National Journal of Physiology, Pharmacy and Pharmacology

RESEARCH ARTICLE

Variation in erythrocyte and leukocyte counts before and after normal vaginal delivery

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Received: November 02, 2017; **Accepted:** November 22, 2017

ABSTRACT

Background: A woman's reproductive period begins at menarche and ends in menopause. It usually extends from 13 to 45 years. Many physiological and hematological changes do occur during the pregnancy period and after delivery. **Aims and Objectives:** The present study was done to evaluate the variations in red blood cell (RBC) and white blood cell (WBC) counts before and after normal vaginal delivery. **Materials and Methods:** A hospital-based cohort study conducted on 500 pregnant females who got admitted to labor room for delivery at McGann Teaching District Hospital, Shivamogga. Blood samples were taken during the time of their admission to labor ward and within 12–24 h after normal vaginal delivery and the cell counts were estimated using Sysmex KX-21 automated hematology analyzer. **Results:** The mean values of RBC count before delivery were found to be 4.4 millions/mm^3 with standard deviation of ±0.5 which dropped to 4 millions/mm^3 with standard deviation of ±0.5 on the 1st day of puerperium. The mean values of WBC count before delivery were found to be 12,495.6 cells/mm^3 with standard deviation of ±3663.5 cells/mm^3 which increased to 16,027 cells/mm^3 with standard deviation of ±3985.4 on the 1st puerperal day. **Conclusion:** Cell counts vary during pregnancy period as well as during the puerperal phase. Any gross variations in these cell counts suspect of pathological possibilities.

KEY WORDS: Puerperium; Red Blood Cell; White Blood Cell

INTRODUCTION

The three trimesters of pregnancy include various changes in digestive system, nutrition and metabolism, changes in circulatory system, respiratory system, integumentary system, changes in coagulation, and fibrinolysis which is been explained in various studies. Nearly, all organ systems undergo profound changes during normal pregnancy to meet the demands of the fetoplacental unit. There are both subtle and substantial changes in hematological parameters during pregnancy and the puerperium, orchestrated by changes in the hormonal milieu. A thorough understanding of these is important to avoid both over- and under-diagnosing abnormalities.

Access this article online	
Website: www.njppp.com	Quick Response code
DOI: 10.5455/njppp.2017.7.1145322112017	

During pregnancy, the total volume of blood increases by about 1.5 L, mainly to supply the needs of the new vascular bed. Nearly, 1 L of blood is contained within the uterus and maternal blood spaces of the placenta. Almost 25–80% of plasma volume gets expanded during mid-pregnancy. Red cell mass also gets increased by 10–20% with the net result in fall of hemoglobin (Hb) concentration.[1]

Red blood cell (RBC) mass begins to increase at 8–10 weeks of gestation and steadily increases by 20–30% (250–450 mL) above non-pregnant levels by the end of pregnancy in those

women who were receiving iron supplements.[2,3] Among women who were not on iron supplements, the red cell mass may increase only by 15–20%.[4] Erythrocyte life span is slightly decreased during normal pregnancy.[5]

There is increase in erythropoietin level by 50% in normal pregnancies and vary according to the presence of pregnancy complications.[6] Increased plasma erythropoietin induces the rise in red cell mass, which partially supports the higher metabolic requirement for oxygen during pregnancy.[7] Mean corpuscular volume decreases during pregnancy and averages 80–84 fL in the third trimester of pregnancy.[8]

White blood cell count (WBC) is increased in pregnancy with a typical reference range of 6×10^9–16×10^9/L.[9] Within few hours after delivery, healthy women have been documented to have WBC count of 9×10^9–25×10^9/L.[10] By 4-week postdelivery, typical WBC ranges are similar to those in healthy non-pregnant women (4×10^9–10×10^9/L). There has been much discussion about the normal ranges for the different types of white cells.[11]

The present study was done to evaluate the variations in RBC and WBC counts before and after normal vaginal delivery.

MATERIALS AND METHODS

The study was conducted on random sample of 500 pregnant females of 18–35 years undergoing vaginal delivery at McGann Teaching District Hospital, Shivamogga. The informed consent was explained to the participants in their vernacular language. The Institutional Ethical Committee clearance was obtained.

About 5 cc of blood samples were taken under aseptic precautions, during the time of their admission to labor ward (predelivery) and on the 1st puerperal day. Erythrocyte and leukocyte counts were estimated using SYSMEX KX-21 Automated Hematology analyzer.

Statistical Analysis

Data analysis was done by calculating the mean and standard deviation of descriptive statistics after entering the data in Microsoft Excel. Paired *t*-test was done to compare the values and check its significance levels. $P > 0.05$ is taken as not significant, <0.05 is significant, <0.01 is highly significant, and <0.001 is very highly significant.

RESULTS

Table 1 summarizes the mean and standard deviation of erythrocyte count during predelivery and on the 1st puerperal day, and *P* value of paired *t*-test. The mean ± standard deviation (SD) of predelivery RBC count was found to be 4.4 ± 0.5 millions/mm^3 of blood, and of the 1st puerperal day was 4 ± 0.5 millions/mm^3 of blood. This difference was statistically highly significant ($P < 0.0001$).

Table 2 summarizes the mean and standard deviation of leukocyte count during predelivery and on the 1st puerperal day, and *P* value of paired *t*-test. The mean ± SD of predelivery WBC was found to 12,495.6 ± 3663.5 cells/mm^3 which increased to 16,027 ± 3985.4 cells/mm^3 on the 1st puerperal day and this difference was statistically highly significant ($P < 0.0001$).

DISCUSSION

The current study has focused on variations in erythrocyte and leukocyte count before and after normal vaginal delivery. The mean ± SD of predelivery RBC count was found to be 4.4 ± 0.5 millions/cumm of blood, and of the 1st postpartum day was 4 ± 0.5 millions/cumm of blood as shown in Table 1. The difference was found to be statistically significant.

Blood volume is markedly raised during pregnancy. RBC volume is increased to the extent of 20–30%. The total increase in volume is about 350 ml. The disproportionate increase in plasma and RBC volume produces a state of hemodilution during pregnancy.[12] The advantages of relative hemodilution are: (i) Diminished blood viscosity ensures optimum gaseous exchange between the maternal and fetal circulation. This is facilitated by lowered oxygen affinity of maternal red cells observed in later half of pregnancy, (ii) It protects the woman against the adverse effects of supine and erect posture, and (iii) Protection of the mother against the adverse effects of blood loss during delivery.[13]

During pregnancy, to supply the demands of the new vascular bed and to compensate for blood loss occurring at delivery, the total blood volume increases by about 1.5 L.[14] Of this, within the uterus and maternal blood spaces of the placenta around 1 L of blood is contained. Therefore, in multiple pregnancies and in iron-deficient states increase in blood volume are more marked. There occurs 10–15% of plasma volume expansion by 6–12 weeks of gestation.[15,16]

During pregnancy, there is increase in plasma renin activity and atrial natriuretic peptide levels slightly reduce. This suggests that, the elevation in plasma volume during pregnant state, is in response to an underfilled vascular system resulting from systemic vasodilatation and increase in vascular capacitance, rather than actual blood volume expansion, which would produce the opposite hormonal profile instead (i.e., low plasma renin and elevated atrial natriuretic peptide levels).[17,18]

There is increase in red cell mass (driven by an increase in maternal erythropoietin production), but the increase

Table 1: RBC count during predelivery and on 1st postpartum day

Parameters	Mean±SD		*P* value
	Predelivery	1st postpartum day	
RBC (millions/mm^3 of blood)	4.4±0.5	4±0.5	<0.0001*

**P*<0.0001 is highly significant. SD: Standard deviation, RBC: Red blood cell

Table 2: WBC count during predelivery and on 1st postpartum day

Parameters	Mean±SD		*P* value
	Predelivery	1st postpartum day	
WBC (/cumm)	12,495.6±3663.5	16,027±3985.4	<0.0001*

**P*<0.0001 is highly significant. SD: Standard deviation, WBC: White blood cell

is relatively less, compared with the increase in plasma volume and net result being a dip in Hb concentration. Thus, there is dilutional anemia due to hemodilution. By the late second trimester, the drop in Hb is typically by 1–2 g/dL and stabilizes thereafter in the third trimester, when there is a reduction in maternal plasma volume (due to an increase in levels of atrial natriuretic peptide). Women who take iron supplements have increased in their red cell mass in a more proportionate manner leading to less pronounced changes in Hb, than those women who are not on hematinic supplements. The RBC indices change little in pregnancy.[19]

The initial fall in RBC count during puerperium may account for compensatory hemodilution which occurs following delivery. In the present study, predelivery RBC count was 4.4 ± 0.5 millions/cumm of blood which goes in line with the studies by Gebreweld on "Hematological profile of pregnant women at St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia" showing predelivery RBC count of 4.46 ± 0.47.[20] A study on 200 cases for "hematological and hemodynamic changes around puerperium" by Kumar RA showed similar findings for predelivery RBC count (3.8 ± 0.5) which decreased to 3.3 ± 0.49 on the 1st postpartum day which is consistent with our study findings.[21]

A descriptive study was conducted to improve the accuracy of visual estimation of blood loss during vaginal delivery by standardizing (using similar sized mops and a fixed container) and correlating with hematocrit changes. The study sample consisted of 250 women. In their study, the predelivery RBC count was found to be 3.8 ± 0.5 millions/cumm of blood which dropped to 3.3 ± 0.49 millions/cumm of blood on the 1st postpartum day.[22]

The mean ± SD of predelivery WBC count was found to be 12,495.6 ± 3663.5 cells/cumm of blood, and of the 1st postpartum day was 16,027 ± 3985.4 cells/cumm of blood as shown in Table 2. The difference was found to be statistically significant.

There is increase in WBC count in pregnancy with the lower limit of the reference range being 6000/cumm (8000/mm^3 and even to 20,000/cumm in labor). The increase may be due to rise in the levels of estrogen and cortisol in pregnancy due to the physiological stress induced.[23] In differential counts, neutrophils are the major type of leukocytes.[24,25]

In the first trimester of pregnancy, there is an absolute monocytosis but decreases as gestation advances. Monocytes by infiltrating the decidual tissue (7–20th week of gestation) possibly, through PGE_2-mediated immunosuppression help in preventing fetal allograft rejection.[26] In pregnancy, monocyte to lymphocyte ratio is markedly increased. However, eosinophil and basophil counts do not change significantly during pregnancy.[10]

There is brisk leukocytosis following delivery due to stress. Healthy women have been documented as having a WBC count varying from 9000 to 25,000/cumm few hours following delivery. By 4-week postdelivery, typical WBC ranges are similar to those in healthy non-pregnant women. By 4–12 weeks of delivery, their levels return to normal.[13]

The National Institute of Health states that both medications and stress can cause increase in WBC count. The immune system is designed to kick into action to manage or prevent disease, so this change occurs. The brain receives signals when feeling stressed, that there is a problem which needs to be addressed. The body may respond in part by increasing the activity of the immune system. This general reaction appears to occur during times of acute or short-term stress.[27]

Leukocytosis can be a reaction to various infectious, inflammatory, and, in certain instances, physiologic processes (e.g., stress and exercise). This reaction is mediated by several molecules, which are released or upregulated in response to stimulatory events that include growth or survival factors (e.g., granulocyte colonies stimulating factor, granulocyte macrophage colony stimulating factor, and c-kit ligand), adhesion molecules (e.g., CD11b/CD18), and various cytokines (e.g., interleukin-1, interleukin-3, interleukin-6, interleukin-8, and tumor necrosis factor).[28]

The mean WBCs were progressively increased from those during predelivery states of 12,495.6 ± 3663.5 to 16,027 ± 3985.4 cells/cumm of blood on the 1st postpartum day. The predelivery finding is similar to the studies by Eledo *et al.* 9000 ± 1.1, Gebreweld 8220 ± 2.6, Akinbami *et al.*

8310 ± 4.1, Osonuga *et al.* 8110 ± 4.1, and Ifeanyi *et al.* 7810 ± 1.7.[20,29-32]

CONCLUSION

Cell counts vary during pregnancy period as well as during the puerperal phase. Any gross variations in these cell counts suspect of pathological possibilities.

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How to cite this article: Sneha K, Babu MG, Lepakshi BG. Variation in erythrocyte and leukocyte counts before and after normal vaginal delivery. Natl J Physiol Pharm Pharmacol 2018;8(2):288-291.

Source of Support: Nil, **Conflict of Interest:** None declared.