Original Articles

COLOR DOPPLER EVALUATION OF UTEROPLACENTOFETAL CIRCULATION IN MANAGEMENT OF HIGH RISK PREGNANCIES

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ABSTRACT

The study group consisted of 75 high risk singleton pregnancies in whom color duplex Doppler evaluation of the uteroplacental circulation was determined and correlated with perinatal outcome. Uterine, umbilical and middle cerebral artery flow velocity waveforms (FVW) were analysed and the resistance index (RI), pulsatility index (PI) and the systolic/diastolic (S/D) ratios measured. On the basis of the FVW the uteroplacentofetal blood flow was classified as normal, increased resistance to flow, absent end\diastolic flow (AEDF), and reversed end diastolic flow (REDF). Ultrasound biometry was simultaneously performed for all fetuses, while non stress testing was performed as and when indicated.

Of the 75 fetuses studied 33 (44%) had abnormal FVWs and only 30.3% of these had an uncomplicated outcome as compared to 81% of those with normal flows. The mortality in cases with abnormal flows was 43% as compared to 7% in those with normal flows. There were 40 growth retarded fetuses in the study group of which 30 (75%) had abnormal umbilical artery FVWs. Of the 18 fetuses with AEDF or REDF, all (n = 7) in whom timely obstetric intervention was not done died in utero, irrespective of fetal weight and gestational age, however 75% of these with weight >1000 g survived when delivered by cesarean section.

Key words: *Color doppler, High risk pregnancy, Flow velocity waveform.*

Doppler ultrasound velocimetry, a non-invasive method of measuring changes in blood flow velocity was first reported to study human pregnancy in 1977 by Fitzgerald and Drumm(l) who used continuous wave Doppler to obtain FVWs from the . umbilical vessels. Recently, developed methods using real time ultrasound images superimposed with blood flow coded in color, which displays direction of flow has made it possible to delineate smaller vessels like the umbilical, uterine, fetal middle cerebral artery and the fetal aorta with greater ease and accuracy, resulting in quicker and more accurate examination.

This technique now offers the potential to evaluate uteroplacental and fetal blood flow serially and to understand the pathophysiology of a complicated pregnancy. This test is particularly helpful in evaluation of the growth retarded fetus who is at great risk of developing *in utero* or perinatal complications(2,3).

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In this study we report our experience with color duplex doppler technique in high risk pregnancies to evaluate its benefit in planning management strategies and predicting perinatal outcome.

Material and Methods

The study group in whom the perinatal outcome was prospectively analysed consisted of 75 high risk singleton pregnancies who delivered between October 1991 and September 1992 *(Table I)* at the Nowrosjee Wadia Maternity Hospital, Bombay. Color doppler examination was done at the Jaslok Hospital and Research Centre on a Siemens Quantum 2000 angiodynography color doppler machine with a 3.5 mHz transducer. Uteroplacental circulation was studied by obtaining flow velocity waveforms (FVW) from the uterine arteries, and the fetoplacental circulation by obtaining FVW from the umbilical artery (UA), fetal aorta and feta! middle cerebral artery. The indices used to describe the resistance to flow in the uteroplacentofetal circulation included the systolic/diastolic ratio (S/D), the pulsatility index (PI) and the resistance index (RI)(4). Because of the alteration of the FVW during fetal breathing, recordings were not taken during periods of fetal breathing movements. Gestational age at the first study ranged from 20 to 39 weeks (mean 34.4 weeks). Serial doppler examinations were performed if diastolic flow was reduced. However, if there was absent or reversed diastolic flow, it was not repeated as these changes were considered irreversible(5).

TABLE **I**-*Obstetric Risk Factors for which Doppler Examination was Performed*

Risk Factor	(n = 75)
Pregnancy induced hypertension (PIH) without IUGR	11
PIH with IUGR	17
IUGR with no apparent cause	18
Diabetes mellitus (DM), no IUGR	5
DM + PIH + IUGR	2
Heart disease, no IUGR	6
Heart disease, with IUGR	3
Miscellaneous	13

The miscellaneous group consisted of 2 with Rhesus isoimmunization, 10 with BOH and 1 with non immune fetal hydrops.

Ultrasonographic fetal biometry and biophysical profile was done in all cases and the presence of intrauterine growth retardation (IUGR) expected fetal weight, placental grading and the amount of *liquor amnii* noted. Asymmetric and symmetric (IUGR) was identified on the basis of fetal biometry(6). Non stress testing was performed whenever indicated (n=29). The results of all the examinations were revealed to the concerned obstetricians. The FVW in the UA were graded as normal, increased resistance to flow (indices >2 SD for gestational age), absent end diastolic flow (AEDF) and reversed end diastolic flow (REDF). Time interval between the last doppler study and delivery ranged from 2 days to 40 days (depending on severity of changes). The decision to deliver a baby by cesarean section was based on expected fetal weight and gestation, report of non stress test, presence of oligohydramnios and severity of the doppler abnormality.

Details of mode of delivery, presence of fetal distress and meconium staining of liquor were noted. The neonate was evaluated for the presence of polycythemia, necrotizing enterocolitis, respiratory distress

and hypoglycemia. Data was analysed using the x^2 test.

Results

Of the 75 high risk pregnancies studied, pregnancy induced hypertension (with or without IUGR) and isolated IUGR constituted the largest group, in which abnormal FVWs were noted in 53.5% and 64.7% cases, respectively. A total of 33/75 cases (44%) had abnormal FVW of which only 30% had uncomplicated perinatal outcome, compared to 81% of those who had normal flows ($p< 0.001$) *(Table II).* Of the 3 cases who expired with normal FVWs, one had multiple congenital anomalies, one had non-immune hydrops and one immune hydrops fetalis.

Forty fetuses had intrauterine growth retardation either primary or secondary to some maternal disease; 38 of these had asymmetric growth retardation and in all cases middle cerebral artery flows were normal or increased. Of the 2 cases with symmetrical IUGR, one had congenital toxoplasmosis and the other congenital rubella syndrome. Both these neonates expired with - in 72 hours due to disseminated intravascular coagulopathy. A total of 30/40 (75%) cases with IUGR, had abnormal FVWs *(Table III).*

and Abnormal Doppler Flows

Doppler results (n = 75)	Outcome		
	Abnormal		Normal
	Mortality n (%)	Morbidity n (%)	n (%)
Abnormal (n = 33)	14 (43)	9 (27)	10 (30)
Normal (n = 42)	3 (7)	5 (12)	34 (81)

Eighteen cases revealed AEDF or REDF (14 at first examination and 4 cases revealed progressive reduction of diastolic flow to AEDF on serial study). Details of fetuses with AEDF and REDF and their outcome is given in *Table IV.* Four cases had REDF and all died *in utero* before any intervention was possible. Of the 14 cases who had AEDF, 50% expired and neonatal complications were noted in 42% of survivors. All fetuses in whom timely intervention was not done died *in utero* (n=3). For the fetus weighing < 1000 g with AEDF, the decision to deliver was difficult. Three fetuses < 1000 g (case numbers 14, 15, 16 in *Table TV)* of which only one survived, were delivered by cesarean section after taking other factors into consideration *(i.e.,* precious baby, bad obstetric history, or non reactive NST) and after discussing with parents about the risks involved to such neonates although delivered by cesarean section.

Of those neonates with AEDF or REDF, severe oligohydramnios were seen in 9, meconium stained liquor in 2, low Apgar score in 3, while 5 developed necrotizing enterocolitis.

Discussion

Accurate assessment of the fetal condition in high risk pregnancies is important if perinatal mortality, and morbidity as also unwarranted intervention in pregnancy and labor are to be reduced. Doppler ultrasound of the uteroplacentofetal circulation offers the potential to study the functional and hence physiological changes in these circulations and may help identify circulatory problems that underlie placental insufficiency and chronic fetal hypoxia(7). Impaired

TABLE III–*Details of Abnormal Doppler FVW in Cases with IUGR*

Obstetric risk factor	Abnormal FVWs (n=30)	Type of abnormal doppler flow	
		Elevated S/D ratio	A/R EDF No. %
Isolated IUGR	11	6	5 (45)
PIH + IUGR	14	4	10 (71)
PIH + DM + IUGR	2	0	2 (100)
Heart disease + IUGR	3	2	1 (33)

FVW = Flow velocity waveforms;
A/R = Absent/Reverse;
EDF = End diastolic flow;
DM = Diabetes mellitus.

diastolic flows suggest that the fetus is usually hypoxic and often acidemic(8). The addition of color flow imaging is an exciting recent development which facilitates quicker and more accurate examination. This investigation is, however, not a global test of fetal well being as fetuses with congenital anomalies, intrinsic metabolic problems or with rhesus disease may have normal findings(9).

The umbilical artery (UA) is the most studied vessel in the fetal circulation. Normally during pregnancy, all indices (S/D, RI, PI) fall with increasing gestation indicating progressive reduction in peripheral resistance. Giles *et al.* (10) reported increased flow indices (S/D, RI, PI) in high risk pregnancies and related these findings to placental microvascular pathology, which reflected changes in placental villous resistance.

In the present study, 25% of the growth retarded fetuses had normal flows with no significant perinatal problems. This implies, as has also been reported by Burke *et al.* (11) that IUGR associated with normal umbilical FVW is a relatively benign condition, that requires no immediate intervention but necessitates adequate follow up. In this study an abnormal FVWs was associated with 43% mortality and 27% morbidity while only 30% had an uncomplicated perinatal outcome. Trudinger *et al.* (12) and Rochelson *et al.* (13) have also shown that the fetus with abnormal umbilical FVW has an increased incidence of fetal distress and perinatal mortality. It is thus clear that an abnormal FVW in the umbilical artery indicates a high risk state requiring close fetal monitoring(14).

The type of FVW abnormality, as seen in our study, could serve as an useful prognostic guide. An increased S/D ratio with presence of diastolic flow was associated with only 25% mortality as compared to 100% mortality in those with AEDF or REDF if timely obstetric intervention was not done. Those with severe FVW abnormalities were also the fetuses with a signifi-

TABLE IV–*Results of Cases with AEDF/REDF*

Case No.	EDF	Inter-vention	GA in weeks	Birth weight (g)	Neonatal compli-cation	Final outcome
1	AEDF	CS	36	1200	NEC	Normal
2	AEDF	CS	35	1200	NEC	Normal
3	AEDF	CS	34	1200	RDS	Death
4	AEDF	CS	35	1080	NEC	Death
5	AEDF	CS	35	1300	–	Normal
6	AEDF	CS	32	1160	–	Normal
7	AEDF	CS	34	1140	–	Normal
8	AEDF	CS	32	1300	–	Normal
9	AEDF	Nil	34	1160	–	IUFD
10	AEDF	Nil	35	1100	–	IUFD
11	AEDF	Nil	35	1100	–	IUFD
12	REDF	Nil	30	1000	–	IUFD
13	REDF	Nil	32	1100	–	IUFD
14	AEDF	CS	30	650	Asphyxia	Death
15	AEDF	CS	32	980	NEC	Death
16	AEDF	CS	30	900	NEC	Normal
17	REDF	Nil	26	480	–	IUFD
18	REDF	Nil	33	880	–	IUFD

GA = Gestational age;
CS = Cesarean section;
NEC = Necrotizing enterocolitis;
AEDF = Absent end diastolic flow;
REDF = Reversed end diastolic flow;
IUFD = Intrauterine fetal death.

cant risk of developing perinatal complications. In the present study, 75% of fetuses with AEDF weighing > 1000 g survived when delivered by cesarean section. Necrotizing enterocolitis was the commonest perinatal complication seen in those with AEDF as has also been reported by Malcolm *et al.* (15). The second vessel of interest in clinical practice is the uterine artery. Abnormal FVW and the persistence of diastolic notching in this vessel is predictive of the development of pre-eclampsia, IUGR or fetal asphyxia(16). Of the cases with PIH in this series, 56% showed abnormal FVW both in the umbilical and uteroplacental circulation. These findings suggest that changes in fetal circulation often result from maternal disease and reduction in uterine perfusion(17). Although, most of pathological FVW in the UA reflects reduction in uterine flows, such

findings may also occur in cases with primary fetal structural abnormality(18).

Blood flow studies of middle cerebral artery are also of prognostic and diagnostic significance. In all cases, with asymmetric IUGR who had abnormal FVW in the fetoplacental circulation in this series, the fetal MCA FVW revealed increased diastolic flows suggestive of a compensatory brain sparing effect(19).

In conclusion, the use of color doppler in trained hands is suitable for clinical obstetric practice, particularly to differentiate between the chronically asphyxiated fetus and the small but healthy fetus. There is increasing evidence that doppler studies of the fetoplacental unit appears to improve pregnancy management. It is becoming apparent that abnormalities in the UA FVW should encourage closer fetal surveillance with other well established fetal testing modalities as fetal compromise seems to be very likely in this scenario. More data is required on the time sequence between alteration in FVW and fetal compromise(20) and further larger prospective controlled trials are required in our setting to validate the encouraging results of color doppler evaluation of the fetal circulation.

Considerable controversy exists as to whether delivery should be carried out when there is AEDF as the fetal capacity to tolerate a redistributive circulation seems to be variable(20,21). Each case has hence to be evaluated on its own merit and the timing of delivery based not only on doppler findings but also on additional traditional methods of fetal assessment. Gestational age, expected weight of fetus and level of neonatal care available also need consideration. In many cases the timing of delivery remains a compromise between threatening fetal asphyxia and prematurity (22).

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