DOPPLER UMBILICAL FLOW WAVEFORMS IN MILD HYPERTENSIVE PREGNANCY

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ABSTRACT

Objective: To assess the relationship between the Doppler umbilical artery flow velocity waveforms (AB ratio) in mild hypertensive pregnancy and the fetal outcome.

Materials & Methods: This is prospective study which carried out between January 2004 and January 2005. Doppler examination of the umbilical artery was available for 135 pregnant women within 1 week of delivery. The value of the last Doppler AB ratio was classified into 3 groups: normal (AB ratio is <95th centile value) high AB ratio (if AB ratio is >95th but <99th centile value) and extreme AB ratio (if ratio is >99th centile value).

Results: Normal AB ratio was found in 91% of mild hypertensive women and 82% of cases were delivered after 36 weeks with average mean birth weight and good Apgar score (more than 6 at one minute). Abnormal ratio was found in 5% of mild hypertensive cases with 40% of them was delivered before 36 weeks with significant admission in the intensive baby care unit.

Conclusion: Doppler study can be used as a good tool for assessment of high risk fetus in mild hypertensive women.

INTRODUCTION

The use of Doppler ultrasound for the assessment of fetal and maternal blood flow is one of the more dramatic refinement in ultrasonic techniques in reproductive medicine with pulsed Doppler ultrasound guided by red-time imaging the so called duplex technique[1]. It is possible to obtain flow signals from the second trimester on ward in the fetal great vessels and cardiac chambers and major abdominal and umbilical cord vessels[1], in addition to its use for evaluation of hemodynamics, the Doppler method has been used to estimate physiological quantities in the fetal and maternal circulation such as velocity, volumetric flow and pressure[1]. There are two methods of estimating circulatory hemodynamics by direct measurement of the volume of blood flow and indirect estimation of flow velocity using waveform analysis[2], the last method might provide useful information about flow without engendering excessive errors[2]. Indices have been developed to express this change in pattern and have been used as a measure of down stream resistance[1]. There are three in common use, systolic-diastolic ratio (AB ratio), resistance index, pulsatility index[2]. Doppler arterial waveforms in non pregnant women are characterized by high systolic velocity and little or no diastolic velocity, during pregnancy maternal and fetal vessels perfusing the placenta assume waveforms indicative of continuous diastolic flow. Doppler waveforms of vessels have been described in form of relationship between systole and diastole, these measurements are intended to relate peak flow at systole to that at end-diastole, and the ratio is calculated from the height of the systolic and diastolic peaks[3]. Waveforms with a high flow in diastole accompany low down stream vessel impedance[4]. In contrast, waveform with little diastolic flow or reversed flow are seen when vascular impedance down stream is abnormally high (e.g placental insufficiency and hypertension and retarded fetal growth[5-7]. This study was undertaken to assess the relationship between the Doppler umbilical artery flow velocity waveforms (AB ratio) in mild hypertensive pregnancy and fetal outcome.

MATERIAL AND METHODS

Prospective study was carried during the period from January 2004 till January 2005 in Basrah Maternity and Child Hospital. The patients included in the study are pregnant women with history of mild hypertension (diastolic blood pressure > 90 mm Hg on at least 2 occasions with 6hrs apart and with patient at rest after 28 weeks with negative proteinurea. Patients were excluded from the study due to chronic hypertension or multiple pregnancy. The maternal characteristics features which were recorded include age, parity, gestational age (depend on the last menstrual period and early ultrasonic examination. The duration of hypertension was obtained from antenatal records (the gestational age at which the diastolic blood pressure measured > 90 mm Hg. The umbilical Doppler flow velocity waveforms (FVWs) were studied at weekly interval after

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admission until delivery. Doppler umbilical FVWs were recorded using a pulsed-wave Doppler system by the same personnel according to the following principles[1]:
FVWs should be recorded during periods of fetal inactivity. Both breathing and body movement alter the umbilical artery waveform. By insisting on fetal inactivity, possible variations due to an altered "state" are eliminated. It is necessary to view a sequence of 10-20 cardiac cycles (8-10 seconds) to establish that the fetus is not breathing and to ensure that the waveforms are constant. The shape of the umbilical artery waveforms is not altered by the site of recording along the cord except at its two extremes *(very close to the fetal abdominal wall, and at the point of attachment of the umbilical cord to the placenta)*. Any variation because of these factors can be checked and eliminated by avoiding cord extremes and recording from at least two different points along it. Because of the coiling of the umbilical cord and its vessels, it is possible for the ultrasound beam to "sight" flow in the same direction in both the artery and the vein. This error can be eliminated by always checking the signal, by recording an arterial waveform with venous signal in the opposite direction. It is important that the maximum height of the flow waveform signal be recorded to ensure that the diastolic flow is not eliminated by high-pass filter. This is especially important when the diastolic component of the waveform is low. Waveforms should not be recorded during uterine contraction that might affect the flow pattern. The mother should be positioned to avoid supine hypotension. According to the normal range of the AB ratio[6], the values of

AB ratios were classified to three groups:
Normal AB ratio (if AB ratio is <95th centile value).
High AB ratio (if AB ratio is ≥95th but <99th centile value).
Extreme AB ratio (if AB ratio is ≥99th centile value).
After delivery, the fetal outcome was recorded in terms of:
Birth weight and centile weight for sex and age (confirmed postnatally by the maturity assessment table).
Apgar Score at 1 and 5 min.
Admission and duration of stay in the neonatal intensive care unit (NICU).
Number of perinatal deaths.

Statistical analysis
Statistical differences between groups were determined using either a t-test or the Chi-square ($\chi 2$) test and analysis of variance (ANOVA). A level of 0.05 was required for significance.

RESULTS
During the period between January 2004 till January 2005, there were (135) pregnant women with mild hypertension without proteinurea were attending antenatal care in Maternity Hospital; 42(27.3%) were multiparous and 93(70.8%) were primigravidae. A Doppler umbilical artery flow velocity waveform relending was available for all the studied patients within 7 days of delivery. The mean interval between the last study and delivery was 1.7 days (SD.1.9). (Table-1) shows the distribution of the studied patients according to the Doppler umbilical artery AB ratio which is classified into three groups (normal, high and extreme). It shows that the majority of the studied patient with mild hypertension have normal Doppler umbilical artery AB ratio.

Table 1. The distribution of the studied pregnant patients according to the Doppler umbilical artery AB ratio.

	Umbilical artery ratio centile		
The number of pregnant patient (%)	Normal (<95th)	High≥95th, <99th	Extreme = >99th
	111 (91%)	19 (21.6)	5 (7%)

(Table-2) shows the distribution of pregnant patient according to the gestational age at delivery and the centile value of the Doppler umbilical artery AB ratio. It shows that 82(82.1%) of patients with normal AB ratio have gestational age at delivery beyond 36 weeks while 3(60%) of these with extreme AB ratio delivered more than 36 weeks which is statistically significant.

Table 2. ***The distribution of the studied pregnant according to the gestational age at delivery for each group of Doppler umbilical artery AB ratio.***

		Umbilical artery ab ratio centale		
		Normal < 95th	High=>95th, < 99th	Extreme= > 99th
Gestational age at delivery weeks	28-32	0 (0%)	0 (0%)	0 (0%)
	33-36	19 (17.9%)	5 (23.6%)	2 (40%)
	>36	82 (82.1%)	14 (76.4%)	3 (60%)
	Total	111 (100%)	19 (100%)	5 (100%)

X^2 =71.0 dif. =4 P<0.01

(Table-3) shows the mean birth weight of neonate delivered for patients of each group Doppler umbilical artery AB ratio and the number of neonate with birth weight less than 10th centile value (for age, sex) for each of above groups. It shows that the mean birth weight of neonates was (3212.9) g for those with normal AB ratio in comparison with the extreme AB ratio with neonate weight 2184.6 which is statistically significant.

Table 3. The mean birth weight of neonates and the number of neonates with birth weight less than 10th centile for each group of Doppler umbilical artery AB ratio.

	Umbilical artery ab ratio centile			
	Normal <95th	High ≥95th, <99th	Extreme ≥ 99th	P- value
Mean birth weight (g) (SD)	3212.9 (551.4) -	2726 (481.7)	2184.6 (326.7)	- P <0.05
No. of neonates with birth weight less than the 10 centile (%)	6	9	5	P <0.01

(Table-4) shows the distribution of neonate with Apgar score at 1min and 5 min according to the Doppler umbilical artery AB ratio. It shows that the majority of neonates with high and extreme AB ratio (31.6%, 83.3%) respectively have APGAR score equal or less than 6 at 1 min in comparing with only 5(4.5%) of those with normal AB while APGAR SCORE estimation at 5min reveals that (58.6%) of neonates with extreme AB ratio had a score less than or equal to 6 in comparing to 1(0.1%) with normal AB ratio which proved to be statistically significant. It shows that the number of perinatal death during the study period was 2(16%).

Table 4. The distribution of neonates with APGAR SCORE ≤6 at 1 min and 5 min according to the Doppler umbilical artery AB ratio.

	Umbilical artery AB ratio centile			
Apgar score ≤6	Normal <95th	High=295th <99th	Extreme≥99th	P- value
Number of neonate (%) at 1 min	5 (4.5%)	6 (31.6)	3 (60%)	<0.01
Number of neonates (%) at 5 min	1 (0.1%)	3 (14.8)	3 (60%)	<0.01

(Table-5) shows the number of neonates whom were admitted to NICU and the mean duration of stay in. It distributed according to the different Doppler umbilical artery AB ratio

centile value and the gestational age at delivery. It shows that 3(60%) of neonates with extreme AB ratio and 3(15%) of those with high AB ratio were admitted to NICU in comparing to only 2(1.2%) of those with normal AB ratio which is statistically significant. It also shows that the mean duration of stay in the NICU is significantly longer for neonates with extreme AB ratio for all the gestational age groups at delivery in comparing to that of neonate with normal AB ratio.

Table 5. The number of neonates admitted to NICU and their mean duration of stay for each group of the Doppler umbilical artery AB ratio.

Gestational age at delivery		Umbilical artery ab ratio centile			
		Normal <95h	High ≥9h, >99th	Extreme >99th	P- value
28-32 (week)	No. of neonates	0	0	0	
	Mean duration of stay in NICU (day)	0	0	0	
33-36 (week)	No. of neonate	2 (1.2%)	3(15%)	3(60%)	P<0.01
	Mean duration of stay in NICU (day)	2	4.4	5.2%	P<0.01
>36(week)	No. of neonate	0	1	0	
	Mean duration of stay in NICU	0	3 days	0	

DISCUSSION

Doppler studies have been extensively evaluated as a test to recognize fetal compromise. In the presence of pregnancy complications this test becomes even more vital and important[8]. In the present study it has been found that most of patients with mild hypertension exhibited a normal Doppler umbilical artery AB ratio, which is in agreement with what had been reported previously[9]. It was also shown that most patients with normal Doppler AB ratio had delivered after 36 weeks (82.5%) while 3 cases show extremely Doppler AB ratio delivered after 36 which proved statistically different and could indicate the higher possibility of fetal stable well being which not need termination of pregnancy before 36 weeks which is in agreement with previous studies[10]. In contrast, in severe preeclampsia and in patient with extreme Doppler AB ratio which indicate fetal decompremized that is need terminalion of pregnancy they demonstrated that absent end diastolic frequency in the umbilical artery is associated with a high incidence of hypoxaemia[11]. While other has been suggested that he presence of an elevated umbilical artery AB ratio should alert the obstetrician to possible fetal problems[11]. At the same time it has been clearly demonstrated that the neonates born with history of normal AB ratio have a low incidence of complications and morbidity, the neonate with normal AB ratio had significant average mean birth weight in comparing to those with abnormal AB ratio. It had been reported that aberration in fetal blood flow velocity detected in hypertensive pregnancy is much more likely if there is retarded fetal growth rate[7,12]. The Apgar score estimation at 1 minute revealed that (4.5%) of those with normal AB rate have a score of equal or less than 6 in comparzing with extreme and high ratio (60%). This statistical difference also proved by the Apgar score estimation at 5 min between those with high and extreme AB ratio and other with normal AB ratio which could reflect higher incidence of neonatal (neurological) and cardio respiratory complication[6]. The admission rate of neonate to NICU and the duration of stay in it were significantly higher in the extreme AB ratio group than the normal group which has been proved for all the gestational age group. This is in agreement with studies that had shown that fetus exhibiting abnormal AB ratio are at very high risk for death or significant neonatal morbidity[13] conversely a normal AB ratio in a pregnancy complication by hypertension establishes an optimistic progress for outcome[13]. The association between the perinatal death and the abnormalities of umbilical artery AB ratio that has been shown in the present study clearly agrees with other

studies[14,15]. From the above results it has been also shown that there was a significant differences between neonates with extreme AB ratio and high AB and the normal ratio regard birth weight and Apgar score estimation, admission rate in NICU which could prove a dose dependent relationship between the degree of abnormalities of AB ratio and adverse fetal outcome. Doppler waveforms reflect the status of the placental circulation, the damage done by disease that obliterate small muscular arteries in the placental tertiary villi will show upon these waveform as a progressivc decrease in end diastotic flow until absent flow and then even veresial flow occurs during diastolic, it is associated with the obliteration of more than 70% of the placental arteries. Central redistribution (brain-sparing reflex) which occur at the expense of reduced flow to the peripheral and placental circulation play as major role in fetal adaptation to oxygen deprivation or hypoxemia[16] which is evident by decrease-end diastotic flow in the umbilical artery (as gaaged by higher umbilical artery systolic-diastolic ratio). In a fetus with IUGR, Doppler changes in the umbilical artery precede the decrease in the cerebro placental ratio (by dividing the cerebral resistance index by the umbilical resistance index and middle cerebral artery pulsatitaly or resistance indices[17] at least one third of fetuses showed early sign of circulatory deregulation 1 week before biophysical profil deterioration[18]. However, this hypothesis of a fetal placental vascular origin for pregnancy hypertension dose not explain the occurrence of hypertension in association with normal umbilical artery Doppler studies. But using a mathematical model of the placental circulation predicts that it is necessary to obliterate approximately 60% of the umbilical placental vascular bed before the Doppler study moves beyond the normal ranges[19]. The principles of management of pregnancy hypertension are simple. Delivery is the definitive treatment. If maternal condition can be safeguarded, then delivery may be deferred in order to allow fetal growth and maturity. Since Doppler umbilical studies predict fetal outcome then it would be reasonable to use such studies to determine those patients suitable for conservative therapy aimed at gaining further fetal maturity before delivery.

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