Diagnostic Usefulness of ^{18}F-FDG PET/CT in Differentiated Thyroid Cancer Patients with Elevated Serum Thyroglobulin or Thyroglobulin Antibody Levels

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Objective: *To evaluate diagnostic accuracy of ^{18}F-FDG PET/CT in detection of recurrence or metastases in differentiated thyroid cancer (DTC) patients with elevated stimulated thyroglobulin (sTg) or thyroglobulin antibody (TgAb) levels but negative ^{131}I whole body scan (^{131}I WBS).*

Material and Method: *Between January 2007 and December 2014, 38 ^{18}F-FDG PET/CT examinations in 38 DTC patients with elevated sTg levels (10 ng/ml or greater, n = 33) or elevated TgAb levels (40.0 IU/ml or greater, n = 5) but negative post-therapeutic ^{131}I WBS or diagnostic ^{131}I WBS were included. All patients underwent total thyroidectomy and radioiodine ablation. The ^{18}F-FDG PET/CT findings were compared with histologic (n = 16) or clinical follow-up results based on serum Tg/TgAb levels or other imaging modalities. Duration of follow-up ranged from six months to seven years (median duration = 30 months).*

Results: *Thirty-two studies showed true positive lesions of local recurrence (n = 23, 60.5%), distant metastases (n = 2, 5.3%) and both local recurrence and distant metastases (n = 7, 18.4%). One study (2.6%) was considered as false positive lesions at cervical nodes, which was confirmed by histological result. Four studies (10.5%) were confirmed true negative results. A patient with no abnormal ^{18}F-FDG avidity in subcentimeter cervical lymph nodes was clarified as false negative, as subsequent follow-up results showed slow rising of Tg levels with suggestion of cervical node metastases demonstrated by neck ultrasonography. Sensitivity, specificity, and accuracy of ^{18}F-FDG PET/CT in the present study were 96.9%, 80%, and 94.7%, respectively. Additional information of previously undiagnosed lesions was found in seven patients i.e., meningioma and metastatic lesions in brain, bone, liver, muscle, and soft tissue.*

Conclusion: *The ^{18}F-FDG PET/CT is useful for detection and localization of recurrence or metastases in DTC patients with negative ^{131}I WBS but elevated sTg or TgAb levels. This technique also provides useful additional findings for appropriate management of these patients.*

Keywords: *Thyroid carcinoma, ^{18}F-FDG PET/CT, Thyroglobulin, ^{131}I whole body scan*

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Differentiated thyroid carcinoma (DTC) have favorable prognosis. Overall 10-year survival is 93% for papillary carcinoma, and 85% for follicular carcinoma[1]. After total thyroidectomy followed by radioiodine remnant ablation, DTC patients are screened for recurrence by serum thyroglobulin (Tg) and ^{131}I whole body scan (WBS)[2]. The ^{131}I WBS has high specificity to detect recurrence (50 to 60% in papillary thyroid carcinoma and 64 to 67% in follicular thyroid carcinoma)[3,4]. The ^{131}I WBS showed negative finding in 10 to 15% of patients with detectable serum Tg levels[5]. Two factors may account for discrepancy between serum Tg and ^{131}I WBS. First, the tumor size might be too small to be detected by WBS. Second, the tumor cell may lose the ability to trap radioiodine while still able to secret Tg[6,7]. It becomes necessary to investigate with other modalities to identify possible residual disease to initiate the appropriate treatment. Various imaging modalities including ultrasonography of neck, computed tomography (CT), and magnetic resonance imaging (MRI) of neck and chest are currently used for further diagnostic evaluation[3]. The ^{18}F-fluorodeoxyglucose positron emission tomography/computed tomography (FDG PET/CT) has been widely accepted for localizing disease in the patients in these group[8-10]. In Thailand, ^{18}F-FDG PET/CT in DTC is not routinely used due to its high cost and inability to reimburse. Therefore, the aim of the present study was to evaluate diagnostic accuracy of ^{18}F-FDG PET/CT in detection of recurrence or metastatic tumor in DTC patients with negative ^{131}I WBS and elevated stimulated thyroglobulin (sTg) or thyroglobulin antibody (TgAb) levels.

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Material and Method

Patients

Between January 2007 and December 2014, a total of 38 ^{18}F-FDG PET/CT examinations from 38 DTC patients (22 women, mean age 47.91±15.9 years, range 24 to 79 years) who had total thyroidectomy and at least once high dose radioiodine ablation for the treatment of DTC were examined. Patient with elevated Tg levels (10 ng/ml or greater, n = 33) after thyroid-stimulating hormone (TSH) stimulation (TSH greater than 30 mIU/l) or elevated TgAb levels (40.0 IU/ml or greater, n = 5) but negative post-therapeutic ^{131}I WBS or diagnostic ^{131}I WBS were included. The patients had previously received high dose I-131 treatment one to six times (median twice) for remnant tissue ablation or treatment of recurrent disease. Total therapeutic dose ranged from 150 to 1,000 mCi (median 300 mCi). The primary tumor histology type was papillary thyroid carcinoma in 37 cases. The remaining one case was follicular carcinoma. Patient characteristics are described in Table 1.

Radioiodine WBS

Radioiodine WBS was performed after thyroid hormone withdrawal for at least four weeks and strict low iodine diet for at least two weeks. Anterior and posterior whole-body images were obtained 48 to 72 hours after administration of 5 mCi of diagnostic ^{131}I WBS or 150 to 200 mCi of post-therapeutic ^{131}I WBS using a dual head gamma camera. Six diagnostic ^{131}I WBS and 32 post-therapeutic ^{131}I WBS were done.

Table 1. Patient demographics (n = 38)

Characteristic	No. of patient (%) or mean ± SD (max, min)
Sex	
Male	16 (42.1)
Female	22 (57.9)
Age at diagnosis (years)	47.91±15.90 (79, 24)
Histological type	
Papillary	37 (97.4)
Follicular	1 (2.6)
Number of I-131 treatment	
1	4 (10.5)
2	19 (50.0)
3	8 (21.1)
4	4 (10.5)
6	3 (7.9)
Total I-131 treatment dose (mCi)	406.84±209.82 (1,000, 150)
Median	300
Range of stimulated Tg level (ng/ml)	
10 to 50	10 (26.3)
50 to 100	7 (18.4)
≥100	16 (42.1)
Anti Tg + ve with low stimulated Tg	5 (13.2)
Duration of follow-up (months)	32.66±19.46 (84, 6)
Median	30

Tg = thyroglobulin

Thyroglobulin and thyroglobulin antibody measurement

The TSH, Tg, and TgAb levels were measured at the day of the radioiodine administration. All patients were in TSH stimulation state with TSH greater than 30 mIU/l. Serum TSH, Tg, and TgAb levels were assayed on the cobas e411 platform (Roche Diagnostics GmbH, Manheim, Germany) which is based upon the electrochemiluminescence immunoassay. The cut-off of elevated Tg was above 10 ng/ml (n = 33). The cut-off of elevated TgAb was above 40 IU/ml[11]. Thirty-three of 38 cases showed sTg above 10 ng/ml ranged from 11.1 to 6,055 ng/ml with normal TgAb level. Five patients showed high TgAb ranged from 1,905 to more than 4,000 IU/ml. Four patients of this group had sTg less than 1 ng/ml while the other one had sTg 4.4 ng/ml. Patients with elevated sTg level were divided into three groups as followed: group I: sTg ranged from 10 to 49.9 ng/ml (n = 10), group II: sTg ranged from 50 to 99.9 ng/ml (n = 7), and group III: sTg more than 100 ng/ml (n = 16).

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

Patients fasted for at least six hours before ^{18}F-FDG PET/CT study. None of patients had blood glucose levels exceeding 150 mg/dl. The dose of 0.14 to 2.0 mCi/kg of ^{18}F-FDG was injected intravenously and scanning began 60 minutes later using a Discovery PET/CT system (GE healthcare). Intravenous contrast agent was also used in all studies. Low-dose CT acquisition was performed first with 140 kV, 80 mA, 0.8 seconds per CT rotation, a pitch of 6 and a table speed of 22.5 mm/second. A PET emission scan was performed immediately after acquisition of CT without changing patient's position. Five to seven bed positions were performed with an acquisition time of three minutes per bed from skull bed to mid-thigh. PETs images were reconstructed using an ordered-subset expectation maximization algorithm. CT data were used for attenuation correction. Studies were interpreted on a Xeleris workstation. PET/CT images were obtained within six months from the ^{131}I WBS.

Image interpretation

PET/CT scans were interpreted independently by two experienced nuclear medicine physicians.

Any increased ^{18}F-FDG uptake was compared with anatomical finding on CT. Focally increased ^{18}F-FDG uptake with maximum uptake values (SUVmax) greater than 3.2 according to Hamed et al[12] which did not correspond to normal structures was recorded as positive. Suggestive findings on CT were interpreted as negative, if they did not correspond to the area of abnormally increased ^{18}F-FDG uptake. For each patient, the presence or absence, and localization of any recurrent lesions were determined. The SUVmax of the suspected lesions on PET/CT were also recorded.

Recurrence evaluation

PET/CT findings were compared with histology from reoperation or biopsy, other imaging modalities such as ultrasound, CT, and MRI, ^{131}I WBS, and subsequent Tg and TgAb titers. The ^{18}F-FDG PET/CT was classified as:

• True-positive: If positive findings on ^{18}F-FDG PET/CT were confirmed by histopathologic results or correlative imaging modalities showed abnormal lesions with persistently abnormal follow-up Tg and TgAb titers, or the elevated Tg titer declined after empirical high dose radioiodine treatment.

• False-positive: If histopathologic results of suggestive lesions on ^{18}F-FDG PET/CT were negative for malignancy or the lesions had resolved on subsequent follow-up imaging.

• True-negative: If no ^{18}F-FDG uptake was found and patients had neither elevated Tg levels without any further treatment nor any evidence of recurrence in sub-sequent follow-up for at least 12 months.

• False-negative: If the findings on ^{18}F-FDG PET/CT were negative and metastatic thyroid cancer was found on histopathologic results from reoperation or biopsy or disease progression was seen on other imaging modalities.

Statistical analysis

Results are presented as mean and SD of the mean. Overall sensitivity, specificity, and accuracy of ^{18}F-FDG PET/CT were calculated. The sensitivities of PET/CT were further evaluated according to three groups of different Tg levels.

Results

Positive ^{18}F-FDG PET/CT

Thirty-three of 38 studies showed positive findings. Thirty-two of 33 studies showed true positive (TP) lesions and were classified into three groups as

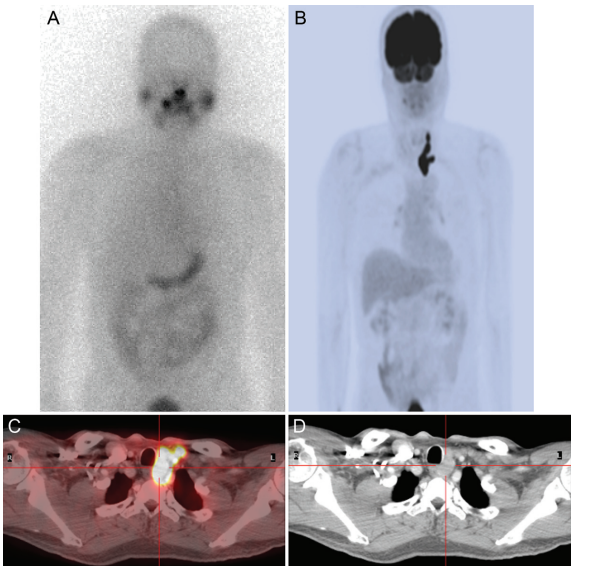

Fig. 1 A 61-year-old male with papillary thyroid cancer received total thyroidectomy and 2 sessions of ^{131}I treatment. (A) The last post-therapeutic ^{131}I WBS shows no abnormal uptake with sTg level of 1,389 ng/ml. (B) Maximum intensity projection PET image reveals irregular intense FDG uptake area along left sided neck down to sternal notch level. (C) Axial fused PET/CT and (D) axial contrast-enhanced CT images show ill-defined markedly hypermetabolic soft tissue mass at left upper paratracheal region, suggestive of recurrent thyroid tumor. Neck exploration with tumor removal confirmed recurrent papillary carcinoma.

followed: 1) local recurrence (LR) group showed positive lesions at thyroid bed (Fig. 1) or cervical nodes (n = 23, 60.5%), 2) distant metastatic group showed positive lesions at pulmonary and vertebrae (n = 2, 5.3%), and 3) LR with distant metastatic group showed positive lesions at thyroid bed or cervical nodes and outside neck regions i.e., brain, mediastinal nodes, pulmonary, muscle, liver, bone (n = 7, 18.4%). Six studies (15.8%) in group III were previously undiagnosed metastatic lesions at brain, pulmonary, muscle (bicep, trapezius, pectoralis minor, and gluteus maximus), liver, femur, and iliac bone which led to a change of therapy included external beam radiotherapy and surgical resection. Table 2 showed sites of positive lesions identified in PET/CT with each validated method. One study (2.6%) was considered as false positive lesion at cervical nodes (SUVmax range from 6.4 to 14.3) which were confirmed by negative malignancy on histological results from cervical node biopsy. Additional information of previously

undiagnosed benign lesion from PET/CT was found in one patient with meningioma.

Negative ^{18}F-FDG PET/CT

Five of 38 studies showed no abnormal FDG uptake. Four of 38 studies (10.5%) were confirmed true negative results by gradual decreased Tg or TgAb levels without any further treatment for over 1 year. The remaining one patient showed no abnormal ^{18}F-FDG avidity (SUVmax range from 1.3 to 1.9) in subcentimeter cervical lymph nodes which was clarified as false negative because of slow rising of Tg levels on subsequent follow-up and neck ultrasonography suggested cervical node metastases.

Performance of PET/CT

Sensitivity, specificity, and accuracy of ^{18}F-FDG PET/CT in the present study were 96.9%, 80%, and 94.7%, respectively (Table 3). The sensitivity increased with high level of sTg. The sensitivity of PET/CT is 85.7% in group I and 100% in both group II and III.

Table 2. Validation of 18F-FDG PET/CT findings and location of recurrence or metastasis

PET/CT	Validation		Total
	Histopathology	Clinical follow-up	
True positive			
LR	13	10	23
Distant metastasis	0	2	2
LR with distant metastasis	2	5	7
False positive: LR	1	0	1
True negative	0	4	4
False negative	0	1	1
Total	16	22	38

FDG = fluorodeoxyglucose; PET = positron emission tomography; CT = computed tomography; LR = local recurrence

Table 3. Overall performance of 18F-FDG PET/CT for detection of local recurrence or metastasis of DTC patients

	Recurrence or metastasis		Total
	Positive	Negative	
PET/CT			
Positive	32	1	33
Negative	1	4	5
Total	33	5	38
	Sensitivity = 96.9%	Specificity = 80%	Accuracy = 94.7%

DTC = differentiated thyroid cancer

Discussion

The ^{18}F-FDG PET/CT is helpful for detecting recurrent or metastatic lesions in patients with increased sTg levels more than 10 ng/ml, and negative ^{131}I WBS[5]. The discordant between I-131 and FDG tumor uptake is attributed to differences in the degree of cellular differentiation. Poorly differentiated tumors showed high glucose uptake but lost their ability to concentrate iodine. "Flip-flop" phenomenon between I-131 and FDG uptake in metastatic thyroid cancer lesions was proposed by Feine[13].

Many studies showed range of sensitivity and specificity of ^{18}F-FDG PET/CT for detecting local recurrence or metastasis in Tg-positive and ^{131}I WBS-negative patients with TSH stimulation demonstrating a sensitivity and specificity of 80 to 95% and 70 to 85%, respectively[10,14]. In present study showed comparable results with overall sensitivity 96.9% and specificity of 80%. In recent study of Na et al, 60 DTC patients with elevated sTg and negative ^{131}I WBS showed sensitivity of 69.4% and specificity of 66.7% for detecting and localizing recurrent or metastatic tumor on ^{18}F-FDG PET/CT[9]. The present study showed higher sensitivity and specificity because we used higher cut-off level of sTg (10 ng/ml or greater vs. 2.0 ng/ml or greater in their study). In their study, the high sTg subgroup showed higher sensitivity than low sTg subgroup (sensitivity was 28.6%, 57.1%, 60%, and 78% for sTg 2 to 5, 5 to 10, 10 to 20, and more than 20 ng/ml, respectively), which are the same in the present study (sensitivity was 85.7% and 100% for sTg 10 to 49.9 and more than 50 ng/ml, respectively) [9]. Schlüter et al showed similar results that positive ^{18}F-FDG PET/CT scans were achieved in 11% of DTC patients with sTg level 10 ng/ml or less and 50% with sTg levels 10 to 20 ng/ml and up to 93% at sTg greater than 100 ng/ml[15]. The present study revealed three studies that clarified as true negative with sTg ranged 13.4 to 17.79 ng/ml. Because serum Tg level obtained after withdrawal of thyroid hormone therapy is strongly related to tumor mass. Patients with higher sTg level tend to have larger tumor mass and more aggressive disease[16] which could be easily detected in ^{18}F-FDG PET/CT. Hence, the usefulness of ^{18}F-FDG PET/CT depends on sTg level.

During the initial years, a SUV of 2.5 was considered by many as a cut-off value to differentiate between benign and malignant disease. An abnormality with SUV more than 2.5 was used to consider malignant. However, learning with time, it is now not valid in the practice of PET. In countries with high

incidence of infectious and inflammatory disease, this cut-off value of 2.5 does not work and significant higher SUV is noted in infection and inflammation[17].

The authors used a cut-off value of ^{18}F-FDG SUVmax greater than 3.2 to classify as s positive lesion for recurrence or metastasis according to Hamed et al, who found that using this cut-off valued for lesion localization (41.6%) in DTC patients with negative ^{131}I WBS and conventional imaging but pathologically increased Tg levels[12]. Similar cut-off value is used by Wong et al, in detection of recurrence or metastases in squamous cell carcinoma of head and neck with sensitivity of 92% and specificity of 70%[18]. Takeda et al, showed that same SUVmax is the cut-off value to detect recurrence of localized non-small cell lung cancer with sensitivity of 100% and specificity of 96%[19].

An important observation in the present study that in 23 of 32 TP cases were LR and 7 of 32 TP cases were LR with distant metastases. Most lesions were located in the neck region which is difficult for physical examination due to postoperative change. Neck ultrasonography is recommended to evaluate local recurrence at thyroid bed and neck node compartments performed at 6 to 12 months and then periodically, depending on the patient's risk for recurrent disease and Tg status[2]. However, for lesions located in thyroidectomy bed, the distinction between recurrent tumors and non-recurrent benign lesions cannot be made on the basis of sonographic features. Fine-needle aspiration is helpful in determining the histologic nature of such lesions which is quite invasive[20]. The ^{18}F-FDG PET/CT in the present study identified positive lesions outside neck which suggested distant metastases in nine studies, predominantly in the chest and bone. Six of nine studies were previously undiagnosed metastatic lesions at brain, pulmonary, muscle (bicep, trapezius, pectoralis minor, and gluteus maximus), liver, femur, and iliac bone which led to a change of therapy. Other various imaging modalities are also used to detect distant metastases in DTC patients with elevated sTg but negative ^{131}I WBS such as CT or MRI of neck, chest, and abdomen. The advantage of ^{18}F-FDG PET/CT is the ability to identify thyroid cancer recurrences and distant metastases in a single imaging procedure and lead to appropriate treatment.

In one case of the present study with sTg 40.9 ng/ml was considered as false negative lesion because no abnormal ^{18}F-FDG avidity in subcentimeter cervical lymph nodes (SUVmax range 1.3 to 1.9) as subsequent follow-up results showed slow rising of Tg levels with suggestion of cervical node metastases demonstrated by neck ultrasonography. This may be due to small size of cervical lymph nodes beyond maximum resolution of PET/CT which had artifactually low SUV from partial volume effect. On standard PET scanners, partial volume effects will definitely occur in lesion size below 2 cm[21].

Very high TgAb were found in five cases with low sTg. Tg value in patient with abnormal high TgAb is unreliable. TgAb trend reflect change in mass of Tg-secreting thyroid tissue which is detected in approximately 20% of DTC patients and about 2-fold of normal upper limit as compared to the general population[22]. TgAb concentration serves as a surrogate post-operative DTC tumor marker. TgAb interfere with Tg immunometric assay (IMA) measurements which caused falsely low/undetectable Tg value. Current guidelines mandate that all specimens sent for Tg testing should have TgAb measurements added because the quantitative TgAb status determines risk for Tg assay interference[23]. In the present, four patients with elevated TgAb showed positive findings in PET/CT and were confirmed with metastatic cervical nodes by two histological results and two clinical follow-ups and all of them were clarified as TP studies. The remaining one case with high TgAb level of 1,417 IU/ml showed no abnormal uptake in PET/CT and after follow-up for over one year, TgAb level revealed gradual decreased to less than 50% of initial value without further treatment. This case was clarified as true negative. It is well documented that a rising TgAb trend, or de novo appearance of TgAb is commonly seen in the first few months (1 to 8 months) following surgery or radioiodine therapy in response to Tg antigen release by damaged cells. It must be distinguished from a sustained and progressive TgAb rise that may indicate of recurrence. In patients whose TgAb concentration fall to less than 50% of their initial value have a low risk of metastatic or recurrent tumor detected during the subsequent five years follow-up[24]. In the previous study of Na et al, three DTC patients with high TgAb (70.0 IU/ml or greater) with sTg less than 2 ng/ml showed positive findings in PET/CT which were confirmed with metastatic cervical lymph nodes by pathological results[9]. Kingpetch et al revealed sensitivity, specificity, and accuracy of ^{18}F-FDG PET/CT in detection of recurrent or metastatic DTC patients with elevated serum TgAb levels but negative ^{131}I WBS were 100%, 62.5%, and 72.7%, respectively[25]. Hereby, ^{18}F-FDG PET/CT may be useful in detection of

recurrent or metastatic tumor in DTC patients with elevated TgAb and negative ^{131}I WBS.

In the present study, treatment plans were changed in 18 patients (47.3%) after PET/CT scans performed. Ultrasonography-guided biopsy followed by operations of the lesions identified on PET/CT were carried out in 13 cases. In four cases, radiotherapy for extensive locoregional lesions and distant metastases (brain and mediastinal nodes) were performed. Radiofrequency ablation of cervical node recurrence in another patient was done.

Although the number of studied patients were rather small, the author's results showed that ^{18}F-FDG PET/CT may be useful for appropriate management of DTC patients with negative ^{131}I WBS but elevated sTg level or TgAb level. Reimbursement of PET/CT for this group of patients should be considered in the future.

Conclusion

The ^{18}F-FDG PET/CT may be a useful diagnostic tool in detection and localization of recurrence or metastases in DTC patients with elevated sTg level or TgAb level but negative radioiodine scan. Diagnostic accuracy of ^{18}F-FDG PET/CT will increase in case of high sTg depending on serum Tg level. The sensitivity of ^{18}F-FDG PET/CT approach can be 100% in DTC patient with sTg more than 50 ng/ml.

What is already known on this topic?

The ^{18}F-FDG PET/CT is widely accepted to localize disease in DTC patients with high sTg levels (10 ng/ml or greater) and negative ^{131}I WBS[2]. Many studies showed range of sensitivity and specificity of ^{18}F-FDG PET/CT for detecting local recurrence or metastasis in Tg-positive and ^{131}I WBS-negative patients with TSH stimulation demonstrating a sensitivity and specificity of 80 to 95% and 70 to 85%, respectively[10,14].

What this study adds?

The present study showed advantage of ^{18}F-FDG PET/CT in detection of previously undiagnosed metastatic lesions in DTC patients with high sTg level and negative ^{131}I WBS at brain, pulmonary, muscle, liver, femur, and iliac bone which led to a change of therapy.

The authors hope that the present study will be recognize by the physicians to use ^{18}F-FDG PET/CT for appropriate management of DTC patients with negative ^{131}I WBS but elevated sTg or TgAb level. Reimbursement of PET/CT for this group of patients should be considered in the future.

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Potential conflicts of interest

None.

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ความแม่นยำในการวินิจฉัยของการตรวจ ^{18}F-FDG PET/CT ในผู้ป่วยมะเร็งไทรอยด์ชนิด differentiated ที่มีค่าไทโรโกลบูลินหรือไทโรโกลบูลินแอนติบอดีในเลือดสูงผิดปกติ

เฉลิมรัตน์ แก้วพุด, ภาวนา ภูสุวรรณ

วัตถุประสงค์: *เพื่อศึกษาถึงความแม่นยำในการวินิจฉัยของการตรวจด้วย ^{18}F-FDG PET/CT ในการวินิจฉัยการกลับเป็นซ้ำ หรือมีภาวะมะเร็งแพร่กระจายในผู้ป่วยมะเร็งไทรอยด์ชนิด differentiated ที่มีค่าไทโรโกลบูลินหรือไทโรโกลบูลินแอนติบอดีในเลือดสูงผิดปกติ แต่ไม่พบรอยโรคจากผลภาพสแกนทั้งตัวด้วยไอโอดีน 131*

วัสดุและวิธีการ: *การศึกษาย้อนหลังตั้งแต่เดือนมกราคม พ.ศ. 2550 ถึง ธันวาคม พ.ศ. 2557 ในผู้ป่วยที่ได้รับการตรวจ ^{18}F-FDG PET/CT ในผู้ป่วยมะเร็งไทรอยด์ชนิด differentiated จำนวน 38 ราย ที่มีระดับไทโรโกลบูลินในเลือดสูงผิดปกติในภาวะที่มีการหยุดฮอร์โมนไทรอยด์ (sTg ≥10 ng/ml, จำนวน 33 ราย) หรือ ไทโรโกลบูลินแอนติบอดีสูง (TgAb ≥40 IU/ml, จำนวน 5 ราย) และมีผลภาพสแกนทั้งตัวด้วยรังสีไอโอดีนทั้งที่ทำภายหลังการรักษาและเพื่อการวินิจฉัยเป็นลบ โดยผู้ป่วยทุกรายจะต้องเข้ารับการผ่าตัด total thyroidectomy และตามด้วยการรักษาด้วยรังสีไอโอดีนอย่างน้อย 1 ครั้ง ผลการตรวจ ^{18}F-FDG PET/CT จะถูกนำมาเปรียบเทียบกับผลทางพยาธิวิทยา (จำนวน 16 ราย) หรือ จากผลการตรวจติดตามทางคลินิกด้วยระดับไทโรโกลบูลินหรือไทโรโกลบูลินแอนติบอดีในเลือด หรือ ผลการตรวจทางรังสีวินิจฉัย ระยะเวลาการตรวจติดตามทางคลินิกอยู่ในช่วง 6 เดือน ถึง 7 ปี (ระยะเวลามัธยฐานเท่ากับ 30 เดือน)*

ผลการศึกษา: *ผลการตรวจ ^{18}F-FDG PET/CT พบว่าร้อยละ 60.5 มีการกลับเป็นซ้ำของโรคที่บริเวณคอ ร้อยละ 5.3 มีการแพร่กระจายของมะเร็งไปที่ส่วนอื่นนอกบริเวณคอ และร้อยละ 18.4 มีการกลับเป็นซ้ำของโรคทั้งที่บริเวณคอและมีการแพร่กระจายของมะเร็งไปยังส่วนอื่น มีผู้ป่วยจำนวน 1 ราย ที่ ^{18}F-FDG PET/CT ให้ผลบวกลวงที่ต่อมน้ำเหลืองบริเวณคอซึ่งได้รับการยืนยันผลการตรวจทางพยาธิวิทยาในภายหลัง ผู้ป่วย 4 ราย พบว่า ^{18}F-FDG PET/CT เป็นผลลบจริง และอีก 1 ราย พบว่าเป็นผลลบลวง เนื่องจาก ^{18}F-FDG PET/CT ไม่พบว่ามีการจับของสารรังสีในต่อมน้ำเหลืองบริเวณคอที่มีขนาดน้อยกว่า 1 เซนติเมตร แต่ภายหลังการตรวจติดตามระดับไทโรโกลบูลินในเลือด พบว่ามีค่าสูงขึ้นเรื่อย ๆ และผลการตรวจอัลตราซาวด์ที่บริเวณคอ พบว่ามีลักษณะที่เข้าได้กับมะเร็งแพร่กระจาย การตรวจด้วย ^{18}F-FDG PET/CT จากการศึกษานี้มีค่าความไว ความจำเพาะ และความแม่นยำเท่ากับร้อยละ 96.9, 80 และ 94.7 ตามลำดับ นอกจากนี้ยังมีข้อมูลที่ได้เพิ่มเติมจากการตรวจด้วย ^{18}F-FDG PET/CT ในผู้ป่วยจำนวน 7 ราย ได้แก่ เนื้องอกที่เยื่อหุ้มสมองชนิด meningioma และภาวะที่มีการแพร่กระจายของมะเร็งในอวัยวะที่ยังไม่เคยได้รับการวินิจฉัยมาก่อนที่บริเวณสมอง ปอด กระดูก ตับ กล้ามเนื้อ และเนื้อเยื่ออ่อน*

สรุป: *การตรวจด้วย ^{18}F-FDG PET/CT มีประโยชน์ในการตรวจหา และระบุตำแหน่งของการกลับเป็นซ้ำหรือการแพร่กระจายของมะเร็งในผู้ป่วยมะเร็งไทรอยด์ชนิด differentiated ที่มีค่าไทโรโกลบูลินหรือไทโรโกลบูลินแอนติบอดีในเลือดสูงผิดปกติ แต่ไม่พบรอยโรคจากผลภาพสแกนทั้งตัวด้วยไอโอดีน 131 นอกจากนี้ยังสามารถช่วยในการวินิจฉัยโรคโรคอื่นเพิ่มเติมเพื่อประโยชน์ในการรักษาในผู้ป่วยกลุ่มนี้ด้วย*