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A Comparative Study of Uterine Artery Doppler Parameters on Sonography between Women with Unexplained Infertility and Fertile Women Attending SMS Medical College, Jaipur

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Abstract

Background: Unexplained infertility remains a diagnostic challenge, with impaired uterine perfusion and suboptimal endometrial receptivity hypothesized as potential contributing factors. This study aimed to compare mid-luteal phase uterine artery Doppler parameters between infertile and fertile women.

Methods: A prospective, comparative observational study was conducted on 60 women attending the Department of Obstetrics and Gynaecology, SMS Medical College, Jaipur. Group I included 30 women with unexplained infertility, while Group II comprised 30 age-matched fertile controls. All participants underwent mid-luteal phase transvaginal sonography to assess uterine artery Doppler indices—Pulsatility Index (PI), Resistive Index (RI), Peak Systolic Velocity (PSV), and End-Diastolic Velocity (EDV). Data were analysed using SPSS version 29.0.

Results: Infertile women demonstrated significantly elevated PI (3.03 ± 0.88 vs. 1.91 ± 0.54; p = 0.01) and RI (0.93 ± 0.40 vs. 0.81 ± 0.35; p = 0.01), along with a significant reduction in EDV (8.47 ± 2.25 cm/s vs. 12.20 ± 1.77 cm/s; p = 0.01), indicating compromised uterine perfusion.

Conclusion: Women with unexplained infertility exhibit impaired uterine artery blood flow. Uterine artery Doppler serve as valuable non-invasive tools for

evaluating endometrial receptivity and guiding infertility management.

Keyword: Unexplained Infertility, Uterine artery Doppler, Pulsatility Index, Resistance index, Peak Systolic velocity, End Diastolic Velocity

Introduction

Infertility is defined as the inability to conceive after 12 months of unprotected regular intercourse and affects approximately 10–15% of couples globally. Among the various causes of female infertility, unexplained infertility accounts for nearly 15–30% of cases, where no apparent cause can be identified despite standard diagnostic work-up including ovulation tracking, tubal patency tests, and semen analysis of the male partner.[1] This poses both a clinical and emotional challenge, as treatment in such cases is often empirical. One of the emerging areas of interest in the pathophysiology of unexplained infertility is the endometrial perfusion and uterine blood flow**,** particularly during the mid-luteal phase, which is crucial for embryo implantation.[2] Adequate uterine perfusion is essential for proper endometrial receptivity, which is influenced by vascular resistance and blood flow in the uterine arteries. Transvaginal Doppler ultrasound is a non-invasive and reliable method to assess uterine artery blood flow. Doppler parameters such as Resistance Index (RI)**,** Pulsatility Index (PI)**,** Peak Systolic Velocity (PSV)**,** and End Diastolic Velocity (EDV) provide valuable information about uterine artery impedance and perfusion. Alterations in these parameters may indicate poor uterine perfusion, which can impair implantation and may be a contributing factor in unexplained infertility.[3] Several studies have attempted to explore the relationship between uterine artery Doppler findings and infertility. Some have demonstrated significantly higher RI and PI values in women with unexplained infertility compared to fertile women, suggesting increased vascular resistance and impaired uterine perfusion. Conversely, fertile women tend to show lower impedance to blood flow, reflecting a more receptive endometrial environment.[4,5] However, data on Doppler flow characteristics during the mid-luteal phase, which corresponds with the window of implantation, remains limited and inconsistent, especially in the Indian population. Therefore, this study aims to compare mid-luteal phase uterine artery Doppler parameters in women with unexplained infertility and healthy fertile controls using transvaginal sonography, to assess whether altered uterine perfusion could be an underlying factor. Identifying such hemodynamic differences could help guide future management strategies, including targeted therapies to improve uterine blood flow and implantation success.

Materials and Methods

This prospective, comparative observational study was conducted in the Department of Obstetrics and Gynaecology at SMS Medical College, Jaipur. The study population included women attending the outpatient department (OPD) at the Department of Obstetrics and Gynaecology, SMS Medical College. Participants were divided into two groups: Group I (cases) comprised women diagnosed with unexplained infertility, and Group II (controls) consisted of fertile, age-matched, non-pregnant, and non-lactating women with no history of assisted reproductive technology (ART) use and whose most recent childbirth occurred within two years prior to enrolment. Women aged between 20 to 40 years with either primary or secondary unexplained infertility, who voluntarily consented to participate after being informed about the study, were included. Exclusion

criteria were pregnant women, those enrolled in other clinical or research trials, and women using intrauterine devices or hormonal contraceptives during the study period. The calculated sample size was 30 women in each group. All participants underwent transabdominal ultrasonography during the mid-luteal phase of the menstrual cycle (typically days 21–23 in a 28–30 day cycle) to assess the pelvis. This was followed by transvaginal sonography (TVS) for detailed evaluation. On B-mode imaging, the uterus and adnexa were assessed to exclude any structural or pathological abnormalities such as endometriosis, fibroids, tubo-ovarian masses, or adnexal cysts that could influence fertility status. Color Doppler imaging was employed to identify the ascending branch of the uterine artery, after which pulsed Doppler was used to obtain spectral waveforms. The following Doppler indices were recorded: peak systolic velocity (PSV), end-diastolic velocity (EDV), pulsatility index (PI), and resistance index (RI). Data were analysed using SPSS software version 29.0. Continuous variables such as PI, RI were expressed as mean ± standard deviation (SD) and compared between groups using the unpaired t-test. Categorical variables were summarized as frequencies and percentages, with group comparisons performed using the Chi-square test or Fisher's exact test as applicable. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 60 women were enrolled in the study, comprising 30 women with unexplained infertility (cases) and 30 age-matched fertile women (controls). Socio-demographic and Menstrual Characteristics (Table I) The mean age of the women in the infertility group was 28.5 ± 5.41 years, while that in the control group was 29.2 ± 5.59 years; this difference was not statistically significant (p = 0.22). The mean duration of menstruation was 3.73 ± 0.57 days in cases and 3.67 ± 0.65 days in controls (p = 0.43). Similarly, the average menstrual cycle length was comparable between the two groups (27.50 ± 2.05 days in cases versus 27.27 ± 2.26 days in controls; p = 0.11). No statistically significant differences were noted between the groups with respect to socioeconomic status, religion, area of residence, or educational level (p > 0.05 for all parameters), indicating that the two groups were demographically similar.

Doppler assessment of uterine arteries revealed significantly impaired vascular dynamics in the unexplained infertility group:

Pulsatility Index (PI): The mean PI was significantly elevated in cases (3.03 ± 0.88) compared to controls (1.91 ± 0.54; p = 0.01), indicating increased downstream vascular resistance and compromised uterine perfusion. This supports the hypothesis that poor uterine blood flow may hinder adequate endometrial preparation for implantation. These findings are in agreement with studies by Tekay et al.[6], Zaidi et al.[7], Ali Zarad et al.[8], and Sindhu L et al.[9] all of whom reported higher PI in infertile women.

Resistive Index (RI): Similarly, the RI was significantly raised in cases (0.93 ± 0.40) versus controls (0.81 ± 0.35; p = 0.01), reinforcing the presence of increased vascular resistance that could impair endometrial receptivity. This is consistent with the observations of Ali Zarad et al.[8], Sindhu L et al.[9], and AE Smart et al.[2].

Peak Systolic Velocity (PSV): Although PSV was slightly lower in infertile women (50.23 ± 11.63 cm/s) than in controls (51.92 ± 7.74 cm/s; p = 0.01), its clinical significance remains uncertain, as previous studies, including Zaidi et al.[7] and AE Smart et al.[2] did not find

consistent differences. This suggests PSV alone may not serve as a reliable marker for uterine perfusion.

End-Diastolic Velocity (EDV): The EDV was markedly reduced in the case group (8.47 ± 2.25 cm/s) compared to controls (12.20 ± 1.77 cm/s; p = 0.01), indicating restricted diastolic blood flow and overall impaired uterine perfusion. These findings are consistent with Kupesic et al.[10] and AE Smart et al.[2] who emphasized the importance of diastolic flow in predicting endometrial receptivity.

Conclusion

This study reveals key differences in uterine blood flow and endometrial characteristics between fertile and infertile women. Infertile women demonstrated poorer uterine artery perfusion, with higher resistance and lower blood flow compared to their fertile counterparts. These findings suggest that impaired uterine perfusion and endometrial abnormalities may contribute to infertility. The use of uterine artery Doppler assessments during the mid-luteal phase can thus provide valuable insights into the underlying causes of infertility, offering potential diagnostic and therapeutic guidance. This study underscores the importance of uterine blood flow in fertility, showing that impaired perfusion are associated with infertility. Uterine artery Doppler and endometrial evaluation could serve as key diagnostic tools in managing infertility.

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Legend Tables

Table 1: Socio-demographic and Menstrual Characteristics of Study Participants

Variable	Case Mean ±SD	Control Mean ±SD	p-value
Age Group (years)	28.5 ± 5.41	29.2 ± 5.59	o.22
Duration of Menses (days)	3.73 ± 0.57	3.67 ± 0.65	0.43
Menstrual Cycle Duration (days)	27.50 ± 2.05	27.27 ± 2.26	0.11
Socioeconomic status n,%			
Lower Middle	17 (56.66)	16 (53.33)	0.34
Upper Lower	9 (30.00)	8 (26.66)	
Upper Middle	4 (13.34)	6 (20.00)	
Religion n,%			
Hindu	14 (46.67)	9 (30.00)	0.23
Muslim	16 (53.33)	20 (66.67)	
Christian	0 (0)	1 (3.33)	
Area of residence n,%			
Rural	20 (67.00)	16 (53.33)	0.72
Urban	10 (33.00)	14 (46.67)	
Education n,%			
Illiterate	13 (43.33)	14 (46.67)	0.54
Primary Literacy	14 (46.67)	11 (36.67)	
Secondary Literacy	3 (10.00)	4 (13.33)	
Higher Education	0 (0)	1 (3.33)	

Table 2: Comparison of Uterine Artery Doppler and Endometrial Parameters between Cases and Controls

Parameter	Case Mean ± SD	Control Mean ± SD	p-value
Pulsatility Index (PI)	3.03 ± 0.88	1.91 ± 0.54	0.01
Resistive Index (RI)	0.93 ± 0.40	0.81 ± 0.35	0.01
Peak Systolic Velocity (cm/s)	50.23 ± 11.63	51.92 ± 7.74	0.01
End-Diastolic Velocity (cm/s)	8.47 ± 2.25	12.20 ± 1.77	0.01