Case – ^{18}F-DCFPyL-positron emission tomography/computed tomography (PET/CT) time of imaging

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Introduction

Prostate cancer is the most commonly diagnosed cancer, except for skin cancer, and the second leading cause of cancer related death among Canadian males.[1] Recurrence is not uncommon, despite local therapies such as radical prostatectomy, radiation and brachytherapy and systemic therapies including hormonal therapy.[2] Often, the first sign of recurrence is a rising PSA, known as "biochemical recurrence".[3] Based on the European Association of Urology and American Urological Association guidelines, biochemical recurrence is defined as serum PSA value of ≥ 0.2 ng/ml after prostatectomy and ≥2 ng/ml increase above the nadir PSA after external beam radiation therapy of the primary tumour.[3] In recent years, prostate specific membrane antigen targeted positron emission tomography/ computed tomography (PSMA-PET/CT) has revolutionized detection of disease in men with biochemical recurrence and has led to a change in management.[4]

^{68}Ga-PSMA-11 is arguably the most widely used PET radiopharmaceutical world-wide for the detection of prostate cancer. However, it has limitations such as short physical half-life (68 min). ^{18}F-labeled PSMA-targeting radiopharmaceutical are easier to distribute given their longer half-life (110 minutes). ^{18}F-DCFPyL is the most commonly used ^{18}F-labeled PSMA-targeting radiopharmaceutical in Canada. The biodistribution patterns of ^{68}Ga-PSMA and ^{18}F-DCFPyL are similar.[5] Many centers acquire images 60 minutes post intravenous administration of ^{18}F-DCFPyL. In this paper we illustrate the value of dual-time point imaging and compare the

imaging at 60 and 120 minutes post radiopharmaceutical injection. All cases had biochemical recurrence with negative bone scan and CT scan.

Case 1

70-year-old man with biochemically recurrent prostate cancer (PSA 0.3 ng/mL) was referred for PSMA-PET/CT. He was treated with radical prostatectomy 10 years ago and hormonal therapy and has been off of hormonal therapy 2 years ago. The creatinine was 78 μmol/L. Total body images obtained 60 minutes following intraveous^{18}F-DCFPyL administration showed intense focal radiopharmaceutical uptake in a left internal iliac lymph node and mild focal uptake in para-aortic soft tissue to the left of the aortic bifurcation (Figure 1A). Additional imaging of the pelvis performed 120-minutes post radiopharmaceutical injection, showed interval increase uptake in the left internal iliac lymph node consistent with prostate cancer spread and interval decrease in uptake in the para-aortic soft tissue consistent with the organ of Zuckerkandl (Figure 1B). Radiopharmaceutical uptake in the sympathetic ganglia and organ of Zuckerkandl can be mistaken for malignant disease spread and is a known pitfall of PSMA-PET/CT.[6] In addition to the lesion location and shape, interval reduction in conspicuity on delayed images suggests a benign process, while interval increase in conspicuity suggests malignant disease spread.[6,7] This case illustrates the value of dual time-point ^{18}F-DCFPyL PET/CT, similar to multi-phase ^{68}Ga-PSMA PET/CT.[8] In this case, the staging could have been potentially changed as internal iliac node (the shown avid node) is a locoregional node for prostate cancer but a node at the level of aortic bifurcation is considered metastatic.

Case 2

69-year-old man with biochemically recurrent prostate cancer (PSA 10.9 ng/mL) 3 years post external radiation therapy, was referred for PSMA-PET/CT. The creatinine was 74 μmol/L. The images obtained 60 minutes following intravenous ^{18}F-DCFPyL administration showed equivocal mild focal uptake in a prevertebral soft tissue nodule (Figure 2A). Interval increase in the radiopharmaceutical uptake on delayed images obtained 120 minutes following intravenous ^{18}F-DCFPyL administration, however, was consistent with prostate cancer spread to a small pre-sacral lymph node (Figure 2B). Given high PSA at biochemical recurrence, hormone therapy was commenced. Also, the patient was offered regional pelvic radiation therapy given the positive PSMA PET/CT finding. His PSA dropped to 1.02 ng/mL post treatment.

Case 3

77-year-old man with history of Gleason 4+3 prostate adenocarcinoma developed biochemically recurrent prostate cancer 8 years post radical prostatectomy (PSA 1.7ng/mL) and subsequently was referred for PSMA-PET/CT. The creatinine was 130 μmol/L. The images obtained 60 minutes following radiopharmaceutical administration showed intense focal radiopharmaceutical uptake in the prostate bed without a suspicious correlating anatomic abnormality, suspicious for

prostate cancer. Indeed, the retro-vesical region or prostate bed is a common site of local recurrence.[9] However, this radiopharmaceutical activity resolved on 120 minutes images consistent with physiologic activity in the genitourinary tract (Figures 3 A and B). In addition, a mildly ^{18}F-DCFPyL-avid right obturator node, which may have been missed on early imaging (SUVmax 1.7), showed increasing conspicuity on delayed imaging (SUVmax 2.6) consistent with malignant disease spread. The patient underwent external beam radiation of a single node detected on delayed imaging and his PSA became undetectable.

Case 4

62-year-old man with biochemically recurrent prostate cancer adenocarcinoma 14 years post radical prostatectomy (PSA was 1.3 ng/mL), was referred for PSMA-PET/CT. The creatinine was 78 μmol/L. Focal intense radiopharmaceutical uptake in a small peri-ureteric left external iliac lymph node on images obtained 60 minutes following radiopharmaceutical administration, increased in conspicuity at 120 minutes consistent with prostate cancer spread. On the other hand, focal intense uptake in the right peri-ureteric region on images obtained 60 minutes following radiopharmaceutical administration, resolved at 120 minutes consistent with physiologic activity in the genitourinary tract. Repeat delayed imaging in cases of urine activity is helpful to avoid upstaging or downstaging cases.

Discussion

While the ratio of target-to-background radiopharmaceutical uptake on PSMA-targeted PET/CT typically decreases over time in benign and physiologic processes, it increases in malignant disease, making dual time-point imaging helpful.[10,11] As illustrated above, benign uptake such as ganglion uptake and urine activity were reduced and cleared on delayed images while involved nodes showed interval increase in conspicuity. Unfortunately, practical considerations including workflow issues and patient preference may limit implementation of dual time-point imaging in clinical practice.[7] Given issues of accessibility, dual time point imaging could be reserved for characterization of equivocal findings. While checking individual cases prior to a patient leaving the department may be an option for centers with low PSMA PET/CT volume, ultimately, if a choice must be made to perform either early and late imaging, an uptake time of 120 minutes is preferred.[10] This is true regardless of whether the radiopharmaceutical used for PSMA-targeted PET is labeled with gallium-68 or fluoride-18.[10-14]

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Figures and Tables

Fig. 1A. Case 1: Total body images obtained 60 minutes following intraveous^{18}F-DCFPyL administration showed intense focal radiopharmaceutical uptake in a left internal iliac lymph node and mild focal uptake in para-aortic soft tissue to the left of the aortic bifurcation.

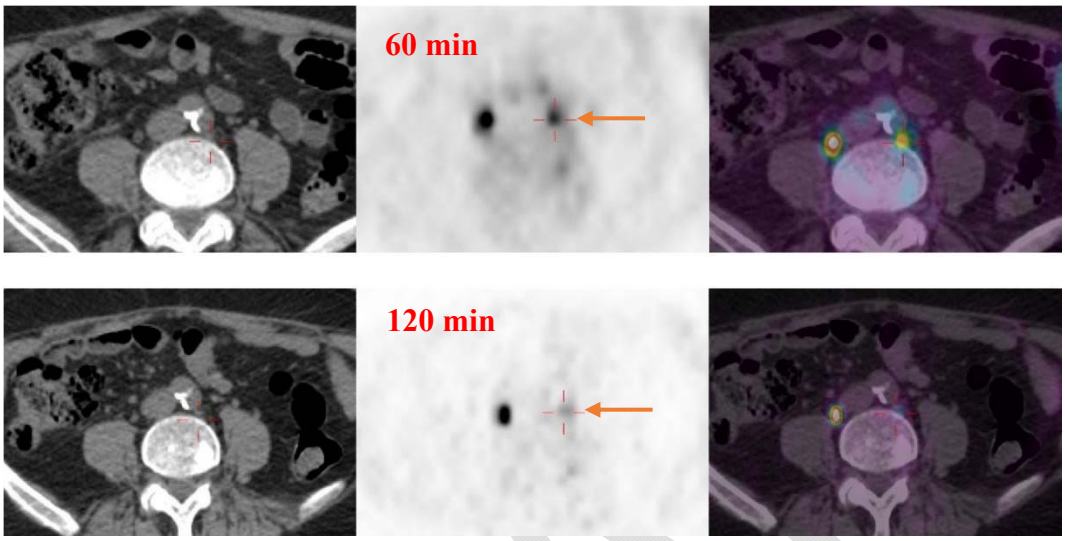


Fig. 1B. Case 1: Additional imaging of the pelvis performed 120 minutes post-radiopharmaceutical injection showed interval increase uptake in the left internal iliac lymph node consistent with prostate cancer spread and interval decrease in uptake in the para-aortic soft tissue consistent with the organ of Zuckerkandl.

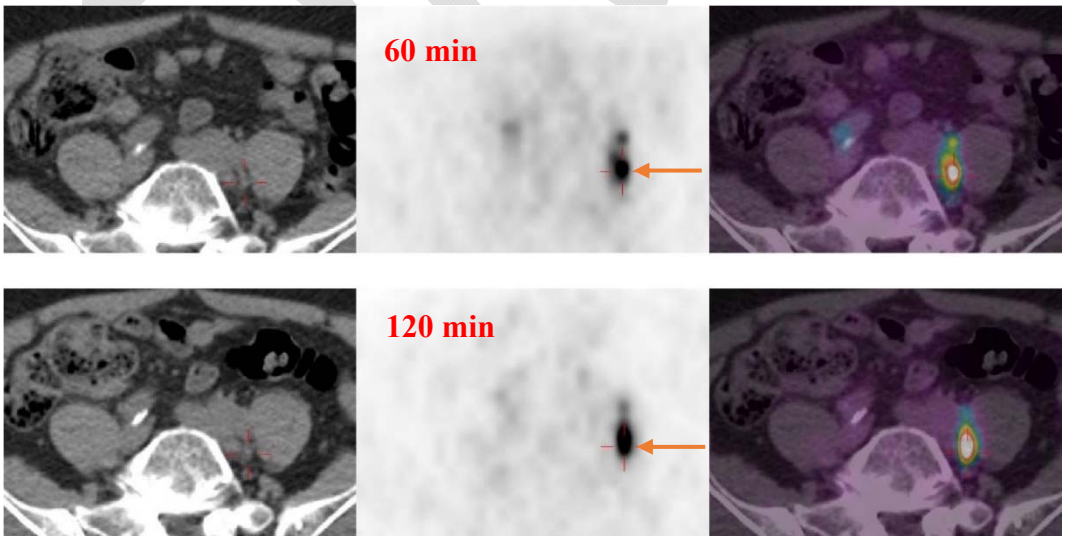


Fig. 2. The images obtained 60 minutes following intravenous ^{18}F-DCFPyL administration showed equivocal mild focal uptake in a prevertebral soft tissue nodule (Figure 2A). Interval increase in the radiopharmaceutical uptake on delayed images obtained 120 minutes following intravenous ^{18}F-DCFPyL administration, however, was consistent with prostate cancer spread to a small pre-sacral lymph node (Figure 2B)

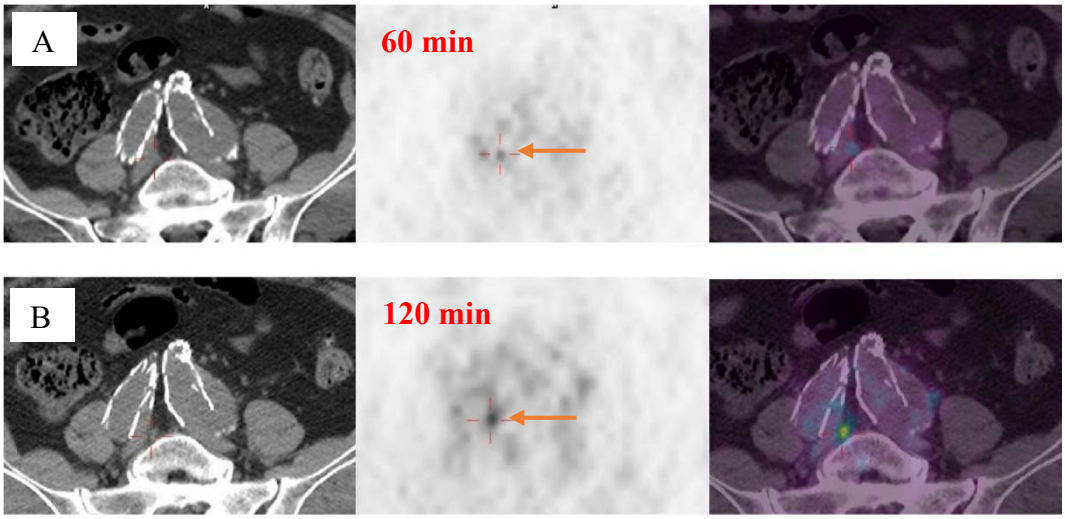
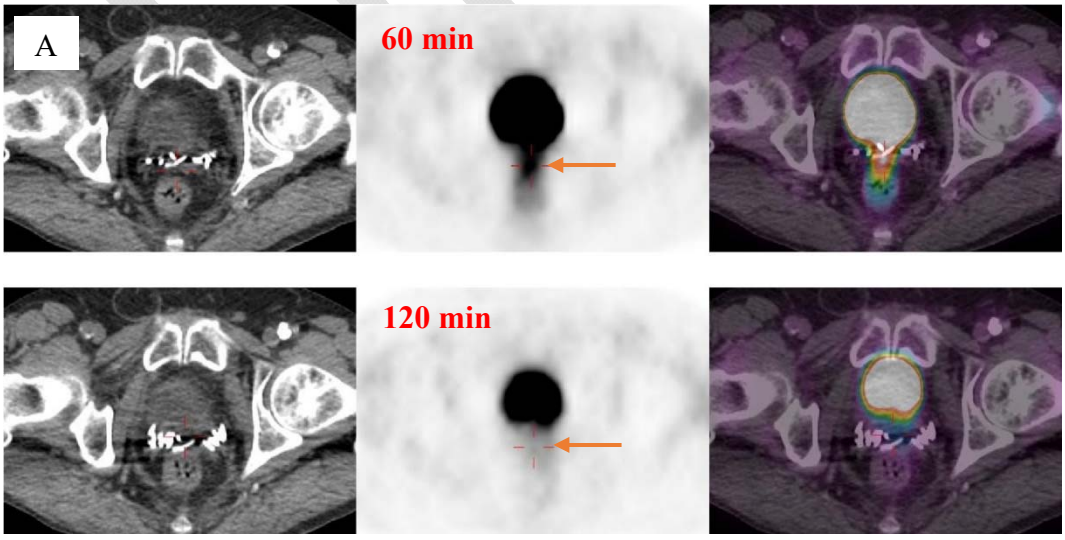


Fig. 3. Case 3: The images obtained 60 minutes following radiopharmaceutical administration showed intense focal radiopharmaceutical uptake in the prostate bed without a suspicious correlating anatomic abnormality, suspicious for prostate cancer. However, this radiopharmaceutical activity resolved on 120 minutes images consistent with physiologic activity in the genitourinary tract.



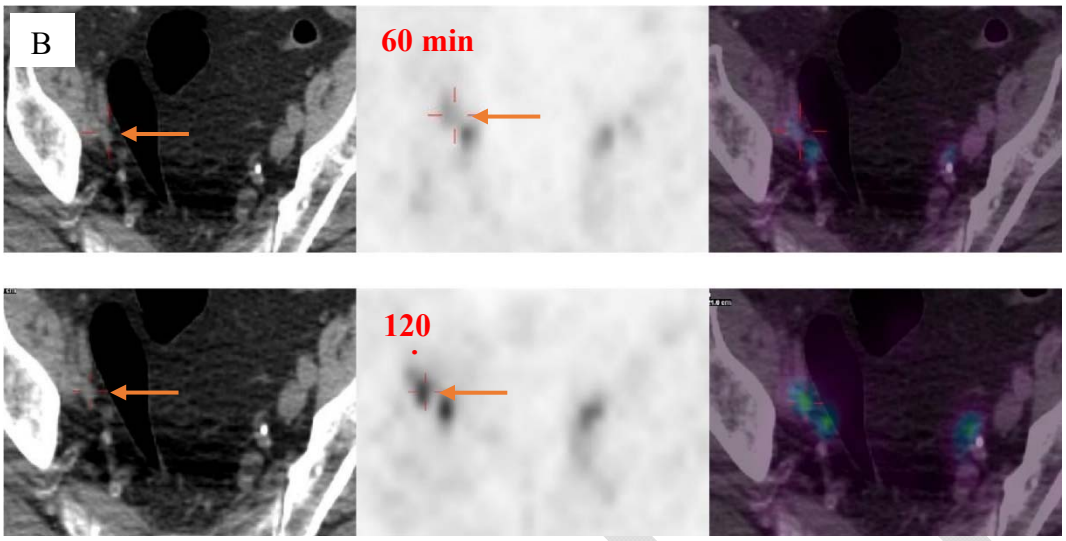


Fig. 4. Case 4: Focal intense radiopharmaceutical uptake in a small peri-ureteric left external iliac lymph node on images obtained 60 minutes following radiopharmaceutical administration, increased in conspicuity at 120 minutes consistent with prostate cancer spread