Utility of pelvic bone SPET in imaging urinary bladder filling defects in urinary bladder carcinoma

Abstract

Urinary bladder carcinoma sometimes can be recognized on bone scans as a filling defect in the bladder. This paper illustrates in three patients that the filling defects of urinary bladder on pelvic bone single photon emission tomography (SPET) scans in cases of bladder carcinoma correspond to those on computerized tomography (CT). In one patient, the void sign could only be discerned on the SPET images, but not on the planar images. In the same patient, the filling defect was almost entirely surrounded by urinary activity, suggesting an intrinsic bladder lesion. The differential diagnosis of filling defects is presented. The above findings are compared to other related studies, although we have found no similar cases in the literature. When compared with CT, pelvic SPET is more sensitive than planar imaging in recognizing bladder filling defects on bone scans and may allow distinguish between intrinsic and extrinsic bladder lesions.

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Introduction

Bone scanning allows the opportunity to identify multiple pathologic conditions outside the skeleton. In particular, the urinary excretion of bone tracers has led to many serendipitous findings in the urinary tract. In the bladder, these can be grouped as either a) anomalous location of activity, as with bladder herniation [1-9], displacement by pelvic masses (as with stool accumulation in the rectosigmoid [10, 11], uterine myoma [12], or malignant pelvic disease [13-15]), prolapse [16], diverticula [17-21], or even bladder rupture [22] or fistulas [23-24], b) anomalous hot spots in the bladder, as described with urinary stones [25, 26] or osteosarcoma of the bladder [27], c) bladder filling defects [28-31] and d) nonvisualisation of the bladder from ureteral severance or obstruction [30]. We here report on three cases of bladder filling defects due to tumours and discuss the differential diagnosis.

Single photon emission tomography (SPET) allows better distinction between uptake in bone versus soft tissues than do planar images**.** We here describe the added value of SPET in the recognition of bladder filling defects in cases of bladder carcinoma and compare the findings with those on computerized tomography (CT). We could not find similar cases of bladder filling defects due to bladder carcinoma reported in the literature.

Description of the cases

Case 1. A 67 years old man with carcinoma of the mouth floor was treated with surgery and radiotherapy. Local tumor recurrence as well as bone and lung metastases were diagnosed 9 months later. During palliative treatment, the need for a urinary bladder catheter arose. Ultrasound of the bladder, performed for guidance of suprapubic catheter placement, showed a space-occupying lesion in the bladder. A bone scan performed 3h after the intravenous (i.v.) injection of 703MBq of technetium-99m oxidronate, for staging purposes showed multiple lesions of the ribs, the twelfth thoracic vertebra, and the right pelvis as well as a faint lesion in the right femur (Fig. 1a). Of note, urinary activity in the bladder remained confined to a crescentic area to the left of the midline. Pelvis SPET confirmed that urinary activity was limited to a small rim at the left side and anteriorly in the bladder, hardly reaching the midline. On the coronal slices, some activity could be seen in the right ureter (Fig. 1b). Pelvic CT (LightSpeed, General Electric, Milwaukee, WI, USA) demonstrated a large tumoral mass in the bladder wall to the right, presumably with serosal breakthrough (Fig. 1c). The bladder lumen on CT agreed with the active area on the bone SPET. It was decided to give only palliative treatment and the patient succumbed 5 weeks after the bone scan. Although the filling defect in this case was apparent on the planar scan, SPET showed it to be larger than sus-

Frank De Geeter[1] MD, PhD,
Lode Goethals[2] MD

1. *Department of Nuclear Medicine, Saint-John's General Hospital, Brugge, Belgium*
2. *Department of Radiology, University Hospital Free University of Brussels, Brussels, Belgium*

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Correspondence address:
F. De Geeter Professor,
Department of Nuclear Medicine
Saint-John's General Hospital
Ruddershove 10,
8000 Brugge, Belgium,
Tel: 32 50 452826
Fax: 32 50 452809
E-mail:
frank.degeeter@azbrugge.be

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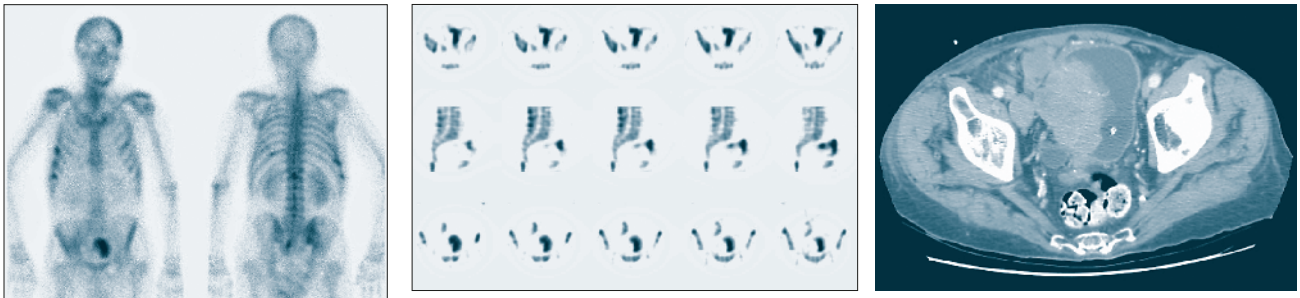
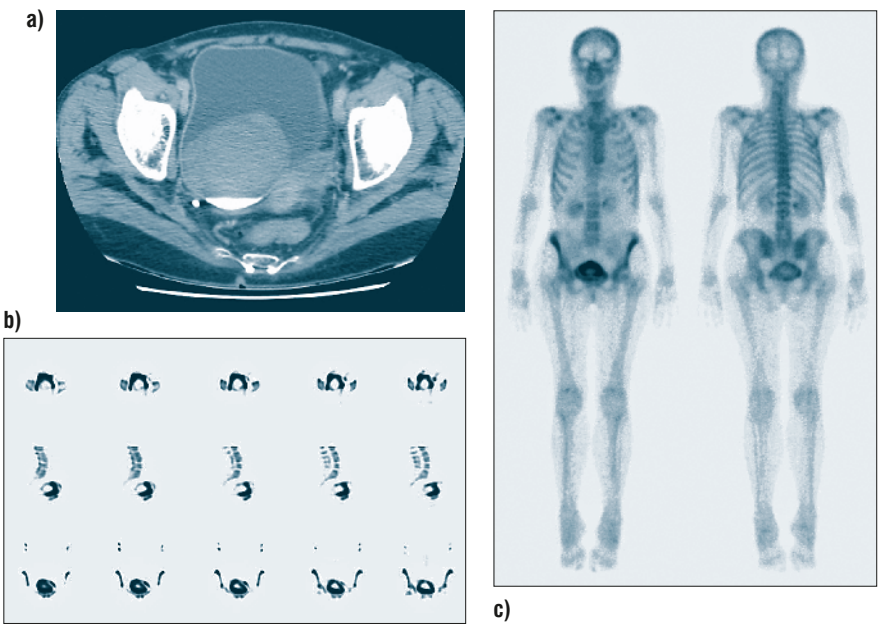


a)

b)

c)

Figure 1a, b and c. a) Whole body bone scan obtained in a 67 years old man 3h after i.v. administration of 703MBq technetium-99m-oxidronate. It shows multiple lesions of the ribs, the twelfth thoracic vertebra, and the right pelvis as well as a faint lesion in the right femur. Of note, urinary activity in the urine bladder remains confined to a crescentic area to the left of the midline. b) Pelvic SPET. Upper row: axial slices. Middle row: sagittal slices. Lower row: coronal slices confirm that urinary activity is limited to a small rim at the left side and anteriorly in the bladder, hardly reaching the midline. On the coronal slices, some activity can be seen in the right ureter. c) Pelvic CT demonstrates a large tumor mass in the urinary bladder wall to the right, presumably with serosal breakthrough. Note how the bladder lumen on CT agrees with the active area on the bone SPET.



a)

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Figure 2a, b and c. a) Pelvic CT in a 62 years old woman with macroscopic hematuria. A large rounded mass is present in the bladder. b) Whole body bone scan obtained 3h after i.v. administration of 666MBq ^{99m}Tc-oxidronate. A void can be seen in the bladder. No bone lesions suggestive of metastases are found. c) Pelvic SPET. Upper row: axial slices. Middle row: sagittal slices. Lower row: coronal slices. They again demonstrate the void, corresponding to the mass seen on CT.

pected from the planar scan, and offered better correlation with CT.

Case 2. A 62 years old woman presented with macroscopic hematuria. Cystoscopy proved difficult because the bladder was filled with clots. Pelvic CT showed a large rounded mass in the bladder (Fig. 2a). On a whole body bone scan, performed as above with 666MBq of ^{99m}Tc-oxidronate, no bone lesions suggestive of metastasis were found. A void was present in the bladder (Fig. 2b). Pelvic SPET again demonstrated the void, which corresponded to the mass seen on CT (Fig. 2c). Transurethral resection was performed; transitional cell carcinoma was diagnosed histologically.

Case 3. A 77 years old man was known to harbour a poorly differentiated transitional cell carcinoma of the bladder, invading the muscularis. No bone lesions were found on a whole-body bone scan performed as above with 814MBq of ^{99m}Tc-oxidronate. The bladder was enlarged and both ureters were visible (Fig. 3a). Pelvic SPET additionally showed a clear rounded photopenic area in the outflow tract of the greatly distended bladder. Behind this area, only a small rim of increased activity could be seen (Fig 3b). In distinction to the other cases presented here, the photopenic area was entirely surrounded by urinary activity, suggesting an intrinsic bladder defect. The cold area corresponded to the bladder tumor, which obstructed the bladder, causing severe urinary frequency and strangury. Unlike in the other cases presented here, the bladder defect went unnoticed on planar images. No CT was available in this patient.

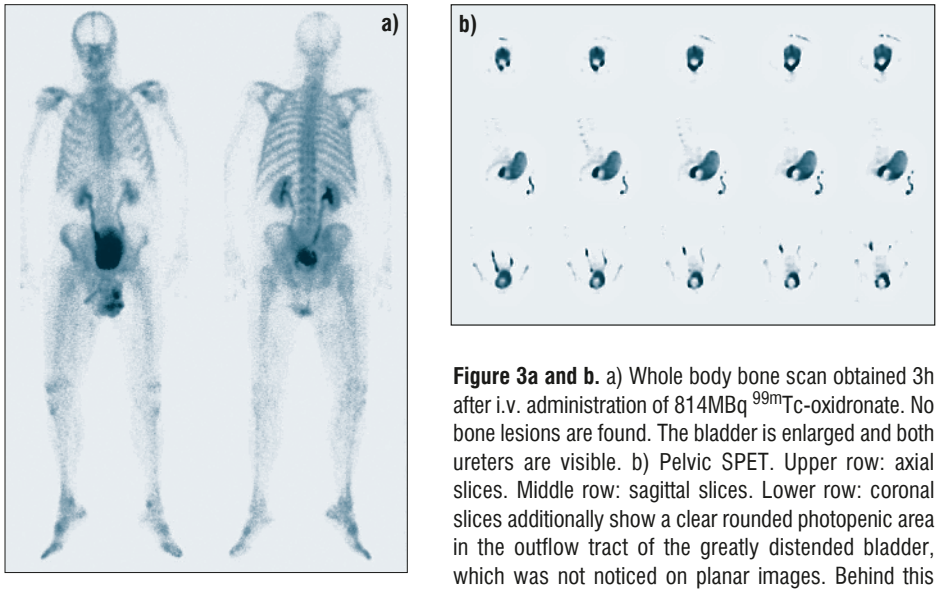

Figure 3a and b. a) Whole body bone scan obtained 3h after i.v. administration of 814MBq ^{99m}Tc-oxidronate. No bone lesions are found. The bladder is enlarged and both ureters are visible. b) Pelvic SPET. Upper row: axial slices. Middle row: sagittal slices. Lower row: coronal slices additionally show a clear rounded photopenic area in the outflow tract of the greatly distended bladder, which was not noticed on planar images. Behind this area, only a small rim of increased activity can be seen. In distinction to the other cases presented here, the photopenic area is entirely surrounded by urinary activity, suggesting an intrinsic bladder defect.

Discussion

Filling defects of the urinary bladder on bone scans have since long been recognized [28-30], but are infrequent. They are not specific for bladder neoplasia, but open up a wide differential diagnosis, including intrinsic bladder lesions (for example tumor, clot, ureterocele, stone, hematoma, schistosoma haematobium lesions, endometriosis) [28, 29] as well as extrinsic compression by pelvic space-occupying lesions, ranging from innocuous ones such as stool in the rectosigmoid [29] or uterine myoma [12], to malignant pelvic disease [31]. 'Cup' defects at the base of the bladder in male patients have been ascribed to an enlarged prostate [30]. A bladder filling defect in a woman on a ^{99m}Tc-diethylene triamine pentacetic acid (^{99m}Tc-DTPA) study has been ascribed to extrinsic compression by a vaginal tampon [32]. However, Orzel and Weinberger (1989) have warned that, at least in pediatric patients, nonhomogeneous distribution of tracer, asymmetry, contour irregularity or asymmetric distribution of radioactivity within the bladder outline on ^{99m}Tc-DTPA scans, only rarely correlate with anatomic abnormality [33]. Likewise, we have ascribed some instances of asymmetric bladder appearance in adults to irregular emptying of the bladder [34].

The filling defects in the cases in the present article (Fig. 1-3) were all due to intrinsic bladder lesions. In 2 cases, transitional cell carcinoma was documented. In two of the cases, SPET afforded better comparison with CT. As in case 3 the bladder void was almost entirely surrounded by urinary activity, this suggested that the void was due to an intrinsic bladder lesion. Therefore, SPET may sometimes help to differentiate intrinsic from extrinsic lesions. In addition, in case 3 the bladder void was only visible on SPET, demonstrating that SPET offers better sensitivity than planar imaging. Recognition of bladder filling defects on SPET may lead to a more comprehensive interpretation of bone scans, in particular in those patients in whom, unlike the patients presented here, the diagnosis of a bladder lesion has not been established before. Despite a thorough search of the PubMed database, and although bladder carcinoma is mentioned in a list of differential diagnoses of urinary bladder defects [28], we could find no published cases of bone scan where filling defects of the urinary bladder where caused by bladder carcinoma, and only one reported instance of a filling defect due to malignant disease [31]. In the latter case, in which the filling defect was due to an extrinsic lesion of recurrent colon carcinoma, only a small indentation was seen on the anteroposterior bladder image. No tomographic nor CT correlation were presented.

Although the recognition of urinary bladder filling defects as an incidental finding on bone scans may have clinical implications and warrants further workup, it should be emphasized that ultrasound and cystoscopy remain the prime methods to investigate the urinary bladder. However, contrast-enhanced multislice pneumo-CT-cystography has been demonstrated to accurately evaluate the local stage of bladder cancer as well as its ureteral extension and possible synchronous lesions elsewhere in the urinary tract [35, 36]. Of course, one should remain aware of the high radiation dose absorbed by the patient undergoing CT scans [37, 38].

In conclusion, the cases presented here highlight the added value of pelvic SPET over planar imaging in recognizing urinary bladder filling defects on bone scans and in distinguishing between intrinsic and extrinsic bladder lesions.

Bibliography

1. Makhija MC. Bladder in the scrotum on a bone scan. *Clin Nucl Med* 1981; 6: 550-551.
2. Apodaca D, Roseland C, Bekerman C, Pinsky S. Bladder in the sac. *Clin Nucl Med* 1985; 10: 596-597.
3. Lee TA 3rd, Siddiqui AR. Urinary bladder herniation into the scrotum seen on bone imaging. *Clin Nucl Med* 1986; 11: 435.
4. Lee HK, Skarzynski J. Bladder herniation in inguinal hernia detected during bone imaging. *Clin Nucl Med* 1986; 11: 740.
5. Morano JU, Burkhalter JL. Bladder hernia simulating osseous metastatic lesion on radionuclide bone scan. *Urol Radiol* 1987; 9: 183-184.
6. Vidal-Sicart S, Pons F, Huguet M et al. Bladder herniation detected on a bone scan. *Clin Nucl Med* 1995; 20: 949-950.
7. Stewart CA, Hung GL, Olsen B, Bennett C. Urinary bladder herniation into the scrotum. Incidental demonstration on bone scintigraphy. *Clin Nucl Med* 1996; 21: 498.
8. Iagaru A, Siegel ME. Demonstration of a right inguinal hernia containing urinary bladder diverticulum on whole-body bone scan and

pelvic CT. *Eur J Nucl Med Mol Imaging* 2006; 33: 234.
9. Ilgan S, Ozguven M, Emer MO, Karacalioglu AO. Massive inguinoscrotal herniation of the bladder with ureter: incidental demonstration on bone scan. *Ann Nucl Med* 2007; 21: 371-373.
10. Shanley DJ, Buckner AB, Alexander HG. Unusual pelvic activity found on bone scan. *Clin Nucl Med* 1991; 16: 453-454.
11. Ackerman L, Shirazi P, Van Drunen M. Bladder displaced by stool-distended rectosigmoid colon presenting on bone scan as a pelvic soft tissue mass. *Clin Nucl Med* 1997; 22: 733-734.
12. Lim ST, Sohn MH, Park SA. Curious radioactivity in the lower abdomen on bone scintigraphy: displacement of the urinary bladder by an incidentally diagnosed uterine myoma. *Clin Nucl Med* 2000; 25: 824-825.
13. Kassamali H, Spencer RP. Lateral bladder due to tumor compression. *Clin Nucl Med* 1987; 12: 974-975.
14. Al Naeem AN, Powe J, Bakheet S, Elgazzar AH. Displaced urinary bladder creating an unusual pattern on bone scan mimicking disease. *Clin Nucl Med* 1999; 24: 137-138.
15. Conrad GR, Sinha P. Severe bladder distortion mimics bone metastasis from pelvic rhabdomyosarcoma. *Clin Nucl Med* 2002; 27: 929-931.
16. Slavin JD Jr, Shoemaker DW, Spencer RP. Prolapse of the urinary bladder demonstrated on bone imaging. *Clin Nucl Med* 1988; 13: 834.
17. Silberstein EB, Volarich D. Bladder diverticula masquerading as pubic metastases. *Clin Nucl Med* 1982; 7: 229-230.
18. Farmer KD, Gellett LR, Vivian GC, Franklin K. Bladder diverticulum simulating a pelvic metastasis on a ^{99m}Tc-HDP bone scan. *Clin Nucl Med* 2001; 26: 60-61.
19. Wong C, Smith A, Mansberg R. Massive bladder diverticuli demonstrated on skeletal scintigraphy. *Clin Nucl Med* 2004; 29: 517-518.
20. Chang CP, Tsai CH, Chen JH et al. Demonstration of large bladder diverticulum on bone scan. *Clin Nucl Med* 2005; 30: 276-277.
21. Meng Z, Tan J, Dong F et al. Demonstration of a congenital urine bladder diverticulum by ^{99m}Tc-MDP SPET/CT scan in a female with bone metastases. *Hell J Nucl Med* 2009; 12: 276-278.
22. Shah PJ, Shreeve WW, Murthy BN. Iatrogenic rupture of urinary bladder: incidental finding on bone scan. *J Nucl Med* 1981; 22: 564-565.
23. Makhija M, Brodie M. Vesicocolonic fistula. *Clin Nucl Med* 1985; 10: 604-605.
24. Khoury J, Loberant N, Jerushalmi J. Post-radiation vesicocolonic fistula demonstrated on bone scintigraphy. *Eur J Nucl Med Mol Imaging* 2009; 36: 1354.
25. Cohenpour M, Simon YC, Zenaty I, Horne T. Unusual urinary bladder accumulation in bone scan. *Semin Nucl Med* 2002; 32: 231-232.
26. Onur Demirkol M, Seymen H, Ihsan Kölgesiz A, Kadioğlu A. Bone tracer uptake in urinary bladder stones. *Clin Nucl Med* 2003; 28: 337-339.
27. Berenson RJ, Flynn S, Freiha FS et al. Primary osteogenic sarcoma of the bladder. Case report and review of the literature. *Cancer* 1986; 57: 350-355.
28. Duong RB, Gelfand MJ, Volarich DT, Williams P. Urinary tract imaging-filling defect in the urinary bladder. *Semin Nucl Med* 1983; 13: 383-385.
29. Mandell GA, Harcke HT. Extrinsic causes of vesical filling defects on scintigraphy. *Clin Nucl Med* 1987; 12: 204-207.
30. Bilchik TR, Spencer RP. Bladder variants noted on bone and renal imaging. *Clin Nucl Med* 1993; 18: 60-67.
31. Stewart CA, Siegel ME, Nafis WA, Wood LA. Bone scan of recurrent colon carcinoma involving the sacrum and urinary bladder. *Clin Nucl Med* 1990; 15: 513-514.
32. Yoosufani Z, Sziklas JJ, Spencer RP. Bladder defect due to use of vaginal tampon. *Clin Nucl Med* 1987; 12: 144-145.
33. Orzel JA, Weinberger E. Misleading appearances of the bladder on pediatric genitourinary imaging. *Clin Nucl Med* 1989; 14: 671-674.
34. De Geeter F, Van Steelandt H. Bladder variants noted on bone and renal imaging. *Clin Nucl Med* 1995; 20: 570-571.
35. Scardapane A, Pagliarulo V, Ianora AA et al. Contrast-enhanced multislice pneumo-CT-cystography in the evaluation of urinary bladder neoplasms. *Eur J Radiol* 2008; 66: 246-252.
36. Browne RF, Murphy SM, Grainger R, Hamilton S. CT cystography and virtual cystoscopy in the assessment of new and recurrent bladder neoplasms. *Eur J Radiol* 2005; 53: 147-153.
37. Grammaticos P, Fountos G. The physician should benefit, not harm the patient. *Hell J Nucl Med* 2006; 9: 82-84.
38. Iakovou I, Karavida N, Kotzassarlidou M. The computerized tomography scans and their dosimetric safety. *Hell J Nucl Med* 2008; 11: 82-85.