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ORIGINAL ARTICLE

Assessment of Hematological Parameters in Pulmonary Tuberculosis Patients

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Abstract The aim of the study was the assessment of hematological parameters in pulmonary tuberculosis patients. Forty patients diagnosed with tuberculosis were recruited from the Institute of Thoracic Medicine on the basis of history, clinical examination, chest radiography, sputum examination and related laboratory parameters and were compared with age and sex matched healthy volunteers (n = 40). Hematological parameters and CRP in tuberculosis patients were determined. The mean values for serum hemoglobin level, RBC count and platelet count in PTB was found to be less ($p < 0.001$). Erythrocyte sedimentation rate (ESR), plasma C-reactive protein, WBC count in PTB subjects was increased ($p < 0.001$ for ESR & CRP, $p < 0.05$ for WBCs) and all were statistically significant. This study demonstrated that serum hemoglobin level, RBC count and platelet count was decreased in tuberculosis patients whereas ESR, CRP and WBC count was increased when compared with healthy controls.

Introduction

Mycobacterium tuberculosis, the causative agent of tuberculosis, is one of the world's most devastating human pathogens. Central to the success of *M. tuberculosis* as a pathogen is its ability to persist within humans for long periods in a clinically latent state: roughly 95 % of the people who become infected develop a latent infection [1–4]. The complex pathogenesis affecting factors of tuberculosis are not fully defined. It is known that the activation of the immune system mediates the systemic inflammation seen in the disease [4–6]. An increase in C-reactive protein (CRP), due to increased hepatic synthesis of acute phase proteins, and an increase in ESR follow the inflammatory process and hence these parameters are used in the diagnosis and follow-up of patients [7]. Studies have proved that CRP can serve as a sensitive indicator of activity of tuberculosis and the return to normal values of initially elevated CRP levels may indicate a good therapeutic response [8]. The body shows a complex, multifaceted response involving a complex immune mechanism, to the pathological changes in tuberculosis with body's defense as the priority. The network of immune responses to the tuberculous bacteria and an understanding of the effector functions of the components involved help in the design and implementation of effective treatments for TB. Determination of immunological and hematological parameters become essential to that effect for further consideration of supportive care and other treatment options that could enhance the treatment outcome. This study analyzed the changes in hematological parameters,

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CRP and ESR in tuberculosis patients at diagnosis versus normal controls.

Materials and Methods

Subjects

The study subjects were recruited from The Institute of Thoracic Medicine, Chennai, India. The study consisted of forty patients (25–75 years) diagnosed with pulmonary tuberculosis (PTB). The diagnosis of tuberculosis was performed using Ziehl–Neelsen staining method for acid-fast microscopy (AFM) and culture for growth of the organism on Lowenstein–Jensen (LJ) medium. The subjects were also tested for radiographic abnormalities. Thirty-seven age and sex matched healthy volunteers (Normal controls; NC) were included in the study for comparison of results.

Sampling and Analysis

Body weights of all the subjects and normal controls were recorded and blood samples were collected from both groups, immediately after diagnosis. Blood samples thus collected in the heparinized vacutainers were delivered to the hospital's hematology laboratory—the supernatant plasma was used for the estimation of C-reactive protein whereas the cells were used for routine hematological investigations in PTB (namely hemoglobin levels, total leukocyte count and erythrocyte sedimentation rate, ESR). The study protocol was approved by the Institutional ethics committee and was carried out in accordance with the principle of declaration of Helsinki. Informed consent was obtained from all the subjects.

Statistical Analysis

Statistical analysis of the results was prepared using students' unpaired t test. A p value of <0.05 was considered significant, <0.01 very significant and <0.001 as extremely significant.

Results

Table 1 shows the age and body weight of NC and PTB. Mean age of both groups were well matched and there was no statistically significant difference in the means. Mean body weight of NC group was significantly lower ($p < 0.001$) (by nearly 1.4-fold) in PTB when compared to NC group. The mean values for serum hemoglobin level, RBC count and platelet count in PTB was found to be less (by nearly 1.4-fold, 1.5-fold and 1.2-fold respectively) than that of normal controls and these differences were statistically significant ($p < 0.001$ for all) as seen in Table 1. Erythrocyte sedimentation rate (ESR), plasma C-reactive protein as well as WBC count in PTB subjects was increased (by nearly 15-fold, 15-fold and 1.1-fold respectively) than that of normal controls and this was statistically significant ($p < 0.001$ for ESR & CRP, $p < 0.05$ for WBCs) as seen in Table 1.

Discussion

In our study, mean body weight of NC group was significantly lower ($p < 0.001$) in PTB subjects when compared to NC group. These findings have been discussed in detail in our earlier study [9, 10].

Anemia is a common hematologic complication among TB patients and is a strong risk factor for mortality [11]. In one study the prevalence of anemia among tuberculosis patients was reported to be 31.9 % [12]. Previous studies in sub-Saharan Africa also found a high prevalence of anemia; 88 % of HIV-positive and 77 % of HIV-negative TB patients were anaemic in Malawi [13, 14]. In our research work, the mean serum haemoglobin level in PTB-0 group was found to be less (by nearly 1.4-fold; $p < 0.001$) thus reflecting anemia. This may largely be due to chronic inflammation. Studies showed that a decline in the serum concentrations of

Table 1 Age, body weight and levels of hematological parameters in normal controls, NC and pulmonary tuberculosis patients at diagnosis, PTB

Parameters	NC (n = 37)	PTB-0 (n = 40)	p value	Magnitude of change
Age (years)	46.49 ± 12.5	46.2 ± 12.05	>0.05	–
Body weight (kgs)	56.97 ± 2.47	41.7 ± 3.79	<0.001	∼1.4-fold ↓
Hb (g/dl)	15.04 ± 1.07	10.61 ± 0.94	<0.001	∼1.4-fold ↓
ESR (mm/h)	4.40 ± 0.95	75.85 ± 40.4	<0.001	∼15-fold ↑
CRP (mg/dl)	19.69 ± 3.93	1.33 ± 0.51	<0.001	∼15-fold ↑
TC ($\times 10^3/\mu l$)	6400 ± 1099.24	7325 ± 1888.53	<0.05	∼1.1-fold ↑
RBC ($\times 10^6/\mu l$)	5.3 ± 0.5	3.49 ± 0.33	<0.001	∼1.5-fold ↓
Platelet ($\times 10^3/\mu l$)	2.24 ± 0.29	1.88 ± 0.34	<0.001	∼1.2-fold ↓

Values are mean ± SD

C-reactive protein, the acute phase reactants, coincided with the increase in hemoglobin concentration during treatment [15, 16]. Excessive production of pro-inflammatory cytokines, such as IL-6, TNF-α and IFN-γ, contributes to anemia through reduced production of erythropoietin, suppressed response of bone marrow to erythropoietin, and altered iron metabolism, which may in turn impair erythropoiesis [17]. In the light of these reports, the decreased red cell count and the increase in CRP in PTB subjects of our study explain the observed anemia in these patients.

Erythrocyte sedimentation rate (ESR) values in PTB subjects was increased (by nearly 15-fold) than that of normal controls and this was statistically extremely significant ($p < 0.001$). ESR is part of a well-established routine investigation for tuberculosis and our ESR findings are in accordance with that expected in tuberculosis patients.

In our study, RBC and platelet counts in PTB subjects was less (by nearly 1.5- and 1.2-fold respectively) and this decrease was statistically extremely significant ($p < 0.001$ for both). Godwin et al. (2010) mention that an acute decline in the serum phosphate concentration may result in rapid complications and altered red blood cell function especially in the immune-compromised [17]. In our study, the PTB subjects were just diagnosed with tuberculosis and hence immunocompromised. We also found decreased serum phosphate in these animals, the details of which we have discussed in an earlier report [3, 4, 18–20]. The proinflammatory milieu could have reduced production of erythropoietin, suppressed response of bone marrow to erythropoietin, and altered iron metabolism, which in turn could have impaired erythropoiesis [17]. We also observed that WBC count in PTB subjects was increased (by nearly 1.1-fold) and this was statistically significant ($p < 0.05$) when compared to normal controls. It is but a conventional conclusion in tuberculosis because WBCs increase during infection, due to the increased polymorphonuclear leukocytes and macrophages as a part of the body's immune defense mechanism to combat the invading bacterial population.

Conclusion

This study demonstrated that serum hemoglobin level, RBC count and platelet count was decreased in tuberculosis patients whereas ESR, CRP and WBC count was increased when compared with healthy controls. As for the observed WBC count, WBCs increase during infection, due to the increased polymorphonuclear leukocytes and macrophages as a part of the body's immune defense mechanism to combat the invading bacterial population. The

decreased red cell count and the increase in CRP explain the observed anemia in these patients.

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