ORIGINAL RESEARCH ARTICLE

Evaluation of Uterine Artery, Umbilical Artery and Fetal MCA in PIH in Predicting the Prenatal Outcome

V Krishnaveni[1], Nithish Kumar Yeslawath[2]

[1]Junior Resident, Department of Radiodiagnosis, [2]Professor, A 7 Staff Quarters, AVMC & H, Pondicherry -607402, India

Corresponding author: Dr. Nithish Kumar Yeslawath, Professor, A 7 Staff Quarters, AVMC &H, Pondicherry -607402, India

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A B S T R A C T

Introduction: Hypertension is the most common medical problem during pregnancy. It affects (maternal, fetal and neonatal morbidity and mortality in approximately) nearly 10-16% of pregnancies. Studies show the USG with Doppler have helped to revolutionize the study of vascular disturbances in various human diseases. It has also helped in understanding the vascular abnormalities during pregnancy, particularly high-risk pregnancies, hypertensive disorders of pregnancy and IUGR. Aim and Objectives: To assess the value of Doppler Ultrasound in predicting the perinatal outcome in patients with pregnancy induced hypertension.

Material and methods: It was a longitudinal follow up study conducted at department of Radio diagnosis, in pregnant women with Pregnancy induced hypertension of >26 weeks between the age of 19 years to 45 years. A total of 60 patients were included after obtaining the informed consent doppler analysis are done.

Results: A total of 60 pregnant women (age range 18-37 years; Mean age 26.20±4.23 years) with >27 weeks of pregnancy (range 27-38 weeks, mean POG 32.27±3.31 weeks) with hypertension Abnormal Doppler PI, RI and SD were found in 55%, 48.3% and 43.3% women respectively for umbilical artery; 30%, 95% and 70% women respectively for uterine artery and 30%, 28.3% and 33.3% women respectively for middle cerebral artery respectively. MCA abnormalities in general and umbilical artery SD abnormality in particular were highly specific about prediction of adverse outcomes

Conclusion: The findings of study showed that third trimester Color Doppler flowmetric studies of umbilical artery, uterine artery and middle cerebral artery were useful in prediction of adverse perinatal outcomes. MCA abnormalities in general and umbilical artery SD abnormality in particular were highly specific about prediction of adverse outcomes.

Keywords: Uterine Artery, Umbilical Artery, Fetal MCA, PIH, iPrenatal Outcome

INTRODUCTION

Hypertension, perhaps, is the most common medical problem during pregnancy. It affects (maternal, fetal and neonatal morbidity and mortality in approximately) nearly 10-16% of pregnancies[1,2,3]. International Society for the Study of Hypertension in Pregnancy (ISSHP) proposed the classification of hypertensive disorders during pregnancy. Hypertensive disorders had been classified as (i) Chronic, (ii) Gestational, (iii) Preeclampsia and (iv) Preeclampsia superimposed on chronic hypertension[4].

Among different hypertensive disorders of pregnancy, pregnancy induced hypertension holds the most important place with nearly prevalence rates ranging from 6-19.4% as reported by different workers across the globe[5,6].

Umesava & Kobashi (2017) presented the prevalence rates of hypertensive disorders, pregnancy induced hypertension, gestational hypertension and preeclampsia to be 5.2-8.2%, 4.1-19.4%, 1.8-4.4% and 0.29.2% reported by various workers across the globe. Variation in rate of prevalence in hypertensive disorder(s) among regions and races might be due to differences in socio-economic factors, culture, medical facilities and availability of medical facilities. Various workers had also studied the seasonal variability in prevalence rates of hypertensive disorders[7,8,9,10].

Doppler flowmetric studies could be performed non-invasively without the need of contrast agents or ionising radiation[11,12,13]

MATERIAL AND METHODS

It was a longitudinal follow up study conducted in tertiary care centre after approval from the institutional ethics committee. A total of 60 patients were included in the study. Pregnant women with pregnancy induced hypertension attending the antenatal clinic of Department of Obstetrics and Gynaecology, Aarupadai Veedu Medical College and Hospital, Puducherry with inclusion criteria of all antenatal women more than 26 weeks of gestation clinically diagnosed as pregnancy induced hypertension.

Method of data collection

All the women falling in sampling frame were enrolled in the study after obtaining informed consent and getting ethical approval from the Institutional Ethics Committee. At enrolment, the demographic profile (age, rural/urban status and religion) were noted. A thorough medical and personal history (smoking/ alcohol/ tobacco use) was obtained. Exposure to risk factors, if any, was also noted. Obstetric

history was obtained and history of obstetric complications was noted. Gestational age determination was based on the best estimate from last menstrual history and by USG or routine fetal biometry in the first trimester or early second trimester. All the women were subjected to Doppler waveform analysis on Color Doppler machine MINDRAY DC 8 / MINDRAY DC 80 with multi frequency curvilinear probe 3-5MHz. To use Doppler velocimetry, patients were first scanned in the routine fashion using B-mode. Then the vessels of interest were confirmed by color Doppler. The Doppler signal was then obtained by placing the Doppler gate directly over the vessel of interest. The flow velocity waveforms were obtained in periods of fetal inactivity and apnea. Doppler velocimetry was performed on umbilical artery, middle cerebral artery, vertebral artery and the ductus venosus close to transducer. Doppler velocimetry of the umbilical arteries was performed in a free floating loop of mid portion the umbilical cord away from the placental and fetal cord insertion.

STATISTICAL ANALYSIS

Statistical tools employed

"The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 21.0 statistical Analysis Software. The values were represented in Number (%) and Mean±SD.

SN	Characteristic	Statistic
1.	Maternal Age	
	≤20 Years 21-30 Years >30 Years Mean age±SD (Range) in years	4 (6.7%) 48 (80%) 8 (13.3%) 26.20±4.23 (18-37)
2.	Period of Gestation at presentation	
	27-32 weeks >32 weeks Mean POG±SD (Range) in weeks	34 (56.7%) 26 (43.3%) 32.27±3.31 (27-38)
3.	Gravida	
	G1 G2 G3 G4 Mean parity±SD (Range)	31 (51.7%) 17 (28.3%) 8 (13.3%) 4 (6.7%) 1.75±0.93 (1-4)

Table-1:

The following Statistical formulas were used:

1. **Mean**: To obtain the mean, the individual observations were first added together and then divided by the number of observation. The operation of adding together or summation is denoted by the sign.
2. **Standard Deviation**
3. **Chi square test:**
4. **Student 't'**
5. **Level of significance**: "p" is level of significance p <0.05Significant

RESULTS

Profile of Study Participants

On evaluating the performance of different Doppler flowmetric parameters for prediction of outcome NICU admission for more than 48 hours among PIH cases, for umbilical artery parameters PI had the maximum sensitivity (93.3%) while SD had maximum specificity (66.7%). The sensitivity and specificity of umbilical artery PI, RI and SD were 93.3% & 57.8%, 86.7% 64.4% and 73.3% & 66.7% respectively. Accuracy of PI, RI and SD was 66.7%, 70% and 68.3% respectively.

For uterine artery parameters, RI had maximum sensitivity (100%) but a very poor specificity (6.7%). The sensitivity & specificity of PI and SD were 26.7% & 68.9% and 60.0% & 26.7% respectively.

For all the MCA parameters, the sensitivity was 60% while specificity ranged from 75.6% (SD) to 82.2% (RI). Accuracy of MCA PI, RI and SD in prediction of NICU admission >48 hrs was 75.0%, 76.7% and 71.7% respectively.

For composite adverse perinatal outcome, among different umbilical artery parameters, the sensitivity & specificity of PI, RI and SD was 73% & 73.9%, 64.9% & 78.3% and 62.2% & 87.0% respectively. The accuracy of different parameters ranged from 70% (RI) to 73.3% (73.3)

DISCUSSION

Hypertension during pregnancy is a cause of concern as it affects the pregnancy outcome bringing about a number of alterations in normal course of pregnancy like intrauterine growth restriction[11], maternal and neonatal morbidity and mortality[12]. According to some authors, placenta is the root cause of hypertension during pregnancy, particularly preeclampsia[13]. Hypertension during pregnancy is an outcome of increased vasoconstriction, reduced vasodilation,

SN	Parameter (Cut-off for abnormality)	Minimum	Maximum	Mean±SD	No. with abnormal values
1.	PI (>1.42)	1.09	1.75	1.42±0.15	33 (55.0%)
2.	RI (>0.72)	0.38	0.81	0.67±0.12	29 (48.3%)
3.	SD (>3.5)	1.87	4.99	3.28±0.80	26 (43.3%)

Table-2: Outcome of Umbilical Artery Doppler Flowmetry Studies in PIH omen with gestational age >26 weeks

SN	Parameter (Cut-off for abnormality)	Minimum	Maximum	Mean±SD	No. with abnormal values
1.	PI (>1.50)	0.94	1.90	1.30±0.30	18 (30.0%)
2.	RI (>0.64)	0.64	0.96	0.77±0.10	57 (95.0%)
3.	SD (>1.93)	1.50	3.90	2.23±0.48	42 (70.0%)

Table-3: Outcome of Uterine Artery Doppler Flowmetry Studies in PIH women with gestational age >26 weeks

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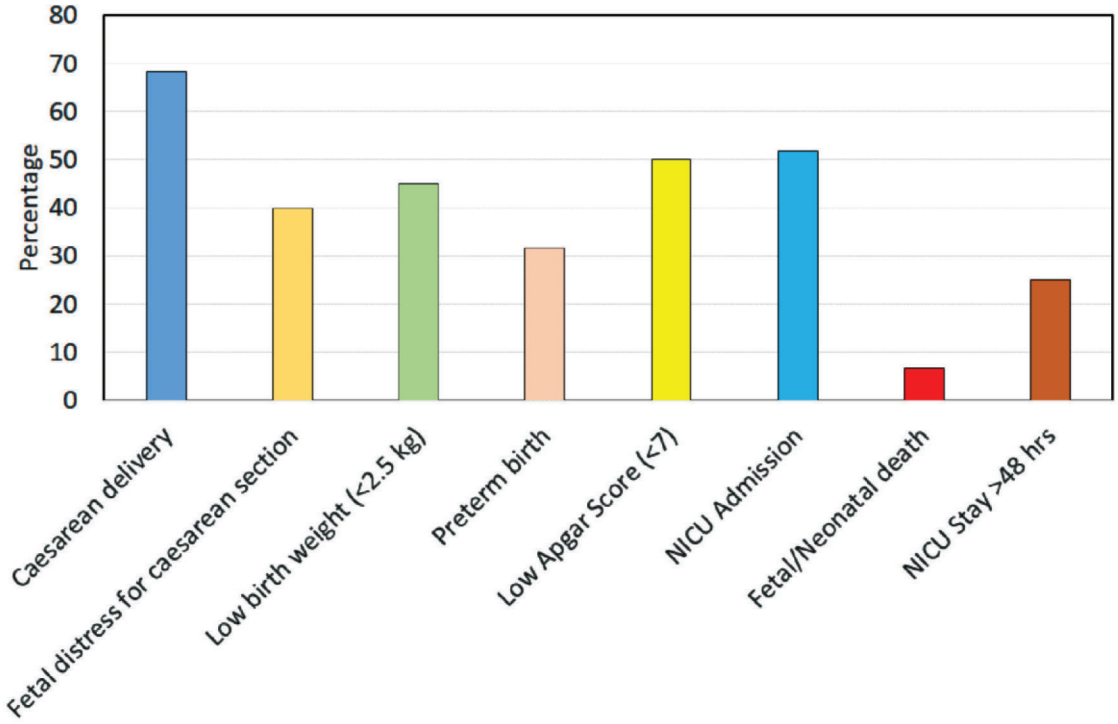

Figure-1: Pregnancy Outcome Profile of PIH Cases enrolled in the study

SN	Parameter (Cut-off for abnormality)	Minimum	Maximum	Mean±SD	No. with abnormal values
1.	PI (<1.50)	1.32	1.98	1.60±0.14	18 (30.0%)
2.	RI (<0.59)	0.42	0.87	0.68±0.12	17 (28.3%)
3.	SD (<4)	2.45	5.39	4.20±0.70	20 (33.3%)

Table-4: Outcome of Middle Cerebral Artery Doppler Flowmetry Studies in PIH women with gestational age >26 weeks

SN	Outcome	No. of cases	Percentage
1.	Caesarean delivery	41	68.3
2.	Fetal distress for caesarean section	24	40.0
3.	Low birth weight (<2.5 kg)	27	45.0
4.	Preterm birth	19	31.7
5.	Low Apgar Score (<7)	30	50.0
6.	NICU Admission	31	51.7
7.	Fetal/Neonatal death	4	6.7
8.	NICU Stay >48 hrs	15	25.0
9.	Composite adverse outcome (Fetal Distress/Preterm birth/Low birth weight/NICU admission/ Fetal/Neonatal death)	37	61.7

Table-5: Pregnancy Outcome Profile of PIH Cases enrolled in the study

and imbalance between endothelium- derived constrictor and dilatory products in systemic maternal arteries[14]. These vascular changes in mother also affect the feto maternal vascular pattern. Hypertension during pregnancy also causes placental insufficiency. To counter the placental insufficiency fetal responses manifest in terms of redistribution of the arterial circulation in such a way so as to maintain adequate oxygenation of brain and heart which in effect results in changed flow velocity in different vessels[15]. It is where the role of Doppler flowmetry comes into picture to help in studying the abnormal flow pattern in different fetal vessels in order to assess their possible impact on perinatal outcome. PI and RI had sensitivity & specificity of 73.3% & 63.3% and 66.7% & 70% respectively. However, Ayyuba *et al.*[16] in their study evaluating usefulness of umbilical artery RI for prediction of adverse outcomes in PIH and preeclampsia women found the sensitivity & specificity of umbilical artery RI for outcomes preterm birth, low Apgar score, low birth weight and early neonatal death to be 50% & 41.38%, 0% & 40%, 66.7% & 42.9% and 0% & 40% respectively in PIH and 66.7% & 50%, 100% & 50% and 66.7% & 50% for outcomes preterm birth, low Apgar and low birth weight respectively in preeclamptic women, thus showing the limited usefulness of umbilical artery RI for prediction of adverse outcomes particularly in PIH group. In present study, the study population was not differentiated into PIH or preeclamptic

SN	Parameter	TP	FP	FN	FN	Predictive Efficacy (%)					
						Sens	Spec	PPV	NPV	Accuracy	J-Index
		(i) Umbilical Artery Parameters									
1.	UmbA PI	31	2	10	17	75.6	89.5	93.9	63.0	80.0	65.1
2.	UmbA RI	28	1	13	18	68.3	94.7	96.6	58.1	76.7	63.0
3.	UmbA SD	25	1	16	18	61.0	94.7	96.2	52.9	71.7	55.7
		(ii) Uterine Artery Parameters									
1.	UtA PI	10	8	31	11	24.4	57.9	55.6	26.2	35.0	-17.7
2.	UtA RI	41	16	0	3	100	15.8	71.9	100	73.3	15.8
3.	UtA SD	25	17	16	2	61.0	10.5	59.5	11.1	45.0	-28.5
		(iii) Middle Cerebral Artery Parameters									
1.	MCA PI	18	0	23	19	43.9	100	100	45.2	61.7	43.9
2.	MCA RI	17	0	24	19	41.5	100	100	44.2	60.0	41.5
3.	MCA SD	19	1	22	18	46.3	94.7	95.0	45.0	61.7	41.0
J-Index = Youden‟s Index											

Table-6: Role of different Doppler flowmetric parameters in prediction of different pregnancy outcomes (a) Caesarean Delivery (n=41)

SN	Parameter	TP	FP	FN	TN	Predictive Efficacy (%)					
						Sens	Spec	PPV	NPV	Accuracy	J-Index
		(i) Umbilical Artery Parameters									
1.	UmbA PI	14	19	1	26	93.3	57.8	42.4	96.3	66.7	51.1
2.	UmbA RI	13	16	2	29	86.7	64.4	44.8	93.5	70.0	51.1
3.	UmbA SD	11	15	4	30	73.3	66.7	42.3	88.2	68.3	40.0
		(ii) Uterine Artery Parameters									
1.	UtA PI	4	14	11	31	26.7	68.9	22.2	73.8	58.3	-4.4
2.	UtA RI	15	42	0	3	100	6.7	26.3	100	30.0	6.7
3.	UtA SD	9	33	6	12	60.0	26.7	21.4	66.7	35.0	-13.3
		(iii) Middle Cerebral Artery Parameters									
1.	MCA PI	9	9	6	36	60.0	80.0	50.0	85.7	75.0	40.0
2.	MCA RI	9	8	6	37	60.0	82.2	52.9	86.0	76.7	42.2
3.	MCA SD	9	11	6	34	60.0	75.6	45.0	85.0	71.7	35.6
J-Index = Youden‟s Index											

Table-7: Role of different Doppler flowmetric parameters in prediction of different pregnancy outcomes (g) NICU Stay >48 hrs (n=15)

group yet we found that umbilical artery had only a limited usefulness for specific outcomes like caesarean delivery and longer duration of NICU stay.

The vascular supply from placenta to fetus is maintained through umbilical cord. Umbilical cord is considered to be the lifeline of the fetus during pregnancy. It holds one vein (umbilical vein) and two arteries (umbilical arteries). Umbilical vessels hold an important place in establishing the fetoplacental circulation. Umbilical arteries transport deoxygenated and nutrient-depleted fetal blood from the placenta to fetus. On the other hand, umbilical vein transports fresh oxygenated and nutrient-rich blood from the fetus to the placenta[17].

Limitation of the study

This study was conducted at a single centric hospital with small sample size. The study has the potential to be conducted among larger population and at multiple settings of hospital to assess the utility of the method and benefit to the patients.

CONCLUSION

The findings of study showed that third trimester Color Doppler flowmetric studies of umbilical artery, uterine artery and middle cerebral artery were useful in prediction of adverse perinatal outcomes. MCA abnormalities in general and umbilical artery SD abnormality in particular were highly specific about prediction of adverse outcomes. Though uterine artery RI was highly sensitive yet it did not have adequate specificity. The present study was carried out in a high risk population with a high possibility of deranged Doppler parameters hence there was a high proportion of abnormal Doppler findings based on previously reported cut-off values. Further studies with a larger sample size are recommended to derive newer cut-off values specific to high risk pregnant women

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