

A Study to Assess the Effect of Exposure to Formalin on the Differential Leucocyte Count of First Year Medical Students

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Abstract: During education and training in medical schools, budding doctors are exposed to a variety of occupational hazards. One of them is formaldehyde, which is commercially available as formalin and is used as a component of embalming fluids in anatomy. It causes mucosal irritation, affects lung functions, skin and even produces changes in the counts of different cells of blood. The present study was therefore intended to observe its effect on differential leucocyte count of first year medical students. A longitudinal, descriptive study was conducted in the Department of Physiology, Rohilkhand Medical College and Hospital with eighty randomly selected first year medical students. Their DLC was recorded at the beginning and end of the academic year. Descriptive statistics and paired T-test was used for analysis. A p-value < 0.05 was considered significant. After exposure, a significant decrease in lymphocytes and a significant increase in eosinophils were observed. The changes are the haematological manifestation of the nature of inflammation produced by formaldehyde, which are predominantly allergic. Counts can also be altered if the process of haemopoiesis is affected either directly by formaldehyde or indirectly by various mediators of inflammation. The exact mechanism remains to be unfolded. We should promote measures to reduce the exposure of students to formaldehyde.

Keywords: Formaldehyde, differential leucocyte count, effect, medical students.

INTRODUCTION

Health and well-being are central to our lives in the present day. And therefore, doctor plays an immensely significant role in the society.

But unfortunately, during their education and training in medical schools, budding doctors are themselves exposed to a variety of occupational hazards. One of them is formaldehyde, which is commercially available as formalin and is used as a component of embalming fluids in anatomy.

Formaldehyde (HCHO) is an aldehyde which is produced by the oxidation of methyl alcohol. At room temperature, it exists as a gas which has noxious and irritating properties and a strong pungent odour. Formalin is 37% aqueous solution of formaldehyde [1]. In the field of medical science, formalin is used for disinfection and sterilization of instruments, preservation of biological specimens and embalming of cadavers.

Study of the human cadaver has been one of the cornerstones of the medical science. A medical student learns about the basics of the body's structure by scrupulous dissection of cadavers. Therefore, instructors and students routinely handle the cadavers

and are therefore regularly exposed to formaldehyde in the gross anatomy dissection classes and often, the exposure rates are high [2, 3]. Inhalation and skin contact serve as the portals of exposure.

Today, evidence shows that formaldehyde can be toxic, allergenic and even carcinogenic [4, 5]. Apart from mucosal irritation symptoms like burning sensation in eyes & nose, effects on lung functions [6, 7] and skin [6] formaldehyde also has chronic effects on blood. Available research done on different communities occupationally exposed to formaldehyde like nurses, healthcare professionals and workers employed otherwise, shows that the cell counts and haemopoiesis are affected to a variable degree [8-10]. In the context of occupational exposure, it gives an insight into two things: firstly, how the body perceives exposure with this foreign substance and secondly, the probable effects of the substance on haemopoiesis. Differential Leucocyte Count (DLC) is a simple but highly informative test that can assess these aspects. Findings of allergic dermatitis and chemical

hypersensitivity from exposure to formaldehyde have been reported by numerous researchers [11-14]. Allergic response is generally accompanied by eosinophilia in blood [15].

Studies conducted on the effects of formalin on blood cell counts in medical students are limited. The present study was therefore undertaken to observe the changes in differential leucocyte count of medical students on exposure to formalin during the first year.

MATERIALS AND METHODS

A longitudinal, descriptive study was conducted in the Department of Physiology, Rohilkhand Medical College and Hospital among first year MBBS students in the academic year 2015-16. Approval was obtained from the Institutional Ethics Committee (vide document IEC/IRB No. IEC/27/2015). Students having no history of previous exposure to formalin by inhalational route or direct contact were considered as subjects. The exclusion criteria comprised of presence of any pre-existing diseases like allergic dermatitis, bronchial asthma, known allergy to any substance, any acute or chronic inflammatory state that affects the differential leucocyte count and those who were not willing to participate in the study. Eighty (80) medical students (40 male and 40 female students) out of the total 150, who suitably fulfilled these criteria, were selected using simple random sampling technique. Informed consent was taken from every participant after explaining the nature of the study. The baseline differential leucocyte count was recorded at the initial part of the academic calendar when the students perform DLC as part of their practical curriculum. An

extra glass slide was provided in each working table for the study. Peripheral blood smears were made and the slides were transferred to the Research Lab of the department, where they were stained using Leishman stain and buffered water. Each stained smear was first observed under low and high power for general scanning and assessment of the quality of smear. Then, a drop of cedar wood oil was placed in the middle third of the smear. The slides were then examined under oil-immersion objective and differential count was recorded by moving the slides in zig-zag manner on the mechanical stage. Since the students attend their practical classes in batches of fifty students, recording of the differential leucocyte count of the participants was completed over six working days. The parameter was again recorded again at the end of 10th month. The baseline readings served as the control against which the follow-up values were compared. Descriptive statistics and suitable statistical tests like Paired ‘t’ test were applied. A p-value < 0.05 was considered significant.

RESULTS

The Differential Leucocyte Count (DLC) of all the participants at baseline and follow-up is shown in Table 1. The average proportions of different types of WBCs on DLC at the initial recording were 62.40 ± 4.14% (Neutrophil), 34.24 ± 3.93% (Lymphocyte), 2.71 ± 1.07% (Monocyte) and 0.65 ± 0.71% (Eosinophil). Basophils were not encountered while counting. After exposure, a significant decrease in lymphocytes and a significant increase in eosinophils was observed.

Table-1: Comparison of DLC of all students before and after exposure to formalin

Parameters	Baseline	After exposure	P-value
Neutrophil (%)	62.40 ± 4.14	62.46 ± 2.87	0.879
Lymphocyte (%)	34.24 ± 3.93	33.35 ± 2.69	0.018
Monocyte (%)	2.71 ± 1.07	2.93 ± 0.95	0.112
Eosinophil (%)	0.65 ± 0.71	1.24 ± 1.08	0.000

When the DLC of male and female students were considered separately, similar changes were observed but the change in male students was statistically insignificant (Table 2), whereas in female

students it was statistically significant. Additionally in females, a significant increase in monocytes was observed (Table 3).

Table-2: Comparison of DLC of male students before and after exposure to formalin

Parameters	Baseline	After exposure	P-value
Neutrophil (%)	61.98 ± 4.22	62.38 ± 2.96	0.517
Lymphocyte (%)	34.25 ± 3.85	33.50 ± 2.75	0.174
Monocyte (%)	2.95 ± 1.06	2.93 ± 1.05	0.897
Eosinophil (%)	0.83 ± 0.71	1.18 ± 1.03	0.060

Table-3: Comparison of DLC of female students before and after exposure to formalin

Parameters	Baseline	After exposure	P-value
Neutrophil (%)	62.83 ± 4.08	62.55 ± 2.81	0.620
Lymphocyte (%)	34.23 ± 4.07	33.20 ± 2.65	0.048
Monocyte (%)	2.48 ± 1.04	2.93 ± 0.85	0.022
Eosinophil (%)	0.48 ± 0.68	1.30 ± 1.14	0.000

DISCUSSION

The findings of the study resonate with similar works by various researchers around the globe. Decrease in lymphocytes was also noted by Zhang L *et al.* [10], Ye X *et al.* [16] and Thrasher JD *et al.* [17]. The increase in eosinophils as noted in our study is in accordance with the findings of Al-Sarraj A *et al.* [18] and Norback D [19]. However, it differed from Zhang L *et al.* [10] who recorded a decrease in all granulocytes. In our study, we observed a very marginal and non-significant increase in the proportion of neutrophils, which was different from the findings of Zhang L *et al.* [10], Al-Sarraj A *et al.* [19] and Lyapina M *et al.* [20] all of whom recorded a significant decline in the number of neutrophils. In the present study, a small and non-significant increase in monocytes was noted, similar to Al-Sarraj A *et al.* [19].

There is no all-encompassing model that can give a coherent explanation of the varied spectrum of effects on different leucocytes. The increase in eosinophils may be considered as the haematological manifestation of an allergic mechanism that underlies the physical symptoms of itching and skin changes on exposure to formaldehyde as observed in various studies [11, 13, 15, 21]. It has also been proposed that among the components of immune system, lymphoid tissue, especially Nasal Associated Lymphoid Tissue (NALT) and Bronchial Associated Lymphoid Tissue (BALT) are the initial targets of the toxic effect of formaldehyde vapour. The interaction of formalin with these cell populations leads to a complex downstream interplay of cytokines, interleukins, growth factors and endothelial adhesion molecules. All these substances are important biological molecules that influence the process of haemopoiesis, migration of cells and kinetics between the circulating and tissue pools of the different cells [13]. These factors might be the probable reason of the changes observed with exposure to formalin.

CONCLUSION

Changes in the proportion of different leucocytes of blood on exposure to formalin reaffirm that it is a form of biological stress to the human body and the effects can be far-reaching. Therefore efforts should be devised to mitigate these health-related impediments. One of the simple methods is reducing exposure by the use of personal protective devices like goggles, masks & gloves, use of specially engineered ventilation systems & dissection beds and prevention of unnecessary spillage of formalin within the dissection hall. Another avenue being explored is modifying the conventional process of embalming by use of accessory chemicals or alternative embalming fluids. Chemicals like phenoxyethanol and phenoxetol have emerged as promising candidates in this regard.

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