

Color Doppler Ultrasonography in High Risk Pregnancies

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Abstract

Color Doppler Ultrasound 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 and offers the potential to evaluate uteroplacental and fetal blood flow serially and to understand the pathophysiology of a complicated pregnancy. Hundred patients with high-risk singleton pregnancies like IUGR, diabetes, bad obstetric history, Rh isoimmunisation and PIH of all childbearing age groups irrespective of parity were included in the study. Color Doppler evaluation of the uteroplacental circulation was determined and correlated with perinatal outcome. Among 46 pregnancies with abnormal Doppler results perinatal mortality and morbidity was 41.3% and 23.9%, respectively, as compared to patients with normal Doppler waveforms with 3.7% perinatal mortality and 11.1% morbidity. Out of 28 cases, which showed AEDF/REDF, caesarean section was done in 16 cases and perinatal mortality in these cases were 31.3% while as in 12 cases, where no intervention was done, perinatal mortality was 100%. Survival rate of babies was 84.6% in cases of AEDF/REDF when terminated by caesarean section and 0% when no intervention was done even if the baby weight was >1350 gram. Doppler provides a safe, noninvasive, relatively cheap, easily available and very effective method in feto-maternal surveillance in high-risk pregnancies and helps to improve feto-maternal outcome in high-risk pregnancies.

Keywords

Color Doppler, High-risk pregnancy

I. Introduction

A pregnancy is considered high risk when there are potential complications that could affect the mother, baby or both. High risk pregnancies require management by a specialist to help ensure the best outcome for the mother and the baby. The risk factors for high risk pregnancy are extremes of maternal age, maternal medical conditions that exist before pregnancy and medical conditions that occur during pregnancy.

Doppler ultrasound enables a better understanding of the hemodynamic changes and has therefore become one of the most important clinical tools for fetomaternal surveillance in high risk pregnancies. It can be credited with causing a significant decrease in perinatal mortality and morbidity¹. Doppler ultrasound velocimetry, a noninvasive method of measuring changes in blood flow velocity, was first reported to study human pregnancy in 1977 by Fitzgerald and Drumm², who used continuous wave Doppler to obtain flow velocity waveform 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 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 risk of

developing in utero or perinatal complications [1,2,3]. The findings on uterine Doppler evaluation predict most occurrences of early-onset preeclampsia and intrauterine growth restriction, and its use in these pregnancies improves a number of perinatal outcomes.

Doppler studies of the fetal circulation in intrauterine fetal compromise have demonstrated increased resistance to flow in the umbilical arteries and redistribution in the fetal circulation with reduced resistance and increased velocity in the internal carotid and middle cerebral artery and the opposite in the descending thoracic aorta [4,5,6]. Doppler investigation of middle cerebral artery in combination with umbilical artery seems to improve prediction of adverse outcome in near-term pregnancies⁷.

The application of Doppler velocimetry has been well established regarding intrauterine growth restriction, fetal hypoxia, hypertension, fetal anemia and cardiac malformations [7, 8]. The hypothesis that Doppler is effective in reducing mortality and major morbidity in high-risk pregnancy needs to be tested with a massive randomized trial [9]. In a retrospective cohort analysis, Gera et al. compared the pregnancy rate after operative hysteroscopy of patients with intrauterine abnormalities at SIS to the pregnancy rate of patients with a normal uterine cavity. A 31.6% increase in pregnancy rate was observed after treatment of detected abnormalities [11]. Furthermore, two randomized trials reported exceptional improvements in pregnancy rates after office hysteroscopy and instant treatment of detected pathology in patients after two

failed IVF attempts. Intervention resulted in a 9–13% increase in clinical pregnancy rate in the subsequent IVF cycle [12]. These results endorsed the findings of other previously published prospective studies. Despite some methodological weaknesses in the study design, the results of these studies indicate a trend towards a beneficial effect of screening hysteroscopy on IVF outcome. This finding, combined with the observed high prevalence of intrauterine abnormalities, has led to a

II. Patients and Methods

Objective of research:

To correlate color Doppler waveforms of uteroplacento-fetal circulation with perinatal outcome of high-risk pregnancies and to evaluate benefit of color Doppler in planning management strategies and predicting perinatal outcome of high-risk pregnancies.

In this prospective study, 100 high-risk pregnancies, attending both outpatient and inpatient department, were included for the study after obtaining the clearance from the college ethical committee. Informed consent was taken from all the patients. Patients with high risk singleton pregnancies like IUGR, diabetes, bad obstetric history, Rh isoimmunisation and PIH of all child bearing age groups, irrespective of parity, were included in the study. Twin pregnancy, early pregnancy up to 29 weeks and congenital anomalies in babies were excluded from study. Detailed history was taken and complete general physical, systemic and obstetric examination was done. Color Doppler evaluation of uteroplacental circulation was

general debate on the beneficial effect of pre-IVF work-up of the uterine cavity [13].

The aim of this work was to evaluate the diagnostic value of screening Saline Infusion Sonohysterography in diagnosing bilateral tubal blockage in patients with normal transvaginal ultrasonography, before undergoing ICSI treatment and its impact on success rate of ICSI in terms of pregnancy rate, miscarriage rate and ongoing pregnancy rate.

Determined and correlated with perinatal outcome.

Uterine, umbilical, middle cerebral artery and ductus venosus flow velocity waveforms (FVW) were analyzed and the resistance index (RI), pulsatility index (PI) and the systolic/diastolic (S/D) ratios were measured. On the basis of flow velocity waveforms (FVW), the uteroplacental blood flow was classified as normal, increased resistance to flow, absent end diastolic flow (AEDF) and reversed end diastolic flow (REDF). In case of reversed and absent end diastolic flow decision to terminate pregnancy irrespective of gestational age was taken. Serial Doppler study was done depending on the need.

III. Results

Among 100 high-risk pregnancies studied, mean age of patients was 31.9 ± 4.03 years, majority were in the age group of 25-40 years. 58 patients were multigravida and 42 were primigravida. Mean gestational age observed at which color Doppler was done was 34.3 ± 1.9 weeks. Caesarean was done in 76 patients (AFD, CPD) and 24 patients had vaginal delivery. The weight of patients in our study had a wide variation with mean of 55.9 kgs.

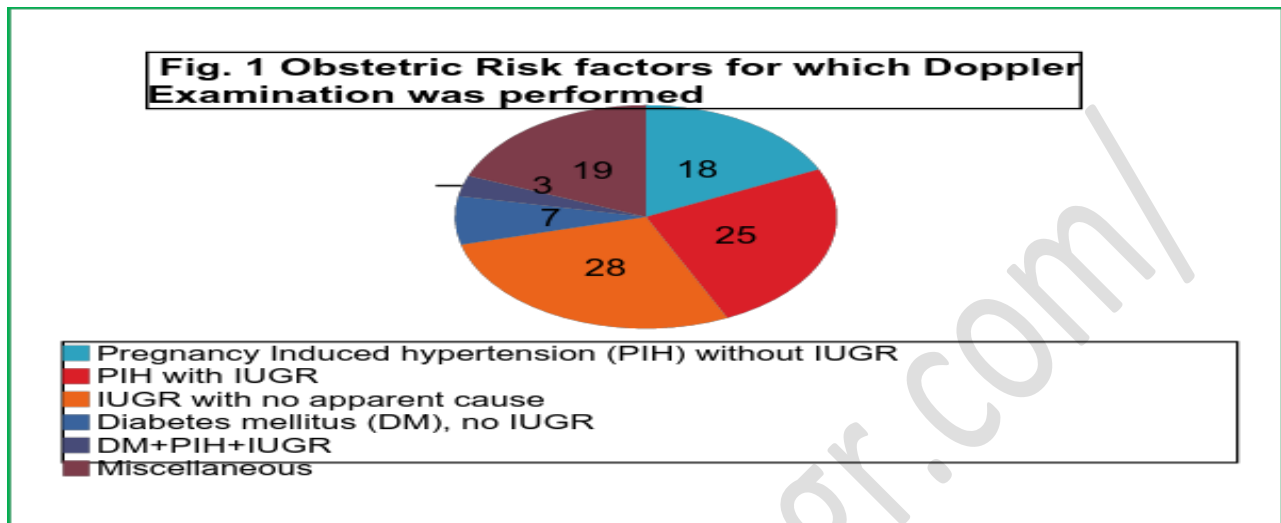


Figure 1:

PIH- Pregnancy induced hypertension; DM- Diabetes mellitus; IUGR- Intrauterine growth retardation

As shown in Figure 1, PIH without IUGR was seen in 18 patients, PIH with IUGR in 25 women, IUGR with no apparent cause in 28 women, diabetes mellitus without IUGR in 7 patients, DM with PIH with IUGR in 3 patients and 19 patients fall in miscellaneous group.

Table 1: Association of Doppler results with perinatal outcome

Doppler results (n=100)	Outcome		
	Abnormal		Normal
	Mortality No. (%)	Morbidity No. (%)	No. (%)
Abnormal (N=46)	19 (41.3)	11 (23.9)	16 (34.8)
Normal (N=54)	2 (3.7)	6 (11.1)	46 (85.2)
Chi-square= 26.78		p-value<0.001 (significant)	

In Table 1, out of 46 pregnancies with abnormal Doppler results, 19 cases had perinatal mortality, 11 cases had morbidity associated with pregnancy outcome, as compared to patients with normal Doppler waveforms, 46 had normal perinatal outcome, 2 had perinatal mortality of unknown cause and 6 had perinatal morbidity.

Table 2: Color Doppler abnormality of various arteries in high risk pregnancy

	Umbilical artery		Middle cerebral artery	Ductus venosus	
	Increased S/D	A/R EDF	Increased diastolic flow	Increased S/D	A/R EDF
IUGR	9 (50%)	5 (27.7%)	9 (50%)	Normal	4 (22.2%)
PIH+ IUGR	6 (27.2%)	10 (45.4%)	6 (27.2%)	Normal	6 (27.2%)
PIH+ IUGR+ DM	Normal	2 (100%)	2 (100%)	Normal	Normal
Heart disease+ IUGR	3 (75%)	1 (25%)	1 (25%)	Normal	Normal
Total	18	18	18	Normal	10

S/D- Systolic/diastolic ratio; A/R-Absent or Reverse; EDF- End Diastolic Flow

As shown in Table 2, out of 46 abnormal color Doppler flow velocity waveforms, as regards the Umbilical artery and Ductus venosus, umbilical artery abnormality was seen in 36 (78.2%) cases in which increased S/D ratio of umbilical arteries was seen in 18 (50%) cases and absent/reversed end diastolic flow of umbilical arteries was seen in 18 (50%) cases and 10 (21.7%) cases had abnormality in ductus venosus. Middle cerebral artery abnormality was seen in 18 cases (39.1%) out of 46 patients.

Table 3: Results of cases with AEDF/REDF

Case no.	EDF	Intervention	GA (Weeks)	Birth weight (grams)	Neonatal complication	Final outcome
1	AEDF	CS	36	1450	-	Normal
2	AEDF	CS	35	1490	NEC	Normal
3	AEDF	CS	31	1370	NEC	Normal
4	AEDF	Nil	32	1170	-	IUFD
5	AEDF	CS	34	1420	NEC	Normal
6	AEDF	CS	32	1360	NEC	Normal
7	AEDF	CS	34	1220	-	Death
8	AEDF	CS	30	1180	-	Death
9	AEDF	CS	29	1020	-	Death
10	REDF	Nil	33	1370	-	IUFD
11	AEDF	CS	32	1360	RDS	Death
12	AEDF	CS	35	1380	RDS	Death
13	AEDF	Nil	34	1360	-	IUFD
14	REDF	Nil	33	1240	-	IUFD
15	REDF	Nil	35	1360	-	IUFD
16	AEDF	CS	35	1440	-	Normal
17	REDF	Nil	35	1420	-	IUFD
18	AEDF	CS	32	1370	-	Normal
19	AEDF	Nil	31	1380	-	IUFD
20	AEDF	CS	35	180	-	Normal
21	REDF	Nil	35	1400	-	IUFD
22	AEDF	CS	34	1430	-	Normal
23	REDF	Nil	32	1180	-	IUFD
24	AEDF	CS	29	1360	NEC	Normal
25	AEDF	Nil	34	1400	-	IUFD
26	AEDF	Nil	29	1360	-	IUFD
27	AEDF	CS	32	1410	NEC	Normal
28	AEDF	Nil	30	1090	-	IUFD

AEDF- Absent end diastolic flow; REDF- Reversed end diastolic flow; CS- Caesarian section; NEC-Necrotizing Enterocolitis; RDS- Respiratory Distress Syndrome; IUFD-Intrauterine fetal death.

Table 4: Intervention and perinatal Mortality

Intervention	Number	Deaths No. (%age)	P-value
Caesarean	16	5 (31.3%)	<0.001 Statistically significant
Nil	12	12 (100%)	
Total	28	17	

Table 5: intervention and survival rate of babies of birth weight >1350g

Intervention	Birth weight >1350g	Survived No. (%age)	P-value
Caesarean	13	11 (84.6%)	0.029 Statistically significant
Nil	8	0	

As shown in Table 3, 4 and 5, out of 28 cases which showed AEDF/REDF caesarean section was done in 16 cases and perinatal mortality in these cases was 31.3% while as 12 cases where no intervention was done perinatal mortality was 100%. Survival rate of babies was 84.6% in cases of AEDF/REDF when terminated by caesarean section and 0% when no intervention was done even if the baby weight was >1350g. This shows that color Doppler helps in early management of abnormal flows by early intervention and thereby improving perinatal outcome.

IV. Discussion

In our present study 100 high risk singleton pregnancies >29 weeks till term were taken and grouped into; PIH without IUGR, PIH with IUGR, IUGR with no apparent cause, Diabetes mellitus without IUGR, Diabetes mellitus with PIH with IUGR and miscellaneous group. Similar study was done by R H Merchant et al [10], who took 75 high risk singleton pregnancies and studied uteroplacental circulation by color Doppler.

Doppler studies revealed abnormal results in 46 patients and out of 46 pregnancies with abnormal Doppler studies 18 pregnancies had isolated IUGR and 22 had PIH with IUGR, 2 pregnancies had PIH with IUGR with Diabetes mellitus and 4 pregnancies fall in miscellaneous group. The abnormal flow velocities in these 46 pregnancies revealed different types of flow in in different subgroups such as in cases with isolated IUGR i.e., 18, abnormal Doppler flow showed elevated S/D ratio in 9 (50%) cases and A/R EDF in 5 (27.7%) cases. In 22 cases with PIH and IUGR elevated S/D ratio was seen in 6 (27.3%) cases and A/R EDF in 10 (45.4%) cases. Patients with PIH with IUGR with DM (2cases) showed A/R EDF in both. In miscellaneous group elevated S/D ratio was seen in 3 (75%) cases and A/R EDF in 1 (25%). These observations are consistent with study done by R H Merchant et al [10].

Color Doppler helps in early management of abnormal flows by early intervention and thereby improving perinatal outcome. Out of 22 patients with AEDF on Doppler caesarean section was done for termination of pregnancy in 16 cases and perinatal mortality was 31.3% in these patients. Patients with AEDF/REDF

where no intervention was done had 100% perinatal mortality. Results were consistent with R H Merchant et al [10], who reported 75% survival in babies with AEDF/REDF when delivered by caesarean section, and all babies in whom timely intervention was not done died in utero, irrespective of fetal weight and gestational age.

Doppler studies revealed abnormal results in 46 patients and perinatal mortality and morbidity among these cases was 41.3% and 23.9%, respectively. Whereas perinatal mortality and morbidity in patients with normal color Doppler waveform was 3.7% and 11.1%, respectively. R H Merchant et al [10] showed that abnormal color Doppler waveform was associated with 43% perinatal mortality and 27% morbidity. Similar studies by Kert Hecser et al [11] and G Burke et al [12] also showed increased perinatal mortality and morbidity with abnormal color Doppler waveform.

In present study two neonates were affected with Respiratory distress syndrome and 6 neonates with necrotizing enterocolitis. Baschat et al [13] reported in fetuses with elevated UA systolic/diastolic ratio, a 10 fold increase in rate of admission to and the duration of stay in NICU and in the frequency and severity of ARDS. Equally importantly, no fetus with normal Doppler measurements was delivered with documented metabolic acidemia.

Doppler parameters of the arterial system and the fetal heart are gestational age dependent. Thus, it could also be assumed that the ratios for venous waveforms are gestational age dependent, and this has subsequently been proven. Systolic/diastolic ratios of umbilical

velocimetry have been used to assess downstream placental vascular resistance. Reverse end diastolic flow velocity suggests extreme abnormality in waveform and resistance. In our study mean gestational age at termination of pregnancy with elevated S/D ratio was 36.47 ± 0.594 weeks which was similar to that reported by R C Pattinson et al [14], where all the fetuses were delivered electively before 36 weeks gestation of mothers who were hypertensive.

V. Conclusion

Doppler provides a safe, noninvasive, relatively cheap, easily available and very effective method in fetomaternal surveillance in high-risk pregnancies assessing the fetal and maternal circulation during high risk pregnancy, and helps to improve fetomaternal outcome in high risk pregnancies. It helps to know the accurate changes in uteroplacental and fetal circulation to predict perinatal outcome and help in appropriate intervention and results in significant decrease in perinatal mortality and morbidity.

The use of color Doppler is suitable for clinical obstetric practice, particularly to differentiate between chronically asphyxiated fetus and the small but healthy fetus. It is becoming apparent that abnormalities in the uterine artery flow velocity waveform 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. And further larger prospective controlled trials are required in our setting to

validate the encouraging results of color Doppler evaluation of the fetal circulation

VI. References

- [1].Fleischer A, Schulman H, Farmakides G, Bracero L, Blattner P, Randolph G. umbilical artery flow velocity waveforms and intrauterine growth retardation. *Am J Obstet Gynecol.* 1985; 151:502-5.
- [2].Fitzgerald De, Drumm JE. Noninvasive measurement of fetal circulation using ultrasound; a new method. *Br Med J* 1977; 2: 1450-64.
- [3].Campbell S, Griffin D, Pearce JM. New Doppler technique for assessing uteroplacental blood flow. *Lancet* 1983; 1: 675.
- [4].Groenenberg IAL, Wladimiroff JW, Hop WCJ. Fetal cardiac and peripheral arterial flow velocity waveforms in intrauterine growth retardation. *Circulation* 1989; 80: 1711-1717.
- [5].Bilardo CM, Nicolaides KH, Campbell S. Doppler measurements of fetal and uteroplacental circulation: relationship with umbilical venous blood gases measured at cordocentesis. *Am J Obstet Gynecol* 1990; 162: 115-120.
- [6].Vyas s, Nicolaides KH, Bower S, Campbell S. middle cerebral artery flow velocity waveforms in fetal hypoxaemia. *Br J Obstet Gynecol* 1990; 97: 797-803.
- [7].Cruz Marteniz R, Figuerers Z. the role of Doppler and placental screening. *Best Prct Resc Clin Obst Gyn* 2009; 23: 845-55.

- [8].BJ, Cook CM, Giles WB Correlly A, Thompson RS. Umbilical artery flow velocity waveforms in high risk pregnancy- randomized controlled trial. Lancet 1987; 1: 188-90.
- [9].De Bono, M Fowerdy Rd, Lifford RJ. Site of trials for evaluation of antenatal tests of fetal well being in high risk pregnancy. J perinatal Med 1990; 18: 77-87.
- [10]. R H Merchant, C P Lulla, V P Gharpure. Color Doppler evaluation of uteroplacentofetal circulation in management of high risk pregnancies. Indian Pediatrics 1994; volume 34.
- [11]. Kurt Hetcher, Stuart Campbell, Pat Doyle, Kevin Harington, Kypros Nicolaides. Assessment of fetal comprise by Doppler ultrasound investigation of the fetal circulation. Circulation 1995; 91: 129-138.
- [12]. G Burke, B Stuart, P Crowley, SN Scanail, J Drumm. Is intrauterine growth retardation with normal umbilical artery blood flow a benign condition? BMJ Clinical research 1990; 300(6731): 1044-5.
- [13]. Baschat AA, Weiner CP. Umbilical artery Doppler screening for detection of the small fetus in need of antepartum surveillance. Am J Obstet Gynecol. Jan 2000; 182(1 Pt 1): 154-8.
- [14]. RC Pattinson, P Hope, R Imhoff, N Manning, V Mannion, CW Redman. Obstetric and neonatal outcome in fetuses with absent end-diastolic velocities of the umbilical artery: a case-controlled study ..American Journal of perinatology 1993; 10(2): 135-8.