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Research Article,

"Early Screening Test for High Risk Pregnancies by Second Trimester Color Doppler Imaging Of the Feto-Placental Circulation"

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Abstrect:

Objective: To examine the diagnostic value of umbilical artery velocity waveforms for the early detection of pregnancy induced hypertension and fetal growth restriction. To determine the utility of color Doppler Sonography of the fetoplacetal circulation for early detection of high risk pregnancies.

Methods: This prospective study was conducted in the Department of Obstetrics & Gynecology, Sir Sallimullah Medical Collage & Mitford Hospital Dhaka in collaboration with radiology and imaging department of Dhaka hospital in 1st July, 2006 to 30 June, 2008. 126 randomly selected patients from 17-35 years of ages whose umbilical artery Doppler sonography was done between 16-22 weeks of gestation. All the patient were taken umbilical artery Doppler ultrasonography. Informed consent was taken from all patients.

Results: A total 126 subjects of 16 to 22 weeks of gestation were included in this series. On application of the student't' test for S/D ratio between normal and abnormal waveforms of the umbilical artery was found significant difference (P<.0001). Distribution of patient according to umbilical artery systolic / diastolic ratio (n=126). Normal UA waveform 76 (60%), abnormal UA waveform 50(40%), Age (Mean ±SD) in year, normal UA waveform 25.63 ± 4.47 and abnormal UA waveform 25.86±3.75. Para: Primiparous normal UA waveform 36 (60%) & abnormal UA waveform 24 (40%), multiparous normal UA waveform 40 (60.6%) & abnormal UA waveform 26 (39.4%). Gestation age at scan in weeks (Mean± SD), normal UA waveform 19.5 ±2.5, abnormal UA waveform 19±2.0. Gestation age at delivery in weeks (Mean± SD), normal UA waveform 39.03±1.61, abnormal UA waveform 35.78 ±1.53, P value 0.0001 Birth wt. in Kg. (Mean ±SD), normal UA waveform 3.10 ±0.38, abnormal UA waveform 2.42 ±0.53, P value 0.0001. S/D ratio (Mean ±SD), normal UA waveform 2.40 ±0.31, abnormal UA waveform 5.46±1.62, P value 0.0001. Cases with an abnormal outcome in relation to whether the umbilical artery waveform was classified as normal or abnormal (n=126). Abnormal outcome in PIH normal UA waveform (n=76) 4%, PIH abnormal UA waveform (n=50) 14%, P value 0.001. In PIH/FGR, normal UA waveform (n=76) 1% & abnormal UA waveform (n=50) 5%, P value 0.024. FGR normal UA waveform (n=76) 5% & abnormal UA waveform (n=50) 13%, P value 0.002. Asphyxia normal UA waveform (n=76) 0% & abnormal UA waveform (n=50) 3%, P value 0.017. PIH /IUD normal UA waveform (n=76) 0% & abnormal UA waveform (n=50) 1%. A significant association was found when the Chi Square (X 2) test was used to examine the relationship between umbilical artery blood flow and the outcome of patient (i.e FGR, PIH, fetal asphyxia). The screening test had a sensitivity of 78.26% & specificity of 82.5% and accuracy 80.95%. The predictive value of a positive test was 72% and of a negative test 86.84%.

Conclusion : A close linear relationship between diagnosis of high risk pregnancy & umbilical artery Doppler velocity waveforms was observed .As umbilical artery Doppler is easy to perform and it is done in between 16 to 22 weeks of gestation can be done along with anomaly scan which is also done at 20-22 week of gestation. So, UA Doppler does not cause additional USG scan. Along with anomaly scan UA Doppler will help to screen out high risk pregnancy.

Keywords: High Risk Pregnancies, Second Trimester Color Doppler Imaging, Feto-Placental Circulation

Introduction:

It has long been recognized that impaired fetoplacental perfusion is associated with pregnancy induced hypertension and fetal growth retardation (FGR). Both the pregnancy related complications make a significant contribution to perinatal mortality and morbidity[1]. The uteroplacental arteries are formed as a result of conversion of the maternal spiral arteries by trophoblastic invasion. The normal pattern of trophoblastic invasion develops from as early as eight weeks gestation and is well established by 20-22 weeks gestation, a process that converts the spiral artery in low resistance, high conductance vessel. Pre-eclamptic pregnancies demonstrate high impedance in the fetoplacental circulation and a reduction in the volume of flow, through to result from failed trophoblastic invasion of the spiral arteries in the early second trimester. Fetoplacental vascular resistance can be assessed by doppler ultrasound and therefore impedance indices measured by Doppler have been evaluated as an early screening test for high risk pregnancies[2]. Quantification of flow velocity waveforms of the umbilical artery obtained with Doppler ultrasound examination has become recognized as a potentially useful additional method of fetal assessment[3]. In adult vascular studies end diastolic velocity has been related to peripheral resistance. Accordingly, a variety of distinct waveforms have been described in deep abdominal and pelvic arteries, with the characteristic of each dependent on the individual vascular bed. In normal pregnancy there is a progressive increase in end-diastolic velocity and hence a steady fall in peripheral resistance in the umbilical-placental circulation[4].Reduced, absent, or even reversed end-diastolic flow velocity may occur in pregnancies complicated by severe intrauterine growth retardation, and such waveforms are associated with an increased risk of perinatal death and low apgar scores[5]. Various hypotheses have been proposed to explain these changes, such as an increase in fetal whole - blood viscosity. In a study have demonstrated reduced mean small arterial vessel counts in placentas from pregnancies with abdominal flow velocity waveforms of the umbilical artery[1]. An increase in placental bed resistance caused by obliteration of these small vessels is the primary cause of the change observed in flow velocity waveforms of the umbilical artery[8]. Small for gestational age babies with abnormal umbilical artery Doppler studies; those with normal umbilical artery Doppler studies are unlikely to be still born or to experience major complications during pregnancy of the neonatal period[6].Doppler wave form abnormalities have been reported to be the most accurate predictor of poor neonatal outcome. Despite numerous reports demonstrating the usefulness of umbilical cord arterial Doppler imaging for assessing fetal health, controversy exists about its usefulness[7]. Few studies have directly compared noninvasive tests and umbilical cord arterial Doppler imaging for predicting high risk pregnancies. A pulsed Doppler apparatus may be used to assess the blood flow velocity profiles in the umbilical arteries at 16 to 22 wks. Gestation to determine if complications associated with impaired trophoblastic invasion of the placental bed could be predicted by this measurement. On the basis of above facts it has been hypothesized that "measurement of umbilical artery blood flow velocity is a useful modality in the prediction of high risk pregnancies".

Material and Methods:

This prospective study was conducted in the Department of Obstetrics & Gynecology, Sir Sallimullah Medical Collage & Mitford Hospital Dhaka in collaboration with radiology and imaging department of Dhaka hospital in 1st July, 2006 to 30 June, 2008. 126 randomly selected patients from 17-35 years of ages whose umbilical artery Doppler sonography was done between 16-22 weeks of gestation. All the patient were taken

umbilical artery Doppler ultrasonography. Informed consent was taken from all patients.

Observations and Results:

126 cases were available for analysis. When mothers were divided into those with normal flow and those with abnormal flow the two groups were found to be similar in terms of age incidence and primi and multiparous (Table- I) The proportion of women with an abnormal outcome was high (36.5%). It can find no source of bias in patient selection to account for this and it may reflect the socially deprived community that this hospital serves.One application of the student't' test for S/D ratio between normal and abnormal waveforms of umbilical artery was found significant difference (P<.0001) shown in (Table-1). (Table-2) showed those with abnormal umbilical artery waveforms were delivered at a significantly earlier gestational age than those with normal umbilical artery waveforms (P <0.0001).

Table-1: Distribution of patient according to umbilical artery systolic / diastolic ratio (n = 126).

	Normal umbilical artery waveform	Abnormal umbilical artery waveform	P value
Number (%)	76 (60)	50 (40)	
Age (Mean ± SD) in year	25.63 ± 4.47	25.86 ± 3.75	NS
Para :			
Primiparous (%)	36 (50)	24 (40)	NS
Multiparous (%)	40 (60.6)	26 (39.4)	
Gestational age at scan In weeks (Mean ± SD)	19.5 ± 2.5	19 ± 2.0	NS
Gestational age at delivery in weeks (Mean ± SD)	39.03 ± 1.61	5.78 ± 1.53	0.0001
No of induction (%)	12(16)	7 (14)	NS
No of C/S (%)	9 (12)	6 (12)	NS
Birth wt. in Kg. (Mean ± SD)	3.10 ± 0.38	2.42 ± 0.53	0.0001
S/D ratio (Mean ± SD)	2.40 ± 0.31	5.46 ± 1.62	0.0001

NB: NS = Non significant, 0.0001 =Highly significant in unpaired't' test.
S/D = Systolic / Diastolic Ratio, C/S cesarean section,
Infants in the abnormal Doppler groups also has a significantly reduced birth weight (p< 0.0001), and an increased frequency of neonatal complications commonly associated with pregnancy induced hypertension and FGR.

Table-2: Age distribution of patient those of abnormal umbilical artery waveform (n = 50).

Age in year	No of patient	% of patients	Mean age (Mean ± SE in year)
16-20	4	3.17	24 ± 0.61
21-25	13	10.31	
26-30	25	19.85	
31-35	8	6.35	

Note: Above table showed P > 0.05for Z test between the highest (26-30 yrs) and lowest (16-20 yrs) age groups, which are statistically insignificant.

Seventy six cases had a normal waveform of these, 10 (13%) had an abnormal and 66 (87%) a normal outcome. Inspection of the 10 cases with an abnormal outcome (Table -3) revealed fetuses being symmetrically small as assessed by serial ultrasound measurement. There were five cases of pregnancy induced hypertension, one of which associated with FGR. All ten fetues delivered spontaneously at term with no evidence of intrapartum or neonatal asphyxia. Among those with a normal outcome there were nine cesarean sections (table-1), three for and abnormal cardiotocography associated with cephalopelvic disproportion, and the remaining six for either breech presentation (two) or for suspected disproportion alone (four). The three fetuses labeled as having intrapartum distress had both normal Apgar scores and umbilical PH values at

delivery. Fifty (50) cases had an abnormal waveform of these, 36 (72%) had an abnormal and 14 (28%) a normal outcome (fig-2). The complications among those pregnancies with abnormal waveforms are listed in (Table-3). Three cases fulfilled all the criteria for the diagnosis of fetal asphyxia, the neonate being delivery by cesarean section. Three (03) other cesarean sections were carried out in this group when an abnormal intrapartum fetal heart rate tracing was recorded in the presence of FGR. Furthermore the one case of intrauterine death was preceded by an abnormal study findings the underlying pathology being PIH. A significant association (table-3) was found when the Chi square (X^2) test was used to examine the relationship between umbilical artery blood flow and outcome of patient (i.e FGR, PIH and fetal asphyxia).

Table-3: Cases with an abnormal outcome in relation to whether the umbilical artery waveform was classified as normal or abnormal (n = 126).

Abnormal outcome	Normal umbilical artery waveform (n = 76)	Abnormal umbilical artery waveform (n = 50)	P value
PIH	4	14	0.001
PIH / FGR	1	5	0.024
FGR	5	13	0.002
Asphyxia	0	3	0.017
PUH / IUD	0	1	
Total	10 (13%)	36 (72%)	

Above P values are highly significant in Chi Square test.

The (table-4) shows the overall accuracy, sensitivity, specificity and positive and negative predictive values of umbilical artery Doppler Ultrasound as an early screening tool or modality for the evaluation of complication of pregnancy like PIH, FGR and asphyxia.

Table-4: Accuracy, Sensitivity, Specificity and position and Negative predictive values of Doppler study of umbilical artery.

Accuracy	80.95%
Sensitivity	78.26%
Specificity	82.50%
Positive predictive value	72.00%
Negative predictive value	86.84%

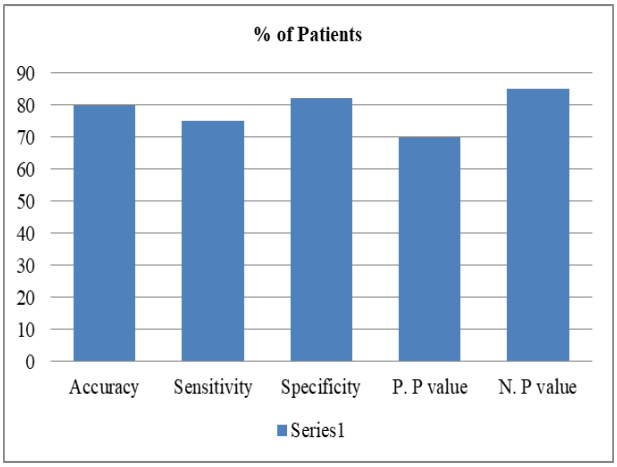

Figure1: Accuracy, Sensitivity, Specificity and position and Negative predictive values of Doppler study of umbilical artery.

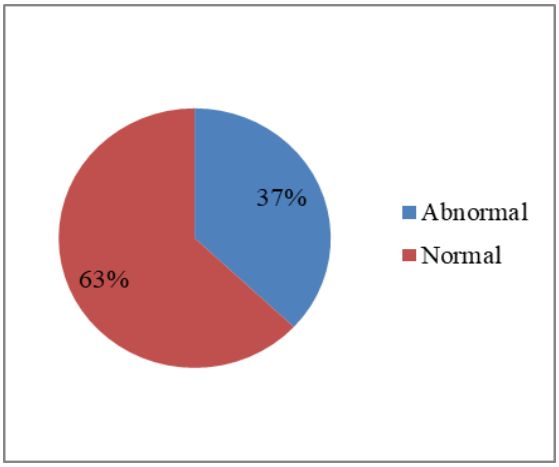

Figure2: Outcome of patients according to normal and abnormal umbilical artery waveform.

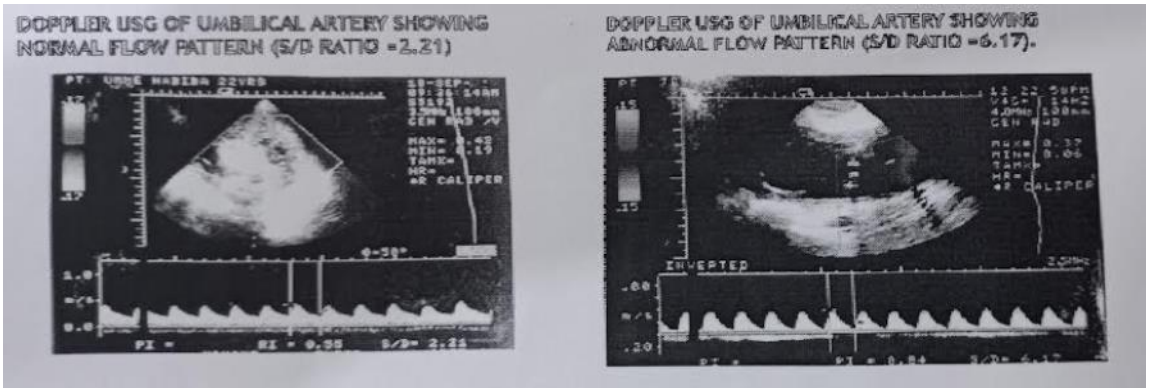

Fig-3: Doppler Usg Of Umbilical Artery Showing Normal Flow Patiern (5/D Ratio -2.21)/Doppler Usg Of Umbilical Artery Showing Abnormal Flow Patiern (5/D Ratio -6.17).

Discussion:

The researcher reviewed other methods of assessing fetoplacental blood flow which are, however either directly invasive. Therefore, only ultrasound techniques are suitable for consideration as a screening tool in pregnancy. Hypertensions, proteinuria of clinically evident fetal growth retardation are late signs in a disease process[9]. Most methods for predicting these conditions, including clinical, biochemical and ultrasound imaging techniques are only of value in the late second and early third trimesters[10]. Maternal serum alpha-fetoprotein screening appears to be the only an insensitive one[11]. Furthermore it is clear that as many cases of FGR follow uneventful course, we need to detect those cases particularly of risk of hypoxia that is, those cases associated with impaired fetoplacental perfusion. This study of 126 singleton pregnancies has shown that analysis of the umbilical artery flow velocity waveforms at 16-22 weeks gestation does appears to be of value in predicting the risk of pregnancy induced hypertension, FGR, and asphyxia; 79.16% of the hypertensive pregnancies were predicted correctly as were 76 % of the growth retarded fetuses. Similar study was done by Berkowitz et al (1988)[3]. Their data suggest that Doppler umbilical veloctimetry studies are valuable in identifying those growth retarded fetuses at increased risk for an adverse perinatal outcome. One case of fetal asphyxia, as defined above, occurred in the abnormal umbilical artery flow velocity waveform group as did the single case of intrauterine death (Table - III). Even in those cases with an abnormal outcome and a normal waveform the clinical course appeared to be more benign; there were no cesarean sections carried out in this group, nor were there either abnormal intrapartum cardiotocographs or low Apgar scores at delivery. Burke et al (1990) examined 179 women by umbilical artery Doppler study. They showed 124 fetuses with normal and 55 fetuses with abnormal flow. From this study they conclude that intrauterine growth retardation associated with normal umbilical blood flow is a different entity from that associated with abnormal flow, normal flow being largely benign and abnormal flow carrying a serious risk of adverse outcome like that of this study[4]. Mc Cowan et al (2000) shown that hypertensive disorders in pregnancy and abnormal uterine artery Doppler studies were more common in mothers of small for gestational age babies with abnormal umbilical artery Doppler studies. This study also correlated with the above findings[8]. 1014 nuliparous women were screened in early pregnancy (median 18 weeks of gestation) by steel et al (1990) with the help of Doppler ultrasound waveforms from the uteroplacental circulation and found hypertension was significantly more frequent among those women than 45/896 (5%). This study also proved that mother of abnormal umbilical artery flow velocity waveforms develop pregnancy induced hypertension followed by fetal IUGR and asphyxia. The abnormal umbilical artery flow velocity waveforms is due to a specific microvascular lesion in the placenta characterized by obliteration of small vascular arteries in the tertiary stem villi[11]. Further improvement in this method are possible by examination of the mothers between 16 to 22 weeks might be more discriminating and also coincide with a policy of

referring for routine ultrasound scan slightly later in pregnancy, which we feel would be more effective at identifying fetal morphology. It has long been recognized that impaired fetoplacental perfusion is associated with PIH and FGR. Both there pregnancy complications make a significant contribution to perinatal mortality and morbidity. A pulsed Doppler apparatus was used to assess the blood flow velocity profiles in the umbilical artery at 16-22 weeks gestation to determine if complication associated with impaired trophoblastic invasion of the placental bed (ie, PIH, FGR and asphyxia) could be predicted by this measurement. 46 of 126 consecutive pregnancies developed one or more of the above complications. The sensitivity was 78.26%, specificity 82.5% and accuracy 80.95%; the predicative value of a positive test was 72% and that of a negative test 86.84 %. These results seem to represent an improvement over existing predictive techniques. Early identification of such a high risk group might allow more discerning use of antenatal resources and may lead to new therapeutic measures.

Conclusion:

Through other methods available of assessing fetoplacetal blood flow which are however either directly invasive only ultrasound techniques are suitable for consideration as a screening tool in pregnancy. The test is relatively cheap, easy to carry out and non-invasive and it can be done in early pregnancy. From this study, it can be concluded that measurement of fetoplacental blood flow in the second trimester appears promising as an early screening tool to indicate those pregnancies at risk from PIH, FGR and fetal asphyxia.

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