Use of Uterine and Ovarian Arteries Doppler Parameters for the Prediction of Infertility in Females

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Abstract

Background: In the context of fertility, Doppler sonography is used to evaluate the blood flow to the uterus and ovaries. The blood flow to these organs plays a crucial role in the process of ovulation, fertilization, and implantation of the fertilized egg. Changes in the Doppler sonographic indices of the uterine and ovarian arteries can provide information about the blood flow to these organs and can help identify potential problems that may be affecting fertility.

Objective: To evaluate the Doppler indices of uterine and ovarian arteries in fertile and infertile women and help clinicians develop more effective diagnostic and treatment strategies for infertility.

Methodology: A cross-sectional Analytical study was conducted for a duration of 9 months at a Medics Dr. Amers, Lahore, Pakistan. The study included 150 fertile and 150 infertile females aged 18-45 and excluded all females using oral contraceptive and contraceptive devices. SPSS software version 25 was used to analyze the data.

Results: Age of participants ranged between 19 to 43 years with a mean + SD age of 28 + 6.5 years. The mean + SD RI and PI of left ovarian artery was 0.48 + 0.03 and 1.1 + 0.13 in the fertile, 0.9 + 0.03 and 4.2 + 1.2 in the infertile group. The mean + SD RI and PI of right ovarian artery was 0.60 + 0.03 and 1.6 + 0.06 in the fertile, 0.8 + 0.01 and 3.0 + 0.4 in the infertile group (Table 1) Overall, results shows that the four variables are significantly different between fertile and infertile groups, with higher values in the infertile group.

Independent sample test showed statistical significance between RI and PI of right ovarian artery of both groups ($P < 0.05$). However, in left ovarian artery the values of PI in both groups showed a significance ($P< 0.05$) were as values RI are found to be insignificant ($P > 0.05$). Independent sample test showed statistical significance between RI and PI of right and left uterine artery of both groups ($P < 0.05$). The mean + SD endometrial thickness in fertile group was 11.0 + 2.6 mm it was 9 + 1.6 mm in infertile group (Table 3). Indicating a significant difference between the two groups ($P < 0.05$).

Conclusion: Uterine and Ovarian artery hemodynamics plays an important role in fertility. Findings from this study revealed that a high RI and PI and thin endometrium significantly affects fertility.

Key words: Resistive index, Pulsatility index, Infertility, Uterine artery, Ovarian artery.

Introduction

The ability to have children is known as fertility, and a couple is deemed infertile if they are unable to conceive after 12 months of unprotected sexual activity. A stricter definition of infertility includes failure to conceive within six months for individuals over 35 and failure to become pregnant within a year for people under 35 (1). According to estimates, one in seven to one in five (14–20%) couples of reproductive age have infertility globally. Ovulatory problems, tubal illness, endometriosis, chromosomal abnormalities, sperm factors, and unexplained infertility are some of the causes of infertility that can affect men, women, or a combination of both sexes. The majority of infertility cases, including those caused by male and female causes, are treated surgically and medically. Age-related infertility continues to be one of the hardest problems despite the fact that infertility therapy has evolved significantly in recent years. When a couple is considering assisted reproductive technologies, age must be taken into consideration. Since many years ago, people have been aware that a woman's age and the likelihood of pregnancy are inversely associated (2).

Infertility rates differ between communities mostly because of differences in food habits, way of life, environmental and work-related factors, and infectious diseases. Unfortunately, infertility affects both male and female partners, and a broad list of diagnostic procedures are needed to make a diagnosis. Do an infertility evaluation as the first step in overcoming infertility? A physical examination, which includes a pelvic ultrasound of the female patient, a semen study, and the medical and sexual histories of both spouses are all included in the evaluation of infertility. A thorough physical examination, as well as a full medical, sexual, and reproductive history, are used to evaluate infertile women (3).

There are two types of infertility, primary and secondary (4). While secondary infertility is defined as the inability to conceive after a prior pregnancy, primary infertility is defined as the failure to conceive within two years of unprotected intercourse (5). Secondary infertility is associated with reproductive tract infections (6). The causes of female infertility are dificult to diagnose sometimes (7). A serious health problem that affects people all around the world is infertility (8). 186 million people experience infertility globally (9-11). The medical condition of infertility may have an impact on a patient's emotional, physical, mental, spiritual, and medical well-being (12).

Almost one-third of women struggle with infertility. Age raises the chance of infertility. According to estimates, 8 to 12 percent of couples worldwide are affected (13). Nonetheless, males account for 20–30% of cases of infertility (14). Infertility is prevalent in Pakistan at 22%, with primary infertility accounting for 18% of cases and secondary infertility for 4% of cases (15). Studies have found that the death risk in infertile women has increased to 10% (16). Radiographic imaging is crucial in evaluating female infertility because it might be challenging to diagnose at times (17). Hysterosalpingography, hysterography, pelvic ultrasound (US), and magnetic resonance imaging (MRI) are common imaging modalities (18).

The study's objective was to examine the measurements of uterine artery Doppler indices, such as the resistance index (RI), pulsatility index (PI), and systolic/diastolic (S/D) ratio, in fertile and infertile females and to look into their relationship with infertility. Congenital abnormalities, abnormal semen analysis, unexplained infertility, endometriosis, or multifactorial artery impedance were the causes of infertility in these women, and it was not able to forecast obstetric difficulties or evaluate uterine artery impedance in these individuals. The lack of information about the local population led to the current study's execution.

Materials and Methods

A cross-sectional Analytical study was conducted for a duration of 9 months at Medics Dr Amers, located in Lahore. Study included 150 fertile and 150 infertile females aged 18-45. Fertile group included all multiparous females and excluded all females on oral contraceptives and IUCDs. Study group included nulliparous females with no known gynecological disease. All participants underwent trans abdominal ultrasound with full bladder using 3-5 MHz curvilinear probe. Patient lay in supine and ultrasound gel was placed on the transducer and the skin to allow for smooth movement of the transducer over the skin and to eliminate air between the skin and the transducer for the best sound conduction. AIUM guidelines were followed to scan patient. Color doppler was used to assess RI, PI values of ovarian and uterine arteries. Data was evaluated and analyzed with Statistical Software for Social Sciences (SPSS version 25.0). Independent sample t-test was applied to check the association between doppler parameters and infertility Value of $P < 0.05$ was taken as significant.

Results

The mean + SD age of participants was 28 + 6.5 years. The mean + SD endometrial thickness in all 300 participants was 10.0 + 2.4 mm. The mean + SD RI and PI of left ovarian artery was 0.48 + 0.03 and 1.1 + 0.13 in fertile, 0.9 + 0.03 and 4.2 + 1.2 in infertile group. The mean + SD RI and PI of right ovarian artery was 0.60 + 0.03 and 1.6 + 0.06 in fertile, 0.8 + 0.01 and 3.0 + 0.4 in infertile group (Table 1) Overall, results shows that the four variables are significantly different between fertile and infertile groups, with higher values in the infertile group.\

Independent sample test showed statistical significance between RI and PI of right ovarian artery of both groups ($P < 0.05$). However, in left ovarian artery the values of PI in both groups showed a significance ($P< 0.05$) were as values RI are found to be insignificant ($P > 0.05$).

The mean + SD RI and PI of left uterine artery was 0.50 + 0.02 and 0.8 + 0.06 in fertile, 0.9 + 0.03 and 2.7 + 0.16 in infertile group. The mean + SD RI and PI of right uterine artery was 0.65 + 0.04 and 1.5 + 0.17 in fertile, 0.83 + 0.01 and 2.3 + 0.11 in infertile group (Table 2). Independent sample test showed statistical significance between RI and PI of right and left uterine artery of both groups ($P < 0.05$).

The mean + SD endometrial thickness in fertile group was 11.0 + 2.6 mm it was 9 + 1.6 mm in infertile group (Table 3). Indicating a significant difference between the two groups ($P < 0.05$).

The mean + RI an PI of Left ovarian artery in age group 19-30 was 0.6 + 0.2 and 2.6 +1.7, in age group 31-43 years 0.7 + 0.2 and 2.8 + 1.7. The mean + RI an PI of Right ovarian artery in age group 19-30 was 0.70 + 0.1 and 2.2 + 0.75, in age group 31-43 years 0.72 + 0.1 and 2.4 + 0.7. The mean + RI an PI of Left uterine artery in age group 19-30 was 0.69 + 0.2 and 1.7 + 0.9, in age group 31-43 years 0.73 + 0.2 and 1.9 + 0.9. The mean + RI an PI of Right uterine artery in age group 19-30 was 0.73 + 0.09 and 1.9 + 0.42, in age group 31-43 years 0.75 + 0.0.9 and 2.0 + 0.42.

Table 1: Group statistics Ovarian artery

Variables	Fertility	N	Mean	Std. Deviation	Std. Error Mean	Independent Samples Test
RI Left Ovarian Artery	Fertile	150	.4876	.03765	.00307	.582
	Infertile	150	.9042	.03079	.00251	
PI Left Ovarian Artery	Fertile	150	1.1641	.13902	.01135	.000
	Infertile	150	4.2367	1.20638	.09850	
RI Right Ovarian Artery	Fertile	150	.6060	.03392	.00277	.000
	Infertile	150	.8235	.01614	.00132	
PI Right Ovarian Artery	Fertile	150	1.6107	.06180	.00505	.000
	Infertile	150	3.0084	.45551	.03719	

Table 2: Group Statistics Uterine artery

	Fertility	N	Mean	Std. Deviation	Std. Error Mean	Independent Samples Test
RI Left Uterine Artery	Fertile	150	.5044	.02318	.00189	.000
	Infertile	150	.9152	.03185	.00260	
PI Left Uterine artery	Fertile	150	.8251	.06645	.00543	.000
	Infertile	150	2.7985	.16001	.01307	
RI Right Uterine Artery	Fertile	150	.6549	.04066	.00332	.000
	Infertile	150	.8309	.01898	.00155	
PI Right Uterine Artery	Fertile	150	1.5834	.17727	.01447	.000
	Infertile	150	2.3748	.11439	.00934	

Table 3: Group Statistics Endometrial thickness

	Fertility	N	Mean	Std. Deviation	Std. Error Mean	Independent Samples Test
Endometrial Thickness (Mm)	Fertile	150	11.0443	2.62756	.21454	.000
	Infertile	150	9.0295	1.67380	.13667	

Discussion

Sonography has been proposed as a mean for the non-invasive identification of transvaginal Doppler indices of ovarian artery and uterine artery in infertile females and fertile females. Trans-vaginal color Doppler ultrasonography is a noninvasive and efficient method for visualizing small vessels and study of blood flow changes (20).

The mean + SD age of our study participants was 28 + 6.5 years. In a study conducted by Smart et al (21) the mean + SD age of participants was 32.28±4.062. In another study the mean age of fertile participants was 26.9 and infertile participants was 28.5 (22). Findings from different literature indicate that infertility is related to advance age. The mean + SD endometrial thickness was 10.0 + 2.4 mm, endometrial thickness of participants in Fatima et al (23) study was 8.29±0.63.

The mean resistive index of left and right ovarian artery in fertile females was 0.48 + 0.03, 0.60 + 0.03 and in infertile females 0.9 + 0.03, 0.8 + 0.01 respectively ($P < 0.05$). In a study conducted by Razik et al (24) on infertile and healthy females the ovarian artery RI was higher in females with infertility when compared with normal healthy females. Dadkhah et al's (25) study showed high RI in right ovary artery. Zebitay et al (26) stated a significant difference between ovarian artery RI of fertile and infertile females. Values of PI also vary significantly in fertile and infertile females in a study conducted by Smart et al (21) the mean + SD PI of ovarian arter was 2.81±0.61 These findings are much same as our findings the mean + SD PI in fertile group was 1.1 + 0.13 and 1.6 + 0.06 in left and right ovarian artery respectively. In infertile group the values of PI were 4.2 + 1.2 and 3.0 + 0.4 in left and right ovarian artery respectively. ($P < 0.05$)

In fertile females the mean + SD RI and PI was 0.50 + 0.02, 0.8 + 0.06 and 0.65 + 0.04 , 1.5 + 0.17 in left and right ovarian artery respectively. In infertile group he means + SD RI and PI was 0.83 + 0.01, 2.3 + 0.11 and 0.9 + 0.03 and 2.7 + 0.16 in right and left uterine artery respectively ($P < 0.05$). The RI in infertile group of Li et al (27) study was > 0.80. In a study conducted by 'Porpora et al (28) the uterine artery RI and PI was higher in infertile group than in fertile. Another local review stated a statistical significance between uterine and ovarian artery hemodynamics of fertile and infertile females (27). In a study conducted by Razik et al (24) infertile females had a high PI of >1.2 in infertile group. This study finding were in coherence with study conducted by Razik et al (24). Muhammad et al also showed a higher RI of 0.9 in infertile and RI of 0.6 in fertile (22).

Endometrial receptivity plays an important role in fertilization. In current study the mean + SD endometrial thickness in fertile group was 11.0 + 2.6 mm it was 9 + 1.6 mm in infertile group (P< 0.05). In a studies conducted by Smart et al the endometrium thickness in infertile and fertile groups was 10.30 + 3.13 and 10.72 + 3.10 mm. (21).

These findings are consistent with previous research that has demonstrated the importance of ovarian artery blood flow and endometrial thickness in fertility. For example, reduced ovarian artery blood flow has been associated with a higher risk of infertility and pregnancy loss, while increased endometrial thickness has been linked to better pregnancy outcomes (29, 30).

The results of the statistical analyses indicate that there are significant differences in several vascular and endometrial parameters between fertile and infertile women. Specifically, the mean values of the left and right ovarian artery resistive indices (RI) and the pulsatility index (PI) in fertile women were significantly lower than those of infertile women. This suggests that fertile women have better blood flow to their ovaries, which is associated with improved ovarian function and increased fertility potential.

In addition, the mean value of the endometrial thickness in fertile women was significantly greater than that in infertile women. This suggests that fertile women have a thicker endometrium, which is associated with improved embryo implantation and pregnancy rates. The findings are consistent with previous studies that have shown a positive association between endometrial thickness and pregnancy rates (19).

The results of the t-tests also indicate that the mean values of these parameters in the infertile group are significantly different from those of the fertile group, with p-values ranging from 0.000 to 0.582. As the p-values are all below the conventional level of significance of 0.05, we can conclude that the observed differences in these parameters are unlikely to have occurred by chance alone.

Overall, the findings of this study suggest that there are significant differences in vascular and endometrial parameters between fertile and infertile women, which could be useful in predicting fertility potential and guiding infertility treatments. However, further research is needed to explore the potential mechanisms underlying these differences and to determine whether they can be modified to improve fertility outcomes.

Conclusion

In conclusion, the results of the statistical analysis suggest that there are significant differences between fertile and infertile women in terms of ovarian blood flow and endometrial thickness. Specifically, the mean values of ovarian artery blood flow parameters (RI and PI) were found to be significantly lower in fertile women compared to infertile women, while the endometrial thickness was significantly higher in fertile women. Overall, the results of this study suggest that ovarian artery blood flow and endometrial thickness are important factors to consider in the evaluation and treatment of infertility.

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