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EFFECT OF PREVIOUS CAESARIAN SECTION ON 2ND TRIMESTER UTERINE ARTERY DOPPLER

Original Research

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ABSTRACT

Background: Previous cesarean section is increasingly common and has been implicated in altered uteroplacental vascular adaptation in subsequent pregnancies. Structural changes related to uterine scarring may influence uterine artery blood flow, particularly during the second trimester when placentation and vascular remodeling are critical. Abnormal uterine artery Doppler indices during this period have been associated with adverse maternal and fetal outcomes, including hypertensive disorders of pregnancy and fetal growth restriction. Understanding these vascular effects is important for improving antenatal surveillance and maternal–fetal risk assessment.

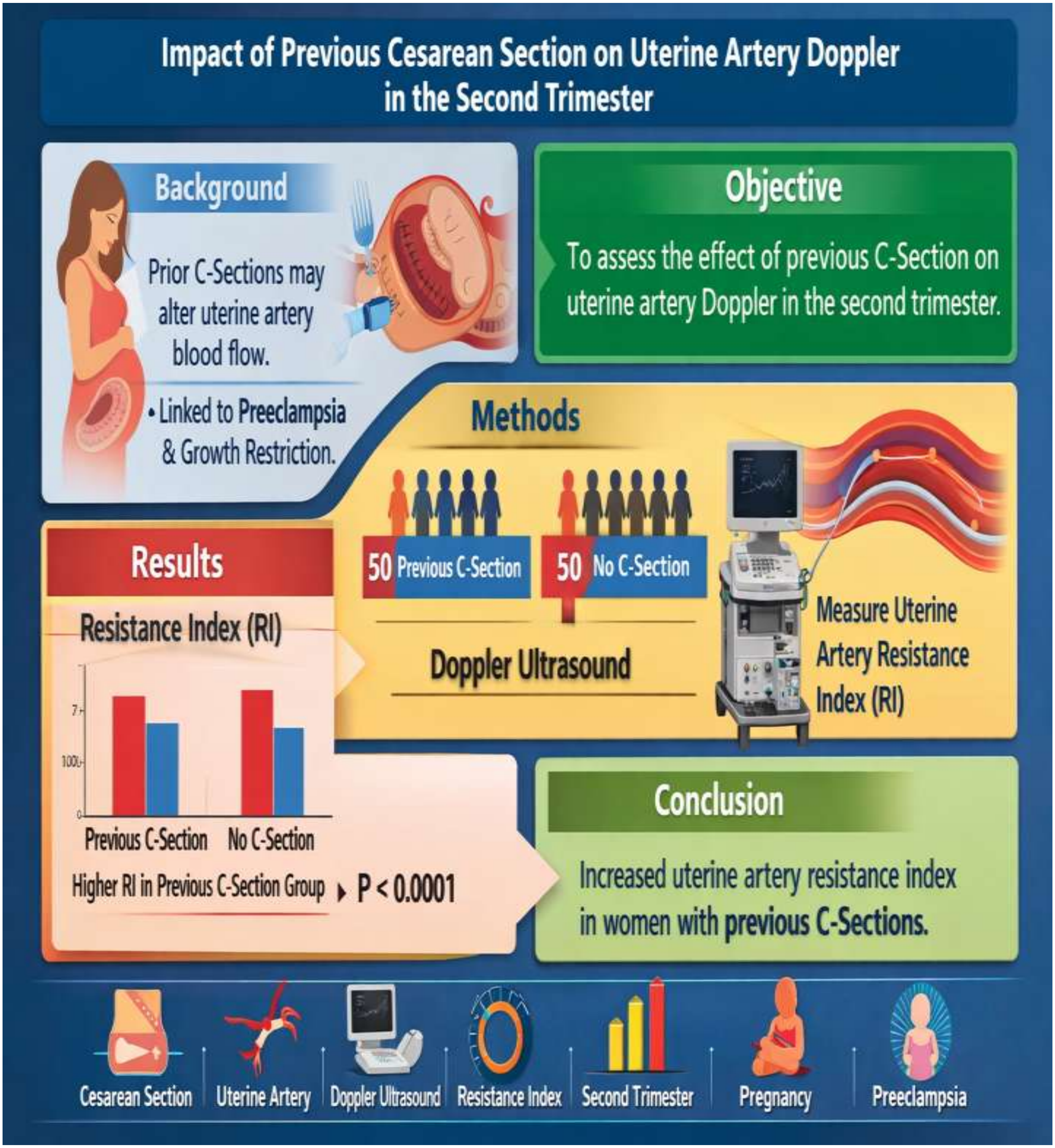
Objective: To evaluate the effect of previous cesarean section on uterine artery Doppler resistive index during the second trimester of pregnancy.

Methods: This comparative study included 100 pregnant women in the second trimester, divided equally into two groups: 50 with a history of previous cesarean section and 50 without prior cesarean section. Participants were recruited from tertiary ultrasound clinics in Lahore. Transabdominal ultrasound examinations were performed using high-resolution Doppler equipment. Gestational age was confirmed using fetal biometric parameters, and uterine artery Doppler assessment was carried out to measure the resistive index. Data were analyzed using appropriate statistical tests, with significance set at a p-value < 0.05.

Results: The overall mean maternal age was 27.45 ± 4.61 years, and the mean gestational age at examination was 20.24 ± 2.32 weeks. Mean uterine artery resistive index was significantly higher in women with a previous cesarean section (0.710 ± 0.063) compared with those without a cesarean history (0.660 ± 0.058), with a mean difference of −0.05 (95% CI: −0.074 to −0.026; p = 0.0001). No statistically significant differences were observed between groups for maternal age, gestational age, or body mass index (p > 0.05).

Conclusion: A history of previous cesarean section was associated with increased uterine artery resistive index during the second trimester, suggesting altered uteroplacental vascular resistance in subsequent pregnancies. These findings support the role of uterine artery Doppler as a useful tool for identifying vascular changes related to prior cesarean delivery and may aid in guiding closer antenatal monitoring.

Keywords: Body Mass Index, Cesarean Section, Gestational Age, Pregnancy Trimester, Second; Resistance Index, Ultrasonography, Doppler; Uterine Artery.


Impact of Previous Cesarean Section on Uterine Artery Doppler in the Second Trimester
Background
Prior C-Sections may alter uterine artery blood flow.
• Linked to Preeclampsia & Growth Restriction.
Objective
To assess the effect of previous C-Section on uterine artery Doppler in the second trimester.
Methods
50 Previous C-Section
50 No C-Section
Doppler Ultrasound
Measure Uterine Artery Resistance Index (RI)
Results
Resistance Index (RI)
Previous C-Section
No C-Section
Higher RI in Previous C-Section Group
P < 0.0001
Conclusion
Increased uterine artery resistance index in women with previous C-Sections.
Cesarean Section
Uterine Artery
Doppler Ultrasound
Resistance Index
Second Trimester
Pregnancy
Preeclampsia

INTRODUCTION

The uterine artery is a principal vascular structure of the female reproductive system, responsible for supplying oxygenated blood and essential nutrients to the uterus and, during pregnancy, to the developing placenta and fetus. Arising from the internal iliac artery, the uterine artery traverses the broad ligament and branches extensively within the uterine wall, ensuring adequate perfusion of the myometrium and endometrium (1). This blood supply is not only fundamental for implantation and placental development but also plays a central role in cyclical endometrial changes associated with menstruation and fertility. During pregnancy, the importance of the uterine artery becomes even more pronounced, as successful fetal growth and maternal adaptation depend heavily on appropriate uteroplacental circulation (2,3). Pregnancy is accompanied by profound cardiovascular and vascular adaptations, particularly within the uterine arteries. As gestation progresses, these vessels undergo marked structural and functional remodeling characterized by vasodilation, reduced vascular resistance, and increased blood flow. These changes are driven by hormonal influences, including rising levels of estrogen and progesterone, and by endothelial-mediated mechanisms that enhance vessel compliance (4). The second trimester, spanning approximately 13 to 26 weeks of gestation, represents a critical window in which these adaptations become well established. During this period, rapid fetal growth and increasing placental metabolic demands necessitate efficient uterine artery perfusion to maintain optimal maternal–fetal exchange (5). Doppler ultrasound assessment of the uterine artery has emerged as a valuable, non-invasive method for evaluating these physiological changes and for identifying pregnancies at risk of adverse outcomes. Indices such as the pulsatility index, resistance index, and systolic/diastolic ratio provide insight into downstream placental resistance and uteroplacental function. Numerous studies have demonstrated that persistently elevated uterine artery Doppler indices or the presence of abnormal waveforms, particularly in the second trimester, are associated with impaired placentation and complications such as preeclampsia, fetal growth restriction, preterm birth, and placental abruption (6-8).

In recent years, increasing attention has been directed toward understanding how previous obstetric interventions, especially cesarean section, may influence uterine artery blood flow in subsequent pregnancies. Cesarean delivery involves surgical incision of the uterine wall, followed by healing and scar formation, which can alter uterine anatomy and vascular responsiveness. Scar tissue and adhesions may interfere with normal arterial remodeling and reduce the ability of the uterine arteries to accommodate the increased blood flow required during pregnancy (9). Several cohort and prospective studies have reported higher uterine artery Doppler indices and a greater frequency of abnormal Doppler findings in women with a history of one or more cesarean sections compared with those who previously delivered vaginally, particularly when the placenta is located near the uterine scar (10,11). These vascular alterations have important clinical implications, as impaired uterine artery flow in women with prior cesarean delivery has been linked to an increased risk of placental insufficiency, abnormal placentation such as placenta previa or accreta, and adverse perinatal outcomes. Despite the growing body of evidence, findings across studies remain heterogeneous, and the extent to which previous cesarean sections independently affect second-trimester uterine artery Doppler parameters is not fully established. This uncertainty is particularly relevant in low- and middle-income settings, where access to advanced biochemical screening is limited and Doppler ultrasound may serve as a practical alternative for risk stratification (12,13). Given the rising global rates of cesarean delivery and the pivotal role of uterine artery blood flow in placental health, further investigation into this relationship is warranted. Clarifying the effect of previous cesarean section on second-trimester uterine artery Doppler findings may enhance early identification of pregnancies at risk for adverse outcomes and inform tailored antenatal surveillance strategies. Therefore, the objective of the present study is to evaluate the effect of previous cesarean section on uterine artery Doppler indices during the second trimester of pregnancy, with the aim of improving understanding of uteroplacental hemodynamics and supporting evidence-based prenatal care.

METHODS

A comparative study was conducted in the Radiology Department, University Ultrasound Clinic, Green Town Hospital, after formal approval of the research synopsis by the University of Lahore Research Ethical Committee. Data were collected over a four-month period following ethical approval. A total sample of 100 participants was obtained through convenience sampling, with all eligible patients presenting during the study window approached for enrollment. The study population comprised married pregnant women aged 20–36 years who were in the second trimester of pregnancy and had a documented history of previous cesarean section. Women were excluded if they were in the first or third trimester, had multiple gestations, had any underlying medical disease, or did not have a previous cesarean section. All examinations were performed using a Toshiba Xario XG ultrasound machine equipped with a convex transducer operating within a frequency range of 3–5 MHz. After obtaining written informed consent from each participant, a standardized transabdominal ultrasound examination was completed by trained sonographers using a uniform acquisition protocol to reduce inter-operator variability. Participants were positioned supine on the examination couch, and coupling gel was applied to the abdomen to optimize acoustic contact. Routine fetal biometry was obtained to confirm gestational age, including biparietal diameter (BPD), abdominal circumference (AC), and femur length (FL), along with assessment of fetal heart rate. Following baseline obstetric assessment, uterine artery Doppler was performed, and the resistive index (RI) was measured according to the predefined parameters on the data collection sheet. Consistency in Doppler image acquisition and measurement technique was maintained across participants by adhering to the same operational steps and documentation method throughout the study.

Ethical safeguards were implemented in accordance with the regulations of the University of Lahore ethical committee. Participation was voluntary, written informed consent was secured prior to ultrasound evaluation, and confidentiality of all collected information was maintained. No identifying information was disclosed in reports, and anonymity was preserved during analysis and dissemination. Participants were informed of the purpose of the study, the non-invasive nature of the ultrasound and Doppler procedure, the absence of known procedure-related risks, and their right to withdraw at any point without penalty. All completed data forms were stored securely with restricted access to protect privacy. Data were entered and analyzed using SPSS version 26. Continuous variables were planned to be summarized as mean ± standard deviation or median with interquartile range depending on distribution, while categorical variables were to be presented as frequencies and percentages. Comparative analyses were planned according to the type of data and distribution, using an independent samples t-test for normally distributed continuous variables or the Mann–Whitney U test for non-normally distributed variables, and chi-square or Fisher's exact test for categorical variables. Where relevant, uterine artery RI was to be compared across predefined participant characteristics, with statistical significance assessed at a p-value < 0.05.

RESULTS

A total of 100 pregnant women in the second trimester were included in the analysis, with an equal distribution between those with a previous cesarean section history (n = 50) and those without a prior cesarean section (n = 50). The overall mean maternal age of the study population was 27.45 ± 4.61 years, with ages ranging from 20 to 35 years. The mean gestational age at the time of examination was 20.24 ± 2.32 weeks, with a minimum of 16 weeks and a maximum of 24 weeks, indicating a well-distributed second-trimester cohort. Comparison of gestational age between the two groups demonstrated a mean gestational age of 20.54 ± 2.26 weeks in women with a previous cesarean section and 19.94 ± 2.36 weeks in women without a prior cesarean section. The mean difference in gestational age between groups was −0.60 weeks, with a 95% confidence interval ranging from −1.52 to 0.32 weeks. Statistical testing showed no significant difference in gestational age between the groups (t = −1.298, p = 0.197), and variance between groups was comparable (p = 0.765). Normality testing using the Shapiro–Wilk test indicated a deviation from normal distribution for gestational age data (p = 0.0117). Uterine artery resistive index values demonstrated a clear difference between the two groups. Women with a history of previous cesarean section had a higher mean uterine artery RI of 0.7102 ± 0.0630 compared with 0.6602 ± 0.0581 in women without a prior cesarean section. The mean difference in RI was −0.0500, with a 95% confidence interval of −0.0741 to −0.0259. This difference was statistically highly significant (t = −4.125, p = 0.0001), while variance between the groups was similar (p = 0.574). The distribution of uterine artery RI values satisfied the assumption of normality based on the Shapiro–Wilk test (p = 0.3481).

Body mass index analysis showed comparable findings between the two groups. The mean BMI in women with a previous cesarean section was 25.53 ± 4.02 kg/m², whereas in women without a prior cesarean section it was 25.29 ± 4.42 kg/m². The mean difference was −0.24 kg/m², with a 95% confidence interval of −1.91 to 1.44 kg/m². This difference was not statistically significant (t = −0.279, p = 0.7806), and homogeneity of variance was confirmed (p = 0.509). However, BMI data did not follow a normal distribution on Shapiro–Wilk testing (p = 0.0011). Maternal age comparison between groups also revealed no significant difference. Women with a previous cesarean section had a mean age of 27.40 ± 4.21 years, compared with 27.50 ± 5.01 years in women without a cesarean history. The mean difference was 0.10 years, with a 95% confidence interval of −1.74 to 1.94 years. Statistical analysis showed no significant difference between the groups (t = 0.108, p = 0.9142), and variances were comparable (p = 0.229). Age data demonstrated non-normal distribution on Shapiro–Wilk testing (p = 0.0008). Overall, the findings demonstrated that maternal age, gestational age, and body mass index were comparable between women with and without a previous cesarean section. In contrast, uterine artery resistive index values were significantly higher in women with a history of cesarean section compared to those without such history, aligning directly with the study objective of assessing the effect of previous cesarean section on second-trimester uterine artery Doppler parameters.

Table 1: Demographic Characteristics of the Study Population (n = 100)

Variable	n	Minimum	Maximum	Mean ± SD	Median
Maternal Age (years)	100	20	35	27.45 ± 4.61	27.50
Gestational Age (weeks)	100	16	24	20.24 ± 2.32	20.00

Table 2: Comparison of Gestational Age Between Study Groups

Parameter	Previous C-Section (n = 50)	No Previous C-Section (n = 50)	p-value
Mean GA (weeks)	20.54 ± 2.26	19.94 ± 2.36	0.197
95% CI	19.90 – 21.18	19.27 – 20.61	
Variance Equality (F-test)			0.765
Normality (Shapiro–Wilk)			p = 0.0117

Table 3: Uterine Artery Resistive Index Comparison (Primary Outcome)

Parameter	Previous C-Section (n = 50)	No Previous C-Section (n = 50)	p-value
Mean RI	0.710 ± 0.063	0.660 ± 0.058	0.0001
95% CI	0.692 – 0.728	0.644 – 0.677	
Mean Difference	−0.050		
95% CI of Difference	−0.074 to −0.026		
Variance Equality (F-test)			0.574
Normality (Shapiro–Wilk)			p = 0.348

Table 4: Body Mass Index Comparison Between Groups

Parameter	Previous C-Section (n = 50)	No Previous C-Section (n = 50)	p-value
Mean BMI (kg/m²)	25.53 ± 4.02	25.29 ± 4.42	0.781
95% CI	24.38 – 26.67	24.03 – 26.55	
Mean Difference	−0.24		
Variance Equality (F-test)			0.509
Normality (Shapiro–Wilk)			p = 0.0011

Table 5: Maternal Age Comparison Between Study Groups

Parameter	Previous C-Section (n = 50)	No Previous C-Section (n = 50)	p-value
Mean Age (years)	27.40 ± 4.21	27.50 ± 5.01	0.914
95% CI	26.20 – 28.60	26.08 – 28.92	

Parameter	Previous C-Section (n = 50)	No Previous C-Section (n = 50)	p-value
Mean Difference	0.10		
Variance Equality (F-test)			0.229
Normality (Shapiro–Wilk)			p = 0.0008

Table 6: Summary of Statistical Assumptions Testing

Variable	Normality (Shapiro–Wilk)	Distribution
Gestational Age	p = 0.0117	Non-normal
Uterine Artery RI	p = 0.3481	Normal
Body Mass Index	p = 0.0011	Non-normal
Maternal Age	p = 0.0008	Non-normal

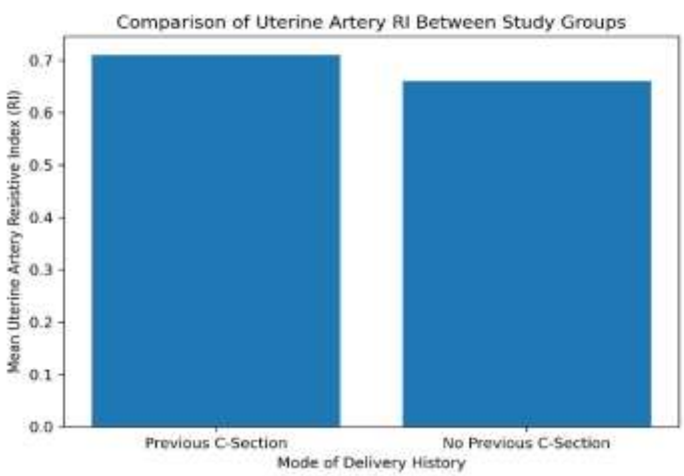


Figure 1 Comparison of Uterine Artery RI Between Study Groups

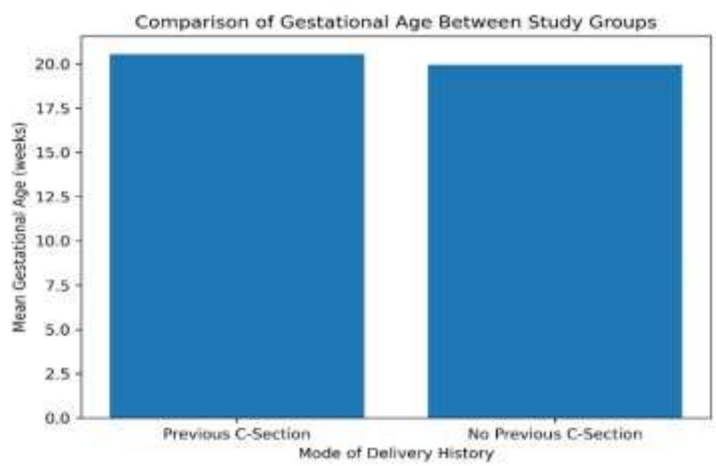
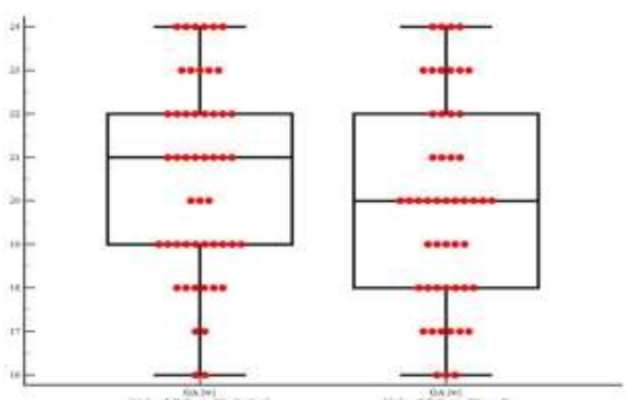
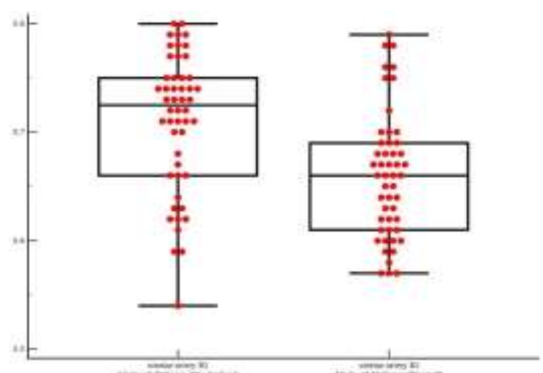


Figure 1 Comparison of Gestational Age Between Study Groups



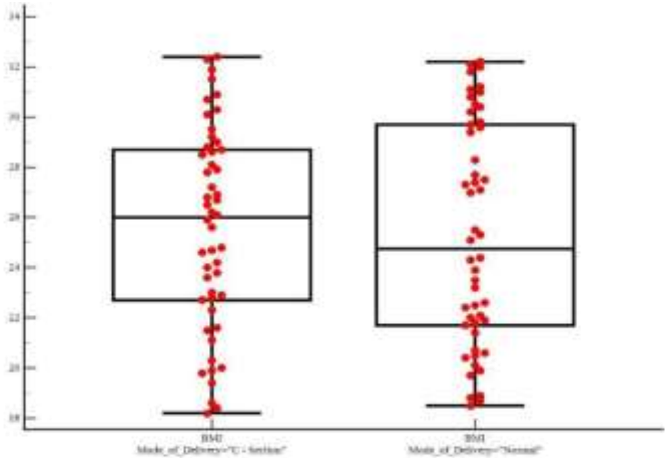
Distribution of Gestational Age by Mode of Delivery (C-Section vs Normal)

Figure 3 Distribution of Gestational Age by Mode of Delivery (C-Section vs Normal)



Comparison of Uterine Artery Resistive Index by Mode of Delivery (C-Section vs Normal)

Figure 4 Comparison of Uterine Artery resistive Index by mode of delivery (C-Section vs Normal)



Distribution of Body Mass Index by Mode of Delivery (C-Section vs Normal)

Figure 5 Distribution of Body Mass Index by Mode of Delivery (C-Section vs Normal)

DISCUSSION

The present study examined the effect of a previous cesarean section on uterine artery Doppler findings during the second trimester of pregnancy and demonstrated a statistically significant increase in uterine artery resistive index in women with a history of cesarean delivery compared with those without such history. This finding suggests that prior surgical disruption of the uterine wall may influence uteroplacental vascular adaptation in subsequent pregnancies, even in the absence of differences in maternal age, gestational age at examination, or body mass index between the groups. The observed elevation in resistive index reflects relatively increased downstream vascular resistance, which is clinically relevant given the central role of uterine artery remodeling in maintaining optimal placental perfusion during pregnancy. These findings are broadly consistent with previously published work in which authors reported higher uterine artery Doppler indices, particularly pulsatility index values above the 95th percentile, among women with a history of cesarean section compared with controls, along with an association with less favorable perinatal outcomes such as lower gestational age at delivery ($p < 0.05$) (14,15). However, some earlier studies did not demonstrate statistically significant differences in mean resistance index or systolic/diastolic ratios when women with any prior cesarean section were compared as a single group, and reported that Doppler indices became significantly higher only in those with more than two previous cesarean deliveries ($p < 0.05$) (16,17). In contrast, the current study identified a significant difference in resistance index even when women with any prior cesarean section were analyzed collectively, which may reflect population-specific characteristics, differences in sample composition, or variation in Doppler measurement protocols (18).

Other investigations assessing uterine artery blood flow in subsequent pregnancies after cesarean delivery have similarly reported higher rates of abnormal Doppler waveforms and a greater frequency of pregnancy complications in women with previous cesarean sections compared with those who had prior vaginal deliveries (19,20). These studies emphasized that abnormal uterine artery Doppler findings were more common when the placenta was located near the previous uterine scar, supporting the concept that scar-related changes in myometrial and vascular architecture may interfere with normal trophoblastic invasion and arterial remodeling. Although placental location was not evaluated in the present study, the significantly higher resistance index observed aligns with this proposed pathophysiological mechanism. The clinical implications of these findings are noteworthy. Increased uterine artery resistance during the second trimester has been associated with impaired placentation and an elevated risk of adverse outcomes such as preeclampsia, fetal growth restriction, and preterm birth in previous literature. While the current study did not follow participants to delivery or assess obstetric and neonatal outcomes, the demonstrated Doppler differences suggest that women with a history of cesarean section may benefit from closer antenatal surveillance, particularly in settings where uterine artery Doppler serves as a practical screening tool for placental insufficiency.

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Several strengths of this study merit consideration. The equal distribution of participants between groups minimized imbalance, and standardized ultrasound examinations performed with the same equipment reduced technical variability. In addition, the focus on second-trimester assessment targeted a clinically important window for uterine artery remodeling. Nevertheless, important limitations should be acknowledged. The use of convenience sampling and a relatively modest sample size may limit generalizability. Only the resistive index was analyzed, whereas inclusion of additional Doppler parameters such as pulsatility index, systolic/diastolic ratio, and the presence of early diastolic notching could have provided a more comprehensive evaluation of uteroplacental hemodynamics. Furthermore, the number of previous cesarean sections, placental location, and pregnancy outcomes were not assessed, restricting the ability to explore dose–response relationships and clinical consequences of the observed Doppler changes. Future research would benefit from larger, multicenter studies incorporating longitudinal follow-up to delivery, stratification by number of prior cesarean sections, and assessment of placental location. Inclusion of additional vascular parameters, such as basal or spiral artery flow, may further clarify the mechanisms underlying altered uterine perfusion after cesarean delivery. Such approaches could strengthen risk stratification models and support more individualized antenatal care (21,22). Overall, the present findings add to the growing body of evidence suggesting that previous cesarean section has measurable effects on uterine artery blood flow in subsequent pregnancies and underscore the importance of Doppler assessment as a component of maternal–fetal evaluation.

CONCLUSION

This study concluded that a history of previous cesarean section was associated with higher uterine artery resistive index during the second trimester when compared with pregnancies without prior cesarean delivery. This finding directly addresses the study objective and highlights the potential influence of uterine surgical history on uteroplacental blood flow in subsequent pregnancies. The observed increase in vascular resistance underscores the clinical value of uterine artery Doppler assessment as a non-invasive tool for identifying subtle alterations in uterine perfusion among women with prior cesarean sections. Recognizing these changes may support more attentive antenatal monitoring and contribute to improved maternal and fetal care by facilitating early identification of pregnancies that may require closer surveillance.

AUTHOR CONTRIBUTIONS

Author	Contribution
Saman Rasool	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Insha Liaquat	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Malaika Liaqat Ali	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Naveed Hussain*	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Eman Fatima	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Yasir Aziz	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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