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A Comparative Study on the Effects of Radiotherapy and Chemotherapy on Hematological Parameters, Liver Function, and Kidney Function in Breast Cancer Patients

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Abstract

Breast cancer is one of the most generic lethal illnesses affecting women and stays a first-rate public fitness subject because of its profound effect on survival results and average exceptional of life. In advanced stages, the disorder frequently calls for in depth healing procedures, which includes surgical intervention, chemotherapy, and radiotherapy. The mechanisms underlying breast most cancers improvement involve multifaceted interactions between genetic predisposition, hormonal law, environmental affects, and immune machine dysfunction, all of which contribute to tumor initiation and progression.The goal of the existing examine is to analyze the adjustments in selected hematological and immunological parameters in ladies with breast cancer, with unique emphasis on comparing the systemic results associated with distinctive treatment modalities. A general

of one hundred twenty contributors were enrolled and categorised into 3 businesses: forty patients undergoing chemotherapy, 40 patients receiving radiotherapy, and forty reputedly healthy women who served as a control institution. Participants had been recruited from Al-Diwaniyah General Hospital between November and December 2025, and diagnosis became hooked up by using oncology specialists based on scientific assessment supported by using laboratory and imaging findings .Venous blood samples were collected for complete blood count (CBC) analysis as well as evaluation of renal and liver function indicators. Comparative statistical analyzes were performed to identify differences between study groups and to clarify the extent to which chemotherapy and radiotherapy affect biological and systemic parameters. Regarding hematological parameters, the mean white blood cell (WBC) count was significantly lower in chemotherapy patients (5.31 ± 1.18) and radiotherapy patients (5.11 ± 1.21) compared to the control group (9.45 ± 1.30), with no significant difference between the two patient groups, indicating that both treatments similarly affect bone marrow function. Platelet counts did not show significant differences; however, plateletcrit (PCT) was notably altered, especially in the radiotherapy group, suggesting that anticancer treatments affect platelet volume and function more than total platelet count.

For renal function, blood urea levels were significantly elevated in radiotherapy patients (132.67 ± 29.0 mg/dl) compared to chemotherapy patients and controls, while serum creatinine levels did not differ significantly between groups, indicating limited impact of treatment on renal filtration function . regarding liver function, chemotherapy patients showed significantly lower ALT and AST levels compared to radiotherapy patients and controls, whereas ALP levels were significantly elevated in

both patient groups compared to controls. Serum albumin levels showed no significant differences among groups These findings indicate that chemotherapy and radiotherapy induce notable hematological and functional changes in patients, particularly affecting WBC counts, liver, and kidney functions, highlighting the importance of regular monitoring of these parameters during treatment to minimize potential complications and ensure accurate patient management.

Keywords: Breast cancer , Chemotherapy, Radiotherapy, Hematological parameters, Renal function, Liver function

Introduction

Cancer is a disease characterized by uncontrolled growth and proliferation of certain cells in the body. A malignant tumor is defined as a potentially unlimited growth that is locally expanded through the invasion and systematically through metastasis (brown at al., 2023). Cancer is considered a hyper-proliferative disease that includes many processes, including cellular changes, apoptosis deformities, proliferation, invasion, angiogenisis and metastasis. Globally, more than half a million people die from annual cancer, in about 9.7 new cases, every day (Kumar, 2019) is reported. The incidence of breast cancer has been steadily increasing, with higher prevalence rates observed in developed countries compared to developing ones. In the Kurdistan Region of Iraq, for example, the reported incidence was estimated at 30–40 cases per 100,000 population during the period 2006–2012 (Majid et al., 2017). Breast cancer typically originates in the ducts, milk-producing lobules, or the nipple area (Akram et al., 2017). Hematological parameters, including hemoglobin, white blood cells, and platelets, are key indicators for monitoring breast cancer patients ‹during treatment.

Studies have shown that chemotherapy, whether given alone or in combination with radiotherapy, can significantly reduce some hematological parameters due to its toxic effects on the bone marrow. Decreases in hemoglobin levels, red blood cells, and lymphocytes have been observed, while radiotherapy alone generally produces mild effects. These findings underline the importance of normal tracking to save you anemia and immunosuppression (Shahid, S. (2016)). A neighborhood look at conducted in Thi-Kar Governorate confirmed that chemotherapy appreciably affects hematological indices in ladies with breast cancer. Patients demonstrated markedly lower white blood cellular counts and hemoglobin levels as compared to the manage organization. These outcomes suggest that chemotherapy might also result in unfavorable modifications in hematological parameters which include anemia and immunosuppression, highlighting the want. Regular blood checking out as part of the remedy observe-up protocol to make certain affected person safety and improve clinical effects. (Sadon, 2024).Both chemotherapy and radiotherapy can induce hepatotoxicity, reflected by elevated AST, ALT, and ALP levels, and in some cases, regular monitoring of liver function is necessary to quickly detect toxicity, adjust therapy accordingly, and prevent treatment delays. (Song, et al.,2025) Renal function is a key indicator to monitor toxicity from anticancer treatments, as many chemotherapeutic agents are nephrotoxic. These medications may increase creatinine levels, decrease glomerular filtration rate (GFR), and cause acute kidney injury, so it is important to assess kidney function before, during, and after treatment(Santos *etal,*.2020).

Aim of the study

The present study was designed to assess the effect of chemotherapy and radiotherapy on selected hematological, renal and liver function parameters in women with breast cancer. Specifically, it aimed to compare white blood cell count, platelet index, renal function markers (including blood urea and serum creatinine), and liver function tests (ALT, AST, ALP, and albumin) between patients receiving chemotherapy, those undergoing radiotherapy, and healthy control subjects. The results of this study are expected to increase the understanding of treatment-related toxicity and highlight the critical importance of routine laboratory monitoring during breast cancer therapy.

Methods

design of experiment

The study was conducted in the Al-Diwaniyah Teaching Hospital, Baghdad Laboratory and the Research Laboratory at the College of Sciences, Al-Qadisiyah University in the Al-Diwaniyah Governorate in the period from September 5, 2025 to December 1, 2025. The participants were d\ivided into three main groups: The first group included 40 women with breast cancer who received chemotherapy according to the protocol. Al-Diwaniyah Teaching Hospital; The second group included 40 women with

breast cancer who underwent radiotherapy under the supervision of oncology specialists; And the third group consisted of 40 healthy women, free of chronic diseases or tumors, and served as a control group. The age of all the participants was between 25 and 60 years.

Ethics approval

Ethical approval for this study was obtained from Al-Diwaniyah Health Directorate, and verbal informed consent was obtained from all participants during the sample collection process.

Data Collection

Questionnaires were developed in Al-Diwaniyah General Teaching Hospital and private clinics to document female patients suffering from breast cancer. They were structured to collect information on demographic and clinical characteristics, including age, family history of breast cancer, weight, presence of other diseases, smoking status, and marital status.

Blood Sample Collection

Venous blood samples of five milliliters were collected from women suffering from breast cancer using sterile medical syringes. Three milliliters of blood was transferred into gel tubes and left at room temperature for 30 minutes. The serum became then separated the usage of a centrifuge, transferred to Eppendorf tubes, and saved at -20 °C till further analysis. All specimens were imprinted with a completely unique serial wide variety and the affected person's name. The final two milliliters of blood were placed in EDTA tubes containing an anticoagulant, blended

lightly on a blood mixer to prevent clotting, and in the end analyzed the (use of the Sysmex tool for complete blood count number (CBC

Complete Blood Count (CBC) Analysis

For CBC checking out, 2 mL of venous blood pattern turned into collected right into a tube containing EDTA to save you coagulation. The tube become gently inverted 8–10 times to make certain thorough mixing of the anticoagulant with the blood. All samples were analyzed within hours of series to keep the integrity and accuracy of hematological parameters. Hematological evaluation was completed the use of the Swelab Alpha automatic hematology analyzer, which makes use of the electric impedance method for blood cellular counting. The following parameters have been measured: white blood cell rely (WBC), platelet be counted (PLT), and plateletcrit (PCT). The outcomes were interpreted according to standard reference levels, thinking of the age, sex and scientific circumstance of the contributors.

Biochemical test

Blood samples of 3 mL had been gathered into tubes containing gel and allowed to solidify at room temperature (20–25 °C) for 15 min. After clotting, the samples were centrifuged at 4000 rpm for approximately 10 min to split the serum. The remoted serum became then divided into 3 equal aliquots (0.Five mL each), transferred into tightly sealed Eppendorf tubes, and stored at -20 °C until in addition analysis.

Immunological markers had been analyzed the use of the ELISA technique, while biochemical analyzes have been finished to assess liver and kidney characteristic. Liver characteristic assessments (LFTs)

blanketed alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP). Renal characteristic assessments (RFT) included serum creatinine and blood urea nitrogen (BUN).

Statistical Analysis :Data were analyzed using SPSS v26 and Microsoft Excel 2010. Numeric data were presented as mean ± standard deviation after testing for normality. Differences between two groups were assessed using independent t-test, while one-way ANOVA was used for comparisons among more than two groups. Chi-square test assessed associations between categorical variables. ROC curve analysis determined cutoff values, accuracy, sensitivity, and specificity. Pearson correlation evaluated relationships between numeric variables. Significance was set at $P < 0.05$, and highly significant at $P \leq 0.01$ (Daniel, 2018).

RESULTS AND DISCUSSION

Results of some blood parameters (WBC, platelets, PCT) in patients and healthy controls.

The comparison of some blood parameters (WBC, platelets, PCT) between patients and control group has been carried out and the results were demonstrated in table (4-5). Mean levels of white blood cells (WBC) count were 5.11 ± 1.21, 5.31 ± 1.18 and 9.45 ± 1.30, in BC patient with radiation, BC patient with chemotherapy and healthy control group respectively; the mean levels was significant lower in both group of patients (BC patient with radiation and BC patient with chemotherapy) in compared to healthy control, but the difference was non-significant between both group of patients (BC patient with radiation and BC patient with chemotherapy) 0.05). Furthermore, the present results show there was non->themselves (P significant difference between patients and healthy control according to 0.05). Results of renal function test (blood urea and >platelets counts, (P serum Creatinine) in patients and healthy controls.

Mean levels of blood urea were 132.67 ± 29.0 mg/dl, 29.18 ± 5.18 mg/dl and 30.71 ± 6.53 mg/dl, in BC patient with radiation, BC patient with chemotherapy and healthy control group respectively; the mean levels was higher in BC patient with radiation in compared to other groups (BC patient with chemotherapy and healthy control) and the difference was highly significant ($P < 0.001$). But there was non-significant difference between BC patient with chemotherapy and healthy control themselves. The mean of serum Creatinine level were 0.56 ± 0.11, 0.55 ± 0.08 and 0.62 ± 0.15, in BC patient with radiation, BC patient with chemotherapy and healthy control group respectively; the result show non-significant difference between all study groups.

Table(4-8) Comparison of renal function test (blood urea and serum Creatinine) in patients and healthy controls

Groups		Blood urea (mg/dl)	Creatinine (mg/dl)
BC with radiation	**Mean ± SD**	**132.67 ± 29.0^{A}**	**0.56** ± 0.11^{A}
	Range	24.00-234.00	0.21-1.61
BC with chemotherapy	**Mean ± SD**	**29.18** ± 5.18^{B}	**0.55** ± 0.08^{A}
	Range	16.80-61.80	0.35-1.13
Control	**Mean ± SD**	**30.71** ± 6.53^{B}	**0.62** ± 0.15^{A}
	Range	24.00-51.00	0.51-1.30
p-value		**0.001****	**0.451**
Means followed by different letters are significantly different according to Duncan's multiple range comparisons (DMRTs), Means followed by the same letter are not significantly different.			

0.05<**SD**: standard deviation; †: one way ANOVA; **: significant at *P*

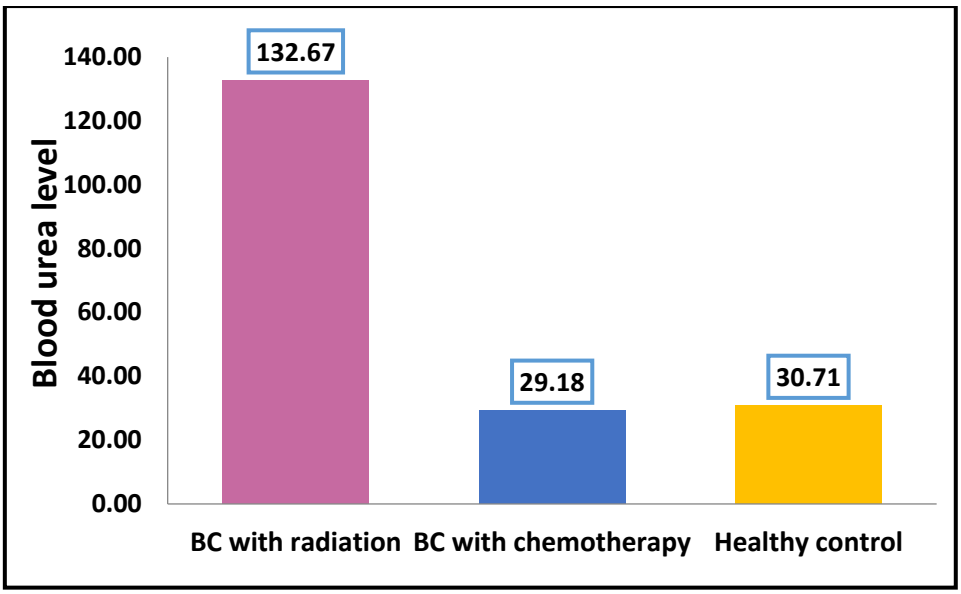

Figure (4-5): The means level of Glucose in patients and control groups

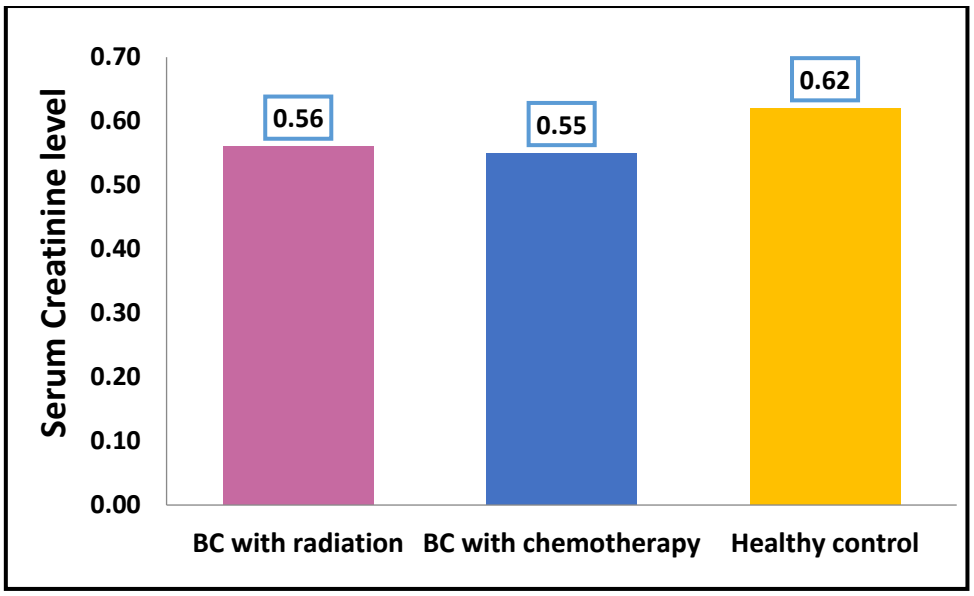

Figure (4-6): The means of serum Creatinine in patients and control groups

The present study demonstrated a statistically significant increase in blood urea levels among breast cancer patients treated with radiotherapy compared to both the chemotherapy and healthy control groups, while no significant differences were observed in serum creatinine levels across all

groups. This dissociative pattern between the two functional indicators can be explained by subtle, early changes in renal function induced by radiotherapy, without evident structural damage or impairment in glomerular filtration, as reflected by creatinine stability. The observed elevation in urea may be attributed to the systemic effects of radiotherapy, such as increased protein catabolism or transient alterations in renal perfusion, whereas the lack of a statistically significant effect of chemotherapy on either marker in this cohort may be due to the nature and relatively low doses of the agents used, a short follow-up period insufficient for the development of nephrotoxicity, or well-preserved baseline renal function in the participants prior to treatment. These findings are consistent with Sions *et al*. (2022), Davila Fajardo *et al*. (2023). In contrast, evidence indicates that chemotherapy, particularly regimens containing cisplatin, can lead to marked nephrotoxicity and a significant decline in glomerular filtration rate (GFR) due to the direct effects of chemotherapeutic agents on renal function, especially in patients with pre-existing risk factors. These findings are consistent with Sato *et al*. (2016).

Table (4-5) Comparison of some blood parameters (WBC, platelets and healthy controls and PCT) in

Groups		WBC	Platelets	PCT
BC with radiation	**Mean ± SD**	**5.11 ± 1.21^{A}**	**215.14** ± 36.6^{A}	**0.41** ± 0.1^{A}
	Range	0.30-11.70	70.79-380.0	0.10-1.27
BC with chemotherapy	**Mean ± SD**	**5.31** ± 1.18^{A}	**241.83** ± 41.9^{A}	**0.24** ± 0.09^{B}

	Range	2.30-17.20	56.00-504.00	0.01-0.51
Control	**Mean ± SD**	**9.45** ± 1.30^{B}	**219.41** ± 21.8^{A}	**0.29** ± 0.06^{B}
	Range	9.00-13.40	130.00-310.00	0.20-0.39
p-value		**0.001****	**0.102**	**0.006****
Means followed by different letters are significantly different according to Duncan's multiple range comparisons (DMRTs), Means followed by the same letter are not significantly different.				

5 0.0<**SD**: standard deviation; †: one way ANOVA; **: significant at *P*

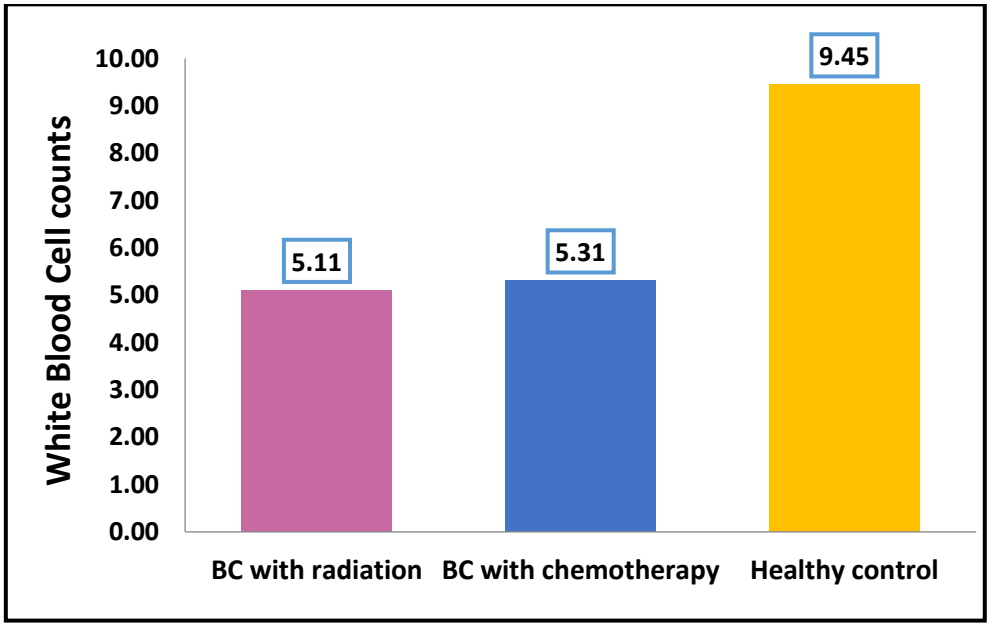

Figure (4-2): The means of WBC count in patients and control groups

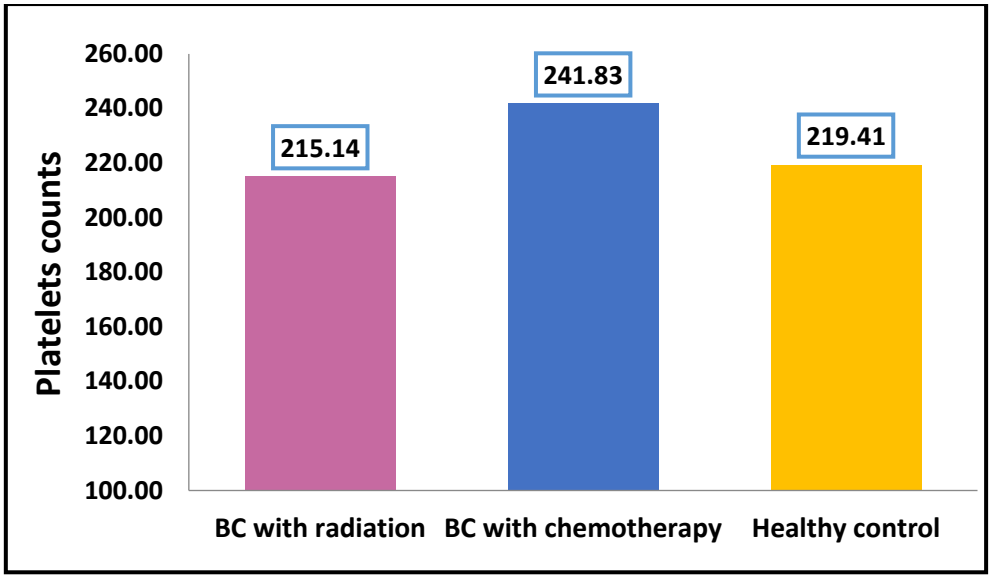

Figure (4-3): The means of platelets count in patients and control groups

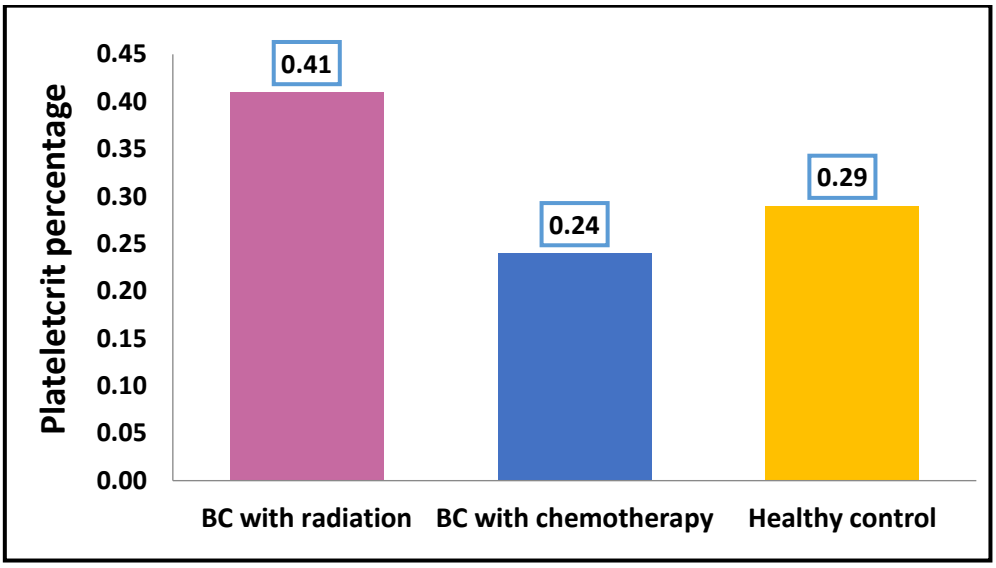

Figure (4-4): The means of Plateletcrit (PCT) in patients and control groups

The present study demonstrated a significant decrease in white blood cell (WBC) counts in breast cancer patients undergoing radiotherapy and chemotherapy compared to the control group, with no significant difference between the two treatment modalities, indicating that both therapies exert a similar impact on bone marrow function. This reduction

can be attributed to the direct cytotoxic effect of chemotherapy on rapidly dividing cells as well as the suppressive effect of radiotherapy on hematopoietic stem cells, resulting in decreased white blood cell (WBC) production. These findings are consistent with previous studies, such as Tadesse and Lemini (2023), which reported that a decline in WBC count is a common hematological consequence of chemotherapy, and are further supported by a systematic review conducted by Gemius (2021). In contrast, platelet counts did not show significant changes; However, platelet count (PCT) was particularly affected in the radiotherapy group. This change is probably due to the effect of anticancer treatments on platelet volume and function rather than their total number, as both chemotherapy and radiotherapy can modify platelet activity and size without changing overall platelet count. These findings are consistent with Zhao *et al*. (2024).

Results of liver function tests (ALT, AST, ALP and ALB) in patients and healthy controls. The comparison of liver function tests (ALT, AST, ALP and ALB) between patients and control group has been carried out and the results were demonstrated in table (4-11). Mean levels of Alanine Aminotransferase (ALT) were 64.05 ± 14.12 U/I, 28.30± 5.45 U/I and 63.00 ± 17.34 U/I, in BC patient with radiation, BC patient with chemotherapy and healthy control group respectively; the mean levels was lower in BC patient with chemotherapy in compared to other groups (BC patient with radiation and control group), and the difference was significant ($P<0.05$) But the mean levels was non-significant difference between both other groups (BC patient with radiation and control group) themselves ($P>0.05$). Also the mean levels of serum Aspartate Aminotransferase (AST) were 100.64 ± 20.29 U/I, 38.23 ± 7.61 U/I and 72.00 ± 13.33 U/I, in BC patient with radiation, BC patient with chemotherapy and healthy control group respectively; the mean levels was lower in BC patient with

chemotherapy in compared to other groups (BC patient with radiation and control group), and the difference was significant (P<0.05). Also there was significant difference between both other groups (BC patient with radiation and control group) themselves (P<0.05).But the mean levels of serum Alkaline Phosphatase (ALP) were 145.82 ± 31.4 U/I, 113.69 ±19.41 U/I and 67.18 ± 11.52 U/I, in BC patient with radiation, BC patient with chemotherapy and healthy control group respectively; the mean levels was higher in both group of patients (BC patient with radiation and BC patient with chemotherapy) in compared to control group, and the difference was significant (P<0.05). But the present result show non-significant difference among all study groups according to the mean of ALB (P> 0.05).

Table (4-11): Results of liver function tests (ALT, AST, ALP and ALB) in patients and healthy controls.

Parameters	Radiation *n* =40	Chemotherapy *n* = 40	control *n* = 40	P value
Alanine Aminotransferase (ALT) (U/I)				
Mean ± SD	**64.05 ± 14.12^{A}**	**28.30± 5.45^{B}**	**63.00 ± 17.34^{A}**	**0.001 † HS**
Range	20.00- 99.00	15.00 – 48.00	17.00 – 133.00	
Aspartate Aminotransferase (AST) (U/I)				
Mean ± SD	**100.64 ± 20.29^{A}**	**38.23 ± 7.61^{B}**	**72.00 ± 13.33^{C}**	**0.001 †**

Range	15.00- 198.00	21.00 – 66.00	28.00 – 120.00	**HS**
Alkaline Phosphatase (ALP) (U/I)				
Mean ± SD	**145.82 ± 31.4^{A}**	**113.69 ± 19.41^{B}**	**67.18 ± 11.52^{C}**	**0.001 † HS**
Range	65.00- 254.00	59.00–265.00	39.00 – 100.00	
Serum Albumin (ALB) (U/I)				
Mean ± SD	**3.88 ± 0.61^{A}**	**3.75 ± 0.35^{A}**	**4.26 ± 0.71^{A}**	**0.201 † NS**
Range	2.70- 5.00	2.90–4.20	2.10 –6.10	
Means followed by different letters are significantly different according to Duncan's multiple range comparisons (DMRTs), Means followed by the same letter are not significantly different.				

n: number of cases; SD: standard deviation; †: one way ANOVA; **HS**: 0.001; NS: non-significant at P > 0.05.<Highly significant at *P*

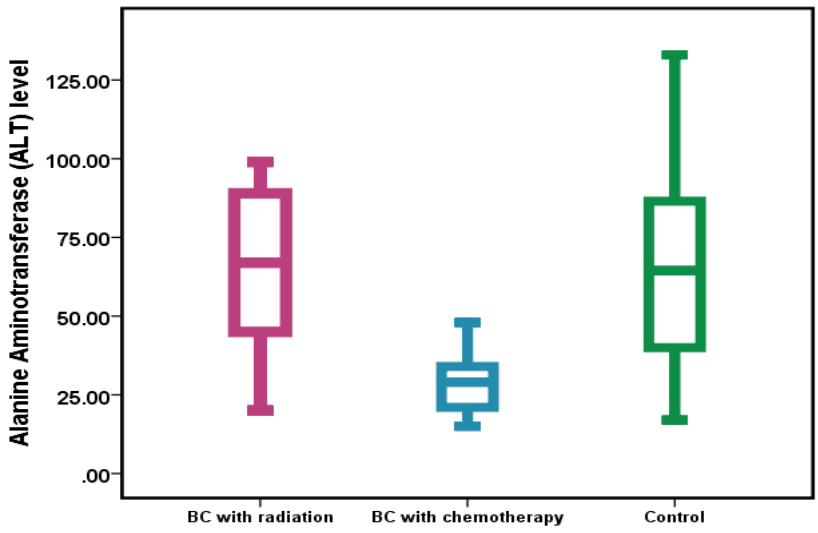

Figure (4-7): The means level of serum ALT in patients and control groups

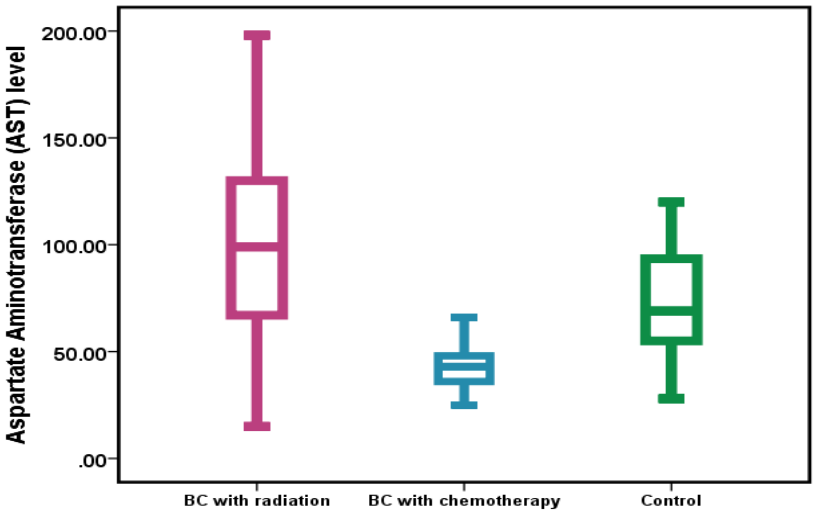

Figure (4-8): The means level of serum AST in patients and control groups.

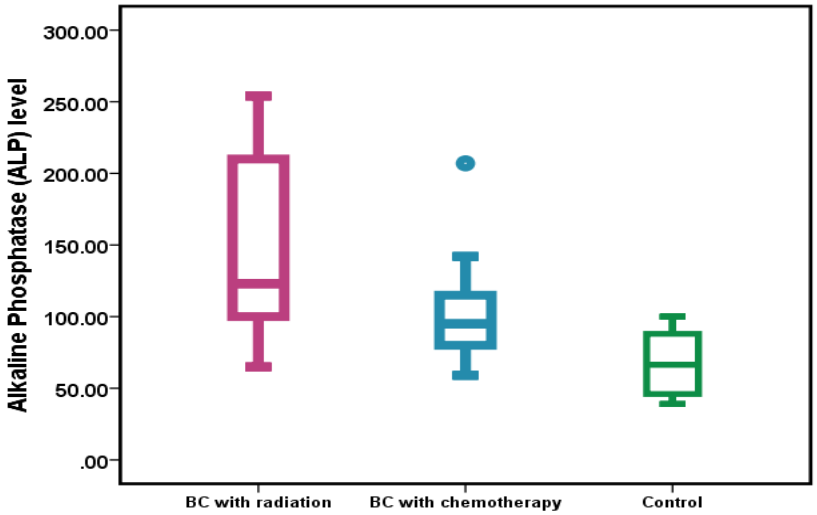

Figure (4-9): The means level of ALP in patients and control groups

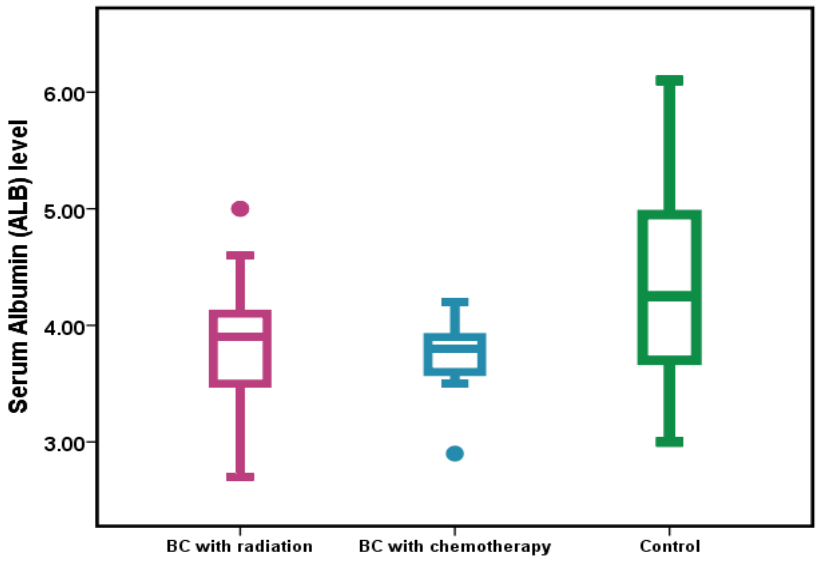

Figure (4-10): The means level of ALB in patients and control groups

The current study results indicate a significant increase in serum ALT and AST levels among breast cancer patients treated with radiotherapy compared to the chemotherapy group, which can be explained by mild cellular injury or transient functional alterations in hepatocytes induced by radiotherapy. In contrast, chemotherapy did not show a statistically significant effect on liver enzymes in this cohort, which may be attributed to the treatment protocols used, relatively low doses, short follow-up duration, or preserved baseline liver function.

Additionally, ALP levels had been considerably accelerated in each patient agencies compared to wholesome controls, whereas albumin stages remained inside normal limits, indicating preserved synthetic liver feature. These findings are regular with preceding studies together with Guzeloz et al. (2023) and Song et al. (2025), which said that radiotherapy can purpose mild will increase in liver enzymes with out resulting in .clinically considerable hepatotoxicity

Conversely, a few research have shown that chemotherapy may also purpose increases in ALT and AST in a few sufferers. The absence of a huge effect in our cohort may be attributed to protocol-associated factors and particular affected person traits. These observations are steady with the findings reported by means of Erfanian et al. (2024) and Lai et al. (2024).

conclusions

The findings of the prevailing examine suggest that both chemotherapy and radiotherapy have sizeable consequences on numerous hematological and biochemical parameters in women with breast cancer. A vast lower in white blood mobile counts changed into discovered in sufferers undergoing chemotherapy and radiotherapy in comparison to wholesome controls, reflecting bone marrow suppression related to anti-most cancers treatments. While platelet counts remained inside ordinary limits, platelet count number (PCT) displayed extensive changes specially in patients receiving radiotherapy, suggesting adjustments in platelet pastime in preference to numbers. Assessment of renal feature discovered a good sized growth in blood urea degrees in patients dealt with with radiotherapy, while serum creatinine tiers remained unchanged in all have a look at organizations, indicating early or practical renal adjustments with out obvious impairment of glomerular filtration. Liver characteristic tests confirmed improved ALT, AST, and ALP stages, in particular in the radiotherapy institution, even as serum albumin degrees have been no longer notably affected, indicating preserved hepatic synthetic function. Overall, the look at highlights that radiotherapy has a extra suggested impact on kidney and liver feature parameters than chemotherapy, even as both remedy modalities have an effect on hematological indices in addition. These findings emphasize the significance of non-stop

monitoring of hematological, renal and hepatic parameters in breast cancer sufferers to come across remedy-related toxicities at an early stage and optimize patient control.

References

- Akram, K., Ali, T., Hassan, R.M. and Moosaalreza, T. (2017) 'Effect of Synbiotic Supplementation on Serum Systemic Inflammatory Marker and Serum Albumin in Patients Admitted to ICU', Journal of Probiotics & Health, 5(2), p. 176.
- Daniel W.W., (2018). Biostatistics: A Foundation for Analysis in the Health Sciences, John Wiley & Sons New York.
- Dávila Fajardo, R., Raymakers-Janssen, P., van Grotel, M., van Wösten-van Asperen, R.M., Terhaard, C.H., Lilien, M.R., van den Heuvel-Eibrink, M.M. and Janssens, G.O. (2023) 'Long-term nephrotoxicity in irradiated pediatric kidney tumor survivors: A systematic review', Pediatric Blood & Cancer, 70(11).
- Erfanian, S.S., Ansari, H., Javanmard, S.H., et al. (2024) 'The hepatorenal protective effects of silymarin in cancer patients receiving chemotherapy: a randomized, placebo-controlled trial', BMC Complementary Medicine and Therapies, 24, p. 329
- Güzelöz, Z., Ayrancıoğlu, O., Aktürk, N., Güneş, M. and Alıcıkuş, Z.A. (2023) 'Dose Volume and Liver Function Test Relationship following Radiotherapy for Right Breast Cancer: A Multicenter Study', Current Oncology, 30(10), pp. 8763–8773
- Hoffbrand, A.V. and Moss, P.A.H. (2016) Hoffbrand's Essential Haematology, 7th edn. Chichester, West Sussex & Hoboken, NJ: John Wiley & Sons. ISBN: 9781118408674

- Jameus, L. (2021) 'Hematological changes following low dose radiation therapy and comparison to current standard of care cancer treatments', Dose Response
- Kumar, P.S., Durgadevi, S., Saravanan, A. and Uma, S. (2019) 'Antioxidant potential and antitumour activities of Nendran banana peels in breast cancer cell line', Indian Journal of Pharmaceutical Sciences, 81(3), pp. 464–473.
- Lai, X., et al. (2024) 'Incidence of antibody-drug conjugate-related hepatotoxicity in breast cancer: a systematic review and meta-analysis', Clinical Drug Investigation.
- Majid, R.A., Mohammed, H.A., Saeed, H.M., Raouf, S.A. and Yassen, A.M. (2017) 'Breast cancer in Iraq is associated with a unimodally distributed predominance of luminal type B over luminal type A surrogates from young to old age', BMC Women's Health, 17(27), pp. 1–9
- Sato, Y., Fujimoto, D., Uehara, K., Shimizu, R., Ito, J., Kogo, M., Teraoka, S., Kato, R., Nagata, K., Nakagawa, A., Otsuka, K., Hamakawa, H., Takahashi, Y., Imai, Y. and Tomii, K. (2016) 'The prognostic value of serum CA 19-9 for patients with advanced lung adenocarcinoma', BMC Cancer, 16, p.Sions, J.M., Donohoe, M., Beisheim-Ryan, E.H., Pohlig, R.T., Shank, T.M. and Nichols, L.R. (2022) 'Test-retest reliability for performance-based outcome measures among individuals with arthrogryposis multiplex congenita', BMC Musculoskeletal Disorders, 23(1), p. 121
- Song, J.Y., Hong, S.W. and Kang, S.-W. (2025) 'Comprehensive Evaluation of Hepatotoxicity Following Radiation Therapy in Breast Cancer Patients', Cancers, 17(19).

- Tadesse, H. and Leminie, M. (2023) ‘Effects of Adriamycin-Cytoxan chemotherapy on hematological parameters among breast cancer patients.
- Zhao, X., Yang, Y., Pan, Z., et al. (2024) ‘Plateletcrit is predictive of clinical outcome and prognosis for early-stage breast cancer: A retrospective cohort study based on propensity score matching’, Cancer Medicine