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Peripheral Blood Smear and RBC Histogram in Anemia: A Two-Year Observational Study

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ABSTRACT

In our geographic region, anemia is a prevalent medical condition, and our study focuses on the use of comprehensive hematological parameters, including the RBC Histogram and peripheral blood smears, as an initial diagnostic approach to promptly identify and enhance cost-effectiveness in anemia diagnosis. The aim of our study is to elucidate the correlation between the RBC Histogram and Peripheral Blood Smear analyses in diagnosing anemia. We examined 200 subjects, utilizing a 5-part Fully Automated Hematology Analyzer for CBC assessments and employing Field's staining technique for peripheral blood smears. Among the 200 anemia cases, 62% presented with Microcytic Hypochromic Anemia, 4.5% with Macrocytic Anemia, 16.5% with Normocytic Normochromic Anemia, 7.5% with Dimorphic Anemia, 7% with Hemolytic Anemia, and 2.5% with Pancytopenia. Microcytic Hypochromic Anemia cases displayed a leftward shift in the RBC Histogram, while Macrocytic Anemia cases exhibited a pronounced rightward shift. Hemolytic Anemia cases were characterized by either a broad-based or bimodal peak in the histogram. In conclusion, the combined use of RBC Histogram analysis and peripheral blood smear scrutiny is a highly valuable diagnostic tool for a spectrum of hematological disorders, with Fully Automated Hematology Analyzers proving beneficial and dependable for peripheral smear evaluation.

Keywords : Anemia, Pancytopenia, Hematology.

INTRODUCTION

In exploring the etiology of anemia, the incorporation of a peripheral blood smear in conjunction with a Red Blood Cell (RBC) histogram assumes a pivotal role. Automated hematology analyzers have proven their mettle, displaying remarkable precision and accuracy while minimizing the potential for subjective errors in anemia diagnosis (Singla, Bedi, & Joshi, 2017). The amalgamation of RBC histograms, Red Cell Distribution Width (RDW), and Mean Corpuscular Volume (MCV)

emerges as an indispensable tool in diagnosing a wide spectrum of hematological disorders (Bessman, Gilmer Jr., & Gardner, 1983; Fossat et al., 1987; William, 1984). However, it remains imperative to conduct a thorough examination of peripheral blood smears to exclude other hematological abnormalities, including those involving White Blood Cells (WBCs) and platelets (Singla, Bedi, & Joshi, 2017).

The automated hematology analyzers operate on the impedance principle, relying on variations in conductance as individual cells traverse an aperture. This phenomenon leads to the generation of electrical pulses, with their amplitude directly correlating with cellular volume. The resultant data is recorded as histogram findings, which are complemented by a microscopic examination of peripheral blood smears. The directional shifts observed in the histogram curve offer invaluable diagnostic insights (Bessman, Gilmer Jr., & Gardner, 1983; Fossat et al., 1987; Interpretation of red blood cell RBC histograms).

METHODS

The present study was conducted at a Pathology laboratory in Central India spanning from April 2021 to March 2023. Ethical standards, as outlined in the Helsinki Declaration, were strictly adhered to, and the study involved 200 individuals who provided informed consent for their participation. Complete Blood Count (CBC) analysis was performed using a 5-Part Fully Automated Hematology Analyzer. Venous blood samples were collected in EDTA anticoagulant vials for CBC analysis, and Peripheral Blood Smears were prepared using Field's staining method. To minimize variations due to sample aging, all samples were tested within 1 hour of collection.

The analysis of histograms focused on their shape, size, center of spread, as well as the starting and ending points of the curve. Any deviations or defects in the RBC histograms, such as left shifts, right shifts, and bimodal peaks, were meticulously recorded (Fossat et al., 1987; Kakkar & Makkar, 2009). A similar examination was conducted for WBC histograms. Anemia was categorized based on RBC indices into Normocytic normochromic (MCV 80-100fl), Microcytic hypochromic (MCV <80fl), and Macrocytic (MCV >80fl) (McKenzie, 1996). Interpretation of histograms was carried out for all cases, and subsequent correlation with peripheral smears was performed.

Inclusion criteria encompassed all patients with hemoglobin levels below 11 g/dl, while exclusion criteria encompassed patients exhibiting leukemoid reactions or diagnosed with leukemia. This stringent approach ensured the study's integrity and relevance.

RESULTS AND DISCUSSION

In our study, 200 cases were included, out of which 75 were males and 125 were females. Out of total cases, 124 (62%) cases were Microcytic hypochromic anemia, 9 (4.5%) cases were Macrocytic anemia, 33 (16.5%) cases were Normocytic normochromic anemia, 15 (7.5%) cases were Dimorphic anemia, 14 (7%) cases were Hemolytic anemia and 5 (2.5%) cases were of Pancytopenia. [Table 1].

Table 1. Distribution of anemia cases based on peripheral smear (Total = 200 cases).

Types of Anemia	Cases	Percentage (%)
Microcytic Hypochromic	124	62
Macrocytic	9	4.5
Normocytic Normochromic	33	16.5
Dimorphic	15	7.5
Hemolytic	14	7
Pancytopenia	5	2.5

Out of total cases, the Histogram pattern was 31 cases (15.5%) show the normal curve, 63 cases (31.5%) cases show left shift, 10 cases (5%) show right shift, 76 cases (38%) show broad base, 14 cases (7%) a Bimodal peak and 6 cases (3%) shows short peak. [Table 2, Figures 1-5].

Table 2. RBC histogram variation in different anemia cases (Total = 200 cases).

Types of Anemia	Normal Curve	Left Shift	Right Shift	Broad Base	Bimodal Peak	Short Peak
Microcytic	4 (2%)	66 (33%)	-	47 (23.5%)	4 (2%)	3 (1.5%)
Macrocytic	-	-	9 (4.5%)	-	-	-
Normocytic	22 (11%)	-	-	11 (5.5%)	-	-
Dimorphic	2 (1%)	1 (0.5%)	4 (2%)	2 (1%)	6 (3%)	-
Hemolytic	-	-	-	8 (4%)	6 (3%)	-
Pancytopenia	-	-	-	5 (2.5%)	-	-

Out of total cases 66 cases (33%) of Microcytic anemia show Left shift, 9 cases (4.5%) of Macrocytic anemia show Right shift. [Table 3, Figures 1-5].

Table 3. RBC histogram variation in different anemia cases (Total = 200 cases).

Types of Anemia	Normal Curve	Left Shift	Right Shift	Broad Base	Bimodal Peak	Short Peak
Microcytic	4 (2%)	66 (33%)	-	47 (23.5%)	4 (2%)	3 (1.5%)
Macrocytic	-	-	9 (4.5%)	-	-	-
Normocytic	22 (11%)	-	-	11 (5.5%)	-	-
Dimorphic	2 (1%)	1 (0.5%)	4 (2%)	2 (1%)	6 (3%)	-
Hemolytic	-	-	-	8 (4%)	6 (3%)	-
Pancytopenia	-	-	-	5 (2.5%)	-	-

Figure 1. Normal Histogram.

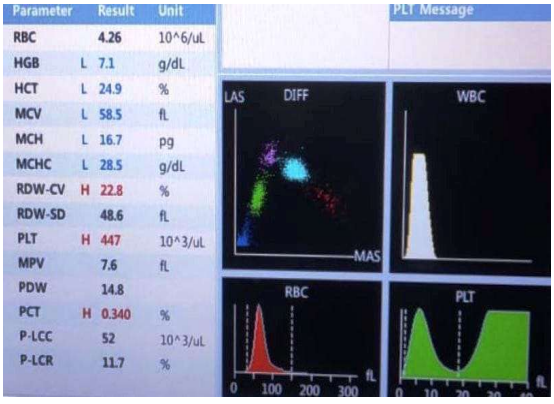

Figure 2. Shift to Left

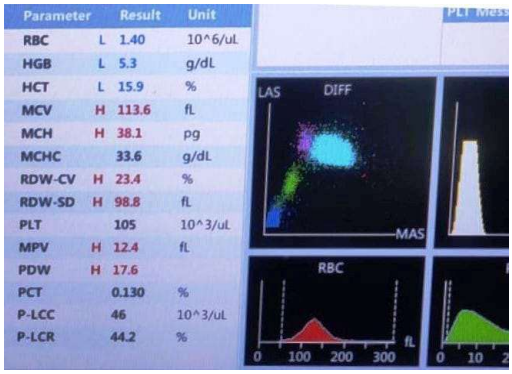

Figure 3. Shift to Right

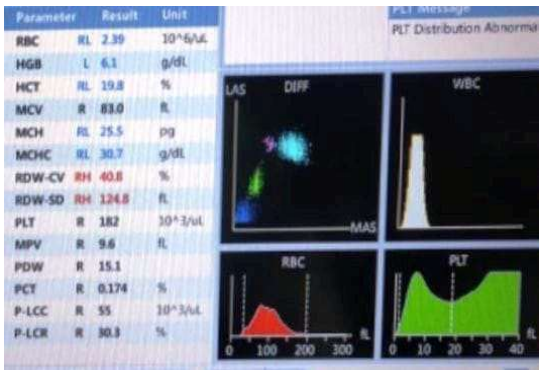

Figure 4. Broad Base

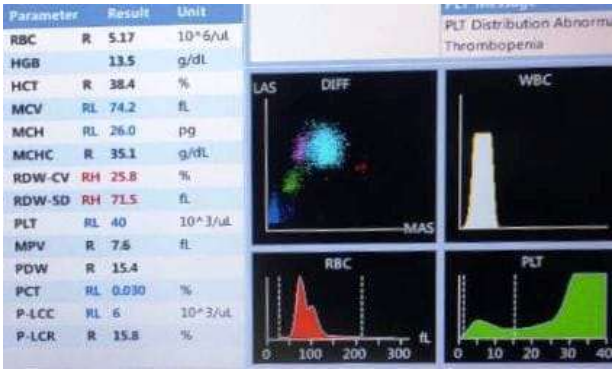

Figure 5. Bimodal Peak

Our study encompassed a total of 200 cases, and the distribution of anemia types within our study cohort revealed a predominant occurrence of microcytic hypochromic anemia, followed by normocytic normochromic anemia, dimorphic anemia, hemolytic anemia, macrocytic anemia, and pancytopenia, in descending order. Specifically, microcytic hypochromic anemia cases exhibited a left shift in the RBC histogram curve, whereas macrocytic anemia cases displayed a right shift in the RBC histogram curve. Hemolytic anemia cases manifested either a bimodal peak or a broad base in the RBC histogram curve, while normocytic normochromic anemias showed either a normal curve or a broad base. These findings align with the observations of many previous studies [Table 4].

Table 4. Study wise comparison of Histogram findings.

Histogram Pattern	Present Study	Sandhya & Muhasin, 2014	Chavda, Goswami, & Goswami, 2015	Rao et al., 2017	Shrivastav et al., 2019	Patel et al., 2022
Normal Curve	15.5 %	15%	19%	17.7%	18%	19.4%
Left Shift	31.5 %	30%	27%	29%	29%	30.6%
Right Shift	5 %	6%	7%	5.45%	6%	10.8%
Broad Base	38 %	40%	38%	37.72%	40%	35.6%
Bimodal Peak	7 %	4%	3%	7.27%	5%	3.6%
Short Peak	3 %	5%	6%	2.70%	2%	1%

A notable limitation of our study is that while the RBC histogram proves to be a valuable screening tool in ascertaining the potential causes of anemia, it falls short of being a definitive diagnostic tool. Nevertheless, it remains a crucial component in the diagnostic process. When used in conjunction with a Peripheral Blood Smear, the RBC histogram aids in guiding the decision-making process for additional investigations. This combined approach proves instrumental in facilitating early and cost-effective management strategies for patients.

CONCLUSION

In conclusion, the integration of Histogram and Peripheral Blood Smear proves to be a powerful diagnostic tool for diverse hematological disorders. Automated Hematology Analyzers exhibit reliability in evaluating peripheral smears, with a notable correlation between histogram and smear findings. This integrated approach streamlines diagnosis, guiding clinicians for further investigations. Overall, this methodology enhances diagnostic precision, contributing to more targeted management strategies for hematological disorders and signaling a promising direction for future research and clinical applications.

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