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Effect the Static Magnetic Field on some Hematological Parameters of Human AML Leukemia: in vitro

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ABSTRACT

In contrast to its relative effects on PLT and white blood cells, the percentage of the magnetic field's influence on red blood cells in this study is lower. The behavior of PLT and RBC are identical (decrease relativity after exposure) at low dose rates of 0.1 Tesla/ hr. and high dose rates of 0.7 Tesla/ hr., and they exhibit opposite behaviors to those of WBC. The ratio of PLT and RBC reaches the high ratio for both males and females at the dose rate of 0.4 Tesla/hr. So, the best exposure dose rate for PLT, WBC, and RBC is 0.4 Tesla/hr.

Because these components are radiosensitive, the reversal of the AML leukemia blood components of the incident magnetic field changes. Additionally, cancer cells experience higher levels of ionization than healthy cells. Therefore, the ratio of PLT and RBC after exposure rose at the high-dose rate (0.7 Tesla/hr.). This is so because healthy cells are also included in the damage rate. It is obvious that leukemia blood samples exhibit distinct PLT, WBC, and RBC behaviors than healthy blood samples. This is a result of the increased rate of ionizations during the radiation treatment of blood samples with leukemia. This indicates that the rates of ionization for blood samples containing leukemia and healthy blood are different. The findings are consistent with the fundamental ideas underlying the phenomenon of biological radiation interaction.

Keywords: magnetic field, Tesla, AML leukemia, hematology, ionization.

INTRODUCTION

Magnetic fields can be either static or pulsed (time veining field). The frequency of a static magnetic field (SMF) is 0 hertz, whereas the frequency of a pulsed magnetic field (PMF) is non-zero. The direction of charges in SMF is constant, and it is generated by a DC cunent or received via a pennant magnet. The intensity of SMF is divided into three categories: (Vergallo and Dini, 2018) week magnetic field PMF is made up of alternating cmTents with varying field directions depending on the frequency. A field with a frequency below 300 Hz is known as an extremely low frequency (ELF) PMF (Hashish *et al*., 2008).

Transportation systems (electric trains, metro, trams, vehicles, etc.), industrial processes (aluminum production), and various medical diagnostic instruments are moderate emitters of SMFs. Inside trams, a 2 mT of SMF produces living cells, exposing users. SMF and PMF have been found in subways and automobiles (Halgamuge *et al*., 2010). The SMF of MRI is very high. ELF EMF manufactures space heaters, high-voltage transmission lines, and a variety of household appliances and residential installations (Dasdag *et al*., 2002; Amara *et al*., 2006. Zaghloul, 2011) found that ELF has an effect on blood cells.

Because it contains both positively and negatively charged panicles and molecules such as proteins and erythrocytes, blood is known as a bio magnetic fluid. Unbounded (or free) electrons in the outermost shells cause negatively ai1d positively molecules. Existing electrically charged molecules could be a factor in how blood's rheological properties react to MF. Blood parameters can be diamagnetic or paramagnetic in nature. RBCs, on the other hand, respond in two ways depending on their oxygenated state: paran1agnetic or diamagnetic (Bansi *et al*., 2018).

RBCs are big molecules that, both theoretically and physically, have a mean. RBCs are aligning in the direction of an applied external magnetic field, according to research (magnetization) approved the san1e behavior in platelets (PLTs). The aggregations of PLTs and RBCs were also studied (Keating *et al.*, 2008; Keating *et al*., 2011). In general, several types of aggregation are identified. To begin, particular particles and chemicals in normal blood induce the formation of closed cells or aggregations. This is known as rouleaux. The second is when an external force causes molecules in blood to close or aggregate (MF). Temperature stability must be maintained in the presence of a magnetic field.

During the last few decades, blood flow and microcirculation have been extensively investigated. Blood flow was altered in both in vitro and in vivo experiments when MF was applied, (Xu and Ohkubo, 2001) studied the effect of SMF on mouse blood flow. Blood was measured in the tibialis anterior muscle using a fluorescent epi-illumination technique. An SMF exposure as low as 1 mT for at 45 minutes after exposure, 10 minutes raised blood velocity by 20% to 45 percent. During the exposure, however, there was no rise. The same experiment was carried out using MF that changed throughout time (50 Hz). In comparison to SMF, blood velocity increased by 26% during the exposure. At lesser levels of exposure (0.3 mT), SMF and time-varying MF both had no effect. Exposed animals with SMF at 10 mT saw their blood velocity shift at the same time, from 15% to 45 percent from the start to the end of the exposure. The researchers used 1 mT as the hematological alteration threshold in mouse blood.

Gmitrov *et al*., (2002) carried conducted a similar study utilizing a greater dose of MF. They looked explored how SMF affected blood circulation in rabbit ear lobe cutanous tissue. Irradiation with MF at 0.25 T for 40 minutes enhanced the blood flow velocity in microcirculation in the tissue by 20% to 40%. When compared to control samples, this is a significant difference. After 10 minutes of exposure, the changes became noticeable and lasted for another 20 minutes. SMF appears to change flow velocity upon exposure at large doses, according to the findings (Ichioka *et al*., 1998) investigated peripheral hemodynamics under the influence of 8 T.

In another experiment, the viscosity of human blood samples was evaluated at various shear speeds. A rheometer was utilized in the experiment. The effect of magnetic fields reduced relative blood viscosity (Mohaseb *et al*., 2017). Employed a Drookfield DV-lll viscometer to assess blood

viscosity. Rats were given various substances to ingest. For 21 and 45 days, 0.3 mT (50 Hz) was used. When compared to control samples, both groups of treated animals showed a considerable increase in whole blood viscosity. Optical rmcroscop1c images were used to acquire their outcome.

Kadhim *et al*., (2016) investigated blood viscosity in polycythemia illness using a 1.5 T MRI magnetic field. The viscosity of blood samples was determined using a U-tube viscometer and a mathematical calculation. The exposure period was increased from one minute to twenty-one minutes. Samples were taken from unwell men between the ages of 28 and 48. The results showed that as the magnetic field was increased, blood viscosity decreased. The most significant changes occurred after 1 and 15 minutes of exposure.

The effect of MF on hematological parameters such as RBCs, WBCs, and PLT counts was investigated. Cardiovascular disorders are caused by abnormal blood cell numbers. An increase in leukocyte counts is associated with a 65 percent increase in the risk of death from ischemic heart disease. Haemoglobin concentration causes blood viscosity and oxygen supply, which is linked to ischemic heart disease in males (Maulood, 2018). The influence of PMF on blood rheological properties was investigated by (Dasdag *et al*., 2002), 16 male wielders (subjected 3-4 hours per day and each with 10 years of fin welding expertise) and 14 healthy guys (control group) took part in the study.

Sarnples were chosen because they were free of chronic ailments and lived a healthy lifestyle. The hematocrit test shows a considerable change. Other blood parameters, such as RBCs, WBCs, and PLTs, are nearly identical to those in control groups. In the field of hematological research, treating blood with micro molecules is being studied (Salem *et al*., 2005). Investigated the effect of SMF (one hour per day for 30 days) on blood parameters in albino rats with and without zinc therapy. SMF was administered to untreated rats and zinc-treated rats. Blood samples were collected and analyzed. The results showed an increase in blood parameters: Hb, WBCs, and RBCs, which contradicted the findings of (Dasdag *et al*., 2002).

The hematocrit level has remained unchanged. The zinc therapy had no effect on WBCs and PLTs. With or without zinc therapy, hematocrit remains nearly unchanged. This causes the rnle of zinc molecules to withstand changes in blood parameters when subjected to the force of SMF.

In an in vitro experiment, Hashish *et al*., (2008) investigated the biological effects of whole-body exposure to SMF (2.9 mT) and ELF-EMF (50 Hz) on mice. They created two exposure systems: one SMF and the other ELF-EMF. Mice were given equal exposure to both fields for 30 days. According to some of the findings, mice lose weight in the same way under both exposure conditions. The amount of total protein in the body has decreased considerably. PLTs and monocyte counts, peripheral lymphocytes, and T and B lymphocyte levels all decreased similarly in both fields. They came to the conclusion that both fields cause physiological disruptions in mice. Both fields had a similar effect on blood measurements. The effect of SMF and ELF-EMF, for example, changed WBCs from 4.87 0.53 (control) to 4.47 0.59 and 3.67 0.45, respectively. The loss of body weight could be caused by MF or other biological causes such as the loss of bodily fluid or proteins.

In vivo tests, (Wyszkowska *et al*., 2018) investigated the effect of extremely low frequency time varying MF (7 mT and 50 Hz) on hematological parameters. One group of rats was exposed to MF for 1 lu-/7 days, while the other was exposed for 24 hours. WBCs, lymphocytes, haematocrit, and haemoglobin all increased after a 24-hour exposure. As a result, a one-hour exposure for seven days had no effect on the hematological parameters evaluated. Strieth *et al*., (2008) used Syrian golden hamsters in an experiment to look at RBC velocity flow in muscle capillaries during SMF exposure. They discovered that the sh01t time of 150 mT exposures greatly lowers RBC velocity and segmental blood flow in tumor microvessels. The main reason of increased blood viscosity is red blood cells (Iino, 1997) investigated the aggregations and sedimentations of RBCs under the influence of a static magnetic field (called erythrocyte sedimentation rate- ESR). Blood was taken from a healthy male person. Under the influence of 6.3 T, ESR increased somewhat in a saline solution and dramatically in plasma. After 20 minutes of exposure, the blood parameters responded MF. The sedimentation rate has been steadily increasing over time. As the ESR grew, the Ht level

decreased. They hypothesize that the MF is responsible for cell orientation and, as a result, increased ESR.

On albino rats, a 0.2 mT time-varying MF (50 Hz) was used to investigate RBC variation (Ali *et al*., 2003). A (Control), B (exposed for 15 days), and C (for 30 days) groups of animals were continually produced. To investigate the effect of post-exposure, Group D rats committed suicide after 45 days. The stiffness of the erythrocyte membrane and permeability reduced, and the physiological structure of Hb and RBCs changed, according to their findings. As the time of exposure increases, the irregular shape begins to grow. The influence of a time-varying magnetic field on PLT aggregation was investigated (Sağdilek *et al*., 2012) 50 Hz, 1 mT, and 6 mT were used. Blood was taken from healthy people and exposed for 90 and 120 minutes. For both the control and exposed blood samples, measurements were taken. At 1 mT, the results demonstrate an increase in aggregation. They came to the conclusion that magnetic fields activate PLT aggregation. The effect of MIR on DNA double strand break was studied by (Fasshauer *et al*., 2018; Brand *et al*., 2015). There was no evidence that MRI induces DNA double strand breaks, according to the researchers. The effect of a time-varying magnetic field (10 t T, 50 Hz) on blood parameters and blood immunity components was examined by (Selmaoui *et al*., 1996). Humans were continuously exposed to MF for 24 hours. Their findings reveal that low frequency magnetic fields have little influence on blood immune ar1d functions.

Milovar1ovich *et al*., (2016) investigated the impact of homogenous static magnetic fields on biological systems. SMF was tested on male Swiss Webster mice of various orientations to determine the effect of SMF at different orientations. The cyclotron was used to create 128 mT. Each animal group was exposed for 5 days, with each day lasting 1 hour. The results demonstrated an obvious influence of SMF on select specific organs and blood parameters with varied orientations rather than the entire body. To the same extent, this is determined by the field orientation. The field's upward exposure lowered the number of WBCs and serum lymphocytes. Inflarnmations in the kidney increased. Granulocytes were seen in the spleen. However, the only downward exposure resulted in inflammation in the liver and a decrease in serum granulocytes. RBCs and PLTs 01ientation has been reported at magnetic fields of 4 T and 3 T (Yamagishi, 1990). The degree of orientation increased in relation to MF. PLTs have been fully orientated at 3mT. Unless both RBCs were saturated at 6T, the difference between oxygenated and deoxygenated RBCs is negligible (Riberiro *et al*., 1981) discovered a theoretically similar outcome (Higashi *et al*., 1997) also demonstrated that cell orientation occurs under the influence of high MF.

MATERIAL AND METHOD

In this study, blood samples were collected from 20 leukemia patients, 20 of whom were male and 20 of whom were female, ranging in age from 4 to 35 years. Patients with the acute leukemia type were exposed for one hour, and the outcomes were fixed in Tables 1 and 2. 20 healthy male individuals between the ages of 4 and 35 who had been leukemia patients at Ibn Al-Atheer Hospital and Ibn Sina Hospital participated in this study.

Experimental

All of the volunteers have consented to provide blood samples and work with the researchers, and they are all in good health. Each donor's 10 ml of vein blood was divided into 5 EDTA tubes for this study, and after 10 minutes of mixing, the blood sample was taken from the EDTA tubes.

A magnetic field, supplied by the physics department, was used to irradiate blood samples for 1 hour at various doses utilizing Tesla at room temperature. A blood analyzer was used to estimate the white blood cell (WBC), red blood cell (RBC), and platelet (PLT) counts after radiation.

RESULTS

Table 1: Effect magnetic field dose on AML Leukemia hematological parameters of male at 1 hr.

Magnetic exposure dose Tesla (T)	Before irradiation			After irradiation			Ages Year
	RBC	WBC	PLT	RBC	WBC	PLT	
0.7± 1.12	4.02	65	78	3.77	72.5	67.3	4-41
0.5 ± 0.97	3.18	63	15.2	3.11	68	14.88	
0.4 ± 0.91	2.87	45	128	3.82	51	143	
0.3± 0. 88	3.29	74	98.3	3.81	70.5	99.2	
±0.79 0.1	4.52	20.7	21.2	4.24	21.55	19.3	

Table2: Ratio of RBC, WBC and PLT After/Before irradiation for male humans at 1 hr.

Magnetic exposure dose Tesla (T)	Ratio measurement %		
	RBC RATIO A/B	WBC RATIO A/B	PLT RATIO A/B
0.7± 1.12	0.937	1.11	0.862
0.5 ± 0.97	0.977	1.079	0.978
0.4 ± 0.91	1.33	1.133	1.11
0.3± 0. 88	1.158	0.952	1.009
±0.79 0.1	0.938	1.041	0.910

Table3: Effect magnetic field dose on AML Leukemia hematological parameters of female at 1hr.

Magnetic exposure dose (T)	Before irradiation			After irradiation			Ages Year
	RBC	WBC	PLT	RBC	WBC	PLT	
0.7± 1.2	2.99	44.5	68.6	2.66	55.2	56.3	4-41
0.5 ± 0.98	4.99	52.2	71.1	4.56	60.1	65.1	
0.4 ± 0.89	3.62	80.3	102	4.77	71.2	121	
0.3± 0. 78	4.22	68.4	53.1	5.2	62.2	55.1	
±0.67 0.1	5.1	18.1	30.2	4.34	19.1	28.2	

Table 4: Ratio of RBC, WBC and PLT After/Before irradiation for female human at 1 hr.

Magnetic exposure dose Tesla (T)	Ratio measurement %		
	RBC RATIO A/B	WBC RATIO A/B	PLT RATIO A/B
0.7± 1.2	0.889	1.24	0.820
0.5 ± 0.98	0.913	1.151	0.915
0.4 ± 0.89	1.317	0.886	1.186
0.3± 0. 78	1.232	0.909	1.037
±0.67 0.1	0.850	1.055	0.933

DISCUSSION

We note that the effects occurring in red blood cells adversely affected the white blood cells; this is in agreement with the basic principle of hematology and radiation casualties (Pohl-Ruehling *et al*., 1990; Ismail and Jaafar, 2011). The percentage of the impact of radiation in red blood cells is unlike of its effect on white blood cells, and PLT relatively. Clearly, at the low-dose rate of 0.1 ±Tesla/hr, and high-dose rate 0.7 ± /hr, the behavior of PLT and RBC are same (reduced relativity after exposure), and they have oppositely behaviors with WBC. At the dose rate 0.4 ± Tesla /hr , the ratio of PLT and RBC go to the high ratio for both male and female (see Table 2 and 4). Thus, 0.4 ± Tesla/hr considered as an optimum exposed dose rates for PLT, WBC, and RBC as shown in (Table 1 and 3). The changing reverse of the blood components of the incident radiation, due to the radiosensitive of these components are varied. As well as, ionization for cancer cells is more than the normal cells. Therefore, at the high-dose rate (0.7 ± 1.13 Tesla /hr) ratio of PLT and RBC after exposure increased too. This is because the damage rate is included healthy cells as well. Thus, for that reason optimum dose rate to make damage of the cancer cells and to avoid normal (health) cells considered as an important part of this research. The impacts of exposed low dose on the density of PLT, WBC and RBC for the healthy blood samples (male; 24 years) are reported by previous work (Al-Dulamey, 2021). Clearly the behaviors of PLT, WBC, and RBC for healthy blood samples are different than leukemia blood samples. This is because of high rate of ionizations within an irradiation of leukemia blood samples. This means that the rates of ionizations are different for healthy and leukemia blood samples. On the other hand, maximum exposed dose rate at the healthy case was not given up to the density of RBC before irradiation. And for providing a more clarify of how to change the values for the PLT, WBC, and RBC with the rate of radiation, the proportion has changed to the duties before and after irradiation was a factor of excellence. The results are in agreement with the basic principles of the phenomena of biological radiation interaction (Pohl-Ruehling *et al*., 2000; Al-Dulamey, 2007).

CONCLUSIONS

For 20 patients, the effects of magnetic field exposure on the density of RBC, WBC, and PLT in leukemia blood samples have been studied (10 males and 10 females). RBC and PLT had an inverse relationship with WBC density in leukemia blood samples. However, the RBC density in the healthy blood sample was roughly constant contrary to that of the leukemia blood sample. Additionally, the optimal exposure dose rate for WBC differs from that for RBC.

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تأثير المجال المغناطيسي الثابت على بعض معلمات الدم للمرضى المصابين باللوكيميا الحاد مختبريا

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الملخص

في هذا العمل تبين على عكس التأثيرات النسبية على PLT وخلايا الدم البيضاء، فإن النسبة المئوية لتأثير المجال المغناطيسي على خلايا الدم الحمراء في هذه الدراسة أقل. إن سلوك PLT وRBC متطابق (انخفاض النسبية بعد التعرض) بمعدلات جرعة منخفضة تبلغ 0.1 تسلا / ساعة ومعدلات جرعة عالية تبلغ 0.7 تسلا / ساعة، ويظهران سلوكيات معاكسة لسلوك WBC. تصل نسبة PLT وRBC إلى نسبة عالية لكل من الذكور والإناث بمعدل جرعة يبلغ 0.4 تسلا / ساعة. لذلك، فإن أفضل معدل لجرعة التعرض لـ PLT وWBC وRBC هو 0.4 تسلا / ساعة.

نظرًا لأن هذه المكونات حساسة للإشعاع، فإن انعكاس مكونات الدم AML leukemia في المجال المغناطيسي الحادث يتغير. بالإضافة إلى ذلك، تعاني الخلايا السرطانية من مستويات تأين أعلى من الخلايا السليمة. لذلك، ارتفعت نسبة PLT و RBC بعد التعرض بمعدل جرعة عالية (0.7 تسلا / ساعة). وذلك لأن الخلايا السليمة مدرجة أيضًا في معدل الضرر. من الواضح أن عينات الدم لسرطان الدم تظهر سلوكيات PLT و WBC و RBC متميزة عن عينات الدم الصحية. هذا نتيجة لزيادة معدل التأين أثناء العلاج الإشعاعي لعينات الدم المصابة بسرطان الدم. هذا يشير إلى أن معدلات التأين لعينات الدم التي تحتوي على اللوكيميا والدم الصحي مختلفة. تتوافق النتائج مع الأفكار الأساسية الكامنة وراء ظاهرة تفاعل الإشعاع البيولوجي.

الكلمات الدالة: المجال المغناطيسي، تسلا، ابيضاض الدم الحاد، أمراض الدم، التأين.