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Colour Doppler Ultrasound Evaluation Of Umbilical Artery And Middle Cerebral Artery In Suspected IUGR Fetuses

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ABSTRACT

The aims and objectives of our study was to study the changes in Umbilical Artery and Middle Cerebral Artery Doppler indices in IUGR pregnancies and correlate with perinatal outcome and to establish the role of doppler ultrasound in the management of IUGR pregnancies.

The present study is a prospective study of Doppler Velocimetry of umbilical artery and Middle cerebral artery in cases with clinical suspicion of IUGR between 24 to 40 weeks of gestation from November 2019 to October 2021. Pregnancies with documented intrauterine death at the time of first Doppler and multiple gestations examination were excluded from the study. The outcome for each pregnancy was obtained by examining the labor ward records and neonatal intensive care unit records wherever appropriate. Findings of Doppler studies were correlated with the following adverse Perinatal outcomes.

The Umbilical artery Pulsatility index and the Middle cerebral artery pulsatility index for the corresponding gestational age were compared with the reference values. The Umbilical artery Pulsatility index was considered abnormal if the value was above the 95th percentile of previously published values for gestational age.

Acceptable wave forms were obtained from MCA and UA in all these cases. All the cases were followed up for the perinatal outcome. It was observed that MCA PI was most sensitive (sensitivity 95.65%). It was more sensitive than either Cerebroplacental Ratio MCA/UA PI (sensitivity 91.3%) or UAPI (sensitivity 91.3%) in predicting any adverse outcome. However, Cerebroplacental Ratio (specificity 81.48%) was more specific compared to UA PI (Specificity 66.6%) and MCA PI (Specificity 63%). Cerebroplacental Ratio (MCA/UA) had highest Positive Predictive Value (PPV=80.8%) compared to UA PI (PPV=70%) and MCA PI (PPV=68.75%) when considered alone. However, UA PI 94.4 has highest Negative Predictive Value followed by Cerebroplacental Ratio 91.66% and MCA PI 90.0.

KEY WORDS: - Intrauterine growth retardation; Umbilical artery Doppler, Middle cerebral artery Doppler; Fetal Doppler; Cerebro-placental Ratio

I.INTRODUCTION

Intrauterine growth restriction (IUGR) is a pathological condition strongly related to the development and function of the uteroplacental and fetoplacental circulation and is associated with an increased risk of perinatal mortality, morbidity and impaired neurodevelopment [1,2,3]. The correct detection of the compromised IUGR fetus to allow timely intervention is a main objective of antenatal care.

Placental insufficiency is the most common cause of IUGR, which is an important obstetric problem on the account of high associated perinatal mortality and morbidity. It is essential to recognize placental insufficiency early so that its hazard can be reduced, if not prevented.

Doppler Ultrasonography (USG) enables a non-invasive assessment and better understanding of the hemodynamic changes[4,5]. Doppler investigation of the umbilical arteries provides information concerning perfusion of the fetoplacental circulation, while Doppler study of fetal vessels detects the hemodynamic rearrangements that occur in response to fetal hypoxia. Therefore, USG has become indispensable tools for fetomaternal surveillance in high-risk pregnancies.

Ultrasonographic biometry helps to identify a heterogeneous group of small–for– gestational age fetuses that include fetuses with IUGR, fetuses with small constitution, and fetuses with appropriate growth (misdiagnosed as small). Not all small for gestational age babies suffer from IUGR and its associated risks.

Umbilical artery (UA) Doppler velocimetry is the most rigorously evaluated test among the noninvasive tests of fetal well being[6]. Several authors have reported a low-end diastolic velocity in the umbilical artery, a consequence of high flow resistance in capillaries of the terminal villi. A metaanalysis of randomized controlled trials of UA Doppler velocimetry in high-risk pregnancies (mainly pregnancies with associated pregnancy induced hypertension and suspected IUGR) demonstrated that its use was associated with a trend towards reduction of perinatal mortality[7].

In response to prolonged fetal hypoxic stress, circulatory adaptation occurs, resulting in redistribution of the cardiac output to provide a constant oxygen supply to the brain and other essential organs (i.e., heart and adrenal glands)[8,9]. This compensatory adjustment, on which the brain sparing effect[10] is based, associated with a rise in diastolic velocities in Doppler cerebral artery waveforms. This rise is considered a manifestation of cerebral vasodilatation, causing a decrease in Doppler indices such as the pulsatility index[11,12]. At cordocentesis, a significant correlation has been observed between hypoxemia in fetuses with IUGR and abnormal middle cerebral artery(MCA) pulsatility index(PI.).

Recent studies indicate that the cerebroplacental ratio of pulsatility index of MCA and UA is the most sensitive Doppler index for predicting perinatal outcome in fetuses with IUGR[13,14].

In the majority of the severely growth retarded fetuses, sequential deterioration of arterial and venous Doppler precedes biophysical profile score deterioration. At least one third of fetuses show early signs of circulatoryderegulation1 week before biophysical profile deterioration, and in most cases, Doppler deterioration preceded biophysical profile deterioration by 1 day [15]. This indicates the significance of Doppler study in these patients for early detection of fetal compromise.

Our study is an effort to establish the role of Umbilical Artery(UA) and Middle Cerebral Artery (MCA) Doppler US in predicting perinatal outcome in clinically suspected IUGR pregnancies, and to determine the role of Doppler velocimetry in clinical management of such pregnancies.

II. AIMS AND OBJECTIVES

1) To study the changes in Umbilical Artery and Middle Cerebral Artery Doppler indices in IUGR Pregnancies and correlate with perinatal outcome.
2) To establish the role of Doppler ultrasound in the management of IUGR Pregnancies.

III. REVIEW OF LITERATURE

Doppler ultrasound provides a unique, non-invasive and safe method of studying blood flow characteristics in both the fetoplacental and uteroplacental circulations that is being used in clinical evaluation of high risk pregnancies. The growing availability of Doppler equipment in the mid to late 1980s led to an outpouring of studies examining the use of this technique in pregnant women.

Many of these studies assessed the potential value of Doppler study of various fetal vessels like, abdominal aorta, ductus venosus, middle cerebral artery and umbilical arteries to assess the fetal hemodynamics in a clinically suspected IUGR.

In a study, perinatal indicators of fetal compromise were assessed according to the results of continuous-wave Doppler umbilical velocimetry for 172 patients at risk for intrauterine growth retardation (IUGR). They found that the last Doppler study before delivery was abnormal in 48.8% of the growth-retarded infants but in only 13.2% of the infants without evidence of IUGR. Furthermore, in the growth-retarded group, early delivery, reduced birth weight, decreased amniotic fluid at birth, admission to the neonatal intensive care unit, neonatal complications associated with IUGR, and a prolonged hospital stay were observed more frequently in those who had an abnormal ratio than in those with a normal ratio. The sensitivity of the systolic/diastolic ratio for an adverse perinatal outcome (operative delivery for fetal distress, neonatal morbidity associated with IUGR, and/or perinatal death) was significantly better for the infants with IUGR (66.7%) than for the infants without IUGR (27.8%; $P < .05$). The predictive value of an abnormal ratio was also higher for the pregnancies complicated with IUGR (57.1%) than for those without IUGR (29.4%), but not to a statistically significant degree. These data suggest that Doppler umbilical velocimetry studies are valuable in identifying those growth- retarded fetuses at increased risk for an adverse perinatal outcome[16].

In a study using Doppler U/S, flow velocity wave forms in the middle cerebral artery were studied. In growth retarded fetuses pulsatility index in MCA was significantly reduced compared with normal pregnancy suggesting participation of MCA in a brain sparing effect in the presence of clinical fetal hypoxia[17].

In a study of fetal middle cerebral artery in 81 small-for-gestational age fetuses (SGA) using color flow imaging and pulsed Doppler studies, Impedance to flow (pulsatility index; PI) was significantly lower, and mean blood velocity was significantly higher, than the respective reference ranges with gestation. Fetal blood sampling by cordocentesis was performed in all SGA fetuses and a significant quadratic relation was found between fetal hypoxemia and the degree of reduction in the PI of flow velocity waveforms (FVWs) from the fetal middle cerebral artery. They concluded that maximum reduction in PI is reached when the fetal PO_2 is 2-4 SD below the normal mean for gestation and when the oxygen deficit is greater there is a tendency for the PI to raise, presumably reflecting the development of brainedema[18].

In a study the changes in fetal Doppler parameters with advancing gestation was studied. Furthermore, they examined the alterations in fetal hemodynamics in relation to fetal blood oxygen tension in samples obtained by cordocentesis from small for gestational age (SGA) fetuses. They found that in SGA fetuses, increased downstream impedance to flow in the umbilical artery, as demonstrated by the absence of end-diastolic frequencies in the FVWs, is associated with fetal hypoxia which presumably reflects the underlying derangement of placental structure and function. The impedance to flow and mean blood velocity were also measured in FVWs from the descending thoracic aorta and common carotid artery, obtained by pulsed Doppler ultrasound, and from the middle cerebral and renal arteries obtained by color flow imaging. There were significant correlations between the degree of fetal hypoxia and alterations in Doppler parameters, which were compatible with the brain sparing effect. Thus, in fetal hypoxia impedance to flow in the common carotid and middle cerebral arteries was decreased, whereas impedance in the aorta and renal artery was increased. They also found that there were simultaneous alterations in the mean blood velocity in the opposite direction to those inimpedance[19].

IV. MATERIALS AND METHODS

Data for the study was collected from all patients of clinically suspected IUGR pregnancies, study was done for a period of 2 years from November 2019 to October2021.
Women referred for antenatal Doppler were included in the study if the following Inclusion criteria were met:

- Singleton pregnancy.
- Fetal gestational age of 24 to 40 weeks with clinically suspected intrauterine growth retardation. (Estimated fetal weight <10th percentile for gestation)
- The gestational age was based on last menstrual period (LMP), ultrasound biometry performed before the 20th gestational week, when the LMP is uncertain or not known and early ultrasound before 13 weeks has not been performed.

Present study included a total number of 50 cases meeting the inclusion criteria. Doppler US evaluation was performed following a detailed clinical history, US biometry, and assessment of amniotic fluid and placental maturity. Follow up Doppler studies were performed if clinically indicated to determine a favorable or a worsening trend in the Doppler indices. However, only the results of the first Doppler ultrasound were used for analysis of perinatal out come.

Doppler US Technique:

After ultrasound biometry assessment, all women were subjected to Doppler studies of the umbilical artery (UA) and middle cerebral artery (MCA) serially between 24-40 weeks. These assessments were performed by using the ultrasound machines GE LOGIQ F8 and PHILIPS ClearVue350 with curviliner probe of 2-5MHz. the filter was set at 100 HZ. All measurements were plotted graphically in accordance with normograms provided by the Srikumar et al for Doppler indices.

The wave forms were obtained during fetal inactivity and apnea. Umbilical artery Doppler flow velocity waveforms were obtained from a free loop of cord, and measurements taken when a clear waveform was acquired in the absence of fetal breathing or body movement.

For MCA Doppler US, a transverse image of the fetal head was obtained at the level of the sphenoid bones. Color flow imaging was used to display the circle of Willis. The MCA in the near field was insonated about 1 cm distal to its origin from the internal carotid artery. The angle of insonation in both the cases are was less than 60deg.

The Pulsatility index (PI) was measured, and the presence or absence of end- diastolic frequencies was noted. The PI was used as it continues to reflect changes in resistance with progressive absence of end-diastolic frequencies or reverse flow.

Fig- 1 GE LOGIQ F8

Fig- 2 PHILIPS ClearVue350

Outcome Criteria

Doppler US results were analyzed for prediction of perinatal outcome. Outcome variables included are:

Birth Weight (less than 10th percentile)

- Perinatal death
- Emergency CS for fetal distress
- Low APGAR score (5 min APGAR score lessthan7)
- Admission to NICU for complications of Low Birth Weight.
- Pregnancy was considered to have "Adverse outcome" when any of the following complications were present
- Perinatal death
- Emergency CS for fetal distress
- 5-minute Apgar score of less than7
- Admission to NICU for complications of low birth weight.

Pregnancy outcome was considered to be Uneventful or Favorable when the above complications were absent. The outcome for each pregnancy was obtained by examining the labor ward records and neonatal intensive care unit records wherever appropriate. The UA Pulsatility index ratios were considered abnormal if the value was above the 95th percentile of previously published values for gestational age[22]**.** The MCA pulsatility index was considered abnormal if the value was below the 5th percentile of previously published values for gestational age[22]. The MCA/UA PI ratio (cerebro-placental ratio) is considered abnormal when it is less than 1.08 as given by the Gramellini D et al[12].

V. RESULTS

The present study was performed during a period of 2 years from November 2019 to October 2021.50 pregnancies with clinically suspected IUGR were evaluated with Doppler ultrasonography. Acceptable waveforms were obtained in all the cases.

The mean age of pregnant women included in the study was 24.64 ± 3.05 years, with minimum age of 20 years and maximum age of 31 years. The mean gestational age at the first Doppler US examination was 32.91 ± 3.10 weeks; minimum gestational age was 25weeks and maximum gestational age 38 weeks. The mean FHR was 136.32 ± 13.5bpm; the minimum FHR observed was 108bpm and maximum 156bpm. The mean EFW observed was 1.81 ± 0.32kg; the minimum EFW was 1.2kg and maximum 2.5kg.

Table – 1 Maternal complications of study group

Maternal complications	Percentage of cases
Pregnancy induced hypertension	52%
Anemia	34%

Out of 50 cases 52% (n=26) had pregnancy induced hypertension, 34% (n=17) had anemia at first Doppler examination.

Table -2: Distribution Characteristics of Placental Maturity

Placental grading	No of Cases (%)
2	29 (58)
3	21 (42)
Total	50 (100)

In our study 58 %(n=29) had grade 2 placenta, 21 %(n=42) had grade 2 placenta

Table -3: Amniotic Fluid distribution in the study group

Amniotic fluid	onormal perinatal outcome	Normal perinatal outcome
Oligo	20	15
Normal	3	12
Total	23	27

70% (n=35) had oligohydramnios and 30% (n=15) had normal amniotic fluid.

Table -4: Gestational Age Distribution in study group

Gestational Age in weeks	No of Cases (%)
25	1
26	4
27	1
28	1
29	1
30	2
31	3
32	12
33	3
34	4
35	7
36	7
38	3
40	1

Mean gestational age at the first Doppler US examination was 33weeks +/- 3weeks (2SD).

Table -5: Pregnancy Outcome in the study group

Pregnancy outcome	No of cases	Percentage
Outcome	No of cases	Percentage
Adverse	23	46%
Uneventful	27	54%

46% (n=23) fetuses had at least one abnormal outcome. Remaining 27 fetuses had normal outcome.

Table -6: Adverse Outcomes in the study group

Adverse Outcomes	No of cases
Intra uterine deaths	6 (26%)
Emergency CS	12(52%)
Low Apgar score	9(39%)
Admission to NICU	10(43%)

There were 6 intra uterine deaths and 44 live births. Of the 44 live births, 10 neonates were admitted to NICU for low birth weight, 9 neonates had 5 min Apgar score of less than 7 and 12 babies were born by emergency cesarean section for fetaldistress.

There was statistically highly significant difference of mean MCA PI, UA PI and MCA/UA between normal and abnormal perinatal outcome (P<0.01) and (P<0.001). The mean MCA PI was significantly lower in the abnormal perinatal outcome as compared to normal perinatal outcome. The mean UA PI was significantly higher in the abnormal perinatal outcome as compared to normal perinatal outcome. The mean MCA PI/UA PI was significantly lower in the abnormal perinatal outcome as compared to normal perinatal outcome. If cerebroplacental ratio is <1, it was considered as abnormal[2]. (Table No. 1).

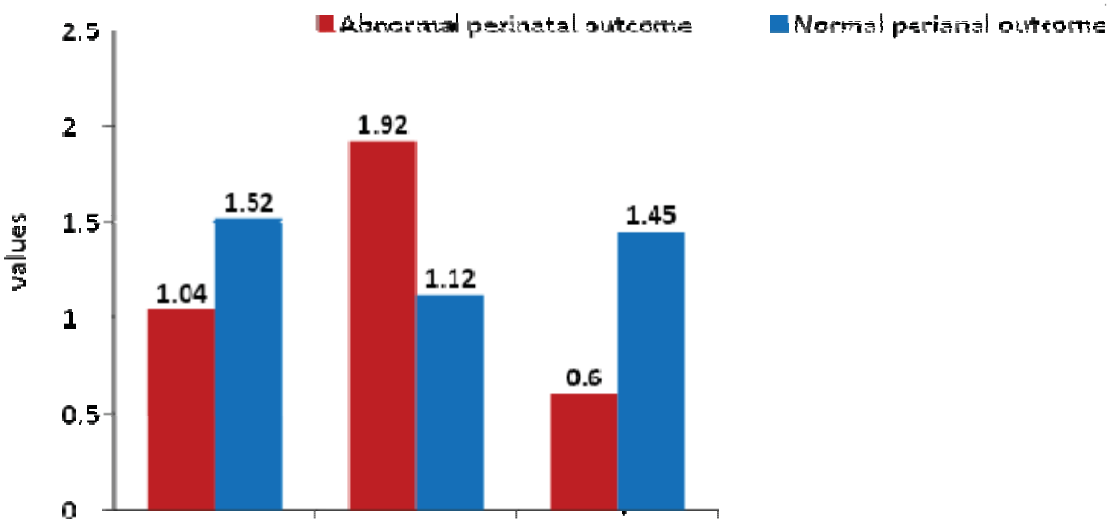
Table -7: Comparison of MCA PI, UA PI and MCA PI/UA PI between normal and abnormal perinatal outcome

Variables	Abnormal perinatal outcome	Normal perinatal outcome	t-test value	P-value and significance
	Mean ± SD	Mean ± SD		
MCA PI	1.04 ± 0.32	1.52 ± 0.38	t = 4.705	P = 0.000, VHS
UA PI	1.92 ± 0.58	1.12 ± 0.29	t = 6.261	P = 0.000, VHS
MCA/UA	0.60 ± 0.32	1.45 ± 0.57	t = 6.205	P = 0.000, VHS

NS= not significant, S=significant, HS=highly significant, VHS=very highly significant

The following Multiple bar diagram represents comparison of MCA PI, UA PI and

MCA/UA between normal and abnormal perinatal outcome



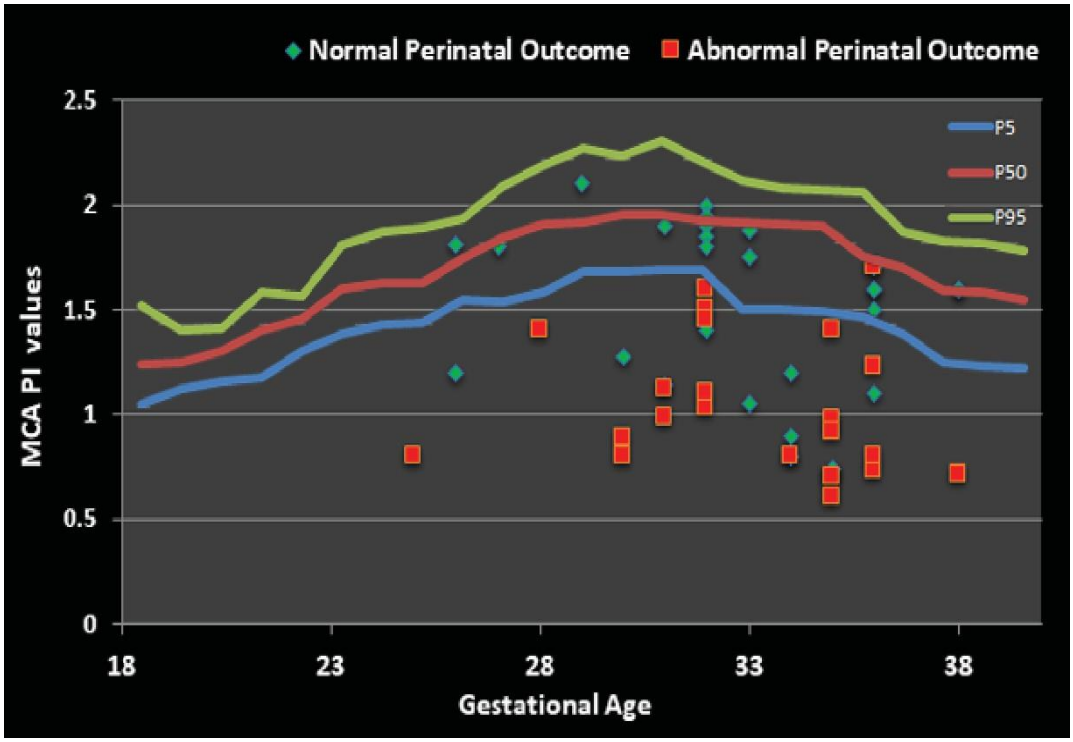
Graph-1: comparison of MCA PI, UA PI and MCA/UA between normal and abnormal perinatal outcome

Table- 8: Spectral Characteristics of Umbilical Artery

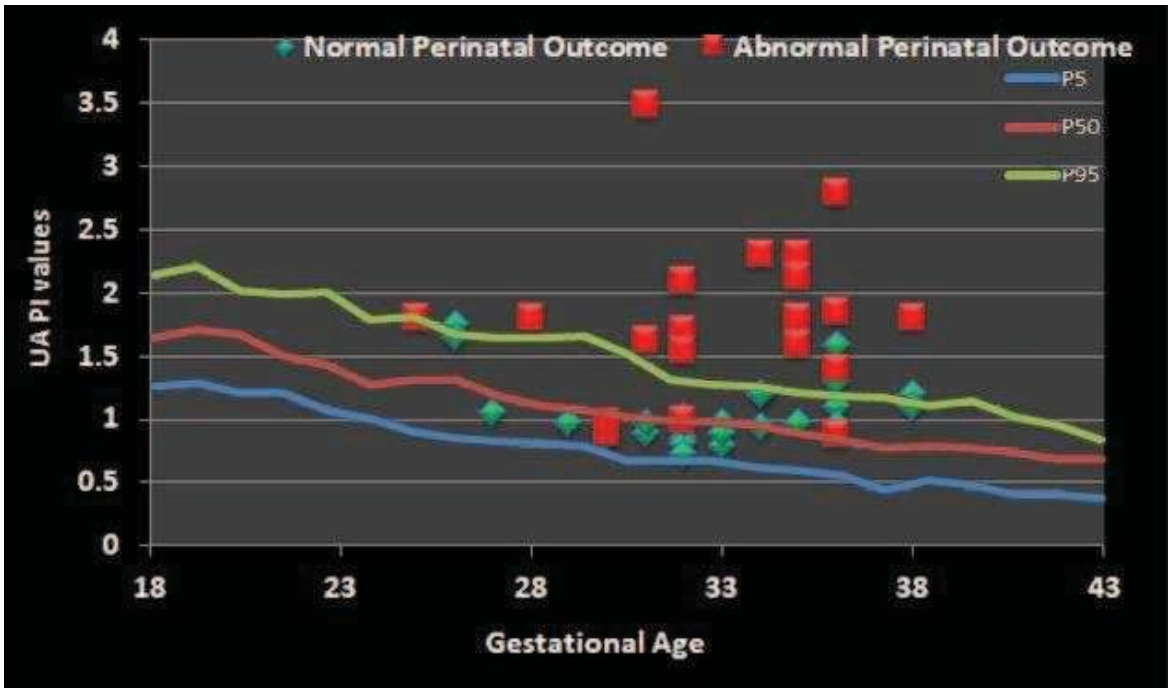
Spectral Characteristics	No Of Cases	IUD	Mortality
Absent EDF	7	2	29%
Reversed EDF	4	4	100%

Of the 6 IUDs, 4 cases had reversal of diastolic flow and 2 had absent diastolic flow. In all cases with reversal of diastolic flow, IUD of the fetus occurred with in one week of diagnosis.

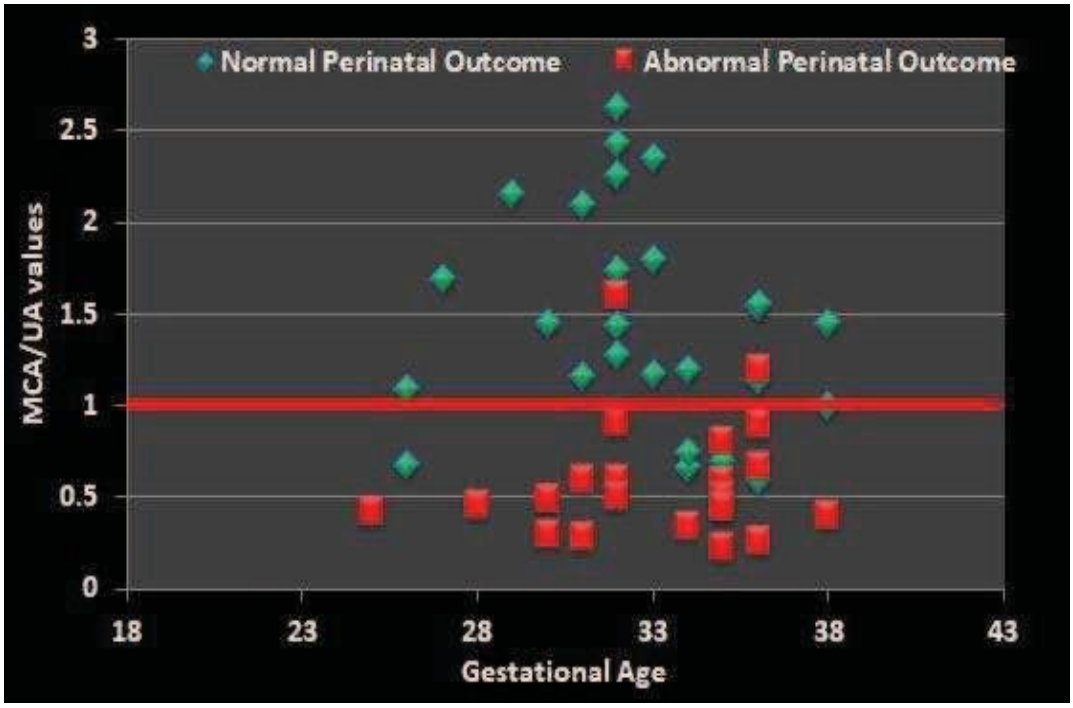
The data of MCA and UA doppler indices obtained from 50 suspected IUGR cases is plotted on the nomogram and scatter diagrams are obtained. The below scatter diagrams show correlation between doppler indices and perinatal outcome.



Graph-2: Scatter diagram shows correlation between gestational ages and MCA PI values among abnormal and normal perinatal outcome



Graph-3: Scatter diagram shows correlation between gestational ages and UA PI values among abnormal and normal perinatal outcome



Graph-4: Scatter diagram shows correlation between gestational ages and MCAPI/UAPI values among abnormal and normal perinatal outcome

MCA PI was most sensitive (sensitivity 95.65%). It was more sensitive than either Cerebroplacental Ratio MCA/UA PI (sensitivity 91.3%) or UA PI (sensitivity 91.3%) in predicting any adverse outcome. However, Cerebroplacental Ratio (specificity 81.48%) was more specific compared to UA PI (Specificity 66.6%) and MCA PI (Specificity 63%). Cerebroplacental Ratio (MCA/UA) had highest diagnostic accuracy (86%) compared to UAPI (78%) and MCA PI (78%) when considered alone. Cerebroplacental Ratio (MCA/UA) had highest Positive Predictive Value (PPV=80.8%) compared to UA PI (PPV=70%) and MCA PI (PPV=68.75%) when considered alone. However, UA PI 94.4 has highest Negative Predictive Value followed by Cerebroplacental Ratio 91.66% and MCA PI 90.0. (Table No. 2)

Table - 9: Performance Characteristics of Doppler indices

Doppler Index	Sensitivity	Specificity	Diagnostic accuracy	PPV	NPV
MCA	95.7	63.0	78.0	68.8	90.0
UA	91.3	66.6	78.0	70.0	94.4
MCA/UA	91.3	81.48	86.0	80.8	91.6

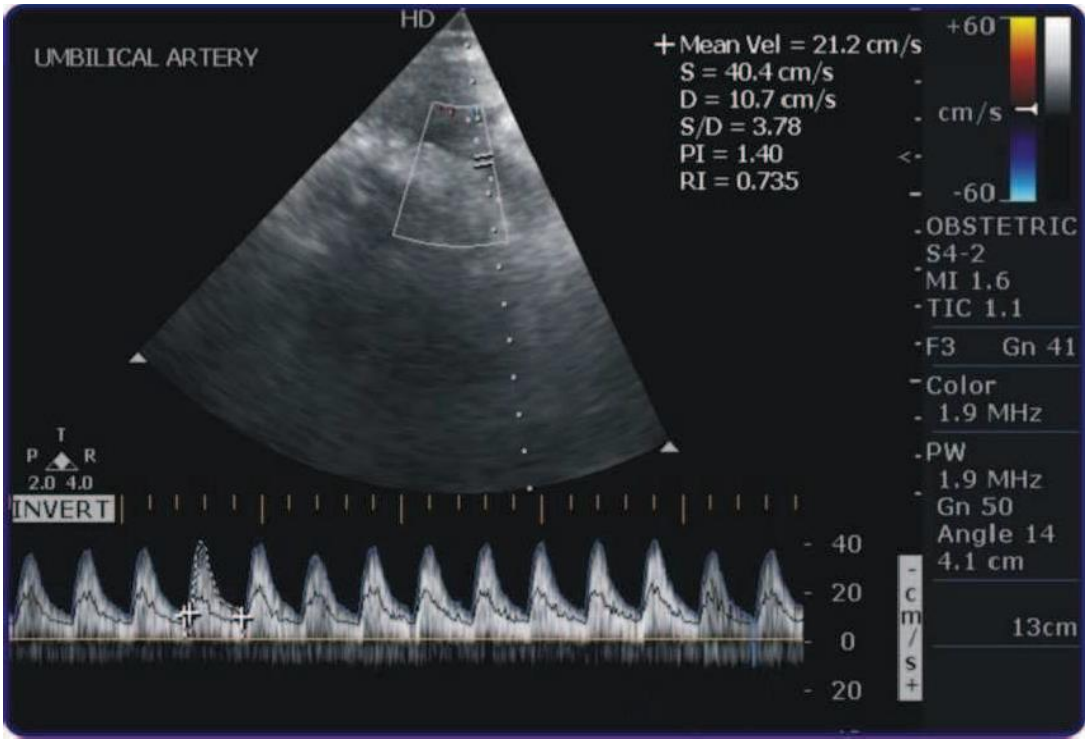


Fig- 3 Decreased Diastolic Flow in Umbilical Artery

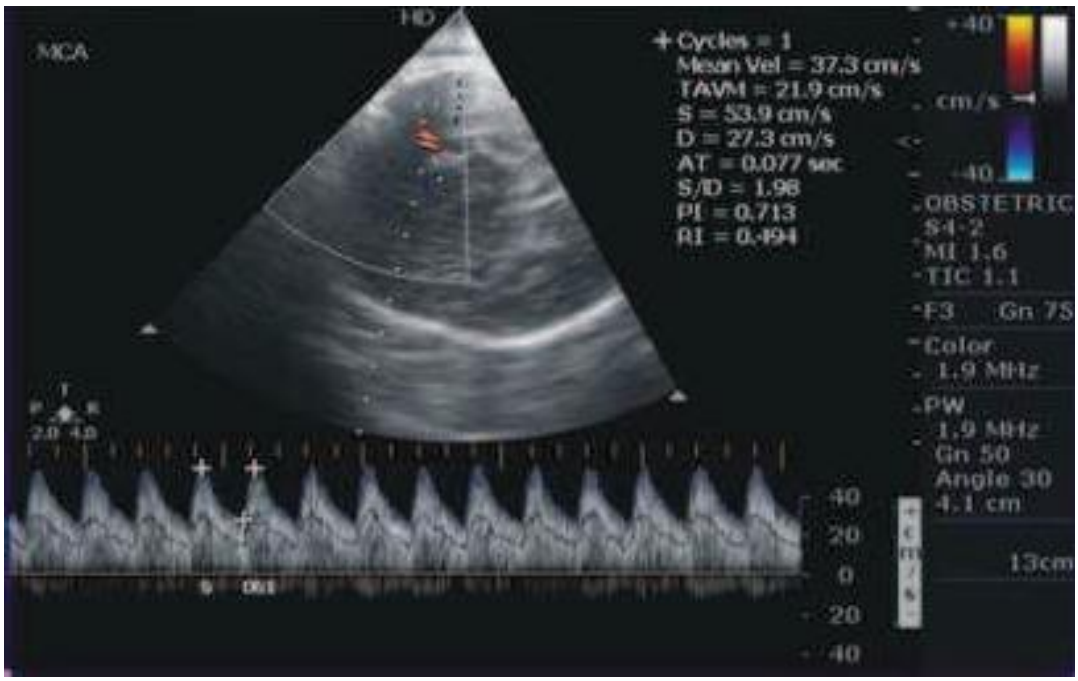


Fig-4 Increased Diastolic Flow' in Middle Cerebral Artery - “Brain Sparing Effect” in the same patient

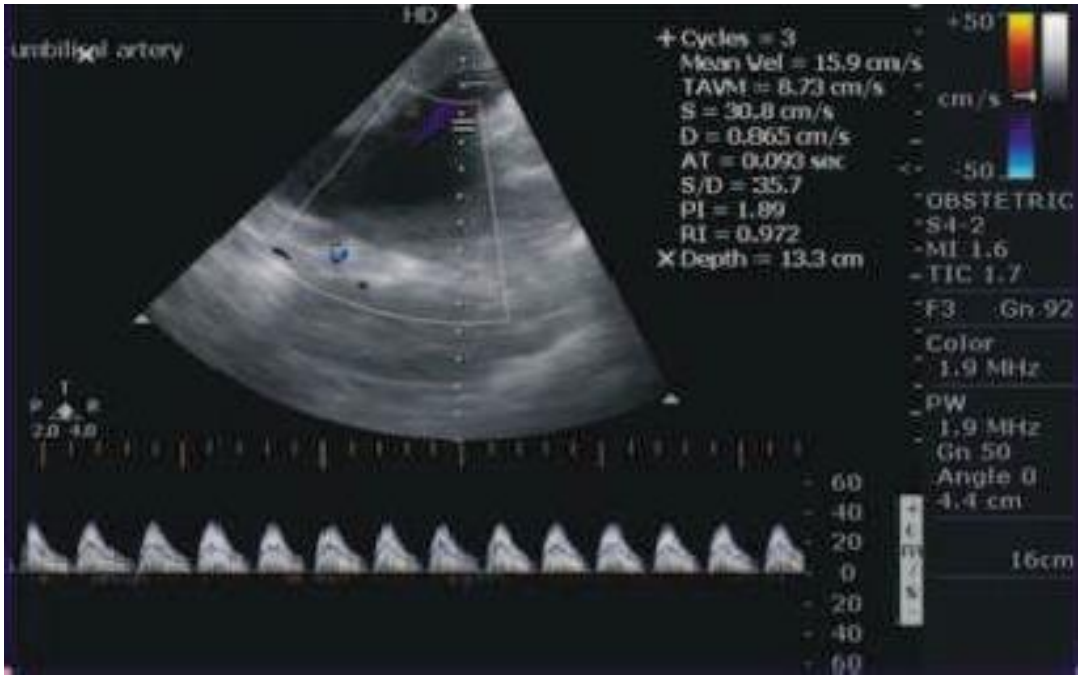


Fig.-5 Absent Diastolic Flow in Umbilical Artery

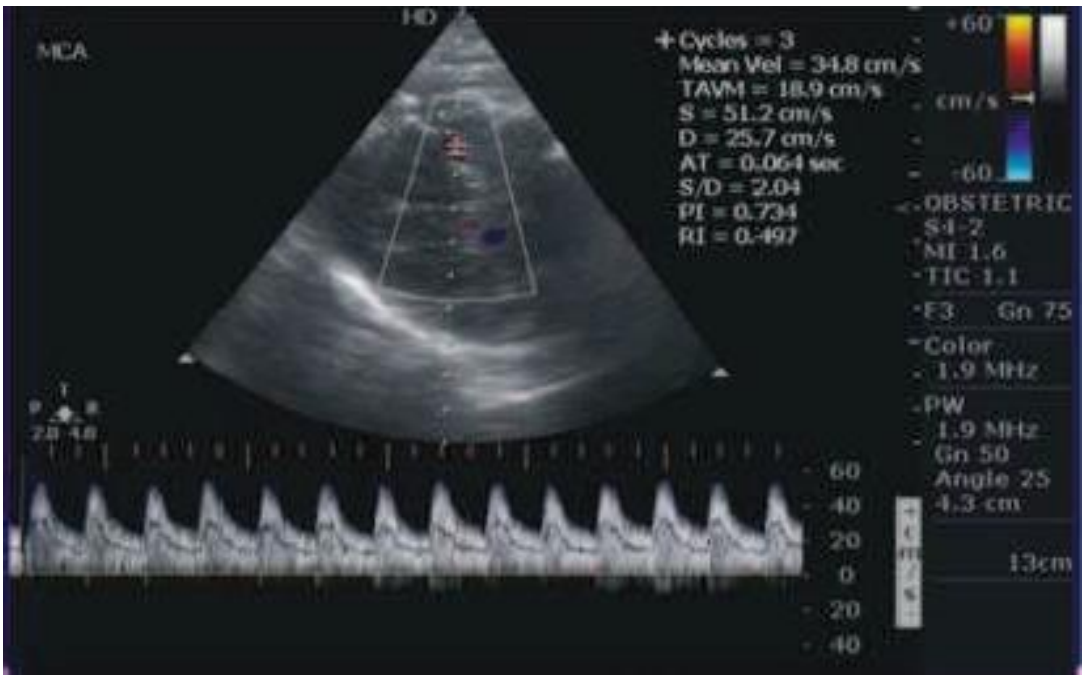


Fig.-6 Increased Diastolic Flow in Middle Cerebral Artery – “Brain Sparing Effect” in the same patient

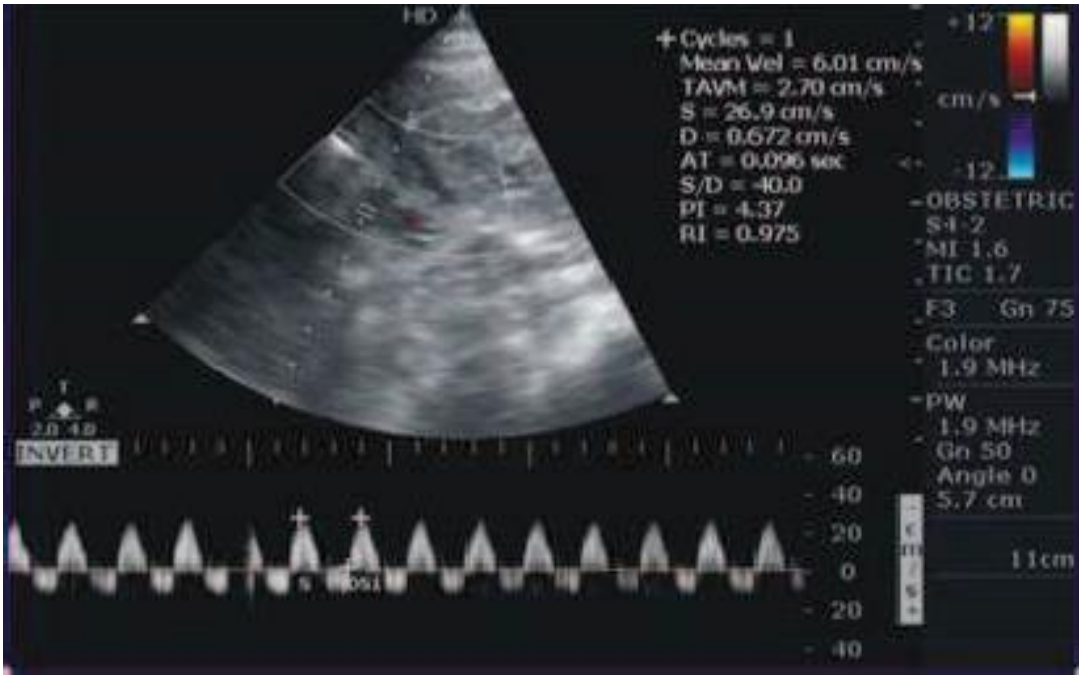


Fig.-7 Reversed Diastolic Flow in Umbilical Artery

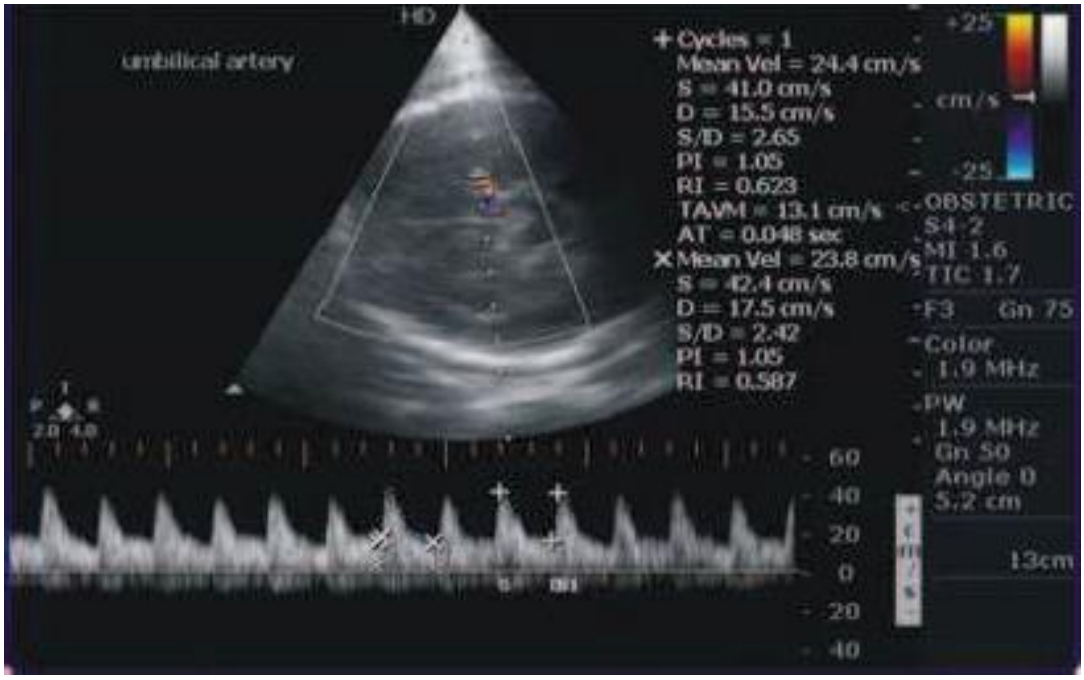


Fig.-8 Increased Diastolic Flow in Middle Cerebral Artery - “Brain Sparing Effect” in the same patient

VI. DISCUSSION

Intrauterine growth restriction is associated with increased risk of perinatal morbidity, mortality and impaired neurological development[1-3]. It is a challenge to differentiate the fetus with pathologic growth restriction and hence at risk for perinatal complications from constitutionally small but healthy fetus. Doppler velocimetry is a noninvasive technique that evaluates abnormal fetal hemodynamics that takes place in response to changes in placental resistance. A Doppler index that reflects both of these areas can be useful for identifying fetuses with increased placental and decreased cerebral resistance.

Umbilical artery and middle cerebral artery Doppler ultrasound clearly depicts the information about placental resistance and the changes in the fetal hemodynamics in response to it. Umbilical arteries Doppler reflects the maldevelopment of the placental tertiary stem villi which increases the placental resistance leading to growth retarded fetus. Middle cerebral artery Doppler has enabled the confirmation of brain sparing effect in IUGR. Hence we chose the UA PI, MCA PI and MCA PI/UA PI i.e. cerebroplacental ratio as the tool for predicting the perinatal out come in IUGR.

We studied the Doppler index of middle cerebral artery because it is the most accessible artery to see the cerebral redistribution as it is the main branch of the circle of Willis and carries 80% of the blood flow to the ipsilateral cerebral hemisphere, a constant 3%–7% of cardiac output throughout gestation.

The MCA PI and UA PI values for the corresponding gestational age were compared with reference values given by Srikumar et al [22]normograms. MCA PI was considered abnormal when it is less than 5thpercentile for that gestational age and UA PI

was considered abnormal when it is more than 95th percentile for the corresponding gestational age.

It is possible to use a single cut off value for cerebroplacental ratio because cerebral- umbilical Doppler ratio does not vary significantly between 30th and 40th weeks as reported by Waldimiroff et al[11] who observed a significant differences in cerebroplacental ratio only between weeks 26-38. After 26th week, the statistical comparison showed no significant differences between the intervals considered. Arbeille[23] et al also found the cerebral-placental ratio constant during the pregnancy and suggested 1 as the cut off value and all values below
1 were considered abnormal. We considered the study of Gramellini et al[12] that cerebroplacental ratio less than 1.08 as abnormal.

We have studied about 50 pregnancies with clinical suspicion of IUGR. There were 6 intra uterine deaths and 44 live births. Of the 44 live births, 10 neonates were admitted to NICU, 9 neonates had 5 min Apgar score of less than 7 and 12 babies was born by emergency caesarian section for fetal distress. Of the 6 IUDs, 4 cases had reversal of diastolic flow and 2 had absent diastolic flow. In all cases with reversal of diastolic flow, IUD of the fetus occurred with in one week of diagnosis.

Umbilical artery - It was found to have slightly low sensitivity of 91.3% when compared to MCA PI (95.7%). The sensitivity higher than that of Fong KW et al[26] and Gramellini et al[12].

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	Fong K W et al	Gramellini et al	Present study
Sensitivity	44.7%	64%	91.3%
Specificity	86.6%	90.7%	66.6%
PPV	54%	72.7%	70.0%
NPV	81.7%	86.7%	94.4%

The specificity of the UA PI 66.6% was found to be better than other variables. The specificity was comparable with the above mentioned studies. The UA PI is effective to rule in the possibility of adverse perinatal out come when it is abnormal. The Positive Predictive Value of UA PI 70.0% was more than that of MCA PI(68.8%). It indicated the likelihood of adverse perinatal outcome in growth retarded fetus with abnormal UA PI. The positive predictive value was comparable to other studies. The negative predictive value 94.4% obtained in our study was comparable with the above mentioned studies. This was more than that of MCA PI and cerebroplacental ratio.

Our findings confirm the results of Fong KW et al[26], Chan et al[24] and Gramellini et al[12] that abnormal UAPI is associated with adverse outcome like NICU admission for low birth weight and low apgar scores than the one with normal UA PI. It provides the most useful information for differentiating fetuses already compromised or likely to become compromised from those that are non-compromised.

Our findings agree with Harrington et al[22] that umbilical artery can be normal in term and near term with abnormal middle cerebral artery. In our study we had 2 false negative values out of which one patient was32 week gestation and one was 36-week gestation.

Middle cerebral artery - was found to have highest sensitivity of 95.7% more than that of cerebroplacental ratio and UA PI. The values were not comparable with the below mentioned studies.

	Fong K W et al	Gramellini et al	Present study
Sensitivity	72.4%	24%	95.7%
Specificity	58.1%	100%	63.0%
PPV	37.7%	100%	68.8%
NPV	85.7%	77.3%	90%

It showed specificity 63% lesser than the other two parameters. It agrees with Fong et al[26] that MCA PI is less specific than cerebroplacental ratio and UA PI. The study had a greater number of false positive values. There are several possible explanations for the low Specificity of the MCA pulsatility index for adverse perinatal outcome. Among several published nomograms for MCA PI [8,96,97] the cutoff values for an abnormal MCA pulsatility index are similar up to about 30 weeks gestational age but differ after 32 weeks. The nomograms we chose to use for analysis are from the largest published cross-sectional study by Harrington K et al[22].

Positive predictive value of MCA PI 68.8% in predicting adverse perinatal outcome is also less than that for other variables, which can be attributed to the more false positive values.

The negative predictive value of 90% is comparable with that Fong et el study. It is more than the UA PI, thus indicating the usefulness of MCA PI in ruling out the possibility of adverse perinatal outcome.

Cerebroplacental ratio - It had the sensitivity value of 91.3% which is less than that of MCA. The values were not comparable with any other study because of variation in the prevalence of IUGR.

The high sensitivity of cerebroplacental ratio indicates its usefulness of cerebroplacental ratio in ruling out the possibility of adverse perinatal outcome in IUGR when the ratio is normal for the gestational age.

It showed the specificity of 81.48% which is more than UA PI and MCA PI. The values were comparable with Fong et al[26] study.

The positive predictive values 80.8% is more than UA PI and MCA PI. The value was comparable with Gramellini et al[12] study.

	Fong K W et al	Gramellini et al	Present study
Sensitivity	51.3%	68%	91.3%
Specificity	80.6%	98.4%	81.48%
PPV	48.1%	94.4%	80.8%
NPV	82.5%	88.8%	91.6%

The negative predictive value 91.6% is better than that of MCA PI but less than UA PI. The values were comparable with that of Fong.K Wetal [26]and Gramel liniet al[12] studies. It indicates that the likelihood of prediction of favorable outcome is better when the cerebroplacental ratio is normal.

Out of 11 cases with absent or reversed end diastolic flow in umbilical artery, 54.4% had perinatal death within one week 100% mortality was seen in cases with reversed diastolic flow and 28.5% mortality in cases with absent diastolic flow. This confirms the findings of Karsdrop et.al[21], which showed that absent and reversed diastolic flow is better indicator of the adverse perinatal outcome. The current study has shown that absent or reversed end – diastolic flow in the umbilical artery is strongly associated with major perinatal morbidity with mortality. This has been well recognized in the literature that there is strict correlation between the abnormal UA PI and poor perinatal outcome in IUGR. Studies have shown that absent and reversed diastolic flow in the umbilical artery is associated with increased perinatal mortality and morbidity [23,35,36,37].

In our study when we compare the overall diagnostic accuracy in prediction of adverse outcome in IUGR. Cerebroplacental ratio has the diagnostic accuracy of 86% which is more than UA PI (78%), MCA PI (78%). The values obtained in our study are comparable with that of Gramellini et al[12].

	Gramellini et al	Present study
MCA/UA PI Ratio	90%	86%
UA PI	83.3%	78%
MCA PI	78.8%	78%

The primary aim of antepartum fetal surveillance is timely recognition of fetal compromise to enable appropriate intervention and to prevent further serious complications. If the fetus would otherwise die inutero, delivery might save its life, but ill-adviced preterm delivery may be followed by postnatal death. Hence Doppler of fetoplacental circulation plays a significant role in predicting the adverse perinatal outcome in IUGR fetus which helps in the management of such fetuses.

Our results in evaluating the usefulness of umbilical artery and middle cerebral artery Doppler in predicting the adverse perinatal outcome in IUGR indicate that both abnormal umbilical Doppler indices and cerebral-umbilical ratio are strong predictors of adverse outcome in IUGR. The MCA PI alone is not a reliable indicator when used alone. The combination of umbilical and fetal cerebral Doppler indices may increase the utility of Doppler ultrasound in clinically suspected IUGR.

VII. CONCLUSION

- Doppler ultrasonography is the best noninvasive investigation to assess changes in fetal hemodynamics in a clinically suspected IUGR.
- Fetal Doppler indices provide information that is not readily obtained from more conventional tests of fetal well-being.
- Fetal vessels such as umbilical artery and middle cerebral artery Doppler helps to differentiate the fetus with pathological growth restriction from that of other small for gestational age fetuses.
- Both abnormal umbilical Doppler indices and cerebral-umbilical ratio are strong predictors of adverse outcome in IUGR.
- Umbilical artery Doppler is more useful than middle cerebral artery in prediction of outcome in IUGR when considered individually.
- Absent and reversed diastolic flow in umbilical artery in IUGR is an ominous finding, associated with increased mortality and morbidity.

Fetal Doppler study plays a significant role in management of growth restricted fetus by identifying compromised growth restricted fetus from that of noncom promised growth restricted fetus. Fetal Doppler study should be an integral part while evaluating in-utero health of the growth restricted fetus.

SUMMARY

IUGR is associated with an increased risk of perinatal mortality, morbidity and impaired neurodevelopment. The correct detection of the compromised IUGR fetus to allow timely intervention is a main objective of antenatal care.

Doppler ultrasound allows a noninvasive assessment of fetal hemodynamics. Doppler investigation of the umbilical arteries provides information concerning perfusion of the fetoplacental circulation, while Doppler study of

cerebral vessels detects the hemodynamic rearrangements that occur in response to fetal hypoxia.

We have studied Umbilical and middle cerebral artery pulsatility index in about 50 pregnancies with clinical suspicion of IUGR and correlated the findings with the perinatal outcome. There were 6 intra uterine deaths and 44 live births. Of the 44 live births 10 neonates were admitted to NICU. 9 neonates had 5 min Apgar score of less than 7 and 12 babies was born by emergency caesarian section. Of the 6 IUDs 4 cases had reversal of diastolic flow and had absent diastolic flow. In all cases with reversal of diastolic flow, IUD of the fetus occurred within one week of diagnosis.

In our study MCA PI/UA PI ratio had a higher Specificity and positive predictive value for predicting adverse perinatal outcome when compared to MCA PI and the UA PI, UA PI had higher negative predictive value than MCA PI and MCA PI/ UAPI, MCA PI had the least specificity. The overall diagnostic accuracy was higher for MCA PI/UA PI than MCA PI and UA PI alone.

In our study MCA PI is most sensitive and MCA PI/UA PI is most specific index in predicting adverse outcome. MCA PI is least specific in predicting adverse perinatal outcome. Absent or reversed end diastolic flow in an umbilical artery is an ominous finding associated with major adverse perinatal outcome and mortality.

Thus the umbilical and middle cerebral artery Doppler studies helps in the prediction of adverse perinatal outcome and management of clinically suspected IUGR.

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