Original Article

Comparison of Sentinel Lymph Node Sampling with Positron Emission Tomography in the Evaluation of Axillary Lymph Node Involvement in Breast Cancer Patients

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ABSTRACT

Objectives

Axillary lymph node status is the most important prognostic factor in breast cancer patients.: This study was carried out to evaluate the diagnostic accuracy of FDG-PET/CT as a non-invasive technique and intraoperative frozen biopsy of sentinel lymphadenectomy (SLNB) in detecting axillary lymph node metastasis.

Materials and Methods

This study was carried out retrospectively on 44 patients diagnosed with breast cancer, who underwent preoperative FDG-PET/CT imaging and intraoperative SLNB, at the General Surgery Clinic of Istanbul Medeniyet University Göztepe Training and Research Hospital. The axilla was clinically negative in all patients. Preopative FDG-PET/CT imaging and intraoperative SLNB were performed. FDG-PET/CT results were compared with the histopathological results of SLNB and axillary lymph node dissection (ALND).

Results

According to the pathology results of axillary dissection, metastatic nodes were detected in 22 of 44 cases, and FDG-PET/CT imaging gave false-negative results in 10. The number of false negative cases of SLNB was 3; Axillary involvement was detected as a result of pathology in one of them, while the others were evaluated as skip metastases. The sensitivity of SLNB and FDG-PET/CT imaging was measured as 86.3% and 54.5%. The specificity values were 95.4% and 100%. FDG-PET/CT imaging has low sensitivity; specificity and positive predictive value were at acceptable levels.

Conclusion

The sensitivity of FDG-PET/CT imaging is low in detecting axillary involvement, and SLNB is needed in those with negative axillary involvement in FDG-PET/CT imaging. In our study, SLNB examination was superior to FDG-PET/CT imaging in detecting axillary nodal status.

Keywords

breast cancer; axillary lymph node dissection; positron emission tomography; sentinel lymph node biopsy;

INTRODUCTION

As the most common cancer type encountered in women, breast cancer (BC) is the cause of approximately 30% of all female cancers and 18% of cancer-related deaths.[1,2] The development of diagnostic methods and multidisciplinary approach have increased survival, and it has been reported that early diagnosis with screening

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methods may reduce mortality.[3] Axillary lymph node (ALN) status is one of the most important factors for the prognosis of BC patients. Axillary lymph node dissection (ALND) is the accepted procedure for nodal staging; however, ALND carries significant physical and psychological risks.[4,5] It can lead to arm numbness, loss of motor function in the upper extremity and lymphedema, and negatively affects quality of life in the long term.[6] Sentinel lymph node (SLN) is defined as the first node visited by lymph flow from the primary tumor, and absence of SLN involvement indicates the absence of axillary tumor infiltration. This data will protect the patient from a traumatic approach such as ALND, which may cause early and late complications.[7,8] False-negativity is possible and its rates depend on the surgeon experience.[9] False-negativity rates of SLNB are between 0-15%.[10] Computed tomography scan (CT) and ultrasonography (US) contributes to the diagnosis of axillary involvement in a limited fashion with sensitivity and specificity rates below 85%. [11.12,13] The clinical use of 18F-Fluoro-2-deoxy-D glucose (FDG) Positron Emission Tomography Scan (PET) is based on the fact that cancer cells use the glycolytic pathway more than non-neoplastic cells.[10] The aim of the present study was to demonstrate the efficacy of preoperative PET imaging in the assessment of axillary status in clinically node-negative BC cases.

MATERIALS AND METHODS

The study included female patients who underwent surgery for biopsy-proven invasive BC between January 2012 and September 2013, underwent SLN sampling and Level 1-2 dissection for those found positive, underwent preoperative PET imaging, and had ALN involvement on clinical examination. The data of the patients were analyzed retrospectively.

Patients with inflammatory BC and DCIS, uncontrolled diabetes mellitus (DM), neoadjuvant chemotherapy, previous excisional biopsy and male patients were excluded. Preoperative diagnosis was made by tru-cut biopsy. All patients underwent preoperative PET imaging to evaluate the breast, axilla and possible metastatic involvement, intraoperative SLN sampling and intraoperative frozen examination. SLNB and PET imaging were analyzed and compared separately and their superiority over each other was tried to be revealed. The Tumor–Node–Metastasis (TNM) system according to the American Joint Committee on Cancer (AJCC) 7th edition was used for the staging of all patients. This study was approved by the institutional ethics committee (2013/0064) and informed consent was obtained from all patients included in the study.

PET Imaging

The patient's PET imaging was obtained with the "Philips Gemini TF 64 Slice PET/CT" branded scanner. In patients with glucose levels <150mg/dl, 222–370 MBq (6-10 mCi; 0.1 mCi / kg) of FDG was injected intravenously. The images were evaluated in sections on the whole body projection and three orthogonal planes. All patients' PET images were evaluated by a specialist of nuclear medicine, interpreted by a digital archive environment.

SLNB-Pathological Examination

All patients were injected with subareolar 5 cc of 1% methylene blue at the beginning of the operation. After a waiting period of approximately 5 minutes, the stained lymph nodes were evaluated histopathologically with frozen technique at the time of operation. SLNs were analyzed with standard hematoxylin & eosin staining. Metastatic lymph nodes were considered positive and axillary dissection was performed. In negative results, axillary dissection was not performed and pathologic results were awaited.

Statistical Analysis

Statistical analyses were carried out with use of the Number Cruncher Statistical System (NCSS)® and Power Analysis and Sample Size (PASS)® Statistical Software (Kaysville, Utah, USA). Along with the descriptive statistical approaches (mean, standard deviation, median, frequency, ratio, minimum, and maximum), the Mann Whitney *U* test was used to evaluate quantitative data and two-group comparisons of parameters with abnormal distribution. The Kruskal-Wallis test was used to compare three or more groups of parameters with abnormal distributions. Fisher-Freeman-Halton test, Fisher's Exact test, Yates' continuity correction test (chi-squared test with Yates adjustment), Mc Nemar concordance test, diagnostic screening tests (specificity, sensitivity, etc.) and ROC Curve analysis were used to compare qualitative data. Statistical significance was accepted as $p<0.05$.

RESULTS

Historical records of 44 women with the diagnosis of BC surgically treated between January 2012 and September 2013 at the department of surgery were included. The mean age of the study group was 56.61 ± 13.03 (range: 28-84) years. Patient characteristics and risk factors are depicted in Tables 1 and 2.

The primary tumor was found to be located in the lower outer quadrant in 6 patients (13.6%), lower inner quadrant in 2 (4.6%), upper outer quadrant in 26 (59.1%) and upper inner quadrant in 10 patients (22.7%). Mean tumor size was calculated as 22.52 ± 9.71 mm (range: 10-60 mm). Histopathological examinations revealed invasive ductal carcinoma in 37 (84.1%) cases, invasive lobular carcinoma in 5 (11.4%) and mucinous carcinoma in 2 (4.5%) cases, while 8 (18.2%) of these cases were grade 1 tumors, 23 (52.3%) were grade 2 and 13 (29.5%) were grade 3 tumors.

The T stages of the patients were as follows: 23 patients (52.3%) T1, 20 patients (45.4%) T2 and 1 patient (2.3%) T3. N stages were N0, 50.0% (n=22), N1 29.5% (n=13), N2 6.9% (n=3) and N3, 13.6% (n=6). No distant metastasis was observed in (n=44) cases. When the stages were analyzed; 36.4% (n=16) were stage IA, 27.3% (n=12) were stage IIA, 13.6% (n=6) were stage IIB, 9.1% (n=4) were stage IIIA and 13.6% (n=6) were stage IIIC. PET SUV max measurements for the primary tumor were between 1.8-18.4 with a mean of 6.36±3.68; PET SUV max measurements for the axilla were between 0.9-23.5 with a mean of 3.29±4.02. No distant metastasis was detected on PET. Multifocal tumors were detected in 2.3% (n=1) and multicentric tumors in 4.6% (n=2) of the patients. Primary tumor involvement was seen on PET imaging in all cases (n=44); ALN involvement on PET in 27.3% (n=12); involvement on SLNB Frozen examination in 45.5% (n=20) and axillary involvement on pathology in 50.0% (n=22). Mastectomy was performed in 36.4% (n=16) and breast conserving surgery (BCS) in 63.6% (n=28).

Ki67 values were between 1-75, with a mean of 19.50±18.29, 77.3% (n=34) were ER positive, 65.9% (n=29) were PR positive and 31.8% (n=14) were CerbB2 positive. The number of sentinel nodes removed was between 1-4, with a mean of 1.50±0.82 and a median of 1. One node was removed in 65.9% (n=29), two nodes in 22.7% (n=10), three nodes in 6.8% (n=3) and four nodes in 4.5% (n=2).

When ALN uptake by PET was analyzed according to pathology results, there was a discordance between the two measurement methods ($p<0.01$). Pathology showed uptake in 50.0% of cases; PET was accurate in 27.3% of cases. Of the 22 (50.0%) cases detected on pathology, only 12 (27.3%) had uptake on axillary PET imaging; no uptake was detected on axillary PET imaging in the other cases and the sensitivity, specificity and accuracy of the test were 54.55%, 100% and 77.27%, respectively. The positive and negative predictive values were 100% and 68.75%, respectively (Table 3). In our study, the number of cases in which PET imaging was evaluated as false-negative in the detection of ALN involvement according to pathology results was 10. When SLNB Frozen examination was performed according to pathology results, there was no discrepancy between the two measurement methods ($p>0.05$). Pathology showed involvement in 50.0% of cases, while SLNB Frozen diagnosed involvement in 45.5% of cases. Of the 22 (50.0%) cases in which pathology diagnosed involvement, 19 (43.2%) were found to have involvement on SLNB Frozen; the remaining cases were not found to have involvement on SLNB Frozen. The sensitivity, specificity and accuracy of the test were 86.36%, 95.45% and 90.91%, respectively. The positive predictive value was 95.00% and the negative predictive value was 87.50%. In the 44 cases examined, there were 12 true positive cases and no false positives in the detection of axillary involvement by PET imaging. The number of true negative cases was 22 and the number of false negative cases was 10. In SLNB, the number of true positive cases in the detection of axillary involvement was 19 and the number of false positive cases was 1. The number of true negative cases was 21 and the number of false negative cases was 3. In primary tumor PET SUV max measurements related to histological types, no statistically significant difference was found between the primary tumor SUV max measurements of Invasive Ductal Carcinoma and Invasive Lobular Carcinoma cases ($p>0.05$) (Table 4). Mucinous carcinoma cases were not evaluated statistically due to insufficient numbers. According to tumor grade values; there was no significant difference between the SUV max measurements of the primary tumor ($p>0.05$). According to T stages; there was no significant difference between the SUV max measurements of the patients regarding the primary tumor ($p>0.05$). According to axillary involvement, no significant difference was found between the SUV max

measurements of the patients regarding the primary tumor ($p>0.05$). According to ER, PR and CerbB2 results; the SUV max measurements of the patients regarding the primary tumor did not show statistically significant difference ($p>0.05$).

According to the pathology results, there was a statistically highly significant difference between the PET SUV max measurements of the axilla ($p<0.01$). The axilla PET SUV max measurements of the patients with axillary involvement on pathology were significantly higher than those without involvement. Based on this significance, it was considered to calculate the cut off point for axilla PET SUV max . ROC analysis and diagnostic screening tests were used to determine the cutoff point according to the groups. The best cut-off value according to the groups was found to be 1.4 for Axilla PET SUV max . For a cut-off value of 1.4 for axilla PET SUV max, sensitivity was 86.36%, specificity was 77.27%, positive predictive value was 79.17 and negative predictive value was 85.00. Accuracy was 81.82%. The area under the ROC curve was 92.8% with a standard error of 3.9%. According to the pathology result, there was a statistically significant correlation between axillary involvement and the cut-off value of 1.4 of the Axilla PET SUV max level ($p<0.01$). The risk of axillary involvement on pathology was 21.5 times higher in patients with an axilla PET SUV max level of 1.4 and above (odds ratio 21.53 (95% CI: 4.463-103.900).

Among the 22 cases with pathologic involvement, there was no statistically significant difference between the histologic types, tumor grades, T stages, N stages, ER, PR and CerbB2 results of those with true positive and false negative pathology ($p>0.05$) (Tables 5, 6). There was also no statistically significant difference for the cut-off value of 1.4 for the Axilla PET SUV max measurements of these patients ($p=0.078$; $p>0.05$). The false negative rates of patients with axilla PET SUVmax measurements of 1.4 and above were lower than those with PET SUV max measurements below 1.4.

DISCUSSION

Breast cancer is the leading cause of cancer-related deaths among women as the 5-year survival rate for all stages in these patients is reported to be 73% in developed countries and 53% in developing countries, where the difference can be explained by the alterations regarding early diagnosis with screening mammography and treatment options.[14]

Axillary lymph node involvement is the most valuable metric accepted for illness prediction, and SLNB is a common method for assessing axillary involvement. PET imaging is one of the technologies that can now be utilized instead of SLNB, which is a minimally invasive procedure. Crippa et al. demonstrated that PET imaging detected 94.5% of initial BCs, including tiny ones with a mean tumor diameter of 20 mm.[15]

In our study, according to PET imaging, we detected primary breast tumors in all BC patients, with a mean tumor diameter of 22.52±9.71 mm. The first study describing 18F-FDG imaging of lymph node metastases was a preclinical animal study carried out in 1990.[16] Many subsequent studies have examined the accuracy of PET in detecting nodal involvement in BC cases. Some of the studies were skeptical about the accuracy of PET for nodal involvement[17-20], while others believed that PET, a non-invasive method for evaluating axillary lymph node involvement, could replace SLNB.[21-23] A study compared preoperative PET with histologic findings of ALND outcomes in BC patients. In this investigation, the sensitivity of PET in detecting axillary metastases was reported as 94%.[22] In certain investigations, the authors reported that PET exhibited a low sensitivity in evaluating positive ALNs. According to Avril et al., PET was insufficient to substitute histologic examination of ALNs.[17] In a study evaluating the response of axillary node involvement to neoadjuvant therapy, the sensitivity, selectivity, positive predictive value and negative predictive value of PET were found to be 100%, 54.5%, 56.5% and 100%, respectively.[24]

Veronesi et al. examined 236 patients without clinical axilla node involvement and all patients received SLNB and PET imaging. In 193 (81.8%) patients, PET imaging showed negative axilla. SLNB was negative in 128 and positive in 65 of these patients. Veronesi reported sensitivity as 37% and specificity as 96% in this study.[25] In our study, we performed preoperative PET imaging and intraoperative SLNB in 44 female BC patients. We found the sensitivity and specificity of PET imaging for the detection of axillary involvement to be 54.5% and 100%, respectively, with no false positive cases and a positive predictive value of 100%. Our results are consistent with the low sensitivity and high specificity values in the literature. In a study of 41 patients with T1-3 BC, all patients underwent PET imaging, SLNB and ALND.

Immunohistochemical (IHC) analysis was used in addition to SLN examination. PET imaging failed to detect any of the metastases detected by IHC analysis alone. Its sensitivity was recorded as 27%.[26,27] When the different sensitivity values of PET imaging in the literature are examined, it is seen that IHC analyses were performed in frozen examination in studies in which new pathology protocols were applied. This situation reveals SLN involvement more clearly and precisely in patients with BC. Normally, undetectable SLNs are detected by IHC analysis, which increases the number of involved SLNs. This increases the number of false-negative cases of PET imaging, thus the sensitivity of PET imaging is low. We believe that one of the reasons for the different values in the literature is the use of IHK analysis.

Micrometastases and small macrometastases cannot be identified with PET imaging. Currently, the spatial resolution of PET imaging can detect lesions between 3-10 mm in diameter.[28,29] We believe that this resolution feature of PET imaging leads to different sensitivity and specificity results. This current situation increases the false negative rate of PET imaging and decreases its sensitivity. Numerous studies have reported good specificity rates, which contrast with the low sensitivity rates of PET imaging in the detection of metastases from ALNs. Increased FDG uptake can also be a result of inflammatory events including sarcoidosis and abscesses, and PET imaging typically has a low false-positive rate of 0.6–6%.[17,20,30,31] In our study, as in the literature, there were no cases in which PET imaging was deemed false-positive, and its specificity and positive predictive value were both 100%. The literature recommends preoperative PET imaging for tumor staging in BC patients due to its high accuracy rates.[18,32]

In our study, the accuracy rate of PET imaging was calculated as 77.2%. PET imaging has been shown to provide useful findings in the detection of locoregional disease, level III ALNs, supraclavicular, internal mammarian lymph nodes and distant metastases. This may affect the management of the disease and bring radiotherapy and systemic chemotherapy to the agenda.[32,33] In our study, consistent with the literature, PET imaging detected multifocal tumors in 2.3% (n=1) and multicentric tumors in 4.6% (n=2) of the patients and gave an idea about the extent of the disease. Taira et al. found the sensitivity of PET imaging for axilla metastasis to be 48.1%, specificity 92.3%, positive predictive value 72.2% and negative predictive value 81.1%. When they took the SUVmax cut-off value of PET for ALN as 2.0, they found that the sensitivity and specificity were 37.0% and 98.5%, and the positive and negative predictive values were 90.9% and 79.0%, respectively. The significant increase in positive predictive value and specificity is noteworthy.[34] In our study, we calculated the SUVmax value of the primary tumor as 6.36±3.68 (1.8-18.4) and the SUVmax value of the axilla as 3.29±4.02 (0.9-23.5). In the group of patients with N+ ALNs, the median SUVmax value of PET imaging was calculated as 5.8 in our study. As a result of the ROC analysis, the best cut-off value of the SUVmax value of PET imaging for ALN involvement was calculated as 1.4. The risk of axillary involvement in the final pathology was 21.5 times higher in patients with axilla PET SUV max level of 1.4 and above. The cut-off value of 1.4 in our study resulted in optimum sensitivity, specificity and accuracy rates of PET imaging. Accordingly, the sensitivity, specificity and accuracy of PET imaging were 86.3%, 77.2% and 81.8%, respectively. When the values of our study are analyzed, the specificity of PET imaging reaches 100% when the PET SUVmax value of the axilla is $\geq$ 2.6. When the PET SUVmax value is $\leq$ 1.1, the sensitivity of imaging reaches 100%. In the light of this statistical analysis of our study, it can be concluded that patients with axilla PET SUVmax value of 1.1 and below do not have axilla involvement. Zornoza et al. reported that the SUVmax value of the primary tumor was significantly higher in patients with larger tumor diameter, invasive ductal carcinoma histological type, ALN involvement and high histological grade ($p<0.05$).[35] In our study, no statistically significant difference was found between SUVmax values of the primary tumor and clinicopathological factors (histological type, tumor grade, T stage, axillary involvement, ER, PR, cerbB2 status) of breast tumors ($p>0.05$). We believe that this result, which is not consistent with the literature, is due to the limited number of cases in the study. Numerous prior investigations have demonstrated a strong correlation between the SUVmax value of the primary tumor and established prognostic factors and biological structures, including tumor diameter, histological grade, nuclear grade, nuclear atypia, number of mitoses, metastasis of lymph nodes, Ki-67 index, hormone receptor status, and c-erbB-2 status.[36,37] Due to the false-negative results of PET imaging, which

has low sensitivity values, we think that SLNB should be performed in this patient group in the absence of axillary involvement. PET imaging can also be usefully utilized in the selection of patients for SLNB. Yap et al. reported that whole body PET imaging changed the stage and treatment modality in up to 30% of patients.[38] Lovrics et al. reported primary breast tumor diameter and tumor grade as factors affecting PET imaging.[26] In our study, we compared the true-positive and false-negative cases of PET imaging by creating a subgroup analysis. Consistent with the literature, when the axillary SUVmax values of the two groups were compared, the values were calculated as 5.8 and 2.1, respectively (p=0.001). The difference in SUVmax values between the two groups was consistent with the study of Gil-Rendo et al. and statistically highly significant. In our study, 77.3% of the patients had early stage BC. The low sensitivity value we obtained with PET imaging was consistent with the literature in parallel with our patient selection. In the light of the literature, sensitivity rates for PET vary between 25% and 100%, while specificity varies between 75%-100%.[20,22,23] The sensitivity and specificity of PET in our study were determined to be 54.5% and 100%, respectively, and these results are in line with previous research. For identifying axillary involvement, SLNB's sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were, in order, 86.3%, 95.4%, 95%, 87.5%, 87.5%, and 90.9%. In a patient with invasive lobular carcinoma, SLNB uptake on frozen examination was interpreted as micrometastasis. PanCK staining was performed on all paraffin blocks and no metastatic cells were observed.

To date, there is no technique that is unlikely to lead to a downstaging risk related to axillary nodal involvement. This is true even for SLNB, a technique with low false-negativity rates reported in almost all studies. When the literature is reviewed, the reasons for SLNB-related false-negativity include surgical experience, skip metastases, and SLN results with negative frozen results but positive pathology results. In our study, skip metastases were detected in two patients (4.5%), which is consistent with the literature. When SLNB is compared with PET imaging in the evaluation of ALN involvement in BC patients, both methods have high specificity (95.4% vs. 100%). However, when the sensitivity values are compared, SLNB with a value of 86.3% is superior to PET imaging with a value of 54.5%.

CONCLUSION

The statistical accuracy of PET imaging and SLNB imaging for ALN involvement in patients with BC differs. We think that the pathologist, surgeon, and expert assessing the PET pictures have an impact on these disparate results. We believe that PET imaging is not a non-invasive substitute for SLNB because it lacks the resolution necessary to identify ALN involvement in patients with BC, particularly in cases of micro and small macrometastases, based on the literature and our own research. PET imaging is not yet a reliable alternative to SLNB and ALND for assessing ALN involvement and staging in BC patients. However, the useful information it gives in terms of evaluating tumor response, detecting distant metastases, tumour recurrence, and detecting synchronous tumours cannot be overlooked.

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Table 1: Values Related to Descriptive Characteristics

		Min-Max	Mean±SD
Age (years)		**28-84**	**56,61±13,03**
		n	**%**
Application Complaint	Routine Control	6	13,6
	Audience	30	68,3
	Pain	6	13,6
	Discharge	2	4,5
Dial	Bottom Outer	6	13,6
	Bottom Inner	2	4,6
	Top Outer	26	59,1
	Top Inner	10	22,7
Smoking	No	33	75,0
	Yes	11	25,0
Alcohol Use	No	43	97,7
	Yes	1	2,3
Comorbidity	No	19	43,2
	Yes	25	56,8

Table 2: Distribution of Breast Cancer Risk Factors

		Min-Max	Mean±SD
Age at Menarche (years)		10-15	13,11±1,02
Age at First Birth (years) (n=39)		16-42	23,90±5,78
Number of Births (n=39)		0-6	2,20±1,42
		n	**%**
Age at Menarche	<12 Years	2	4,5
	≥ 12 years old	42	95,5
Age at First Birth	<30 years old	30	68,2
	Age ≥ 30 years	9	20,5
Number of Births	No Birth	5	11,4
	Birth Available	39	88,6
	1 Birth	7	17,9
	2 Birth	17	43,6
	3 Birth	9	23,1
	≥ 4 births	6	15,4

		Min-Max	Mean±SD
Breastfeeding (n=39)	No	2	5,1
	Yes	37	94,9
Menopause Status	Postmenopausal	31	70,5
	Premenopausal	13	29,5
HRT Use	No	43	97,7
	Yes	1	2,3
The Radiation Story	No	43	97,7
	Yes (RT to Other Nozzle)	1	2,3
Family Anamnesis	No	34	77,3
	Yes	10	22,7

HRT: Hormone Replacement Therapy, **RT:** Radiotherapy

Table 3: Values Related to Axillary Lymph Node Involvement Detection of PET Imaging According to Final Pathology Results

		Pathology Axilla						p
		Eclipse (+)		Eclipse (-)		Total		
		n	%	n	%	n	%	
PET Axilla LAP	**Eclipse (+)**	12	27,3	0	0,0	**12**	**27,3**	**0,002****
	Eclipse (-)	10	22,7	22	50,0	**32**	**72,7**	
	Total	**22**	**50,0**	**22**	**50,0**	**44**	**100**	
Sensitivity (%)		54,55						
Specificity (%)		100,0						
Positive predictive value		100,0						
Negative predictive value		68,75						
Accuracy (%)		77,27						

Mc Nemar Test **p<0,01

PET: Positron emission tomography, **LAP:** Lymph adenopathy

Table 4: The Relationship between Clinicopathological Factors of Breast Tumours and SUV_{max} Values of Primary Tumour

		Primary Tumour PET SUV_{max}			*p*
		n	Mean±SD	Median	
Histological Type	Invasive Ductal Carcinoma	37	6,71±3,82	6,2	**[b]0,683**
	Invasive Lobular Carcinoma	5	5,42±1,79	5,2	
	Mucinous Carcinoma	2	2,15±0,21	2,1	
Tumour Grade	Grade 1	8	4,96±1,20	5,0	**[a]0,086**
	Grade 2	23	5,53±2,94	5,4	
	Grade 3	13	8,68±4,85	7,8	
T	T 1	23	5,75±3,85	4,9	**[b]0,102**
	T 2+3	21	7,03±3,45	6,4	
Axillary Involvement	Negative	22	5,90±4,19	4,7	**[b]0,118**
	Positive	22	6,82±3,13	6,6	
ER	Negative	10	7,45±5,25	5,8	**[b]0,624**
	Positive	34	6,04±3,11	5,8	
PR	Negative	15	6,85±4,83	5,2	**[b]0,931**
	Positive	29	6,10±3,00	6,2	
CerbB2	Negative	30	6,20±3,28	6,1	**[b]0,950**
	Positive	14	6,70±4,55	5,3	

[a]Kruskal Wallis Test [b]Mann Whitney U Test

Mucinous carcinoma was not included in the evaluation of histological type due to insufficient number of cases.

PET SUV_{max} : Positron emission tomography maxium standardised uptake value

ER: Estrogen receptor, **PR:** Progesterone receptor

Table 5: Analysis of the Characteristics of True-Positive and False-Negative Cases Obtained by PET Imaging According to the Final Pathology Result

		True Positive	False Negative	pN+	False Negative Rate	p
Histological Type	Invasive Ductal Carcinoma	10	8	18	44,4	[b]**1,000**
	Invasive Lobular Carcinoma	2	1	3	33,3	
Tumour Grade	Grade 1	1	3	4	75,0	[a]**0,236**
	Grade 2	5	5	10	50,0	
	Grade 3	6	2	8	25,0	
T	T 1	2	5	7	71,4	[b]**0,172**
	T 2+3	10	5	15	33,3	
N	N 1	6	7	13	53,8	[b]**0,415**
	N 2+3	6	3	9	77,8	
ER	Negative	4	2	6	33,3	[b]**0,646**
	Positive	8	8	16	50,0	
PR	Negative	5	2	7	28,6	[b]**0,381**
	Positive	7	8	15	53,3	
CerbB2	Negative	9	7	16	43,7	[b]**1,000**
	Positive	3	3	6	50,0	
Aksilla PET SUV_{max}	< 1,4	0	3	3	100	[b]**0,078**
	≥ 1,4	12	7	19	36,8	

[a]Fisher-Freeman-Halton Test bFisher's Exact Test Mucinous Carcinoma was not included in the evaluation of histological type due to insufficient number of cases.

T: Tumour, **N:** Nod, **ER:** Estrogen receptor, **PR:** Progesterone receptor

PET SUV_{max}: Positron emission tomography maxium standardised uptake value

Table 6: Correlation of True-Positive and False-Negative Cases Obtained by PET Imaging with SUV_{max} Values of the Tumour

	True Positive (n=12)	False Negative (n=10)	*p*
	Mean±SD (Median)	Mean±SD (Median)	
Primary PET SUV_{max}	7,83±3,23 (7,5)	5,60±2,65 (5,5)	**0,086**
Aksilla PET SUV_{max}	8,00±5,37 (5,8)	2,00±0,72 (2,1)	**0,001****

PET SUV_{max}: Positron emission tomography maxium standardised uptake value

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