Research Article

Hematological Variations Induced by Paint Chemicals in Occupationally Exposed Painters

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Abstract | Effect of paints and their associated chemicals on hematological parameters were assessed in this investigation. For this purpose, 20 healthy controls and 25 male painters in the age range of 23-65 years, persistently engaged in domestic painting were approached. Unpaired student t-test was used for statistical analysis. There was a significant ($P < 0.05$) decrease in RBC in the painters as compared to the control group. Red cell indices such as HGB, HCT, MCH and MCHC were significantly ($P < 0.05$) reduced in painters. On the contrary, PLT, MPV, WBC, LYM and Gran count were substantially ($P < 0.05$) elevated in the painters. In conclusion, chronic paint exposure predicts future illnesses such as anemia and cancer.

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Introduction

Any occupational work has its own beneficial as well as harmful aspects. Painters are occupational workers who are exposed to a variety of hazardous chemicals. It has become a great health concern to investigate the deleterious effects related to paint exposure due to its huge usage (Awodele *et al*., 2014).

Paint is a liquid, paste, or powder substance that forms sticky films on the surface of objects. It has widespread use in industry for various purposes, including the addition of pigmented coatings to the surface of a substrate for shielding against corrosion and weathering, for the attractive and eye-catching appearance of household appliances, to protect the surfaces from dirt, and many other purposes (El Mahdy and Radwan, 2009).

Due to the liquefiable composition of paint, its thin layer is transformed into a solid film after it is applied to a substrate. There are two groups of paints: Oil-based paints, also called solvent-based paints (SBP) and water-based paints (WBP) also known as acrylic emulsions. Due to the difference in composition between the two groups, water-based paints generally release fewer vapors and dry quickly after application, in comparison with oil-based paints, which normally contain xylene, hydrocarbons, various heavy metals, and toluene (Wiggers *et al*., 2008).

The most commonly used metal in paints is Pb due

to its corrosion resistance property and capability of holding the pigments together. It does not only give color to the paints but is also associated with increased durability and quick drying. It enters the body of professional painters by inhalation (Oginawati *et al.*, 2018). It is a very toxic metal and has no beneficial role in human metabolism rather than only generating deleterious effects by inducing oxidative stress, which eventually results in physiological and behavioral disorders (Courtois *et al.*, 2003).

Benzene, being a constituent of paints, disturbs the functioning of bone marrow, which leads the disturbed hematopoiesis (Kang *et al.*, 2005). These paint fumes may cause disturbances in the normal functioning of bone marrow, such as hematopoiesis, hematological alterations, leukemia, and kidney malfunction (Nkemjika *et al.*, 2015). These disorders can be easily assessed by a complete blood count. In Pakistan, a large number of occupational workers are exposed to benzene in their working area, but unfortunately, they are not examined properly, and therefore the associated diseases have not been well reported (Kamal and Malik, 2012).

Due to the inhalation of the harmful fumes, painters are susceptible to the dangerous effects of paint such as cancer, anemia, nausea, headache, mental and nervous system abnormalities (Townsend and Maynard, 2002).

Blood is a very good indicator of metabolic dysfunction in the body. Hematology demonstrates the fluctuations in the number of blood cells. Examining the hematological variables is an important tool to study the toxic effects induced by occupational exposure. The functioning of particular tissues can be evaluated by the analysis of hematological parameters such as the complete blood count (Liaqat *et al.*, 2009).

The current study was designed to investigate the alterations in blood physiology and their severity in occupational house painters, possibly linked to their area of work. It specifically, focuses on the variations associated with long term exposure to paints chemical constituents in the main hematological parameters and their ultimate impact on human health.

Materials and Methods

Twenty healthy male volunteers aged 23-45 years were chosen as controls for blood sampling from the Lahore population for this comparative analysis of major hematological parameters. Twenty-five house painters were selected voluntarily for sampling from Lahore, Pakistan. All the painters were male between the ages 25-65 years. Subjects for painters group were selected on the basis of inclusion and exclusion criteria. Only those painters were selected who had working experience of more than ten years and did not have any disease history like hepatitis, hypertension, kidney dysfunction, etc.

A questionnaire was formulated to record the demographic data of the subjects in the control and painters groups. Proforma included the fundamental features such as duration of exposure, drug addiction, gender, age, disease history, body weight (kg), height (m), systolic and diastolic blood pressure, heart rate, body mass index (kg/m^2). All the participants were informed that their data would only be used for research work. Volunteers were asked to keep fasting for at least 12-hours.

Blood sampling was performed with the help of a registered technician. Blood samples were carefully collected in the early morning before painters arrived at work by ensuring a proper hygienic environment. After sterilizing the skin with spirit, 2mL of blood was drawn with a sterile syringe and emptied into EDTA coated tubes. Blood samples were immediately carried for hematological analysis.

Hematological parameters such as red blood cells (RBC) hemoglobin (HGB) hematocrit (HCT) mean corpuscular volume (MCV) mean corpuscular hemoglobin (MCH) mean corpuscular hemoglobin concentration (MCHC) platelet (PLT) mean platelet volume (MPV) white blood cells (WBC) lymphocyte (LYM) and granulocyte number (Gran) were analyzed by the Sysmex 3-part Differential Automated Hematology Analyzer. The three main reagents (Hemolyzer-3-cleaner, Diluent and Hemolyzer-3-Lyzer) were used to run each blood sample.

Statistical analysis

Graph Pad version 6.00 was used to analyze the variations between the comparable groups by applying a two tailed independent student "t" test at $P < 0.05$ and confidence interval of 95%.

Results and Discussion

Significant reduction (P < 0.05) was evidenced in the red blood cells counts in painters as compared to controls. Similarly, prominent reduction (P < 0.001) was evidenced in the levels of hemoglobin in painters as compared to controls. Moreover, hematocrit also presented a marked reduction (P < 0.01) in painters as compared to controls. Meanwhile, mean corpuscle volume did not manifested any prominent variation in its comparison. While, mean corpuscular hemoglobin and mean corpuscular hemoglobin concentration, both depicted significant reduction (P < 0.01 and P <0.05, respectively) in painters as compared to controls. Additionally, marked elevation (P < 0.001) of platelets was documented in painters as compared to healthy controls. Similarly, mean platelet volume, white blood cells, lymphocyte and granulocyte count presented prominent elevation in painters as compared to healthy controls.

The current study was designed to investigate the alterations in hematological parameters and their severity in household painters. Specifically, focusing on the risk associated with long term exposure to paint chemicals on the chief hematological parameters like RBC, HGB, HCT, MCV, MCH, MCHC, PLT, MPV, WBC, LYM, Gran.

The results of present study have shown that the number of RBCs decreased significantly in the painters as compared to the control group. Additionally, hemoglobin concentration has decreased significantly in the painters in comparison with the control group. RBCs play a very important role in the transport of oxygen, so a decrease in their number will cause a decline in oxygen supply to all the body organs, which ultimately results in different medical conditions. In painters, a reduction in red blood cells may be due to

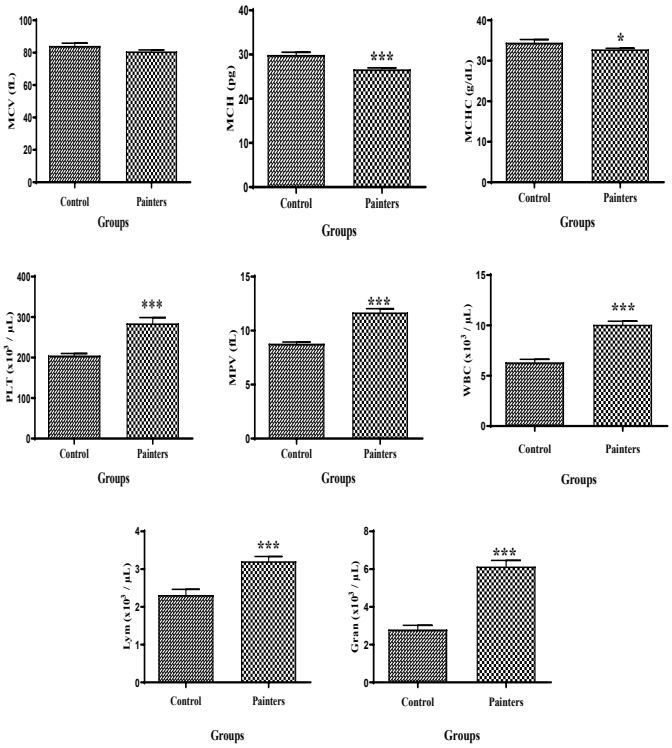

Figure 1: *Fluctuations in hematological parameters in the control and painters group. Values are (mean ± SEM). *, **, *** Significant at (P< 0.05, 0.01, 0.001), respectively.*

Table 1: *Inter group comparison (mean ± SEM) of hematological parameters of control group and painters.*

Parameters	Control N=20	Painters N=25	t value	P-value	Difference %
Red blood cells (RBC)	5.90 ± 0.18	5.44 ± 0.14	2.01	0.04*	↓8
Hemoglobin (HGB)	16.87 ± 0.22	15.14 ± 0.22	5.34	< 0.0001***	↓10
Hematocrit (HCT)	51.46 ± 2.09	45.98 ± 0.59	2.77	0.008**	↓11
Mean corpuscular volume (MCV)	84.24 ± 1.61	80.82 ± 0.87	1.96	0.05	↓4
Mean corpuscular hemoglobin (MCH)	29.92 ± 0.58	26.64 ± 0.32	5.13	<0.0001***	↓11
Mean corpuscular hemoglobin concentration (MCHC)	34.49 ± 0.76	32.83 ± 0.26	2.24	0.03*	↓5
Platelets (PLT)	205.3 ± 4.97	284.4 ± 14.44	4.71	<0.0001***	↑39
Mean platelet volume (MPV)	8.79 ± 0.15	11.68 ± 0.34	7.07	<0.0001***	↑33
White blood cells (WBC)	6.32 ± 0.30	10.06 ± 0.35	7.75	<0.0001***	↑59
Lymphocyte (LYM)	2.31 ± 0.14	3.20 ± 0.12	4.61	<0.0001***	↑38
Granulocyte (Gran)	2.80 ± 0.21	6.14 ± 0.32	8	<0.0001***	↑118

, **, * denote significance level at P<0.05, 0.01 and 0.001, respectively. ↑ and ↓ denote increase and decrease, respectively.*

Links Researchers

the activated process of hemolysis. Hemolysis occurs due to the exposure of various harmful chemical constituents, especially lead in paints (Patrick, 2006). The hemolytic process is basically initiated by making the membrane of red blood cells more frangible and pliable. Reason behind this rupturing is the imbalance between ROS and anti-oxidants in the body, which eventually stimulates the process of lipid peroxidation. It will cause oxidative stress, due to which hemoglobin will undergo oxidation. It also causes retardation in the formation process of hemoglobin by enzyme inactivation associated with basophilic stippling, which ultimately leads to anemia. In this scenario, exogenous antioxidants should be used to lessen the number of free radicals (Saxena and Flora, 2004).

Levels of MCH have declined significantly in the blood of painters as compared to controls. Moreover, the level of MCHC has also reduced prominently in painters as compared with control subjects. Findings of our study have revealed that the level of HCT has declined significantly in painters when compared with the control group. As in painters, RBC count and hemoglobin concentration have prominently decreased, ultimately leading to a significant reduction in levels of MCH, MCHC, and HCT because these three parameters are inter-dependent red cell indices.

When painters were compared to control subjects, there was a significant increase in the number of WBCs, specifically lymphocytes. The remarkable elevation in WBC in painters may be due to the increased infection in their bodies due to chemical exposure. Whenever, there is an infection, body's immune system gets stimulated and starts working against infection through rapid WBC production. If exposure of harmful chemicals remains for longer duration, it may cause serious diseases such as leukemia, because body starts forming more and more immature WBCs to cope with the infection.

PLT count has increased significantly in comparison with control group. The elevation in platelets may be associated with the depleted oxygen concentration due to RBC reduction in painters and they will have to deal with a lot of blood clotting.

The prevailing lead intoxication has revealed that the occupational painters are suffering from several disorders caused by lead exposure, even at lower levels. The point to be focused is that those painters who were using precautionary measures and were more careful about their personal hygiene showed less infection. So, there must be a complete guideline for the painters to work in the occupational environment and they should be trained well to maintain their personal hygiene for their good health status. This step can be easily taken, and it will considerably reduce the exposure to lead (Majgi *et al*., 2013).

The risk associated with painters is directly linked with the social as well as economic status of the workers. Various studies have shown that the occupational workers are mostly with lower ranks and uneducated. So, they do not know all the terms and conditions of their work. Due to their lack of education, they are unable to understand how to cope with toxic chemicals by following safety measures. So, basic education and proper training are necessary to make them aware of all the pros and cons of their occupation. This step would definitely be helpful in securing the good health of painters (Ishikawa and Kiuchi, 2010).

Inspite of the fact that occupation-related disorders are increasing day by day, in Pakistan there is no active reporting of the health hazards related to specific occupations. Daily exposure to the toxic constituents in the working area is now a great concern to be focused on. In this context, Pakistan has not conducted any proper studies on the associated risks for workers. So, government should introduce some planned activities to survey the working environment in order to check the extent of chemical exposure there. Proper awareness about chemical exposure and health effects should be introduced among occupational workers to work in a safe environment. A clean working environment with regular monitoring and a set number of daily working hours will undoubtedly help reduce chemical exposure (Kamal *et al*., 2011).

Conclusions and Recommendations

It is pertinent to say that significant decrease in RBC and other red cell indices (HGB, HCT, MCH, MCHC) and prominent elevation in PLT and WBC count specifically LYM and Gran in occupational painters can have adverse health outcomes in these workers. Hence, proper organizations should be made to keep a complete check and balance on the paint manufacturing industries to restrict the addition of

harmful chemicals in paints beyond the permissible limits. It will be very good for the health security of the public, and especially for the children, who are more prone to health risks due to lead exposure. Moreover, there must be a regular medical check-up for house painters, including CBC and other biochemical variables. Occupational painters, the government and health consultants must all work together to ensure success. Although painters have not been currently diagnosed with any serious diseases, if exposure continues for a longer duration, it may lead to associated health risks like anemia and cancer.

Conflict of interest

The authors have declared no conflict of interest.

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