Original Article

Hematological Profile in HIV-Positive Patients: A Cross-Sectional Analysis from a Tertiary Care Centre

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Abstract

Background: Hematological abnormalities are common in human immunodeficiency virus (HIV) infection and are influenced by disease stage, opportunistic infections, and antiretroviral therapy (ART). Assessment of hematological parameters offers valuable insights for clinical management and prognosis, particularly in resource-limited settings. **Material and Methods:** This prospective, longitudinal study was conducted over 18 months at a tertiary care centre, enrolling 100 newly diagnosed HIV-positive patients before ART initiation. Patients already on ART, pregnant women, and those with malignancy were excluded. Baseline evaluations included hemoglobin, blood indices, total and differential leukocyte counts, platelet count, and CD4+ cell count. The same parameters were reassessed after six months of ART. Data were analysed using appropriate statistical tests, with $p < 0.05$ considered significant. **Results:** The cohort comprised 64% males and 36% females, with the largest age group being 30–39 years (37%). Most participants were married (77%) and had only primary (46%) or secondary (33%) education. Common occupations included non-agricultural labour (22%), housework (21%), and private employment (20%). After six months of ART, significant improvements were observed in hemoglobin (11.59 ± 2.44 to 12.43 ± 1.90 g/dL; $p < 0.0001$), mean corpuscular volume (84.15 ± 11.78 to 91.08 ± 11.10 fL; $p < 0.0001$), absolute lymphocyte count ($p = 0.0028$), platelet count ($p = 0.0084$), and CD4+ count (323.8 ± 254.02 to 465.02 ± 259.15 cells/mm³; $p < 0.0001$). Absolute monocyte count showed a significant decline ($p = 0.0163$). Total leukocyte, neutrophil, and eosinophil counts remained statistically unchanged. **Conclusion:** Hematological abnormalities are frequent in HIV infection at diagnosis. ART leads to significant improvements in several hematological parameters, particularly hemoglobin levels, lymphocyte count, platelet count, and CD4+ levels, underscoring its role in immune restoration.

Keywords: HIV, hematological profile, anemia, CD4 count, antiretroviral therapy.

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Introduction

Human immunodeficiency virus (HIV) infection remains a major global health concern, with India ranking third in terms of disease burden, harbouring an estimated 2.14 million people living with HIV and reporting approximately 87,000 new infections and 69,000 AIDS-related deaths annually.[1] HIV is the most common cause of acquired immunodeficiency, ultimately progressing to acquired immunodeficiency syndrome (AIDS) if untreated.[2] The hallmark of HIV infection is a progressive decline in CD4+ T lymphocytes, leading to immune dysfunction and increased susceptibility to opportunistic infections and malignancies.[3]

Hematological abnormalities are among the most frequent complications in HIV-infected individuals and may occur at any stage of the disease.[4] These changes, including anemia, leukopenia, and thrombocytopenia, can arise from the direct effects of the virus, secondary infections, malignancies, nutritional deficiencies, or as adverse effects of antiretroviral therapy (ART).[5] Anemia is the most common hematological manifestation, affecting more than 70% of patients during the disease course, and is associated with disease progression, poor ART response, and increased mortality.[6] Leukopenia and neutropenia have also been reported in up to 70% of patients with advanced HIV infection, while thrombocytopenia may occur in 3–40% of cases.[4-7]

In resource-limited settings, monitoring hematological parameters offers a cost-effective tool for evaluating disease status and guiding therapy, as these indices often correlate with CD4+ counts.[5,8] ART has been shown to improve immune function and reverse many HIV-related hematological changes.[9] Understanding the baseline hematological profile in newly diagnosed patients and its correlation with CD4 counts is crucial for optimising patient care, initiating timely interventions, and predicting outcomes.

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The present study aims to assess the hematological profile of newly diagnosed HIV-positive patients attending a tertiary care centre and to evaluate changes in these parameters following six months of ART.

Materials and Methods

Study Design and Setting: This was a prospective, longitudinal study conducted over 18 months at the Antiretroviral Therapy (ART) Centre of a tertiary care hospital.

Study Population: A total of 100 newly diagnosed HIV-positive patients were enrolled. Inclusion criteria comprised adults diagnosed with HIV infection and not yet initiated on ART. Exclusion criteria included individuals already receiving ART, pregnant women, those declining treatment, patients with known malignancies, and individuals who did not provide informed consent.

Data Collection: Baseline demographic details, including age, gender, marital status, educational level, and occupation, were recorded. Clinical data included HIV status confirmation, complete blood counts (CBC), and CD4+ T-cell counts at diagnosis. These investigations were repeated six months after the initiation of ART.

Laboratory Procedures: For hematological analysis, 3–5 mL of EDTA-anticoagulated venous blood was collected by trained laboratory personnel. CBC, including red cell indices, total leukocyte count, and differential counts, was performed using a 5-part automated hematology analyser (Beckman Coulter DxH 800), which employs the Volume, Conductivity, and Scatter (VCS) technology for cell characterization.[10]

Platelet counts were recorded from the same analyzer. CD4+ T-cell enumeration was conducted using a BD FACSPresto™ automated analyser, which operates on flow cytometry principles. Samples for CD4 counts were obtained either by venipuncture or finger-prick, processed according to manufacturer guidelines, and analysed within the recommended time frame.

Statistical Analysis: Data were entered into Microsoft Excel and analysed using appropriate statistical methods. Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. The paired t-test was used to compare pre- and post-ART hematological parameters. A p-value of <0.05 was considered statistically significant.

Results

The highest proportion of participants was in the 30–39-year age group (37%), followed by 40–49 years (27%). The lowest representation was among those aged ≥60 years (5%). Across all age categories, males predominated except in the ≥60-year group, where females constituted the majority [Table 1].

Table 1: Distribution of study cases according to age and gender

Age (years)	Gender				Total	
	Male		Female			
	Number	Percentage	Number	Percentage	Number	Percentage
18-29	12	12	07	07	19	19
30-39	24	24	13	13	37	37
40-49	15	15	12	12	27	27
50-59	12	12	00	00	12	12
≥60	01	01	04	04	05	05
Total	64	64	36	36	100	100

Most participants were married (77%), with smaller proportions being widowed (13%), single (7%), or divorced (3%). Regarding education, nearly half (46%) had only primary schooling, while 33% had completed secondary school, 15% were illiterate, and 6% had attended college [Table 2].

Table 2: Marital and educational status of patients.

Marital and educational status		Number	Percentage (%)
Marital status	Single	7	7
	Married	77	77
	Divorced	3	3
	Widow	13	13
Educational status	Illiterate	15	15
	Primary school	46	46
	Secondary school	33	33
	College	6	6

The most common occupations were non-agricultural labour (22%), private sector employment (20%), and housework (21%). All housewives were female, whereas truck driving, private service, and non-agricultural labour were predominantly male occupations [Table 3].

Table 3: Occupational status of patients

Occupational status	Male		Female		Total	
	Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)
Truck driver	10	10	0	0	10	10
Student	1	1	1	1	2	2
Government service	5	5	1	1	6	6
Small business	6	6	1	1	7	7

Agricultural laborers	5	5	1	1	6	6
Unemployed	5	5	1	1	6	6
Housewife	0	0	21	21	21	21
Private service	18	18	2	2	20	20
Non-agricultural laborers	14	14	8	8	22	22

At baseline, the mean hemoglobin concentration was 11.59 ± 2.44 g/dL, which increased significantly to 12.43 ± 1.90 g/dL after six months of antiretroviral therapy ($p < 0.0001$). Mean corpuscular volume (MCV) rose from 84.15 ± 11.78 fL to 91.08 ± 11.10 fL ($p < 0.0001$). Significant increases were also observed in absolute lymphocyte count (1797.46 ± 807.60 to 2057.02 ± 742.88 cells/µL; $p = 0.0028$), platelet count (245.19 ± 87.47 to 268.82 ± 83.20 × 10^9/L; $p = 0.0084$), and CD4+ count (323.8 ± 254.02 to 465.02 ± 259.15 cells/mm^3; $p < 0.0001$). In contrast, total leukocyte count, absolute neutrophil count, and absolute eosinophil count did not change significantly over the study period. Absolute monocyte count showed a modest but statistically significant decline (609.45 ± 283.24 to 533.23 ± 235.41 cells/µL; $p = 0.0163$), while basophils were absent in all samples at both time points [Table 4].

Table 4: Comparison of haematological parameters before and after treatment

Haematological parameters	At the time of diagnosis		After 6 months of treatment		P- value
	Mean	SD	Mean	SD	
Haemoglobin(g/dl)	11.59	2.44	12.43	1.90	<0.0001
Mean corpuscular volume (fl)	84.15	11.78	91.08	11.10	<0.0001
Total leukocyte counts (/µL)	6567	2233.22	6743.5	2171.15	0.5238
Absolute neutrophil counts (/µL)	3946.35	1986.53	3947.45	1871.52	0.9967
Absolute lymphocyte counts (/µL)	1797.46	807.60	2057.02	742.88	0.0028
Absolute monocyte counts (/µL)	609.45	283.24	533.23	235.41	0.0163
Absolute eosinophil counts (/µL)	213.74	211.06	205.8	175.71	0.7688
Absolute basophil counts (/µL)	0	0	0	0	0
Total platelet counts (/µL)	245.19	87.47	268.82	83.20	0.0084
CD4 counts (cells/mm3)	323.8	254.02	465.02	259.15	<0.0001

Discussion

The present study evaluated the hematological profile of newly diagnosed HIV-positive patients and the changes observed after six months of antiretroviral therapy (ART). Hematological abnormalities were frequent at baseline, with anemia being the most common finding, followed by lymphopenia and thrombocytopenia. These observations are consistent with earlier studies reporting anemia prevalence rates ranging from 31% to over 90% among HIV-infected individuals, depending on disease stage and study population. [11,12]

Anemia in HIV infection is multifactorial, arising from bone marrow suppression by the virus, chronic inflammation, nutritional deficiencies, opportunistic infections, and myelotoxic drug use.[13] In our study, hemoglobin levels improved significantly after ART initiation, aligning with reports that effective viral suppression and immune reconstitution can reverse HIV-related anemia.[14,15] Macrocytosis, reflected by increased mean corpuscular volume (MCV) after therapy, is a known effect of certain ART drugs, particularly zidovudine.[16]

Lymphopenia was the second most common abnormality, occurring in 42% of patients at diagnosis. This reduction primarily reflects CD4+ T-cell depletion, the hallmark of HIV pathogenesis. [17] Following ART, there was a significant rise in absolute lymphocyte counts and CD4+ levels, confirming the therapy's role in immune restoration. Similar immune recovery patterns have been documented in other studies.[14,18]

Thrombocytopenia was present in a smaller proportion of patients but improved with treatment. Immune-mediated platelet destruction and impaired production are the primary mechanisms in HIV-associated thrombocytopenia.[19] The significant increase in platelet counts after ART supports its role in reducing immune-mediated platelet clearance and enhancing megakaryocyte function.

In contrast, total leukocyte count, neutrophil count, and eosinophil count showed no significant change post-therapy. This finding suggests that some hematological alterations may be influenced by factors other than HIV replication, such as co-infections, nutritional status, or drug effects.[13,20]

Overall, our results reinforce the utility of hematological parameters—particularly hemoglobin, lymphocyte count, platelet count, and CD4+ levels—as cost-effective markers for monitoring HIV disease progression and treatment response, especially in resource-limited settings.

Conclusion

In this study, anemia was the most frequent hematological abnormality in newly diagnosed HIV-positive patients, followed by lymphopenia and thrombocytopenia. After six months of ART, there was a statistically significant improvement in key hematological parameters. These findings indicate that ART has a beneficial effect on several hematological parameters, reflecting immune recovery, although some abnormalities may persist. Regular assessment of hematological indices, alongside CD4+ counts, is essential for monitoring disease progression and treatment response in HIV-infected individuals.

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Conflicts of interest

There are no conflicts of interest.

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