



Correlation between Doppler and Perinatal Outcome in IUGR Babies

Authors

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Abstract

Introduction: Intrauterine growth retardation refers to a rate of growth of a fetus that is less than normal for the growth potential of a fetus (for that particular gestational age). IUGR affects 26 % of our population and is a major concern area both for obstetrician and neonatologist. Immediate complications to a growth restricted foetus include risk of intrauterine death, perinatal asphyxia, hypoglycemia, hypothermia and risk of sepsis in the neonatal period. IUGR predisposes them to adult onset diseases like diabetes and cardiovascular diseases too. Ultrasound with doppler velocimetry of the uteroplacental and foetal circulation is used to monitor the progress of disease in these IUGR babies. In the present study, an attempt is made to establish a relationship between foetal and uteroplacental changes and perinatal outcome.

Materials and Methods: It is a prospective study done in the Dept. of obstetrics and gynecology at Govt. medical college, thiruvananthapuram. 65 cases of clinically detected ultrasound confirmed cases of IUGR in third trimester were the subjects. Serial Doppler measurements of the umbilical artery, middle cerebral artery and ductus venosus were recorded till a decision for termination of pregnancy was taken. Last measurement values were taken for statistical analysis. Based on these measurements patients were classified into 4 groups.

Group 1-IUGR with normal velocimetry in all 3 vessels

Group 2-abnormal Doppler velocimetry in umbilical artery only (elevated UA PI and or S/D ratio)

Group 3—abnormal Doppler velocimetry in MCA (MCA PI & or S/D ratio < 2 SD below the gestational age mean) in addition to abnormal UA PI with normal flow patterns in ductus venosus.

Group 4-abnormal wave forms in ductus venosus in addition to group 2&3. Pregnancy outcome including mode of delivery, gestational age at delivery, birth weight, APGAR scores, neonatal complications were recorded.

Results: 46% of subjects belonged to group1, 21% to group2, 29% to group3 and 3% to group 4. results showed that the mean gestational age at delivery of group 1 was 38.1 weeks, group2 -37 weeks, group 3 -35 weeks, and group 4- 30 weeks. (p value <.001). while considering the mode of delivery in group 1, 80 % had vaginal delivery and 20% CS. group 2 had 78% vaginal and 22 % caesarean section. Group 3 had 57% delivered vaginally and 43% by cs. In group 4, 100% cases were delivered by cs.

(p value>0.05). average birth weight in group1 -2.3 kg, group 2-1.89kg, group 3-1.69kg and group4-1.05kg (p value<0.01).

Summary and Conclusions: Doppler study of the foetoplacental circulation can accurately identify IUGR cases at risk of abnormal perinatal outcome. Normal umbilical Doppler velocimetry in IUGR effectively rules out the chance of an abnormal perinatal outcome. Cases with AEDV/REVD are associated with higher risk of perinatal morbidity and earlier deterioration of pregnancy. Abnormal ductus venous flow is a pre-terminal event and can cause rapid fetal loss if not intervened immediately.

Introduction

Intrauterine growth retardation refers to a rate of growth of a fetus that is less than normal for the growth potential of a fetus (for that particular gestational age). Growth restricted foetus have a 4-8 fold increase in risk of perinatal morbidity and mortality. Complications include increased risk of intrauterine death, perinatal asphyxia, hypoglycaemia, hypothermia, and risk of sepsis in the perinatal period. Complications of being small can be lifelong that it appears to predispose to adult disease including diabetes and cardiovascular disease¹.

In obstetric practice when to intervene in a pregnancy with intrauterine growth restriction is a million dollar question. Too early interventions can lead on to complications of prematurity while being late can lead on to intrauterine death of the baby. There are different modalities to help the obstetrician in this difficult decision. They include USS with biophysical profile, cardiotocography, foetal blood gas studies etc. CTG changes usually occur late while abnormal Doppler changes precede abnormal CTG by 1 day to 10 days². Foetal blood sampling studies are too cumbersome a procedure. Hence now foetal arterial and venous Doppler has been used as the best and non-invasive foetal monitoring method in IUGR babies³.

Ultrasound biometry picks up IUGR babies. These babies are further monitored with Doppler velocimetry of the foetal and uteroplacental circulation. Increased resistance patterns in umbilical artery are one of the criteria for diagnosis of uteroplacental insufficiency (Brain sparing in Doppler represents foetal compensatory mechanisms to uteroplacental insufficiency⁴. While the foetus is no longer able to thrive in the hostile intrauterine environment, venous Doppler changes start appearing. So by carefully studying the foetal circulation foetal oxygenation status, hypoxia and acidosis can be picked up by serial Doppler measurements. Thus Doppler becomes an effective tool for non-invasive monitoring of these high risk growth restricted foetuses and aids in the

timely intervention of these pregnancies prior to development of acidosis⁴.

In the present study an attempt is made to establish the relationship between foetal and uteroplacental Doppler changes and perinatal outcome.

Objectives of the study were

- To correlate the foetal arterial and venous Doppler findings with perinatal outcome in foetuses with IUGR
- Study design-prospective study
- Study setting-done by Department of obstetrics and gynaecology, Govt. Medical College, Thiruvananthapuram.
- Study period -1 year from 2011sep-2012 September

Subjects

65 cases of clinically and sonographically confirmed cases of IUGR admitted in hospital in third trimester of pregnancy were recruited into the study after informed consent from patients. Clinical criteria was fundal height < period of gestation by 4 weeks. And grey scale USS criteria was those patients with EFW < 10th centile for the gestational age. Patient details including LMP, dating USS, medical history details including pregnancy induced hypertension, chronic hypertension, other chronic diseases like renal disease, SLE, diabetes etc were recorded.

Serial Doppler parameters were obtained from Umbilical artery, Middle cerebral artery and Ductus venosus were recorded for all patients till a decision for pregnancy was taken. For IUGR with normal Doppler values serial evaluation was done at 3 weeks intervals. For patients with abnormal Doppler values, serial evaluation was done at weekly and less frequent intervals depending on the severity. Doppler values of the last measurement were taken for statistical analysis. Based on the measurements patients were classified into 4 categories.

Group 1-IUGR with normal velocimetry in all 3 vessels

Group 2-abnormal Doppler velocimetry in umbilical artery only (elevated UA PI and or S/D ratio)

Group 3—abnormal Doppler velocimetry in MCA (MCA PI & or S/D ratio <2 SD below the gestational age mean) in addition to abnormal UA PI with normal flow patterns in ductus venosus.

Group 4- abnormal wave forms in ductus venosus in addition to group 2&3

Outcome of these cases including mode of delivery, gestational age at delivery, APGAR scores, meconium staining of amniotic fluid, neonatal ICU admissions were recorded.

Method of statistical analysis

Mean and standard deviations for UA and MCA(S/D and PI values) were calculated for each group. Statistical comparisons between the outcomes in the groups were done using analysis of variance test and students T test. For qualitative data chi-square test was applied. Statistical significance was assigned to $p < .05$ level. Sensitivity and specificity of cerebroplacental ratio in predicting abnormal outcome was also calculated.

Study group consisted of 65 patients diagnosed with IUGR assessed with periodic duplex Doppler evaluation

Maternal demo graphics (n=65)

Maternal age	Number	percentage
<20	1	1.54
20-24 yrs	21	32.3
25-30yrs	29	44.62
>30	14	21.5

Maternal complications

Maternal complication	Number	percentage
Pre eclampsia	31	47.7
Chronic hypertension	2	3
Gestational diabetes	5	7
Heart disease	1	1
No underlying complication	26	40

Groups according to Doppler measurements

Group 1(normal Doppler)	30	46%
Group2(abnormal UA)	14	21%
Group3(abnormal UA+MCA)	19	29%
Group4(abnormal DV)	2	3%

Umbilical and MCA spectral waveforms were analysed and meanS/D ratio and PI were calculated.

Mean values for umbilical artery S/D ratio

	Group1	Group2	Group3	Group4
Mean UA S/D	2.7	4.3	4.88	-
Standard deviation	0.4	1	1.5	
n	30	13	16	2

Mean values for UA PI

	Group1	Group 2	Group3	Group4
mean UA PI	1	1.46	1.57	4
Std.dev	0.2	0.4	0.4	0
n	30	14	19	2

Mean values for MCA PI

	Group1	Group 2	Group3	Group4
Mean MCA PI	1.72	1.48	1.04	2.6
Std.dev	0.2	0.2	0.16	0
n	30	14	19	2

Mean values for MCA S/D

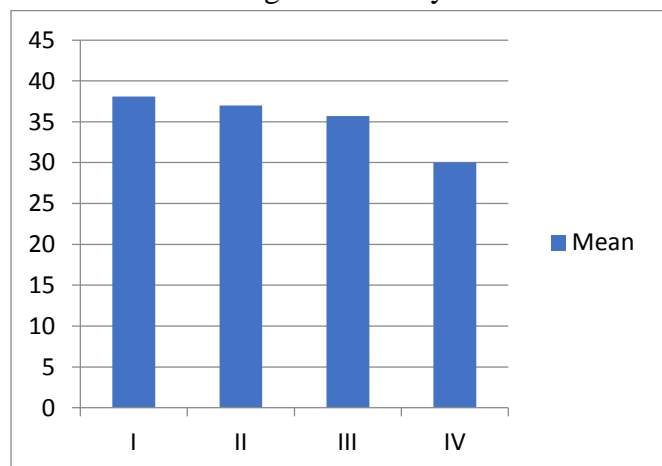
	Group1	Group 2	Group3	Group4
Mean MCA S/D	5.4	4.8	3.06	9
Std.dev	0.9	0.6	0.5	0.5
n	30	14	19	2

Pregnancy outcome was analysed by recording the mode of delivery, gestational age at delivery, birth weight, Apgar score at 5 minutes, meconium staining of amniotic fluid, neonatal ICU stay and neonatal complications.

Average gestational age at delivery(in weeks)

	Group1	Group 2	Group3	Group4
Mean	38.1	37	35	30
Stddev	0.9	1.2	1.7	0.5

Mean Gestational Age at Delivery

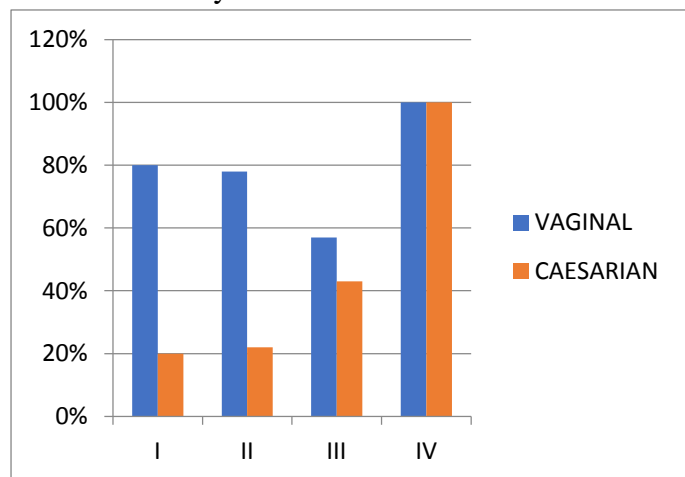
**Observation**

As the severity of Doppler abnormalities increased across the groups the mean gestational age at delivery decreased. This was found to be statistically significant. ($p < 0.001$)

Mode of delivery

Mode of delivery	Group1	Group 2	Group3	Group4
vaginal	80%	78%	57%	0
Caesarean	20%	22%	43%	100

Mode of delivery



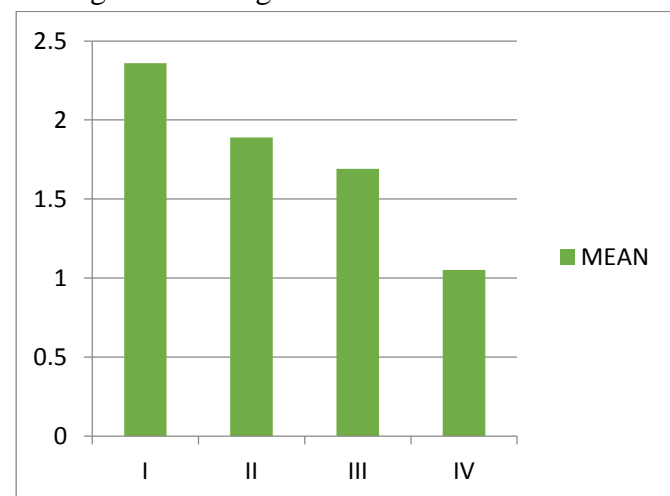
Chi-square value 3.13
 $p > 0.05$

The incidence of caesarean sections increased as the severity of Doppler abnormality increased across the groups. But this was not found to be statistically significant.

Average Birth Weight

B.Weight	Group1	Group 2	Group3	Group4
mean	2.36	1.89	1.69	1.05
Std.Devn	0.3	0.4	0.3	0.2

Average Birth Weight



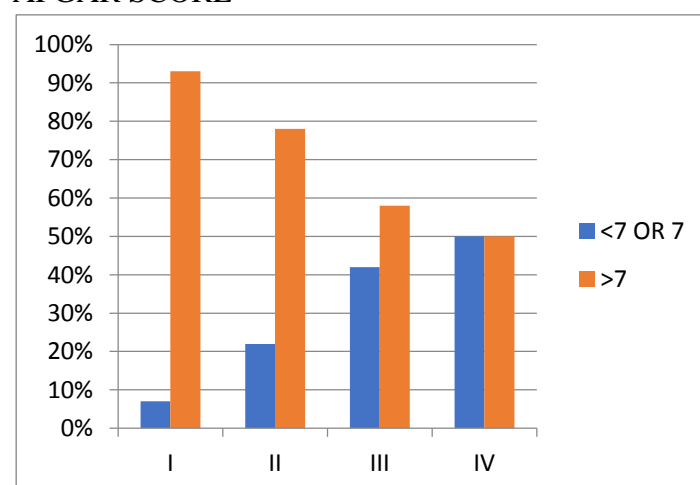
P value < 0.01

From this study we observed that mean birth weight decreased across the groups. This difference was found to be statistically significant

APGAR scores at 5 minutes

groups	>7	<7
1	93%	7%
2	78%	22%
3	58%	42%
4	50%	50%

APGAR SCORE



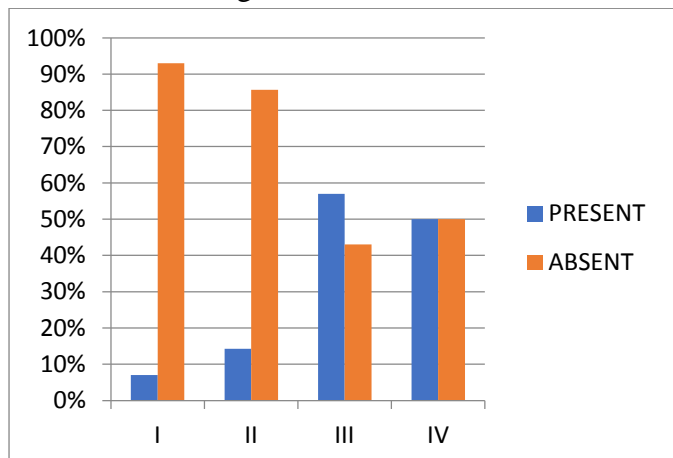
Chi-square value 8.5
P value < 0.05

As we move across the groups the incidence of low APGAR scores and foetal distress became more prevalent. This was found to be statistically significant.

Meconium staining of amniotic fluid

MSAF	Group1	Group 2	Group3	Group4
present	7%	14.3%	47%	50%
Absent	93%	85.75	43%	50%

Meconium staining of amniotic fluid



Chi-square value 22.84

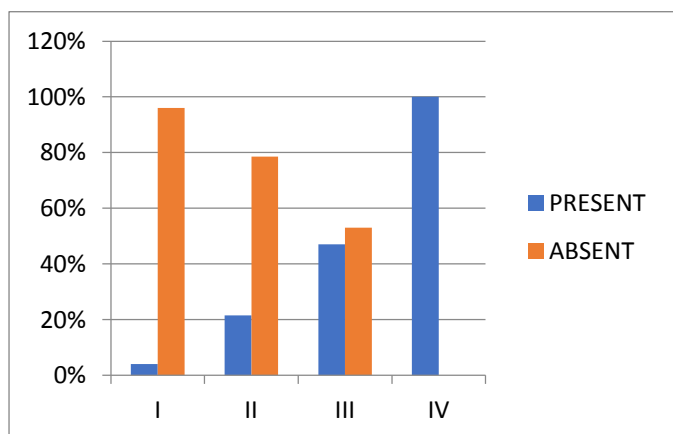
P<0.001

Meconium staining of amniotic fluid became more prevalent as the Doppler abnormality increases and this was found to be statistically significant

Neonatal ICU admissions

NICU admissions	Group1	Group 2	Group3	Group4
Present	4%	21.5%	47%	100%
ABSENT	96%	78.5%	53%	0%

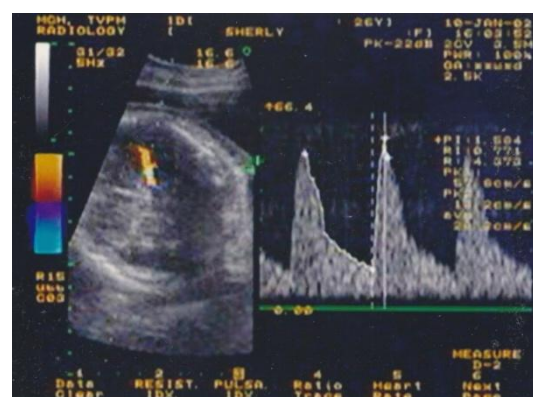
Neonatal ICU admissions



Reduced diastolic flow Umbilical artery



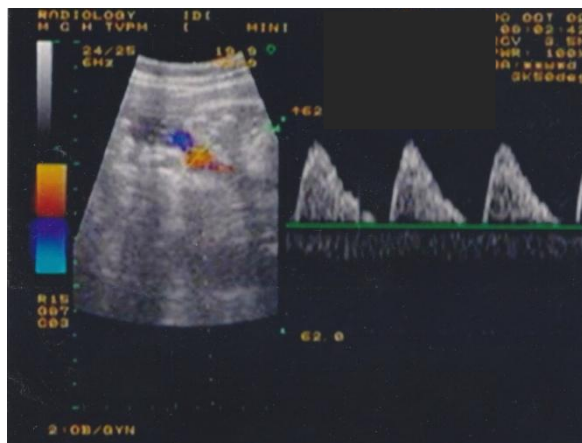
Absent end-diastolic flow Umbilical artery



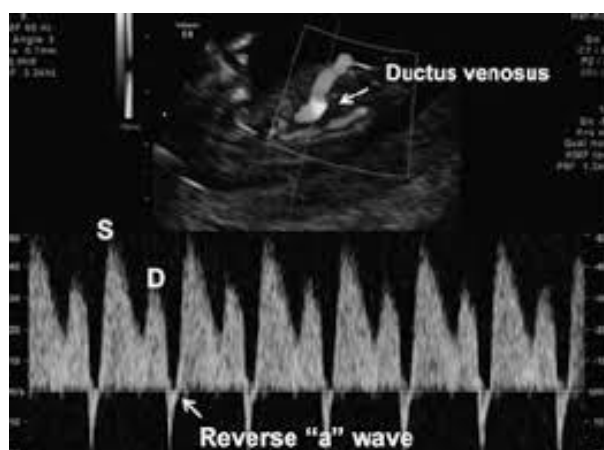
Normal flow in middle cerebral artery



Compensatory stage of middle cerebral Artery



Normal flowing Ductus Venosus



Reversal of flow in Ductus Venosus a wave

Discussion

Babies who are small due to intrauterine growth restriction are higher risk of poor perinatal and long term outcome than those who are appropriately born. The nature of this compromise is best assessed by the combination of foetal biometry, biophysical profile scoring and arterial and venous Doppler studies. This combination accurately predicts the foetal states and therefore the risk of still birth or poor transition to extra uterine life. In the preterm neonate, foetal factors, gestational age and neonatal course interact significantly to impact on short and long-term outcomes. The potential for iatrogenic prematurity is great and ongoing appraisal of peripartum management is critical. This study examined the relationship between Doppler findings of the arterial and venous circulation of foetuses with intrauterine growth restriction and their subsequent perinatal outcome.

In this study 46% of patients had normal Doppler velocimetry in all three vessels till the termination of pregnancy. The mean gestational age at delivery for these patients was 38 weeks (S.D 0.9). 80% of these patients had normal vaginal delivery and rest of them were delivered by caesarean section. Only two patients had non elective caesarean section. The mean birth was 2.36 kg (S.D 0.3). Only two patients in this group had low Apgar score and meconium staining of liquor at delivery. Of this one was a case of congenital nephrotic syndrome and died in the neonatal period. The other baby recovered immediately without any long-term sequelae. With the exception of these two cases, no foetus with a normal Doppler measurement had abnormal perinatal outcome.

In this study we found that there is a statistically significant relationship between abnormal Doppler parameters and pregnancy outcome except for the mode of delivery. The outcome parameters like low APGAR score, meconium staining of liquor and neonatal ICU admissions which were indicators of foetal distress were significantly higher in patients with abnormal Doppler than in patients with normal Doppler findings. We also found that as the severity of Doppler abnormality increased which reflects the hemodynamic modification of foetuses the incidence of foetal distress also increased significantly.

The mean gestational age at delivery also decreased significantly as the severity of Doppler abnormality decreased. In all these cases decision to terminate pregnancy was based on multiple parameters like abnormal biophysical profile, cessation of foetal growth on interval ultrasound biometry, non reactive NST or deteriorating maternal conditions. This shows the role of Doppler to predict iatrogenic prematurity. Even though our study shows an increased incidence of caesarean sections, with abnormal Doppler findings this was not statistically significant.

We compared our study with another study conducted by Baschat⁵ from university hospital, Baltimore. They compared MCA, IVC, Ductus

venous and umbilical vein velocimetry in 121 IUGR fetuses with UA PI>2 SD above gestational age. They classified the study group into three based on last Doppler examination. 1) abnormal UA PI only 2) MCA PI >2SD below the gestational age mean 3) Ductus venous or IVC PVIV>2SD above GA mean. Perinatal outcomes were calculated. AEDF/REDF was found in 9.5% of group 1, 34% of group 2, and 82% of group 3 patients. A low MCA PI was found in 78% fetuses of group 3. Analysis showed that the association was strongest for with gestational age for each complication. There was no significant difference in APGAR scores between the groups at delivery. Brain sparing was associated with hypoxemia and abnormal venous changes with academia. Perinatal mortality was highest in group 3 and stillbirth was observed when venous flows were abnormal.

In the present study we had a control group that is IUGR with normal Doppler velocimetry as well. And we could see that IUGR with normal Doppler in umbilical artery is a benign condition⁶, and almost all of these babies had an uneventful perinatal outcome. Brain sparing effect was associated with higher perinatal complications in our study. In another study by Bacchantetal⁷ Neonatal nucleated red blood cell counts in growth-restricted fetuses: relationship to arterial and venous Doppler and nucleated red cells and circulatory decompensation in IUGR were studied. Fetuses were classified into 3 groups as in previous study. Comparing the outcome of our study with that of Bacchat

	Gp -1	Gp -2	Gp -3
Av. Gest. Age	37 34	35.7 32.2	30 30
B wt	1.89 1.57	1.69 1.45	1.05 853g
Mode of Delivery (cs)	22% 50%	43% 69%	100% 92%
Apgar <7 at 5 mts	22% 59%	42% 54%	50% 75%
NICU stay	22% 60%	47% 60%	100% 75%

Group 1 -abnormal umbilical artery flow

Group 2- abnormal UA+MCA flow.

Group 3-abnormal flow in ductus venous

First value in each column –present study

Second value in each column study by Bacshat et al

He concludes that increasing abnormality of arterial and venous flows in fetuses with intrauterine growth restriction is associated with increasing nucleated red blood cell count at birth⁷. Metabolic academia rather than altered PO₂ associated with this circulatory state appears to be the main determinant of the rise in nucleated red blood cells. All the data in these two studies are comparable except the average gestational age was found to be lower in the western study.

This study has shown that Doppler screening of these IUGR patients can accurately pick up those cases at high risk of abnormal outcome and a strict antenatal surveillance can be offered to this target group. Thus Doppler study has an important cost implication in that it reduces the number of unwanted antenatal surveillance tests in the routine grayscale ultrasound detected cases of IUGR and also reduces unwanted maternal psychosocial stress. Pregnancies complicated by absent or reversed end diastolic flows are at risk of perinatal morbidity and mortality and should be timely terminated⁸. Studies have shown that there is high incidence of respiratory distress syndrome, hypoglycemia and anemia in this group due to large number of preterm infants in this group. There is also increased incidence of necrotizing enter colitis due to diversion of blood from intestines to vital organs.⁹

Studies including pregnancies complicated by absent or reversed end diastolic flow shows that during absent or reversed end diastolic flow an extremely low cerebral vascular resistance exists with sudden cerebral hyper perfusion which may cause cerebral haemorrhage. Studies show that pregnancies complicated by pre-eclampsia and associated IUGR has highest risk of being complicated by absent or reversed end diastolic flow in umbilical artery.¹⁰ In our study 4 cases out of six cases had maternal pregnancy induced hypertension. Hence patients with pregnancy

induced hypertension complicated by IUGR should be assessed by Doppler to enhance early detection of uteroplacental insufficiency¹¹ and enable selection of patients at risk of developing absent or reversed end diastolic flow especially when IUGR has set in early.

Studies have shown that growth restricted fetuses with abnormal venous flow has worst perinatal outcome compared to those where flow abnormality is confined to umbilical or middle cerebral artery¹². In fetuses with low MCA pulsatility, venous Doppler allows detection of further deterioration. While abnormal venous flows can be significantly associated with fetal demise, gestational age at delivery significantly impacts on all short term outcomes.

Summary and Conclusion

- Doppler study of foetoplacental circulation can accurately identify those cases of IUGR who are at risk of abnormal perinatal outcome.
- The finding of normal antenatal Doppler study in an uncomplicated case of IUGR effectively rules out the subsequent risk of perinatal complications.
- Cases with absent or reversed end diastolic flow in umbilical arteries is frequently associated with pre-eclampsia and higher risk of perinatal mortality and earlier deterioration of pregnancy than those with presence of diastolic flow
- Abnormal ductus venosus waveform is a pre-terminal event and leads to rapid fatal loss if not intervened immediately.

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