Palestine Ahliya University Journal for Research and Studies
مجلـة جامعة فلسطين الأهلية للبحوث والدراسات
ISSN: 2959-4839
Vol. 02 Issue 01 (2023)

Evaluating the efficacy of breast cancer treatments using PET-CT Imaging

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Received:03/02/2023 Accepted:11/03/2023 Published: 01/04/2023

Abstract:

Positron emission tomography-computed tomography (PET-CT) scans are used to detect and stage cancer and can be used to evaluate the effectiveness of treatments used for patients with different types of cancer. The current study aims to evaluate the effectiveness of treatments provided to breast cancer patients and the effect of treatment on the right and left breasts separately. A sample of (84) female left and right breast cancer patients were treated with radiation therapy and/or chemotherapy. The efficacy of the treatments was evaluated on 18 follow-up patients among the original sample who already underwent a PET-CT scan before starting their treatment. Treatment efficacy was evaluated by measuring the standard uptake value (SUV) of cancer lesions in patients before and after treatment. Results showed that 32.1% of the diagnosed lesions did not change their SUV values, 39.3% were treated, 27.4% were new lesions do not present in the original PET-CT scan, and 1.2% for lesions that increased the value of the SUV. Moreover, the results also showed that left breast cancer was more responsive to treatment than right breast cancer, while chemotherapy was more effective than radiation therapy. In summary, the efficacy of chemotherapy and/or radiotherapy for both right and left breast cancer patients was evaluated using PET-CT technology. Only one-third of the cancerous lesions were treated using the treatment methods described in this study. The research is unique in that it is the first in Palestine to investigate the feasibility and efficacy of the treatment delivered to breast cancer patients.

Keywords: *PET-CT; Breast Cancer; Chemotherapy; Radiation therapy.*

تقييم فعالية علاجات سرطان الثدي باستخدام التصوير المقطعي بالإصدار البوزيتروني

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تاريخ الاستلام:03/02/2023 تاريخ القبول:11/03/2023 تاريخ النشر:01/04/2023

ملخص:

تُستخدم فحوصات التصوير المقطعي بالإصدار البوزيتروني– التصوير المقطعي المُحوسب **(PET-CT)** للكشف عن السرطان ومرحلته، ويمكن استخدامها لتقييم فعالية العلاجات المستخدمة للمرضى المصابين بأنواع مختلفة من السرطان. تهدف الدراسة الحالية إلى تقييم فعالية العلاجات المُقدّمة لمرضى سرطان الثدي، وتأثير العلاج على الثديين الأيمن والأيسر بشكلٍ منفصل. أُجريت الدراسة على عينة مُكّونة من (84) أنثى من مرضى سرطان الثدي الأيمن والأيسر، واللواتي قُدّم لهنّ العلاج الإشعاعي و/ أو العلاج الكيميائي، وتم تقييم فعالية العلاجات على (18) مريضةً تم عمل متابعة لهنّ من بين العينة الأصلية اللواتي خضعنّ بالفعل لفحص **(PET-CT)** قبل بدء العلاج، كما تم تقييم فعالية العلاج عن طريق قياس قيمة الامتصاص القياسية **(SUV)** لآفات السرطان في المرضى قبل وبعد العلاج. أظهرت النتائج أن (32.1٪) من الآفات التي تم تشخيصها لم تُغيّر قيم الامتصاص القياسية **(SUV)**، و(39.3٪) تم علاجها، و(27.4٪) كانت آفات جديدة غير موجودة في فحص **(PET-CT)** الأصلي، و(1.2٪) للآفات التي زادت من قيم الامتصاص القياسية **(SUV)**. علاوةً على ذلك، أظهرت النتائج أن سرطان الثدي الأيسر كان أكثر استجابة للعلاج من سرطان الثدي الأيمن، بينما كان العلاج الكيميائي أكثر فعالية من العلاج الإشعاعي. باختصار، تم تقييم فعالية العلاج الكيميائي و/ أو العلاج الإشعاعي لكل من مرضى سرطان الثدي الأيمن والأيسر باستخدام تقنية **PET-CT**. تم علاج ثلث الآفات السرطانية فقط باستخدام طرق العلاج الموصوفة في هذه الدراسة.

الكلمات المفتاحية: *العلاج الكيميائي، سرطان الثدي، العلاج الإشعاعي، التصوير المقطعي بالإصدار البوزيتروني – التصوير المقطعي المُحوسب.*

1. Introduction:

Breast cancer is considered the most common type of cancer affecting women's lifestyles in the world and causing death. Most of cases, the cancerous tissue lining on the milk ducts and lobules are called ductal and lobular carcinomas, respectively. Several techniques are used to diagnose breast cancer including mammography (Ahmad et al., 2020a), ultrasound (Oglat et al., 2020; Oglat et al., 2018a; Oglat et al., 2018b), computed tomography (CT) (Al-Tell, 2019; Kmail et al., 2022; Ahmad et al., 2019; Ahmad et al., 2021a), Magnetic resonance imaging (MRI) (Ahmad et al., 2020b; Ahmad et al., 2022; Mohammad et al., 2020; Ahmad et al., 2020c), Positron Emission Tomography (PET)scan, and others. Breast Cancer cannot be definitively diagnosed unless a biopsy sample from the affected tissue is taken, through which the type and grade of the disease can be identified (Lubejko et al., 2019;Ban et al., 2021; Ahmad et al., 2019; Ahmad et al., 2022).

There are five phases of breast cancer, each with a different size and location of the malignant tissues. As Stage 0 is the initial stage its distinguished by a non-invasive stage of cancer, in which the cancer cells are localized in the same part of the breast and have not spread to nearby cells. Stage 1 cancer is an aggressive and microscopic invasion. This stage is divided into two categories: 1A, which is defined as a tumor with a diameter of less than 2 cm in size with no lymph nodes involvement, and 1B, which is defined as a tumor with a diameter of more than 2 cm and lymph nodes involvement in the same region of the breast. Stage 2 similarly has two parts, 2A, which describes the presence of axillary lymph nodes or sentinel lymph nodes but no malignancy within the breast tissue itself, and tumour with a diameter size of 2-5 cm, and 2B, which describes a tumor greater than 5 cm without axillary lymph nodes. Stage 3 is divided into two parts. 3A breast tissue tumor with 4-9sentienal or axillary lymph nodes is present, 3B more than 9 lymph nodes with breast tissue ulcers. Stage 4 is the final stage and it includes metastasis from the breast tissue to other organs such as the lungs, liver, and bone(Ahmad et al., 2021b; Makhamrah et al., 2019).

Depending on the type and stage of the illness, people with breast cancer can choose from a variety of treatments. Among these are resection surgery, in which the surgeon eliminates breast cancerous tissue, whether it be a mastectomy, in which all breast tissue is removed, or surgery with breast preservation, in which a portion of the normal tissue surrounding the affected area is removed. Adjuvant Chemotherapy which is sometimes administered before surgery in order to shrink the tumor, is another form of chemotherapy that is employed to kill any leftover cells following surgery. Chemotherapy might involve hormonal or biological therapy. Finally, breast cancer can be combined with radiation therapy. It is usually done after surgery and chemotherapy, and the number of sessions is dependent upon the patient's condition (Waks & Winer, 2019a; Makhamrah et al., 2023; Ahmad et al., 2021c; Ahmad et al., 2020d).

Although structural imaging modalities provide a tool for diagnostic purposes, such as computed tomography, magnetic resonance imaging and ultrasonography. PET-CT is a hybrid imaging modality that provides structural and functional information for breast cancer diagnosis, staging and treatment (Paydary et al., 2019; Ahmad et al., 2020a), and it is known that this method based on injecting a radioactive material into the patient body and detecting its distribution in biological tissues to form tomographic images. The objectives of the current study were to determine the justification rate for PET-CT procedures, the use of PET-CT to assess breast cancer response to different treatments, and to evaluate the effect and response on both the right and left breast individually.

2. Materials and Methods:

2.1 Study design

A retrospective study was performed to assess response to breast cancer after appropriate treatment types that had been provided. Information about the diagnostic and treatment procedures for patients during the period from 2021 to 2022 was collected from the Nuclear Medicine archive, Department at Al-Ahli Hospital - Hebron, Palestine.

2.2 Study population and data collection:

The sample consisted of 84 patients with a history of breast cancer, either in the right or left breast, where the sex of all patients was female. The number of women with left breast cancer was 38 and the number with right breast cancer was 46. All ages were included. However, patients who had only one PET-CT procedure without follow-up, who had not had chemotherapy or radiotherapy, patients who did not have a PET-CT report, were excluded.

2.3 Data Collection:

Whole-body PET-CT scans were performed in 3D mode using a dedicated in-line PET-CT scanner. All patients were instructed to fast for more than 6 hours prior to examination. Data were acquired 45-minutes after intravenous injection of approximately 5 MBq/kg body weight of FDG (up to 550 MBq). The scan Field of view from the vertex to the midthigh was obtained using the following parameters: kVp: 120, mAs: 250, Field of view: 1500 mm, scan width: 2.00mm, scan time:19 seconds, length: 936mm. All patients didn't receive intravenous iodinated contrast. On completion of CT, PET-CT scans of the same area were acquired for 1.5 min/bed position, with 11-13 bed positions per pat. All patients were imaged using a device manufactured by: Philips medical system (Cleveland), lnc. - 595Miner Road - Cleveland, Ohio 44143 - USA. The archives of the Nuclear Medicine Department at Al-Ahli Hospital were also used to collect previous reports. Ethical approval was obtained from the relevant departments of Al-Ahli Hospital. Data on breast cancer patients were collected in 2021-2022 including: patient age, clinical history, reports, SUV volumes, chemotherapy sessions, radiotherapy sessions, and tumor size and location.

2.4 Data Analysis:

SPSS software version 23 was used to analysis of the data where: Chi-Square Tests used to find the Relationship between Radiotherapy and Chemotherapy and to find the Significant differences between SUV's values. ANOVA test was used to find the statistically significant differences between breast cancer and the extent of treatment provided, and the effect of radiotherapy and Chemotherapy sessions on both SUV pre and post-treatment.

3. Results

Demographic data for all patient

A total of 84 females' patient's data was collected, 54.8% had right breast cancer. where 79.8% of the participants were over 40 years old. Most patients 67.5% did not underwent any radiotherapy session. while 48.8% of the participants, did not underwent any chemotherapy session. However only 3.6% underwent more than 20 chemotherapy sessions. To evaluate the response to both radiotherapy and chemotherapy only 18 patients participated in these evaluations because they had follow-up sessions. Table 1 summarizes the demographic data of all participants who underwent follow-up PET-CT sessions.

Table (1): Distribution demographic data in the sample.

Patients underwent first PET-CT			Patients who underwent a follow-up PET-CT scan
		N (%)	N (%)
Patient History	Rt Breast Ca	46 (54.8%)	9 (5.0%)
	Lt Breast Ca	38 (45.2%)	9 (5.0%)
Age group	20-40 years	17 (20.2%)	3 (16.7%)
	>40 years	67 (79.8%)	15 (8.3%)
Radiotherapy Sessions	no session	57 (67.9%)	15 (8.3%)
	< 10 sessions	4 (4.8%)	-
	between 10-20 sessions	15 (17.9%)	3 (16.7%)
	> 20 sessions	8 (9.5%)	-
Chemotherapy Sessions	no session	41 (48.8%)	7 (38.9%)
	< 10 sessions	33 (39.3%)	1 (5.6%)
	between 10-20 sessions	7 (8.3%)	6 (33.3%)
	> 20 sessions	3 (3.6%)	4 (22.2%)

Assessment of treatment

The Chi Square test was used to find the difference between radiotherapy and chemotherapy with respect to patients' history after the first and second follow-up PET-CT scans. Table 2 shows that there is no difference between radiotherapy and chemotherapy after the first follow-up examination because they are greater than 0.05, which was a p-value of 0.141 and a p-value of 0.193, respectively. This means that the both types of treatment of breast cancer does not have any differences.

Table (2): Relationship between Radiotherapy and Chemotherapy Sessions and patients history after first and second PET-CT scan.

Radiotherapy Sessions	Value	df	P-value
Pearson Chi-Square	5.46[a]	3	0.14
Likelihood Ratio	5.44	3	0.14
N of Valid Cases	84		
a. 6 cells (75.0%) have expected count less than 5. The minimum expected count is .33.			
Chemotherapy Sessions	Value	df	P-value
Pearson Chi-Square	3.29[a]	2	0.19
Likelihood Ratio	3.07	2	0.21
N of Valid Cases	84		
a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is 1.33.			

Assessment SUV values

Distributions of SUV values in sample

SUVs, measured to find the hypermetabolic rate, then each SUV is averaged and categorized into 3 categories: mild, moderate and hypermetabolic. The SUV values were as follows: mild absorption <2.48, moderate absorption 2.48–4.96, and hyper- absorption >4.96. Table 3 shows the SUV's classification through the 18 patients according to lesions number. According to SUV, 56% of lesions did not show any uptake value while 17.9% demonstrated hyper metabolic lesion. According to SUV_1, 21.4% of right (RT) breast lesion and 45.2% of left (LT) breast lesions did not demonstrate any uptake value, while 3.6% presented a hyper metabolic rate in RT breast lesions, and 10.7% have a hyper metabolic in LT breast lesions. According to SUV_2, 38.1% of lesions in RT breast cancer patients and 65.5% of lesions in LT breast cancer patients did not show any uptake while 4.8% demonstrated hyper uptake in RT breast lesions but no hyper uptake in LT breast lesions.

Table (3): The SUV's classification through the 18 patients according to lesions number.

		N (%)	
SUV	no uptake	47(56.0%)	
	Poor uptake <2.48	4 (4.8%)	
	Mild uptake 2.48- 4.96	18 (21.4%)	
	Hyper uptake> 4.96	15 (17.9%)	
	Total	84	
		history of patient	
		Rt Breast Ca	Lt Breast Ca
SUV_1	no uptake	18 (21.4%)	38 (45.2%)
	Poor uptake <2.48	1 (1.2%)	3 (3.6%)
	Mild uptake 2.48- 4.96	6 (7.1%)	6 (7.1%)
	Hyper uptake> 4.96	3 (3.6%)	9 (10.7%)
SUV_2	no uptake	23 (38.1%)	55 (65.5%)
	Poor uptake <2.48	0	1 (1.2%)
	Mild uptake 2.48- 4.96	1 (1.2%)	0
	Hyper uptake> 4.96	4 (4.8%)	0
Total		28	56

SUV: first SUV; SUV_1: after first follow up: SUV_2: after second follow up

To find the Significant differences between SUV's using Chi-Square Tests. Table 4 shows there are no difference between SUV_1 and SUV_2 because the P-value are more than 0.05 which was p-value 0.565 and 0.012, respectively.

Table (4): Significant differences between SUV's using Chi-Square Tests.

SUV_1	Value	Df	P-value
Pearson Chi-Square	2.03^a	3	0.56
Likelihood Ratio	1.97	3	0.57
N of Valid Cases	84		
SUV_2	Value	Df	P-value
Pearson Chi-Square	11.01^a	3	0.01
Likelihood Ratio	12.32	3	0.01
N of Valid Cases	84		

SUV categories in sample

In Table 5, SUVs were classified out of 84 lesions and distributed into five classes (no changes, small changes, intermediate changes, large changes, and recurrent carcinoma with increasing value), where no changes means that there were no differences between SUV_1 and SUV lesion values. Small changes means that the difference between SUV_1 and SUV values was less than 33% of the original SUV value; Intermediate changes means that the difference between SUV_1 and SUV values was between 33-66% of the original SUV value; Significant changes means that the difference between SUV_1 and SUV values greater than 66% of the original SUV value; Recurrent cancer means that the lesion was not found in the original image SUV = 0 while the SUV_1 value is present after the first follow-up; Increasing the value means that the same pest is in the original and the first follow-up images while the value of the SUV has increased. Post the first treatment sessions, no change occurred on 32.1%. The percentage of treatment response includes both small changes 39.3% and large changes 27.4%, were new lesions that were not present in the original PET-CT scan, and 1.2% lesions in which the value of the SUV increased. That means, the response rate to treatment was only 39.3% after providing the first treatments sessions. Lesions distribution among patients underwent the second treatment sessions, 66.7% of the lesions did not change, 28.6% of the lesions were treated, and 2.4% of both the recurring lesions in which the SUV value increased.

Table (5): SUV's categories through the 84 lesions.

		N (%)
SUV_1 category	no changing	27 (32.1%)
	small changing	3 (3.6%)
	Large changing	30 (35.7%)
	Recurrent Ca	23 (27.4%)
	Increasing value	1 (1.2%)
	Total	84
SUV_2 category	no changing	56 (66.7%)
	small changing	2 (2.4%)
	Large changing	22 (26.2%)
	Recurrent Ca	2 (2.4%)
	Increasing value	2 (2.4%)
	Total	84

SUV_1 category: Differences between SUV_1 and SUV, SUV_2 category: Differences between SUV_2 and SUV_1

Treatment effect on Patient history

Response of breast cancer patients

SUV's of the 84 lesions, categories in 5 (no changes, small changes, large changes, recurrent Cancer, and Increasing size). As shown in Table 6 the differences between Right and Left breast cancer in SUV_1 category. In SUV_1 RT breast cancer ,6.0% represented a recurrent cancer while the total treated lesions 13.1% (small and large changes). However, for LT breast cancer, 36.9% represented a recurrent cancer while the total treated lesions was 20.2%.

Table (6): Differences between Right and Left breast cancer in SUV_1 category after providing first sessions of treatment.

		history of patient		
		Rt Breast Ca	Lt Breast Ca	Total
SUV_1 category	no changing	10 (11.9%)	8 (9.5%)	18
	small changing	1 (1.2%)	1 (1.2%)	2
	Large changing	10 (11.9%)	16 (19.1%)	26
	Recurrent Ca	5 (5.9%)	31 (36.9%)	36
	Increasing Size	2 (2.4%)	0	2
Total		28	56	84

The differences type of cancer and treatment

ANOVA test was conducted to find the differences between SUV_1 category, radiotherapy, chemotherapy in right and left breast cancer. Table 7 shows that there is Significant differences between SUV category with p-value was 0.013. However, both treatment types radiotherapy and chemotherapy show no difference between right and left cancer where the p-value was 0.217 and 0.835, respectively.

Table (7): Significant differences between right and left breast cancer respect treatments.

		Sum of Squares	Df	Mean Square	F	P-value
SUV_1 category	Between Groups	15.48	1	15.48	6.52	0.013
	Within Groups	194.66	82	2.37		
	Total	210.14	83			
Radiotherapy Sessions	Between Groups	0.214	1	0.21	1.54	0.21
	Within Groups	11.35	82	0.13		
	Total	11.57	83			
Chemotherapy Sessions	Between Groups	0.006	1	0.006	.04	0.83
	Within Groups	11.23	82	0.13		
	Total	11.23	83			

The effect of radiotherapy on both SUV and SUV1

As shown in Table 8, patients underwent 10-20 sessions had improved between SUV and SUV_1 values. Where LT Breast Cancer the SUV was 3 improved to SUV_1 0. However, the RT breast cancer patient values showed no improvement but on the contrary worsened in SUV 0.5 value reaching to 2.5. LT breast cancer the SUV was 0.927 and it improved into SUV_1 0.76. However, RT breast cancer patient values showed a little improvement in SUV 1.15, reaching to 0.65.

Table (8): Distribution the effect Radiotherapy Sessions on both SUV and SUV_1.

Radiotherapy Sessions	history of patient		SUV	SUV_1
no session	Rt Breast Ca	N (%)	1.15	0.65
		N	26	26
		SD	1.19	1.06
	Lt Breast Ca	Mean	0.93	0.76
		N	55	55
		SD	1.25	1.19
between 10-20 sessions	Rt Breast Ca	Mean	0.5	2.50
		N	2	2
		SD	0.71	0.71
	Lt Breast Ca	Mean	3.00	0.00
		N	1	1
		SD	.	.
Total	Rt Breast Ca	Mean	1.11	0.79
		N	28	28
		SD	1.17	1.13
	Lt Breast Ca	Mean	0.96	0.75
		N	56	56
		SD	1.26	1.18

The effect of Chemotherapy on both SUV and SUV1

As shown in Table 9, patients who underwent 10-20 sessions improved in SUV and SUV1 values. LT breast cancer patients, SUV 3 was improved to SUV_1 0.0. Conversely, RT breast cancer patient SUV values showed a regression from SUV 0 to 3. Patients did not undergo any session, where LT breast cancer, improved from SUV 0.94 to SUV_1 0.81. However, breast cancer patients' RT values showed an improvement from SUV 1.15 to 0.65. Patients underwent less than 10 sessions were improved SUV to SUV_1. Where LT breast cancer was SUV 0.67 improved to SUV_1 0.00. Whereas, RT breast cancer patient's SUV values worsened from 1.00 to 2.00.

Table (9): The effect of chemotherapy to RT and LT breast cancer on both SUV and SUV_1

Chemotherapy Sessions	history of patient		SUV	SUV_1
no session	Rt Breast Ca	Mean	1.15	0.65
		N	26	26
		SD	1.19	1.06
	Lt Breast Ca	Mean	0.94	0.81
		N	52	52
		SD	1.26	1.21
< 10 sessions	Rt Breast Ca	Mean	1.00	2.00
		N	1	1
		SD	.	.
	Lt Breast Ca	Mean	0.67	0.00
		N	3	3
		SD	1.15	0.00
between 10-20 sessions	Rt Breast Ca	Mean	0.00	3.00
		N	1	1
		SD	.	.
	Lt Breast Ca	Mean	3.00	0.00
		N	1	1
		SD	.	.
Total	Rt Breast Ca	Mean	1.11	0.79
		N	28	28
		SD	1.17	1.13
	Lt Breast Ca	Mean	0.96	0.75
		N	56	56
		SD	1.26	1.18
	Total	Mean	1.01	0.76
		N	84	84
		SD	1.23	1.16

4. Discussion

The current study examines the justification for PET-CT scanning procedures for breast cancer patients. Moreover, as different treatments are offered to breast cancer patients, the study also aims to assess the therapeutic response of breast cancer by PET-CT scan. The current study included 84 female patients with a history of breast cancer, whether the cancer was located on the right or left side. The study focused on the number of cancerous lesions in all patients. 79.8%, of patients were over 40 years old. Breast cancer is closely related to the age of the patient, due to age is one of the impact factors that increase the spread of breast cancer. This came due to the menopause period, which is usually over 40 years old, and thus the patient’s hormonal disorders increase, and among the hormones are milk hormones, progesterone and others, and from here the increase in the incidence of women over 40 years can be explained (Schoemaker et al., 2018).

The distribution of treatment sessions for both radiotherapy and chemotherapy are usually through one cycle, each cycle contains 10 treatment sessions over a period of 21 days. This system is followed by the American Cancer Society(Ban et al., 2021). The values of the SUVs were divided into three sections to evaluate the efficacy of the treatment on the cancerous lesions. The sections were mild uptake <2.48, second moderate uptake 2.48-4.96, third Hyper uptake > 4.96. These values are similar to previous studies, where the value of the number 2 was adopted as a reference point (Bohnert et al.,2018; Brownlee et al., 2018).

Among the patients, the treatment rate for right Breast Cancer patients after receiving the first treatment sessions was 13.1%, while the treatment rate for left Breast Cancer patients reached 20.2%. This indicates that patients with Left Breast Cancer are more responsive than Right Breast Cancer patients, and this is due to the fact that the percentage of tissue concentration on the left side is more than the right (Han et al., 2020; Hennessey et al., 2014). On the other hand, the blood flow from the heart to the left side is higher than the blood flow from the right side Thus, when receiving treatment such as chemotherapy, the movement is faster and at the same time more focused on the left side. This theory should be studied in the future through the work of studies focusing on this idea.

According to the significant differences between the SUV categories in both types of breast cancer support the result obtained that the treatments provided to patients had a greater effect on the left side than on the right side. While the effect of chemotherapy and radiotherapy on both sides does not affect the method of treatment and this is normal because of the presence of the same tissues on both sides.

Because the efficacy of the radiotherapy treatment offered on the left breast cancer compared to the right side, the effect was apparent on the values of SUV, where LT Breast Cancer the SUV was 3 and it improved into SUV_1 0, while the SUV values were not in favor of the right side as it increased from 0.5 to 2.5 and this supports the result we obtained previously. For the chemotherapy treatment, the SUV of LT breast cancer changes from 3 to 0.00, while in the RT breast cancer patient the SUV values reaching to 0 instead of 3.00. This gives the impression that chemotherapy for breast cancer patients has a more positive effect than radiation therapy. The reason for this is that the breast tissue has a high radiation tissue factor, but on the contrary, it may be the reason for increasing the spread of cancer instead of treating it (Hudson et al., 2020).

With the results obtained, there are shortcomings in the current study, which includes knowing the type of breast cancer, and tumor classification to know the disease most responding to treatment than others. Therefore, it can be used to conduct another study that includes these shortcomings.

5. Conclusion

The aim of this research is to know the effectiveness of the PET-CT device in evaluating the treatment of breast cancer. The study demonstrated that PET-CT technology is highly effective in evaluating the response of breast cancer to the given treatment. There are no significant differences between the two treatment values (chemotherapy or radiotherapy) in both breast cancers. However, chemotherapy has affected more than radiotherapy in treating breast cancer. Moreover, the results showed that left breast cancer is more responsive to treatment than right breast cancer.

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