

COLOUR DOPPLER EVALUATION OF UTERINE ARTERY AND MIDDLE CEREBRAL ARTERY IN INTRAUTERINE FETAL GROWTH ASSESEMENT AND ITS PROGNOSTIC SIGNIFICANCEJ. S. Sikarwar¹, Amit Jain², Ritu Ashok Sonnad³**HOW TO CITE THIS ARTICLE:**

J. S. Sikarwar, Amit Jain, Ritu Ashok Sonnad. "Colour Doppler Evaluation of Uterine Artery and Middle Cerebral Artery in Intrauterine Fetal Growth Assesement and its Prognostic Significance". Journal of Evolution of Medical and Dental Sciences 2015; Vol. 4, Issue 18, March 02; Page: 3083-3092, DOI: 10.14260/jemds/2015/448

ABSTRACT: AIMS: To evaluate the role of colour doppler in assessment of intrauterine fetal growth by studying vascular resistance patterns. To evaluate the diagnostic accuracy of uterine artery and middle cerebral artery doppler indices as predictors of perinatal outcome in clinically suspected IUGR pregnancies to determine its role in timely management. **MATERIALS AND METHODS:** The study was conducted in department of radiodiagnosis in Gajra raja medical college, Gwalior in a period of 1 year, the study included all antenatal women after 24 weeks and follow up done at 30 weeks till term. Uterine artery and MCA Doppler indices were calculated. **RESULTS:** out of 90 patients all after 24 weeks gestational age included in the study and later followed. Total 36 examinations in between 24-30 weeks and 120 examinations in between 31-36 weeks. Our study confirmed that the uterine artery PI has the best diagnostic accuracy of 83.33% in between 24-30 weeks and MCA PI had best diagnostic accuracy of 84% between 31-36 weeks. Total 28 had adverse perinatal outcome with 7 deaths and 21 live births and all had abnormal Doppler indices. In uterine artery, RI value at which maximum fetuses had adverse outcome is near 1(>0.7 abnormal) whereas PI value at which maximum foetuses had adverse perinatal outcome was 1.9 (>1.4 abnormal). Adverse outcome including the deaths were observed in MCA PI value below 1.2 whereas adverse outcome including deaths were observed in MCA S/D ratio at value below 2.2(<3 abnormal). The results were correlated with parameters of fetal outcome. **CONCLUSION:** In suspected IUGR, uterine artery PI proved to be a better predictor in early weeks of pregnancy than uterine artery RI and diastolic notch and middle cerebral artery Doppler parameters. Best results are obtained when we use MCA PI, which is more sensitive in detecting IUGR in later weeks of gestation from 31-36 weeks rather than umbilical artery and uterine artery and the diagnostic accuracy of the middle cerebral artery is maximum between 31-36 weeks.

KEYWORDS: Intrauterine growth retardation, pulsatility index, umbilical artery pulsatility index, middle cerebral artery pulsatility index, systolic to diastolic ratio.

INTRODUCTION: Placental insufficiency, whether primary or secondary to maternal factors such as hypertension, poor nutrition, etc., is the most common cause of intrauterine growth retardation (IUGR), which is an important obstetric problem on account of the high associated perinatal mortality and morbidity. It is essential to recognize placental insufficiency early so that its hazards can be reduced, if not prevented.

Doppler USG enables a better understanding of the hemodynamic changes and has therefore become one of the most important clinical tools for fetomaternal surveillance in high-risk pregnancies. It can be credited with causing a significant decrease in perinatal mortality and morbidity. The purpose of our study was to evaluate the usefulness of the pulsatility index (PI) and

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(RI) and diastolic notch in uterine artery and (PI) and S/D ratio of the middle cerebral artery (MCA), in the diagnosis of those intrauterine growth restricted fetuses and in the prediction of perinatal outcome.

MATERIAL AND METHOD: Data for the study was collected from patients attending the department of Radiodiagnosis, referred by Department of Obstetrics and Gynecology at our college.

Study Design: Prospective study for one year.

Work Plane: Department of Radiodiagnosis G.R. Medical College & Jayarogya Hospital, Gwalior.

Inclusion criteria:

- i) All singleton antenatal women (at 24 weeks).
- ii) Females with pregnancy confirmed by first trimester ultrasound by CRL or BPD or with known LMP.

Exclusion Criteria:

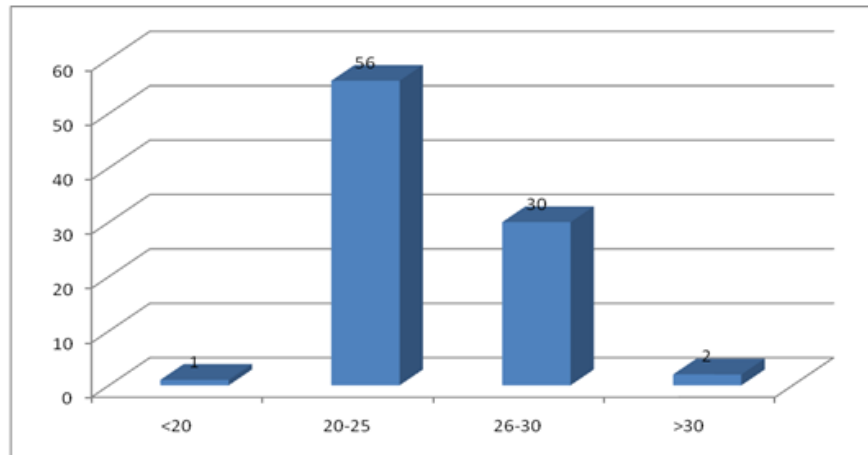
- i) All antenatal women less than 24 weeks.
- ii) All subjects with history of fetuses with congenital anomalies, multiple pregnancies rupture of membranes, active labour.

STUDY GROUP: All antenatal women at 24 weeks fulfilling inclusion criteria in department of radiodiagnosis, G.R. Medical College Gwalior for colour Doppler evaluation of intrauterine fetal growth assessment. Doppler US evaluation was performed following a detailed clinical history and US biometry. Subject will be considered cases if fetus is diagnosed with intrauterine growth restriction based on grey scale ultrasound and subsequent Doppler ultrasound will be performed. Follow up doppler at 30 weeks and at term will be done if clinically indicated to determine a favorable or worsening trend in Doppler Indices. Prospective study of 90 antenatal patients was done after considering the inclusion and exclusion criteria. Out of these 90 patients 44 patients were considered for follow up out of which 23 patients were again followed up. Total ultrasound examination done was 156 in 90 patients out of whom 36 examinations were between 26-30 weeks and 120 examinations between 31-36 weeks, accordingly. Flow velocity waveforms of the uterine, umbilical, middle cerebral artery were obtained from all 156 total examinations in 90 patients and analyzed. The uterine artery RI > 0.7 and uterine artery PI value >1.4 and presence of diastolic notch were considered abnormal. The MCA pulsatility index was considered abnormal if the value was below the 5th percentile for the gestational age reference value PI <1.45 and S/D ratio <3.

Data thus obtained was subjected to standard statistical analysis.

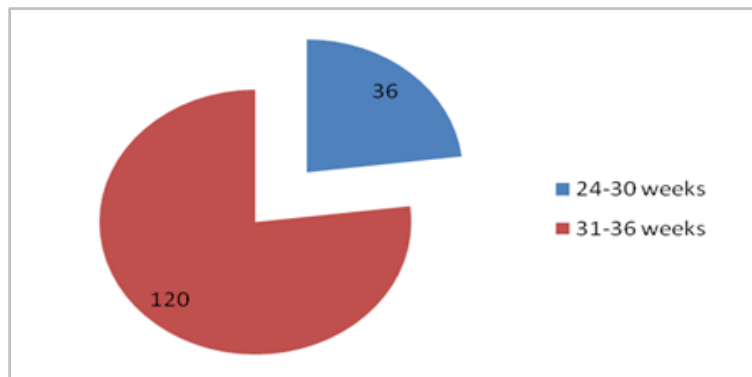
RESULTS: All our patients ranged from 18 years to 35 years. Majority of the patients 56 were in 20-25 years age group. 30 were between 25-30 years and 2 patients were > 30 years and only 1 patient was < 18 years. This can be attributed probably for the increased pregnancy rate in these age groups. PIH is more common in primigravida due to first time exposure to chorionic villi.

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Graph 1: Showing the distribution of age of patients

In this study all patients underwent Doppler study in the third trimester of their pregnancy with 70% being investigated between 31 - 35 weeks of gestation. The earliest study was done at 29th week of gestation. Hence most pregnancies were monitored between 31-35 weeks, when the fetus would have begun developing sufficient lung maturity to survive outside the uterus. Symmetrical IUGR accounts for 20-30% and asymmetrical IUGR accounts for 70-80%. In asymmetrical IUGR insult begins later than symmetrical IUGR, usually after 28 weeks of gestation.



Graph 2: Showing the distribution of Doppler examinations done in gestational age period

DOPPLER INDEX	TP	TN	FP	FN	SENSITIVITY	SPECIFICITY	PPV	NPV	DIAGNOSTIC ACCURACY
Uterine artery RI	11	12	10	3	78.57%	54.54%	52.38%	80%	63.8%
Uterine artery PI	12	18	4	2	85.71%	81.81%	75%	90%	83.33%
Uterine artery DN	11	20	3	2	84.6%	86.95%	78.57%	90%	86%

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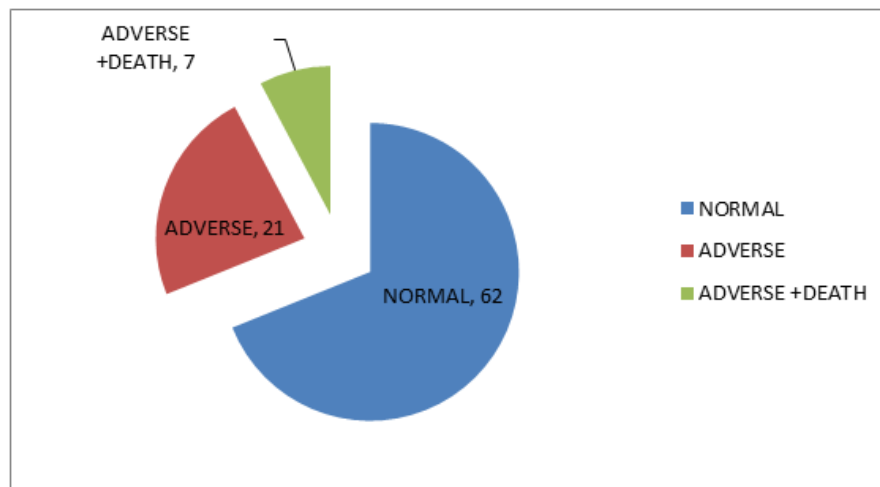
UMA PI	11	22	0	3	78.57%	88%	100%	88%	91.6%
UMA S/D	11	22	0	3	78.57%	88%	78.5%	88%	91.6%
MCA PI	6	21	2	7	46.15%	91%	75%	75%	75%
MCA S/D	7	21	1	7	50%	93%	87.5%	75%	77.77%

Table 1: Showing the comparism of doppler indices in 24-30 weeks-total 36 examinations

DOPPLER INDEX	TP	TN	FP	FN	SENSITIVITY	SPECIFICITY	PPV	NPV	DIAGNOSTIC ACCURACY
Uterine artery RI	10	75	12	23	30.30%	86.2%	45.45%	76.5%	70.8%
Uterine artery PI	10	73	16	21	32.2%	84.8%	38.4%	77.6%	70%
Uterine artery DN	10	76	13	21	32.2%	87.3%	43.47%	84.6%	71.6%
UMA PI	17	83	5	15	53.12%	94.3%	77.2%	84.69%	83.3%
UMA S/D	17	71	7	15	53.12%	91%	70.8%	82.5%	73.3%
MCA PI	27	73	17	3	90%	82%	61.36%	96%	84%
MCA S/D	28	73	15	4	87.5%	83%	65%	94.8%	84.16%

Table 2: Between 31-36 weeks-total 120 examinations

ANALYSIS OF PERINATAL OUTCOME: There were total 90 patients from which total 62 had normal and 21 had adverse perinatal outcome and 7 had dead babies.



Graph 3: Showing the adverse perinatal

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ADVERSE OUTCOME	NO. OF CASES
INTRAUTERINE DEATHS	7
ADMISSION TO NICU	5
EMERGENCY CAESARIAN SECTION	16

Table 3: Showing the distribution of adverse outcomes

There were 7 intrauterine deaths and out of 21 live babies 5 had to be admitted to NICU and 16 had emergency caesarian sections

The cuff-off value for Doppler parameters in 28 adverse perinatal outcomes: In uterine artery, RI value at which maximum fetuses had adverse outcome is near 1(>0.7 abnormal) whereas PI value at which maximum fetuses had adverse perinatal outcome was 1.9(>1.4 abnormal)

MCA PI	NUMBER
<1.2	25
1.2-1.45	1
>1.45(NORMAL)	2
TOTAL	28

Table 4: Showing the distribution of MCA PI in adverse perinatal outcome fetuses

25 babies with adverse outcome including the deaths were observed in MCA PI value below 1.2 were as only 2 babies with MCA PI above 1.2 had adverse perinatal outcome which was below the normal value for MCA PI (>1.45). And 1 baby had adverse outcome though MCA PI was normal.

MCA S/D ratio		
2-2.5	16	
2.5-3	8	
>3(NORMAL)	4	

Table 5: Showing the distribution of MCA S/D ratio value in adverse perinatal outcome fetuses

16 babies with adverse outcome including the deaths were observed in MCA S/D ratio value between 2-2.5 maximum at value of 2.2 whereas 8 babies with adverse perinatal outcome had MCA S/D ratio between 2.5-3 and 4 babies born with adverse perinatal outcome has normal MCA S/D ratio.

DISCUSSION: Intrauterine growth restriction does not imply a specific pathophysiology but merely a result of a series of events occurring along several possible pathways. Hence, accurate antenatal diagnosis must decide whether the fetus is constitutionally small for gestational age or small as a consequence of impaired placental perfusion. Doppler flow velocity analysis can be valuable in

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solving this problem, by examining uterine arteries (Uteroplacental circulation), umbilical arteries (Feto-placental circulation) and middle cerebral artery (Fetal-circulation).

Our study was done in 90 pregnant women, who were diagnosed as having fetuses with intrauterine growth restriction based on clinical suspicion and grey scale ultrasound examination. Numerous studies with varying results have been published and difficult to compare. This controversy can partly be explained by small number of patients enrolled, varying sample sizes and techniques as well as different criteria used to define the adverse perinatal outcome. In addition some studies were performed in high risk and some in low risk population, similarly major and minor perinatal outcome.

As can be seen yet no universally accepted standard for defining an abnormal Doppler flow velocity waveforms as well as the pregnancy outcome measure, so conflicting observations might continue to emerge.

AGE INCIDENCE: It is observed that the maximum number of pregnant women were in the age groups of 21-25 years. This can be attributed probably for the increased pregnancy rate in these age groups. PIH is more common in primigravida due to first time exposure to chorionic villi.

DISTRIBUTION OF GESTATIONAL AGE: In this study all patients underwent Doppler study ranging from 24 weeks to 36 weeks onwards till the termination of pregnancy. Total 156 examinations were done among which 120 examinations were between 31-36 weeks.

The earliest study was done at 24th week of gestation. Hence most pregnancies were monitored between 31-36weeks, when the fetus would have begun developing sufficient lung maturity to survive outside the uterus. Symmetrical IUGR accounts for 20-30% and asymmetrical IUGR accounts for 70-80%. In asymmetrical IUGR insult begins later than symmetrical IUGR, usually after 28 weeks of gestation. Hence 31-35 weeks of gestation probably could be more common.

DISTRIBUTION OF CLINICAL PRESENTATION IN 90 ANTENATAL PATIENTS: Among women where a cause for IUGR was identified. 28 had pregnancy induced hypertension (PIH), 3 had anemia complicating pregnancy. This can be attributed to asymmetrical IUGR which accounts for 70-80% in which uteroplacental insufficiency (PIH) was the most common cause. Hypertensive disorders are present in 30% to 40% of pregnancies complicated with IUGR. Bad obstetric history as a cause is seen in 5 patients, 3 had pregnancy induced hypertension with anemia and only 1 had PIH with bad obstetric history.

51 patients of the study group had no detectable cause for IUGR.

DISTRIBUTION OF AMNIOTIC FLUID IN 90 ANTENATAL PATIENTS:

UTERINE ARTERY: Total 150 examinations were done between 24-36 weeks in 90 patients.36 examinations were between 24-30 weeks and 120 examinations between 31-36 weeks.

The sensitivity of RI was 78.57% in our study between 24-30 weeks and sensitivity of RI between 31-36 weeks was 30.3 % which showed uterine artery to be a better predictor of intrauterine fetal growth restriction in earlier periods of gestation than later weeks of pregnancy because of pregnancy induced hypertension which starts developing after 24 weeks and maximum examinations which had abnormal RI in between 24-30 weeks on follow up improved with time.

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In comparison with that of Benson and Doubliet 73 which had overall 67% sensitivity between 24-36 weeks which is less than the sensitivity we found in our study between 24-30 weeks. This discrepancy may be contributed to different cut of levels of resistive index, varying between 0.5 to 0.7. Best screening test is measuring placental site uterine artery RI. If the placenta is situated at the midline, the highest RI is best predictor.

**The following compares the results of the present study with other Studies:
UTERINE ARTERY RI IN PREDICTING PERINATAL OUTCOME:**

STUDY SENSITIVITY:

Benson and Doubliet 75 67%.
Present study*
24-30weeks-78.57%.
31-36weeks-30.3%.

UTERINE ARTERY PI IN PREDICTING PERINATAL OUTCOME:

Jamal A and co-workers ⁷⁹-61.23%.
Present study*
24-30 weeks-85.71%.
31-36 weeks-31.2%.

In our present study sensitivity of uterine artery PI was 85.71% and between 31-36 weeks was 31.2% which is more than previous study done.

Hence, present study concludes uterine artery PI to be a better predictor and more significant than uterine artery RI in early weeks of gestation in intrauterine fetal growth assessment and in predicting perinatal outcome.

In the present study, the persistent early diastolic notch beyond 24 weeks of gestation showed a sensitivity of 84.6%. This is much higher than the study by Colemann et al 74 who showed sensitivity of the uterine artery notch as 76% for adverse perinatal outcome. This may be because of the included women was with bilateral notches in Colemann study, whereas in present study presence of diastolic notch either left or right or both were included. However, the analysis done by Farrell et al 75 for reliability of early diastolic notch in uterine artery as predictor for uteroplacental insufficiency revealed a sensitivity of 88%. The following compares the results of the present study with other studies: uterine artery PI appears to be more significantly superior to other parameters

STUDY SENSITIVITY:

Colemann et al⁷⁴ 76%.
Farrell et al⁷⁵ 88%.
Present study* 84.6%-24-30 weeks.

However, uterine artery diastolic notch according to our study showed sensitivity of only 32.2% in study between 31-36 weeks showing very less number of persistence of diastolic notch in later weeks of pregnancy.

There were three cases who had been detected with diastolic notch in early weeks of pregnancy but timely interventional management at that time with bed rest and medications and

follow up caused the disappearance of diastolic notch at follow ups and termination of pregnancy was uneventful.

UMBILICAL ARTERY: In the present study the umbilical artery PI had a sensitivity of 78.57% in between 24-30 weeks and 53.12% between 31-36 weeks.

According to D. Gramellini et al⁵⁹, the overall sensitivity of PI in the Umbilical artery in predicting perinatal outcome was 64%. Umbilical artery was the main vessel used for monitoring high risk pregnancies. This is because umbilical artery represents fetoplacental system and primarily reflects placental resistance. In present study as there is more number of PIH cases probably this can be attributed for difference in the studies. Another study by K W Fong et al⁷⁶ showed the sensitivity of PI in the umbilical artery as 58.3%. The following compares the results of the present study with other studies.

**UMBILICAL ARTERY PI IN PREDICTING PERINATAL OUTCOME:
STUDY SENSITIVITY:**

- D Gramellini et al⁵⁹ 64%.
- K W Fong et al⁷⁶ 44.7%.
- BN Lakhkar et al⁷⁷ 50%.
- Present study* 78.57% between 24-30 weeks.
53.12% between 31-36 weeks.

Hence, our study concludes that umbilical artery PI showed more sensitivity in between 24-30 weeks than 31-36 weeks.

In our present study umbilical artery S/D ratio between 24-30 weeks showed sensitivity of 78.57% and between 31-36 weeks 53.12% which was similar to the performance of the umbilical artery S/D ratio between 31-36 weeks.

FETAL BLOOD CIRCULATION AND REDISTRIBUTION: In the present study fetal middle cerebral artery PI had a sensitivity of 46.15% in between 24-30 weeks of gestation whereas the sensitivity of the middle cerebral artery PI in between the 31-36 weeks gestation was found to be 90%. This outstanding performance of the middle cerebral artery PI in between 31-36 weeks of pregnancy is because changes of IUGR in the artery become prevalent in later weeks of pregnancy as in earlier weeks there is brain sparing effect which protects the fetal brain from the profound effects of hypoxia.

In Arduini and Rizzo⁷⁸ study the sensitivity of MCA in predicting perinatal outcome was 68%. Obviously the present study cannot be compared with the above study in view of difference in considering the intra cranial artery as it is clearly established that PI varies in relation to the intra cranial artery considered. So it is important that the artery be identified precisely and with certainty. The following compares the results of the present study with other studies:

**MIDDLE CEREBRAL ARTERY PI IN PREDICTING PERINATAL OUTCOME:
STUDY SENSITIVITY:**

- K.W Fong et al⁷⁶ 72.4%.
- Arduini and Rizzo⁷⁸ 68%.

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BN Lakhkar et al 77 41.6%.

Present study- 24-30 WEEKS- 46.15%.

31-36 WEEKS-90%.

PREDICTION OF PERINATAL OUTCOME: Among those 28 fetuses there were 7 Intra uterine deaths and 21 live births. Out of 21 live births 5 were admitted to NICU, 16 were born by emergency caesarian section. These results are slightly higher Gramellini et al⁵⁹ This can be contributed to difference in perinatal mortality and morbidity rates from western standards to Indian standards. By using Doppler ultrasound results for analysis, the MCA pulsatility index had a higher sensitivity and positive predictive value for predicting the adverse perinatal outcome than the Umb A pulsatility indices and uterine artery PI.

Our findings agree with the results of the studies that have shown MCA PI.

Doppler to be more useful than UmA PI or uterine artery in predicting the adverse outcome. Comparison between different studies would be meaningful if uniform of standardized criteria were used.

COMPARISON OF DIAGNOSTIC ACCURACIES IN THOSE PARAMETERS SHOWING HIGHEST SENSITIVITY:

	24-30 WEEKS	31-36 WEEKS
UTERINE ARTERY PI -	83.33%	70%
MCA PI-	75%	84%

Hence, our study confirmed that the uterine artery PI has the best diagnostic accuracy In between 24-30 weeks and MCA PI proved to have better diagnostic accuracy between 31-36 weeks.

Cuff-off values were observed for the Doppler parameters below or above which these parameters were significantly associated with perinatal outcome. In uterine artery, RI value at which maximum fetuses had adverse outcome is near 1(>0.7 abnormal) whereas PI value at which maximum foetuses had adverse perinatal outcome was 1.9 (>1.4 abnormal).

Maximum adverse outcome was seen when UMA PI value was found to be near 1.6 (>1.45 abnormal) whereas maximum adverse outcome was seen when UMA S/D ratio value was found to be above 3.5. Adverse outcome including the deaths were observed in MCA PI value below 1.2 whereas adverse outcome including deaths were observed in MCA S/D ratio at value below 2.2 (<3 abnormal)

CONCLUSION:

- In suspected IUGR, uterine artery PI proved to be a better predictor in early weeks of pregnancy than uterine artery RI and diastolic notch and middle cerebral artery.
- Best results are obtained when we use MCA PI, which is more sensitive in detecting IUGR in later weeks of gestation from 31-36 weeks rather than umbilical artery and uterine artery And the diagnostic accuracy of the middle cerebral artery is maximum between 31-36 weeks.
- Cuff-off values were observed for the Doppler parameters below or above which these parameters were significantly associated with perinatal outcome. In uterine artery, RI value at which maximum fetuses had adverse outcome is near 1(>0.7 abnormal) whereas PI value at which maximum fetuses had adverse perinatal outcome was 1.9 (>1.4 abnormal). Adverse

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outcome including the deaths were observed in MCA PI value below 1.2 whereas adverse outcome including deaths were observed in MCA S/D ratio at value below 2.2(<3 abnormal).

- Adverse outcome including the deaths were observed in MCA PI value below 1.2 whereas adverse outcome including deaths were observed in MCA S/D ratio at value below 2.2(<3 abnormal).

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FINANCIAL OR OTHER

COMPETING INTERESTS: None

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Date of Submission: 24/01/2015.
Date of Peer Review: 27/01/2015.
Date of Acceptance: 21/02/2015.
Date of Publishing: 27/02/2015.