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Microcytic Anemia Among patient In Al-Bayda Medical Educational Center through Complete Blood Count

Fadhila Othman
Medical Laboratories Department of higher institute of sciences and medical Technology, Al-Byda, Libya؛
Fadhilaothman297@gmail.com

ABSTRACT

Microcytic anemia is a common hematologic disorder primarily caused by iron deficiency, and to a lesser extent by thalassemia and chronic diseases such as renal failure. It is characterized by the presence of red blood cells (RBCs) with reduced mean corpuscular volume (MCV), leading to decreased oxygen-carrying capacity and associated with some symptom's. This study aimed to assess the hematological parameters of patients with microcytic anemia in comparison with healthy group, while identifying the most prevalent underlying causes and associated demographic patterns. The study was conducted at Al-Bayda Medical Educational Center, Libya, in May 2024. A total of 61 participants (30 patients and 31 healthy controls), aged between 18 and 60 years, were included. Blood samples were analyzed using automated hematology analyzers to measure Hb, RBC count, MCV, MCH, MCHC, and HCT. Statistical analysis was performed using SPSS v23, with significance set at $p < 0.05$. The study revealed statistically significant differences ($p < 0.000$) between patients and controls in all measured hematological parameters. The causes of microcytic anemia among the 30 patients were identified based on their medical records. iron deficiency was the most frequent diagnosis (80%), followed by anemia of chronic renal disease (13.3%) and thalassemia (6.7%). Among the patient group, 90% were female, reflecting a gender predominance in this population. Iron deficiency remains the leading cause of microcytic anemia in the studied population, predominantly affecting women of reproductive age. Routine hematological screening, nutritional interventions, and awareness programs are essential for early detection, prevention,

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and management. Further research is recommended to investigate the molecular mechanisms and long-term impacts of iron deficiency on health and quality of life.
KEYWORDS: Iron deficiency anemia, microcytic anemia, hematological parameters.

فقر الدم صغير الحجم بين المرضى في مركز البيضاء الطبي التعليمي من خلال تحليل صورة الدم الكامل

فضيلة عثمان

[1]قسم المختبرات الطبية، المعهد العالي للعلوم والتقنيات الطبية، البيضاء، ليبيا
Fadhilaothman297@gmail.com

الملخص

يُعد فقر الدم صغير الحجم أحد اضطرابات الدم الشائعة، وينجم بشكل أساسي عن نقص الحديد، وإلى حد أقل عن الثلاسيميا والأمراض المزمنة مثل الفشل الكلوي. ويتميز هذا النوع من فقر الدم بوجود خلايا دم حمراء (RBCs) ذات حجم كروي متوسط منخفض (MCV)، مما يؤدي إلى انخفاض قدرة الدم على حمل الأكسجين وارتباطه ببعض الأعراض. هدفت هذه الدراسة إلى تقييم المؤشرات الدموية لدى المرضى المصابين بفقر الدم صغير الحجم مقارنة بمجموعة من الأصحاء، مع تحديد الأسباب الأكثر شيوعًا والأنماط الديموغرافية المرتبطة. أُجريت الدراسة في مركز البيضاء الطبي التعليمي في ليبيا، في مايو 2024، وشملت 61 مشاركًا (30 مريضًا و31 شخصًا سليمًا) تتراوح أعمارهم بين 18 و60 عامًا. تم تحليل عينات الدم باستخدام محللات دموية آلية لقياس الهيموغلوبين(Hb) ، وعدد كريات الدم الحمراء(RBC) ، والحجم الكروي المتوسط (MCV)، ومتوسط تركيز الهيموغلوبين في الكرية(MCH) ، وتركيز الهيموغلوبين الكروي المتوسط(MCHC) ، ومعدل (HCT) الهيماتوكريت.

تم إجراء التحليل الإحصائي باستخدام برنامج SPSS الإصدار 23، مع اعتبار القيمة الإحصائية ذات دلالة عند ($p < 0.05$) . أظهرت الدراسة فروقًا ذات دلالة إحصائية ($p < 0.000$) بين المرضى والمجموعة السليمة في جميع المؤشرات الدموية التي تم قياسها. وكان السبب الأكثر شيوعًا لفقر الدم صغير الحجم هو نقص الحديد (80%)، يليه فقر الدم الناتج عن أمراض الكلى المزمنة (13.3%)، ثم الثلاسيميا (6.7 %) ومن

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بين المرضى، كانت نسبة 90% من الإناث، مما يعكس غلبة هذا النوع من فقر الدم لدى الإناث. لا يزال نقص الحديد هو السبب الرئيسي لفقر الدم صغير الحجم في السكان الذين شملتهم الدراسة، وهو يؤثر بشكل كبير على النساء في سن الإنجاب. تُعد الفحوصات الدموية الروتينية، والتدخلات التغذوية، وبرامج التوعية ضرورية للكشف المبكر والوقاية والعلاج. ويوصى بإجراء مزيد من الأبحاث لاستكشاف الآليات الجزيئية والتأثيرات طويلة الأمد لنقص الحديد على الصحة وجودة الحياة.

الكلمات المفتاحية :فقر الدم الناتج عن نقص الحديد، فقر الدم صغير الحجم، المعلمات الدموية.

INTRODUCTION

Anemia is a common hematological disorder defined as a reduction in the number of circulating red blood cells (RBCs) or the hemoglobin concentration below normal levels, leading to impaired oxygen delivery to body tissues [1]. It can be classified based on the mean corpuscular volume (MCV) into normocytic, microcytic, and macrocytic types[2]. Microcytic anemia is characterized by the presence of smaller-than-normal red blood cells, reflected by a decreased MCV [3]. The primary causes of microcytic anemia include iron deficiency, thalassemia, and anemia of chronic disease or inflammation [4]. Iron deficiency is the most prevalent cause worldwide and often results from poor dietary intake, malabsorption syndromes such as celiac disease or Helicobacter pylori infection, chronic blood loss (especially gastrointestinal bleeding), or increased iron demands during menstruation, pregnancy, and lactation [5]. Thalassemia, a genetic disorder affecting hemoglobin synthesis, also leads to microcytic anemia due to defective production of hemoglobin chains [6]. Although thalassemia is inherited, its clinical impact varies, and it can present with mild to severe anemia depending on the genetic mutation involved[7]. The pathophysiology of microcytic anemia involves insufficient hemoglobin production, which reduces the oxygen-carrying capacity of the blood and results in clinical symptoms such as fatigue, pallor, and shortness of breath [8]. Accurate diagnosis of microcytic anemia relies on hematological parameters, including hemoglobin concentration, RBC count, MCV, mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration

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(MCHC), and hematocrit (HCT) [9]. Given the public health significance of anemia, particularly in developing countries where nutritional deficiencies are prevalent, understanding the underlying causes of microcytic anemia is essential for effective prevention and management [10]. This study aims to evaluate hematological parameters among patients diagnosed with microcytic anemia and to identify the most prevalent underlying causes within a clinical population in Al-Bayda, Libya. By comparing patient data to healthy group, this research seeks to provide insights that can inform targeted interventions for diagnosis, treatment, and prevention.

MATERIAL AND METHODS

Study design and data collection

In my study, the data was conducted at Al-Bayda Medical Educational Center, Libya, between May 1 and May 30, 2024. The study aimed to compare hematological parameters between a group of patients diagnosed with microcytic anemia and a group of healthy individuals.

A total of 61 participants, aged between 18 and 60 years, were included and divided into two groups: patients diagnosed with microcytic anemia based on documented blood test results from medical records, and healthy individuals with no signs of anemia or hematological disorders. Data were collected from laboratory records, including hematological parameters such as hemoglobin level (Hb), red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and hematocrit (HCT). The documented laboratory results were used to evaluate and compare hematological parameters between the two groups, and to calculate the prevalence of microcytic anemia within the studied sample.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics version 23. Descriptive statistics were used to summarize the data, and results were presented as means and standard deviations (SDs). An Independent samples t-test was applied to compare the mean values of hematological parameters between the patient and control groups. A p-value of less than 0.05 was considered statistically significant. The level of significance (alpha) was set at 0.05 as the critical threshold to determine statistical differences between groups.

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RESULTS

Sixty one cases, were included in the study. There were 13 (21.3%) males and 48 (78.7%) females with a mean age of 35 years. Patient group were 30 (49.2%) with a mean age of 37.8 years 27 (90%) female and 3 (10%) males , healthy group were 31 (50.8%) with a mean age of 32.4 years 17 (54.8%) female and 14 (45.2%) males.

TABLE 1. Demographic Characteristics of the Study Participants

Characteristic		Patient Group (n = 30)	Healthy Group (n = 31)	Total (n = 61)
Mean Age (years)		37.8	32.4	35.0
Sex	- Male	3 (10.0%)	14 (45.2%)	13 (21.3%)
	- Female	27 (90.0%)	17 (54.8%)	48 (78.7%)

The Table 1. shows the distribution of participants by age and sex.
The homological parameters were compared between the patient and healthy groups. Statistically significant differences were observed in all measured indices ($p < 0.000$). The mean hemoglobin (Hb) level was significantly lower in the patient group (7.83 ± 0.42 g/dL) compared to the healthy group (13.69 ± 0.37 g/dL), confirming the presence of anemia.
In addition, red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and hematocrit (HCT) were all significantly reduced in patients with microcytic anemia compared to healthy individuals, reinforcing the hematological profile typical of this condition. Furthermore, the results demonstrate that patients experience a significant reduction in hemoglobin levels, which explains the associated clinical symptoms such as fatigue and shortness of breath. The decrease in hematocrit levels also highlights the impact of iron deficiency on the blood's ability to efficiently transport oxygen. The table provides evidence that mean corpuscular volume (MCV) is lower in patients than the control subjects, thereby confirming that the sizes of red blood cells are smaller in patients because it is one of the main indicators of microcytic anemia. The difference between both groups is also highly significant statistically ($p < 0.000$), which adds to the significance of these parameters in terms of differentiating between healthy and anemic individuals.
The data displayed in this table relates well with previous research in terms of iron deficiency being accounted as the very prevalent cause of microcytic anemia and also shedding light on the

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significance of blood tests in diagnosing and differentiating different types of anemia. The mean corpuscular volume for the patients is considerably lower, as reported in the data shown in the table, when compared with the control subjects, indicating that conditionally the patients had smaller red blood cells one of the major features of microcytic anemia. Both the groups, on the other hand, are highly statistically significant ($p < 0.000$), which further emphasizes the importance of these parameters in making a difference between healthy individuals and anemic patients.

TABLE 2 Statistical Analysis of Hematological Indices in Patients with Microcytic Anemia Compared to Healthy group.

Homological parameters	Groups	N	Mean	Std. Error Mean	p. value
Hemoglobin g/dl	Healthy Patient	31 30	13.6871 7.8333	.36611 .41739	.000
Red Blood Cells × 1003 cells/µ	Healthy Patient	31 30	4.8829 7.8333	.09636 .41739	.000
MCV fL/cel	Healthy Patient	31 30	85.9677 65.6033	.86983 1.35957	.000
MCHC g/d	Healthy Patient	31 30	33.2613 29.7500	.41384 .67488	.000
MCH pg/cel	Healthy Patient	31 30	28.7290 20.1433	.42800 .60339	.000
Hematocrit %	Healthy Patient	31 30	40.4290 24.5500	.92631 1.03886	.000

The table 2. shows statistically significant differences (p.value < 0.000) between the healthy group and the patient group for all the listed parameters: Hemoglobin, Red Blood Cells, MCV, MCHC, MCH, and Hematocrit. A strong statistical inference shows another primarily significant difference between patients and the controls in the measured hematological parameters, suggesting the deep effects of iron deficiency on red blood cell formation.

The analyses also Indicated that the mean corpuscular volume (MCV) was lower for the patients than for the health controls, that iron deficiency affects the size of red blood cells.

In contrasting the genders, it was observed that there was a higher rate of women who were found to be anemic, as compared to men. This phenomenon may be attributed to physiological factors such as menstrual blood loss and impaired iron absorption. Further, the variations In the presenting severities of anemia among the cases studied were evident; some patients were found to have immensely lower hemoglobin levels, thereby necessitating advanced

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therapeutic interventions. Statistical analysis has revealed that hematological parameters are significantly different between patients and healthy controls in support of the role of iron deficiency in red blood cell production .A diminished mean corpuscular volume (MCV) is a distinguishing hallmark of microcytic anemia's, which further aids in figuring out their cause induction.

Figure 1 illustrates the distribution of the primary causes of microcytic anemia among the study participants. Iron deficiency was the most prevalent cause, accounting for 80% of cases. This was followed by anemia of chronic renal disease (13.3%) and thalassemia (6.7%). These percentages are based on the clinical diagnoses recorded in the patients' medical files. The findings highlight iron deficiency as the dominant etiology within the studied population.

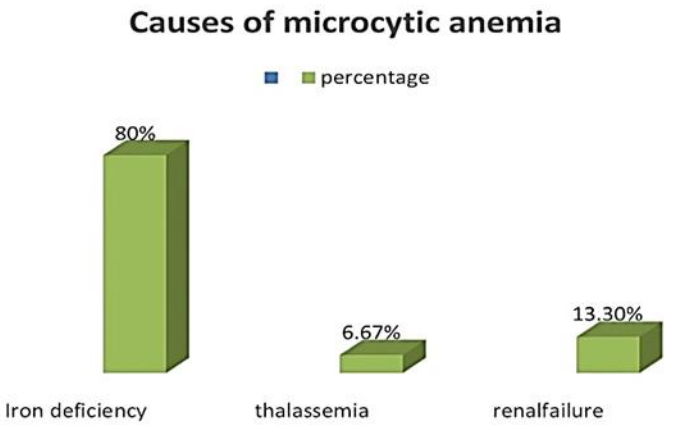

Figure 1 showing the percentage for causes of anemia.

DISCUSSION

This study investigated the hematological characteristics and underlying causes of microcytic anemia in a clinical cohort from Al-Bayda, Libya. The results revealed that iron deficiency was the most common cause, accounting for 80% of cases, followed by anemia of chronic renal disease (13.3%) and thalassemia (6.7%). All measured hematological parameters—including hemoglobin (Hb), red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and hematocrit (HCT)—were significantly

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lower in the patient group compared to the healthy controls ($p < 0.000$).

In our study statistically significant differences (p.value < 0.000) between the healthy group and the patient group for all the listed parameters: Hemoglobin, Red Blood Cells, MCV, MCHC, MCH, and Hematocrit. In all the parameters measured, the healthy group has higher values compared to the patient group. Hemoglobin levels were an average of 13.69 g/dl in the healthy group compared to 7.83 g/dl in the patient group. MCV, which indicates the average size of red blood cells, is lower in the patient group (65.6 fL) compared to the healthy group (85.97 fL). This suggests microcytosis, which is characteristic of microcytic anemia. And this is consistent with study in [11]. Overall, the findings suggest that iron deficiency is the most common cause of microcytic anemia in the studied population. The patients with anemia have lower red blood cell counts and smaller red blood cells compared to the healthy group. And this is consistent with study in [12]. The most common cause of anemia in the study was iron deficiency, affectinge 80% of the patients. Renal failure (13.3%) and thalassemia (6.7%) were the other causes of anemia identified in the study participants. The provided graph depicts a similar distribution of causes of anemia, with iron deficiency being the most prevalent, followed by thalassemia and then anemia of chronic disease (though the graph lists the latter cause as "anemia of renal disease"). It is important to note that the graph might not represent the data from this specific study but rather anemia causes in general, and this is consistent with study in [13]. The present findings are consistent with past studies demonstrating the correlation between Iron deficiency and microcytic anemia, thereby amplifying the significance of proper diagnosis and treatment. The significant statistical differences noted between the two groups encourage further studies to unravel the molecular effects exerted via iron deficiency on red blood cells and their physiological functions. Furthermore, the higher prevalence of anemia among females is in congruence with worldwide studies that indicate iron deficiency is more prevalent in women due to several hormonal and biological factors. Although this study reports a clear link between anemia and iron deficiency, other factors contributing to the disease, such as genetic predisposition, chronic illnesses, and dietary habits, should also be taken into account for a holistic understanding of the disease's etiology. The study calls for the necessity to establish awareness programmes on the importance of

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nutrition and iron supplementation among high-risk groups to reduce the prevalence of microcytic anemia and improve health outcomes.

There are other causes (such as renal failure and thalassemia) that might also indirectly contribute to lower hemoglobin levels and smaller RBC size. The study was supported the necessity of preventive tactics with better nutrition and education regarding supplementation with iron, especially among certain high-risk populations. Close follow-up is very important for microcytic anemia, as it needs careful identification of the causative illness and consequently its appropriate management.

CONCLUSION

Anemia is a common condition, most commonly described as iron deficiency. As factors responsible for iron deficiency anemia can vary, testing is done with the likelihood to ascertain an underlying disorder. Microcytic anemia is defined by red blood cells that are smaller than the normal size. hence, these cells are important for the conduction of oxygen throughout the body. If they are smaller, they cannot transport it sufficiently, leading to signs of tiring and shortness of breath. Iron insufficiency is actually considered the foremost cause of microcytic anaemia, even though thalassemia and kidney disease could also be responsible.True to reality, microcytic anemia occurs largely as a result of iron deficiency, although it could have thalassemia or kidney disease as other probable causes. Both of these conditions originate from poor dietary intake, chronic blood loss, and a lot of malabsorption syndrome, making nutritional and gastrointestinal evaluations a must for anyone suffering from iron deficiency anemia. Anemia in geriatric individuals is also closely related to Persistent inflammatory illness like Joint inflammation and bowel disorders because they affect iron metabolism and erythropoiesis.

Iron deficiency is the most common cause of microcytic anemia and is complemented by thalassemia and renal disease. These were primarily caused by poor dietary intake, though they were also due to other factors like chronic blood loss, malabsorption syndromes, and so on. Therefore, there has to be a thorough appraisal of nutritional status and gastrointestinal health about the individual. One of them is chronic inflammation diseases that form a link between the condition of anemia, such as rheumatoid arthritis and inflammatory bowel disease, which cause alteration in iron

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metabolism and erythropoiesis. Particularly in developing nations where nutritional deficiencies are compounded by infectious diseases. Effects of untreated anemia are not merely hematological; they include reduced cognitive function, less endurance for physical activity, and increased morbidity and mortality rates among particularly vulnerable populations, including children and pregnant women. This is how serious the extent of understanding the multifactorial nature of microcytic anemia becomes in the designing of effective strategies for prevention and treatment. Iron supplementation was, until now, probably the most popularly accepted treatment of microcytic anemia; however, any long-term management strategy should also be directed towards the underlining causes, such as chronic disease or mutations in the gene. In future, it would be wise for researchers to concentrate on identifying means to improve diagnostic accuracy and on possible targeted intervention to prevent anemia and its consequences.

In addition, the current study proves that microcytic anemia affects cognitive functioning, one's capability to feel energetic, and the overall quality of life along with physical ailments. Hence, treatment must take an all-inclusive approach; it would require dietary correction, pharmacological management, and monitoring chronic conditions leading to the disorder.

However, We need to improve lifestyle and quality of life and enhance physical and mental activity by following good healthy nutrition.

On a further note, the present study encourages extensive research to investigate the molecular impact of iron deficiency on red blood cell function and to analyze the various treatment interventions regarding efficacy in improving patient outcome. Future studies should also broaden the scope to cover larger populations and assess genetic and environmental factors that contribute to the prevalence of microcytic anemia.

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