THE UTILITY OF 18F-FDG PET/CT IN DETECTING RECURRENT BREAST CANCER AND ITS CORRELATION WITH SOME CLINICAL CHARACTERISTICS

Cao Van Trung[1], Nguyen Quang Toan[2*], Pham Lam Son[2], Pham Van Thai[1,3]

ABSTRACT

Objective: To evaluate the role of 18F-FDG PET/CT in detecting recurrent breast cancer lesions and its association with various clinical characteristics.

Materials and Methods: A cross-sectional descriptive study was conducted on 32 patients at Vietnam National Cancer Hospital who were diagnosed with recurrent breast cancer based on histopathological confirmation and subsequently underwent 18F-FDG PET/CT for evaluation.

Results: The mean age of the 32 female patients was 53.7 years (range: 39-74 years). The most common histopathological subtype was infiltrating duct carcinoma, not otherwise specified (59.4%). Recurrence was most commonly detected in stage II (43.8%) and stage III (34.4%), with 56.3% of cases presenting with lymph node metastases prior to treatment. The most common sites of recurrence were the lymph nodes (53.1%) and chest wall (18.8%). The median time to recurrence detection was 25 months. 18F-FDG PET/CT accurately identified recurrent disease in 28 cases (sensitivity: 87.5%), with a mean SUVmax of 10.2. Additionally, metastatic lesions in other locations were detected in 15 out of 28 cases. Higher SUVmax values were observed in patients with advanced-stage disease, lymph node metastases, ER-negative status, PR-negative status, and HER2-positive tumors. No significant difference in SUVmax was observed among different histopathological subtypes.

Conclusion: 18F-FDG PET/CT demonstrates high sensitivity in detecting recurrent breast cancer lesions and reveals variations in SUVmax values associated with clinical and paraclinical characteristics. However, given the limited sample size, further studies with larger cohorts are required to validate these findings.

Keywords: Recurrent breast cancer; 18F-FDG PET/CT; clinical - paraclinical characteristics.

[1]Ha Noi Medical University;
[2]Vietnam National Cancer Hospital;
[3]Bach Mai Hospital.

*Corresponding Author: bsquangtoan@gmail.com

Date received: 22/3/2025
Date reviewed: 03/4/2025
Date accepted for publication: 10/4/2025

1. INTRODUCTION

Breast cancer (BC), as defined by the World Health Organization (WHO), is a malignant disease characterized by the uncontrolled proliferation of breast glandular cells, leading to tumor formation. According to GLOBOCAN 2022, breast cancer ranks as the second most common cancer worldwide, with 2,296,840 new cases, and the fourth leading cause of cancer-related mortality, accounting for 666,103 deaths[1].

Recurrent breast cancer occurs in approximately 20% of breast cancer patients and is often associated with a poor prognosis. The median survival time for patients with recurrent breast cancer ranges from 9 to 36 months; however, early detection of recurrence can improve survival outcomes[2, 3].

In addition to conventional imaging modalities such as ultrasound, computed tomography (CT), and magnetic resonance imaging (MRI), several studies have demonstrated that 18F-FDG PET/CT is a highly accurate diagnostic tool for detecting recurrent breast cancer, with a reported sensitivity of 90-97% and specificity of 71-93%[4-7]. The interpretation of 18F-FDG PET/CT findings is influenced by multiple factors, particularly clinical and paraclinical characteristics. Therefore, patient stratification based on these factors is crucial for optimizing imaging indications and ensuring accurate diagnosis. However, limited research has been conducted on the correlation between clinical characteristics and imaging findings on 18F-FDG PET/CT in recurrent breast cancer. Thus, this study aims to evaluate the role of 18F-FDG PET/CT in detecting recurrent breast cancer lesions and its association with specific clinical and paraclinical characteristics.

2. PATIENTS AND METHODS

2.1. Patients

This study included 32 female patients diagnosed with recurrent breast cancer based on histopathological findings. All patients had completed curative treatment at least six months prior and were identified with suspected recurrent lesions on ultrasound, computed tomography (CT), or magnetic resonance imaging (MRI) at Vietnam National Cancer Hospital between April 2023 and November 2023. Suspicious lesions were confirmed by cytological or histopathological examination, and all patients underwent 18F-FDG PET/CT for disease evaluation.

- The study excluded patients who had two or more distinct primary cancers.

2.2. Methods

- Study design: Cross-sectional descriptive study.

- Sampling method: Convenience sampling.

- Data analysis: Data were processed using Excel 2016 and SPSS 26. One-way ANOVA was applied to analyze differences between groups.

- 18F-FDG PET/CT Imaging Protocol:

+ 18F-FDG was produced by the cyclotron (HIC-KOTRON13) and PET/CT was performed using the PET/CT system (GE Discovery IQ).

+ The 18F-FDG PET/CT imaging procedure was conducted following the EANM (EARL standards). All patients were instructed to fast for at least 6 hours before imaging. At the time of the tracer injection, patients should have had a blood glucose level of less than 140 mg/dL. Before and after injection, patients were kept lying comfortably in a quiet, dimly lit room. Image acquisition was started 45-60 minutes after intravenous administration of FDG (0.15 mCi/kg body weight).

- Image Interpretation:

+ Two nuclear medicine specialists independently reviewed the images.

+ Lesions presenting with abnormal anatomical findings on CT and abnormal FDG uptake on PET

were classified as malignant.

+ SUVmax was determined based on a 1 mL region of interest (ROI) at the site of recurrence on 18F-FDG PET/CT.

- Histopathological and immunohistochemical classification followed the 2012 WHO classification system, while disease staging was conducted according to the AJCC 8th edition [8, 9].

3. RESULTS

3.1. Characteristics of the patients

The study included 32 female patients with recurrent breast cancer. The mean age was 53.7 ± 1.6 years, ranging from 39 to 74 years. The median time to recurrence was 25 months. The earliest recurrence was observed at 7 months, while the latest recurrence occurred at 212 months post-treatment.

Table 1. Histopathological characteristic initial pre-treatment

Histopathological type	Percentage (%)	No. of patients (n)
Infiltrating duct carcinoma, NOS	59,4	19
Lobular carcinoma, NOS	6,3	2
Other histological types	34,4	11
Total	100	32

Table 2. Immunohistochemical characteristics initial pre-treatment

	Positive		Negative	
	Percentage (%)	Number of patients (n)	Percentage (%)	Number of patients (n)
ER (Estrogen receptor)	62,5	20	37,5	12
PR (Progesteron receptor)	46,9	15	53,1	17
HER-2	37,5	12	62,5	20

Table 3. Staging initial pre-treatment

Staging initial pre-treatment	Percentage (%)	No. of patients (n)
Stage I	21,8	7
Stage II	43,8	14
Stage III	34,4	11
Stage IV	0	0
Lymph node metastasis status before treatment		
Lymph node metastasis	56,3	18
No lymph node metastasis	43,8	14

Comment: In the present study, the majority of patients had invasive ductal carcinoma, no special type (59.4%). The most common immunohistochemical profile was ER-positive (62.5%), PR-negative (53.1%) and HER-2-negative (62.5%). The most frequently observed disease stages before treatment were Stage II (43.8%) and Stage III (34.4%). Lymph node metastasis was present in 56.3% of patients before treatment.

Table 4. Recurrent disease locations

Recurrence site	Percentage (%)	No. of patients (n)
Lymph nodes	53,1	17
Chest wall	18,8	6
Lungs	9,4	3
Liver	9,4	3
Bones	9,4	3
Total	100	32

Comment: The most common recurrence sites in this study were lymph nodes (53.1%) and chest wall (18.8%).

3.2. The role of 18F-FDG PET/CT in diagnosing recurrent breast cancer

Table 5. Role of 18F-FDG PET/CT in diagnosing recurrent breast cancer

	No. of patients recurrence	Total no. of patients (n)	Sensitivity (%)
18F-FDG PET/CT	28	32	87,5%
Histopathology	32	32	
Additional lesions detected on 18F-FDG PET/CT	15/28 patients		
Mean SUVmax: 10,2 ± 0,9			

Comment: 18F-FDG PET/CT demonstrated a high sensitivity (87.5%) in detecting recurrent breast cancer with the mean SUVmax of recurrent lesions was 10.2 ± 0.9, indicating a high metabolic activity in these lesions. Additional, metastatic lesions were detected in 53.6% of cases using 18F-FDG PET/CT.

3.3. Correlation between 18F-FDG PET/CT and clinical, paraclinical characteristics

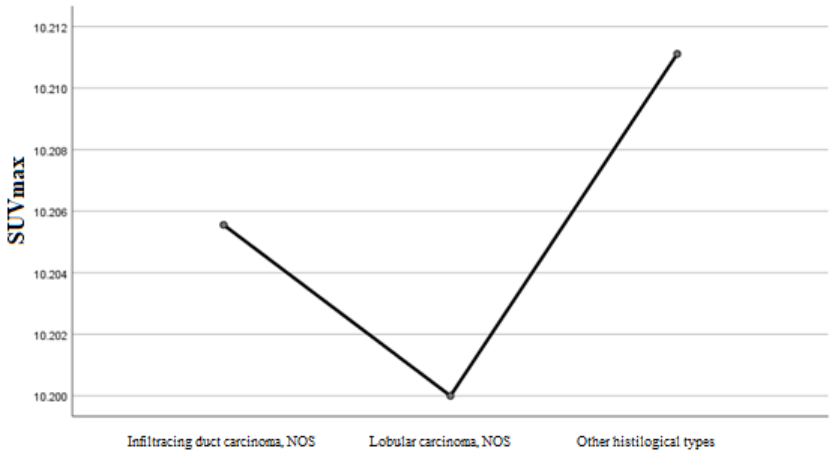


Figure 1. Correlation between SUVmax and histopathological characteristics

Comment: The SUVmax values for the three histopathological subtypes were 10.2 ± 1.2, 10.2, and 10.2 ± 1.8, respectively. There was no significant difference in SUVmax among the different histopathological subtypes on 18F-FDG PET/CT.

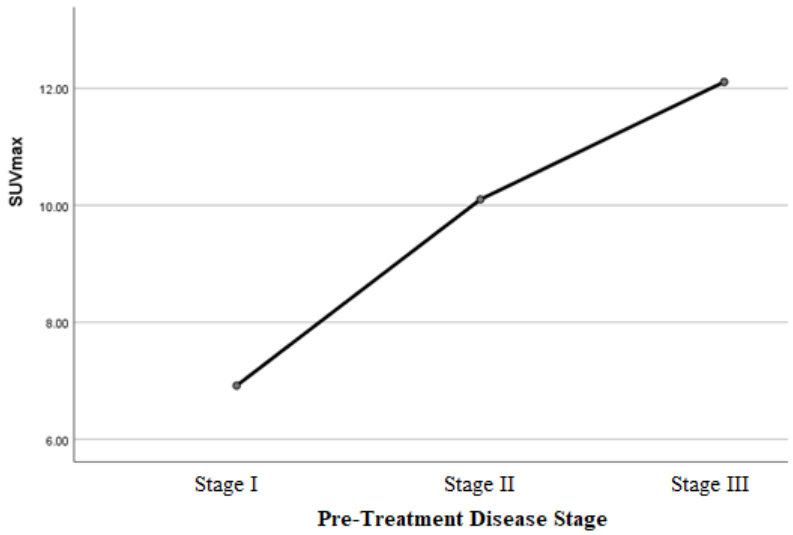


Figure 2. Correlation between SUVmax and initial pre-treatment disease stage

Comment: There was a trend of increasing SUVmax with more advanced pre-treatment disease stages, however, the difference was not statistically significant (p = 0.16).

Table 6. Correlation between SUVmax and lymph node metastasis initial pre-treatment

Patient characteristics		Have lymph nodes metastasis	No lymph node metastasis	Total
PET/CT positive	Number of patient (n)	17	11	28
	Mean SUVmax	11,7±1,3	7,7±1,2	-

Comment: Patients with pre-treatment lymph node metastasis had significantly higher SUVmax values than those without metastasis, the difference was statistically significant (p = 0.02).

Table 7. Correlation between SUVmax and immunohistochemical markers

Characteristics / Immunohistochemical Marker		PET/CT positive		PET/CT negative
		No of patients (n)	Mean SUVmax	
ER	Positive	16	7,7±0,9	4
	Negative	12	13,6±1,3	0
PR	Positive	12	7,6±1,2	3
	Negative	16	12,1±1,2	1
HER-2	Positive	12	11,9±1,6	0
	Negative	16	8,9±1,0	4

Comment: SUVmax was significantly higher in ER-negative and PR-negative groups, with p-values of 0.01 and 0.02, respectively. HER-2 positive patients had higher SUVmax than HER-2 negative patients, but the difference was not statistically significant (p = 0.12).

4. DISCUSSION

The study included 32 patients, with an average age of 53.7 ± 1.6 years. Before treatment, most patients were in stages II and III, with a high rate of lymph node metastasis. Regarding histopathological characteristics, invasive ductal carcinoma was the predominant subtype, which is also the most common histological type of breast cancer. The recurrence time in the study group ranged from 7 to 212 months, with a median of 25 months. The most frequent recurrence sites were local and regional (lymph nodes and chest wall, accounting for 79.1%), consistent with the typical recurrence pattern of breast cancer.

In this study, we compared the detection capability of 18F-FDG PET/CT for recurrent lesions with histopathological/cytological results. The findings demonstrated that the sensitivity of 18F-FDG PET/CT in diagnosing recurrent breast cancer was 87.5%, with an average SUVmax of 10.2 ± 0.9, facilitating the visualization of lesions on imaging. These results align with previous studies, such as Taalab et al. (2017), which evaluated 18F-FDG

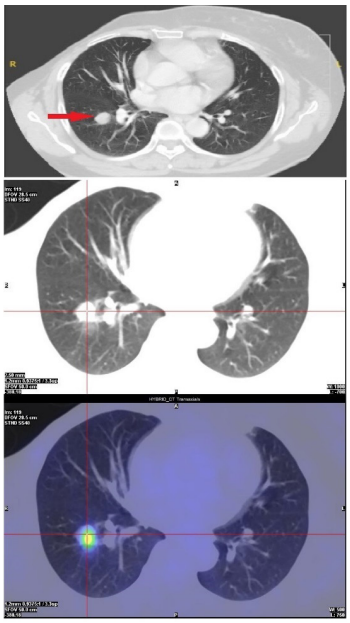
PET/CT in 37 patients with recurrent breast cancer, and Dong et al. (2015), which investigated the role of CA15-3 and 18F-FDG PET/CT in diagnosing recurrent breast cancer. These studies consistently highlight the high diagnostic accuracy of 18F-FDG PET/CT for detecting breast cancer recurrence [5, 6]. Additionally, in our study, 18F-FDG PET/CT identified additional suspicious recurrent lesions in 15 out of 28 patients with positive PET/CT findings. This represents a significant advantage of this imaging modality over conventional diagnostic techniques, which typically detect lesions at only a single site.

Our analysis of the relationship between 18F-FDG PET/CT characteristics and histopathological features in this study revealed no significant difference in SUVmax among different histopathological subtypes. However, a study conducted by Almir Galvão Vieira Bitencourt et al. (2014) reported a significant difference in SUVmax between invasive ductal carcinoma and other histological subtypes[10]. Since both studies had small sample sizes, further research is necessary to confirm these findings. Regarding disease stage, our study demonstrated that patients with more advanced disease stages or lymph node metastases exhibited higher SUVmax values compared to those in earlier stages or without lymph node involvement. This may be explained by the biological characteristics of cancer, as higher disease stages are associated with increased tumor burden and greater potential for metastasis. With respect to hormone receptor status, our results showed that patients with ER-negative or PR-negative tumors had significantly higher SUVmax values compared to those with positive hormone receptor expression. This finding is consistent with a 2023 study by Cornelis M. de Mooij et al., which also demonstrated a correlation between the immunohistochemical characteristics of breast cancer and 18F-FDG PET/CT findings. [11]. Regarding HER-2 status, our study found that SUVmax values were higher in HER-2-negative cases than in HER-2-positive cases, but this difference was not statistically significant ($p = 0.12$). In contrast, the study by Cornelis M. de Mooij et al. reported a similar trend, but their results were statistically significant ($p = 0.004$). This discrepancy may be attributed to the small sample size of our study, which may not have been sufficient to detect a significant difference.

Clinical case: A 53-year-old female patient was diagnosed with infiltrating duct carcinoma, NOS breast cancer, stage III, with lymph node metastasis in 2004. Her immunohistochemical profile was ER (-), PR (-), HER-2 (+), and she underwent surgical treatment followed by adjuvant chemotherapy. During a routine follow-up, a solitary pulmonary nodule in the right lung was detected on CT imaging. Histopathological examination of the lung lesion confirmed metastatic carcinoma originating from the breast. To further assess the extent of the disease, the patient underwent FDG-PET/CT imaging.

5. CONCLUSION

The 18F-FDG PET/CT imaging technique demonstrates high accuracy in diagnosing recurrent breast cancer. In our study, we observed that patients with a more advanced initial diagnosis stage, lymph node metastasis, ER-negative, PR-negative, and HER2-positive status exhibited higher SUVmax values. This suggests that 18F-FDG PET/CT may have greater diagnostic value in patients with these characteristics. However, further studies with larger patient cohorts and a broader range of clinical variables are necessary to fully establish the diagnostic utility of 18F-FDG PET/CT across different breast cancer subtypes.



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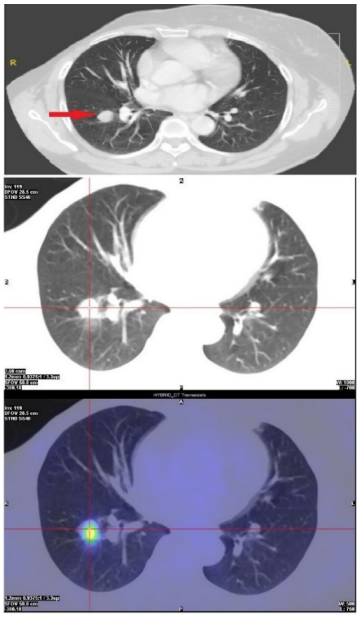

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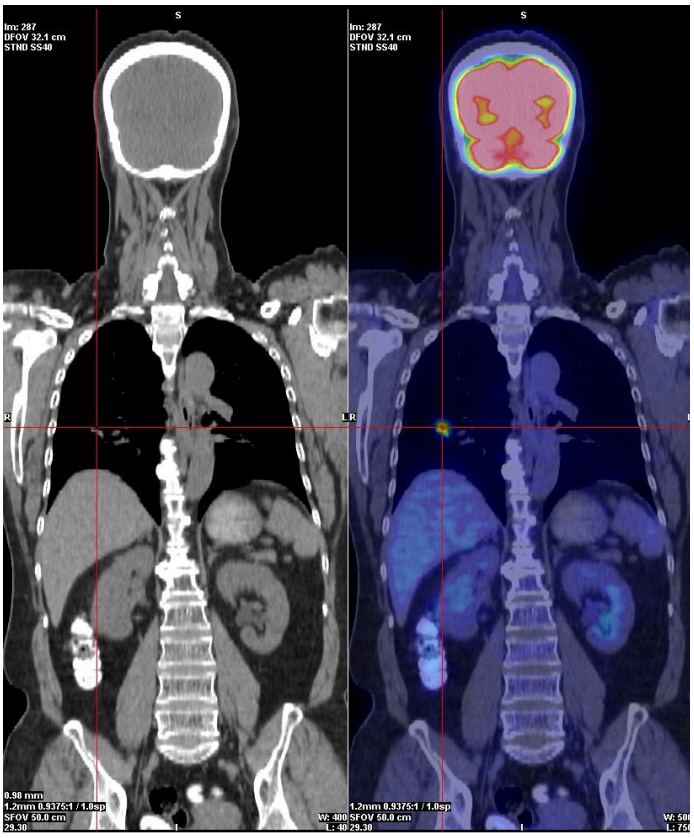

C

Figure 3. CT imaging revealed a solitary pulmonary nodule in the left lung (arrow) (Figure A). Figures B - C: FDG-PET/CT imaging demonstrated increased FDG uptake at the lesion site, with an SUVmax of 17.2, raising suspicion of metastatic disease

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