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Original Research Article

PREIMPLANTATION UTERINE ARTERY DOPPLER AND IT`S CORRELATION WITH PERINATAL AND MATERNAL OUTCOMES

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ABSTRACT

Background: The aim of present study is to perform preimplantation uterine artery doppler and it`s correlation with perinatal and maternal outcomes.
Materials and Methods: It was a prospective, observational study was carried out in the Department of gynecology, on the women coming for fertility treatment. The study was carried out for a period of 24 months was conducted on 50 patients. All pregnant women aging between 21 years and 35 years with single fetus for follow up were included.
Results: The present study found that most participants were aged 26–30 years, with a mean age of 28.12 years, and 68% were primiparous. Centrally located placenta was observed in 60% of cases. Common pregnancy complications included gestational hypertension (12%), pre-eclampsia (8%), and HELLP syndrome (4%). Abnormal Doppler indices, particularly in uterine and umbilical arteries, were associated with adverse neonatal outcomes such as low birth weight (22%) and preterm birth (18%). The pulsatility and resistance indices were significantly higher in subjects with adverse outcomes. Right uterine artery PI and RI showed the highest sensitivity and negative predictive value. Umbilical artery PI demonstrated excellent specificity and positive predictive value.
Conclusion: The study concludes that abnormal uterine and umbilical artery Doppler indices are significantly associated with adverse neonatal outcomes such as low birth weight, preterm birth, IUGR, and NICU admissions. Routine Doppler assessment, particularly of the uterine and umbilical arteries, can serve as an effective tool in predicting and managing high-risk pregnancies.
Keywords: Neonatal Intensive Care Unit, Relative Risk, Intrauterine Growth Restriction, Pulsatility Index , Resistance Index.

INTRODUCTION

Most pregnancies, labours, and deliveries are normal biological processes that result in a healthy outcome for mothers and babies. Those that are not normal, however, can result in maternal and/or perinatal mortality or substantial morbidity. In the latest Centre for Maternal and Child Enquiries (CEMACE) report on maternal deaths (“Saving Mothers’ Lives” 2006–2008), preeclampsia/eclampsia was the second commonest cause of direct maternal deaths in the United Kingdom (0.83 per 100,000 maternities).[1] Preeclampsia and fetal growth restriction (FGR) have been identified as antecedent causes of 6% and 10% of perinatal deaths, respectively. Modern antenatal care provision is focused on a risk-based approach to monitoring for adverse pregnancy outcomes such as preeclampsia and fetal growth restriction, Increasingly, research is geared towards early identification of risks, thereby allowing early commencement of management strategies to minimize the risk of adverse outcome, including facilitation of an appropriate level of pregnancy monitoring.[2] Hence the present study was initiated to reduce perinatal and maternal complications by identifying them in early gestation.

MATERIALS AND METHODS

It was a prospective, observational study was carried out in the Department of gynecology, on the women coming for fertility treatment at Government Maternity Hospital, Hanamkonda. The study was carried out for a period of 24 months, i.e., from September 2022 to August 2024. The study was conducted on 50 patients.

Inclusion Criteria:

All pregnant women aging between 21 years and 35 years with single fetus for follow up.

Exclusion Criteria:

Pregnant women aging less than 21 years and more than 35 years, with comorbid conditions, with Mullarian anomalies.

All the patients fulfilling selection criteria were explained about the details of the disease process, options of treatment, ultimate outcome, possible effects, complications and chances of recurrence in both procedure and a written informed consent was obtained before enrolment. They were informed of their right to withdraw from the study at any stage.

Data Collection

A detailed clinical history and physical examination was carried out on patients followed by a thorough review of their hospital records. All the patients meeting inclusion criteria were included in the study. Patient was put in recumbent position with transducer in the longitudinal plane. The external iliac artery was visualized at pelvic side wall with color Doppler. The transducer was then angled medially towards the uterine arty. The spectral waveforms on the right and left uterine arteries were taken, when 3 or 4 waves of equal height were seen, the image was frozen and measurements were taken either by trace method/manually/automatic trace. Then Doppler indices were obtained directly from the machine.

The transducer was then placed over anterior abdominal wall over the uterus and was carefully manipulated till a free loop of umblical cord seen by gray scale imaging and colour was used to identify the umblical artery. Thus Doppler waveform was obtained. Recordings of umblical artery are obtained from free loop of umblical cord. These were identified with the characteristic audio output and typical Doppler shift waveforms appearance on the screen. It was done in fetal apnea as breathing alters the Doppler shifts. Waveforms obtained were maximum frequency shift along with venous flow signals display in reverse side. When 3 or 4 waves of equal height were seen the image was frozen and measurement were taken and cursor was moved tangential over the trough and peak. Indices were obtained directly from machine. The uterine artery and umblical artery Doppler was done. In uterine artery RI, S/D ratio and early diastolic notching was noted and in umblical artery the RI, S/D ratio, Absent end diastolic flow and reverse end diastolic flow was noted. The flow velocity waveforms were considered abnormal if there was an early diastolic notch in uterine artery in either right or left uterine arteries S/D, RI exceeds 95th percentile of the reference range for that population. In umblical artery if S/D, RI exceeds 95th percentile and if there was absent and reverse end diastolic flow in velocity in umblical artery. These patients were followed up till delivery and details of pregnancy events, labour and delivery and neonatal outcome were noted. The abnormal pregnancy outcomes considered were preeclampsia and IUGR. Perinatal outcomes considered were IUD, Apgar at 5 minute, NICU admission low birth weight.

Statistical Analysis

The collected data was entered into Microsoft Excel Worksheet-2010 and data was taken into IBM SPSS Statistic for windows, version 24 (IBM Corp., Armonk, N.Y., USA) software for calculation of frequency, percentage, mean, standard deviation and probability value. Analysis of quantitative data within the groups was done using paired t test if data passes 'Normality test'. One Way Analysis (ANOVA) was used to compare more than two groups. A 'P' value of <0.05 was considered statistically significant.

RESULTS

Majority subjects were found in the age group of 26-30 years, i.e., 23 subjects (46 %); followed by 15 subjects (30 %) in the age group of 31-35 years and finally 12 subjects (24 %) in the age group of 20-25 years. The mean age of subjects was 28.12 ± 2.17 years. Majority subjects were found in the primi parity, i.e., 34 subjects (68 %) and 16 subjects (32 %) in multi parity. Majority subjects had centrally located placenta, i.e., 30 subjects (60 %). Majority subjects had no events in pregnancy i.e., 38 subjects (76 %); followed by 6 subjects (12 %) Majority subjects had normal vaginal delivery, i.e., 29 subjects (58 %); followed by 14 subjects (28 %) with emergency LSCS.

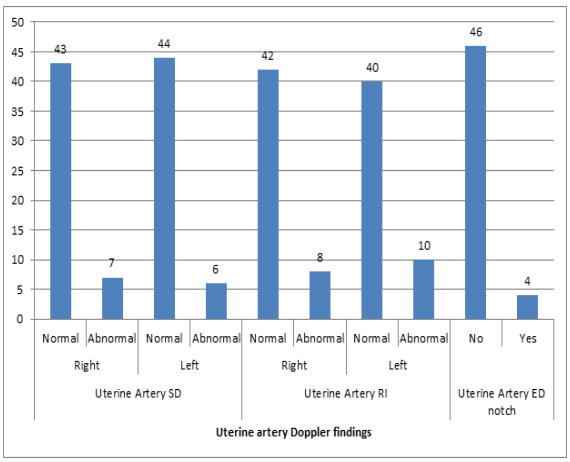

Figure 1: Distribution of subjects basing on uterine artery Doppler findings.

Table 1: Distribution of subjects in present study

Age group (years)	No. of subjects (N)	Percentage (%)
20-25	12	24
26-30	23	46
31-35	15	30
Total	50	100
Mean age	28.12 ± 2.17	
Primi	34	68
Multi	16	32
Placental position		
Left	10	20
Right	10	20
Centre	30	60
Events in pregnancy		
Pre-eclampsia	4	8
Gestational hypertension	6	12
HELLP syndrome	2	4
Nil	38	76
Type of delivery		
Vaginal Delivery	29	58
Instrumental	2	4
Emergency LSCS	14	28
Elective LSCS	5	10

Table 2: Distribution of subjects basing on umbilical artery Doppler findings.

Umbilical artery	Doppler findings	No. of subjects (N)	Percentage (%)
Umbilical artery PI	Normal	45	90
	Abnormal	5	10
Umbilical artery RI	Normal	47	94
	Abnormal	3	6

Doppler findings of umbilical artery PI of 45 subjects (90 %) were normal and those of 5 subjects (10 %) were abnormal. Doppler findings of umbilical artery RI of 47 subjects (94 %) were normal and those of 3 subjects (6 %) were abnormal.

Table 3: Distribution of subjects basing on incidence of adverse neonatal outcomes.

Condition	No. of subjects (N)	Percentage (%)
Intrauterine Growth Restriction	7	14
Pre term	9	18
Neonatal Intensive Care Unit	9	18
Low birth weight	11	22
NIL	14	28

Neonates of majority subjects had no adverse neonatal outcomes i.e., 14 subjects (28 %); followed by 11 neonates (22 %) with low birth weight.

Table 4: Comparison of pulsatility index values of subjects on basis of adverse outcomes.

Variable	Adverse outcomes	Min.	Max.	Mean	SD
Left Uterine Artery	Yes	1.25	2.81	1.89	0.44
	No	0.63	2.65	1.45	0.41
Right Uterine Artery	Yes	0.63	2.55	1.68	0.57
	No	0.53	2.89	1.45	0.41
Umbilical Artery	Yes	0.93	2.45	1.78	0.43
	No	0.58	2.68	1.43	0.38

The pulsatility index values of left uterine artery in subjects with adverse outcomes mean: 1.89 ± 0.44. The pulsatility index values of right uterine artery in subjects with adverse outcomes mean: 1.68 ± 0.57. The pulsatility index values of umbilical artery in subjects with adverse outcomesmean: 1.78 ± 0.43.

Table 5: Comparison of resistance index values on basis of adverse outcomes.

Variable	Adverse outcomes	Min.	Max.	Mean	SD
Left Uterine Artery	Yes	0.35	1.01	0.65	0.15
	No	0.25	0.91	0.53	0.16
Right Uterine Artery	Yes	0.38	0.95	0.68	0.18
	No	0.29	0.92	0.59	0.18
Umbilical Artery	Yes	0.38	0.93	0.69	0.16
	No	0.00	0.91	0.52	0.15

The resistance index values of left uterine artery in subjects with adverse outcomes mean: 0.65 ± 0.15. The resistance index values of right uterine artery in subjects with adverse outcomes mean: 0.68 ± 0.18. The resistance index values of umbilical artery in subjects with adverse outcomes mean: 0.69 ± 0.16.

Table 6: Distribution of validity parameters of Doppler test for adverse maternal outcomes.

Parameter	Sensitivity	Specificity	Positive Predictive value	Negative Predictive value
Right Uterine Artery PI	88.73	91.35	40.45	97.99
Left Uterine Artery PI	58.15	93.35	31.76	97.58
Right Uterine Artery RI	88.79	88.58	38.53	98.15
Left Uterine Artery RI	56.15	85.85	23.15	95.38
Umbilical Artery PI	45.89	93.48	30.03	96.57
Umbilical Artery RI	29.58	95.79	41.07	93.79
Uterine artery ED Notch	45.82	95.65	38.52	96.63

The right uterine artery PI was 88.73 sensitive; 91.35 specific and negative predictive value of 97.99. The left uterine artery PI was 93.35 specific and negative predictive value of 97.58. The right uterine artery RI was 88.79 sensitive; 88.58 specific and negative predictive value of 98.15. The left uterine artery RI was 85.85 specific and negative predictive value of 95.38. The umbilical artery PI was 93.48 specific and negative predictive value of 96.57. The umbilical artery RI was 95.79 specific and negative predictive value of 93.79. The uterine artery ED Notch was 95.65 specific and negative predictive value of 96.63.

Table 7: Distribution of validity parameters of Doppler test for adverse neonatal outcomes.

Parameter	Sensitivity	Specificity	Positive Predictive value	Negative Predictive value
Right Uterine Artery PI	55.83	91.18	47.86	93.93
Left Uterine Artery PI	39.41	95.31	41.39	91.85
Right Uterine Artery RI	55.82	88.67	44.71	93.15
Left Uterine Artery RI	39.45	85.95	27.33	91.19
Umbilical Artery PI	68.38	97.83	91.99	96.51
Umbilical Artery RI	17.77	97.95	21.15	86.38
Uterine artery ED Notch	31.79	97.90	55.99	93.31

The right uterine artery PI was 91.18 specific and negative predictive value of 93.93. The left uterine artery PI was 95.31 specific and negative predictive value of 91.85. The right uterine artery RI was 88.67 specific; and negative predictive value of 93.15. The left uterine artery RI was 85.95 specific and negative predictive value of 91.19. The umbilical artery PI was 97.83 specific; had a positive predictive value of 91.99 and negative predictive value of 96.51. The umbilical artery RI was 97.95 specific and negative predictive value of 86.38. The uterine artery ED Notch was 97.90 specific and negative predictive value of 93.31.

DISCUSSION

During a routine low-risk pregnancy, the uterine arteries undergo a trophoblastic change in which the hemodynamics transition from a high resistive blood flow to a low resistive blood flow. This is to perfuse the uteroplacental system with oxygenated blood to allow for adequate fetal development. Complications of fetal development and well-being can occur when this transition is compromised. There are predisposing health conditions that have been identified with interrupting this hemodynamic transition such as hypertension, diabetes, autoimmune disorders, clotting disorders, and renal disease, as well as maternal factors, such as body mass index (BMI) and ethnicity, that increase chances of pregnancy complications.[3] Uterine artery Doppler has been a useful aid in the sonographic evaluation of uteroplacental hemodynamics of the gravid uterus. Over the years, practitioners have been using it as a predictive tool to analyze or isolate pregnancies that are at-risk for adverse outcomes. Numerous parameters can be calculated in the evaluation of the blood flow; typical quantitative values used include the pulsatility index (PI), resistive index (RI), and systolic/diastolic (S/D) ratio. The waveform itself can be evaluated for diastolic notching, defined as an early diastolic velocity measurement lower than the mid-diastolic measurement, used to interpret the qualitative appearance of the blood flow. There have been numerous studies that have demonstrated the benefits of uterine artery Doppler in assessing for pregnancies at an increased risk for adverse pregnancy outcomes.[4,5] However, there is debate as to which Doppler parameter provides the best screening parameter to most effectively isolate the potentially problematic pregnancy. In addition to the hemodynamic characteristics, practitioners have also tried to incorporate maternal serum tests in the attempt to isolate at-risk candidates.[6,7] Hence the present study was aimed to perform preimplantation uterine artery doppler and correlate the result with perinatal and maternal outcomes.

In the present study, the subjects were categorized into three age groups. Majority subjects were found in the age group of 26-30 years, i.e., 46 % subjects; followed by 30 % subjects in the age group of 31-35 years and finally 24 % subjects in the age group of 20-25 years. The mean age of subjects was 28.12 ± 2.17 years. The results of our study were in co-relation with the past studies conducted by Owen P et al,[8] Fay RA et al,[9] Tamim H et al.[10]

Table 8: Comparision of our study with other studies

Majority age group (Percentage)	
Owen P et al,[8]	25-30 years (43 %)
Fay RA et al,[9]	21-30 years (58 %)
Tamim H et al,[10]	25-30 years (46 %)
Present study	26-30 years (46 %)
Parity in group (percentage)	
A. E. Wallace et al,[11]	Primi parity (65 %)
I. Brosens et al,[12]	Primi parity (65 %)
Present study	Primi parity (68 %)
Majority placental position (Percentage)	
L. Carbillon et al,[13]	Central (62 %)
T. R. Everett et al,[14]	Central (68 %)
M. G. Tuuli et al,[15]	Central (61 %)
Present study	Central (60 %)
Majority events in pregnancy (Percentage)	
L. Carbillon et al,[13]	Nil (71 %)
T. R. Everett et al,[14]	Nil (73 %)
M. G. Tuuli et al,[15]	Nil (73 %)
Present study	Nil (76 %)
Majority type of delivery (Percentage)	
J. Lefebvre et al,[16]	Normal vaginal delivery (63 %)
W. Plasencia et al,[17]	Normal vaginal delivery (68 %)
G. Ridding et al,[18]	Normal vaginal delivery (67 %)
Present study	Normal vaginal delivery (58 %)

Majority subjects were found in the primi parity, i.e., 68 % subjects and 32 % subjects in multi parity. The results of our study were in co-relation with the past studies conducted by A. E. Wallace et al,[11] I. Brosens et al.[12]

Majority subjects had centrally located placenta, i.e., 60 % subjects; followed by 20 % subjects each with placenta located on left and right respectively. The results of our study were in co-relation with the past studies conducted by L. Carbillon et al,[13] T. R. Everett et al,[14] M. G. Tuuli et al.[15]

Majority subjects had no events in pregnancy i.e., 76 % subjects; followed by 12 % subjects with gestational hypertension; 8 % subjects with pre-eclampsia and finally 4 % subjects with HELLP syndrome. The results of our study were in co-relation with the past studies conducted by L. Carbillon et al,[13] T. R. Everett et al,[14] M. G. Tuuli et al.[15]

Doppler findings of right uterine artery PI of 86% RI of 84 % subjects were normal and those of 14 %, 16% subjects were abnormal. Doppler findings of left uterine artery PI of 88 % subjects were normal and those of 12% subjects were abnormal. Doppler findings of left uterine artery RI of 80% subjects were normal and those of 20% subjects were abnormal. Uterine artery ED notch was absent in 92% subjects and present in 8 % subjects. The results of our study were in co-relation with the past studies conducted by Y. Zhong et al,[19] Alves et al,[20] O. G´omez et al.[21]

Doppler findings of umbilical artery PI of 90%, RI of 94 % subjects were normal and those of 10%, 6%subjects were abnormal. The results of our study were in co-relation with the past studies conducted by Y. Zhong et al,[19] Alves et al,[20] O. G´omez et al.[21]

Majority subjects had normal vaginal delivery, i.e., 58 % subjects; followed by 28 % subjects with emergency LSCS; 10 % subjects with elective LSCS and finally 4 % subjects with Instrumental deliveries. The results of our study were in co-relation with the past studies conducted by J. Lefebvre et al,[16] W. Plasencia et al,[17] G. Ridding et al.[18]

Neonates of majority subjects had no adverse neonatal outcomes i.e., 28 % neonates; followed by 22 % neonates with low birth weight; 18 % neonates were born pre-term; 18 % neonates were admitted into NICU and finally 14 % neonates had intrauterine growth restriction.

CONCLUSION

The predictive accuracy of first-trimester uterine artery Doppler is better in the detection of early-onset preeclampsia and FGR than late-onset disease. Combination of Doppler indices of uterine and umblical artery is the best indicator for prediction of Preeclampsia and IUGR. Diastolic notch in the uterine artery as a single parameter is better than the individual Doppler indices in uterine artery. Absent diastolic flow in umblical artery is better predictor of Preeclampsia, fetal growth restriction and poor prenatal outcome. Uterine and umblical artery Doppler may be included in hospitals with facilities and infra structure to identify a group of patients at a risk of developing Preeclampsia or fetal growth restriction. Combined uterine artery and umblical artery Doppler is the best predictor for Preeclampsia and IUGR.

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