Original Article

Analysis of Haematological Parameters of Peripheral Blood in COVID-19 Patients with a Special Emphasis on D-dimer

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ABSTRACT

Introduction: Coronavirus disease 2019 (COVID-19) is assessed by nasal / throat swab test, and further confirmed by Polymerase Chain Reaction (PCR) technique, albeit the day-to-day monitoring of COVID-19 patients depends largely on biochemical and haematological tests. There are differing results by various studies with respect to haematological parameters in Covid 19 infection. Hence this study was undertaken to analyse the haematological parameters in Covid 19 infection.

Aim: To analyse the haematological parameters in peripheral blood samples of COVID-19 patients with a special emphasis on D-dimer.

Materials and Methods: A prospective study was conducted on 75 Covid 19 patients, for six months from August 2020 to January 2021 in Department of Pathology, ESIC Medical College Sanath Nagar, Hyderabad, Telangana, India after obtaining ethical clearance from Institutional Ethical Committee. Patient blood samples were evaluated for complete haemogram, coagulation parameters, followed by correlation with various categories of D-dimer levels. Following demographic assessment, the patient data was then stratified into four distinct categories based on D-dimer levels. Pearson's correlation test was used to analyse the correlation of D-dimer and fibrinogen levels with various haematological parameters. Stratification analysis of D-dimer categories with haematological parameters were assessed with respect to mean, standard deviation, median and interquartile range, significance (p-value) of which were calculated using Kruskall wallis test. A p-value of <0.05 was considered to be statistically significant.

Results: 29 patients (38.7%) belonged to age range of 31-50 years category. Sixteen patients had normal D-dimer levels, 18 had mild elevation, moderately elevated D-dimer levels was noted in 26 patients, followed by 15 patients who had a severe elevation of D-dimer. Changes in Haemoglobin, Red Blood Cells (RBC) count and haematocrit were found to be significantly correlated with D-dimer levels, with p-values of 0.006, 0.021 and 0.010 respectively. Changes in Neutrophil (N) count, absolute Lymphocyte counts (L) and N:L ratio were also found to be having statistically significant correlation (p-values 0.032, 0.011, 0.001 respectively) with D-dimer levels.

Conclusion: Assessment of haematological parameters can be a valuable tool in finding the severity of COVID-19 infection, thereby helping the clinicians in triaging, and treating the Covid 19 patients.

INTRODUCTION

Coronavirus diseases 2019 is a pandemic disease caused by a novel Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). It belongs to the family of beta coronavirus. It started in China and now has spread all over the world taking major toll of lives in many countries [1]. It is suspected clinically by common flu like symptoms such as sore throat, fever, myalgia, dry cough and breathlessness and tested by nasal and/or throat swab test, confirmed by PCR technique [1].

Considering the haematological changes, COVID-19 patients are prone to get lymphopenia, neutrophilia with an increased neutrophil/lymphocyte ratio to name a few. There are also changes in the morphology of the blood cells as documented by myriad studies, but with differing results. Studies have also documented changes in D-dimer and serum fibrinogen values, as the pathogenesis of COVID-19 involves even the clotting/fibrinolytic system [2]. Hence, this study was undertaken while COVID-19 was in its peak, to find any significant changes in haematological parameters that help in triaging patients for further management. The aim of the study was to analyse the haematological parameters in peripheral blood samples of COVID-19 patients. The objectives were, to categorize patients based on D-dimer levels thereby, to find any significant association if exists between the haematological parameters.

MATERIALS AND METHODS

A prospective study for a period of six months, from August 2020 to January 2021 was conducted on 75 COVID-19 positive patients who were admitted in the isolation ward in a tertiary care hospital at ESIC Medical College Sanath Nagar, Hyderabad, Telangana, India. The study was carried out in the Department of Pathology. The Institutional Ethical Clearance number is 799/U/IEC/ESICMC/F0202/08-2020. After obtaining proper ethical clearance and by taking formal consent, the blood samples were taken in COVID-19 positive patients and from those patients who were symptomatic but tested negative, served as control.

Inclusion criteria: All patients who tested positive for COVID-19 were included in the study.

Exclusion criteria: Patients who had associated co-morbidities such as diabetes, hypertension, heart disease etc were excluded from study population.

Study Procedure

Samples were taken in Ethylenediamine Tetraacetic Acid (EDTA) and sodium citrate vacutainers (2 mL each) for complete haemogram and coagulation analysis, respectively. Complete blood count was assessed by automated five part sysmex XS1000i Haematology analyser, followed by a peripheral smear, which was stained by routine leishman staining. Samples for coagulation analysis were subjected to D-dimer and fibrinogen levels. This was carried out with Sysmex CA 50 semi-automated coagulation analyser. All the data were compiled, and statistical analysis was carried out for any significant observations in haematological values in the COVID-19 patients. Following demographic assessment, the patient data was

then stratified into four distinct categories based on D-dimer levels such as normal (D-dimer levels of <250), mild elevation in D-dimer levels (>250<500), moderate (D-dimer >500<2000) and severe (D-dimer>2000) [2].

All haematological parameters were evaluated with various categories of D-dimer levels, with an intent to know if there was any significant association of these parameters with the severity of disease. This was based on the well-established role of D-dimer in predicting severity of COVID-19 disease as patients who suffer from severe COVID-19 had high D-dimer levels.

STATISTICAL ANALYSIS

Correlation of D-dimer and fibrinogen levels with various haematological parameters was done with Pearson's correlation test. Stratification analysis of D-dimer categories with haematological parameters were assessed with respect to mean, standard deviation, median and interquartile range, significance (p-value) of which were calculated using Kruskall wallis test. A p-value of <0.05 was considered to be statistically significant. Microsoft Excel software (Microsoft office 365) was used for the data analysis.

RESULTS

The age and gender distribution of 75 COVID-19 positive patients was presented in [Table/Fig-1]. Most patients 29 (38.7%) belonged to age range of 31-50 years category. With respect to gender distribution, male:female ratio was found to be 2.2:1. The mean, standard deviation, median and interquartile range of all haematological parameters which parameters which were assessed in the study is shown in [Table/Fig-2]. The frequency and percentage of stratified D-dimer levels was seen in [Table/Fig-3]. Correlation statistics of D-dimer with haematological parameters where, changes in haemoglobin, RBC count and haematocrit were found to be significantly correlated with D-dimer levels, with p-values of 0.006, 0.021 and 0.010 respectively was shown in [Table/Fig-4]. Out of the RBC indices, Mean Corpuscular Haemoglobin Concentration (MCHC) showed significant (p-value of 0.044) correlation with D-dimer levels. Not surprisingly, changes in neutrophil count, absolute lymphocyte counts and N:L ratio were also found to be having statistically significant correlation (p-value 0.032, 0.011, 0.001 respectively) with D-dimer levels.

Age distribution (in years)	Frequency	Percentage
30 and below	10	13.3%
31-50	29	38.7%
51-70	28	37.3%
Above 70	8	10.7%
Total	75	100.0%
Gender distribution		
Male	52	69.3%
Female	23	30.7%
Total	75	100%

[Table/Fig-1]: Age and gender distribution of the COVID-19 patients.

Parameters	Mean	Std. deviation	Median	IQR	
				25th	75th
Hb (g/dL)	12.80	2.68	13.10	11.20	14.90
RBC count (million/mm³)	4.47	0.75	4.40	3.90	5.10
Haematocrit (L/L)	37.77	6.83	37.70	33.20	43.00
MCV (f/L)	84.07	8.27	85.20	79.50	89.30
MCH (pg per cell)	28.37	3.36	29.10	27.30	30.30
MCHC (g/dL)	33.70	2.02	34.00	32.90	34.70
RDW SD (f/L)	42.87	4.24	42.20	40.00	45.40
RDWCoV (%)	14.57	1.77	14.10	13.40	15.30

Platelet count	2.57	1.16	2.40	1.70	3.20
MPV (fL)	10.74	1.37	10.70	10.40	11.40
PCRT (%)	0.28	0.11	0.27	00.19	0.34
PLT-LCR Ratio (%)	31.95	7.07	31.10	27.70	35.80
Total WBC count (%)	11123.60	4704.99	10720.00	7120.00	14600.00
Neutrophils (cells/uL)	8682.60	4723.84	7900.00	5040.00	12640.00
Lymphocytes (Cells/uL)	1883.47	1296.94	1640.00	800.00	2470.00
N:L ratio	7.85	7.58	5.26	1.91	11.65
Eosinophils (cells/mcL)	138.93	361.33	30.00	10.00	150.00
Monocytes (Cells/uL)	406.00	219.56	400.00	250.00	530.00
Basophils (cells/mcL)	22.67	20.54	10.00	10.00	30.00
D-dimer	1425.07	2260.97	543.00	286.00	1299.00
Fibrinogen (mg/dL)	688.03	1648.00	387.00	262.00	526.00

[Table/Fig-2]: Haematological parameters in study population.
Hb: Haemoglobin; MCV: Mean corpuscular volume; MCH: Mean corpuscular haemoglobin; MCHC: Mean corpuscular haemoglobin concentration; RDW-SD and RDW- CV: Red cell distribution width in standard deviation and coefficient of variation; MPV: Mean platelet volume; PCRT: Plateletcrit; PLT-LCR ratio: Platelet large cell ratio; N:L ratio: Neutrophil lymphocyte ratio; IQR: Interquartile range

D-dimer levels	Frequency	Percentage
Normal	16	21.3%
Mild	18	24.0%
Moderate	26	34.7%
Severe	15	20.0%
Total	75	100.0%

[Table/Fig-3]: Frequency and percentage of stratified D-dimer levels.

Parameters	Pearson correlation	p-value
Hb (g/dL)	-0.317	**0.006**
RBC count (million/mm³)	-0.267	**0.021**
Haematocrit (L/L)	-0.297	**0.010**
MCV (f/L)	-0.115	0.324
MCH (pg per cell)	-0.209	0.071
MCHC (g/dL)	-0.234	**0.044**
RDW SD (f/L)	0.140	0.230
RDWCoV (%)	0.194	0.096
Platelet count (mcL)	0.009	0.940
MPV (fL)	0.066	0.571
PCRT (%)	0.047	0.689
PLT-LCR ratio (%)	0.115	0.325
Total WBC count (uL)	0.153	0.190
Neutrophils (cells/uL)	0.248	**0.032**
Lymphocytes (Cells/uL)	-0.293	**0.011**
N:L ratio	0.369	**0.001**
Eosinophils (cells/mcL)	-0.125	0.285
Monocytes (Cells/uL)	-0.115	0.326
Basophils (cells/mcL)	-0.195	0.093

[Table/Fig-4]: Correlation of D-dimer with haematological parameters.
Statistical test used: Pearson's correlation test; Hb: Haemoglobin; MCV: Mean corpuscular volume; MCH: Mean corpuscular haemoglobin; MCHC: Mean corpuscular haemoglobin concentration; RDW-SD and RDW-CV: Red cell distribution width in standard deviation and coefficient of variation; MPV: Mean platelet volume; PCRT: Plateletcrit; PLT-LCR ratio: Platelet large cell ratio; N:L ratio: Neutrophil lymphocyte ratio

Changes in all other parameters were not statistically significant with respect to D-dimer levels. Correlation statistics of fibrinogen with haematological parameters is presented in [Table/Fig-5], where changes in Mean Corpuscular Haemoglobin (MCH) and Platelet crit found to be significantly correlated with fibrinogen levels (p-values of 0.034 and 0.023 respectively). The statistical analysis of red cell, platelet and White Blood Cells (WBC) parameters with respect to stratified D-dimer levels,respectively, significance of which were

calculated by performing Kruskall wallis test was seen in [Table/Fig-6-8]. There were significant association noted with varying grades of D-dimer values and haemoglobin, RBC count, haematocrit with p values of 0.002, 0.003 and 0.003 respectively. In addition, the change in neutrophil counts, lymphocyte absolute counts and N:L ratio had significant association with different grades of D-dimer values (p-values of 0.013,0.010, and 0.001 respectively).

Parameters	Pearson correlation	p-value
Hb (g/dL)	-0.109	0.351
RBC count (million/mm³)	0.051	0.666
Haematocrit (L/L)	-0.053	0.652
MCV (f/L)	-0.175	0.134
MCH (pg per cell)	-0.246	**0.034**
MCHC (g/dL)	-0.224	0.054
RDW SD (f/L)	0.029	0.805
RDWCoV (%)	0.204	0.079
Platelet count (mcL)	0.202	0.083
MPV (fL)	0.081	0.490
PCRT (%)	0.263	**0.023**
PLT-LCR ratio (%)	0.065	0.580
Total WBC count (uL)	-0.050	0.671
Neutrophils (cells/uL)	-0.089	0.447
Lymphocytes (Cells/uL)	0.165	0.156
N:L Ratio	-0.121	0.303
Eosinophils (cells/mcL)	-0.047	0.691
Monocytes (Cells/uL)	-0.056	0.634
Basophils (cells/mcL)	-0.094	0.422
D-dimer (mg/L FEU)	-0.092	0.433

[Table/Fig-5]: Correlation of Fibrinogen with haematological parameters.
Statistical test used: Pearson's correlation test; Hb: Haemoglobin; MCV: Mean corpuscular volume; MCH: Mean corpuscular haemoglobin; MCHC: Mean corpuscular haemoglobin concentration; RDW-SD and RDW-CV: Red cell distribution width in standard deviation and coefficient of variation; MPV: Mean platelet volume; PCRT: Plateletcrit; PLT-LCR ratio: Platelet large cell ratio; N:L ratio: Neutrophil lymphocyte ratio

DISCUSSION

In the present study, the levels of D-dimer, fibrinogen and other haematological parameters in COVID-19 positive patients admitted in the isolation ward, of a tertiary care hospital, in Hyderabad were analysed. The patients were categorised into four categories viz., normal, mild, moderate, and severe based on the levels of D-dimer in blood. The stratification is performed because D-dimer is a well-established factor which helps in predicting the severity of the disease [2]. This is followed by the assessment of individual haematological parameters and their significance of association among distinct categories of patients with elevated D-dimer levels and fibrinogen levels.

Of 75 COVID-19 positive patients admitted in the hospital, haematological parameters namely, haemoglobin, Red Blood Cell (RBC) count, haematocrit, Mean Corpuscular Haemoglobin Concentration (MCHC), neutrophil counts, absolute lymphocyte counts, and neutrophil/lymphocyte ratio were significantly correlated with the values of D-dimer. There was a significant correlation between fibrinogen values with Mean Corpuscular Haemoglobin (MCH) and plateletcrit. Haematological parameters mentioned above not only correlated with the values of D-dimer but also showed significant association with varying grades of the disease based on the D-dimer values.

Viral infections like influenza, Human Immunodeficiency Virus (HIV), varicella, dengue along with the present pandemic SARS-COV2 infections can have laboratory abnormalities and haematological changes at various stages of infection help to monitor as well as suspect the severity of the disease.

A meta-analysis of four studies done by Lippi G et al., found, a significantly low concentration of haemoglobin in severe COVID-19 positive patients [3]. According to Cavezzi A et al., there is a possibility for haemoglobin denaturation and iron dysmetabolism in the pathogenesis of reduced haemoglobin in COVID-19 patients [4]. Rahman M.A. et.al, 2021 found a positive association among severe COVID-19 patients with haemoglobin, packed cell volume, Mean Corpuscular Volume

Parameters	D-dimer	N	Mean	Std. deviation	Median	IQR		p-value (Kruskall wallis test)
						25th	75th	
Hb (g/dL)	Normal	16	14.31	2.34	14.80	13.38	15.53	**0.002**
	Mild	18	13.78	2.80	13.85	12.30	15.65	
	Moderate	26	12.01	2.38	11.85	10.15	14.18	
	Severe	15	11.38	2.32	11.50	9.90	12.40	
RBC count (million/mm³)	Normal	16	4.92	0.65	4.97	4.53	5.38	**0.003**
	Mild	18	4.72	0.57	4.70	4.30	5.10	
	Moderate	26	4.23	0.76	4.17	3.70	4.93	
	Severe	15	4.10	0.74	4.12	3.70	4.70	
Haematocrit (L/L)	Normal	16	41.28	5.79	42.70	36.85	45.05	**0.003**
	Mild	18	40.62	7.32	40.40	37.53	45.50	
	Moderate	26	35.82	6.09	34.50	32.03	41.05	
	Severe	15	34.00	5.73	34.50	29.70	36.90	
MCV (f/L)	Normal	16	83.44	7.65	85.25	79.63	87.90	0.857
	Mild	18	85.32	9.36	85.55	81.43	91.33	
	Moderate	26	84.42	7.99	84.40	80.33	89.00	
	Severe	15	82.65	8.61	85.50	77.20	89.40	
MCH (pg per cell)	Normal	16	28.80	3.24	29.35	27.90	30.60	0.199
	Mild	18	28.90	3.79	29.40	27.70	31.53	
	Moderate	26	28.21	3.27	28.40	26.98	29.23	
	Severe	15	27.53	3.23	29.00	25.50	29.40	
MCHC (g/dL)	Normal	16	34.44	1.61	34.85	33.50	35.63	0.065
	Mild	18	33.79	1.46	34.45	33.13	34.90	
	Moderate	26	33.41	2.65	33.80	32.65	34.23	
	Severe	15	33.27	1.61	33.30	32.50	34.20	

RDW SD (f/L)	Normal	16	40.72	2.85	41.10	38.63	42.30	0.052
	Mild	18	43.89	3.28	43.60	41.38	46.63	
	Moderate	26	43.02	4.80	42.65	39.78	45.05	
	Severe	15	43.68	4.98	43.90	41.20	45.90	
RDWCoV (%)	Normal	16	13.83	1.48	13.45	13.20	13.70	0.077
	Mild	18	14.65	1.84	14.05	13.50	15.38	
	Moderate	26	14.68	1.83	14.25	13.08	16.35	
	Severe	15	15.09	1.77	14.60	14.00	16.20	

[Table/Fig-6]: Statistical analysis of red cell parameters with respect to stratified D-dimer levels.
Statistical test used: Kruskall wallis test; Hb: Haemoglobin; MCV: Mean corpuscular volume, MCH: Mean corpuscular haemoglobin; MCHC: Mean corpuscular haemoglobin concentration; RDW-SD and RDW-CV: Red cell distribution width in standard deviation and coefficient of variation

Parameters	D-dimer	N	Mean	Std. deviation	Median	IQR 25th	IQR 75th	p-value (Kruskall wallis test)
Platelet count (mcL)	Normal	16	2.41	0.92	2.60	1.85	2.90	0.768
	Mild	18	2.56	0.86	2.55	1.70	3.13	
	Moderate	26	2.84	1.46	2.40	1.75	3.45	
	Severe	15	2.27	1.12	2.00	1.60	3.40	
MPV (fL)	Normal	16	10.24	2.47	10.50	10.33	10.90	0.068
	Mild	18	10.89	0.63	10.95	10.48	11.43	
	Moderate	26	10.63	0.87	10.60	10.13	10.83	
	Severe	15	11.29	0.98	11.10	10.70	11.90	
PCRT (%)	Normal	16	0.27	0.09	0.28	0.20	0.33	0.956
	Mild	18	0.28	0.09	0.28	0.19	0.34	
	Moderate	26	0.28	0.14	0.26	0.18	0.37	
	Severe	15	0.27	0.10	0.27	0.20	0.30	
PLT-LCR ratio (%)	Normal	16	31.54	6.90	29.70	27.55	34.80	0.074
	Mild	18	31.79	4.78	32.05	28.45	35.85	
	Moderate	26	30.42	7.21	30.35	26.35	32.95	
	Severe	15	35.25	8.74	35.00	31.90	40.60	

[Table/Fig-7]: Statistical analysis of platelet parameters with respect to stratified D-dimer levels.
Statistical test used: Kruskall wallis test; MPV: Mean Platelet Volume; PCRT: Plateletcrit; PLT-LCR ratio: Platelet large cell ratio

Parameters	D-dimer	N	Mean	Std. deviation	Median	IQR 25th	IQR 75th	p-value (Kruskall wallis test)
Total WBC count (uL)	Normal	16	10493.75	3352.62	10210.00	8600.00	12970.00	0.147
	Mild	18	9398.33	4526.61	7405.00	6292.50	13142.50	
	Moderate	26	11276.92	4668.57	11050.00	6915.00	15632.50	
	Severe	15	13600.00	5501.87	12380.00	9130.00	18800.00	
Neutrophils (cells/uL)	Normal	16	7375.63	3666.66	6695.00	5452.50	8660.00	**0.013**
	Mild	18	7005.00	4300.05	5755.00	3597.50	12095.00	
	Moderate	26	8685.38	4512.09	7925.00	4440.00	12890.00	
	Severe	15	12085.00	5173.23	11040.00	8300.00	16000.00	
Lymphocytes (Cells/uL)	Normal	16	2323.13	1170.50	2275.00	1362.50	3040.00	**0.010**
	Mild	18	1986.11	1325.76	1800.00	965.00	2567.50	
	Moderate	26	2029.62	1485.56	1660.00	982.50	2512.50	
	Severe	15	1038.00	554.71	800.00	600.00	1490.00	
N:L ratio	Normal	16	5.16	6.12	2.41	1.62	4.96	**0.001**
	Mild	18	5.92	6.44	3.17	1.67	8.28	
	Moderate	26	7.03	6.53	5.34	2.24	9.40	
	Severe	15	14.48	8.69	13.14	6.69	19.84	
Eosinophils (cells/mcL)	Normal	16	335.63	724.46	140.00	37.50	275.00	0.066
	Mild	18	97.22	163.66	20.00	10.00	157.50	
	Moderate	26	91.15	128.01	50.00	10.00	120.00	
	Severe	15	62.00	94.66	10.00	10.00	100.00	
Monocytes (Cells/uL)	Normal	16	453.13	170.09	450.00	305.00	535.00	0.063
	Mild	18	296.67	170.26	290.00	170.00	462.50	
	Moderate	26	454.62	190.10	420.00	350.00	572.50	
	Severe	15	402.67	319.00	320.00	130.00	600.00	

Basophils (cells/mcL)	Normal	16	33.75	31.38	20.00	10.00	67.50	0.187
	Mild	18	21.11	17.37	10.00	10.00	30.00	
	Moderate	26	21.15	16.57	10.00	10.00	30.00	
	Severe	15	15.33	10.60	10.00	10.00	20.00	
Fibrinogen (mg/dL)	Normal	16	536.44	493.51	402.50	237.50	668.75	0.162
	Mild	18	1188.94	3233.40	323.00	234.50	770.00	
	Moderate	26	633.31	707.26	406.00	304.75	611.75	
	Severe	15	343.47	156.42	294.00	228.00	413.00	

[Table/Fig-8]: Statistical analysis of WBC parameters and fibrinogen with respect to stratified D-dimer levels.
Statistical test used: Kruskall wallis test; N:L ratio: Neutrophil lymphocyte ratio

(MCV) [5]. In the present study, it was found that there was a significant association of haemoglobin, haematocrit, and RBC count with the D-dimer values of varying grades of severity of the disease based on the levels of D-dimer.

Numerous studiessuch as Huang C et al., Wang D et al., Wu C et al., Fan BE et al., Young BE et al., and Arentz M et al., showed significant correlation between the lymphocyte counts and severity of the disease among the COVID-19 patients who needed ICU care [6-11]. A meta-analysis performed by Yang H et al., found association between lymphocyte counts, neutrophil counts, neutrophil/lymphocyte ratio and severe COVID-19 positive patients needing ICU care, thus suggesting the use of these parameters as markers for severity of the disease [12].

Rahman A et al., found common haematological abnormalities in COVID-19 disease as lymphocyte counts, elevated D-dimer levels and thrombocytopenia which can serve as possible biomarkers for the disease [13]. Huan I et al., and Yan X et al., suggested association between haematological parameters like lymphocyte counts, neutrophil counts, neutrophil/lymphocyte ratio in COVID-19 patients with the severity of disease [14,15]. Study done by Amer SA et al., analysed the outcomes of COVID-19 infection such as disease severity, ICU admission, and mortality all of which found to be significantly correlated to Neutrophil lymphocyte ratio [16]. Meta-analysis of 18 studies done by Shah S et al., 2020 assessed the relationship between levels of D-dimer with the grades of severity of the disease [17]. The present study correlated well with the most of above-mentioned studies on the association of haematological parameters with the severity of the disease.

A special note on peripheral smear finding of these COVID-19 patients, showed neutrophils with densely vacuolated cytoplasm, analogous to mott cells in the bone marrow of myeloma patients. In addition, there were giant platelets, platelet aggregates which showed spurious thrombocytopenia on counters. A manual count was preferred for these patients. There were reactive lymphocytes seen, similar to a dengue like picture in some patients. Interestingly, apoptotic neutrophils were prominently noted in severely ill patients. Those patients who had increased haematocrit, showed smears with closely populated RBCs at places forming agglutination.

In a study done by Kaur G et al., few morphologic findings seen in peripheral smear were neutrophils bearing clumped nuclear chromatin, anisokaryosis, pseudo Pelger-Huet anomaly, lymphoplasmacytoid lymphocytes, activated monocytes with cytoplasmic vacuolation, and platelet clumping [18].

In a study by Bahadur S et al., the authors studied the peripheral blood picture of COVID-19 patients and found that complete blood count with peripheral smear analysis provided only a partial support in understanding disease pathogenesis [19]. On the contrary Gabr H et al., in their study, on changes in peripheral blood parameters in COVID-19 patients found a significant change in morphology in COVID-19 patients which can be used to assess the severity of disease [20].

Limitation(s)

In the present study the clinical assessment parameters were not included. Instead, the stratification levels of D-dimer were directly taken as an attempt to assess the severity of the disease.

CONCLUSION(S)

Assessment of haematological parameters can be of a valuable tool in finding the severity of COVID-19 infection, thereby helping the clinician in formulating risk stratification and prognostic work up of these patients.

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