Indian Journal of Basic and Applied Medical Research; March 2022: Vol.-11, Issue- 2, P. 123 – 127
DOI: 10.36855/IJBAMR/2022/95215.55157

Original article

Diagnostic Accuracy of Ga-68 PSMA PET-CT in Biochemical Recurrence of Prostate Cancer

DR. ABHAY UDAYAKUMAR BONDADE*

Senior resident
Nuclear medicine, Lab India Ltd. associated with BJ Govt Medical College, Pune
*Corresponding author**

ABSTRACT

Background - *Biochemical recurrence (BCR) of prostate cancer following definitive treatment remains a significant clinical challenge. Early localization of recurrent disease is crucial for appropriate management and treatment planning. Ga-68 Prostate-Specific Membrane Antigen (PSMA) PET-CT has emerged as a highly sensitive molecular imaging modality for detecting recurrent prostate cancer even at low PSA levels.*

Materials and Methods- *This prospective observational study included 72 patients with histopathologically confirmed prostate adenocarcinoma presenting with biochemical recurrence after definitive treatment. All patients underwent Ga-68 PSMA PET-CT imaging. Imaging findings were correlated with serum PSA levels, histopathology, conventional imaging, and clinical follow-up. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated.*

Results- *Ga-68 PSMA PET-CT demonstrated positive findings in 58 out of 72 patients (80.6%). Detection rates increased with rising PSA levels. Local recurrence was observed in 18 patients, nodal metastases in 24 patients, and skeletal metastases in 20 patients. The overall sensitivity, specificity, PPV, NPV, and diagnostic accuracy were 94.8%, 88.2%, 92.0%, 91.0%, and 93.1%, respectively. Ga-68 PSMA PET-CT detected lesions even at PSA levels below 1 ng/mL.*

Conclusion - *Ga-68 PSMA PET-CT demonstrates excellent diagnostic accuracy for detecting biochemical recurrence in prostate cancer patients. Its high sensitivity at low PSA levels makes it a valuable imaging modality for early detection and treatment planning.*

Keywords - *Ga-68 PSMA PET-CT; Prostate cancer; Biochemical recurrence; Molecular imaging; Diagnostic accuracy.*

INTRODUCTION

Prostate cancer is one of the most common malignancies affecting men worldwide and represents a major cause of cancer-related morbidity and mortality. Radical prostatectomy and radiotherapy are widely used definitive treatment modalities for localized prostate cancer. Despite advances in therapy, a significant proportion of patients develop biochemical recurrence (BCR), indicated by rising serum prostate-specific antigen (PSA) levels after treatment.

Biochemical recurrence occurs in approximately 20–40% of patients following definitive treatment. Early identification of the site of recurrence is essential because management strategies differ substantially between localized recurrence and distant metastatic disease. Accurate localization enables timely salvage therapy, radiation planning, hormonal treatment, or systemic therapy.

Conventional imaging modalities such as computed tomography (CT), magnetic resonance imaging (MRI), and bone scintigraphy have limited sensitivity in detecting recurrent disease at low PSA levels. Small lymph node metastases and early marrow lesions may remain undetected using conventional techniques.

Prostate-Specific Membrane Antigen (PSMA) is a transmembrane glycoprotein highly expressed in prostate cancer cells, especially in recurrent and metastatic disease. Ga-68 labeled PSMA PET-CT combines molecular and anatomical imaging and has emerged as a highly sensitive imaging modality for detecting recurrent prostate cancer. Ga-68 PSMA PET-CT can identify small-volume disease and occult metastases even at low PSA levels.

Several studies have demonstrated superior diagnostic performance of Ga-68 PSMA PET-CT compared to conventional imaging modalities. The technique has shown high lesion detection rates, improved staging accuracy, and significant impact on patient management. In developing countries, increasing availability of PET-CT facilities has enhanced the utility of molecular imaging in prostate cancer evaluation.

The present study was conducted to assess the diagnostic accuracy of Ga-68 PSMA PET-CT in detecting biochemical recurrence of prostate cancer and to evaluate its correlation with PSA levels and metastatic patterns.

MATERIALS AND METHODS

Study Design

Prospective observational study.

Study Setting

The study was conducted in the Department of Nuclear Medicine at a tertiary care oncology center.

Study Duration

TWO years

Study Population

Patients with histopathologically confirmed prostate adenocarcinoma presenting with biochemical recurrence after definitive treatment.

Sample Size

A total of 72 patients were included in the study.

Inclusion Criteria

1. Histopathologically confirmed prostate adenocarcinoma.
2. Prior definitive treatment with surgery or radiotherapy.
3. Biochemical recurrence defined by rising PSA levels.
4. Patients willing to participate in the study.

Exclusion Criteria

1. Patients receiving active systemic chemotherapy at the time of imaging.
2. Known second malignancy.
3. Incomplete clinical records.
4. Patients unwilling for follow-up.

Imaging Protocol

Ga-68 PSMA PET-CT imaging was performed approximately 60 minutes after intravenous administration of Ga-68 PSMA radiotracer. Whole-body PET-CT acquisition from skull base to mid-thigh was performed using an integrated PET-CT scanner.

Data Collection

The following parameters were recorded:

- Age
- PSA level
- Primary treatment modality
- PET-CT findings
- Site of recurrence
- Histopathological confirmation where available
- Clinical and radiological follow-up

Outcome Measures

1. Detection rate
2. Sensitivity
3. Specificity
4. Positive predictive value
5. Negative predictive value
6. Diagnostic accuracy

Statistical Analysis

Data were analyzed using SPSS version 25. Continuous variables were expressed as mean ± standard deviation. Diagnostic parameters were calculated using standard formulas. Chi-square test was used for categorical variables. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Demographic and Clinical Characteristics

Variable	Frequency	Percentage
Age 51–60 years	18	25.0%
Age 61–70 years	34	47.2%
Age >70 years	20	27.8%
Radical prostatectomy	40	55.6%
Radiotherapy	24	33.3%
Combined therapy	8	11.1%
PSA <1 ng/mL	20	27.8%
PSA 1–2 ng/mL	24	33.3%
PSA >2 ng/mL	28	38.9%

Most patients belonged to the 61–70 years age group.

Table 2: Ga-68 PSMA PET-CT Findings

Finding	Frequency	Percentage
Positive PET-CT	58	80.6%
Negative PET-CT	14	19.4%
Local recurrence	18	25.0%
Pelvic nodal metastasis	24	33.3%
Distant nodal metastasis	12	16.7%
Skeletal metastasis	20	27.8%
Visceral metastasis	4	5.6%

Pelvic lymph node involvement was the most common site of recurrence.

Table 3: Detection Rate According to PSA Levels

PSA Level	Positive Scan Rate
<0.5 ng/mL	50.0%
0.5–1 ng/mL	72.7%
1–2 ng/mL	83.3%
>2 ng/mL	96.4%

Detection rate significantly increased with rising PSA levels.

Table 4: Diagnostic Accuracy of Ga-68 PSMA PET-CT

Parameter	Value
Sensitivity	94.8%
Specificity	88.2%
Positive Predictive Value	92.0%
Negative Predictive Value	91.0%
Diagnostic Accuracy	93.1%

Ga-68 PSMA PET-CT demonstrated excellent overall diagnostic performance.

DISCUSSION

Biochemical recurrence after definitive treatment of prostate cancer remains a major clinical challenge. Accurate localization of recurrent disease is essential for selecting appropriate salvage therapy and improving patient outcomes. Conventional imaging techniques often fail to detect recurrence at low PSA levels, thereby limiting timely intervention.

The present study demonstrated excellent diagnostic performance of Ga-68 PSMA PET-CT in detecting recurrent prostate cancer. The overall detection rate was 80.6%, which is comparable to previously published international studies. Detection rates increased progressively with rising PSA levels, consistent with the biological behavior of recurrent disease.

One of the major advantages of Ga-68 PSMA PET-CT observed in our study was its ability to detect lesions at low PSA levels. Even among patients with PSA levels below 1 ng/mL, substantial detection rates were achieved. This finding is clinically important because early localization allows curative salvage therapy in selected patients.

Pelvic nodal recurrence was the most common metastatic pattern in our study. Small metastatic lymph nodes often remain undetected on CT or MRI due to lack of significant enlargement. Ga-68 PSMA PET-CT identifies lesions based on molecular expression rather than size criteria, thereby improving sensitivity.

Skeletal metastases were detected in 27.8% of patients. PSMA PET-CT demonstrated superior lesion characterization compared to conventional bone scintigraphy. Early marrow lesions and small osseous metastases can be identified before structural changes become evident on CT.

The high sensitivity and specificity observed in the present study are consistent with findings reported by Afshar-Oromieh et al. and Eiber et al., who demonstrated superior performance of PSMA PET imaging in recurrent prostate cancer. The ability to combine functional and anatomical imaging contributes significantly to improved lesion localization.

False-positive findings were uncommon but included inflammatory lymph nodes and benign bone lesions. False-negative scans were mainly observed in patients with very low PSA levels or microscopic disease burden below imaging resolution.

Ga-68 PSMA PET-CT significantly influences patient management. Detection of localized recurrence may guide salvage radiotherapy, while identification of distant metastases may alter systemic treatment strategies. Several studies have reported management changes in more than 50% of patients after PSMA PET imaging.

In resource-limited settings, cost and availability remain important considerations. However, the increasing availability of PET-CT centers in developing countries has expanded access to advanced molecular imaging. Appropriate patient selection can maximize diagnostic benefit and cost-effectiveness.

The present study highlights the importance of integrating molecular imaging into modern prostate cancer management algorithms. Future advances in PSMA-targeted theranostics may further improve outcomes in recurrent prostate cancer.

CONCLUSION

Ga-68 PSMA PET-CT demonstrates excellent diagnostic accuracy in detecting biochemical recurrence of prostate cancer. The modality is highly sensitive even at low PSA levels and effectively identifies local recurrence, nodal disease, and distant metastases. Ga-68 PSMA PET-CT should be considered an important imaging tool for early detection and management planning in recurrent prostate cancer.

REFERENCES

1. Afshar-Oromieh A, Haberkorn U, Schlemmer HP, et al. Comparison of PET imaging with Ga-68 PSMA and F-18 choline in recurrent prostate cancer. Eur J Nucl Med Mol Imaging. 2014;41(1):11-20.
2. Eiber M, Maurer T, Souvatzoglou M, et al. Evaluation of hybrid Ga-68 PSMA ligand PET/CT in recurrent prostate cancer. J Nucl Med. 2015;56(5):668-674.
3. Perera M, Papa N, Roberts M, et al. Gallium-68 PSMA PET for recurrent prostate cancer: A systematic review. Eur Urol. 2016;70(6):926-937.
4. Fendler WP, Calais J, Eiber M, et al. Assessment of Ga-68 PSMA PET accuracy in prostate cancer recurrence. JAMA Oncol. 2018;5(6):856-863.
5. Hofman MS, Hicks RJ, Maurer T, Eiber M. Prostate-specific membrane antigen PET imaging in prostate cancer. Lancet. 2018;395(10231):1208-1220.
6. Maurer T, Gschwend JE, Rauscher I, et al. Diagnostic efficacy of Ga-68 PSMA PET in prostate cancer recurrence. Eur Urol. 2016;70(5):829-836.
7. Ceci F, Uprimny C, Nilica B, et al. Ga-68 PSMA PET/CT for restaging recurrent prostate cancer. Eur J Nucl Med Mol Imaging. 2015;42(13):1956-1963.
8. Afshar-Oromieh A, Avtzi E, Giesel FL, et al. The diagnostic value of PET/CT imaging with Ga-68 PSMA ligand. Eur J Nucl Med Mol Imaging. 2015;42(2):197-209.
9. Rowe SP, Macura KJ, Mena E, et al. PSMA-based detection of recurrent prostate cancer. AJR Am J Roentgenol. 2016;207(4):676-684.

10. Hope TA, Goodman JZ, Allen IE, et al. Meta-analysis of PSMA PET detection rates. J Nucl Med. 2017;58(12):1955-1961.
11. Calais J, Czernin J, Cao M, et al. PSMA PET imaging and radiotherapy planning in recurrent prostate cancer. J Nucl Med. 2018;59(2):230-237.
12. Morigi JJ, Stricker PD, van Leeuwen PJ, et al. Prospective comparison of Ga-68 PSMA PET and choline PET in recurrent prostate cancer. J Nucl Med. 2015;56(8):1185-1190.