Original Research Article

Role of Doppler Velocimetry in Intrauterine Growth Restriction

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Abstract:

Aims of the Study: 1. To determine the efficiency of Doppler velocimetry in the early diagnosis of hypoxia in Intra Uterine Growth Restriction. 2. To determine the predictive value of the Doppler velocimetry of umbilical and middle cerebral artery with the perinatal outcome in fetuses Intra Uterine Growth Restriction. 3. To predict the effect of Doppler velocimetry on the mode of delivery.

Objective: To determine Efficacy of Doppler velocimetry of umbilical artery (UA- S/D) and middle cerebral artery (MCA-S/D, Brain sparing effect BSE, Cerebro placental ratio CPR<1) in early diagnosis of hypoxia in intrauterine growth restriction (IUGR), effect on mode of delivery and in predicting perinatal outcome in fetuses with IUGR.

Materials and Methods: 50 pregnant women with clinically suspected IUGR are subjected to ultrasonography with Doppler. The Doppler results were related to perinatal outcomes including birth weight, mode of delivery and perinatal complications.

Results: a) Mode of delivery: When CPR<1 & BSE combined – 80% vaginal delivery. b) With AEDF &REDF, very low birth weight increased by 4 times than high S/D. No difference between AEDF & REDF → reversal is an acute event. c) Perinatal outcome: UA-All abnormal waveforms – meconium aspiration syndrome -100% while MCA *BSE -66.7%: CPR<1 – 50%. d) Mortality rate: higher with all abnormal UA waveforms than abnormal MCA waveforms. CPR<1 more sensitive in early detection of fetal hypoxia than other parameters of MCA as well UA thereby averting perinatal mortality.

Conclusion: MCA shows high sensitivity (92%) compared to UA (76.92%) in predicting fetal hypoxia with high positive and negative predicting value (92%). CPR<1 is more sensitive in predicting the hypoxia than BSE. UA and MCA waveforms as an indication for cesarean section are not significant.

Keywords: Doppler, Foetal Growth Restriction, Resistance Index, Fetal Hypoxia, IUGR.

Introduction

Fetal Growth: Lin and Santolaya –Forgas (1998) [1] divided fetal growth into three consecutive cell growth phases.

Table 1:

Phases	Period of Gestation	Cellular Events
I	Upto16 weeks	Hyperplasia
II	16-32 weeks	Hyperplasia+hypertrophy
III	After32weeks	Hypertrophy

Corresponding fetal growth rates (Williams andCo-workers,1982)[Ref.No-2]

- 5g/day at 15weeks
- 15-20g/day at 24weeks
- 30-35g/day at 34 weeks

Factors like

- Growth factors (IGF–1, IGF– II))[Ref.No-3,4]
- Leptin[5,6,7]
- Angeogenic factors (SFIt–1))[Ref.No-8]

Are implicated as responsible for fetal growth. But precise cellular and molecular mechanism by which normal fetal growth occurs is not well understood.

Table 2: Substrates needed for normal fetal growth

Substrates	Mode of transport	In fetus
Oxygen	Simple diffusion	Energy (ATP) synthesis
Glucose	Facilitated diffusion	Carbon-building blocks
Amino Acids	Active transport	Protein synthesis

Intrauterine Growth Restriction

Definition: Intra Uterine Growth Restriction is defined as a pathological decrease in the rate of fetal growth.

Incidence

- 3to10%[Division and HSU, 1992]
- 10%(fetus weight<10th percentile is used) [Battag liaand Lubchenco,1967]) [9]
- 3%(fetal weight I2 SD is used)[Usher-andMclean,1969])[10]

Etiology

Several conditions may interfere with normal placentation and culminate in either pregnancy loss or Intra Uterine Growth Restriction.

Broadly categorized factors are

- Maternal factors
- Uterine Factors
- Placental factors
- Fetal factors

Materials and Methods of Study

Study Design: Prospective Study

Place of Study: Govt Dharmapuri Medical College and Hospital in the department of Obstetrics and Gynaecology

Period of Study: January 2023 to December 2023

Case Selection: 50 pregnant women, who were all attending the antenatal outpatient department in GDMCH, were randomly selected and included in the study after their admission. Informed and written concerned was obtained from all patients who participated in this study. Only patients who could be followed upto term were included.

All pregnant women irrespective of age or parity were included in the study when they were suspected to have IUGR clinically. Important was given to patients who are at high risk for IUGR with the following inclusion and exclusion criteria.

Inclusion Criteria:

Patients who are at high risk of IUGR like

- Preeclampsia
- Hypertension
- Anaemia
- Malnutrition
- Chronic Renal
- Disease SLE
- Previous History of IUGR baby Singleton Pregnancy

Those patients clinically suspected to be suffering from IUGR like Disparity in the growth of uterus regularity booked patients of > 2 -3cm SFH (>2-3weeks Clinical reduction in liquor volume.

Pregnancy beyond 28weeks to 42weeks

Exclusion Criteria: Those patients in whom regular followup to term and delivery are not possible. Multiple pregnancy.

Method of study: In all patients besides history taking, complete general and obstetric examinations were done. Routine biochemical investigation, USG and Doppler were done. The cases were followed upto term every 15 days and the mode of delivery and fetal outcome were studied, documented and analyzed.

History: History regarding high risk factors in the mother likes history of hypertension, diabetes mellitus. Chronic renal disease, SLE is taken. History regarding any high risk factors in previous pregnancy and its outcome were obtained in detail.

Observation

Table 3: Age Distribution

Age	No. of cases	Percentage
<19 yrs	4	4%
22-25 yrs	28	56%
26-30yrs	17	34%
31-35yrs	1	2%
>35yrs	2	4%

In the study group 80% of patients belong to the age group between20-30yrs.Teenage pregnancy was 4% and elderly gravid women were 6%

Table 4:

Parity		
Parity	**No. of Cases**	**Percentage**
Primi	27	54%
Multi	23	46%

Among the 50 patients studied 27 (54%) were primi and 23 (46%) were multi.

Table 5:

IUGR By USGEFW		
By EFW	**No. of Cases**	**Percentage**
IUGR By USGEFW	33	66%
Normal	17	34%

Out of the 50 patients in whom IUGR is suspected clinically, when ultrasonographic EFW <10th percentile was used 66% found to have IUGR.

Mode of Delivery

Table 6: UMA Flow Pattern

Umbilical artery flow pattern	Mode of Delivery		'P' Value
	Vaginal	**Cesarean section**	
High resistance flow (8)	5 (62.5)	3 (37.5%)	0.378
AEDF(2)	1 (50%)	1 (50%)	
REDF(2)	1 (50%)	1 (50%)	
Normal(38)	26(68.4%)	12(24%)	

When umbilical artery flow pattern was analyzed, it was found that with normal Doppler flow 68.4% delivered vaginally and 24% went in for caesarean section, that too for obstetrical indications like previous LSCS, breech presentation. When there is high resistant flow almost 2\3rd (62.5%) delivered vaginally and 1\3rd (37.5%) ended up in caesarean section. When it showed absent or reversal of end diastolic flow (4patients) 50% ended up in caesarean section and 50% ended up in normal delivery.

Table 7: MCA Flow Pattern

MCA Doppler	Mode of Delivery		'P'Value
	Vaginal	**Caesarean**	
BSE(14)	11(78.57%)	3 (21.43%)	**0.07386**
CPR<1(11)	9 (81.8%)	2 (18.18%)	
Normal(25)	13(52%)	12(48%)	

On analysis MCA flow pattern when found normal, the mode of delivery was not altered, 52% vaginal Vs 48% caesarean section. When there is brain sparing effect (BSE) almost 3\4th (78.37%) ended up vaginally and 1\4th (21.43%) only needed caesarean section. CPR study which is the most sensitive when <1, showed almost 4\5th (81.1%) need have vaginal delivery and lessthan1\5th (18.1%) need caesarean section, showing vaginal delivery in more patients since CPR < 1 which detects hypoxemia in an earlier stage.

Birth Weight

Perinatal outcome

Table 8: Umbilical Artery Flow Pattern

Abnormal UA Doppler	Birth Weight (kg)			
	<1.5	1.6-2.0	2.1-2.5	>2.5
High resistance flow(8)	1 (12.5%)	6 (75%)	1 (12.5%)	-
AEDF(2)	1 (50%)	1 (50%)	-	-
REDF (2)	1 (50%)	1 (50%)	-	-

Analysis of the abnormal umbilical artery and birth weight, the following results are obtained. With REDF(2), 1 baby (50%) had a birth weight<1.5kg and 1baby (50%) had a birth weight in the range1.6_2.0kg. With AEDF (2)1baby (50%) had

birth weight <1.5kg and the other (50%) had birth weight in the range1.6_2.0kg. In the high resistant flow category 75% of then had a birth weight range of 1.6-2.0kg and the rest, 12.5% each in the category < 1.5kg and 2.1_2.5kg. None of the abnormal

umbilical artery wave forms had babies reaching   >2.5kg birth weight.

Table 9: Middle Cerebral Artery flow Pattern

Abnormal MCA Doppler	Birth weight(kg)			
	<=1.5	1.6– 2.0	2.1– 2.5	>2.5
BSE(14)	4 (28.6%)	8(57.1%)	2 (14.2%)	-
CPR<1	2 (18.2%)	6 (54.5%)	3 (27.3%)	-

Out of the 14 babies with brain sparing effect 57.1% (8) had a birth weight of 1.6 –2.0 kg and 1/4thft hose (28.6%) had a very low birth weight of<1.5kg and only14.2% attain sa birth weight of 2.1 – 2.5 kg. In CPR < 1, nearly ½ of them (54.5%) had birth weight in the range of 1.6 – 2.0 kg,3 babies (27.3%) had a birth weight the range of 2.1 – 2.5 kg and only 2 (18.2%) had birth weight _< 1.5 kg. none of the babies with abnormal MCA flow attain a weight of > 2.5 kg.

Perinatal outcome

Table 10: Umbilical Artery wave forms

Normal and Abnormal waveforms		
Umbilical artery Doppler	Normal	Abnormal
Normal wave forms 38 (76%)	35(92.1%)	3 (7.89%)
Abnormal wave forms 12(24%)	2 (16.67%)	10(83.33%)

On analysis of the perinatal outcome with abnormal umbilical artery flow, when the flow was abnormal 83.33%had abnormal outcome and only 16.67% had normal babies whereas when the flow was normal 92.1%had normal baby and only 7% had abnormal perinatal outcome.

Table 11: Middle Cerebral Artery (MCA)

Normal and Abnormal waveforms		
MCA Doppler	Normal	Abnormal
Normal Wave forms25 (50%)	23(92%)	2(8%)
Abnormal Wave forms 25(50%)	2(8%)	23(92%)

When the MCA is normal 92% delivered normally and only 8% had abnormal outcome and the reverse was true when the MCA flow was abnormal (ie 8% delivered normally and 92% had abnormal outcome)

Table 12: Types of abnormal waveforms and Perinatal Outcome

Umbilical Artery Doppler	Perinatal Outcome			
	Normal	Abnormal		
		Total	PN Mortality	PN Morbidity
High resistance flow(8)	2 (25%)	6 (75%)	3 (37%)	3 (37%)
AEDF(2)	-	2 (100%)	1 (50%)	1 (50%)
REDF (2)	-	2 (100%)	2 (100%)	-
'P' Value			0.0004	0.0239

When there is resistance flow in umbilical artery, 75% had abnormal perinatal outcome and 25% had abnormal baby. Among the abnormal perinatal outcome 1/2 of them had mortality and another 1/2 had morbidity. When there is absent or reversal of end diastolic flow, almost all the babies had an abnormal perinatal outcome (100%). In absent end diastolic flow (AEDF) the morbidity is 50% and mortality is 50%, where as in reversal of end of end diastolic flow (REDF) there is 100% mortality.

Table 13:

MCA Doppler	Perinatal outcome			
	Normal	Abnormal		
		Total	PN Mortality	PN Morbidity
BSE(14)	1 (7.14%)	1392.85%)	7 (50%)	6 (42.85%)
CPR<1(11)	1(9%)	10(90.9%)	4(36.36%)	6 (54.54%)
P Value			0.0002	0.0004

On correlating, when the CPR < 1 is taken into account 91% babies had abnormal perinatal outcome and only 9% had a normal perinatal out come when the brain sparing effect (BSE) was there 92.8% had abnormal

perinatal outcome and only 7.1% babies were normal. The morbidity and mortality were equal when there is brain sparing effect, whereas the mortality was less than morbidity when CPR < 1 (36.36% Vs 54.54%).

Table 14: Types of perinatal morbidity

Abnormal UA Doppler	Types of Perinatal Morbidity		
	APGARat5min<7/10	MAS	Preterm Delivery
High resistance flow (3)	2 (66.7%)	3 (100%)	2 (66.7%)
AEDF (1)	1 (100%)	1 (100%)	-
REDF (0)	-	-	-

On analyzing the type of perinatal morbidity with abnormal umbilical artery Doppler, with high resistance flow (3) all 3 babies (100%) suffered meconium aspiration syndrome and 2 babies (66.7%) have a 5min APGAR of < 7and preterm delivery.

With absent end diastolic flow (1), the baby suffered meconium aspiration syndrome and had a APGAR< 7 at 5 mm (100%) with reversal of end diastolic flow, there is no perinatal morbidity, since 100%of babies had perinatal mortality.

Table 15:

Abnormal MCA Doppler	Types of Perinatal Morbidity		
	APGAR at 5min<7/10	MAS	Preterm Delivery
BSE(16)	3 (50%)	4 (66.7%)	2 (33.3%)
CPR<1(16)	2 (33.3%)	3 (50%)	2 (33.3%)

When the different morbidity parameters are analyzed with abnormal middle cerebral artery Doppler, meconium aspiration syndrome is present in 50% with CPR<1 and 66.7% with BSE, the APGAR at 5 min < 7 in 50 % of babies with BSE and only 33.3% in both the groups.

Mortality and Salvage Rate

Table 16: Umbilical Artery Flow Pattern

Outcome	High resistance flow (8)	AEDF(2)	REDF (2)
Salvage	5 (62.5%)	1 (50%)	-
Mortality	3 (37.5%)	1 (50%)	2 (100%)

On analysing the mortality and salvage rate in babies with abnormal umbilical artery waveforms, 62.5% babies are salvaged and 37.5%babies expired when there is high resistance flow. With AEDF (2), 1baby is salvaged (50%) and 1baby expired (50%) and when there is REDF (2), both babies (100%) expired.

Table 17: Middle Cerebral Artery Flow Pattern

Outcome	BSE(14)	CPR<1(11)
Salvage	7 (50%)	7 (63.6%)
Mortality	7 (50%)	4 (36.4%)

The salvage rate and the morality rate are equal when there is brain sparing effect, whereas the salvage rate in more (63.6%) and mortality is less (36.4%) when CPR<1is taken into account showing CPR is the most early sensitive index of fetal hypoxia.

Discussion

This study was under taken in Government Dharmapuri Medical College and Hospital, Dharmapuri during the period from January 2023 to December 2023, with an aim of evaluating abnormal Doppler flow velocimetry in the early detection of fetal hypoxia and its effect on perinatal outcome and operative delivery. About 50 patients were randomly selected from antenatal ward admission with IUGR.

- Majority of them belonging to the age group of 20-30yrs (%). Above 30yrs comprise only %
- Multi gravidas and primi gravidas were equally distributed (----% vs --------------- %)
- Among the 50 patients studied, by USG- EFW <10[th]percentile, 66% was found to have IUGR.

Effect of Wave Forms on Mode of Delivery:

Umbilical Artery:

a) Normal flow pattern –3/4th of them delivered vaginally reducing the caesarean section rate to almost nil since in the other 1/4th caesarean section was done for other obstetrical indication.

b) High resistant flow–2/3rd ended up in vaginal delivery and 1/3rd in caesarean section.

c) Absent or reversal of end diastolic flow –high incidence of caesarean section (50%)

Middle Cerebral Artery:

a) When both the BSE and CPR<1, is put together there is absolutely increase in the vaginal delivery (80%) and caesarean section rate is reduced (20%), showing that MCA detects the fetal hypoxemia earlier and does reduces the incidence of caesarean section rate.

b) When comparing the BSE with CPR<1 again it indicates, vaginal delivery more with CPR<1 (4/5th) than BSE (3/4th)

c) SogotPetal,(2001),stated that odds ratio is 1.9 when caesarean section is done for other indication which is higher than IUGR(OR=1.6)

Correlation Of Birth Weight With Abnormal Doppler Wave Forms: Umbilical Artery:

a) High resistant flow - it is found that majority of babies with high resistant flow, had a birth weight of <2.0kg (87.5%), out of which 1/8th had a very low birth weight (<1.5 kg), none of them reached the birth weight of >2.5kg.

b) Absent or reversal of end diastolic flow – the very low birth weight has increased by 4 times when compared with high resistance flow (50%vs. 12.5%) and none of them reached a birth weight of 2.0 kg.

c) There is no difference in the birth weight of patients with absent and reversal of end diastolic flow, showing that the reversal is an acute event ending in fetal demise thereby has no consistent duration of action to have an effect on birth weight.

Perinatal outcome analysis:

Umbilical Artery:

a) When the flow is normal 92% have normal babies, when the flow is abnormal only 16% had normal babies, showing umbilical artery flow pattern had a major impact on the prenatal outcome.

b) On critical analysis, reversal of end diastolic has almost 100% mortality. Absent end diastolic flow had 50% mortality and 50% morbidity showing AEDF and REDF had absolutely no normal babies and / or predicts ominous sign.

c) On the contrary, high resistant flow had1/4[th]normal baby and the mortality and morbidity are equal among the rest (31.5% vs. 37.5%).

Yildirim G, et al,(2008), Jang DG, et al (2010), Nanthakomm T (2010) studied and stated that pregnancies with absent or reversed end diastolic flow in the umbilical arteries have high perinatal mortality and morbidity. According to Fleisher et al, 1989, umbilical artery S/D ratio has a sensitivity of 778%, specificity of 83%, positive predictive value of 66% and negative predictive value of 95% in determining adverse perinatal outcome.

According to Ozeren Met al Eur Obstet Gynecol Reprod Biol. 1999, Jan, the umbilical artery S/Dratio has highest sensitivity (88%) and diagnostic accuracy (94%) in predicting the adverse perinatal outcome.

According to this above study, with abnormal umbilical artery wave forms when the factors per inatal morbidity and mortality are analyzed meconium aspiration syndrome is present in all high resistant (100%) and AEDF (100%). 5 min APGAR < 7 is seen in 100% with AEDF and 66.7% in high resistance flow. Preterm delivery is also66.7%with high resistant flow.

Thus this study from its above data is comparable to all the other a fore mentioned studies with regard to abnormal umbilical artery waveforms and perinatal complications.

Middle Cerebral Artery:

Romera Guti (2009) stated that MCA wave forms were abnormal in a small number of fetuses with perinatal complications.

The data from this above study shows good correlation of MCA flow pattern with perinatal outcome , correlation of middle cerebral artery flow pattern with perinatal outcome, normal flow showed 92% normal babies, whereas when the flow is abnormal only 8% is normal babies, and the reverse, 8% normal babies vs. 92% abnormal babies was true when the flow is abnormal. Fuchs T (2000) reported that CPR has a sensitivity of 85%, Odibo Ao (2005) stated that CPR<1.08 had a sensitivity of 72% in predicting adverse perinatal outcome.

Nanthakomon T (2010), Franzin CM et al (2010) stated that babies with abnormal MCA waveforms showed increased incidence perinatal morbidity Yaltietal, study of Doppler indices and fetal outcome Indian J Med Res 120, July2004, stated that a linear relationship between MCA/UA ratio and adverse perinatal outcome (p<0.01) Ozeran M et al, in a study of Doppler indices in patients with preeclampsia Eur J Obstet Gynecol Reprod Biol, 1999 Jan, stated that MCA has higher predictive value in determining perinatal outcome by a sensitivity of 84% and a diagnostic accuracy of 87%.

This above study states that by critically analyzing the type of abnormality in middle cerebral artery and perinatal outcome BSE and CPR<1 show almost the same normal perinatal outcome (7.4% Vs 9%) the difference is not significant statistically.

Abnormal perinatal outcome when BSE and C PR <1 is present 92% is also same in both (92.85 % Vs 90.9 %), which is very well comparable to the other studies But the type of abnormal outcome varies in both. The perinatal mortality when BSE is present

(50%) which is reduced to 1/3rd (36.36%) when there is CPR < 1, showing CPR is more sensitive in early detecting there by averting perinatal mortality. With abnormal middle cerebral artery waveforms, analysis of the factors of perinatal morbidity reveals meconium aspiration syndrome and APGAR at 5 min <7/10 are more with BSE than CPR <1 (66.7%, 54% Vs 50%, 33%).

The preterm delivery rate are the same in both groups (33.3%) when MCA Flow is correlated with birth weight 3/4th of babies with brains paring effect and CPR<1(85%and73%) had birth weight <2.0kg, out of which1/3rd of them (28%and18%) had a very low birth weight. Birth of 2.12.5kgwas 14.2% with brain sparing effect which was increased by almost two folds (27.3%) with CPR <1, showing again, this parameter detects the fetal hypoxia at an earliest age even before the baby suffers severe growth restriction.

Critical analysis of salvage rate with types of flow pattern shows ½ is salvage rate with presence of BSE(50%), whereas 2/3rd is salvageable with CPR < 1 (63.6%)again showing with CPR <1 detection of early fetal hypoxemia, and increase in the perinatal salvage rate.

Comparison of UA & MCA Doppler Waveforms: Doppler study of umbilical artery with perinatal outcome has got 94% specificity and a very high negative predictive value of 92.1% and a positive predictive value of 8.3% sensitivity of also 76.9% with minimal false positive value of 5.4%. MCA shows a very high sensitive (92%) compared to umbilical artery (76.92%) and its positive predictive value, negative predictive value and sensitivity are all high (92%), but the false positive is slightly high (8%), false negative value of MCA is almost reduced to 1/3rd, when compared to umbilical artery (8%Vs 23%) showing MCA, is more dependable and sensitive when compared to umbilical artery.

Analysis of Mortality Rate:

Nanthakoman T (2010), Jang DG et al (2010), Yildirum G. et al (2008), stated that abnormal UA waveforms are associated increased perinatal mortality. According to Baschat AA(2004) Feb; 23(2)111-8 state that with UAA/REDV the perinatal mortality was 11.9%. The above study states that while evaluating: Evaluating the fetal salvage rate, high resistance flow showed2\3rd fetal salvage, which getsreducedto1\2(50%) when there is AEDE and the salvage is nil when there is a reversal.

Critical analysis of mortality rate with umbilical artery flow pattern reveal, 100% mortality with reversal (REDF), 50% mortality with absent end diastolic flow and37% mortality when there is a high resistance flow Doppler USG for fetal

assessment in high risk pregnancies, Cochrane library issue 4, 2001 stated that the caesarean section rate for delivering IUGR babies depends on the institution where it was managed. The umbilical and middle cerebral artery waveforms as an indication for caesarean section are not significant. Since the mode of delivery depends on the institution and obstetric vigilance available, and section for other indicational so dilutes the rates.

Conclusion

Doppler flow velocimetry is a very good tool for the early diagnosis and effective management of hypoxia particularly associated with IUGR. Umbilical artery Doppler has a sensitivity of 86.9%. Specificity of 94.5% with a positive predictive value of 83.33% and negative predictive value of 92.1% the false positive is very minimal 5.4%.

Middle cerebral artery flow is more sensitive in predicting hypoxia than umbilical artery with a sensitivity specificity, positive predictive value and negative predictive valueall92% .CPR<1is more sensitive in predicting the hypoxia than BSE. Doppler studies, by detecting intrauterine hypoxia earlier, helps us early induction and vaginal delivery thereby decreasing operative delivery when there is no other obstetrical indication. It is non-invasive and, easy to perform, easy to interpret, needs minimal training and hence most valuable tool in the arm amentarium of obstetrician for the management of IUGR.

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