Uterine Tumors and PET-CT

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At the first instance the title may be a bit surprising as uterus is not a frequently visited domain in Nuclear Medicine. Ultrasonogram has taken over all sort of imaging modalities as it is simple, inexpensive technique. But along with other anatomical imaging procedures like CT or MRI, it cannot provide the functional and metabolic information. Here Positron emission tomography – Computed Tomography (PET-CT) can play useful roles.

The most common uterine tumors include leiomyoma (benign) and endometrial carcinoma (malignant). There are times when preoperative differentiation is needed. FNAC is not an easy option for uterine tumors. PET-CT with metabolic and receptor tracers can help us in this regard.

PET-CTwith fluorine 18 (18F) fluorodeoxyglucose(FDG) has been used for diagnosis of gynecologic malignant tumors and is considered to be superior to conventional imaging methods in diagnostic accuracy for detection of metastatic lesions and local recurrence (1–5). The size of the tumorand inflammatory changes of the lesion may affect PET imaging and FDG accumulation. FDG uptake is also affected by the menstrual cycle as well (6,7). Additional physiologic information other than glucose metabolism may improve the diagnostic accuracy of PET.

Uterine leiomyomas usually show mild FDG uptake (8). Although the exact mechanism responsible for FDG uptake in leiomyomas is unclear, the phenomenon would be regulated by several factors including hormonal dependency, cellularity (the number of viable tumor cells), vascularity (microvessel density), tumor cell proliferation (the expression of growth factors such as basic fibroblast growth factor, transforming growth factor β, granulocyte-macrophage colony-stimulating factor, and Ki-67 and their receptors), expression of glucose transporter 1 (GLUT-1) and hexokinase, the existence of endometrial tissue, and the presence of inflammatory cells (9,10).

Receptor imaging is a new trend in Nuclear Medicine. There are two types of estrogen receptors in the body (Erα and ER β). 16-[18F]fluoro-17-estradiol (FES)is an 18F-labeled compound of estradiol, the most bioactive type of estrogen, and is used for the detection of estrogen receptor (ER)–positive organs and diseases (11,12). FES PET imaging is well established in patients with ER-positive breast cancer for diagnosis, staging, and post therapeutic follow-up (13–18). Investigators in previous studies (13–15) reported that FES accumulation was well associated with the concentration of ER in in vitro measurements, and it could therefore enable in vivo non-invasive measurement of ER density. In benign lesions the receptor are intact but in malignant tissues due to its anaplasia the receptors are lost, hence the receptor tracers are poorly taken up.

Endometrial cancer generally shows intense FDG uptake. Kitajima et al. (19) reported that the mean SUV of endometrial cancer in 40 patients was 11.2 ± 5.9 (SD) (range: 2–25.6). PET-CT is a useful technique for assessing distant metastases throughout the whole body in a single examination in patients with advanced-stage disease. PET-CT can often detect normal-sized lymph node metastases from 5-9 mm, which conventional CT and MRI cannot diagnose.

ER expression and glucose metabolism of uterine tumors measured by using PET show opposite patterns between benign and malignant lesions. 18F-labeled FES is an analog of estradiol, and FES accumulation is well correlated with the concentration of ER in in vitro measurements (13–15). Because FES PET is used for the detection of ER expression in estrogen-related diseases such as breast cancer (13–18), it is possible to measure in vivo ER density noninvasively. On the other hand, FDG is a glucose analogue that reflects the activity of glucose transport proteins and the intracellular phosphorylation by hexokinase (20). PET studies with both FES and FDG can provide pathophysiologic information for the differential diagnosis of uterine endometrial neoplasias (endometrial carcinoma and hyperplasia) and myometrial tumors (sarcoma and leiomyoma).

Tsujikawa et.al. (21) showed in a study, malignant endometrial tumors showed higher FDG and lower FES accumulation, a finding that was in contrast to that for benign lesions, which showed high FES and low FDG uptake. These results indicate the possibility of noninvasive differential diagnosis for endometrial lesions by using PET.

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