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Role of 18F-FDG PET/CT in the Evaluation and Staging of Breast Carcinoma in a tertiary care centre

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ABSTRACT

Breast carcinoma is the most common malignancy among women worldwide, and accurate staging is crucial for guiding appropriate therapy. Conventional imaging often fails to provide complete information regarding locoregional and distant disease. 18F-fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) offers a whole-body metabolic and anatomical assessment in a single study.To evaluate the role of 18F-FDG PET/CT in the assessment and staging of breast carcinoma and to correlate metabolic activity with histopathological features.This hospital-based observational study included 40 histopathologically proven breast carcinoma patients who underwent 18F-FDG PET/CT over an 8-month period. PET/CT findings were analyzed for detection of primary lesions, regional lymph node involvement, and distant metastases. The maximum standardized uptake value (SUVmax) was measured and correlated with tumor grade and receptor status. Data were analyzed using descriptive and comparative statistical methods.18F-FDG PET/CT identified the primary breast lesion in 95% of patients, axillary nodal involvement in 75%, and distant metastases in 30%. PET/CT detected additional lesions not visualized on conventional imaging in 10% of cases, leading to upstaging in several patients. A significant positive correlation was observed between SUVmax and histological grade ($p = 0.002$).18F-FDG PET/CT is a highly sensitive and comprehensive imaging modality for evaluating breast carcinoma. It improves staging accuracy, detects unsuspected metastases, and provides valuable prognostic information through metabolic quantification.

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Key Words
Breast carcinoma, 18F-FDG PET/CT, SUVmax, staging, metastasis detection, tumor grade

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INTRODUCTION

Breast carcinoma continues to be the most frequently diagnosed cancer among women globally and represents a major contributor to cancer-related deaths. As reported by the World Health Organization, the incidence of breast cancer is steadily increasing, particularly in developing nations, where delayed diagnosis and limited availability of advanced diagnostic tools often result in advanced-stage presentation. Precise staging at the time of diagnosis is essential for selecting appropriate treatment strategies and predicting patient outcomes.

Traditionally, imaging modalities such as mammography, ultrasonography, and contrast-enhanced computed tomography have been used in the evaluation of breast cancer. Although these techniques are useful in identifying the primary tumor and assessing regional lymph node involvement, they may not reliably detect distant metastases or provide a complete overview of disease extent. Consequently, reliance solely on conventional imaging can sometimes lead to underestimation of disease stage.

The advent of 18F-FDG PET/CT has significantly improved oncologic imaging by integrating functional and structural information into a single examination. This technique is based on the increased glucose metabolism of malignant cells, allowing for the detection of both primary and metastatic lesions throughout the body. It is particularly valuable in identifying distant organ involvement and metastases in lymph node groups beyond the axilla, which may not be adequately visualized using conventional methods.

Multiple studies have highlighted the clinical utility of FDG PET/CT in the staging of breast carcinoma, especially in patients with locally advanced disease. The modality has demonstrated an ability to reveal previously unrecognized metastatic sites, thereby altering disease staging and influencing therapeutic decision-making. In addition to lesion detection, FDG PET/CT provides quantitative parameters such as the maximum standardized uptake value (SUVmax), which reflects tumor metabolic activity. Higher SUVmax values have been associated with more aggressive tumor characteristics, including higher histological grade and adverse biological behavior.

Against this background, the present study is undertaken to assess the role of 18F-FDG PET/CT in the evaluation and staging of breast carcinoma in a tertiary care centre. Furthermore, the study aims to examine the relationship between metabolic activity, as indicated by SUVmax, and histopathological features, thereby evaluating its potential role as a prognostic indicator.

Aim: To evaluate the role of 18F-fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) in the assessment, staging, and detection of metastatic disease in patients with breast carcinoma.

Objectives:

- To assess the diagnostic utility of 18F-FDG PET/CT in detecting the primary tumor, regional lymph node involvement, and distant metastases in breast carcinoma.
- To correlate the metabolic activity parameters (SUVmax) obtained on PET/CT with histopathological findings and clinical staging.

MATERIALS AND METHODS

Study Design and Setting: This was a hospital-based observational study conducted in the Department of Nuclear Medicine and Radiology, at a tertiary care centre over a period of 8 months.

Study Population

A total of 40 patients with a diagnosis of breast carcinoma who underwent 18F-FDG PET/CT for evaluation and staging were included in the study.

Inclusion Criteria:

- Patients with histopathologically or cytologically confirmed carcinoma of the breast.
- Patients referred for initial staging, restaging, or response assessment using FDG PET/CT.
- Adult patients ($\geq$18 years) of both sexes.

Exclusion Criteria:

- Pregnant or lactating women.
- Patients with uncontrolled diabetes mellitus (blood glucose >200 mg/dL at the time of tracer injection).
- Patients with recurrent breast carcinoma previously treated and currently under surveillance. Poor-quality
- or incomplete PET/CT studies.

Ethical Considerations: Institutional Ethical Committee approval was obtained prior to commencement of the study. All participants provided written informed consent before undergoing PET/CT scanning. Patient confidentiality was maintained throughout the study.

Data Collection: Clinical details, including patient demographics, histopathological diagnosis, tumor grade, and receptor status (ER, PR, HER2/neu), were collected from medical records. PET/CT findings were correlated with histopathological and clinical staging data.

Patient Preparation: Patients were instructed to fast for at least 6 hours prior to the scan.

Blood glucose levels were checked and confirmed to be below 150 mg/dL before 18F-FDG injection.
The patients were asked to rest in a quiet, dimly lit room before imaging to minimize muscular uptake of FDG.

Radiotracer Administration: Each patient received an intravenous injection of 18F-FDG at a dose of 5–7 MBq/kg body weight. The uptake period was 60 minutes before image acquisition.

Image Acquisition: Whole-body PET/CT scans were performed from the skull base to mid-thigh using a hybrid PET/CT scanner.

CT component: Low-dose, non-contrast CT for attenuation correction and anatomical localization (parameters: 120 kVp, 100-150 mAs).

PET component: 3D acquisition mode, 2-3 minutes per bed position. Images were reconstructed using an iterative algorithm and fused with corresponding CT images.

Image Analysis: Images were reviewed on a dedicated workstation by two experienced nuclear medicine physicians.

The following parameters were recorded:

- Presence and location of FDG-avid primary lesion.
- Regional lymph node involvement (axillary, internal mammary, supraclavicular).
- Distant metastases (lung, liver, bone, brain, etc.).
- Maximum standardized uptake value (SUVmax) for each lesion.
- The pattern and intensity of FDG uptake were correlated with histopathological grade and receptor status where available.
- Data Analysis
- Data were tabulated and analyzed using descriptive statistics.
- The frequency and distribution of primary and metastatic lesions detected by PET/CT were evaluated.
- Correlation between SUVmax and histological tumor grade / receptor status was assessed using appropriate statistical tests (e.g., Pearson or Spearman correlation).
- A p-value < 0.05 was considered statistically significant.
- Outcome Measures
- Diagnostic yield of PET/CT for detection of primary, nodal, and metastatic lesions.
- Correlation of SUVmax with tumor grade and clinical stage.
- Identification of additional metastatic lesions not detected on conventional imaging.

RESULTS AND DISCUSSIONS

Most patients were in the 40-60 year age group, with invasive ductal carcinoma being the predominant histological type. Nearly one-third of patients had high-grade tumors (Table 1).

A significant positive correlation was observed tumors due to reduced metabolic activity. PET/CT between SUVmax and tumor grade, indicating that metabolically more active tumors tend to have higher histological grades (Table 2).

FDG PET/CT demonstrated superior detection capability compared to conventional imaging, especially for nodal and distant metastatic lesions, altering staging in several cases (Table 3 and 4).

In this study, 18F-FDG PET/CT demonstrated high utility in staging breast carcinoma, particularly for nodal and distant disease. The predominance of invasive ductal carcinoma and intermediate-to-high tumor grades is consistent with patterns reported in tertiary care populations.

The primary tumor detection rate of 95% in our study is comparable with recent literature, although false-negative findings may occur in small or low-grade showed improved detection of axillary and extra-axillary nodal disease compared to conventional imaging, supporting evidence that it has higher sensitivity for nodal staging and systemic evaluation. Distant metastases were identified in 30% of patients, with additional lesions detected in 10% of cases, resulting in stage modification. This aligns with recent Distant metastases were identified in 30% of patients,

Table 1: Demographic and Clinical Characteristics of the Study Population (n = 40)

Parameter	Category	No. of Patients (n)	Percentage (%)
Age group (years)	<40	8	20.0
	40–49	12	30.0
	50–59	13	32.5
	≥60	7	17.5
Laterality	Right breast	22	55.0
	Left breast	18	45.0
Histopathological type	Invasive ductal carcinoma	33	82.5
	Invasive lobular carcinoma	4	10.0
	Others (medullary, mucinous, etc.)	3	7.5
Histological grade	Grade I	8	20.0
	Grade II	19	47.5
	Grade III	13	32.5
Receptor status	ER/PR positive	23	57.5
	HER2 positive	9	22.5
	Triple-negative	8	20.0

Table 2: Detection of Lesions by 18F-FDG PET/CT (n = 40)

Site of Lesion	No. of Positive Cases	Detection Rate (%)	Mean SUVmax±SD
Primary breast lesion	38	95.0	10.4±4.3
Axillary lymph nodes	30	75.0	8.7±3.9
Internal mammary nodes	5	12.5	6.1±2.2
Supraclavicular nodes	4	10.0	7.8±2.9
Distant metastases	12	30.0	9.9±3.5
Bone	6	15.0	—
Lung	3	7.5	—
Liver	2	5.0	—
Others (brain/ovary)	1	2.5	—

FDG PET/CT successfully identified the primary lesion in 95% of cases. Axillary lymph node involvement was seen in 75% of patients, and distant metastases were detected in 30%

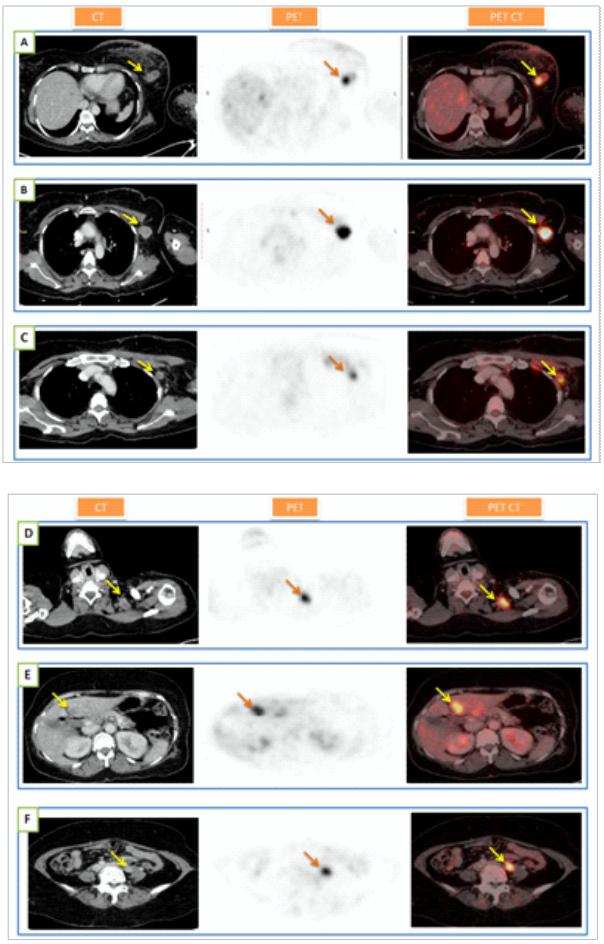
Table 3: Correlation of SUVmax with Histological Tumor Grade

Tumor Grade	No. of Patients (n)	Mean SUVmax ± SD	Range	p-value
Grade I	8	6.8 ± 2.1	4.2–9.3	0.002*
Grade II	19	9.7 ± 3.2	5.8–15.4	
Grade III	13	13.6 ± 4.1	8.2–20.1	

*Statistically significant difference (ANOVA test)

Table 4: Comparison of FDG PET/CT Findings with Conventional Imaging

Parameter	Conventional Imaging (USG/MRI/CT)	FDG PET/CT	Additional Findings on PET/CT
Primary lesion detected	37 (92.5%)	38 (95.0%)	1 additional multifocal lesion
Regional lymph node metastases	26 (65.0%)	30 (75.0%)	4 additional nodal sites
Distant metastases	8 (20.0%)	12 (30.0%)	4 new metastatic sites (bone/liver/lung)
Overall detection accuracy	—	—	PET/CT identified 10% more lesions overall



A 53-year-old female with a biopsy-proven carcinoma of the left breast underwent evaluation with contrast-enhanced CT, PET, and fused PET/CT imaging.
(A) A heterogeneously enhancing, lobulated mass with spiculated margins is identified in the outer quadrant of the left breast, consistent with the primary tumor. The lesion demonstrates internal non-enhancing necrotic areas. The fat planes with the pectoralis muscle posteriorly and the overlying skin anteriorly are preserved, with no definite evidence of direct invasion. Associated dermal thickening is noted.
(B) An enlarged left axillary lymph node, **(C)** a left interpectoral (deep pectoral) lymph node, and **(D)** an enlarged left supraclavicular lymph node are seen, all demonstrating loss of fatty hilum, rounded morphology, and central necrotic areas, suggestive of nodal metastases.
(E) A hypoenhancing lesion in segment IVb of the liver is noted, consistent with metastatic involvement.
(F) An enlarged enhancing left common iliac lymph node with central non-enhancing necrotic areas is also identified, in keeping with metastatic disease.

with additional lesions detected in 10% of cases, resulting in stage modification. This aligns with recent studies demonstrating that PET/CT frequently reveals occult metastases and leads to significant changes in staging and management decisions . The advantage of whole-body imaging in a single session contributes to improved staging accuracy compared to multiple conventional modalities.

A significant positive correlation between SUVmax and tumor grade (p = 0.002) was observed, indicating that metabolically active tumors tend to be biologically aggressive. This finding is supported by recent evidence showing that FDG uptake correlates with tumor biology, receptor status, and prognostic factors.

Overall, the findings of this study are consistent with recent literature supporting FDG PET/CT as a comprehensive imaging modality that improves staging accuracy, detects occult metastases, and provides additional prognostic information in breast carcinoma.

Limitation: However, limitations such as reduced sensitivity for small lesions and low-grade histologies must be recognized. Future studies with larger sample sizes and molecular correlation may further clarify the prognostic implications of metabolic parameters such as SUVmax, metabolic tumor volume, and total lesion glycolysis.

CONCLUSION

The present study demonstrates that 18F-FDG PET/CT plays a pivotal role in the comprehensive evaluation and staging of breast carcinoma. It provides accurate whole-body assessment, enabling simultaneous visualization of the primary tumor, regional nodal spread, and distant metastases in a single imaging session. In our series of 40 patients, PET/CT showed a high detection rate for primary

lesions and metastatic sites, outperforming conventional imaging modalities in identifying additional nodal and distant lesions that influenced staging and management decisions.

A significant correlation between SUVmax and tumor grade observed in this study reinforces the value of FDG uptake as a marker of tumor aggressiveness and biological behavior. PET/CT also helped in differentiating metabolically active viable disease from post-treatment changes and non-specific findings, thereby improving diagnostic confidence.

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