PET-CT findings in surgically transposed ovaries

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ABSTRACT. The aim of this study is to present the PET/CT findings of surgically transposed ovaries. PET/CT studies and associated abdominal imaging studies of seven women, aged 28–43 years, with 11 transposed ovaries were retrospectively reviewed. Attention was directed to the location and the 18F-Fluorodeoxyglucose (FDG) avidity of the transposed ovaries. On the CT part of the PET/CT, location of the transposed ovaries was in the ipsilateral iliac fossa or paracolic gutter abutting the anterior aspect of the ipsilateral colon (n=6), posterolateral to the cecum (n=4) and in the anterior abdominal cavity (n=1). Ovaries were of soft-tissue density (n=10 with a hypodense region in two) and one was cystic. In three patients, the transposed ovary was associated with increased FDG uptake with standard uptake values ranging from 2.4 to 4.8. Two of the latter patients had more than one PET/CT study. FDG uptake altered between studies, probably related to the performance of the study on different phases of the cycle. Menstrual history in one of the patients confirmed that the study was performed at the ovulatory-phase of the cycle. To conclude, a transposed ovary may appear on a PET-CT study as a mass with occasionally increased FDG uptake that may be related to its preserved functionality. Physicians interpreting PET/CT should be aware of surgically transposed ovaries in young female patients to avoid misdiagnosing it as tumour.

Pelvic radiation therapy for cervical, vaginal or colorectal cancer often leads to ovarian failure. Ovarian transposition outside the radiation field, to the paracolic gutter or iliac fossa, is a surgical procedure performed to preserve ovarian function mainly in young females with early stages of cervical carcinoma [1]. On imaging, the transposed ovary may appear as a small soft-tissue mass, often with one or more tiny cysts, or alternatively as a larger intraperitoneal cystic mass which may show functional, periodic changes on follow-up studies, according to the expected changes in the ovary during the different phases of the menstruation cycle. Surgical clips are usually placed to permit identification of the transposed ovary [2–5]. In oncologic patients, the recognition of the position and the appearance of the transposed ovary are crucial to avoid misinterpreting it as a tumour. We have encountered 10 18F-Fluorodeoxyglucose (FDG) PET/CT studies in 7 females with 11 surgically transposed ovaries and we present their imaging findings on PET/CT and conventional abdominal imaging.

Materials and methods

We reviewed the clinical data and imaging studies of seven female oncologic patients (aged 28–43 years) after ovarian transpositions who were referred for PET/CT studies. Ovarian transposition was bilateral in four patients and unilateral in the other three. Five women had carcinoma of the cervix, one had a rectovaginal cleft mucinous adenocarcinoma and one had uterine non-Hodgkin’s lymphoma. Six patients reported amenorrhoea after hysterectomy and one was menstruating. Two of the study patients had more than one PET/CT study, at different time points in the menstruation cycle, available for assessment. One patient had two studies and the other had three. Five PET/CT studies were performed for findings suggestive of recurrence that were detected on physical examination and/or seen on MRI or diagnostic CT performed for follow-up. In two patients, five follow up PET-CT studies were performed, for re-staging and for monitoring response to treatment. PET-CT scan was performed following the administration of iodinated oral contrast material and after intravenous injection of 370–666 MBq (10–18 mCi) of 18FDG. Low-dose CT scanning was performed (140 kV, 80 mA, 0.8 s per CT rotation, pitch of 6, and table speed of 22.5 mm s⁻¹) during normal respiration. PET scanning was performed immediately following the CT without changing the patient position. Images were interpreted at a work-station (Xeleris Elgems, Haifa, Israel) equipped with fusion software that enables the display of PET, CT and fused PET/CT images.

Results

The clinical and imaging findings of the patients are summarized in Table 1. All 11 transposed ovaries were...
### Table 1. The clinical data and imaging findings of 7 patients with transposed ovaries

<table>
<thead>
<tr>
<th>Patient no., age (years), primary tumour</th>
<th>Medical history</th>
<th>Indication for PET/CT</th>
<th>PET/CT findings</th>
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<tbody>
<tr>
<td>1. 35, carcinoma of cervix</td>
<td>6 months after Lt. SO, Rt. OT and 3 months after combined chemo-radiotherapy</td>
<td>A Rt. gutter ST mass on CT – suspicion of recurrence</td>
<td>A 2.3 cm × 3.2 cm ST mass, with central hypodensity, near surgical clips, in Rt. gutter, posterolateral to AC, cranially to a normal appendix. No FDG uptake</td>
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<tr>
<td>2. 43, carcinoma of cervix</td>
<td>18 months after radical hysterectomy, Rt. SO and Lt. OT</td>
<td>An intra-abdominal ST mass on CT – suspicion of recurrence</td>
<td>A 1.7 cm × 3.7 cm ST mass, near surgical clips, in the anterior mid-abdomen, between bowel loops and Lt. rectus abdomini muscle. No FDG uptake</td>
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<td>3. 32, carcinoma of cervix</td>
<td>10 months after radical hysterectomy, pelvis lymphadenectomy and bilateral OT</td>
<td>Suspected mesenteric lymphadenopathy on CT</td>
<td>Rt. A 2.1 cm × 3.3 cm ST mass, near surgical clips, in the Rt. iliac fossa, posterolateral to the cecum. No FDG uptake</td>
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<tr>
<td>4. 30, carcinoma of cervix</td>
<td>10 years after radical hysterectomy, pelvis lymphadenectomy and bilateral OT</td>
<td>A 5 cm cystic (necrotic?) RLQ mass on MRI – suspicion of recurrence</td>
<td>Lt. A 2.4 cm × 2 cm ST mass, near surgical clips, in the Lt. iliac fossa, anterior to DC. No FDG uptake</td>
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<tr>
<td>5. 43, carcinoma of cervix</td>
<td>6 years after radical hysterectomy, pelvis lymphadenectomy and bilateral OT</td>
<td>Clinical suspicion of recurrence</td>
<td>Lt. A 2.6 cm × 0.6 cm ST mass, near surgical clips, in the Lt. gutter posterolateral to DC. No FDG uptake</td>
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<tr>
<td>6. 39, uterine non-Hodgkin's lymphoma</td>
<td>5 years after radical hysterectomy, pelvis lymphadenectomy and bilateral OT</td>
<td>1st: Clinical suspicion of recurrence</td>
<td>Lt. A 2.1 cm × 2.4 cm ST mass with hypodense centre, near surgical clips, in the Lt. gutter, lateral to DC. No FDG uptake 2nd. Rt. A 2.9 cm × 2.7 cm ST mass. No FDG uptake 3rd: same as in the previous study</td>
</tr>
<tr>
<td>7. 28, rectovaginal cleft mucinous adenocarcinoma, S/P breast cancer</td>
<td>4 months after limited surgical excision of the tumour, RT OT + chemo-radiotherapy</td>
<td>1st: Suspected local recurrence in the Rt. pararectal space on MRI</td>
<td>Lt. Same as in the previous study 3rd: no change from previous study</td>
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SO, salpingo-oophorectomy; Lt., left; Rt., right; LLQ, left lower quadrant; RLQ, right lower quadrant; ST, soft tissue; AC, ascending colon; DC, descending colon; OT, ovarian transposition.
recognized on the CT part of the PET/CT study, adjacent to surgical clips. Their location was in the ipsilateral iliac fossa or paracolic gutter (n=10), either abutting the anterior or lateral aspect of the ipsilateral colon (n=6) (Figure 1) or posterolateral to the cecum (n=4) (Figure 2), and in the anterior abdominal cavity between small bowel loops and the left rectus abdomini muscle at the level of L3 vertebra (n=1). Ten ovaries were of soft-tissue density, with a hypodense region in two of them, while the remaining one showed periodic CT changes, related to the menstruation cycle, which varied from a “cystic” to a soft-tissue attenuating mass.

In three patients, the transposed ovary was associated with increased FDG uptake. One patient, with bilateral ovarian transposition, was referred for PET/CT for the assessment of a “necrotic” mass demonstrated on MRI (Figure 1a). On PET/CT, performed 1 month later, the lesion showed significant diminution in size without FDG uptake, while minimal uptake (standard uptake value of 2.4) was seen in the contralateral transposed ovary (Figure 1b,c). As the patient was amenorrhoeic following hysterectomy, we could only assume that the MRI and PET/CT findings represented periodic changes in bilaterally transposed ovaries. The second patient, with bilateral ovarian transposition after hysterectomy, had three PET-CT studies. On the first study, the right transposed ovary presented as a soft-tissue mass with increased FDG uptake (standard uptake value of 4.8) (Figure 2a,b). On the second study, 6 months later, without any treatment in the interim, the same ovary presented as a soft-tissue mass with no uptake (Figure 2c). These findings remained unchanged on a third follow-up study. In the third patient, who was still menstruating as she had an intact uterus, a rim of FDG uptake (standard uptake value of 3.6) was detected in the transposed ovary on a study performed 14 days after menstruation. That ovary was demonstrated on the CT part of the study as a soft-tissue mass. Based on the menstrual history of the patient, it appeared that the patient was in the ovulatory-phase of the cycle.

**Figure 1.** A 30-year-old woman, 10 years after radical hysterectomy and bilateral ovarian transposition for carcinoma of the cervix, referred for PET/CT for suspected recurrence on MRI (patient no. 4). (a) An axial T2 weighted MR image at the pelvic inlet shows the transposed right ovary (RO) anteriorly to the ascending colon (AC) as a 5 cm hyperintense mass with a thin hypointense rim, suspected to be a necrotic tumour recurrence. Note also the left transposed ovary (LO), abutting the anterior aspect of the descending colon (DC), as a hypointense lesion. That ovary was not reported on the MRI. (b) Axial PET/CT images (from left to right: CT, PET and fused PET/CT images). On the CT, the bilateral transposed ovaries are seen (thin white arrows). Note the diminution in size of the right ovary in comparison with the previous MRI performed 1 month earlier, most likely related to its periodic functional changes. The left transposed ovary shows increased FDG uptake on the PET and on fused images (thin arrows). Additional physiological sites of FDG uptake are seen, including bowel (arrowhead), bone marrow (medium-size arrow) and iliac blood vessels (large arrow). (Continued)
This increased ovarian uptake was not detected on a previous PET/CT study, performed not at the ovulatory phase, associated with an altered appearance of the ovary, seen on the CT part of that study, as a hypodense mass.

**Discussion**

Ovarian transposition was described by McCall et al in 1958 for young (<40 years old) females with an early-stage cervical carcinoma planned for pelvic radiosurgical treatment, to maintain ovarian function [6]. The procedure may be unilateral or bilateral, performed at the time of the radical hysterectomy or staging lymphadenectomy [1]. The repositioning of the ovary outside the radiation field may be above the iliac crest, into the ipsilateral paracolic gutter or lower down, below the iliac crest lateral to the iliopsoas muscle [2].

The normal transposed ovary may appear on abdominal CT as a soft-tissue mass, sometimes with small cysts or as a predominant cystic lesion, mimicking a peritoneal or retroperitoneal tumour implants. The location of the transposed ovary on CT is generally either adjacent to the ascending or descending colon, or in the upper pelvis lateral to or anterolateral to the psoas muscle [2-5]. However, in one of our patients, the transposed ovary was in an atypical location, i.e. in the anterior abdominal cavity between the abdominal wall musculature and the small bowel loops, mimicking a peritoneal implant. Adjacent surgical clips assisted in identifying it as a transposed ovary.

Lack of familiarity with the procedure as well as with the CT features of a transposed ovary may lead to a diagnostic error in the interpretation of abdominal CT or MR imaging, misdiagnosing the transposed ovary as a metastatic deposit. It was the case in five of our patients, who were referred for a PET/CT study for a “suspected” tumoural recurrence on either CT or MRI. A right-sided transposed ovary should also be differentiated from a mucocle of the appendix, although an appendectomy is usually performed at the time of the surgical procedure [5]. In one of our patients, the appendix was not removed and was identified separately from the ovary on the CT part of the study, obviating such an interpretation mistake.

Recently, hybrid systems composed of PET and CT have been introduced in addition to conventional...
cross-sectional imaging methods in the routine practice of oncologic patients for staging, monitoring response to treatment and assessment of recurrence. PET and CT data, acquired at the same clinical setting, with generation of fused PET/CT images, provide both functional and anatomical information [7]. A transposed ovary may show increased FDG uptake on the PET part of the study due to functional changes, as was seen in three of our patients. FDG uptake in normal ovaries was reported in pre-menopausal patients without a known ovarian malignancy at mid-menstrual cycle. In oligomenorrheic patients too, FDG uptake may be high and resemble the uptake values found at mid-cycle [8]. In menstruating patients, the physiological cause of uptake may be sorted out by discussing the menstruation history with the patient. However, as ovarian transposition is carried out primarily in patients with gynaecological malignancies that are often post-hysterectomy, their ovulatory-phase cannot be determined by history alone. Therefore, when detecting a focal increased abdominal uptake on PET in a young female patient, the possibility of a functional uptake in a transposed ovary should be born in mind and adjacent surgical clips should be looked for on the CT part of the study. Directly interviewing the patient may also assist, as unfortunately the information of ovarian transposition is often omitted from the referral sheath for a PET/CT study. It was, indeed, not provided in any of our patients.

In conclusion, the physician interpreting a PET/CT study should be familiar both with the clinical history and the imaging findings of ovarian transposition. Increased FDG uptake in a transposed ovary may be related to its preserved functionality.

**References**