To Study the Role of Doppler Ultrasound in High-Risk Pregnancies in Regard to Obstetrical Management as Well as Fetal, Prenatal, and Neonatal Outcome

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Abstract

Background: Evaluation of fetal well being is major concern in obstetrics especially in high risk pregnancy. Fetal monitoring is based on a diagnostic procedure, among which Doppler sonography has become a top-level non-invasive method. Uterine Doppler evaluation predicts most of the occurrences of the early-onset preeclampsia and intrauterine growth restriction, and its use in these pregnancies will improve the perinatal outcomes. Doppler investigation of middle cerebral artery in combination with umbilical artery seems to improve the early prediction of adverse perinatal outcome in high risk pregnancies.

Method: 100 pregnant women with high risk factors (pre-Eclampsia, IUGR and GDM) after 34 weeks till term were evaluated for their colour Doppler findings and the perinatal outcome was analysed.

Results: UA PI had high specificity and low sensitivity for adverse perinatal outcome. MCA RI had highest sensitivity, MCA PI had highest specificity. Ratio of MCA/Umibilical artery PI has highest specificity than independent vessel Doppler. All Doppler indices were highly specific in diagnosing abnormal perinatal outcome with comparatively low sensitivity.

Conclusions: Adverse fetal outcome has been seen to be associated with abnormal Doppler finding. Thus prompt diagnosis of impaired feto-placental circulation in form of abnormal Doppler guides us for appropriate fetal surveillance and timely termination in high risk pregnancy.

Keywords: Umbilical artery doppler; MCA Doppler; sensitivity; prematurity.

Introduction

First application of Doppler velocimetry in obstetrics was reported by Fitzgerald and Drum.[1] It has been assumed that insufficient uterine, placental and fetal circulation results in adverse pregnancy outcomes & those abnormality can be defined by use of Doppler. Doppler ultrasound is capable to detect haemodynamic alterations in maternal and placental circulation (in high risk pregnancy), therefore the method can be utilized in the early detection of maternal and fetal complications in high risk pregnancy. Uterine Doppler evaluation along with umbilical Doppler predicts most of the occurrences of the early-onset preeclampsia and intrauterine growth restriction, and its use in these pregnancies will improve the number of perinatal outcomes.[2]

Our Study Was Conducted Keeping in Mind the Following Aims:

- To study the Systolic/Diastolic ratio (S/D ratio), pulsatility index (PI) and resistance index (RI) of umbilical artery and middle cerebral arteries in high risk pregnancies.

- Ratio of middle cerebral PI to umbilical artery PI blood velocity in high risk pregnancies.

- To evaluate the role of these blood flow indices in the prediction of adverse foetal outcome.

Doppler investigation of middle cerebral artery in combination with umbilical artery seems to improve the prediction of adverse outcome in high risk pregnancies.[3]

Materials and Methods

This prospective observational study was conducted at tertiary care centre, SMIMER hospital, Surat over period of 18 months from 19/01/2017 to 10/09/2018 and informed consent was obtained from women who underwent colour Doppler study. They were followed till delivery and outcome of pregnancy were evaluated and perinatal outcome was recorded.

Inclusion Criteria

- Singleton pregnancy
- Gestational age beyond 34 weeks up to 40 weeks with following high risk factors
- √ Pre-eclampsia
- √ Intra uterine growth restriction
- √ Gestational diabetes mellitus

Exclusive Criteria

- √ Threatened preterm labour
- √ Wrong dates
- √ Multiple pregnancies
- √ Beyond 40 weeks
- √ Anemia
- √ Placenta previa & APH
- √ Congenital anomalies
- √ PROM
- √ Patients who didn't give consent

After ensuring a single live pregnancy - lie and presentation, gestational age, amount of liquor (AFI), placental localization and maturation, presence or absence of intrauterine growth restriction were recorded. Then umilical artery & MCA vessel Doppler were recorded and S/D ratio, PI & RI were calculated as below.

- Peak systolic velocity (PSV)
- End diastolic velocity (EDV)
- Mean velocity (MV)

S/D ratio= peak systolic frequemcy/end diastolic frequency

Pulsatility Index (PI) calculated as follows:-

$PI=(S-D)/M$

Resistance Index (RI) of calculated as follows:

$RI=(S-D)/S$

S/D ratio, RI, and PI are three well- known indices to describe arterial flow velocity waveforms. All three are highly correlated.

S/D ratio and RI of >95th percentile from standard value were classified as abnormal.

Statistical analysis of data was done after compiling and tabulating of data. The sensitivity, specificity, positive predictive value, Negative predictive value were calculated and compared with other studies.

Result

The mean age of the study population was 24.18 years. The maximum number of cases were in the 21-25 years of age group.

➢ The number of primigravida (57%) were more than number of multigravidas (43%) in the present study. Median parity is 1.This can be explained on the basis of more prevalence of preeclampsia in primigravida in younger age.

➢ The most commonly associated pregnancy complication was PIH+IUGR (41%),

➢ followed by IUGR(31%), pre-eclampsia (24%) and 4% had GDM in the present study.

➢ The finding of AEDF and REDF in UA Doppler velocimetry is associated with a highperinatal mortality (8o%).

➢ Out of 100, 46 patients (46%) underwent vaginal delivery. Rest 54 patients (54%) required either emergency or elective caesarean section.

➢ In the present study we found that the average birth weight of the babies was 2050 gramsand most of the babies were born between 1501-2499 grams of weight.

➢ Among all the parameters of U.A, Umbilical artery S/D ratio had highest.

➢ sensitivity (61.11%), Umbilical artery PI had highest Specificity (88.88%).

➢ Among all parameters of MCA, MCA RI had highest sensitivity (60.86%), MCA PI had highest specificity (81.48%)

➢ In my study among all parameters of UA and MCA, Umbilical artery S/D ratio had

➢ highest sensitivity (61.11%), & Umbilical artery PI had highest specificity (88.88%).

➢ CP ratio had the highest accuracy (78.89%) amongst all other parameters of Doppler.

➤ study showed that all Doppler indices were highly specific in diagnosing abnormal perinatal outcome with comparatively low sensitivity.

➤ Cerebro-umbilical ratio was found to be useful in identifying fetuses with increased placental resistance and/or decreased cerebro-vascular resistance.

➤ Patients with abnormal Doppler and preterm delivery who were directly taken for LSCS had better perinatal outcome than who were induced.

➤ Prematurity associated with abnormal Doppler had worst perinatal outcome.

➤ From above data it is evident that adverse fetal outcome is associated with abnormal Doppler finding. Thus prompt diagnosis of impaired feto-placental circulation in form of abnormal Doppler guides us for appropriate management and timely termination in high risk pregnancy.

Observation and Discussion

A total of 100 antenatal patients were included in the study. The period of gestation was between 34-40 weeks of pregnancy. The results are as follows.

When age distribution was studied, it was found that 45%cases were between 21-25 yrs, mean age group being 24.18 yrs.

In the present study 57 patients (57%) were primigravida and 43 patients (43%) were multi-gravida. This may be attributed to high incidence of PIH in Primigravida patients.

100 cases of the study included 24 cases of PIH, 31 of IUGR, 41 with PIH and IUGR and 4 cases of GDM.

1. Assessment of umbilical artery Doppler

a) (Table 1) Qualitative assessment of umbilical artery doppler

Table 1: Correlation of Umbilical artery AEDV and REDV with abnormal perinatal outcome (n=100)

End Diastolic Flow	Total	Perinatal Outcome		PNM (%)
		Abnormal (%)	Normal (%)	
Normal diastolic flow	79	24(30)	55(70)	1(1)
reduced end diastolicflow	11	7(64)	4(36)	2(18)
AEDF	04	4(100)	0	2 (50%)
REDF	06	6(100)	0	6 (100%)

AEDF - absent end diastolic flow; REDF -reversal of end diastolic flow

Among all the patients in study, 79 patients with normal diastolic flow, (70%) had normal perinatal outcome and only 1% perinatal mortality which increased upto 50%and 100%respectively. Though comparatively less perinatal mortality, cases with reduced EDF had 64% of abnormal perinatal outcome.

It is also seen from above table, abnormal end diastolic flow (AEDF +REDF) had sensitivity of 24.34%, Specificity of 100%, PPV of 100%, and NPV of 65.55%. From above finding we can say that prompt detection of AEDV and prompt management could improve the perinatal outcome and prevent perinatal mortality before it progresses to REDV.

This is comparable to other studies like Gaik wardetal (75), where all the four babies with AEDF were admitted to NICU and there was no perinatal death.Butout of 3 babies with REDF, one required NICU admission and remaining two were still born resulting in mortality rate of 66.67%.

Table 2: Quantitive Assessment of Umbilical Artery Doppler

Umbilical artery S/D ratio	Perinatal outcome	
	Abnormal(%)	Normal(%)
Abnormal (3o)	22(71)	8 (29)
Normal (60)	15(25)	45(75)

Table 3: Present Study Umbilical Artery Doppler

sensitivity	61.11%	NPV	70.9%
specificity	83.33%	PPV	76.27%

NPV negative predictive value; PPV positive predictive value

Note: 10 patients were excluded due to absent or reversal of flow.

Out of 90 patients, 22 pts had true positive value, 45 cases had true negative value, 9 had false positive value and 14 had false negative value. In Remaining 10 cases, S/D, RI, PI could not be calculated due to absentl or reversal of diastolic flow and they were directly taken for LSCS. (Table 2)

As per table 3, In the present study umibilical artery Doppler showed 61% sensitivity but 83% specificity with 70% PPV and 76% NPV. Gaikward et al study had a sensitivity of 40.54%, specificity of 89.86%, positive predictive value of 68.18%, and negative predictive value of 73.81% comparable with my study.[4]

Umbilical artery S/D ratio had less sensitivity (61.11%) than specificity (83.33%). We noticed that S/D ratio increased in some patients but they did not show any abnormal perinatal outcome. This

may indicate that fetal compromise is present, but not sufficient to reach the limits of defined end points. This was also explained by Trudinger et al.[5] Also some cases with abnormal Doppler had good perinatal outcome. Timely termination & proper mode of delivery can be credited for it.

Similarly, sensitivity, specificity, PPV and NPV of UA PI and RI was calculated by comparing perinatal outcome with abnormal PI and RI Doppler & they were compared with UA S/D ratio.

Table 4: Comparison of Umbilical artery S/D ratio, RI and PI in prediction of abnormal perinatal outcome

	Sensitivity	Specificity	PPV	NPV
UA S/D	61.11%	83.33%	70.96%	76.27%
UA PI	52.78%	88.88%	76%	73.84%
UA RI	58.33%	81.48%	67.74%	74.57%

From above table 4 it is seen that, though UA S/D has highest sensitivity that is 61%, it was lesser than the UA PI specificity (88.88%) which is highest among S/D, RI and PI. UA PI had highest specificity (88.88%) and lowest sensitivity (52.78%) for adverse perinatal outcome resulting in highest PPV for adverse perinatal outcome.

UA-PI are significantly associated with more operative interventions as well as perinatal complications showing the significance of umbilical artery PI over other two Doppler that is S/D and RI.

results were seen in other studies like Lakhkar et al.[6]

Table 5: Middle Cerebral Artery Doppler Assessment

MCA S/D ratio	Perinatal outcome	
	Abnormal	Normal
Abnormal (40)	27	13
Normal (60)	19	41

When predictability of MCA S/D was compared with MCA PI and RI following observation were seen.

Table 6: Comparison of MCA S/D ratio, RI and PI in prediction of abnormal perinatal outcome

	Sensitivity	Specificity	PPV	NPV
MCA S/D	58.69%	75.92%	67.50%	68.33%
MCA PI	58.69%	81.48%	72.97%	69.84%
MCA RI	60.86%	74.07%	66.66%	68.96%

Above table 5 and 6 showed that MCA RI had highest sensitivity (60.86%), MCA PI had highest specificity (81.48%), MCA PI had highest PPV (72.97%) and MCA PI had highest NPV (69.84%).

MCA Doppler indices were comparable with other similar studies like Gaikwad et al[4] and Lakhkar et al[6] but differs from Kuber et al.[7] with 80% sensitivity but less specificity. These variations may be due to subjective observation error and angle of insonation.

The placental and fetal cerebral vascular beds both undergo hemodynamic adjustments through out antenatal period. Cerebroplacental ratio is a Doppler index that reflects both of these areas and hence can be useful in identifying foetuses with increased placental and/or decreased cerebral resistance. Hence we have also calculated the MCAPI to UAPI ratio (the cerebro umbilical ratio) as variable to find their efficacy to predicta normal per inatal out come in high risk fetus.

Table 7: Cerebro-umbilical ratio/ Cerebroplacental ratio

MCA PI/UA PI	Perinatal outcome	
	Abnormal	Normal
Abnormal (27)	22	5
Normal (63)	14	49

Table 8: highestPositive and highest Negative predictive value

Sensitivity	61.11%	NPV	81.48%
Specificity	90.74%	PVP	77.77%

In our study, (Table 7 and 8) MCA/UA PI was found to be themost specific test (90.74%), highest positive predictive value (81.48%) and highest negative predictive value (77.77%).

CPR is ratio of the MCA to UA pulsatility index. CPR compare the resistance to blood flowin the umbilical artery and MCA. CPR measures the proportion of flow supplying the brain and the placenta. The Cerebro placental ratio is a possibly better predictor of adverse outcome than the ratio in either of the vessels on their own. Combination of various parameters along with umbilical Doppler can be useful indecision making process especially to decide the timing and mode of delivery.[8]

Gerbe retal also confirmed that c/pratiois best predictor forne onatal morbidity and poor outcome specially in IUGR babies.[9]

N. Uma et al (2015) also concluded that High risk pregnancy require close follow up. and fetal Doppler provides more accurate assessment of fetal wellbeing. of all the tests, ratio of (MCA-PI/UA-PI is a more dependable index; ratio of <1 and <1.1 is associated with operative intervention and

perinatal complications with high significance, good specificityand moderate sensitivity.[10]

Table 9: Distribution of cases according to mode of delivery

Mode of delivery

Vaginal delivery (46)		LSCS (54)	
Induced	Spontaneous	Emergency	Elective
36	10	22	32

When termination of pregnancy was studied (Table 9) in high risk patients it was seen that necessity of surgical intervention was required in more than 50% cases for better fetal outcome. Similar results were seen in Gaikwad et al where 47% delivered vaginally and 53% needed LSCS.[4]

Out of 46 cases who were delivered vaginally 78.26% needed induction. Whereas out of 54 cases taken for LSCS, 40.74% cases needed emergency LSCS for fetal distress, others were operated electively to reduce perinatal morbidity.

In my study, (Table 10) out of 100 patients 46 patients underwent vaginal delivery, in which 22 fullterm patients had normal Doppler amongst which 19 had healthy baby and 3 babies were admitted in NICU. 12 preterm patients had normal Doppler with 6 normal heathy baby and 6 baby admitted in NICU.

6 full term patients had abnormal Doppler with 4 healthy baby and 2 baby admitted in NICU. 6 preterm patients had abnormal Doppler with 4 heathy baby and 2 baby admitted in NICU.

Out of 100 patients, 54 patients under went LSCS, in which 10 fullterm patients &10 preterm patients had normal Doppler and 7 full term patients and 27 preterm patients had abnormal Doppler.

Out of 10 full-term patients with normal Doppler, there were 8 healthy babies and 2 NICU admission. Out of 10 pre-term patients with normal Doppler, there were 7 healthy babies and 3 NICU admission. Out of 7 full term patients with abnormal Doppler, there were 3 healthy babies and 4 babies admitted in NICU.

Out of 27 preterm LSCS with abnormal Doppler, there were 3 healthy baby and 24 babies admitted in NICU.Out of which 13 babies survived and 10 NND & 1 still birth occured due to very low birth weight and birth asphyxia. So patients with preterm with abnormal Doppler who were directly taken for LSCS had good outcome.

As per table 11 When perinatal outcome was measured & compared to gestational age of high risk patients & her Doppler studies, it was found that, among cases who were delivered vaginally 33% of patients having abnormal Doppler needed NICU admission. But among those patients who were taken for LSCS, 79% cases needed baby NICU admission. Higher incidence of NICU admission was due to preterm termination of pregnancy due to abnormal Doppler either electively or due to fetal distress. This indicates prematurity as itself high risk factor for NICU admission & it may worsen the perinatal outcome.

To avoid the bias of prematurity in NICU

Table 10: Comparison of mode of deliveries, Fullterm & Pre-term, Normal & Abnormal Doppler and perinatal outcome.

Mode Of Delivery	FT/PT	Doppler outcome	Perinatal outcome
Vaginal (46)	Full term (28)	Normal (22)	Healthy (19)
			NICU admission (3)
		Abnormal (6)	Healthy (4)
			NICU admission (2)
	Preterm (18)	Normal (12)	Healthy (6)
			NICU admission (6)
		Abnormal (6)	Healthy (4)
			NICU admission (2)
LSCS (54)	Full term (17)	Normal (10)	Healthy (8)
			NICU admission (2)
		Abnormal (7)	Healthy (3)
			NICU admission (4)
	Preterm (37)	Normal (10)	Healthy (7)
			NICU admission (3)
		Abnormal (27)	Healthy (3)
			NICU admission (24)/10 NND/1 SB/13 survived

admission, when all full term patients only studied, it was seen that among 13 fullterm cases with abnormal Doppler, about 50% (6) needed baby NICU admission where as when preterm patient with abnormal Doppler were studied, it was seen that 75% cases needed NICU admission & again 1 SB occurred & 10 NND occurred after NICU admission suggesting prematurity as a addictive factor for already compromised baby.

Again, fullterm cases with abnormal Doppler, 50% needed LSCS whereas preterm cases with abnormal Doppler, 81% needed LSCS indicates increased surgical intervention in delivery due to abnormal Doppler.

Table 11: Perinatal Outcome (n=100)

Perinatal Outcome		Number	Percentage (%)
	Still birth	1	1%
Live birth	NICU Admission – Yes but Survived	35	35%
	NICU Admission –Not required	54	54%
Neonatal Death		10	10%

When perinatal outcome was analysed in high risk pregnancies, it was seen that there was 11% perinatal mortality with one case of still birth n 10 cases in which baby could not be survived even after utmost possible NICU care, commonest causes being low birth wt n prematurity. 54% cases had good perinatal outcome with healthy babies as they did not require NICU admission, but 35% babies were admitted in NICU with good recovery.

These results were comparable with other studies like Gaikwad et al[4] and Lakhkar et al.[6] etc.

Conclusion

In High risk pregnancies, doppler ultrasound examination is a non invasive, quick and simple assessment of uteroplacental and fetal circulation. Increase in UA and decrease in MCA are early marker for detection of fetal compromise. Combination of various parameters for evaluation of perinatal outcome is more accurate and informative rather than single parameter in Doppler study. Patients with abnormal Doppler and preterm delivery who were directly taken for LSCS had better perinatal outcome than who were induced. To improve neonatal outcome in high risk pregnancy, we need regular follow up and periodic investigations for fetal well being and timely termination of pregnancy with proper mode of delivery in cases with abnormal Doppler studies.

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