.9%, p = 0.625). Several studies also showed high sensitivity of ^{18}F-FDG PET and PET/CT in primary tumor detection. Suzuki R et al analyzed both primary and metastatic lesions of 30 endometrial cancer patients. They showed ^{18}F-FDG PET could identify primary lesions with sensitivity 96.7%, which was higher than the 83.3% by CT/MRI. Although they used only ^{18}F-FDG PET without combined CT, the result is similar to our study. Furthermore, they found that ^{18}F-FDG PET could not identify lymph node metastasis less than 1 cm in diameter[9]. Similarly, Picchio M et al studied 32 high grade endometrial carcinoma patients and found that sensitivity of ^{18}F-FDG PET/CT in primary tumor detection was 90.6%[10], and Suga et al also reported high sensitivity and specificity of ^{18}F-FDG PET/CT for primary tumors were 83% and 100%, respectively[11].

Overall mean SUVmax of primary tumor in this study was 8.24±5.38. It is known that endometrial carcinoma has been found to show ^{18}F-FDG avidity in PET/CT imaging; however, there may be some factors effecting FDG uptake pattern such as variable shapes of tumor gross anatomy, cellular density or metabolic activity of cancerous endometrium. In case of small size tumors or low cellular density tumors, they may not show FDG uptake[12]. To date, not many researchers have studied the intensity and patterns of FDG uptake of endometrial carcinoma in PET/CT. By pathology, endometrial cancer may be grossly visible as a localized disease with round, polypoid expansile masses that are friable and often hemorrhage; or it may be diffuse involvement with an indurated-appearing surface

Table 2. Association between SUVmax and FDG uptake pattern

Uptake pattern	No. of cases (%)	SUVmax mean ± SD	p-value
Focal uptake	22 (71.0)	6.66±3.33	0.008*
Diffuse uptake	9 (29.0)	12.10±7.47	
Overall	31 (100)	8.24±5.38	

* Independent t-test

Table 3. Association between SUVmax of primary lesion and clinicopathologic features

	No. of cases (%)	SUVmax mean ± SD	*p*-value
Maximum tumor size			
<4 cm	20 (64.5)	6.07±3.22	0.001*
≥4 cm	11 (35.5)	12.17±6.39	
Menopause state			
Premenopausal	8 (25.8)	9.31±8.57	0.522*
Postmenopausal	23 (74.2)	7.86±3.95	
Histologic grade			
Well-differentiated	13 (41.9)	8.18±7.02	0.622**
Moderate-differentiated	14 (45.2)	7.60±3.70	
Poor-differentiated or high grade	4 (12.9)	10.65±4.84	
Depth of myometrial invasion			
<1/2 myometrial invasione	20 (64.5)	7.95±6.19	0.694*
≥1/2 myometrial invasion	11 (35.5)	8.76±3.69	
Nodal metastasis			
Negative	26 (83.9)	8.01±5.80	0.601*
Positive	5 (16.1)	9.42±2.16	

***** Independent t-test
** Oneway ANOVA

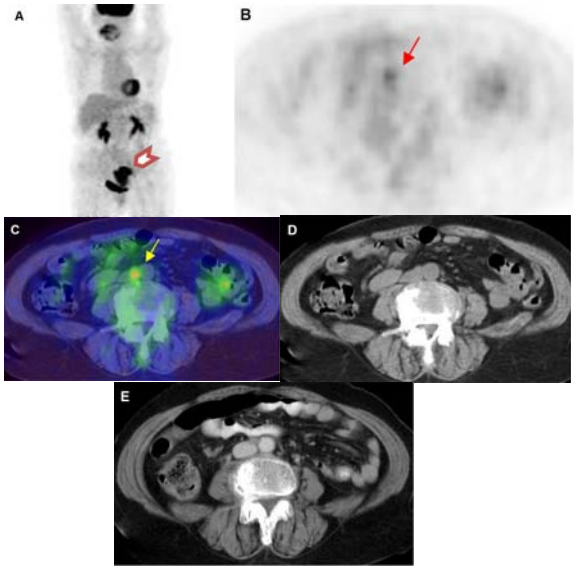

Fig. 3 71-year-old endometrioid adenocarcinoma woman. A) MIP ^{18}F-FDG PET/CT shows a large intense FDG uptake of uterine mass in pelvic cavity with SUVmax 8.5 (arrowhead), B-D) ^{18}F-FDG PET, Fusion PET/CT and non contrast CT images show abnormal focal FDG uptake (arrow) corresponds to aortocaval lymph node (SUVmax 2.2); however, E) this lesion was skipped on the enhanced CT due to small size. Histopathologic specimen confirmed lymph node involvement by cancer (false negative case in CT).

without a visible exophytic component[3]. Following the gross pathology, the authors designed pattern of FDG uptake as focal and diffuse uptake and found that ^{18}F-FDG PET/CT appeared more often with the focal FDG uptake pattern rather than with diffuse uptake, but the SUVmax was higher when the primary tumor had a diffuse uptake pattern (p = 0.008).

Concerning the correlation between SUVmax and clinicopathologic features, Nakamura et al reported the measurement of SUVmax in endometrial cancer. They concluded that SUVmax had a significant association with the FIGO stage, tumor histology, depth of myometrial invasion and maximum tumor size[2]. Similar to Lee HJ et al's, this research evaluated ^{18}F-FDG PET/CT in 60 female endometrial cancer patients. With multivariate analysis, they found that FIGO stage, histological grade, lymphovascular space involvement and maximum tumor size were significantly associated with SUVmax. The optimal SUVmax cut-off value of 8.7 revealed sensitivity 75.6%, specificity 89.5%, and accuracy 81.7% for risk stratification. High-risk endometrial cancer might be differentiated by means of higher SUVmax from low-risk endometrial cancer[13]. The presented study also demonstrates that the SUVmax of a primary tumor was associated with the maximum tumor size (p = 0.001), but in contrast with other researches, we found that it was not associated with histological grade and depth of myometrial invasion. Nevertheless, our statistical power is probably weaker

Table 4. Diagnostic performance of ^{18}F-FDG PET/CT and either CT or MRI for nodal detection in endometrial cancer patients

	Sensitivity (95% CI)	Specificity (95% CI)	Accuracy
Patient-based analysis			
^{18}F-FDG PET/CT	80.0% (4/5) (37.55-96.38)	96.4% (27/28) (82.29-99.37)	93.9% (31/33)
CT/MRI	40.0% (2/5) (11.76-76.93)	96.4% (27/28) (82.29-99.37)	87.9% (29/33)
Node-based analysis			
^{18}F-FDG PET/CT	64.7% (11/17) (41.30-82.69)	99.7% (376/377) (98.51-99.95)	98.2% (387/394)
CT/MRI	47.1% (8/17) (26.17-69.04)	99.7% (376/377) (98.51-99.95)	97.5% (384/394)

than Lee HJ et al's research due to smaller number of subjects. Furthermore, we found that the SUVmax of primary tumor was not associated with menopausal state and nodal metastasis. Another research, Kitajima K et al, also reported no association of mean SUV of endometrial carcinoma at primary uterine lesions with and without nodal metastasis (mean 12.9$\pm$4.8 and 10.6$\pm$6.7, respectively, $p = 0.329$)[8].

Regarding nodal metastasis, the presented study found that ^{18}F-FDG PET/CT had higher sensitivity, without statistically significant difference, compared with CT/MRI in both patient and node-based analysis (80.0% vs. 40.0%, $p = 0.500$ and 64.7% vs. 47.1%, $p = 0.453$, respectively). Both ^{18}F-FDG PET/CT and CT/MRI had high specificity and accuracy for metastatic node detection in both patient and node-based analysis. Picchio M et al reported lower sensitivity of ^{18}F-FDG PET/CT in patient-based lymph node detection (57.1%) but they showed high specificity, positive predictive value, negative predictive value and accuracy for revealing lymph node involvement (100.0, 100.0, 86.4 and 88.5%, respectively)[10]. The specificity and accuracy of this study are similar to ours (96.4 and 93.9% respectively). On the other hand, Suga et al reported very high sensitivity and specificity of ^{18}F-FDG PET/CT for the patient-based nodal evaluation (100 and 100% respectively)[11]. Additionally, Kitajima K et al showed comparison of contrast enhanced PET/CT (PET/ceCT) with conventional PET/CT scan with low-dose CT (PET/ldCT) and full-dose CT with IV contrast (ceCT). They found higher sensitivity of PET/ceCT than PET/ldCT and ceCT (57.1, 42.9, 28.6% in patient-based and 57.7, 50.0, 38.5% in node-based analysis, respectively)[14].

One of the pitfalls in interpretation of ^{18}F-FDG PET/CT images of female patients is that the increased ^{18}F-FDG uptake in the endometrium or ovaries is not always associated with pathologic condition, but may be physiologic. Lerman et al reported 85 normal menstrual cycle premenopausal patients without gynecologic malignancy that mean SUV in menstrual, proliferative, ovulatory and secretory phases were 5$\pm$3.2, 2.6$\pm$1.1, 3.7$\pm$0.9 and 2.5$\pm$1.1, respectively. They concluded that FDG uptake in uterine endometrium of normal premenopausal patients usually changes cyclically, and may increase during menstrual and ovulation phases. Meanwhile, in postmenopausal women, normal endometrial uptake is minimal[15]. Not only physiologic FDG uptake, but also some benign lesions may cause confusion in ^{18}F-FDG PET/CT interpretation. For example, uterine leiomyomas, adenomyosis and endometrial hyperplasia usually show mild FDG uptake, but some cases of leiomyomas may show intense uptake, and adenomyosis may show increased intensity during menstruating and ovulating phases[12,16]. Kitajima et al showed mean SUVmax of 61 leiomyoma patients was 2.34$\pm$0.75 (range 1.59-5.15)[17]. Tsujikawa et al found higher mean SUVmax of endometrial cancer (mean SUVmax 9.6$\pm$3.3) rather than those of leiomyomas (2.2$\pm$1.1) and endometrial hyperplasia (1.7$\pm$0.3)[18]. However, Chura et al reported an ordinary leiomyoma of 13 mm which showed very high SUV (SUV = 16)[16]. The mentioned factors may cause pitfalls in our study which included 8 premenopausal patients and the pathological reports reviewed coincidental leiomyomas in 6, adenomyosis 5 and both leiomyomas and adenomyosis 3 cases.

Compared with other research studies, the presented study had a limitation due to the relatively small number of patients; therefore, further study is

required for proper evaluation.

Conclusion

In summary, ^{18}F-FDG PET/CT had slightly higher diagnostic sensitivity in both primary tumor and metastatic node detection than CT/MRI. The common finding of primary tumor in ^{18}F-FDG PET/CT was focal uptake pattern rather than diffuse uptake, but the diffuse uptake pattern show higher SUVmax. Concerning clinicopathologic features, the SUVmax of primary tumor was associated with maximum tumor size, but not correlated with other characteristics such as menopausal state, histological grade, depth of myometrial invasion and lymph node metastasis.

Potential conflicts of interest

None.

References

1. Brocker KA, Alt CD, Eichbaum M, Sohn C, Kauczor HU, Hallscheidt P. Imaging of female pelvic malignancies regarding MRI, CT, and PET/CT : part 1. Strahlenther Onkol 2011; 187: 611-8.
2. Nakamura K, Hongo A, Kodama J, Hiramatsu Y. The measurement of SUVmax of the primary tumor is predictive of prognosis for patients with endometrial cancer. Gynecol Oncol 2011; 123: 82-7.
3. Gordon MD, Ireland K. Pathology of endometrial carcinoma [Internet]. 2008 [cited 2013 Aug 6]. Available from: http://www.glowm.com/section_view/heading/Pathology%20of%20Endometrial%20Carcinoma/item/238.
4. Lee JH, Jung US, Kyung MS, Choi JS. Laparoscopic-assisted staging surgery for Korean women with endometrial cancer. JSLS 2008; 12: 150-5.
5. Thai Gynecologic Cancer Society. Endometrial Cancer for General Public [Internet]. 2009 [cited 2013 May 15]. Available from: http://www.tgcsthai.com/dataview.php?id=20&code=KP.
6. Kitajima K, Murakami K, Kaji Y, Sakamoto S, Sugimura K. Established, emerging and future applications of FDG-PET/CT in the uterine cancer. Clin Radiol 2011; 66: 297-307.
7. Manfredi R, Mirk P, Maresca G, Margariti PA, Testa A, Zannoni GF, et al. Local-regional staging of endometrial carcinoma: role of MR imaging in surgical planning. Radiology 2004; 231: 372-8.
8. Kitajima K, Murakami K, Yamasaki E, Fukasawa I, Inaba N, Kaji Y, et al. Accuracy of 18F-FDG PET/CT in detecting pelvic and paraaortic lymph node metastasis in patients with endometrial cancer. AJR Am J Roentgenol 2008; 190: 1652-8.
9. Suzuki R, Miyagi E, Takahashi N, Sukegawa A, Suzuki A, Koike I, et al. Validity of positron emission tomography using fluoro-2-deoxyglucose for the preoperative evaluation of endometrial cancer. Int J Gynecol Cancer 2007; 17: 890-6.
10. Picchio M, Mangili G, Samanes Gajate AM, De Marzi P, Spinapolice EG, Mapelli P, et al. High-grade endometrial cancer: value of [(18)F]FDG PET/CT in preoperative staging. Nucl Med Commun 2010; 31: 506-12.
11. Suga T, Nakamoto Y, Saga T, Higashi T, Hamanaka Y, Tatsumi M, et al. Clinical value of FDG-PET for preoperative evaluation of endometrial cancer. Ann Nucl Med 2011; 25: 269-75.
12. Kitajima K, Murakami K, Kaji Y, Sugimura K. Spectrum of FDG PET/CT findings of uterine tumors. AJR Am J Roentgenol 2010; 195: 737-43.
13. Lee HJ, Ahn BC, Hong CM, Song BI, Kim HW, Kang S, et al. Preoperative risk stratification using (18)F-FDG PET/CT in women with endometrial cancer. Nuklearmedizin 2011; 50: 204-13.
14. Kitajima K, Suzuki K, Senda M, Kita M, Nakamoto Y, Sakamoto S, et al. Preoperative nodal staging of uterine cancer: is contrast-enhanced PET/CT more accurate than non-enhanced PET/CT or enhanced CT alone? Ann Nucl Med 2011; 25: 511-9.
15. Lerman H, Metser U, Grisaru D, Fishman A, Lievshitz G, Even-Sapir E. Normal and abnormal 18F-FDG endometrial and ovarian uptake in pre- and postmenopausal patients: assessment by PET/CT. J Nucl Med 2004; 45: 266-71.
16. Chura JC, Truskinovsky AM, Judson PL, Johnson L, Geller MA, Downs LS, Jr. Positron emission tomography and leiomyomas: clinicopathologic analysis of 3 cases of PET scan-positive leiomyomas and literature review. Gynecol Oncol 2007; 104: 247-52.
17. Kitajima K, Murakami K, Yamasaki E, Kaji Y, Sugimura K. Standardized uptake values of uterine leiomyoma with 18F-FDG PET/CT: variation with age, size, degeneration, and contrast enhancement on MRI. Ann Nucl Med 2008; 22: 505-12.
18. Tsujikawa T, Yoshida Y, Mori T, Kurokawa T, Fujibayashi Y, Kotsuji F, et al. Uterine tumors: pathophysiologic imaging with 16 alpha-[18F] fluoro-17beta-estradiol and 18F fluorodeoxyglucose PET—initial experience. Radiology 2008; 248: 599-605.

ลักษณะภาพทางรังสีของ ^{18}F-FDG PET/CT ในผู้ป่วยมะเร็งเยื่อบุโพรงมดลูก: ความสัมพันธ์ระหว่างค่า SUVmax และลักษณะทางพยาธิวิทยา

ตรีรัตน์ บุญญอัศดร, Woo Hee Choi, Joo Hyun O, Sung Hoon Kim, Soo Kyo Chung, Ie Ryung Yoo

วัตถุประสงค์: ศึกษาลักษณะภาพทางรังสี (findings) ของ ^{18}F-FDG PET/CT ในผู้ป่วยมะเร็งเยื่อบุโพรงมดลูกและหาความสัมพันธ์ระหว่างค่า maximum standardized uptake value (SUVmax) กับลักษณะทางคลินิกและผลพยาธิวิทยาหลังผ่าตัด

วัสดุและวิธีการ: เป็นการศึกษาย้อนหลังภาพทางรังสีของ ^{18}F-FDG PET/CT และ abdominal CT หรือ MRI ในผู้ป่วย 33 ราย ที่ได้รับการผ่าตัดมดลูกและรังไข่ รวมถึงต่อมน้ำเหลืองบริเวณข้างเคียง แล้วได้รับการวินิจฉัย ว่าเป็นมะเร็งเยื่อบุโพรงมดลูก และมีผลตรวจทางพยาธิยืนยันอย่างละเอียดครบถ้วน ที่เข้ามารับการตรวจในช่วงเดือน มิถุนายน พ.ศ. 2548 ถึงเดือนตุลาคม พ.ศ. 2552 โดยศึกษาภาพทางรังสีของ ^{18}F-FDG PET/CT โดยแยกรูปแบบ FDG uptake เป็นแบบ focal และ diffuse uptake pattern, วิเคราะห์ความสัมพันธ์ระหว่างค่า SUVmax กับลักษณะทางคลินิกและผลตรวจทางพยาธิวิทยาหลังผ่าตัดในแง่ขนาดของก้อนเนื้องอก, ภาวะก่อนหรือหลัง หมดประจำเดือนของผู้ป่วย, histologic grade, ความลึกของmyometrial invasion, การที่มีหรือไม่มีกระจาย ไปยังต่อมน้ำเหลืองรวมทั้งหาความสามารถในการวินิจฉัยของ ^{18}F-FDG PET/CT และ CT/MRI ในการตรวจพบ primary tumor และการกระจายไปยังต่อมน้ำเหลืองเปรียบเทียบกับผลชิ้นเนื้อ

ผลการศึกษา: ความไวในการตรวจหา primary tumor ของ ^{18}F-FDG PET/CT สูงกว่า CT/MRI เล็กน้อยอย่างไม่มีนัยสำคัญ (93.9% และ 87.9%, p = 0.625) ค่าเฉลี่ย SUVmax ที่ primary tumor อยู่ที่ 8.24±5.38 รูปแบบ focal FDG uptake pattern พบได้บ่อยกว่า diffuse uptake pattern (71.0% และ 29.0% ตามลำดับ), แต่ diffuse uptake pattern จะมีค่าเฉลี่ย SUVmax ที่สูงกว่า (diffuse pattern 12.10±7.47 และ focal pattern 6.66±3.33, p = 0.008) มีความสัมพันธ์อย่างมีนัยสำคัญระหว่างค่า SUVmax ที่ primary tumor กับขนาดของก้อนเนื้องอก (p = 0.001) แต่ไม่มีความสัมพันธ์ระหว่างค่า SUVmax กับภาวะก่อนหรือหลังหมดประจำเดือนของผู้ป่วย, histologic grade, ความลึกของ myometrial invasion, การที่มีหรือไม่มีกระจายไปยังต่อมน้ำเหลือง (p = 0.522, 0.622, 0.694 และ 0.601 ตามลำดับ) สำหรับการหาต่อมน้ำเหลืองที่มีมะเร็งกระจายไป พบว่าความไวในการตรวจด้วย ^{18}F-FDG PET/CT สูงกว่า CT/MRI อย่างไม่มีนัยสำคัญ (อิงตามจำนวนผู้ป่วย patient basis; 80.0% และ 40.0%, p = 0.500; อิงตามจำนวนต่อมน้ำเหลือง nodal basis 64.7% และ 47.1%, p = 0.453 ตามลำดับ).

สรุป: ความไวในการตรวจหา primary tumor และการกระจายของต่อมน้ำเหลืองด้วย ^{18}F-FDG PET/CT สูงกว่า CT/MRI เล็กน้อยแต่ไม่มีนัยสำคัญ ลักษณะภาพทางรังสีของ FDG uptake แบบ focal uptake pattern เป็นแบบที่พบ ได้บ่อยกว่า แต่แบบ diffuse uptake pattern มี FDG uptake ที่สูงกว่าค่า SUVmax ที่ primary tumor ความสัมพันธ์กับขนาดของก้อนเนื้องอกแต่ไม่มีความสัมพันธ์กับ ภาวะก่อนหรือหลังหมดประจำเดือนของผู้ป่วย, histologic grade, ความลึกของmyometrial invasion, การที่มีหรือไม่มีกระจายไปยังต่อมน้ำเหลือง