Original Research Article

The role of umbilical artery doppler indices in predicting perinatal outcome in preeclampsia

Omoregie Irowa[1]*, Mohammad Hameed[2], Nombur Lahaga Isaac[3], Eti Arichi Elizabeth[3]

[1]Department of Obstetrics and Gynecology, Federal University of Health Sciences Otukpo, Benue State (FUHSO), Nigeria
[2]Department of Radiology, Benue State University Teaching Hospital Makurdi, Benue State, Nigeria
[3]Department of Obstetrics and Gynecology, Federal Medical Centre, Makurdi, Benue State, Nigeria

*Correspondence:
Dr. Omoregie Irowa,
E-mail: reggie_irowa@yahoo.com

ABSTRACT

Background: Preeclampsia currently accounts for the majority of causes of perinatal morbidity and mortality. Umbilical artery Doppler (UAD) is a non-invasive effective method of antenatal fetal surveillance for early detection and prevention of potentially adverse perinatal outcome in preeclampsia. The objective of this study is to predict adverse perinatal outcome using UAD in Preeclampsia.
Methods: This was a prospective cohort study in which 170 consecutively consenting women with preeclampsia were recruited. An UAD was done using Voluson P8 ultrasound. The pulsatility index, resistance index, systolic/diastole ratio. Reduced end diastolic flow, absent end diastolic flow and reversed end diastolic flow were measured. The participants were divided into two groups based on UAD indices findings. Both groups were followed up to determine their perinatal outcomes.The data was analyzed using SPSS version 20.0 for windows (IBM SPSS Inc, Chicago, IL, USA). Categorical variables were analyzed using Chi-Square (x^2) test and Fisher's exact test p<0.05 was considered statistically significant. Specificity, sensitivity, PPV and NPV were determined.
Results: The sensitivity, specificity, PPV, and NPV of umbilical artery Doppler in predicting adverse perinatal outcomes was 68.5%, 59.7%, 74.7%, and 52.1% respectively.
Conclusions: Although the use of UAD indices in this study showed modest predictive values for adverse perinatal outcome in preeclampsia, it's use should be combine with other methods of antenatal fetal surveillance to prevent adverse perinatal outcome.

Keywords: Umbilical artery, Doppler indices, Perinatal outcomes

INTRODUCTION

Preeclampsia is a pregnancy specific condition which occurs after the twentieth week of pregnancy in which hypertension with proteinuria develop in a woman who has been previously normotensive and non proteinuric. It is a multi-systemic disorder with both maternal and fetal manifestations, complicating 2-10% of all pregnancies globally.[1-5] Preeclampsia has been a major challenge to obstetric practice as it is one of the most common and dangerous complications of pregnancy associated with high maternal and perinatal morbidity and mortality especially in developing countries like Nigeria.[1,3,6] The prevalence of preeclampsia in Nigeria ranges between 2% and 16.7%.[7] The impaired uteroplacental perfusion caused by vascular abnormalities due to preeclampsia can be detected by Doppler ultrasound.[8] Doppler measurement is one of the most important conventional techniques for

assessing antenatal condition in preeclampsia due to its clinical applicability and non-invasiveness.[9,10] Doppler measurement of umbilical artery indices such as pulsatility index (PI), resistance index (RI), systolic/diastole (S/D) ratio and the Reduced end diastolic flow (EDF), absent end diastolic flow (EDF) and reversed end diastolic flow can be used in the evaluation of the fetus at risk of having adverse perinatal outcome in preeclampsia.[8,9,11]

The use of the umbilical artery Doppler has been and is still being investigated around the world as a useful, non-invasive tool to predict adverse perinatal outcome in preeclampsia. Several studies have shown its usefulness though with varying sensitivities and specificities.[8,9,12,13-20] More research in this area is therefore imperative to establish the usefulness of this investigation as a screening tool to predicting adverse perinatal outcomes in preeclampsia. More so, there is a paucity of prospective studies on UAD, in this part of the world, to investigate this very important screening test, for this prevalent problem. Furthermore, from previous studies there is no clear conclusion stating which of the Doppler indices was a better predictor of adverse perinatal outcome. The purpose of this study was to predict adverse perinatal outcome using umbilical artery Doppler in preeclampsia.

Aim and objectives

Aim of current study was to predict adverse perinatal outcome using umbilical artery Doppler in preeclampsia. Objectives of current study were to determine the incidence of abnormal umbilical artery Doppler findings in patients with preeclampsia, to determine the sensitivity and specificity of umbilical artery Doppler as a predictor of adverse perinatal outcome in patients with preeclampsia and to determine the positive predictive value and negative predictive value of umbilical artery Doppler as a predictor of adverse perinatal outcome in patients with preeclampsia.

METHODS

This was a prospective cohort study conducted in the department of obstetrics and gynaecology at the federal medical Centre, Makurdi between January to August, 2018. Ethical clearance was obtained from the ethical committee of the Federal Medical Centre, Makurdi. One hundred and seventy consecutive consenting pregnant women with singleton fetus at a gestational age of ≥ 28 weeks diagnosed of preeclampsia were recruited to participate in the study.

Inclusion criteria

All consenting pregnant women with singleton fetus at a gestational age of ≥ 28 weeks diagnosed of preeclampsia were included to participate in the study.

Exclusion criteria

All pregnant women with Preeclampsia < 28 weeks, normal pregnancy, gestational hypertension without proteinuria, chronic hypertension, intrauterine fetal death, multiple gestation, having a fetus with congenital abnormality, history of antepartum haemorrhage, smoking, hepatic disease, renal disease, systemic lupus erythematosus (SLE), and patient who declined consent were excluded from the study.

Doppler studies were done using Voluson P8 ultrasound with 3-5 MHz transabdominal probe developed and produced by GE health care LTD. With each patient in the supine position, umbilical artery was localized and sampled from a free-floating part of the cord. The waveforms obtained were optimized using the necessary knobs like wall filter, baseline and scale. The wave forms were recorded once there were equal wave of at least five consecutive pulsatile arterial wave form with all the crests at the same levels and also all the troughs at the same level. Umbilical artery Doppler were performed at least twice on each patient and the last Doppler before delivery was used for calculation of the indices. The following Doppler indices; pulsatility index (PI), resistance index (RI), systolic/diastole (S/D) ratio were measured and reduced end diastolic flow (EDF), absent end diastolic flow (EDF) and reversed end diastolic flow were also noted.

The values of S/D ratio ≥3.0, PI >0.85, and RI >0.60, presence of reduced EDF, absent EDF, and reversed EDF were considered as abnormal umbilical artery Doppler indices. The patients were divided into two groups (A and B) based on the second UAD indices findings (abnormal and normal). Those with normal umbilical artery Doppler indices were used as control (Group B). Both groups were followed up to determine their perinatal outcomes (adverse and normal). Those with abnormal umbilical artery Doppler indices were admitted and had other ultrasound findings determined including biophysical profile and treatment in preparation for delivery. Perinatal outcome determined include intrauterine growth restriction, intrauterine fetal death/ still birth, low birth weight (birth weight <2.5kg), prematurity, emergency caesarean section for fetal distress, five minutes APGAR score < 7, meconium stained liquor, requirement of special care baby unit (SCBU) admission, and early neonatal death. Those fetuses with any of the above perinatal parameters were labeled as poor or adverse outcome, while others were labeled as having good outcome.

Statistical analysis

The data was analyzed using statistical package for social sciences version 20.0 for windows (IBM SPSS Inc, Chicago, IL, USA). Quantitative variables were converted to categorical variables. Categorical variables were analyzed using Chi-Square (x^2) test and Fisher's exact test, p<0.05 and CI (if the interval does not include or cross the number one) were consider statistically significant. The

value of the umbilical artery Doppler indices as a screening tool in predicting adverse perinatal outcome was determined using specificity, sensitivity, positive predictive value (PPV) and negative predictive value (NPV).

RESULTS

Basic characteristics of study participants

Most (41.2%) of the study participants were within the age group of 26-30 years and few participants were below the age group of ≤20 years (6.5%) and above ≥40 years (4.1%). About sixty three percent of participants were multigravidae, 44.1% were multiparous, and 85.9% were booked. One hundred and seven (62.9%) participants had severe preeclampsia. The commonest mode of delivery among the study participants was caesarean section (50.6%).

Table 1: Basic characteristics of study participants (n=170).

Characteristic	N	%
Age group (years)		
≤20	11	6.5
21-25	17	10.0
26-30	70	41.2
31-35	46	27.1
36-40	19	11.2
≥41	7	4.1
Gravidity		
Primigravida	63	37.1
Multigravida	107	62.9
Parity		
Primipara	73	42.9
Multipara	75	44.1
Grandmultipara	22	13.0
Booking status		
Booked	146	85.9
Unbooked	24	14.1
Severity of preeclampsia		
Mild	63	62.9
Severe	107	37.1
Mode of delivery		
Spontaneousvaginal delivery	33	19.4
Induction of labour	49	28.8
Caesarean section	86	50.6

Incidence of abnormal umbilical artery Doppler findings

Ninety-nine (58.2%) participants had an abnormal umbilical artery Doppler. The incidence of abnormal umbilical artery PI, RI, and S/D ratio was 58.2%, 51.4%, and 41.8% respectively. The incidence of Reduced end diastolic flow, reversed end diastolic flow, and absent end

diastolic flow were seen in 34.7%, 8.2% and 4.1% of the participants respectively.

Umbilical artery Doppler indices and perinatal outcome

The comparison of individual umbilical artery indices with perinatal outcome. The difference in adverse perinatal outcomes in participants with normal compared to abnormal for the individual umbilical artery indices were statistically significant for the perinatal outcome.

Table 2: Incidence of abnormal umbilical artery Doppler findings (n=170).

Doppler findings	N	%
Umbilical artery Doppler		
Normal	71	41.8
Abnormal	99	58.2
PI		
Normal	71	41.8
Abnormal	99	58.2
RI		
Normal	78	45.9
Abnormal	92	54.1
SD ratio		
Normal	99	58.2
Abnormal	71	41.8
Reduced EDF		
Absent	111	65.3
Present	59	34.7
Absent EDF		
Absent	163	95.9
Present	7	4.1
Revered EDF		
Absent	156	91.8
Present	14	8.2

Comparison of Doppler findings with perinatal outcome to determine the screening value of umbilical artery Doppler

The sensitivity and specificity of umbilical artery Doppler in predicting adverse perinatal outcome was 68.5% and 59.7% respectively. The positive and negative predictive values were 74.7% and 52.1% respectively.

Comparison of the screening values of umbilical artery PI, RI and S/D ratio, reduced EDF, absent EDF, reversed EDF as predictors of adverse perinatal outcome

The umbilical artery Doppler PI was the most sensitive (68.5%) parameter in predicting adverse perinatal outcome compared to RI (64.8%) and S/D ratio (53.7%).

S/D ratio was the most specific (79.0%) parameter in predicting adverse perinatal outcome compared to RI

(64.5%) and PI (59.7%). S/D ratio and PI had the highest positive predictive value (81.7%) and negative predictive value (52.1%) respectively. Reduced EDF has sensitivity, specificity, PPV and NPV of 45.4%, 83.9%.83.1% and 46.8 respectively. Absent EDF and Reversed EDF are the least sensitive (5.6% and 12.0% respectively) umbilical artery indices.

Table 3: Umbilical artery Doppler indices and perinatal outcome.

| Umbilical artery Doppler Indices | Perinatal outcome | | P value[a] | CI |
	Abnormal N (%)	Normal N (%)		
PI				
Abnormal (N=99)	74 (74.7)	25 (25.3)	0.000	1.68-6.17
Normal (N=71)	34 (47.9)	37 (52.1)		
RI				
Abnormal (N=92)	70 (76.1)	22 (23.9)	0.000	1.74-6.43
Normal (N=78)	38 (48.7)	40 (51.3)		
S/D ratio				
Abnormal (N=71)	58 (81.7)	13 (18.3)	0.000	2.13-8.97
Normal (N=99)	50 (50.5)	49 (49.5)		
Reduced EDF				
Abnormal (N=59)	49 (83.1)	10 (16.9)	0.000	0.11-0.50
Normal (N=111)	59 (53.2)	52 (46.8)		
Absent EDF				
Abnormal (N=7)	6 (85.7)	1(14.3)	0.017	0.03-2.37
Normal (N=163)	102 (62.6)	61 (37.4)		
Reversed EDF				
Abnormal (N=14)	13 (92.9)	1 (7.1)	0.017	0.02-0.94
Normal (N=156)	95 (60.9)	61(39.1)		

CI = 95% confidence interval; [a]Chi-square test

Table 4: Comparison of Doppler findings with perinatal outcome to determine the screening value of umbilical artery Doppler.

| Parameters | | Perinatal outcome | | | Screening value | |
		Abnormal; N (%)	Normal; N (%)	Total; N (%)		
Doppler findings	Abnormal; N (%)	74[a] (74.7)	25[b] (25.3)	99[a+b] (100)	74.7%[a/(a+b)]	Positive predictive value
	Normal; N (%)	34[c] (47.9)	37[d] (52.1)	71[c+d] (100)	52.1%[d/(c+d)]	Negative predictive value
	Total; N (%)	108[a+c] (63.5)	62[b+d] (36.5)	170[a+b+c+d] (100)	-	-
Screening value	Sensitivity; %	68.5[a/(a+c)]	-	-	-	-
	Specificity; %	-	59.7[d/(b+d)]	-	-	-

[a]True positive (TP); [b]false positive (FP); [c]false negative (FN); [d]true negative (TN)

Table 5: Comparison of the screening values of umbilical artery PI, RI and S/D ratio, reduced EDF, Absent EDF, reversed EDF as predictors of adverse perinatal outcome.

Doppler test	Sensitivity %	Specificity %	Positive predictive value %	Negative predictive value %
PI	68.5	59.7	74.8	52.1
RI	64.8	64.5	76.1	51.3
S/D Ratio	53.7	79.0	81.7	49.5
Reduced EDF	45.4	83.9	83.1	46.8
Absent EDF	5.6	98.4	85.7	37.4
Reversed EDF	12.0	98.4	92.9	39.1

DISCUSSION

This study has demonstrated that most of the study participants was in the age group 26-30 (41.2%), multigravidae (62.9%) and multipara (44.1%), booked (85.9%), had severe preeclampsia (62.9%) and cesarean section (50.6%). The incidence of abnormal Doppler indices was 58.7%. The sensitivity, specificity, PPV, and NPV of UAD was 68.5%, 59.7%, 74.7%, and 52.1% respectively. Our findings in this study shows that the incidence of abnormal umbilical artery Doppler was 58.2%. The incidence of abnormal umbilical artery Doppler PI, RI, and S/D ratio was 58.2%, 51.4%, and 41.8% respectively. This was similar to studies by Laltthantluanga et al and Hazra et al who also found high incidence of abnormal umbilical artery Doppler indices of 58% and 76% respectively.[9,21] However, this was different from the studies done by Yadav et al, Mishra et al and Gaikwad et al, who found more incidence of normal umbilical artery indices of 54%, 64%, and 84.9% respectively.[12,18,20] The incidence of reduce end diastolic flow, absent end diastolic flow and reversed end diastolic flow was 34.7%, 4.1%, and 8.2% respectively. This was consistent with the findings by Mishra et al who also found an incidence of 30%, 10% and 6.7% for reduce end diastolic, absent end diastolic flow and reversed end diastolic flow respectively.[18] This was also similar to the study by Lalthantluanga et al who found an incidence of absent end diastolic flow and reversed end diastolic flow of 9% and 5% respectively, although they had a lower incidence of reduced end diastolic flow of 14%.[9] In this study, comparison of the Doppler findings with perinatal outcome to determine its value as a screening tool using, sensitivity, specificity, positive predictive values, and negative predictive values. Although, the findings in this study shows significant association between Doppler finding indices and perinatal outcomes, umbilical artery Doppler in this study shows modest sensitivity (68.5%), specificity (59.7%), positive predictive value (74.7%) and negative predictive value (52.1%). This suggest that umbilical artery Doppler has a role to play as a screening tool in predicting adverse perinatal outcome especially when use together with other forms of antenatal fetal surveillance like biophysical profile. This was in keeping with several studies.[9,12,13,15,20,22] For the individual umbilical artery Doppler indices, PI was the most useful umbilical artery indices (sensitive=68.5% specificity=59.7%, PPV=74.8% NPV=52.1%) when compared to RI (sensitivity=64.8%, specificity=64.5% PPV=76.1%, NPV=51.3%), S/D ratio (53.7% specificity=79.0% PPV=81.7%, NPV=49.5%). This suggests that that umbilical artery PI is a better predictor of adverse perinatal outcome in preeclampsia among the individual umbilical artery indices because it is the most sensitive of all the indices. This findings are in agreement with study by Yadav et al (PI, sensitivity=84.21%, specificity=93.54%, PPV=88.88%, NPV=90.62%; S/D ratio, sensitivity=80.64%, Specificity=88.54%, PPV=76.92%, NPV=90.62%; RI, sensitivity=77.35%, specificity=87.21%, PPV=73%, NPV=90.62%), who similarly found that umbilical artery PI was a better predictor of adverse perinatal outcome among the indices.[12] This was however different from the study by Padmini et al (RI, sensitivity=95.2%, specificity=79.66%, PPV=62.5%, NPV=97.91%; S/D ratio, sensitivity=86.96%, Specificity=77.2%, PPV= 60.6%, NPV=93.6%; PI, sensitivity=75%, specificity= 98.3%, PPV=93.3%, NPV=92.19%), who found umbilical artery RI as a better predictor of adverse perinatal outcome.[17] This present study was also not in keeping with the studies by Shah et al (S/D ratio, sensitivity=66.6%, specificity=45.4%, PPV=66.6%, NPV=45.4%; PI, sensitivity=50%, Specificity=59%, PPV=66.6%, NPV= 41.9%; RI, sensitivity=44.4%, specificity=81.8%, PPV= 80%, NPV=47.3%) and Gaikwad et al (S/D ratio, sensitivity=40.54%, specificity=89.86%, PPV=68.18%, NPV=73.81%; RI, sensitivity=37.83%, Specificity= 79.71%, PPV=50%, NPV=70.51%; PI, sensitivity= 29.73%, specificity=92.75%, PPV=68.75%, NPV= 71.11%), who both found S/D ratio as a better predictor of adverse perinatal outcome.[19,20]

Limitations

The limitations observed in this study is that normotensive participants were not used as controls in this present study this may be responsible for the modest predictive value of umbilical artery Doppler found in this study.

CONCLUSION

This present study has shown a high incidence of abnormal umbilical artery Doppler. Although there was a strong association between abnormal doppler findings and perinatal outcome, the sensitivity, specificity, PPV and NPV of the umbilical artery Doppler was modest in predicting adverse perinatal outcome and therefore from this study umbilical should not be use as a single tool but in combination with other methods of antenatal fetal surveillance in making clinical decision in high-risk pregnancy such as preeclampsia.

Recommendations

From this study it is recommended that umbilical artery Doppler should be used in combination with other methods of antenatal fetal surveillance in high-risk pregnancies especially in preeclampsia to enable appropriate and early decision making in the management of these patients to avoid adverse perinatal outcome. There is a need for more studies using Umbilical artery Doppler in predicting adverse pregnancy and perinatal outcomes in preeclampsia because there are few studies in our environment and need to compare results and make better policies as regards patient management. Also, normotensive patients should be used as controls in these studies.

Ethical approval: The study was approved by the Institutional Ethics Committee

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