Role of Obstetric Colour Doppler in Intra Uterine Growth Restriction Detection (A study of 50 cases)

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ABSTRACT

Objective: To evaluate the role of obstetric colour Doppler in normal and IUGR fetuses by middle cerebral, umbilical and uterine arterial Doppler indices after 25 weeks of gestation.

Material and Method: A prospective cross sectional study was done, including fifty pregnant women, 31 with normal fetal growth parameter, and 19 with IUGR fetuses. Umbilical, middle cerebral and uterine arterial Doppler indices were examined. **Results**: Middle cerebral arterial Pulsatility Index (PI) and Resistive Index (RI) were significantly raised in IUGR. Umbilical arterial PI and uterine arterial RI were significantly raised in IUGR.

Conclusion: The middle cerebral, umbilical and uterine arterial indices have a significant role in diagnosing and monitoring IUGR past 25 weeks of gestation.

Keywords: Obstetric Doppler, IUGR, Middle Cerebral Artery, Umbilical Artery, Uterine Artery.

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INTRODUCTION

IUGR is a condition where the estimated weight of a fetus is below the 10th percentile for its gestational age.[1] It is an important perinatal problem which results in increased morbidity and mortality. When the normal mechanism of maintaining utero-placental blood flow fails or if abnormal vascular resistance develops, it leads to compromised fetal oxygenation and nutrition resulting in IUGR. Hence the Doppler parameters of the uterine artery, umbilical artery and middle cerebral artery helps in recognizing early signs of IUGR thereby improving the prognosis.[2]

METHODS

This was a prospective, cross-sectional study conducted in Shree Shayaji Rao, General Hospital, Vadodara in the Radiology Department. The duration of the study was one year from 1st January 2013 to 31st December 2013. A total 50 women were included in the study after getting informed consent. All patients F-Form according to Pre-Conception and Pre-Natal Diagnostic Techniques (**PCPNDT**) **Act of India**, 1994 were filled first. The inclusion criteria were singleton pregnancy more than 25 weeks of gestation. Patients with multiple gestations, diabetes, preeclampsia, oligohydroamnios,

polyhydroamnios, with congenital anomalies or any medical disorder complicating pregnancy were excluded. Fifty women were included, 31 were from uncomplicated, normal pregnancies and 19 with intrauterine growth restriction (IUGR). All ultrasound examinations were performed using color Doppler duplex ultrasound system (Esaote My Lab 20 plus) Medical System, equipped with a 3.75-MHz abdominal transducer. One examiner performed all ultrasonography examinations to avoid inter observer errors. Gestational age was based on the first day of the last normal menstrual period and confirmed by either first or early second-trimester ultrasound scan. Fetal biometry including biparietal diameter, head circumference, abdominal circumference, and femur length was measured. Estimated fetal weight was calculated using the formula by Hadlock using head circumference, abdominal circumference, and femur length.[3] Criteria for the diagnosis of IUGR is when the Estimated Fetal Weight (EFW) falls below the 10th percentile for gestational age.[4] Umbilical artery Doppler flow velocity waveform was assessed in free-floating loop at angle close to 0 degree to transducer.[5] The umbilical arterial waveform should be obtained during the period of fetal apnea because fetal breathing affects the wave forms. The umbilical arterial waveform, usually has a "saw tooth" type pattern with flow always in the forward direction. **[Figure-1]** Umbilical artery Pulsatility Index (PI) and Resistive Index (RI) were measured.[6]

The middle cerebral artery Doppler was performed with color Doppler visualization of the circle of Willis in the fetal brain in axial section of the head at the level of the sphenoid bones. Angle of insonation was kept near 0 degree and sample volume of 1 to 2 mm. Middle cerebral arterial Pulsatility Index (PI) and Resistive Index (RI) were measured. **[Figure-2]** A reduction in middle cerebral artery (PI) is an indicator of 'brain sparing effect' due to fetal redistribution.[7] Each uterine artery was sampled soon after crossing of the iliac vessels. Uterine arterial PI and RI were recorded. **[Figure-3]** All statistical analyses were performed using Microsoft Excel 2013 using Windows-8. Data are expressed as mean ± SD (Standard Deviation).

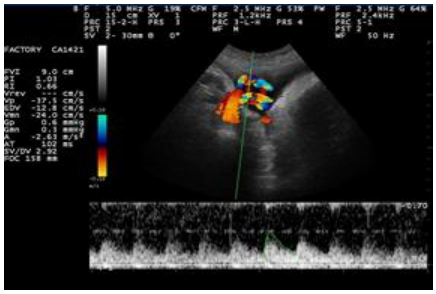

Figure - 1: Colour Doppler image in normally grown fetal mother shows normal PI and RI values in free loop of umbilical artery with typical "saw – tooth" appearance.

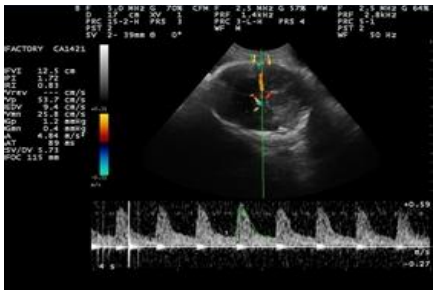

Figure -2: Colour Doppler image in normally grown fetal shows normal PI and RI values in fetal middle cerebral artery.

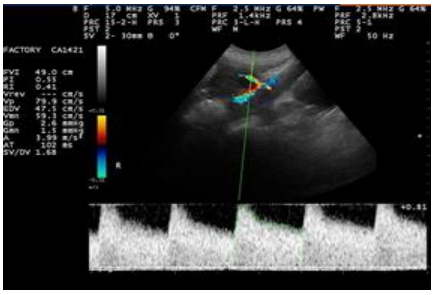

Figure-3: Colour Doppler image in normally grown fetal mother shows normal PI and RI values in maternal uterine artery with low resistance flow.

RESULTS

As shown in Table-1 Middle cerebral arterial Pulsatility index in IUGR fetuses was significantly higher as compared to normal fetuses with p-value of 0.0232 (i.e. $p < 0.05$) and Resistive index in IUGR fetuses was significantly higher as compared to normal fetuses with p-value of 0.02 (i.e. $p < 0.05$). [Figure-4] Umbilical arterial Pulsatility index in IUGR fetuses was significantly higher as compared to normal fetuses with p-value of 0.025 (i.e. $p < 0.05$) and no significant difference in Resistive index of umbilical artery between IUGR fetuses to normal fetuses. [Figure-5] Uterine arterial Resistive index in IUGR fetuses was significantly higher as compared to normal fetuses with p-value of 0.049 (i.e. $p < 0.05$) and no significant difference in Pulsatility index of uterine artery between IUGR fetuses to normal fetuses.

Table 1: Doppler parameters in normal and IUGR fetuses after 25 weeks of gestation.

Doppler Indices	Normal Fetus (n=31)	IUGR Fetus (n=19)
Middle Cerebral Artery (PI)	1.73±0.51	2.03±0.51#
Middle Cerebral Artery (RI)	0.79±0.09	0.85±0.08#
Umbilical Artery (PI)	1.04±0.20	1.16±0.23#
Umbilical Artery (RI)	0.68±0.16	0.68±0.08
Right Uterine Artery (PI)	0.72±0.20	0.78±0.25
Right Uterine Artery (RI)	0.47±0.08	0.52±0.12#
Left Uterine Artery (PI)	0.74±0.24	0.87±0.42
Left Uterine Artery (RI)	0.49±0.10	0.56±0.14

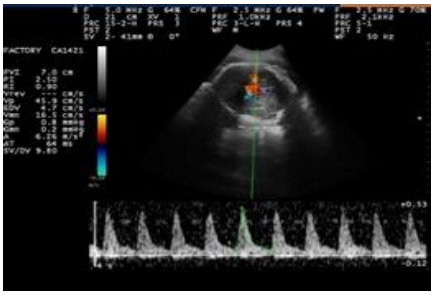

Figure-4: Colour Doppler image in IUGR fetal shows raised PI and RI values in fetal middle cerebral artery.

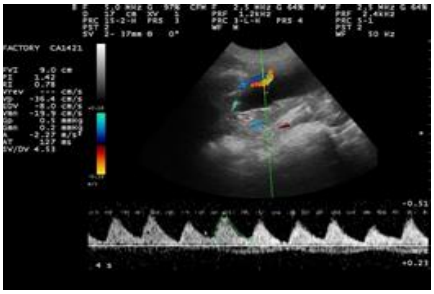

Figure-5: Colour Doppler image in IUGR fetal mother shows mildly reduced diastolic flow in umbilical artery with normal RI value and raised PI value.

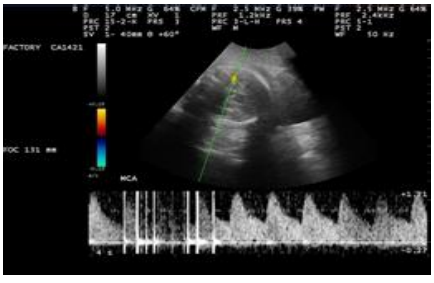

Figure-6: Color Doppler image in IUGR fetus shows increased blood flow during diastole indicating early brain sparing effects.

DISCUSSION

In IUGR fetus increased blood flow during diastole can be demonstrated by Doppler ultrasound of MCA.[8] This effect is termed as the brain sparing effect and is demonstrated by a lower value of MCA PI. [Figure-6] However, fetal middle cerebral arterial PI changes with increasing gestational age. In IUGR fetuses with a PI below the normal range, there is a greater incidence of adverse perinatal outcome. However, this brain sparing effect is transient and it may have lost in the overstressed fetus.[9] The MCA PI is below the normal range when oxygen tension is (Po_2) is reduced. The maximum reduction in PI is reached when the fetal PO_2 is 2 to 4 standard deviation (SD) below normal range, for gestational age.[10] When O_2 deficit is greater, the PI tends to rise, which presumably reflects the development of brain edema. In IUGR fetus the disappearances of the brain-spring effect or presence of reversed MCA flow is a critical event for the fetus and precedes fetal deaths. The MCA peak systolic velocity is increased in IUGR fetuses. This finding can be explained by increased PI in MCA. In our study this finding is consistent and increased PI & RI in MCA were observed.

The umbilical artery was the first vessel to be assessed in a fetus and has become the most widely investigated components of the fetal circulation. In uteroplacental insufficiency secondary to various causes, umbilical arterial resistance is increased in the fetus. The umbilical artery waveforms reflect the resistance in feto-placental circulation. Thus umbilical artery Doppler has been used extensively for fetal surveillance, especially in high-risk pregnancy.[11] It is established that an increase in umbilical resistance expressed by Doppler indices is well associated with fetal hypoxia and acidosis, especially in fetuses with growth restriction.[12,13] In our study this finding is consistent and increased PI of umbilical artery was observed in all cases of IUGR.

The uterine arterial blood flow in non-pregnant women is 50 ml per minute and increased to over 700 ml/min in the third trimester of pregnancy. Thus the diastolic component of the waveform is transformed during normal pregnancy from one of low peak flow velocity and an early diastolic notch, to one high flow velocity and an early diastolic notch by 18 weeks to 22 weeks.[14] With advancing gestation, the degree of the end diastolic flow typically increased. However, failure of the normal endovascular trophoblastic invasion of the spiral arteries results in increased uterine arterial vascular resistance and decreased perfusion of the placenta. If the end diastolic flow does not increase throughout pregnancy, or if a small notch is detected at the beginning of diastole, the fetus is at higher risk for the development of IUGR. Thus an abnormal PI and uterine arterial notching are the better predictor of the preeclampsia, whereas the best predictor of the IUGR in high risk pregnancy is an increased RI. In our study this finding is consistent and increased RI of the right uterine artery was observed.

CONCLUSION

The middle cerebral, umbilical and uterine arterial indices have a significant role in diagnosing and monitoring IUGR past 25 weeks of gestation.

Conflict of Interest: None.

Source of Funding: Nil.

Abbreviations:

IUGR: Intra Uterine Growth Retardation

PI: Pulsatility Index

RI: Resistive Index

PSV: Peak Systolic Velocity

EDV: End Diastolic Velocity

MCA: Middle Cerebral Artery

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