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Significance of Umbilical Artery Velocimetry in Perinatal Outcome of Growth Restricted Fetuses

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Summary:

Objectives: To study pregnancy outcomes in growth restricted fetuses with normal umbilical artery velocimetry, low end-diastolic umbilical flow, and absent or reversed diastolic flow. 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%), the low end diastolic flow group (n=23; 46%), the group with absent diastolic 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 velocimetry 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 noninvasive assessment of uteroplacental insufficiency and is an accurate method for diagnosis and management of fetal growth retardation.

Key Words: Intrauterine Growth Retardation, Doppler, Umbilical Artery Velocimetry.

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Introduction:

Intrauterine growth restriction is a common clinical sign of chronic fetal hypoxaemia. It is difficult to differentiate between suboptimal fetal growth due to intrauterine starvation and adequate growth of a constitutionally small infant. Umbilical artery velocimetry is a good predictor in these growth restricted fetuses at risk of antenatal compromise.[1,2,3]

Intrauterine growth retardation is defined as a birth weight below the 10th percentile for a given gestational age.[4,5] Small for gestational age (SGE) occurs in approximately 5-10% of all pregnancies.[6] The primary cause in 60% of pregnancies with fetal growth restriction (FGR) has been reported to be placental insufficiency.[6,7] Inadequate invasion or non-invasion of the trophoblastic tissue within chorionic villi vessels leads to reduction in umbilical artery blood flow. Doppler index increases and in the end, there appears absent/reversed end diastolic blood flow. [6,8,9] In IUGR fetuses there exists strict correlation between the umbilical artery doppler waveform and increased incidence of perinatal complications and, particularly, absent/reversed end diastolic umbilical arterial blood flow has been shown to be associated with high perinatal mortality, long term impairment of intellectual development, and neuro-developmental delay.[6,10,11,12] detecting the fetus with pathological growth restriction that is at risk for perinatal complications has been an on going challenge in obstetrics.[1] Doppler flow velocity analysis can be valuable in resolving this question.[13,14]

Materials and Methods:

A cross sectional comparative study on "Significance of Umbilical Artery Velocimetry in Perinatal Outcome of Growth Restricted Fetuses" was carried out in CMCH at the department of obstetrics and gynaecology during the period of April 2010 to March 2011. The study population consisted of 50 women with singleton IUGR pregnancy and their gestational age ranged between 28 and 39 weeks. The purpose of the study was explained to all potential candidates and those who volunteered were selected after taking their informed written consent. They were registered for delivery with us.

Known date of last menstrual period, clinical discrepancy of symphysis fundal height of four weeks or more and ultrasonography showed fetal weight less than10th 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, PROM were excluded.

Data were collected in case record form containing both open ended and structured questionaries through

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observation, interviewing, clinical examination and evaluation of all available medical reports, documents.

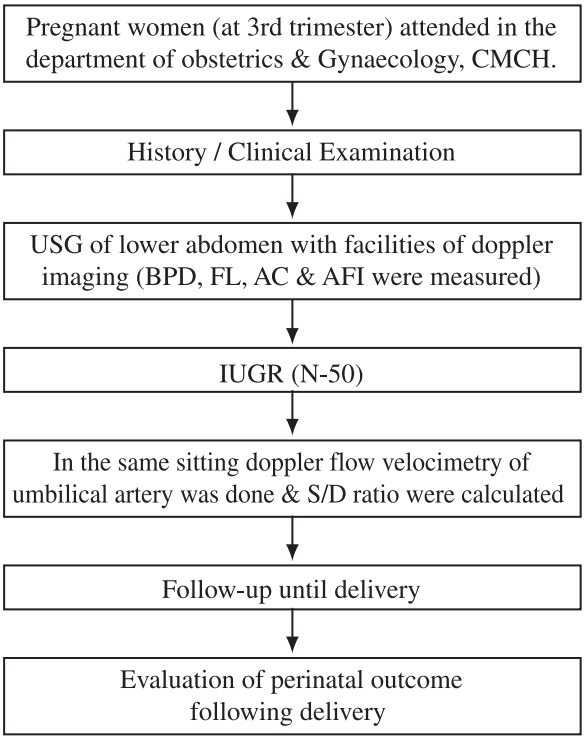
High definition image with a 3.5 MHz curvilinear transducer were used to obtain IUGR and doppler waveforms. BPD, FL, AC and AFI were measured and IUGR were corroborated. In the same sitting, doppler flow velocimetry of umbilical artery was done and systolic-diastolic ratio (S/D ratio) was calculated.

For the purpose of analysis, the study populations were distributed in four groups: 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.

Data collected included diagnosis to delivery interval, abnormal fetal heart pattern before labour, elective cesarean section rate, emergency cesarean section rate for fetal distress, gestational age at delivery.

Perinatal outcome were evaluated following delivery and correlated with calculated values of doppler indices. Adverse perinatal outcome included low birth weight, Apgar score <7 at birth, admission to NICU and duration of stay there, need for positive pressure ventilation and perinatal death.

Following flow chart showing the Methodology:



Result:

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.[15-18] 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 end –diastolic velocity of abnormal doppler group.(Table-I) An additional 8 fetuses had absent end diastolic velocity and two fetuses had reversal of diastolic flow.

There was no statistically significant difference in maternal age and parity between mothers with small for gestational age babies of normal umbilical artery velocimetry and those with abnormal umbilical artery velocimetry studies. Mothers of small for gestational age babies with abnormal umbilical artery doppler studies were more likely to need caesarean section for fetal distress. 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-III)

Table-I

Characteristics of patient and 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	Within6 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

Table-III

Profile of women with AEDV / REDV

Umbilical arterial Blood flow velocity	Fetal Outcome	Birth Weight (g)	Apgar score at 1 &5 min	Admission in NICU	Perinatal Outcome
REDV at 36 wks 3 days	Still Born at 36 wks 4 days LSCS	1400	-	-	-
REDV at 36 wks 2 days	Alive LSCS at 36 wks 2 days	1500	6 and 8	Needed	Death on 7th day
AEDV at 29 wks 5 days	Alive LSCS at 30 wks	800	5 and 7	Needed	Death on 2nd day
AEDV at 29 wks 4 days	Alive LSCS at 30 wks	700	5 and 7	Needed	Death on 1st day
AEDV at 31 wks 1 days	Alive LSCS at 31 wks 1 days	1250	6 and 8	Needed	Survived
AEDV at 31 wks 3 days	Alive LSCS at 31 wks 5 days	1300	6 and 8	Needed	Survived
AEDV at 32 wks 2 days	Alive VD at 32 wks 4 days	1200	4 and 7	Needed	Survived
AEDV at 33 wks 2 days	IUD VD at 33 wks 3 days	1300	-	-	-
AEDV at 33 wks 3 days	IUD VD at 33 wks 5 days	1250	-	-	-
AEDV at 35 wks 2 days	IUD VD at 38 wks	1200	-	-	-

AEDV – Absent End Diastolic Velocity
REDV – Reversed End Diastolic Velocity
IUD – Intra Uterine Death
VD –Vaginal Delivery
LSCS – Lower Segment Caesarean Section
NICU – Neonatal Intensive care unit

Discussion:

Doppler velocimetry identifies normal and altered blood flow velocity in the umbilical artery and is responsive to changes in placental resistance. It is a noninvasive technique that evaluates abnormal fetal hemodynamics that results in abnormal pregnancy outcome. It has been shown by various workers that perinatal morbidity and mortatily were significantly greater in small for gestational age babies with abnormal umbilical artery doppler studies than in those with normal studies.[1,18-20] Various studies have reported on the association of abnormal umbilical artery velocity waveforms with fetal growth restriction and its prediction.[1,2,3] All infants whose birth weight is below the 10th percentile are not exposed to pathologic process in utero but some are constitutionally small and healthy. It is a challenge to differentiate the fetus with pathologic growth restriction and hence at risk for perinatal complications from constitutionally small but healthy fetus.

Meta-analysis of the use of doppler ultrasonography in high risk pregnancies with IUGR has revealed a statistically significant improved perinatal outcome.[21] The result shown in Table - II reveal that fetuses with abnormal umbilical artery velocimetry have a shorter diagnosis to delivery interval, early delivery, decreased birth weight, increased NICU admission and duration of stay there, and need for positive pressure ventilation with low apgar scores than those with normal doppler group. Various workers have noticed in fetuses with abnormal umbilical artery doppler velocimetry a similar poor perinatal outcome.[15,17,21-23]

Torres et al in their retrospective study, reported that absence of end diastolic flow was correlated with IUGR in 100% of pregnancies and fetal death by 66.6%.[24] Higher mortality rates are reported in those fetuses with absent or reversed end-diastolic flow on antenatal doppler velocimetry which is similar with present result.[25,26] In this study it was found that still birth and IUD (Intrauterine death) was 4(8%) and neonatal death was 3(6%).

Doppler findings may be detected several hours to days before any abnormality, in cardiotocographic tracings.[27,28,29] Assessment of EDF(end diastolic flow) is useful because when it is reduced it detect 30% severe hypoxia, when there is AEDF(absent end diastolic flow) is very worrying sign & detect 50% severe hypoxia and in case of REDF (reverse end diastolic flow) is ominous which detect 70% severe

hypoxia and fetal death occur within 7 days.[30] The pregnancy could be continued even in the presence of AEDF for approximately 1 to 2 weeks with intensive fetal surveillance. This may provide time for administration of steroids to enhance fetal lung maturity and also the extra days may add to the fetal weight. This time also enables for shifting of the patient to a tertiary centre where proper neonatal care can be provided.[27] REDF is a terminal event associated with an extremely high perinatal mortality.[27] Immediate delivery is advocated when REDF sets in usually within 24 hours of diagnosis and mainly the route of delivery is cesarean section in these pregnancies.[31] It is reasonable to assume that decreased uteroplacental perfusion during uterine contractions is likely to further jeopardize gaseous exchange in fetuses with preexisting abnormal umbilical artery velocimetry.[32]

However, despite encouraging results, controversy still exists as to the optimal timing of delivery. Arguments tending towards an immediate delivery in the absence of the diastolic velocity waveform or by the appearance reverse end-diastolic blood flow are counterbalanced by the risks associated with prematurity.[31,33,34] In most studies intrauterine growth restriction (IUGR) has been shown to have deleterious effects on mortality and morbidity in newborn infants, both in term and preterm infants.[31, 35,36,37]

Conclusion:

In conclusion, this can be recommended that doppler studies should be done for all pregnant women with intrauterine growth retardation (IUGR). If end-diastolic flow is normal or reduced, we can wait and patient should be followed-up by repeat doppler along with other methods of fetal surveillance like non-stress test (NST) and biophysical profile (BPP). But in women with absent end diastolic flow (AEDF) or reversed end diastolic flow (REDF), if the baby is salvageable and nursery facilities are available, it is safer to deliver the baby for a better perinatal outcome, as the number of perinatal deaths is very high in this group. Where nursery facilities are not available, patients should be followed-up closely and carefully by biophysical profile and cardiotocographies in order to gain time for steroid administration in premature fetuses. These measures will reduce perinatal death.

References:

1. Devendra A, Desai SK, Prem NS, Kania P. Significance of umbilical artery velocimetry in perinatal outcome of growth restricted fetuses. J Obstet Gynaecol India 2005 March/April ;(55):2. 138-143.
2. Berkowitz GS, Chitkara U.J Rosenberg et al. Sonographic estimation of fetal weight and Doppler analyses of umbilical artery velocimetry in the prediction of intrauterine growth retardation: A prospective study, Am J Obstet Gynaecol 1988; 158: 1149-53.
3. Rochelson B, Bracero LA, Porte J et al. Diagnosis of intrauterine growth retardation as two step process with morphometric ultrasound and Doppler umbilical artery velocity. J Reprod Med 1992; 37: 925-9.
4. Harkness UF, Mari G. Diagnosis and management of intrauterine growth restriction. American Journal of clinical Perinatology. 2004 Dec; 31(4): 743-64.
5. American College of Obstetricians and Gynecologists. Intrauterine growth restriction. ACOG practice bulletin no.12. Washington, DC: American College of Obstetrics and Gynecologists; 2000.
6. Byun YJ, Kim HS, Yang JI, Kim JH, Kim HY, Chang SJ. Umbilical artery Doppler study as a predictive marker of perinatal outcome in preterm small for gestational age infants. Yonsei Med J 2009; 50(1):39-44.
7. Gagnon R, Van den Hof M; Diagnostic Imaging Committee, Executive and Council of the Society of Obstetricians and Gynaecologists of Canada. The use of fetal Doppler in obstetrics. J Obstet Gynaecol Can 2003;25:601-14.
8. Giles WB, Trudinger BJ, Baird PJ. Fetal umbilical artery flow velocity waveforms and placental resistance: pathological correlation. Br J Obstet Gynaecol 1985;92:31-8.
9. Morrow RJ, Adamson SL, Bull SB, Ritchie JW. Effect of placental embolization on the umbilical arterial velocity waveform in fetal sheep. Am J Obstet Gynaecol 1989;161:1055-60.
10. Soregaroli M, Bonera R, Danti L, Dinolfo D, Taddei F, Valcamonico A, et al. Prognostic role of umbilical artery Doppler velocimetry in growth-restricted fetuses. J Matern Fetal Neonatal Med 2002;11:199-203
11. Brar HS, Plat LD. Reverse end-diastolic flow velocity on umbilical artery velocimetry in high risk pregnancies: an ominous finding with adverse pregnancy outcome. Am J Obstet Gynaecol 1988;159:559-61.
12. Wienerroither H, Steiner H, Tomaselli J, Lobendanz M, Thun-Hohenstein L. Intrauterine blood flow and long-term intellectual, neurologic and social development. Obstet Gynecol 2001;97:449-53.
13. Harneet N, Kapila AK, Kaur MM. Cerebral and umbilical arterial blood flow velocity in normal and growth retarded pregnancy. J Obstet Gynecol India Jan/Feb 2009; 59(1): 47-52.

14. Gramellini D, Folli MC, Robins et al. Cerebral umbilical Doppler ratio as a predictor of adverse perinatal outcome. Obstet Gynecol 1992; 79: 416-20.

15. Bohem FH, Gabbe SG. Putting it all together. Clinical Obstet Gynecol 2002; 45: 1063-8.

16. Divon MY, Ferber A. Doppler evaluation of fetus. Clinical Obstet Gynecol 2002; 45: 1015-25.

17. Maulik D. Doppler ultrasound velocimetry for fetal surveillance. Clinical Obstet Gynecol 1995;38:91-11.

18. Rochelson B, Schulman H, Fleischer A et al. The clinical significance of Doppler umbilical artery velocimetry in the small for gestation fetus. Am J Obstet Gynecol 1987;156:1223-6.

19. Burke G, Stuart G, Crowly P et al. Is intrauterine growth retardation with normal umbilical artery flow a benign condition? B M J 1990;300:1044-5.

20. Craigo SD, Beach ML, Harvey-Wilkes KB et al. Ultrasound predictors of neonatal outcome in intrauterine growth retardation. Am J Perinatal 1996;13:465-71.

21. Alfervic Z, Neilson JP. Doppler ultrasonography in high risk pregnancies: systemic review and meta-analysis. Am J Obstet Gynecol 1995;172:1379-87.

22. Mc Cowan LM, Harding JE, Stewart AW. Umbilical artery Doppler studies in small for gestational age babies reflect disease severity. Br J Obstet Gynecol 2000;107:916-25.

23. Baschat AA. Weiner CP. Umbilical artery Doppler screening for the detection of the small fetus in need of ante-partum surveillance. Am J Obstet Gynecol 2000;182:154-8.

24. Hackett GA, Campbell S, Gamsu H et al. Doppler studies in the growth retarded fetus and prediction of neonatal necrotizing enterocolitis, haemorrhage and neonatal morbidity. BMJ 1987; 294: 13-6.

25. Simchen MJ, Beiner ME, Strauss-Liviathan N, et al. Neonatal outcome in growth restricted versus appropriately grown preterm infants. Am J Perinatol 2000; 17: 187-92.

26. Malhotra N, Chanana C, Kumar S, Roy K, Sharma JB. Comparison of perinatal outcome of growth restricted fetuses with normal and abnormal umbilical artery Doppler waveforms. Indian Journal of Medical Science. 2006; 60(8) : 311-317.

27. Tyrrell SN, Lilford RJ, Macdonald HN, Nelson EJ, Porter J, Gupta JK. Randomized comparison of routine vs highly selective use of doppler ultrasound and biophysical scoring to investigate high risk pregnancies. Br. J. Obstet Gynecol 1990; 97: 909-16.

28. Alonstrom H, Axelsson O, Cnattingius S, Ekman G, Maesel A, Ulmsten U, et al. Comparison of umbilical-artery velocimetry and cardiotocography for surveillance of small for gestational age fetuses. Lancet 1992; 340: 936-40.

29. Kwek K. Lecture on intrauterine growth retardation. Consultant, Department of maternal & fetal medicine, KK Women's and Children's Hospital, Singapore. Dated-15.09.2005.

30. GRIT Study group. When do obstetricians recommend delivery for a high-risk preterm growth-retarded fetus? Eur J Obstet Gynecol Reprod Biol 1996; 67: 121-6.

31. Gezginc K, Acar A, Peru H, Karatoyli R, Colic C, Capar M. How to manage intrauterine growth restriction associated with severe preeclampsia at 28-34 weeks of gestation? Eur J Gen Med 2008; 5(4): 212-215

32. Maulik D, Mundy D, Heitmann E, Maulik D. Umbilical artery Doppler in the assessment of fetal growth restriction. Clinics in Perinatology 2011 March 38;65-82.

33. Baschat A. Doppler application n the delivery timing of the preterm growth-restricted fetus: another step in the right direction. Ultrasound Obstet Gynecol 2004; 23: 111-8.

34. Mc Intire D, Bloom S, Casey B, Leveno K. Birth weight in relation to morbidity and mortality among newborn infants. N Engl J Med 1999; 340: 1234-8.

35. Lackman F, Capewell V, Richardson B, daSilva O, Gagnin R. The risks of spontaneous preterm delivery and perinatal mortality in relation to size at birth according to fetal versus neonatal growth standards. Am J Obstet Gynecol 2001; 184: 946-53.

36. Bernstein I, Horbar J, Badger G, Ohlsson A, Golan A. Morbidity and mortality among very-low-birth-weight neonates with intrauterine growth restriction. Am J Obstet Gynecol 2000; 182: 198-206.

37. Gluck L, Kulovich MV. Lecithin / Shingomyelin ratios in amniotic fluid in normal and abnormal pregnancy. Am J Obstet Gynecol 1973; 115: 539-46.