Original Article

Evaluation of Diagnostic Accuracy and Impact of Preoperative Positron Emission Tomography/Computed Tomography in the Management of Early Operable Breast Cancers

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Abstract

Aim: Our aim of this study was to evaluate the diagnostic accuracy of staging positron emission tomography/computed tomography (PET/CT) in early breast cancers (EBCs) and to assess its impact on disease management. **Patients and Methods:** We retrospectively reviewed preoperative PET/CT scans of patients from January 2015 to December 2018 with Stage I/II, clinically T1–T2 N0–N1 breast cancers. The diagnostic performance of PET/CT for nodal (N) and distant metastases (M), its correlation with patient/tumor-specific factors, and its impact on disease management were analyzed using histopathology/clinical follow-up as standards of reference. **Results:** Of 158 patients evaluated, 14% of patients were Stage I (T1N0), 60% were Stage IIA (T1N1, T2N0), and 26% were Stage IIB (T2N1). Sensitivity, specificity, and the diagnostic accuracy of PET/CT for axillary staging were 76%, 97%, and 84% and for distant metastasis evaluation were 100%, 98%, and 99%, respectively. The diagnostic accuracy of PET/CT for axillary staging was lower for low-grade, T1 tumors, postmenopausal group, and luminal A pathological subtype (77%, 84%, 81%, and 73%, respectively) compared to high-grade, T2 tumors, premenopausal group, and nonluminal A subtype (88%, 88%, 94%, and 87%, respectively). Distant metastases were detected on PET/CT in overall 16% (n = 25) of the patients (9% in Stage IIA and 27% in Stage IIB). PET/CT also incidentally identified clinically occult internal mammary nodes in 5% (n = 8) and organ-confined synchronous second malignancies in 5% (n = 8) of the patients. **Conclusion:** Preoperative PET/CT should be considered in all EBCs> 2 cm as it upstages the disease and alters management in about 24% of these patients. Given its high specificity for axillary staging PET/CT, patients with PET-positive axilla can be subjected to axillary dissection and those with PET-negative axilla to sentinel lymph node biopsy. The yield and diagnostic accuracy of PET/CT is less for low-grade tumors <2 cm and with luminal A subtype.

Keywords: *Breast, cancer, early, fluorodeoxyglucose, positron emission tomography/computed tomography*

Introduction

With increased awareness and wider availability in breast cancer screening across the globe, breast cancer is increasingly being detected at a much earlier stage. Breast cancers are considered as early operable if there is clinically no extension of the primary tumor/axilla node disease to skin/chest wall or in the absence of extra-axillary nodes.[1] However, even after surgery, about 30% of these early breast cancers (EBCs) do recur on follow-up. Nearly 80% of these relapses are seen distally and the rest 20% are seen locally or in the contralateral breast.[2] The high incidence of distant relapse at follow-up suggests the possibility of micro-metastases at diagnosis or clinically occult macro-metastasis which was not identified as it is uncommon that patients with early cancers get referred for whole-body screening.

Staging fluorodeoxyglucose (FDG) positron emission tomography/computed tomography (PET/CT) is not generally recommended in EBC at diagnosis due to a low risk of distant metastasis and high incidence of false positives.[3] As per Oncology National Comprehensive Cancer Network (NCCN®) guidelines, PET/CT is generally not routinely recommended in Stage I, II, or operable Stage III tumor and is considered only optional for the evaluation of symptomatic patients.[4] This is despite the fact that multiple studies in

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the recent past suggesting that staging preoperative PET/CT might provide meaningful information and impact disease management in about 20%–30% of patients with clinical Stage IIB onward.[5-10]

The aim of this study was to evaluate the role of preoperative diagnostic PET/CT in the staging and management of early operable breast cancers (including patients with Stages I and II only, up to Stage IIB).

Patients and Methods

This was a retrospective analysis of preoperative PET/CTs of all EBCs acquired in our hospital from January 2015 to December 2018. Clinical stage was established after clinical and mammography examinations. In most patients, nodal staging was evaluated only after axillary clearance or sentinel lymph node biopsies (SLNBs). In few patients, ultrasound (US)-guided fine-needle aspiration cytology (FNAC) was done preoperatively to assess the axillary nodal status. Patients who received surgery, chemotherapy, or radiation for their breast cancers prior to PET/CT examination were excluded from the study. Other exclusion criteria were tumors without immunohistochemistry (IHC), previous history of any other cancers, uncontrolled diabetes mellitus, and pregnancy. All patients had at least 6 months of clinical follow-up with or without a follow-up imaging. The study was performed as per the guidelines of the institutional ethical committee.

Positron emission tomography/computed tomography, image interpretation, and statistics

Patients fasted for 6 h, and blood glucose was <180 mg/dl prior to the study in all patients. 6 MBq/kg FDG was intravenously injected in the arm, and scans were acquired after 60 min. Imaging was performed on a GE 5 ring PET/CT system Discovery IQ 5 Ring block detectors PET/CT (General Electric, Milwaukee, WI), combining Bismuth Germanium Oxide (BGO) - based PET crystal and 16-slice CT components. The patients were allowed to breathe normally. CT and PET data were acquired from mid-thigh level to the top of the skull with the arms raised. Intravenous contrast was used in most eligible patients, and CT was of diagnostic quality. PET emission counts were collected over 2 min/table position, acquired in a three-dimensional mode with VUE-pointHD (VPHD) reconstruction/Q. clear algorithm.

PET/CT scans were interpreted by two separate experienced nuclear medicine experts who were not made aware of the patients' histopathology or clinical details. Gold standard for the evaluation of PET/CT findings was histopathology or clinical follow-up (in the instance of distant metastasis). None of the distant metastatic lesions were biopsied. For nodal metastasis to be positive on PET/CT, we used only qualitative criteria and no size or standardized uptake value (SUV) threshold. Any axillary node showing higher FDG uptake than the adjacent background or higher uptake than the mediastinal blood pool was considered as positive. For most of the distant metastases, combination of both FDG uptake and CT findings was considered. Any focal abnormal increased uptake in any of the commonly involved visceral organs such as liver, skeleton, or lung, not explained by clinical obvious alternative clinical differentials, was considered as positive. For skeletal lesions, increased focal or multi-focal FDG nonarticular uptake with or without CT abnormalities was considered as positive. Diffuse FDG uptake in the bone marrow was considered as benign. For lung evaluation, any noncalcified solid pulmonary nodules with high FDG uptake or the presence of multiple small angiocentric nodules on the CT part even in the absence of increased FDG uptake were considered as positive. Care was taken to avoid overreporting of common physiologic/degenerative FDG uptakes (such as brown fats, traumatic rib fractures, facetal arthopathy, physiological FDG uptake in uterus and ovary in premenopausal age group, and FDG injection hotspots in lungs). However, FDG uptake in uterus and ovaries in a postmenopausal age group was reported as abnormal and further evaluation was advised to rule out malignancy.

Data analysis and statistics

The diagnostic performance and accuracy of PET/CT for nodal and M staging was analyzed using histopathology and clinical follow-up as standard of reference. The clinicopathological characteristics were analyzed in patients with or without axillary lymph node and distant metastasis using independent sample *t*-test or Chi-square tests. Chi-square tests were done to see if the yield and accuracy of PET/CT differs depending on the age, size of the tumor, and tumors' histopathology. $P \leq 0.05$ was regarded as indicating statistical significance. Analyses were performed using Statistical Package for social sciences (SPSS) version 23, IBM corporation, NY, USA.

Results

Patient/primary tumor characteristics and their association with axillary and distant metastasis status are summarized in Table 1.

Nearly 20% of the patients had T1 and 80% of the patients were T2 tumors. Clinical stage was Stage I (T1N0) in 14%, Stage IIA (T1N1, T2N0) in 60%, and Stage IIB (T2N1) in 26% of patients. Most of the primary tumors (92%) were invasive carcinoma of no special subtype. On IHC, the most common subtype was luminal B (ER+, PR+, Her2+, or Her2− with Ki-67 >30%) in 48% (n = 75) followed by triple-negative (all estrogen receptor [ER], progesterone receptor [PR], and Her2−) in 20% (n = 31), luminal A (ER+/PR+, Her2−, and Ki-67 <30%) in 20% (n = 30), and Her2-enriched tumor (ER−/PR− and Her2+) in 14% (n = 22) of patients. PET/CT detected all the primary tumors (mean SUV_{max} 8.53, range 1.40–38.47)

Table 1: Patient characteristics and N and M status

Characteristics	Total (*n*=158)	Node negative	Node positive	*P*	Metastasis absent	Metastasis present
Patient age, years	55.78±11.04	54.27±10.60	57.29±11.32	0.085*	55.26±10.79	58.52±12.11
Tumor size, cms	2.76±0.93	2.66±0.89	2.85±0.97	0.199*	2.64±0.91	3.38±0.83
Primary tumor SUVmax	8.54±5.07	7.89±4.21	9.19±5.76	0.107*	8.54±5.26	8.52±3.99
Axillary node SUVmax	7.56±4.37	3.02±0.03	7.72±4.37	0.137*	7.74±4.80	7.12±3.19
Tumour subtype						
A	30 (18.99%)	17 (21.52%)	13 (16.46%)	0.337#	24 (18.04%)	6 (24%)
B	75 (47.77%)	33 (41.77%)	42 (53.16%)		61 (45.86%)	14 (56%)
HER2	22 (13.92%)	10 (12.66%)	12 (15.19%)		19 (14.29%)	3 (12%)
TNBC	31 (19.62%)	19 (24.05%)	12 (15.19%)		29 (21.81%)	2 (8%)
Histologic grade						
Low (grade 1 and grade 2)	70 (44.31%)	40 (50.63%)	30 (37.97%)	0.109#	60 (45.11%)	10 (40%)
High (grade 3)	88 (55.69%)	39 (49.37%)	49 (62.03%)		73 (54.89%)	15 (60%)

*Independent *t*-test; #Chi square test; $P<0.05$ was considered as statistically significant

except in two cases with mucinous subtype. The mean SUV_{max} of primary tumor was 4.54 (range: 1.4–8.28) in luminal A type, 9.06 (range: 3.02–15.28) in luminal B subtype, 10.04 in Her2-enriched type (range 3.6–38.47), and 9.72 (range: 2.7–19.68) in triple-negative tumors.

Nodal staging

On clinical examination, 32% (n = 51/158) of patients had palpable mobile nodes (N1) and 68% (n = 107/158) had no palpable axillary nodes. Nodal staging was done either with SLNBs (in 27% patients, n = 44) or axillary dissection (in 56% of patients, n = 89). In the rest of the patients, nodal disease was identified on guided FNAC (n = 25). Overall, 50% of the recruited patients (n = 79/158) had nodal disease positive on histopathology or US-guided FNAC. Out of these 79 patients, PET/CT was positive in 70% of patients (n = 56). Beyond identifying axillary nodes, PET/CT identified clinically occult extra-axillary regional nodes such as ipsilateral internal mammary (IM) in 5% (n = 8) and infra-clavicular nodes in 3% (n = 6) of the patients. No significant association was noted between patient-/tumor-specific variable and probability of detection of nodal metastasis [Table 1].

The diagnostic accuracy of clinical examination and PET/CT for regional nodal and distant metastasis staging is summarized in Table 2. PET/CT was found to be more accurate than clinical examination owing to the high sensitivity of identification of subcentimeter-sized axillary nodes or nodes that are deep and are not clinically palpable. SLNBs done in 44 patients with PET-negative axilla were found to be positive nodes in 27% (n = 12) of patients. The overall sensitivity and specificity of PET/CT was 76% and 97%, respectively, for axillary staging. Although not statistically significant, PET/CT showed higher yield and accuracy for nodal staging in T2 compared to T1 tumors (P = 0.259), high-grade compared to low-grade tumors (P = 0.109), nonluminal A tumors compared to luminal A type tumors (P = 0.417). and premenopausal patients compared to postmenopausal patients (P = 0.093) [Table 3].

M staging

PET/CT identified distant metastases in overall 15.8% of the patients (n = 25/158), with isolated skeletal metastases noted in 28% of these patients (n = 7) [Figure 1]. The common visceral metastases noted was lung (n = 7) followed by mediastinal nodes (n = 4) and liver (n = 2). Surgery was differed in all the patients with distant metastases. All the patients with distant metastases had primary tumors >2 cm (P = 0.000), with eight patients having N0 disease (Stage IIA) and 17 patients having positive axillary nodes either clinically or on imaging (Stage IIB).

In two patients, PET/CT was falsely positive for distant metastasis. One patient had low-grade, FDG-avid multiple hypodense lesions in the liver, subsequently characterized as liver adenomas on the combination of magnetic resonance imaging/hepatobiliary scintigraphy. Another patient had 2.5-cm cortical lesion in the left kidney, which was proven to be papillary renal cell carcinoma on partial nephrectomy.

The overall sensitivity and specificity of PET/CT was 100% and 98%, respectively, for the identification of distant metastasis [Table 2].

Identification of nonbreast synchronous malignancies

PET/CT incidentally identified organ-confined synchronous malignancies in 5% of the patients (n = 8). All these were subjected to curative resection and were histopathologically confirmed as malignancy. These were papillary thyroid (n = 1), renal cell carcinoma,[2] Grade I neuroendocrine tumor (NET) pancreas (n = 1), carcinoma ovary (n = 1), carcinoma endometrium (n = 2), and adenocarcinoma sigmoid (n = 1) [Figure 2].

Discussion

Growth of the primary tumor and the metastasis of the

Table 2: Diagnostic performance of PET/CT for N and M staging

N staging	Sensitivity% (confidence interval %)	Specificity % (confidence interval %)	Positive Predictive value% (confidence interval %)	Negative predictive value % (confidence interval %)	Accuracy
Clinical examination	50% (22-77)	94% (42-99)	85% (42-99)	73% (51-88)	73%
PET/CT	76% (60-87)	97% (82-99)	97% (82-99)	76% (60-87)	84%
M staging PET/CT	98% (93-99)	100 (81-100)	88% (67-96)	100 (96-100)	99%

Table 3: Axillary staging accuracy of PET depending upon specific variables

Variables	Sensitivity%	Specificity %	Positive Predictive value %	Negative predictive value %	Accuracy %
T1	52	95	90	71	77
T2	80	98	97	81	88
Low grade	63	97	95	78	84
High Grade	80	97	97	79	88
Pre-menopausal	85	100	100	90	94
Post-menopausal	68	95	95	72	81
Luminal A	46	94	85	69	73
Luminal B	76	96	96	76	85
ER/PR-ve/HER2+	75	100	100	76	86
TNBC	75	100	100	86	90

same appear to be two separate autonomous processes as shown by an epidemiological study done by Engel *et al*.[11] In mouse models, it has been shown that dissemination of tumor cells can occur even in preinvasive stage of the tumor progression, and the number/genotype of seeded tumor cells is not just associated with tumor size.[12] Hence, the prevailing view that metastatic dissemination is a late event should be modified, and studies must be done to detect the spread of cancer early in order to improve the staging accuracy and plan appropriate/effective treatment. In our study, PET/CT upstaged the disease and impacted management in 21% (n = 33) of the patients by identifying clinically occult axillary, IM, or distant metastasis. The PET/CT upstaged cT1N0 to cT1N1 (Stage IA–IIA) in 2 patients, cT2N0 to cT2N1 (Stage IIA–IIB) in 11 patients, cT2N1M0 to cT2N3M0 in 3 (Stage IIB–IIIC) patients, cT2N0M0 to cT2N1M1 (Stage IIA–IV) in 5 patients, and cT2N1M0 to cT2N1M1 in 12 patients (Stage IIB–IV). Hence, upstaging of the disease in EBC and subsequent change in management can be expected in about 24% of patients undergoing preoperative PET/CT with primary tumor size >2 cm. PET/CT also correctly downstaged seven patients (three patients from cT1N1 to cT1N0 and four patients from cT2N1 to cT2N0), thereby changing the course of axillary disease management.

As per the NCCN guidelines, routine systemic staging is not indicated in the EBC in the absence of systemic symptoms.[4] Breast cancer, as we have seen it over the years, is a systemic disease, and 30% of patients operated in the early stage eventually present with distant metastases at follow-up. The high incidence of relapse in most cases suggests that some of these patients would have had clinically occult metastases which were not identified at presentation. In our study, we found that PET/CT detects distant metastasis and changes management in almost 20% of the patients with primary early operable breast cancers >2 cm, with most of these patients being clinically asymptomatic (98%). Our findings are in synchronization with the results of several similar studies done in EBCs (>2 cm) where distant metastasis was detected in 8%–19% of Stage IIB patients.[7-10]

In the present study, lungs and skeletal systems were the most common sites of distant metastases followed by mediastinum and liver. Although not statistically significant, distant metastasis was more frequently seen in patients having tumor of luminal B immunological subtype. On univariate analysis, except for tumor size >2 cm (P = 0.00), we were unable to find any significant predictors for distant metastasis on PET/CT [Table 1]. This finding suggests that the likelihood of distant metastasis in EBC being detected on PET/CT increases with increasing size and may not be related to aggressive tumor biology. None of the metastatic lesions identified at presentation on PET/CT were biopsied and were evaluated only at clinically follow-up (average follow-up 12.6 months, range 6–32 months). Out of these 25 patients, 19 patients had partial/complete response to systemic chemotherapy/hormonal treatment (these were mostly patients with metastatic disease limited to bone with minimal or no extraskeletal disease), 3 patients had progressive disease on chemotherapy, and 3 patients died. None of the patients with localized disease on PET/CT at presentation had evidence of disease recurrence on follow-up.

For regional nodal staging in carcinoma breast, preoperative detection of the axillary nodes has always

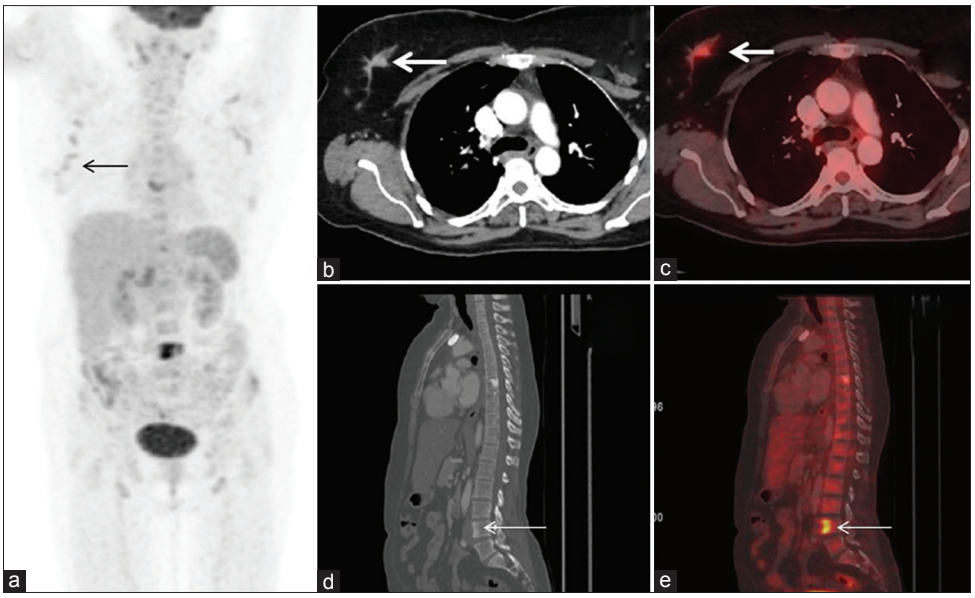

Figure 1: (a) Whole-body, maximum-intensity projection image showing focal low-grade uptake in the right breast (thin black arrow). (b and c): Transaxial contrast computed tomography and fused positron emission tomography/computed tomography images showing enhancing low-grade fluorodeoxyglucose-avid 2.1-cm in the right breast parenchyma (bold white arrows). (d and e) Sagittal computed tomography and fused positron emission tomography/computed tomography images showing metabolically active sclerotic lesions involving D7 and L4 vertebrae suggestive of metastasis (thin white arrows)

been challenging. The mean sensitivity of conventional staging (combination of the physical examination, mammography, and ultrasonography [USG]) is about 56%.[13] Adding PET/CT to axillary staging although marginally improves the diagnostic sensitivity of axillary staging, it is not significantly different from conventional imaging and definitely inferior to SLNB.[14] A meta-analysis done to assess the diagnostic accuracy of PET/CT for axillary nodal staging found PET/CT to have a mean sensitivity of 56% and a mean specificity of 96%.[15] A moderate sensitivity (76%) which was also the case in our study suggests that PET/CT is indeed inferior to SLNB or surgical staging. In our study, we found that patients with PET-negative axilla had 27% chance of being metastatic on SLNB. The high specificity of PET/CT in nodal staging which was reported in the meta-analysis and also our study (97%) suggests that patients with PET-positive axilla can proceed for axillary nodal clearance and SLNB can be avoided in such patients. SLNB is not readily available at majority of the centers in developing countries like India. Using the high positive predictive value of PET/CT for nodal staging may obviate the need for SLNB. This would be more helpful in centers which lack facilities/expertise for performing SLNB.

In our study, we also identified the patient-specific factors that can affect the accuracy of PET/CT in axillary staging. The false-negative rate of PET/CT was less in premenopausal age group compared to postmenopausal group (15% vs. 32%), high-grade tumors versus low-grade tumors (20% vs. 37%), T2 tumors compared to T1 (20% vs. 48%), and nonluminal A versus luminal A molecular subtype (25% vs. 54%) [Table 3]. This is expected as low-grade/luminal A type shows low FDG uptake (as seen in our study) compared to the more aggressive subtypes, leading to high incidence of false-negative findings. This is also the reason that in premenopausal patients (which are more common to have aggressive histology), PET/CT was more sensitive for diagnosing axillary disease than postmenopausal counterparts. We did not find any significant difference in the accuracy of PET/CT for axillary staging among the nonluminal A subtypes.

Beyond axilla, pretreatment identification of extra-axillary disease such as IM node appears to be advantageous from the point of view of a radiation oncologist to modify the treatment field for better disease control and improving disease-specific survival.[16] In this regard, PET/CT has found to be more sensitive and accurate than CT alone.[17] In our study, PET/CT identified IM node in 5% patients (n = 8/158) which led to modification in the radiation field. Most of the IM nodes identified in our study were subcentimeter sized showing low-grade FDG uptake, which was better seen on PET or PET/CT than CT alone (CT was positive only in 4/8 cases).

Spatial resolution of PET is hampered by partial-volume effects (PVEs), leading to underestimations of SUV, further compromising lesion detection.[18] In our study, we used advanced commercially available PET reconstruction algorithms that model the point spread function which improves spatial resolution throughout the entire field of view, reduces PVE, and improves image contrast.[19] In our study, we found that the mean SUV_{max} of axillary and IM nodes was 16% and 33% higher, respectively,

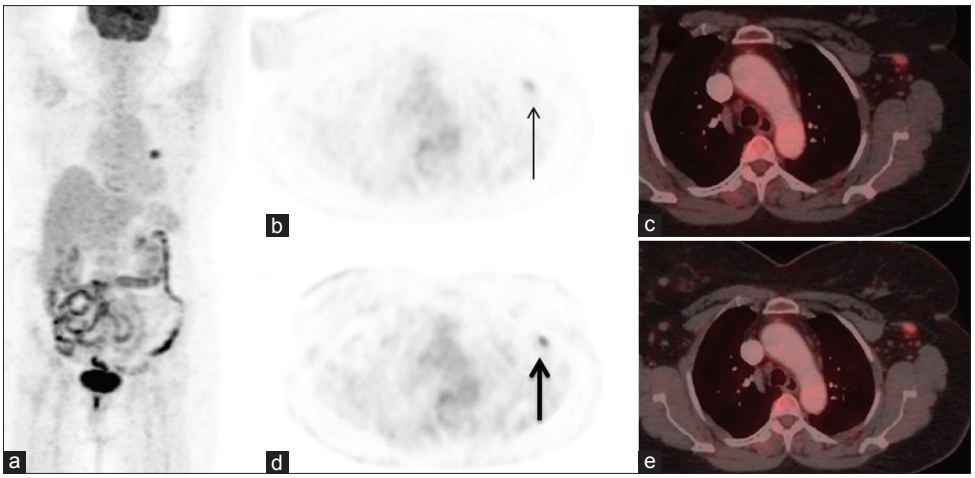

Figure 2: (a) Whole-body, maximum-intensity projection image showing focal intense uptake in the left breast. (b and c) Conventional reconstructive positron emission tomography and fused positron emission tomography/computed tomography images showing focal low-grade uptake in 1-cm-sized node in the left axilla – maximum standardized uptake value – 2.24 (thin black arrow). (d) Positron emission tomography with point spread function reconstruction and partial volume effect correction. (e) Fused positron emission tomography/computed tomography images showing increased contrast-to-noise ratio and maximum standardized uptake value – 3.87. Final histopathology was positive for nodal metastasis (bold black arrow)

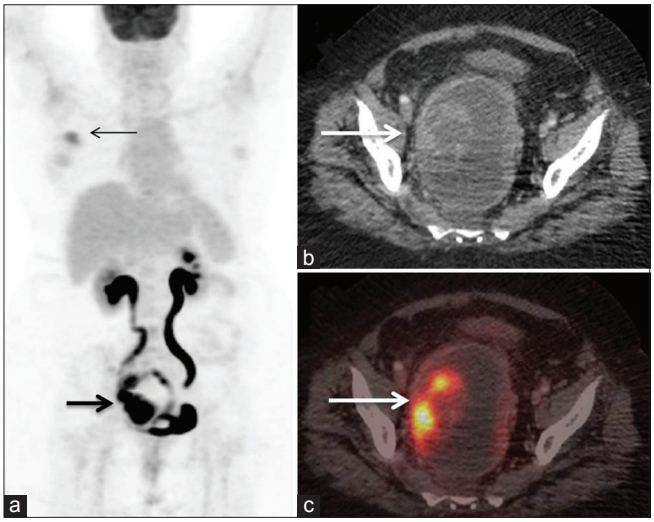

Figure 3: (a) Whole-body, maximum-intensity projection image showing focal increased uptake in the 2.5-cm lesion in the upper quadrant of the right breast (thin black arrow) and abnormal fluorodeoxyglucose-avid lesion in the right side of the pelvis (bold black arrow). (b and c) Transaxial contrast-enhanced computed tomography and fused positron emission tomography/computed tomography images showing incidentally detected large metabolically active solid cystic mass in the right adnexa (bold white arrows) confirmed as malignant posttotal abdominal hysterectomy and bilateral salpingo-oophorectomy

with Partial Volume correction PVC applied in PET image reconstructions[Figure 2]. Hence, we recommend PVC to be applied to acquire PET images to further improve the precision of PET/CT in nodal/extra-nodal staging in EBCs.

Another interesting observation in our study was the occurrence of synchronous malignancies on PET/CT in 5% (n = 8) of the patients at presentation. All of these tumors were clinically occult and were all histopathologically verified. These were papillary thyroid (n = 1), renal cell carcinoma,[2] Grade I NET pancreas (n = 1), carcinoma ovary (n = 1), Figure 3 carcinoma endometrium (n = 2), and adenocarcinoma sigmoid (n = 1). Most (n = 7/8) of these patients were postmenopausal, and all of them underwent curative resection of their respective malignancies. Detection of these cancers on PET/CT at presentation suggests that the occurrence of secondary malignancy in breast cancers is not always be related to chemotherapy/radiotherapy alone and might be related to genetic factors.[20] Care should be taken in interpreting the FDG uptake in the ovarian/endometrium in premenopausal age group, as most patients in this group show variable physiological FDG uptake in these organs depending on the time of menstrual cycle.[21] If possible, it is wise for premenopausal patients to undergo PET/CT few days after menstrual flow or a week before it to avoid mis-interpretation of ovarian/endometrial FDG uptake.[21] Similarly, any postmenopausal patients with FDG uptake in endometrium or any FDG-avid ovarian lesion should be suspected to be malignant, unless otherwise proven [Picture 3].

The main limitations of our study are the single-institution design, retrospective nature, small sample size, and lack of long-term follow-up. Although we selected consecutive patients with predefined eligibility criteria, we acknowledge that an element of a selection bias could not be completely avoided in this study. Other limitation was that most of the distant metastases detected were not biopsied and only follow-up served as the standard of reference. This could have probably been the reason for the high diagnostic accuracy of PET/CT in M staging. We did not compare FDG PET/CT findings such as bone scan/F-18 PET/CT, which is the conventional/

gold standard for the identification of bone metastases. However, it is acknowledged in the NCCN guidelines that if bone metastases are detected on FDG PET/CT, a bone scan can be avoided.[3]

Conclusion

The most important indication of preoperative PET/CT in EBC appears to be the identification of distant metastasis, as seen in the present study in about 20% of the patients with tumors >2 cm.

The excellent specificity of PET/CT for axillary staging helps identify the group of patients in whom (node-positive cases on PET/CT scan) we can avoid SLNB and direct them for axillary clearance instead. On the contrary, high false-negative rate of PET/CT for axillary staging (especially seen in low-grade tumors <2 cm and of luminal A subtype histology) always calls for a confirmation with SLNB.

By identifying small centimeter/subcentimeter-sized metastatic IM nodes in about 5% of the patients with EBC, PET/CT offers advantage over CT alone and can potentially alter surgical/radiation treatment plan. Furthermore, the 5% incremental value in detecting synchronous second primary malignancies and additional treatment provided for these patients is of substantial value.

Hence, preoperative whole-body PET/CT scan appears to be a useful tool in deciding the optimal management of clinical Stage II early operable breast cancers and can obviate the need for multiple staging/diagnostic investigations such as CT scan of chest, abdomen, Tc-99 methylene diphosphonate bone scan, and USG axilla/ USG-guided aspiration cytology.

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Conflicts of interest

There are no conflicts of interest.

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