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Radiology

CEREBRO-PLACENTAL-UTERINE RATIO IN PREDICTING LATE IUGR BY DOPPLER ASSESSMENT.

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INTRODUCTION:

ACOG (American College of Obstetricians and Gynaecologists) defines IUGR (Intra Uterine Growth Restriction) by failure of the baby in achieving its individual growth capability. Personalised growth charts based on maternal age, height, weight, parity and ethnicity (1). Screening method to detect fetal growth restriction should be able to differentiate small babies which are healthy from babies which are pathologically small (2). Intrauterine growth restriction (IUGR) or fetal growth restriction (FGR) is defined as an estimated fetal weight (EFW) and/or abdominal circumference (AC) at one point in time during pregnancy being below 3rd percentile or EFW and/or AC below the 10th percentile for gestational age with deranged Doppler parameters. The management of IUGR complicated pregnancy is still challenging.. Cerebro-placental-uterine ratio (CPUR) is a recent acceptable instrument for determining the high-risk SGA(small for gestation age) embryos. As per the brain sparing hypothesis, in any type of fetal distress, it is seen that a diminishing the blood supply to the baby leads to a diminishing in the cerebral vascular resistance to maintain the blood supply to the brain. This change is seen as an increment in the end diastolic velocity (EDV). A Cerebro-placental-uterine ratio (CPUR) is a Doppler ratio which combines information from the placental, uterine, and/or fetal vessels and could improve detection of utero-placental insufficiency late in pregnancy.

AIMS AND OBJECTIVES:

To evaluate the usefulness of the cerebro-placental-uterine ratio in predicting late IUGR by assessing several Doppler indices and their combinations/ratios.

Objectives:

1. To study Systolic/Diastolic ratio, Resistive index, and CPR and CPUR of fetal UA, MCA and uterine artery in late intrauterine growth restriction.
2. To identify doppler waveforms and ratios which can best predict late IUGR.
3. To determine role of third trimester doppler sonography in management of IUGR pregnancy.

Methodology:

This is a prospective observational study done in the department of radio-diagnosis in collaboration with the department of Obstetrics and Gynaecology, CHRI, Kelambakkam, Tamil Nadu from 2021-2023 after obtaining written and informed consent. 250 women with singleton pregnancies amid 28 to 40 weeks of gestation coming to Chettinad hospital to the Radiology department for antenatal scans and the Obstetrics and Gynecology department for delivery were included in the study. Pregnants with a singleton gestation, third trimester (28 - 40 weeks), normal anomaly scan, normal AFI (8-24cm), primigravida were included in the study, and patients with previous abnormal antenatal scans, twin pregnancies, patients with any systemic diseases (diabetes mellitus, pregnancy-induced hypertension) were excluded in the study. Institutional ethical committee clearance was obtained and the study abides by the guidelines laid by the declaration of Helsinki. Data were entered in excel sheets and statistical analysis was done using Microsoft Excel. During the scan these Doppler parameters are taken. Umbilical artery: a free loop of the umbilical artery is selected which is almost halfway from the fetal and the maternal end. Impedance is highest at the fetal end, so that is why the free loop is better. On the other hand, a value near the placental end is more likely to be compressed by the fetal part and give erroneous PI values. PI values which are greater than 95th percentile is significant for abnormality. Middle cerebral artery: MCA tracings are taken in the axial section with the visualization of bilateral thalamus and sphenoid bone wings. The vessel is magnified and the doppler tracings are taken near to the origin of the MCA rather than the far end. The angle of insonation used should be as close to zero as possible. Any undue pressure on the fetal head should be avoided. A normal MCA waveform demonstrated a continuous low velocity forward flow. In brain sparing phenomenon, there will be vasodilatation and hence a low PI which is less than 5th percentile, whereas in anemia, there will be a high PSV (MoM > 1.5). Uterine artery: the ultrasound probe should be placed longitudinally in the lower-outer abdominal quadrant. Color doppler is helpful in visualizing the uterine artery. Uterine artery is seen to cross perpendicular to the iliac arteries. The waveform is taken nearly one centimeter from the point of crossover. There is a very high diastolic flow in the third trimester. PI of the uterine artery more than 95th percentile is abnormal. The CPR was calculated as mean MCA PI divided by mean UA PI. As of now, CPR is considered as the most sensitive marker of cephalization of flow during fetal hypoxemia. CPR value which is less than 5th percentile is abnormal. Cerebro-placental-uterine ratio was calculated by dividing the cerebroplacental ratio to the mean uterine artery PI.

RESULTS:

The mean age of the study population was 25.2 ±5.2 years. The mean gestational age of the study population was 37.1 ± 2.1 weeks. The mean Middle cerebral artery PI value was 1.2. The mean Uterine artery PI value was 1.3. 233 patients had CPUR >1.07.

MCA PI:

MCA PI	Value
<0.4	0
0.4 – 1.6	180
1.6 – 1.8	37
>1.8	33

UA PI:

UA PI	Value
<0.4	0
0.4 – 1.6	181
1.6 – 1.8	37
>1.8	32

Sensitivity And Specificity Of CPR:

Statistic	Value	95% CI
Sensitivity	50.00%	27.20% to 72.80%
Specificity	97.83%	95.00% to 99.29%
Positive Likelihood Ratio	23.00	8.71 to 60.76
Negative Likelihood Ratio	0.51	0.33 to 0.79

Disease prevalence (*)	8.00%	4.95% to 12.09%
Positive Predictive Value (*)	66.67%	43.09% to 84.09%
Negative Predictive Value (*)	95.74%	93.55% to 97.21%
Accuracy (*)	94.00%	90.30% to 96.60%

Graph Showing The Distribution Of CPR Values:

Sensitivity And Specificity Of CPUR:

Statistic	Value	95% CI
Sensitivity	75.00%	50.90% to 91.34%
Specificity	99.13%	96.89% to 99.89%
Positive Likelihood Ratio	86.25	21.21 to 350.78
Negative Likelihood Ratio	0.25	0.12 to 0.54
Disease prevalence (*)	8.00%	4.95% to 12.09%
Positive Predictive Value (*)	88.24%	64.84% to 96.83%
Negative Predictive Value (*)	97.85%	95.52% to 98.98%
Accuracy (*)	97.20%	94.32% to 98.87%

DISCUSSION:

This is a prospective study which was done in the department of Radio-Diagnosis about cerebro-placental uterine ratio and its usefulness on detecting late intrauterine growth restrictions. The Doppler parameters studied included Cerebro-placental ratio and Cerebro-placental-uterine ratio. Both parameters were found to be significantly associated with SGA and IUGR at birth. In the study, around 75% of the women were from the age group of 18 to 26 years. 65% of the ultrasound scans were done between 35^{+1}-36 weeks of gestation, while the remaining were done between 36^{+1}-37 weeks of gestation. Out of the 250 study cases, 181 had an UA PI value between 0.4 to 1.6, 37 had between 1.6 to 1.8 and 32 had greater than 1.8. 180 cases had MCA PI between 0.4 to 1.6, 37 had between 1.6 and 1.8 and 33 had a value greater than 1.8. 204 cases had a UtA PI value between 0.4 and 0.8, and 46 had a value greater than 0.8. Total number of cases who had a calculated CPR of less than 1 was 15, whereas, the number of cases who had a CPUR less than 1.07 was 17.

The sensitivity and specificity of CPR at diagnosing fetal growth restriction was 50% and 97% respectively. The positive likelihood ratio and negative likelihood ratio was calculated at 23 and 0.51. the PPV and the NPV was calculated as 66 and 95%. The accuracy of the test was 94%. On the other hand, sensitivity and specificity of CPUR at diagnosing fetal growth restriction was 75% and 99% respectively. The positive likelihood ratio and negative likelihood ratio was calculated at 86 and 0.25. the PPV and the NPV was calculated as 88 and 97%. The accuracy of the test was 97%. Using McNemar's chi-square test, the CPR and CPUR as indicators of late FGR were compared. The test statistic is 3.2. The 1-tail and 2-tail p-values are 0.036 and 0.073 respectively. Therefore, the null hypothesis is rejected (according to 1-tail test) with 5% significance level. Uteroplacental insufficiency is linked to changes in blood flow resistance in the blood vessels of the uterus, placenta, and fetus (9). During these pregnancies, the uterine arteries (UtAs) and umbilical artery (UA) of the mother show higher resistance, causing the foetus to respond by redirecting blood flow towards vital organs. The presence of diminished pulsatility index (PI) in the middle cerebral artery (MCA) can indicate vasodilatation of the foetal cerebral arteries (10). Currently, the cerebroplacental ratio (CPR; MCA-PI/UA-PI) is the most promising method for detecting foetuses at risk in the latter stages of pregnancy (11). However, its clinical application is not yet standardised. Reduced CPR is linked to stillbirth, even after considering the size of the foetus. Additionally, near term, cerebral vasodilatation is a more accurate predictor of placental insufficiency compared to the growing UA-PI. Perinatal death at term is independently related with high UtA-PI at 36 weeks, however this is not commonly assessed in clinical practice. This is a prospective study which was done in the department of Radio-Diagnosis about cerebro-placental uterine ratio and its usefulness on detecting late intrauterine growth restrictions.

CONCLUSION:

Cerebro-placental-uterine ratio is a new ratio with a strong association with placental insufficiency. It is also more sensitive for intra-uterine growth restriction than the other commonly used doppler indices. If CPUR is combined with other biomarkers/ ultrasound biometry markers, it may be possible to detect IUGR with a higher accuracy than any single approach. Better and accurate estimation of IUGR would lead to reduction in perinatal morbidity and mortality by timely obstetrical intervention. Moreover, if CPUR gets similar results in larger study populations, it can be better at detecting SGA and FGR babies.

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