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Original

Incidental diagnosis of tumor thrombosis on FDG PET/CT imaging

S. Erhamamci*, M. Reyhan, G.N. Nursal, N. Torun, A.F. Yapar

Department of NuclearMedicine, Faculty of Medicine, BaskentUniversity, Turkey

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ABSTRACT

Objective: Clinical data are presented on patients with tumor thrombosis (TT) incidentally detected on FDG PET/CT imaging, as well as determining its prevalence and metabolic characteristics.
Materials and methods: Out of 12,500 consecutive PET/CT examinations of patients with malignancy, the PET/CT images of 15 patients with TT as an incidental finding were retrospectively investigated. A visual and semiquantitative analyses was performed on the PET/CT scans. An evaluation was made of the pattern of FDG uptake in the involved vessel as linear or focal via visual analyses. For the semiquantitative analyses, the metabolic activity was measured using SUVmax by drawing the region of interest at the site of the thrombosis and tumor (if any).
Results: The prevalence of occult TT was 0.12%. A total of 15 patients had various malignancies including renal (1 patient), liver (4), pancreas (2), stomach (1), colon (1), non-Hodgkin lymphoma (1), leiomyosarcoma (1), endometrial (1), ovarian (1), malign melanoma (1) and parotid (1). Nineteen vessels with TT were identified in 15 patients; three patients had more than one vessel. Various vessels were affected; the most common was the inferior vena cava ($n = 7$) followed by the portal ($n = 5$), renal ($n = 3$), splenic ($n = 1$), jugular (n = 1), common iliac ($n = 1$) and ovarian vein ($n = 1$). The FDG uptake pattern was linear in 12 and focal in 3 patients. The mean SUVmax values in the TT and primary tumors were 8.40 ± 4.56 and 13.77 ± 6.80, respectively.
Conclusion: Occult TT from various malignancies and locations was found incidentally in 0.12% of patients. Interesting cases with malign melanoma and parotid carcinoma and with TT in ovarian vein were first described by FDG PET/CT. Based on the linear FDG uptake pattern and high SUVmax value, PET/CT may accurately detect occult TT, help with the assessment of treatment response, contribute to correct tumor staging, and provide additional information on the survival rates of oncology patients.

Diagnóstico incidental de trombosis tumoral con FDG PET/TC

Palabras clave:
FDG
PET/TC
SUVmax
Trombosis tumoral

RESUMEN

Objetivo: Se presentan los datos clínicos de pacientes con trombosis tumoral (TT) detectada incidentalmente en estudios FDG PET/TC, y se determinan su prevalencia y sus características metabólicas.
Material y Métodos: De 12,500 exploraciones consecutivas PET/TC realizadas en pacientes con tumores malignos, se analizaron de forma retrospectiva las imágenes PET/TC de 15 pacientes con TT como un hallazgo incidental. Se realizaron un análisis visual y un análisis semicuantitativo de las exploraciones PET/TC. El patrón de captación de FDG en el vaso afecto, evaluado por análisis visual, fue lineal o focal. En el análisis semicuantitativo se midió la actividad metabólica usando SUVmax, dibujando regiones de interés en el sitio de la trombosis y en el tumor (si existía).
Resultados: La prevalencia de TT fue 0.12%. Quince pacientes tenían diversos tumores malignos incluyendo riñón (1), hígado (4), páncreas (2), estómago (1), colon (1), linfoma no Hodgkin (1), leiomiosarcoma (1), endometrio (1), ovario (1), melanoma maligno (1) y parótida (1). Se identificaron 19 vasos con TT en 15 pacientes. Tres pacientes tenían más de un vaso afecto. El vaso más frecuentemente afectado fue la vena cava inferior (n = 7), seguido de porta (n = 5), renal (n = 3), esplénica (n = 1), yugular (n = 1), ilíaca común (n = 1) y venas ováricas (n = 1). El patrón de captación de FDG fue lineal en 12 y focal en 3 pacientes. El SUVmax medio en el TT y en los tumores primarios fue $8,40 \pm 4,56$ y $13,77 \pm 6,80$, respectivamente.
Conclusión: Trombosis tumoral oculta en diversos tumores malignos y en diferentes localizaciones se encontró incidentalmente en un 0,12%. Casos interesantes fueron el melanoma maligno y el carcinoma de parótida. La TT en la vena ovárica se describe por primera vez mediante FDG PET/TC. Basado en el patrón lineal captación de FDG y el elevado valor SUVmax, la PET/TC puede detectar con exactitud la TT oculta, ayudar en la evaluación de la respuesta al tratamiento, contribuir en la correcta estadificación del tumor y también puede proporcionar información adicional sobre la supervivencia en pacientes oncológicos.

* Corresponding author.
E-mail address: sevaler@yahoo.com (S. Erhamamci).

Introduction

Thrombosis is a common finding in patients with malignancies compared with the general population.[1] It can be divided into two clinical entities: venous thromboembolism (VTE) and tumor thrombosis (TT). VTE is a well-recognized, relatively common complication in cancer patients and a significant cause of morbidity and mortality. However, TT is a rare but serious complication in oncological patients. The true incidence of TT is unknown. The presence of TT has significant impacts on staging, treatment and prognosis.[2] VTE is managed with anticoagulant therapy; TT requires aggressive multimodality management. Therefore, the correct diagnosis of TT and its differentiation from VTE can change patient management and might facilitate the start of an appropriate therapy.[3]

Thrombosis is most often detected by chance during staging investigations.[2] Anatomical diagnostic imaging including ultrasonography, contrast-enhanced computerized tomography (CECT) and magnetic resonance imaging is used to confirm the existence of the thrombus, evaluate the extent of its spread and monitor its response to therapy.[4] Positron emission tomography/computed tomography (PET/CT) using fluorodeoxyglucose (FDG) is a very powerful functional imaging modality for the diagnosis, staging, restaging, treatment planning and follow-up of patients with various malignancies. It also provides the best anatomical and functional information. The routine use of FDG PET/CT has resulted in clinicans detecting many incidental findings, which have proven to be clinically significant, such as TT (2–17). The recognition of this rare complication by FDG PET/CT is essential for the accurate management of patients, preventing unnecessary long-term anticoagulation treatment and also decreasing morbidity.[2–5] However, limited sporadic case reports and retrospective studies with small cohorts of patients due to the rarity of this disease have reported the role of FDG PET/CT in TT (2–24). Therefore, the purpose of this retrospective study was to present clinical data of patients with TT incidentally detected on FDG PET/CT imaging and also to determine its prevalence and metabolic characteristics in our population of oncological patients.

Material and methods

Patients

Between November 2009 and October 2014, we conducted 12,500 consecutive FDG PET/CT examinations of patients with malignancy at Department of Nuclear Medicine of Baskent University, we retrospectively investigated FDG PET/CT imaging of 15 patients with TT. In these 15 patients, FDG uptake in the TT was recorded as an incidental finding on FDG PET/CT imaging. The demographic and clinical data of the patients, including type of cancer, site of thrombus, indication of scan and other imaging findings for comfirmation of TT, were analyzed. The protocol of this study was approved by our local ethics committee for retrospective analyses.

FDG PET/CT imaging

PET/CT scans were obtained 60 min after injection using an integrated scanner (Discovery-STE 8; General Electric Medical System, Milwaukee, WI, USA). All patients fasted for at least 6 h before the intravenous administration of 370–555 mBq (10–15 mCi) FDG. We measured preinjection blood glucose levels to ensure that they were below 200 mg/dL. During the distribution phase, patients lay supine in a quiet room. The patients were scanned on a flat-panel carbon fiber composite table insert. First, an unenhanced CT scan with a slice thickness of 3.3 mm from the vertex or base of the skull to the inferior border of the pelvis was acquired using a standardized protocol (140 kV and 80 mA). The subsequent PET scan was acquired in the three-dimensional mode from the vertex or base of the skull to the inferior border of the pelvis (6–7 bed positions, 3 min per bed position) without repositioning the patient on the table. The patient was allowed to breathe normally during the PET and CT acquisitions. FDG PET images were reconstructed using CT data for attenuation correction.

Imaging analysis

The diagnosis of TT was based on the increased FDG uptake of solid masses inside the vessels. We performed visual and semiquantitative analyses of the PET/CT scans. We evaluated the pattern of FDG uptake in the involved vessel as linear or focal via visual analyses. For the semiquantitative analyses, we measured metabolic activity using SUVmax by drawing the region of interest at the site of thrombosis and primary tumor (if any). The FDG PET/CT results were comfirmed with CECT, clinical follow-up or follow-up FDG PET/CT for assessment of the response to the anticancer treatment.

Statistical analysis

All data were expressed as mean ± standard deviation. The clinical data of the patients and scan results were analyzed with using descriptive statistics including frequencies, means and medians. All statistical analyses were performed using Statistical Package for the Social Sciences software (SPSS, version 15.0; SPSS Inc, Chicago, IL, USA) for Windows.

Results

A total of 15 patients with TT were evaluated; 9 men and 6 women with a mean age 55.40 ± 15.53 years (range: 21–83 years). The prevalence of occult TT accounted for 0.12% of our population. All demographic and clinical data of the patients, including type of cancer, site of thrombus, indication of scan and scan results are presented in Table 1. These patients had various types of malignancies including renal cell carcinoma (RCC) (1 patient), liver adenocarcinoma (1), hepatocellular carcinoma (HCC) (1), cholangiocellular carcinomas (2), pancreas (2), stomach (1), colon adenocarcinoma (1), non-Hodgkin lymphoma (1), retroperitoneal leiomyosarcoma (1), endometrial carcinoma (1), ovarian carcinoma (1), malignant melanoma (1) and parotid (1), as shown in Table 1.

Indication for the scan was initial staging in 9 patients, restaging in 4 patients and the diagnosis of an unknown primary tumor in 2 patients. Eight patients were lost to follow-up with a median follow-up duration of 5 months (range: 1–16 months) after the diagnosis of TT via PET/CT imaging. At the time of this analysis, 7 patients were alive with a median follow-up duration of 15 months (range: 1–20 months) after the diagnosis of TT on PET/CT imaging.

Nineteen vessels of TT were identified in 15 patients; three patients had more than one vessel of TT. Various vessels were affected; the most common was the inferior vena cava (IVC) ($n = 7$, Figs. 1 and 2) followed by portal vein ($n = 5$, Fig. 3), renal vein ($n = 3$, Fig. 1), splenic vein ($n = 1$, Fig. 4), jugular vein ($n = 1$, Fig. 5), common iliac vein ($n = 1$) and ovarian vein ($n = 1$, Fig. 6). The pattern of FDG uptake was increased linearly in 12 patients (Figs. 1 and 3–6) and focal in 3 patients (Fig. 2). Direct invasion from tumors or metastases was present in all veins. The mean SUVmax value in the TT of the 19 involved vessels was 8.40 ± 4.56 (range: 3.3–18.3) and the mean SUVmax of the primary tumor of the 12 patients was 13.77 ± 6.80 (range: 6.1–30.8). Three patients underwent surgery due to a primary tumor before PET/CT imaging; only one patient had a residual tumor (case 13).