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Assessment and Comparison of Color Doppler Indices in IUGR and Normal Fetuses

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Abstract

Introduction: Fetal growth restriction (FGR), also known as intrauterine growth restriction (IUGR) is defined when estimated fetal weight is below 10th percentile for a given gestational age. It is a pathological process that modifies the growth potential of the fetus and restricts its intrauterine development. It is associated with increased risk of perinatal morbidity, mortality and long term complications. Doppler is used to determine vascular resistance and end organ function. Doppler assessment is mainly done of umbilical artery (UA), middle cerebral artery (MCA), and ductus venosus (DV). Evaluation of placental and fetal Doppler blood flow has significantly altered the management of FGR. In this study we evaluated and compared colour doppler indices, pregnancy and perinatal outcome between IUGR and healthy foetuses.

Materials and Methods : In this study 40 patient of each group (Healthy women & women with IUGR) are taken after informed consent. All subjects were subjected to standard ultrasound and color doppler indices. Various parameters of study recorded. The data thus collected and were analysis.

Results: All fetoplacental Doppler parameters were significantly jeopardised in the IUGR group. Pregnancy and perinatal outcome were poor in IUGR group.

Conclusion: Doppler is more sensitive in early detection of foetal compromises and thus aids in the appropriate timing of delivery.

Keywords: Color Doppler, FGR, IUGR

Introduction

Fetal growth restriction (FGR), also known as intrauterine growth restriction (IUGR) is defined when estimated fetal weight is below 10th percentile for a given gestational age. It is a pathological process that modifies the growth potential of the fetus and restricts its intrauterine development.[1] It can be symmetric (33%), asymmetric (55%) or mixed (12%). Several factors either maternal foetal or placental can lead to IUGR, commonest being Placental insufficiency (pre-eclampsia chronic HT, DM, renal disease, cardiac disease, anaemia) 75-80%, maternal condition not associated with Placental insufficiency (Severe malnutrition, Smoking, Alcohol ingestion, Hemoglobinopathies) 5%, Foetal chromosomal abnormality 5%, Multifactorial foetal abnormalities 2-3 %, Foetal infections 1%. It is associated with increased

risk of perinatal morbidity, mortality and long term complications. Thus, prediction of risk and correct detection of the compromised IUGR foetus to allow for timely intervention is a main objective of antenatal care.

Clinically, FGR is suspected when serial measurement of symphyseal - fundal height shows a lag of 4 weeks. It is only a physical screening test with its poor sensitivity and specificity.[2] Ultrasound with Doppler studies is the benchmark for accurate pregnancy dating, diagnosis and management of FGR. Doppler is used to determine vascular resistance and end organ function. Doppler assessment is mainly done of umbilical artery (UA), middle cerebral artery (MCA), and ductus venosus (DV).[3] Evaluation of placental and fetal Doppler blood flow has significantly altered the management of FGR.

Doppler velocimetry of the umbilical artery assesses the resistance to blood perfusion of the fetoplacental unit. It is a low impedance artery which permits continuous forward flow throughout the cardiac cycle. Early in placental dysfunction, there is an increase in the resistance to blood flow through the UA, seen as increased pulsatility index (PI). In severe placental insufficiency, diastolic flow becomes absent or reversed, a finding associated with increased perinatal mortality and morbidity. Reversed end-diastolic flow in the umbilical arterial circulation represents an advanced stage of placental compromise and has been associated with obliteration of >70% of arteries in placental tertiary villi.

On the other hand, normally, the cerebral circulation is a high impedance circulation with continuous forward flow present throughout the cardiac cycle possible. In the presence of fetal hypoxemia, there is reorganization of blood flow, shunting blood from visceral, and less essential organs, to vital organs such as the brain, heart, and adrenal glands. This centralization of blood flow is known as the brain-sparing effect, characterized by increased end-diastolic flow velocity(shown by a low PI)in the middle cerebral artery. It can also be assessed with the cerebroplacental ratio, defined as middle cerebral artery PI/umbilical artery PI. A fetus is considered to have fetal brain sparing when this ratio is <5th percentile for gestational age.[4]

In this study we evaluated and compared colour doppler indices, pregnancy and perinatal outcome between IUGR and healthy foetuses.

Material and Method

It is a hospital based prospective and comparative analytical study. It is performed in the Department of Obstetrics and Gynecology, in collaboration with Department of Cardiology at SMS Medical College and attached hospitals, Jaipur for a period of 1 year.

The study included two groups : A and B consisting of 40 women each with singleton pregnancy with gestational period of more than equal to 28 wks with IUGR and with normal fetuses respectively. Pregnancies with medical disorders or congenitally malformed fetuses were excluded. Informed written consent was taken from the women willing to participate in the study. Approval from Institutional Research, Review Board and Ethical Committee was taken. Detailed history and examination with all relevant routine investigations were done.

Ultrasound was done to diagnose IUGR (Abdominal circumference <10th percentile). Doppler & biometry measurement were performed.

Fetal Biometry included

- Femur length, Bi-parietal diameter, Abdominal circumference, Liquor amount and Estimated fetal weight

Fetal peripheral circulation included

- Umbilical artery (UA) Doppler pulsatility index (PI), resistance index (RI) was measured on a free-floating loop of the umbilical cord.
- Middle cerebral artery (MCA) pulsatility index (PI), resistance index (RI) was measured in a transverse view of the fetal head at the level of its origin from the circle of Willis.
- Cerebroplacental ratio (CPR) – obtained by dividing MCA-PI / UA-PCI.

Pregnancy and perinatal outcome in terms of Gestational age at Delivery, birth weight, caesarean section, 5 min APGAR score <7, days in NICU, perinatal mortality.

Results were noted and compared between both the groups A and B.

Results

The table no.1 shows characteristics of the study groups. Baseline characteristics were similar in both study and control group, except BMI which was significantly lower in cases as compared to the controls.

Table No1. Baseline Characteristics

Characteristics	Case (n = 40)	Control (n = 40)	p-value
Maternal Age (yrs)	25.03 ± 3.51	25.70 ± 3.78	0.410
Haemoglobin (gm/dl)	9.67 ± 0.91	9.61 ± 1.12	0.810
BMI (kg/m^2)	19.71 ± 1.90	21.91 ± 2.09	0.009
Primipara	21 (52.50%)	17 (42.50%)	0.272

Table No.2 Fetoplacental USG and Color Doppler Indices

Characteristics	Case (n = 40)	Control (n = 40)	p-value
GA at USG (wks)	35.95 ± 2.52	35.70 ± 1.74	0.607
EFW (kg)	1.80 ± 0.44	2.23 ± 0.42	<0.001
AFI (cm)	3.75 ± 1.86	7.63 ± 1.29	<0.001
Mean UA-PI	1.486 ± 0.402	0.780 ± 0.228	<0.001
Mean MCA-PI	1.694 ± 0.526	1.840 ± 0.471	0.195
CPR	1.224 ± 0.602	1.835 ± 0.590	<0.001
BSE	19 (47.50%)	0 (0.00%)	<0.001

Table no.2 shows various features of fetal ultrasound and color doppler. Gestational age at ultrasound was comparable in both groups, while all fetoplacental Doppler parameters were significantly jeopardised in the IUGR group.

Table No.3 Pregnancy and Perinatal Outcome

Characteristics	Case (n = 40)	Control (n = 40)	p-value
Pre-eclampsia	10 (25.00%)	0 (0.00%)	0.002
GA at Delivery (wks)	37.35 ± 1.35	39.00 ± 0.91	<0.001
Birth Weight (kg)	1.96 ± 0.37	2.86 ± 0.22	<0.001
Caesarean Section	23 (57.50%)	12 (30.00%)	0.02
5 min APGAR Score <7	5.88 ± 1.28	7.18 ± 0.98	<0.001
Days in NICU	5.65 ± 6.94	0.13 ± 0.52	<0.001
Perinatal Mortality	1 (2.50%)	0 (0.00%)	1.0

Table no.3 shows pregnancy and perinatal outcome. The growth-restricted group showed a significantly higher prevalence of pre-eclampsia, lower birth-weight centile and longer neonatal hospitalization in the neonatal intensive care unit as expected. Also as compared to the controls, IUGR fetuses were delivered mainly by Caesarean section and with poor 5-min Apgar scores.

Discussion

Fetal growth restriction (FGR) or intrauterine growth restriction (IUGR) has an incidence of 5 - 10%. The major concern in FGR is not the small size of the fetus per se, but the possibility of life-threatening fetal compromise. The challenge is to identify the subset of pregnancies affected with pathological growth restriction in order to allow intervention that would decrease morbidity and mortality.

Screening options for fetal growth restriction can be:

A. Clinical : Symphysio-fundal height measurement is a screening method to detect growth restriction foetuses. Though measurement of symphysio-fundal

height is a poor screening tool for the detection of FGR but accuracy of subsequent ultrasound prediction of FGR is enhanced if there is clinical suspicion of FGR based on lagging fundal height (less than 2 to 3 cm from the expected height).

B. Ultrasonography

Abdominal Circumference (AC) : The AC is the single best measurement for the detection of FGR.[5] The AC percentile has both the highest sensitivity and negative predictive value for the sonographic diagnosis of FGR whether defined postnatally by birth-weight percentile or ponderal Index.

Estimate of fetal weight (EFW) : A EFW below the 10^{th} percentile provides a graphic image easy for both patient and referring physician to conceptualize. Therefore, use of the estimated fetal weight has become the most common method for characterizing fetal size and thereby growth abnormalities.[5]

C. Doppler velocimetry : Doppler ultrasound velocimetry is a non-invasive method of measuring changes in blood flow velocity. Evaluation of placental and fetal Doppler blood flow has significantly altered the management of FGR. Role of Doppler velocimetry in the management of fetal growth restriction is unique because it serves as a diagnostic as well as a monitoring tool.

In our study the mean age of the study group and control group was 25.03 ± 3.51 yrs and 25.70 ± 3.78 yrs respectively. The groups were similar with regards to the age distribution. The mean BMI of the case group and control group was 19.71 ± 1.09 kg/m^2 and 21.91 ± 2.09 kg/m^2 respectively, showing a strong association of IUGR with the women with low BMI.

The mean gestational age of evaluation among the case group and control group was 35.95 ± 2.52 wks and 35.70 ± 1.74 wks respectively. The mean estimated fetal weight (EFW) in the study group was 1.80 ± 0.44 kg, whereas in the control group it was 2.23 ± 0.42 kg. The mean gestational age at evaluation for both the groups was comparable. But the EFW of the IUGR babies was much less than that of the controls. A salient feature observed in FGR is the reduction of amniotic fluid volume. Normal AFI implies normal placental perfusion. In contrast, low AFI with intact membranes is most commonly associated with uteroplacental insufficiency. Two third patients in the study group had AFI <5 cm, (65% of the cases had oligohydramnios) while none in control group had oligohydramnios. Thus the difference between the both the groups was statistically significant.

In study group mean Umbilical Artery Pulsatility Index was 1.486 ± 0.402 whereas in control group mean was 0.780 ± 0.228. There was statistical difference between both the groups. In study group mean Middle Cerebral Artery Pulsatility Index was 1.694 ± 0.526 whereas in control group mean was 1.840 ± 0.471. The CPR was significantly reduced among the cases as compared to the controls (0.930 v/s 1.695). CPR reflects both the placental status and fetal response to chronic hypoxia. It is considered as a more sensitive doppler index for predicting perinatal outcome. In our study, 57.50% patients had CPR <1 while none in the control group had CPR <1. All fetuses in control group had CPR >1 as compared to only 42.50% fetuses in the study group who had CPR >1.

The mean gestational age of delivery in study group was 37.35 ± 1.35 wks and that in control group was 39 ± 0.9 wks with mean birth weight of the neonates in study group was 1.96 ± 0.37 kgs, whereas in the control group it was 2.86 ± 0.22 kgs. In study group, 28 (70%) babies had APGAR score <7 while in control group 34 (85%) babies

had APGAR score >7 with 1 IUFD in the cases. There was longer NICU stay by the IUGR group (5.65 ± 6.94 days) as compared to control group (0.13 ± 0.52 days). The difference between both the groups was statistically significant.

Our results were comparable with the study by Perez-Cruz M et al (2015)[6] who assessed fetal cardiac function in IUGR and SGA babies. The mean EFW in IUGR was 2.39 ± 0.54 kg, while in control group was 2.19 ± 0.40 kg. The mean MCA-PI in IUGR group was 1.70 ± 0.40 as compare to 1.90 ± 0.33 in the control group. The difference between both the groups was statistically significant.

Our results were similar to the study of Cruz-Lemini M et al (2016)[7] on cardiovascular remodeling in IUGR fetuses. The mean EFW in IUGR was found to be significantly reduced as compared to control group (2.19 ± 0.45 v/s 1.91 ± 0.81 kg).They found lower CPR in IUGR group (1.52 ± 0.60) as compared to control group (1.99 ± 0.50).

Rodriguez-Guerineau L et al (2018)[8] studied cardiovascular adaptation in IUGR fetuses. They found significantly lower EEW among the IUGR group as compared to controls (1.802 v/s 2.314 kg). They observed mean UA-PI in IUGR and control Group to be 1.03 ± 0.25 and 0.91 ± 0.19 respectively. These results were comparable to our results.

Comas M et al (2010) [9] in their study on cardiac dysfunction in IUGR observed that there is a significant increment in the mean value of UA-PI among the IUGR group as compared to the control group (1.89 ± 0.34 v/s 1.06 ± 0.24). They observed significantly decreased mean MCA-PI in IUGR (1.37 ± 0.3) as compared to control group (2.08 ± 0.38). The difference in CPR was significant between case and control groups (0.77 v/s 2.05). The results obtained by them were similar to our results.

Our results were comparable to those by Comas M et al (2011)[10] who observed increased mean UA-PI in IUGR group. The mean UA-PI of the study group was 1.02 ± 0.2 while that of control group was 0.9 ± 0.19. Also decreased CPR was found in IUGR group as compared to the control group (1.65 v/s 1.79). They reported more patients in study group underwent caesarean section as compared to the control group.

In a study conducted by Crispi F et al (2012)[11] on cardiovascular programming in small for gestational age fetuses and its relationship with prenatal signs of severity, 5 min APGAR score of ≤7 was found in 20% of the neonates in the study group as compared to only 1% of normal neonates. The mean days at NICU were 15 ± 2 days by FGR group v/s 1± 6 days in controls.

Conclusion

Doppler patterns follow a longitudinal trend with early changes in the umbilical artery followed by middle cerebral artery and other peripheral arteries. As compared to other methods of foetal monitoring, Doppler is more sensitive in early detection of foetal compromises and thus aids in the appropriate timing of delivery. CPR is the most sensitive and specific indicator of foetal compromise in IUGR. Hence, if UA PI is abnormal MCA PI should be performed to know extent of brain sparing, thus emphasizing importance of studying two vessels in Doppler.

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