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RESEARCH ARTICLE

ROLE OF THIRD TRIMESTER DESCENDING FETAL AORTA (DFA) COLOR DOPPLER FLOWMETRIC ASSESSMENT FOR PREDICTION OF IUGR IN PREGNANCIES

Sachin Khanduri, Anshita Singh, Amit Mishra , Smriti Deswal, Tarim Usmani and Daraksha Ekta

Department of radiodiagnosis, ground floor Era's Lucknow Medical College and hospital, Sarfarzganj, Hardoi Road Lucknow, Uttar Pradesh- 226003, India

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ABSTRACT

Purpose: To evaluate the third trimester descending fetal aorta Doppler flowmetric assessment for prediction of IUGR in pregnancies complicated by hypertension.

Methodology: A total of 52 women aged 20 to 33 years. (Mean age 27.6 years) attending the antenatal clinic in the Department of Obstetrics and Gynecology, Era's Lucknow Medical College, Lucknow with pregnancy induced hypertension diagnosed after 26 weeks of gestation were included in the assessment after 28 weeks of gestation. Color Doppler flowmetric studies were carried out for descending fetal aorta (PI, RI, S/D ratio and EDV) at two visits (28-32 weeks and 32-36 weeks). All the pregnancies were followed up till delivery. The focused outcome was IUGR defined as Ponderal index of less than the 10th percentile for gestational age. Data was analyzed using Independent samples't'-test through SPSS version 20.0. A 'p' value less than 0.05 has been considered to be indicative of a significant association.

Results: IUGR rate was 71.2% (n=37). Mean PI, RI, and S/D ratio values at both visits were significantly higher in IUGR group ($p<0.001$) whereas mean EDV values were significantly lower in IUGR group as compared to no IUGR group ($p<0.001$). Among different parameters studied, EDV had the maximum sensitivity and specificity. EDV <7.6 cm/s was found to have a sensitivity and specificity of 94.6% and 93.3% at first visit and 100% and 93.3% at second visit.

Conclusion: Third trimester DFA Color Doppler assessment was highly useful predictor of IUGR in pregnancies complicated by hypertension.

INTRODUCTION

Hypertension is the most common medical disorder during pregnancy[1]. Approximately 70% of women diagnosed with hypertension during pregnancy have gestational hypertension–preeclampsia. It is a significant cause of fetal growth restriction, preterm delivery, increased cesarean rate, placenta abruption, placental infarction and other maternal and neonatal morbidity and mortality[2-6]. Intrauterine growth restriction (IUGR) is one of the major complications of maternal hypertension during pregnancy[7,8]. Both IUGR and preeclampsia are reportedly related with placental insufficiency, thus sharing the link between two.

Although preliminary approach to diagnosis of IUGR is based on clinical diagnosis only, however, with the advent of imaging tools such as ultrasound and color Doppler imaging, a quantum leap has taken place in the direction of diagnosis and detection of IUGR in early fetal life. Today these imaging studies help in early diagnosis, detection and management of IUGR and help to reduce the neonatal, infancy and probably adulthood complications in life. However, with the emergence of new technology and identification of new predictive markers, more and more improvisations are taking place that have helped to increase the diagnostic efficacy and accuracy of these predictive markers. It is essential that with the emergence of new markers, a re-evaluation of their performance should be done in view of traditionally used markers in order to find out which of these markers can be utilized at different stages of fetal life.

A number of indices based on Color Doppler Flowmetry have been proposed to evaluate the adverse fetal outcome in an ongoing pregnancy, some of these include pulsatility index (PI), resistive index (RI) and SD (systolic-diastolic) ratio of the uterine artery (UtA), umbilical artery (UmA), middle cerebral artery (MCA), renal artery (RA), cerebro-umbilical (C/U) ratio and descending fetal aorta in predicting adverse fetal outcome[9-19] with varying predictive efficacy for different perinatal outcomes.

Descending fetal aorta (DFA), is the continuation of the thoracic aorta that begins at the aortic hiatus of the diaphragm at the level of T12, descends within the retroperitoneal space, and terminates as the aortic bifurcation by dividing into the right and left common iliac arteries[20]. The blood flow estimations in DFA have been shown to provide useful information about fetal growth and well-being[21,22]. Despite its usefulness in earlier studies, it has not been fully explored for its predictive role in estimation of IUGR. In present study, we made an attempt to study the usefulness of Color Doppler flow metric assessment of DFA in a high risk population in pregnancies complicated by hypertension for prediction of IUGR.

METHOD

A total of 52 pregnant women aged 20 to 33 years (mean age 27.6 years) attending the antenatal clinic in the Department of Obstetrics and Gynecology, Era's Lucknow Medical College, Lucknow with pregnancy induced hypertension diagnosed after 26 weeks of gestation were included in the assessment after 28 weeks of gestation. Women with chronic hypertension and those with intrauterine death at the time of first Doppler examination were excluded from the assessment. After a clinical work-up for fetal well being, All the patients were subjected to Doppler waveform analysis on Color Doppler machine Voluson P8-GE using 3.5 MHz probe between 28-32 weeks of gestation. 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.

Descending fetal aorta was identified at the lower thoracic level just above the diaphragm, with angle of insonation of the Doppler beam below 45°. Doppler sample gate was placed at the point of maximum color brightness and flow velocity waveform was recorded (Fig. 1).

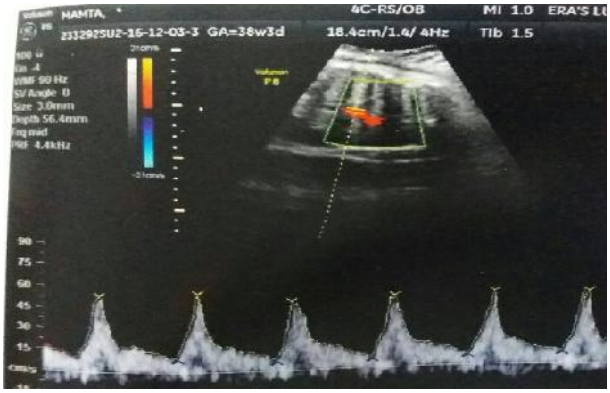


Figure Showing normal waveform of Descending Fetal Aorta in third trimester measured at the level of diaphragm

End-diastolic velocity, pulsatility index (PI), resistance index (RI) and S/D ratio were noted. The cut-off values for Descending fetal aorta were derived from the study of Bahlmann *et al.* (2001)[23] who projected cut-off values for PI and RI to be >1.87 and >0.79. For S/D ratio, 95th percentile (equivalent to >6) value as projected by Cameron *et al.* (1988)[24]. For descending fetal aorta, end diastolic velocity was also chosen as a predictor, for which cut-off value was derived from the study of Balhmann *et al.* (2001)[23]. EDV value <7.6 cm/s was considered to be abnormal.

Patients were again followed up between 32-36 weeks of gestation. A repeat Doppler evaluation was made at this interval. After delivery, birth weight (immediately within 6 hours) was measured on electronic weighing machine (machine's lower limit of measurement is less than 10 gm) with Apgar's score measured after 5 minutes of birth. Baby anthropometry *i.e.* length, head circumference, abdominal circumference, upper segment and lower segment ratio were also measured. Ponderal index was calculated using the following formula:

$$\text{Ponderal Index} = (\text{Birth weight in gms}) / (\text{Crown-heel length in cms})^3 \times 100$$

Neonates with a Ponderal index of less than the 10th percentile for gestational age are defined as growth restricted[25]. This parameter is usually less than 2 in asymmetrical IUGR and 2 or more in symmetrical IUGR[26].

The data so collected was subjected to statistical analysis. Data was analyzed using Statistical Package for Social Sciences (SPSS) version 20.0. Independent samples 't' and chi-square tests were used to compare the data. Diagnostic efficacy was expressed in terms of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy.

RESULTS

IUGR was confirmed in 37 (71.14%) of cases.

At visit 1, DFA PI of Group I (IUGR) (2.25±0.40) was found to be elevated as compared to Group II (1.74±0.27) and this difference was found to be statistically significant. Similarly, DFA RI of Group I (0.88±0.09) was found to be statistically significantly elevated as compared to Group II (0.72±0.11). DFA S/D of Group I (6.48±0.51) was found to be higher than Group II (5.22±0.81) and this difference was found to be statistically significant. DFA EDV of Group I (6.74±0.71) was found to be statistically significantly lower than that of Group II (13.23±2.51). At visit 2, DFA PI of Group I (IUGR) (2.40±0.46) was found to be elevated as compared to Group II (1.81±0.33) and this difference was found to be statistically significant. Similarly, DFA RI of Group I (0.93±0.13) was found to be statistically significantly elevated as compared to Group II (0.74±0.12). Umbilical artery S/D of Group I (6.65±0.55) was found to be higher than Group II (5.33±0.81) and this difference was found to be statistically significant. DFA EDV of Group I (6.15±0.76). was found to be statistically significantly lower than that of Group II (15.36±3.03) (Table 1).

Table 1 Distribution of Cases according to Outcome

SN	Group	Outcome	No. of cases	Percentage
1.	I	IUGR confirmed on delivery	37	71.15
2.	II	No IUGR on delivery	15	28.85

Using a cut off PI >1.9 for Descending Fetal Artery Sensitivity, Specificity, PPV, NPV and diagnostic accuracy at visit 1 were 94.6%, 86.7%, 94.6%, 86.7% and 92.3% respectively. At visit 2 using same cut off no change in Sensitivity, Specificity, PPV, NPV and diagnostic accuracy was observed. Using a cut off RI >0.79 for Descending Fetal Artery Sensitivity, Specificity, PPV, NPV and diagnostic accuracy at visit 1 were 91.9%, 86.7%, 94.4%, 81.3% and

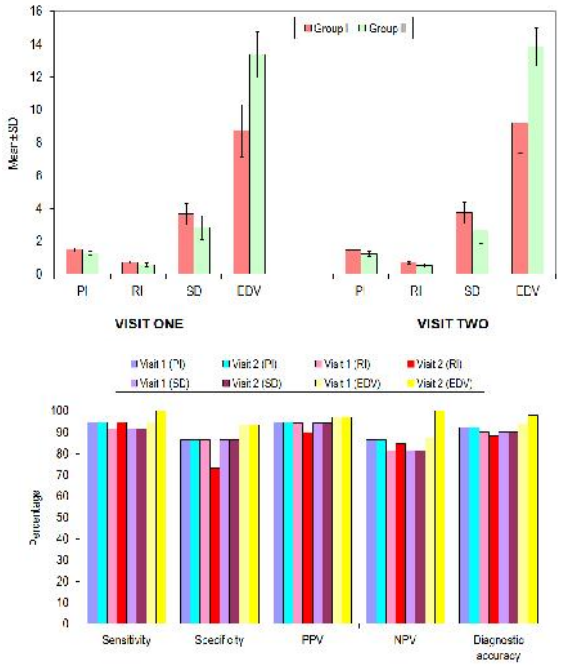
90.4% respectively. At visit 2 using same cut off Sensitivity, Specificity, PPV, NPV and diagnostic accuracy were 94.6%, 73.3%, 89.7%, 84.6% and 88.5%. Using a cut off S/D >6 for Descending Fetal Aorta Sensitivity, Specificity, PPV, NPV and diagnostic accuracy at visit 1 were 91.9%, 86.7%, 94.4%, 81.3% and 90.4% respectively. At visit 2 using same cut off no change in Sensitivity, Specificity, PPV, NPV and diagnostic accuracy were observed. Using a cut off EDV <7.6 cm/s for Descending Fetal Aorta Sensitivity, Specificity, PPV, NPV and diagnostic accuracy at visit 1 were 94.6%, 93.3%, 97.2%, 87.5% and 94.2% respectively. At visit 2 using same cut off Sensitivity, Specificity, PPV, NPV and diagnostic accuracy were 100%, 93.3%, 97.4%, 100% and 98.1% respectively (Table 2).

Table 2 Evaluation of DFA by Color Doppler of Study Population at different gestational Age

	IUGR (n=37)		No IUGR (n=15)		"t"	"p"
	Mean	SD	Mean	SD		
Visit 1						
PI	2.25	0.40	1.74	0.27	4.51	<0.001
RI	0.88	0.09	0.72	0.11	5.75	<0.001
S/D	6.48	0.51	5.22	0.81	6.80	<0.001
EDV	6.74	0.71	13.23	2.51	14.52	<0.001
Visit 2						
PI	2.40	0.46	1.81	0.33	4.52	<0.001
RI	0.93	0.13	0.74	0.12	5.03	<0.001
S/D	6.65	0.55	5.33	0.81	6.82	<0.001
EDV	6.15	0.76	15.36	3.03	17.40	<0.001

Table 3 Evaluation of Descending Fetal Artery Parameters at different visits

SN	Visit No.	IUGR (n=37)		No IUGR (n=15)		Sens	Spec	PPV	NPV	Accuracy
		+ve	-ve	+ve	-ve					
PI > 1.9										
1.	Visit 1	35	2	2	13	94.6	86.7	94.6	86.7	92.3
2.	Visit 2	35	2	2	13	94.6	86.7	94.6	86.7	92.3
RI > 0.79										
1.	Visit 1	34	3	2	13	91.9	86.7	94.4	81.3	90.4
2.	Visit 2	35	2	4	11	94.6	73.3	89.7	84.6	88.5
S/D > 6										
1.	Visit 1	34	3	2	13	91.9	86.7	94.4	81.3	90.4
2.	Visit 2	34	3	2	13	91.9	86.7	94.4	81.3	90.4
EDV <7.6 cm/s										
1.	Visit 1	35	2	1	14	94.6	93.3	97.2	87.5	94.2
2.	Visit 2	37	0	1	14	100	93.3	97.4	100.0	98.1



DISCUSSION

The present study focused on the predictive role of DFA Doppler flowmetric studies for the outcome fetal growth restriction. In present study, a total of 37 out of 52 pregnancies culminated into fetal growth restriction. Thus the prevalence of IUGR in present study was 71.2%. The IUGR rate in PIH pregnancies has been reported to vary substantially. In a study by Yücesoy *et al.* (2005)[27] spanned over 5,155 deliveries, out of 255 cases, the incidence of IUGR was observed to be 29.4%. However, Srinivas *et al.* (2009)[28] in their study, taking 10th percentile as the criteria for diagnosis of IUGR found IUGR rate to be 38% in mild preeclampsia and 82% in severe preeclampsia cases. PIH affects the placental sufficiency which in turn restricts the fetal growth. Owing to PIH, the fetal growth is jeopardized and the fetal outcome is adverse in a large proportion of cases. In a similar study, Meshram *et al.* (2014)[29], though reported the rate of IUGR to be only 17% yet reported perinatal death rate in as many as 28.7% of cases. The high IUGR rate in present study could be justified to a certain extent owing to the strict inclusion criteria of study.

Measurements of fetal descending aortic blood flow is considered to be important in assessing placental function and fetal well-being. Velocity waveform of descending fetal aorta represents summation of blood flow as well as resistance to abdominal organs and placenta. However, in recent years it is one of the less studied artery[15,18] and as such its evaluation of its role in IUGR has been studied rarely. In present study, we focused on the pulsatility index, resistance index, S/D ratio and end diastolic velocity(flow) of descending fetal aorta for their predictive value in determining IUGR among pregnancies complicated by hypertension. As previous work on this issue with specific reference to IUGR is less, hence we adopted the cut-off values from different sources based on lower percentiles of normograms. For end-diastolic value we adopted the policy of studying it in continuous quantitative terms rather than studying in terms of absent/reverse flow.

For all the four parameters, mean values showed a significant difference between IUGR and non-IUGR cases at both the visits, thus indicating that these parameters have a possible discriminant role. All the four parameters showed a high efficiency with diagnostic accuracy ranging from 88.5% (visit 2 RI) to 98.1% (visit 2 EDV). One of the encouraging findings was the high sensitivity value for all the parameters. It ranged from 91.9% (RI at first and second visits) to 100% (second visit EDV). Among different parameters studied, end diastolic velocity was found to have both high sensitivity as well as specificity at both the visits - (94.6% and 93.3% at first visit and 100% and 93.3% at second visit).

Role of end-diastolic velocity in terms of continuous values has not been studied so far in literature. It has been studied in terms of absent/reverse flow only[18]. However, similar to present study, Laurin *et al.* (1987)[30] found blood flow rate to have an accuracy as high as 93% in determination of IUGR, a finding close to the observations made in present study.

Similar to present study where pulsatility index was found to be 94.6% sensitive and 86.7% specific on visits 1 and 2 at a cut off value of >1.9, Okagaki *et al.* (1994)[31] using variable cut-off levels reported a sensitivity rate ranging from 62% to 88%. Rozpravka *et al.* (2004)[32] in their study made surveillance for IUGR in high risk pregnancies using PI and RI of descending fetal aorta and was able to detect IUGR in

52.6% of high risk pregnancies complicated by hypertension. However, they did not validate the findings clinically. Considering the IUGR rate in high risk pregnancies to be quite high risk pregnancies (71.2% in present study), their attempt seems to have a high diagnostic value. Descending aorta PI is related to fetal heart rate. Near term different values of PI are found in different fetal behavioral states. In fetuses with retarded growth and in fetuses at distress, characteristic changes of the aortic velocity waveform have been reported by several researchers: the end-diastolic velocity diminishes and disappears, and in extreme cases a brief reversal of flow in diastole was observed[33]. In present study, we focused not on extreme cases but on IUGR and instead of making absent/reverse flow as the criteria used continuous end diastolic velocity as the criteria and found it to be useful in both early and late third trimester pregnancies complicated by hypertension.

The findings of present study were encouraging and highlighted the role of third trimester Doppler flow studies in prediction of fetal outcome in pregnancies complicated by hypertension. The role of Doppler flow studies in prediction of outcome at different trimesters in uncomplicated and complicated studies has been studied extensively in various perspectives. The findings of present study must be viewed in context of applicability of Doppler flowmetric studies in a high risk pregnancy group focused towards adverse fetal outcome in terms of fetal growth restriction. The present study identified end diastolic velocity of descending fetal aorta to be of value in evaluating the fetal restriction and for the first time tried to evaluate them in continuous rather than categorical terms, thus widening the scope of their usefulness in fetal outcomes other than extreme outcomes such as fetal/ perinatal death. Being a raw tool rather than a modified ratio such as PI, RI or S/D ratio its usefulness could be varied in different contexts and in different population groups and needs further exploration for which further studies are recommended.

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