The Role of Umbilical Artery Doppler in Detection and Management of Fetal Growth Retardation

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Abstract

Background*:** To evaluate the efficacy of Doppler flow study in the umbilical, artery in the diagnosis and management of FGR (Fetal growth retardation). ***Methods: Fifty pregnant women with growth restricted fetuses were evaluated by umbilical artery velocimetry between 28 and 39 weeks of pregnancy. Outcome of pregnancy was recorded for the normal Doppler group (n=17; 34%) and abnormal doppler groups which includes the low end diastolic flow group (n-23, 46%), the group with absent diastologic flow (n=8, 16%) and the group with reversed diastolic flow (n=2; 4%). ***Results:*** The average birth weight, diagnosis to delivery interval and gestational age at delivery were comparatively lower in case of abnormal umbilical Doppler velocimetary group. Again there was higher incidence of LSCS for fetal distress, Apgar score <7 at 1 minute, admission to neonatal intensive care unit and perinatal death with those of the abnormal umbilical Doppler velocimetry. ***Conclusion:*** Doppler study of umbilical artery allows a non-invasive assessment of uteroplaental insufficiency and is an accurate method for diagnosis and management of fetal growth retardation.

Key words: Umbilical artery Doppler, Fetal growth retardation, Perinatal morbidity.

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Introduction

Intrauterine growth retardation (IUGR) is defined as a birth weight below the 10th percentile for a give gestational age[1,2] . Small for Gestational Age (SGA) occurs approximately 5-10% of all pregnancies[3]. Being SGA is a major cause of fetal and neonatal mortality and long term morbidity; therefore, its effects are important not only to the obstetricians but also to the neonatologists and pediatricians. These children are at a risk of impaired growth and neurodevelopment and increased risk of cerebral palsy[4]. Furthermore, the implications of being SGA are life long, in that, it appears to predispose to adult disease, including maturity onset diabetes and cardiovascular disease[5]. The primary cause in 60% of pregnancies with fetal growth retardation (FGR) has been reported to be placental insufficiency[3,6]. Inadequate invasion and non invasion of the trophoblastic tissue within the chorionic villi vessels leads to reduction in umbilical artery blood flow. Doppler index increases and in the end there appears absent/reversed end diastolic flow[3,7,8]. In IUGR fetuses there exists strict correlation between umbilical artery Doppler wave form and increased incidence of perinatal complications[3,9,10,11].

Detecting the fetus with pathological growth restriction that is at risk for perinantal complications has been an on-going challenge in obstetrics[12] .

The aim of this study was to assess the efficacy of umbilical artery Doppler in the diagnosis and management of foetal growth retardation.

Methods

This is a prospective study done over a period of 6 month in Chittagong medical college hospital from 1st january 2017 to 30th june 2017 population consisted of 50 women with singleton IUGR pregnancy and their gestational age ranged between 28 and 39 weeks. Detailed history and clinical examination was followed by antenatal Ultrasound scan. Known date of last menstrual period, clinical discrepancy of symphysis fundal height of four weeks or more and ultrasonography showed fetal weight less than 10th percentile of their gestational age on femur length (FL), biparietal diameter (BPD) and abdominal circumference (AC) were included as study group. Congenital malformation of the fetus, uterine malformation, transverse lie, Premature Rupture of Membrane (PROM) were

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excluded. Doppler flow study in the umbilical artery was done which categorized SGA fetuses into two group: normal umbilical artery Doppler study group and abnormal umbilical artery Doppler study group.

In women with SGA pregnancies and a normal Doppler study, repeat growth scans and Doppler study were performed fortnightly. The women with abnormal umbilical artery Doppler were admitted to antenatal ward for closer monitoring and fetal surveillance. Grossly abnormal Doppler dictated emergency delivery irrespective of gestational age. In all SGA pregnancies cardiotochography (CTG) was recorded during labour that facilitated the decision of continued augmentation of labour or emergency abdominal delivery.

Data collected by GE Voluson E6 convex probeC1-6-D (MHz: 3-6). With Ultrasonography fetal biometry and morphology scan was done, then Doppler mode was switched on. Then transducer is placed over anterior abdominal wall over the uterus and is carefully manipulated till a free loop of umbilical cord seen by Grey scale imaging and colour was used to identify the umbilical artery. Thus, Doppler waveform was obtained. Parameters studied are systolic-diastolic (S/D) ratio and RI in umbilical artery. The flow velocity waveforms were considered abnormal if S/D ratio, Resistance index (RI) exceeds 95th centile and if there is absent and reverse end diastolic flow.

For the purpose of analysis the study populations were distributed in four group: a normal Doppler group, a diminished end-diastolic flow group, an absent diastolic and reversed diastolic flow group. All the women were followed until delivery.

The perinatal outcome, NICU admission, APGAR score, low birth weight and perinatal death were recorded. Data was collected on maternal birth outcomes and mode of delivery.

Results

Thirty three of the 50(66%) pregnancies with low birth weight 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 3 (three) or diastolic flow was absent/ reversed in fetuses above the gestational age of 28 weeks[13-16]. The mean S/D ratio was 2.26 for the normal Doppler group (N=17) and the S/D ratio was 3.72 in case of low endiastolic velocity of abnormal doppler group.(Table-I) An additional 8 fetuses had absent end diastolic velocity and two fetuses had reversal of diastolic flow.

Mothers of small for gestational age babies with abnormal umbilical artery doppler studies were more likely to need caesarean section for fetal distress (82.6%). There was spontaneous labour of 5(29.4%) patient with normal doppler group, 4(17.48%) with low end diastolic velocity and there was no vaginal delivery in absent or reversed diastolic velocity wave form group. (Table-I)

The total fetuses delivered at less than 36 weeks gestation were 2(11.76%) in normal doppler group, 6(26%) in low end-diastolic velocity group, 7(87.5%) in the group with absent end-diastolic velocity (Table-II). Frequently the fetuses in the abnormal doppler group were delivered by caesarean section and mainly because of non-reassuring fetal heart rate pattern than the fetuses with normal umbilical flow findings.(Table-I). These neonates had lower birth weight percentiles with higher perinatal asphyxia in terms of low apgar score which was below 7 at birth. The need for positive pressure ventilation for resuscitation was more in fetuses with absent/reversed diastolic flow studies.(Table-II)

Babies with abnormal umbilical artery doppler studies were more likely to be admitted to the neonatal intensive care unit and spend longer time there. Overall 53% (n=9) of small for gestational age babies with normal umbilical aertery doppler studies were admitted to neonatal intensive care unit (NICU) in contrast to 69.5% (n=16) small for gestational age babies with low end diastolic velocity on umbilical artery doppler. However all the fetuses with absent/reversed diastolic umbilical artery flow were admitted to the neonatal intensive care unit.(Table-II)

There was absent end diastolic flow in 8 (eight) subjects and reversed end-diastolic flow in 2 (two) subjects in this study. One subject with reversed end-diastolic velocity (REDV) of umbilical artery had stillborn and neonatal death occurred on 7th day of life in case of another one. Out of 8 (eight) subjects with absent end-diastolic velocity (AEDV) of umbilical artery 3 had IUD (Intrauterine death), 2 had neonatal death (one on 1st day of life and another one on second day of life) and 3 of them survived.

Table-I: Characteristics of patient of labour outcome (N=50)

	Normal Doppler (N=17 , 34%)	Abnormal Doppler (N=33, 66%)		
		Low end-diastolic velocity (N=23, 69.70%)	Absent diastolic velocity (N=8, 24.24%)	Reversed diastolic velocity (N=2, 6.06%)
Mean S/D Ratio	2.62		3.72	
Maternal age (years)	24.78		25.52	
Parity a) primipara	6(35.29%)		11(33.31%)	
b) Multipara	11(64.70%)		22(66.66%)	
Diagnosis of abnormal Doppler to delivery interval	NA	9.0 days	4 days	Within 6 hours
Emergency LSCS for fetal distress	2(70%)	19(82.6%)	5(62.5%)	2(100%)
Spontaneous labour	5(29.4%)	4(17.4%)	3(37.5%)	nil

S/D - Systolic /Diastolic
NA - Not Applicable
LSCS - Lower Segment Caesarean Section

Table-II: Neonatal outcome (N=50)

	Normal Doppler (N=17 , 34%)	Abnormal Doppler (N=33, 66%)		
		Low end-diastolic velocity N=23, 69.70%)	Absent diastolic velocity (N=8, 24.24%)	Reversed diastolic velocity (N=2, 6.06%)
Delivery at less than 36 weeks gestation	2(11.8%)	6(26%)	7(87.5%)	0 (0.0%)
Average birth weight (gm)	2091	1965	1330	1285
NICU Admission	9(53%)	16(69.5%)	5(62.5%)	1(50%)
Average stay in Neonatal intensive care unit (days)	1.8	4.5	7.6	3.5
Need for positive pressure ventilation	2(12%)	6(23%)	5(62.5%)	1(50%)
Apgar score <7 at birth	5(29%)	9(39%)	5(62.5%)	1(50%)
Perinatal death	0(0.0%)	0(0.0%)	5(62.5%)	2(100%)
Sex a) Female	6	7	4	-
b) Male	11	16	4	2

NICU-Neonatal Intensive Care Unit

Discussion

In the present study group there is significant decrease in S/D and RI of umbilical artery as birth weight increases, the birth weight being higher in the normal Doppler group (2091gm) and lowest in the absent/ reversed end diastolic flow group (1285gm).

This is in accordance with Fleischer et al who demonstrated that those fetuses with lower birth weight (<25th percentile) had higher placental vascular resistance than those with higher birth weight (>25th percentile)[17]. [Table-II]

Doppler investigations of the umbilical arteries provide information concerning perfusion circulation, while doppler studies of selected foetal organs are valuable in detecting the haemodynamie rearrangements that occur in response to foetal hypoxia and anaemia. When caused by uteroplacental dysfunction, the typical progress begins with increased resistance in the umbilical artery, is followed by decreased resistance in the middle cerebral artery, and is completed with the development of abnormal venous waveforms as cardiac function deteriorates. Even though the failure of a foetus to attain or exceed its expected growth potential may result from numerous different pregnancy complications, the final common pathway most often encountered in practice is via uteroplacental insufficiency[18].

S/D ratio and RI of umbilical artery was significantly higher in those fetuses that had Apgar <7 than those who had Apgar >7 (Table 2). This shows a higher umbilical vascular resistance and therefore, a decreased placental perfusion in those who had low Apgar at birth. The mean S/D ratio of umbilical artery was 2.62 in those babies who remained with the mother after delivery as compared to 3.72 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 S/D ratio of umbilical artery in those babies who remained with their mothers was 1.8 as compared to 3.5 in those admitted to NICU. Doppler ultrasound allows a direct estimation of foetal circulation and placental function[19]. The most widely employed indices for arterial flow are the systolic diastolic ratio (S/D ratio) the resistive index (RI) and the pulsatility index (PI). A fall in end diastolic velocity elevates each of the indices and usually indicates increased down stream resistance.

These mothers of small for gestational age babies with abnormal umbilical artery Doppler velocimetry frequently delivered by caesarean section (42.8% versus 35.4%) for fetal distress with subsequent low Apgar scores and greater need for NICU admission than those with normal Doppler as was also noticed by Seyam et al[20].

In this report umbilical artery doppler studies were performed in all SGA foetuses, this helped us to predict foetal morbidity and mortality in the abnormal umbilical artery doppler group. This along with CTG recording enabled us to intervene at an appropriate time to improve perinatal outcome[21].

As has been shown by others[22] perinatal morbidity and mortality were significantly greater in SGA babies with abnormal umbilical artery doppler. In a large study of neonatal out come in relation to umbilical artery doppler finding by Trudinger et al, babies were grouped by gestational age at delivery and those, with abnormal umbilical artery doppler spent significantly longer in neonatal intensive care unit[23]. A number of studies have found that SGA babies with abnormal umbilical artery doppier studies are smaller and their mothers were delivered earlier than those with normal umbilical artery doppler studies[24].

There were no perinatal deaths in SGA babies with normal umbilical artery doppler studies in this series. Whereas, in the abnormal artery doppler study category there were seven perinatal deaths, one

stillbirth, three IUD and three neonatal deaths. This group was associated with a higher mortality indicating that abnormal umbilical artery doppler studies reflected disease severity in the SGA fetuses.

In a study on the role of umbilical artery doppler to predict adverse perinatal outcome in women with pre-eclampsia Yoon et al, reported, that when gestational age at birth and pre-eclampsia were controlled for, an abnormal umbilical artery doppler study was still a significant independent predictor of adverse perinatal outcome[24].

Conclusion

We conclude that SGA foetuses necessitate categorization into constitutionally normal small foetuses (NSF) and foetal growth retardation (FGR). This categorization helped us to reduce unnecessary apprehensions and intervention in NSF group and enabled us to have closer surveillance and timely intervention in the FGR group.

Doppler ultrasound allows a non-invasive assessment of the degree of uteroplacental insufficiency and thereby categorises SGA foetuses into the FGR group. Once FGR is diagnosed these patients are placed in high-risk pregnancy group requiring vigilant and frequent foetal surveillance.

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