PET-CT/Clinical Case Study

Theranostics, a New Approach to Patient Management: Pre- and Post-Radioligand Therapy PSMA PET-CT Imaging with Cartesion Prime

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Introduction

It is estimated that 299,010 new cases of prostate cancer will be diagnosed in the United States in 2024.[1] Prostate cancer is affecting quality of life and is a leading cause of cancer-related mortality and morbidity. Novel PET imaging tracers, targeting the Prostate-Specific Membrane Antigen (PSMA) overexpressed in prostate cancer cells,[2] have shown very promising results in the management of prostate cancer patients. F-18 and Ga-68 based PSMA PET imaging agents have recently been cleared by the FDA for imaging of patients with suspected prostate cancer metastasis who are candidates for therapy or suspected recurrence based on elevated prostate-specific antigen (PSA) level.[3] National Comprehensive Cancer Network (NCCN) guidelines and Society of Nuclear Medicine and Molecular Imaging (SNMMI) Appropriate Use Criteria (AUC) were recently expanded to allow PSMA PET imaging for screening of patients to determine Pluvicto™ eligibility.

This case study presents the utility of PET-CT imaging for patient evaluation pre- and post- Radioligand Therapy (RLT) with Pluvicto™. The images were acquired by Cartesion Prime PET-CT, an air-cooled Premium Digital TOF PET scanner, by Canon Medical.

Patient History

Patient with prior prostate cancer diagnosis, treatment with prostatectomy and radiation, rising PSA and known skeletal metastases, was referred for initial assessment with Prostate-Specific Membrane Antigen (PSMA) PET-CT imaging.

Imaging and Findings

An initial PET-CT PSMA scan with Canon Medical's Cartesion Prime digital TOF PET-CT scanner was performed with a 64-minute post injection delay of 8 mCi of Piflufolastat F-18 (PYLARIFY®). The workflow was streamlined using the variable bedtime (vBT) feature on Cartesion Prime PET-CT that enabled extended acquisitions over the pelvis for three beds at three minutes each and at two minutes for three beds covering the anatomy beyond the pelvic region. The total scan time was 15 minutes. Images were reconstructed using OSEM with 3 iterations and 12 subsets, point-spread-function and Gaussian postfilter with 6 mm FWHM. Acquired non-contrast CT data were reconstructed with Canon Medical's Deep Learning Reconstruction method, Advanced intelligent Clear-IQ Engine (AiCE) for CT. The CT images were used for attenuation correction and anatomic localization of PET abnormalities.

The PET-CT PSMA scan confirmed widespread skeletal metastases and the patient was referred for radioligand therapy (RLT) with Pluvicto™. A follow-up Ga-68 Gozetotide (Illuccix®) PSMA PET-CT imaging study was performed with Cartesion Prime after six cycles of intravenously administered Pluvicto™ RLT at the recommended dosage of 200 mCi per cycle. The follow-up PET-CT scan demonstrated marked improvement compared to the previous PET-CT PSMA study.

The post-treatment whole-body PET-CT PSMA scan was performed 77 minutes after the injection of 5 mCi of Ga-68 Gozetotide (Illuccix®). The acquisition covered the anatomy from the cranial vertex to the toes for whole-body posttreatment follow-up assessment. The Variable bedtime (vBT) feature on Cartesion Prime PET/CT was used again to

setup extended acquisitions over and around the pelvic area for six bed positions at three minutes each and shorter acquisitions at one minute for five bed positions covering the remaining anatomy. The total PET scan time was 23 minutes. Images were reconstructed using OSEM with 3 iterations and 12 subsets, point-spread-function and Gaussian postfilter with 6 mm FWHM. Non-contrast CT data were reconstructed with AiCE for CT for attenuation correction and anatomic localization of PET abnormalities.

Tables 1 and 2 provide the acquisition parameters for the PET and CT scans.

Table 1

PET Parameters

Region Covered	BMI	Injected Dose	Total PET Acquisition Time	Acquisition Time	Number of Beds	Uptake Time	Reconstruction
Skull Vertex to Mid Thighs	29.4 kg/m^2	8 mCi Piflufolastat F-18	15 min	3x180 sec/bed + 3x120 sec/bed	6	64 min	TOF Listmode, OSEM
Skull Vertex to Toes	29.4 kg/m^2	5 mCi Ga-68 Gozetotide	23 min	6x180 sec/bed + 5x60 sec/bed	11	77 min	TOF Listmode, OSEM

Table 2

CT Parameters

Scan Mode	Collimation	kVp	mAs	HP	Rotation Time	Scan Range	Reconstruction
Helical	0.5 mm x 80	120	SURE Exposure	65	0.5 s	1010 mm	AiCE[4] for CT
Helical	0.5 mm x 80	120	SURE Exposure	65	0.5 s	1792 mm	AiCE[4] for CT

MIP coronal PET images[5] acquired before RLT (Figure 1a) show multiple PET positive lesions with intense PSMA uptake within blastic metastases throughout the spine, pelvis, and skeletal chest wall. Posttreatment MIP whole body PET image (Figure 1b) shows marked reduction in extent and prominence of PSMA-expressing prostate cancer compared to the pretreatment MIP image on the left.

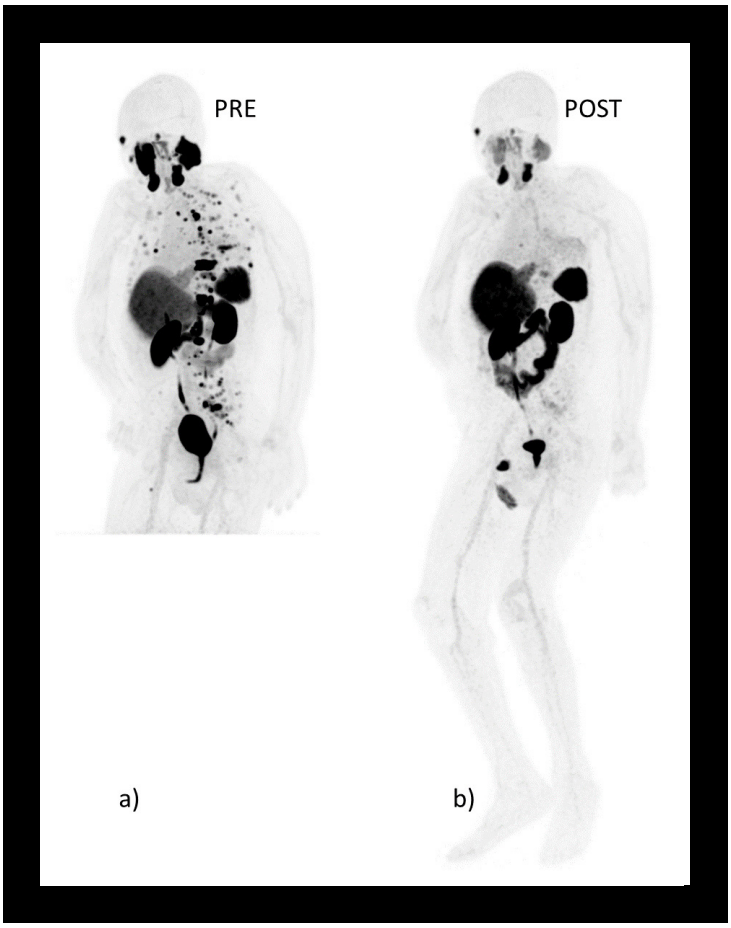

Figure 1: Pre- and post-RLT MIP PET images.

Conclusion

PSMA PET imaging plays a significant and growing role in cancer patient management with the continuous advances in novel tracers, theranostics, new treatments, and PET technology. Initial PET PSMA images showing multiple metastatic lesions indicated that this patient could be a candidate for subsequent radioligand therapy with Pluvicto™. PET-CT imaging following RLT showed markedly reduced presence of PSMA-expressing prostate cancer both in extent and prominence. Cartesion Prime PET-CT resulted in images of excellent quality both for the pre- and post-RLT evaluation and guided patient management. Furthermore, the image quality of "time-cut" reconstructions demonstrated the possibility of PET acquisition time reduction for further potential workflow improvements with Cartesion Prime PET-CT.

Acknowledgment

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The clinical results, performance and views described in this case study are the experience of the author. Results may vary due to clinical setting, patient presentation and other factors. Many factors could cause the actual results and performance of Canon Medical's product to be materially different from any of the aforementioned. The views and opinions expressed in this case study are those of the presenter and do not necessarily reflect the views of Canon Medical Systems.

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1. https://www.cancer.org/cancer/prostate-cancer/about/key-statistics
2. Ceci, F., Oprea-Lager, D.E., Emmett, L. et al. E-PSMA: the EANM standardized reporting guidelines v1.0 for PSMA-PET. Eur J Nucl Med Mol Imaging 48, 1626–1638 (2021). https://doi.org/10.1007/s00259-021-05245-y
3. https://www.medscape.com/viewarticle/959838
4. Clinical results may vary due to clinical setting, patient presentation, and other factors.

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