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Evaluation of Arterial and Venous System Doppler in Growth Restricted Fetus.

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Abstract:
Background: Detection of "fetal growth restriction" early and monitoring of changes on colour Doppler will help in identifying the at-risk pregnancies and avoiding adverse obstetric and perinatal outcome. **Objectives:**In this study we aim to evaluate the accuracy of "arterial and venous system Doppler" in "growth restricted foetuses" in predicting the impending adverse outcomes. **Methodology:**This is a time bound prospective, cross sectional study in which 98 pregnant women referred to antenatal ultrasonography of "department of radiodiagnosis" of "Acharya Vinoba Bhave Rural Hospital" with clinical diagnosis/suspicion of growth restricted fetus and abnormal growth parameters on antenatal ultrasonography will be subjected to "doppler study of arterial and venous system" with the help of Aloka Hitachi Arietta 65 USG machine using 3.5 MHZ curvilinear transducer with coupling gel.
Results: After performing statistical analysis, we hope to find a positive correlation between "sonographic and Colour Doppler detection and monitoring of growth restricted foetuses" and timely obstetric management to facilitate reduction ofadverse maternal and perinatal outcome.**Conclusion:** In this prospective, cross sectional study, we expect to find that sonographic monitoring of fetal growth not only helps in detecting "abnormal growth patterns"early but also that the colour Doppler study helps in increased diagnostic accuracy and aid obstetricians in timely management of "IUGR pregnancies" and have a positive impact in reducing "maternal and perinatal morbidity and mortality".

Keyword: ColourDoppler, Ultrasonography, "Fetal Growth restriction", "Perinatal outcome".

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INTRODUCTION:

Intra uterine growth restriction is a common condition with a world-wide incidence of about 10-15% of the pregnancies (1). It has a very high incidence in South Central Asia (33%). In India LBW with IUGR affects 21% and LBW (Low Birth Weight) affects 28% of pregnancies (1). But it is less commonly detected when compared to its prevalence.

Intra uterine growth restriction refers to the deviation of fetus from normalgrowth patterns resulting in failure to reach its full growth potential, because of genetic or maternalcauses, utero-placental insufficiency or environmental insult. It is linked to an increased risk of adverse perinatal results as it is associated with "respiratory distress syndrome" and other lung conditions, "necrotizing enterocolitis", "intracranial haemorrhage" , "intra-uterinedeath",higher incidence of renal diseases and chronic cardiovascular disorders. IUGR babies also have increased risk of developing obesity and systemic hypertension in later life (2).

Arterial and Venous Doppler evaluation remains one of the most valuable diagnostic tools to predict adverse outcomes in "IUGR". When taken complementary to other parameters like BPP (Biophysical Profile) and CTG (Cardiotocography), doppler can have a crucial role in stratifying the risk of morbidity to the fetus and in detecting impending fetal death. Thus it can aid the obstetrician in timely management of the pregnancy and helps in reducing perinatal complications, incidence of emergency caesarean sections and the burden of NICU admissions(3).

"Doppler examination is the best predictor in IUGR" and is relatively safer in pregnant women due to the lack of ionizing radiation but judicious use of doppler evaluation in keeping with the ALARA principle is equally important so as to reduce any possible thermal effects especially in very early pregnancies.

Colourdoppler evaluation of arterial and venous system :

1. **"Umbilical ArteryDoppler":**

The resistance to "umbilical artery flow" declines as the placenta matures, allowing constant forward flow during the entire "cardiac cycle". When the small muscular arteries in tertiary villi of placenta get obliterated, the end diastolic flow starts progressively decreasing till it becomes absent and then reversed. The waveform, the S/D (Systolic peak/ End diastolic flow) ratio and the PI (Pulsatility Index) values are obtained to look for any abnormalities.

2. **"Uterine Artery Doppler":**

Uterine artery impedance normally decreases when trophoblastic invasion into maternal spiral arterioles occurs. Persistence of notch and increased PI values above 95^{th} percentile are indicators for abnormal uterine artery doppler.

3. **"Middle cerebral Artery Doppler":**

Blood flow gets redistributed in a brain sparing pattern when fetal hypoxemia occurs

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causing MCA doppler to show low PI values and increased end diastolic flow.

4. "Ductus VenosusDoppler":

"Constant forward flow" in the entirety of "cardiac cycle" is the normal finding in ductus venosus doppler. The normal waveform pattern consists of a) A "ventricular systolic peak", b) A "ventricular diastolic peak" during passive filling followed by c) A nadir with "atrial contraction 'a' wave". When 'a' wave is absent or reversed in IUGR, "adverse outcome" can be predicted.

5. "Umbilical VeinDoppler":

"The oxygenated blood" to the fetus is carried in the "Umbilical Vein". Flow in the umbilical vein decreases in the cases of fetal compromise. UV flow should be linear forward flow normally. When it becomes pulsatile, it signifies abnormalflow.

RATIONALE:

IUGR has very high incidence in developing countries, especially in India (1 in every 5 pregnancies). Health care gap is especially more in rural India. In India, pregnant mothers often do not get regular antenatal check-ups or ultrasound scans because of many factors like low socio-economic status, lack of awareness or lack of health facilities in the peripheral places. Sometimes pregnant women present with obstetric complications in late third trimester or at the time ofdelivery without any prior documentation or investigations. Ultrasonography and doppler examination are relatively inexpensive, non-invasive and easily available imaging modalities and they should be utilized for detecting fetal compromise, especially in high risk patients.

The changes in Doppler characteristics of "Umbilical artery", "Middle cerebral artery" and "Uterine arteries" have been reiterated through different studies. Doppler study of veins like "ductus venosus" and "umbilical vein" have also been described to have important prognostic value for fetuses. However, the role of doppler examination of arterial and venous system in a comprehensive study in IUGR, and its accuracy in detecting the fetal compromise and in guiding timely obstetric management is under-studied and under-utilized in many places, especially in ruralIndia.

This study aims to underscore the crucial role of a comprehensive doppler study in diagnosing and monitoring growth restricted fetuses to gain a clear advantage in preventing complications which can range from reduced intellect to life threatening situations of fetus.

Doppler study of any one artery or vein has pitfalls and "false positives and false negatives". Thus, taking doppler study of all the different vessels as complementary to each other can improve the accuracy of predicting adverse outcome in IUGR. Therefore, we include "arterial and venous system doppler" in our study of "growth restrictedfetuses".

Colour Doppler may display variations in waveform and flow characteristics and doppler indices even before the "fetal heart rate decelerations", "fetal respiratory distress" and life-endangering situations develop(4) and so is very crucial as part of

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antenatal care and this study aims to underline its importance.

OBJECTIVES:

1. To study the growth parameters of fetuses on antenatal scans and to identify growth restrictedfetuses.
2. To study the Doppler characteristics of arterial system of growth restrictedfetuses.
3. To study the Doppler characteristics of venous system of growth restrictedfetuses.
4. To determine the utility and accuracy of Color Doppler in predicting perinatal outcomes of growth-restricted fetuses.

METHODS:

"Study design": "Prospective, Cross sectional study."

Study Area: "Acharya Bhave Rural Hospital (AVBRH), Sawangi and Jawaharlal Nehru Medical College (JNMC)"

Source of Data: Patients from AVBRH attached to DMIMS. The patients are taken from both IPD and OPD basis.

Subjects: Pregnant women with clinical suspicion or fetal growth restrictiondetected on antenatal ultrasonography who give informed consent to take part in the study will be taken as study subjects.

Sampling Procedure: The patients with single live fetus referred to the "department of Radio diagnosis(AcharyaVinobhaBhave Rural Hospital, DMIMS, Sawangi, Wardha)" with clinically suspected high risk factors or parameters and intra uterine growth restriction detected on routine antenatal ultrasonography will be included in the study. After obtaining informed consent and ethical clearance, patients will undergo history recording and sonographic examination, and Colour Doppler study will be conducted.

Sample Size:98 pregnant patients with growth restricted fetusreferred to Antenatal ultrasonography of "department of radiology of AcharyaVinobaBhave Rural Hospital, Sawangi (Meghe)" will be included. "Calculated by formula:

$$n = \text{א}^2 \; X \; N \; X \; P(1-P) \; C^{\;2}(N-1)+\text{א}^2 \; P(1-P)$$

$$n = \frac{3.84 \times 131 \times 0.5 \times 0.5}{0.05^2 \times 130 + 3.84 \times 0.5 \times 0.5}$$

Total patients in two years, N = 131

א^2 =Chi-square value for 1 degrees at some desired probability level. That is 3.84 at 5% level of significance."

Duration of study: 2020 – 2022

DIAGNOSTIC TOOL: The Patients in our study will be screened with the help of Color Doppler, using "3.5 MHz curvilinear transducer" with coupling gel, with an

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Aloka Hitachi Arietta 65 USG machine. Color Doppler study of Fetal "arterial and venous system" will be performed with the help of this machine.

INCLUSION CRITERIA:

1. All patients with clinical suspicion, high risk factors and symptoms and signs of fetal growthrestriction
2. Patients with abnormal growth patterns of fetuses on successive antenatal scans ("estimated fetal weight by USG below the 10^{th} percentile and Fetal abdominal circumference $<5^{th}$ percentile or fulfilling other criteria for fetal growthrestriction").
3. Normal fetalanatomy.
4. Abnormal findings on ColourDoppler.

EXCLUSION CRITERIA:

1. Patients who do not have any antenatal scans or unavailable forfollow-up.
2. Patients who deliver outside the hospital are excluded fromstudy.
3. Neonates with structural or chromosomal anomalies detected afterbirth.
4. Twins and/ or multiple gestationpregnancies.
5. Patients who refuse to give consent/not willing for dopplerexamination.

METHODOLOGY:

This is a time bound prospective, cross sectional study in which pregnant women referred to "department of radiodiagnosis" with high risk factors or clinical diagnosis/suspicion of growth restricted fetus and abnormal growth parameters and growth patterns of fetus on antenatal ultrasonography will be subjected to doppler examination of arterial and venous system in Acharya Vinoba Bhave Rural Hospital.

The duration of study will be of two years. "Informed consent" will be obtained from every patient for the study. All patients will undergo arterial and venous system colour doppler, with minimum of one colour doppler study in the third trimester and increased surveillance with colour doppler studies will be conducted if abnormal findings on doppler are detected at any stage.

The doppler studies will be used asanadjunctivediagnostictooltopredictimpendingfetalcompromiseandfollow-upwill be done till the delivery. The results will be correlated with perinatal outcome of thefetuses.

Arterial and fetal venous colour doppler will be done with an Aloka Hitachi Arietta S65 USG machine with curvilinear low frequency probe (3.5 MHZ or 1-5MHZ) with Colour Doppler function.

All patients will be examined in a comfortable lying down position. Coupling gel will be used with the low frequency curvilinear probe. Colour Doppler of "Umbilical artery", "Middle cerebral artery" and "Uterine arteries" and fetal venous system will be performed in each sitting and regular serial studies will be performed in order to monitor the fetalcondition and to help the obstetrician in optimizing the timing of delivery, depending on doppler indices in

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the growth restricted fetuses (doppler is used as an adjunct to other obstetric parameters. Doppler is not the sole tool, though an important one, in guiding the obstetricians). The results of doppler studies will be evaluated by appropriate statistical analysis in comparison to the actual perinatal outcome and their accuracy in prediction of adverse outcome will beevaluated.

Methods:

1. "Umbilical arteryexamination":

"The Umbilical artery (UmA) doppler" will be evaluated by locating a "free loop of umbilical cord" and then placing the "Power Doppler window" at its midsection, When PI value is raised above the upper limit for "respective gestational age", or when "the end diastolic flow in the vessel becomes absent or reversed", "The UmAdoppler" will be taken as abnormal. "Absent or reversed diastolic flow" is an ominous sign(5).

2. "Middle Cerebral Artery Examination":

Fetal "Middle cerebral arteries" are located near the "base of skull", overlying the "anterior wing of sphenoid". The Doppler readings from the MCA will be taken at its point of origin from the "internal carotid artery". There is a decrease in "systolic velocity" as we move away from the point of origin, so the standard method is to take readings as proximally as possible.

3. "Uterine Artery Examination":

"Flow velocity waveforms" of the "ascending branch of uterine artery" should be taken at its origin at "the point that's closest to the Internal Os". PI (Pulsatility index) will be calculated after getting three continuous waveforms. Then, "the Mean Uterine artery PI" will be calculated from the PI of right and left uterine arteries. Different indices like end diastolic velocities and presence or absence of notch will be evaluated.

4. "Ductus venosusexamination":

Either the "mid-sagittal longitudinal plane" or "oblique transverse plane" through the fetal upper abdomen can be used to obtain visualization of "Ductus venosus (DV)". The origin of "ductus venosus" from the "umbilical vein" will be taken as the point for obtaining the doppler indices. The DV waveforms will be considered abnormal when PI (Pulsatility index) becomes >1 or when deep "a" waveis present since it indicates "absence" or "reversal of flow in the ductus venosus" in atrial contraction phase. This will mean that the flow to vital organs of fetus and fetal circulation.(6)

5. Umbilical veinexamination:

The intra-abdominal part of the UV will be taken as the sampling site. The "UV Doppler pattern" should show "continuous linear forward flow" physiologically. Any pulsatile flow in the form of "monophasic", " biphasic" or "triphasic" patterns will be taken as abnormal doppler.(7).

Bias: Intra-observer variability will be minimized by taking the average of 3 readings of each

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colour Doppler waveform.

Expected Outcomes:

In this study, we expect to find a "positive correlation" between the early diagnosis of "fetal growth restriction" on colour Doppler and reduction in "maternal and perinatal morbidity and mortality", reduced incidence of intra uterine foetal deaths, still births, caesarean sections and NICU admissions. We expect to find that sonographic monitoring of fetal growth and inclusion of colour Doppler especially in high risk pregnancies will detect any impending adverse fetal outcomes early and will aid the obstetrician in planning the management of the patients.

DISCUSSION:

Fetal growth restriction is a very common condition, especially in the rural population of india. Regular sonographic monitoring helps to determine the development of any "abnormal growth pattern" of the fetus and "Colour Doppler study" especially to monitor high risk pregnancies, will help to diagnose and stage fetal growth restriction(8-9) and predict adverse outcomes. Colour Doppler of no one individual vessel is found to be accurate in correlating with fetal outcome. In our study, we aim to detect "IUGR" and to use colour Doppler flow indices and spectral waveforms of both arteries and veins to detect the development of fetalcompromise(10) more accurately and better aid in the planning of management of the patients. Kumar et. al. reported on significance of fetaldoppler flow velocimetry in the perinatal outcome of growth-restricted fetuses (11). Related studies were also reported by Noman et. al. (12), Roy et. al (13) and Shrivastava et. al. (14). Few of the studies on causative factors of fetal growth restriction were reviewed (15-18). Choudhary et. al. reported on fetomaternal outcome in premature rupture of membranes in pregnancy more than 34 weeks (19). Kshirsagaret .al. reported a study on evaluation of serum ferritin level in anaemic & nonanemic pregnant women & its correlation with maternal and perinatal outcome (20).

CONCLUSION:

This research will hopefully underline the utility of "Colour Doppler" in the early detection of "fetal growth restriction" and the impact of the diagnosis in avoiding adverse obstetric and neonatal outcome, especially for the underserved rural population of India.

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