Case report

Can Gallium-68 Prostate-specific Membrane Antigen Ligand be a Potential Radiotracer for Renal Cortical Positron Emission Tomography Imaging?

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Abstract

Gallium-68 prostate-specific membrane antigen (Ga-68 PSMA) ligand (HBED-CC) is a new promising positron emission tomography (PET) tracer for prostate cancer. Intense renal parenchymal uptake is a physiologic finding on Ga-68 PSMA ligand PET images. Evaluation of kidneys in low intensity demonstrates excellent distribution of this radiotracer in renal parenchyma with excellent image quality and resolution. In this article, we present the Ga-68 PSMA ligand PET renal images of four patients with prostate cancer. In two patients, there is normal distribution of radiotracer, and in other two, there are renal cysts causing parenchymal defects.

Keywords: Gallium-68 prostate-specific membrane antigen ligand, kidney, positron emission tomography, renal cortex, renal parenchyma

Introduction

Renal cortical scintigraphy with technetium-99 m dimercaptosuccinic acid (Tc-99 m DMSA) has been widely used for decades to assess renal parenchyma. It is mainly utilized to detect acute pyelonephritis or scarring from chronic pyelonephritis, for quantitative assessment of relative functioning renal parenchyma/split function, detection of ectopic kidney, and evaluation of renal abnormalities.[1-3] In routine studies with Tc-99 m DMSA, planar images in multiple projections are usually obtained. Single-photon emission computed tomography (SPECT) imaging is optional. SPECT/computed tomography (CT) image is not preferred in children due to additional radiation dose from CT. Although it is a sensitive study in detecting scarring due to recurrent urinary tract infections, long waiting time for imaging after radiotracer injection which is approximately 2–3 h and relatively long image acquisition time of 30–60 min are not well tolerated by children.

In recent years, gallium-68 prostate-specific membrane antigen (Ga-68 PSMA) ligand positron emission tomography (PET) imaging has gained high attention for accurate staging of primary prostate cancer and restaging after biochemical recurrence.[4-6] Because we incidentally recognized excellent uptake of this tracer in the renal parenchyma with high-resolution images, we decided to present renal parenchymal PET images of Ga-68 PSMA ligand in our four patients in this article.

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Materials and Methods

Ga-68 PSMA ligand PET/CT images were obtained in four patients with prostate cancer to evaluate the extent of disease and diagnose recurrence. Radiolabeling was carried out at another institute (Kuwait Cancer Control Center). Images were obtained at Philips Time of Flight PET/CT camera. PET images were obtained 60 min following intravenous injection of 222 MBq (6 mCi) Ga-68 PSMA ligand. Before PET image acquisition, a low-dose CT was obtained for attenuation correction and anatomic localization purposes. PET acquisition was 3 min/bed from skull base to mid thighs. PET images were corrected for attenuation on the basis of the CT data and reconstructed using a standard iterative algorithm and reformatted into transaxial, coronal, and sagittal views. Maximum intensity projection images were also generated.

Due to intense uptake in the kidneys, PET images were reviewed in low intensity to better evaluate renal parenchymal uptake. Both attenuation corrected (AC) and uncorrected (non-AC) PET images as well as PET/CT fusion images were evaluated visually.

Results

Three patients were 66-year-old, and all had recently diagnosed prostate cancer (patients 1, 3, and 4). One patient had a history of prostate cancer with rising prostate-specific antigen value of 10 ng/ml (patient 2).

Figure 1 shows normal distribution of Ga-68 PSMA ligand (patient 4). Figure 2 shows normal renal parenchymal uptake of Ga-68 PSMA ligand (patient 1). Figure 3 shows normal renal parenchymal uptake of Ga-68 PSMA ligand with some mild pelvic excreted activity (patient 2).

Figure 4 shows focal renal parenchymal defect in the upper pole of the right kidney due to cyst (patient 3). Figure 5 demonstrates multiple renal parenchymal defects on PET corresponding to the multiple cysts seen on CT images (patient 4).

Discussion

PSMA is a Type II transmembrane protein with enzymatic activity which is mainly found in prostate tissue and is overexpressed in prostate cancer. It is also expressed in some other extraprostatic normal tissues including kidneys and malignancies.[7,8] In an immunohistochemical analysis, detectable PSMA levels were identified in a subset of proximal renal tubules as well as some other tissues.[7]

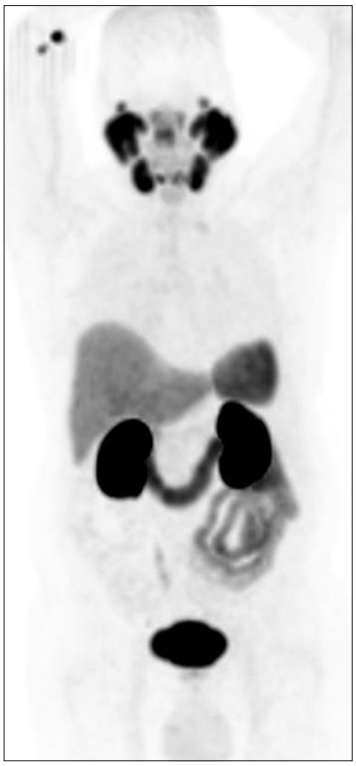

Figure 1: Gallium-68 prostate-specific membrane antigen ligand maximum intensity projection image shows normal distribution of radiotracer in lacrimal and salivary glands, liver, spleen, bowel, kidneys, and bladder

As clearly seen in our images of adult/elder patients, renal parenchymal uptake, image quality, and resolution with Ga-68 PSMA ligand PET appear to be excellent and better than Tc-99 m DMSA scintigraphy including planar, SPECT, and SPECT/CT. The majority of the excreted activity is already in the bladder at 60 min after radiotracer injection with no or mild pelvicalyceal activity to obscure parenchyma. For mild renal pelvic activity, images may be obtained with more delay at 90 min.

Effective and kidney radiation doses with Ga-68 PSMA ligand appear to be comparable or may be even less than Tc-99 m DMSA scintigraphy for per 37 MBq (1 mCi) of each radiotracer although this could be further studied.[9,10] Ga-68 has also shorter half-life (68 min) than Tc-99 m (6 h).

Given high renal image quality in non-AC images, CT AC may not be necessary. This is particularly important for children to further reduce radiation dose. If there is need for CT, mainly in adults, it should include only renal region with 1 or 2 bed positions and abdominal and pelvic region if there is question for ectopic kidneys. Image acquisition time and waiting period after radiotracer injection are also significantly less with Ga-68 PSMA ligand PET imaging than with Tc-99 m DMSA

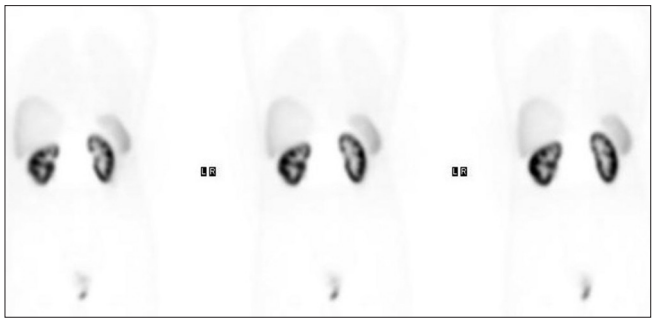

Figure 2: Selected nonattenuation-corrected coronal gallium-68 prostate-specific membrane antigen ligand positron emission tomography images demonstrate excellent localization of radiotracer in renal parenchyma with high-resolution images. Due to patient motion positron emission tomography attenuation corrected and positron emission tomography/computed tomography fusion images are not shown. Note the focal uptake in the primary tumor in the left portion of the prostate gland with possible local extension to surrounding tissues

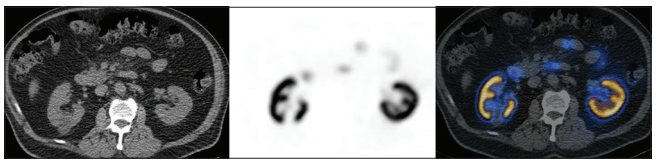

Figure 4: Selected transaxial computed tomography, positron emission tomography, and positron emission tomography/computed tomography fusion images of the kidneys demonstrate focal renal parenchymal defect in the upper pole of the right kidney posteriorly due to cyst (arrow)

scintigraphy, approximately 5–6 min and 60–90 min versus 30–60 min and 2–3 h.

Main limitation of Ga-68 PSMA ligand PET imaging is its high cost as it requires PET camera, Ga-68 generator, and radiolabeling synthesis unit.

Ga-68 PSMA renal parenchymal images in our older age patients appear to be excellent, and we are expecting high quality maybe even better renal images in pediatric as well as young and middle-aged people although this should be further studied.

Conclusion

In hospitals with Ga-68 PSMA ligand availability, this tracer may substitute or be an alternative to Tc-99 m DMSA after careful radiation dosimetry and further renal imaging studies with this PET tracer, particularly in children.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

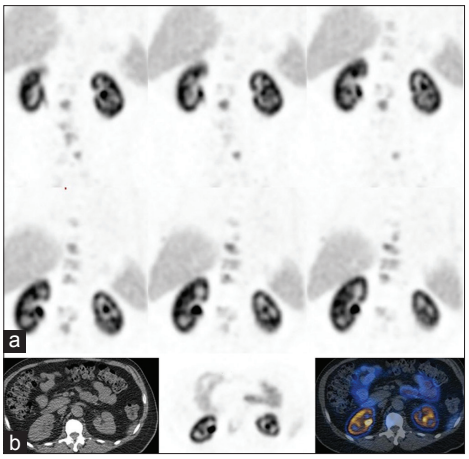

Figure 3: Selected coronal (a) and transaxial computed tomography, positron emission tomography and fusion (b) images of the kidneys demonstrate excellent parenchymal localization of radiotracer in renal cortex with mild bilateral pelvic activity which does not seem to obscure renal parenchyma. Note multiple bone metastases

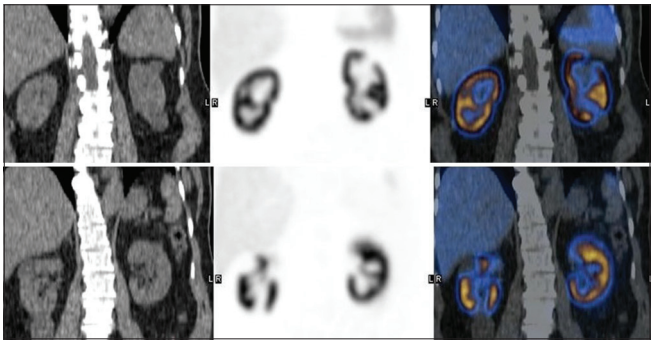

Figure 5: Selected coronal computed tomography, positron emission tomography, and positron emission tomography/computed tomography fusion images of the kidneys demonstrate multiple renal parenchymal defects on positron emission tomography corresponding to the multiple cysts seen on computed tomography images (arrows)

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