Incidence and characteristics of uterine leiomyomas with FDG uptake

Sadahiko Nishizawa · Masayuki Inubushi · Aki Kido
Masao Miyagawa · Takeshi Inoue · Katsura Shinohara
Makoto Kajihara

Abstract

Objective Uterine leiomyomas sometimes show focal \(^{18}\)F-fluorodeoxyglucose (FDG) uptake on positron emission tomography (PET) images that may result in a false-positive diagnosis for malignant lesions. This study was conducted to investigate the incidence and characteristics of uterine leiomyomas that showed FDG uptake.

Methods We reviewed FDG-PET and pelvic magnetic resonance (MR) images of 477 pre-menopausal (pre-MP, age 42.1 ± 7.3 years) and 880 post-MP (age 59.9 ± 6.8 years) healthy women who underwent these tests as parts of cancer screening. Of 1357, 323 underwent annual cancer screening four times, 97 did three times, 191 did twice, and the rest were screened once. Focal FDG uptake (maximal standardized uptake value > 3.0) in the pelvis was localized and characterized on co-registered PET/MR images.

Results Uterine leiomyomas were found in 164 pre-MP and 338 post-MP women. FDG uptake was observed in 18 leiomyomas of 17 of the 164 (10.4%) pre-MP women and in 4 leiomyomas of 4 of the 338 (1.2%) post-MP women. The incidence was significantly higher in pre-MP women than in post-MP women (chi-square, \(P < 0.001\)). Of the 22, 13 showed signal intensity equal to or higher than that of the myometrium on T2-weighted MR images, which suggested abundant cellularity, whereas the majority of leiomyomas without FDG uptake showed low signal intensity. Of the 13 women, 12 examined more than twice showed substantial changes in the level of FDG uptake in leiomyomas each year with FDG uptake disappearing or newly appearing. These changes were observed frequently in relation with menopause or menstrual phases.

Conclusions Leiomyomas with focal FDG uptake were seen in both pre- and post-MP women with a higher incidence in pre-MP women. Abundant cellularity and hormonal dependency may explain a part of the mechanisms of FDG uptake in leiomyomas. It is important to know that the level of FDG uptake in leiomyomas can change and newly appearing FDG uptake does not necessarily mean malignant transformation.

Keywords FDG-PET · MRI · Uterine leiomyomas · Genitourinary oncology

Introduction

Positron emission tomography (PET) using \(^{18}\)F-fluorodeoxyglucose (FDG) has been proved to be an effective diagnostic tool for a variety of malignant tumors and is frequently used for the management of patients with such tumors. However, it is true that many benign tumors and diseases or other physiological conditions also show focal FDG uptake that mimics that of malignant lesions and leads to misinterpretation of FDG-PET images [1–3]. Therefore, it is important to understand those conditions as much as possible to prevent misinterpretation. Recent articles showed that, as diagnostic pitfalls specific to the pelvic organs in women, focal FDG uptake was frequently seen in the normal uterine endometrium and ovaries of premenopausal women in certain phases of the menstrual (or ovarian hormonal)
cycle [4–6]. Several case reports also demonstrated that uterine leiomyomas, although benign, show FDG uptake on rare occasions that may cause false-positive diagnosis for malignant lesions [7–10]. The objective of this study was to investigate the incidence and characteristics of uterine leiomyomas that showed FDG uptake from data of a large number of healthy women who underwent FDG-PET and pelvic magnetic resonance (MR) imaging as parts of cancer screening.

Materials and methods

Subjects

We included a total of 1357 female subjects in this study, 477 premenopausal (pre-MP, age 42.1 ± 7.3 years) and 880 post-menopausal (post-MP, age 59.9 ± 6.8 years) women, after excluding those who met the exclusion criteria: (1) history and/or diagnosis of gynecological malignancy or surgery, (2) receiving hormonal therapy, and (3) blood sugar level over 150 mg/ml at the time of PET examination. They underwent whole-body FDG-PET and pelvic MR imaging as parts of cancer screening in the Hamamatsu Medical Imaging Center. Medical interviews, encompassing prior malignancy and gynecological surgery, menstrual status, and phase of the menstrual cycle were conducted with all women. All women underwent the cancer screening at least once between August 2003 and December 2006. Of 1357, 323 underwent the annual cancer screening four times, 97 did three times, and 191 were screened twice.

Diagnoses of uterine leiomyomas were made on the basis of findings of MR imaging and results of follow-up till the end of 2007. Women with findings suggestive of malignant lesions were referred to local hospitals for further examinations or periodical follow-ups to obtain the final diagnosis. Some women with findings suggestive of leiomyomas were also referred to local hospitals depending on the size and characteristics on MR images and symptoms. We checked the occurrence of cancer including gynecological malignancy 1 year after the cancer screening by sending a questionnaire to women who did not receive further examinations or follow-ups.

Written informed consents were obtained from all women for the study, which was approved by the ethics committee of the Hamamatsu Medical Photonics Foundation.

PET imaging

Positron emission tomography imaging was performed with a dedicated PET scanner (SHR-92000, Hamamatsu Photonics, Hamamatsu, Japan). The scanner has a long axial field of view of 685 mm, containing 12 rows of detector blocks (60 detector blocks in each row), which produced 336 transverse sections with a section thickness of 3.2 mm covering from the upper thigh to the top of the brain in two bed positions with an effective axial field of view of 1075 mm [11]. Each detector block has a flat panel position-sensitive photomultiplier (PS-PMT) (R8400-00-M64, Hamamatsu Photonics) and a 16 x 8 bismuth germanate (BGO) crystal array with a crystal size of 2.9 mm x 6.3 mm x 20 mm. All women fasted for at least for 5 h prior to being administered an injection of FDG. The serum glucose levels were measured just prior to the injection. All women voided immediately prior to the scan, which was started 60 min following the injection of 3 MBq/(kg body-weight) FDG. A lower part of the body was scanned first to avoid the degradation of image quality by the urinary activity in the bladder. The acquisition time was 7 min for one bed position.

Whole-body computed tomography (CT) with low radiation dose (120 kV, 10 mAs, 0.5 s/rotation, effective radiation dose of less than 0.5 mSv) was also obtained with an 8-slice CT scanner (LightSpeed Ultra, GE Medical Systems, Milwaukee, WI, USA) with holding breath in an expiration phase, which was used for attenuation correction of the PET images. The position and shape of the body at the time of the CT scan were reproduced in the PET scanner using the vacuum molded immobilization mattress (BlueBag Vacuum Cushion, Medical Intelligence, Schwabmunchen, Augsburg, Germany) made for each woman, which had been proved to be a practical device for reproducing the position of the body [12, 13]. The PET images were reconstructed by means of a dynamic row-action maximum likelihood algorithm [14]. Reformatted transaxial, sagittal, coronal, and maximum intensity projection (MIP) images were used for the interpretation.

MR imaging

Magnetic resonance imaging was performed with a 1.5-T MR scanner (EXCITE, GE Medical Systems). A T2-weighted fast spin-echo (FSE) sequence was used for transaxial [repetition time (ms)/echo time (ms) = 4300/102, 320 x 224 matrix], transaxial fat-saturation (3700/102, 256 x 192 matrix), and sagittal (2400/102, 320 x 224 matrix) images. Two signals were averaged. Coronal T1-weighted FSE images (470–570/7.5–8.5, 320 x 224 matrix, one or two signal averaged) were also obtained. All images were acquired with a 30–36 cm field of view, a 4–5 mm section thickness, and a 1-mm intersection gap.