Significance of cerebral and umbilical artery doppler velocimetry in normal and growth restricted pregnancy

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Abstract

Background: Doppler velocimetry is a rapid non invasive test that provides valuable information about hemodynamic situation of the fetus and is an efficient diagnostic test of fetal jeopardy which helps in timely intervention and management of high risk pregnancy for better perinatal outcome. **Material and Methods:** This is a prospective study including 40 women with normal singleton pregnancy and 40 women with Intra uterine growth restricted pregnancy carried out over a period of 1 year from april 2015 to march 2016 at MNR Medical College and Hospital, Sangareddy. **Results:** Umbilical artery mean pulsatility index and resistive index were significantly greater in IUGR pregnancy as compared to normal pregnancy. Systolic/diastolic (S/D) ratios were comparable in both the groups. There was significant reduction in cerebroumbilical (C/U) ratio in IUGR pregnancy as compared to normal pregnancy suggesting presence of a brain sparing effect. 17.5% patients in study group had absent end diastolic volume (AEDV) and 2.5% had reversal of end diastolic volume. **Conclusion:** In normal pregnancy, there is gestational age related fall in impedance in umbilical and middle cerebral arteries. Doppler study of umbilical artery is highly sensitive in the detection of IUGR while Middle cerebral artery doppler is useful for the prediction of adverse perinatal outcome in small for gestational age.
Key Words: Intrauterine growth restriction, Umbilical artery, Middle cerebral artery, Pulsatility index, Resistive index, Systolic/diastolic ratio, cerebroumbilical (C/U) ratio.

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INTRODUCTION

IUGR is defined as sonographic expected fetal weight less than the 10th percentile for gestational age[1]. The hemodynamics of the fetus takes into account both the umbilical-placental and cerebral vascular beds. Placental insufficiency , whether primary or secondary to maternal factors such as hypertension , poor nutrition etc is the most common cause of IUGR, which is an important obstetric problem on account of the high associated perinatal mortality and morbidity. It is essential to recognize placental insufficiency early so that its hazards can be reduced, if not prevented. IUGR is the common clinical sign of chronic fetal hypoxemia. It is difficult to differentiate between suboptimal fetal growth due to intrauterine starvation and adequate growth of a constitutionally small infant. Umbilical and MCA velocimetry is a good predictor of growth restricted fetus at risk of antenatal compromise[2,3,4]. The purpose of our study was to evaluate usefulness of MCA and umbilical artery velocity waveforms and their various indices during third trimester of pregnancy, to calculate the ratio of MCA PI to Umbilical artery PI (C/U ratio) and to study the mode of delivery and perinatal outcome in terms of birth weight, APGAR score and admission to NICU.

MATERIAL AND METHODS

This is a prospective study carried out in a Tertiary care centre at MNR Medical College and Hospital, Sangareddy. Present study was carried out over a period of 1 year from April 2015 to March 2016. Total number of cases included in the study is 80, 40 women with normal singleton pregnancy and 40 women with IUGR pregnancy. Inclusion criteria for the control group were: Women with known last menstrual period, no medical, surgical and obstetrical complications that can affect fetal growth and normal intrauterine fetal growth in clinical examination and ultrasound. Inclusion criteria for the Study group were: Women with known last menstrual period, clinical discrepancy of fundal height of 4weeks or more and ultrasound showing fetal weight with 10th percentile of their gestational age based on biparietal diameter, femur length and abdominal circumference. Exclusion criteria for the study group: Women with gestational age less than 32weeks duration.

RESULTS

Total number of patients studied were 80

Table 1: Comparison of age and gestational age between both the groups

Variables	Mean ± sd		P value
	Study group	Control group	
Age(Years)	23.8±2.63	22.13±3.02	0.87
Gestational Age(weeks)	33.15±3.07	32.82±3.41	0.56

Table 1 shows age and gestational age comparison between both the groups. Age of the patients were comparable in between study (23yrs) and control group (22yrs) ($P > 0.05$). Similarly gestational ages were comparable between study (32wks) and control group (33wks) ($P > 0.05$). This indicates equal distribution of patients in study and control groups in terms of age and gestational age.

Table 2: Umbilical artery Doppler indices

Period of Gestation (in weeks)	PI		RI		S/D	
	Mean	Upper limit (Mean+ISD)	Mean	Upper limit (Mean+ISD)	Mean	Upper limit (Mean+ISD)
32-33	0.94	1.04	0.58	0.68	2.54	2.9
34-35	0.89	0.99	0.57	0.65	2.42	2.84
36-37	0.83	0.96	0.55	0.61	2.37	2.63

Table 3: Middle cerebral artery indices

Period of Gestation (in weeks)	Mean	PI	RI		S/D	
		Lower limit (Mean-ISD)	Mean	Lower limit (Mean-ISD)	Mean	Lower limit (Mean-ISD)
32-33	1.70	1.44	0.80	0.75	5.62	3.97
34-35	1.60	1.31	0.77	0.71	5.15	3.9
36-37	1.55	1.20	0.75	0.69	4.64	3.7

Table 4: Cerebroumbilical ratio (C/U) in the control group

Period of Gestation(in weeks)	C/U Ratio
32-33	1.85
34-35	1.82
36-37	1.80

PI, RI, S/D ratio of the umbilical artery and MCA were calculated and reference values were constructed for comparison with the study group (Table 2, 3). Cerebroumbilical (C/U) ratio was calculated as the ratio of PI of MCA/ PI of Umbilical artery (Table 4). All indices showed progressive fall with advancing gestation in normal pregnancy suggestive of decrease in peripheral impedance and increase in diastolic flow with progression of gestation in both umbilical artery and MCA. When compared with the control group, most of the subjects in the study group showed elevated umbilical indices suggestive of decreased diastolic flow. MCA mean pulsatility index is reduced in IUGR pregnancy as compared to normal pregnancy though the difference was not statistically significant. However, we found significant reduction in C/U ratio in IUGR pregnancy as compared to normal pregnancy suggesting the presence of a "brain sparing effect".

Table 5: Comparison of absent end diastolic volume between both the groups

AEDV	N (%)		Grand Total	P value
	Study group	Control group		
Present	7	0	7	
	17.5%	-	8.75%	0.01
Not Present	33	40	73	
	82.5%	100%	91.25%	
Grand Total	40	40	80	

In our study, 17.5% patients in the study group had absent end diastolic volume while none of the patients in control group had this finding. Difference between these two groups is statistically significant.

Table 6: Comparison of reversal of end diastolic volume between both the groups

REDV	N (%)		Grand Total	P value
	Study group	Control group		
Present	1	0	1	
	2.5%	-	8.75%	
Not Present	39	40	79	1.00
	97.5%	100%	98.75%	
Grand Total	40	40	80	

In our study, 2.5% patients in study group had reversal of end diastolic volume while none of the patients in control group had this finding. Difference between these two groups is comparable.

Table 7: Comparison of mode of delivery between both the groups

Mode of delivery	N (%)		Grand Total	P value
	Study group	Control group		
Preterm vaginal delivery	3	-	3	
	7.5%		3.75%	
LSCS	21	14	35	
	52.5%	35%	43.75%	
Normal vaginal delivery	16	26	42	0.04
	40%	65%	52.5%	
Grand Total	40	40	80	

In the study group, 52.5% patients had delivery by LSCS, 40% had normal delivery and 7.5% had preterm delivery. In control group, 65% had normal delivery and 35% had delivery by LSCS. Difference was statistically significant.

Table 8: Comparison of fetal outcome between both the groups

Fetal outcome	Mean ± sd		P value
	Study group	Control group	
Birth weight	1906.3±699.8	2853.3±197.1	0.00
APGAR	6.45±0.83	6.93±0.58	0.01

Mean birth weight and APGAR score of babies were significantly greater in the control group as compared to the study group.

Table 9: Comparison of NICU admission between both the groups

NICU admission	N (%)		Grand Total	P value
	Study group	Control group		
-	20	34	54	
	50%	85%	67.5%	
+	20	6	26	0.01
	50%	15%	32.5%	
Grand Total	40	40	80	

In our study, 50% babies of patients in study group required NICU admission while only 15% babies of patients in control group required NICU admission. Difference was statistically significant.

DISCUSSION

Doppler velocimetry identifies normal and altered blood flow velocity in the MCA and umbilical artery and is responsive to changes in placental resistance. It has been shown by various workers[5] that perinatal morbidity and mortality were significantly greater in small for gestational age babies with abnormal Doppler than in those with normal studies. The perinatal mortality and

morbidity of IUGR foetuses can be reduced by this early detection and therapeutic intervention[6]. This prospective study was conducted in order to evaluate cerebral and umbilical arterial blood flow velocity in normal and growth retarded pregnancy. The gestational age related decrease of the pulsatility index (PI) in the umbilical artery has been reported by many authors and reflects a reduction of flow resistance in the placental villous circulation. Wladimiroff *et al*[7] constructed the reference range for PI of umbilical artery in the third trimester. The values calculated in our study corroborate with the values of Wladimiroff *et al*[7], Lakhar and Ahamed[8] who calculated the mean resistive index (RI) values at different gestational ages amongst the normal pregnant women to b 0.7 at 28weeks and 0.65 at 37 weeks. These are comparable to our values. However, systolic/diastolic (S/D) ratios were comparable in both the groups. Khurana *et al*[9] calculated S/D ratios as 3.07 at 28 weeks and 2.64 at 37 weeks. Similarly, Narula *et al*[10] reported S/D ratio of 3.07 at 28 weeks and 2.37 at 37 weeks. Kirkinen *et al*[11], Gramilleni *et al*[12], Chandran *et al*[13] studied MCA indices in normal and growth restricted pregnancies and constructed reference limits of PI and RI which showed progressive decline with advancing gestation. However, in growth restricted pregnancy, they observed that low PI and RI were associated with increase in perinatal risk. Our study observed that though MCA Doppler indices were not sensitive in identification of IUGR, they were highly suggestive of poor perinatal outcome in fetuses with altered hemodynamics. Narula *et al*[10] found elevated indices in umbilical artery in 47 out of 50 cases of the study group, showing its high sensitivity in diagnosing hemodynamically compromised growth restricted fetuses. AEDV and REDV were seen in 2 and 1 case respectively and were associated with poor perinatal outcome. MCA values were decreased in 18 cases of the study group and had poor perinatal outcome in terms of need for LSCS for fetal distress, APGAR <7 at 1min and admission to nursery. In our study, 17.5% patients in study group had AEDV and 2.5% patients had REDV. Narula *et al*[10] pointed that umbilical artery doppler study is highly sensitive in detection of IUGR while MCA Doppler is very useful in predicting small for gestational age babies with adverse perinatal outcome when umbilical velocimetry is abnormal and low cerebroumbilical(C/U) ratio of <1.08 is a good predictor of adverse perinatal outcome. In our study, 50% babies of patients in study group required NICU admission. In a study by Mari *et al*[4] small for gestational age fetuses with abnormal PI values had a significantly higher incidence of abnormal fetal heart rate and admission into NICU. Author suggested that the small for gestational age fetus with a normal MCA PI is at a lower risk than the fetus with abnormal PI

values. Mean birth weight and APGAR score of babies were significantly greater in control group as compared to study group. Most of the babies in the study group had APGAR score of 6 and 7 and few babies had APGAR score of 5. In control group, APGAR score was between 6 to 8. In a study by Serap yalti *et al*[14], APGAR scores at 1 and 5 min were found to be lower in the group with MCA/UA ratio <1 than group with MCA/UA ratio >1.

CONCLUSION

Cerebral and umbilical flow velocimetry studies should be an integral parameter while evaluating in-utero health of the growth restricted fetuses. There is a strict correlation between umbilical Doppler velocimetry and increased incidence of perinatal complications in IUGR fetuses. MCA Doppler is very useful in predicting small for gestation age babies with adverse perinatal outcome when umbilical velocimetry is abnormal. Significant reduction in cerebroumbilical (C/U) ratio was noted in IUGR pregnancy as compared to normal pregnancy, suggesting the presence of brain sparing effect. Significant number of babies having IUGR were delivered by LSCS, required NICU admission and had low APGAR scores. The finding of reduced end diastolic flow is ominous and absent end diastolic flow also correlated with poor fetal outcome. Thus Doppler investigation of fetal circulation plays an important role in monitoring the redistribution of blood flow in fetus and thereby may help to determine the optimal time for delivery.

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