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HYBRID IMAGING AND NUCLEAR MEDICINE

PICTORIAL ESSAY

Normal physiological variants and benign conditions in pelvic oncologic fluorodeoxyglucose positron emission tomography/magnetic resonance imaging

Ayşe Erden[1]
Diğdem Kuru Öz[1]
Nuriye Özlem Küçük[2]

[1]Ankara University Faculty of Medicine, Department of Radiology, Ankara, Türkiye

[2]Ankara University Faculty of Medicine, Department of Nuclear Medicine, Ankara, Türkiye

ABSTRACT

Fluorodeoxyglucose (FDG) positron emission tomography (PET)/magnetic resonance imaging (MRI) is an advanced hybrid imaging modality that holds substantial promise in oncologic imaging. FDG PET, a well-established molecular imaging technique, enables assessment of tumor glucose metabolism and is widely utilized for diagnosing and monitoring a range of malignancies; MRI offers superior soft tissue contrast, facilitating precise anatomical localization of PET findings. This pictorial essay presents a series of physiological FDG uptake variants observed in the uterus, fallopian tubes, ovaries, colon, internal anal sphincter, pelvic musculature, and bone marrow. Additionally, it highlights benign conditions such as uterine tumors, vaginal condyloma acuminatum, and infected Bartholin cysts that may exhibit FDG uptake and potentially mimic malignancy. The essay also illustrates FDG-avid post-treatment changes and various infectious and inflammatory lesions such as osteitis pubis, perianal fistulas, and pelvic abscesses that may complicate oncologic interpretation.

KEYWORDS

Benign, bone marrow, bowel, fallopian tube, false positive results, inflammation, magnetic resonance imaging, ovary, positron emission tomography, radiation therapy, uterus

Positron emission tomography (PET) combined with magnetic resonance imaging (MRI) using fluorodeoxyglucose (FDG) is a promising hybrid imaging tool for evaluating gynecologic and genitourinary malignancies. It has a potential pivotal role in staging, treatment planning, recurrence detection, and prognosis assessment. However, interpreting pelvic PET/MRI is often challenging due to physiological uptake patterns and benign mimickers that may resemble pathology. In this pictorial essay, we aim to illustrate incidental FDG uptake in various pelvic structures encountered during routine oncologic PET/MRI examinations.

Normal Physiological Variants

Physiological uptake of FDG in the uterus, fallopian tubes, and ovaries is a common finding on FDG PET/computed tomography (CT), particularly in premenopausal women, and may mimic pathological processes if not carefully interpreted.

Physiological endometrial uptake

FDG uptake in the uterus varies with hormonal changes during the menstrual cycle, especially in premenopausal women. Increased endometrial FDG activity is commonly observed during the menstrual (Figure 1) and ovulatory phases and is considered physiological.[1] This uptake likely reflects the peristaltic activity of the subendometrial myometrium, which facilitates menstrual blood expulsion.[2]

Corresponding author: Ayşe Erden

E-mail: ayse.erden@medicine.ankara.edu.tr

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In postmenopausal women, endometrial FDG uptake is typically low. Any focal or intense uptake in this age group should prompt further investigation.[1]

Physiological uptake in fallopian tubes

Studies performed with PET/CT demonstrate that the fallopian tubes may exhibit physiological FDG uptake, particularly in premenopausal women. In a study by Yun et al.[3], bilateral tubal FDG activity was observed in 8.8% of women aged <53 years, most commonly during the mid-menstrual cycle. The uptake appears as tubular, comma-, or tadpole-shaped foci adjacent to the ovaries, corresponding to fallopian tube anatomy.

MRI coregistration and analysis of morphologic features and symmetry can aid differentiation (Figure 2). In the absence of corresponding structural abnormalities or clinical suspicion, further investigations are usually unnecessary. Misinterpretation of tubal uptake as peritoneal implants, enlarged lymph nodes, or adnexal malignancy may lead to unwarranted procedures.

Physiological ovarian uptake

Ovarian FDG uptake fluctuates with the menstrual cycle. A common physiological variant is FDG accumulation in the corpus luteum during the luteal phase. The corpus lu-

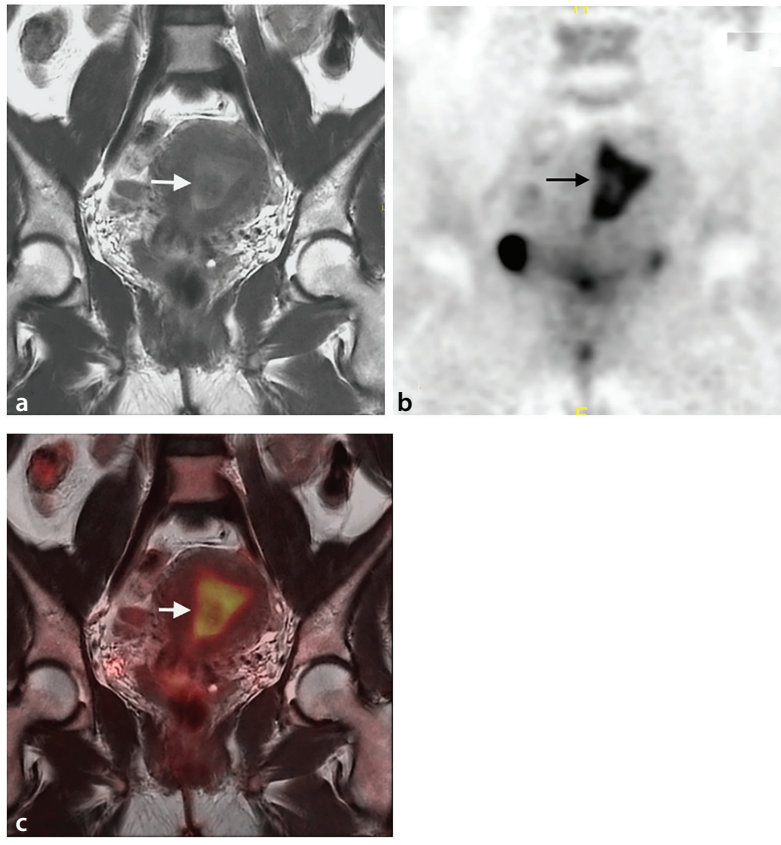

Figure 1. Menstrual endometrial uptake. The coronal T2-weighted image **(a)** shows the endometrial cavity containing hypointense blood products (arrow). The coronal maximum intensity projection fluorodeoxyglucose (FDG) positron emission tomography (PET) **(b)** and coronal fused PET/magnetic resonance **(c)** images demonstrate increased FDG uptake in the endometrium (arrows), consistent with menstruation-related physiological activity in a 41-year-old premenopausal woman.

Main points

- Physiological fluorodeoxyglucose (FDG) uptake is frequently observed, particularly in the uterine cavity, fallopian tubes, corpus luteum, colon, and the distal internal anal sphincter.
- Benign processes and post-treatment changes with FDG uptake can result in false-positive interpretations during positron emission tomography/magnetic resonance imaging for oncologic evaluation.
- Increased FDG uptake can be seen in conditions such as perianal fistulas, vaginal condyloma acuminatum, infected Bartholin cysts, osteitis pubis, and inflammatory bowel disease.
- Diffuse or asymmetrical FDG uptake may be present in pelvic muscles following insulin administration or strenuous physical activity.
- Physiological FDG accumulation in the sigmoid colon and rectum varies among individuals and may be increased in patients on metformin therapy, potentially complicating colorectal cancer assessment.

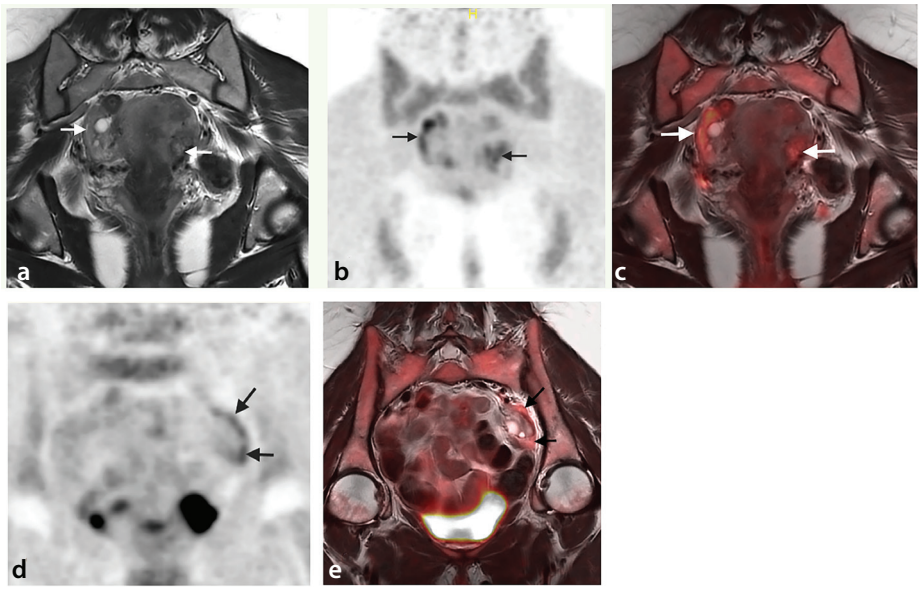

Figure 2. Physiological fluorodeoxyglucose (FDG) uptake in fallopian tubes. The coronal T2-weighted image **(a)** shows bilateral fallopian tubes (arrows). The coronal positron emission tomography (PET) **(b)** and coronal fused PET/magnetic resonance images (MRI) **(c)** show increased comma- or tadpole-shaped FDG uptake in both fallopian tubes (arrows). The arrow on the left indicates to intramural (interstitial) part of the left tube. The coronal PET **(d)** and coronal fused PET/MRI **(e)** show increased FDG uptake in the ampullar part of the left fallopian tube (arrows) that forms a curve over and around the ovary.

teum, a transient endocrine structure formed post-ovulation, produces progesterone and may demonstrate moderate FDG avidity.[1,3-5]

This uptake typically appears as a unilateral, focal, rounded lesion (Figure 3). Although it may mimic malignancy, it is transient and usually resolves in subsequent cycle phases. Correlation with MRI can clarify the nature of the lesion, as corpus luteum cysts appear as unilocular structures (1–3 cm) with thick, crenulated enhancing walls. Presence of blood products may cause signal heterogeneity in the corpus luteum.[1,3-5]

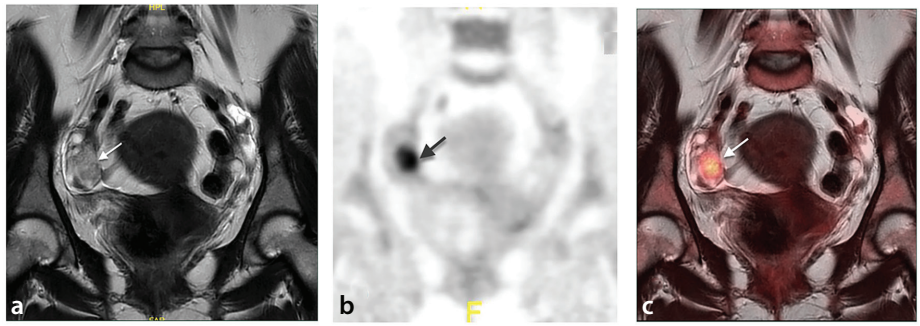

Figure 3. Corpus luteum. The coronal T2-weighted magnetic resonance image (MRI) **(a)** shows normal corpus luteum in the right ovary (arrow) along with ovarian follicles. The coronal positron emission tomography (PET) **(b)** and coronal fused PET/MRI **(c)** display focal fluorodeoxyglucose uptake in the corpus luteum (arrow), reflecting its metabolic activity.

Physiological bowel activity on fluorodeoxyglucose positron emission tomography/magnetic resonance imaging

FDG accumulation is frequently observed in the colon and rectum, typically in a diffuse, linear pattern (Figure 4).[6] However, focal or segmental uptake may also be present. Rectal FDG activity can pose diagnostic challenges, and correlation with clinical data and MRI is essential.

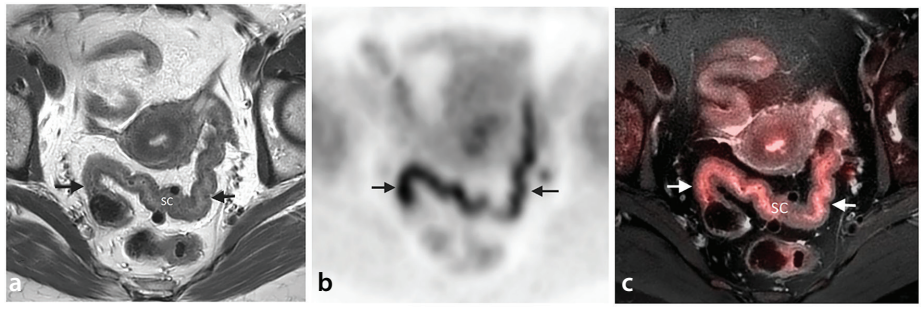

Figure 4. Physiological colonic uptake. The axial T2-weighted image of the pelvis **(a)** reveals a normal sigmoid colon (SC) (arrows) with incidental diverticula. The axial positron emission tomography (PET) **(b)** and fused PET/magnetic resonance **(c)** images show mild physiological fluorodeoxyglucose uptake exhibiting the diffuse and linear pattern in a normal SC (arrows).

Effect of metformin on intestinal fluorodeoxyglucose uptake

Metformin, a widely used oral antidiabetic, is known to increase FDG uptake in the intestines, especially in the sigmoid colon and rectum (Figure 5). Although the mechanism is not fully understood,[6] this effect may mimic pathological lesions and result in false-positive findings during oncologic evaluation.[7]

If focal colonic uptake is identified, colonoscopy may be required for further evaluation to rule out neoplasia. Despite this effect of metformin on intestinal FDG uptake, the European Association of Nuclear Medicine guideline (v2.0) recommends continuing this drug unless there are other clinical concerns.[8]

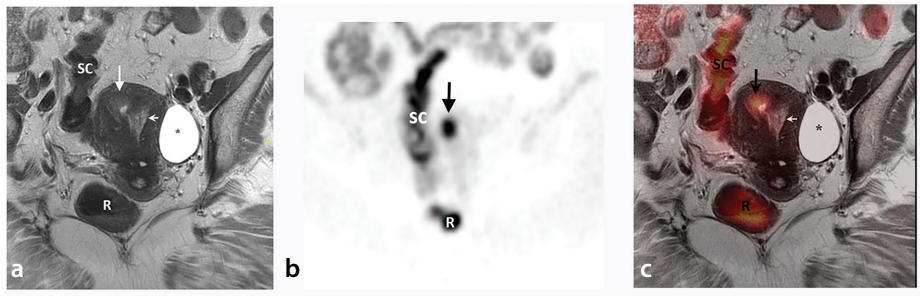

Figure 5. High fluorodeoxyglucose (FDG) bowel uptake in a patient with diabetes treated with metformin. The coronal oblique T2-weighted image of the pelvis **(a)** shows a normal-appearing sigmoid colon (SC) and rectum (R). Note, the long white arrow points to a *uterine serous carcinoma* arising in an endometrial *polyp (short arrow)*. The maximum intensity projection coronal oblique FDG positron emission tomography (PET) **(b)** and coronal oblique fused PET/magnetic resonance images (MRI) **(c)** show intense physiological activity accumulation in the rectum and SC due to metformine use. Coregistration with MRI and attention to morphologic features and distribution patterns can aid differentiation from pathologic conditions. Furthermore, note the pathological FDG accumulation in the uterine cavity, compatible with endometrial cancer (black arrow). No FDG uptake is seen in the left portion of the endometrial cavity that corresponds to the polyp (short arrow). An incidental left ovarian serous cystadenoma is marked with an asterisk in **(a)** and **(c)**. Diagnoses were made by histopathological evaluation of a total abdominal hysterectomy and bilateral salpingo-oophorectomy specimens.

Anal uptake from internal anal sphincter activity

The internal anal sphincter (IAS) is a smooth muscle structure that maintains resting anal tone and is responsible for >70% of baseline anal pressure.[9,10] Physiological FDG uptake in the IAS is a well-recognized finding on pelvic PET/MRI (Figure 6), typically seen at its distal end. This uptake is attributed to the basal tone and metabolic activity of the sphincter muscle, even in the absence of anal disease, such as hemorrhoids or fissures.

Muscular fluorodeoxyglucose uptake

Increased FDG uptake in skeletal muscles can result from voluntary or involuntary contractions. Normally, pelvic muscle uptake is either absent or very mild and homogeneous. Intense uptake may occur due to the following:[11]

- Recent insulin administration,
- Strenuous physical activity within 6 hours of imaging,
- Inadequate fasting (minimum 4 hours required before FDG injection).[8]

Uptake typically appears linear and symmetric (Figure 7), but may sometimes be focal or asymmetric (Figure 8), potentially complicating interpretation.

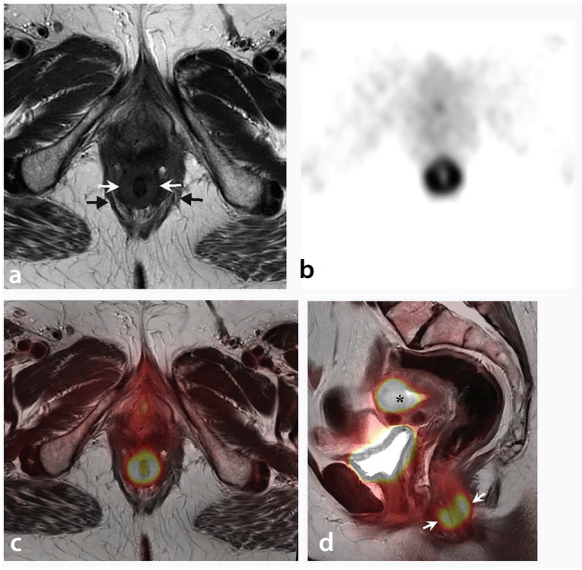

Figure 6. Physiological fluorodeoxyglucose (FDG) uptake in the internal anal sphincter (IAS). The axial T2-weighted image **(a)** shows the normal IAS with slightly higher signal intensity (white arrows) than the *external* anal sphincter (black arrows). The axial positron emission tomography (PET) **(b)** and axial fused PET/magnetic resonance images (MRI) **(c)** show physiological uptake in the normal IAS. High FDG uptake may indicate high *metabolic* activity in the IAS due to its basal tone, which is fundamental for anal continence. *The* sagittal fused PET/MRI **(d)** shows intense physiological FDG accumulation in the distal IAS. An asterisk indicates concurrent endometrial cancer.

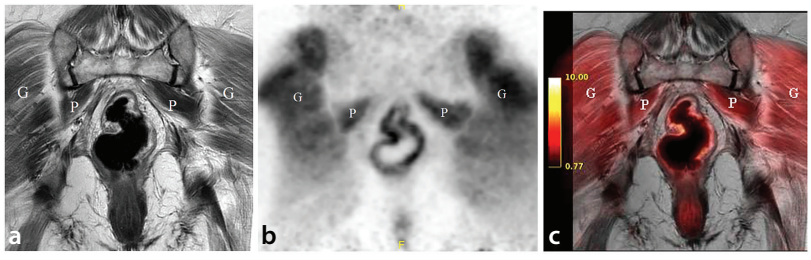

Figure 7. Symmetrical muscular fluorodeoxyglucose (FDG) uptake. Variable FDG uptake within the muscles throughout the body may be observed in individuals who have recently received an insulin injection, engaged in intense physical activity, or consumed a meal. In this patient, who had a history of external radiotherapy and brachytherapy due to endometrial cancer, the muscles in the pelvic region appear normal on the coronal T2-weighted image **(a)**. The maximum intensity projection coronal positron emission tomography (PET) **(b)** and coronal fused PET/magnetic resonance images (MRI) **(c)** show diffuse and intense bilateral FDG uptake in the gluteal and piriform muscles, Whole body PET/CT imaging obtained approximately 30 minutes earlier than the PET/MRI showed no muscular uptake elsewhere in the body.

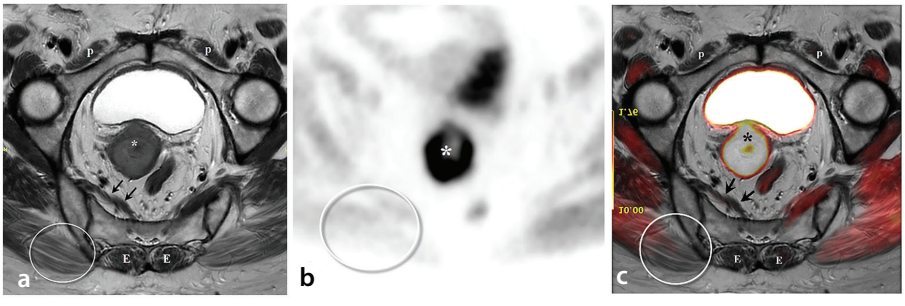

Figure 8. Asymmetrical muscular fluorodeoxyglucose (FDG) uptake. The axial oblique T2-weighted magnetic resonance image (MRI) **(a)** shows no abnormality in the striated pattern of pelvic muscle architecture except for the right piriform muscle (arrows), which exhibits atrophy and fat replacement in a patient with endometrial cancer invading the cervical stroma (asterisk). The axial positron emission tomography (PET) **(b)** and axial oblique fused PET/MRI **(c)** show uneven and asymmetrical FDG uptake in the pelvic muscles. Uptake is not observed in the right piriformis muscle (arrows), the medial portion of the right gluteus maximus muscle (circle), the pectineus muscles (p), or the erector spinae (E) muscles. Since the patient was using insulin, the FDG accumulation in the pelvic muscles could be attributed to a recent insulin injection.

Bone marrow fluorodeoxyglucose uptake

Although there is no physiological FDG uptake in the cortical bone, uptake may be observed in the bone marrow, which may vary depending on patient factors and hematopoietic activity (Figure 9). Conditions such as anemia, infection, inflammation, or use of hematopoietic stimulants [e.g., granulocyte colony-stimulating factor (G-CSF), erythropoietin] may lead to diffuse bone marrow hypermetabolism.[8,12,13]

Following administration of pegylated G-CSF, a minimum interval of 3 weeks is recommended before performing PET imaging to avoid false-positive marrow uptake.[12]

Benign Gynecologic Lesions

Endometritis refers to inflammation or infection of the endometrial lining. On MRI, it may present as endometrial thickening with heterogeneous signal intensity, which is non-specific. The differential diagnosis includes endometrial carcinoma, intrauterine hematoma, and endometrial polyps.[14]

FDG PET/MRI typically shows faint FDG uptake in endometritis (Figure 10), helping to distinguish it from endometrial cancer. Minimal metabolic activity supports a benign etiology.

Adenomyosis is a benign condition characterized by ectopic endometrial glands within the myometrium. In premenopausal women, adenomyosis often demonstrates mild FDG uptake (Figure 11), which may increase during menstruation or ovulation.[2,15]

In patients with gynecologic malignancies, FDG-avid adenomyosis may mimic or obscure intrauterine metastases.[16] The MRI component of PET/MR is highly valuable, typically revealing a globally enlarged uterus with a thickened junctional zone containing tiny hyperintense foci on T2-weighted imaging (Figure 11).

Endometrial hyperplasia is defined by an increased gland-to-stroma ratio due to abnormal glandular proliferation. On T2-weighted MRI, it appears as a diffusely thickened endometrium, with low or intermediate signal intensity, though imaging features are non-specific.[14]

FDG uptake in endometrial hyperplasia is typically mild [mean standardized uptake value (SUV) ~2], significantly lower than in endometrial carcinoma (mean SUV ~9.3).[17] It often occurs in peri- or postmenopausal women (Figure 12).

Endometrial polyps are benign overgrowths of endometrial glands and stroma that protrude into the uterine cavity. Although usually indolent, they may carry a risk of malignant transformation.[14,18]

On FDG PET, polyps generally exhibit faint or no uptake. However, hypermetabolic activity has been reported, similar to carcinomas.[19] In this study, cases of histopathologically confirmed polyps did not show significant FDG avidity (Figure 5). In contrast, in a case of serous carcinoma arising within a polyp, the fusion PET/MR image clearly demonstrated marked FDG uptake in the cancerous portion while the polyp itself remained photopenic (Figure 5).

Leiomyomas (fibroids) are the most common benign gynecologic tumors. FDG uptake is uncommon, reported in approximately 10.4% of premenopausal and 1.2% of postmenopausal women.[20] Uptake, when present, is typically mild (Figure 13), although rare cases with high FDG avidity exist, particularly during the proliferative phase of the menstrual cycle.[15,21]

Uptake variability may be influenced by cellularity, vascularity, hormonal status, or degenerative changes.[21] MRI remains essential for characterization and differentiation from malignancy (Figure 14). Importantly, new FDG avidity in a known leiomyoma does not necessarily indicate malignant transformation.[20]

Smooth muscle tumors of uncertain malignant potential lesions exhibit histologic features that overlap with leiomyosarcoma, but with much less aggressive behavior. These rare tumors can demonstrate intense FDG uptake[22] and may coexist with benign leiomyomas (Figure 14).

Vaginal condyloma acuminata (genital warts) is a common sexually transmitted infection caused by low-risk types of human papillomavirus. In patients undergoing PET/MRI for gynecologic malignancies, vaginal FDG uptake due to condylomas may raise suspicion for metastasis (Figure 15).[23] Awareness of this entity is crucial to avoid false-positive interpretations.

Bartholin gland cysts result from ductal obstruction and are typically seen in women of reproductive age. Uninfected cysts do not show FDG uptake.[24] However, when infected or forming an abscess, they may become FDG-avid (Figure 16), often appearing as a small focus in the distal vagina.

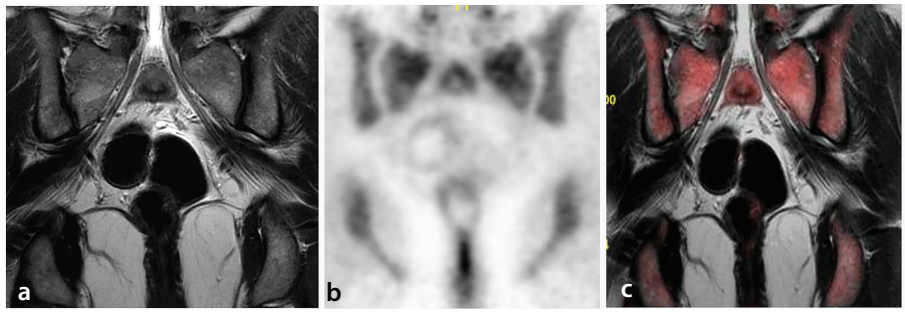

Figure 9. Bone marrow fluorodeoxyglucose (FDG) uptake. Pelvic bone marrow signal intensity is seen to be normal on a coronal T2-weighted magnetic resonance image (MRI) **(a)**. The maximum intensity projection coronal positron emission tomography (PET) **(b)** and coronal fused PET/MRI **(c)** show mild diffuse uptake in the pelvic bone marrow. Mild FDG accumulation in bone marrow tends to occur as a result of benign conditions. This patient with endometrial cancer also had severe anemia and a chronic urinary tract infection.

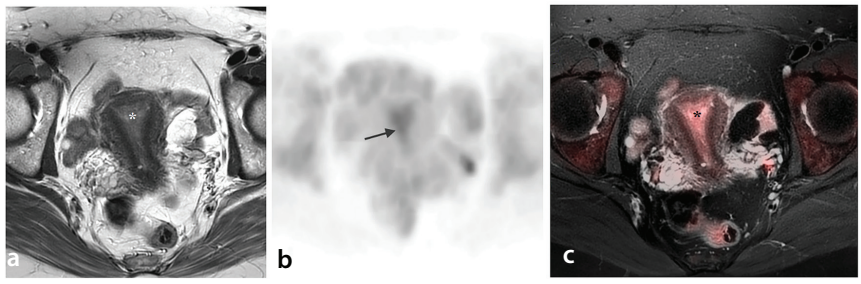

Figure 10. Endometritis. The axial oblique T2-weighted magnetic resonance images (MRI) **(a)** shows a thickened endometrium with heterogeneous signal intensity (asterisk) in a patient with histopathologically proven endometritis. The maximum intensity projection axial oblique positron emission tomography (PET) **(b)** and axial oblique fused PET/MRI **(c)** show faint fluorodeoxyglucose uptake in the endometrium, consistent with a benign process (arrow in b; asterisk in c).

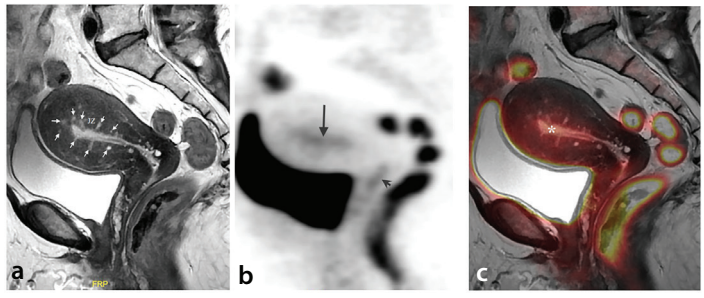

Figure 11. Adenomyosis. The sagittal T2-weighted magnetic resonance image (MRI) **(a)** shows hyperintense tiny foci (arrows) in the enlarged junctional zone (JZ), consistent with diffuse adenomyosis. The maximum intensity projection sagittal positron emission tomography (PET) **(b)** and sagittal fused PET/MRI **(c)** show mild FDG uptake in the endometrium in some places and in the JZs (inner myometrium) (long arrow in b; asterisk in c). Note also the mild FDG accumulation in the cervical canal (small arrow in b). A histopathological evaluation revealed active severe cervicitis characterized by erosion. FDG, fluorodeoxyglucose**.**

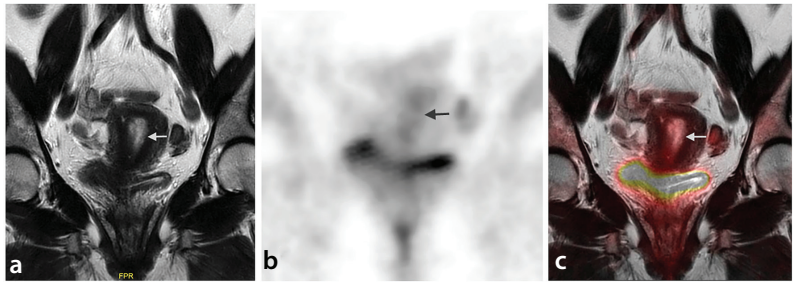

Figure 12. Endometrial hyperplasia in a postmenopausal woman. The coronal T2-weighted MRI **(a)** shows thickened endometrium (arrow). The coronal positron emission tomography (PET) **(b)** and coronal fused PET/MRI **(c)** reveal faint FDG uptake, consistent with histologically confirmed atypical hyperplasia. MRI, magnetic resonance imaging; FDG, fluorodeoxyglucose**.**

Posttreatment Changes in Pelvic Tissues

FDG uptake in the **presacral region following rectal cancer surgery** may raise concern for local recurrence. However, benign postoperative complications, such as anastomotic leakage, can result in inflammatory changes, abscesses, or sinuses, which may also exhibit FDG avidity.

Studies have reported a positive predictive value of only 58% for FDG-avid presacral lesions in identifying true local recurrence.[25] The high soft-tissue contrast of the MRI component of PET/MRI helps differentiate between recurrent tumor and postoperative fibrosis. In such cases, diffusion-weighted imaging (DWI) is reported to be helpful for further characterization.[26] However, it can sometimes be difficult to comment on the nature of lesions that are of intermediate intensity on T2-weighted images and FDG-avid on PET (Figure 17).

Radiation-induced proctitis, inflammation of the rectal mucosa, is a complication of pelvic radiotherapy, particularly in patients with cervical, rectal, and prostate cancer. Early imaging findings on MRI include submucosal edema and high signal intensity of the rectal wall on T2-weighted images, along with prominent mucosal enhancement. Progressive damage leads to wall thickening and elevated signal in the muscularis layer.[27,28]

Mild FDG uptake can be observed in the irradiated rectum on PET/MRI (Figure 18). Although this generally does not interfere with post-treatment response assessment in patients with rectal cancer,[27] it may complicate interpretation in cases with only partial metabolic response, as simultaneous inflammatory activity cannot be fully excluded.[28]

Fat necrosis is a benign process that typically occurs after surgery, trauma, or infection. In this entity, a fibrous connective tissue capsule covers necrotic and degenerated fatty tissue. On imaging, it can mimic tumor recurrence by appearing as a mass-like lesion.[29] Features in MRI often include a well-circumscribed lesion with a hyperintense fatty center and a hypointense fibrous capsule–the so-called "doughnut sign."

Increased FDG uptake may be observed along the periphery of fat necrosis lesions (Figure 19), and this uptake can persist for up to 12 months postoperatively. Importantly, serial imaging typically shows no change in lesion size or metabolic activity, supporting a benign etiology.[29]

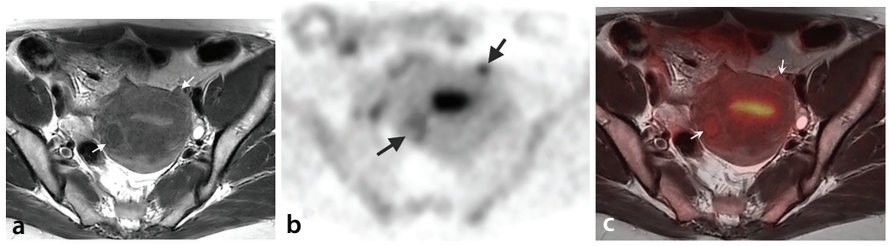

Figure 13. Uterine leiomyomas. The axial T2-weighted magnetic resonance image (MRI) **(a)** shows two leiomyomas with typical low signal intensity (arrows). The axial positron emission tomography (PET) **(b)** and axial fused PET/MRI **(c)** show mild FDG uptake in the leiomyomas, better distinguishable in the PET image [black arrows in (b)]. FDG uptake in leiomyomas may vary during the menstrual cycle and may be higher in the proliferative phase. The high activity in the uterine cavity in this patient is physiological and is related to menstruation. FDG, fluorodeoxyglucose.

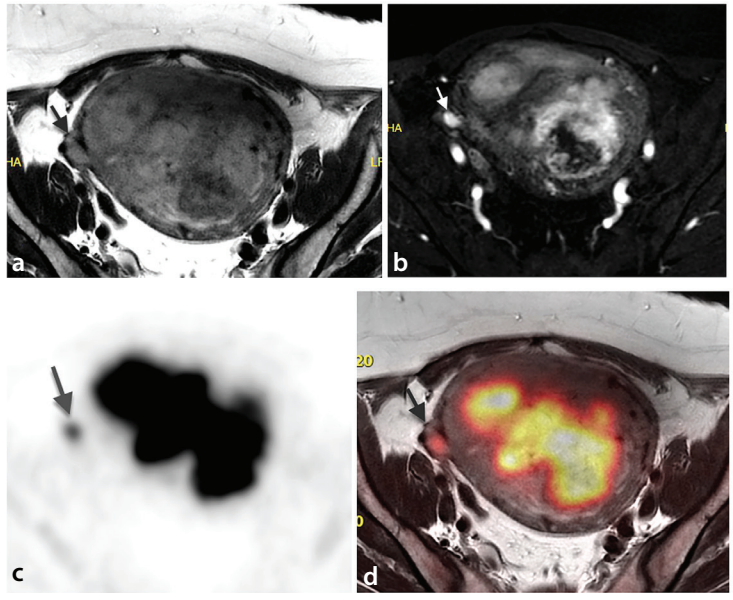

Figure 14. Fluorodeoxyglucose (FDG)-avid leiomyoma in a patient with large smooth muscle tumors of uncertain malignant potential (STUMP). The axial T2-weighted MRI **(a)** shows a high-signal subserosal leiomyoma (arrow). The axial early postcontrast T1-weighted fat-saturated MRI **(b)** shows intense enhancement in leiomyoma (arrow). The axial positron emission tomography (PET) **(c)** and axial fused PET/MRI **(d)** demonstrate high FDG activity in leiomyoma. Leiomyomas showing high signal intensity on T2-weighted MRI tend to show higher FDG uptake than that of the hypointense leiomyomas. A histopathological diagnosis of the total abdominal hysterectomy and bilateral salpingo-oophorectomy specimen in this patient revealed STUMP and multiple leiomyoma nodules without dysplasia or malignancy. MRI, magnetic resonance imaging.

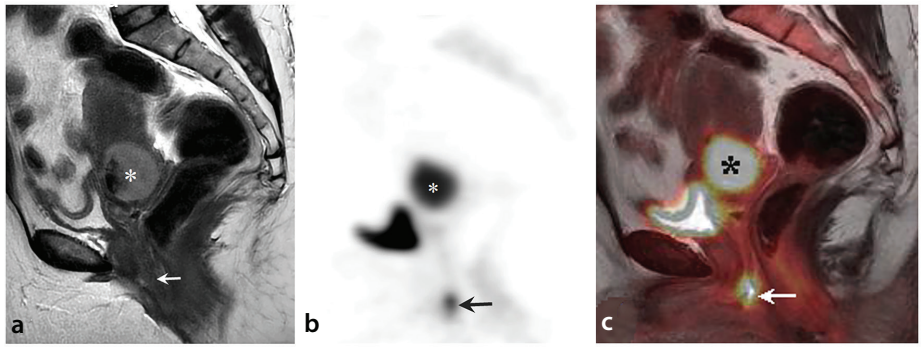

Figure 15. Vaginal condyloma acuminatum. The sagittal T2-weighted magnetic resonance image (MRI) **(a)** shows no visible vaginal abnormality (arrow) in a patient with endometrial cancer invading cervical stroma (asterisk). The sagittal positron emission tomography (PET) **(b)** and sagittal fused PET/MRI **(c)** show FDG uptake in the vagina (arrow), mimicking metastasis. However, the hospital records indicate the presence of vaginal condyloma acuminatum, which are known to exhibit FDG uptake. FDG, fluorodeoxyglucose.

Radiation-induced changes in the sacral bone marrow are a common consequence of pelvic radiotherapy. These include radiation osteitis, insufficiency fractures, and, less commonly, osteoradionecrosis. These changes may present with sacral FDG uptake on PET imaging (Figure 20).

Differentiating between benign post-radiation effects and metastatic bone lesions is essential for accurate interpretation. The MRI component of the PET/MRI study can be useful in localizing and characterizing foci of increased FDG accumulation within the bone. MRI can reveal these changes bilaterally or unilaterally, with findings more prominent adjacent to the sacroiliac joints.[30]

Various Infectious and Inflammatory Lesions

General mechanism of fluorodeoxyglucose uptake in inflammation and infection

FDG uptake in infection and inflammation is mediated by activated inflammatory cells, particularly neutrophils and cells of the monocyte/macrophage lineage. These cells demonstrate upregulated glucose transporter (GLUT) expression (mainly GLUT 1 and GLUT3) and enhanced hexokinase activity, leading to increased glucose metabolism. Both acute and chronic inflammation can produce intense FDG uptake.[31]

Inflammatory bowel disease includes Crohn's disease and ulcerative colitis, each with distinct imaging patterns. PET/MRI offers a non-invasive method for assessing disease extent and activity. Increased FDG uptake may appear as focal or linear enhancement along affected bowel segments (Figure 21).[32] Additionally, PET imaging may be helpful in therapy monitoring and in distinguishing between fibrotic and active inflammatory strictures.[31,32]

Perianal fistula is an infected tract that develops between the anal canal and the perianal skin, often resulting from prior or ongoing abscess formation. FDG uptake in perianal fistulas may be encountered incidentally in PET/MRIs obtained for oncological purposes (Figure 22).

Osteitis pubis is a non-infectious inflammatory condition affecting the pubic symphysis and surrounding structures. It has been associated with pelvic surgery, childbirth, trauma, urological interventions, and repetitive mechanical stress.

MRI may demonstrate parasymphyseal bone marrow edema, diffusion restriction

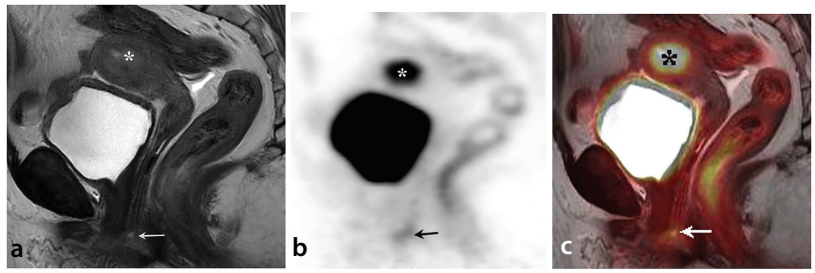

Figure 16. Infected Bartholin gland cyst. The sagittal T2-weighted magnetic resonance image (MRI) **(a)** shows a hyperintense small rounded lesion (arrow) compatible with a Bartholin cyst lying at the distal end of the vagina in a patient with endometrial cancer (asterisk). Its location below the level of the pubic symphysis is typical. The sagittal positron emission tomography (PET) **(b)** and sagittal fused PET/MRI **(c)** show a tiny focus with fluorodeoxyglucose (FDG) uptake (arrows) in the distal vagina, suggesting that it is infected. Asterisks in **(b)** and **(c)** indicate intense FDG accumulation in endometrial cancer.

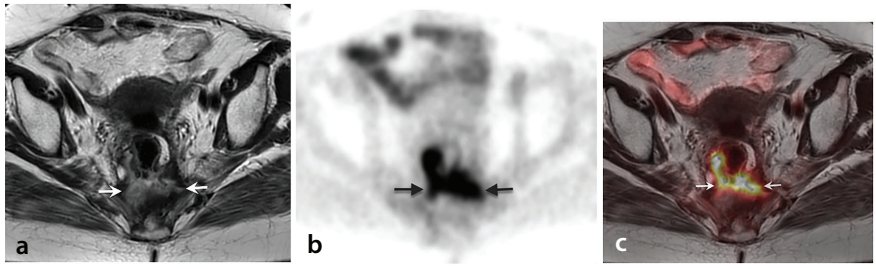

Figure 17. Fluorodeoxyglucose (FDG) uptake in presacral soft tissue after *rectal* cancer *surgery. The* axial T2-weighted magnetic resonance image (MRI) **(a)** reveals a lesion of intermediate signal intensity with presacral extension (arrows). The lesion showed diffusion restriction on diffusion-weighted images (not shown). The axial positron emission tomography (PET) **(b)** and axial fused PET/MRI **(c)** exhibit high FDG activity (arrows) in the lesion. Pathological FDG accumulation in PET **(b)** was evaluated in favor of recurrence. A computed tomography-guided fine needle aspiration biopsy confirmed highly hypocellular fibrocollagenous mesenchymal tissue without malignancy.

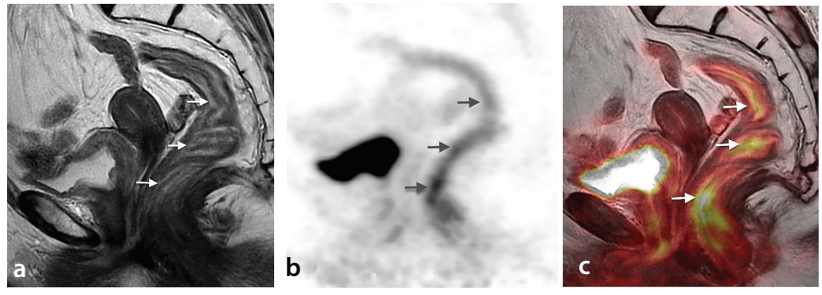

Figure 18. Radiation-induced proctitis in a patient with cervical cancer. The sagittal T2-weighted magnetic resonance image (MRI) **(a)** shows rectal wall thickening and submucosal edema (arrows) in a patient who underwent radiation therapy. The sagittal positron emission tomography (PET) **(b)** and sagittal fused PET/MRI **(c)** demonstrate increased uptake consistent with post-radiation inflammation.

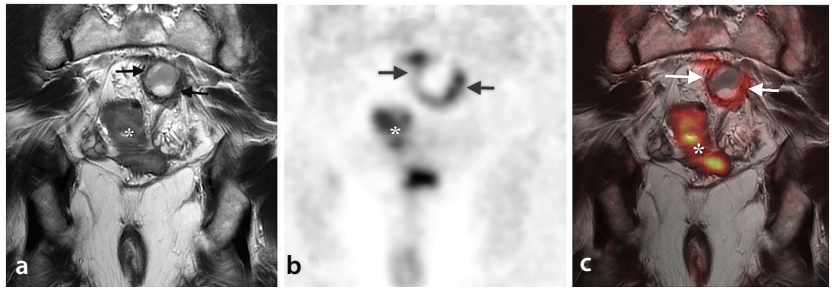

Figure 19. Postsurgical fat necrosis in a patient with operated rectal cancer arising from ulcerative colitis. The coronal T2-weighted magnetic resonance image (MRI) **(a)** shows a presacral lesion with central hyperintensity and a hypointense fibrous capsule (arrows) (the "doughnut sign"). The coronal positron emission tomography (PET) **(b)** and coronal fused PET/MRI **(c)** reveal peripheral fluorodeoxyglucose (FDG) uptake. There was no progression on follow-up. Note also that the asterisks in images **(a-c)** mark FDG-avid bowel segments with ulcerative colitis.

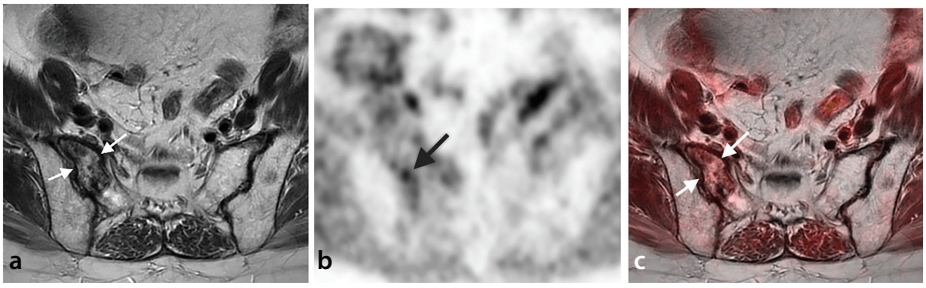

Figure 20. Sacral osteonecrosis following radiation therapy in a patient with cervical cancer. The axial T2-weighted magnetic resonance image (MRI) **(a)** shows a heterogeneous lesion of intermediate signal intensity in the sacral side of the right sacroiliac joint (arrows). The lesion is newly developed after radiation therapy. The axial positron emission tomography (PET) **(b)** and axial fused PET/MRI **(c)** show moderate fluorodeoxyglucose activity (arrows) in the osseous lesion.

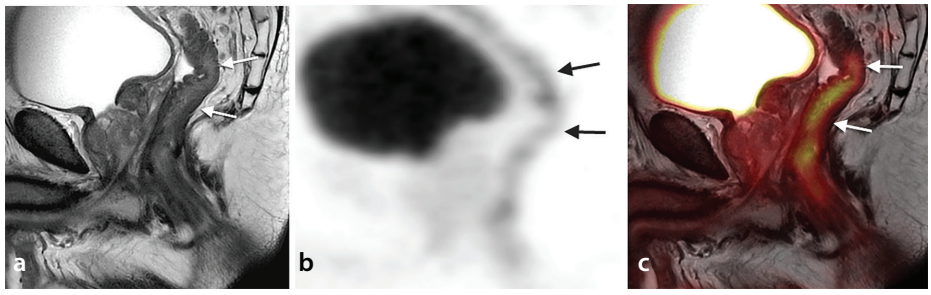

Figure 21. Ulcerative colitis. In the patient who underwent rectal excision, the sagittal T2-weighted magnetic resonance image (MRI) **(a)** shows subtle wall thickening and loss of haustration of the colon segment (arrows) that is pulled into the pelvis for coloanal anastomosis. The sagittal positron emission tomography (PET) **(b)** and sagittal fused PET/MRI **(c)** demonstrate diffuse, linear fluorodeoxyglucose uptake in the affected bowel segment (arrows).

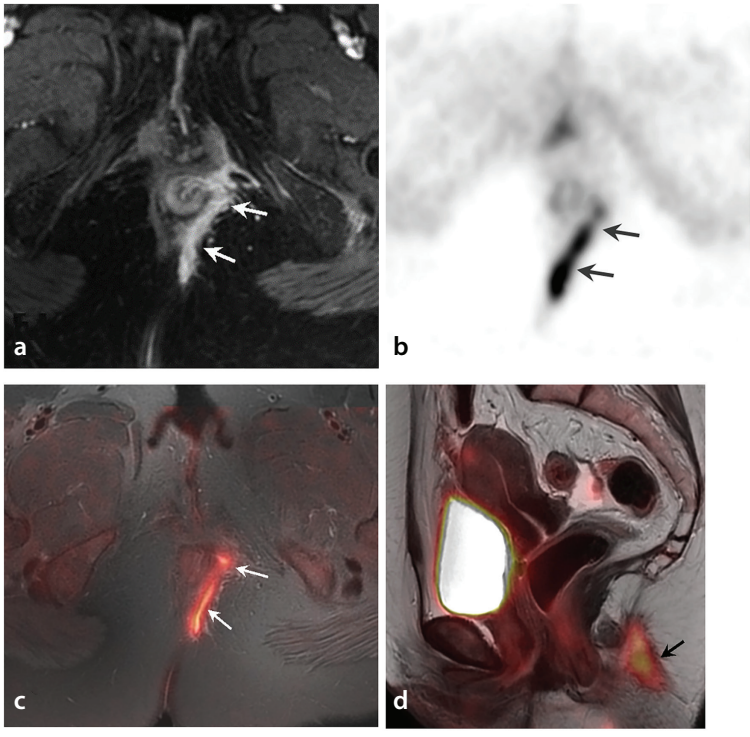

Figure 22. Transsphincteric perianal fistula. *The* axial contrast-enhanced fat-suppressed T1-weighted image **(a)** shows a fistula tract (arrows), which begins at the 1 o'clock position and curves posteriorly, penetrating the external anal sphincter. The axial positron emission tomography (PET) **(b)** and axial fused PET/magnetic resonance images (MRI) **(c)** reveal intense fluorodeoxyglucose accumulation along the tract (arrows). The sagittal fused PET/MRI **(d)** shows pathological uptake posterior to the external anal sphincter (arrow).

(Figure 23), and surrounding soft-tissue inflammation. On PET/MRI, moderate to intense unilateral or bilateral FDG uptake near the symphysis pubis is observed (Figure 23).[33]

Pelvic abscess formation may result from surgical complications or underlying inflammatory conditions, such as pelvic inflammatory disease, diverticulitis, or inflammatory bowel disease. Imaging reveals complex cystic masses with heterogeneous contents, thick enhancing walls, and perilesional fat stranding. Typically, FDG PET shows intense peripheral uptake with a centrally photopenic (non-avid) core, which is characteristic of abscesses (Figure 24).[24]

In conclusion, PET/MRI is a powerful imaging modality that integrates the functional capabilities of FDG PET with the superior anatomical detail and tissue characterization provided by MRI. A comprehensive understanding of physiological FDG uptake patterns–in the uterus, fallopian tubes, ovaries, bowel, muscles, and bone marrow–is essential to avoid misinterpretation. Moreover, recognizing benign conditions and posttreatment changes that may mimic malignancy helps reduce false-positive findings and unnecessary interventions.

The MRI component of PET/MRI adds significant value by offering high-resolution anatomical information, functional insights (by DWI), lesion characterization, and reduced radiation exposure compared with PET/CT. These advantages make PET/MRI a highly valuable tool in oncologic imaging, particularly in complex cases involving the pelvis.

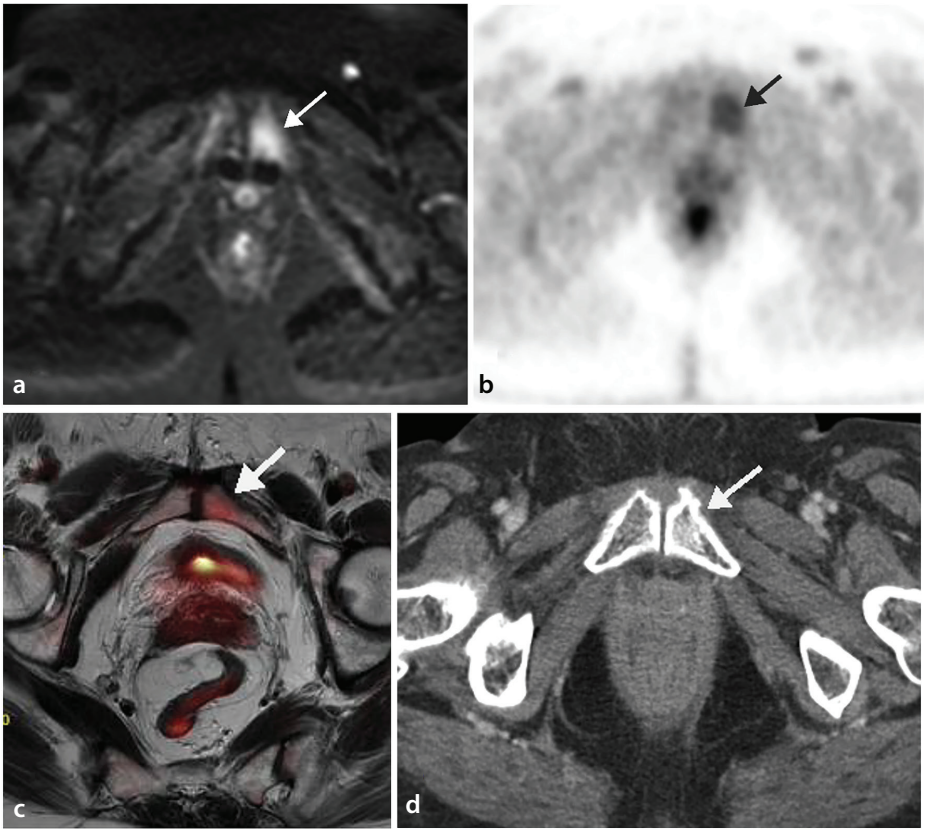

Figure 23. Osteitis pubis. The axial diffusion-weighted magnetic resonance image (MRI) **(a)** shows diffusion restriction (arrow) at the left side of the pubic symphysis. The axial positron emission tomography (PET) **(b)** and axial fused PET/MRI **(c)** show moderate unilateral fluorodeoxyglucose uptake (arrows) adjacent to the pubic symphysis. On the computed tomography **(d)** image, mild subchondral sclerosis associated with cortical irregularity (arrow) supports the diagnosis.

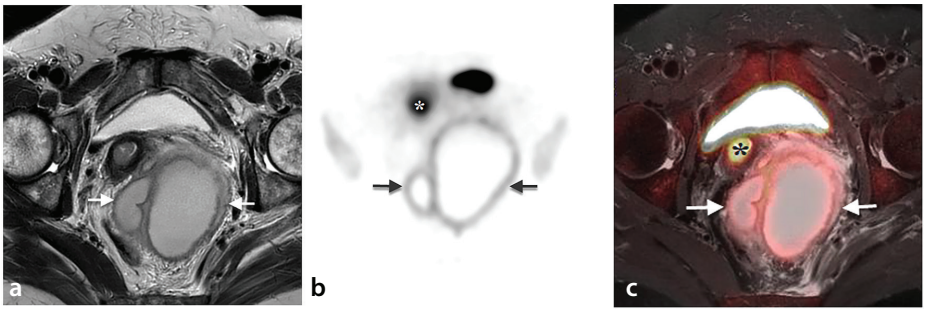

Figure 24. Pelvic abscess. The axial T2-weighted magnetic resonance image (MRI) **(a)** shows a walled-off biloculated fluid-filled collection (arrows) displaying moderately high signal intensity content in keeping with pus. The axial positron emission tomography (PET) **(b)** and axial fused PET/MRI **(c)** show intense peripheral fluorodeoxyglucose (FDG) uptake (arrows) and central photopenia, consistent with abscess. Surgical pathology revealed fibrous tissue with mixed inflammation and abscess formation. The uterine lesion seen as an FDG-avid focus [asterisks in **(b)** and **(c)**] on the right anterior aspect of the abscess was diagnosed as serous endometrial cancer invading the cervix uteri.

Footnotes

Conflict of interest disclosure

The authors declared no conflicts of interest.

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