

Bladder diverticulitis on PET/CT

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Diverticula are commonly seen in hollow viscous organs. One common complication of diverticula is infection, known as diverticulitis. Although diverticulitis has been extensively described with respect to the colon, not many cases describe diverticulitis of the urinary bladder. We report a case of diverticulitis of the bladder to emphasize the imaging findings on PET/CT and to discuss management and possible complications.

Case report

A 77-year-old male with history of non-Hodgkins lymphoma, status post chemotherapy and radiation therapy approximately five years ago, presented for multiple PET/CT scans at yearly intervals for surveillance imaging. The PET/CT protocol for each scan consisted of imaging from the vertex of the skull to the mid thighs 60 minutes after the intravenous administration of approximately 15 mCi of FDG. IV and oral contrast were administered before the CT portion of each examination.

The patient's initial disease before any treatment involved multiple lymph nodes on both sides of the neck. In addition, an infiltrative mass was inseparable from the right parotid tail and the superficial surface of the right sternocleidomastoid muscle. There was no evidence of lymphoma in the chest, abdomen, or pelvis. Particularly, there was no involvement of the spleen or bone marrow.

The initial followup PET/CT contained no anatomic or functional imaging evidence to suggest recurrence of the previously treated lymphoma. However, there was an incidental bladder diverticulum in the posterolateral aspect of the left side of the bladder without evidence of surrounding fatty infiltration (Fig. 1). Radioactive urine was seen within

the lumen of the diverticulum and within the lumen of the bladder, indicating free communication between the two structures. In addition, the prostate was enlarged, with lobular indentation of the bladder floor. The patient was asymptomatic at the time.

Approximately one year later, another followup PET/CT demonstrated no imaging evidence of recurrent lym-

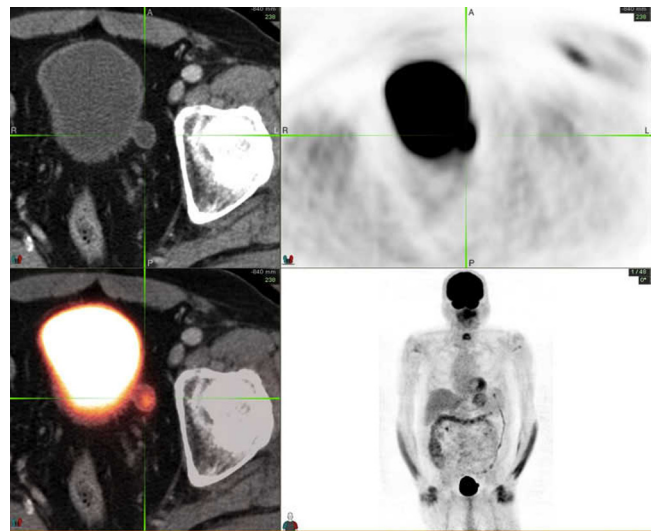


Figure 1. 77-year-old male with bladder diverticulitis. Initial PET/CT demonstrates a bladder diverticulum in the posterolateral aspect of the left side of the bladder. Radioactive urine is seen within the lumen of the diverticulum and within the lumen of the bladder, indicating free communication between the two structures. The CT image (upper left corner) demonstrates that the fat surrounding the diverticulum is clean, without any evidence of fatty infiltration.

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phoma in the neck, chest, abdomen, or pelvis; however, the bladder diverticulum was demonstrated again, with interval development of mild haziness of the fat surrounding the diverticulum (Fig. 2). The prostate was again enlarged, indenting the urinary bladder, and heterogeneous bladder wall thickening suggested chronic bladder outlet obstruction. The patient was still asymptomatic.

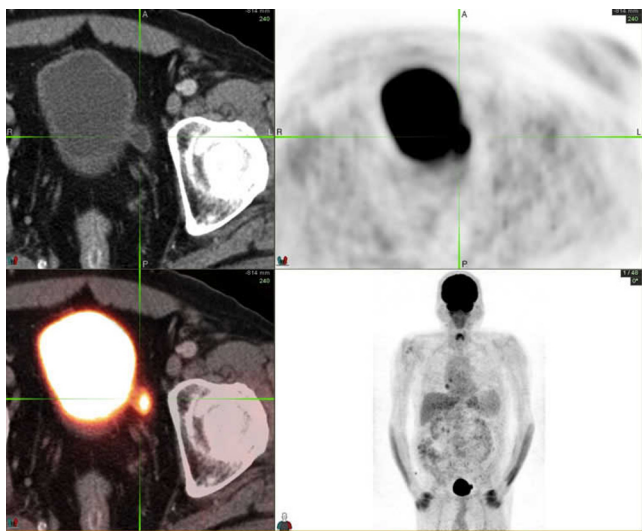


Figure 2. 77-year-old male with bladder diverticulitis. Followup PET/CT approximately one year after PET/CT in Figure 1 again demonstrates a bladder diverticulum in the posterolateral aspect of the left side of the bladder that freely communicates with the bladder lumen. The CT image (upper left corner) demonstrates very mild haziness of the fat surrounding the diverticulum, suggesting mild inflammatory/infectious changes. Heterogeneous bladder-wall thickening suggests chronic bladder outlet obstruction.

After an additional year, a followup PET/CT (Fig. 3) demonstrated no evidence of recurrent lymphoma; however, there was interval development of faint mucosal enhancement of the bladder diverticulum and extensive fatty infiltration surrounding the diverticulum, consistent with inflamed perivesicle fat and highly suggestive of bladder diverticulitis. An enlarged prostate with indentation on the urinary bladder was still present. The patient was again asymptomatic. To date, the patient has not received any treatment or further investigation for bladder diverticulitis.

Discussion

Although diverticulitis has been described extensively with regard to the colon, very few case reports describe diverticulitis of the urinary bladder (1, 2). We report our case to emphasize the imaging findings of diverticulitis on PET/CT and to discuss pathophysiology, management, and possible complications.

As a review, a diverticulum is an outpouching of some or all of the layers of the wall of a hollow viscous organ (3-5).

Depending on which layers of the wall are involved, the diverticulum may be described as true (all layers) or false (only mucosa and submucosa) (1, 6). Diverticula may also be characterized as single or multiple, and congenital or acquired (1, 6, 7). One of the most common complications of bladder diverticula is infection, known as diverticulitis (1). Such infection usually results from urinary stasis, with *E. coli* being the most frequent culprit organism (1, 8).

On CT imaging, bladder diverticulitis usually manifests as mucosal enhancement with infiltration of the periventricular fat, as seen in this case (1). Increased FDG uptake in the diverticular wall and surrounding fat may also be seen on PET imaging; however, due to the intense activity of FDG excreted in the urinary bladder and blooming artifacts, evaluation of FDG uptake in the bladder wall and surrounding fat is limited (9).

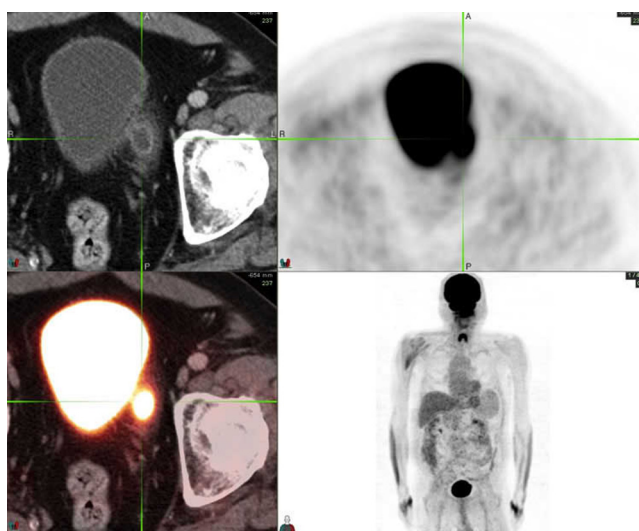


Figure 3. 77-year-old male with bladder diverticulitis. Followup PET/CT approximately one year after PET/CT in Figure 2 again demonstrates a bladder diverticulum in the posterolateral aspect of the left side of the bladder that freely communicates with the bladder lumen. The CT image (upper left corner) demonstrates interval development of extensive fatty infiltration surrounding the diverticulum consistent with inflamed perivesicle fat and highly suggestive of bladder diverticulitis.

On PET/CT, our patient's bladder diverticulum was clearly identified on the maximum intensity projection (MIP) image, since radioactive urine filled the diverticulum (9). Although in this case there was free communication between the lumen of the diverticulum and the lumen of the bladder, in cases of severe diverticulitis, the mouth of the diverticulum may be walled off, and radioactive urine may not be seen within the diverticulum (1).

Bladder diverticula are frequently seen in elderly men such as this patient (1). These bladder diverticula are often caused by longstanding bladder outlet obstructions due to benign prostatic hypertrophy, prostatitis, or prostate carci-

noma (8). On this patient's CT scan, heterogeneous bladder-wall thickening suggested chronic bladder outlet obstruction. The patient's enlarged prostate, indenting the urinary bladder, likely caused increased intravesical pressure, in turn leading to formation of the diverticulum in a weak portion of the bladder wall (1).

Although the patient's PET/CTs demonstrated no focal FDG uptake in the prostate to suggest primary prostate neoplasm, the relatively lower FDG avidity of prostate neoplasms and the adjacent intense, physiologically excreted FDG activity in the urinary bladder make FDG functional imaging a suboptimal modality for characterization of primary prostate neoplasms (9). In this patient, neither PSA nor other imaging studies were available, but the lack of suspicious FDG uptake in the prostate on PET/CT and the lack of any focal mass in the prostate on CT favored benign prostatic hyperplasia as the cause of bladder outlet obstruction (9).

Since bladder diverticulitis is not a well-known entity, there are no official guidelines for diagnosis and treatment. Urinalysis should be one of the first steps, to evaluate for urinary-tract infection and to identify the causative organism so that the appropriate antibiotics can be selected (1). Antibiotics and anti-inflammatory drugs will treat inflammation and infection of the diverticulum as well as any symptoms; however, identification and correction of the primary cause of the diverticulum is necessary to prevent future complications. With correction of the primary cause, many diverticula will resolve (10).

Relief of bladder outlet obstruction in this patient would likely resolve the bladder diverticulum. If no cause such as bladder-outlet obstruction were identified, or if relief of obstruction were not successful, surgery such as diverticulectomy would be necessary to prevent future complications (11). Small diverticula may be left alone, but large diverticula often require surgical removal (8, 10, 11). Cystoscopy should be performed before surgical intervention (12).

Several complications can arise if bladder diverticulitis is left untreated. Diverticulum perforation and cancer formation have been described (13-17). Chronic bladder diverticulitis may lead to adhesions involving the ureters, prostate, seminal vesicles, and rectum (16). Colovesical fistula formation has also been described and may be detected by symptoms of fecaluria or pneumaturia (16, 18, 19).

As in many patients with bladder diverticuli and bladder diverticulitis, this patient was asymptomatic. In this patient, no treatment has been performed yet, and unfortunately no surgical pathology, urinalysis, or PSA were available for diagnostic confirmation. Therefore, our diagnosis was based on imaging alone (1).

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