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The Effects of Soft Laser on Some Blood Parameters of Patients with Breast Cancer

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ABSTRACT

Background: Soft Laser has been advantageous in medical applications and is widely used in clinical practice. It is applied because it doesn't cause the significant thermal effects or tissue hurt when irradiated. The blood response to low power laser radiation provides information about processes of laser radiation interaction with live creatures.

Objective: The aim of the current work was to evaluate the laser-induced changes of in vitro erythrocyte sedimentation rate (ESR), mean corpuscular volume (MCV), and mean corpuscular hemoglobin concentration (MCHC) in patients with breast cancer by irradiating a human blood sample using a green laser and comparing its effects before and after irradiation with the same power density (100mW/cm^2) and wavelength (532nm) of laser light.

Materials and methods: Fresh blood samples of 30 cancer breast females were collected in EDTA tubes and divided into four equal quantities; one as a control sample and the other three for irradiation with laser at various exposure time. The blood parameters were measured by automatic hematology analyzer and ESR values were measured by using a Westergren method.

Results: The MCV values were increased, the MCHC values were decreased and the ESR values were decreased significantly with increased exposure time.

Conclusion: The change in blood parameters at various irradiated times with different doses using Soft Lasers with a532nm wavelength for breast cancer patients, are helpful to explain decrease in the ESR values induced by Soft Laser in phototherapy and give information about how the laser interaction with biological tissues.

Keywords: Green laser, Breast Cancer, Erythrocyte sedimentation rate, GLP

INTRODUCTION

The abbreviation "LASER" describes the action of "Light Amplification by Stimulated Emission of Radiation" [1].

A difference between hard laser and soft tissue laser is due to how interaction of laser with tissues. A Low Level-Laser-Therapy (LLLT) has a many of names like as "low power, soft tissue laser, cold laser, biostimulation laser, therapeutic laser, and laser acupuncture". The mean output power of the lasers ranges is from{1-500}mW, and ranges of the wavelengths from (400-1000) nm from UV to near-infrared in the Electromagnetic spectrum. While the lasers with high-power is to ablate tissue (surgically), then laser with low-power is stimulate the difference tissues and induce the cells to function [2].

The positive influence of laser on the rheological properties of blood is of special importance to "angiology, surgery, and cardiology". Although the blood reaction to laser with low power radiation provides critical information about the processes of laser radiation interacts with live creatures [3, 4].

The effect of laser therapy within blood, inclusive blood cells and serum, is one of its majority essential components, according to most experts. As a result, laser blood irradiation is one of the most exciting applications of low-power lasers. Improve of the blood rheological properties, in addition microcirculation and a reduced the infarction area. Some research has looked at the influence of low power laser irradiation on human blood parameters, particularly red and white blood cells (RBC & WBC) [5 - 7].

When the "RBCs" are exposed to Laser exposure, it stimulates conformational transitions in the cell membrane of RBC, which be associated with modifications to the structural states of both erythrocyte membrane proteins and lipid bilayer, which results in a change in the activity of membrane cell ion pumps. The first point of interaction between the cellular machinery and the external environment is known as the function of a cell membrane. It is where significant events in the interaction of lasers with cells take place. The red blood cell membrane is the most noticeable due to its ease of usage, availability, and physiological importance. Many in vitro and in vivo researches have been done that demonstrate the major impact of irradiation of laser on red blood cell activities [8, 9].

The aim of the current work was to evaluate the influence of soft laser in *vitro* study on ESR, MCV, and MCHC of patients with breast cancer by irradiating a human blood sample using a green laser and comparing its effects before and after irradiation with the same power density (100mW/cm^2) and wavelength (532nm) of laser light.

PATIENTS AND METHOD

This study included a total of 30 adult females with breast cancer, attending at Department of Medical Physics, College of Medicine, Baghdad University,

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Baghdad, during the period from **(November 2021 and April 2022).**

Eight ml of fresh blood was collected from each participant and added to EDTA blood collection tube. Each sample was divided equally between four tubes (2 ml each), one was used as a control (not irradiated), and the other three aliquots were irradiated samples by exposure to green laser at various irradiation time.

Laser irradiation of whole blood and processing the samples

In this study, we had used a green laser pointer (GLP) with a wavelength 532 nm and irradiation source had output power 33 mW (the model of this device was; Diode laser pointer JD- 303); thediameter of the laser beams was about0.65 cm, and fixed power density was 100 mW/cm^2, The distance between lasers light and the tube of blood sample was fixed at 2cm. The samples irradiated with various irradiation time 10 min, 20 min, and 30 min, respectively, then laser doses that used were 60J/cm^2, 120J/cm^2, and 180J/cm^2, respectively (Without the control samples). The blood samples were irradiated at room temperature (between18°C to 23°C).

Measurements of changes of blood parameter values (RBCs count, MCV, MCHC) were performed by using Automatic hematology analyzer ("humaCount 5D, Human Gesellschaft fur Biochemica und Diagnostica mbH, made in Wiesbaden Germany") before and after various irradiation time with the same power density (100mW/cm^2) and wavelength (532nm) of laser light. The Erythrocyte Sedimentation Rate was measured by using a Westergren method [10].

***Ethical Consideration*:**

This study was ethically approved by local Ethics Committee, Department of Physiology, College of Medicine, Baghdad University, Baghdad, Iraq. Written informed consent of all the participants was obtained with keeping the patient confidentiality during the entire research. The study protocol conformed to the Helsinki Declaration, the ethical norm of the World Medical Association for human testing.

Statistical analysis

The Statistical analysis "SPSS software" (version 22.0, IBM Corp., Armonk, NY) was used to analyze the data. The differences between control and the samples that irradiated were evaluated by using a paired t- test. The P-value is calculated based on the significance of the difference analysis, as a P- value is less than 0.05 it was expressed a significant.

RESULTS

Note: mention the demographic data of the patients including age (mean and range) and sex.

The mean age for females with breast cancer patients was (48.73 ± 10.61)

Table 1 shows the changes of blood parameter values (MCV, MCHC) and ESR of breast cancer females before and after irradiation with different exposure time (10, 20,30) min and different doses (60,120,180) J/cm^2 .

Table1: The blood parameter (RBCs count, MCV, MCHC, and ESR) of breast cancer female patients (for UN irradiated & irradiated with laser).

Blood Parameters	Before Irradiation (mean ± (SD	10 min dose 60J/cm^2 (mean ± (SD	20 min dose 120J/cm^2 (mean ± (SD	30 min dose 180J/cm^2 (mean ± (SD	*p*-value
RBCs ×10^6 µl	4.341 ±0.0381	4.296 ± 0.040	4.187 ± 0.038	4.163 ± 0.046	0.3366
MCV fL	80.97 ± 4.263	80.943 ± 4.827	80.896 ± 5.03	80.843 ± 5.31	0.0499*
MCHC g/dL	33.49 ± 0.073	34.566 ± 0.066	34.676 ± 0.065	34.953 ± 0.067	0.0182*
ESR mm/h	37.1 ± 0.643	34.9 ± 0.464	27.866 ± 0.427	27.1 ± 0.231	0.03037*
*** Significant Difference at level ≤0.05 when comparative with control**					

The MCV of erythrocytes as a function with time (mean ± SD) values significantly decreased, while the MCHC significantly increased, with increased irradiation time (10, 20, and 30) min and doses (60, 120, and 180) J/cm^2 pre- and post-irradiation, as shown in figure1.

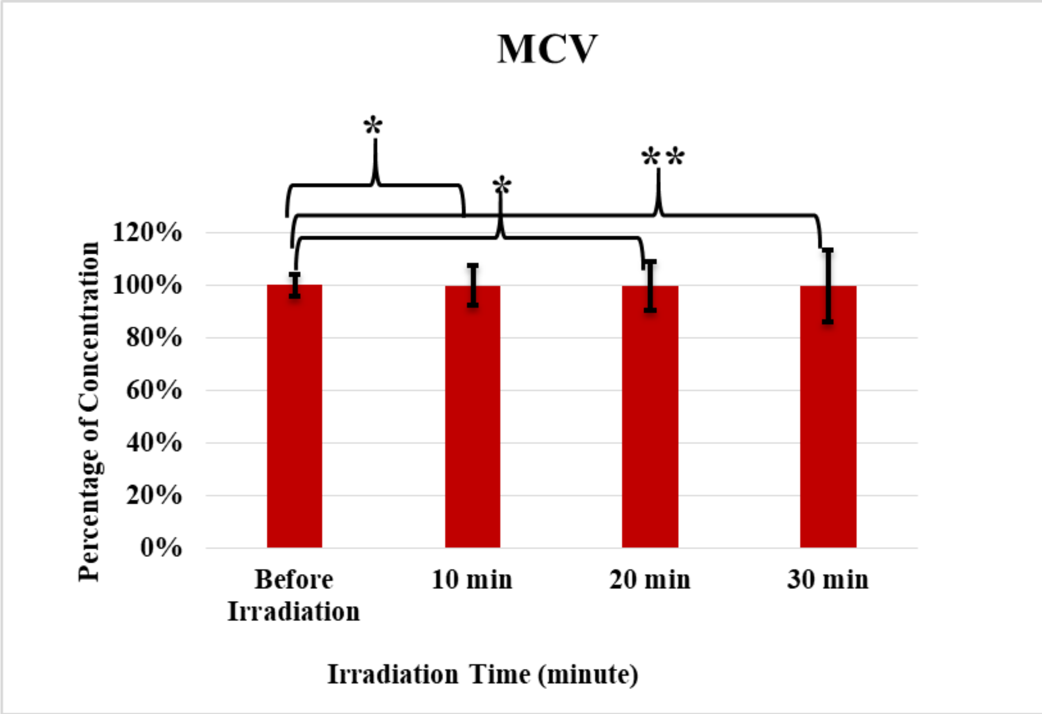

FIGURE 1. The change in MCV of RBCs pre- and post-laser irradiation for Breast Cancer patients

Remarkably our data that MCHC more significant affected by increasing the exposure time of laser radiation at 30 min with (34.953± 0.067) for BC patients it is shown in Figure 2.

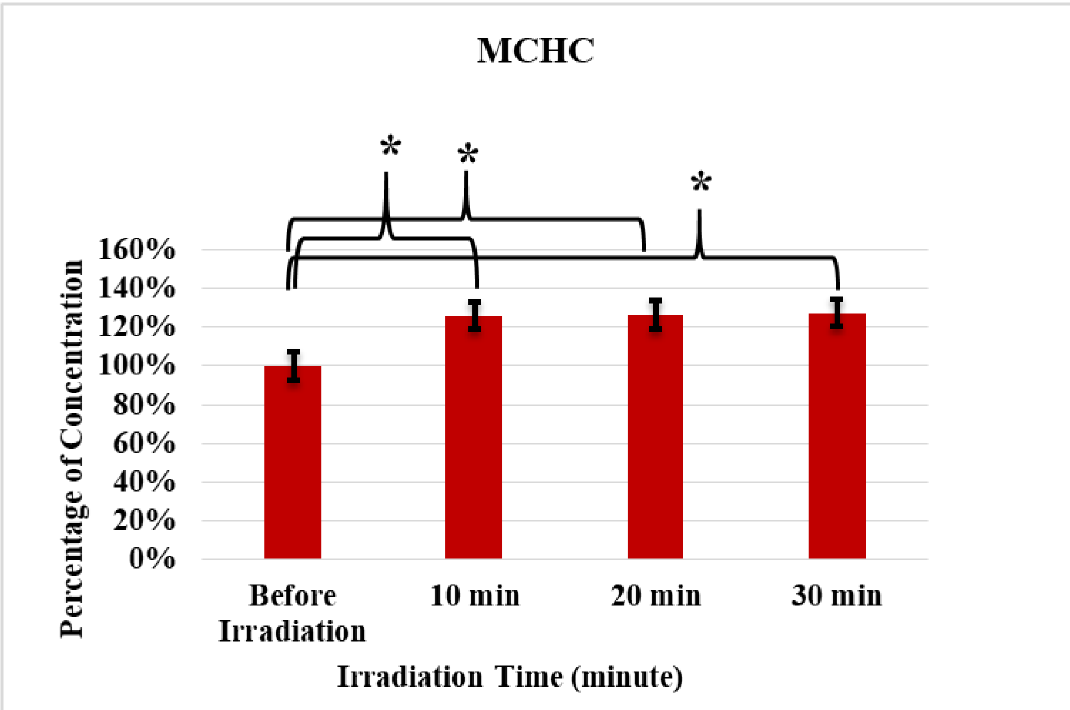

FIGURE 2. The changes in MCHC before and after laser irradiation for Breast Cancer patients

The change in ESR values as function to exposure time table 1. The ESR values significantly decreased with an increased exposure time of laser irradiation, and the maximum reduction of ESR values at irradiation time 30min with dose (180J/cm^2) as shown in figure 3. Although laser irradiation induced physical changes within a certain range, which is clearly apparent in ESR values within breast cancer patients that decreased with increased irradiation time.

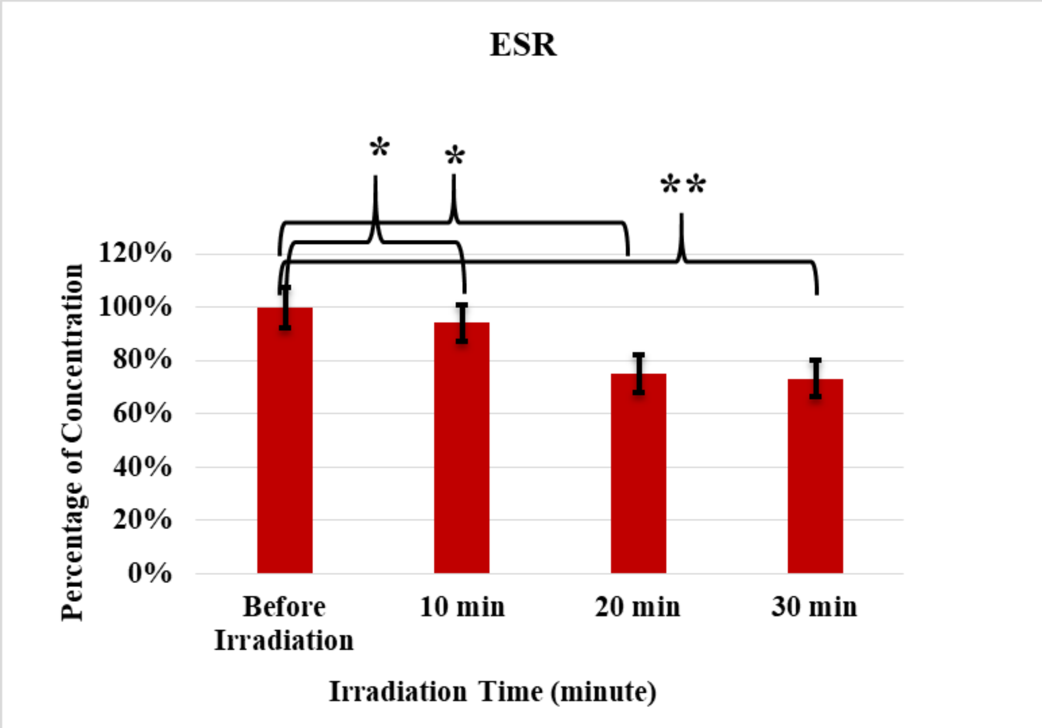

FIGURE 3. The change in ESR Values of Breast Cancer patients before and after exposure time.

DISCUSSION

The RBCs counts were nonsignificantly changed with various exposure time and doses. They remained constant during laser irradiation regardless of the exposure time that apparently excluded the thermal effects of laser and damages of RBC or hemolysis. In this system, the temperature was increased in the tissues and irradiation was limiting between "0.1 to 0.5 °C" [13, 14]. These results disagreed with some other authors who demonstrated that the He-Ne laser had strongly significant effects on RBCs, HGB, MCH, and HCT [11]. The MCHC regulates the viscosity of cytoplasmic and modulates RBC deformability [12].

The parameter of MCV is an index to measure the integrity of the erythrocyte membrane, and changes to it may be caused by laser light [15].

In present research the MCV of erythrocytes was inversely related with exposure time and doses and reach at high p-value at irradiation time (30min) and at doses (180J/cm^2). This behavior explaination is based on the theory that laser irradiation causes changes in cell membrane conformational properties, that connected with changes in the structural states of both erythrocyte membrane proteins and the lipid bilayer; which leads to the activity of membrane ion pumps [16].

In this study, the RBCs were exposed with various exposure time to LLL and the MCV was significantly decreased. Our results actually completely supported the hypothesis made by Al-Musawi [15] who stated that RBC exposure to LLL lowered their volume, possibly as a result of an increase in free intracellular Ca+^{2} that activates Ca+^{2} dependent potassium channels. In contrast to these results, other study revealed that MCV exhibited a relative significant change after He-Ne laser irradiation. The laser's unusual dose (9 J/cm^2) and exposure period 30 min might be the root cause of the problem [17].

Change significant decreased in the volume of RBC had been detected in this study.

Additionally, a greater dose of laser failed to stimulate any discernible alters in the ESR value and MCV. This might mean that at this dose, the bio-stimulation has reached its limit and is being replaced by bio-inhibition [18].

The ESR test evaluated the rate of RBC gravitational setting after one hour in an anticoagulant whole blood sample taken at a fixed point inside a calibrated tube with a specific length and diameter held in an upright position [19]. Both biological and non-biological factors have an effect on the ESR. The erythrocyte factor, plasma, viscosity factor, and gender are examples of biological factors. Technical variables, physical factors, such as the impact of laser radiation, and some mechanical factors are examples of non-biological factors [20].

Other researcher when used a different wavelengths of laser irradiation (504nm, 589nm, 780nm) at power density of 30 mW/cm^2 of laser with different doses, found that the ESR values were significantly decreased in doses 72 J/cm^2 when Comparing between irradiated and non- irradiated of healthy human blood samples [15].

Other significant ESR modulators, such as plasma proteins like (fibrinogen and globulin), shouldn't be ignored, too. Previous research has shown that the He-Ne laser (638.2 nm) seemed to change the charges in plasma proteins depending on the dose and incubation period [21].

CONCLUSION

The change in blood parameters at various irradiated times with different doses using Soft Lasers with a532nm wavelength for breast cancer patients, are helpful to explain decrease in the MCV, MCHC, and ESR induced by Soft Laser in phototherapy and give information about how the laser interaction with biological tissues.

The maximum decreased in blood parameters in whole blood samples irradiated at irradiation time of30min with a dose of180J/cm^2 where compared with pre- and post-irradiation. This decreased in ESR values its useful to use the laser in therapy, diagnostic and other clinical application such as in surgery.

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