Experimental
&
Clinical Article

First-Trimester Threatened Abortion: Can Red Blood Cell Distribution Width-Standard Deviation Predict Miscarriage?

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ABSTRACT

OBJECTIVE: The objective of the study was to investigate the predictive value of red blood cell distribution width-standard deviation (RDW-SD) and another complete blood count (CBC) derived blood markers in patients presenting with threatened abortion concerning miscarriage.

STUDY DESIGN: This retrospective cross-sectional study included a cohort of 222 women with threatened abortion in the first trimester. The study group consisted of 114 patients who underwent miscarriage, and the control group included 108 pregnant women who delivered at term. The prognostic potential of RDW-SD and other CBC indices, readily obtainable from blood counts at the presentation of threatened abortion, was examined in the context of miscarriage development. The predictive value was calculated using the Receiver Operating Characteristic (ROC) curve.

RESULTS: The analysis revealed a statistically significant decline in RDW-SD within the miscarriage cohort compared to the control group. Notably, no statistically significant differences were identified in the neutrophil-lymphocyte ratio (NLR), derived NLR (DNLR), systemic inflammatory immune index (SII), platelet-to-lymphocyte ratio (PLR), and delta neutrophil index (DNI).

CONCLUSION: In this study, we found that RDW-SD, as a novel inflammatory mediator may be a useful marker for miscarriage in first trimester bleeding. However, it should be noted that traditional CBC indices, including NLR, DNLR, SII, PLR, and DNI, were found to be unsuitable indicators for miscarriage in threatened abortion.

Keywords: Complete blood count indices; Miscarriage; Rred blood cell distribution width-standard deviation; Threatened abortion

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Introduction

A threatened abortion (TA) is defined as vaginal bleeding accompanied by a closed cervical os in the presence of a viable intrauterine pregnancy confirmed by ultrasound during the first half of pregnancy (1). Bleeding is a prevalent complication of pregnancy, affecting 7 to 24% of pregnancies in the first trimester (2). Currently, multiple etiologic factors, such as genetic, immunological, endocrine, thrombophilic, and inflammatory, have been found to trigger miscarriage. Nevertheless, the complete pathophysiological mechanisms remain unclear. The finding of an elevated inflammatory response in first-trimester euploid chromosome miscarriages has increased interest in inflammation in aetiological studies (3). There is a growing interest in analyzing simple and low-cost approaches, such as complete blood count (CBC) indicators, to evaluate signs of inflammation for predicting miscarriage (4-6).

Inflammation leads to rapid red blood cell (RBC) clearance due to increased erythrocyte binding to the endothelium and decreased blood flow (7). Anisocytosis refers to the change in the volume of RBC caused by increased membrane flexibility and decreased hemoglobin concentration (8). Red cell distribution width– standard deviation (RDW-SD) measures the variability in the size of RBCs (9). Research has investigated the role of red cell distribution width (RDW) in

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pregnancy as a predictor of hypertensive disorders, intrahepatic cholestasis, and recurrent pregnancy loss (10-12).

The utilization of CBC-derived parameters for predicting miscarriage has garnered recent attention (4,5,13). However, studies on this topic exhibit substantial heterogeneity, often employing healthy pregnant women without bleeding as a control group (13,14). Consequently, their predictive efficacy for miscarriage in patients experiencing threatened abortion has been limited. This study was aimed at investigating the RDW-SD level and other CBC-derived blood markers such as platelet large cell ratio (P-LCR), delta neutrophil index (DNI), neutrophil-to-lymphocyte ratio (NLR), derived neutrophil-to-lymphocyte ratio (dNLR), lymphocyte-to-monocyte ratio (LMR), platelet-to-lymphocyte ratio (PLR), systemic inflammation index (SII), systemic inflammation response index (SIR-I), pan-immune inflammation value (PIV), and RDW platelet ratio (RPR) in first-trimester bleeding to predict miscarriage, using the TA group as a control instead of the healthy pregnant group compared to the previous literature.

Material and Method

This retrospective cross-sectional study was conducted among patients who presented with threatened miscarriage between January 1, 2020, and October 31, 2023, in a tertiary care center where high-risk pregnancies are managed. The requisite approval for the study was obtained from the ethics committee at Mersin University (Decision No. 20023 / 774). The study was conducted in accordance with the principles outlined in the Declaration of Helsinki. Data related to patients were collected from the electronic records of the hospital. As the study was retrospective and patient data were collected anonymously, the study was conducted without the need for informed consent.

Subjects: The research protocol involved a cohort of 222 pregnant women who were admitted with a diagnosis of threatened abortion during the first trimester. The pregnant women were categorized into two groups: those who experienced vaginal hemorrhage resulting in miscarriage throughout the first trimester (n = 114) (miscarriage group) and individuals who experienced vaginal hemorrhage during the matched gestational week but who delivered at full term (control group) (n = 108). In accordance with the abortus imminence algorithm employed at our clinic, routine blood tests are conducted at the time of diagnosis for all pregnant women presenting with first-trimester bleeding. These pregnant women were not subjected to any form of medical or surgical intervention before the blood test. The inclusion criteria were a confirmed singleton live pregnancy verified by ultrasonography and the presence of first-trimester vaginal bleeding. Patients who had inadequate data, fetal structural abnormalities detected by ultrasonography, uterine structural anomalies, a history of recurrent miscarriages, acute or chronic infections, other concurrent medical conditions, progesterone use, alcohol addiction, and smoking were excluded from the study.

Sample collection: The study collected the maternal age, BMI (body mass index), antenatal history, and gestational week at which vaginal bleeding was observed. The gestational age was determined based on the crown-rump length (CRL) obtained through ultrasonography. At our hospital, we conduct a standard evaluation for pregnant women who experience vaginal bleeding. This entails employing ultrasonography to assess the viability of the pregnancy, evaluating the cervical length, and conducting laboratory tests such as a complete blood count, coagulation parameter tests, and liver enzyme tests. Markers of inflammation that are derived from the CBC, such as RDW - SD, plateletcrit (PCT), mean platelet volume (MPV), P - LCR, delta neutrophil index (DNI), NLR, dNLR, LMR, PLR, SII, SIR - I, aspartate transaminase / platelet ratio (APRI), pan-immune inflammation value (PIV), and RPR were compared between the miscarriage and control group. DNI represents the number of immature granulocytes. The inflammatory scores have been calculated using the following formulas: NLR = absolute neutrophil count (ANC) / absolute lymphocyte count (ALC); PLR=absolute platelet count (APC) / absolute lymphocyte count (ALC); MLR = absolute monocyte count (AMC) / ALC; SII = APC × ANC) / ALC; SIRI = AMC × ANC / ALC; PIV = APC × AMC / ALC, APRI = aspartate transaminase / APC.

Statistical analysis

The data were analyzed using the SPSS (Statistical Package for Social Sciences) 18.0 package program. In descriptive analyses, frequency data were expressed as numbers (n) and percentages (%), and numerical data were given as arithmetic mean ± standard deviation (SD) and median (1-3rd quartile (IQR)). The compatibility of the numerical data with the normal distribution was analyzed by the Kolmogorov-Smirnov test. The distribution of normally distributed numerical data in two independent groups was assessed using the Independent Samples t-test, and the distribution of non-normally distributed numerical variables in two independent groups was evaluated with the Mann-Whitney U test. The cut-off point determination characteristics of the variables for the presence of imminence were evaluated by ROC (Receiver Operating Characteristics) curve analysis. The statistical significance level was set at $p < 0.05$ for all tests.

Results

A total of 222 pregnant women with a diagnosis of threatening abortion in the first trimester, 114 of whom had a miscarriage and 108 of whom gave birth at term, were included in the study. The control group consisted of patients who were diagnosed with threatening abortion and then had a term birth. Table 1 presents the demographic data of the patients and the clinical characteristics observed at initial admission.

Table I: *Demographic and clinical characteristics of the groups*

	Control (n = 108) X ± SD / median (min - max)	Miscarriage (n = 114) X ± SD / median (min - max)	p
Age (years)	30.82 ± 5.14 30.5 (26.2 - 35.0)	30.85 ± 6.32 30.5 (27.0 - 35.0)	0.066*
BMI (kg/m^2)	24.30 ± 3.42 23.5 (22.0 - 27.0)	23.81 ± 3.48 24.0 (20.7 - 27.0)	0.335**
Gravidity	2.43 ± 2.16 2.0 (0.0 - 3.0)	2.55 ± 1.50 2.0 (1.0 - 3.2)	0.174**
Parity	0.70 ± 0.92 0.0 (0.0 - 1.0)	0.75 ± 1.50 2.0 (1.0 - 3.2)	0.946**
Gestational week of threatening abortion	9.60 ± 2.46 9.6 (7.4 - 11.4)	8.25 ± 1.96 7.8 (6.5 - 9.5)	0.845**
Cervical length (CL) (mm)	36.88 ± 5.24 37.0 (33.0 - 40.0)	35.50 ± 5.45 36.0 (31.0 - 40.0)	0.473*

**: Independent Samples t-test. **: Mann Whitney U Test*

The distribution of CBC parameters and derived scores measured in the control and miscarriage groups are given in Table II. RDW-SD was found to be significantly lower in the miscarriage group compared to the control group (p = 0.021). There was no statistically significant difference in the distribution of other laboratory parameters (p > 0.05).

ROC curve analysis was performed to find the RDW-SD parameter's cut-off point for identifying patients who are likely to have a miscarriage (Figure 1). For the RDW-SD value, values of 39.30 and less were found to predict the diagnosis of miscarriage with 50.6% sensitivity and 34.3% specificity. The area under the curve was 0.390 (p=0.021; confidence interval: 0.298 – 0.482).

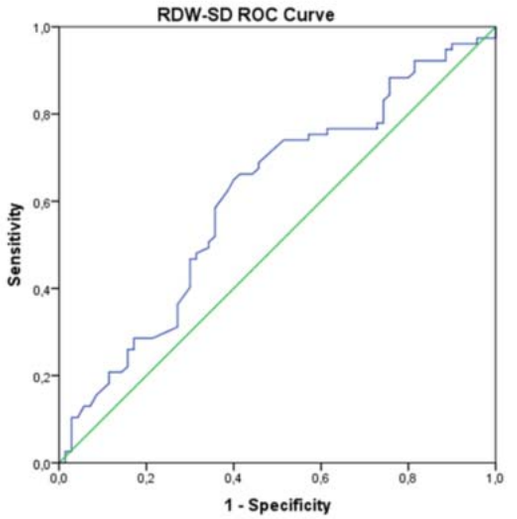

Figure 1: *ROC curve analysis of the RDW - SD for predicting miscarriage*

Discussion

The main outcomes of the current study are as follows: Our initial findings of the study indicated that RDW - SD had a significant predictive value for missed abortion in patients with first-trimester vaginal bleeding. To the best of our knowledge, this is the first study in the threatened abortion population to find that RDW-SD is reduced in miscarriage patients. The secondary outcome is that DNI, LMR, NLR, PLR, SII, SIRI, APRI, RPR, and dNLR values were inadequate for predicting miscarriage in threatened abortion patients.

Understanding threatened abortion is important for both women and their obstetricians to plan antenatal care and consider the management of pregnancy. While the focus has been on fetal viability, it is important to consider predicting miscarriage, as this may help in managing maternal anxiety. In recent years, CBC parameters as systemic markers of inflammation have received increasing attention in the prediction of miscarriage due to their advantages of simplicity, cost-effectiveness, and universal availability (14-16). Nevertheless, there are inconsistent reports addressing the utilization of these inflammatory markers during pregnancy (17,18).

The severity of inflammation could be directly related to the predictive value of inflammatory markers (19). DNI, a novel inflammatory index, was found to be increased in histological chorioamnionitis, an example of severe inflammation (20), but was not associated with hyperemesis gravidarum, characterized by mild inflammation (21). In line with our research, Yakıştıran et al., similarly found that DNI did not show a statistically significant difference in predicting miscarriage (14). Kale et al. found a significant increase in NLR compared to healthy pregnant women with miscarriage (15); however, in our study, we included the control group from the threatened abortion patient population, which may explain why we did not find a significant increase in NLR. Similar to our results, Liu et al., also found that NLR and PLR could not be indicators for miscarriage, in contrast to our results, they found that MPV was significantly decreased in patients with

Table II: *Comparison of laboratory parameters and inflammatory scores between miscarriage and control groups*

	Control (n = 108) X ± SD / median(min - max)	Miscarriage (n = 114) X ± SD / median(min - max)	p
Hemoglobin (g/dL)	11.99 ± 1.15 12.0 (11.2 - 12.9)	12.15 ± 1.42 12.0 (11.2 - 13.1)	0.064*
MCHC (g/dL)	34.35 ± 1.23 34.0 (33.7 - 35.0)	33.93 ± 1.95 34.0 (33.0 - 35.0)	0.160**
Lymphocyte (10^3/μL)	2.14 ± 0.77 2.0 (1.7 - 2.3)	2.28 ± 0.86 2.0 (1.7 - 2.7)	0.257**
Monocyte (10^3/μL)	0.64 ± 0.35 0.6 (0.4 - 0.7)	0.60 ± 0.19 0.5 (0.4 - 0.7)	0.604**
Neutrophil (10^3/μL)	6.35 ± 2.22 6.2 (4.8 - 0.7)	6.79 ± 2.78 6.5 (4.9 - 7.8)	0.488**
Platelet (×1000 mL)	270.30 ± 65.10 266.0 (220.5 - 320.0)	267.85 ± 84.82 268.5 (219.7 - 304.2)	0.906**
PDW (fL)	12.42 ± 2.21 12.0 (11.0 - 14.0)	12.47 ± 2.27 12.0 (11.0 - 14.0)	0.803**
RDW-SD (fL)	41.22 ± 3.75 40.8 (38.2 - 43.8)	40.15 ± 4.17 39.4 (37.4 - 41.4)	**0.021****
MPV (fL)	10.52 ± 1.08 10.5 (9.8 - 11.1)	10.36 ± 0.91 10.4 (9.6 - 11.0)	0.235*
PCT (%)	0.28 ± 0.08 0.28 (0.24 - 0.32)	0.28 ± 0.08 0.28 (0.24 - 0.32)	0.949**
P-LCR (%)	29.80 ± 8.48 29.2 (22.9 - 34.5)	28.05 ± 8.04 28.9 (22.4 - 33.7)	0.587*
DNI	0.42 ± 0.28 0.30 (0.30 - 0.50)	0.37 ± 0.20 0.30 (0.30 - 0.40)	0.622**
LMR	3.69 ± 1.35 3.43 (2.78 - 4.28)	3.95 ± 1.48 3.91 (2.94 - 4.64)	0.123**
NLR	3.25 ± 1.77 2.85 (2.24 - 3.83)	3.26 ± 1.71 2.82 (2.11 - 3.97)	0.910**
PLR	136.61 ± 48.79 132.3 (98.7 - 166.9)	126.79 ± 47.48 118.4 (95.4 - 150.7)	0.139**
SII	875.09 ± 486.28 773.3 (539.4 - 1066.4)	866.12 ± 566.31 755.5 (536.3 - 997.1)	0.622**
SIRI	2.03 ± 1.30 1.7 (1.1-2.6)	2.06 ± 1.43 1.7 (1.0 - 2.5)	0.756**
PIV	563.75 ± 409.44 441.8 (277.5 - 719.5)	568.93 ± 577.56 447.3 (264.2 - 660.7)	0.524**
APRI	0.11 ± 0.06 0.09 (0.06 - 0.13)	0.12 ± 0.19 0.09 (0.06 - 0.12)	0.393**
RPR	0.05 ± 0.01 0.05 (0.04 - 0.06)	0.06 ± 0.09 0.05 (0.04 - 0.06)	0.736**
DNLR	0.89 ± 0.13 0.8 (0.8 - 0.9)	0.90 ± 0.13 0.8 (0.8 - 0.9)	0.614**

**: Independent Samples t-test. **: Mann Whitney U Test. The significant group comparison result was represented in bold.*

miscarriage (4). Regarding the predictive value of mean platelet volume (MPV) for miscarriage, Akin et al. observed a statistically significant increase (18), while Oğlak et al., reported a non-significant increase (22). Similarly, Kale et al. found a non-significant decrease (15), which aligns with our findings. There was no statistically significant difference in

the NLR, PLR, LMR, dNLR, SII, SIRI, and PIV parameters in a study that predicted miscarriage with a smaller population size (23). In the subgroup analysis of Soysal et al., SII, NLR, MLR, PLR, and WBC parameters were significantly increased in the miscarriage group (13). However, the subgroup was quite limited.

Physiologically high RDW levels can occur due to erythropoietin deficiency, exercise, and pregnancy (24). The study conducted by Li et al. evaluated the evolution of RDW values throughout the trimesters and revealed a consistent increase originating in the first trimester (25). In this particular context, the reduced RDW-SD could be interpreted as indicating a poor response of the pregnancy to bleeding. In healthy individuals, it correlates with inflammatory parameters such as plasma viscosity, ESR, fibrinogen, leukocyte, and neutrophil counts (26). Furthermore, there was a significant correlation between RDW and inflammatory indicators such as C-reactive protein (hs-CRP) and erythrocyte sedimentation rate (ESR) in patients with rheumatoid arthritis (27). The association between RDW-SD and inflammation has attracted significant interest due to its identification as an independent prognostic marker for mortality and morbidity in heart failure, regardless of hemoglobin levels (28). Consistent with these findings, our hemoglobin results did not show any significant variation, meanwhile RDW-SD demonstrated a statistically significant difference among the groups. Our study revealed that lower RDW-SD values were indicative of miscarriage in patients with threatened abortions, whereas higher RDW values were linked to a poorer prognosis in cancer patients (29). In this context, it can be concluded that threatened abortion patients who are unable to respond adequately to the inflammatory response that develops with bleeding and fail to increase RDW-SD values as much as in the non-miscarriage group are prone to miscarriage.

In their percutaneous coronary intervention study, Fatemi et al. observed that patients with elevated RDW values experienced significant occurrences of major bleeding and vascular complications (30). The low RDW-SD observed in patients present after bleeding in our study may serve as an indicator of the severity of hemorrhage and inflammation in pregnant women. It is understandable that pregnant women who have miscarriages cannot adapt to the inflammatory response to hemorrhage, whereas pregnant women with a continuing pregnancy respond adequately to the inflammatory response as an indicator of an increase in RDW-SD. The progression of pregnancy to term will be possible with a successful inflammatory response in inflammation-inducing conditions such as hemorrhage. If the level of inflammation at the feto-maternal interface is outside the optimal range, miscarriage of karyotypically normal embryos may occur (31).

Limitations: The study exhibits both strengths and weaknesses. The primary limitations of biomarkers for predicting miscarriage are the retrospective design and the relatively low statistical power. Nevertheless, this study is limited to a single center and adheres to a standardized follow-up protocol. The strength of our study lies in the assessment of a cost-effective and user-friendly technique for underestimation. Moreover, the incorporation of cervical length measurement, an aspect that was not considered in prior studies, enhances the strength of our study.

Conclusion

Although it is established that individuals experiencing threatened abortion have an inflammatory response caused by bleeding, it remains uncertain which patients are likely to have miscarriages. There are conflicting studies on the use of CBC-based inflammatory parameters in the prediction of miscarriages. Our study found that a low RDW-SD value is a valid predictor of miscarriage in patients with threatened abortion. Evaluating the validity of different CBC-based inflammatory markers in comparison to RDW-SD in future prospective studies on threatened abortion will help in predicting the development of miscarriage.

Declarations

Ethics approval and consent to participate

Given that the study was retrospective in design and that patient data were collected anonymously, the need for informed consent was obviated in conducting the study. The study was reviewed and approved by the ethics committee of ethics committee of Mersin University (Ethics approval reference number: 20023/774. Date 21.11.2023). All procedures were performed according to the Declaration of Helsinki.

Availability of data and materials

The data supporting this study is available through the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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References

1. Mouri M, Hall H, Rupp TJ. Threatened Miscarriage. StatPearls. Treasure Island (FL): StatPearls Publishing StatPearls Publishing LLC.; 2024.
2. Hasan R, Baird DD, Herring AH, Olshan AF, Jonsson Funk ML, Hartmann KE. Association between first-

trimester vaginal bleeding and miscarriage. Obstet Gynecol. 2009;114(4):860-7. Doi: 10.1097/AOG.0b013e3181b79796. PMID: 19888046, PMCID: PMC2828396.

3. Yamada H, Kato EH, Kobashi G, Ebina Y, Shimada S, Morikawa M, et al. High NK cell activity in early pregnancy correlates with subsequent abortion with normal chromosomes in women with recurrent abortion. Am J Reprod Immunol. 2001;46(2):132-6. Doi: 10.1111/j.8755-8920.2001.460203.x. PMID: 11506077.
4. Liu D, Huang X, Xu Z, Chen M, Wu M. Predictive value of NLR and PLR in missed miscarriage. J Clin Lab Anal. 2022;36(3):e24250. Doi: 10.1002/jcla.24250. PMID: 35103988, PMCID: PMC8906043.
5. Turgut E, Yildirim M, Sakcak B, Ayhan SG, Tekin OM, Sahin D. Predicting miscarriage using systemic immune-inflammation index. J Obstet Gynaecol Res. 2022;48(3):587-92. Doi: 10.1111/jog.15156. PMID: 35040233.
6. Bas FY, Tola EN, Sak S, Cankaya BA. The role of complete blood inflammation markers in the prediction of spontaneous abortion. Pak J Med Sci. 2018;34(6):1381-5. Doi: 10.12669/pjms.346.15939. PMID: 30559789, PMCID: PMC6290208.
7. Straat M, van Bruggen R, de Korte D, Juffermans NP. Red blood cell clearance in inflammation. Transfus Med Hemother. 2012 Oct;39(5):353-61. Doi: 10.1159/000342229. PMID: 23801928, PMCID: PMC3678279.
8. Paliogiannis P, Zinellu A, Mangoni AA, Capobianco G, Dessole S, Cherchi PL, et al. Red blood cell distribution width in pregnancy: a systematic review. Biochem Med (Zagreb). 2018;28(3):030502. Doi: 10.11613/BM.2018.030502. PMID: 30429667, PMCID: PMC6214699.
9. Lippi G, Targher G, Montagnana M, Salvagno GL, Zoppini G, Guidi GC. Relation between red blood cell distribution width and inflammatory biomarkers in a large cohort of unselected outpatients. Arch Pathol Lab Med. 2009;133(4):628-32. Doi: 10.5858/133.4.628. Erratum in: Arch Pathol Lab Med. 2009;133(8):1186. PMID: 19391664
10. Sen-Yu W, Chao X. Assessment of the relationship between red blood cell distribution width and preganecy hypertension disease. J Obstet Gynaecol Res. 2016;42(10):1258-62. Doi: 10.1111/jog.13067. PMID: 27436585.
11. Vural Yilmaz Z, Gencosmanoglu Turkmen G, Daglar K, Yılmaz E, Kara O, Uygur D. Elevated red blood cell distribution width is associated with intrahepatic cholestasis of pregnancy. Ginekol Pol. 2017;88(2):75-80. Doi: 10.5603/GP.a2017.0015. PMID: 28326516.
12. Dundar O, Pektas MK, Bodur S, Bakır LV, Cetin A. Recurrent pregnancy loss is associated with increased red cell distribution width and platelet distribution width. J Obstet Gynaecol Res. 2015;41(4):551-8. Doi: 10.1111/jog.12600. PMID: 25370870.
13. Soysal C, Sarı H, Işıkalan MM, Özkaya EB, Ulaş Ö, Taşçı Y, et al. Role of the systemic immune-inflammation index in threatened abortion patients and predicting of abortion. J Obstet Gynaecol Res. 2023 Jul;49(7):1723-8. Doi:10.1111/jog.15655. PMID: 37088799.
14. Yakıştıran B, Tanacan A, Altınboğa O, Yücel A. Can derived neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, and delta neutrophil index predict spontaneous abortion? Z Geburtshilfe Neonatol. 2021;225(5):418-22. Doi: 10.1055/a-1363-2855. PMID: 33530116.
15. Kale İ, Helvacıoğlu Ç, Muğurtay TE. Evaluation of complete blood count parameters in the first trimester: an early indicator of miscarriage. J Clin Invest Surg. 2021;6(1):48-52. Doi: 10.25083/2559.5555/6.1.9
16. Jiang L, Du Y, Lu Y, Wu X, Tong X. Monitoring of hemostatic parameters for early prediction of first-trimester miscarriage. Biomarkers. 2021;26(6):532-8. Doi:10.1080/1354750X.2021.1933592. PMID: 34020571.
17. Kaplanoglu M, Yuce T, Bulbul M. Decreased mean platelet volume is associated with the developing stage of fetoplacental unit in spontaneous abortion. Int J Clin Exp Med. 2015;8(7):11301-6. PMID: 26379939, PMCID: PMC4565322.
18. Akin MN, Kasap B, Yuvaci HU, Turhan N. Association between platelet indices and first trimester miscarriage. Blood Coagul Fibrinolysis. 2016;27(5):526-30. Doi: 10.1097/MBC.0000000000000445. PMID: 26569515.
19. Sato N, Kinoshita A, Imai N, Akasu T, Yokota T, Iwaku A, et al. Inflammation-based prognostic scores predict disease severity in patients with acute cholecystitis. Eur J Gastroenterol Hepatol. 2018;30(4):484-9. Doi: 10.1097/MEG.0000000000001063. PMID: 29303882.
20. Cho HY, Jung I, Kwon JY, Kim SJ, Park YW, Kim YH. The Delta Neutrophil Index as a predictive marker of histological chorioamnionitis in patients with preterm premature rupture of membranes: A retrospective study. PLoS One. 2017;12(3):e0173382. Doi: 10.1371/journal.pone.0173382. PMID: 28278168, PMCID: PMC5344388.
21. Dal Y, Akkuş F, Karagün Ş, Çolak H, Coşkun A. Are serum delta neutrophil index and other inflammatory marker levels different in hyperemesis gravidarum? J Obstet Gynaecol Res. 2023;49(3):828-34. Doi: 10.1111/jog.15542. PMID: 36627732.
22. Oğlak SC, Aydın MF. Are neutrophil to lymphocyte ratio and platelet to lymphocyte ratio clinically useful for the prediction of early pregnancy loss? Ginekol Pol. 2020;91(9):524-7. Doi: 10.5603/GP.a2020.0082. PMID:33030732.
23. Genc SO, Erdal H. Are pan-immune-inflammation value, systemic inflammatory response index and other hematologic inflammatory indexes clinically useful to predict first-trimester pregnancy loss. Ann Clin Anal Med. 2023;14(5):473-7.
24. Salvagno GL, Sanchis-Gomar F, Picanza A, Lippi G. Red blood cell distribution width: A simple parameter with multiple clinical applications. Crit Rev Clin Lab Sci.

2015;52(2):86-105. Doi: 10.3109/10408363.2014.992064. PMID: 25535770.

25. Li A, Yang S, Zhang J, Qiao R. Establishment of reference intervals for complete blood count parameters during normal pregnancy in Beijing. J Clin Lab Anal. 2017; 31(6):e22150. Doi: 10.1002/jcla.22150. PMID: 28105762, PMCID: PMC6816986.

26. Vayá A, Sarnago A, Fuster O, Alis R, Romagnoli M. Influence of inflammatory and lipidic parameters on red blood cell distribution width in a healthy population. Clin Hemorheol Microcirc. 2015;59(4):379-85. Doi: 10.3233/CH-141862. PMID: 25159489.

27. He Y, Liu C, Zeng Z, Ye W, Lin J, Ou Q. Red blood cell distribution width: a potential laboratory parameter for monitoring inflammation in rheumatoid arthritis. Clin Rheumatol. 2018;37(1):161-7. Doi: 10.1007/s10067-017-3871-7. PMID: 29101675.

28. Förhécz Z, Gombos T, Borgulya G, Pozsonyi Z, Prohászka Z, Jánoskuti L. Red cell distribution width in heart failure: prediction of clinical events and relationship with markers of ineffective erythropoiesis, inflammation, renal function, and nutritional state. Am Heart J. 2009;158(4):659-66. Doi: 10.1016/j.ahj.2009.07.024. PMID: 19781428.

29. Hu L, Li M, Ding Y, Pu L, Liu J, Xie J, et al. Prognostic value of RDW in cancers: a systematic review and meta-analysis. Oncotarget. 2017;8(9):16027-35. Doi: 10.18632/oncotarget.13784. PMID: 27926498, PMCID: PMC5362543.

30. Fatemi O, Torguson R, Chen F, Ahmad S, Badr S, Satler LF, et al. Red cell distribution width as a bleeding predictor after percutaneous coronary intervention. Am Heart J. 2013;166(1):104-9. Doi: 10.1016/j.ahj.2013.04.006. PMID: 23816028

31. Christiansen OB, Nielsen HS, Kolte AM. Inflammation and miscarriage. Semin Fetal Neonatal Med. 2006;11 (5):302-8. Doi: 10.1016/j.siny.2006.03.001. PMID:16682265.