7 Gynecologic Neoplasms: Cervical, Ovarian, Vulvar, Uterine, and Endometrial Cancer

Bhushan Desai and Hossein Jadvar

Cervical Cancer

Case 7.1

History

A 59-year-old female presenting with newly diagnosed cervical carcinoma on biopsy. PET/CT was ordered as a part of the initial treatment strategy evaluation.

Findings

The uterus is anteverted, demonstrating physiologic FDG activity (Fig. 7.1). Intense metabolic activity is seen in the cervical region with associated thickening, SUVmax 16.3, which is compatible with biopsy-proven diagnosis of primary neoplasm. There is a fat plane between the cervix and urinary bladder anteriorly which excludes the direct tumor invasion.

Impression

Cervical thickening demonstrating intense hypermetabolism, which is compatible with biopsy-proven diagnosis of primary neoplasm.

P.S. Conti, A. Kaushik (eds.), *PET-CT*, DOI 10.1007/978-1-4419-5811-2_7

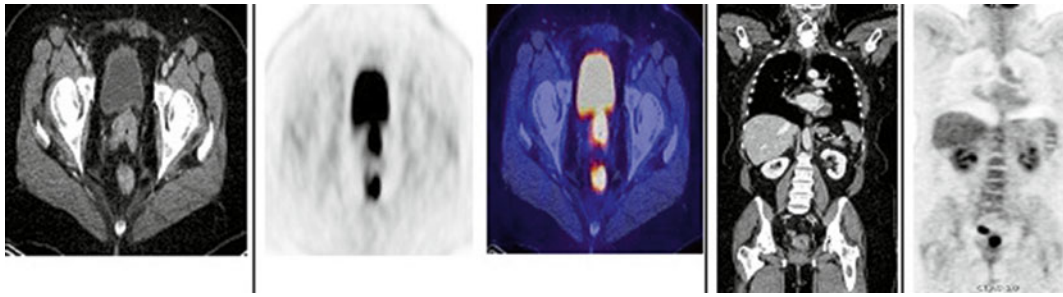

Fig. 7.1

Case 7.2

History

A 51-year-old female with history of cervical cancer.

Findings

1. There are bilateral supraclavicular, bilateral internal mammary, left axillary, and mediastinal lymph nodes, demonstrating intense FDG activity which is compatible with distant metastatic spread (Fig. 7.2). As a reference, right precarinal lymphadenopathy demonstrates SUVmax 12.9, measuring approximately 2.4 × 3.6 cm, subcarinal lymph node measures approximately 1.7 cm with SUVmax 8.9, left internal mammary lymph node demonstrates SUVmax 7.8, and AP window lymphadenopathy shows SUVmax 10.8.
2. There is a large hypermetabolic uterine cervical mass demonstrating intense FDG activity, SUVmax 13.8. Exact tumor margins cannot be identified due to lack of IV contrast. There is no fat plane between the tumor and posterior wall of urinary bladder anteriorly, which also abuts the ventral surface of the rectal wall posteriorly, worrisome for local tumor invasion.
3. There are several hypermetabolic, enlarged retrocrural, retroperitoneal, bilateral common iliac lymph nodes extending inferiorly to involve bilateral external iliac lymph nodes, compatible with metastatic disease. As a reference, left para-aortic lymph node at the level of L1 demonstrates SUVmax 7.5; a right retrocrural lymph node, measuring approximately 1.5 cm at the level of T11 and T12, demonstrates SUVmax 5.5; right common iliac lymphadenopathy also shows SUVmax 5.5; and right internal iliac lymph nodes demonstrate SUVmax 12.1.
4. Solitary hypermetabolic osseous focus identified at the posterolateral aspect of left eleventh rib, demonstrating SUVmax 5.0.

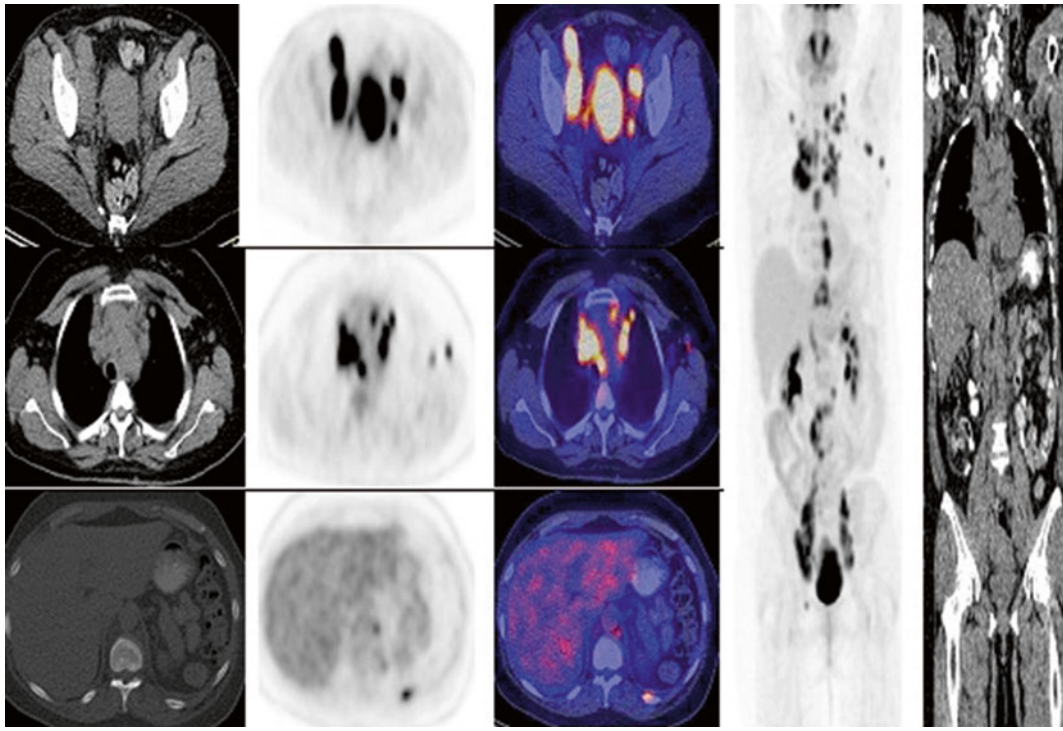

Fig. 7.2

Impression

1. Hypermetabolic, large, uterine cervical mass which is worrisome for local tumor invasion.
2. Metastatic lymphadenopathy involving multiple nodal stations in the neck, chest, abdomen, and pelvis.
3. Findings compatible with early metastatic disease within the lungs.

Pearls and Pitfalls

1. FDG PET/CT has no significant role in screening/diagnosis of cervical cancer.
2. Lymph node staging with PET/CT provides unique prognostic information [1, 2].
3. Early response assessments using PET/CT might help to avoid unnecessary and ineffective treatments.
4. The sensitivity and specificity of PET for early recurrent cervical cancer is 90 % and 76 %, respectively [3].

Discussion

Cervical cancer was once the most common cause of cancer death in women, but the mortality rate has decreased by 50 % due to widespread screening. Worldwide, cervical cancer is the third commonest cancer diagnosed, and it remains the major gynecologic cancer in underdeveloped countries. Squamous cell carcinoma is the most frequent cervical cancer with 85–90 % being invasive. The most common risk factors include lower socioeconomic groups, smoking, early initial sexual activity and/or multiple sexual partners, and history of sexually transmitted disease like gonorrhea, syphilis, and herpes simplex.

MRI is considered the method of choice in the staging of primary tumor since it can evaluate tumor depth and stromal invasion. However, it lacks the ability to accurately diagnose nodal involvement. For this reason, PET is used to assess nodal malignancy as well as regional and distant metastatic disease. Frequency and pattern of cervical cancer lymph node metastasis on FDG PET is influenced by FIGO staging [12, 13]. PET has a 91 % positive value for pelvic and para-aortic lymphadenopathy. In a prospective study on 560 patients, Kidd et al. concluded that the PET findings correlated with the risk of disease progression and survival. In another study looking at the prognostic value of SUVmax, on 73 patients with operable cervical cancer, Chung et al. concluded that FDG tumor uptake correlated with FIGO stage, tumor size, parametrial involvement, and lympho-vascular invasion. These results will likely have important implications for management of cervical cancer patients with lymph node metastasis on FDG PET.

Ovarian Cancer

Case 7.3

History

A 61-year-old female with metastatic stage IV ovarian carcinoma, post gamma knife radiosurgery for left frontal and left cerebellar metastasis. PET/CT was done as part of the subsequent treatment strategy evaluation.

Findings

Three hypermetabolic peritoneal implants are seen in the abdomen (Fig. 7.3). These include a hypermetabolic lesion at the hepatorenal surface of segment 6 of the liver measuring 4.2 cm (long axis) with SUVmax 14.8; peritoneum implant in the splenic flexure, measuring 2.0 cm with SUVmax 8.3; and peritoneal implant in the right hemipelvis internal to the right internal iliac vessels showing SUVmax 10.2. Hypermetabolic subcarinal lymph node is seen with increase in size and activity, SUVmax 8.2. Physiologic brown fat activity is seen in the superior mediastinal and bilateral paravertebral regions.

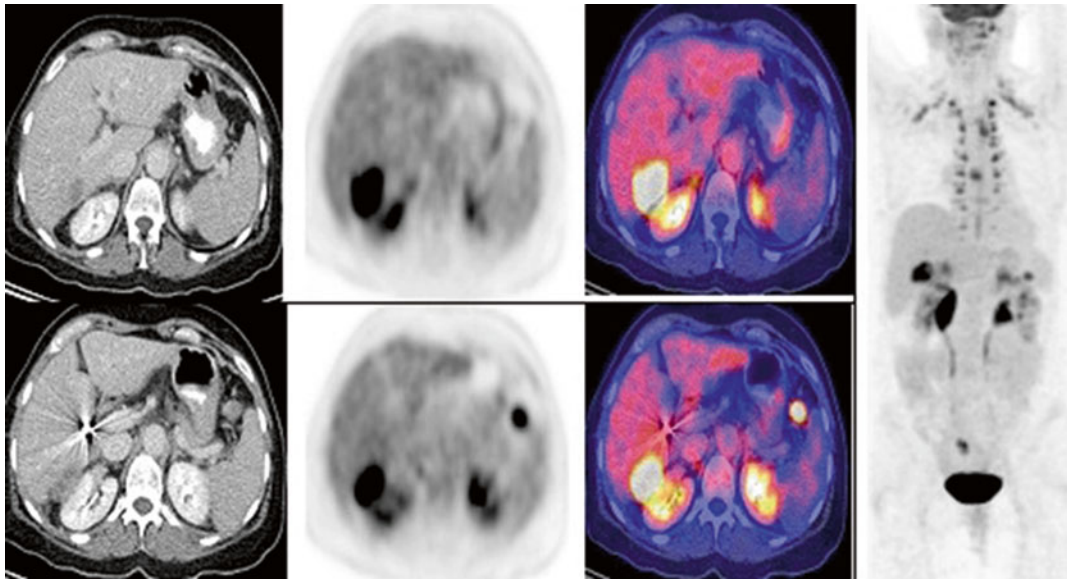

Fig. 7.3

Impression

Three peritoneal implants with increased size and metabolic activity.

Case 7.4

History

A 53-year-old female with stage IV ovarian carcinoma, status post hysterectomy, bilateral salpingo-oophorectomy, omentectomy, and bilateral lymph node dissection with appendectomy, currently on chemotherapy (Taxol). PET/CT was done as part of subsequent treatment strategy evaluation.

Findings

Overall, previously seen majority of the hypermetabolic abdominal lymph nodes have resolved (Fig. 7.4). Exceptions include a porta hepatis lymph node which has decreased in FDG activity and currently demonstrates SUVmax 6.5, previously 9.5; a mesenteric lymph node near the terminal ileum has increased in FDG activity and currently demonstrates SUVmax 12.1 previously 9.3. Additionally, there is a new right retrocrural lymph node which currently demonstrates SUVmax 8.6.

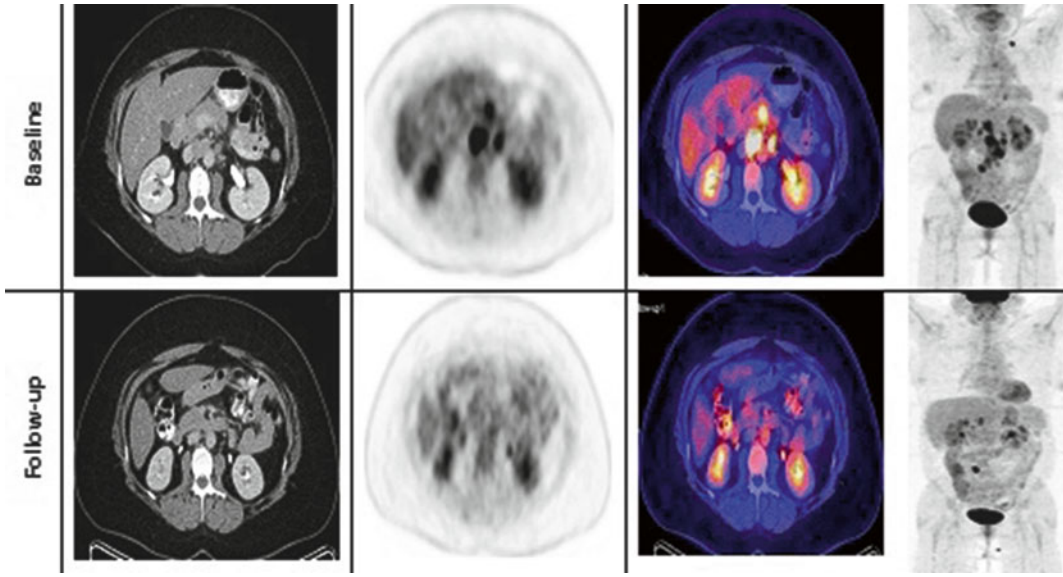

Fig 7.4

Impression

1. Resolution of majority of hypermetabolic abdominal and chest lymph nodes with the exception of the porta hepatis lymph node and mesenteric lymph node adjacent to the terminal ileum.
2. New hypermetabolic right retrocrural lymph node.
3. Overall findings consistent with a substantial partial response to interval chemotherapy.

Case 7.5

History

A 65-year-old female with ovarian cancer, currently on chemotherapy.

Findings

Multiple hypermetabolic omental/peritoneal metastases are seen, like the peritoneal implant lateral to psoas in the left iliac fossa with SUVmax 9.3 (Fig. 7.5). The lymph nodes are involved which are intensely hypermetabolic, for example, retroaortic node at L4 with SUVmax 12.3, left common iliac with SUVmax 8.8, left external iliac with SUVmax 7.1, and left hypogastric with SUVmax 5.7.

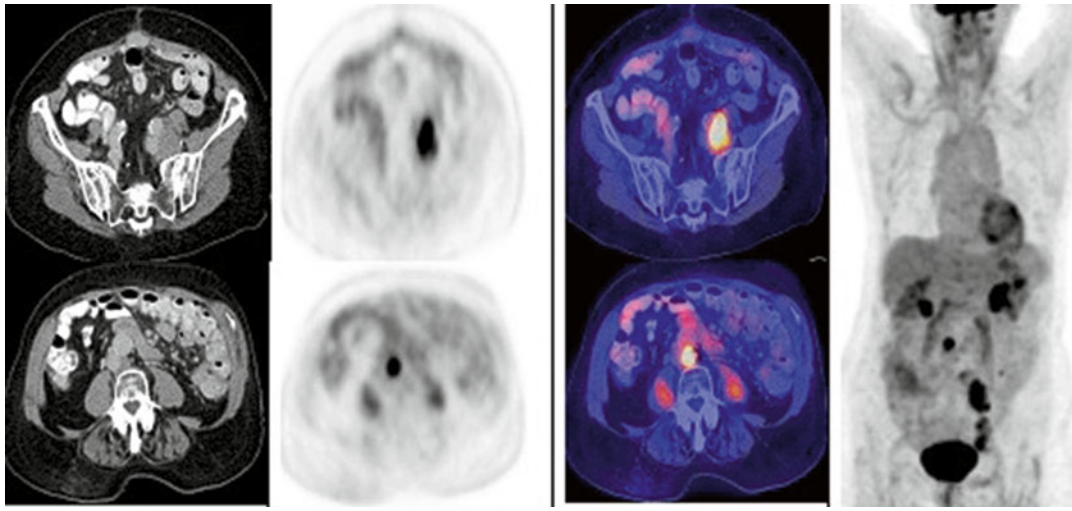

Fig. 7.5

Impression

Widespread metastases in the abdomen and pelvis.

Case 7.6

History

A 66-year-old female with well-differentiated papillary serous adenocarcinoma of the ovary, status post total abdominal hysterectomy and left salpingo-oophorectomy.

Findings

PET/CT showed multiple hypermetabolic calcified masses in the abdomen and pelvis consistent with metastatic disease (Fig. 7.6).

Pearls and Pitfalls

1. PET has the sensitivity of 80–90 %, specificity of 92–100 %, and accuracy of 79–92 % for detecting recurrent ovarian tumor [4–6].
2. PET has a sensitivity of 73 %, specificity of 92 %, accuracy of 86 %, positive predictive value of 89 %, and negative predictive value of 86 % for detecting lymph node involvement. The sensitivity of CT for detecting lymph node involvement ranges from 40 to 63 %; the specificity of CT for detecting the same ranges from 81 to 83 % [4–6].

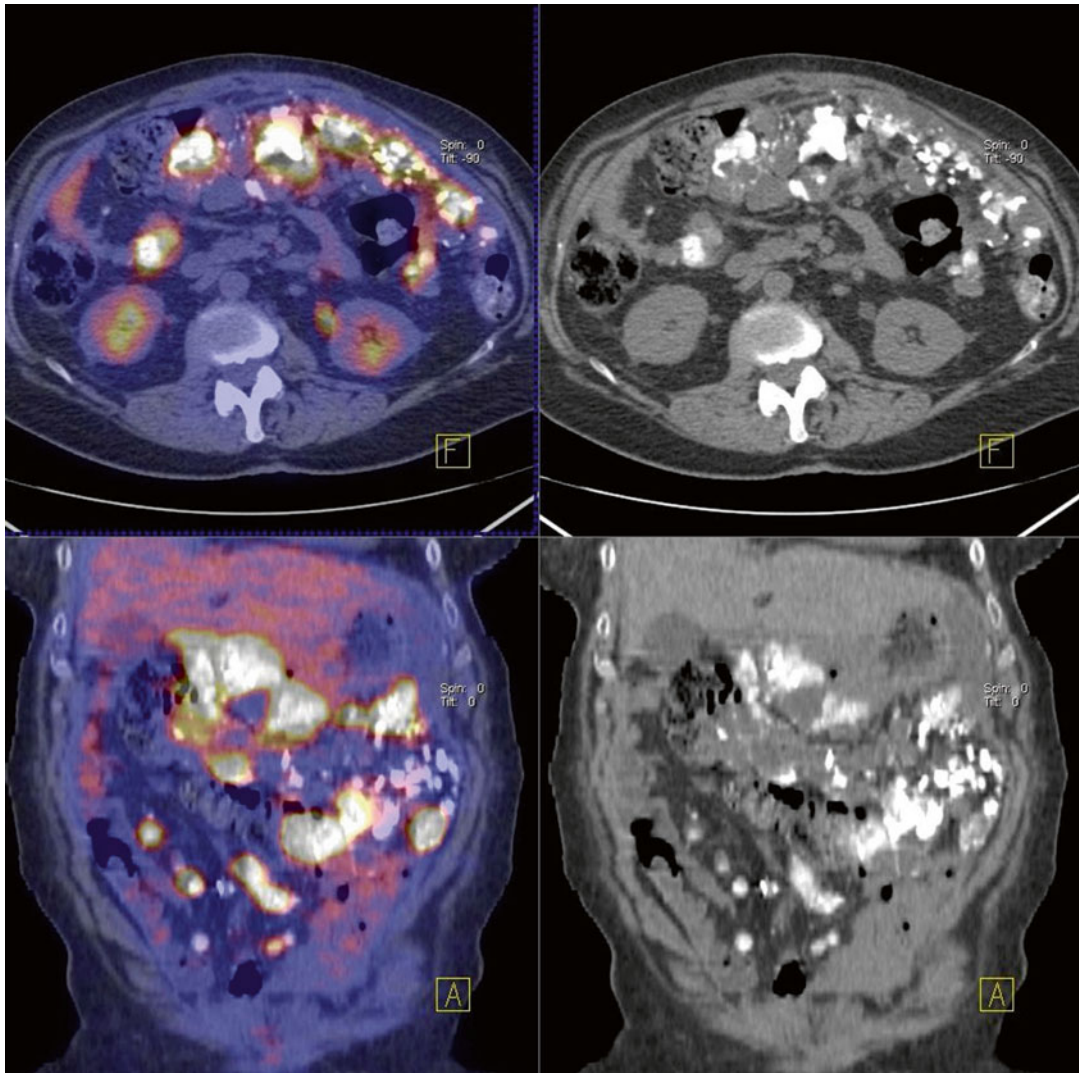

Fig. 7.6

3. FDG PET has a sensitivity of 71 %, specificity of 100 %, positive predictive value of 100 %, negative predictive value of 76 %, and accuracy of 85 % in the detection of peritoneal carcinomatosis [4–6].
4. Peritoneal metastases along the serosa of the colon may be mistaken for physiologic bowel activity, while calcified metastases along the bowel can be mistaken for oral contrast and is typical of mucinous cystadenocarcinoma histology [7].

Discussion

Ovarian cancer is the fifth cause of cancer-related death in women. 24,000 new cases of ovarian cancer were detected in the USA in 2010 with 16,000 deaths/year. More women die of ovarian cancer than of endometrial and

cervical cancer combined. Age-specific incidence peaks in the eighth decade. Some of the common risk factors associated with ovarian cancer are BRCA1 and 2, infertility, nulliparity, family Hx, and endometriosis. At the time of initial evaluation, about 80–85 % of patients have CA-125 > 35 U/mL (postmenopausal women with asymptomatic pelvic mass and CA-125 > 65 U/mL: 78 % specific and 97 % sensitive for cancer). Ovarian tumors can be of epithelial cell, stromal cell, or germ cell origin. Two thirds of patients will have metastatic disease outside the pelvis at the time of diagnosis. Approximately 85 % of the malignant ovarian tumors are epithelial origin of which 50 % are benign, 33 % malignant, and around 15 % borderline with a good prognosis.

In a prospective study on 60 patients who underwent PET/CT scan within 2 weeks prior to surgery, Risum et al. found that the presurgical SUVmax was not predictive of the outcome in patients with primary ovarian cancer. PET/CT scans are accurate for staging but probably not very relevant since impact on management and outcome is small [8]. PET/CT has a high accuracy and positive predictive value in diagnosing recurrent ovarian cancer and can alter patient management [14, 15]. Restaging with PET/CT is not only accurate but also provides the foundation for monitoring of chemotherapy which can help in shortening the duration of ineffective treatments and reduce costs. PET can detect an intra-abdominal relapse with peritoneal carcinomatosis in 40–60 % of the cases. Most recurrent ovarian carcinomas present with peritoneal seeding from para-aortic or peritoneal lymphatics. Unfortunately, false-positive examinations can occur with associated non-malignancy physiology including inflammatory adnexal mass or corpus luteum. Urine activity can also potentially mask the lesions. Some institutions recommend the use of bladder lavage in order to minimize this artifact.

Endometrial/Uterine Cancer

Case 7.7

History

An 81-year-old female with endometrial adenocarcinoma, status post total abdominal hysterectomy with bilateral salpingo-oophorectomy, pelvic radiation therapy, and chemotherapy. PET/CT is done as part of the subsequent treatment strategy evaluation.

Findings

There is an intensely hypermetabolic left adrenal lesion, measures 1.4 cm with SUVmax 5.0, consistent with metastatic disease (Fig. 7.7). There are several hypermetabolic peritoneal/serosal implants, some of which demonstrate central necrosis, again compatible with progression of metastatic disease. A serosal implant overlying the right hepatic lobe demonstrates SUVmax 13.2. Serosal implants are also seen adjacent to the sigmoid and in the region of lower rectum (SUVmax 18.5). Most avid omental implant

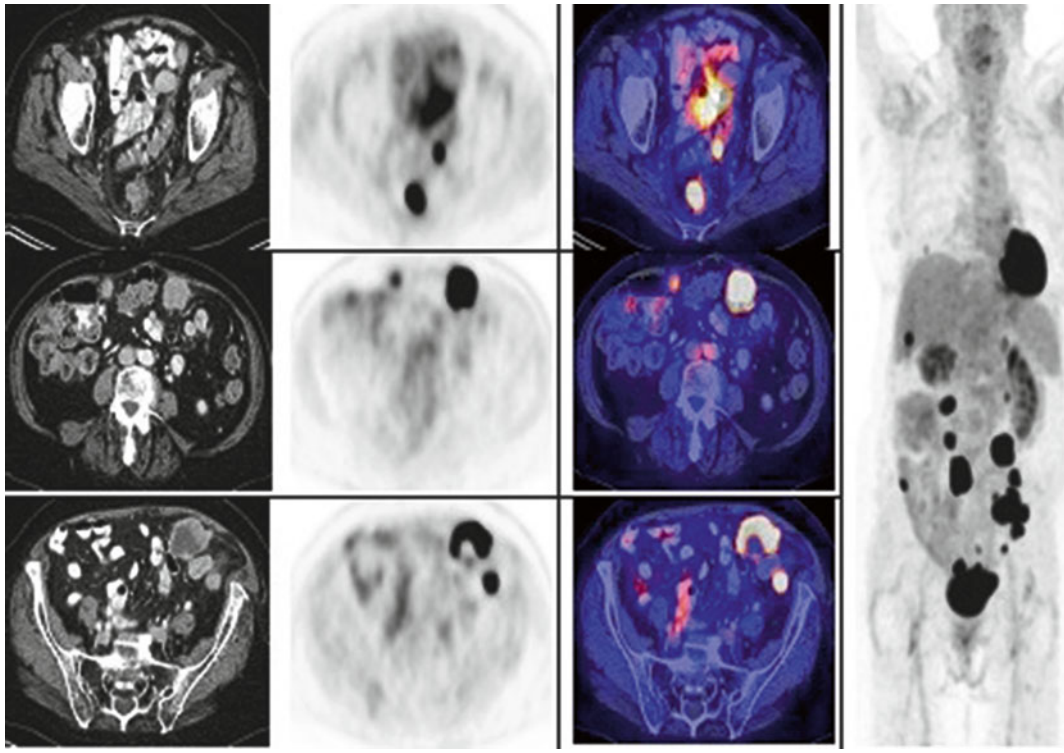

Fig. 7.7

is seen in the lower right abdomen, adjacent to the anterior abdominal wall at the level of L5, demonstrating (SUVmax 19.9).

Impression

Overall findings compatible with progression of metastatic disease.

Case 7.8

History

An 88-year-old female with history of recurrent uterine carcinoma, currently on chemotherapy. PET/CT is done as part of the subsequent treatment strategy evaluation.

Findings

Bilateral adrenal glands demonstrate interval increase in PET activity, suspect for metastatic disease (Fig. 7.8). As a reference, right adrenal

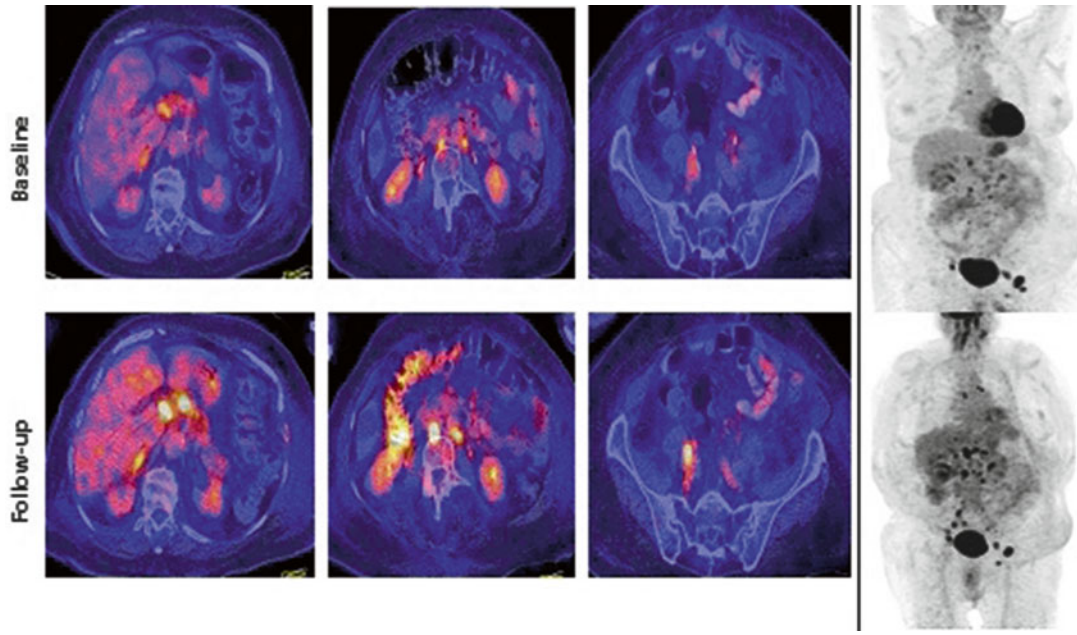

Fig. 7.8

gland currently shows SUVmax 5.0 (previously 3.9), and left adrenal shows SUVmax 4.5 (previously 4.3). There is an interval increase in hypermetabolic activity within gastrohepatic, portacaval, celiac, right retrocaval, mesenteric, retroperitoneal and bilateral common, external and internal iliac, right obturator, and left inguinal and bilateral femoral lymph nodes with marginal increase in size of some of them, compatible with progression of disease. As a reference, gastrohepatic lymph node currently shows SUVmax 4.2 (previously 2.3), and portacaval lymph nodes show SUVmax 9.1 (previously 6.3).

Impression

Progression of metastatic disease.

Case 7.9

History

A 72-year-old female with poorly differentiated endometrial carcinoma, status post-radiation therapy. Approximately 1 year later, she developed a recurrent mass in the vaginal vault and metastases to the lungs.

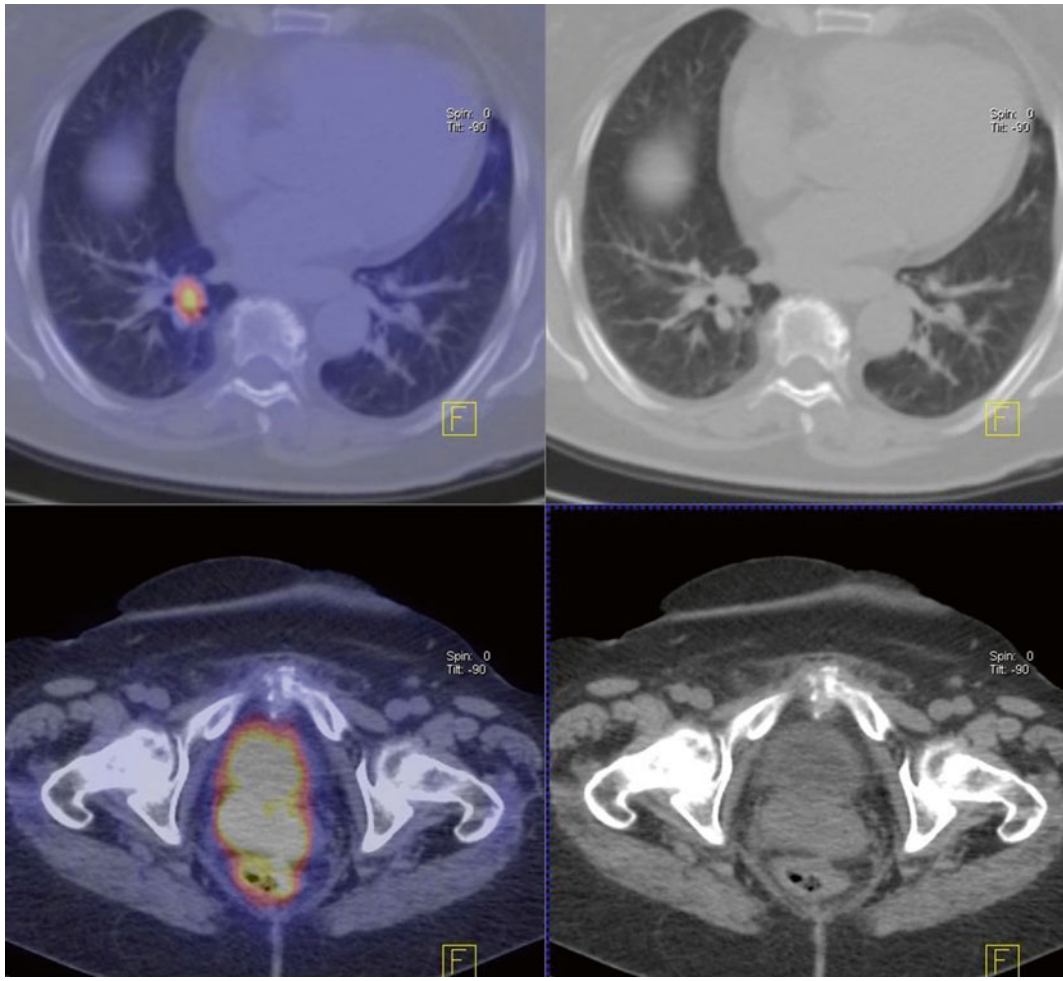

Fig. 7.9

Findings

Hypermetabolic mass in the vagina and lung consistent with recurrent and metastatic disease (Fig. 7.9).

Pearls and Pitfalls

1. Need to avoid pitfalls associated with benign pathology or physiological processes (fibroids, menstruation).
2. FDG PET/CT is insensitive for presurgical LN staging in endometrial CA [9].
3. Highly accurate for detecting recurrence and distant metastasis which can help in clinical decision-making: sensitivity 93 %, specificity 93 %, and accuracy 93 % [10].
4. Very limited data on treatment monitoring [11].

Discussion

Uterine cancer is the most common cancer of the female pelvic organs. Around 40,000 new cases of uterine cancer were detected in the USA in 2010, and the mortality rate was 7400 deaths/year. The most common cancer in the uterus is adenocarcinoma (75–80 % adenocarcinomas, 10 % adenocarcinomas with squamous differentiation, 5 % mucinous carcinoma, and 5–10 % papillary serous carcinoma). Postmenopausal bleeding is the most common presentation in 90 % of the patients; 70–75 % are diagnosed with surgical stage I disease. The most common risk factors include obesity, low fertility index, early menarche, late menopause, chronic anovulation, unopposed estrogen replacement, and hypertension. Clinical staging underestimates the extent of disease, and thus the FIGO staging system requires surgical and histopathologic evaluation. Most endometrial cancers are diagnosed in stage I and surgery alone is adequate. Beyond that, adjuvant radiotherapy may be necessary for treatment. The 5-year survival rate for endometrial carcinoma in stage I is 74–92 % depending on histologic grade.

There is physiologic uptake of FDG in the endometrium in premenopausal women that increases during the menstrual and ovulatory phases [16]. FDG PET/CT is helpful in the staging of endometrial carcinoma because it can detect distant metastatic disease which can change patient management [17]. In a prospective study on 88 patients by Park et al. [18] they found that PET/CT scan helped in clinical decision-making in 22 % of the patients. In another study by Nakamura et al., they concluded that the SUVmax of 18F FDG PET correlated with the histological grade in endometrial cancer ($p = 0.017$). Around 10–30 % of women with clinical stage I or II disease will have metastasis to the pelvic and para-aortic lymph nodes at the time of surgery [19, 20]. However, lymph nodes that are too small may not be detected. Physiologic uptake in the ovaries, ureters, bladder diverticulum, and blood vessels may be mistaken for metastatic disease.

Vulvar Cancer

Case 7.10

History

A 60-year-old female with history of recurrent vulvar cancer, who had undergone a recent perianal biopsy which showed invasive squamous cell carcinoma, status post-radiation therapy to the rectal/vaginal region. PET/CT is done as part of the subsequent treatment strategy evaluation.

Findings

Focal activity seen in the region of anal verge with SUVmax 8.0, presumed to correspond to biopsy site of known neoplasm (Fig. 7.10).

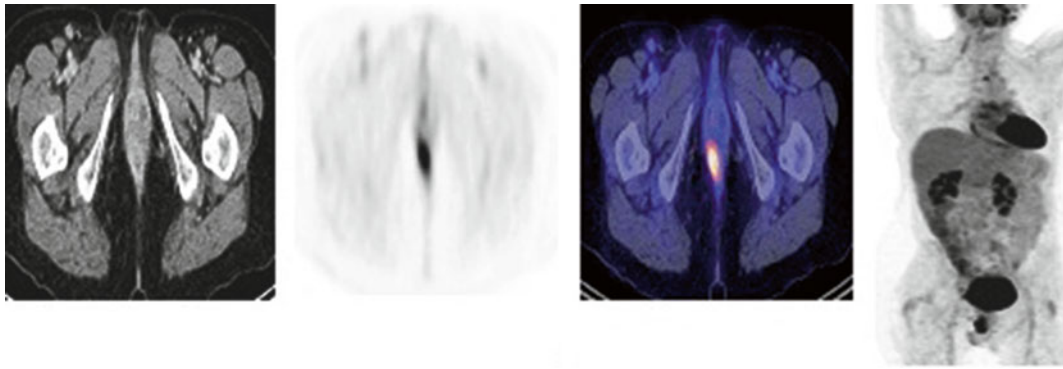

Fig. 7.10

Impression

Focal metabolic activity in the region of anal verge corresponds to known biopsy site of neoplasm.

Case 7.11

History

A 72-year-old female with recent history of vulvar intraepithelial neoplasm, level 3, status post modified radical vulvectomy. PET/CT is done as part of the subsequent treatment strategy evaluation.

Findings

There is linear tracer activity in the perineal region which likely represents urinary contamination (Fig. 7.11).

Impression

Probable perineal urine soiling that reduces the sensitivity for local recurrence evaluation.

Pearls and Pitfalls

1. Currently, there is no data in the literature to evaluate the sensitivity and specificity of PET for detecting vulvar carcinoma.
2. PET scanning has the ability to identify small nodal metastasis.

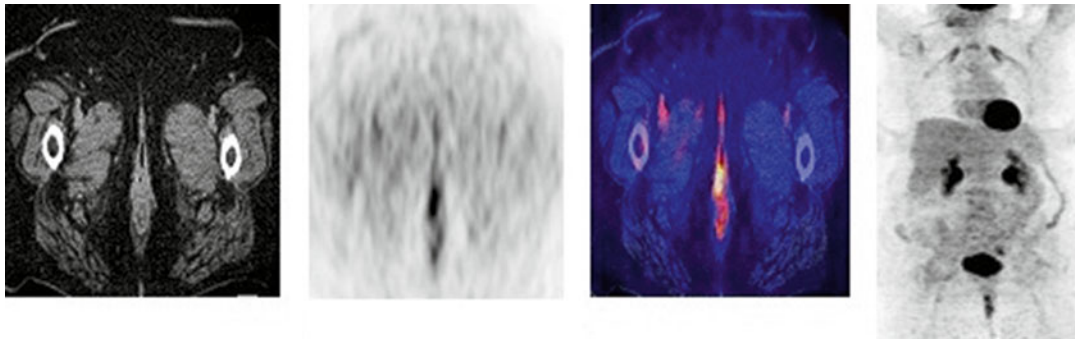

Fig. 7.11

Discussion

Vulvar carcinoma represents 1 % of the female genital cancers. The majority arises in the labia majora and minora. Vulvar carcinoma includes squamous cell carcinoma, adenocarcinoma, and melanoma. Human papillomavirus, sexually transmitted disease, smoking, and multiple sexual partners are risk factors. Patients may be asymptomatic or present with a mass, pruritus, bleeding, or pain. Biopsy is confirmatory. Imaging studies may be helpful. CT can evaluate adenopathy with a sensitivity of 30 %. MRI can evaluate lymphatic involvement. PET can also help in detecting nodal metastasis. Radical primary tumor excision and en bloc lymph nodes dissection are the treatment of choice. Cure rate is 80 % if malignancy is contained in stages I and II. Stage III has a 68 % 5-year survival rate vs. stage IV with 20 %.

References

1. Chung H, et al. Preoperative [^{18}F] FDG PET/CT maximum standardized uptake value predicts recurrence of uterine cervical cancer. Eur J Nucl Med Mol Imaging. 2010;37:1467–73.
2. Kidd E, et al. Lymph node staging by positron emission tomography in cervical cancer: relationship to prognosis. J Clin Oncol. 2010;28:2108–13.
3. Ryu SY, et al. Detection of early recurrence with 18F FDG PET in patients with cervical cancer. J Nucl Med. 2003;44:347–52.
4. Nakamoto Y, et al. Clinical value of positron emission tomography with FDG for recurrent ovarian cancer. Am J Roentgenol. 2001;176:1449–54.
5. Turlakow A, et al. Peritoneal carcinomatosis: role of 18F FDG PET. J Nucl Med. 2003;44:1407–12.
6. Risum S, et al. The diagnostic value of PET/CT for primary ovarian cancer—a prospective study. Gynecol Oncol. 2007;105:145–9.
7. Burkill GJ, et al. Significance of tumor calcification in ovarian carcinoma. Br J Radiol. 2009;82:640–4.
8. Risum S, et al. Standardized FDG uptake as a prognostic variable and as a predictor of incomplete cytoreduction in primary advanced ovarian cancer. Acta Oncol. 2010;50:415–9.

9. Horowitz N, et al. Prospective evaluation of FDG-PET for detecting pelvic and para-aortic lymph node metastasis in uterine corpus cancer. Gynecol Oncol. 2004;95:546–51.
10. Kazuhiro K, et al. Performance of FDG-PET/CT in the diagnosis of recurrent endometrial cancer. Ann Nucl Med. 2008;22:103–9.
11. Nishiyama Y, et al. Monitoring the neoadjuvant therapy response in gynecological cancer patients using FDG PET. Eur J Nucl Med. 2008;35:287–95.
12. Kaur H, et al. Diagnosis, staging, and surveillance of cervical carcinoma. Am J Roentgenol. 2003;180:1621–32.
13. Schwarz J, et al. The role of 18F-FDG PET in assessing therapy response in cancer of the cervix and ovaries. J Nucl Med. 2009;50:64S–73S.
14. Seung J, et al. CT and MR imaging of ovarian tumors with emphasis on differential diagnosis. Radiographics. 2002;22:1305–25.
15. Prakash P, et al. Role of PET/CT in ovarian cancer. Am J Roentgenol. 2010;194:W464–70.
16. Lerman H, et al. Normal and abnormal 18F-FDG endometrial and ovarian uptake in pre- and postmenopausal patients: assessment by PET/CT. J Nucl Med. 2004;45:266–71.
17. Subhas N, et al. Imaging of pelvic malignancies with in-line FDG PET–CT: case examples and common pitfalls of FDG PET. Radiographics. 2005;25:1031–43.
18. Park J, et al. Comparison of the validity of magnetic resonance imaging and positron emission tomography/computed tomography in the preoperative evaluation of patients with uterine corpus cancer. Gynecol Oncol. 2008;108:486–92.
19. Picchio M, et al. High-grade endometrial cancer: value of [18F] FDG PET/CT in preoperative staging. Nucl Med Commun. 2010;31:506–12.
20. Gambir SS, et al. A tabulated summary of the FDG PET literature. J Nucl Med. 2001;42:1S–93S.