Original Article

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Quick Response Code:

Website: www.ijhonline.org

DOI: 10.4103/ijh.ijh_28_23

Evaluation of platelet count and platelet distribution width during normal pregnancy course

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Abstract:

BACKGROUND: Platelet (PLT) counts (PCs) underwent various changes during pregnancy that occur due to hormonal profiles. A reduction in PC is the major event that occurs in PLT disorder during pregnancy. The common laboratory and clinical findings of these disorders make the diagnosis challenging.

OBJECTIVES: The study aimed to evaluate the effect of pregnancy on PLT indices among healthy pregnant ladies.

METHODS: A case–control hospital-based study was carried out from February 2020 to February 2021 on 150 participants, 100 of them were healthy pregnant Sudanese ladies at different trimesters (36 pregnant in 1st trimester, 33 pregnant in 2nd trimester, and 31 pregnant in 3rd trimester). The control group included 50 healthy nonpregnant Sudanese ladies matched according to age and body mass index. A structured questionnaire was used covering data about demographic history, trimetric period, number of pregnancies, and parity. Five milliliters of blood samples was obtained for the measurement of PLT indices using Sysmex KX-21 automated hematology analyzer. Data were analyzed using the SPSS computer programs version 2S. Independent sample *t*-test was used to compare the PLT indices between the healthy pregnant and nonpregnant (control). $P \leq 0.05$ is considered statistically significant.

RESULTS: The mean of participant's age was found to be 25 years (range of 18–45 years) and all of the participants were within the reproductive age. In all pregnant groups, the mean of PCs, mean PLT volume (MPV), and PLT distribution width (PDW) were found to be 284.3 ± 71.7 × 10^3/μL, 8.8 ± 1.0 fL, and 13.7 ± 2.5, respectively. While in control groups, the mean of PCs, PMV, and PDW was found to be 218 ± 14.4 × 10^3/μL, 10.3 ± 3.2 fL, and 11.5 ± 2.5, respectively. The MPV was not significantly changed during pregnancy ($P = 0.774$). However, the changes in the PC and PDW between the pregnant and nonpregnant (control) group were significant with a $P = 0.020$ and 0.007, respectively. In the course of pregnancy, the PC in the first, second, and third trimesters was found to be 312 ± 78.3 × 10^3/μL, 268 ± 62.5 × 10^3/μL, and 273 ± 65.8 × 10^3/μL with only statistically significant change between the 1st and 2nd trimesters of pregnancy ($P = 0.027$). The MPV in the first, second, and third trimesters was found to be 8.7 ± 0.92 fL, 8.9 ± 1.1 fL, and 8.8 ± 1.0 fL, with no statistically significant change during the course of pregnancy. The PDW in the first, second, and third trimesters was found to be 12.8 ± 2.6, 13.7 ± 2.5, and 15 ± 1.8 with only statistically significant change between the 1st and 3rd trimesters of pregnancy ($P = 0.001$).

CONCLUSION: The PC and PDW increase significantly during pregnancy in comparison to the control group. PC has the highest reading in the first trimester, and the PDW has the highest reading in the third trimester in comparison to the other trimesters. On the other hand, the MPV is nonsignificantly decreased throughout the three trimesters of pregnancy in comparison to the general population. These new values, which are most likely due to the hormonal profile of pregnancy, should be taken into consideration.

Keywords:

Mean platelet volume, platelet distribution width, platelet count, pregnancy

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Submission: 11-03-2023
Revised: 12-04-2023
Accepted: 15-04-2023
Published: 30-05-2023

How to cite this article: Ali IA, Ahmed ME. Evaluation of platelet count and platelet distribution width during normal pregnancy course. Iraqi J Hematol 2023;12:93-7.

Introduction

Platelets (PLTs) are small, granulated bodies that play a vital role in certain physiological activities. They half-life of approximately was 4 days. The megakaryocytes are the precursor of the PLT. The majority of PLT are circulating and the remaining cells are found in the spleen.[1]

PLTs contain certain elements that serve their function, for example, actin, myosin molecules, endoplasmic reticulum, and the Golgi apparatus for enzymatic syntheses and calcium storage. In addition, it has mitochondria and enzyme systems, which are used for the production of energy. In PLTs, prostaglandins cause local tissue and vascular reaction. Moreover, it contains a fibrin-stabilizing factor, which has a vital role in the coagulation process and growth factors that stimulate the process of healing and repair.[2]

Mean PLT volume (MPV) is defined as the average apparent volume of all particles in a blood sample that is counted as individual PLTs. Whereas PLT distribution width (PDW) is a measurement of PLT anisocytosis calculated from the distribution of individual PLT volume.[1]

Pregnancy is the period of development of the fetus and it lasts approximately 40 weeks. The levels of estrogen and progesterone increase steadily throughout pregnancy. They maintain endometrium, prepare the breast for lactation, and suppress new ovarian follicle development. The corpus luteum is the main source of these hormones in the first trimester. While the placenta takes place in mid-to-late pregnancy.[3]

Nitric oxide (NO) is secreted from PLTs and endothelial cells with very short half-life of 3–5 s. Its major role is to inhibit PLT aggregation and cause vasodilatation. Moreover, prostacyclin does the same function as (NO) by raising cyclic guanosine monophosphate levels. An ectonucleotidase (CD39) acts as an ATPase and prevents PLT aggregation in healthy vessels.[4]

Gestational thrombocytopenia is recognized when the PLT count (PC) is being <150,000/mm^3 during a healthy pregnancy. Reduction in the mean of PCs is reported in the first trimester of normal pregnancy. Another

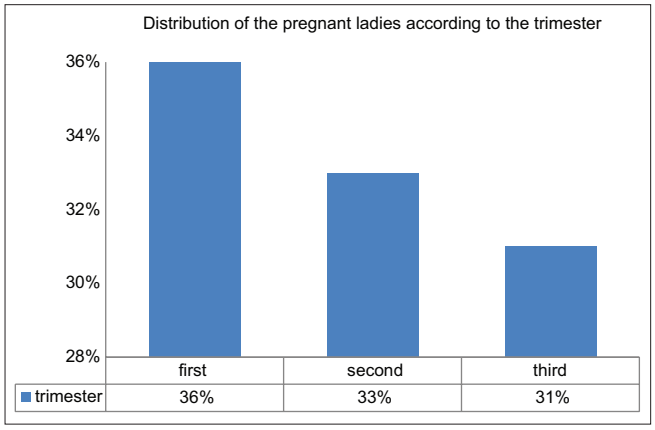

Figure 1: The distribution of the pregnant ladies according to the trimester, *n* = 100

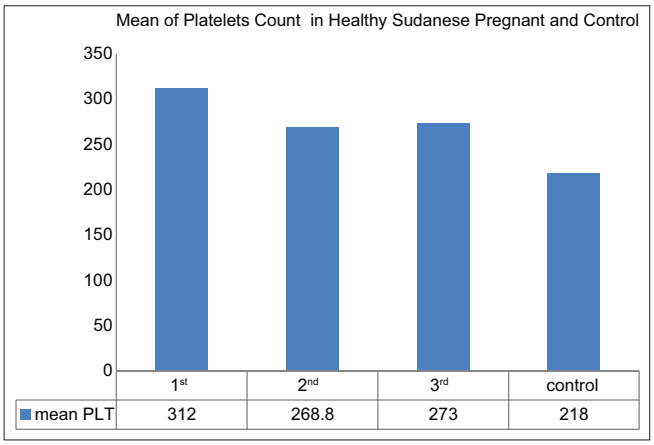

Figure 2: The mean platelet count of pregnant ladies according to the trimester in comparison to nonpregnant *n* = 150

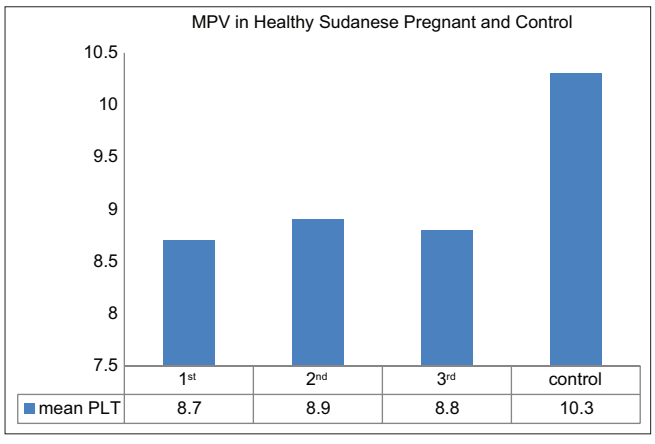

Figure 3: The mean MPV of pregnant ladies according to the trimester in comparison to nonpregnant *n* = 150. MPV = Mean platelet volume

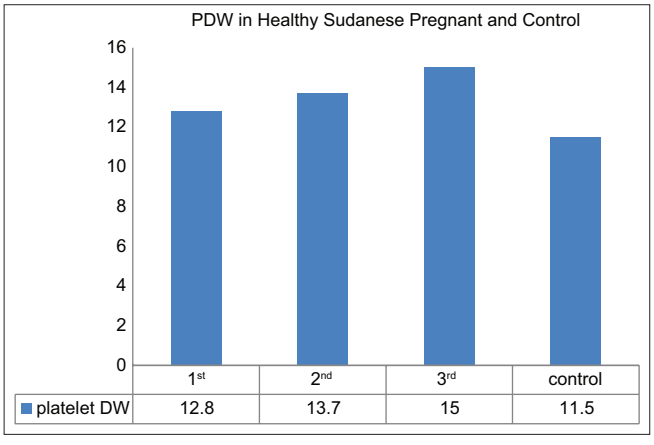

Figure 4: The mean PDW of pregnant ladies according to the trimester in comparison to nonpregnant *n* = 150. PDW = Platelet distribution width

cause of thrombocytopenia apart from pregnancy or its complications should be considered if a PC of <100,000/mm^3 is recorded.[5]

In Italy, in 2011 Maconi *et al*. conducted a study to investigate the effects of different pathological conditions associated with pregnancy (preeclampsia, gestational diabetes, autoimmune disorders, and some viral infections) on PLT indices. Furthermore, they found that MPV is a significant change in preeclampsia and gestational diabetes.[6]

Vagdatli *et al*.'s study concluded that the PC and hemoglobin concentration had a mild decrease throughout pregnancy. However, there was a substantial increase in MPV, PDW, and white blood cells.[7]

Regarding the Sudanese' reference for hematological indices, a study was carried out by Taha *et al*. on 1076 healthy Sudanese adults and found that the median of PC was 280 × 103/μL (ranging of 124–465 × 103/μL), for PDW was 14.6% (ranging of 9.1–17.1), and for the MPV was 9.8 (ranging 8–13.2FL). Females had a significantly higher PC (295 × 103/μL) than males (245 × 103/μL) [Figure 1].[8]

The aim of this study was to evaluate the effect of pregnancy on PLT indices among healthy Sudanese ladies attending antenatal care clinics at the National Ribat University Hospital from January to March 2021.

Methods

This case–control hospital-based study was conducted during January–March 2021 on 150 healthy Sudanese ladies. One hundred of them were pregnant and attending the antenatal clinic at the National Ribat University Hospital for follow-up and 50 nonpregnant ladies from the general population who served as the control group and who were matched based on age and body mass index for the pregnant group.

Informed written consent was obtained from any participant after explaining the purpose of the research. An interview questionnaire was filled out by the investigators to obtain relevant data that included age, trimester, type of pregnancy single or multiple, trimester, any comorbidity, any antenatal supplement, hormonal contraceptive, and recent transfusion history. Those who diagnosed with bone marrow or blood disorders, recent malaria or infections, drugs may affect PLT indices, any chronic diseases or those who used hormonal contraception within the last 5 years were excluded from the study. Five milliliters of venous blood was collected by a standard procedure under complete aseptic conditions in an ethylenediaminetetraacetic acid container for laboratory workup of PLTs. PLT indices were measured using Sysmex KX-21 automated hematology analyzer.

Data analysis

Data were analyzed using the SPSS software version 25.0 (IBM Corp. SPSS Inc. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk,NY, USA). Independent sample *t*-test was used to compare the PLT indices between the cases and control. $P \leq 0.05$ was considered statistically significant.

Ethical consideration

The objectives of the study were explained to all the individuals participating in the study. Informed consent was obtained from each participant in the study. Ethical approval of this study was obtained from the Faculty of Medicine, National Ribat University.

Results

This case–control hospital-based study aimed to evaluate the effect of pregnancy on PLT indices. One hundred and fifty healthy ladies participated in the study, 100 of them were pregnant and 50 were used as control following an individual matching process.

The majority of pregnant ladies had a single fetus with a percentage of 97% and only 3% of them had multiple fetuses.

In the pregnant groups, the mean of PCs, MPV, and PDW was found to be 284.3 ± 71.7 10^3/μL, 8.8 ± 1.0 fL, and 13.7 ± 2.5, respectively. While in control groups, the mean of PCs, MPV, and PDW was found to be 218 ± 144.4 10^3/μL, 10.3 ± 3.2 fL, and 11.5 ± 2.5, respectively [Tables 1 and 2].

The MPV was not significantly changed during pregnancy. However, the changes in the PC and PDW between the pregnant and nonpregnant (control) group were significant with a $P = 0.020$ and 0.007, respectively [Tables 1 and 2].

Table 1: Descriptive statistics for platelet count among pregnant ladies and control group, mean platelet volume, and platelet distribution width (*n*=150)

Variable	Group	Mean±SD	Median	Minimum	Maximum
PC (10^3/μL)	Pregnant (*n*=100)	284.3±71.7	280	142	503
	Control group (*n*=50)	218±144.1	249	57	520
MPV/fL	Pregnant (*n*=100)	8.8±1.0	8.8	7	12
	Control group (*n*=50)	10.3±3.2	10	8	27.9
PDW	Pregnant (*n*=100)	13.7±2.5	15.3	9	17
	Control group (*n*=50)	11.5±2.5	10.9	7.8	18.5

PDW=Platelet distribution width, SD=Standard deviation, MPV=Mean platelet volume, PC=Platelet count

Table 2: Platelet indices changes during the pregnancy during all trimesters and in comparison with the control group

Trimester (indices/mean±SD)	1st trimester (*n*=36)	2nd trimester (*n*=32)	3rd trimester (*n*=31)	Control (*n*=50)	*P* (independent sample *t*-test)
PC (×10³/μL)	312±78.3	268±62.5	273±65.8	218±14.4	1st versus 2nd: 0.027
					1st versus 3rd: 0.130
					2nd versus 3rd: 0.498
					Pregnant versus control: 0.020
MPV/fL	8.7±0.92	8.9±1.1	8.8±1.0	10.3±3.2	1st versus 2nd: 0.109
					1st versus 3rd: 0.410
					2nd versus 3rd: 0.398
					Pregnant versus control: 0.774
PDW	12.8±2.6	13.7±2.5	15±1.8	11.5±2.5	1st versus 2nd: 0.168
					1st versus 3rd: 0.001
					2nd versus 3rd: 0.075
					Pregnant versus control: 0.007

Independent sample *t*-test was used and *P* value was generated. PDW=Platelet distribution width, SD=Standard deviation, MPV=Mean platelet volume, PC=Platelet count

Table 3: Relation between the platelet indices and the number of pregnancies (*n*=100)

Number of pregnancy	Test	Mean±SD	Median	*P*
Single fetus (*n*=97)	PC	284.8±69	277	0.517
	PMV	8.8±1	8.8	0.868
	PDW	13.8±2.4	15.3	0.149
Multiple fetuses (*n*=3)	PC	312±156.9	344	0.517
	PMV	8.7±1	8.6	0.868
	PDW	11.7±3.4	10.5	0.149

PDW=Platelet distribution width, SD=Standard deviation, MPV=Mean platelet volume, PC=Platelet count

The PC in the first, second, and third trimesters was found to be 312 ± 78.3 × 10^3/μL, 268 ± 62.5 × 10^3/μL, and 273 ± 65.8 × 10^3/μL with only statistically significant change between the 1st and 2nd trimesters of pregnancy (P = 0.027) [Figure 2].

The MPV in the first, second, and third trimesters was found to be 8.7 ± 0.92 fL, 8.9 ± 1.1 fL, and 8.8 ± 1.0 fL with no statistically significant change during the course of pregnancy [Figure 3].

The PDW in the first, second, and third trimesters was found to be 12.8 ± 2.6, 13.7 ± 2.5, and 15 ± 1.8 with only statistically significant change between the 1st and 3rd trimesters of pregnancy [P = 0.001, Tables 1 and 2]. No significant differences was reported between number of pregnancies and platelet indices [Table 3] [Figure 4].

Discussion

This study aimed to evaluate the effect of pregnancy on PLT indices among healthy Sudanese ladies attending antenatal care clinics at the National Ribat University Hospital during 2020–2021.

The range of PC for the pregnant group was (142–503 × 10^3/μL), the mean was 284.3 × 10^3/μL (standard deviation SD ± 71.7), and the median was 280 × 10^3/μL which was less than the median of the control group in this study (249.15 × 10^3/μL), but exactly similar to the reference range of PC in healthy adult Sudanese (280 × 10^3/μL) and[8] higher than the median in the study done at Algazira, Sudan (215.15 × 10^3/μL).[9]

The higher PCs of Sudanese pregnant ladies compared with the Algazira population may be due to the environmental differences between the two geographical areas and the gender difference, since the Algazira's study was done on males.

We have found that women in the first trimester had higher PCs compared to women in the second and third trimesters and this agreed with a previous studies.[5,10] This could be explained because of variations of the physiological increase in plasma volume by approximately 50% during the first and second trimesters in compared to physiological increase that occurs in red cell mass which is only 20-30%,[11] and this lead to progressive decrease in the PC during pregnancy since platelet production remains constant during pregnancy course. In addition, differences in the hormonal profiles during normal pregnancy where estradiol trigger the formation of PLT in the megakaryocytic cells.[5,6] However, the increase in PCs caused by the hormonal effect is cancelled by the reduction caused by the increase in plasma volume thus the PCs remain static.

The median of MPV of the study group was 8.8 fL which was lower than the control MPD median (9, 8 fL). Moreover, the median of MPV was lower compared with British and Sudanese studies (11.0) and (9.8 fL), respectively.[5,12] The MPV changes during inflammation, and it significantly increases in some conditions such a sepsis, cerebrovascular diseases and myocardial infarction, chronic pulmonary diseases, and respiratory

distress syndrome.[13,14] This could be explained by the fact that pregnancy is a state of immunosuppression.

MPV was insignificantly lower in the first trimester than in the second and third trimesters [Table 2], and this disagreed with Dangana *et al*.'s study which they found a significant reduction in the third trimester compared to the first and second trimester.[15]

Regarding the PDW in the control group the median was lower than the pregnant group and the range of PDW was higher in comparison with the study group. Moreover, the mean PDW of the studied group was slightly higher when comparable with the mean of a British study.[13]

In the current study, PDW was lower than the PDW in Italian, Brazilian, and Sudanese studies done among pregnant (14.14), (16.8), and (14.6), respectively.[6,16,17] This might be due to environmental or/and genetic factors. PDW does not increase during simple PLT swelling, so it can be regarded as more specific marker of PLT activation.[18]

Conclusion

The PC and PDW increase significantly during pregnancy in comparison to the nonpregnant group. PC has the highest reading in the first trimester, and the PDW has the highest reading in the third trimester in comparison to the other trimesters. On the other hand, the MPV is decreased in comparison to the general population, however, these changes were not significant throughout the three trimesters of pregnancy with the lowest reading observed during the first trimester in comparison to the other trimesters. These new values, which are most likely due to the hormonal profile of pregnancy, should be taken into consideration.

Limitations of the study

The present study had certain limitations. First, the sample size was not a big scale and the number of pregnant ladies with multiple pregnancies was not sufficient.

Acknowledgment

The authors would like to thank all volunteers who participated in this study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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