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Study of the effects of Internal Radiation Pollution with Depleted Uranium using some Hematological Parameters

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Abstract

This study aimed to evaluate the effects of Depleted Uranium (DU) presence inside human body by estimation of some hemopeitic parameters in peoples identified with elevated DU levels, and compare them with the levels of normal individuals. A total of (33) blood samples were collected from persons in Iraqi community. Depleted Uranium was estimated using whole blood and the technique of polymer CR-39, a method of Solid State Nuclear Track Detectors (SSNTDs). Results: There were (17) persons (51.5% from total 33), recorded as contaminated with DU, represented Group1 (G1) members; (5) males and (12) females. In addition; (16) persons had accepted values of DU; represented Group2 (G2) members (control group); (7) males and (9) females. The parameters; RBCs count and Erythrocytes indices (McHc, MCH and MCV) did not show remarkable effects, Hct (Hb %) and HCV (pcv) values affected but not significantly. While, PLT count values affected significantly in both genders (decreased in males and increased in females). Conclusions: DU was able to cause anemia due to diminishing Hct (Hb%), HCV(pcv) while did not affecting the morphology characteristics of the contaminated blood RBCs, by it did not affect RBCs count and indices. Moreover, it affected obviously PLT counts in both genders.

Key words: *CR-39 polymer, Erythrocytes indices, Hemoglobin, pcv and platelets count.*

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الخلاصة

هدفت هذه الدراسة الى تقييم تاثيرات التلوث الداخلي باليورانيوم المنضب على جسم الانسان من خلال قياس بعض المؤشرات الدموية لدى الاشخاص الذين ترتفع لديهم مستويات اليورانيوم المنضب في الدم ومقارنتها بالاشخاص الذين لديهم مستويات يورانيوم منضب ضمن الحد المسموح به. لقد تم جمع (33) عينة دم من اشخاص ضمن المجتمع العراقي, حيث استخدمت تقنية البوليمرCR-39 مع الدم لقياس نسبة اليورانيوم المنضب. النتائج: وجد بأن (17) شخص (بنسبة 51% من مجموع كلي 33 شخص) سجلوا تلوثا باليورانيوم المنضب ومثلوا المجموعة الاولى G1 (شملت 12 اناث و 5 ذكور). أما المجموعة الثانية G2 تمثلت بالاشخاص ذوي المستويات المسموح بها من اليورانيوم أومجموعة السيطرة وشملت (16) شخصا (9 اناث و7 ذكور). لم تظهر مقاييس الدم (العد الكلي لكريات الدم الحمر ومؤشرات كريات الدم الحمر MCH ,MCV, MCHC تأثيرا ملحوظا بوجود اليورانيوم المنضب لدى الاشخاص في مجموعة G2 , أما مستوى الهيموكلوبين وحجم الخلايا الحمر المضغوط Hct Hcv, , فقد انخفضت بشكل معنوي. وأختلفت قيم العد الكلي للصفيحات الدموية اختلافا معنويا في كلا الجنسين (انخفضت في الذكور وأرتفعت في الاناث). الاستنتاج: سبب وجود اليورانيوم المنضب بمستويات عالية في الدم فقر دم ناتج عن انخفاض في حجم الخلايا المضغوط PCV وقيمة الهيموكلوبين Hb% ,ولكنه لم يؤثر على مؤشرات تلك الكريات , أما العد الكلي للصفيحات الدموية فانه تأثر بشكل واضح.

Introduction

Ionizing Radiation is one of the most dangerous types of environmental pollution since it cannot be seen, smelled or tasted; also it can be detected only by special instruments and equipments and requires specialized expertise technicians [1]. In Iraq, Depleted Uranium (DU) was and still an environmental pollution problem since its levels raised after both Gulf wars I and II, and the contaminated places have not been limited or isolated to stop and avoid the spreading of this radioactive contamination [2].

Depleted Uranium is an alpha particles radiation emitter; its importance came from its radioactivity and cytotoxicity. It is able to precipitate and accumulate inside human body when there is an internal exposure and acts as a source of radiation until excretion by urine which may take years. What is worse than that; DU contamination has a

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latent period until the appearance of clinical signs and that period usually takes (1-5 years) depending on dose of exposure and personal susceptibility. Depleted Uranium effects in human body are so many; the hemopoitic system is one of its targets; since it involves continuous developing cells which are most sensitive to radiation than mature cells [3].

Methods and Materials

Patients Groups and Controls: A total of (33) blood samples were collected from adult peoples (aged more than 18 years), non-smokers with no clinical sings of any disease, from Iraqi community, resident in Baghdad and randomly chosen. Also blood samples of females were taken from non pregnant women and not during their periodic menstruation. Blood samples; represented by the anticoagulated whole blood with EDTA; are used in all the tests of this study. And were divided into two major groups after DU detection tests as follows:

1. **Group of contaminated** persons with DU, **(G1).** This group included (17) individuals; (5) males and (12) females. They were identified with DU levels higher than the allowed limits.
2. **Group of non-contaminated** persons with DU**, (G2).** This group included (16) individuals; (7) males and (9) females. They were identified with DU levels within the allowed limits. This group represented the healthy controls in this study.

Depleted Uranium Estimation: Searching for ionizing radiation pollution due to contamination of blood samples (whole blood) with DU. It was accomplished depending on the method of Solid State Nuclear Track Detectors (SSNTDs). The technique of whole blood and the polymer CR-39; Pershore Ltd. (UK); was used and an appropriate standard curve in order to obtain DU values in p.p.m [4 and 5]. This detection was applied on all blood samples that were collected and accomplished under the supervision of specialized nuclear physics professors [6 and 7].

Heamatological parameters evaluation: The parameters that were used to determine the effects of DU contamination on human hemopoitic system were:

I. **Hemoglobin concentration measurement; Hct (Hb%):** The method of **Haemoglobincyanide (HiCN**), was used via the dilution of blood; whole blood with EDTA; with Drabkin's reagent; Al-Talaba comp. (Iraq). This diluting solution contains

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potassium cyanide (KCN) and forming HiCN. The absorbance was measured using Digital photoelectric colorimeter; Yamato (Japan); and the obtained concentrations were in g /dl, whereas dl=100 ml of blood [8 and 9].

II. **Hematocrit value Hcv:** This test is also called packed cell volume (pcv). It was confirmed using whole blood in capillary tube and centrifuging instrument in high speed; Yamato (Japan). Values were obtained in percentages resembling the ratio of blood cells to plasma [9].

III. **Erythrocytes count and Erythrocytes indices:** These tests were done using an automatic digital Hemolyzer instrument; Yamato (Japan). Erythrocytes indices were mean cell volume (MCH), mean cell hemoglobin (McHc) and mean cell hemoglobin concentration (MCV). These indices with erythrocytes number are used as clues for the classification of anemia types as rotten laboratory tests [8 and 9].

IV. **Manually Platelets count (PLT):** This test was performed by the visual examination of diluted and lysed whole blood using improved Neubauer counting chamber. The diluting fluid contains 1% Ammonium oxalate; Fluka (Germany); the counting was confirmed after RBCs are lysed [9].

Statistical Analysis for results:

All the obtained results for both G1 and G2 group members; healthy control group and DU contaminated persons group; were analyzed statistically by mean (M) and standard Error (SE) calculations using statistical analysis system (SAS) [10]. Each group results were compared with the other group results by t-test to find the significance of probability level (p) of increase or decrease for all parameters used. The level ($p<0.05$) was dependent as the significance level.

Results and Discussion

Results

After DU estimation in blood samples for all the volunteers involved in this study, there were (17) persons recorded with elevated DU levels (up than the allowed limit 0.125 ppm as recommended by ICRP) [11]. These (17) persons represented Group1 (G1) members (contaminated persons). While the other (16 persons); who had accepted values of DU; represented Group2 (G2) members (control group). Group1 included (5) males and (12) females. In addition, the Group2 included (7) males and (9) females. Ages for females ranged (17-50) and (18-45) in G1and G2 respectively. Moreover, males ages ranged (24-67)

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and (18-51) in G1and G2 respectively.

Because most of the present study hematological parameters are effectible by sex factor [8 and 9], hence, each obtained mean value for G1 members was compared statistically with the mean value in G2 of the same sex.

The results of the present study parameters are shown in Table (1). Total **RBCs count** showed no significant differences after comparing G1 with G2 values. All recorded values were within normal range for each sex according to [8]. This result was the same of those obtained for **Erythrocytes indices** values.

Concerning **Hct (Hb %)** results, despite of that no significant difference obtained after comparing G1with G2 values. There were (7) cases in G1 recorded with values lower than normal depended range according to [8]. They involved (6) females and one male. Those seven cases also recorded decreased values of **Hcv** (pcv) . While other members showed normal values and there was no significant difference obtained after statistical comparing between G1 and G2 Hcv mean values.

According to **PLT count**, there was a significant difference obtained after doing statistical analysis. Whereas males PLT counts decreased significantly ($p \leq 0.05$) comparing with G2 males. And G2 females values increased significantly ($p \leq 0.05$) comparing with the values obtained for G2 females.

Discussion

Depleted Uranium is a public health problem in Iraq [2 and 3], many authors; scientists and researchers focused light on this problem [12, 13 and14]. This study outcome was in agreement with those of [15, 16, 17, 18 and 19]. Since 51.5% of the involved individuals in this study were identified with elevated DU levels. Living in DU contaminated region is associated with high radiological risk, as stated by Milacic and Simic, (2009) [20].

Females were more cooperative than males, they volunteer to support this study by giving their blood samples; hence, female's number was higher than males.

Firstly, DU pollution upon internal exposure, and according to the WHO [21], is able to damage bone marrow due to radiation exposure by its α-particles emitted. This damage differs from person to another depending on the dose, duration of exposure, personal susceptibility and many other factors [22 and 23].

The obtained results for the parameters used in this study; to

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estimate the effects of DU presence inside human body, indicated that RBCs count did not show a big influence with DU contamination. No significant difference obtained and that can be explained as DU contamination is of chronic radiation exposure type [24]. Furthermore, RBCs count is more sensitive to acute ionizing radiation exposure than chronic type [25 and 26]. These results were in agreement with those of [20], They didn't find significant difference and considered RBCs count of low influence with DU radiation.

Moreover, and concerning erythrocytes indices values, the obtained results did not show any significant differences between G1 and G2 recorded data. All values were normal. These findings gave clue that DU might not affect the morphology characteristics of the contaminated blood RBCs. As far as our concern, this is the first study, locally, dealing with DU contamination effects on these blood parameters. Prolonged exposure with high doses of ionizing radiation will interfere with normal DNA replication mechanisms and reduce the ability of precursor cells in bone marrow to undergo normal mitosis, as stated by [27]. This opinion can explain the above moderately normal results; since; DU contamination is not of acute radiation exposure, except the cases with high doses of DU poisoning which were not included among our cases.

Despite of no significant difference obtained in Hct (Hb%) and HCV results during the statistical analyses, Hct values in G1 members were affected with DU presence. Since, there were 41.2% of G1 members recorded with decreased values of (8.4-11.6) and (11.4) for females and male respectively. Moreover, HCV (pcv) obtained values recorded 41.2% of G1 cases with diminished of (29-36.9) and (36.5) for females and male values respectively. The author Ammash and her group; [28] estimated these parameters in their investigation of DU effects on some individuals among random population resident in Bsrah; south of Iraq. They found that the percentage of (21%) of them; were suffering from Hb% reduction ranged (9-13 g/dl). In addition, they found that (25.5%) of the same peoples under investigation had abnormal pcv rates of (30-39%) and recorded as less than normal rate cases. These findings support ours by the outcome that DU was able to affect Hct and HCV. Ionizing radiation is one of the environmental factors that cause anemia just like other toxic substances due to its interference with RBCs development and reduce the integrity of mature RBCs [27]. Furthermore, Apoptosis of RBCs with rates faster than production of new cells can be an explanation for these decreased values. That because ionizing radiation is able

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to induce early apoptosis in mature cells [29].

The data analysis of PLT counts showed disparate outcomes. Whereas, males' values decreased significantly, females' values increased significantly. However, both values were recorded as abnormal comparing with controls and normal rang dependent in this study. The scientists Asaad and his colleagues [30], during their research of α-particles emitter (radon) by irradiating blood sample and used CR-39 polymer to detect the effects of these α-particles on platelets count. They found that PLT count in both genders had decreased significantly in dose dependent manner. This research might support our results for males' values, while; that the gender factor may interfered with the response against radiation in females, regarding their results increased significantly with respect to the threshold $p \leq 0.05$. This result may because this parameter is highly sensitive to females' menstruation cycle [8]; despite of no female in our study was within her menstruation.

Platelets counts did not show a significant difference in the study of DU effect on PLT counts [20]. Ionizing radiation is able to diminish PLT count in dose dependant manner, and if the effect is not damaging and reversible; PLT count is able to return normal within a month, as stated by [25]. Moreover, radiation is able to suppress hemopoitic stimulation and retreat blood component production [31].

Conclusions

DU was able to cause anemia due to diminishing Hct (Hb%), HCV(pcv) while not affecting the morphology characteristics of the contaminated blood RBCs, by it did not affect RBCs count and indices. Moreover, it affected obviously PLT counts.

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Table (1): Hematological Parameters Results obtained in the present study as (M ± SE)

Parameter	Group 1		Group 2	
	Male	Female	Male	Female
RBCs count×10^6	5.24±0.08	4.6±0.2	5.3±0.13	4.57±0.14
Hct (Hb%)	14.8±0.95	12.2±0.6	14.5±0.4	12.3±0.4
Hcv (pcv%)	42.5±1.9	36.6±1.56	42.97±1.03	36.6±0.9
PLT×10^3	88.4±24.2 *	113.9±14.5*	130±20.5	89.7±16.4
McHc	34.7±1.2	32.9±0.9	33.9±1.1	33.6±0.5
MCH	28.2±1.6	26.6±1.01	27.5±0.8	26.9±0.4
MCV	81.1±2.9	80.7±1.8	81.3±1.6	80.3±1.4

(M ± SE): Mean ± Standard error.

**: Significant difference at level (p<0.05).*

RBCs Count: Red Blood Cells Count

Hct (Hb %): Hemoglobin concentration measurement

Hcv (pcv): Hematocrit value Hcv

PLT: Manually Platelets count

MCH: Mean cell volume

McHc: Mean cell hemoglobin

MCV: Mean cell hemoglobin concentration