

# White Blood Cells Morphology in COVID-19 Infection

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**Abstract:** Background: To study the clinical significance of morphological changes in peripheral blood smear of COVID-19 infected patients. Aim: To determine the morphological changes in WBC series in COVID-19 infected patients. Material and Methods: The present study carried out in covid laboratory, Department Pathology, B.J Medical college, Ahmedabad during January 2022 to March 2022. Peripheral blood is drawn from all COVID-19 infected patients from OPD and IPD under aseptic precautions in EDTA container. Results: All COVID-19 infected patients show striking morphological changes as well as WBC count according to severity of disease. More severe the disease more significant Neutrophillia and Lymphopenia. Conclusions: According to severity of disease COVID-19 has significant effects on WBC count and their morphology.

**Keywords:** COVID-19, Neutrophillia, Lymphopenia, Atypical Lymphocytes, Peripheral blood, cytoplasmic vacuolations.

## 1. Introduction

In mid of 2019, a new corona virus- related disease called COVID-19 emerged from Wuhan, China. This disease spread quickly and became a pandemic disease in a few days. More than 2 million deaths have been reported from all over world in COVID-19 and research on this subject turned to be the priority of many countries' health system (1). Symptoms related to respiratory systems are the most common presentation like cold, cough, running nose, fever, body ache, difficulty in breathing etc. COVID-19 affects many other organs as well (2). Radiological and Pathological investigations are the useful for diagnose and treatment the COVID-19 infection.

Blood investigation is simplest, easiest and cheapest available method in COVID-19 patients. Peripheral blood smear are use to see various morphological changes in blood cells including Neutrophils, Lymphocytes, Monocytes. (3).

## 2. Material and Method

The study included 100 patients with COVID-19 positive admitted at 1200 bed covid hospital, B.J Medical College and civil hospital, Ahmedabad from January 2022 to March 2022. 31 patients were admitted to ICU and 69 patients were admitted to non-ICU. Routine CBC and WBC differential was performed on COVID-19 diagnosed patients (confirmed by SARS-coV reverse transcription polymerase chain reaction) on admission date on HORIBA PENTRA XLR-five parts as a part of routine clinical care. The parameters

were standardized by routine and internal quality control done as per our laboratory protocols. WBCs morphology was studied on giemsa stained peripheral smear under oil immersion. The smears were made and stained within two hours of receiving the sample. Smears of healthy individuals were also used for reference.

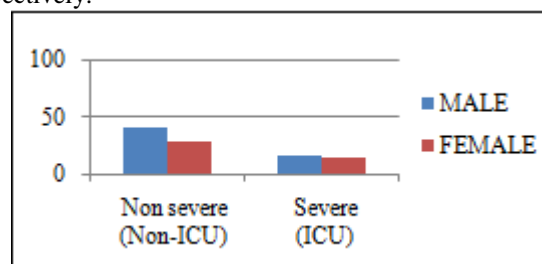
**Inclusion criteria:** All RT-PCR / Rapid antigen test (RAT) kit COVID-19 positive patients above 18 years of age

**Exclusion criteria:** Known cases of WBC disorders and haematological malignancies.

## 3. Observation and Result

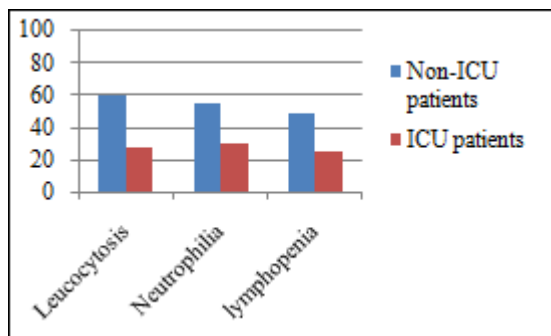
Severity of disease	Male	Female
Non severe (Non-ICU)	41	28
Severe (ICU)	17	14

A total 100 cases were included. A male: female ratio in non-ICU and ICU patients were 1.5:1 and 1.14:1 respectively.



**Most Common Findings:**

	Non-ICU patients	ICU patients
Leucocytosis (>11x10 <sup>6</sup> /L)	60	27
Neutrophilia(>8x10 <sup>6</sup> /L)	55	30
Lymphopenia(<10x10 <sup>6</sup> /L)	49	25



Toxic granulations and hypergranular cells	2	4	3
	3	0	1
	0	33	13
	1	11	11
Hypogranular cells	2	18	4
	3	7	3
	0	68	31
	1	1	0
Myeloid shift	2	0	0
	3	0	0
	0	45	17
	1	12	9
	2	8	5
	3	4	0

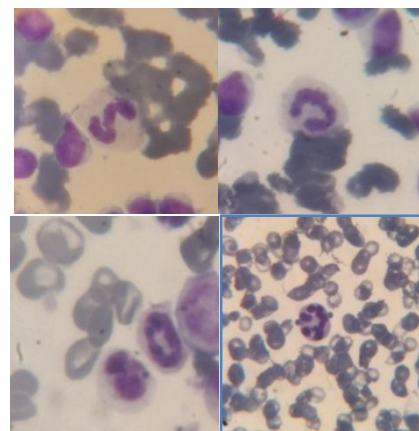
- Grade 0 – No changes
- Grade 1- changes in <10% of cells
- Grade 2 – changes in 11-25 % of cells
- Grade 3 - >25% of cells

**WBC Quantitative Parameters:**

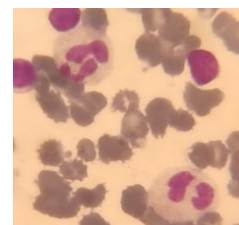
Leucocytosis(87%), Neutrophilia(85%) and lymphopenia(74%) are the most common findings in covid-19 patients, but they are most significant in ICU patients. Eosinophils, Monocytes and basophils -WBC lineages show no significant changes in this study.

**Morphological Changes in WBC Series:**

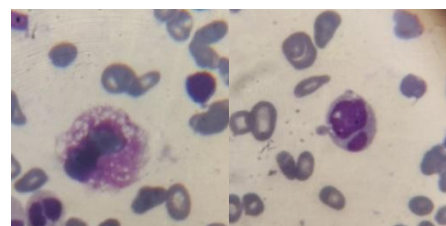
Neutrophils	lymphocytes	Monocytes
Abnormal nuclear shapes –ring shape/ C shape/blebbing of nucleus	Larger lymphocytes	Cytoplasmic vacuolations
Pseudo-pelger-huet like anomaly	Granular lymphocytes	Nuclear blebbing
Cytoplasmic vacuolations	Atypical lymphocytes	Granular monocytes
Toxic granulations and hypergranular cells	Cytoplasmic vacuolations	
Hypogranular cells		
Myeloid shift		



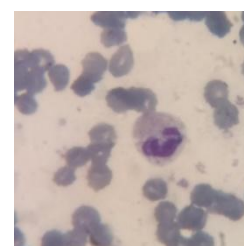
**Abnormal Nuclear shapes**



**Pseudo-pelger-huet like anomaly**



**Cytoplasmic vacuolations**



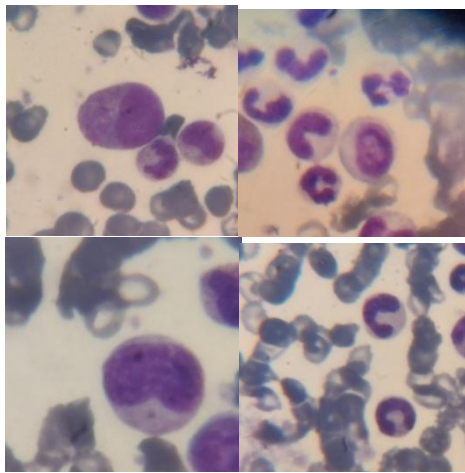
**Hypogranular cells**

**WBC Morphology:**

**Neutrophils:**

Morphological changes in Neutrophils was most common changes seen in covid-19 patients. Toxic granulations and hypergranularity were most common findings followed by abnormal nuclear shapes –ring shape/ C shape in non-ICU as well as in ICU patients. Myeloid shift (Myelocytes, Metamyelocytes, Band cells) and cytoplasmic vacuolations were also seen in some cases. Pseudo-pelger-huet like anomaly and hypogranular cells were least common findings.

Morphological changes in neutrophils			
	Clinical severity grade	Non-ICU patients	ICU patients
Abnormal nuclear shapes –ring shape/ C shape	0	41	18
	1	21	9
	2	5	3
	3	2	1
Pseudo-pelger-huet like anomaly	0	66	31
	1	3	0
	2	0	0
Cytoplasmic vacuolations	3	0	0
	0	53	19
	1	12	8

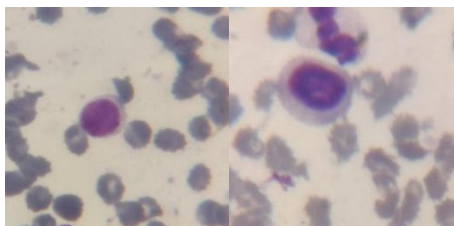


Myeloid shift

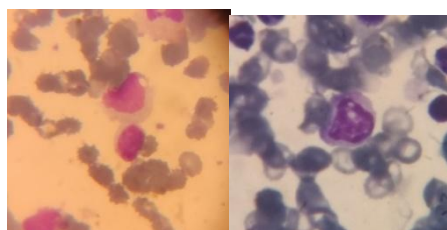
**Lymphocytes:**

Atypical lymphocytes were the most common change followed by larger lymphocytes and cytoplasmic vacuolations in non-ICU patients where as larger lymphocytes were most common change in ICU admitted patients. Granular lymphocytes were least common finding seen.

Morphological changes in lymphocytes			
	Clinical severity grade	Non-ICU patients	ICU patients
Larger lymphocytes	0	59	26
	1	10	4
	2	0	1
	3	0	0
Granular lymphocytes	0	69	31
	1	0	0
	2	0	0
	3	0	0
Atypical lymphocytes	0	47	27
	1	15	4
	2	7	0
	3	0	0
Cytoplasmic vacuolations	0	58	29
	1	9	2
	2	2	0
	3	0	0



Larger lymphocytes    A typical lymphocytes

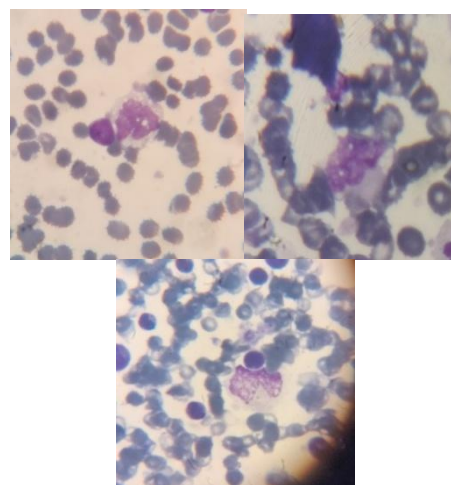


Cytoplasmic vacuolations

**Monocytes:**

Cytoplasmic vacuolations was the most common finding in non-ICU as well as in ICU patients of covid-19. Granular monocytes and nuclear blebbing were rare findings.

Morphological changes in monocytes			
	Clinical severity grade	Non-ICU patients	Non-ICU patients
Cytoplasmic vacuolations	0	63	27
	1	6	4
	2	0	0
	3	0	0
Nuclear blebbing	0	69	31
	1	0	0
	2	0	0
	3	0	0
Granular monocytes	0	69	31
	1	0	0
	2	0	0
	3	0	0



Cytoplasmic vacuolations

**4. Discussion**

COVID-19 has significant impact on blood cell counts and its morphology. Real time RT-PCR is gold standard investigation for COVID-19. Other investigations like of SpO2, radiological imaging, pulmonary function tests etc are also use. Automated haematology analyzer is also helpful in diagnosis and management of COVID-19 infection. Despite the use of automation, microscopic evaluation is one of the tool for morphological grading of blood cells. Here my study is on grading based on morphology of WBC series on COVID-19 affected patients and comparison of these data between non-ICU and ICU admitted COVID-19 positive patients.

A study by Pozdnyakova O et al. shows significant changes in WBCs of COVID-19 patients. ICU admitted patients had significant leucocytosis with Neutrophilia, similar to our study. They also found that these patients were lymphopenia which was also statistically significant in our study. Toxic granulation was most common finding in our study where as cytoplasmic vacuolation were most common finding in Pozdnyakova study (1).

NIDHA GAFFOOR, et al., study leucocytosis with Neutrophilia was most striking feature just like our study, but pseudo-pelger-huet anomalies is significant in their study but not in our study (7)

In Fan BE et al. study, the most common haematological findings were lymphopenia, neutrophilia, eosinopenia, mild thrombocytopenia while in present study, WBCs show significant leucocytosis and neutrophilia.(2) AnupamMitra et al., study leucocytosis with left shifted WBC series seen like in our study (5).

In the study done by Weinberg SE et al., morphological changes seen reported in lymphocytes were 1) presence of medium to large size atypical lymphocytes 2) Atypical cells of plasmacytoid morphology with eccentric nuclei,

perinuclearhoff some mimicking blasts. But the percentage of atypical lymphocytes did not correlate with the severity of the disease in this study, unlike our study(3). Zini G et al., noticed abnormalities of nuclear segmentation, pseudo-pelger-huet morphology, which was also seen in our study(4). Monocytes demonstrated the cytoplasmic vacuolisation in patients with severe cases as compared to the non severe cases in our study.

In Nath D, Madan U, et al., study Neutrophils were features like hypolobation, ring shaped polymorph nucleus, cytoplasmic vacuoles, coarse granules mimicking toxic granules and some hypogranular polymorph and Eosinophils did not show any relevant morphological changes like in our study(6).

Characteristics	Non-ICU				ICU			
	Grade 0		Grade ≥1		Grade 0		Grade ≥1	
	Olga Pozdnyakova study (Non-ICU=39)	Present study	Olga Pozdnyakova study (ICU=51)	Present study	Olga Pozdnyakova study (Non-ICU=39)	Present study	Olga Pozdnyakova study (ICU=51)	Present study
<b>NEUTROPHILS MORPHOLOGY COMPARISON</b>								
Cytoplasmic vacuolations	7	53	32	16	8	19	43	12
Toxic granulations and hypergranular cells	2	33	37	36	1	13	50	18
Myeloid shift	26	45	13	24	20	17	31	14
<b>LYMPHOCYTES MORPHOLOGY COMPARISON</b>								
Cytoplasmic vacuolations	12	58	27	11	22	29	29	2
Atypical Lymphocytes	13	47	26		36	27	15	4
Large Lymphocytes	4	59	35	10	9	26	42	5
<b>MONOCYTES MORPHOLOGY COMPARISON</b>								
Cytoplasmic vacuolations	5	63	34	6	21	27	30	4

Characteristics	Non-ICU				ICU			
	Grade 0		Grade ≥1		Grade 0		Grade ≥1	
	NIDHA GAFFOOR (n=120, Non-ICU=61)	Present study	NIDHA GAFFOOR (n=120, Non-ICU=61)	Present study	NIDHA GAFFOOR (n=120, ICU=59)	Present study	NIDHA GAFFOOR (n=120, ICU=59)	Present study
<b>NEUTROPHILS MORPHOLOGY COMPARISON</b>								
Abnormal nuclear shapes –ring shape/ C shape/blebbing of nucleus	7	41	54	28	0	18	59	13
Pseudo-pelger-huet like anomaly	5	66	56	3	1	31	58	0
Cytoplasmic vacuolations	20	53	41	16	16	19	43	12
Toxic granulations and hypergranular cells	47	33	14	36	48	13	11	18
Hypogranular cells	9	68	52	1	6	31	53	0
Myeloid shift	18	45	43	24	18	17	41	14
<b>LYMPHOCYTES MORPHOLOGY COMPARISON</b>								
Larger lymphocytes	24	59	37	10	13	26	46	5
Granular lymphocytes	24	69	37	0	13	31	46	0
Atypical lymphocytes	23	47	38	22	27	27	32	4
Cytoplasmic vacuolations	40	58	21	11	40	29	30	2
<b>MONOCYTES MORPHOLOGY COMPARISON</b>								
Cytoplasmic vacuolations	14	63	47	6	6	27	53	4

Nuclear blebbing	27	69	34	0	18	31	41	0
Granular monocytes	21	69	40	0	11	31	48	0

## 5. Conclusion

COVID-19 has significant impact on WBC count and their morphology according to severity of disease. These can be helpful in COVID-19 infected patient's management and risk stratification along with other lab investigations.

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