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Thyroid Incidentalomas on Fluorine-18-Fluorodeoxyglucose Positron Emission Tomography-Computed Tomography: Incidence, Malignancy Risk, and Comparison of Standardized Uptake Values

Yung H. Kao, MBBS, MRCP^{a,*}, Siew S. Lim, MB, BCh, BAO^b,
Seng C. Ong, MBBS, FRCR^c, Ajit K. Padhy, MBBS, MNAMS, FICNM, FAMS^a

^aDepartment of Nuclear Medicine and PET, Singapore General Hospital, Singapore

^bDivision of Family Medicine, Singhealth Polyclinics, Singapore

^cNuclear Medicine and PET Centre, Mount Elizabeth Hospital, Singapore

Abstract

Introduction: To determine the incidence of fluorine-18-fluorodeoxyglucose (FDG) avid thyroid incidentalomas detected on positron emission tomography (PET) with integrated computed tomography (CT), and correlate the FDG–PET–CT findings to cytology.

Methods: A total of 942 FDG–PET–CT reports were retrospectively reviewed. Patients with FDG-avid thyroid incidentalomas were further reviewed for correlative cytology.

Results: The incidence of FDG-avid thyroid incidentalomas is 2.2%. Thyroid malignancies were identified in 3 of 6 patients who underwent cytologic correlation, with a positive predictive value of 50% (95% confidence interval, 14%–86%). The mean maximum standardized uptake values of benign and malignant FDG-avid thyroid incidentalomas were 5.6 and 6.6, respectively.

Conclusion: A FDG-avid thyroid incidentaloma may predict underlying malignancy. Cytologic assessment should be considered for FDG-avid thyroid incidentalomas.

Résumé

Introduction : Déterminer l'incidence d'incidentalomes thyroïdiens avides au 18F fluorodésoxyglucose (FDG) décelés par tomographie par émission de positons (TEP) avec tomodensitométrie (TDM) et établir un lien entre les conclusions de TEP–TDM–FDG et la cytologie.

Méthodes : Un total de 942 TEP–TDM–FDG ont été examinés rétrospectivement. Les patients présentant des incidentalomes thyroïdiens avides pour le 18F FDG ont fait l'objet d'un examen approfondi aux fins de corrélation cytologique.

Résultats : L'incidence d'incidentalomes thyroïdiens avides au 18F FDG est de 2,2 %. Des tumeurs thyroïdiennes ont été relevées chez 3 des 6 patients qui ont fait l'objet d'un dépistage, avec une valeur prédictive de 50 % (intervalle de confiance de 95 %, de 14 % à 86 %). Les valeurs de fixation normalisées moyennes maximales des incidentalomes thyroïdiens avides au 18F FDG bénins et malins étaient de 5,6 et 6,6 respectivement.

Conclusion : Un incidentalome thyroïdien avide au 18F–FDG peut indiquer une malignité sous-jacente. Un examen cytologique devrait être envisagé dans le cas d'un incidentalome thyroïdien avide au 18F–FDG.

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Key Words: Fluorine-18-fluorodeoxyglucose positron emission tomography–computed tomography; Thyroid incidentaloma; Fine needle aspiration cytology; Standardized uptake value; Cancer; Malignancy risk

Thyroid incidentalomas are thyroid lesions detected during imaging for nonthyroid disease [1,2]. Whole-body fluorine-18-fluorodeoxyglucose (FDG) positron

emission tomography (PET) with integrated computed tomography (CT) is an accurate functional and anatomic hybrid imaging modality based on the principle of

* Address for correspondence: Dr Yung Hsiang Kao, MBBS, MRCP, Department of Nuclear Medicine and PET, Singapore General Hospital, Outram Road, Singapore 169608.

E-mail address: kao.yung.hsiang@singhealth.com.sg (Y. H. Kao).

tumour glucose hypermetabolism relative to normal tissue.

With the increasing use of FDG–PET–CT imaging, FDG-avid thyroid incidentalomas are becoming more common. The reported incidence of FDG-avid thyroid incidentalomas in patients undergoing FDG–PET or PET/CT for other cancers ranges from 1.1%–4.8%, with positive predictive values for underlying thyroid malignancy between 27.8% and 74% [3–7]. Thyroid malignancies incidentally detected on FDG–PET have also been reported to have a high rate of unfavorable prognostic features and may be more aggressive [8]. For these reasons, current clinical practice guidelines have recommended further assessment for FDG-avid thyroid incidentalomas [9]. We aim to evaluate the incidence of FDG-avid thyroid incidentalomas at our institution and to compare the FDG–PET–CT findings with correlative cytology.

Methods

From April 2006 to March 2007, at the Department of Nuclear Medicine and PET, Singapore General Hospital, a total of 952 FDG–PET–CT scans were performed for cancer-related indications. Ten patients with a known history of primary thyroid malignancies were excluded. FDG–PET–CT reports of all remaining 942 patients were retrospectively reviewed.

All the scans were performed on a dedicated PET–CT scanner (Siemens Biograph LSO, Erlangen, Germany). FDG–PET imaging was acquired from the skull vertex to the femur over 7 bed positions at 3 minutes each. Unenhanced CT (single-slice, 5-mm slice thickness, 110 mAs, 130 kV) was obtained for attenuation correction and anatomic correlation. Patient preparation involved 6 hours of fasting and a serum glucose level below 180 mg/dL (10 mmol/L) before FDG injection. The administered FDG activity was estimated empirically and ranged between 333 and 444 MBq (9–12 mCi). No attempt was made to adjust the maximum standardized uptake values (SUV_{max}) by blood glucose levels or recovery coefficients. FDG–PET–CT images were reviewed in the coronal, transaxial, and sagittal planes by 2 nuclear medicine physicians (Y.H.K., S.C.O., or A.K.P.), and any disagreement was resolved by consensus. The CT component was interpreted in cooperation with a diagnostic radiologist.

A FDG-avid thyroid incidentaloma was defined as focal unilateral thyroid FDG uptake higher than the background thyroid bed and surrounding blood pool by visual assessment, regardless of any underlying lesions seen on CT. This definition was applied by all PET–CT reporting doctors at our institution. For this study, only the scan reports were reviewed, not the actual images.

FDG–PET–CT reports were reviewed for any mention of thyroid incidentalomas, regardless of FDG avidity. Patients reported to have FDG-avid thyroid incidentalomas had their medical records further reviewed for correlative cytology, up to 3 years after FDG–PET–CT. The patients and their primary physicians were not contacted during this study. The decision on whether to proceed with cytology was at the

discretion of the primary physician, who assessed the need in context of the patient's existing cancer illness. Patients with diffuse thyroid FDG uptake were not further analysed, because diffuse FDG uptake is usually due to thyroiditis and generally is not associated with an increased risk of thyroid malignancy [4,6,9]. The SUV_{max} of FDG-avid thyroid incidentalomas were compared with the correlative cytologic findings. The results were tabulated and analysed by standard noncommercial statistical software.

Results

FDG–PET–CT scan reports of 942 patients were reviewed. Thyroid incidentalomas were reported in 66 patients (7.0%). Twenty-one of these 66 patients had FDG-avid thyroid incidentalomas (31.8%); the remaining 45 patients had non–FDG-avid thyroid incidentalomas detected on the CT component. The overall incidence of FDG-avid thyroid incidentalomas was 2.2% (21 of 942 patients). Follow-up data for the 45 cases of non–FDG-avid thyroid incidentalomas were not reviewed.

Six patients underwent further cytologic evaluation by fine needle aspiration. Malignancies were identified in 3 patients: 2 papillary thyroid carcinomas (Figure 1) and 1 medullary thyroid carcinoma (Figure 2). All 3 patients with malignant cytology underwent thyroid surgery, and the final diagnoses were confirmed on histopathology. The other 3 patients yielded benign cytologic findings: 1 lymphocytic thyroiditis and 2 nodular goiters (Figure 3). The patient with lymphocytic thyroiditis showed interval reduction in FDG activity in a FDG–PET–CT 1 month later. 1 patient with nodular goiter showed stable FDG–PET–CT findings 2 years later. The remaining patient with nodular goiter had no further follow-up. The results are summarized in Table 1.

The positive predictive value of FDG-avid thyroid incidentalomas for underlying thyroid malignancy was 50% (95% confidence interval, 14%–86%; 3 of 6 patients). The mean SUV_{max} of benign and malignant FDG-avid thyroid incidentalomas were 5.6 and 6.6, respectively, which may suggest a trend for FDG-avid thyroid incidentalomas with higher SUV_{max} to be malignant, although the differences did not reach statistical significance in our small group of 6 patients ($P = .40$, Mann-Whitney U test).

Discussion

With the increasing use of whole-body FDG–PET–CT, FDG-avid thyroid incidentalomas are being detected more frequently. Our study found the incidence of FDG-avid thyroid incidentalomas among patients with other primary malignancies to be 2.2% (21 of 942 patients) and the positive predictive value for underlying thyroid malignancy to be 50% (3 of 6 patients), in keeping with the published medical literature [3–7]. Are et al [8] found that thyroid malignancies detected incidentally on FDG–PET have a high rate of unfavorable prognostic features and are likely to be more aggressive. We, therefore, recommend cytologic assessment

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