Original Article

Hematological Parameters in Children with Type-1 Diabetes

Kamal Hussein Khudhur, Mouroge Hashem Al-Ani[1]

Department of Pediatrics, Raparin Pediatric Hospital, [1]Department of Pediatrics, College of Medicine, Hawler Medical University, Erbil, Iraq

Abstract

Background and Objective: This study was done to investigate and compare the hematological parameters related to hemoglobin (Hb), total white blood cell (WBC) count, and platelet parameters in a case–control study of patients with diabetes with those of nondiabetic healthy persons, potentially predisposing patients with diabetes to complications. **Materials and Methods:** A case–control study consisted of 50 children with type I diabetes have been diagnosed since 5 years attending Laila Qasim Diabetic Center compared with another 50 nondiabetic healthy children attending Pediatric Clinic at Raparin Pediatric Hospital from October 2018 to March 2019. Investigations were done as follows: (a) both patients and controls including Hb (g/dl), total WBC count (109/L), platelet count (109/L), mean platelet volume (MPV) (fl), platelet distribution width (PDW) (fl), platelet-large cell ratio (P-LCR) (%), and (b) patients only HbA1C (%) to know their control state. **Results:** WBC, MPV, PDW, and P-LCR were significantly higher among children with diabetes in comparison with the control group (WBC 9.34 ± 1.56 109/L vs. 8.14 ± 1.88 109/L, $P = 0.001$; MPV 9.60 ± 1.13 fL vs. 8.07 ± 0.87 fL, $P = 0.001$; PDW 11.91 ± 1.18 fL vs. 10.03 ± 1.1 fL, $P = 0.001$; and P-LCR 19.34% ± 4.85% vs. 12.09% ± 4.37%, $P = 0.001$); Hb was significantly lower among children with diabetes in comparison with the control group (Hb 12.61 ± 0.75 g/dl vs. 12.89 ± 0.64 g/dl, $P = 0.04$); No significant difference was detected between the two groups regarding platelet count. **Conclusion:** The study revealed that hematological parameters changed as a result of diabetes mellitus, especially Hb was decreased among patients with diabetes and WBC, MPV, PDW, and P-LCR were highly elevated in type I as compared with nondiabetic participants.

Keywords: Children, hematological parameters, type-1 diabetes

Introduction

Type 1 diabetes mellitus (T1DM) is a heterogeneous disorder associated with the destruction of pancreatic beta cells, with the resultant effect of absolute insulin deficiency.[1] T1DM is the most common metabolic disease among children, adolescents, and young adults and its incidence rate is still rapidly increasing.[2] The global prevalence of diabetes is estimated that there will be 592 million patients with diabetes worldwide in 2035.[3] As the onset of the disease occurs in early life, the patients are at great risk of developing cardiovascular disease as a complication of diabetes.[4] Anemia is functionally defined as a "decrease in the competence of blood to carry oxygen to tissues, thereby causing tissue hypoxia."[5] The total leukocyte counts were significantly altered in patients with uncontrolled type II diabetes.[6] Mean platelet volume (MPV) is considered as a marker of platelet function. This is based on the fact that the larger platelets are younger, contain more dense granules, and thus produce more thromboxane A2.[7]

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Recent epidemiological studies indicate that T1DM is as great a risk factor for cardiovascular mortality and stroke as T2DM and that these complications also can occur at a young age.[8,9]

Thus, early detection and treatment of risk factors for cardiovascular disease are important achievements also in T1DM. These parameters are altered in type 2 diabetes, so our study was aimed to compare hemoglobin (Hb), total leukocyte counts, and platelet parameters between children with T1DM and their healthy peers.

Materials and Methods

A case–control study consisted of 50 children with type I diabetes have been diagnosed since 5 years attending Laila Qasim Diabetic Center compared with another 50 children nondiabetic healthy age-

Address for correspondence: Dr. Kamal Hussein Khudhur, Department of Pediatrics, Raparin Pediatric Hospital, Erbil, Iraq. E-mail: kamalhussein86@gmail.com

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and sex-matched attending Pediatric Clinic at Raparin Pediatric Hospital in Erbil city, Kurdistan region, Iraq, from October 1, 2018, to March 1, 2019. Investigations were done as follows: A- For both patients and controls including hemoglobin (gm/dl), total white blood cell count (109/L), platelet count (109/L), mean platelet volume (fl), platelet distribution width (fl), platelet-large cell ratio (%), and B- For patients only HBA1C (%) to know their control state. Exclusion criteria: patients with acute diabetic complications and patients with ongoing infections. The protocol of the study was approved by the Research Ethics Committee of Kurdistan Board for Medical specialties before the beginning of the study. Informed consent (oral and written) was taken from parents of all children. All patients were reviewed with special reference to the following: family history of diabetes, anthropometric measurements including weight and height. Patients with diabetes were reviewed with special reference to the type of insulin, admission to hospital, associated chronic illness, and regular follow-up.

Data collection

Hb, total WBC count, and platelet morphology parameters, for example, platelet, MPV, PDW, and P-LCR, were extracted from routinely performed complete blood count results. The blood counts were performed with Medonic M-series (Boule Medical AB, Stockholm, Sweden). HbA1c measurements were performed with the Gesan 400 device (Gesan production S.r.l. Campobello di Mazara, Italy). Results of HbA1c measurements were in line with the National Glycohemoglobin Standardization Program guidelines on HbA1c measurement standardization as meeting the diabetes control and complications trial standard.

Statistical analysis

Statistical analysis began by entering the data into a computer using the Microsoft Excel program. The statistical package for the social sciences program version 24 (SPSS, IBM Company, Chicago, IL, USA), was used for data analysis. The results were analyzed using frequency distribution and *t*-test. $P < 0.05$ was considered as statistically significant.

Results

Diabetic patients

As shown in Table 1, the vast majority of diabetic children (96%) were using more than one type of insulin (combined therapy). Nearly half (48%) of the patients had a history of admission to hospital, one-third of them had at least one admission per year. Seventy percent of diabetic patients had a positive family history of diabetes.

The mean ± standard deviation of HbA1c level for the 50 patients with diabetes was 9.35% ± 2.21%; the maximum level was 16.4% mean while the lowest rate was 5.3% [Figure 1].

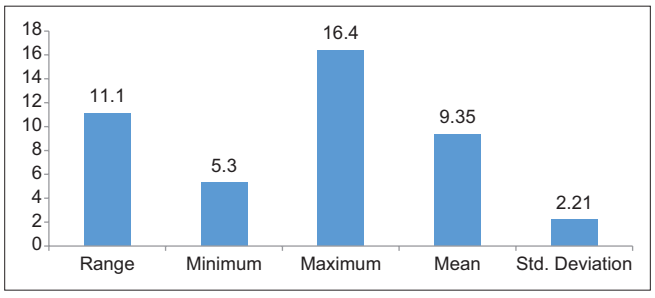

Figure 1: Hemoglobin A1c levels of patients with diabetes

Diabetic and nondiabetic patients

The results of Table 2 indicate that there was a statistically significant difference between diabetic and nondiabetic

Table 1: Variables related to diabetic children

Variable	Categories	Frequency (%)
Type of insulin	Mixtard	2 (4)
	More than one type	48 (96)
Admission to hospital	Yes	24 (48)
	No	26 (52)
Annual admission	None	25 (52)
	One	15 (30)
	Two	7 (14)
	Three	2 (4)
The family history of diabetes	Yes	35 (70)
	No	15 (30)
Chronic illnesses	Yes	2 (7)
	No	48 (96)
Regular follow-up	Yes	47 (94)
	No	3 (6)
Place of follow-up	No	3 (6)
	Diabetes center	33 (66)
	Private clinic	14 (28)
Total		50 (100)

Table 2: Comparison between diabetic patients and nondiabetic participants

Variables	Study groups	*n*	Mean±SD	*P*
Age (years)	Diabetics	50	11.46±2.69	0.001
	Nondiabetics	50	8.13±2.65	
Weight (kg)	Diabetics	50	42.02±14.07	0.001
	Nondiabetics	50	30.25±11.06	
Height (cm)	Diabetics	50	147.19±15.23	0.001
	Nondiabetics	50	130.76±15.30	
Hb (g/dl)	Diabetics	50	12.61±0.75	0.04
	Nondiabetics	50	12.89±0.64	
WBC	Diabetics	50	9.34±1.56	0.001
	Nondiabetics	50	8.14±1.88	
Platelet count	Diabetics	50	290.66±80.58	0.94
	Nondiabetics	50	291.82±85.41	
MPV	Diabetics	50	9.60±1.13	0.001
	Nondiabetics	50	8.07±0.87	
PDW	Diabetics	50	11.91±1.18	0.001
	Nondiabetics	50	10.03±1.12	
P-LCR	Diabetics	50	19.34±4.85	0.001
	Nondiabetics	50	12.09±4.37	

SD: Standard deviation, Hb: Hemoglobin, WBC: White blood cell, MPV: Mean platelet volume, PDW: Platelet distribution width, P-LCR: Platelet-large cell ratio

individuals except for platelet count. A *t*-test was used to analyze the difference between both groups, and *P* value was calculated for each variable separately. The mean age of diabetic children was higher (11.46 years) than nondiabetic participants (8.13 years) and $P = 0.001$.

Discussion

In this study, we selected a group of patients with diabetes and a group of nondiabetic healthy persons to compare hematological parameters between them. In our study, we observed that the Hb as an index of anemia was significantly lower among patients with diabetes compared to nondiabetic controls.

In a cross-sectional survey of patients with diabetes in a single clinic, Thomas *et al*.[10] found that nearly a quarter of all outpatients had anemia. While several factors contribute to the increased prevalence of anemia in diabetes, the failure of the kidney to increase erythropoietin in response to falling Hb appears to be the dominant factor. The previous report indicated that the occurrence of anemia in DM is due to the increased nonenzymatic glycosylation of red blood cell membrane proteins, which correlates with hyperglycemia.[11,12] Anemia in diabetics is more complex and multifactorial and in addition to erythropoietin deficiency, other causes can be inflammation, nutritional deficiencies, autoimmune disease, drugs, or hormonal changes.[13]

The total WBC count was significantly higher among diabetics compared to nondiabetics. Previous studies indicate increase in peripheral leukocyte count as a result of DM.[14-16] Ford suggested that elevation of leukocyte provides partial support to the supposition that inflammation is a pathogenesis aspect for diabetes.[17]

DM is considered as a prothrombotic state characterized by increased platelet activation and coagulation and decreased fibrinolytic activity.[18] In diabetes, there is an alteration in all the systems that maintain the integrity and patency of the blood vessels, and a vicious circle of events is initiated in the vascular wall which includes platelet hyperactivity and dysfunction, increased inflammation, altered coagulation, and endothelial dysfunction.[19]

Previous studies have shown that in DM there is increased production of platelets and circulation of large, young and activated platelets which undergo more frequent episodes of the release of granules, accelerated sequestration in the circulation and have reduced survival.[20] The alteration of platelets in diabetes is an increase in its size and hyperactivity, and these changes are proposed to be caused due to hyperglycemia, insulin deficiency and resistance, associated metabolic conditions, and other cellular abnormalities including endothelial dysfunction, oxidative stress, and inflammatory state.[21] These altered platelet function and activity cause thrombus formation.

In our study, we found that MPV, PDW, and P-LCR were elevated in patients with diabetes than nondiabetic individuals which are in accordance with Malachowska *et al*.,[22] changes in MPV reflects the state of the production of platelets. A procoagulant effect is generated by elevated MPV, which leads to thrombotic vascular complications.[23] Children with T1DM have elevated platelet volume, wider platelet size distribution width, and increased percentage of large platelets.

Studies conducted on patients with T2DM found a significant relationship between micro- and macro-vascular complications and MPV.[20,24] This had led us to hypothesize that even a small increase of MPV might reflect a higher propensity for vascular complications in patients with diabetes than healthy peers.

Conclusion

The study revealed that hematological parameters changed as a result of DM, especially Hb was decreased among patients with diabetes and WBC, MPV, PDW, and P-LCR were highly elevated in type I as compared with nondiabetic individuals. We recommend the routine hematological monitoring of patients with type 1 diabetes to prevent complications associated with disturbed hematological values in this group of patients.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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