Original Article

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The Role of Uterine Artery Doppler Analysis in Predicting the Amount of Postpartum Hemorrhage in Cesarean Section

Sezaryende Postpartum Kanama Miktarını Öngörmede Uterin Arter Doppler Analizinin Yeri

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ABSTRACT

Objective: Postpartum hemorrhage (PPH) most commonly occurs within the first 24 hours after delivery. During this period, the uterus undergoes physiological involution, accompanied by hemodynamic changes that reduce uterine blood flow. This early postpartum phase represents a critical window in which uterine artery Doppler (UAD) indices begin to change but may not yet reach peak values. We hypothesized that Doppler measurements obtained during this period could provide early insight into susceptibility to blood loss. This study aimed to evaluate whether UAD parameters can predict hemoglobin (Hb) decrease in the early postpartum period.

Methods: A total of 56 low-risk pregnant women who underwent elective cesarean section were included. Bilateral UAD resistive index (RI) values were measured within the first 24 hours postpartum. Demographic characteristics and laboratory parameters were recorded. Mean UAD RI values were analyzed in relation to significant Hb decrease. Receiver operating characteristic analysis was performed to determine the optimal cut-off value of mean UAD RI associated with significant Hb decrease.

Results: The 75th percentile of Hb change was 0.938 g/dL and was defined as the threshold for significant Hb decrease. A

ÖZ

Amaç: Postpartum kanama (PPK) en sık doğumdan sonraki ilk 24 saat içinde ortaya çıkar. Bu dönemde uterus fizyolojik involüsyona uğrar ve uterin kan akımını azaltmaya yönelik hemodinamik değişiklikler meydana gelir. Bu erken postpartum dönem, uterin arter Doppler (UAD) indekslerinin değişmeye başladığı ancak henüz pik değerlere ulaşmadığı kritik bir zaman aralığını temsil eder. Bu çalışmada, bu dönemde yapılan Doppler ölçümlerinin kan kaybına yatkınlığı erken dönemde öngörmeye katkı sağlayabileceği hipotez edildi. Çalışmanın amacı, erken postpartum dönemde UAD parametrelerinin hemoglobin (Hb) düşüşünü öngörmedeki değerini değerlendirmektir.

Yöntem: Elektif sezaryen ile doğum yapan düşük riskli toplam 56 gebe çalışmaya dahil edildi. Doğum sonrası ilk 24 saat içinde bilateral UAD rezistif indeks (RI) değerleri ölçüldü. Demografik özellikler ve laboratuvar parametreleri kay-dedildi. Ortalama UAD RI değerleri ile anlamlı Hb düşüşü arasındaki ilişki analiz edildi. Anlamlı Hb düşüşü ile ilişkili ortalama UAD RI eşik değerini belirlemek amacıyla alıcı işletim karakteristiği eğrisi analizi yapıldı.

Bulgular: Hb değişiminin %75'lik persentil değeri 0,938 g/dL olarak bulundu ve bu değer anlamlı Hb düşüşü için eşik olarak kabul edildi. Ortalama UAD RI ≤0,915 olduğunda Hb düşüşü ile

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ABSTRACT

mean UAD RI value ≤0.915 was significantly associated with greater Hb decrease (p=0.025). A significant correlation was observed between mean UAD RI and preoperative Hb levels (r=-0.360, p=0.006). No significant correlation was found with other variables.

Conclusion: Monitoring mean UAD RI values in the early postpartum period may serve as a complementary clinical parameter for the early identification of PPH. While current evidence on postpartum UAD measurements remains limited, UAD indices appear to undergo dynamic changes within the first 24 hours in cases complicated by PPH. These findings suggest that UAD assessment may contribute to early risk stratification and support clinical decision-making; however, further large-scale studies are required to validate these results.

Keywords: Postpartum hemorrhage, uterine artery Doppler, hemoglobin, cesarean delivery

ÖZ

istatistiksel olarak anlamlı ilişki saptandı (p=0,025). Ortalama UAD RI ile preoperatif Hb düzeyleri arasında istatistiksel olarak anlamlı bir korelasyon bulundu (r=-0,360, p=0,006), diğer değişkenlerle anlamlı bir ilişki saptanmadı.

Sonuç: Erken postpartum dönemde ortalama UAD RI değerlerinin izlenmesi, PPK'nın erken tanımlanmasında tamamlayıcı bir klinik parametre olarak kullanılabilir. Postpartum dönemde UAD ölçümlerine ilişkin mevcut kanıtlar sınırlı olmakla birlikte, PPK ile komplike olgularda UAD indekslerinin ilk 24 saat içinde dinamik değişiklikler gösterdiği düşünülmektedir. Bu bulgular, UAD değerlendirmesinin erken risk sınıflandırmasına katkı sağlayabileceğini ve klinik karar verme süreçlerini destekleyebileceğini düşündürmektedir; ancak bu sonuçların doğrulanması için daha geniş ve çok merkezli çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: Postpartum kanama, uterin arter Doppler, hemoglobin, sezaryen doğum

Introduction

Increased uterine contractions, placental separation, and reduced uterine blood supply after delivery are normal physiological processes. However, postpartum hemorrhage (PPH) that exceeds the expected physiological amount can progress rapidly, leading to maternal morbidity and mortality. While maternal mortality is a significant indicator of a country's level of development, it is often preventable with prompt intervention and treatment (1). Statistically, it has been revealed that PPH is observed in 1-5% of all pregnant women who give birth (2-4). PPH accounts for approximately 27% of maternal deaths each year. PPH is classified into two categories, primary and secondary, based on the timing of its occurrence. Primary PPH is the most common type. Generally, bleeding of more than 500 mL within the first 24 hours after a vaginal delivery, or more than 1000 mL within the first 24 hours after a cesarean delivery, is considered PPH (1). PPH is classified into two groups: minor and major bleeding. In this classification, minor PPH is defined as bleeding between 500 and 1000 mL, while major PPH is defined as bleeding of ≥1000 mL (1).

The uterine artery which is the main artery supplying the uterus, provides a blood flow of 500-700 mL per minute to the uterus, representing approximately 15% of the cardiac output on its own (5). Although uterine artery Doppler (UAD) measurements have been extensively studied obstetrically during the antenatal period, there is insufficient research on UAD measurements in the postpartum period, particularly during the first 24 hours when primary PPH is monitored. The literature indicates that notching can be observed in UAD during the first 8 weeks postpartum, with a 22% occurrence in the first week and a 95% occurrence between the 2nd and 8th weeks. Additionally, the UAD pulsatility index is approximately 1.2 in the first week but increases to >2 by the 8th week (6). In recent years, with the increase in cesarean section rates, it has become one of the most commonly performed surgeries worldwide (7,8). In our study, we aimed to correlate UAD measurements taken within the first 6 hours postpartum with preoperative and postpartum hemoglobin (Hb) levels changes in patients who delivered by cesarean section.

Postpartum hemodynamic shifts include a rapid reduction in uterine blood flow and increased vascular resistance as part of the physiological involution process. However, deviations from this normal pattern may reflect poor uterine contractility or abnormal placental bed remodeling-two important contributors to PPH. By assessing uterine artery resistive indices (RI) in the early hours postpartum, clinicians may detect insufficient vascular resistance increases that correlate with greater blood loss or Hb decrease. Our decision to perform UAD measurements at the 24 hours postpartum hour aimed to capture this transitional hemodynamic window, when both physiological and pathological changes are most pronounced and intervention can be most impactful. This novel approach aligns with limited but emerging literature suggesting the utility of postpartum Doppler evaluation in hemorrhage prediction.

Through this study, we aimed to predict Hb level changes during the postpartum period using UAD measurements.

Methods

Our study is designed as a prospective cohort study. Ethical approval for the study was obtained from the University of Health Sciences Türkiye, İzmir City Hospital (decision no: 2024/57, date: 10.05.2024). This study was conducted in compliance with the Helsinki Declaration and informed consent was obtained from all participants before starting the study.

Patient Selection

Between May 10, 2023, and June 1, 2024, 56 pregnant women who met the inclusion criteria and had no additional diseases or characteristics were included in the study at University of Health Sciences Türkiye, İzmir City Hospital, whom delivered via elective or emergency cesarean section. Bilateral UAD measurements were performed using postpartum pelvic Doppler ultrasound. For this, a GE Voluson Ultrasound Machine (GE Healthcare, Milwaukee, Wisconsin, USA) with a Convex 4C-RS (2-5 MHz) probe was used. Hemogram parameters from the last 24 hours before delivery and hemogram values at the 24th hour postpartum were collected. Data related to delivery, as well as Hb, white blood cell (WBC), and platelet (PLT) values, were recorded.

Inclusion Criteria

Pregnancies beyond 37 weeks and less than 41 weeks of gestation, women aged 18 to 40 years, patients with a body mass index (BMI) under 35 kg/m², those who did not progress to the active phase of labor before cesarean section, those without any vascular conditions such as vasculopathy or autoimmunity affecting the vascular bed, those without coagulopathy or anticoagulant therapy, those without injuries that could cause additional blood loss, those without intense bleeding from the wound site postpartum, those without placental anomalies, and those who were willing to participate in the study.

Exclusion Criteria

<37 weeks gestation and >41 weeks gestation, women under 18 years of age and over 40 years of age, patients with a BMI >35 kg/m², patients in the active phase of labor, pregnant women with vascular conditions such as vasculopathy or autoimmunity affecting the vascular bed, those with coagulopathy or receiving anticoagulant therapy, those with injuries that could cause additional blood loss, patients with placental anomalies such as previa, accreta, placental abruption, intrauterine growth restriction or other conditions known to alter uterine hemodynamics, postpartum patients with intense bleeding from the wound site, patients with detected placental anomalies, those unwilling to participate in the study, and those with four or more previous cesarean sections.

Surgical Technique

Spinal anesthesia was administered to the patients according to the procedure. After the abdominal layers were dissected according to the Pfannenstiel incision technique, the baby was delivered through a Kerr incision. Following the removal of the placenta, intrauterine cleaning was performed. A Kehr suture was applied. Bleeding was controlled, and the abdominal layers were closed according to standard procedures (8).

Patients with stable hemodynamics after cesarean delivery were monitored in our clinic. Hourly vital signs were tracked. Infusion of a 2% oxytocin Ringer's lactate solution was continued for approximately 4 hours. Routine analgesia and IV hydration treatments were administered postpartum. If there was no bleeding and the uterine tone was good, the uterotonic infusion was discontinued. Breastfeeding and uterine massage were encouraged. Routine hemogram checks were performed at the 24th hour postpartum. The results were recorded.

Uterine Artery Doppler Measurement

Patients were subjected to ultrasound examination in the supine position at 24 hours after cesarean operation, once their hemodynamics were stable. The uterus was examined in the midsagittal position. The cervical canal was identified, and the iliac and uterine arteries were visualized using Doppler flow mapping. Doppler measurements were performed at least twice for each uterine artery, 1 cm distal to the point where the uterine artery crosses the external iliac artery, capturing at least three consecutive waveforms. Average values were recorded.

Based on the uterine artery diameter, the sample volume size was adjusted, and measurements were taken with an insonation angle of <25°. All ultrasound and Doppler evaluations were conducted by a single researcher (E.Ş.). All measurements were recorded for further analysis. UAD ultrasound measurements were recorded for both the right and left uterine arteries, and the average values were calculated (9).

Statistical Analysis

Sample size was calculated using G*Power software (version 3.0.10). With a type I error level of α=0.05 and a power of 80% (1-β=0.80), the required sample size was determined to be 56 participants. Statistical analyses were performed using IBM SPSS Statistics (version 17.0; IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Continuous variables were presented as mean ± standard deviation for normally distributed data and as median (minimum-maximum) for non-normally distributed data. The distribution of postpartum Hb change was analyzed, and the 75th percentile (fourth quartile) was used as the cut-off value to define significant Hb decrease. Comparisons between two independent groups were performed using the Student's t-test for normally distributed variables and the Mann-Whitney U test for non-normally distributed variables. For comparisons among more than two independent groups, one-way analysis of variance or the Kruskal-Wallis test was used, as appropriate. Categorical variables were analyzed using the Pearson chi-square test or Fisher's exact test when necessary. Correlation analysis between continuous variables was performed using Pearson or Spearman correlation coefficients, depending on data distribution. Receiver operating characteristic (ROC) curve analysis was conducted to evaluate the ability of mean UAD RI values to predict postpartum Hb change.

The area under the curve (AUC), optimal cut-off values, sensitivity, and specificity were determined. A p-value of <0.05 was considered statistically significant. Bonferroni correction was applied where appropriate to adjust for multiple comparisons.

Results

The age, preoperative and postoperative WBC, Hb, PLT, estimated fetal weight (EFW), left and right UAD systolic/diastolic flow ratios, right and left UAD RI, and the mean UAD RI measurements of the participants included in the study are listed in Table 1. In our study, we primarily tried to evaluate the usefulness of UAD indices in the prediction of PPH. Therefore, the relationship between UAD RI (mean) and Hb changes (difference between post-Hb and pre-Hb) was evaluated. The 4th quartile (75% percentile) value for Hb level change was 0.938 g/dL. Accordingly, a Hb level change of ≥0.938 g/dL measurements obtained at the 24th hour postpartum were considered as a significant Hb decrease and subsequently used as a criterion for PPH. The percentile data of Hb changes of the patients are presented in Table 2. An ROC curve was constructed for the continuous variable of mean UAD RI, which was found to be associated with a significant Hb decrease (Figure 1). The area under the AUC was determined to be 0.674 [(95%) confidence interval (CI): 0.531-0.818] (p=0.027).

In the AUC, appropriate cut-off values with the highest sensitivity and specificity were determined. The risk of PPH appeared to increase when UAD RI (mean) ≤0.915. Furthermore, the distribution of patients with a significant decrease in Hb when UAD RI (mean) was taken as 0.915 is shown in Table 3. When the data of 56 patients were analyzed in total, a significant Hb decrease (≥0.938 g/dL) was observed in 20 of 36 patients (55.55%) with UAD RI (mean) ≤0.915, whereas a significant hemogram decrease (≥0.9387 g/dL) was observed in 4 of 20 patients (20%) with UAD RI (mean) >0.915. Accordingly, statistical significance of significant Hb level decrease was achieved when UAD RI (mean) ≤0.915 (p=0.025) (Table 3).

An AUC was constructed for age, a continuous variable found to be associated with a significant decrease in Hb (Figure 2). The area under the AUC was 0.768 (95% CI: 0.636-0.901) (p=0.001). This indicated that the risk of bleeding increased when the age threshold was set at 24.5 years (p=0.001) (Table 4).

The statistical correlation between preoperative WBC, preoperative Hb values and mean RI values are summarized in Table 5.

The correlation between groups with and without significant Hb decrease and the continuous variables was analyzed. The variables showing statistically significant differences were age and mean RI values (p<0.05). These findings are summarized in Table 6.

Table 1. Descriptive statistical analysis of continuous variables

Continuous variables	Min. value	Max. value	Mean	SD
Age (year)	19.0	33.0	26.60	4.474
Preoperative WBC (/µL)	7230.0	18720.0	12137.85	2465.07
Postoperative WBC (/µL)	10300.0	20580.0	14238.21	2605.72
Preoperative Hb (g/dL)	7.4	13.6	11.73	1.43
Postoperative Hb (g/dL)	8.2	13.3	10.70	1.34
Preoperative PLT (/µL)	128000.0	377000.0	249892.85	61580.0
Postoperative PLT (/µL)	111000.0	360000.0	217321.42	55849.8
EFW (gr)	2100.0	4370.0	3101.42	591.42
Left UAD S/D	1.9600	10.0	5.227	1.851
Right UAD S/D	2.1000	7.36	4.726	1.337
Mean systolic/diastolic ratio of the right and left UAD (S/D)	2.1	7.5	4.977	1.231
Left UAD RI	0.54	1.48	0.914	0.223
Right UAD RI	0.57	1.39	0.916	0.204
Mean UAD RI	0.695	1.38	0.915	0.190

S/D: Systolic/diastolic flow ratio, RI: Resistive index, WBC: White blood cell, Hb: Hemoglobin, SD: Standard deviation, PLT: Platelet; EFW: Estimated fetal weight, UAD: Uterine artery Doppler

Table 2. Percentile data of postpartum hemoglobin (Hb) change

	%25	%50	%75
Hb change (g/dL)	0.80	0.84	0.938

When the Spearman's rho correlation analysis between mean UAD RI value and Hb level change and continuous variables was analyzed, it was found that age was negatively correlated with Hb change (r=-0.438, p=0.001) (p<0.05), negative between mean RI and gravida (r=-0.322, p=0.016), negative between mean RI and parity (r=-0.350, p=0.008), positive between mean RI and EFW (r=0.322, p=0.0016) (p<0.05). The results are summarized in Table 7.

Discussion

PPH is a significant condition that often arises acutely due to unpredictable causes during the postpartum period and can lead to maternal morbidity and mortality. Predicting and preventing this condition is crucial for preventing maternal mortality and morbidity (10). In the literature, UAD analysis has been studied in relation to menstrual cycles, healthy pregnancy monitoring during the intrapartum period, high-risk pregnancy monitoring during the intrapartum period, and throughout both the intrapartum and postpartum processes (9,11). However, studies using UAD analysis during the postpartum period are limited. In this study, we aimed to predict the amount of bleeding by measuring UAD resistances at the 24th hour postpartum.

In multiparous women, decreased UAD RI values were observed compared to primiparous women. In a study conducted by Guedes-Martins et al. (5), it was found that multiparous women had lower UAD RI values in the early postpartum period compared to primiparous women. This study is highly similar to ours in that it evaluates PPH

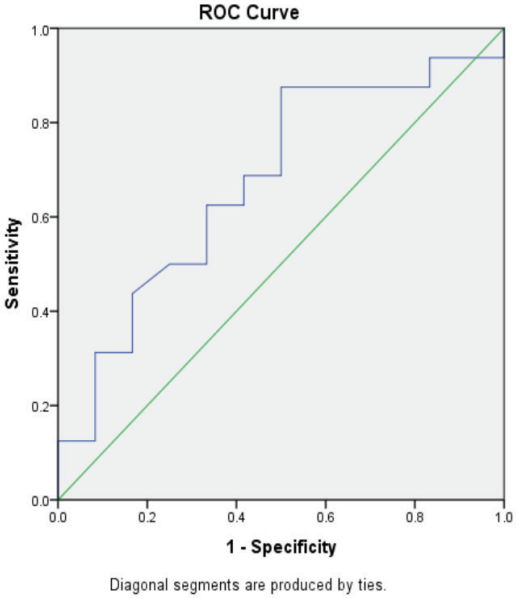

Figure 1. ROC analysis for mean UAD RI value in relation to significant Hb decrease

ROC: Receiver operating characteristic, UAD: Uterine artery Doppler, RI: Resistive index, Hb: Hemoglobin

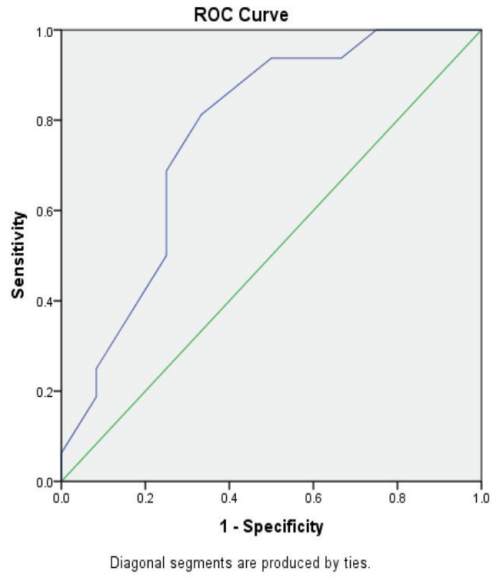

Figure 2. ROC analysis for significant Hb change and age continuous variable

ROC: Receiver operating characteristic, Hb: Hemoglobin

Table 3. Distribution of significant Hb decrease in patients when the cut-off value for UAD RI (mean) is chosen as 0.915

UAD RI (mean)				
Significant Hb decrease (≥0.938 g/dL)	**≤0.915**	**>0.915**	**Total**	**p**
Absent	16	16	32	
Present	20	4	24	
Total	36	20	56	**0.025**

UAD: Uterine artery Doppler, RI: Resistive index, Hb: Hemoglobin, RI: Resistive index

Table 4. Distribution of significant Hb decrease among patients based on age (cut-off 24.5 years)

Age (year)				
Significant Hb decrease (≥0.938 g/dL)	**≤24.5**	**>24.5**	**Total**	**p**
Absent	12	20	32	
Present	14	10	24	
Total	26	30	56	**0.021**

Hb: Hemoglobin

Table 5. Average RI value and correlation analysis of variables correlation analysis

Spearman's rho	Preoperative WBC (/μL)	r	-0.241
		p	0.074
	Preoperative Hb (g/dL)	r	-0.360
		p	**0.006**

r: Correlation coefficient p: Significance level p<0.05 is shown in bold with statistically significant data, WBC: White blood cell, RI: Resistive index, Hb: Hemoglobin

in women who deliver by cesarean section. In the study conducted by Diniz et al. (11), uterine blood flow was assessed with two ultrasound examinations, one within the first 48 hours and the other between the 31st and 50th days. According to this study, a lower increase in UAD RI was recorded in multiparous women compared to primiparous women (11). The underlying reason for this finding is most likely the recorded uterine artery regenerations that occurred in previous pregnancies of multiparous women. The remaining regenerations in the uterine artery affect subsequent pregnancies.

In our study, we found that women aged 19-24.5 had a higher tendency towards PPH. In this group, UAD RI values were below 0.915, and Hb level decrease was above 0.938 g/dL. According to the literature, Cleary-Goldman et al. (12) compared postpartum complications of cesarean deliveries between women aged 18-24 and those aged 35 and older. They reported that women aged 18-24 undergoing cesarean delivery had an increased risk of PPH and a higher need for blood transfusion (12). It has been shown to increase neonatal complications in women of advanced maternal age and maternal complications in women aged 18-24 years in the reproductive period. In another study by Lao et al. (13) evaluating the correlation between PPH and maternal age, it was reported that the risk of PPH decreased from the 20-24 age group to the >40 age group. In this study, the adjusted odds ratio for PPH was 0.84 in the 25-29 age range, and a progessive decrease was observed, reaching 0.59 in women aged 40 and over. In a study conducted by Hessler et al. (14), age-related vascular changes in uterine arteries were demonstrated, with calcific lesions present in 0% of women aged 45-49 years, increasing to 3.9% in the 50-59 age group, 37% in the 60-69 age group, and reaching 50% in women aged 70-81 years. It can be understood that the decreasing uterine blood flow index with aging may play a protective role against PPH. In our study, postpartum UAD RI values were found to be higher in women who delivered macrosomic babies (>4000 g) compared to those who delivered babies of normal weight. In contrast, the study by Guedes-Martins et al. (5) did not report a significant effect of infant birth weight. In this study, while the timing of data collection was not standardized, UAD measurements were conducted no earlier than one week postpartum. Our study measured UAD at the 24th hour, and the data were recorded. We found that early UAD analysis did not increase the risk of PPH following cesarean delivery of a macrosomic baby. This is probably due to the fact that the pregnant women with a birth weight of 4000 g and above in our study population were 30 years of age and older and were primiparous. In these pregnant women who did not have additional defining risk factors, a low severity positive RI correlation was observed according to our study results. It would be useful to evaluate the presence of a macrosomic baby, which is considered among the risk factors for PPH, with other defining risk factors. It is a normal physiological finding that uterine artery resistance has low values in UAD records during a healthy pregnancy, as this low resistance helps provide the necessary blood flow to the uterus. In the postpartum period, an increase in uterine artery resistance is expected due to the reduced blood supply to the uterus. This physiological change helps mitigate the risk of PPH (5). In this study, a decrease in UAD resistance index values and an increase in uterine artery resistance were observed in the postpartum uterus, which can be seen as a natural physiological consequence of the physiological cascade. We aimed to determine the correlation between UAD resistance and the change in Hb levels by comparing the values before cesarean delivery and at the 24th hour postpartum. Since there is no specific Hb level change laboratory value defined for PPH in the literature, we used laboratory data from our population to define PPH. According to this distribution, the reference threshold for PPH was estimated at the 4th quartile (75th percentile), with an average blood loss (Hb) of 0.938 g/dL. A decrease in Hb of 0.938 g/dL or higher was selected as the indicator for PPH. In our study, other factors that we selected as potentially affecting blood loss were also evaluated (gravida, parity, birth weight, age, PLT, WBC). The correlation between the variable created for Hb change and the mean UAD RI value was tested separately. The correlations of the variables with Hb change and the mean UAD RI value were tested separately. While the mean UAD RI value showed a correlation with four parameters, Hb level change was only correlated with maternal age. In our study, we believe that the mean UAD RI value could be a more sensitive parameter

Table 6. Correlation analysis between significant hemoglobin decrease and continuous variables

	Hb decrease >0.938 g/dL		Hb decrease <0.938 g/dL		
	Mean	**± SD**	**Mean**	**± SD**	**p**
Age (year)	25.5	3.94	28.5	4.52	**0.001**
Mean UAD RI	0.908	0.21	0.932	0.19	**0.022**

SD: Standard deviation, Hb: Hemoglobin, UAD: Uterine artery Doppler, RI: Resistive index

Table 7. Correlation analysis between the mean UAD RI value, Hb change, and continuous variables

		Mean RI	Hb change (g/dL)
Age (year)	r	-0.109	-0.438
	p	0.426	0.001
Gravida (n)	r	-0.322	0.072
	p	0.016	0.598
Parity (n)	r	-0.350	0.026
	p	0.008	0.850
EFW (gr)	r	0.322	0.187
	p	0.0016	0.168

r: Correlation coefficient, p: Significance level, UAD: Uterine artery Doppler, RI: Resistive index, Hb: Hemoglobin, EFW: Estimated fetal weight

for the early detection of PPH. What distinguishes our study from the limited similar studies in the literature is the correlation between Hb level change and the average RI value for each variable. Our ROC analysis of age groups, average RI, and Hb level change groups revealed a strong correlation with high CIs.

Study Limitations

This study has several limitations that should be acknowledged. First, the relatively small sample size may limit the statistical power of the findings. Second, the absence of a clearly defined PPH cohort restricts the ability to draw definitive conclusions regarding predictive performance. Third, the single-center design may limit the generalizability of the results to broader populations. In addition, the timing of Doppler measurements was limited to a single postpartum time point, which may not fully capture the dynamic changes in uterine artery hemodynamics. Therefore, the findings should be interpreted with caution, and further large-scale, multicenter studies are warranted to validate these results.

Conclusion

Monitoring mean UAD RI values in the early postpartum period may serve as a complementary clinical parameter for the early identification of PPH. These findings suggest that UAD assessment may provide additional support in early risk stratification and clinical decision-making when interpreted together with clinical and laboratory parameters. However, given the limitations of the study, these results should be interpreted with caution, and further large-scale, multicenter studies are needed to confirm these findings.

Ethics

Ethics Committee Approval: Ethical approval for the study was obtained from the University of Health Sciences Türkiye, İzmir City Hospital (decision no: 2024/57, date: 10.05.2024).

Informed Consent: This study was conducted in compliance with the Helsinki Declaration and informed consent was obtained from all participants before starting the study.

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Footnotes

Authorship Contributions

Surgical and Medical Practices: E.Ş., M.F.K., Concept: E.Ş., R.E.P., Design: E.Ş., M.B.B., Data Collection or Processing: E.Ş., M.B.B., Analysis or Interpretation: R.E.P., Y.K.A., Literature Search: E.Ş., Y.K.A., Writing: E.Ş., M.F.K.

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