Physiological FDG uptake in the ovaries after hysterectomy

Sadahiko Nishizawa · Masayuki Inubushi
Fukujiro Ozawa · Aki Kido · Hiroyuki Okada

Abstract

Objective It is known that focal 18F-fluorodeoxyglucose (FDG) uptake is physiologically seen in the ovaries and uterus of premenopausal women in correlation with the menstrual cycle, which may cause false-positive diagnoses on the images of FDG positron emission tomography (PET). The objective of this study was to clarify whether women of reproductive age after hysterectomy whose ovaries were preserved, also showed physiological ovarian FDG uptake.

Methods We reviewed 26 women after hysterectomy (age 51.1 ± 5.0 years), who underwent annual cancer screening, including FDG-PET and pelvic magnetic resonance (MR) imaging, three times.

Results Seven women (age 45.9 ± 5.8 years, range 34–52 years) had at least one ovary, showing changes in its appearance including the size and number of follicles on MR images each year, which suggested that the ovary was functioning. Four of the seven women showed focal FDG uptake (standardized uptake value 4.2 ± 1.1) that corresponded to the normal ovaries on five PET examinations. Another group of 19 women (age 53.1 ± 3.1 years, range 47–59 years) who had small ovaries without changes on MR images each year did not show FDG uptake in the ovaries.

Conclusions Physiological FDG uptake observed in the ovaries of women of reproductive age even after hysterectomy is reasonably common. As it is not easy to determine the hormonal cycle in these women, it is essential to correlate focal FDG uptake in the pelvis with anatomical and morphological findings on MR images to avoid false-positive diagnoses.

Keywords FDG · PET · Ovary · Physiological uptake · Hysterectomy

Introduction

In the interpretation of whole-body positron emission tomography (PET) images using 18F-fluorodeoxyglucose (FDG), good knowledge of physiological FDG uptake in the healthy population is of great importance to avoid false-positive diagnoses. To date, many physiological variations and pitfalls of whole-body FDG-PET images have been reported [1–3]. Recent investigations have revealed that most premenopausal women show focal FDG uptake in the normal ovaries and uterine endometrium in correlation with the menstrual cycle [4, 5], which resembled pathological uptake, and could cause the misinterpretation of FDG-PET images.

Physiological FDG uptake in the ovaries is frequently observed in the late follicular to early luteal phases [5] and seems to be tightly related to periovulatory processes, including inflammatory reaction and/or increased energy demand [6–8]. Women who have undergone a hysterectomy should also show physiological FDG uptake in the ovaries when they are in the reproductive age and have normal ovarian functions with ovulation periodically. We examined physiological FDG uptake in
the ovaries of women after hysterectomy by reviewing FDG-PET and magnetic resonance (MR) images of healthy volunteers in our cancer screening trial.

Materials and methods

Subjects

We included 26 post-hysterectomy women (age 51.1 ± 5.0 years, range 34–59 years), who were identified from 428 healthy volunteers in the research protocol of a cancer screening trial done in the Hamamatsu Medical Imaging Center. All women had received a hysterectomy because of benign diseases such as uterine leiomyoma, adenomyosis, or intractable bleeding after delivery. All underwent annual cancer screening including FDG-PET and pelvic MR imaging three times.

Written informed consent was obtained from all subjects for the study, which was approved by the Institutional Ethics Committee.

PET Imaging

All subjects fasted for at least 5 h before an injection of FDG. The serum glucose levels measured just before the injection were normal in all subjects. All subjects voided immediately before the scan. PET imaging was performed on the dedicated PET scanner (SHR-92000, Hamamatsu Photonics, Hamamatsu, Japan), starting 60 min after the injection of 3 MBq/(kg body weight) FDG. The scanner produced 336 transverse sections with a section thickness of 3.25 mm covering from the upper thigh to the brain by two bed positions [9]. The lower part of the body was scanned first to avoid the degradation of image quality by the urinary activity in the bladder. Whole-body computed tomography (CT) with low radiation dose (effective radiation dose of less than 0.5 mSv) was also obtained, which was used as attenuation correction data for the PET images. Images were reconstructed by means of a dynamic row-action maximum likelihood algorithm [10]. Reformatted transaxial, sagittal, coronal, and maximum intensity projection images were used for interpretation.

MR imaging

Anatomical and morphological information of the pelvis were acquired from MR images. MR imaging was performed with a 1.5-T MR scanner (EchoSpeed, GE Medical Systems, Milwaukee, WI, USA). T2-weighted fast spin-echo (FSE) sequence was used for transaxial [repetition time 4300 ms, echo time 102 ms (4300/102), 320 × 224 matrix], transaxial fat saturation (3700/102, 256 × 192 matrix), and sagittal (2400/102, 320 × 224 matrix) images. Two signals were averaged. Coronal T1-weighted FSE images (470–570/7.5–8.5, 320 × 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.

Image analysis

FDG-PET images were evaluated for focal FDG uptake in the ovaries both visually and by standardized uptake values (SUVs). The FDG uptake value was corrected for the injected dose and the body weight to obtain the maximal pixel SUV. MR images were used to localize the foci of the increased FDG uptake and to evaluate the size of the ovaries, the visualization of follicles, and the morphological abnormality of the ovaries. The size of the ovaries was measured on axial T2-weighted MR images.

The anatomical correlation of FDG-PET images with MR images was performed on directly superimposed PET and MR images. For this purpose, we referred to CT images obtained with low radiation dose for attenuation correction, which could be superimposed closely on PET images. Anatomical markers such as bony structures of the pelvis were used for manual co-registration of CT and MR images. Then PET images were superimposed on MR images.

Results

Table 1 summarizes the characteristics and results of all women after hysterectomy. Seven of the 26 women (age 45.9 ± 5.8 years, range 34–52 years) had at least one ovary that showed changes in size and shape and in the number of follicles on MR images each year, which indicated that the ovary was functioning (Fig. 1). Four of the seven women demonstrated focal FDG uptake in the pelvis on five PET studies (SUV 4.2 ± 1.1, range 2.8–5.3), which corresponded to the normal ovaries on MR images (Fig. 2). By contrast, 19 women (age 53.1 ± 3.1 years, range 47–59 years) who had small ovaries without follicles or change in the size and shape on MR images each year did not show FDG uptake in the ovaries.

Discussion

In a previous report, we demonstrated that physiological FDG uptake in the ovaries of premenopausal women was frequently observed in the late follicular to early