Original Article

Significance of umbilical artery Doppler velocimetry in the perinatal outcome of the growth restricted fetuses

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Abstract

Objectives: To evaluate the role of umbilical artery Doppler in growth restricted fetuses. Methods: In a prospective observational study, 100 pregnant women with growth restricted fetuses confirmed by ultrasound were evaluated by umbilical artery Doppler velocimetry after 28 weeks of gestation. Outcome of the pregnancy was recorded for the normal Doppler group (n=54) and abnormal Doppler group (n=46). Abnormal Doppler group consisted of low end diastolic flow group (n=29) and absent or reversed end diastolic flow (REDF) group (n=17). Results: Fetuses with abnormal umbilical flow velocimetry had higher incidence of oligohydramnios and abnormal NST compared to the fetuses with normal umbilical flow. The average birth weight and gestational age at delivery were lower in the abnormal Doppler group. Neonates with abnormal umbilical artery velocimetry had increased incidence of caesarean delivery, low apgar scores at birth, increased NICU admissions, increased requirement of positive pressure ventilation, and higher perinatal morbidity and mortality. Conclusion: Umbilical artery Doppler velocimetry should be used in the management of the intrauterine growth restricted fetuses, as it helps in differentiating fetus with pathological growth restriction at risk for perinatal complications from small and healthy fetuses.

Key words: perinatal outcome, intrauterine growth restriction, Doppler, umbilical artery velocimetry,

Introduction

Identification of the pregnancies at risk for preventable perinatal morbidity and mortality is a primary goal of the obstetric care provider. Intrauterine growth restriction (IUGR) is a clinical sign of chronic fetal hypoxemia. IUGR is associated with significant

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morbidity in the form of meconium aspiration syndrome (MAS), hypoglycemia, hyaline membrane disease (HMD), early onset sepsis (EOS), intrapartum asphyxia and stillbirth in extreme cases. The perinatal mortality rate for these infants is 6 to 10 times greater than that for a normally grown population. This can be lowered by timely identification and management of growth restricted fetuses.

Assessment of the umbilical artery Doppler velocimetry provides information on the blood perfusion of the fetoplacental unit. Normally there is very little impedance against blood flowing through the umbilical arteries. As the placenta matures and the pregnancy advances, more tertiary villi is formed, which directly

leads to an increase in the end diastolic flow. Umbilical artery Doppler reflects downstream placental vascular resistance, strongly correlated with intrauterine growth restriction and the multisystem effects of placental deficiency. Abnormalities in the umbilical artery waveforms are progressive with reduction, loss and finally reversal of the diastolic flow. Reversed flow is associated with high incidence of perinatal and overall mortality and severe IUGR compared to absent end diastolic flow[1].

Material and Methods

The study population consisted of 100 women who had singleton pregnancies with small for gestational age (SGA) fetuses. These women either attended the antenatal clinics with us or were referred from the peripheral hospitals in view of IUGR over a period of two years (2005-2007).

The pregnancies were dated by the combination of last menstrual period and first trimester dating scan. The diagnosis of IUGR was made clinically and confirmed subsequently on ultrasound when the fetal abdominal circumference was less then 2SD (standard deviation) from mean value. A detailed anomaly scan was performed on all fetuses and dysmorphic fetuses were excluded from the study. All women included in the study were subjected to umbilical artery Doppler measurements in addition to growth parameter, liquor and placental grading. For the purpose of analysis, the study population was distributed into two groups - a normal Doppler group (Group 1) and an abnormal Doppler group. Abnormal Doppler group was subdivided into diminished end diastolic flow group (Group II), and an absent or reversed diastolic group (Group III).

Doppler examinations were repeated weekly or biweekly according to the severity of the reduction of the end diastolic flow in the umbilical artery. Patients with S/D ratio equal to or more than three and those with absent diastolic or reversed diastolic flow were admitted for further evaluation and delivery. Steroids were administered as single dose to women between 28 and 34 weeks of gestation to enhance fetal lung maturity. Decision to deliver was taken in situations as–

Gestation age of 37 weeks

Absent end diastolic flow, Reversed end diastolic flow (Abnormal umbilical artery Doppler)

Abnormal fetal heart rate pattern

Worsening of maternal condition eg. preeclampsia.

Severe IUGR with amniotic fluid index (AFI) <5

Induction of labor was performed with prostaglandin E2 gel or oxytocin in those planned for vaginal delivery. A group of women with associated obstetric indications were scheduled for elective cesarean section. Those developing fetal distress during labor were delivered by emergency cesarean section. Outcome data were collected including gestational age at birth, birth weight, apgar scores, admission to neonatal intensive care unit, need for positive pressure ventilation and neonatal mortality.

In order to establish the statistical significance, the data were compared by applying the student's 't' test and chi-square test. The probability 'p' value less than or equal to 0.05 was considered statistically significant.

Results

The average age of patients in the study group was higher (27.2 years), 58% of the mothers having IUGR babies were primigravida, 70% of these patients had hypertensive disorders, just 34% had anemia. This low incidence of anemia in the study population was due to the higher incidence of hypertensive disorders leading to hemoconcentration in these patients. Nine percent of the women had bad obstetric history (BOH), 2% of the mothers having IUGR babies had renal dysfunction and 3% had anti-cardiolipin antibodies (ACA) positive.

Out of the total IUGR babies 96% had live birth, 4% were still born and 14% had neonatal death. Average gestational age at delivery was 34.4 weeks and 52% of the IUGR babies were delivered by cesarean section. Average birth weight of these IUGR babies was quite low i.e. 1.61 kg.

Forty five of the 100 (45%) pregnancies with IUGR had abnormal Doppler waveforms in the umbilical arteries. Doppler waveform of the umbilical artery was considered abnormal if S/D ratio was equal to or more than three or diastolic flow was absent / reversed in fetuses above the gestational age of 28 weeks[1-4]. The mean for the normal S/D ratio group (n=55) was 2.53

and for the higher S/D ratio group or for low end diastolic flow group (n=28) was 3.82. An additional 13 fetuses had absent end diastolic velocity and 4 fetuses had reversal of diastolic flow. The mean PI in the normal Doppler group was 0.954; for the low end diastolic flow group was 1.345 and that in the absent /reversed end diastolic flow group was 5.18.

Fetuses with abnormal umbilical artery Doppler wave forms are at increased risk of oligohydramnios (Table 1) and delivery at low gestational age with low birth weight. Out of the total 15 (27.7%) fetuses of normal Doppler group with average birth weight of 2.01 kg were delivered at less than 36 weeks of gestation, compared to 18 (62.07%) fetuses with average birth weight of 1.66 kg with decreased end diastolic flow and 17 (100%) fetuses with average birth weight of 1.16 kg with absent and reversed end diastolic flow. Fetuses with abnormal Doppler had increased incidence of NICU admission, positive pressure ventilation and neonatal mortality. 88.24% of the fetuses with AEDF/REDF required NICU admission compared to just 24.07% of the fetuses with normal Doppler flow. Out of those admitted in NICU, neonatal mortality was highest in AEDF/REDF group. All the four stillbirths that occurred in the study population were in the abnormal Doppler group.

Maternal characteristics

There was a trend for more underlying medical problems in mothers with abnormal umbilical artery Doppler studies. 78.57% (n=22) fetuses with low end diastolic velocity and 82.35% (n=14) with absent/ reversed diastolic flow were associated with maternal gestational hypertension. However, the mothers of small for gestational age babies with normal umbilical artery Doppler also had a high incidence of (61.8%) (n=34) hypertensive disorders. Oligohydramnios was associated with hypertension and was about three times more commonly seen with abnormal Doppler studies.

Mothers of small for gestational age babies with abnormal umbilical artery Doppler studies had increased incidence of cesarean section. In contrast to 33% (n=18) of the normal umbilical artery Doppler velocimetry group, 76% (n=34) of the abnormal umbilical artery Doppler velocimetry group underwent LSCS.

Table 1. Antenatal characteristics of study population.

Characteristics	Normal Doppler (n=55) (Group-I)	Abnormal Doppler		P value
		Low EDF (n=28) (Group-II)	ADF/RDF (n=17) (Group-III)	
Mean S/D ratio	2.53	3.82		
Mean PI	0.954	1.354	5.18	
Hypertensive disorder	34(61.80%)	22(78.60%)	14(82.35%)	>0.05
Anemia	20(36.40%)	8(28.60%)	6(35.30%)	<0.05
Oligohydramnios	13(28.60%)	18(64.30%)	14(82.35%)	>0.05

Labor outcome in study population.

Labor outcome	Normal Umbilical Artery Doppler		Abnormal Umbilical Artery Doppler	
	No.	%	No.	%
LSCS	18	33	34	76
Vaginal delivery	37	67	11	24

Table No. 2. Average PI of umbilical artery velocimetry related to perinatal outcome.

Perinatal Outcome Normal Doppler (n=65) (Group-I)	Low EDF) (n=28) (Group-II)	Abnormal Doppler ADF/RDF) (n=17) (Group-III)	P value
Delivery			
● <36 weeks	0.98 ± 0.179	1.39 ± 0.209	5.18±1.119
● =36 weeks	0.92 ± 0.137	1.30 ± 0.199	-
Apgar			
● <7 at birth	1.13 ± 0.099	1.33 ± 0.312	5.33 ± 0.353
● =7 at birth	0.93 ± 0.215	1.38 ± 0.157	4.51 ± 1.051
NICU			
● Admission req.	1.036 ± 0.077	1.43 ± 0.182	5.10 ± 1.062
● Mother side transfer	0.98 ± 0.176	1.24 ± 0.141	-
PPV in NICU			
● Required	1.20 ± 0.00	1.32 ± 0.217	5.20 ± 0.383
● Not required	0.93 ± 0.215	1.41 ± 1.744	4.83 ± 0.796
Neonatal death among NICU admission	-	1.34 ± 0.230	5.43 ± 1.156

Table 3. Neonatal outcome with umbilical artery velocimetry.

Characteristics	Normal Doppler (n=54) (Group–I)	Abnormal Doppler		P value
		Low EDF(n=29) (Group–II)	ADF/RDF(n=17) (Group-III)	
Delivery <36 weeks	15(27.77%)	18(62.07%)	17(100%)	<0.001
Live/still birth	54/0	27/2	15/2	>0.05
Average. birth weight	2.01	1.66	1.16	-
Apgar <7 at birth	2(3.70%)	10(34.48%)	14(82.35%)	<0.001
NICU admission	13(24.07%)	21(72.41%)	15(88.24%)	<0.001
PPV among NICU admissions	1(1.85%)	6(20.68%)	11(64.70%)	<0.05
Outcome of NICU				
L Certified	0 (0%)	5(23.81%)	9(60.00%)	<0.05
L LAMA	1(7.7%)	2(6.90%)	3(17.65%)	
L Discharged	12(92.30%)	14(66.66%)	3(20.00%)	

Discussion

In our study group, the umbilical artery PI in the normal Doppler group was 0.954, in the low end diastolic flow group, 1.345 and 5.18 in the A/REDF group. This is comparable to the study done by Seyam[2] who found that PI of umbilical artery was 1.32 in the abnormal Doppler group and 0.85 in the normal Doppler group.

There is significant decrease in PI of umbilical artery as birth weight increases, the birth weight being higher in the normal Doppler group and lowest in the absent/reversed end diastolic flow group. This is in accordance with Fleischer et al[3] who demonstrated that those fetuses with lower birth weight (<25th percentile) had higher placental vascular resistance than those with higher birth weight (>25th percentile).

In a study done by Malhotra et al[4], birth weight in abnormal Doppler group was 742±126 gm and in normal Doppler group was 1680±259gm.

PI of umbilical artery was significantly higher in those fetuses that had apgar <7 than those who had apgar ≥7. This shows a higher umbilical vascular resistance and therefore, a decreased placental perfusion in those who had low apgar at birth.

The mean PI of umbilical artery was 0.98±0.176 in those babies who remained with the mother after delivery as compared to 1.036±0.077 in those who got transferred to NICU in the normal umbilical artery Doppler group. On the other hand, in the low end diastolic flow group, the mean PI of umbilical artery in those babies who remained with their mothers was 1.24±0.141 as compared to 1.43±0.182 in those admitted to NICU. In consonance with our study Vergani et al[5] demonstrated that Doppler PI of umbilical artery independently predicts the likelihood of NICU admission for reasons other than low birth weight. Conversely, the study of McCowan[6] found that the effect of abnormal umbilical artery Doppler was not important in terms of admission of the newborn to the nursery, birth weight and gestational age.

The results of our study show that fetuses with abnormal umbilical artery velocimetry have early delivery (at less than 36 weeks of gestation (28% vs 76%), increased NICU admission (24% vs 78%), need for PPV (0.8% vs 47%), low apgar score (3.7% vs 52%) than those with normal Doppler. Various workers have noticed in fetuses with abnormal umbilical artery Doppler velocimetry, a similar poor perinatal outcome[2,12,6].

Morbidity of fetuses namely HMD, IVH, NEC, prematurity, oligohydramnios, SGA, hyperbilirubinemia etc. were all higher in fetuses with AEDF/REDF. Our results are comparable to the results of previous studies[7,8].

Increased incidence of cesarean section was found in patients with abnormal umbilical artery Doppler study (76% vs 33%). This was in consonance with the findings reported by other authors[9-11].

Perinatal mortality was highest in the absent/reversed end diastolic flow group. Two still births and 9 (60%) neonatal deaths occurred in this group. Various studies also suggest that in the most extreme waveform abnormality, there is REDF or AEDF which is considered a very ominous sign of placental compromise and is associated with high perinatal mortality rates.

Madazli[11] also studied the severely growth restricted fetuses with AEDF and found a perinatal mortality of 40%. Brodszki et al[12] analyzed the outcome of 44 fetuses with REDF and found a perinatal mortality of 59%.

Our study underlines the existence of a strict correlation between umbilical Doppler velocimetry and an increased incidence of perinatal complications in IUGR fetuses, in consonance with the study of Soregaroli et al[13].

Similar results were drawn by Baschat[14] when they looked at the umbilical artery resistance to determine if it can help improve the accuracy of diagnosing IUGR and help in identifying a small fetus at risk of chronic hypoxemia.

Recent meta analysis of randomized controlled trials suggest that incorporation of umbilical artery Doppler waveform analysis into management protocols for intrauterine growth restricted fetuses significantly decreased perinatal mortality[15].

The results of the present study clearly demonstrated the efficacy of Doppler in predicting the fetal outcome. We are of the opinion that umbilical artery Doppler studies should be done for all the patients with IUGR, but larger follow up studies are required to confirm the same.

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