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ORIGINAL ARTICLE

ROLE OF COLOUR DOPPLER: CEREBRAL AND UMBILICAL ARTERIAL BLOOD FLOW VELOCITY IN NORMAL AND GROWTH RESTRICTED PREGNANCY

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ABSTRACT: INTRODUCTION: Doppler velocimetry is a rapid noninvasive test that provides valuable information about haemodynamic situation of the foetus and is an efficient diagnostic test of foetal jeopardy which helps in timely intervention and management of high risk pregnancy for better perinatal outcome. **OBJECTIVES:** To evaluate middle cerebral artery and umbilical arterial velocity waveforms and their various indices during third trimester of pregnancy. **METHODOLOGY:** Prospective study including 50 women with normal singleton pregnancy and 50 women with intrauterine growth restricted pregnancy booked for regular antenatal checkups in our hospital. **RESULTS:** Foetal biometery i. e. EFW(estimated foetal weight) , BPD (bi parietal diameter), HC(head circumference), AC(abdominal circumference) and FL(femur length) all the values were significantly reduced in IUGR pregnancy. Mean amniotic fluid index was significantly reduced for IUGR pregnancy. Umbilical artery indices were significantly raised in IUGR pregnancy. Mean Pulsatility index (PI) for study group was 1.03±0.22 as compared to control group of 0.87±0.17, P value being < 0.0003. Mean Resistance index (RI) for study group was 0.65±0.14 as compared to 0.58±0.06 for control group, P value being 0.0015. Mean Systolic diastolic ratio (S/D) for study group was 2.96±0.78 as compared to 2.43±0.32 for control group, P value being < 0.0001. Reduced mean middle cerebral artery indices in IUGR pregnancy. Cerebro umbilical ratio was significantly reduced in study group. AEDV was present in 12% of women in study group and REDV in 8% women of study group. IUGR pregnancies deliver early as in comparison to normal pregnancies. Significant numbers of babies having IUGR were delivery by LSCS. Mean birth weight is significantly reduced in control for study group. Similarly, significant number of babies in IUGR pregnancies requires NICU admission .Significant number of patients in study group has associated PIH. **CONCLUSIONS:** In normal pregnancy there is gestational age related fall in impedance in umbilical and middle cerebral arteries. Doppler study of umbilical and middle cerebral artery is highly sensitive in the detection of IUGR and prediction of adverse perinatal outcome in small for gestational age.

KEYWORDS: Intra uterine growth restriction. Pulsatility index. Resistance index. Systolic/diastolic ratio. Umbilical artery. Middle cerebral artery. Cerebro umbilical ratio.

INTRODUCTION: Timely diagnosis and management of IUGR is one of the major achievements in contemporary obstetrics. If the growth-restricted fetus is identified and appropriate management instituted, perinatal mortality can be reduced,[1] underscoring the need for assessment of fetal growth at each prenatal visit. To reduce the perinatal morbidity and mortality of intrauterine growth restricted (IUGR) fetuses, their early detection and therapeutic intervention are important. Doppler has been used in recent literature to support expectant management or delivery of IUGR fetuses and to identify fetuses at risk. In fetal growth restriction the umbilical and intra-cranial arteries are the

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vessels most commonly examined.[2] When fetal growth restriction is diagnosed during the third trimester of pregnancy, the obstetrician must decide whether the fetus is 'constitutionally' small or small as a consequence of impaired placental perfusion. Doppler flow velocity analysis can be valuable in resolving this question.[3] In a group of high risk fetuses, Doppler assessment of the umbilical artery and middle cerebral artery (MCA) was useful in predicting the fetuses with neonatal wasting.[4] There is significant association between the Doppler waveform analysis and clinical outcome.[5] Doppler velocimetry uses ultrasound to measure peak-systolic and end-diastolic blood flow through the umbilical artery. These measurements are averaged as the systolic/ diastolic ratio. As the pregnancy progresses, diastolic flow increases, and the systolic/diastolic ratio should gradually decrease. In a large number of IUGR pregnancies, an alteration in placental blood flow occurs. As a result, researchers have correlated an increased systolic/diastolic ratio with IUGR. An average systolic/ diastolic ratio greater than three at 30 or more weeks of gestation has a sensitivity of 78 percent and a specificity of 85 percent in predicting IUGR.[6]

AIMS AND OBJECTIVES:

1. To evaluate middle cerebral artery and umbilical arterial velocity waveforms and their various indices during third trimester of pregnancy.
2. To calculate the ratio of pulsatility index of middle cerebral artery and umbilical artery.
3. To study the mode of delivery and perinatal outcome in terms of birth weight, Apgar score and admission to neonatal intensive care unit.

METHODOLOGY: Prospective study including 50 women with normal singleton pregnancy and 50 women with intrauterine growth restricted pregnancy booked for regular antenatal checkups between 28 to 40 weeks of gestation in our hospital.

Method of collection of Data: A prospective analysis, duration based study was performed on patients fitting into inclusion criteria from October 2011- May 2013 and a prestructural proforma was used to obtain

1. History taking
2. Clinical examination
3. Colour Doppler imaging
4. Biparietal diameter, Femur length, abdominal circumference, Amniotic fluid index measured by ultrasound.

INCLUSION CRITERIA CONTROL GROUP:

1. Women with known last menstrual period.
2. No medical, surgical and obstetrical complications that can effect fetal growth.
3. Normal intrauterine fetal growth in clinical examination and ultrasound.

STUDY GROUP:

1. Women with known last menstrual period.
2. Clinical discrepancy of fundal height of 4 wks. or more.
3. Ultrasound showing fetal weight with 10th percentile of their gestational age based on Biparietal diameter, Femur length and abdominal circumference.

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STATISTICAL ANALYSIS: Data was analyzed using mean, standard deviation, chi square test.

TECHNIQUE OF DOPPLER ULTRASOUND: All scans were performed in a semi-recumbent position by trained sonographers or radiologists. A fetus was classified as small for gestational age if its abdominal circumference on ultrasound scan was <10th centile for the gestation. Measurements were also obtained of the biparietal diameter, head circumference and femur length using standard techniques.

UMBILICAL ARTERY: Umbilical artery Doppler studies were obtained from a mid-segment of umbilical cord. This site was chosen as recordings taken from the placental end result in lower resistance indices compared to recordings obtained at the abdominal end, in both normal and growth restricted pregnancies.

MIDDLE CEREBRAL ARTERY: An axial view of the fetal head was obtained at the level of the cerebral peduncles. Using color Doppler, the middle cerebral artery was identified in the lateral sulcus after its origin from the internal carotid artery.

OBSERVATIONS AND TABLES:

Variables	Mean ±SD		P value
	Study group	Control group	
Age (Yrs.)	24.20 ± 3.68	23.82 ±2.95	0.57
Gestational Age (wks.)	32.36 ± 1.79	32.80 ±1.85	0.23

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

Unpaired t test is applied. P value is significant if < 0.05

Fetal Biometry	Mean ±SD		P value
	Study group	Control group	
Estimated fetal weight (gms) [EFW]	1599.22 ± 475.76	2056.38 ± 493.02	< 0.0001
Biparietal diameter (mm) [BPD]	77.70 ± 6.66	82.66 ± 4.98	< 0.0001
Head circumference (mm) [HC]	284.08 ± 22.37	300.58 ± 18.15	< 0.0001
Abdominal circumference (mm) [AC]	254.74 ± 29.24	282.82 ± 27.51	< 0.0001
Femur length [FL]	58.72 ± 6.11	62.74 ± 5.28	< 0.0007
FL/AC	0.23 ± 0.014	0.22 ± 0.008	< 0.0003

Table 2: Comparison of fetal biometry between both the groups

Unpaired t test is applied. P value is significant if < 0.05

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Variable	Mean ±SD		P value
	Study group	Control group	
Amniotic fluid index (AFI)	8.94 ± 3.18	12.48 ± 2.62	<0.0001

Table 3: Comparison of amniotic fluid index between both the groups

Unpaired t test is applied. P value is significant if < 0.05

Umbilical artery	Mean ±SD		P value
	Study group	Control group	
Pulsatility index (PI)	1.03 ± 0.22	0.87 ± 0.17	< 0.0003
Resistance index (RI)	0.65 ± 0.14	0.58 ± 0.06	0.0015
Systolic diastolic ratio (S/D)	2.96 ± 0.78	2.43 ± 0.32	< 0.0001

Table 4: Comparison of umbilical artery index between both the groups

Unpaired t test is applied. P value is significant if < 0.05

Middle cerebral artery [MCA]	Mean ±SD		P value
	Study group	Control group	
Pulsatility index (PI)	1.45 ± 0.31	1.50 ± 0.20	0.2981
Resistance index (RI)	0.74 ± 0.08	0.76 ± 0.04	0.1627
Systolic diastolic ratio (S/D)	4.17 ± 1.43	4.41 ± 0.88	0.3051

Table 5: Comparison of middle cerebral artery index between both the groups

Unpaired t test is applied. P value is significant if < 0.05

Variable	Mean ±SD		P value
	Study group	Control group	
Cerebroumbilical Ratio (C/U)	1.47 ± 0.45	1.77 ± 0.43	0.0012

Table 6: Comparison of cerebroumbilical ratio between both the groups

Unpaired t test is applied. P value is significant if < 0.05

Absent end diastolic volume (AEDV)	N (%)		Grand Total	P value
	Study group	Control group		
Present	6	0	6	0.0267
	12.00%	-	6.00%	
Not present	44	50	94	
	88.00%	100.00%	94.00%	
Grand Total	**50**	**50**	**100**	

Table 7: Comparison of absent end diastolic volume between both the groups

Fisher exact test is applied. P value is significant if < 0.05

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Reversal of end diastolic volume (REDV)	N (%)		Grand Total	P value
	Study group	Control group		
Present	4	0	4	0.1175
	8.00%	-	4.00%	
Not present	46	50	96	
	92%	100.00%	96.00%	
Grand Total	**50**	**50**	**100**	

Table 8: Comparison of reversal of end diastolic volume between both the groups

Fisher exact test is applied. P value is significant if < 0.05

Variable	Mean ±SD		P value
	Study group	Control group	
Gestational Age At delivery (wks.)	36.30 ± 2.45	38.86 ± 1.19	<0.0001

Table 9: Comparison of gestational age at delivery between both the groups

Unpaired t test is applied. P value is significant if < 0.05

Mode of delivery	N (%)		Grand Total	P value
	Study group	Control group		
Lower segment caesarean section (LSCS)	30	13	43	0.0011
	60.00%	26.00%	43.00%	
Normal vaginal delivery (NVD)	20	37	57	
	40.00%	74.00%	57.00%	
Grand Total	50	50	100	

Table 10: Comparison of mode of delivery between both the group

Fisher exact test is applied. P value is significant if < 0.05

Variable	N (%)		Grand Total	P value
	Study group	Control group		
Term Delivery	32	50	82	< 0.0001
	64.00%	100%	82.00%	
Preterm Delivery	18	0	18	
	36.00%	-	18.00%	
Grand Total	50	50	100	

Table 11: Comparison of Term/ Preterm between both the group

Fisher exact test is applied. P value is significant if < 0.05

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APGAR	N (%)		Grand Total
	Study group	Control group	
5	6	0	6
	12.00%	-	6.00%
6	12	0	12
	24.00%	-	12.00%
7	6	6	12
	12.00%	12.00%	12.00%
8	20	44	64
	40.00%	88.00%	64.00%
0	6	0	6
	12.00%	-	6.00%
Grand Total	**50**	**50**	**100**

Table 12: Comparison of APGAR score between both the groups

Variable	Mean ± SD		P value
	Study group	Control group	
Birth weight (gms)	1789.20 ± 521.84	2742.02 ± 389.15	<0.0001

Table 13: Comparison of birth weight between both the groups

Unpaired t test is applied. P value is significant if < 0.05

Variable	N (%)		P value
	Study group	Control group	
NICU Admission	21	0	<0.0001
Baby expired out of NICU admissions	5	0	0.0563
IUD/Still birth	6	0	0.0267

Table 14: Comparison of NICU admission between both the groups

Fisher exact test is applied. P value is significant if < 0.05

VARIABLE (PIH)	N (%)		Grand Total	P value
	Study group	Control group		
Present	29	0	29	<0.0001
	58.00%	-	29.00%	
Not present	21	50	71	
	42.00%	100.00%	71.00%	
Grand Total	**50**	**50**	**100**	

Table 15: Comparison of association of PIH between both the groups

Fisher exact test is applied. P value is significant if < 0.05

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SUMMARY AND CONCLUSION: EFW, BPD, HC, AC and FL all the values were significantly reduced in IUGR pregnancy. Mean amniotic fluid index was significantly reduced for IUGR pregnancy.

Umbilical artery indices were significantly raised in IUGR pregnancy. Reduced mean middle cerebral artery indices in IUGR pregnancy. Cerebro umbilical ratio was significantly reduced in study group suggesting the presence of brain sparing effect in some cases. IUGR pregnancies delivered early as in comparison to normal pregnancies. Significant numbers of babies having IUGR were delivery by LSCS. Mean birth weight was significantly reduced in control for study group. Similarly, significant number of babies in IUGR pregnancies required NICU admission. Significant number of patients in study group had associated PIH.

DISCUSSION: The perinatal morbidity and mortality of intrauterine growth restricted (IUGR) fetuses can be reduced by their early detection and therapeutic intervention. [7] Doppler is a rapid non-invasive test that provides valuable information about the hemodynamic situation of the fetus is an efficient diagnostic test of fetal jeopardy and helps in the management of high-risk pregnancy including IUGR.

The gestational age related decrease of the PI in the umbilical artery has been reported by many authors and reflects a reduction of flow resistance in the placental villous circulation.

In our study all the parameters i.e. EFW, BPD, HC, AC and FL all the values are significantly greater in normal pregnancy as compared to IUGR pregnancy. Mean amniotic fluid index is significantly higher in normal pregnancy as compared to IUGR pregnancy.

These parameters indicate that there is a clear distinction between the IUGR and normal pregnancy. Mean pulsatility index (PI) (1.03 Vs. 0.87), Mean resistance index (RI) (0.65 Vs. 0.58) and mean S/D ratio of umbilical artery is significantly greater in IUGR pregnancy as compared to normal pregnancy and values corroborate with the values of Wladimiroff et al[8], Lakhkar and Ahamed[9], Khurana et al.[10]

We found reduced mean pulsatility index (1.45 Vs 1.50) in IUGR pregnancy as compared to normal pregnancy, of middle cerebral artery though; the difference was not statistically significant. However, we found significant reduction in cerebro-umbilical ratio (1.47 Vs 1.77) in IUGR pregnancy as compared to normal pregnancy, (< 0.05), suggesting the presence of a "brain-sparing" effect. The findings of study are comparable to published literature on cerebral artery index in IUGR pregnancies. by Wladimiroff et al,[8] Noordam,[11] van den Wijngaard et al,[12] Degani et al[13] and Arduini et al.[14]

Other parameters like resistance index (0.74 Vs 0.76) and systolic diastolic ratio (4.17 Vs 4.41) are reduced in study group as compared to control group though the difference is not statistically significant.

Mean birth weight and APGAR score of babies is significantly greater in control group as compared to study group. In study group, 60.00% patients underwent LSCS, 40% by normal delivery and 36.00% patients delivered before term in study group(IUGR) while none of the patient in control group delivered before term. In control group, 74.00% patients had normal delivery and 26% patients delivered by LSCS.

Difference is statistically significant. Most of the babies in study group had APGAR score of 6 and 8 (24.00% had APGAR score of 6 and 40.00% had APGAR score of 8). In control group most of the babies had APGAR score of 8 (88.00%). Narula[15] 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 ratio (C/U) of <1.08 is a good predictor of adverse perinatal outcome. Kirkinen et al,[16] Gramellini et al [17] and Chandran et al [18] studied MCA indices in normal and growth restricted pregnancies and concluded that low PI and RI were associated with increase in perinatal risk.

In a study by Bahado-Singh et al[19] in 203 fetuses at risk for IUGR, there was a statistically significant increase in perinatal morbidity and mortality in cases with an abnormal cerebro placental ratio. In our study, 21 babies of patients in study group required NICU admission and out of that 5 babies expired. 6 babies in study group were IUD/still birth while none of the babies of patients in control group require NICU admission or expired.

Difference was statistically significant. In a study by Mari et al[20] small-for-gestational-age fetuses with abnormal pulsatility index values had a significantly higher incidence of abnormal fetal heart rate and admission into the neonatal intensive care unit. Author suggested that the small-for gestational age fetus with a normal middle cerebral artery pulsatility index is at lower risk than the fetus with abnormal pulsatility index values 12.00% patients in 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 and AEDV is associated with poor perinatal outcome. 8% patients in study group had reversal of end diastolic volume while none of the patients in control group had this finding**.** REDV is associated with poor perinatal outcome. Narula et al [15] 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. Absent end diastolic velocity (AEDV) and reversed end diastolic velocity (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 lower segment caesarean section (LSCS) for fetal distress, Apgar <7 at 1 minute, and admission to nursery. Cerebroumbilical (C/U) ratio of <1.08 was similarly associated with poor perinatal outcome. Narula et al[15] concluded that 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 MCA doppler is very useful for the prediction of adverse perinatal outcome in small for gestational age. Therefore in high risk pregnancies, Doppler assessment of umbilical and middle cerebral artery is useful in predicting fetuses with neonatal wasting. There is significant association between Doppler waveform analysis and clinical outcome. The availability of Doppler studies lead to better obstetrics decision making.

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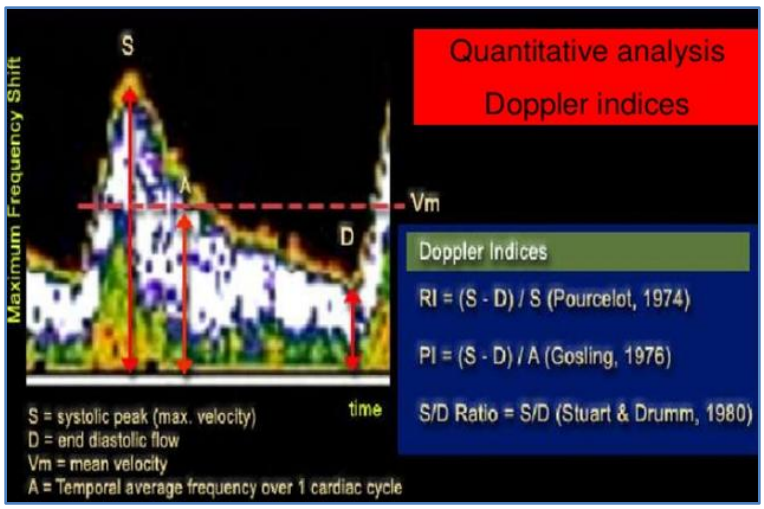
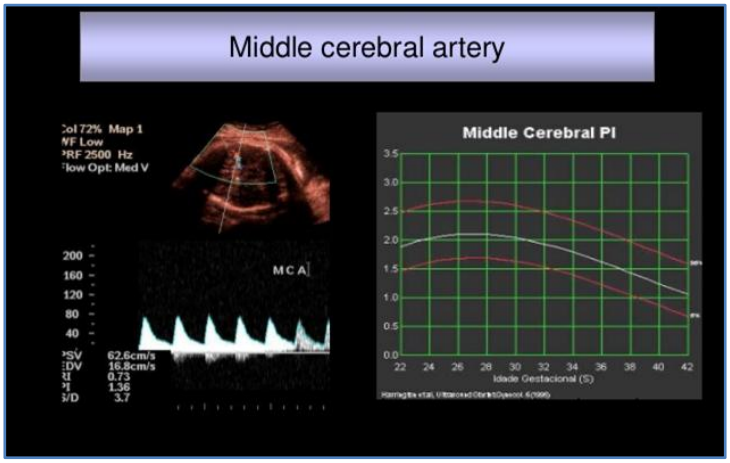
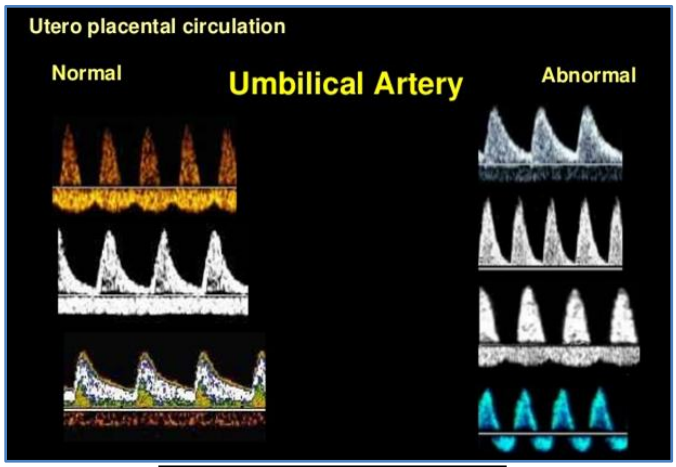


DOPPLER INDICES



MIDDLE CEREBRAL ARTERY



UMBILICAL ARTERY

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