Antepartum fetal assessment in normal and hypertensive preganancies: An ultrsound doppler based study

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Abstract:

Hypertensive disorders in pregnancy are one of the common causes for maternal and fetal mortality and morbidity related the pregnancy, incidence being 5-15% of cases in general. They pose significant threat over the community health for which they are to be identified at the earliest and optimally managed. Sonographic Doppler studies offer promising results in identifying the complications and outcomes of pregnancies complicated by pregnancy related hypertensive disorders. Doppler parameters offer important clues regarding normal fetal outcome. Umbilical artery Doppler is a strong and independent predictor of adverse perinatal outcome in patients with pre-eclampsia, significantly related to low birth weight. MCA/UA Pulsatility index ratio had high sensitivity and positive predictive value, in predicting adverse perinatal outcome.

Key words: Adverse perinatal outcome Doppler study, Pregnancy induced hypertension, Pregnancy outcome, Pulsatility index

Introduction:

Hypertensive disorders complicating pregnancy are common and form one of the deadly triad, along with hemorrhage and infection that results in much of the maternal morbidity and mortality related to pregnancy. The term pregnancy induced hypertension is defined as the hypertension that develops as a direct result of the gravid state. The incidence of Pregnancy induced Hypertension ranges from 5-15% in cases in general, 16% in cases of primi gravida and around 7% in multi gravida. The term pregnancy induced hypertension is used to describe any form of new onset pregnancy related hypertension. Recently the term gestational hypertension was developed by working group of NHBPEP (National High Blood Pressure Education Programme) to replace pregnancy induced hypertension. The five types of hypertensive disease include Pre-eclampsia, Eclampsia, Pre-eclampsia super imposed on chronic hypertension, chronic hyper tension and Gestational Hypertension. The hypertensive disorders pose significant threat over the community health in terms maternal and neonatal mortality and morbidity. The identification of this

clinical entity and effective management play a significant role in the outcome of pregnancy, both for mother and baby.

Aim of the study

This study is basically taken up to study the abnormalities that can be detected early by means ultrasound Doppler in cases of hypertensive disorders of pregnancy and also to identify the placental circulatory failure and neonatal outcome.

Materials and Methods

The Prospective comparative Clinical study was conducted at department of Obstetrics and Gynecology, Government General Hospital, Kurnool in association with department of Radiology for a period of two years from November 2007 to November 2009. The study group included 50 normal pregnant women and 50 patients with hypertension is undertaken to study the diagnostic value of Doppler findings with pregnancy outcome and low birth weight. The inclusion criterion for this study is women with singleton pregnancy with a gestational age ranging from 32-40 weeks and has pregnancy induced hypertension with or without proteinuria and IUGR. Women presenting with multiple gestation, chronic hypertension, fetus with major congenital abnormalities, renal o collagen vascular disease and people with diabetes complicated pregnancy are excluded from the study.

Following a detailed clinical history and examination in obstetrics clinics, patients were referred to radiology department, for ultrasonographic investigations. After ultrasound biometry, assessment of amniotic fluid and placental maturity, Doppler wave patterns of umbilical and middle cerebral arteries were obtained. The waveforms were obtained during fetal inactivity and apnea. Umbilical artery (UA) Doppler flow velocity waveform was obtained from a free loop of cord and measurements taken when a clear waveform was acquired in the absence of fetal breathing or body movement. The Pulsatility index (PI) was measured and the presence or absence of end diastolic frequencies was noted. The Pulsatility index was used as it continues to reflect changes in resistance with progressive absence of end diastolic frequencies or reverse flow and the values are normally distributed in third trimester. For middle cerebral artery (MCA) Doppler ultrasound, a transverse image of the fetal head was obtained at the level of the sphenoid bones.

The Sonographic Pulsatility index ratios were considered abnormal if the value was above the 95th percentile of previously published values for gestational age. The MCA Pulsatility index was considered abnormal if the value was below the 5th percentile of previously published values for gestational age. The MCA/UA PI ratio (Cerebro placental ratio) is usually constant during the last 10 wks of gestation. A single cut off value (1.08) was used above which velocimetry was considered normal and below which it was considered abnormal.

Adverse perinatal outcome was defined as the presence of any of the following:

1. Emergency cesarean delivery for fetal distress.
2. 5 minute APGAR score of less <7
3. Admission in NICU for prematurely IUGR, birth asphyxia.
4. Perinatal death

The findings in the study are recorded in a pretested Proforma and statistical methods Chi-Square and P-value are used to find the diagnostic value of ultrasound and Doppler findings to diagnose the bad pregnancy outcome.

Results:

When age and PIH is concerned (table 1), 52% patients in the PIH group belonged to the age group 21 – 25 years, 32% (16) were in the age group of less than 20 years, 12% (6) were in the age group 26-30 years and 4% (2) belonged to more than 30 years age group. In normal group also similar age group subjects were considered.

Table 1: **Age wise distribution in normal and PIH Patients**

Age in years	No. of cases		Percentage (%)	
	Normal	**PIH**	**Normal**	**PIH**
15-20 years	10	16	20%	32%
21 – 25 years	30	26	60%	52%
26 – 30 years	8	6	16%	12%
> 30 years	2	2	4%	4%

Out of 50 PIH cases studied (Table 2), 26 were primi gravida, 14 were second gravida, 7 were third gravida and 3 were fourth gravida and out of 50 normal cases 24 were primi gravida, 16 second

gravida, 7 were third gravida and 3 were fourth gravida.

Table 2: Parity wise distribution of cases

Parity distribution	Number of cases	
	Normal	**PIH**
Primi gravida	24	26
Second gravida	16	14
Third gravida	7	7
Fourth gravida	3	3

When placental maturity is considered with adverse out come in pregnancy induced hypertension patients (Table 3), 38 cases with Grade – III placental maturity 55.3% had adverse perinatal outcome and 44.7% had uneventful course. Of the 12 cases with Grade – II placental maturity, 75% had uneventful outcome and 25% had adverse outcome. Therefore Grade-III placental maturity is significantly associated with adverse pregnancy outcome in PIH patients. No significant perinatal adverse out comes were observed in normal group.

Table 3: Association of placental maturity with pregnancy outcome in PIH subjects

Placental Maturity	Pregnancy outcome in PIH		Total
	Normal	**Abnormal**	
Grade – II	9 (75%)	3 (25%)	12
Grade – III	17 (44.7%)	21 (55.3%)	38
	26	24	50

As for as Ultrasound Doppler studies are concerned(Table 4), Out of 50 cases of PIH, studied, 36 (72%) cases showed abnormal Doppler indices and 14 (28%) cases showed normal Doppler indices Out of the 50 normal cases studied, only 2 cases had abnormal umbilical artery Doppler finding. There was no correlation between the UA Doppler finding and placental maturity, birth weight or perinatal outcome.

Table 4: showing cases presented with abnormal Doppler indices in PIH group.

PIH group	Number of cases	Percentage (%)
Abnormal Doppler indices	36	72%
Normal Doppler study	14	28%

No cases of intrauterine death or neonatal death were observed in normal group but 6 cases of low APGAR score were recorded and 1 case needed admission in NICU. In case of PIH group, 18 cases

showed adverse perinatal outcome, of which 3 were intrauterine deaths, 1 was still birth/neonatal death, 10 cases showed low APGAR score at 5 min and 4 babies were admitted in NICU. (Table 5)

Table 5: Incidence of abnormal outcome in both study groups

Outcome	Number of cases	
	Normal	**PIH**
Intrauterine death	Nil	4
Still birth/ Neonatal death	Nil	3
Low apgar score	6	12
Admission in NICU	1	5
Total:	7	24

The Table.6 below shows that, abnormal MCA – PI values were found in 35 (70%) cases and normal in 15 (30%). Abnormal UA – PI values were found in 25 (50%). Abnormal MCA/UA PI ratio was found in 27 (54%) and normal flow in MCA was seen in 26% (13) of which 9 cases had AEDF (Absent End Diastolic Flow) and 4 cases has (Reverse End Diastolic Flow) REDF and normal i.e. Positive End Diastolic Flow was seen in 74% of cases.

Table 6: Doppler findings in PIH

Doppler findings in PIH	**Normal**	**Abnormal**	**Total**
UA – PI	25 (%0%)	25 (50%)	50
MCA-PI	15 (30%)	35 (70%)	50
MCA/UA	23 (46%)	27 (54%)	50
Diastolic flow	37 (74%)	13 (26%)	50

When association of MCA Doppler findings are correlated to the birth weight of babies in PIH group, 35 cases with abnormal MCA – PI 62.9% (22) had low birth weight and 37.1% (13) had birth weight above 2.5 kg. Of the 15 cases with normal MCA – PI 53.3% of cases (8) had low birth weight and 46.7% of cases had a normal birth weight. MCA–PI value is significantly related to the low birth weight with P value of 0.5287 (Table 7).

Table 7: Association of MCA Doppler with birth weight in PIH patients

MCA-PI values	Birth weight	
	Normal(>2.5Kg)	Low birth(<2.5Kg)
Normal	7 (46.7%)	8 (53.3%)
Abnormal	13 (37%)	22 (62.9%)
Total :	20 (40%)	30 (60%)

Similarly abnormal UA-PI values (Table 8) also related to low birth weight babies in that 25 cases with abnormal UA – PI 92.0% of cases (23) had low birth weight and 8% of cases (2) had normal birth weight. Of the 25 cases with normal UA-PI, 28% of cases (7) had low birth weight and 72% of cases (n=18) had normal birth weight. UA–PI is significantly related to the low birth weight with P < 0.000003.

Table 8: UA-PI values in relation to low birth weight

UA-PI	Birth weight	
	Normal(> 2.5 Kg)	Low birth(< 2.5 Kg)
Normal	18 (72%)	7 (28%)
Abnormal	2 (8%)	23 (92%)
Total :	20 (40%)	30 (60%)

Of the 27 cases with abnormal MCA/UA–PI ratio 81.5% of cases (n=22) had low birth and 18.5% of cases (5) had normal birth weight. Of the 23 cases with normal MCA/UA–PI ratio 3.48% of cases (n=8) had low birth weight and 65.2% had normal birth weight. MCA/UA-PI is significantly related to the low birth weight with P < 0.00078.

Table 9: **Association of MCA/UA-PI ratio with birth weight in PIH**

C/P ratio	Birth weight	
	Normal(> 2.5 Kg)	Low birth(< 2.5 Kg)
Normal	15 (65.2%)	8 (34.8%)
Abnormal	5 (18.5%)	22 (81.5%)
Total :	20 (40%)	30 (60%)

Of the 50 patients 7 (14%) had adverse perinatal outcome. However none of these patients had any abnormal Doppler parameters. Table No.10 shows that of the 35 cases with abnormal MCA-PI, 60% of cases (21) had adverse perinatal outcome and 40% of cases had uneventful course. Of the 25cases with abnormal UA-PI ratio 85.2% of cases (23) had an adverse outcome and 14.8% (4) had normal

outcome. Of the 13 cases with absent and reverse outflow in umbilical artery, all had an adverse outcome; all 7 deaths belong to this group.

Table 10: **Association of Doppler findings with pregnancy outcome in PIH**

Doppler Parameters	Pregnancy outcome		Total
	Normal	Abnormal	
MCA-PI (Abnormal)	14 (40%)	21 (60%)	35
UA-PI (Abnormal)	4 (16%)	21 (85%)	25
MCA/UA (Abnormal)	4 (14.8%)	23 (85.2%)	27
AEDF/REDF	-	13 (100%)	13

Of the 9 cases with absent end diastolic flow, 2 intrauterine deaths and 1 perinatal death were seen and of the 4 cases with reversed diastolic flow, there was intrauterine death in all the 4 cases. Incidence of mortality is higher with reverse EDF with P=0.00721171.

Table 11: **Association of absent EDF/Reverse EDF with Perinatal mortality in PIH**

Doppler Parameters	No. of cases	IUD/Perinatal mortality
Absent EDF	9	3 (33.3%)
Reverse EDF	4	4 (100%)

If diagnostic Doppler parameters for adverse pregnancy outcome are taken in to consideration, Cerebroplacental ratio was not sensitive (95.94%). It was more sensitive than either UA-PI (87.50) or MCA-PI (85.50).Cerebroplacental ratio also had the diagnostic accuracy (92.00) compared to UA-PI (88%) and MCA (68%) (Table 12)

Table 12: **Diagnostic values of Doppler findings for adverse pregnancy out come**

Doppler findings	Adverse pregnancy outcome				
	Sensitivity	Specificity	ppv	npv	Accuracy
MCA-PI	85.50	49.50	70.00	90.00	68.00
UA-PI	87.50	86.62	85.00	88.00	88.00
MCA/UI	95.94	85.72	86.19	97.95	92.00

If diagnostic parameters are taken for incidence of low birth weight (Table 13), UA-PI has

highest sensitivity and positive predictive value (77.76 and 93.00) compared to MCA/PI ratio (75.34 and 76.00).

Table 13: **Diagnostic value of Doppler findings for low birth weight**

Doppler findings	Low birth weight				
	Sensitivity	Specificity	PPV	NPV	Accuracy
MCA-PI	74.86	36.00	63.86	51.00	60.1
UA-PI	77.76	92.00	93.00	74.00	84.00
MCA/UA	75.34	76.00	82.28	67.24	76.00

Discussion:

Good laboratory evidence indicates that where growth restriction is secondary to placental vascular damage blood velocity measurements in the umbilical artery become abnormal. An abnormal umbilical artery Doppler wave form is a strong and independent predictor of adverse perinatal outcome in patients with pre-eclampsia.

In a clinical trial conducted by Fleischer[1] and his associates, it was observed that higher placental vascular resistance with low birth weight. They concluded that umbilical artery Doppler study had sensitivity of 78%, specificity 83% and positive predictive value was 49%. But in pregnancies complicated with hypertension, positive predictive value was 66%.

In our study there are 25 cases with abnormal umbilical artery-PI, out of which 23 (92%) are of low birth weight. UA-PI is significantly related to low birth weight with P<0.000003.

Study by Drias[2] and associated correlated umbilical artery RI (Recessive Index), middle cerebral artery RI and MCA/UA ratio with adverse perinatal outcome. They concluded that abnormal MCA/UA ratios identified population at significant risk of IUGR and severe neonatal morbidity. PI varies in relation to the intracranial artery considered, so it is important that the artery be identified precisely and with certainty. So in the evaluation of fetal cerebral circulation we used middle cerebral artery, as it is most accessible vessel and it can be easily located on color Doppler. It is a branch of circle of Willis and carried 80% of blood flow to the lateral cerebral hemisphere, a constant 3 – 7% of cardiac output flows through it during entire gestational period. We have studied the Doppler index of umbilical artery only after 30th week because in agreement with Schulman and Granullini[3], it is difficult to define normal and abnormal umbilical flow velocity before 30th week, except the absent EDFV after 20 weeks.

In our study of 50 cases with PIH 24 (45%) had an adverse perinatal outcome. Of the 35 patients who had abnormal MCA-PI there was a significant co-relation with perinatal outcome. NICU admission was done in 5 (14.3%) cases. 4 (11.4%) patients with abnormal MCA-PI had intrauterine death of fetus. 3 (8.5%) patients had still births. Out of these 35 abnormal MCA-PI 12 (34.2%) had low APGAR score. Out of the 50 PIH patients 25 (50%) patients had abnormal UA-PI. Abnormal MCA/UA PI ratio was seen in 27 cases of which 23 cases (85.2%) had an adverse perinatal outcome. Out of the 50 normal (control cases) 5 (10%) had adverse perinatal outcome. All the 50 (100%) control cases showed normal ultrasonogrpahic findings.

Trudinger BJ, Cook CM[4] in their study in 1990 observed that an elevated umbilical S/D ratio was significantly associated with small for gestation fetuses and neonatal inorbidity. They showed that uteroplacental artery flow velocity wave form did not correlate with fetal or neonatal velocity or morbidity. They concluded that an abnormal fetal umbilical artery. Doppler correlates with adverse fetal outcome in severe proteinuric PIH and suggested that abnormal placental vascularisation which is the primary vascular pathology deprives the fetus of normal blood flow. Maternal hypertension is also secondary to this.

In our study 50% of cases showed abnormal UA-PI values. Of the 25 cases with abnormal UA-PI 84% of cases had adverse perinatal outcome and 14.8% had normal outcome.

In a study conducted by Gramellin D[5], Folic, Rabonis et al. in 1992, Doppler velocity recording were obtained from MCA and UA. The Pulsatility index for the two and ratio between MCA/UA PI was calculated. They found that C/U ratio had 70% diagnostic accuracy in predicting small for gestational age neonates compared with 54.4% for MCA and 65.5% for UA. They concluded that the results were more encouraging for prediction of adverse perinatal outcome. Diagnostic accuracy for the C/U ratio was 90% compared with 78.8% for MCA and 83.3% for UA.

In our study also, it was found that the MCA/UA Pulsatility index ratio had high sensitivity

and positive predictive value, 95-83% and 81.19% respectively, in predicting adverse perinatal outcome, compared to that of UA Pulsatility index and MCA Pulsatility index.

We found that UA-PI had sensitivity and positive predictive value of 87.5% and 84% respectively. Our findings are compared with that of Yoon et al. and Ozeren et al. they concluded that abnormal umbilical artery Doppler is an independent factor for predicting adverse perinatal outcome in pregnancy induced hypertension.

In a study conducted by Torres PJ[6] and Collegun on 172 women with pregnancy induced hypertension, it was found that absence of end diastolic flow predicted low birth weight in 100% of pregnancies and fetal death in 66.60%.

Bhatt Arora J, Shah[7] studied 100 cases of pregnancy induced hypertension between 28 – 36 weeks gestation. They observed that 56% of cases had abnormal S/D ratio in umbilical artery and / or uterine artery, 60% of these patients delivered IUGR babies. In patients with AEDV and REDV, perinatal mortality was 50% and 50% had IUGR babies. They concluded that color Doppler is an excellent tool for non invasive hemodynamic monitoring of PIH patients.

In our study of 50 cases there were 6 IUGR and 1 perinatal death out of which 4 had reverse end diastolic flow and 3 had absent end diastolic flow. In all cases of reversal IUD occurred with in 1 week of diagnosis and all cases were less than 33 weeks. A mortality rate of 33% in cases of AEDF and 100% in cases of REDF was observed.

Fairlie FM[8] and his associates studied 43 pregnancies with PIH and either absent end diastolic velocity or reversed end diastolic velocity. The incidence of perinatal mortality and morbidity was 44% in AEDV and 54% in REDV. They concluded that AEDV and REDV are associated with a high-risk of adverse perinatal outcome.

Conclusion:

From the study we would like to conclude that

1. Doppler parameter predicts normal placental physiology, Normal Doppler parameters are strong predictors of normal fetal outcome.

2. Umbilical artery Doppler is a strong and independent predictor of adverse perinatal outcome in patients with pre-eclampsia, significantly related to low birth weight.

3. MCA/UA Pulsatility index ratio had high sensitivity and positive predictive value, in predicting adverse perinatal outcome, compared to that of UA Pulsatility index and MCA Pulsatility index.

4. In patients with AEDV and REDV, perinatal mortality was 50% and 50% had IUGR babies.

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