

Research Article

Doppler study of middle cerebral artery and umbilical artery in biometrically suspected intra uterine growth restricted pregnancies

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ABSTRACT

Background: Intra uterine growth restricted (IUGR) is when the expected foetal weight is less than 10th percentile for gestational age. The hemodynamics of the fetus takes into account both the umbilical-placental and cerebral vascular beds. Underlying etiology that results in the failure of a foetus to attain its expected growth may vary. However the final infliction is via uteroplacental insufficiency. It is highlighted that inadequate uteroplacental perfusion is the main and primary pathology in growth restriction resulting in an increased umbilical artery impedance. Following this step are the changes in the middle cerebral artery (MCA) which categorically set in as a secondary phenomenon.

Methods: Duplex Doppler Sonography is a reliable, non-invasive and rapid diagnostic technique in IUGR patients. Grey scale findings together with colour Doppler characteristics help in the qualitative as well as quantitative evaluation of the Uteroplacental and Fetoplacental circulation. Hence ultrasonography (USG) has become the most widely used, standard and simple way of detecting and confirming IUGR. Ultrasound biometry is the gold standard for assessment of foetal size. Various criteria are used to label a foetus growth restricted; foetal weight less than 10th percentile for gestational age is mostly widely accepted criterion. Others like elevated HC/AC ratio, elevated FL/AC ratio, and presence of oligohydramnios without ruptured membranes, presence of advanced placental grade can also be used for improving the accuracy of diagnosis. After establishing the diagnosis of IUGR, Doppler imaging becomes a valuable investigating method for monitoring the pregnancy because it provides information about the hemodynamic status of the foetus. Uteroplacental system evaluation takes into account the flow pattern of uterine artery, reflecting any underlying Uteroplacental vascular ischemia. Umbilical artery Doppler waveforms reflect the status of the fetoplacental circulation and any underlying placental insufficiency.

Results: Fourteen cases showed absent umbilical artery end diastolic flow and four patients showed reversal of end diastolic flow. Twenty two patients showed elevated PI. Adverse perinatal outcome was observed in all patients with absent and reversal of end diastolic flow. Out of the twenty two with elevated PI fifteen showed adverse outcome. Thirty six cases showed low MCA PI and six showed a pseudonormalization. A cerebro-placental ratio of < 1.08 was observed in 16 patients, it was calculated in only those pregnancies that showed forward diastolic flow in umbilical artery (n= 22). Fifteen of them showed adverse perinatal outcome.

Conclusions: Doppler imaging is of value for monitoring pregnancies complicated with IUGR because it can provide indirect evidence of foetal compromise and is known to improve outcome of high risk pregnancies. Doppler evaluation is complementary to all other surveillance modalities. Because the changes in umbilical, uterine & MCA strongly correlate with pregnancy outcome in growth restricted foetuses the use of foetal biometry & Doppler examination is recommended in all cases of suspected IUGR cases.

Keywords: IUGR, Umbilical artery, uterine artery, Middle cerebral artery (MCA), Pulsatility Index (PI), Resistive Index (RI), Systolic to Diastolic Ratio (S/D)

INTRODUCTION

Materno-foetal medicine works with a sole purpose of delivering healthy newborns without any compromise on maternal and foetal health. The unborn foetus undergoes the process of continuous growth in the maternal womb, the assessment of which is a topic of concern and extensive research. Before the Ultrasound era, this growth assessment was done by taking into account the uterus size by palpation and inferring the weight of foetus on birth. But birth of ultrasound has further improved the challenges faced with timely birth of physically altered growth restricted foetuses, by confirming the diagnosis of growth restricted babies on antenatal scans.

The condition intrauterine growth restriction (IUGR) is implied to those foetuses who do not achieve their genetically determined potential size. IUGR being a major complication of pregnancy may result in significant morbidity and mortality, hence timely diagnosis is of utmost importance. The widely accepted definition of IUGR is a foetus whose estimated foetal weight is below the 10th percentile for its gestational age.¹

Growth of the foetus is multifactorial depending upon the mother, the foetus and the placenta. Disturbance in any of these determinants results in IUGR.² Both foetal and maternal blood flow has to be adequate for normal placental function and subsequently foetal growth. Any compromise in the fetoplacental circulation results in placental insufficiency which further promotes compensatory changes in the foetal circulation.

Accurate and timely diagnosis of IUGR is the pivotal role fulfilled by modern day sophisticated Real time ultrasound equipment, reducing the devastating perinatal complications.

After biometric parameters have been assessed Doppler imaging is taken into account for monitoring the high risk pregnancies/ foetuses diagnosed with IUGR on grey scale findings. It exploits the Doppler Effect reported by Christian Doppler in 1842, which is an apparent variation in frequency of a light or a sound wave as the source of the wave approaches or moves away relative to an observer. With the advent of Doppler ultrasound, assessment of uteroplacental and fetoplacental circulations of high risk pregnancies can be monitored. Non-invasive Doppler technique is also exploited to assess foetal circulation in response to hypoxia. Doppler techniques give us various flow velocity waveforms or spectral waveforms of the vessels that contribute to fetoplacental and uteroplacental circulations. Various parameters such as pulsatility index (PI), resistivity index (RI) and systolic to diastolic (S/D) ratios can be assessed.

Aim

Doppler study of Middle Cerebral Artery (MCA) and Umbilical Artery (UA) in biometrically suspected Intra Uterine Growth Restricted (IUGR) pregnancies.

Objectives

1. To evaluate the role of Doppler ultrasound in the evaluation of biometrically suspected IUGR pregnancies.
2. To assess the fetoplacental circulation (umbilical artery) and foetal circulation (middle cerebral artery).
3. To evaluate the usefulness of Doppler indices in predicting the adverse perinatal outcome in biometrically suspected IUGR pregnancies using umbilical artery and middle cerebral artery indices.

METHODS

Fifty women with biometrically suspected singleton intrauterine growth restricted pregnancy were enrolled in this Doppler study after clearance from the ethical Committee of Dr. D. Y. Patil Medical College, Hospital and Research Centre. The study was conducted over two years from July 2012 to September 2014.

All biometrically suspected singletons IUGR pregnancies were enrolled in this study and Duplex Doppler ultrasound findings of Uteroplacental, Fetoplacental and foetal circulation was assessed. Biometric parameters suggestive of IUGR that were included in our study are foetal weight, head circumference, Biparietal Diameter, Abdominal circumference, Femur length, Amniotic fluid index and Placental grading.

Patient selection criteria

All the patients included were singleton pregnancies suspicious for IUGR on the basis of above mentioned biometric parameters, Doppler study was performed and these patients were followed up to their clinical outcome.

Exclusion criteria

- Pregnancies with congenital abnormality.
- Multiple gestations.

After taking an Informed consent from all the patients, a detailed history was obtained from the patient focusing on risk factors of IUGR, previous obstetric history, any associated history of pregnancy induced hypertension (PIH), Diabetes Mellitus (DM) and infections. The Doppler examination was explained to the patient and any questions were answered. Doppler examination with good results and spectral waveforms was obtained when the foetus was particularly at rest. Follow up Doppler studies were performed, if clinically indicated to determine a favourable or a worsening trend in the Doppler indices. In addition also to aid in decision

making of when to immediately intervene the pregnancy. Also the clinical outcome of the pregnancy enrolled in the study was analysed.

Variables of perinatal outcome assessment included

1. Birth Weight
2. Perinatal death
3. Emergency Caesarean section for foetal distress
4. Low 5 APGAR score (APGAR score less than 7)
5. Admission to NICU for complications of low birth weight

A pregnancy was considered to have an “Adverse outcome” in the terms of the following complications:

1. Perinatal death
2. Emergency CS for foetal distress
3. 5 minute APGAR score of less than 7
4. Admission to NICU for complications of low birth weight.

In the absence of above complications pregnancy outcome was considered to be “Uneventful or Favourable”.

Duplex Doppler sonography was performed with Siemens X300, Siemens Acuson Antares and Aloka ProSound sonography unit operating at a frequency of 2 to 6 MHz (curvilinear probe) with pulsed and colour Doppler capability (Figure 1).



Figure 1: Aloka ProSound, Siemens Acuson X300 and Siemens Acuson Antares unit.

Grey scale imaging was done initially, followed by colour flow imaging and spectral evaluation of the uterine arteries, umbilical artery and Middle cerebral artery.

Doppler evaluation

Assessment of uterine artery

Technique of Doppler examination

Mother should lay relaxed and supine; the Doppler

examination is carried out during a period of uterine inactivity. Region of interest is just lateral to the cervico-corporal junction, first the external iliac artery is identified, and then the uterine artery is identified medial to it, crossing the external iliac artery during its course from the internal iliac artery to the body of the uterus. Doppler measurements are taken near this junction at the crossover. The angle of insonation should be appropriate as to get good waveforms (Figure 2).

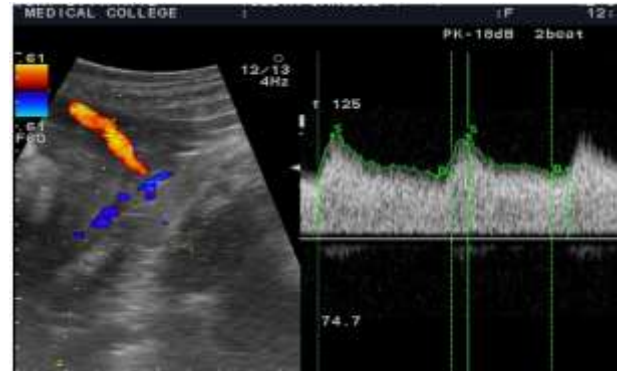


Figure 2: Showing crossing of artery during its course from the internal iliac artery to the body of the uterus.

Assessment of umbilical artery

The umbilical arteries take their origin from the two internal iliac arteries and join together to enter the umbilical cord. Approximately 40% of the combined foetal ventricular output passes through the umbilical arteries.

Technique of Doppler examination

Colour duplex Doppler mode is first used to identify a free floating loop of the umbilical cord. With the use of lowest possible wall filter and angle of insonation (<10o) measurements are obtained (Figure 3).



Figure 3: Showing identification of a free floating loop of the umbilical cord and subsequently Doppler indicates are obtained.

Assessment of middle cerebral artery

MCA assessment is a direct reflection of cerebral blood flow in fetuses. The ease of detectability makes MCA, the most frequently examined vessel. MCA, the largest terminal branch of the internal carotid artery courses laterally towards the edges of the orbits at the level of the lesser wing of sphenoid bone. Then it courses in the lateral sulcus and the cerebral fossa through the insula and temporal lobe.

Technique of Doppler examination

A transaxial view of the foetal head is obtained; section chosen is a plane that is slightly more caudal to the plane used for BPD measurements, which include the cerebral peduncles. Proximal part of the MCA is chosen to place the Doppler sample volume. The angle of insonation is kept close to zero for this vessel. After obtaining a good waveform Peak systolic velocities are measured (Figure 4).



Figure 4: Showing identification of circle of Willis and then subsequently MCA.

Systolic flow (A) and the diastolic flow (B) for the above mentioned arteries were obtained.

Doppler indices were calculated.

- Systolic/Diastolic(S/D) ratio= A/B
- Resistance index (RI)= A-B/A
- Pulsatility index (PI)= A-B/mean

Doppler examination was used to decide further management of the cases. In addition depending upon clinical status of the patients and the Doppler report, decisions on termination of pregnancy or continuation of pregnancy with close surveillance were taken. Follow up Doppler and biometric scans for foetal wellbeing and growth assessment varied from patient to patient.

The uterine artery RI > 0.58 and presence of diastolic notch were considered abnormal.

The umbilical artery PI was considered abnormal if the

value was above the 95th percentile for the gestational age.

The MCA pulsatility index was considered abnormal if the value was below the 5th percentile for the gestational age, according to reference values of D Gramellini et al.³

In our study a single cutoff value of 1.08 for MCA/UmbA PI ratio (cerebral-umbilical ratio) was used, values above 1.08 were considered normal and below were considered abnormal, according to reference values of D Gramellini et al.

RESULTS

A total of 50 cases were included in the prospective study, after considering the inclusion and exclusion criteria. Doppler study of the maternal Uterine and foetal Umbilical and Middle cerebral arteries was performed on the 50 patients suspected to have intrauterine growth restricted babies on biometric parameters.

Age distribution

In our study the mean maternal age of pregnant women with IUGR babies (n=50), was in range of 18- 35 years. Higher incidence was noted in women in the 20-30 years age group (n=44). This was followed by patients that constituted the < 20 age group or >30 years age group.

Table 1: Age wise distribution of cases.

Age in years	Number	Percentage
<= 20	5	10%
21-25	22	44%
26-30	22	44%
>30	1	2%
Total	50	100%

Parity distribution

Primipara (n=29) constituted 58% and multipara (n= 21) constituted 42 %. In this study multiparous patients were marginally less than the primi group.

Table 2: Parity distribution.

Parity	Number (N= 50)	Percentage
Primi	29	58%
Multi	21	42%

Distribution of gestational age at Doppler examination

In the study group of 50 pregnant mothers, the gestational age at the time of Doppler examination ranged between 31 to 39 weeks.

Table 3: Distribution of gestational age at Doppler examination.

Gestational age	Number (N= 50)	Percentage
30- 33 weeks	12	24%
34- 36 weeks	14	28%
>36 weeks	24	48%
Total	50	100%

Majority i.e. twenty four of the pregnant females examined were above 36 weeks of gestation. None of the females were examined before 28 weeks since Doppler parameters stabilize by 28 weeks of gestation.

Clinical presentation with associated risk factors

In our study on 50 patients who were biometrically suspected to have growth restricted babies, majority (n= 21) presented with maternal hypertensive disorder, followed by anaemia (n= 7), Diabetes mellitus (n= 3) and bad obstetric history (n=4). Only IUGR with no other associated risk factor was observed in 16.

Bad obstetric history included previous IUGR pregnancy and placenta Previa.

Table 4: Clinical presentation (Maternal Risk factor) at Doppler examination.

Clinical presentation	Number	Percentage
IUGR with PIH	21	42 %
IUGR with Anaemia	7	14 %
IUGR only	16	32 %
IUGR with bad obstetric history	7	14 %

Amniotic fluid index

Growth restricted babies showed a high association with oligohydroamnios.

Twenty four percent of pregnancies had a normal amniotic fluid index.

Table 5: showing Distribution of AFI in cases.

Amniotic fluid index	Percentage
Normal	24 %
Oligohydromanios	76 %

Placental grading

The proportion of Grade III placenta was higher among growth restricted babies as compared to Grade II.

Umbilical artery Doppler parameters

Umbilical artery Pulsatility Index (PI):

The pulsatility index was calculated in all those patients who showed a forward positive end diastolic flow. The pulsatility index was elevated in 22 patients and normal in 10 patients.

Table 6: Distribution of placental grade of cases.

Placental Grade	Number (n=)	Percentage
Grade II	17	34 %
Grade III	33	66 %

Table 7: Distribution of PI of umbilical artery.

PI	Number (n= 32)	Percentage
Normal	10	31.2 %
Elevated	22	68.7 %
Total	32	

Umbilical artery Resistive Index (RI):

Out of the 32 cases with forward diastolic flow, twenty five showed elevated RI.

Table 8: Distribution of RI of umbilical artery.

RI	Number (n= 32)	Percentage
Normal	7	21.8 %
Elevated	25	78.1 %
Total	32	

Umbilical artery Systolic to Diastolic ratio (S/D):

Twenty one cases showed elevated S/D ratios and eleven showed normal values.

Table 9: Distribution of S/D of umbilical artery.

S/D	Number (n= 32)	Percentage
Normal	11	34.3 %
Elevated	21	65.6 %
Total	32	

Table 10: Distribution of end diastolic flow of umbilical artery.

End diastolic flow patterns	Number (n= 50)	Percentage
Positive diastolic flow	32	64%
Absent	14	28%
Reversal	4	8%

End diastolic velocity flow patterns of foetal umbilical artery

In our study fourteen growth restricted foetuses showed absence of diastolic flow (28%) and four of the foetuses showed reversal of flow (8%). Foetuses with absence or

reversal of diastolic flow were associated with higher incidence of foetal complications.

Foetal outcome in growth restricted babies in relation to altered umbilical artery Doppler parameters

Table 11: Distribution of adverse vs uneventful outcome.

Parameter	Adverse (N)	Percentage	Normal (N)	Percentage
Absent Diastolic flow N= 14	14	100 %	0	
Reversed Diastolic flow N= 4	4	100 %	0	
Raised PI N= 22	15	68.1 %	7	31.8 %
Raised RI N= 25	15	60 %	10	40 %
Raised S/D N= 21	15	71 %	6	71.4 %

Total Number of patients with Adverse outcome in relation to the altered Umbilical artery parameters (n = 50)

Table 12: Adverse vs uneventful outcome.

Outcome	Total (n= 50)	Percentage
Normal	17	34 %
Adverse	33	66 %
Total	50	

Middle cerebral artery Doppler study

Pulsatility index (PI) of Middle cerebral artery:

Out of the 50 cases seventy two percent showed reduced PI and twelve percent showed pseudonormalization.

Table 13: Pulsatility index (PI) of middle cerebral artery.

PI	Total (n= 50)	Percentage
Normal	8	16 %
Decreased	36	72 %
Pseudonormalization	6	12 %

Adverse outcome in Patients with altered PI (Reduced PI and Pseudonormalization, n = 42)

Adverse pregnancy outcome was seen in 42 cases.

Resistive Index (RI) of Middle cerebral artery:

Total of twenty seven patients showed reduced RI and six showed pseudonormalization.

Table 14: Adverse vs normal outcome in foetuses with altered Pulsatility Index (PI) of Middle cerebral artery.

Outcome	Number (n= 42)	Percentage
Adverse	32	76.1 %
Normal	10	23.8 %
Total	42	

Table 15: Resistive Index (RI) of Middle cerebral artery.

RI	Total (n= 50)	Percentage
Normal	17	34 %
Decreased	27	54 %
Pseudonormalization	6	12 %

Adverse outcome in Patients with altered RI (Reduced RI and Pseudonormalization, n = 33)

Table 16: Adverse vs normal outcome in foetuses with altered resistive index (PI) of middle cerebral artery.

Outcome	Number (n= 33)	Percentage
Adverse	32	96.9 %
Normal	1	3.0 %
Total	33	

S/D ratio of middle cerebral artery

Twenty nine patients out of fifty showed reduced S/D ratios.

Table 17: S/D ratio of middle cerebral artery.

S/D	Total (n= 50)	Percentage
Normal	15	30 %
Decreased	29	58 %
Pseudonormalization	6	12 %

The growth restricted foetuses with cerebral changes secondary to foetal hypoxemia which resulted in adverse outcome.

Table 18: Distribution of adverse vs normal outcome.

Outcome	Number (n= 50)	Percentage
Adverse	33	66 %
Normal	17	34 %
Total	50	

Cerebro-placental ratio (CPR)

Pulsatility index of MCA: Pulsatility index of Umbilical artery- Determinant of foetal blood flow redistribution. This ratio was calculated in those patients that showed a forward positive end diastolic flow in the umbilical artery.

Table 19: (PI) of MCA: PI of umbilical artery.

MCA/ Umb A PI	Number (n= 32)	Percentage
<1.08	16	50 %
Normal	16	50 %
Total	32	

A ratio of less than 1.08 is an indicator of redistribution of blood to the foetal brain.

Pulsatility Index of Umb A and MCA, CPR and Adverse outcome.

Table 20: Distribution of adverse outcome in relation to PI of both Umb A and MCA and CPR of cases.

Parameter	Number (n= 32)	Percentage
Raised Umb A PI	22	68.7 %
Reduced MCA PI	18	56.25 %
CPR <1.08	16	50 %
Adverse outcome	15	46.8%

Uterine artery Doppler study

Uterine artery early diastolic notch:

Notch was seen in thirty five patients out of the 50 cases in our study.

Table 21: Persistence of early diastolic uterine notch.

Diastolic Notch	Number (n= 50)	Percentage
Present	35	70 %
Absent	15	30 %
Total	50	100 %

Uterine artery early diastolic notch:

Out of the 35 cases, 14 cases showed unilateral notch and 21 cases showed bilateral notches.

Table 22: Distribution of early diastolic uterine notch.

Notch	Number (n=50)	Percentage
Unilateral	14	28 %
Bilateral	21	42 %
Absent	15	30 %
Total	50	100 %

Unilateral Notch either in the left or right uterine artery of a patient was considered significant depending on the placental localization i.e. (Non- placental side uterine artery notch is mostly insignificant, however placental side uterine artery notch needs follow up and could be associated with morbidity and mortality).

Resistive index of uterine artery

Abnormal RI was calculated for each uterine artery separately.

Table 23: Distribution of resistive index of uterine artery of cases.

RI	Right uterine artery		Left uterine artery	
	Number	Percentage	Number	Percentage
Abnormal	25	50 %	31	62 %
Normal	25	50 %	19	38 %
Total	50		50	

Uterine artery S/D ratios

The ratios were calculated for each uterine artery separately.

Table 24: Distribution of uterine artery S/D of cases.

Uterine artery S/D	Right uterine artery		Left uterine artery	
	Number	Percentage	Number	Percentage
≤2.6	23	46 %	23	46 %
>2.6	27	54 %	27	54 %
Total	50		50	

Variables of adverse outcome of pregnancy

Table 25: Distribution of adverse pregnancy outcome.

Adverse outcome	No of cases (n=50)	Percentage
Low APGAR score	21	42%
LSCS sections	30	60%

DISCUSSION

Foetal growth and development is a dynamic process, since not all fetuses grow or develop equally extensive research in this sphere has been done. The pathophysiology of intrauterine growth restriction cannot be pinned down to one specific cause it results due to a series of events occurring along several possible pathways. Accurate antenatal diagnosis therefore distinguishes between the foetus which is constitutionally small for gestational age or a foetus which is growth restricted due to a consequence of impaired placental perfusion. Doppler flow velocity analysis aids in solving this problem. An assessment of uterine arteries

(uteroplacental circulation), umbilical arteries (Feto-placental circulation) and middle cerebral artery (foetal-circulation) can help in diagnosing at risk fetuses in addition aid in taking a timely call as to when to intervene the pregnancy without major foetal and maternal compromises.

Our study included 50 pregnant women, who were suspected to have fetuses with intrauterine growth restriction based on biometric parameters (grey scale ultrasound imaging).

Literature shows diversified results on this challenging and emerging issue. Controversies in the results and inability to compare results could be attributed to various factors such as the sample size in a particular study, varying techniques, different cut off values and lastly different criteria used to define the adverse perinatal outcome. Even after years of research and extensive study no definite universally accepted standard for defining abnormal Doppler flow velocity waveforms has been proposed, so the problem of conflicting observations might continue to emerge. But over the years literature has supported the use of certain standard cut offs which have improved the perinatal morbidity and mortality associated with at risk fetuses.

Age and parity incidence

It is observed that the maximum number of pregnant women were in the age group of 21-30 years (>50%). This could be due to the small sample size in our study or increased pregnancy rate in these age groups. Fifty eight percent of females were primi and forty two percent were multi gravida.

Distribution of gestational age

In our study all patients underwent Doppler study in the third trimester of their pregnancy with 48% being investigated above 36 weeks of gestation. This was followed by 14 % in between 31 to 35 weeks. The earliest study was done at 31 weeks of gestation.

Etiology of IUGR

Among women where a cause for IUGR was identified. 42% had pregnancy induced hypertension (PIH), 14% had anaemia complicating pregnancy. Bad obstetric history as a cause is seen in 14%. 32% (n= 16) patients of the study group had no detectable cause for IUGR.

In a study by Bhatt et al, the association between PIH and IUGR was demonstrated. Further an adverse perinatal outcome was also observed in their study group. Our study showed similar trends.⁴

Placental grade

In our study we found a strong correlation between high

placental grade (Grade III) and IUGR. Sixty six percent patients showed Grade III placenta and thirty four percent patients showed Grade II. This is further associated with adverse perinatal outcome due to its direct relation to the fetoplacental circulation that in turn is reflected in the foetal circulation.

This has been highlighted in a study by K. H. Chen et al in 2010. They demonstrated a direct relationship between high grade placenta and adverse perinatal outcome.⁵

Amniotic fluid index

All growth restricted pregnancies showed oligohydroamnios as another common association. Seventy six percent had a lower amniotic fluid index against twenty four percent who had a normal amniotic fluid index.

In a study by Arora et al, they highlighted the increased risk of oligohydroamnios in growth restricted fetuses with abnormal Doppler indices, as an associated finding in their study group.⁶

Umbilical artery evaluation

Umbilical artery was the main vessel used for monitoring high risk pregnancies. This is because it represents fetoplacental system and primarily reflects placental resistance.



Figure 5: Showing absent diastolic flow in the Umb A in a patient.



Figure 6: Showing reversal of diastolic flow in Umb A.

As the severity of a compromised fetoplacental flow increases there is an increased impedance to flow. This results in absent end diastolic flow as shown in Figure 5. With further compromise in hemodynamic status the flow progresses to reverse end diastolic flow in the umbilical arteries as shown in Figure 6. This is ominous which results in an adverse perinatal outcome and prompts immediate delivery.

In our study sixty four percent (n=32) of the pregnancies showed a positive diastolic flow, whereas fourteen (28%) had absent diastolic flow and four (8%) had reverse diastolic flow. The Doppler indices were calculated in the 32 pregnancies that showed forward diastolic flow. Out of the thirty two patients, 68.7% (n= 22) showed elevated PI values.

Ghosh GS, et al studied 353 growth restricted pregnancies and observed abnormal umbilical artery parameters in 102 patients.⁷

Out of the patients showing elevated PI (n=22) and absent/ reversal of diastolic flow (n=18), adverse perinatal outcome was seen in sixty six percent of the patients (n= 33). Highest mortality/ morbidity rate was observed in patients with reverse end diastolic flow followed by those with absent diastolic flow and last was those with raised PI.

Shah Nehal et al and Yildirim et al emphasized the above observation in their studies, stating that absent and reverse diastolic flow are associated with a higher morbidity and mortality.^{8,9}

Comparing the umbilical artery S/D ratios of our study to the study of Trudinger, et al.¹⁰ The following observation was seen.

Table 26: Comparison of the umbilical artery S/D ratios of our study to the study of Trudinger, et al.

	Trudinger et al	Our study
Number of patients with elevated S/D ratio	64%	65.6%
Perinatal mortality	16%	66 %

Table 27: Perinatal death reported in various studies.

Authors	Perinatal death
Bhat CJ et al.73 2003	50%
Neena Malhotra et al. 2006	40%
Our study	44.4%

Brar et al. stated that in pregnancies with an umbilical artery S/D ratio >3 stand a greater chance of SGA and other associated findings like an APGAR score<7 at 5 minutes, caesarean section for foetal distress and

meconium stained liquor. This observation has correlated well with our study.¹¹

In our study there was strong correlation of poor perinatal outcome with AEDF or REDF. Literature shows similar trends.^{4,12}

Patients with REDF showed a 100% mortality rate in our study. This concludes that termination of pregnancy should be prompt in cases with AEDV and REDF as it safer to deliver the baby if NICU facilities are available. This will decrease the perinatal mortality associated with such adverse observations.

In cases with AEDF delivery can be delayed by 1-2 weeks, with intensive foetal surveillance, this buys more time for maturation of lung and in due course the foetus can sustain external environment much better. However reversal of flow is an ominous sign and requires prompt delivery.

In our study 68.7 % had raised pulsatility index. 15 cases (68.1%) showed adverse perinatal outcome. Whereas 78.1% (25 cases) had a raised RI and 60 % (n=15) cases out of them showed adverse perinatal outcome.

In a study by Wladimiroff et al, he stated that there is a linear decline in PI and RI values according to advancing gestational age, whereas elevated PI and RI values are observed in IUGR.¹³

In our study we found similar trend in the patients showing altered umbilical artery Doppler parameters (elevated umbilical artery resistance).

Middle cerebral artery

As an adaptation to hypoxemia there is redistribution of blood flow during early stages, this is called the brain-sparing reflex. Reflected as a decrease in PI and RI due to increased end diastolic flow as shown in Figure 7.

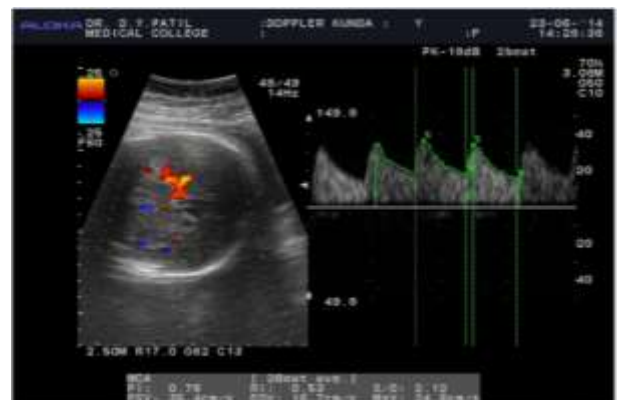


Figure 7: Showing reduced Doppler indices reflecting “Brain sparing effect” in the MCA.

In our study we found low MCA PI in 72 % (36 cases).

66% (33 cases) cases were associated adverse perinatal outcome. The fall in Doppler indices was the foetus's adaptive mechanism to hypoxemia mentioned in literature as "brain sparing effect".

In a study by P. Johnson, et al there was a rapid and sharp change in PI of the severely growth restricted babies. Thus confirming our observations.⁷

The foetuses with abnormally low MCA PI values in our study also underwent emergency caesarean section as the mode of delivery, to avoid provoking any further insult due to underlying foetal hypoxemia.

In a study by Dhand Hemlata, et al high risk mothers with altered MCA Doppler indices underwent caesarean section to prevent any further progression in foetal distress.¹⁴

Six growth restricted babies (12%) with severely altered umbilical artery parameters (AEDV or REDV) showed a phenomenon of pseudonormalization i.e. the PI values of MCA in such patients instead of the normal trend of fall in the values showed a rise of Indices or normalization. The perinatal outcome was unfavourable as these growth restricted babies did not survive. The normalization in values was due to cerebral oedema which is a more severe and ominous finding in such foetuses. This actually reflects a terminal decompensation in the setting of acidemia or brain oedema as shown in Figure 8.

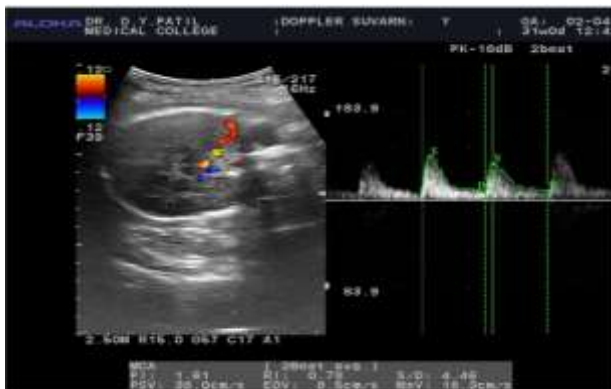


Figure 8: Showing a pseudo-normalization of Doppler indices in the MCA due to underlying.

Cerebral oedema (Reversal of Umb a diastolic flow was noted in the same patient).

Shahina Bano et al also stressed on the above mentioned observation that if hypoxia persisted diastolic flow in the MCA returns to normal.¹⁵

Out of the 50 IUGR cases enrolled in our study, in 32 cases which showed positive umbilical diastolic flow (including those with high resistance; high PI) cerebroplacental ratio was calculated. Fifty percent (n=16) cases showed a ratio of less than 1.08 and was

considered abnormal. Out of them 46.8 % (n= 15) cases showed adverse outcome. Considering Doppler parameters of umbilical artery and middle cerebral artery separately, 68.7% showed elevated umbilical artery PI and 56.2% cases showed low MCA PI values. Thus, highlighting that CPR is a better indicator of predicting adverse perinatal outcome than either umbilical artery PI or MCA PI alone.

The MCA/UA pulsatility index ratio is a better index in predicting perinatal outcome as it tells us about placental status and also the foetal response. So the monitoring of growth restricted patients should take into account CPR.

Gramellini, et al in their study calculated the C/U ratio and found that it remains fairly constant in the last 10 weeks of pregnancy; hence a single cut off of 1.08 was used in there and our present study. They also highlighted that it provides a better diagnostic accuracy than either vessels PI considered alone.³

Our observations also correlated well with the study by Shahina Bano et al who concluded that the C/U ratio is a better predictor of SGA foetuses and adverse perinatal outcome than the MCA PI or the UA PI used alone.¹⁵

Uterine artery

In our study out of the 50 pregnancies, twenty one cases (42 %) were complicated with pregnancy induced hypertension (PIH).

Out of 42% complicated with PIH twenty (95 %) showed adverse pregnancy outcome. Pre-diastolic notch was seen in all twenty one cases complicated with PIH as shown in Figure 9. Also high RI and PI values were observed in 42 % IUGR pregnancies complicated with PIH.



Figure 9: Showing early diastolic notch in the uterine artery.

In a study by Gomez o et al on 870 singleton pregnancies, Sixty-four (7.3%) pregnancies developed a hypertensive disorder and/or IUGR. In their study complicated

pregnancies showed a higher prevalence of a bilateral notch and a higher mean PI. 30% of them showed persistence of a bilateral notch.¹⁶

Lastly in a study by Ghosh G, et al in 2006, they stated that RI and PI are the best predictors of adverse outcome of IUGR-suspected pregnancies.¹⁷

CONCLUSIONS

This was a hospital based study which was conducted to evaluate the hemodynamic changes in fetoplacental system in patients with biometric suspicion of growth restricted fetuses. Fifty patients with biometrically suspected Intra Uterine Growth Restricted Foetuses were included in this study which was carried out over a period of two years. Ultrasound evaluation followed by Duplex Doppler evaluation of the Fetoplacental, Uteroplacental and Foetal circulation was conducted.

Biometric parameters/ grey scale findings that were suggestive of Intra Uterine Growth Restriction:

- a) Low Foetal Weight
- b) Elevated Head Circumference/ Abdominal Circumference
- c) Elevated Femur Length / Abdominal Circumference ratio
- d) High Placental Grade
- e) Oligohydroamnios

Doppler Assessment of following vessels:

- a) Foetal Umbilical Artery
- b) Foetal Middle Cerebral Artery
- c) Maternal Uterine arteries

Doppler Parameters studied were:

- a) Pulsatility Index (PI)
- b) Resistive Index (RI)
- c) Systolic to Diastolic Ratio (S/D)
- d) MCA PI/Umb A PI

Other Considerations were:

- a) Mode of Delivery (Normal or Caesarean section)
- b) Foetal Birth Weight
- c) 5 minute APGAR score
- d) Perinatal Outcome (Adverse/ Uneventful)

Adverse Perinatal Outcome variables were:

- a) Foetal death
- b) NICU admission for the following,
 - i. Intrapartum foetal acidosis
 - ii. Meconium aspiration syndrome
 - iii. Hypoxic ischemic encephalopathy
 - iv. Hypoglycemia

- v. Hypocalcemia
- vi. Hypothermia
- vii. Perinatal asphyxia
- viii. Necrotizing Entero-colitis
- ix. Complication of low Birth weight

Observations from our study are as follows:

Majority of the patients forming our study were in the age group of 20 to 30 years and most of them were Primi Gravida.

Associated risk factors were PIH, DM and anaemia, PIH was the most common risk factor.

Pathologically Growth restricted Foetuses showed abnormal Trends in the Doppler Indices- Elevated Indices in Umbilical artery and uterine artery and low Indices in MCA.

Fourteen cases showed absent umbilical artery end diastolic flow and four patients showed reversal of end diastolic flow. Twenty two patients showed elevated PI. Adverse perinatal outcome was observed in all patients with absent and reversal of end diastolic flow. Out of the twenty two with elevated PI fifteen showed adverse outcome.

Thirty six cases showed low MCA PI and six showed a pseudonormalization.

A cerebro-placental ratio of < 1.08 was observed in 16 patients, it was calculated in only those pregnancies that showed forward diastolic flow in umbilical artery (n=22). Fifteen of them showed adverse perinatal outcome.

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