

Original Research Article

A comparative study between peripheral blood smears, RBC indices and histograms in anemia in the geriatric age group

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ABSTRACT

Background: Hematological evaluation in geriatric age group is essential, as anemia and red cell disorders contribute significantly to morbidity and mortality. Overlap between symptoms of anemia and features of natural aging make its diagnosis in the elderly difficult. This study was done to compare the diagnostic utility of peripheral blood smears, RBC indices, and histograms in evaluating anemia in the geriatric age group.

Methods: This was a comparative study done on 298 cases of anemia for a period of 1 year from February 2024 to January 2025 in a tertiary care teaching hospital. Blood samples were examined using microscopy for peripheral blood smears, automated hematology analyzers for RBC indices and histogram interpretation. Findings were noted and analyzed.

Results: Out of 298 cases, across the different diagnostic methods (peripheral blood smear, RBC indices and RBC histograms), normocytic normochromic anemia was the most common type (62.4-67.40%), followed by microcytic hypochromic anemia (27.20-29.50%), macrocytic anemia (4.70-5.40%), hemolytic anemia (2%) and dimorphic anemia (1.30%).

Conclusions: The many forms of anemia can only be diagnosed using peripheral smear, RBC indices and histogram. A combined approach using PBS, RBC indices, and histograms ensures greater diagnostic accuracy in geriatric patients, where anemia is often multi-factorial and can mimic natural aging.

Keywords: Anemia, Geriatric, Histogram, Peripheral smear, RBC indices

INTRODUCTION

Anemia in geriatric population is important because the common presenting symptoms of anemia, like fatigue, breathlessness and generalized weakness often mimic features of the physiological aging process and hence are easy to overlook. This makes the early diagnosis of anemia in geriatric population difficult, ultimately leading to increased mortality and morbidity due to complications associated with delayed diagnosis of anemia.¹ Other comorbid conditions such as diabetes, hypertension, renal

disease and malignancies may worsen the anemic condition.

Increasing functional deterioration is associated with decreasing hemoglobin concentration in an inverse manner. Thus, the finding of even mild anemia in an elderly patient may be a good reason to investigate the cause and consider appropriate intervention. There is a lack of literature on anemia in the elderly age group.

Laboratory investigations, including a complete blood count (CBC), histogram and peripheral blood smear are

important for ensuring the quality of blood count results and for diagnosing anemia. Hematology analyzers generate RBC indices- MCV, MCH, MCHC, which help in categorization of anemia into microcytic, macrocytic, or normocytic anemia. These values are graphically displayed in the form of RBC histogram, also generated by automated hematology analyzers. RBC histograms reflect the size of the erythrocytes or any other particle in the erythrocyte size range.² A microscopic analysis of the peripheral blood smear provides valuable knowledge about the variation of the shape and size of RBCs or the presence of any inclusion bodies which cannot be properly identified by RBC indices or histograms.

This study was conducted in our institute to see the patterns of anemia in the geriatric population, as well as to understand the importance of CBC parameters- RBC indices, histograms and peripheral blood smears and how they compare and correlate with each other.

METHODS

This study was conducted in the department of pathology at Jawahar Lal Nehru Medical College and Associated group of hospitals, Ajmer (Rajasthan) from February 2024 to January 2025. 298 patients 60 years and above having hemoglobin level less than 12 gm/dl were included in this study. The relevant history and clinical information were recorded and informed consent was taken.

Exclusion criteria

Patients with age <60 years. Patients with hemoglobin >12 gm/dl. Patients with lack of clinical details.

Venous blood samples collected in EDTA vials were taken up for complete hemograms- analyzed by 5 part or 6 part automated cell counters.

Depending upon availability, venous blood collected in EDTA vials/finger prick were taken for peripheral blood smear. Finger prick peripheral smears were preferred over

venous blood smears. The smears were then stained by Leishmann stain and examined under a light microscope.

Histograms are generated automatically by the automated cell counters. Comparison was done between, RBC indices, histograms and peripheral smear findings.

Statistical analysis was done using SPSS v25.

RESULTS

The study included 298 geriatric patients, with a majority (63.10%) in the 60-70 age range. The female population (159) was slightly higher than the male population (139), with females dominating in the 60-70 years and 81-90 years age groups. The age distribution showed a decline in the number of patients with increasing age, with 28.18% in the 71-80 age range, 8.05% in the 81-90 age range, and only 0.67% above 90 years.

Table 1: Distribution of case as per age and sex.

Age range (years)	Male	Female	Total	Percent
60-70	84	104	188	63.10
71-80	44	40	84	28.18
81-90	10	14	24	8.05
>90	1	1	2	0.67
Total	139	159	298	100.00

The comparison of anemia types across different diagnostic methods showed that normocytic normochromic anemia was the most common type, consistently occurring around 62.4-67.40% across peripheral blood smear, RBC indices, and histogram analysis. Microcytic hypochromic anemia was the second most common, with 27.20-29.50% across the different methods. Macrocytic anemia was consistently low with 4.70-5.40% across all three diagnostic methods. Hemolytic anemia detected by peripheral blood smear was 2%, while dimorphic anemia detected by both peripheral blood smear and histogram analysis was 1.30%.

Table 2: Comparison of diagnosis between PBS, RBC indices and histogram.

Type of anemia	Peripheral blood smear		RBC Indices		Histogram	
	N	%	N	%	N	%
Normocytic normochromic	186	62.40	201	67.40	197	66.10
Microcytic hypochromic	88	29.50	81	27.20	81	27.20
Macrocytic	14	4.70	16	5.40	16	5.40
Hemolytic	6	2.00	0	0.00	0	0.00
Dimorphic	4	1.30	0	0.00	4	1.30
Total	298	100	298	100	298	100

Table 3: Severity of anemia.

Grading of anemia on basis of severity	Male	Female	Total	%
Mild (10-11.9 gm/dl)	80	89	169	56.70
Moderate (7-10 gm/dl)	52	52	104	34.90
Severe (<7 gm/dl)	7	18	25	8.40
Total	139	159	298	100.00

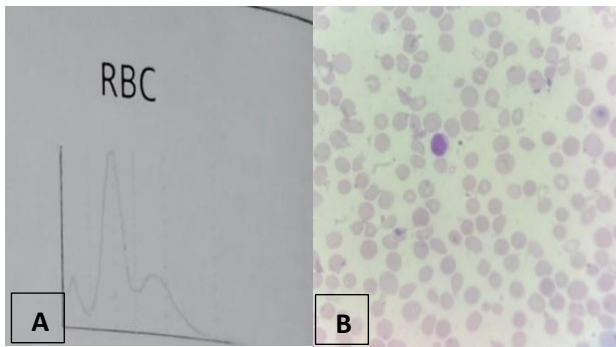


Figure 1: (A) RBC histogram shows bimodal curve and (B) peripheral blood smear shows dimorphic anemia.

The grading of anemia based on severity showed that mild anemia was the most common affecting 169 cases (56.70% of the total). The distribution of anemia severity was similar between males and females, with mild anemia being the most common in both groups. However, females had a slightly higher proportion of severe anemia (18 cases of females versus 7 cases of males).³

Table 4: Distribution of types of anemia based on PBS and RBC indices.

Type of anemia	PBS N (%)	RBC indices N (%)
Microcytic	88 (29.5)	81 (27.2)
Normocytic	186 (62.4)	201 (67.4)
Macrocytic	14 (4.7)	16 (5.4)
Hemolytic	6 (2.0)	0
Dimorphic	4 (1.3)	0
Total	298 (100)	298 (100)

Table 5: Agreement between PBS and RBC indices.

PBS	RBC indices			
	Micro	Normo	Macro	Total
Microcytic	74	14	0	88
Normocytic	5	181	0	186
Macrocytic	0	0	14	14
Hemolytic	0	5	1	6
Dimorphic	2	1	1	4
Total	81	201	16	298

Agreement between peripheral blood smear and RBC indices was assessed using Cohen’s Kappa test. The analysis showed a Po value of 0.90 and Pe value of 0.56, giving Kappa value of 0.78 (p<0.001), indicating substantial agreement between the two methods.

Sensitivity was highest for macrocytic anemia (100%), followed by normocytic (97.3%) and microcytic anemia (84.1%). Specificity was 95% for microcytic and macrocytic anemia. Positive and negative predictive values were also high, suggesting reliable classification by RBC indices.

Table 6: Diagnostic accuracy of RBC indices.

Type of anemia	TP	FN	FP	TN	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Microcytic	74	14	7	203	84.1	96.7	91.4	93.5
Normocytic	181	5	20	92	97.3	82.1	90.0	95.8
Macrocytic	14	0	2	282	100.0	99.3	87.5	100.0

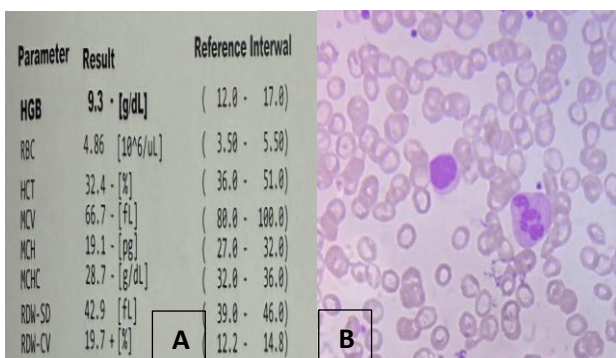


Figure 2: (A) RBC indices show low MCV and MCH value and (B) peripheral blood smear shows microcytic hypochromic anemia.

DISCUSSION

Anemia in the geriatric population is a highly prevalent yet frequently under-recognized clinical condition. Although reduced hemoglobin levels are often dismissed as an expected consequence of aging, current evidence strongly challenges this misconception. Anemia commonly reflects underlying pathology and its symptoms including fatigue, malaise, weakness etc. are non-specific and often overlap with the normal aging process, contributing to delayed diagnosis and under-reporting.⁴

Geriatric health is complex and the nature of anemia is multi-factorial, which emphasizes the need for comprehensive diagnostic approaches.⁵

Modern diagnostic tools, including automated hematology analyzers, have greatly enhanced the ability to classify anemia in older adults. While complete blood count (CBC) and peripheral blood smear (PBS) examination remain useful assessments, analyzer-generated RBC indices and histograms offer more detailed insights into red cell morphology and size distribution. Visual data such as RBC histograms provide clinicians with more immediate diagnostic cues, often flagging abnormalities even before the smear is reviewed.

The age distribution of geriatric patients with anemia in the present study is comparable to previous studies, with a majority of patients (63.10%) in the 60-70 age range, followed by 28.18% in the 71-80 age range, and 8.72% above 80 years. This trend is consistent with studies by Talukdar et al and Shrivastava et al, which reported similar age distributions.^{4,6} The present study's findings are also in line with Krishnamurthy et al, which reported a slightly lower proportion of patients in the 60-70 age range (51%).⁷

In the present study male-to-female ratio is comparable to previous studies, with a slight female predominance (53.35%), consistent with studies by Talukdar et al, Dhakar et al, and Greeshma et al.^{4,8,9}

In this study, across the different diagnostic methods, normocytic normochromic anemia was the most common type (62.4-67.40%), followed by microcytic hypochromic anemia (27.20-29.50%), macrocytic anemia (4.70-5.40%), hemolytic anemia (2%) and dimorphic anemia (1.30%), similar to studies by Shrivastava et al, Agarwal et al, Singh et al, Jain et al, Swami et al, and Bhasin et al.^{6,10-14}

The present study shows a majority of cases with mild anemia (56.70%), followed by moderate (34.90%) and severe anemia (8.40%) consistent with Talukdar et al, whereas Jain et al and Munesh et al, reported a higher proportion of moderate and severe anemia cases.^{4,5,12}

From the results of the current study, a conclusion can be drawn that the usage of peripheral blood smear, RBC indices and RBC histograms together increases the chances for better diagnostic accuracy of specific morphologic types of anemia and covers the shortcomings of the individual methods.

The study is limited by being a hospital-based study with a small sample size and may not effectively reflect the actual difficulties in anemia faced by the broader geriatric population. Etiology of geriatric anemia could also not be evaluated in this study as this study was more focused on morphological and hematological parameters analysis.

CONCLUSION

As geriatric health is multifaceted and anemia itself is multi-factorial, comprehensive diagnostic approaches are essential.⁵ Modern diagnostic tools such as automated

hematology analyzers and PBF have greatly enhanced the ability to classify anemia in older adults.

Automated hematology analyzers have become the go-to tool for initial screening and detection of hematological abnormalities in modern clinical diagnostic laboratories. For accurate morphological diagnosis of anemia, the histogram provided by these analyzers is particularly important.

The microscopic examination of peripheral blood smears plays a pivotal role in ruling out other hematological disorders that may go undetected through automated analysis alone and remains the gold standard.

Therefore, a combined approach using PBS, RBC indices, and histograms ensures greater diagnostic accuracy in geriatric patients, where anemia is often multifaceted and can mimic natural aging.

Early and accurate diagnosis of anemia in the elderly helps in directing towards appropriate management leading to an improvement in the expectancy and quality of life.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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