Original Research Article

Role of doppler ultrasonography in prediction of adverse perinatal outcome in intrauterine growth retardation (IUGR)

T. Parijatha[1], P. Sushmitha Rao[2*], P. Keerthi Bharathi[3]

[1]Associate Professor, Department of Obstetrics and Gynecology, Prathima Institute of Medical Sciences, Karimnagar, Telangana State, India
[2]Associate Professor, Department of Radiology, Prathima Institute of Medical Sciences, Karimnagar, Telangana State, India
[3]Assistant Professor, Department of Radiology, Prathima Institute of Medical Sciences, Karimnagar, Telangana State, India
[*]Corresponding author email: **sushmitha51@gmail.com**

International Archives of Integrated Medicine, Vol. 9, Issue 2, February, 2022.
Available online at http://iaimjournal.com/
ISSN: 2394-0026 (P) **ISSN: 2394-0034 (O)**
Received on: 03-12-2021 **Accepted on:** 30-12-2021
Source of support: Nil **Conflict of interest:** Nil

How to cite this article: T. Parijatha, P. Sushmitha Rao, P. Keerthi Bharathi. Role of doppler ultrasonography in prediction of adverse perinatal outcome in intrauterine growth retardation (IUGR). IAIM, 2022; 9(2): 35-41.

Abstract

Introduction: A Doppler ultrasound is a noninvasive test that can be used to estimate the blood flow through the blood vessels by bouncing high-frequency sound waves (ultrasound) off circulating red blood cells. Objective of current study was to determine and compare accuracy of various Doppler parameters for perinatal outcome - Umbilical artery (UA), middle cerebral artery (MCA), and ductus venosus (DV) for predicting adverse perinatal outcome in patients of intrauterine growth retardation.

Materials and methods: A total of 172 singleton pregnancies between 33 to 36 weeks of gestation complicated by intrauterine growth restriction were prospectively examined with Doppler ultrasound of the umbilical artery, middle cerebral artery and ductus venosus. Patients kept under surveillance till confinement. According to increasing severity of Doppler indices categorized the cases into six grades from grade 0 to grade 5.Duration of this study was two years, from December 2019 to November 2021.

Results: Out of 172 cases, 146 were live born and 26 were neonatal death. There were 7 cases of intrauterine death of fetuses and 5 were still born. Out of the live born 27 had increased perinatal morbidity like poor APGAR score, development of necrotizing enterocolitis, hypoxic ischemic encephalopathy, meconium aspiration syndrome, hyperbilirubinemia, and prolonged admission in neonatal care unit for reasons like sepsis / birth asphyxia.

Conclusion: Absent end diastolic flow (EDF) / reversal in umbilical artery had high positive predictive value in predicting adverse fetal outcome. Ductus venosus changes seem to be an ominous sign of a severely compromised fetus with poor perinatal outcome. Doppler investigation of the MCA, UA and DV plays an important role in monitoring the compromised fetuses and helps to determine the optimal time of delivery.

Key words

Adverse perinatal outcome, Doppler, Ultrasound, Intra-uterine growth retardation, Umbilical artery, Still Born, Perinatal.

Introduction

The development of a good utero-placental circulation is essential for achievement of a normal pregnancy. Intrauterine growth retardation (IUGR) is associated with an increased risk of perinatal mortality, morbidity, and impaired neurodevelopment. Accurate detection of the compromised IUGR fetus allows the treating obstetrician for timely intervention and better antenatal care and ultimately reducing the complications during the delivery. Fetal growth and development rely on normal uteroplacental and fetoplacental circulation to supply oxygen and nutrients from the maternal circulation. Doppler sonography offers a unique tool for the noninvasive evaluation of physiological hemodynamic fetoplacental blood flow information [1, 2, 3, 4, 5, 6].

There are specific abnormalities in doppler parameters in asymmetric intrauterine growth retardation. Doppler flow velocimetry, particularly of the middle cerebral artery and umbilical arteries is an earlier predictor of hypoxemia, when compared to biophysical profile (BPP)/ non stress test (NST). Nearly 70% of patients with IUGR may be classified as having an asymmetrical growth pattern. These cases may be at greater risk for perinatal hypoxia and neonatal hypoglycemia. However, their long-term prognosis with appropriate management is good.

Aim of the study

The aim of the study was to detect any abnormalities in fetoplacental unit and fetal circulation in IUGR fetus, to correlate the occurrence of adverse perinatal outcome with degree of abnormality in Doppler indices.

Materials and methods

The present study was conducted in Department of Obstetrics and Gynecology and Radiology, Prathima Institute of Medical Sciences, Karimnagar, Telangana State, India. Duration of this study was two years, from December 2019 to November 2021. A total of 172 singleton pregnancies with abdominal circumference less than 5th percentile and estimated fetal weight less than 10th percentile for that gestational age were selected for study. In cases with risk factors, serial sonography was done to identify fetal growth restriction. Initial dating scan followed by follow up scan was done at around 33 to 36 weeks.

Patients with irregular cycles, unknown dates, those with restricted growth from the 1st trimester onwards by ultrasound, multiple gestation and congenital anomalies were excluded from the study groups as were those with history of viral exanthematous fever, intake of drugs like antiepileptics, antipsychotics and anticoagulants. All these cases were kept under surveillance till confinement. A careful search for cases of IUGR like smoking, alcoholism, and hypertension were made. Anemia, if present, was corrected and PIH, if detected, was managed appropriately. These cases were monitored by fetal kick count, cardiotocography, and serial measurements of fetometry, AFI and Doppler studies. Doppler studies were done on umbilical artery, middle cerebral artery, and ductus venosus with a real time color Doppler ultrasound machine.

Umbilical cord was located in the pool of amniotic fluid and values were taken at the mid cord or placental insertion. Middle cerebral artery was localized in transverse section of fetal skull, at the level of thalamus in the sylvian fissure. The ductus venosus was sampled in the abdominal circumference section, where it joins the umbilical vein to IVC. Doppler was considered as abnormal when there was absent or reverse diastolic flow in umbilical artery or PI values were above the 95th percentile for that gestational age. Cerebroplacental ratio less than one was also taken as abnormal. Those cases where fetal assessment was normal were monitored fortnightly till delivery. Those with absent and reverse flow were taken up for termination of pregnancy. In those cases with low diastolic flow in umbilical artery, where fetal maturity was adequate for survival, the pregnancy was terminated.

In cases where fetal maturity was not reached monitoring was done with NST and BPP daily or twice weekly depending upon the severity of abnormality and associated complications. Pregnancy was terminated when there were abnormal readings from CTG or a low score on the bio-physical profile. In those cases where differential shunting of blood flow to fetal brain was present, termination was done even before NST or BPP were found to be abnormal.

Mode of delivery was planned depending on the weight and gestational age and amount of liquor present. Outcome of pregnancy was recorded in detail including intrauterine demise, neonatal death, birth weight, APGAR score, development of neonatal complications and presence of congenital anomalies, placental weight and pathology. These details were entered in a proforma and the data was statistically analyzed and evaluated.

Results

This study was conducted on 172 pregnant women with ultrasonographically confirmed IUGR cases. Among the 172 cases that were confirmed to be IUGR by B-Mode ultrasound, 149 cases (86.62%) showed abnormalities in the Doppler wave forms and 23 cases (13.37 %) revealed normal Doppler wave forms.

Table - 1: Grading of the Doppler abnormalities.

Grade	Description	Number	Percentage
0	Normal Doppler	16	9.30
1	Increased umbilical artery pulsatility Index (UA-PI)	33	19.20
2	Cerebro-placental Ratio (CPR) reversal	84	48.86
3	Absent or Reversed End Diastolic Flow (EDF) in Umbilical Artery (UA) with decreased Middle Cerebral Artery (MCA) Pulsatility Index (PI)	16	9.30
4	Absent/ reversed End Diastolic Flow (EDF) in Umbilical Artery (UA) with increased Middle Cerebral Artery (MCA) Pulsatility Index (PI)	18	10.45
5	Ductus venosus alteration	5	2.90

Out of the 172 cases included, 16 cases showed normal Doppler findings, 33 cases had increased umbilical artery pulsatility index (UA-PI), 84 cases showed cerebro-placental ration reversal, 16 cases showed absent or reversed end-diastolic flow in the umbilical artery with decreased middle cerebral artery pulsatility index, 18 cases had absent or reversed end diastolic flow in umbilical artery with increased middle cerebral artery pulsatility index and 5 cases showed ductus venosus alteration.

Grading of the Doppler abnormalities were done and tabulated in **Table - 1**.

Table - 2: Distribution of the risk factors.

Risk factor	Number of cases	Percentage
No risk factor	62	36.05
PIH / pre-eclampsia	56	32.56
Gestational diabetes	4	2.32
Heart disease	6	3.50
Epilepsy/neurology disorders	3	1.75
Other risk factors	41	23.82

Table - 3: Distribution of perinatal outcome.

Perinatal outcome	Number of cases	Percentage
Intrauterine death (IUD)	7	4.10
Still born	5	2.11
Neonatal death (NND)	26	15.15
Increased perinatal morbidity	27	15.69
No significant adverse outcome	107	62.30

When the maternal risk factors were studied and tabulated (**Table - 2**), it was observed that 56 (32.56%) of them had pregnancy induced hypertension (PIH) as the risk factor. In 4 cases (2.32%) gestational diabetes was the identified risk factor and 6 cases (3.5%) had heart disease complicating pregnancy. Epilepsy and neurological disorders seen in 3 cases (1.75%) , 41 cases (23.84%) had one of the other risk factors like breech, postdates, bronchial asthma, anemia, hypothyroidism, or chronic hepatitis, 62 cases patients (36.05 %) had no risk factors.

When the perinatal outcome was studied, it was documented that out of 172 cases, 146 were live born and 26 were neonatal death. There were 7 cases of intrauterine death of fetuses and 5 were still born. Out of the live born 27 had increased perinatal morbidity like poor APGAR score, development of necrotizing enterocolitis, hypoxic ischemic encephalopathy, meconium aspiration syndrome, hyperbilirubinemia, and prolonged admission in neonatal care unit for reasons like sepsis / birth asphyxia (**Table - 3**).

Discussion

Doppler ultrasonography is a medical ultrasonography that employs the Doppler Effect to perform the imaging of the tissue movements and relative velocity of the blood flow. Color Doppler images are usually combined with grayscale (B-mode) images to display duplex ultrasounography images allowing for simultaneous visualization of that particular anatomical area. This particular principle is very useful in analyzing vascular system and is essential in many areas to know the blood flow, reverse blood flow, pulsatility index etc in various blood vessels.

Fetometry by B-mode ultrasound is a reliable method of investigation to distinguish between IUGR and normal fetuses [7]. This is probably because in IUGR fetuses, the earliest feature is reduced growth that is readily assessed by a measurement of abdominal circumference that will show consistently lower values than those expected for the particular gestational age [1, 2, 7].

In this study, the following vessels were studied in the pregnant women in a recumbent position during fetal inactivity and apnea.

1. Umbilical Artery (UA)
2. Middle Cerebral Artery (MCA)
3. Descending Abdominal Aorta (DAA)
4. Umbilical Vein (UV)
5. Inferior Vena Cava (IVC)

The umbilical artery measurements were made from free loop of cord midway between the placental and abdominal wall insertion. The middle cerebral artery was located in a transverse plane at the level of the lesser wing of the sphenoid bone with sample gate placed on proximal portion of the vessel. The descending abdominal aorta was located in the transverse section of abdomen above the level of the bifurcation of the aorta. The inferior vena caval flow is recorded adjacent to it. Umbilical vein flow was also noted at the time of recording umbilical artery. Flow velocity waveforms, the resistance index (R.I), pulsatility index (P.I), systolic/diastolic ratio (S/D) of umbilical artery, middle cerebral artery and descending abdominal aorta were noted.

Doppler study was considered abnormal when

1. S/D ratio, Resistance and Pulsatility index of umbilical artery (>2SD), middle cerebral artery (<5th percentile) and descending abdominal aorta (>2SD) for the gestational age according to the standard reference values; Umbilical artery RI reference was according to Kurmanavicius, et al. [8]. The reference value of umbilical artery P.I., descending abdominal aorta P.I., cerebroumbilical ratio are according to Dandolo Gramellini, et al. and MCA P.I. ratio are according to Giancarlo Mari et al [9, 10] . Rajan, et al. reference values were taken for Umbilical artery S/D ratio [11].
2. The ratios examined were considered abnormal when

S/D of MCA/UA < 1

P.I. of MCA/UA

< 1

Fetal outcome was studied under major and minor adverse outcomes

1. Major adverse outcomes were perinatal deaths including intrauterine and early neonatal deaths. Major complications like hypoxic ischemic encephalopathy, intraventricular hemorrhage, periventricular leukomalacia, pulmonary hemorrhage and necrotizing enterocolitis.
2. Minor outcomes include-cesarean delivery for fetal distress, APGAR score below 7 at 5 minutes, admission to NICU (neonatal intensive care unit) for treatment.

The patients were followed by serial Doppler assessment and non-stress test and the result of the last Doppler examination within 10 days of delivery was considered in the subsequent correlation with perinatal outcomes.

In this study, it was observed that the patients who had mild abnormalities on Doppler (Grade 0, 1, 2) neither had any mortality related to severity of IUGR, nor did they have any significant morbidity. There was a significant increase in occurrence of adverse perinatal outcome with increasing severity of Doppler abnormalities (P value 0.001). 97.96 % of the patients with marked Doppler abnormalities (Grade 3 or more) had adverse perinatal outcome, compared to 10% of those with mild Doppler abnormalities (grade 0, 1, 2). This again was significant (P value 0.001). There was a significant increase in perinatal mortality with increasing grades of Doppler (including intrauterine demise, neonatal deaths and stillbirths), with a P-value of 0.001. All the cases with intrauterine demise and still births as also 23 out of 24 neonatal deaths all had grade 3 or more Doppler abnormalities. There was also a significant rise in perinatal morbidity with increasing grades of Doppler (P value 0.001). These observations show us that Doppler can accurately prognosticate IUGR cases and can help in optimizing the time of intervention in a hypoxic fetus [12, 13, 14].

Among the 172 USG confirmed IUGR cases, 156 cases revealed Doppler abnormalities (90.70%) and 16 cases revealed normal Doppler findings. No adverse perinatal outcome was observed in these cases. It means that if the Doppler is normal, in an IUGR case, the possibility of an abnormal perinatal outcome is very rare [9, 14]. The normal Doppler result has more importance than an abnormal Doppler result. The explanation for these observations is

probably that fetal growth retardation can be either due to low intrinsic growth potential or due to defective placental nutritive and circulatory functions, of which Doppler can investigate only the circulatory components.

Diagnosis of IUGR was done by clinical assessment and serial sonography. With the use of Doppler of umbilical and middle cerebral arteries it is possible to predict that an IUGR fetus is not hypoxic. Predictive value of normal Doppler is 100%. There is a strict correlation between abnormal umbilical Doppler velocimetry and an increased incidence of perinatal complications in an IUGR fetus. In cases with absent and reversed diastolic flow in umbilical artery the perinatal morbidity is nearly 100%. The perinatal mortality in cases of ductus venosus alteration is 100%. In cases with differential shunting of blood flow to fetal brain, frequent monitoring and early delivery should be done. Thus, Doppler can be used as a prognostic tool in IUGR fetus as it gives an accurate prediction of potentially compromised IUGR fetus.

Absent end diastolic flow (EDF)/reversal in umbilical artery had high positive predictive value in predicting adverse fetal outcome. Ductus venosus changes seem to be an ominous sign of a severely compromised fetus with poor perinatal outcome. Doppler investigation of the MCA, UA and DV plays an important role in monitoring the compromised fetuses and helps to determine the optimal time of delivery.

Conclusion

Doppler investigation of the fetal circulation plays an important role in monitoring the growth restricted fetus and thereby may help to determine and plan the optimal time for delivery. Fetal Doppler indices, in particular ratios that include measurements obtained from the cerebral circulation, help in the prediction of neonatal morbidity. Hence, the use of Doppler provides information that is not readily obtained from more conventional tests of fetal well being.

References

1. Barker DJP, Bull AR, Osmond CO, Simmonds SJ. Fetal and placental size and risk of hypertension in adult life. Br Med J., 1990; 301(6746): 259-62.
2. Ott WJ. The diagnosis of altered fetal growth. Obstet Gynecol Clin North Am., 1988; 15: 237-63.
3. Wilcox AJ. Intrauterine growth retardation: beyond birth weight criteria. Early Hum Dev., 1983; 8: 189-93.
4. Fleischer A, Schulman H, Farmakides G, Bracero L, Blattner P, Randolph G. Umbilical artery flow velocity waveforms and intrauterine growth retardation. Am J Obstet Gynecol., 1985; 151: 502-5.
5. Morris RK, Malin G, Robson SC, Kleijnen J, Zamora J, Khan KS. Fetal umbilical artery Doppler to predict compromise of fetal/neonatal wellbeing in a high-risk population: systematic review and bivariate meta-analysis. Ultrasound Obstet Gynecol., 2011; 37(2): 135-42.
6. Coomarasamy A, Fisk N, Gee H, Robson S. The investigation and management of the small for gestational age fetus. 2002. RCOG Press; London, 2003.
7. Pollack RN, Divon MY. Intrauterine growth retardation: definition, classification and etiology. Clin Obstet Gynecol., 1992; 35(1): 99-107.
8. Kurmanavicius J, Florio I, Wisser J, et al. Reference resistance indices of the umbilical, fetal middle cerebral and uterine arteries at 24-42 weeks of gestation. Ultrasound in Obstetrics and Gynecology, 1997.
9. Gramellini D, Folli MC, Raboni S, Vadora E, Merialdi A. Cerebral - Umbilical Doppler Ratio As a Predictor of Adverse Perinatal Outcome. Obstetrics and Gynecology, 1992; 79: 416-20.
10. Mari G, Deter RL. Middle cerebral artery flow velocity waveforms in

normal and small for gestational age fetuses. American journal of obstetrics and gynecology, 1992; 166: 1262-1270.

11. Chauhan R, Samiksha Trivedi. Role of Doppler study in high risk pregnancy. Journal of obstetrics and gynecology of India, 2002; 52(3).
12. Pardi G, Cetin I, Marconi AM, Lanfranchi A, Bozzetti P, Ferrazzi E. Diagnostic value of blood sampling in fetuses with growth retardation. N Engl J Med., 1993; 328: 692-6.
13. Ribbert LSM, Snijders RJM, Nicolaides KH, Visser GHA. Relation of blood gasses and data from computer assisted analysis of fetal heart rate patterns in small-for-gestational-age fetuses. Br J Obstet Gynaecol., 1991; 98: 820-3.
14. Arbeille P, Maulik D, Fignon A, Stale H, Berson M, Bodard S. Assessment of the fetal pO2 changes by cerebral and umbilical Doppler on lamb fetuses during acute hypoxia. Ultrasound Med Biol., 1995; 21: 861-70.