ROLE OF FDG PET/CT IN EVALUATION OF PATIENTS WITH METASTATIC CANCER BREAST

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Received: 21/11/2021
Accepted: 20/12/2021

Online ISSN: 2735-3540

ABSTRACT:

Background: *Many studies have pointed out the role of 18F-FDG PET/CT in the assessment of metastatic breast cancer patients, compared to conventional imaging. Using the FDG PET metabolic parameters to measure tumor burden shows potentiality to predict their survival.*

Aim of work: *To evaluate the role of PET/CT in assessment of metastatic breast cancer patients, monitoring the treatment response and correlating this with the molecular subtypes.*

Patients and methods: *A retrospective study was done at Maadi military hospital (from February 2017 to March 2021) involved fifty female patients with metastatic breast cancer (mean ±SD age 53.4±10.8), underwent FDG PET/CT before receiving treatment. PET/CT follow-up protocol was done depending on the type of treatment. Comparison between PET/CT and CT findings were carried out and metabolic PET parameters were calculated and analyzed.*

Results: *PET/ CT was superior to CT in detecting bone, lymph nodes, liver, and pleural metastases than did CT while CT was more sensitive for lung metastases. HR-/HRE2+ and triple-negative patients showed worse prognosis with more frequent mortality than hormonal positive patients did. Non-survivors showed statistically significantly higher mean WB-MTV and WB-TLG than survivors did (307.7±171.1 VS 97.8±57.4 and 1214.0±962.1 VS 383.0±214.4 respectively, P-Value = <0.001 each) while W-SUV max values showed no statistically significant difference between the two groups. Survival analysis revealed that WB-MTV was the only independent factor affecting mortality rate (HR (95% CI) =13.46 (1.36-132.72); P-Value = 0.026).*

Conclusion: *18F-FDG PET/CT could be a non-invasive suitable imaging technique in the assessment of metastatic IDC breast cancer patients with the advantage of being a single modality. WB-MTV is suggestive to be a strong independent parameter in predicting the survival in metastatic breast cancer patients.*

Keywords: *18F-FDG PET/CT; Metastatic breast cancer; PET metabolic parameters.*

INTRODUCTION:

Worldwide, Breast cancer is considered the most common cause of cancer death in women[(1)]. Breast cancer is a heterogeneous disease, which is classified currently into different subtypes[(2)]. Approximately 30% of breast cancer patients are at the risk of developing loco-regional recurrence or distant metastasis[(3)]. Stage IV disease (stage IV at first diagnosis or recurrent from previous breast cancer) showed a 5-year survival rate of approximately 22%, However, this rate varies according to several factors, one of the most

important is the hormone receptor status[4]. The hormone receptor positive (HR+) subtype is the most common subtype and is subdivided into luminal A and luminal B. Human epidermal growth factor receptor 2 (HER2)-overexpressing (HR− /HER2+) and triple-negative (HR− /HER2−) subtypes are known to be more aggressive, compared with the luminal A and luminal B, and have poorer outcomes [3]. Fusion of Positron emission tomography with the CT provides the ability to combine functional and morphological information into a single study[5]. 18 F-fluorodeoxyglucose (18F-FDG) PET/CT has been introduced as an additional imaging modality facilitating breast cancer staging, distant-metastasis detection, and prognostic prediction [6]. In recent years, volume-based PET metabolic parameters such as the metabolic tumor volume (MTV) and total lesion glycolysis (TLG) were demonstrated to yield prognostic significance as they represent not only the tumor metabolic activity but also the total tumor burden[7].

AIM OF WORK:

To determine the role of PET/CT to evaluate patients with metastatic cancer breast, monitoring the treatment response and correlating this with the molecular subtypes.

Inclusion criteria:

Histo-pathologically confirmed diagnosis of IDC breast cancer presented initially with metastasis or relapse after primary treatment.

Exclusion criteria:

Patients presented with other synchronous malignancy, or non-breast invasive tumors/ other breast invasive types.

Patient preparation:

Fasting for four to six hours prior to the scan. All metallic items are removed from the patient. Diabetic patients should be controlled. Before FDG administration, all patients should have a blood glucose level of less than 200 mg/d. Avoid any kind of strenuous activity prior to the examination and following injection of the radioisotope to avoid physiologic muscle uptake of FDG. Rest in a quiet room and urinary bladder voiding prior to scanning.

PET/CT machine: GE; DISCOVERY VCT PET/CT (128 slice CT).

PATIENTS AND METHODS:

A retrospective study was done at Maadi military hospital (from February 2017 to March 2021) involved fifty female patients with IDC who had distant metastases (mean ± SD age 53.4 ± 10.8) and underwent FDG PET/CT before receiving treatment. PET/CT follow-up protocol was done depending on the type of treatment. Comparison between the PET/CT and CT findings were carried out and metabolic PET parameters, including the highest SUV max of whole malignant lesions (w-SUV max), the whole-body (WB) metabolic tumor volume (MTV), and WB total lesion glycolysis (TLG), were analyzed to determine their suitability in predicting 3-year overall survival (OS). Diagnosis of metastasis was made by laboratory evidence; elevated tumor markers, other imaging modalities, biopsy, and/ or follow up imaging.

Technique: Low dose non-enhanced CT scan first, then a whole-body PET study (from the skull to mid-thigh) followed by diagnostic enhanced whole-body CT scan.

Imaging analysis: Comparison between the baseline PET/CT and CT findings were carried out and baseline PET metabolic parameters, including the highest SUV max of the whole malignant lesions (w-SUV max), whole-body (WB) metabolic tumor volume (MTV), and WB total lesion glycolysis (TLG), were calculated and analyzed.

Whole-body metabolic tumor volume (WB-MTV) = the sum of metabolic tumor volume (MTV) values of each malignant lesion in one patient.

Whole-body total lesion glycolysis (WB-TLG) = the sum of total lesion glycolysis values of each malignant lesion in one patient.

Follow-up and survival analysis: PET/CT follow-up protocol was done depending on the type of treatment. Overall Outcome assessment was categorized according to PET/CT follow up as Progressive response (including died cases), Partial response, and complete response. Survival time was calculated from the date that the PET/CT was done till the date of death. For the survivors, 3 years follow-up was the endpoint.

Statistical methods: The collected data were coded, tabulated, and statistically analyzed using IBM SPSS statistics (Statistical Package for Social Sciences) software version 28.0, IBM Corp., Chicago, USA, 2021. Statistical significance was denoted by $p < 0.05$.

RESULTS:

Patients' characteristics:

Total number of patients was 50 (age range :32–71, mean age ±SD 53.4 ±10.8), (luminal A=19: 38%, luminal B=16: 32%, HR- / HER2+=6:12%, triple negative= 9: 18%). Sites of distant metastases (regarding patient- based analysis) included bone (n = 32), lymph nodes (n = 28), lung (n = 20), liver (n = 16), brain (n=3), (Others : (suprarenal = 1), pleural (deposits/ malignant effusion) (n=3), peritoneal (n=1) and soft tissue (n=3).

Outcome:

30 out of 50 patients showed progressive course including the number of died patients, 15 out of 50 patients showed partial response, and 5 out 50 patients showed complete response. At the endpoint follow up time 15 patients died (range: 3-35 months; median (1st-3rd interquartile): 13 (6-22)) (Table 1) (Diagram 1).

Performance of PET/CT versus CT in detecting lesions in metastatic breast cancer patients:

Regarding patient-based analysis, in the 50 patients, there was significant statistical perfect agreement between CT and PET/CT in detecting lymph nodes, brain, suprarenal, and peritoneal metastatic lesions, and significant statistical high agreement between the two modalities in detecting bone, lung, and liver metastatic lesions. Meanwhile, there was non-significant statistical low agreement between them in detecting pleural and soft tissue metastatic lesions (Table 2).

Regarding lesion-based analysis, no statistically significant differences between the number of metastatic lesions in brain and suprarenal as detected by PET/CT and that detected by CT. There were statistically significant differences between number of metastatic lesions in bone, lymph node, lung, and liver as detected by PET/CT and that detected by CT (Table 3).

No statistically significant differences in evaluated different metastatic sites regarding the different molecular subtypes (Table 4).

PET Metabolic Parameters analysis:

The range values of each measurement were as follow: for the W-SUV max: 4.7 to 22.3 (median 9.4; mean ±SD 10.5±4.3), for the WB-MTV (cm3): 10.4–673.5 (median 116.5; mean ± SD 160.8 ± 141.8) and for the WB-TLG: 40.0–3812.5 (median 471.2; mean ±SD 632.3±666.6) (Table 5).

There was no statistically significant difference regarding the W-SUV max values among the non-survivors and survivors (Range: 6.1–22.3, Mean ± SD: 11.6±5.2 versus Range: 4.7–16.8, Mean ± SD: 10.0±3.8 respectively). Conversely, the WB-MTV (cm3) values were statistically significantly higher among non-survivors than among survivors (Range: 34.4–673.5, Mean ± SD: 307.7±171.1 versus Range: 10.4–210.8, Mean ± SD: 97.8±57.4 respectively; $p < 0.001$), as were WB-TLG values (Range: 68.5–3812.5,

Mean±SD: 1214.0±962.1 versus Range: 40.0–829.3, Mean±SD: 383.0±214.4 respectively; p <0.001) (Table 6).

Survival analysis:

The optimal cut-off values for predicting mortality for each measurement-using receiver operating characteristic (ROC) curve analysis were as follow:

For W-SUV max : ≥12.9 ; For WB MTV: ≥158.9 (cm3), and for WB-TLG: ≥ 544.0 (Tables 7,8, and 9) (Diagram 2).

Survival regression was used for multivariate analysis to find out independent factors affecting the mortality rate. According to their medians, only WB-MTV had statistically significant hazard risk for mortality (Table 10).

Table (1): Outcome characteristics of metastatic breast cancer patients.

Characteristics	Luminal-A (N=19)	Luminal-B (N=16)	Triple-negative (N=9)	HR-/Her2 (N=6)	§p-value
Prognosis					
Progressive response (N=30)	8/19 (42.1%)	9/16 (56.25%)	8/9 (88.9%)	5/6 (83.3%)	0.356
Partial response (N=15)	8/19 (42.1%)	5/16 (31.25%)	1/9 (11.1%)	1/6 (16.7%)	
Complete response (N=5)	3/19 (15.8%)	2/16 (12.5%)	0/9 (0.0%)	0/6 (0.0%)	
Mortality					
Mortality (N=15)	3/19 (15.8%)	4/16 (25.0%)	5/9 (55.6%)	3/6 (50.0%)	0.111
Survival (N=35)	16/19 (84.2%)	12/16 (75.0%)	4/9 (44.4%)	3/6 (50.0%)	

§Fisher's Exact test.

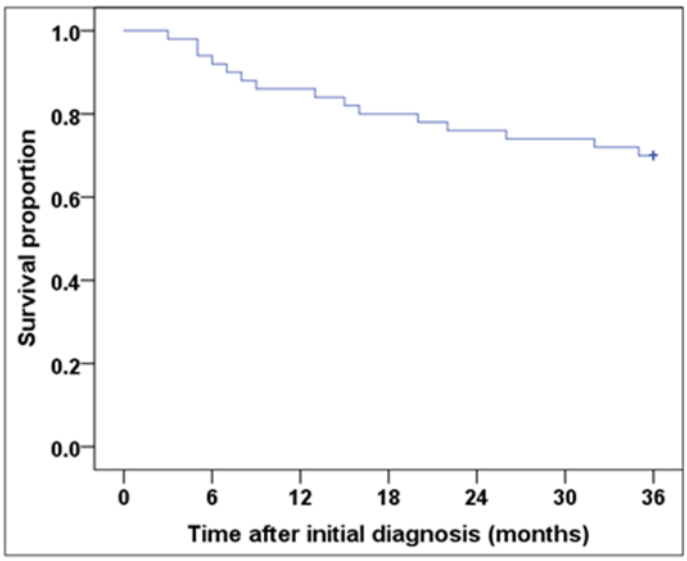


Diagram (1): Kaplan Meier curve for survival among the studied cases.

Table (2): Performance of baseline PET/CT Versus CT in detecting metastases in metastatic breast cancer patients (patient-based analysis).

Sites	CT	PET/CT	Kappa	p-value
Bone	30 (60.0%)	32 (64.0%)	0.915	<0.001*
Lymph nodes	28 (56.0%)	28 (56.0%)	1.000	<0.001*
Lung	20 (40.0%)	19 (38.0%)	0.958	<0.001*
Liver	15 (30.0%)	16 (32.0%)	0.963	<0.001*
Brain	3 (6.0%)	3 (6.0%)	1.000	<0.001*
Suprarenal	1 (2.0%)	1 (2.0%)	1.000	<0.001*
Pleural	1 (2.0%)	3 (6.0%)	0.485	0.060
Peritoneal	1 (2.0%)	1 (2.0%)	1.000	<0.001*
Soft tissue	1 (2.0%)	3 (6.0%)	0.485	0.060

Total=50. Kappa test. *Significant

Table (3): Performance of baseline PET/CT Versus CT in detecting metastases in metastatic breast cancer patients (Lesion-based analysis).

Metastatic lesions sites	Total	PET/CT relative to CT			#p-value
		Higher	Equal	Lower	
Bone	32	7 (21.9%)	25 (78.1%)	0 (0.0%)	<0.001*
Lymph node	28	9 (32.1%)	14 (50.0%)	5 (17.9%)	<0.001*
Lung	20	0 (0.0%)	16 (80.0%)	4 (20.0%)	<0.001*
Liver	16	5 (31.3%)	11 (68.7%)	0 (0.0%)	<0.001*
Brain	3	0 (0.0%)	3 (100%)	0 (0.0%)	0.999
Suprarenal	1	0 (0.0%)	1 (100%)	0 (0.0%)	0.999

Percentages taken from row total. #Chi square test *Significant

Table (4): Comparison according to molecular subtypes regarding metastatic lesion sites in patients with metastatic breast cancer patients (patient-based analysis).

Sites	Luminal-A (N=19)	Luminal-B (N=16)	Triple-negative (N=9)	HR-/Her2+ (N=6)	§p-value
Bone	14 (73.3%)	11 (68.8%)	4 (44.4%)	3 (50.0%)	0.440
Lymph nodes	10 (52.6%)	9 (56.3%)	5 (55.6%)	4 (66.7%)	0.975
Lung	7 (36.8%)	8 (50.0%)	3 (33.3%)	2 (33.3%)	0.828
Liver	4 (21.1%)	5 (31.3%)	4 (44.4%)	3 (50.0%)	0.467
Brain	0 (0.0%)	1 (6.3%)	1 (11.1%)	1 (16.7%)	0.224
Suprarenal	0 (0.0%)	1 (6.3%)	0 (0.0%)	0 (0.0%)	0.620
Pleural	1 (11.1%)	1 (11.1%)	1 (11.1%)	0 (0.0%)	0.999
Peritoneal	0 (0.0%)	0 (0.0%)	1 (11.1%)	0 (0.0%)	0.300
Soft tissue	0 (0.0%)	1 (6.3%)	2 (22.2%)	0 (0.0%)	0.108

§Fisher's Exact test.

Table (5): Baseline PET/CT metabolic parameters among the studied cases.

Variables	Median	Mean±SD	Range
WB-SUVmax	9.4	10.5±4.3	4.7–22.3
WB-MTV (cm3)	116.5	160.8±141.8	10.4–673.5
WB-TLG	471.2	632.3±666.6	40.0–3812.5

Total=50

Table (6): Comparison according to mortality regarding baseline PET/CT metabolic parameters in metastatic breast cancer patients.

Variables	Measures	Mortality (N=15)	Survival (N=35)	^p-value
W-SUVmax	Mean±SD	11.6±5.2	10.0±3.8	0.222
	Range	6.1–22.3	4.7–16.8	
WB-MTV (cm3)	Mean±SD	307.7±171.1	97.8±57.4	<0.001*
	Range	34.4–673.5	10.4–210.8	
WB-TLG	Mean±SD	1214.0±962.1	383.0±214.4	<0.001*
	Range	68.5–3812.5	40.0–829.3	

^Independent t-test. *Significant

Table (7): Diagnostic performance of baseline PET/CT metabolic parameters in predicting mortality in metastatic breast cancer patients.

Factors	AUC	SE	p-value	95% CI	Cut point
W-SUVmax	0.576	0.089	0.397	0.402–0.750	≥12.9
WB-MTV	0.913	0.056	<0.001*	0.804–1.000	≥158.9 cm3
WB-TLG	0.844	0.080	<0.001*	0.688–1.000	≥ 544.0

AUC: Area under curve, SE: Standard error, CI: Confidence interval, *significant W-SUVmax= Highest SUVmax of whole malignant lesions, WB MTV = whole-body metabolic tumor volume, WB TLG = whole-body total lesion glycolysis.

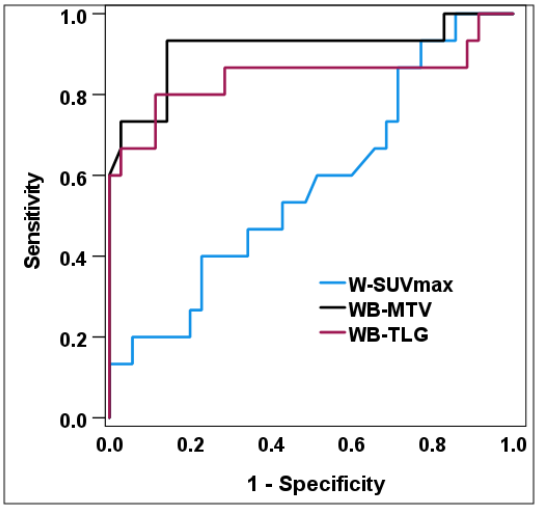


Diagram (2): ROC curve of baseline PET/CT metabolic parameters in predicting mortality in metastatic breast cancer patients.

Table (8): Diagnostic characteristics of baseline PET/CT metabolic parameters cut points in predicting mortality in metastatic breast cancer patients.

Characters	W-SUVmax ≥12.9		WB-MTV ≥ 158.9 cm3		WB-TLG ≥ 544.0	
	Value	95% CI	Value	95% CI	Value	95% CI
Sensitivity	40.0%	16.3%–67.7%	93.3%	68.1%–99.8%	80.0%	51.9%–95.7%
Specificity	77.1%	59.9%–89.6%	85.7%	69.7%–95.2%	71.4%	53.7%–85.4%
DA	66.0%	51.2%–78.8%	88.0%	75.7%–95.5%	74.0%	59.7%–85.4%
YI	17.1%	-11.3%–45.6%	79.0%	61.9%–96.2%	51.4%	26.3%–76.6%
PPV	42.9%	17.7%–71.1%	73.7%	48.8%–90.9%	54.5%	32.2%–75.6%
NPV	75.0%	57.8%–87.9%	96.8%	83.3%–99.9%	89.3%	71.8%–97.7%

CI: Confidence interval, DA: Diagnostic accuracy, PPV: Positive Predictive Value, NPV: Negative Predictive Value. W-SUVmax= Highest SUVmax of whole malignant lesions, WB MTV = whole-body metabolic tumor volume, WB TLG = whole-body total lesion glycolysis

Table (9): Agreement between Suggested baseline PET/CT metabolic parameters cut-off values and actual mortality in metastatic breast cancer patients.

		Mortality 15/50	Survival 35/50	Kappa	p-value
W-SUVmax	≥12.9	6 (12.0%)	8 (16.0%)	0.175	0.216
	<12.9	9 (18.0%)	27 (54.0%)		
WB-MTV	≥158.9 cm3	14 (28.0%)	5 (10.0%)	0.735	<0.001*
	<158.9 cm3	1 (2.0%)	30 (60.0%)		
WB-TLG	≥ 544.0	12 (24.0%)	10 (20.0%)	0.454	<0.001*
	<544.0	3 (6.0%)	25 (50.0%)		

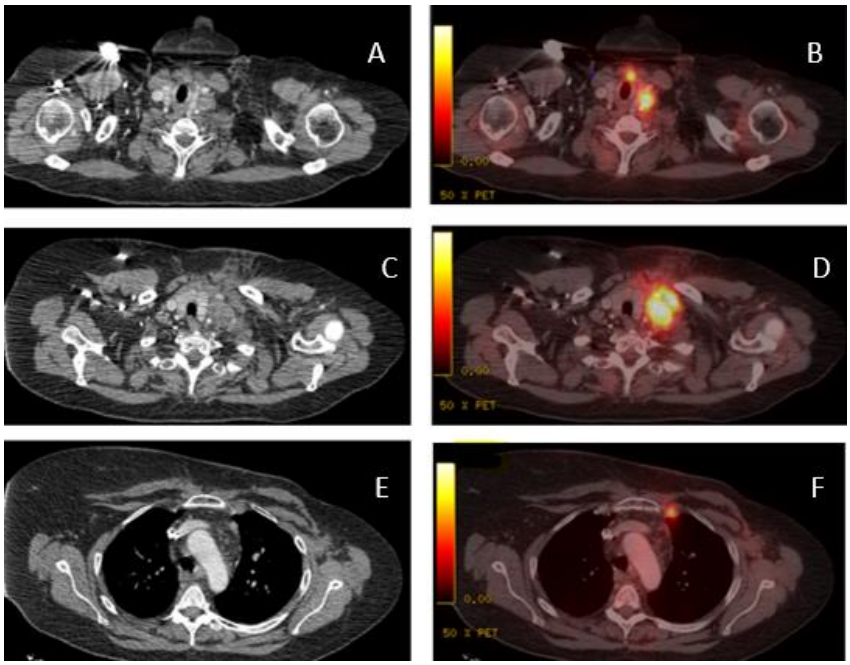
Percentages are taken from total=50. Kappa test. *Significant.

Table (10): Survival analysis (Cox regression) of baseline PET/CT metabolic parameters in relation to mortality in metastatic breast cancer patients.

Factors	B	SE	p-value	Hazards ratio (95% CI)
W-SUVmax (Above or equal median=9.4)	0.43	0.56	0.439	1.54 (0.52–4.57)
WB-MTV (Above or equal median =116.5 cm3)	2.69	1.17	0.026*	13.46 (1.36–132.72)
WB-TLG (Above or equal median =471.2)	0.90	0.88	0.306	2.45(0.44–13.89)

β: Regression coefficicent. SE: Standard error, CI: Confidence interval, *significant.

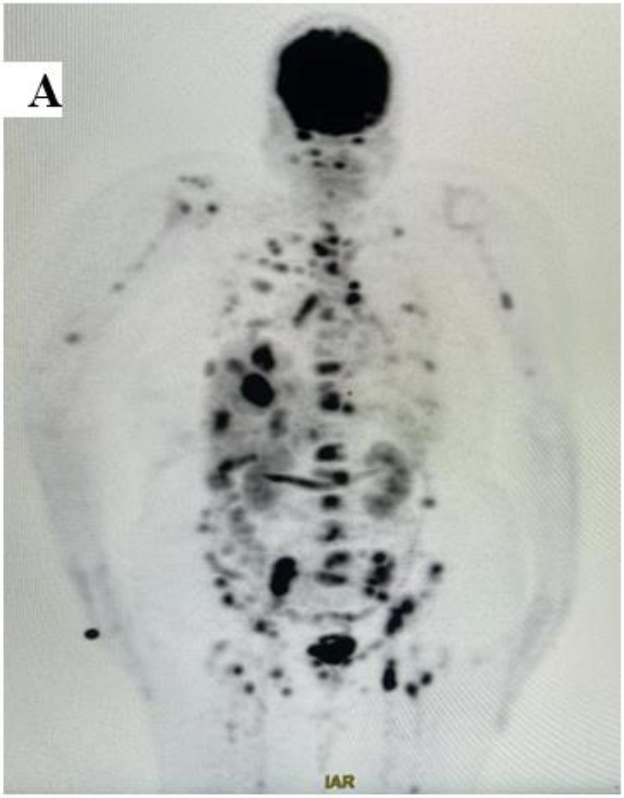
Figure 1:



35-year-old female with history of left breast invasive ductal carcinoma (triple-negative subtype) underwent mastectomy. (A and B) CE-CT and corresponding PET/CT showed submental, left cervical metabolically active lymph nodes, (C and D) supraclavicular metabolically active lymph nodes; the submental lymph node could be missed on CE-CT easily, (E and F) CE-CT and corresponding PET/CT showed metabolically active left internal mammary lymph node; the left internal mammary lymph node couldn't be detected on CE-CT clearly.

Figure 2:

51-year-old female patient with history of left breast invasive ductal carcinoma (luminal B subtype) underwent left mastectomy; (A) MIP image of PET showing widespread metastases with increased uptake in metastatic cervical and mediastinal lymph nodes as well as lung, liver, and bones deposits, W-SUV max = 13.4, WB- MTV = 297.5 cm3 and total lesion glycolysis =1524.7, she died after 9 months.



DISCUSSION:

In this retrospective study, which included 50 female patients with metastatic breast cancer, our aim was to detect the diagnostic value of PET/CT in assessment of metastatic breast cancer patients compared to CT and correlate this with the molecular subtype.

Performance of PET/CT Versus CT: In our study, we found that PET/CT is of very high add value to CT in detecting and identifying distant metastases.

Groheux D et al [8] reported that 18F-FDG PET/CT was superior to conventional imaging in the detection of bone metastases, distant lymph nodes, and liver metastasis, while CT was more sensitive for lung metastases. These results came in agreement with our results.

Bone, lung, liver, and brain are common sites of distant metastasis in breast cancer with bone metastasis being the most common site[9].

PET/CT shows a magnificent combination of morphological and functional images [10]. CT portion may be useful in localizing and distinguishing fractures, cysts, or degenerative changes[11].

In our retrospective study, PET/CT showed better performance than CT in detecting bone deposits, P-value <0.001. PET/CT showed a higher ability to detect developing bone metastases and early bone marrow infiltration without CT structural changes (occult CT metastases). These results are consistent with those of Wafaie et al. [12], who reported that PET/CT was highly efficient in assessing bone metastases as well as detecting early bone marrow metastases without CT structural changes.

Groheux D et al. [8] reported that PET/CT led to change in the staging of 77 out of 254 breast cancer patients (30.3%). It detected unsuspected N3 disease in 40 women (sub- or supra-clavicular or internal mammary nodes). Aukema et al. [13] reported that FDG-PET/CT detected extra-axillary lymph nodes in 28% of the patients, while in 17% FDG-PET/CT showed suspicious uptake that was not detected by conventional imaging.

In our study, the overall number of lymph node metastases detected by PET/CT was significantly higher than that of CT with a P-value < 0.001. In 9 out of 28 patients PET/CT was significantly higher than CT regarding the number of metastatic lymph nodes detected, meanwhile in 5 out of 28 patients the CT showed up a higher number of metastatic lymph nodes, regarding the morphology, while these lymph nodes showed no significant FDG uptake in corresponding PET/CT and considered false-positive CT finding; as evident by follow up.

Diagnostic CT is efficiently capable of detecting sub-centimetric pulmonary nodules. While PET lacked sensitivity for detecting small subcentimetric nodules, this is maybe due to the partial volume effect and respiratory movements'. Therefore, combined PET/CT improved the sensitivity of PET/CT in comparison to PET alone [13]. In our study, 4 out of 20 patients showed PET/CT- CT mismatch, as the PET portion of the PET/CT failed to pick up small sub-centimetric pulmonary nodules showing no FDG uptake and considered indeterminate, while considered metastatic in the CT assessment regarding the multiplicity (P-value = 0.001).

Groheux D et al.[14] stated that PET/CT corrected the diagnosis of patient with isolated pleural effusion, which was considered benign on CT. PET/CT scan showed high nodular uptake in the effusion, which was interpreted as metastasis and later confirmed by pleural aspiration as malignant. In our study, in 2 patients with pleural effusion, PET/CT was superior to CT in detecting malignant nature and showed pleural thickening with FDG uptake.

18F-FDG PET/CT had similar sensitivity to that of conventional imaging for liver metastases, yet PET/CT helped to classify

doubtful lesions on conventional imaging [15]. In our study, PET/CT sensitivity was higher than CT alone in hepatic metastases assessment with P-value < 0.001. PET/CT was superior to CT in detecting developing hepatic metastases as well as identifying small indeterminate lesions (Too small to be characterized lesions and cystic metastases).

The role of PET/CT in brain metastases assessment is limited by the high physiologic uptake of FDG by the brain as well as the lack of contrast in the CT part of most examinations, which may lead to missed metastases. Detection of brain metastasis could be performed more accurately by re-adjusting PET images to reduce normal brain FDG uptake and assessing CT images in the brain window [16].

Regarding molecular subtype characteristics: According to different gene expressions, breast cancer is classified into 4 main subtypes; luminal types A and B, triple-negative (TN), and Her 2+ molecular subtypes[17]. Although there are discrepancies between reports regarding the preferential sites for metastasis of breast cancer subtypes, it is now accepted that different molecular subtypes exhibit distinctive behavior regarding the sites of distant metastasis[18]. Bartmann C et al. [19] and Soni A et al. [20] reported in their studies that the luminal subtypes showed more frequent bone metastasis while the HER2+ subtype showed more frequent liver metastasis. Patients with triple-negative subtype were most likely to develop visceral metastases. Brain metastasis was predominately found in patients with HER2+ and TN breast cancer.

Consistent with these previous studies, we found in our study that luminal types (A and B) showed a higher propensity for bone metastases (73.3% and 68.8%, respectively) compared with lung, liver, and pleural metastases. Otherwise, there was no statistically significant difference between the different molecular subtypes regarding metastatic sites. This could be attributed to the small sample size of our study compared to previous studies. In keeping with several previous studies (21 and 22), we found in our study that luminal types (A and B) had a better prognosis with lesser mortality rates than HR-/HER2 + and Triple-negative subtypes (15.8 % and 25%, 50%, and 55.6% mortality respectively).

Regarding the PET/CT metabolic parameters: Glucose uptake, which is a hallmark of cancers, increases with malignancy. It is usually evaluated on FDG/PET by calculating the standard uptake value (SUV) in the tumor. SUV max is the most commonly used parameter in clinical trials. However, tumor metabolic burden in terms of metabolic tumor volume (MTV) and total lesion glycolysis (TLG) has been reported to be capable of reflecting glucose uptake within the whole tumor rather than a single-pixel value of 18F-FDG activity (SUV max) [23].

Morris PG et al. [24] reported that in metastatic bone lesions, the SUV max showed a strong proportional association with overall survival; meanwhile, Zhang J et al. [25] showed that the SUV max of the primary tumors at baseline assessment was significantly correlated with progression-free survival and overall survival. In these studies, in patients with multiple metastatic sites, the lesion with the highest SUV max was included in the analysis, the condition in which probably seems to underestimate the risks presented by other metastatic sites [26].

Many studies have been conducted to assess the importance of the metabolic tumor burden in primary breast cancer. Chen W et al [23] declared that the metabolic tumor burden (represented by the MTV and TLG) could reflect the tumor metabolic differences in different breast cancer molecular subtypes. Yoo J et al [7] reported that total lesion glycolysis of the primary tumors could be useful in predicting pathologic axillary lymph node metastasis in IDC patients with clinically negative axillary lymph.

Chen W et al[23] defined the metabolic tumor volume (MTV) as the volume of the tumor that shows increased FDG uptake; it is the extent of FDG uptake by a tumor, not solely the intensity of FDG uptake. They reported that MTV is able to reflect the metabolic volume, rather than the size of the mass; it provides more accurate measurement than the maximum or minimum diameters, especially for lesions with non-FDG-uptake necrosis inside. Total lesion glycolysis (TLG); the product of mean SUV and MTV, represents the combination of the volumetric and metabolic information of FDG-PET [27].

As PET can provide information on whole-body (WB) metabolism, it also allows the total volume of metastatic lesions to be determined [26].

Few studies were carried out to evaluate the role of PET metabolic parameters in metastatic cancer patients. Son SH et al. [26] reported in their study on patients with metastatic breast cancer that WB-MTV and WB-TLG values were statistically significantly higher among non-survivors than among survivors, (p= 0.0430 ; p = 0.0428 respectively), while WB-MTV ; representing systemic WB tumor burden, was the only independent prognostic index of over-all survival in these patients.

Another study was done by Marinelli B et al. [28] on 47 metastatic triple-negative breast cancer patients, and they reported that W-SUV max and WB-TLG were not significantly predictive of survival yet WB-MTV was.

In agreement with previous studies, in our study, there was no statistically significant difference in the SUV maximum values between survivors and non-survivors. Meanwhile, the mean of WB-MTV and WB-TLG values were statistically significant in the non-survivors than in the survivors (p= <0.001 each), yet survival analysis revealed that WB-MTV was the only independent factor affecting mortality rate (hazard ratio (95% CI) =13.46 (1.36-132.72); P-Value = 0.026).

Conclusion:

18F-FDG PET/CT could be a non-invasive suitable imaging technique for assessment of metastatic IDC breast cancer patients with the advantage of being a single modality. WB-MTV is suggestive to be a strong independent parameter in predicting the survival in metastatic breast cancer patients.

Limitations:

Small number of patients and Short-term follow-up.

Retrospective nature of our study with heterogeneous population and consequently different treatment regimens and heterogeneity in the timing of follow-up.

No biopsy for metastases for most cases.

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دور التصوير الطبقي بالبوزيترون المنبعث (فلوريد الجلوكوز منقوص الاكسجين) المدمج مع الأشعة المقطعية فى تقييم المرضى الذين يعانون من ثانويات سرطان الثدي

الخلفية: يعد المسح الذرى المقطعى بالإنبعاث البوزيتروني المدمج مع الأشعة المقطعية(PET/CT) طريقة للتصوير تسهل تقييم مراحلة اورام الثدي و معرفة و تحديد مناطق انتشار الأورام الثانوية، و التنبؤ بمسار المرض، لأنه يوفر القدرة على الجمع بين المعلومات الوظيفية والمورفولوجية في فحص واحد.

في السنوات الأخيرة، تم إثبات أن المعلومات الأيضية القائمة على الحجم مثل حجم الورم الأيضي و مجموع تحلل السكر الكي لدى الورم تعطي أهمية إنذارية, لأنها لا تمثل فقط نشاط الورم ولكن أيضًا عبء الورم الكلي.

الهدف: كان الهدف من دراستنا هو اكتشاف القيمة التشخيصية للتصوير الطبقي بالبوزيترون المنبعث (فلوريد الجلوكوز منقوص الاكسجين) المدمج مع الأشعة المقطعية (FDG PET/ CT) في تقييم المرضى الذين يعانون من ثانويات سرطان الثدي وتقييم الاستجابة العلاج مع التركيز على الأنواع الفرعية لسرطان الثدي.

الطرق: كانت هذه الدراسة بأثر رجعي ، أجريت في مستشفى المعادي للقوات المسلحة - قسم الطب النووي، و تضمنت ٥٠ مريضة مصابات بسرطان الثدي النقلي (متوسط اعمارهن ٥٣+/-١٠) وخضعن للتصوير المقطعي بواسطة الانبعاث الإشعاعي البوزيتروني قبل تلقي العلاج و المتابعة حسب خطة العلاج لكل مريضة. كانت نقطة النهاية ٣ سنوات للمتابعة لكل مريضة. توفى خمسة عشر مريضة من الخمسين المريضة (متوسط معدل الوفيات ١٣ شهرا).

تم جمع البيانات بما في ذلك الأنواع الفرعية لسرطان الثدي، نتائج التصوير المقطعي البوزيتروني و التصوير المقطعي والنتائج الايضية للتصوير البوزيتروني (متضمنة أعلى قيمة امتصاص قياسية للاورام بالجسم كله-W) (SUVmax , مجموع الحجم الأيضي للاورم بالجسم كله(WB-MTV) ، و مجموع تحلل السكر الكلي لدى الاورام بالجسم كله (WB-TLG)), ثم تم جدولة النتائج وتحليلها.

النتائج: طبقا للفحوصات الاولية, اثبت المسح الذرى المقطعى بالإنبعاث البوزيتروني المدمج مع الأشعة المقطعية انه افضل من التصوير المقطعي في اكتشاف و تقييم الاورام السرطانية الثانوية لسرطان الثدي في العظام والغدد الليمفاوية والكبد بينما كان التصوير المقطعي أكثر حساسية في تقييم ثانويات الرئة خاصة التي يقل قطرها عن واحد سنتيمتر.

تساوى المسح الذرى المقطعى بالإنبعاث البوزيتروني المدمج مع الأشعة المقطعية و التصوير المقطعي في الكشف عن الثانويات بالمخ وقد يرجع ذلك الي الحساسية المنخفضة لدى المسح الذرى المقطعي بالانبعاث البوزيتروني الناتجة عن امتصاص المخ لمادة فلوريد الجلوكوز منقوص الاكسجين, وبالتالي يتم تقييد استخدامه في هذا الغرض.

كان للنوعان اللمعيان أ و ب (luminal A and B) ميلًا مرتفعًا للانتشار في الهيكل العظمي مقارنةً بالأماكن الاخرى، بينما لم يكن هناك فرق معتد به إحصائيا بين الأنواع الفرعية المختلفة فيما يتعلق بأماكن انتشار الاورام الثانوية, يمكن أن يعزى ذلك إلى صغر حجم عينة دراستنا مقارنة بالدراسات السابقة.

أظهرت المريضات اللاتي كانت لديهن اورام ذوي المستقبلات السالبة ثلاثيا (TN) و ذوي مستقبلات الهورمونات سالبة و تحتوي على مستقبلات لعامل نمو البشرة البشرية (HR-/HER2+) تدهور للحالة المرضية و ارتفاع في نسب الوفيات مقارنة باللاتي كانت لديهن مستقبلات للهرمونات موجبة.

كان متوسط مجموع الحجم الأيضي للأورام وتحلل السكر الكلي لدى الاورام بالجسم كله أعلي في الحالات المتوفية عن ذلك في الحالات الباقيين على قيد الحياة، بينما لم يظهر متوسط أعلى قيمة امتصاص قياسية للأورام أي فرق ذي دلالة إحصائية بين المجموعتين.

أظهر تحليل البقاء الاحصائي (survival analysis) أنه يمكن فقط استخدام مجموع متوسط الحجم الأيضي للأورام بالجسم كله كعامل مستقل يؤثر في معدل الوفيات.

الخلاصة: خلصنا في دراستنا الى اننا نقترح استخدام المسح الذرى المقطعى بالإنبعاث البوزيتروني المدمج مع الأشعة المقطعية في تقييم المرضى الذين يعانون من ثانويات سرطان الثدي، حيث انه يعد من الوسائل الجيدة والجوهرية في تحديد انتشار الأورام الثانوية وتقييم الجسم كله فحص واحد، وكذلك متابعة العلاج مما يساهم في اخيار العلاج الامثل.

استخدام مجموع متوسط الحجم الأيضي للأورام بالجسم كله يمكن ان يكون مفيدا في تقييم المرضى الذين يعانون من ثانويات سرطان الثدي وذو قيمة في التنبؤ بمعدل الوفيات.