International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Role of Umbilical Artery and Middle Cerebral Artery Doppler in Clinically Suspected Intrauterine Growth Restricted Pregnancies

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Abstract: ***Background: Antepartum foetal surveillance is the corner stone of management aimed at reducing maternal and perinatal mortality and morbidity. Doppler velocimetry of the uteroplacental and foetoplacental circulation can be used to further investigate such complications of pregnancy as foetal growth restriction and other forms of foetal distress that result from foetal hypoxemia or asphyxia.***

Objectives: 1) To evaluate the usefulness of umbilical artery and middle cerebral artery Doppler indices as predictors of adverse perinatal outcome in clinically suspected IUGR Pregnancies.
2) To establish the Role of Doppler Ultrasound in the Management of IUGR Pregnancies.

Methods : This prospective study included 30 pregnant patients with clinically suspected IUGR in the III trimester between 31-40 weeks who got admitted to K.S.Hegde Medical Academy Hospital, from October 2014 to October 2016.

Results: Total numbers of 30 IUGR cases were studied. In cases of IUGR, the Cerebroplacental Ratio (MCA PI/ UAD PI) is less than 1.07 and hence this was taken as the Gold standard for my study. One of the major interpretations obtained while concluding the study is that if the Cerebroplacental Ratio $\leq$ 0.95:

a) The birth weight less than 2.5kg has a sensitivity of 60% and specificity of 55%.
b) Fetuses going for Intrauterine Death/ postnatal NICU death have a sensitivity of 56% and specificity of 80%.
c) Fetuses going for NICU admissions have a sensitivity of 61% and specificity of 56%.

- ***If the Middle Cerebral Artery RI value is $\geq$ 0.65 in the third trimester, then the fetuses going for IUGR have a sensitivity of 70% and specificity of 45%.***
- ***If the Umbilical Artery S/D Ratio is $\geq$ 2.95 in the third trimester, then the fetuses going for IUGR have a sensitivity and specificity of 70%.***
- ***If the Umbilical Artery RI value $\geq$ 0.65 in the third trimester, then the fetuses going for IUGR have a sensitivity of 50% and specificity of 80%.***

Conclusion: It is been proved that Doppler technology has a significant impact on our ability to assess the physiological status of the fetus. It can help in identifying the changes in the fetal circulation. This study suggests that, Doppler assessment of foetoplacental circulation including both umbilical and middle cerebral artery is a better prognostic indicator than individual vessels for the prediction of adverse fetal outcomes in Intrauterine Growth Restricted pregnancies. Also the umbilical artery and middle cerebral artery pulsatility indices is equally an important tool in predicting adverse fetal outcome.

Keywords: Doppler Velocimetry, Umbilical Artery, Middle Cerebral Artery, Systolic/ Diastolic ratio, Cerebroplacental Ratio

1. Introduction

Antepartum foetal surveillance is the corner stone of management aimed at reducing maternal and perinatal mortality and morbidity. Ultrasound has revolutionized the antepartum foetal assessment as a whole.The incorporation of Doppler derived haemodynamic information into the standard anatomic sonographic assessment allows the additional evaluation of a variety of physiologic parameters in obstetrics and gynaecology, previously out of reach to the sonographer and sonologist. In obstetrics, Doppler velocimetry of the uteroplacental and foetoplacental circulation can be used to further investigate such complications of pregnancy as foetal growth restriction and other forms of foetal distress that result from foetal hypoxemia or asphyxia [1, 2, 3]. Thus Doppler studies are useful in making the critical distinction between fetus that is truly growth restricted and one who is small and healthy[4].

The present study is designed to evaluate the role of Doppler velocimetry of uteroplacental and foetoplacental circulation in the prediction of abnormal perinatal outcomes, in Intrauterine Growth Restricted pregnancies.

2. Methodology

2.1 Source of Data

The study is a prospective observational study conducted in 30 cases between Octoboer 2014 to October 2016, in the department of Radio diagnosis, Justice K. S. Hegde Hospital, Mangalore.

2.2 Method of study

A colour Doppler ultrasound apparatus (**GE VOLUSON 730 EXPERT**) equipped with **3.5 MHz** transducer was used for the Doppler study.

All the examinations were made with the patient lying in semi recumbent position with a lateral tilt. Doppler transducer was placed on the abdominal wall over the uterus and carefully manipulated till Doppler signals appropriate for those particular vessels were identified. All the examinations were performed only during foetal apnoea and foetal inactivity.

The signal was recorded for a minimum of 5 to 8 cycles with blood flow velocity waveforms of equal shape and amplitude and satisfactory quality. Then the image was frozen and measurements were taken.

Doppler velocity waveforms of umbilical and middle cerebral were taken for both normal and high risk pregnancies.

2.3 Inclusion Criteria

(a) Singleton pregnancy.
(b) Fetal gestational age of 31 to 40 weeks with clinically suspected intrauterine growth retardation. (Estimated fetal weight <10th percentile for gestation)

2.4 Exclusion Criteria

(a) Documented major congenital abnormality
(b) Multiple gestations

2.5 Statistical Analysis

Diagnostic comparison of Cerebroplacental Ratio (MCA PI/ UA PI) with adverse fetal outcomes using Sensitivity, Specificity, p value, ROC curve diagrams (Area under the curve) were done.

3. Results

Among 30 patients in the study, comparisons of Cerebroplacental Ratio with certain parameters were performed. Table 1 shows comparison with Gestational age by LMP, where as Table 2 shows comparison with Gestational Age by Ultrasound. Table 3, 4 and 5 shows comparison of IUGR with Umbilical Artery S/D Ratio and Birth Weight.

Table 1: Comparison of IUGR v/s GA (LMP)

IUGR	N	Mean	Std. Deviaon	95% Confidence Interval for Mean		t value	p value
				Lower Bound	Upper Bound		
Present	20	35.820	1.828	34.964	36.676	1.72	.097
Absent	10	37.280	2.813	35.268	39.292		(Not significant)
Total	30	36.307	2.266	35.461	37.153		

Those having IUGR (Cerebroplacental Ratio <1.07), the mean GA(LMP) according to our study is 36wks $\pm$ 2wks and patients without IUGR, mean GA(LMP) is 37wks$\pm$ 3wks.

However, test shows no significant difference in GA(LMP) between presence and absence of IUGR. (p value = 0.097)

Table 2: Comparison of IUGR v/s GA (USG)

IUGR	N	Mean	Std. Deviation	95% Confidence Interval for Mean		t value	p value
				Lower Bound	Upper Bound		
Present	20	31.455	2.446	30.310	32.600	2.09	**.046 (Significant)**
Absent	10	33.350	2.107	31.843	34.857		
Total	30	32.087	2.474	31.163	33.011		

Those having IUGR (Cerebroplacental Ratio <1.07), the mean GA(USG) according to our study is 31wks $\pm$ 2wks and patients without IUGR, mean GA(USG) is 33wks$\pm$ 2wks.

Here, test shows significant difference in GA (USG) between presence and absence of IUGR. (p value = 0.046)

Table 3: Comparison of IUGR v/s UA S/D ratio

IUGR	N	Mean	Std. Deviation	95% Confidence Interval for Mean		t value	p value
				Lower Bound	Upper Bound		
Present	20	3.170	.718	2.834	3.506	1.41	.170 (Not significant)
Absent	10	2.790	.651	2.325	3.255		
Total	30	3.043	.709	2.779	3.308		

Those having IUGR (Cerebroplacental Ratio <1.07), the mean UA S/D ratio according to our study is 3.1 $\pm$ 0.7 and patients without IUGR, mean UA S/D ratio is 2.8 $\pm$ 0.6. Here, test shows no significant difference in UA S/D between presence and absence of IUGR. (p value = 0.17). This test is in keeping with increased UA S/D ratio (>3) in 3rd trimester UA Doppler studies.

Table 4: Comparison of IUGR v/s Birth Weight (Kg)

IUGR	N	Mean	Std. Deviation	95% Confidence Interval for Mean		t value	p value
				Lower Bound	Upper Bound		
Present	20	2.113	.543	1.858	2.367	1.49	.148
Absent	10	2.385	.269	2.193	2.577		(Not significant)
Total	30	2.203	.482	2.023	2.383		

Those having IUGR (Cerebroplacental Ratio <1.07), the mean birth weight according to our study is 2.1 $\pm$ 0.5 and patients without IUGR, mean birth weight is 2.3 $\pm$ 0.2. Here, test shows no significant difference in birth weight between presence and absence of IUGR. (p value = 0.14)

Table 5: Comparison of Birth Weight v/s Cerebroplacental Ratio (IUGR)

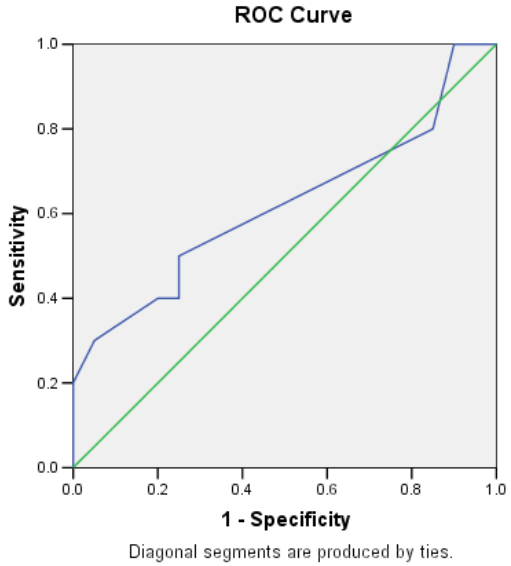
		Cerebroplacental Ratio (MCA PI/UA PI)		
		Present	Absent	Total
Birth Wt(kg)	<2.5	15	5	20
		75.0%	25.0%	100.0%
		75.0%	50.0%	66.7%
	>= 2.5	5	5	10
		50.0%	50.0%	100.0%
		25.0%	50.0%	33.3%
Total		20	10	30
		66.7%	33.3%	100.0%
		100.0%	100.0%	100.0%

In cases of Intrauterine Growth Restriction (IUGR), 75% of cases had birth weight less than 2.5kg and 25% of cases without IUGR also had birth weight less than 2.5kg.

In cases of IUGR, 50% of cases had birth weight more than 2.5kg and 50% of cases without IUGR had birth weight more than 2.5kg.

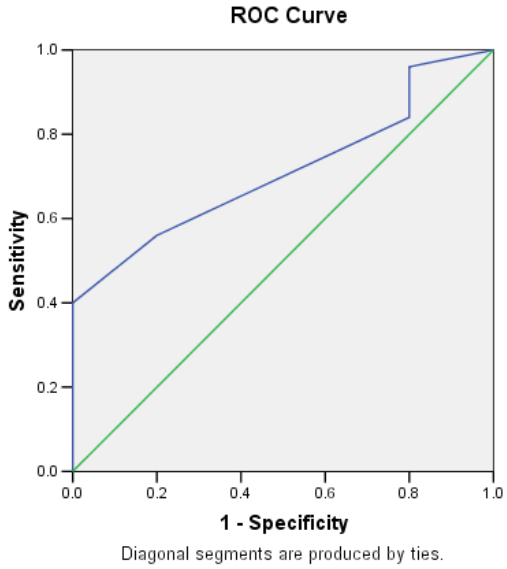
4. ROC Curve Diagrams

1) IUGR v/s Birth Weight



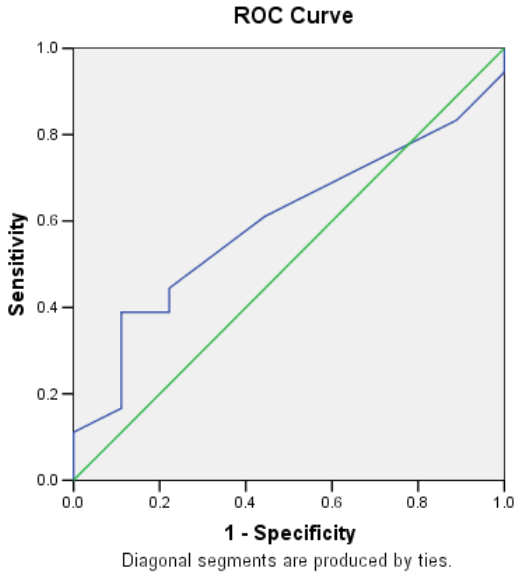
Area under the curve is 0.6 which is good. The study shows that if the Cerebroplacental Ratio is less than 0.95, then the birth weight being <2.5kg has a sensitivity of 60% and specificity of 55%.

2) IUGR v/s Intrauterine Death



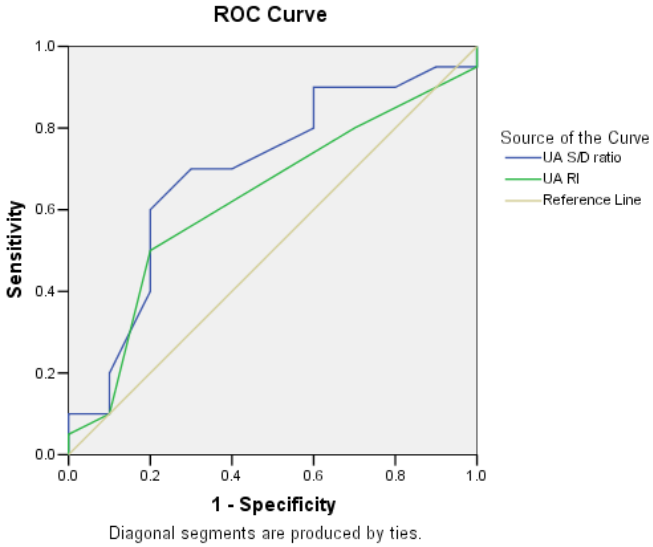
Area under the curve is 0.7 which is good. The study shows that if the Cerebroplacental Ratio is $\leq$0.95, then the sensitivity and specificity for fetuses going for Intrauterine death are 56% and 80% respectively.

3) IUGR v/s NICU Admissions



Area under the curve is 0.6 which is reasonably good. The study shows that if the Cerebroplacental Ratio is ≤ 0.95, then the sensitivity and specificity for fetuses going for NICU admission is61% and 56% respectively.

4) Role of UA S/D Ratio and UA RI in IUGR



The area under the curve for UA S/D ratio and UA RI in IUGR is 0.7 and 0.6 respectively, which is good. The study shows that if the UA S/D ratio is ≥2.9 then sensitivity and specificity for IUGR is 70%.Similarly if the UA RI value is ≥0.65, then the sensitivity and specificity for IUGR is 50% and 80% respectively.

5. Discussion

a) Abnormal S/D Ratio of Umbilical Artery In IUGR

Study	Sensitivity	Specificity
Schulman et al(1991)	65	91
Present study	70	70

According to the study conducted by Schulman et al [6] (1991) in identifying IUGR, the S/D ratio of umbilical artery has got a sensitivity and specificity of 65% and 91% respectively.

In my study the sensitivity and specificity were 70%.

b) Abnormal RI of Umbilical artery and adverse fetal outcome in IUGR

Study	Sensitivity	Specificity
Ebrashy A and co-workers (2005)	53.3%	86.4%
Present study	50%	80%

According to the study done by Ebrashy A and co-workers [5] it was reported that UA RI was more accurate than each of its components in the diagnosis of fetal morbidity and compromise in IUGR. The umbilical artery RI had 53.3% sensitivity and 86.4% specificity.

In my study the sensitivity and specificity were 50% and 80% respectively.

c) Those having IUGR (Cerebroplacental Ratio <1.07), the mean GA(USG) according to our study is 31wks + 2wks and patients without IUGR, mean GA(USG) is 33wks+ 2wks. Here, test shows significant difference in GA(USG) between presence and absence of IUGR. (p value = 0.046)

d) My study shows that if the Cerebroplacental Ratio is less than 0.95, then the birth weight being <2.5kg has a sensitivity of 60% and specificity of 55%.

e) The study shows that if the Cerebroplacental Ratio is < 0.95, then the sensitivity and specificity for fetuses going for Intrauterine death are 56% and 80% respectively.

f) The study also shows that if the Cerebroplacental Ratio is < 0.95, then the sensitivity and specificity for fetuses going for NICU admission is 61% and 56% respectively.

6. Conclusion

- One of the main goals of antepartum fetal monitoring is to identify the fetuses at increased risk for perinatal morbidity and mortality. Doppler technology has had a significant impact on our ability to assess the physiological status of the fetus. It can help in identifying the changes in the fetal circulation at a time when other tests are normal and in doing so, identify the truly hypoxic fetus.
- This study was conducted in Justice K. S. Hegde Charitable hospital to evaluate the role of Doppler velocimetry of foetoplacental circulation in the prediction of abnormal perinatal outcomes, in Intrauterine Growth Restricted pregnancies.
- In cases of IUGR, the Cerebroplacental Ratio (MCA PI/ UAD PI) is less than 1.07 and hence this was taken as the Gold standard for my study.
- The study showed significant difference in Gestational Age by Ultrasound between presence and absence of IUGR.
- One of the major interpretations obtained while concluding the study is that if the Cerebroplacental Ratio ≤ 0.95

a) The birth weight less than 2.5kg has a sensitivity of 60% and specificity of 55%.

b) Fetuses going for Intrauterine Death/ postnatal NICU death have a sensitivity of 56% and specificity of 80%.

c) Fetuses going for NICU admissions have a sensitivity of 61% and specificity of 56%.

- If the Middle Cerebral Artery RI value is ≥0.65 in the third trimester, then the fetuses going for IUGR have a sensitivity of 70% and specificity of 45%.
- If the Umbilical Artery S/D Ratio is ≥2.95 in the third trimester, then the fetuses going for IUGR have a sensitivity and specificity of 70%.
- If the Umbilical Artery RI value ≥ 0.65 in the third trimester, then the fetuses going for IUGR have a sensitivity of 50% and specificity of 80%.
- The decreased sensitivity and negative predictive value of the ratio of Middle cerebral artery (MCA) and Umbilical

artery (UA) resistance indices is due to increased number of false negative values when compared to umbilical artery S/D ratio. This is explained by the fact that in extreme cases of IUGR, instead of decreased middle cerebral artery resistance, there will be normal or increased resistance due to increase in intra cranial tension because of brain edema.

- This study suggests that Doppler assessment of feto-placental circulation including both umbilical and middle cerebral artery is a better prognostic indicator than individual vessels for the prediction of adverse fetal outcomes in Intrauterine Growth Restricted pregnancies.

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