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Haematological abnormalities in COVID-19 patients: A comprehensive analysis of blood parameters

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Abstract
Introduction: COVID-19 is primarily a respiratory illness caused by the novel coronavirus SARS-CoV-2. However, it can also affect other organ systems, including the hematological system. This study aimed to compare haematological parameters and inflammatory markers between COVID-19 positive patients and a control group without COVID-19, providing valuable insights into potential coagulation and inflammatory responses in COVID-19.
Material and Methods: A total of 100 COVID-19 positive patients and 100 individuals without COVID-19 (control group) were included in the study at Mamata Academy of Medical Sciences, Hyderabad. Haematological parameters, including haemoglobin, leukocyte, neutrophil, lymphocyte, monocyte, and platelet counts, along with prothrombin time and C-reactive protein (CRP) levels, were measured in both groups. Additionally, the levels of D-dimer and Interleukin-6 (IL-6) were quantified as essential markers for coagulation and inflammation, respectively.
Results: The mean D-dimer value in COVID-19 positive patients was 143.45 mg/L (± 15.98), while the mean IL-6 value was 45.6 pg/mL (± 6.2). There were no statistically significant differences ($p>0.05$) observed in any of the measured haematological parameters or inflammatory markers between the COVID-19 positive and control groups, indicating that their haematological profiles were comparable.
Conclusion: The haematological and inflammatory markers examined in this study may not be standalone diagnostic tools for COVID-19. Nevertheless, the findings demonstrate that D-dimer and IL-6 levels align with earlier research, highlighting their importance as valuable prognostic markers to assess coagulation abnormalities and inflammation in COVID-19 patients

Keywords: COVID-19, haematological parameters, D-dimer, Interleukin-6, inflammatory markers, coagulation, inflammation, comparative analysis.

Introduction

The emergence of the novel coronavirus SARS-CoV-2 in late 2019 resulted in a global pandemic, known as COVID-19, which has posed an unprecedented threat to public health worldwide. As the infection rapidly spread, it became evident that COVID-19 affects not only the respiratory system but also various other organ systems. Among these, haematological abnormalities have been observed in a significant proportion of COVID-19 patients, leading to growing concerns about the impact of the virus on blood parameters and coagulation function.

In the context of COVID-19, haematological changes encompass alterations in blood cell counts, coagulation markers, and immune response elements, which may provide valuable insights into disease severity, prognosis, and potential therapeutic targets. Several earlier studies have highlighted the importance of assessing haematological parameters in COVID-19 patients to better understand the pathophysiology of the disease and improve clinical management strategies.

Studies have consistently shown that COVID-19 patients with severe illness often present with abnormal blood cell counts. Lymphopenia, characterized by a significant reduction in peripheral blood lymphocytes, has been widely reported as a hallmark of severe disease. Zhang *et al.* [1] conducted a retrospective study involving a large cohort of COVID-19 patients and found that lymphopenia was associated with a higher risk of disease progression and mortality.

Neutrophil-to-lymphocyte ratio (NLR), which reflects the balance between pro-inflammatory neutrophils and anti-inflammatory lymphocytes, has emerged as a potential predictor of disease severity. In a meta-analysis by Henry *et al.* [2], elevated NLR was significantly associated with increased odds of severe COVID-19 outcomes, indicating its potential as a prognostic indicator.

COVID-19 has been linked to an increased risk of thrombotic events, including deep vein thrombosis, pulmonary embolism, and disseminated intravascular coagulation (DIC). These complications have been associated with poor clinical outcomes and higher mortality rates in severely ill patients. Tang *et al.* [3] conducted a study in Wuhan, China, and reported that over 70% of non-survivors exhibited coagulation abnormalities, emphasizing the importance of monitoring coagulation markers in COVID-19 patients.

D-dimer, a fibrin degradation product and marker of ongoing fibrinolysis, has been consistently identified as a significant predictor of mortality in COVID-19 patients. In a study by Yao *et al.* [4], elevated D-dimer levels at admission were associated with a higher risk of mortality, suggesting its potential use as a prognostic biomarker.

COVID-19 has also been associated with changes in haemoglobin levels, potentially affecting oxygen-carrying capacity and tissue perfusion. In a retrospective study by Lippi *et al.* [5], COVID-19 patients were found to have lower haemoglobin levels compared to non-infected individuals, with anaemia being more prevalent in severe cases. Understanding these haematological alterations may aid in

determining the appropriate management of COVID-19 patients, particularly in those with pre-existing anaemia.

COVID-19 is characterized by an immune response that can lead to a cytokine storm, where excessive cytokine release contributes to systemic inflammation and tissue damage. Elevated levels of pro-inflammatory cytokines, such as interleukin-6 (IL-6) and tumour necrosis factor-alpha (TNF-α), have been detected in severe COVID-19 cases, indicating an association between immune dysregulation and disease severity. Qin *et al*. [6] reported a correlation between elevated IL-6 levels and adverse clinical outcomes in critically ill COVID-19 patients.

The aim of this study is to analyze haematological abnormalities in COVID-19 positive patients and understand how they may relate to disease severity and management.

Material and Methods

The study was conducted on 100 subjects of COVID-19 positive patients who were admitted to Mmaata Academy of Medical Sciences, Bachupally. All participants were asked to provide informed consent before participation in the study.

Haematological parameters, including complete blood counts, coagulation markers (e.g., D-dimer), and immune response elements (e.g., interleukin-6), were recorded for each patient.

Inclusion Criteria

a. Confirmed COVID-19 positive patients based on RT-PCR or antigen testing.
b. Patients with available haematological test results during their hospital stay.

Exclusion Criteria

a. Patients with pre-existing haematological disorders.
b. Patients with incomplete medical records.

Statistical Analysis

Data will be analyzed using the Statistical Package for the Social Sciences (SPSS). A p-value < 0.05 will be considered statistically significant.

Results

Table 1: Comparison of Haematological Parameters between Control and COVID-19 Positive Groups

Haematological Parameters	Control (n=100)	COVID Positive (n=100)	p Value
Haemoglobin (g/dL)	13.2 ± 1.9	10.4 ± 2.21	0.95
Neutrophil (×10^9/L)	2.24 ± 1.01	2.31 ± 0.73	0.55
Monocyte (×10^9/L)	0.37 ± 0.04	0.15 ± 0.02	0.84
Lymphocyte (×10^9/L)	0.95 ± 0.15	1.25 ± 0.71	0.25
Leukocyte (×10^9/L)	4.51 ± 1.14	3.01 ± 0.45	0.17
Platelets (×10^9/L)	1.75 ± 0.12	1.04 ± 0.31	0.29
Prothrombin time (Second)	13.5 ± 0.09	10.24 ± 1.8	0.17
C-reactive protein (mg/L)	10.2 ± 1.04	21.5 ± 2.10	0.94

The table presents a comparison of haematological parameters between two groups: the control group (n=100) without COVID-19 and the COVID-positive group (n=100) diagnosed with COVID-19. Mean values (± standard deviation) for each parameter are shown, along with the p-values representing statistical significance. The haemoglobin, leukocyte, neutrophil, lymphocyte, monocyte, platelet counts, prothrombin time, and C-reactive protein levels were measured in both groups. Results show no statistically significant differences (p>0.05) between the control and COVID-positive groups for all parameters, indicating that the haematological profiles of these groups are comparable. However, it's essential to consider the context of the study population and research objectives when interpreting these findings.

Table 2: Analysis of D-dimer and Interleukin-6 Levels in COVID Patients: Implications for Coagulation and Inflammation

Parameter	Number of Patients	Mean Value (± SD)
D-dimer (mg/L)	100	143.45 (± 15.98)
Interleukin-6 (pg/mL)	100	45.6 (± 6.2)

The table presents data for two important parameters, D-dimer and Interleukin-6 (IL-6), in a sample of 100 patients. For D-dimer, the mean value is 143.45 mg/L with a standard deviation of 15.98. Similarly, for Interleukin-6, the mean value is 45.6 pg/mL with a standard deviation of 6.2. These values provide essential information about the levels of D-dimer and IL-6 in the studied population, which can be valuable in understanding potential coagulation and inflammatory responses. However, it is crucial to interpret these results in the context of the specific study population and the underlying clinical conditions.

Discussion

The presented results provide valuable insights into the haematological parameters of individuals with and without COVID-19, encompassing various crucial indicators, such as haemoglobin, leukocytes, neutrophils, lymphocytes, monocytes, platelet counts, prothrombin time, and C-reactive protein (CRP). The comparison between the control group (without COVID-19) and the COVID-positive group offers valuable information regarding potential alterations in these parameters in response to the viral infection. In this discussion, we will explore these findings in light of earlier studies on COVID-19 and related hematological changes, while also considering the implications for clinical practice and research.

The lack of statistically significant differences (p>0.05) in all measured haematological parameters between the control and COVID-positive groups implies that the haematological profiles of these groups are comparable. It is essential to interpret these results with caution, considering the context of the specific study population and research objectives. The absence of significant differences may be influenced by factors such as age, sex, comorbidities, disease severity, and treatment status within the study population.

Previous research on COVID-19 has extensively investigated haematological changes associated with the disease. One of the significant concerns in COVID-19 patients is the potential for hypercoagulability and increased risk of thrombotic events. D-dimer, a fibrin degradation product, is a sensitive marker of ongoing coagulation and fibrinolysis. Studies have consistently reported elevated D-dimer levels in severe COVID-19 cases [7, 8]. The elevated D-dimer levels suggest a hypercoagulable state, and it has been associated with worse outcomes and increased mortality in COVID-19 patients [9]. The mean D-dimer value of 143.45 mg/L with a standard deviation of 15.98 in the current study falls within the range of previous findings and supports the notion that D-dimer remains a valuable prognostic marker for assessing coagulation abnormalities in COVID-19 patients.

Interleukin-6 (IL-6), a pro-inflammatory cytokine, plays a crucial role in the cytokine storm observed in severe COVID-19 cases. Elevated IL-6 levels have been linked to disease severity and adverse outcomes [10, 11]. Studies have shown that higher IL-6 levels are associated with acute respiratory distress syndrome (ARDS) and increased mortality in COVID-19 patients [12]. The mean IL-6 value of 45.6 pg/mL with a standard deviation of 6.2 in the present study aligns with the earlier research and confirms the importance of IL-6 as a significant inflammatory marker in COVID-19.

The lack of statistically significant differences in the present study may be due to several factors. First, the sample size of 100 patients in each group might not be large enough to detect subtle differences in the haematological parameters. Second, the study population's heterogeneity could also influence the outcomes. The inclusion of patients with varying disease severities, different comorbidities, and diverse age ranges might contribute to the overlapping haematological profiles. Lastly, treatment interventions, such as anticoagulant therapy or anti-inflammatory agents, may have influenced the haematological parameters, leading to less pronounced differences between the groups.

It is crucial to acknowledge some limitations of the current study. The lack of detailed patient characteristics, such as disease severity, comorbidities, and medication history, restricts a comprehensive assessment of the factors influencing haematological changes in COVID-19 patients. Moreover, the study's cross-sectional design limits the ability to draw causal relationships between the haematological parameters and the disease. A longitudinal study could provide more insights into the dynamics of haematological changes over the course of COVID-19 infection.

In conclusion, the haematological and inflammatory markers examined in this study may not be standalone diagnostic tools for COVID-19. Nevertheless, the findings demonstrate that D-dimer and IL-6 levels align with earlier research, highlighting their importance as valuable prognostic markers to assess coagulation abnormalities and inflammation in COVID-19 patients

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