Radiology Case Reports

Volume 6, Issue 1, 2011

Improved diagnosis of pelvic lesions with dual-phase (18F)FDG-PET/CT

Ettore Pelosi, MD; Andrea Skanjeti, MD; and Paola Scapoli, MD

Positron Emission Tomography (PET) with 2-deoxy-2-(18F)fluoro-D-glucose ([18F]FDG) is an integral part of the diagnostic workup in patients with suspected or confirmed cancer. The ability of the (18F)FDG-PET study to characterize and detect malignancies can be increased by dual-phase acquisition; this is due to the different kinetics of the radiotracer in the tumor tissue and in the background. We present two cases of (18F)FDG-PET/CT scans acquired in patients previously treated for malignant neoplasms who had suspected pelvic recurrences, in which the delayed acquisition was critical in accurately characterizing abnormalities.

Case report 1

A 79-year-old woman had previously been treated for breast and urothelial cancer. A contrast-enhanced CT, acquired during followup, showed multiple pulmonary and lymph-node lesions as well as irregularly vascularized solid tissue inside the bladder.

A whole-body PET scan was acquired 60 minutes after intravenous injection of the (18F)FDG. At the time of the tracer injection, the patient had fasted for more than six hours, and the glucose blood level was 101 mg/dL. A second scan of the pelvis was acquired 30 minutes after the end of the whole-body exam, that is, two hours after the injection. As shown in Fig. 1, the delayed acquisition made it possible to visualize and characterize as malignant the tissue inside the bladder. In fact, (18F)FDG uptake, semiquantified by the Standardized Uptake Value (SUV), increased in the lesion while the urinary activity significantly decreased; the final result was the inversion of the lesion/background ratio (see Table). Biopsy of the tissue inside the bladder confirmed the presence of urothelial cancer recurrence.

Case report 2

This 66-year-old woman had been previously treated for cervical cancer by radiochemotherapy. During followup, a pelvic MRI identified a 20-mm solid lesion in the uterine cervix. The result of the whole-body PET scan was ambiguous due to the closeness of the abnormal (18F)FDG uptake to the bladder; thus it was impossible to distinguish between cervical recurrence and urinary stasis (which is often evident inside the distal part of the ureter). Delayed acquisition, as shown in Fig. 2, made it possible to characterize the abnormal pelvic finding near the bladder as pathological: the activity of the lesion increased over time, while the urinary activity decreased (Table). In this case as well, the biopsy confirmed the presence of a cancer recurrence.

Discussion

Today, PET with 2-deoxy-2-(18F)fluoro-D-glucose ([18F]FDG) is an integral part of the diagnostic workup in patients with suspected or confirmed cancer (1). In fact, by using a radiolabeled analog of the glucose (for example, [18F]FDG), it is possible to study glucose metabolism that is overstocked in cancer cells (2). That is due to the fact that

Citation: Pelosi E, Skaneti A, Scapoli P. Iimproved diagnosis of pelvic lesions with dual-phase 18F)FDG-PET/CT. *Radiology Case Reports*. [Online] 2011;6:479.

Dr. Pelosi is associated with the IRMET PET Centre;. Dr. Skanjeti is associated with the Nuclear Medicine Unit, University of Turin;. and Dr. Scapoli is associated with the Nuclear Medicine Unit at IRCC Candiolo, all in Turin, Italy. Contact Dr. Pelosi at e.pelosi@irmet.com.

Competing Interests: The authors have declared that no competing interests exist.

DOI: 10.2484/rcr.v6i1.479

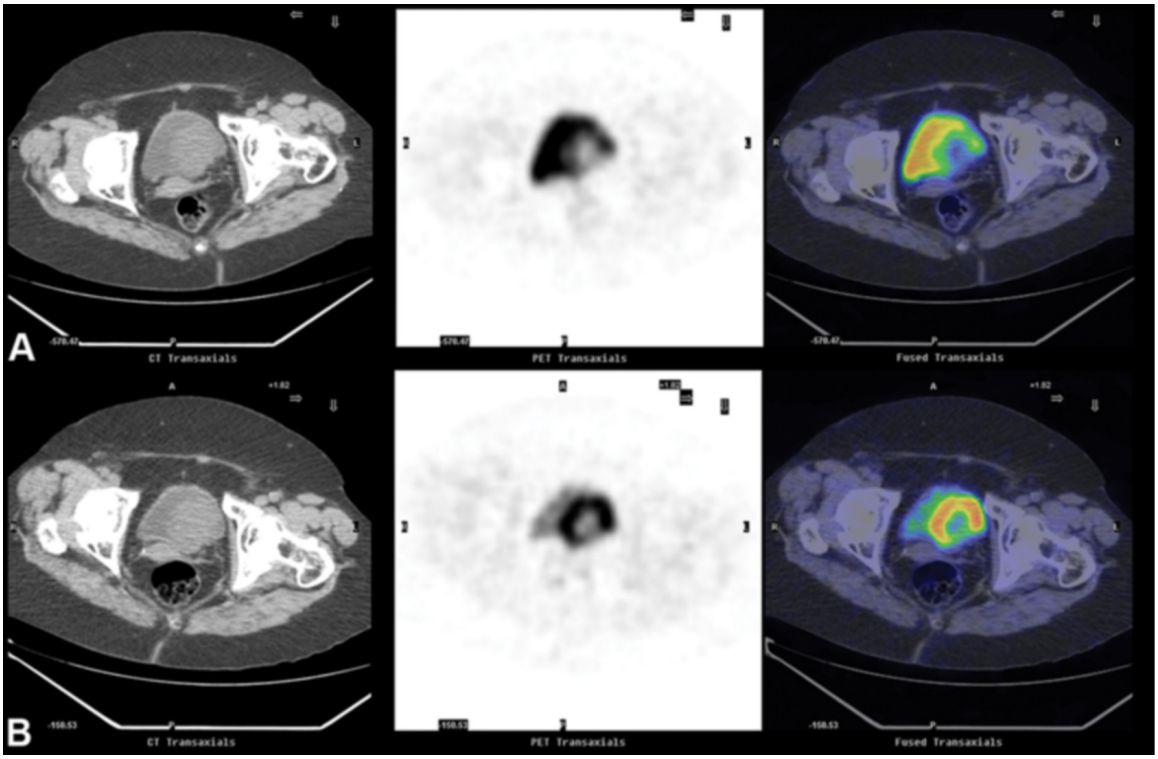

Figure 1. 79-year-old woman with suspected recurrance of urothelial cancer. Transaxial images at the bladder level, CT scan, PET scan, and fusion. **A**. At one hour post injection, PET shows a "minus" inside the bladder. **B**. At two hours post injection, the tumoral lesion is clearly evidenced by greater (18F)-FDG uptake than the background.

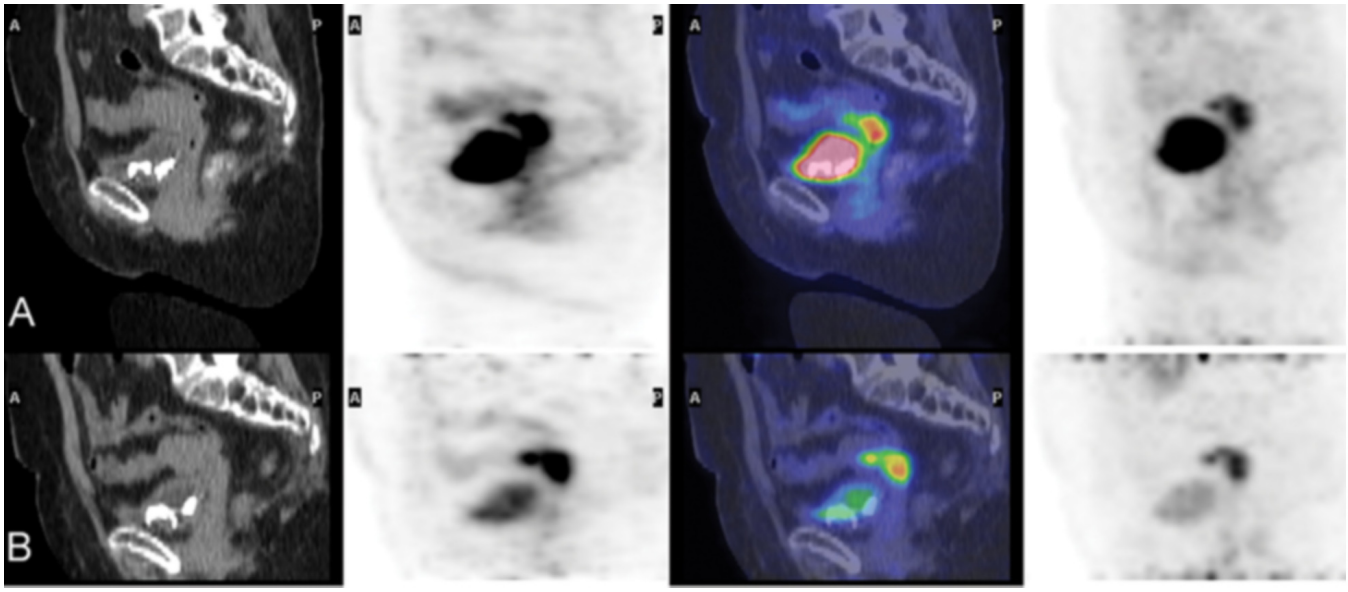

Figure 2. 66-year-old woman previously treated for cervical cancer, with suspected recurrence. Sagittal images at the bladder level, CT scan, PET scan, fusion, and Maximum Intensity Projection (MIP). **A**. At one hour post injection, PET shows an abnormal (18F)-FDG close to the bladder. **B**. At two hours post injection, the kinetics of the abnormal uptake make it possible to characterize the lesion.

most of the tumors overexpress glucose transporters and hexokinase enzymes, leading to an increase of the glucose uptake over time. Furthermore, thanks to the possibility of matching PET functional images with CT anatomical ones, this kind of study yields a very high diagnostic accuracy, leading to a change of the patient management in about 30% of cases (3).

However, some pitfalls limit the use of PET in cancer patients; in the case of pelvic malignancies, due to (18F)FDG renal excretion, focal uptake at the level of the urinary tract can mimic pathological uptake, thus allowing false positive results (4). In order to improve PET accuracy, several methods have been proposed (5, 6): some authors have used retrograde irrigation of the bladder (7, 8), and others have performed forced diuresis by injecting furosemide and acquiring PET scans immediately after. Some researchers have used different metabolic tracers such as choline and acetate, and others have used dual-phase acquisition (5, 6, 9). However, each one of these techniques presents some limits. The retrograde irrigation of the bladder causes discomfort to the patient, increases the radiation exposure for the operators, and could cause infection. The injection of furosemide before image acquisition does not guarantee accurate results, and no consensus has yet formed about the optimal time and the dose of diuretic that should be injected. Tracers other than (18F)FDG are not commonly available and can be expensive; in addition, few are familiar with them. Dual-phase acquisition is time-consuming and is limited by both tracer and PET tomograph availability. The rationale of delayed acquisition is based on the kinetic biodistribution of (18F)FDG, which is different in cancer cells compared to normal ones. In fact, while the neoplastic tissue continues to accumulate the tracer over the time, the normal cell undergoes tracer washout. This phenomenon leads to an increase of tumor-to-background ratio over time, with a clear improvement of the lesion visualization and characterization (Table).

	SUV	Acquisition	Lesion	Bladder	Ratio (L/Bg)
Case 1	max	1	8.5	19.3	0.440
		2	15.4	8.5	1.812
	mean	1	6.2	16.5	0.376
		2	12.7	7.2	1.764
Case 2	max	1	13	24	0.542
		2	18.9	8.8	2.148
	mean	1	11.2	21.5	0.521
		2	13.2	7.6	1.737

Table. (18F)-FDG uptake, semiquantified by SUVmax and SUVmean of the lesion and of the bladder, and ratio for the first and second acquisition, respectively.

The kinetics of (18F)FDG biodistribution have been extensively investigated, and the use of delayed acquisition has been suggested by several authors to address different clinical problems. In the case of suspected inflammatory lesions, we can use dual-phase acquisition: while cancer tissue continues to increase tracer uptake over time, inflammatory disease is more often characterized by the stability or by the decrease of the (18F)FDG uptake. In the identification of hepatic and peritoneal metastases, Arena and Penna demonstrated how delayed acquisition can be useful; in these cases, while the tumor tissue increased its activity over time, the background level tended to decrease, with a final increase in the lesion/background ratio (10, 11).

In the two cases presented above, the increased activity of the cancer tissue, together with the reduction of the urinary activity, led to the detection of two lesions that could not be visualized or characterized by standard acquisition. In our present experience, the comparison of delayed to standard acquisition is very useful, allowing the clear identification of the lesion and clarifying its pathological nature. The key observation in our paper is that with delayed acquisition we can observe a significant reduction in the maximum and mean activity values of the urinary system while, as expected, the neoplastic tissue activity continues to increase over time with an inversion of the tumor/urinary background ratio (Table).

In conclusion, the dual-phase scan is a method that is safe and easy to perform. It does not cause excessive radiation exposure for technologists or discomfort for patients. While it is time-consuming, the indisputable benefit for the patient suggests that it should be performed more frequently. The ability of an (18F)FDG-PET study to detect pelvic malignancies is increased by dual-phase acquisition due to the kinetics of (18F)FDG in tumor tissue and to the significant reduction of urinary activity during the time. Therefore, while clinical trials would be useful to compare this practice with the other methods already mentioned, this procedure should be encouraged in order to metabolically characterize suspect findings in the pelvic area.

References

1. Facey K, Bradbury I, Laking G and Payne E. Overview of the clinical effectiveness of positron emission tomography imaging in selected cancers. *Health Technol Assess*, 2007, Oct; 11(44): iii-iv, xi-267. [PubMed]

2. Pauwels EK, Sturm EJ, Bombardieri E, Cleton FJ and Stokkel MP. Positronemission tomography with [18F]fluorodeoxyglucose. Part I. Biochemical uptake mechanism and its implication for clinical studies. *J Cancer Res Clin Oncol*, 2000, Oct; 126(10): 549-59. [PubMed]
3. Gambhir SS, Czernin J, Schwimmer J, Silverman DH, Coleman RE and Phelps ME. A tabulated summary of the FDG PET literature. *J Nucl Med*, 2001, May; 42(5 Suppl): 1S-93S. [PubMed]
4. Abouzied MM, Crawford ES and Nabi HA. 18F-FDG imaging: pitfalls and artifacts. *J Nucl Med Technol*, 2005, Sep; 33(3): 145-55; quiz 62-3. [PubMed]
5. Anjos DA, Etchebehere EC, Ramos CD, Santos AO, Albertotti C and Camargo EE. 18F-FDG PET/CT delayed images after diuretic for restaging invasive bladder cancer. *J Nucl Med*, 2007, May; 48(5): 764-70. [PubMed]
6. Kamel EM, Jichlinski P, Prior JO, et al. Forced diuresis improves the diagnostic accuracy of 18F-FDG PET in abdominopelvic malignancies. *J Nucl Med*, 2006, Nov; 47(11): 1803-7. [PubMed]
7. Kosuda S, Kison PV, Greenough R, Grossman HB and Wahl RL. Preliminary assessment of fluorine-18 fluorodeoxyglucose positron emission tomography in patients with bladder cancer. *Eur J Nucl Med*, 1997, Jun; 24(6): 615-20. [PubMed]
8. Koyama K, Okamura T, Kawabe J, et al. Evaluation of 18F-FDG PET with bladder irrigation in patients with uterine and ovarian tumors. *J Nucl Med*, 2003, Mar; 44(3): 353-8. [PubMed]
9. Schoder H and Larson SM. Positron emission tomography for prostate, bladder, and renal cancer. *Semin Nucl Med*, 2004, Oct; 34(4): 274-92. [PubMed]
10. Arena V, Skanjeti A, Casoni R, Douroukas A and Pelosi E. Dual-phase FDG-PET: delayed acquisition improves hepatic detectability of pathological uptake. *Radiol Med*, 2008, Sep; 113(6): 875-86. [PubMed]
11. Penna D, Varetto T, Deandreis D, Castellano G and Bisi G. Dual-phase F-18 FDG PET/CT scanning in the suspicion of relapse of ovarian neoplasia. *Clin Nucl Med*, 2009, Feb; 34(2): 111-3. [PubMed]