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Evaluation of mean platelet volume/platelet count ratio before and after Iron deficiency anemia treatment

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Abstract:
Background: *Iron deficiency anemia (IDA) is the most common diet-related anemia and a major public health problem worldwide. Iron reduces megakaryopoiesis, so IDA contributes to micro thrombosis. Iron treatment improves thrombocytosis.*
Objective: *The purpose is to assess the importance of mean platelet volume (MPV)\platelet count ratio in the diagnosis of iron deficiency anemia.*
Patients and methods: *From the 10th November 2020 to 30th June 2021 in the pediatric unit of the AL-Karama teaching hospital, a retrospective study was carried out. A total of 51 patients diagnosed with iron deficiency anemia (35 were males, and 16 were female).*
Result: *The mean patients' age was 4.9 years, ranging from (3-240) months. In the pretreatment phase, the mean Hb was 8.1 g/dl, mean MCV was 60.7 fL, the MPV was 5.6 fL, and MPV/PLT ratio was 0.012. In the post-treatment phase, the mean Hb was 10.7 g/dl, mean MCV was 68.2 fL, the MPV was 6.7 fL, and MPV/PLT ratio was 0.02, and the p value was (0.01), significantly higher in post treatment group than those in pretreatment group and all patients responded to treatment.*
Conclusion: *MPV/PLT ratio displayed a simple but good marker in diagnosis and follow up of treatment of IDA.*
Keywords: *Iron deficiency anemia, mean platelet volume, MPV/PLT ratio*

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I. Introduction:

Iron is an important element presents during a range of molecular systems and it is recognized as a vital cofactor for variety of molecular structures [1]. It's the essential element for the assembly of new red blood cells (RBC). If it is not utilized in organic process, it is hold on as protein or pigment [2]. It's been estimated that 30% of the population suffers from IDA and most of them in the developing countries [3]. In developing countries, iron deficiency and iron-deficiency anemia generally result from poor dietary intake, loss of blood because of enteral worm colonization, or both. In high-income countries, consumption habits (e.g. a vegetarian diet or no intake of red meat) and pathologic conditions (e.g. chronic blood loss or malabsorption) are the foremost common causes. Paradoxically, it seems to be the prevalence of iron-deficiency anemia in high-income countries higher than in lower income countries. One reason for this that the high rate of iron deficiency in aging populations [4]. However, since excess levels of iron are often toxic, its absorption is restricted to 1 to 2 mg daily, and most of the iron required daily (about 25 mg per day) is provided through the macrophages that phagocytose ageing erythrocytes. The latter two mechanisms are controlled by the endocrine hepcidin, that maintains total-body iron inside traditional ranges, avoiding each iron deficiency and excess [5]. Platelets play an important role in blood vessels. After being formed by megakaryocytes, platelets exist in the bloodstream for 5-7 days, mainly as a regulator of hemostasis and thrombosis. Due to a vascular insult or injury, the platelets in the blood are activated, causing adhesion to the extracellular matrix exposed under the endothelium, forming platelet plug, and finally forming and consolidating a thrombus composed of a core and a thrombus membrane [6].

The size and functional activity of circulating platelets vary. Larger platelets may be younger, more reactive, and produce more thrombotic factors, Mean platelet volume (MPV) reflects the size of platelets. It is

an important marker of platelet function [7]. Although MPV measurement provides clinically useful information, it is still a research tool that has not yet been incorporated into daily clinical decision-making [8]. Iron isn't solely related to erythropoiesis; however, it additionally suppresses megakaryopoiesis. Physiologically, iron plays a vital role in hematopoiesis, as well as thrombopoiesis; iron levels direct, alongside genetic factors, the lineage commitment of megakaryocytic /erythroid progenitors toward either bone cell or blood cell progenitors [9]. Thrombocytosis, possibly favoring vascular thrombosis, is a classical feature observed with abnormally low total body iron stores [10]. MPV/PLT ratio quantitative relation has been projected as a new parameter for the prediction of long-term mortality in patients with cardiac diseases, while iron therapy corrects the symptoms and normalizes peripheral thrombocytes it should be given precisely because it causes an increase in thrombocytes into peripheral blood. Iron therapy should be in caution to patients with thrombosis, heart disease, and ischemic stroke.

So, in this study we aimed to investigate and analyze MPV and MPV/PLT ratio in patients with IDA.

Aim:

This study was conducted to assess the importance of MPV\PLT ratio in the diagnosis and treatment follow up of IDA.

Materials and methods:

Study design and sampling technique: A retrospective study (From the 10th November 2020 to 30th June 2021) in hematology center in the pediatric unit of the AL-Karama teaching hospital. This study targeted children with IDA.

Data collection: The cases in this study were referred to hematology center as cases of undiagnosed anemia. A total of 51 patients (35 were males, and 16 were female), investigations that was needed to confirm the diagnosis of anemia was made. The information of the patients like gender, age and other parameters obtained from the medical file of the patients. Depending on data information, the patients were considered as cases of IDA. The patients with hypochromic microcytic anemia other than IDA were excluded depending on normal iron parameters and/or abnormal Hb electrophoresis.

Statistical analysis: All data were organized and analyzed using Computerized statistical package for social sciences (SPSS) version 25.0. SPSS software was used to detect paired sample – test, independent sample T test and P values < 0.05 were considered significant. Mean and standard deviation (SD) was used to express data. Roc curve was used to determine the level of cutoff MPV/PLT point.

II. Results:

This study analyzed fifty-one pediatric patients who were referred to haemato- oncology center in AL-Kut city. The patients were diagnosed as cases of IDA depending on clinical data and laboratory investigations such as CBC, blood film, iron profile and Hb electrophoresis (in some cases). Male to female ratio was 2.1:1 (35 patients were male and 16 patients were female). The mean age of patients was 59.3 months (4.9 years) ranging from (3 to 240) months. The mean Hb is 8.1 g/dl with range (4.4 to 15.2 g/dl) and mean RBC was 4.6 g/dl. The mean MCV was 60.7 fL, the mean of MCH, and MCHC were 17.5 pg, 28.6 g/dl respectively. The mean MPV was 5.6, PLT count was 464,000 and the MPV/PLT ratio has a mean of 0.016. (Table.1)

Table 1: RBCs indices of patients with IDA before treatment

Item	N	Minimum	Maximum	Mean	SD
Age in months	51	3	240	59.3	62.4
RBC $X10^{12}$/L	51	2.72	6.02	4.6	0.68
Hb g/dl	51	4.42	15.20	8.11	2.2
HCT %	51	17.80	43.70	27.9	5.4
MCV (fL)	51	48.0	86.8	60.7	7.6
MCH (pg)	51	11.0	30.1	17.5	3.7
MCHC g/dl	51	22.1	34.7	28.6	3.0
RDW %	51	11.30	29.1	17.9	4.4
MPV (fL)	51	4.33	9.00	5.6	1.1
Platelet ($X10^3$/L)	51	99	1699	464.08	257.8
MPV/PLT ration	51	0.0028	0.054	0.016	0.009

Changes in blood parameters after iron therapy was reported and documented. The level of mean Hb is 10.7 g/dl and mean RBC was 4.9 g/dl. The mean MCV was 68.2 fL, the mean of MCH, MCHC were 21.4 pg, and 31.2g/dl respectively. The mean RDW was 17.9% and MPV was 6.7, platelet count was 377,200. The MPV/PLT ratio has a mean 0.02. These findings are shown in Table. 2.

Table 2: RBCs indices of patients with IDA after treatment

Item	N	Minimum	Maximum	Mean	SD
RBC $X10^{12}$/L	44	3.05	6.18	4.9	0.5
Hb g/dl	44	5.89	21.10	10.7	2.5
HCT %	44	20.90	42.10	33.6	4.9
MCV (fL)	44	55.4	84.9	68.2	6.9
MCH (pg)	44	13.4	28.6	21.4	3.6
MCHC g/dl	43	24.1	37.6	31.2	2.6
RDW %	43	11.4	35.2	18.4	6.0
MPV (fL)	41	4.27	9.71	6.7	1.2
Platelet ($X10^3$/L)	44	188	1146	377.2	162.1
MPV/PLT ratio	44	0.0032	0.03	0.02	.0081

Further statistical analysis has shown that there were statistically significant changes in MPV/PLT ratios, it was 0.016 before treatment and become 0.02 after treatment has been taken. (Table.3)

Table 3: Means of blood parameters before and after treatment

	Pretreatment	Post treatment	P value
RBC $X10^{12}$/L	4.6	4.9	0.0001
HB (g/dl)	8.11	10.7	0.0001
HCT %	27.9	33.6	0.0001
MCV (fL)	60.7	68.2	0.0001
MCH (pg)	17.5	21.4	0.0001
MCHC (g/dl)	28.6	31.2	0.0001
RDW %	17.9	18.4	0.9
MPV	5.6	6.7	0.001
Platelet ($X10^3$/L)	464.08	377.2	0.06
MPV/PLT ration	0.016	0.02	0.01

Error bar chart, of MPV/PLT ratio before and after the treatment shows
A 95% confidence limit.

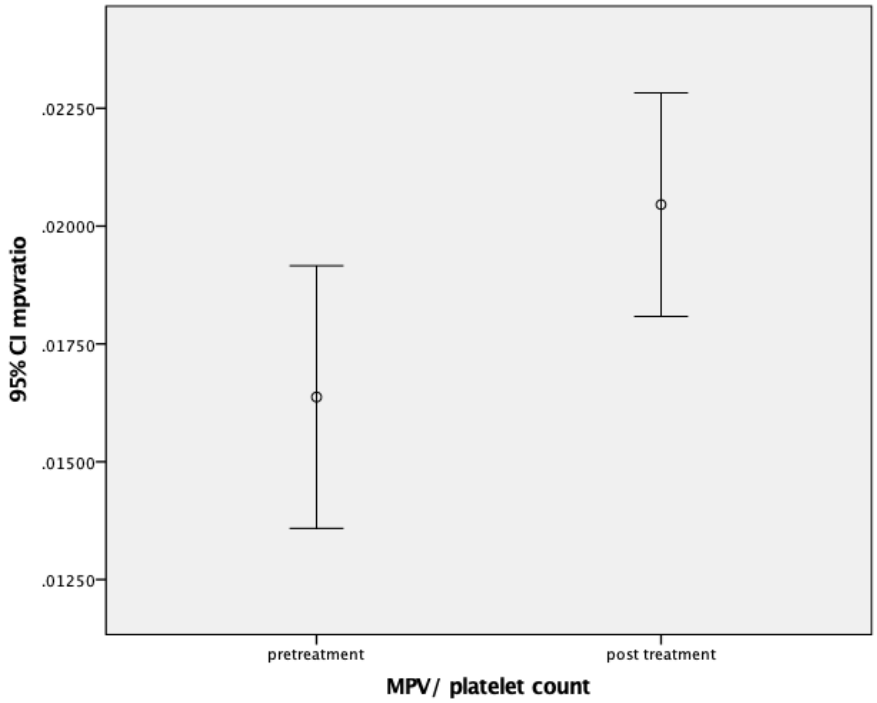

Fig.1: Error bar chart, MPV/PLT ration

Table 4 show no significant relationship between MPV/PLATE COUNT and gender either male or female, before and after treatment.

Table 4: RBCs indices before and after treatment according to gender

Item	Gender	N	Mean	SD	SE	P value
MPV/PLT ratio						
Before treatment	Male	35	0.0159	0.010	0.001	0.007
After treatment	Male	31	0.0208	0.0079	0.001	
MPV/PLT ratio before						
treatment	Female	16	0.0179	0.009	0.002	0.5
After treatment	Female	13	0.0195	0.0078	0.002	

The area under the curve (AUC) was 0.68 with a significant p-value (0.002). By this means, the platelet /MPV ratio at level 0.015, can help the pediatrician to have a high index of suspicion to diagnose IDA. (Figure 2)

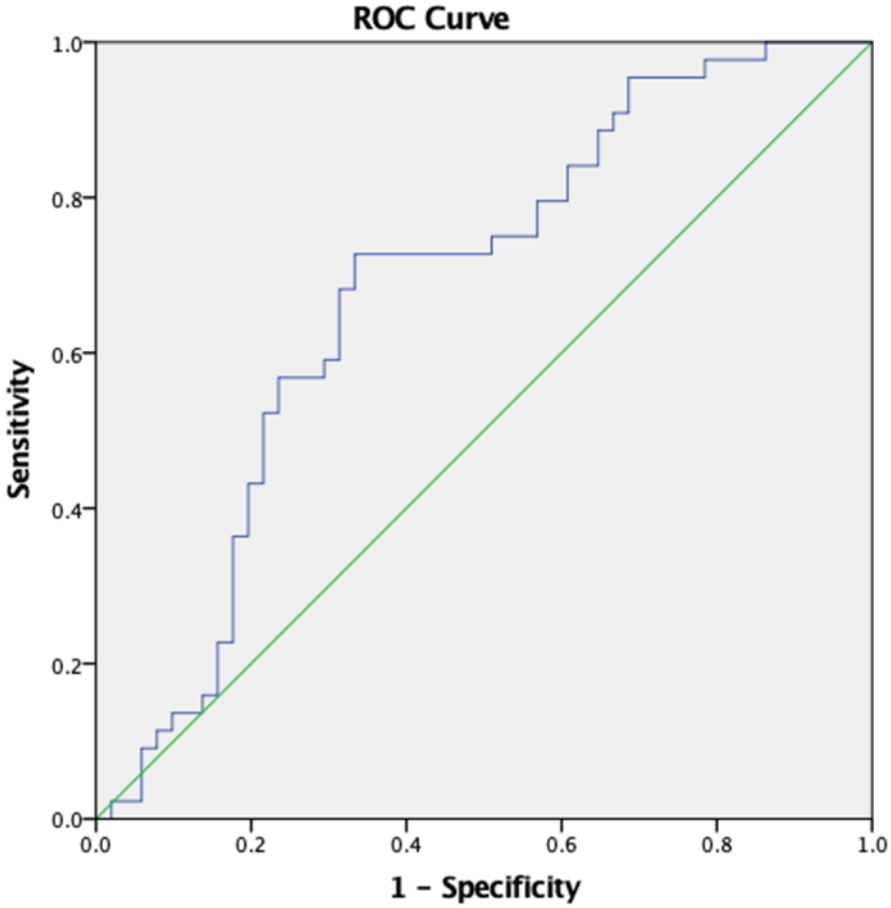

Fig.2: ROC curve analysis of MPV/PLT ratio.

III. Discussion:

The data have shown elevation of Hb, MCV, MPV and decrease in platelet count levels following oral iron treatment in patients with IDA. Iron deficiency is the leading cause of anemia and affects nearly a quarter of the world's population. IDA generally occurs in children due to decreased food intake and in young women due to menstruation. The laboratory investigation in the pretreatment phase shown as the lowest Hb level was reported was 4.4 (g/dl) with mean 8.1(g/dl). The mean HCT was 27.9 (L/L), mean MCV was 60.7(fL) and mean MPV was5.6 (fL). In the post treatment phase shown as the lowest Hb level was reported was 5.8 (g/dl) with mean 10.7(g/dl). The mean HCT was 33.6 (L/L), mean MCV was 68.2(fL) and mean MPV was 6.7 (FL). Another study was performed at Adnan Mendere university, Hb was 10±1.4(g/dl), MPV was 8.7±1.4(FL) and MCV was 70.7±1.4(FL), this may be due to late diagnosis in the current study which made such a different result. Reactive thrombocytosis recovers immediately after iron supplementation [11]. In humans, intracellular iron is stored as ferritin making this protein important in maintaining iron levels. Hematologic parameters of IDA include: low serum ferritin, low iron, increased total iron binding capacity, increased erythrocytes, protoporphyrin, and increased transferrin binding receptor levels [12]. In a previous study, thrombocytes and MPV levels were compared before and after 8 weeks of oral ferrous sulfate (4 mg/kg/day) in children [13]. In the current study MPV was found to be increased even though thrombocytes number decreased following iron

therapy. The duration and degree of IDA may play a role in determining the mechanism of platelet production. It has been reported to stimulate megakaryogenesis in IDA. In moderate IDA, the causes of thrombocytosis may be: 1) increased influx rate of primary cells into the megakaryocyte compartment with increased flow rate 2) shortening of giant cell maturation; 3) transformation of stem cells due to inhibition of erythropoiesis, which leads to increased production of other pluripotent cells (hemostatic compensation mechanism); 4) effect of transferrin stimulator on nuclei formation; and 5) iron inhibition on megakaryocytes maturation [14].

Iron treatment may lead to the release of active and large thrombocytes into peripheral blood. Iron stimulation of oxidative stress may lead to increased MPV. Iron inhibition of megakaryocytes may lead to slower and normal or exaggerated maturation. In addition, iron overload can lead to increased platelet aggregation. Excess iron can increase oxidative stress, which increases platelet aggregation [15]. The current study shows male gender was more than female. There is conflicting evidence with regard to the relationship between sex and IDA in children. Contrary to our study, data from Yemen and India found a higher prevalence of IDA in girls than boys [16,17]. However, studies from Western Kenya and Haiti found boys to be more at risk [18, 19]. Many quantitative details obtained from the 2011-2012 Pakistan National Nutrition Survey; UNICEF reported a total of 7,138 children aged 6-59 months 3439 were female and 3699were male. Another study was conducted in the Rece Tayyip Erdogan University, a total of 80 patients with IDA, the research involved 70 females and 10 males [20]. The difference may be attributed to the small size sample. A 95% confidence limit means that there is only a 5% chance that the true value is not included within the span of the error bar. From the MPV/PLT ratio of the ROC curve study in both pre and post treatment period, the tolerance was 74% and the precision was 45%. At the cut-off level of 0.015, AUC is 0.68, and P-value 0.002. In another study from Korea, ROC curve test MPV/PLT ratio in pre and post treatment period, tolerance was 72.7% and specificity was 79.6% at a cut-off rate of 0.0318 with significant p-value (0.001) [21]. By this means, the MPV/PLT ration at level 0.015, can help the pediatrician to have a high index of suspicion to diagnose IDA.

Limitations:

The period during which this study was conducted was short. Due to the spread of the coronavirus pandemic the number of participants was less than expected. The inability to exclude confounding factors such as obesity or other medical condition may also contribute to the results.

IV. Conclusion:

Reliance on available data, the MPV/ PLT ratio displayed an outstanding performance in diagnosis of IDA, the physician should pay attention for this figure. It can be expected to be utilized as one of panels along with conventional biochemical markers such as iron, TIBC, and serum ferritin.

References:

[1]. Gunawardena S, Dunlap ME. Anemia and iron deficiency in heart failure. Curr Heart Fail Rep 2012; 9:319-27.
[2]. Winter WE, Bazydlo LA, Harris NS. The molecular biology of human iron metabolism. Lab Med 2014; 45:92-102
[3]. Jameel T, Baig M, Ahmed I, Hussain MB, Alkhamaly MBD. Differentiation of beta thalassemia trait from iron deficiency anemia by hematological indices. Pak J Med Sci. 2017;33(3):665-669.
[4]. Kassebaum NJ, Jasrasaria R, Naghavi M, et al. A systematic analysis of global anemia burden from 1990 to 2010. Blood. 2014;123(5):615-624.
[5]. Goodnough LT, Nemeth E, Ganz T. Detection, evaluation, and management of iron-restricted erythropoiesis. Blood. 2010;116(23):4754-4761.
[6]. Holinstat M. Normal platelet function. Cancer Metastasis Rev. 2017;36(2):195-198.
[7]. Park Y, Schoene N, Harris W. Mean platelet volume as an indicator of platelet activation: methodological issues. Platelets. 2002;13(5-6):301-306.
[8]. Lancé MD, van Oerle R, Henskens YM, Marcus MA. Do we need time adjusted mean platelet volume measurements?. Lab Hematol. 2010;16(3):28-31.
[9]. Park MJ, Park PW, Seo YH, et al. The relationship between iron parameters and platelet parameters in women with iron deficiency anemia and thrombocytosis. Platelets. 2013;24(5):348-351.
[10]. Brissot E, Troadec MB, Loréal O, Brissot P. Iron and Platelets: a subtle, under-recognized relationship. American Journal of Hematology. 2021; 96(8):1008-1016.
[11]. Kadikoylu G, Yavasoglu I, Bolaman Z, Senturk T. Platelet parameters in women with iron deficiency anemia. J Natl Med Assoc. 2006;98(3):398-402.
[12]. van Tellingen A, Kuenen JC, de Kieviet W, van Tinteren H, Kooi ML, Vasmel WL. Iron deficiency anaemia in hospitalised patients: value of various laboratory parameters. Differentiation between IDA and ACD. Neth J Med 2001;59:270-279.
[13]. Kürekçi AE, Atay AA, Sarící SU, Zeybek C, Köseoðlu V, Ozcan O. Effect of iron therapy on the whole blood platelet aggregation in infants with iron deficiency anemia. Thromb Res 2000; 97:281-5.
[14]. Stenberg PE. Hill RJ. Clusters and giant cells. In: Lee GR. Foerster J. Lukens J, et al, eds. Clinical Hematology. Baltimore, Williams and Wilkins, 10th ed. 1999. 1178-1199.
[15]. Praticó D, Pasin M, Barry OP, et al. Iron-dependent human platelet activation and hydroxyl radical formation: involvement of protein kinase C. Circulation. 1999;99(24):3118-3124.
[16]. Keikhaei B, Zandian K, Ghasemi A, Tabibi R. Iron-deficiency anemia among children in southwest Iran. Food Nutr Bull. 2007;28(4):406-411.
[17]. Kaur, IP, and S. Kaur. "A Comparison of Nutritional Profile and Prevalence of Anemia among Rural Girls and Boys." 2011.

Journal of Exercise Science and Physiotherapy, 2011;7(1):11–18.
[18]. Foote EM, Sullivan KM, Ruth LJ, et al. Determinants of anemia among preschool children in rural, western Kenya. Am J Trop Med Hyg. 2013;88(4):757-764.
[19]. Ayoya MA, Ngnie-Teta I, Séraphin MN, Mamadoultaibou A, Boldon E, Saint-Fleur JE, Koo L, Bernard S. Prevalence and Risk Factors of Anemia among Children 6-59 Months Old in Haiti. Anemia. 2013;2013:502968.
[20]. Habib MA, Black K, Soofi SB, Hussain I, Bhatti Z, Bhutta ZA, Raynes-Greenow C. Prevalence and Predictors of Iron Deficiency Anemia in Children under Five Years of Age in Pakistan, A Secondary Analysis of National Nutrition Survey Data 2011-2012. PLoS One. 2016 May 12;11(5):e0155051.
[21]. Cho SY, Yang JJ, You E, Kim BH, Shim J, Lee HJ, Lee WI, Suh JT, Park TS. Mean platelet volume/platelet count ratio in hepatocellular carcinoma. Platelets. 2013;24(5):375-7