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To Identify the Predictive Role of Aortic Isthmus Blood Flow in IUGR

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Abstract: The purpose of this study was to study To Identify the Predictive Role of Aortic Isthmus Blood Flow in IUGR, which is conducted in the Dept. of Radio Diagnosis. AI blood flow represents the output flow of both ventricles and the difference of placental and cerebral blood flow resistance. The AI is the only Arterial connection between the right ventricle, which mainly supplies the systemic and placental circulation, and the left ventricle, essentially corresponding to the cerebral vascular network. Consequently, its blood flow pattern reflects the balance between both ventricular outputs and the differences in the impedance of both vascular systems. This study confirms and expands on previous observations suggesting that the occurrence of retrograde blood flow in the AoI is associated with adverse perinatal outcome. Growth-restricted preterm foetuses showed decreased absolute velocities in the AoI, very likely reflecting reduced systemic blood flow. Combination of AoI and umbilical artery Doppler is the best indicator for prediction of IUGR. Aortic Isthmus changes occur 24-48 hrs before deterioration of flow in Ductus Venosus.
Keywords: Aortic Isthmus, Blood, IUGR & Predictive.

INTRODUCTION

The Aortic Isthmus (AI) is the portion of the Aorta between the origin of the left subclavian artery and that of the intersection point of the Ductus Arteriosus and Descending Aorta; it marks the partial separation of fetal blood flow derived from the right and left ventricles.

In the postnatal period following the closure of the ductus arteriosus, it serves only as a vascular conduit transporting blood from the aortic arch down to the descending aorta.

However, during prenatal life, it plays an important role in maintaining an adequate balance between the brachiocephalic circulation supplying the upper body (including the brain) and the subdiaphragmatic circulation supplying the lower body and placenta[1]. In fetal life, upper body and brain are perfused by blood coming from left ventricle whereas lower body and placenta are exclusively perfused from blood coming right ventricle through ductus arteriosus.

The parallel arrangement of the fetal circulation allows for unequal right and left ventricular outputs as the placental, pulmonary and lower body vascular resistances act mainly on the right ventricle, whereas the upper body resistance acts mainly on the left ventricle[2]. Under physiological conditions and in the absence of structural cardiovascular malformations, such as hypoplastic left heart syndrome, critical aortic stenosis and interrupted aortic arch, the flow in the aortic isthmus is forward during the whole cardiac cycle. The volume and direction of aortic isthmus blood flow are determined by the systolic performance of the individual ventricles and the peripheral vascular resistances. During systole, the left ventricular ejection facilitates forward flow while the right ventricular ejection has the opposite effect. During diastole, when the ventricles are not ejecting blood and both semilunar valves are closed, the direction of blood flow in the aortic isthmus depends mainly on the relative difference between the upper body (including brain) and lower body (including placenta) vascular resistances[1]. Therefore, conditions that lead to an increased right ventricular afterload (e.g. intrauterine fetal growth restriction due to placental insufficiency) or a reduced left ventricular afterload (e.g. hypoxemia, cerebrovascular aneurysms, and vascular tumors of the neck) may cause a reversal of aortic isthmus blood flow during diastole.

Doppler examination of the umbilical artery (UA) and the middle cerebral artery (MCA) have proved to be good predictors of adverse perinatal

outcome. However, because the risks of iatrogenic prematurity are very high before 32 weeks gestation, further Doppler parameters are needed to assessfetal compromise. With further fetal deterioration, cardiac dysfunction results in abnormal venous flow velocity profiles, including reversed flow in the ductus venosus (DV) during atrial contraction and atrial pulsations in the umbilical vein.

Venous Doppler patterns together with gestational age (GA) at delivery have been advocated as the best predictors of adverse perinatal outcome in IUGR fetuses [3]. However, such venous changes are often signs of advanced fetal compromise and so are frequently associated with the presence of academia [4]. Abnormal UA and MCA Doppler flow-related fetal hypoxia were "early change," whereas abnormal venous Doppler flows was determined to be a "late change" when associated with fetal acidosis.

Detection of progression from hypoxia to acidosis is crucial to decide the optimal time of delivery to prevent fetal acidosis and fetal demise. For this reason the AI is thought to be a new horizon for FGR. The AI is the only vessel that provides blood from both the right and left ventricular systems.

MATERIALS AND METHODS

Present study "To Identify the Predictive Role of Aortic Isthmus Blood Flow in IUGR" was carried out in the Department of Radiology , Index medical College Hospital and Research Centre, Indore during the period of 18 months from February 2016 to August 2017.

Approach

Patient's clinical history and examination findings were recorded prospectively in a proforma form. All sonographic results were recorded and evaluated prospectively. The Isthmic Flow Index (IFI) was calculated using the following formula: IFI = (S +D)/S [5] where S and Dare, respectively, the systolic and diastolic Doppler blood flow velocity integrals. If IFI was 1, the flow was anterograde, and if IFI was <1, the flow was retrograde. In all cases, AI flow was taken. Fetal Gestational Age was calculated according to the maternal Last Menstrual Period and confirmed by first Trimester Ultrasound Crown-Rump Length. If the difference between Crown-Rump Length and Last Menstrual Period was more than seven days, the Crown-Rump Length calculation was accepted as the Gestational Age.

Estimated foetal weight was calculated using the Biparietal diameter, Abdominal Circumference and Femur length measurements as observed by Ultrasound. Estimated foetal weight <10th percentile for Gestational Age was considered equivalent with IUGR, and this diagnosis was confirmed after birth. UA, Middle Cerebral Artery (MCA) and AI Doppler measurements were performed. All measurements were performed in the supine and left lateral tilt position, but not during fetal movement, fetal respiration or uterine contractions. The AI Doppler measurement was performed using the longitudinal Aortic Arch or three- vessel and trachea section with an insonation angle of <30°. An MCA pulsatility index (PI) of <5th percentile for Gestational Age was considered a brain sparing effect. If IFI was <1, the flow was considered retrograde (abnormal).

Inclusion criteria

- Subjects between 28 to 37 weeks of gestation.
- Subjects with high risk pregnancy (Pre-eclampsia, Anaemia, previous history of IUGR.)
- Pregnancies with abnormal previous Doppler scan.
- Follow-up patient in the institution during the study period.

Exclusion criteria

- Subjects not giving consent to be a part of the study.
- Pregnancies independent of risk factors.
- Pregnancies with normal Doppler measurement.

Stastical analysis

Statistical analysis was computed for all the variables that were considered in this study. Data was entered in the Microsoft excel 2016 for windows. Frequencies and percentages (%) of variables were calculated. The comparability of the 2 groups (IUGR and HIGH RISK PREGNANCY) was investigated through t-tests (numeric variables) and chisquare tests on various perinatal variables.

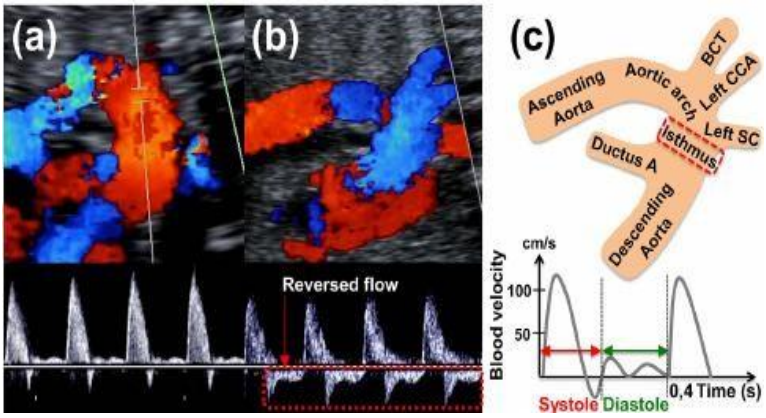

Fig-01: LAA view showing waveform pattern of Aortic Isthmus (a) Antegrade flow (b) Retrograde Flow (c) schematic presentation of landmark of Aortic Isthmus.

Table-01: Overall distribution of patients According to aortic isthmus index

Risk factors	IFI = (<1)	IFI = (>1)
IUGR (45)	10 (22.2%)	35 (77.7%)
ANEMIA (15)	02 (13.5%)	13 (86.6%)
PRE – ECLAMPSIA (15)	02 (13.5%)	13 (86.6%)
PREVIOUS H/O IUGR (10)	02 (20%)	08 (80%)

Table-02: Association of aortic isthmus index with perinatal outcome in iugr (n=45)

Perinatal Outcome	Aortic Isthmus Index			
	Cases(< 1)		Control(> 1)	
	No	%	No	%
Respiratory Distress Syndrome	05	50%	05	14.2%
Birth asphyxia	01	10%	03	8.5%
Acidosis	01	10%	00	-
IUFD	01	10%	00	-
Sepsis	01	10%	00	-
Normal	01	10%	27	77.1%

Table-03: Association of aortic isthmus index with perinatal outcome in previous iugr (n=10)

Perinatal Outcome	Aortic Isthmus Index			
	Cases (< 1)		Control (> 1)	
	No	%	No	%
Respiratory Distress Syndrome	00	-	01	12.50%
Birth asphyxia	00	-	01	12.50%
Acidosis	00	-	00	-
IUFD	01	50%	00	-
Sepsis	00	-	00	-
Normal	01	50%	06	75%

DISCUSSION

Our study confirms preliminary observations that there is a strong association between retrograde flow in the AoI and adverse perinatal outcome. As suggested by previous authors [6,7] and confirmed in this study, the best correlation between AoI and perinatal outcome is obtained when the Doppler waveform pattern is classified as antegrade or retrograde. When AoI patterns were defined according to the proposed classification of IFI into types, all normally grown fetuses had an IFI Type 1. Among IUGR fetuses, 10 cases were classified as having an IFI ranging from Type III to Type V, which by definition corresponds to retrograde flow. Group 1 (IUGR) consisted of 45 fetuses in which 10/45 (22%) had Retrograde AoI net blood flow and 35/45 (77.7%) between 28 and 37 weeks of gestation which was comparable with the results of previous study Del Rio *et al*.[8]

Umbilical artery Doppler tracings revealed a decreased diastolic blood velocity component in two cases, and a retrograde diastolic blood flow component in 8 cases. In Group B2 (h/o Previous IUGR), 3/10 (30%) were Asymetrical IUGR and placental insufficiency (UA RI increased) and 2/10 had

retrograde flow in aortic isthmus and rest had antegrade flow. 2/10 had adverse perinatal outcome. There was statistically non-significant relation of umbilical and Aortic Isthmus in our study with its perinatal outcome.

Group B3 (Anemia), 3/15 (20%) were associated with Asymetrical IUGR, and has shown increased resistance in Umbilical artery, 2/15 (13.3%) had retrograde flow in aortic isthmus. 3/15 had adverse perinatal outcome. Again Anemia was independent on isthmus index for fetal outcome.

CONCLUSION

To conclude, this study confirms and expands on previous observations suggesting that the occurrence of retrograde blood flow in the AoI is associated with adverse perinatal outcome. Growth-restricted preterm foetuses showed decreased absolute velocities in the AoI, very likely reflecting reduced systemic blood flow. Combination of AoI and umbilical artery Doppler is the best indicator for prediction of IUGR. Aortic Isthmus changes occur 24-48 hrs before deterioration of flow in Ductus Venosus. Therefore, Doppler study may be used for the prediction of fetal outcome to reduce the maternal and perinatal morbidity and mortality. The role of Doppler studies of the AoI as an additional clinical parameter in the routine assessment of hemodynamically compromised growth-restricted fetuses deserves further evaluation in large longitudinal studies.

As there are few studies on the role of Aortic Isthmus in the prediction of Perinatal outcome in IUGR, the present study was undertaken to meet these challanges and determine the role of this parameter in evaluation of Perinatal outcome.

In Group B3 (k/c/o Previous IUGR), 3/15 (20%) were Asymetrical IUGR and placental insufficiency (UA RI increased) and 1/15 had retrograde flow in aortic isthmus and rest had antegrade flow. 2/15 had adverse perinatal outcome. SENSITIVITY of IFI for perinatal outcome - 33.3%, SPECIFICITY – 85% ,PPV – 50%, NPV-75% with non-significant p value. Sensitivity -75% , Specificity - 66.6% ,PPV -60% , NPV-80% of Umbilical Artery RI for prediction of perinatal outcome.

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