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CLINICAL IMAGING

Impact of age on FDG uptake in the liver on PET scan

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Abstract

Purpose: The intensity of physiological 18F-2-deoxy-D-glucose (FDG) uptake in the liver varies. It is important to be familiar with the varying degree of FDG accumulation in the liver that represents normal distribution and physiological changes, before attempting to interpret whole-body positron emission tomography (PET) imaging for malignancy detection. The aim of this study is to evaluate the possible factors influencing the intensity of physiological FDG uptake in the liver on FDG PET imaging. **Materials and Methods:** From 2005 to 2007, a total of 339 consecutive healthy subjects, referred from the Department of Community Medicine and Health Examination Center of our hospital for health screening, were retrospectively recruited for analysis. Demographic data were collected from chart records. Whole body FDG PET imaging and serologic determination of hepatitis B virus (HBV) and hepatitis C virus (HCV) infection status were performed on all subjects. The mean and maximum standard uptake values (SUVs) of the liver were calculated. The relationships between sex, age, HBV and HCV infection status, and SUVmax and SUVmean of the liver on FDG PET imaging were evaluated. **Results:** There was no statistically significant relationship between sex, HBV and HCV infection status and maximum standard uptake value (SUVmax) or mean standard uptake value (SUVmean) of the liver. After adjusting for covariables, age was a statistically significant predictor of SUVmax (B=0.18; P= .001) and SUVmean (B=0.16; P= .004) of the liver on FDG PET imaging. **Conclusion:** Age has a significant and positive impact on both maximum and mean standard uptake values of the liver on FDG PET imaging. High physiological background FDG uptake will reduce diagnostic sensitivity and accuracy for malignancy detection in the liver.

Keywords: Whole-body PET imaging; Standard uptake values

1. Introduction

Clinical use of positron emission tomography (PET) has grown rapidly due to its usefulness in cancer diagnosis, staging, and management. 18F-2-deoxy-D-glucose (FDG) PET is a functional imaging modality, which reflects cellular glucose metabolism. Accumulation and trapping of FDG allow the visualization of increased uptake in most malignant cells compared to normal cells. FDG is the most commonly used radiopharmaceutical for positron emission tomography studies in oncology and the tracer is a substrate of energy metabolism [1,2]. However, increased FDG uptake is not limited to malignant tissue alone [3–7]. The intensity of physiological FDG uptake in the liver varies. It is important to be familiar with the varying degree of FDG accumulation that represents normal distribution and physiological changes, before attempting to interpret whole-body PET imaging for malignancy detection. The aim of this study is to evaluate the

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possible factors influencing the intensity of physiological FDG uptake in the liver on FDG PET imaging.

2. Materials and methods

2.1. Subjects

From 2005 to 2007, a total of 339 consecutive healthy subjects, referred from the Department of Community Medicine and Health Examination Center of our hospital for health screening, were retrospectively recruited for analysis. Demographic data were collected from chart records. Whole body FDG PET imaging and serologic determination of hepatitis B virus (HBV) and hepatic C virus infection status were performed on all subjects. Infections with HBV and hepatitis C virus (HCV) were defined as positive serum tests for HBsAg and anti-HCV antibody, respectively. The mean and maximum standard uptake values (SUV) of the liver were calculated. The relationships between sex, age, HBV and HCV infection status, and SUVmax and SUVmean of the liver on FDG PET imaging were evaluated. The SPSS statistical package version 13.0 was used for statistical analysis, and the conventional P value of .05 was used as the cutoff for statistical significance.

2.2. FDG-PET imaging

Whole body PET images were acquired on a GE Advance NXi scanner (35 image planes, 4.30 mm/slice, 15 cm axial-field-of-view), 40 min–1 h after intravenous injection of 370 MBq (10 mCi) of F-18-FDG. Emission PET images of the neck, chest, abdomen, and pelvis were acquired in two-dimensional mode, 4 minutes per bed position, followed by transmission scans at selected sites. Images were reconstructed using vendor-provided software and formatted into transaxial, coronal, and sagittal image sets. All subjects fasted for at least 4 h before the examination.

The SUV, which is defined as the ratio of activity in tissue per milliliter to the activity in the injected dose per patient body weight, has been proposed as a simple useful semiquantitative index for FDG accumulation in tissue.

$$\text{SUVmax} = \frac{\text{maximum activity in ROI (kBq)}}{\text{injected dose (MBq)} \times \text{body weight (kg)}}$$

$$\text{SUVmean} = \frac{\text{mean activity in ROI (kBq)}}{\text{injected dose (MBq)} \times \text{body weight (kg)}}$$

3. Results

A total of 339 subjects, 134 male and 205 female, were recruited in the study. The mean age of the subjects was 54.09 ± 9.96 years. The mean of the maximum standard uptake value (SUVmax) of the liver was 2.89±0.56. The mean of the mean standard uptake value (SUVmean) of the liver was 2.37±0.45 (Table 1). There was no statistically significant relationship between sex, HBV and HCV infection status, and SUVmax or SUVmean of the liver. After adjusting for covariables, age was a statistically significant predictor of SUVmax (B=0.18; P= .001) (Table 2) and SUVmean (B=0.16; P=.004) of the liver on FDG PET imaging (Table 3).

Table 1
Demographic data of subjects

	No.	
Sex (male; female)	134; 205	
	Mean	S.D.
Age (year)	54.09	9.96
SUVmax of liver	2.89	0.56
SUVmean of liver	2.37	0.45

4. Discussion

Molecular imaging is the visualization, characterization, and measurement of biological processes at the molecular and cellular levels in a living system. PET is one of the most rapidly growing areas of medical imaging in the clinical management of patients with cancer [8]. However, some physiological FDG uptake can cause misinterpretation of a PET scan and, as a consequence, may lead to false-positive or false-negative reports, thus reducing the accuracy of the technique [9–12]. The causes of physiological variation in FDG distribution have been reported in articles [7,13-15]. It has been reported that there was positive relationship in age and mean SUV of the liver on FDG PET imaging, but the relationship between age and maximal SUV of the liver on FDG PET was not assessed [16]. In this study, we found that age was a significant predictor in the both SUVmax and SUVmean of the liver on FDG PET imaging.

HBV infects more than 350 million people worldwide [17]. Hepatitis B infection is a leading cause of chronic hepatitis, liver cirrhosis, and hepatoma in Taiwan. Today, approximately 2.5 million people in Taiwan are carriers of the HBV, and the serum HBsAg-positive carrier rate in the general population is 20.2% in Taiwan [18]. HCV infection is a global health problem. HCV infection is becoming the

Table 2
Relationship between sex, age, HBV, and HCV infection status, and SUVmax of the liver by multiple linear regression analysis

	Beta coefficient	P value
Sex	.003	.96
Age	.182	.001*
HBV infection	.042	.434
HCV infection	−.1	.067

Dependent variable: SUVmax of the liver.

* $P < .05$.

Table 3
Relationship between sex, age, HBV and HCV infection status, and SUVmean of the liver by multiple linear regression analysis

	Beta coefficient	*P* value
Sex	−.038	.49
Age	.16	.004*
HBV infection	.042	.443
HCV infection	−.095	.083

Dependent variable: SUVmean of the liver.
* $P < .05$.

second most common chronic viral infection in the world with a global prevalence of about 180 million people [19]. Approximately 700,000 people are afflicted with hepatitis C in Taiwan. The prevalence of positive serum test for anti-HCV antibody in the general population in Taiwan is 4% [20]. HBV and HCV infections are the leading risk factors of hepatoma in Taiwan. Nevertheless, FDG PET imaging plays only a limited role in detecting hepatoma, because only 50% of the patients with hepatoma can be detected by FDG PET imaging [21,22].

In this study, we found a statistically significant and positive relationship between age and SUV of the liver. This indicates that older people may have higher physiological FDG uptake in the liver than younger adults. High physiological background FDG uptake may reduce diagnostic sensitivity and accuracy for detecting malignant lesions, and, in an aging population, may result in false negative findings in the liver on FDG PET imaging. In conclusion, age has a significant and positive impact on both maximum and mean SUV of the liver on FDG PET imaging. High physiological background FDG uptake will reduce diagnostic sensitivity and accuracy for malignancy detection in the liver.

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