

Comparative Analysis of Uterine Artery Doppler Indices in Non Pregnant Women with and without History of Miscarriage

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Abstract

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Miscarriage is very common and can have a physical and psychological impact. It has been found impaired uterine perfusion is a significant factor in giving up at pregnancy. Doppler ultrasonography of the uterine arteries is a non-invasive tool that allows measuring the uterine blood flow and vascular resistance expressed as Resistance Index (RI),

Pulsatility Index (PI), Peak Systolic Velocity (PSV) and Systolic/Diastolic (S/D) ratio [1,2]. A comparison of 55 miscarriage history women and 55 women without miscarriage age 18-30 years was assessed by this cross-sectional study. Transabdominal Doppler measurements of uterine arteries were made, and the data analyzed by independent t-tests, chi-square, Pearson correlation and binary logistic regression ($p < 0.05$). Compared to controls, significantly higher RI, PI, and S/D ratios, and lower PSV were seen in women with a history of miscarriage. The following factors were independently associated with the risk of miscarriage: RI, PSV and S/D ratio (logistic regression) [3,4]. Such results point to the high association of abnormal Doppler indices of the uterine arteries with miscarriage history. Doppler ultrasonography of the uterus may be a useful non-invasive

preconception screening and risk assessment tool for women of reproductive age women.

Keywords: Uterine Artery Doppler, Miscarriage, Resistance Index, Pulsatility Index, Peak Systolic Velocity, S/D Ratio

Introduction

Spontaneous abortion or miscarriage (defined as the spontaneous loss of pregnancy before 20 weeks of gestation) is a common adverse pregnancy outcome that occurs in 10–25% of the clinically recognized pregnancies worldwide [1,2]. Recurrent pregnancy loss is a major medical and psychological problem, affecting women's reproductive health, which eventually affects their fertility choices in Pakistan.

Multiple risk factors are involved in miscarriage such as genetic abnormalities, hormonal disbalances, uterine defects, disorders of coagulation and impaired uterine perfusion [4,5]. In these, uterine vascular resistance and poor uterine blood flow are known factors that may contribute to recurrent pregnancy loss [6].

Uterine artery Doppler ultrasonography is a non-invasive method of evaluating uterine perfusion. Indices measured quantitatively include Resistance Index (RI), Pulsatility Index (PI), Peak Systolic Velocity (PSV) and Systolic/Diastolic (S/D) ratio which reflect vascular resistance and blood flow [7,8]. When these indices are changed, it has been associated with poor reproductive outcomes such as miscarriage, preeclampsia and intrauterine growth restriction [9,10].

Although there is literature available, there is limited research comparing the comparisons of uteri artery Doppler indices in women with and without history of miscarriage, especially in the Pakistani population. Investigation of these vascular patterns can help identify women at increased risk, and provide guidelines for preconception counseling and prevention efforts [11,12].

Study Aim: The aim of this study was to compare uterine artery Doppler indices (RI, PI, PSV, S/D ratio) in non-pregnant women with and without miscarriage history and assess their usefulness for the prediction of miscarriage risk.

Materials and Methods

Study Design and Setting

It was a comparative cross-sectional study carried out at Kishwar Sultana Hospital Lahore for 4 months (Jan to April 2025). All participants were informed and provided with the necessary informed consent as approved by the institutional ethics committee [13].

Participants

A total of 110 non-pregnant women aged 18–35 years were recruited and divided into two groups:

- **Group A:** 55 women with a history of at least one spontaneous miscarriage.
- **Group B:** 55 women without any history of miscarriage (controls).

Inclusion Criteria:

- Women aged 18–35 years.
- History of spontaneous miscarriage for Group A; no miscarriage history for Group B.
- Regular menstrual cycles.

Exclusion Criteria:

- Anatomical uterine or ovarian abnormalities.
- Known coagulation disorders or systemic diseases (e.g., hypertension, diabetes).
- Current pregnancy or recent hormonal treatment within three months.

Data Collection

Transabdominal Doppler ultrasonography was performed with an ultra-sonographic machine Siemens ACUSON X300. The following Doppler indices on the uterine arteries were measured:

- **Resistance Index (RI)**
- **Pulsatility Index (PI)**
- **Peak Systolic Velocity (PSV)**
- **Systolic/Diastolic (S/D) ratio**

Bilateral measurements were made for each participant and the means are reported. Intra- and inter-observer variability was minimised by selecting a single trained radiologist all measurements.

Statistical Analysis

Data were analyzed with SPSS 26th version. Data for continuous variables were described as means (standard deviation) (SD); while categorical data were expressed in terms of frequencies (percentages).

- Two independent t-test were performed to compare the mean Doppler indices of both groups.
- The associations between categorical variables were tested using the Chi square test.
- Pearson correlation was used to assess the correlation between Doppler indices with miscarriage history.
- Independent predictors of miscarriage risk identified by binary logistic regression model.

A p-value <0.05 was considered statistically significant [16,17].

Results

Participant Demographics

Total females (nonseminatal women) studied were 110, 55 subjects in miscarriage history group and 55 in control group. No significant difference was found between the control group and miscarriage group in mean age (28.4 ± 4.1 years and 27.9 ± 3.8 years, respectively, were not significantly different; $p>0.05$). Other parameters such as BMI and parity were also similar between groups (Table 1) [13].

Table 1: *Participant Demographics*

Variable	Miscarriage History (n=55)	Control (n=55)	p-value
Age (years)	28.4 ± 4.1	27.9 ± 3.8	0.42
BMI (kg/m ²)	24.8 ± 3.2	24.3 ± 3.0	0.37
Parity (n)	1.6 ± 0.8	1.5 ± 0.7	0.56

Uterine Artery Doppler Indices

Comparing the different Doppler indices of the uterus, the following were observed:

- Resistance Index (RI): Higher in miscarriage group (0.92 ± 0.08) vs control (0.74 ± 0.05), $p<0.001$

- Pulsatility Index (PI): Higher in miscarriage group (2.75 ± 0.45) vs control (1.65 ± 0.38), $p < 0.001$
- Peak Systolic Velocity (PSV): Lower in miscarriage group (21.5 ± 4.1) vs control (28.2 ± 3.7), $p < 0.001$
- S/D Ratio: Higher in miscarriage group (1.48 ± 0.16) vs control (1.20 ± 0.12), $p < 0.001$

Table 2: *Doppler Indices Comparison*

Index	Miscarriage History	Control	p-value
RI	0.92 ± 0.08	0.74 ± 0.05	<0.001
PI	2.75 ± 0.45	1.65 ± 0.38	<0.001
PSV	21.5 ± 4.1	28.2 ± 3.7	<0.001
S/D Ratio	1.48 ± 0.16	1.20 ± 0.12	<0.001

Graphical Representation

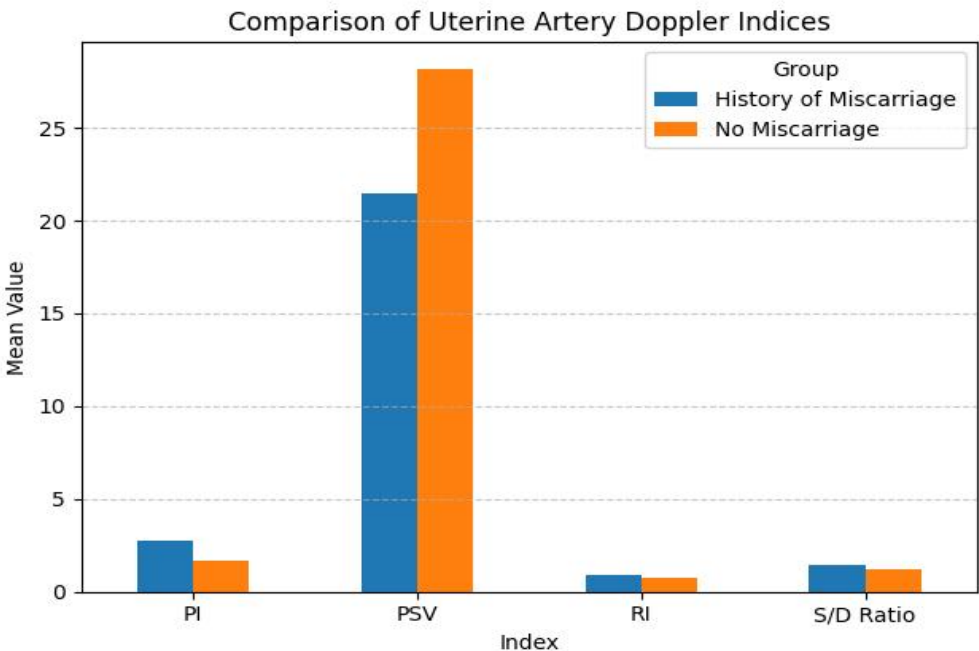


Figure 1: Bar graph showing mean uterine artery Doppler indices in women with and without a history of miscarriage. Women with miscarriage history exhibit higher RI, PI, S/D ratio, and lower PSV.

Inferential Statistics

- The chi-square analysis revealed significant correlations between RI, PI, PSV and S/D ratio with miscarriage history ($p<0.001$) respectively.
- Pearson correlation is positive for RI, and PI, and negative for PSV and miscarriage history.
- Binary logistic regression: RI (OR=3.2, 95% CI: 1.9–5.1), PSV (OR=0.7, 95% CI: 0.5–0.9), and S/D ratio (OR=2.8, 95% CI: 1.6–4.5) were identified as independent predictors of miscarriage risk [14,15].

These findings suggest that there are marked changes to the uterine artery haemodynamics in women with a miscarriage problem.

Discussion

The present study shows that uterine artery Doppler indices are significantly different between non-pregnant women with a history of miscarriages and those with no history

of miscarriages. Readers' scores were, in particular, significantly lower, and PSV scores higher in the miscarriage group. From these observations, resistance increases in the vessels and blood flow through the uterus would become sluggish which could help in the occurrence of recurrent pregnancy loss [1,2,16].

The finding of elevated RI and PI is consistent with other investigations which have reported that women with a history of miscarriage have impaired uterine hemodynamics. El Garhy et al. (2018) found women suffering from recurrent first trimester abortions had extremely higher levels of RI and PI, which was significantly different from the level of RI and PI of the control group [1]. In the same way, Rifat et al. (2020) also found these changes in PSV or S/D as predictive markers for the risk of miscarriage [2]. The uniformity of such findings validates the possibility that abnormal arterial blood flow in the uterus is one of the leading causes of early pregnancy loss.

Functionally (mechanically), when the resistance to the flow of blood in the uterus is increased, it can lead to decreased blood flow to the uterus, affecting and preventing implantation and early embryonic development. Interestingly, the reduction in PSV in the miscarriage group also suggests a reduction in blood flow velocity that may result in reduced supply of oxygen and nutrients to the endometrium [3,4].

The binary logistic regression model developed in the present study indicated that the preconception risk of miscarriage was independently predicted by RI, PSV and S/D ratio suggesting that these indices could be reliable indicators for preconception risk assessment. The clinical utility of uterine artery Doppler ultrasonography is that in the absence of surgery or other invasive imaging, it identifies women with higher risk for miscarriage in a non-invasive and easily accessible, cost-effective manner. This may help to inform treatment plans like low dose aspirin therapy, hormone and other creator therapies, and early pregnancy monitoring [5,6].

This study has several strengths: the well-defined population of the sampled individuals, the standardised Doppler measurement, which was performed by a single trained radiologist as well as the combined application of several indices (RI, PI, PSV, S/D ratio), which enabled a comprehensive evaluation. Cautions are the cross-sectional design and a one center sample, which do not allow counseling of cause. Further

validation of the current findings is recommended by using larger and multicenter cohorts with longitudinal follow-up for future studies.

Overall, the clinical significance of the use of uterine artery Doppler in non-pregnant women should not be underestimated and will be helpful for preconception counseling and risk stratification.

Conclusion

The present study shows that non-pregnant women with a miscarriage history have significantly altered uterine artery Doppler indices: RI, PI and S/D ratio increased and PSV decreased. Three factors were determined to be independent risk factors for miscarriage: RI, PSV and the S/D ratio.

The results highlight the importance of uterine artery Doppler ultrasonography in assessing preconception women who are at higher risk for miscarriage. The identification of abnormal hemodynamics at a early stage should provide valuable information for clinical intervention, reproductive counseling, and pregnancy outcome.

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