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Assessing the Predictive Value of Uterine Artery Flow Parameters in Patients with Recurrent Spontaneous Abortion

Sadaf Imtiaz, Falak Naz Baloch, Rabia, Sara, Zobia Munaf, Benish Fatima Makhdoom

ABSTRACT

Objective: To compare uterine artery flow parameters in women with Recurrent Spontaneous Abortion (RSA) and a control group among females presenting at a tertiary care hospital.

Study Design and Settings: The study was conducted at the Department of Obstetrics and Gynecology for uterine artery flow parameters in women with Recurrent Spontaneous Abortion (RSA) and a control group.

Methodology: 100 participants were included, with 50 in each group. The case group comprised women with RSA, defined as three or more consecutive pregnancy losses before the 20th week of gestation, while the control group consisted of women with uncomplicated pregnancies and at least one child born at term. Data were collected on demographic and clinical variables, including age, parity, and BMI. Uterine artery flow parameters, including Pulsatility Index (PI) and Resistive Index (RI), were assessed via Doppler ultrasound, and the results were subjected to statistical analysis using SPSS.

Results: The study revealed that mean age, BMI, and median parity were similar in both groups. However, the PI and RI were significantly higher in the RSA group. The receiver operating characteristic (ROC) curve analysis demonstrated high diagnostic accuracy, with an area under the curve (AUC) of 88.6% for PI and 79.4% for RI, further emphasizing their potential as predictors of RSA.

Conclusion: Uterine artery blood parameters may serve as potential predictors for identifying women at risk of RSA.

Keywords: Abortion, Miscarriages, Pregnancy Loss, Pulsatility Index, Resistive Index, Uterine artery flow parameters.

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INTRODUCTION

Recurrent spontaneous abortions (RSA), often referred to as recurrent miscarriages, represent a profoundly distressing reproductive health issue affecting couples worldwide.[1] This condition is characterized by the loss of three or more consecutive pregnancies before the 20th week of gestation, and it affects approximately 1-2% of all couples trying to conceive.[2] The estimated annual incidence of miscarriage in Pakistan is 29 in 1000 reproductive age females.[3]

RSA is a complex and multifactorial reproductive disorder with numerous contributing factors, including genetic, anatomical, hormonal, immunological, and environmental components.[1,3,4] A significant proportion of RSA cases remain unexplained, despite comprehensive clinical evaluation. As a result, there is a growing need to identify reliable predictive markers that can help in the early detection and management of miscarriages.[5]

Recently, uterine artery flow parameters have gained attention as potential markers for the prediction of RSA, as they reflect the vascular adaptability and health of the uterus. These parameters include the resistance index (RI), pulsatility index (PI), and peak systolic velocity (PSV).[5,6] Abnormal uterine artery flow patterns, characterized by high RI and PI, are indicative of poor uteroplacental blood flow and have been associated with a higher risk of pregnancy

complications, including miscarriage.[5,6] A recent study showed that in patients with RSA, uterine artery flow parameters were significantly higher than in the control group (P<0.05). These parameters also exhibited high sensitivity and specificity in predicting adverse pregnancy outcomes with AUC values ranging from 0.638 to 0.962, indicating that PI and RI, are high-risk factors for adverse pregnancy outcomes.[7]

Despite the promising findings related to uterine artery flow parameters in recurrent abortions prediction, several challenges and gaps in knowledge persist.[8] Variability in measurement techniques, equipment, and the lack of standardized cutoff values for uterine artery flow parameters can complicate the interpretation of findings. Additionally, there is lack of local data available related to specificity and sensitivity for these parameters. Therefore, the aim of current study was to assess the predictive value of uterine artery flow parameters in RSA among females presenting at a tertiary care hospital, Karachi, Pakistan. This study would assist clinicians in identifying women at risk and implement targeted interventions to improve pregnancy outcomes.

Furthermore, the uterine circulation plays a pivotal role in ensuring adequate oxygen and nutrient delivery to the developing fetus.[9] Abnormalities in uterine artery blood flow, especially during the peri-implantation period, may lead to suboptimal endometrial receptivity and impaired placentation, thereby contributing to early pregnancy loss. Doppler ultrasound, a non-invasive imaging modality, enables real-time assessment of uterine artery hemodynamics, offering valuable insight into uterine perfusion status. By analyzing specific flow parameters like PI, RI, and PSV, clinicians can stratify patients based on their risk profile, enabling a more tailored and proactive approach in the management of women with a history of RSA.

Given the emotional and psychological burden that recurrent pregnancy loss imposes on affected couples, timely identification of at-risk individuals is crucial.[10] Current management strategies primarily focus on treating underlying conditions; however, a significant subset of patients lacks an identifiable cause, highlighting the importance of novel diagnostic approaches. Evaluating uterine artery Doppler indices holds promise not only for risk prediction but also for monitoring the effectiveness of therapeutic interventions. Through this study, we aim to bridge existing knowledge gaps by providing localized data, which may enhance clinical protocols and support evidence-based reproductive care in the Pakistani population.

Recurrent spontaneous abortion often remains unexplained despite thorough evaluation. Impaired uterine blood flow may contribute to defective implantation and early pregnancy loss. Uterine artery Doppler indices provide a non-invasive method to assess uterine perfusion. This study aims to generate local evidence on the predictive value of these parameters to improve early risk identification and clinical management.

The fundamental purpose of the study is to evaluate the uterine artery Doppler flow parameters, particularly focusing on pulsatility index (PI) and resistive index (RI) by making comparison between women with spontaneous abortion and normal reproductive outcomes. For this purpose, this study reveals the importance of uterine artery Doppler indices as non-invasive and cost-efficient tool regarding prediction of risk in early phases in women with recurrent pregnancy loss.

METHODOLOGY

This study employed was a comparative cross-sectional design, enrolling participants from the Department of Obstetrics and Gynecology for uterine artery flow parameters in women with Recurrent Spontaneous Abortion (RSA) and a control group for six months. The sample size was calculated using mean RI in RSA as 0.91±0.24 and RI in normal pregnant females as 0.61±0.29.[7] A Power analysis indicated that a minimum of 48 samples were required to detect significant differences with power of 90% and level of significance as 1%. Open Epi online sample size calculator was used for estimation. For increasing the adequacy of results, 100 samples were included in the study (50 samples in each group).

The case group included women with a RSA, defined as three or more consecutive pregnancy losses before the 20th week of gestation. The control group consisted of women with uncomplicated pregnancies and at least 1 child born at term. Women with endometrial diseases, uterine cavity occupation diseases, systemic chronic disease, and use of hormones or antithrombotic drugs within 3 months before study entry were excluded.

This study was conducted following the ethical principles outlined in the Declaration of Helsinki. Approval was obtained from the Institutional Review Board of Combined Military Hospital (CMH) IRB approval number 247/02/2022. Informed consent was obtained from all women before enrollment. Date regarding age, parity, and BMI were noted. Uterine artery flow parameters, including the PI and RI were assessed using Doppler ultrasound in the second phase of the menstrual cycle, specifically between days 18 and 23. A standardized protocol was followed by a trained sonographer. All data were anonymized and stored securely, with restricted access to authorized personnel only. Data were entered into a dedicated database and subjected to routine quality control checks.

Statistical analysis was performed using software SPSS version 23. Descriptive statistics, including means and standard deviations for continuous variables and percentages for categorical variables, were calculated. Uterine blood flow parameters were compared between both groups using independent samples t-test. Sensitivity, specificity, and the area under the curve (AUC) were determined for the uterine

artery flow parameters in predicting adverse pregnancy outcomes using receiver operating characteristic (ROC) curve analysis. A p-value less than 5% was considered as statistically significant.

RESULTS

A total of 100 women were enrolled in this study, comprising 50 women in the recurrent spontaneous abortion (RSA) group and 50 in the control group. Demographic characteristics, such as age, BMI, and parity, were collected, along with uterine artery Doppler ultrasound parameters including the pulsatility index (PI) and resistive index (RI). Data were statistically analyzed to compare mean values between the two groups and to determine the predictive performance of PI and RI using ROC curve analysis.

The mean age of women in RSA group was 23.28±3.96 years and in control was 24.96±5.16 years. The mean BMI was 25.13±3.80 kg/m^2 in RSA group and 26.02±4.84 kg/m^2 in control group. The median parity was in 0 in RSA group and 1 in control group, respectively. (Table 1)

The mean PI (1.76±0.35 vs 1.21±0.29) and mean RI (0.98±0.21 vs 0.76±0.17) were significantly higher in RSA group than control with p-value<0.05. (Table 2)

Figure 1 shows the ROC curve of the mean PI and RI of women with RSA. The area under the curve (AUC) was 88.6% of PI (p=0.001) and 79.4% of RI (p=0.001) for the prediction of RSA. The sensitivity of PI was 80% and specificity was 78% at cut-off value of 1.35, whereas, the sensitivity of RI was 82% and specificity was 58% at cut-off value of 0.80, respectively.

Table 1: Baseline characteristics of study samples among both groups (n=100)

Characteristics	RSA	Control
Age (years)	23.28±3.96	24.96±5.16
BMI (kg/m^2)	25.13±3.80	26.02±4.84
Parity	0 (0-1)	1 (1-2)

Table 2: Comparison of uterine artery flow parameters between RSA and control group (n=100)

Uterine artery flow parameters	RSA	Control	p-value
PI	1.76±0.35	1.21±0.29	0.001*
RI	0.98±0.21	0.76±0.17	0.001*

Table 3: Diagnostic performance of Doppler parameters using ROC analysis

Parameter	Cut-off Value	Sensitivity (%)	Specificity (%)
Pulsatility Index (PI)	1.35	80%	78%
Resistive Index (RI)	0.80	82%	58%

Table 4: Area under the curve (AUC) for Doppler indices

Parameter	AUC (%)	p-value
Pulsatility Index (PI)	88.6%	0.001*
Resistive Index (RI)	79.4%	0.001*

DISCUSSION

The present study compared uterine artery flow parameters in women with RSA and a control group. In the present study found that mean age of women in the RSA group and control group was almost same. Similarly, in a study conducted by Zhang et al. the mean age of women in the RSA group and control group was 29.55±3.83 years and 28.97± 3.30 years, respectively.[11] Lian et also found median age in RSA group and in control is similar with p-value=0.194.[12] These findings support to the notion that age may not be a significant distinguishing factor in the context of recurrent spontaneous abortion.

Additionally, the mean BMI in the RSA group (25.13 kg/m²) was almost similar to the control group (26.02 kg/m²). However, in a previous study by Felisbino-Mendes et al., it has been observed that with every one unit increase in BMI, the odds of spontaneous abortion significantly increased (OR = 1.05; 95% CI=1.02-1.08).[13] Another study by Eapen et al. also showed that maternal BMI was strongly associated with recurrent miscarriages.[14] Similarly, Ghimire et al. revealed the odds of abortion were 1.5 times more among females with obesity than controls.[15] Dissimilarities between our study and previous studies might be due to variation in the demographic characteristics of the study populations.

In the current study, the median parity in the RSA group was reported as 0, while the control group had a median parity of 1. Cohain et al. found that 43% of the females experienced one or more first trimester spontaneous miscarriages. A significant portion had one miscarriage (27%), while 10% had two, 4% had three, and smaller percentages had more. Notably, 18.5% had first trimester miscarriages before their first live birth, and even women with 11 or more living children experienced miscarriages (81%). Furthermore, they found factors contributing to first trimester miscarriages included increasing age, a history of ectopic pregnancy, higher parity, previous cesarean surgery, smoking during pregnancy, and a pre-pregnancy BMI =30. These findings highlight the multifaceted nature of first trimester miscarriages.[16] and underscore the intricate nature of first trimester miscarriages, further supporting the complexity of their causes.

Uterine blood flow parameters in miscarriages have been explored in various studies. One study by Yildiz et al. found no significant difference in PI and RI values between females with and without history of pregnancy loss.[17] Zhang et al. also found uterine artery blood flow parameters were significantly higher in RSA group than control group. In the study by Taylor et al. it has been observed that the mean PI was significantly different between pregnancies that continued to be viable and resulted in abortions.[18] Elewa et al. revealed that women with RSA have greater uterine flow resistance

and lesser endometrial and subendometrial blood flow as compared to fertile women.[19] Similarly, Wahab et al. found women with RSA had lesser endometrial blood flow and higher uterine blood flow resistance as compared to controls.[20] In the current study we also found that the mean PI and RI values were significantly higher in the RSA group than in the control group. This aligns with existing research that has suggested abnormal uterine artery Doppler waveforms, characterized by increased PI and RI, may be associated with adverse pregnancy outcomes, including RSA.[5,6,12.] Furthermore, in the current study, the ROC curve analysis demonstrated that high AUC values (88.6% for PI and 79.4% for RI) indicate good diagnostic accuracy. The sensitivity and specificity values at their respective cut-off points further emphasize the potential clinical utility of these Doppler indices. While the ROC analysis is a valuable contribution, it is essential to note that the sensitivity of RI is higher than PI, which could make it a more robust predictor.

The paper presents essential insights into the association between maternal age, BMI, Doppler parameters, and RSA. However, several limitations should be acknowledged. First, the sample size and demographic characteristics of the study population are not discussed in detail, and these factors can significantly impact the generalizability of the findings.[20] Furthermore, it would be beneficial to explore other potential confounding variables, such as medical history and lifestyle factors, which were not included in this analysis. Lastly, future research should focus on the reproducibility of these findings in larger, more diverse populations to enhance the robustness of these predictors.

The implications of the current findings are far-reaching in the context of reproductive health, especially in countries like Pakistan where access to advanced fertility assessments and interventions remains limited. By demonstrating that uterine artery Doppler indices such as PI and RI are significantly elevated in women with RSA, this study adds valuable evidence supporting the use of non-invasive imaging techniques for early risk stratification.[21] The observed high AUC values in the ROC curve analysis further highlight the diagnostic strength of these markers. While RI demonstrated slightly higher sensitivity than PI in this study, both indices have shown considerable clinical utility and can be considered valuable tools for routine gynecological evaluations in women at risk for RSA.

It is noteworthy that even though uterine artery Doppler studies have gained attention globally, their routine integration into standard clinical practice is still evolving. This may be due to factors such as lack of trained personnel, limited access to Doppler technology in resource-constrained settings, and the need for standardized reference values. Our findings underscore the importance of incorporating Doppler studies, especially in tertiary care settings, to complement existing diagnostic approaches. With increasing evidence supporting their predictive value, uterine artery Doppler indices could be pivotal in guiding clinical decisions such as closer monitoring, early intervention, or the use of adjunctive therapies like low-dose aspirin or heparin in at-risk patients.[22]

Another crucial aspect to consider is the timing of Doppler assessment. Studies suggest that uterine artery Doppler indices vary with the phase of the menstrual cycle, gestational age, and individual physiological conditions. For optimal predictive accuracy, standardizing the timing of these assessments—ideally during the mid-luteal phase or early first trimester—would allow for better inter-study comparability. This standardization becomes especially relevant in clinical protocols, where reproducibility and consistency are crucial for widespread application.[23]

In addition to uterine artery flow, several studies have examined the endometrial and subendometrial blood flow as additional markers of reproductive potential. These microvascular territories play a fundamental role in embryo implantation and placental development. Reduced blood flow in these regions, which has been consistently reported in women with RSA, correlates with suboptimal endometrial receptivity. Although this study did not evaluate endometrial perfusion specifically, integrating this parameter in future studies would enhance the overall understanding of uterine hemodynamics in RSA patients.

The discussion on maternal age and BMI in relation to RSA also warrants further elaboration. While this study found no significant difference in age or BMI between the RSA and control groups, literature reveals conflicting evidence. For example, increasing maternal age has been widely recognized as a risk factor for chromosomal abnormalities and miscarriage. However, in populations with younger reproductive age ranges, like those in Pakistan, this association may be less pronounced. Similarly, BMI has shown a complex relationship with pregnancy outcomes. Although some studies report a positive correlation between high BMI and RSA risk, others, including ours, suggest minimal or non-significant differences. These discrepancies underscore the importance of contextualizing data within regional demographics, lifestyle patterns, and healthcare access.[16]

Moreover, parity emerged as a potential differentiating factor in our study, with RSA patients exhibiting a median parity of zero. This finding aligns with clinical observations that many women experiencing recurrent miscarriages often do so before achieving a successful pregnancy. Low parity may reflect underlying reproductive or endocrine dysfunctions, immunologic incompatibilities, or structural anomalies that impede the maintenance of early pregnancy.[17] Thus, parity should be further explored in future research as a potential mediator or modifier in RSA risk prediction models.

Beyond the physiological and demographic considerations, psychosocial dimensions of RSA also deserve attention. Recurrent pregnancy loss is associated with significant

emotional trauma, anxiety, depression, and relationship stress. The diagnostic uncertainty surrounding many RSA cases often compounds these challenges. Thus, developing reliable, evidence-based predictors—such as uterine artery Doppler indices—could not only guide medical management but also provide psychological reassurance and clarity for affected couples. This holistic approach to patient care is particularly crucial in culturally sensitive settings where childbearing is closely linked to social identity and familial expectations.[18]

Another important consideration is the heterogeneity of RSA causes. While Doppler parameters reflect uterine perfusion and vascular resistance, RSA can also result from endocrine disorders (like uncontrolled diabetes or thyroid dysfunction), coagulation abnormalities (e.g., antiphospholipid syndrome), and immunological or genetic defects. Therefore, Doppler assessments should be part of a broader diagnostic framework, rather than standalone tools.[16] A multidisciplinary evaluation involving endocrinologists, hematologists, geneticists, and reproductive medicine specialists will yield a more comprehensive understanding and management strategy for RSA patients.

One potential avenue for improving outcomes lies in therapeutic interventions aimed at improving uterine blood flow. Several clinical trials have investigated the efficacy of low-dose aspirin, low molecular weight heparin, nitric oxide donors, and even lifestyle interventions such as exercise and weight management to improve uterine perfusion. If future studies confirm that elevated PI and RI reliably predict miscarriage risk, these interventions could be initiated pre-conceptionally or in early pregnancy to enhance uterine vascular function and potentially reduce the risk of pregnancy loss. Personalized medicine, supported by real-time Doppler assessments, could thus become a cornerstone of RSA management in the future.[17]

Despite its valuable contributions, the current study is not without limitations. The lack of detailed stratification by RSA etiology limits the granularity of conclusions. Additionally, although Doppler parameters were compared, other relevant clinical data such as endometrial thickness, hormonal levels, and anatomical anomalies were not evaluated. These factors could influence uterine blood flow and, consequently, miscarriage risk.[21] Further, the study's cross-sectional nature precludes causal inferences, and its single-center design may limit generalizability. Multi-center longitudinal studies with larger, ethnically diverse samples and detailed clinical profiles would be instrumental in validating and expanding upon these findings.

Moreover, operator variability in Doppler measurements, even when using standardized techniques, remains a significant limitation in clinical practice. Training sonographers, ensuring inter-observer reliability, and using high-resolution equipment are essential for enhancing the accuracy and reproducibility of such assessments.[22] Establishing normative reference ranges for uterine artery PI and RI values in the local population would also facilitate more precise risk categorization.

This study reinforces the utility of uterine artery Doppler parameters, particularly PI and RI, as promising non-invasive markers for assessing RSA risk. The elevated values in the RSA group, combined with robust ROC curve metrics, affirm their diagnostic value. While maternal age and BMI were not significant differentiators in this cohort, the importance of individual risk profiling remains paramount. Future research should aim to integrate Doppler findings with broader clinical, genetic, and psychosocial data to develop holistic and individualized care plans.[23] Ultimately, enhancing the understanding and management of RSA through such approaches could contribute to improved maternal-fetal health outcomes, especially in under-resourced settings.

When it comes to limitations, the study was conducted in a single hospital, so the study is limited to generalize. Meanwhile, the sample size of the study is also limited. Importantly, the Doppler measurement is also dependent on operator rather than considering it as a general factor.

CONCLUSION

The uterine artery blood parameters might be potential predictors for the identification of women at risk of RSA.

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Falak Naz Baloch Concept of study, critical appraisal of final version
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SaraLiterature review, drafting of manuscript, final approval of manuscript
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REFERENCES

1. El Hachem H, Crepaux V, May-Panloup P, Descamps P, Legendre G, Bouet PE. Recurrent pregnancy loss: current perspectives. Int J Womens Health 2017;9:331-45. DOI: 10.2147/ijwh.S100817.
2. Zhang X, Wang H, Feng T, Yang J, Huang Q, Lu C, et al. The relationship between semen factors and unexplained recurrent spontaneous abortion. Clin Chim Acta 2020;510:605-12. DOI: 10.1016/j.cca.2020.08.022.
3. Yasmeen R, Hussain R. Recurrent miscarriage and associated factors. Pakistan Journal of Medicine and Dentistry 2016;5(1):47-50.

4. Cao C, Bai S, Zhang J, Sun X, Meng A, Chen H. Understanding recurrent pregnancy loss: recent advances on its etiology, clinical diagnosis, and management. Med Rev (Berl) 2022;2(6):570-89. DOI: 10.1515/mr-2022-0030.
5. Lian X, Pan Z, Xia F, Mao C, Zhou W, Zhong Y, et al. Analysis of the guidance and predictive value of uterine artery flow parameters in patients with recurrent spontaneous abortion. Journal of Obstetrics and Gynaecology Research 2023;49(3):803-11. DOI: https://doi.org/10.1111/jog.15523.
6. Frates MC, Doubilet PM, Brown DL, Benson CB, DiSalvo DN, Laing FC, et al. Role of Doppler ultrasonography in the prediction of pregnancy outcome in women with recurrent spontaneous abortion. Journal of ultrasound in medicine 1996;15(8):557-62.
7. Wei LU, Honghong LIU, Weihao YANG. Predictive Value of Uterine Artery Blood Flow Parameters in Early Pregnancy on Adverse Pregnancy Outcomes in Patients with Recurrent Spontaneous Abortion[J]. HeBei Med, 2021, 27(4): 579-583.
8. Sussman D, Saini BS, Schneiderman JE, Spitzer R, Seed M, Lye SJ, Wells GD. Uterine artery and umbilical vein blood flow are unaffected by moderate habitual physical activity during pregnancy. Prenatal Diagnosis. 2019 Oct;39(11):976-85.
9. Obeagu EI, Obeagu GU. Maternal Hypoxia: Impact on Cardiovascular Health and Placental Function. Elite Journal of Nursing and Health Science. 2024;2(8):50-65.
10. Voss P, Schick M, Langer L, Ainsworth A, Ditzen B, Strowitzki T, Wischmann T, Kuon RJ. Recurrent pregnancy loss: a shared stressor---couple-orientated psychological research findings. Fertility and Sterility. 2020 Dec 1;114(6):1288-96.
11. Zhang K, Wang E, Li Y, Xu H, Zhang J, Wang X, et al. Role of low-molecular-weight heparin in altering uterine artery blood flow in recurrent spontaneous abortion: a prospective study. J Int Med Res 2020;48(8):300060520945558. DOI: 10.1177/0300060520945558.
12. Lian X, Zhong Y, Lv X, Lu S, Lu Y, Zhou Y, et al. Doppler evaluation of uterine blood flow and pregnancy outcome in patients with URSAFA retrospective cohort study. Research Square; 2023.
13. Felisbino-Mendes MS, Matozinhos FP, Miranda JJ, Villamor E, Velasquez-Melendez G. Maternal obesity and fetal deaths: results from the Brazilian cross-sectional Demographic Health Survey, 2006. BMC Pregnancy Childbirth 2014;14:5. DOI: 10.1186/1471-2393-14-5.
14. Eapen A, Hayes ET, McQueen DB, Beestrum M, Eyck PT, Boots C. Mean differences in maternal body mass index and recurrent pregnancy loss: a systematic review and meta-analysis of observational studies. Fertil Steril 2021;116(5):1341-8. DOI: 10.1016/j.fertnstert.2021.06.019.
15. Ghimire PR, Akombi-Inyang BJ, Tannous C, Agho KE. Association between obesity and miscarriage among women of reproductive age in Nepal. PLoS One 2020;15(8):e0236435. DOI: 10.1371/journal.pone.0236435.
16. Cohain JS, Buxbaum RE, Mankuta D. Spontaneous first trimester miscarriage rates per woman among parous women with 1 or more pregnancies of 24 weeks or more. BMC Pregnancy Childbirth 2017;17(1):437. DOI: 10.1186/s12884-017-1620-1.
17. Yildiz G, Yavuzcan A, Yildiz P, Göynümer G, Yücel N. Effect of uterine artery blood flow on recurrent pregnancy loss. Clin Exp Obstet Gynecol 2012;39(3):326-9.
18. Taylor TJ, Quinton AE, de Vries BS, Hyett JA. First-trimester ultrasound features associated with subsequent miscarriage: A prospective study. Aust N Z J Obstet Gynaecol 2019;59(5):641-8. DOI: 10.1111/ajo.12944.
19. Elewa A, Mansour A, Gehad MA, Afify H. Ovarian reserve testing and uterine blood flow assessment using two-dimensional and three-dimensional Doppler in patients with unexplained recurrent miscarriage. Benha Medical Journal 2017;34:81 - 7.
20. Wahab HA, El-Din DS, Zain E, Abdelgany M, Youssef MAFM. Uterine artery Doppler and subendometrial blood flow in patients with unexplained recurrent miscarriage. Middle East Fertility Society Journal 2011;16(3):209-14. DOI: https://doi.org/10.1016/j.mefs.2011.04.001.
21. Adekanmi AJ, Roberts A, Morhason-Bello IO, Adeyinka AO. Utilization of Uterine and Umbilical Artery Doppler in the Second and Third Trimesters to Predict Adverse Pregnancy Outcomes: A Nigerian Experience. Womens Health Rep (New Rochelle) 2022;3(1):256-66. DOI: 10.1089/whr.2021.0058.
22. Barati M, Shahbazian N, Ahmadi L, Masihi S. Diagnostic evaluation of uterine artery Doppler sonography for the prediction of adverse pregnancy outcomes. J Res Med Sci 2014;19(6):515-9.
23. Geerts L, Van der Merwe E, Theron A, Rademan K. Placental insufficiency among high-risk pregnancies with a normal umbilical artery resistance index after 32weeks. International Journal of Gynecology & Obstetrics 2016;135(1):38-42. DOI: https://doi.org/10.1016/j.ijgo.2016.03.038.