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Original Research Article

A STUDY OF HEMATOLOGICAL AND BLOOD COAGULATION PARAMETERS IN PATIENTS WITH TUBERCULOSIS BEFORE AND AFTER THE INTESIVE PHASE OF ANTI TUBERCULAR TREATMENT

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ABSTRACT

Background: Tuberculosis is a major infectious disease associated with significant changes in haematological and coagulation parameters due to persistent inflammation. These abnormalities may indicate disease severity and treatment response. The present study was undertaken to evaluate haematological and blood coagulation parameters in tuberculosis patients before and after the intensive phase of anti-tubercular treatment. **Objectives:** The present study aimed to evaluate alterations in haematological and blood coagulation parameters among patients with tuberculosis and to determine the changes occurring after completion of the intensive phase of anti-tubercular treatment.

Materials and Methods: A prospective case-control study was conducted among 50 newly diagnosed tuberculosis patients and 50 healthy controls. Haematological and coagulation parameters were measured at diagnosis and after the intensive phase of anti-tubercular treatment. The findings were statistically analysed to determine disease-related changes and treatment-associated improvements.

Results: TB patients and healthy controls had comparable age, gender, smoking status, and comorbidity profiles, minimizing potential confounding effects. Pulmonary tuberculosis was the predominant form of disease. Before treatment, TB patients exhibited anemia, elevated WBC and neutrophil counts, thrombocytosis, and increased CRP and fibrinogen levels, indicating active inflammation and a hypercoagulable state. After two months of intensive anti-tubercular therapy, significant improvements were observed, including increased hemoglobin levels and reductions in inflammatory and coagulation markers, demonstrating effective disease control and clinical recovery.

Conclusion: This study showed that active tuberculosis is associated with anemia, inflammation, and coagulation abnormalities. After two months of intensive anti-tubercular therapy, significant improvements were observed in hemoglobin, WBC count, neutrophil count, platelet count, CRP, and fibrinogen levels. These findings indicate that effective treatment reduces systemic inflammation and coagulation disturbances and may help monitor disease progression and therapeutic response.

Keywords: Tuberculosis, Anti-tubercular therapy, Hematological parameters, C-reactive protein, Coagulation profile.

INTRODUCTION

Tuberculosis (TB) remains one of the most important infectious diseases worldwide and continues to contribute significantly to morbidity and mortality, especially in developing countries. Caused by Mycobacterium tuberculosis, the disease primarily affects the lungs but may also involve other organ systems. India continues to bear a substantial proportion of the global TB burden, making it a major public health challenge.[1] Although advances in diagnosis and treatment have improved disease management, tuberculosis continues to exert widespread effects on the body, necessitating a better understanding of its systemic manifestations. Apart from pulmonary involvement, tuberculosis is associated with several haematological and coagulation abnormalities resulting from chronic inflammation and immune activation. These alterations may reflect disease severity and can be useful in monitoring treatment response.[2] Haematological changes commonly involve erythrocytes, leukocytes, and platelets. Anaemia is among the most frequently encountered abnormalities in patients with active tuberculosis. The development of anaemia has been attributed to chronic inflammation, impaired iron utilisation, nutritional deficiencies, and reduced red blood cell production.[3,4] This condition may contribute to fatigue, reduced physical performance, and poor quality of life. Previous studies have also reported an association between anaemia and increased disease severity as well as delayed recovery.[4,5] Changes in white blood cell parameters are also observed in active tuberculosis. Elevated total leukocyte counts, neutrophilia, and relative lymphopenia may occur due to the host inflammatory response against the infection.[2] Such changes reflect immune system activation and may provide insight into disease activity. Similarly, platelet abnormalities, particularly reactive thrombocytosis, are frequently reported in TB patients. Inflammatory cytokines stimulate platelet production, leading to elevated platelet counts during active disease.[6] In addition to their haemostatic function, platelets play a role in inflammation and immune regulation. Studies have shown that platelet counts often decline following successful treatment.[6,7] Tuberculosis may also affect the coagulation system, producing a hypercoagulable state. Persistent inflammation can activate coagulation pathways, resulting in increased fibrinogen and D-dimer levels along with abnormalities in coagulation indices such as prothrombin time and activated partial thromboplastin time.[8,9] These alterations may increase the risk of thrombotic complications and contribute to disease-related morbidity. The intensive phase of anti-tubercular therapy (ATT), consisting of isoniazid, rifampicin, pyrazinamide, and ethambutol, reduces the mycobacterial burden and suppresses inflammation.[8]Consequently, improvement in haematological and coagulation abnormalities is often observed during treatment. Several studies have demonstrated normalisation of these parameters following the intensive phase of ATT.[8,10] Therefore, the present study was designed to assess haematological and blood coagulation parameters in patients with tuberculosis before treatment initiation and after completion of the intensive phase of therapy.

Aim and objective: The present study aimed to evaluate alterations in haematological and blood coagulation parameters among patients with tuberculosis and to determine the changes occurring after completion of the intensive phase of anti-tubercular treatment.

MATERIALS AND METHODS

Study design: The present study was conducted as a prospective case-control study to evaluate haematological and blood coagulation parameters in patients with tuberculosis before and after completion of the intensive phase of anti-tubercular treatment (ATT).

Study setting: The study was carried out at the District Hospital, Chikkaballapura, Karnataka, a designated centre under the National Tuberculosis Elimination Programme (NTEP). The study was conducted over a period of 18 months.

Study population: A total of 100 participants were enrolled in the study. The study group comprised 50 newly diagnosed tuberculosis patients, while the control group included 50 healthy age- and sex-matched individuals. Both pulmonary and extrapulmonary tuberculosis cases were included.

Inclusion Criteria

1. Adults aged 18 years and above with confirmed tuberculosis.
2. Patients registered under NTEP and not initiated on anti-tubercular treatment.
3. Individuals willing to provide written informed consent.

Exclusion Criteria

1. Patients with other acute or chronic infections.
2. Individuals with bleeding or coagulation disorders.
3. Patients with chronic liver disease, autoimmune disorders, endocrine disorders, or other systemic illnesses affecting study variables.
4. HIV-positive individuals.
5. Pregnant women.

Sampling method: Participants were selected using a purposive sampling technique. Healthy controls were recruited from the same hospital and matched with tuberculosis patients for age and sex to ensure comparability between the groups.

Methods: After obtaining written informed consent, demographic and clinical details were recorded using a structured proforma. Information regarding age, sex, occupation, presenting symptoms, and

relevant medical history was collected from all participants.

Collection of blood samples: Venous blood samples were collected from tuberculosis patients before initiation of anti-tubercular treatment and again after completion of the two-month intensive phase of therapy. A single blood sample was collected from healthy controls for baseline comparison. All samples were collected under aseptic conditions and processed according to standard laboratory procedures. The haematological and coagulation parameters measured before treatment were compared with those obtained after completion of the intensive phase of ATT. Comparisons were also made between tuberculosis patients and healthy controls to identify disease-related changes and treatment-associated improvements.

Study parameters:

Haematological parameters:

1. Haemoglobin concentration
2. Total white blood cell count
3. Differential leukocyte count
4. Platelet count
5. Erythrocyte sedimentation rate (ESR)
6. C-reactive protein (CRP)

Coagulation parameters

1. Prothrombin time (PT)
2. Activated partial thromboplastin time (aPTT)
3. International normalised ratio (INR)
4. D-dimer
5. Fibrinogen

Statistical Analysis: Data were entered into Microsoft Excel and analysed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Independent sample t-test and Chi-square test were used for comparison between groups. Paired t-test was applied to compare pre-treatment and post-treatment values within the tuberculosis group. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations: Prior approval was obtained from the Institutional Ethics Committee before commencement of the study. Written informed consent was obtained from all participants after explaining the study details. Participation was voluntary, and confidentiality of data was maintained throughout the study. The study was conducted in accordance with accepted ethical principles and research guidelines.

RESULTS

The demographic characteristics of the study participants were comparable between the tuberculosis (TB) group and healthy controls. The mean age and age range did not differ significantly between the two groups, indicating a similar age distribution and reducing the likelihood of age-related bias in the study findings. [Table 1] Likewise, the gender composition was comparable, with a marginal predominance of males in both groups. [Table 2] Smoking was reported slightly more frequently among TB patients than healthy controls; however, the difference was small and unlikely to have substantially influenced the observed haematological and coagulation profiles. [Table 2] The prevalence of comorbid conditions such as hypertension and diabetes mellitus was low in both groups, and no significant difference was observed, suggesting minimal impact of these factors on the study outcomes. [Table 3] Among patients with tuberculosis, pulmonary TB was the predominant form, accounting for 76% of cases, while extrapulmonary TB represented 24% of the study population. [Table 4] This distribution is consistent with the commonly reported pattern of disease presentation. Assessment of haematological parameters revealed significant improvements following the intensive phase of anti-tubercular therapy (ATT). Hemoglobin levels showed a significant rise after two months of treatment, indicating recovery from tuberculosis-associated anemia and improvement in general health status. [Table 5] Total white blood cell counts were elevated before treatment, reflecting active infection and inflammation, but decreased significantly after ATT, suggesting a favourable therapeutic response. [Table 6] A similar trend was observed for neutrophil counts, which were markedly raised at baseline and declined significantly following treatment, indicating resolution of the inflammatory process. [Table 7] Platelet counts were significantly higher before initiation of therapy and decreased after treatment, suggesting improvement in inflammation-related thrombocytosis and hypercoagulability. [Table 8] C-reactive protein levels, a marker of systemic inflammation, were markedly elevated prior to treatment and declined significantly after two months of ATT (Table 9). Furthermore, fibrinogen levels, which were increased before treatment, showed a significant reduction following therapy, reflecting improvement in coagulation status and reduction in the pro-inflammatory state associated with active tuberculosis. [Table 10]

Table1: Age distribution of the participants

Group	Mean ± SD	Range (Min-Max)
TB Patients	35.2 ± 12.5	18-70
Healthy Controls	34.6 ± 11.2	20-68

Table 2: Smoking habits of the participants

Smoking Status	TB Patients (n = 50)	Healthy Controls (n = 50)
Smokers	22 (44%)	18 (36%)
Non-smokers	28 (56%)	32 (64%)

Table 3: Comorbid Conditions among the participants

Comorbidity	TB Patients (n = 50)	Healthy Controls (n = 50)
Hypertension	10 (20%)	5 (10%)
Diabetes Mellitus	8 (16%)	4 (8%)
No Comorbidity	32 (64%)	41 (82%)

Table 4: Type of Tuberculosis among the participants

TB Type	TB Patients (n = 50)
Pulmonary TB	38 (76%)
Extrapulmonary TB	12 (24%)

Table 5: Haemoglobin levels among the participants pre and post intensive phase

Group	Pre-Intensive Phase (Mean ± SD)	Post-Intensive Phase (Mean ± SD)	p-value
TB Patients	9.2 ± 1.4	11.4 ± 1.1	<0.001
Healthy Controls	13.5 ± 1.2	N/A	N/A

Table 6: White Blood Cell Count (cells/µL) among the participants pre and post intensive phase

Group	Pre-Intensive Phase (Mean ± SD)	Post-Intensive Phase (Mean ± SD)	p-value
TB Patients	10,500 ± 2,000	7,800 ± 1,500	<0.001
Healthy Controls	7,200 ± 1,000	N/A	N/A

Table 7: Neutrophil count among the participants pre and post intensive phase

Group	Pre-Intensive Phase (Mean ± SD)	Post-Intensive Phase (Mean ± SD)	p-value
TB Patients	6,800 ± 1,200	4,200 ± 1,000	<0.001
Healthy Controls	3,200 ± 800	N/A	N/A

Table 8: Platelet count among the participants pre and post intensive phase

Group	Pre-Intensive Phase (Mean ± SD)	Post-Intensive Phase (Mean ± SD)	p-value
TB Patients	350,000 ± 50,000	270,000 ± 60,000	<0.001
Healthy Controls	250,000 ± 40,000	N/A	N/A

Table 9: C-Reactive Protein (CRP, mg/L) among the participants pre and post intensive phase

Group	Pre-Intensive Phase (Mean ± SD)	Post-Intensive Phase (Mean ± SD)	p-value
TB Patients	45 ± 15	15 ± 10	<0.001
Healthy Controls	5 ± 3	N/A	N/A

Table 10: Fibrinogen (mg/dL) among the participants pre and post intensive phase

Group	Pre-Intensive Phase (Mean ± SD)	Post-Intensive Phase (Mean ± SD)	p-value
TB Patients	450 ± 80	250 ± 60	<0.001
Healthy Controls	250 ± 50	N/A	N/A

DISCUSSION

Tuberculosis (TB) remains a significant public health problem and is associated with several systemic effects that extend beyond the respiratory system. The present study evaluated changes in haematological, inflammatory, and coagulation parameters among tuberculosis patients before initiation of anti-tubercular therapy (ATT) and after completion of the intensive phase of treatment. The findings revealed substantial abnormalities in haemoglobin levels, white blood cell count, neutrophil count, platelet count, C-reactive protein (CRP), and fibrinogen levels during active disease, with significant improvement following treatment.The demographic characteristics of the study population were comparable between TB patients and healthy controls. Similar age and gender distributions reduced the likelihood of demographic factors influencing the observed laboratory findings. The majority of patients had pulmonary tuberculosis, which is the most common clinical presentation of the disease and is often associated with pronounced inflammatory responses.[11,12]

A major finding of the present study was the significantly lower haemoglobin concentration among TB patients before treatment. Anaemia is a well-recognised complication of active tuberculosis and usually develops due to chronic inflammation, nutritional deficiencies, impaired iron utilisation, and suppression of red blood cell production. Persistent infection stimulates inflammatory mediators that interfere with normal iron metabolism, resulting in reduced haemoglobin synthesis. The significant rise in haemoglobin levels observed after two months of ATT indicates improvement in disease status and recovery of

normal erythropoietic function. Similar observations have been reported in previous studies, where correction of anaemia was noted following successful anti-tubercular treatment. White blood cell counts were significantly elevated in untreated TB patients compared to healthy controls. Leukocytosis is a common response to infection and reflects activation of the body's immune system against Mycobacterium tuberculosis. Increased production and mobilisation of white blood cells occur as part of the host defence mechanism. In the present study, WBC counts declined significantly after the intensive phase of treatment, suggesting effective control of infection and reduction of inflammatory activity. This improvement indicates that ATT successfully reduced the microbial burden and helped restore normal immune function.[13,14]

Neutrophils also showed a similar pattern. Elevated neutrophil counts observed before treatment reflected active inflammation and ongoing immune response. Although macrophages and lymphocytes play a central role in tuberculosis, neutrophils contribute significantly to the early inflammatory process and are often increased during active disease. Following treatment, neutrophil counts decreased significantly, indicating resolution of inflammation and clinical improvement. This finding supports the view that neutrophil count may serve as a useful marker of disease activity and treatment response.Another important observation was the significant increase in platelet count among TB patients before treatment. Reactive thrombocytosis is frequently encountered in chronic inflammatory disorders and is believed to occur due to cytokine-mediated stimulation of platelet production. In addition to their role in haemostasis, platelets participate in inflammatory and immune processes. Elevated platelet counts in active TB may therefore reflect both inflammation and activation of coagulation pathways. Following two months of ATT, platelet counts decreased significantly towards normal levels. This reduction suggests a decline in inflammatory activity and restoration of normal haematological balance. Similar findings have been reported by earlier investigators who identified thrombocytosis as a marker of active disease.[15,16]

CRP levels were markedly elevated in TB patients before treatment. CRP is an acute-phase protein synthesised by the liver in response to inflammatory cytokines and is widely used as a marker of systemic inflammation. High CRP levels observed in active tuberculosis indicate ongoing infection and tissue inflammation. In the present study, CRP concentrations decreased significantly after completion of the intensive phase of treatment. This reduction reflects effective suppression of the inflammatory process and successful response to therapy. The findings are in agreement with previous reports that demonstrated progressive normalisation of CRP levels during anti-tubercular treatment. The study also highlighted significant alterations in coagulation status, particularly with respect to fibrinogen levels. Fibrinogen is an important coagulation factor and an acute-phase reactant that increases during inflammatory conditions. Elevated fibrinogen levels observed in untreated TB patients indicate the presence of a hypercoagulable state. Chronic inflammation promotes activation of coagulation pathways, endothelial dysfunction, and increased production of procoagulant proteins, thereby increasing the risk of thrombotic complications. The significant reduction in fibrinogen levels after treatment suggests reversal of these abnormalities and improvement in coagulation status. This finding indicates that effective ATT not only controls infection but also reduces the prothrombotic effects associated with active tuberculosis.[17-20]

The parallel reduction in CRP and fibrinogen levels observed in the present study further emphasises the close interaction between inflammation and coagulation. Persistent inflammatory activity in tuberculosis stimulates both acute-phase reactants and coagulation factors, contributing to disease-related complications. As treatment reduces the bacterial burden, inflammatory cytokine production decreases, leading to improvement in both inflammatory and coagulation parameters.The overall findings of this study suggest that haematological and coagulation abnormalities are common in active tuberculosis and reflect the systemic impact of the disease. Significant improvements observed after two months of intensive anti-tubercular therapy demonstrate the effectiveness of treatment in reversing these alterations. Routine assessment of haemoglobin, WBC count, neutrophil count, platelet count, CRP, and fibrinogen may therefore provide valuable information regarding disease severity, treatment response, and patient recovery. A limitation of the study is that it was conducted in a single centre with a relatively small sample size. Furthermore, advanced coagulation markers were not evaluated, and long-term follow-up beyond the intensive phase of treatment was not performed. Despite these limitations, the study provides useful evidence regarding the beneficial effects of anti-tubercular therapy on haematological, inflammatory, and coagulation parameters.

CONCLUSION

This study showed that active tuberculosis is associated with anemia, inflammation, and coagulation abnormalities. After two months of intensive anti-tubercular therapy, significant improvements were observed in hemoglobin, WBC count, neutrophil count, platelet count, CRP, and fibrinogen levels. These findings indicate that effective treatment reduces systemic inflammation and coagulation disturbances and may help monitor disease progression and therapeutic response.

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