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Original Research Article

Correlation of Abnormal Umbilical Artery and Fetal Middle Cerebral Artery S/D Ratios with Oligohydramnios and Pre-Eclampsia and Its Role in Predicting Intrauterine Growth Restriction (IUGR)

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ABSTRACT

Introduction: The correct detection of the compromised IUGR fetus to allow for timely intervention is a main objective of antenatal care. Doppler plays an important role, as it offers the potential to evaluate the feto-placental blood flow in a noninvasive manner.
Purpose: The purpose of this study is to correlate abnormal umbilical artery (UA) and MCA S/D ratios with oligohydramnios and pre-eclampsia. This study also describes the importance of Doppler in third trimester using umbilical artery and middle cerebral artery indices in predicting intrauterine growth restriction (IUGR).
Materials and Methods: Study of 50 suspected IUGR babies between 30 to 41 weeks of gestation using high resolution ultrasound machines. The Doppler studies of UA and MCA's were performed and results were analysed.
Results and Conclusion: Analysis by umbilical artery S/D ratio showed that the abnormal ratio group had higher incidence of pre-eclampsia, oligohydramnios as compared to normal ratio group. When middle cerebral artery S/D ratio was abnormally low, the incidence of preeclampsia, oligohydramnios was higher.
IUGR associated with abnormal umbilical velocity waveform is a strong predictor of small for gestational age fetuses.

Keywords: IUGR, MCA, UA, S/D Ratio.

Abbreviations: UA - Umbilical Artery, MCA- Middle Cerebral Artery, IUGR-Intrauterine Growth Restriction. S/D Ratio- Systolic / Diastolic Ratio

INTRODUCTION

The development of a good utero-placental & fetoplacental circulation is essential for achievement of a normal pregnancy. The correct detection of the compromised IUGR fetus to allow for timely intervention is a main objective of antenatal care.[1] The most common methods for evaluating health in these fetuses are the biophysical profile (BPP) and the non-stress test (NST). Unfortunately neither of these tests is particularly sensitive for predicting poor outcome in IUGR pregnancies. It is here that role of colour Doppler comes to

detect these abnormal vascular resistance patterns.

The important issue is not the identification of small fetus, but rather the "fetus at risk" for compromise. Intrauterine growth restriction (IUGR) is most commonly defined on the basis of weight below 10th percentile for that gestational age. [2,3] Most common cause of IUGR is placental insufficiency either primary or secondary to maternal etiology such as hypertension, poor nutrition etc.

The normal growth of the fetus during the intrauterine life, its ability to withstand the stress of labour and its healthy development during the neonatal period depends to a great extent upon the integrity of the fetoplacental circulation. Ultrasound is useful for evaluating growth of the fetus. But it has its own limitation as it cannot tell us about the haemodynamic status of the fetus in utero.

In this regard Doppler plays an important role, as it offers the potential to evaluate the feto-placental blood flow in a noninvasive manner. Umbilical artery (UA) & middle cerebral artery (MCA) abnormalities confirm the presence of hypoxaemia in the growth restricted fetuses. [4]

In the present study we have correlated abnormal umbilical artery and Middle cerebral artery S/D ratios with oligohydramnios and pre-eclampsia.

We have also evaluated the usefulness of abnormal Doppler of the umbilical artery (UA) and fetal middle cerebral artery (MCA) in predicting intrauterine growth restriction (IUGR).

Aims and objectives

The purpose of this study is:

1) To correlate abnormal umbilical artery (UA) S/D Ratio with oligohydramnios and pre-eclampsia.

2) To correlate MCA S/D ratios with oligohydramnios and pre-eclampsia.

3) To describe the importance of Doppler in third trimester using umbilical artery and middle cerebral artery S/D Ratio in predicting intrauterine growth restriction (IUGR).

MATERIALS AND METHODS

The study population comprised of 50 suspected IUGR pregnancies of mean age 25.04 yrs +/- 4.2 S.D., who were referred to department of Radiodiagnosis. All pregnant women studied were between 30 to 41 weeks of gestation with institutional ethical committee clearance and written consent taken from participants.

The study was conducted in Department of Radiodiagnosis by using colour Doppler machine with 3 - 5 MHz transabdominal probe. This study was conducted over a period of 2 year.

Inclusion criteria:

1. Pregnancies with clinically suspected intrauterine growth restriction
2. Women giving history of previous regular cycles of 3 to 4 days per 28 days
3. Women having definitive knowledge of last menstrual period were included in the study.

Exclusion criteria:

1. Women who are not sure about their last menstrual period
2. Women with previous gross irregular cycles
3. Women who conceived in lactational amenorrhoea
4. Pregnant women with congenital anomalies of the fetus were not included in the study.

Detailed previous menstrual & present obstetrical history was asked for all 50 patients. Special stress was given on menstrual history, LMP, and accordingly gestational age was calculated. Patients were then subjected to routine obstetrical ultrasound examination in terms of Bi-parietal diameter (B.P.D.), Head–

circumference (H.C.), Abdominal circumference (A.C.), Femur length (F.L.) along with Amniotic fluid index (A.F.I.), Placental location and expected fetal weight.

All the 50 patients were then subjected to Doppler examination. Doppler examination was done with the patients in a semirecumbent position and fetus in a quite resting state. Flow velocity waveforms were recorded from the umbilical artery and fetal middle cerebral artery.

The umbilical artery was identified and flow velocity waveforms were obtained from free floating loop of cord. Recording were obtained from the umbilical artery by placing the sample volume in the lumen of the artery at a site away from the placental & total cord insertion. [5] After recording technically satisfactory Doppler waveforms, the S/D ratio was noted.

Doppler waveforms of the umbilical arteries can be obtained from any segment along the cord .Waveforms obtained from placental end of the cord show more end – diastolic flow, thus lower S/D ratio, than waveforms obtained from the abdominal cord insertion. Differences in Doppler indices of arterial waveforms obtained from different anatomic locations of the same umbilical cord are generally minor and have no significance on clinical practice. [4]

S/D (systolic/diastolic) ratio of the fetal middle cerebral artery was noted using a transverse section of the fetal head at the level of the thalami and the cavum septum pellucidum. By moving the probe caudally, on a plane parallel to the previous one, we identified the flow of the middle cerebral artery in the sylvian fissure. After recording a technically satisfactory Doppler waveform, S/D ratio was noted. The Doppler studies of umbilical and middle cerebral arteries were performed and results were analysed.

Interpretation of doppler flow velocitimetries:

Umbilical artery: Abnormal flow velocimetry considered when reduced diastolic flow with S/D (systolic/diastolic) ratio >=3

Absent or reversed end diastolic flow

Middle cerebral artery:

Increased diastolic flow with S/D (systolic/diastolic) ratio <=3

RESULTS

1) Maximum subject of study population were of age group 20-24 yrs. (44%).

Table No. 1 showing age wise distribution of study population

Age (years)	No. of patients
<20	03(6%)
20-24	22 (44%)
25-29	17 (34%)
30 and above	08(16%)

2) 31 (62%) patients were of 33 wks to 36.6 wks gestational age.

Table No. 2 showing gestational agewise distribution of study population

Gestational age (wks)	No. of patients
30-32.6	15(30%)
33-36.6	31 (62%)
37-41	04 (8%)

Maximum No. of Patients from mid third trimester

3) Most of studied patients were multigravida.

Table No. 3 showing gravida wise distribution of study population

Gravida	No. of patients (%)
Primigravida	16(32%)
Multigravida	34 (68%)

4) 36 (72%) of the 50 patients showed abnormal Doppler flow-velocity wave forms (FVWs). Of these all showed abnormal umbilical artery flow-velocity wave forms and only 15 (30%) showed abnormal middle cerebral artery flow velocity wave forms.

Table No. 4 showing S/D (systolic / diastolic) ratio

	No. of patients
Abnormal UA S/D Ratio	36 (72%)
Normal UA S/D Ratio	14 (28%)
Abnormal MCA S/D Ratio	15 (30%)
Normal MCA S/D Ratio	35 (70%)

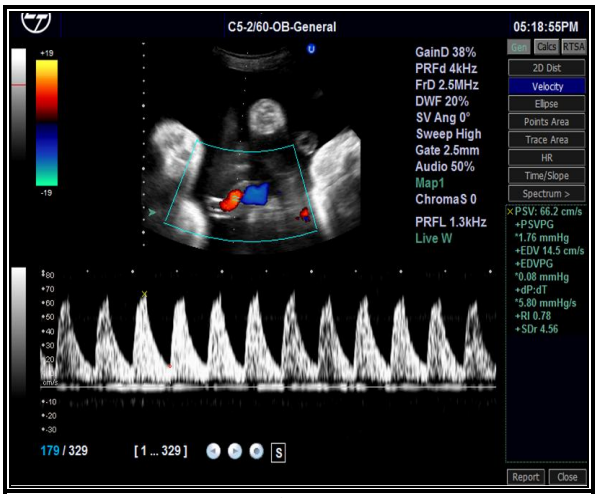

Fig 1showing reduced diastolic flow in umbilical artery.

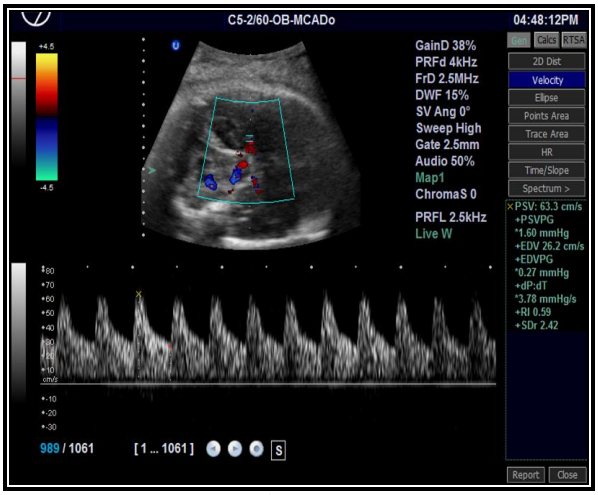

Fig 2 showing raised diastolic flow in middle cerebral artery.

5) Prevalence of pre-eclampsia was more in patients showing abnormal umbilical artery flow velocity waveforms (UA FVWs) than normal and the difference was statistically significant. Similarly difference in prevalence of oligohydramnios was statistically significant in patients with abnormal UA FVWs compared to normal UA FVWs.

Table No. 5 showing Correlation of abnormal umbilical artery (UA) S/D ratio with Pre-eclampsia and Oligohydramnios

Maternal characteristics (n)	Abnormal UA S/D Ratio (n=15)	Normal UA S/D Ratio (n=35)	P value
Pre-eclampsia (n=30)	26 (73%)	4 (28%)	<0.05 *
Oligohydramnios (n=30)	26 (73%)	4(28%)	<0.05 *

* p< 0.05 =Statistically significant

6) Pre-eclampsia and oligohydramnios were significantly more common in patients showing abnormal middle cerebral artery flow velocity waveforms (MCA FVWs) than in normal.

Table no. 6 showing Correlation of abnormal middle cerebral artery (MCA) S/D ratio with Pre-eclampsia and Oligohydramnios

Maternal characteristics (n)	Abnormal MCA S/D Ratio (n=15)	Normal MCA S/D Ratio (n=35)	P value
Pre-eclampsia (n=30)	14 (93%)	16 (45%)	<0.05 *
Oligohydramnios (n=30)	14 (93%)	16 (45%)	<0.05 *

* p< 0.05 =Statistically significant

DISCUSSION

An Austrian physicist, Christian Doppler first described the Doppler Effect in 1842. However only after the introduction by Fitzgerald et al (1977) [6] of the study of characteristics of blood flow in the human fetal umbilical artery, Doppler ultrasound has become valuable in the antenatal surveillance of high risk pregnancies especially pregnancies with intrauterine growth restriction.

Doppler ultrasound of the fetoplacental circulation offers the potential to study the functional and hence physiological changes in these circulations and may help to identify circulatory problems that underlie placental insufficiency and chronic fetal hypoxia. Impaired diastolic flows suggest that the fetus is usually hypoxic and often acidemic. The addition of color flow imaging is an exciting recent development which facilitates quicker and more accurate examination. Doppler velocimetry identifies normal and altered blood flow velocity in the umbilical artery, fetal middle cerebral artery, other peripheral arteries and fetal venous system.

Tonge et al [7] studied blood flow velocity waveforms in the descending fetal aorta and compared between normal and growth restricted pregnancies. In normal pregnancies, the peak systolic, end diastolic

velocity and pulsatility index remained unchanged with increasing gestational age. End diastolic velocity was lowered or at zero level (high pass filter level), and the pulsatility index was elevated in most cases of severe intrauterine growth restriction. Peak velocity related closely with the quality of the heart rate patterns and the conditions of the fetus at birth.

Arduini et al [8] studied 75 high-risk pregnancies to define the clinical value of the analysis of fetal blood flow velocity waveform in the early screening of growth restriction. The ratio between PI especially of the umbilical artery and internal carotid proved to be an accurate predictor of growth restriction with 92.3% specificity, 78.2% sensitivity and 88% diagnostic accuracy.

Wladimirrof et al [9] studied the fetal cerebral blood flow velocity waveforms in growth-restricted fetuses associated with uteroplacental insufficiency and in fetuses with prolonged oligohydramnios. PI value was noted in all the cerebral vessels and internal carotid artery. The effect of external variables such as vibroacoustic stimulation and internal variables such as fetal breathing movements, behavioral states and heart rate-, was also studied. In the intrauterine growth, restricted fetuses associated with uteroplacental insufficiency the finding were suggestive of existence of brain sparing effect. In intrauterine growth restricted fetuses associated with structural chromosomal abnormalities normal fetal cerebral blood flow velocities were observed. In the presence of severe oligohydramnios, cerebral blood flow velocities indicated increased cerebral vascular resistance probably because of head compression.

Rochelson et al [10] studied pregnant women with IUGR serially by continuous wave Doppler velocimetries. Outcomes were compared between normal and abnormal S/D umbilical artery ratio. Seventy-eight percent babies had an abnormal S/D ratio. The group with abnormal ratios had significantly higher incidence of abnormal FHR, preeclampsia, oligohydramnios, cesarean delivery for fetal distress and admission to NICU. Average birth weight and gestational age at delivery were significantly lower and there were six perinatal deaths in group with abnormal umbilical S/D ratio and none in group with normal ratio. This data suggests that the small for gestational age babies with abnormal umbilical artery S/D ratio are at higher risk than those with normal ratio. This implies that management of pregnancies with short for gestational age (SGA) babies may now be aided by functional classification based on umbilical artery velocimetry.

Consistent with results of Rochelson et al [10] our study showed the women who had abnormal umbilical artery Doppler were more likely to have hypertensive disorder of pregnancy and ultrasonographic criteria for decreased amniotic fluid. This implies that management of pregnancies with small for gestational age (SGA) babies may now be aided by functional classification based on umbilical artery velocimetry.

Colour Doppler studies of middle cerebral artery are also of prognostic and diagnostic significance.

Prenatal cerebral vasodilation is a sensitive marker for growth restriction and it seems to be a physiologic response to hypoxia. [11] In response to hypoxia fetus uses a compensatory mechanism to redistribute the cardiac output and blood supply to brain to maintain constant oxygen delivery to this vital organ. This increase in flow may be reflected in elevated diastolic velocities in Doppler wave forms obtained from cerebral blood vessels. [12]

Patients with abnormal middle cerebral artery Doppler were more

frequently to have pre-eclampsia and oligohydramnios.

CONCLUSION

Analysis by umbilical artery S/D ratio showed that the abnormal ratio group had higher incidence of pre-eclampsia, oligohydramnios as compared to normal ratio group. When middle cerebral artery S/D ratio was abnormally low, the incidence of preeclampsia, oligohydramnios was higher. IUGR associated with abnormal umbilical velocity waveform is a strong predictor of small for gestational age fetuses. Assessment of fetal MCA flow velocity waveform provides an additional insight into the haemodynamic adaptation of the fetuses having a compromised blood flow.

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