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Original research

CHARACTERISTICS OF HAEMOGRAM, SERUM IRON, AND FERRITIN LEVELS IN PATIENTS WITH HYPOCHROMIC MICROCYTIC ANEMIA

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ABSTRACT

Background: *Hypochromic microcytic anemia (HMA) is a prevalent and serious condition if left untreated. Haemograms, serum iron, and ferritin tests play crucial roles in diagnosis and in guiding the identification of underlying causes. This study was conducted with the objective of describing the haemogram characteristics and assessing serum iron and ferritin levels in patients with hypochromic microcytic anemia.*

Methods: *A cross-sectional study was conducted on 62 patients with hypochromic microcytic anemia who visited and were treated at Hue University of Medicine and Pharmacy Hospital from March 2024 to July 2024.*

Results: *The erythrocyte indices in the iron-deficiency anemia (IDA) group were as follows: RBC 4.0 ± 0.7 T/L, HGB 77.8 ± 15.7 g/L, MCV 67.7 ± 7.2 fL, MCH 19.3 ± 3.1 pg, RDW 18.8 ± 2.7 %. In the hemoglobinopathy group: RBC 4.8 ± 0.5 T/L, HGB 90.6 ± 8.3 g/L, MCV 61.9 ± 4.7 fL, MCH 18.8 ± 1.1 pg, RDW 19.2 ± 4.3 %. In the chronic inflammation/disease group: RBC 3.8 ± 1.1 T/L, HGB 85.1 ± 20.2 g/L, MCV 72.2 ± 6.6 fL, MCH 22.4 ± 2.5 pg, and RDW 16.3 ± 2.2 %. Erythrocyte morphology included various shapes such as ring-shaped (85.5%), pencil-shaped (22.6%), target-shaped (17.7%), teardrop-shaped (14.5%), and stomatocyte (14.5%). The average serum iron level of the iron-deficiency anemia, hemoglobinopathy, and chronic inflammation/disease groups was 3.3 ± 1.3 µmol/L, 15.9 ± 7.5 µmol/L, and 8.2 ± 6.4 µmol/L, respectively. The average serum ferritin level of the iron-deficiency anemia, hemoglobinopathy, and chronic inflammation/disease group was 7.6 ± 4.4 pmol/L, 408.1 ± 202.0 pmol/L, and 204.1 ± 145.9 pmol/L, respectively.*

Conclusion: *Hypochromic microcytic anemia is characterized by decreased RBC, HGB, MCV, and MCH, along with increased RDW. Ring-shaped erythrocytes were the most commonly observed morphology. Serum iron and ferritin levels varied depending on the underlying cause.*

Keywords: *Hypochromic microcytic anemia, haemogram, serum iron, serum ferritin.*

I. BACKGROUND

According to the World Health Organization (WHO), anemia is a condition in which the amount of hemoglobin and the number of red blood cells in the peripheral blood are reduced, leading to a lack of oxygen supply to tissues in the body [1]. Hypochromic microcytic anemia is the most common syndrome, characterized by small red blood cells and low hemoglobin content. Common causes include iron deficiency (highest frequency), thalassemia (a genetic disorder that leads to abnormal hemoglobin production), and chronic inflammation/disease (tumors and malignancies, chronic inflammation, and infections). In addition, there is a small percentage of cases due to other causes.

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The complete blood count with erythrocyte parameters is the basis for diagnosing hypochromic microcytic anemia and for continuously performing another test to find the underlying cause [2]. On the other hand, the characteristics of red blood cells in peripheral blood smears, such as shape, size, color, etc., are also important information that helps identify the cause of anemia [3]. Based on the reticulocyte count, serum iron, and ferritin levels, we can initially classify anemia and then choose the appropriate treatment, helping patients quickly improve their health and avoid complications from treatment. Therefore, this highlights the importance of haemograms, serum iron, and ferritin tests in diagnosing and curing anemia syndrome.

Because of the popularity of hypochromic microcytic anemia, there are many research projects on this issue around the world in general and Vietnam in particular. Foreign studies often analyze all causes of hypochromic microcytic anemia [4, 5], but most studies in Vietnam focus on each cause [6-8]. No study has been conducted on the entire population of patients with hypochromic microcytic anemia to comparing different causes. Based on this, we conducted the study titled "Characteristics of haemogram, serum iron, and ferritin levels in patients with hypochromic microcytic anemia". The objective of the study is to describe the hematological features and to assess serum iron and ferritin levels in patients with hypochromic microcytic anemia.

II. MATERIALS AND METHODS

2.1. Materials

Patients with hypochromic microcytic anemia who visited and were treated at Hue University of Medicine and Pharmacy Hospital from March 2024 to July 2024. Patients diagnosed with microcytic anemia based on age and gender. Patients agreed to participate in the study.

2.2. Methods

Study design: A cross-sectional study. Sample size and collecting samples methods: Convenience sampling from March to July 2024 identified 62 patients who met the inclusion criteria.

2.3. Collecting data

Venous blood samples were obtained for complete blood counts at a study visit. Patients with results showing decreased hemoglobin (HGB), decreased mean corpuscular volume (MCV), and decreased mean corpuscular hemoglobin (MCH) were assigned additional blood tests, including serum iron, and serum ferritin, using the Sysmex XN -550 machine and the Cobas 8000 machine. The above tests were performed at the Department of Hematology and Blood Transfusion and the Department of Biochemistry and Immunology at Hue University of Medicine and Pharmacy Hospital. The patient's anemia symptoms, indicators of red blood cell quality, serum iron, and ferritin levels were collected through a survey form.

2.4. Data analysis

The data were entered and managed using Microsoft Excel 365. The data were analyzed using SPSS (version 26). The frequency, percentage, mean, and standard deviation of all the parameters were calculated.

III. RESULTS

3.1. Participants' characteristics

Among the 62 patients who participated in the study, the majority were female, accounting for 71%. The mean age was 40 years, with the lowest and the highest being 2 and 81. The study subjects were mainly from rural areas (59.7%) and more than half were farmers, workers, and traders (Table 1).

Table 1: General characteristics

Characteristic		**n**	**%**
Mean age ± SD year		40.2 ± 21.0	
Sex	Men	18	29.0
	Women	44	71.0
Location	City	25	40.3
	Countryside	37	59.7
Occupation	Farmer / Worker / Businessman	32	51.6
	Staff / Management	7	11.3
	Students	13	21.0
	Retirement	7	11.3
	Children 6-59 months of age	3	4.8

The average BMI was 20.1 ± 2.7 kg/m^2, within normal limits. The majority of patients with pallor were 75.8%, followed by fatigue (37.1%), anorexia

(35.5%), dizziness and headache (29%), shortness of breath (exertion) (12.9%), and hair fragility (12.9%) (Table 2). The cause with the highest proportion is iron deficiency anemia (39 patients), followed by the chronic inflammation/disease group (14 patients) and hemoglobinopathy with the least number (9 patients) (Figure 1).

Table 2: Clinical symptoms

Clinical characteristics		n	%
BMI (kg/m^2)	Mean BMI ± SD	20.1 ± 2.7	
Clinical signs of anemia	Pallor	47	75.8
	Brittle nails	7	11.3
	Hair fragility	8	12.9
	Shortness of breath	8	12.9
	Irregular heartbeats	4	6.5
	Dizziness and headache	18	29.0
	Fatigue	23	37.1
	Anorexia	22	35.5
	Jaundice	1	1.6

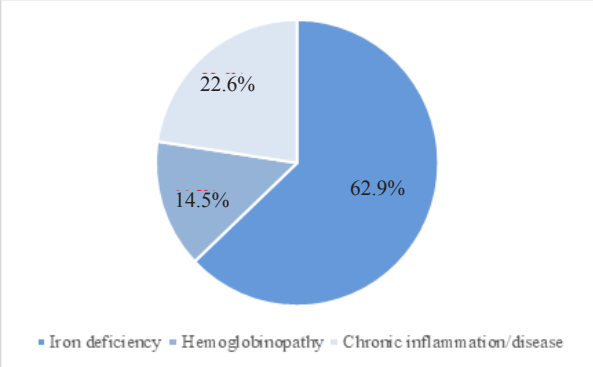

Figure 1: Causes of anemia

3.2. Haemogram

The red blood cell count decreased, with a mean value of 4.1 ± 0.8 T/L. Hemoglobin, mean corpuscular volume and mean corpuscular hemoglobin also decreased, with mean values of 81.3 ± 16.6 g/L, 67.9 ± 7.3 fL, and 19.9 ± 3.0 pg, respectively. The red blood cell distribution width (RDW) increased, with a mean value of 18.3 ± 3.0%. There were statistically significant differences ($p < 0.05$) in this parameter of RBCs among the three etiological groups (Table 3).

Table 3: Complete blood count

	Mean	IDA	Hemoglobinopathy	Chronic inflammation/disease	p-value
RBC (T/L)	4.1 ± 0.8	4.0 ± 0.7	4.8 ± 0.5	3.8 ± 1.1	0.002
HGB (g/L)	81.3 ± 16.6	77.8 ± 15.7	90.6 ± 8.3	85.1 ± 20.2	0.009
MCV (fL)	67.9 ± 7.3	67.7 ± 7.2	61.9 ± 4.7	72.2 ± 6.6	0.003
MCH (pg)	19.9 ± 3.0	19.3 ± 3.1	18.8 ± 1.1	22.4 ± 2.5	< 0.001
RDW (%)	18.3 ± 3.0	18.8 ± 2.7	19.2 ± 4.3	16.3 ± 2.2	0.008

In hypochromic microcytic anemia, most red blood cell sizes were irregular (58.1%). Ring-shaped was the most common abnormal morphology, followed by the pencil cell, target cell, teardrop cell, and stomatocyte erythrocyte, respectively. The study subjects had an increased reticulocyte count, which took up a low percentage of 16.1% and primarily belonged to the hemoglobinopathy group (Table 4).

Table 4: Peripheral blood smears

		IDA n (%)	Hemoglobinopathy n (%)	Chronic inflammation/ disease n (%)	HMA n (%)
Anisocytosis		26 (66.7)	6 (66.7)	4 (28.6)	36 (58.1)
Morphology	Ring-shaped	34 (87.2)	9 (100)	10 (71.4)	53 (85.5)
	Target cell	7 (17.9)	4 (44,4)	0 (0.0)	11 (17.7)
	Teardrop cell	3 (7.7)	3 (33,3)	3 (21.4)	9 (14.5)
	Pencil cell	13 (33.3)	1 (11,1)	0 (0,0)	14 (22.6)
	Stomatocyte	3 (7.7)	4 (44,4)	2 (14.3)	9 (14.5)
	Normal	5 (12.8)	0 (0,0)	4 (28.6)	9 (14.5)
Increased reticulocyte count		1 (2.6)	6 (66,7)	3 (21.4)	10 (16.1)

The mean value of serum iron decreased in the iron deficiency group and was regular in the chronic inflammation/disease group and hemoglobinopathy group. Serum ferritin declined in the iron deficiency, remained normal in the chronic inflammation/disease, and rose in the Hemoglobinopathy group (Table 5).

Table 5: Iron serum and ferritin serum

	IDA	Hemoglobinopathy	Chronic inflammation/ disease	p-value
Iron (µmol/L)	3.3 ± 1.3	15.9 ± 7.5	8.2 ± 6.4	< 0.001
Ferritin (µg/L)	7.6 ± 4.4	408.1 ± 202.0	204.1 ± 145.9	< 0.001

IV. DISCUSSION

Among the microcytic hypochromic anemia patients participating in the study, women accounted for more than 71% (Table 1), similar to studies in Hue (76.04%) [9] and Can Tho (69.7%) [7]. The age of the study subjects ranged from 2 to 81 years old, with an average of 40.2 ± 21.0, similar to the results of Vo The Hieu (37 ± 12.0) [9] and higher than the results of Nguyen Van Chinh (23.8 ± 6.4) [10]. Different sample sizes and study subjects can lead to these discrepancy.

Most participants had BMI within normal limits with an average of 20.1 ± 2.7 (Table 2). This result is lower than the study by A. Hanan et al [11], which was conducted on students with hypochromic microcytic anemia in Giza province, Egypt, in 2014 (21.2 ± 4.6 kg/m2). This result may be due to age and racial differences.

Research subjects were almost entirely pallor, similar to the study by Tran Xuan Tuan and Nguyen Van Son [6], which also showed the highest percentage of pallor. Moreover, Hanan A [11] indicated that pale skin is the most common symptom in patients with hypochromic microcytic anemia.

Table 3 illustrates that the group with inflammatory/chronic diseases exhibited the lowest RBC count, averaging 3.8 ± 1.1 T/L. This finding is consistent with the study conducted by Nguyễn Chí Thành et al. in 2020 [8], where the RBC count was 3.91 ± 0.69 T/L. The reduction in RBC count in inflammatory/chronic diseases resulted from the combination of decreased production, increased destruction, and shortened lifespan of erythrocytes, which may result in a more pronounced decrease compared to other pathological groups.

The study also revealed that hemoglobin levels were most significantly reduced in the iron-deficiency anemia group (77.8 ± 15.7 g/L), with the mean corpuscular volume being lowest in the hemoglobinopathy group (61.9 ± 4.7 fL) and mean corpuscular hemoglobin (MCH) showing lower

values in both the iron-deficiency group (19.3 ± 3.1 pg) and the hemoglobinopathy group (18.8 ± 1.1 pg). These results align with the findings of Alexandra M. Harrington et al. [4], where HGB levels had the lowest value in the iron-deficiency group (76 g/L), the lowest MCV was in the β-Thalassemia group (66.6 fL), and reduced MCH values were noted in both iron-deficiency and hemoglobinopathy groups (18.9 pg and 21.6 pg, respectively). Iron is an essential substrate that significantly impacts hemoglobin synthesis; therefore, the amount of hemoglobin produced in iron deficiency anemia is generally lower compared to the other two pathological groups. In hemoglobinopathies, erythrocytes are often markedly small and deformed, with various abnormal shapes due to disrupted and incomplete hemoglobin synthesis, contributing to a significant reduction in MCV. The pathogenesis of inflammatory and chronic diseases does not directly affect hemoglobin production, resulting in its mean value of MCH being higher than that of the iron deficiency and hemoglobinopathy groups.

Red blood cell distribution width (RDW) was highest in the hemoglobinopathy group (19.2 ± 4.3%) due to the underlying mechanism of disordered hemoglobin synthesis. This condition leads to a variable size in erythrocytes, with a mixture of abnormally small cells and some normal or larger ones, causing a more pronounced anisocytosis.

The study indicated that anisocytosis often occurs in iron deficiency and hemoglobinopathies like thalassemia. In contrast, the chronic inflammation and disease group typically has unremarkable RBCs, which aligns with J. Ford's description of red blood cell morphology [3]. However, J. Ford also mentioned that this presentation is relative; normal erythrocytes may appear in iron deficiency and thalassemia, and our study found the same.

The results showed that 85.5% of subjects had ring-shaped red blood cells (Table 4), consistent with the characteristics of hypochromic microcytic anemia. Ring-shaped erythrocytes are hypochromic and have a very wide central pallor (central pallor/RBC diameter >⅓) due to severely reduced hemoglobin that is only sufficient to make a thin circle around the cell membrane. Pencil cells mainly appeared more in the iron deficiency group than in others, similar to research in the United States in 2008 [4]. It indicated that the pencil-shaped erythrocytes support the diagnosis of iron deficiency anemia. All patients in the hemoglobinopathy group appeared to have abnormal erythrocyte morphology with target-shaped, stomatocyte, and teardrop-shaped, similar to Lam Thi Huong Giang's study in Can Tho [12].

Reticulocytes increased mainly in the hemoglobinopathy group, consistent with J.F. Koepke and J.A. Koepke's description [13]. Because erythrocytes in hemoglobinopathy often have a short lifespan and disordered function, bone marrow has to increase the production of red blood cells, leading to increased reticulocytes in the blood. Besides, we found some patients in the iron deficiency group who have increased reticulocyte count. There is a possibility that supplying unprescribed iron for iron-deficient patients a month prior could raise reticulocytes.

Comparing our study with that of Kafle and Lakhey [5], we observed that serum iron levels were consistently lower in the iron deficiency anemia group and regular in the hemoglobinopathy group. However, there was a discrepancy in chronic inflammation/disease. In their study, serum iron levels in that group decreased, whereas ours found them to be ordinary. This finding is consistent with research from Vita-Salute San Raffaele University, Milan, Italy [14], which indicated that serum iron levels could be either typically limited or decreased in chronic inflammation/disease.

Additionally, the change in serum ferritin levels among the three groups is similar to the study by Kafle and Lakhey [5], with a decrease in the iron deficiency group and an acceptable limitation in the inflammation/chronic disease group. However, there is a difference in that our study found serum ferritin increased in the hemoglobinopathy group, which results from secondary iron overload in patients with severe thalassemia who undergo regular blood transfusions. Furthermore, a study performed in Thai Nguyen province [15] reported that the ferritin levels of patients with hemoglobinopathy also increased.

V. CONCLUSION

Overall, hypochromic microcytic anemia is characterized by decreased RBC, HGB, MCV, and MCH, along with increased RDW. However, these indicators for different underlying causes

show varying values. Ring-shaped erythrocytes were the most commonly observed morphology on peripheral blood smears. Reticulocytes increased mainly in the hemoglobinopathy group. Serum iron and ferritin levels varied depending on the underlying cause. The serum iron of the iron-deficiency anemia group significantly declined, while the ferritin serum in the hemoglobinopathy group elevated. In the chronic inflammation/ disease group, both indicators were regular.

Disclosure

The authors report no other conflicts of interest in this work.

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