ORIGINAL RESEARCH

Evaluation of changes in blood counts before and after normal vaginal delivery: A cross sectional study

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Received: 02 May, 2023 Accepted: 05 June, 2023

ABSTRACT

Background and Objectives: The reproductive lifespan of a woman commences with the onset of menarche and concludes with the onset of menopause. Throughout the course of pregnancy and in the postpartum phase, numerous physiological and hematological alterations take place. The aim of this study was to examine the fluctuations in red blood cells (RBC) and white blood cells (WBC) counts prior to and following a normal vaginal delivery. **Materials & methods:** In this hospital-based prospective study, a total of 432 pregnant women who were admitted to the labor room for delivery was included. Blood samples were collected from these women upon their admission to the labor ward, as well as within a timeframe of 12 to 24 hours after the normal vaginal delivery. The estimation of cell counts was conducted using a automated hematology analyzer. **Results**: The study revealed that the mean value of RBC count decreased on the first day of the postpartum period. Regarding the WBC count, interestingly, on the first day of the puerperal period, this count increased significantly. **Conclusion:** Cell counts exhibit variations not only during the pregnancy period but also during the puerperal phase. Any significant deviations from the expected values in these cell counts may raise suspicions of underlying pathological conditions. Therefore, careful monitoring and analysis of cell counts during these periods are important for identifying potential health concerns.

Key words: Pregnancy, Erythrocyte Count, Postpartum Period, Leukocytes.

INTRODUCTION

The three trimesters of pregnancy encompass a wide range of physiological changes that affect multiple systems within the body. These changes include alterations in the digestive system, nutrition, metabolism, circulatory system, respiratory system, integumentary system, as well as coagulation and fibrinolysis. Numerous studies have elucidated these changes, highlighting the comprehensive nature of the adaptations required to support the developing fetus and placenta.

During normal pregnancy, virtually all organ systems undergo significant modifications to meet the demands of the fetoplacental unit. These adaptations are influenced by hormonal changes and result in both subtle and substantial alterations in hematological parameters. A thorough comprehension of these changes is crucial to ensure accurate diagnosis and prevent both over diagnosis and under diagnosis of abnormalities.

Understanding the intricate interplay between hormonal factors and the hematological system is essential. This knowledge enables healthcare professionals to effectively manage and monitor hematological parameters throughout pregnancy and the puerperium. By avoiding the pitfalls of over diagnosing or under diagnosing abnormalities, healthcare providers can ensure optimal care for pregnant individuals and postpartum women.

The increase in red blood cell (RBC) mass during pregnancy typically initiates at around 8 to 10 weeks of gestation. With the administration of iron

supplements, this RBC mass steadily rises, reaching 20% to 30% (250-450 ml) above the levels observed in non-pregnant individuals by the end of pregnancy [2, 3]. However, in women who do not take iron supplements, the increase in red cell mass may be limited to 15% to 20% [4]. It is worth noting that the lifespan of erythrocytes, or red blood cells, is slightly reduced during normal pregnancy [5].

During normal pregnancies, there is a significant increase of approximately 50% in erythropoietin levels. However, these levels can vary depending on the presence of pregnancy complications [6]. The elevated plasma erythropoietin stimulates the expansion of the red cell mass, contributing to the increased oxygen requirements during pregnancy [7]. As a result, the mean corpuscular volume (MCV), which indicates the size of red blood cells, decreases throughout pregnancy. By the third trimester, the average MCV ranges from 80 to 84 fl [8].

During pregnancy, there is an increase in the white blood cell count (WBC) with a reference range typically ranging from 6 × 10^9/L to 16 × 10^9/L [9]. Within a few hours after delivery, healthy women have been observed to have a WBC count ranging from 9 × 10^9/L to 25 × 10^9/L [10]. However, by four weeks post delivery, the WBC ranges typically return to levels similar to those observed in healthy non-pregnant women, which range from 4 × 10^9/L to 10 × 10^9/L. It is important to note that there have been ongoing discussions and debates regarding the normal ranges for the different types of white blood cells [11].

The objective of this study was to assess the fluctuations in red blood cell (RBC) and white blood cell (WBC) counts before and after a normal vaginal delivery. The study aimed to examine any changes in these cell counts in relation to the childbirth process.

MATERIAL & METHODS

The study was conducted on a random sample of 432 pregnant females aged between 18 and 35 years who were undergoing a normal vaginal delivery at a tertiary care teaching hospital in Central India. Prior to the study, informed consent was obtained from the participants in their native language, ensuring that they were fully aware of the study's purpose and procedures. Furthermore, the study ensured adherence to ethical guidelines [12, 13].

To collect the necessary data, approximately 5 cc of blood samples were taken from each participant under aseptic precautions. These samples were obtained both during the participants' admission to the labor ward before delivery (pre delivery) and on the first day after delivery (1st puerperal day). The estimation of erythrocyte and leukocyte counts was performed using a five-part automated hematology analyzer.

The data obtained from the study was analyzed by calculating the mean and standard deviation of descriptive statistics. To perform this analysis, the data was entered into Microsoft Excel. To compare the values before and after delivery, a paired t-test was conducted. A p-value less than 0.05 were considered significant.

RESULTS

Table 1 presents the mean and standard deviation of the erythrocyte count during pre delivery and on the 1st puerperal day, along with the P-value obtained from the paired t-test. The difference between these two values was found to be statistically highly significant ($P < 0.05$) [Figure 1].

Table 1: Variation in RBC count in study population

Parameter	Before delivery (Mean ± SD)	First postpartum day (Mean ± SD)	P Value
RBC count (millions/mm^3)	4.3 ± 0.6	4.1 ± 0.4	<0.05

Table 2 provides the mean and standard deviation of the leukocyte count during pre delivery and on the 1st puerperal day, along with the corresponding P-value from the paired t-test. The difference between these two values was found to be statistically highly significant ($P < 0.05$) [Figure 2].

Table 2: Variation in WBC count in study population

Parameter	Before delivery (Mean ± SD)	First postpartum day (Mean ± SD)	P Value
WBC count (millions/mm^3)	12,611 ± 3727	16,312 ± 4124	<0.05

Figure 1: Variation in RBC count

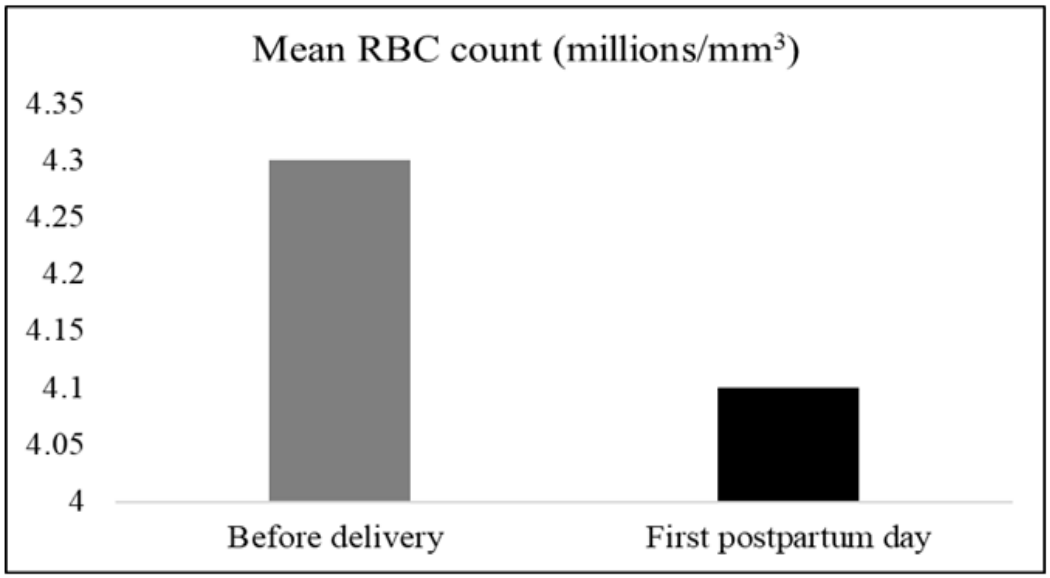
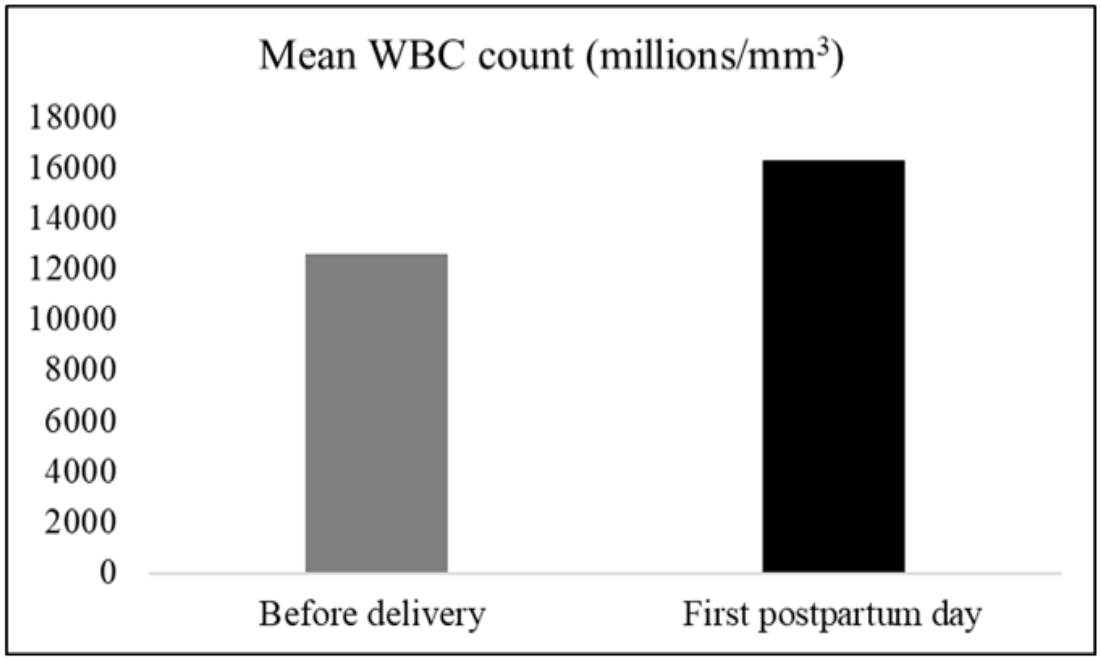


Figure 2: Variation in WBC count



DISCUSSION

The present study aimed to investigate the changes in erythrocyte and leukocyte counts before and after a normal vaginal delivery.

During pregnancy, there is a significant increase in blood volume. Specifically, the volume of red blood cells (RBCs) is increased by approximately 20-30%. This increase amounts to around 350 ml in total. However, it is important to note that this rise in blood volume is disproportionate, with the plasma volume increasing to a greater extent than the RBC volume. Consequently, a state of hemodilution occurs during pregnancy [14].

Relative hemodilution during pregnancy offers several advantages. Firstly, the diminished blood viscosity resulting from the increased plasma volume ensures optimal gaseous exchange between the maternal and fetal circulations. This is further facilitated by the lowered oxygen affinity of maternal red blood cells observed during the latter half of pregnancy. Secondly, relative hemodilution provides protection for the mother against the adverse effects of both supine and erect postures. Lastly, it serves as a safeguard for the mother, mitigating the adverse effects of blood loss that may occur during delivery [15].

During pregnancy, the total blood volume increases by approximately 1.5 liters in order to meet the demands of the developing vascular bed and compensate for blood loss that may occur during delivery [16]. Within this increased blood volume, approximately 1 liter is contained within the uterus

and the maternal blood spaces of the placenta. It is worth noting that in cases of multiple pregnancies and iron-deficient states, the increase in blood volume tends to be more pronounced. Around 10-15% of plasma volume expansion occurs by 6-12 weeks of gestation, contributing to the overall increase in blood volume during pregnancy [17, 18].

During pregnancy, there is an increase in plasma renin activity, indicating the activation of the renin-angiotensin-aldosterone system. However, levels of a trial natriuretic peptide (ANP) tend to slightly decrease. This suggests that the elevation in plasma volume during pregnancy is not primarily due to actual blood volume expansion, but rather a response to an under filled vascular system resulting from systemic vasodilation and increased vascular capacitance. In a scenario of actual blood volume expansion, the hormonal profile would typically exhibit low plasma renin and elevated ANP levels. Thus, the observed hormonal changes during pregnancy support the concept of an adaptive response to maintain adequate vascular volume and perfusion [19, 20].

During pregnancy, the increase in red blood cell mass is relatively less compared to the expansion of plasma volume, resulting in dilutional anemia. Hemoglobin levels typically decrease by 1-2 g/dL in the late second trimester, stabilizing thereafter. Women taking iron supplements have a more proportionate increase in red blood cell mass, leading to less pronounced changes in hemoglobin levels. Red blood cell indices show minimal alteration during pregnancy [21].

In the current investigation, the study population exhibited a pre delivery red blood cell (RBC) count of 4.3 ± 0.6 millions/cumm of blood. These findings are consistent with Gebreweld's study conducted in Addis Ababa, Ethiopia, which also reported a pre delivery RBC count of 4.46 ± 0.47 [22]. Similarly, Kumar RA's study on hematological and hemodynamic changes during the puerperium revealed comparable results, with a pre delivery RBC count of 3.8 ± 0.5 that decreased to 3.3 ± 0.49 on the first postpartum day, corroborating the observations made in our investigation [23]. Moreover, a descriptive study aiming to enhance the precision of visual estimation of blood loss in vaginal deliveries discovered a pre delivery RBC count of 3.8 ± 0.5 millions/cumm of blood, which subsequently decreased to 3.3 ± 0.49 millions/cumm of blood on the first postpartum day. This study, which involved a sample size of 250 women, standardized the estimation process by employing mops of similar sizes and a fixed container [24].

During pregnancy, there is an elevation in WBC count, with the lower limit of the reference range being 6000/cumm (8000/mm3) and potentially rising to 20,000/cumm during labor. This increase in WBC count may be attributed to the elevated levels of estrogen and cortisol, which are associated with the physiological stress induced by pregnancy [25]. Neutrophils are the predominant type of leukocytes observed in the differential counts [26, 27]. During the first trimester of pregnancy, there is a notable increase in absolute monocyte count, which subsequently decreases as gestation progresses. Monocytes play a role in preventing fetal allograft rejection by infiltrating the decidual tissue, possibly through the immunosuppressive effects mediated by PGE2. This infiltration typically occurs between the 7th and 20th week of gestation [28]. Additionally, the monocyte to lymphocyte ratio is significantly increased during pregnancy. However, the counts of eosinophils and basophils do not undergo significant changes throughout pregnancy [10].

According to the National Institute of Health, both medication usage and stress can lead to an increase in WBC count. When the body senses stress, signals are sent to the brain indicating a problem that needs attention. In response, the immune system may become more active. This general reaction typically occurs during acute or short-term periods of stress [29].

Leukocytosis, an increase in WBC count, can occur in response to various infectious, inflammatory, and physiological processes, including stress and exercise. This reaction involves the release or up regulation of several molecules, such as growth or survival factors (e.g., granulocyte colony-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) [30]. The mean white blood cell (WBC) count showed a progressive increase from pre delivery states, with values of 12,495.6 ± 3663.5 cells/cumm of blood, to 16,027 ± 3985.4 cells/cumm of blood on the 1st postpartum day. This finding aligns with similar studies conducted 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) [22, 31-34].

CONCLUSION

The study revealed significant variations in hematological parameters during both pregnancy and the puerperal phase. These changes, driven by hormonal influences, are crucial for a successful reproductive process. Careful monitoring and analysis of cell counts during these periods are essential for identifying any deviations from the expected values, which may indicate underlying pathological conditions. This understanding is vital to prevent both over diagnosing and under

diagnosing abnormalities in pregnant and postpartum women.

CONFLICTS OF INTEREST
None

SOURCE OF FUNDING
None

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