

A Comparative Evaluation of Sonographic Markers, Progesterone, and Hematological Indices in First-Trimester Missed Abortion

✉ Selma Atiye Kolcu, ✉ Nebile İzel Vargün, ✉ Ayça Küçükyurt

University of Health Sciences Türkiye, İstanbul Training and Research Hospital, Department of Obstetrics and Gynecology, İstanbul, Türkiye

ABSTRACT

Introduction: Despite advancements in early pregnancy monitoring, accurately identifying asymptomatic fetal loss remains a significant clinical challenge. In light of conflicting evidence in the literature, this prospective study was designed to conduct a multimodal comparative evaluation of sonographic markers [gestational sac (GS), yolk sac (YS), crown-rump length (CRL)], serum progesterone, and a comprehensive panel of systemic inflammatory indices [neutrophil-to-lymphocyte ratio (NLR), lymphocyte-to-monocyte ratio (LMR), mean platelet volume (MPV), platelet distribution width] in the context of first-trimester missed abortion.

Methods: A total of 129 pregnant women (51 with missed abortion and 78 healthy controls) at 6-9 gestational weeks were prospectively enrolled. Serum progesterone and complete blood count parameters were analyzed at the time of diagnosis. Diagnostic performance was evaluated using receiver operating characteristic (ROC) analysis, and independent associations were evaluated using multivariable logistic regression.

Results: In the missed abortion group, GS and CRL measurements were significantly smaller ($p<0.001$), whereas YS diameter was significantly larger than in healthy pregnancies ($p=0.039$). Serum progesterone levels were markedly lower in cases (10.4 ± 5.2 ng/mL vs. 17.1 ± 5.1 ng/mL, $p<0.001$). Multivariable analysis identified lower serum progesterone [odds ratio (OR): 0.791], smaller GS diameter (OR: 0.839, $p=0.004$), and larger YS diameter (OR: 2.255, $p=0.044$) as strong independent indicators of missed abortion. ROC analysis confirmed that serum progesterone had the highest discriminatory power [area under the curve (AUC): 0.840, $p<0.001$], followed by CRL (AUC: 0.754), and GS diameter (AUC: 0.738). While absolute lymphocyte counts were significant in univariate models ($p=0.012$), systemic inflammatory markers (NLR, LMR, MPV) failed to show independent diagnostic performance.

Conclusion: Morphometric sonographic parameters and serum progesterone levels are independently associated with first-trimester missed abortion, reinforcing their reliability as clinical indicators for identifying non-viable pregnancies. Conversely, routine systemic inflammatory markers lack a sufficient independent association to serve as useful standalone markers for asymptomatic fetal loss. Clinical assessment should prioritize standardized sonographic and hormonal profiles over hematological indices.

Keywords: Basophils, gestational sac, monocytes, lymphocytes, yolk sac, platelets

Introduction

Early pregnancy loss (EPL) is defined as a non-viable intrauterine pregnancy occurring before the end of the first trimester (1,2). Accurate clinical assessment relies heavily on sonographic parameters; crown-rump length (CRL) is the most precise measurement for gestational dating (3,4), while the fluid-filled gestational sac (GS) serves as the earliest indicator of intrauterine pregnancy (5). Furthermore, the yolk sac (YS) provides vital prognostic information, as diameters exceeding 6 mm are generally associated with unhealthy pregnancy outcomes (3,4). Hormonal stability is equally critical, particularly regarding progesterone, which maintains pregnancy by supporting decidualization, reducing

uterine contractions, and enhancing maternal immune tolerance to the fetal allograft (6-9).

Beyond morphometric and hormonal markers, growing evidence suggests that immune dysfunction and abnormal systemic inflammation are significant contributors to miscarriage (10-15). Fluctuations in leukocyte subsets, such as monocytes and basophils, reflect the complex inflammatory environment required to prevent fetal allograft rejection (10-13). Consequently, the lymphocyte-to-monocyte ratio (LMR) has emerged as a promising parameter that reflects this systemic inflammatory state during early gestation (14,15).



Address for Correspondence: Selma Atiye Kolcu, MD, University of Health Sciences Türkiye, İstanbul Training and Research Hospital, Department of Obstetrics and Gynecology, İstanbul, Türkiye
E-mail: selma.a.91@hotmail.com **ORCID ID:** orcid.org/0000-0002-6849-0136

Cite this article as: Kolcu SA, Vargün Nİ, Küçükyurt A. A comparative evaluation of sonographic markers, progesterone, and hematological indices in first-trimester missed abortion. İstanbul Med J. 2026; 27(4): 372-378

Received: 15.05.2026

Accepted: 17.09.2026

Publication Date: 30.10.2026



©Copyright 2026 by the University of Health Sciences Türkiye, İstanbul Training and Research Hospital/İstanbul Medical Journal published by Galenos Publishing House.
Licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 (CC BY-NC-ND) International License

Recent research also indicates that thrombo-inflammatory processes and impaired placental perfusion play a crucial role in multifactorial pregnancy loss (16). Hematological markers reflecting platelet activation and thrombotic tendency, such as platelet distribution width (PDW) and mean platelet volume (MPV), have been proposed as indirect indicators of microthrombosis within placental vessels (17-19). Additionally, the neutrophil-to-lymphocyte ratio (NLR), a low-cost and easily accessible marker of systemic inflammation, has demonstrated significant predictive power in identifying pregnancies at increased risk of first-trimester loss (20-23).

The primary objective of this prospective study was to perform a multimodal comparative evaluation of sonographic measurements (GS, YS, CRL), serum progesterone levels, and a comprehensive panel of systemic inflammatory biomarkers, including lymphocyte, monocyte, and basophil counts, NLR, LMR, MPV, and PDW, in the identification and clinical assessment of first-trimester missed abortion.

Methods

This prospective study was conducted at the Gynecology and Obstetrics Clinic of a University of Health Sciences Türkiye, İstanbul Training and Research Hospital between January 01, 2024, and July 01, 2024. The study included pregnant volunteers and inpatients aged 18-44 years who presented to the clinic during the study period. All participants underwent a standardized ultrasonographic examination, and venous blood samples were collected after a comprehensive clinical evaluation. Ethical approval for the study was obtained from the University of Health Sciences Türkiye, İstanbul Training and Research Hospital Clinical Research Ethics Committee (approval number: 331, date: 22.12.2023). Written informed consent was obtained from all participants prior to enrollment in the study.

A total of 129 pregnant women were included in the study: 51 between 6 and 9 gestational weeks with a diagnosis of missed abortion, and 78 with healthy pregnancies between 6 and 9 gestational weeks who served as the control group. Pregnant women with systemic diseases, uterine anatomical disorders, aged under 18 or over 44 years, multiple pregnancies, receiving progesterone and/or antianemic therapy, or with GS, YS, or CRL diameters measured on USG below 6 weeks or above 9 weeks were not included in the study group.

The women's ages, gravida and parity, height, weight, and body mass index were recorded. CRL, GS, and YS were measured in millimeters (mm) during ultrasonographic examination. A Mindray DC-7 ultrasound device was used in our study. We determined GS measurements as the largest sagittal, axial, and coronal diameters, defined as the length from one inner edge of the chorionic cavity to the opposite inner edge. We obtained YS measurements by measuring the diameter from outer edge to outer edge. CRL was measured as the distance from the fetal head to buttocks in the sagittal plane.

Serum progesterone (P) level and hematology parameters, including monocyte and basophil counts, MPV and PDW values, NLR, and LMR, were recorded.

Laboratory studies were performed in the Medical Biochemistry and Medical Microbiology Laboratory of İstanbul Training and Research

Hospital. Blood samples were collected from the pregnant women included in the study group, without fasting, into S-Monovette yellow-colored gel tubes. Within 2 hours of collection, the serum sample was centrifuged at 4000 rpm for 10 minutes. P titers in the centrifuged serum sample were determined photometrically using a ROCHE COBAS 501 device (UniCel® DxI 600 immunoassay system).

CBC levels were evaluated using tests performed in the Medical Microbiology Laboratory. Before taking any medication, blood samples (2.5-3 cc) were collected from the patients into sterile tubes containing ethylenediaminetetraacetate anticoagulant. Then, it was placed in the Mindray BC 6800 Plus Hematology Analyzer (Mindray, Shenzhen, China). After being inverted 3 times, 1.5 cc of blood was withdrawn and taken for reading. Blood samples were taken at the time of diagnosis (24).

Statistical Analysis

Statistical analyses were performed using the SPSS version 27.0 software package (IBM Corp., Armonk, NY, USA). Descriptive statistics were expressed as mean $\pm$ standard deviation, median (minimum-maximum), frequency, and percentage values. The normality of the data distribution was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. For comparisons between the missed abortion and healthy pregnancy groups, the independent samples t-test was used for normally distributed variables, while the Mann-Whitney U test was applied for non-normally distributed variables. To identify markers independently associated with missed abortion and to adjust for potential confounding factors such as gestational age, a multivariable logistic regression analysis was conducted. Furthermore, receiver operating characteristic (ROC) curve analysis was performed to evaluate the diagnostic performance and discriminatory power of sonographic and laboratory parameters by calculating the area under the ROC curve (AUC). A p value was considered statistically significant for all analyses.

Results

In our study, ultrasound examination showed no fetal heartbeat in 51 pregnant women, whereas it showed a fetal heartbeat in 78. The demographic characteristics, including age, gravidity, parity, number of miscarriages, and number of living children, did not differ significantly between the case and control groups (Table 1). GS size and CRL were significantly lower in the case group than in the control group ($p < 0.001$), whereas YS size was significantly higher ($p = 0.039$; Table 1).

Most hematological parameters—including monocyte, basophil, and neutrophil counts; MPV; PDW; NLR; and LMR—did not differ significantly between the groups ($p > 0.05$). However, absolute lymphocyte counts were significantly lower in the missed abortion group ($p = 0.012$) (Table 1). Serum progesterone levels in the case group were also significantly lower than those in the control group ($p < 0.001$). Gestational age according to the last menstrual period did not differ significantly between the groups ($p = 0.105$). Conversely, the gestational age determined by ultrasound was significantly lower in the case group ($p = 0.002$) (Table 1).

Table 1. Baseline clinical and demographic characteristics of the case and control groups

	Control group (n=78)				Case group (n=51)				p	
	Mean ± SD/n (%)			Median	Mean ± SD/n (%)			Median		
Age (years)	29.0	±	5.6	28.0	30.8	±	6.4	30.0	0.125	^m
Gravida (n)	2.4	±	1.2	2.0	2.6	±	1.4	2.0	0.567	^m
Parity (n)	1.9	±	1.0	2.0	2.0	±	1.1	2.0	0.450	^m
Living children (n)	1.6	±	0.7	1.0	1.7	±	0.5	2.0	0.374	^m
Number of miscarriages (n)	1.0	±	0.0	1.0	1.5	±	0.9	1.0	0.079	^m
Gestational sac diameter (mm)	28.7	±	5.7	27.8	23.4	±	5.9	24.4	0.000	^m
Yolk sac diameter (mm)	4.6	±	0.7	4.5	5.0	±	0.9	4.7	0.039	^m
Crown-rump length (CRL) (mm)	11.9	±	3.5	12.3	9.8	±	7.9	8.9	0.000	^m
Monocyte count (×10 ³ /μL)	0.5	±	0.1	0.5	0.5	±	0.2	0.4	0.184	^m
Basophil count (×10 ³ /μL)	0.0	±	0.1	0.0	0.0	±	0.0	0.0	0.512	^m
Mean platelet volume (MPV) (fL)	9.6	±	1.1	9.5	9.4	±	1.1	9.2	0.396	^m
Platelet distribution width (PDW) (%)	15.7	±	1.0	16.0	16.0	±	0.4	16.0	0.577	^m
Neutrophil count (×10 ³ /μL)	6.2	±	2.3	5.9	6.2	±	2.7	5.8	0.868	^m
Lymphocyte count (×10 ³ /μL)	2.3	±	0.6	2.2	2.0	±	0.7	1.9	0.012	^m
NLR	3.0	±	1.7	2.6	3.4	±	2.4	2.9	0.108	^m
LMR	4.5	±	1.3	4.4	4.6	±	1.8	4.5	0.654	^t
Serum progesterone (ng/mL)	17.1	±	5.1	16.9	10.4	±	5.2	9.2	0.000	^m
Gestational age by LMP (days)	56.4	±	2.3	56.0	58.0	±	0.0	59.0	0.105	^m
Gestational age by USG (days)	52.3	±	4.5	52.0	49.7	±	5.0	49.0	0.002	^m

†: Independent samples t-test, ^m: Mann-Whitney U test. NLR: Neutrophil lymphocyte ratio, LMR: Lymphocyte monocyte ratio, USG: Ultrasonography, SD: Standard deviation

Multivariable logistic regression analysis was performed to identify factors independently associated with first-trimester missed abortion (Table 2). The analysis revealed that lower serum progesterone levels [odds ratio (OR): 0.791, $p<0.001$], smaller GS diameter (OR: 0.839, $p=0.004$), and larger YS diameter (OR: 2.255, $p=0.044$) were strong, independent indicators of missed abortion. While absolute lymphocyte counts showed a significant association in the univariate model ($p=0.025$), they did not retain independent significance in the multivariable analysis. Notably, systemic inflammatory markers—including NLR, LMR, MPV, and PDW—were not significantly associated with missed abortion in either univariate or multivariable models ($p>0.05$; Table 2).

ROC analysis was performed to determine how effectively each parameter could distinguish between missed abortions and healthy pregnancies (Figure 1). Serum progesterone demonstrated the highest diagnostic accuracy, with an AUC of 0.840 (95% CI: 0.764-0.915, $p<0.001$), indicating excellent discriminatory power. Among the ultrasound markers, CRL (AUC: 0.754, $p<0.001$) and GS diameter (AUC: 0.738, $p<0.001$) also showed significant accuracy in identifying non-viable pregnancies. While lymphocyte counts had a modest but statistically significant discriminatory value (AUC: 0.631, $p=0.012$), other hematological markers—specifically NLR, LMR, and MPV—did not demonstrate diagnostic utility ($p>0.05$) (Figure 1).

Discussion

This study presents a prospective multimodal analysis evaluating the comparative diagnostic and associative value of sonographic

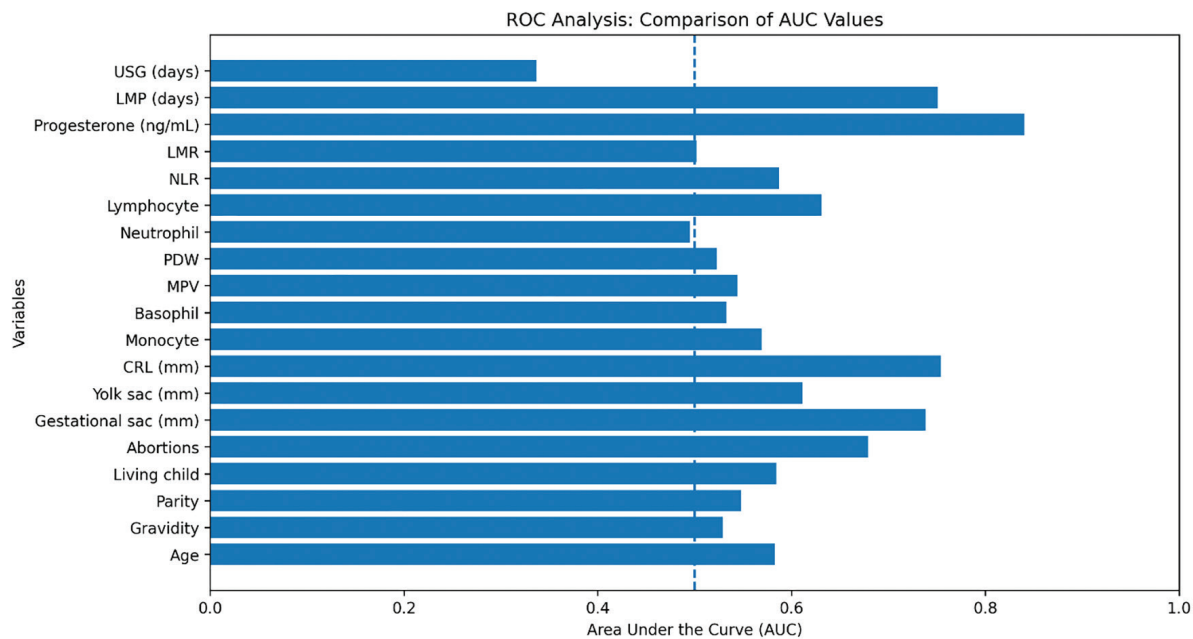
measurements, serum progesterone levels, and systemic inflammatory markers in first-trimester missed abortion. Our findings demonstrate that, in the missed abortion group, GS and CRL measurements were significantly diminished, whereas the YS diameter was significantly enlarged ($p<0.001$ and $p=0.039$, respectively). Serum progesterone levels were markedly lower in cases of EPL than in healthy controls ($p<0.001$). Using multivariable logistic regression, we identified lower serum progesterone, smaller GS diameter, and larger YS diameter as strong independent indicators of missed abortion. Furthermore, ROC analysis confirmed that serum progesterone provides the highest discriminatory power with an AUC of 0.840, followed by CRL and GS diameter. Notably, despite the growing popularity of hematological indices such as NLR, LMR, and MPV in recent literature as potential indicators of pregnancy outcomes, these parameters did not demonstrate a significant independent association in our multivariable model.

Our literature search indicated that USG examinations and inflammatory biomarkers during early gestational weeks may vary. Marin et al. (25) in a study of 82 pregnant women, found that a YS size smaller or larger than normal was associated with pregnancy loss; similarly, a larger YS diameter was significantly associated with missed abortion in our study, further established as a strong independent indicator through multivariable analysis. Liu et al. (26) reported that small GS and CRL measurements were risk factors for EPL. Consistent with their findings, GS and CRL measurements in our case group were significantly smaller (26), and our findings were objectively validated by ROC analysis, demonstrating significant discriminatory power for both CRL and GS diameter. Suguna and Sukanya (27) demonstrated that while the

Table 2. Univariate and multivariable logistic regression analysis of factors associated with first-trimester missed abortion

	Univariate model					Multivariable model				
	OR	%95 CI			p	OR	%95 CI			p
Age (years)	1.052	0.991	-	1.118	0.097					
Gravida (n)	1.117	0.850	-	1.467	0.428					
Parity (n)	1.151	0.738	-	1.796	0.535					
Living children (n)	1.282	0.450	-	3.654	0.642					
Gestational sac diameter (mm)	0.847	0.786	-	0.913	0.000	0.839	0.746	-	0.944	0.004
Yolk sac diameter (mm)	1.860	1.107	-	3.124	0.019	2.255	1.022	-	4.975	0.044
CRL (mm)	0.906	0.821	-	1.000	0.050					
Monocyte count ($\times 10^3/\mu\text{L}$)	0.590	0.063	-	5.501	0.643					
Basophil count ($\times 10^3/\mu\text{L}$)	0.992	0.978	-	1.005	0.231					
Mean platelet volume (MPV) (fL)	0.854	0.608	-	1.200	0.363					
Platelet distribution width (PDW) (%)	1.677	0.948	-	2.965	0.076					
Neutrophil count ($\times 10^3/\mu\text{L}$)	1.002	0.869	-	1.155	0.977					
Lymphocyte count ($\times 10^3/\mu\text{L}$)	0.517	0.290	-	0.922	0.025					
NLR	1.117	0.928	-	1.343	0.241					
LMR	1.055	0.836	-	1.331	0.651					
Serum progesterone (ng/mL)	0.766	0.693	-	0.846	0.000	0.791	0.700	-	0.894	0.000
Gestational age by LMP (days)	1.208	1.109	-	1.317	0.000	1.358	1.171	-	1.574	0.000
Gestational age by USG (days)	0.886	0.817	-	0.961	0.003	0.805	0.702	-	0.922	0.002

OR: Odds ratio, CI: Confidence interval, NLR: Neutrophil lymphocyte ratio, LMR: Lymphocyte monocyte ratio

**Figure 1.** ROC analysis of sonographic and laboratory parameters for the identification of missed abortion. ROC: Receiver operating characteristic, USG: Ultrasonography, LMP: Last menstrual period, LMR: Lymphocyte-to-monocyte ratio, NLR: Neutrophil-to-lymphocyte ratio, PDW: Platelet distribution width, MPV: Mean platelet volume, CRL: Crown-rump length

presence or absence of a YS has strong clinical value, its shape may be a more distinct indicator of poor outcomes than its diameter. In our study, we evaluated the diameter of the YS and found it to be significant in the comparative evaluation of missed abortion (27). Detti et al. (28) reported that small GS and large YS measurements were reliable indicators of pregnancy loss. Correspondingly, we found significantly smaller GS diameters and significantly larger YS diameters in patients with missed abortion (28), identifying both as independent associative factors in our multivariable model. Nayak et al. (29) reported that USG findings and lower progesterone levels play an important role in the identification of pregnancy loss. Unlike some of the aforementioned literature focusing on longitudinal prediction, our study performed a comparative evaluation of pregnancies diagnosed with missed abortion to healthy pregnancies, demonstrating significant differences in GS, YS, CRL measurements, and serum progesterone levels (29), with serum progesterone providing the highest diagnostic accuracy among all parameters evaluated.

Regarding hormonal markers, Kadam et al. (30) reported that higher progesterone levels were associated with viable pregnancies in women with threatened miscarriage, a finding corroborated by the significantly elevated progesterone levels observed in our control group, which was further established as the strongest independent indicator of missed abortion in our multivariable model and the parameter with the highest diagnostic accuracy. In terms of hematological profiles, Liu et al. (13) identified pre-pregnancy leukopenia and neutropenia in cases of spontaneous abortion; however, monocyte and basophil counts did not differ significantly between the groups in our study. Although the absolute lymphocyte count was significantly lower in our missed-abortion group, it did not retain independent significance in the multivariable analysis and demonstrated only modest discriminatory power. This lack of significant difference in other inflammatory parameters aligns with Kale et al. (31) who similarly reported that basophil and monocyte values did not differ significantly, reinforcing our finding that systemic inflammatory indices lack sufficient independent associative value for identifying first-trimester missed abortion.

The role of systemic inflammatory markers in missed abortion remains a subject of ongoing debate, characterized by conflicting results across various studies. While Feng et al. (15) suggested that a lower LMR correlates with an increased risk of pregnancy loss, our comprehensive analysis of basophil, monocyte, neutrophil counts, as well as MPV, PDW, NLR, and LMR, did not differ significantly between the groups. This lack of association was further confirmed by our multivariable analysis, which demonstrated that these hematological indices had no independent diagnostic value in our cohort. This result contrasts with the work of Topkara et al. (32), who found only the systemic immune-inflammatory index to be discriminative among various indices, including NLR, PLR, and MLR, in the clinical assessment of pregnancy outcomes for threatened miscarriage cases. Moreover, although Morisaki et al. (33) reported a gestational age-dependent decrease in LMR values, our study did not find LMR to be a significant indicator for missed abortion when comparing cases to healthy pregnancies, even after adjusting for gestational age in our multivariable model.

Discrepancies also extend to other well-studied indices, such as the NLR. A recent meta-analysis by Hantoushzadeh et al. (34) indicated significantly higher NLR values in women with recurrent miscarriage compared to healthy controls; however, our findings demonstrated that NLR lacked significant associative value for missed abortion in our specific study population, which was further supported by its lack of independent significance in our multivariable model and its failure to demonstrate significant discriminatory power in ROC analysis. Similarly, investigations into platelet indices have yielded inconsistent results. Yilmaz et al. (19) observed significantly elevated MPV levels in patients with recurrent miscarriage, whereas our data align more closely with Gürsoy et al. (16). Their study similarly reported that MPV, PDW, and their respective ratios did not differ significantly, a finding that remained consistent in our analysis even after adjusting for potential confounding factors. Overall, our results suggest that while these hematological parameters are cost-effective and easily accessible, they do not show a significant independent association with missed abortion in our cohort, particularly compared with the more consistent and robust differences observed in sonographic and hormonal markers.

A notable finding in our analysis was a significantly lower lymphocyte count in the missed abortion group compared with healthy controls ($p=0.012$). While this parameter demonstrated a modest but statistically significant discriminative ability in our ROC analysis (AUC: 0.631), it did not retain independent significance in multivariable analysis, suggesting that its role is likely secondary to other primary markers. This result is consistent with the established understanding that immune system dysfunction and abnormal inflammation are central to the pathophysiology of early pregnancy failure (34). Pregnancy requires a delicate balance of maternal-fetal immune tolerance to protect the fetal allograft; a decrease in peripheral lymphocytes may reflect a shift toward a pro-inflammatory state or a breakdown in this immunoprotective environment (15). Furthermore, while systemic indices like NLR did not reach statistical significance in our cohort, the observed lymphopenia aligns with the biological response where inflammation often leads to a rise in neutrophils and a corresponding fall in lymphocyte counts (34). This suggests that absolute lymphocyte counts may serve as sensitive, albeit non-specific, indicators of the altered immune milieu in missed abortion, potentially linked to the diminished immunomodulatory effects of lower progesterone levels observed in these cases (30).

Study Limitations

This study has several limitations that should be considered when interpreting the results. First, the sample size was relatively small, and the study was conducted at a single tertiary care center, which may limit the generalizability of our findings to more diverse populations. Second, missed abortion is a pathologically heterogeneous condition with multiple etiologies, including chromosomal abnormalities, embryonic factors, and maternal conditions, all of which were not investigated or differentiated in this cohort. This lack of etiological classification may limit the generalizability of our findings to specific subgroups of pregnancy loss. Third, hematological and hormonal parameters were assessed using single-point measurements taken at the time of diagnosis, precluding longitudinal analysis of subtle biological fluctuations during

early gestation. Fourth, although a statistically significant difference in gestational age was observed based on ultrasound measurements ($p=0.002$), we addressed this potential confounding effect by performing a multivariable logistic regression analysis. Our model confirmed that serum progesterone, GS diameter, and YS diameter remain strong, independent indicators of missed abortion even after adjusting for gestational age. Finally, although strict exclusion criteria were applied, certain unmeasured confounding factors, such as maternal subclinical infections, could have influenced systemic inflammatory markers. Despite these limitations, our study provides important prospective data to inform the comparative evaluation of multimodal markers for missed abortion.

Conclusion

Our study demonstrates that morphometric sonographic parameters (specifically GS and YS diameters) and serum progesterone levels are independently associated with first-trimester missed abortion. Multivariable logistic regression and ROC analysis confirm that these markers, particularly serum progesterone, which has high discriminatory power, serve as robust clinical indicators for assessing non-viable pregnancies at 6-9 weeks' gestation. Conversely, routine hematological indices, including NLR, LMR, and MPV, did not show a significant independent association in our multivariable model, indicating that they lack sufficient sensitivity to serve as reliable standalone markers for identifying asymptomatic fetal loss. While standardized sonographic and hormonal data provide more consistent diagnostic clarity, further large-scale multicenter prospective studies incorporating etiological subgrouping, such as chromosomal analysis, are warranted to validate these associations across the heterogeneous causes of pregnancy loss and to determine their clinical utility more definitively.

Ethics

Ethics Committee Approval: Ethical approval for the study was obtained from the University of Health Sciences Türkiye, İstanbul Training and Research Hospital Clinical Research Ethics Committee (approval number: 331, date: 22.12.2023)

Informed Consent: Written informed consent was obtained from all participants prior to enrollment in the study.

Footnotes

Authorship Contributions: Surgical and Medical Practices - S.A.K., N.İ.V., A.K.; Concept - N.İ.V.; Design - S.A.K., N.İ.V.; Data Collection or Processing - S.A.K., N.İ.V., A.K.; Analysis or Interpretation - S.A.K.; Literature Search - S.A.K., N.İ.V.; Writing - S.A.K., N.İ.V., A.K.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

- Redinger A, Nguyen H. Incomplete Miscarriage. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan.

- American College of Obstetricians and Gynecologists' Committee on Practice Bulletins—Gynecology. ACOG Practice Bulletin No. 200: early pregnancy loss. *Obstet Gynecol.* 2018; 132: e197-207.
- Dewald O, Hoffman JT. Gestational Sac Evaluation. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan.
- Skinner C, Mount CA. Sonography Assessment of Gestational Age. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan.
- Richardson A, Gallos I, Dobson S, Campbell BK, Coomarasamy A, Raine-Fenning N. Accuracy of first-trimester ultrasound in diagnosis of intrauterine pregnancy prior to visualization of the yolk sac: a systematic review and meta-analysis. *Ultrasound Obstet Gynecol.* 2015; 46: 142-9.
- Ku CW, Zhang X, Zhang VR, Allen JC, Tan NS, Østbye T, et al. Gestational age-specific normative values and determinants of serum progesterone through the first trimester of pregnancy. *Sci Rep.* 2021; 11: 4161.
- Arck PC, Rütke M, Rose M, Szekeres-Bartho J, Douglas AJ, Pritsch M, et al. Early risk factors for miscarriage: a prospective cohort study in pregnant women. *Reprod Biomed Online.* 2008; 17: 101-13.
- Liang YX, Liu L, Jin ZY, Liang XH, Fu YS, Gu XW, et al. The high concentration of progesterone is harmful for endometrial receptivity and decidualization. *Sci Rep.* 2018; 8: 712.
- Ku CW, Allen JC Jr, Lek SM, Chia ML, Tan NS, Tan TC. Serum progesterone distribution in normal pregnancies compared to pregnancies complicated by threatened miscarriage from 5 to 13 weeks gestation: a prospective cohort study. *BMC Pregnancy Childbirth.* 2018; 1: 360.
- Pitkin RM, Witte DL. Platelet and leukocyte counts in pregnancy. *JAMA.* 1979; 242: 2696-8.
- Chirumbolo S, Bjørklund G, Sboarina A, Vella A. The role of basophils as innate immune regulatory cells in allergy and immunotherapy. *Hum Vaccin Immunother.* 2018; 14: 815-31.
- Zhang Y, Qian Y, Liu C, Fan X, Li X, Song Y, et al. Association between white blood cell count and adverse pregnancy outcomes: a retrospective cohort study from a tertiary hospital in China. *BMJ Open.* 2023; 13: e072633.
- Liu Y, Yang Y, Zhao C, Liu M, Xu D, Wu H, et al. An immune window of opportunity to prevent spontaneous abortion: prepregnancy peripheral leukocytes and subsets were associated with a decreased risk of spontaneous abortion. *Hum Reprod.* 2024; 39: 326-34.
- Horasanlı JE, Görkemli H, Özkaya EB, Işıkalın MM, Akıncı D, Kılıç F. Evaluation of hemogram parameters in the diagnosis of ectopic pregnancy and threatened miscarriage. *Cukurova Med J.* 2021; 46: 63-69.
- Feng QT, Chen C, Yu QY, Chen SY, Huang X, Zhong YL, et al. The benefits of higher LMR for early threatened abortion: a retrospective cohort study. *PLoS One.* 2020; 15: e0231642.
- Gürsoy A, Atasayan K, Doğan Tekbaş E, Çelik A. Effectiveness of the trimester MPV/platelet and PDW/platelet ratios in predicting abortus imminens and abortion. *Namık Kemal Med J.* 2022; 10: 260-4.
- Artunc Ulkumen B, Pala HG, Calik E, Oruc Koltan S. Platelet distribution width (PDW): a putative marker for threatened preterm labour. *Pak J Med Sci.* 2014; 30: 745-8.
- Aktün LH. The role of platelets as an early prognostic factor in preterm labor. *Medeniyet Med J.* 2017; 32: 101-5.
- Yılmaz M, Delibas IB, Isaoglu U, Ingec M, Borekci B, Ulug P. Relationship between mean platelet volume and recurrent miscarriage: a preliminary study. *Arch Med Sci.* 2015; 11: 989-93.
- Christoforaki V, Zafeiriou Z, Daskalakis G, Katasos T, Siristatidis C. First trimester neutrophil to lymphocyte ratio (NLR) and pregnancy outcome. *J Obstet Gynaecol.* 2020; 40: 59-64.

21. Yucel Cicek OS, Doger E. Neutrophil-to-lymphocyte ratio is a predictor of biochemical miscarriage following artificial frozen embryo transfer cycles. *J Obstet Gynaecol.* 2022; 42: 3349-55.
22. Uddin SF, Rani K, Shah T, Zeba N, Kalo AW, Waheen K, et al. Physiological and statistical evaluation of neutrophil-lymphocyte ratio as a predictor of first trimester miscarriage among residents of Hyderabad. *J Soc Obstet Gynaecol Pak.* 2024; 14: 320-4.
23. 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: e24250.
24. Sacchetti S, Vidali M, Esposito T, Zorzi S, Burgener A, Ciccarello L, et al. The role of new morphological parameters provided by the BC 6800 plus analyzer in the early diagnosis of sepsis. *Diagnostics (Basel).* 2024; 14: 340.
25. Marin M, Pătru CL, Manolea MM, Novac L, Dijmărescu AL, Boldeanu MV, et al. Can ultrasound analysis of the yolk sac be a predictor of pregnancy outcome? *Curr Health Sci J.* 2021; 47: 547-52.
26. Liu C, Wei X, Wang F. The predictive value of ultrasound markers for pregnancy outcomes in recurrent pregnancy loss: a retrospective study. *Sci Rep.* 2024; 14: 16657. Erratum in: *Sci Rep.* 2024; 14: 24920.
27. Suguna B, Sukanya K. Yolk sac size & shape as predictors of first trimester pregnancy outcome: a prospective observational study. *J Gynecol Obstet Hum Reprod.* 2019; 48: 159-64.
28. Detti L, Francillon L, Christiansen ME, Peregrin-Alvarez I, Goedecke PJ, Bursac Z, et al. Early pregnancy ultrasound measurements and prediction of first trimester pregnancy loss: a logistic model. *Sci Rep.* 2020; 10: 1545. Erratum in: *Sci Rep.* 2021; 11: 21598.
29. Nayak KD, Poojari VG, Pai MV, Mundkur A, Adiga P. Prediction of pregnancy outcomes in women with threatened abortion using ultrasound parameters, uterine artery doppler, and serum progesterone levels: a prospective cohort study. *J Obstet Gynaecol India.* 2025; 75: 414-21.
30. Kadam VK, Agrawal S, Saxena P, Laul P. Predictive value of single serum progesterone level for viability in threatened miscarriage. *J Obstet Gynaecol India.* 2019; 69: 431-5.
31. Kale I, Helvacioğlu C, Muğurtay TE. Evaluation of complete blood count parameters in the first trimester: an early indicator of miscarriage? *J Clin Invest Surg.* 2021; 6: 48-52.
32. Topkara Sucu S, Dereli ML, Özkan S, Sucu S, Küçükkayıkçı AS, Çağlar A. Association of haematological inflammatory parameters with miscarriages. *Jinekoloji-Obstetrik ve Neonatoloji Tıp Dergisi.* 2024; 21: 95-101.
33. Morisaki N, Piedvache A, Nagata C, Michikawa T, Morokuma S, Kato K, et al. Maternal blood count parameters of chronic inflammation by gestational age and their associations with risk of preterm delivery in the Japan Environment and Children's Study. *Sci Rep.* 2021; 11: 15522.
34. Hantoushzadeh S, Gargar OK, Jafarabady K, Rezaei MM, Asadi F, Eshraghi N, et al. Diagnostic value of neutrophil-to-lymphocyte and platelet-to-lymphocyte ratio to predict recurrent pregnancy loss and abortion: a systematic review and meta-analysis. *Immun Inflamm Dis.* 2024; 12: e1210.