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Optimising perinatal outcome in fetal growth restriction using doppler velocimetry

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Abstract

Objectives: To determine and compare the diagnostic performance of doppler sonography of fetal umbilical artery (UA) and middle cerebral artery (MCA) in optimising adverse perinatal outcome in suspected fetal growth retardation (FGR).

Methodology: One hundred singleton pregnancies between 28 and 40 weeks of gestation complicated by fetal growth restriction were prospectively examined with doppler Ultrasonography of the UA and MCA and fetal outcome are correlated.

Results: Of the 100 cases, 64 had elevated umbilical pulsatality index (PI), 45 had abnormal MCA PI and 56 had abnormal cerebroplacental ratio (CPR) <1. Birth weight <10th percentile was highest (71.42%) in the abnormal CPR group. LSCS for fetal distress incidence was maximum (33.33%) in the abnormal MCA PI group. meconium stained liquor was seen maximum in the elevated umbilical artery PI group 53.12%. Maximum perinatal mortality was 5 in all groups but maximum in abnormal MCA doppler PI group(11.11%). NICU stay for >48 hrs was maximum (60.71%) in the CPR<1 group. Abnormal CPR has the highest sensitivity in predicting more than one adverse perinatal outcome.

Conclusion: Doppler studies of multiple vessels in the fetoplacental circulation can help in the monitoring of

compromised fetus and can help us predicting neonatal morbidity and mortality. This is helpful in determining the optimal time of delivery in complicated pregnancies.

Keywords: Doppler, Umbilical Artery, Middle Cerebral Artery, Cerebroplacental Ratio, Fetal Growth Restriction.

Introduction

Fetal growth restriction (FGR) is a complex and multifactorial disorder affecting fetal development, which represents currently one of the leading causes of perinatal mortality and morbidity, including iatrogenic preterm delivery. FGR is either estimated fetal weight (EWF) <10th percentile or an abdominal circumference (AC) <10th percentile for gestational age.[1] FGR still remains the major cause of fetal wastage inspite of major advances in fetal medicine. FGR is an indicator of chronic fetal hypoxemia. Detecting the FGR fetus, which is at risk of perinatal complications, is an ongoing challenge in obstetrics. Prematurity and FGR are the first and second leading causes of perinatal mortality and morbidities respectively. [2]

According to the Delphi consensus criteria, FGR is differentiated into early- and late-onset phenotypes, depending on whether it is identified before or after 32 weeks gestation. Uteroplacental insufficiency is acknowledged to represent the major determinant of impaired fetal growth across gestation. However, available evidence has shown that early- and late-onset FGR types are characterized by different clinical presentation. Where early onset FGR is associated commonly with hypertensive disorders of pregnancy and a high risk of preterm delivery, while the late onset FGR is more common but difficult to discriminate from constitutionally small baby. Except for delivery, there is no effective treatment to reverse the course of FGR.

The aim of the fetal medicine is not just to prevent the occurrence of FGR in high risk pregnancies, but also to deliver the fetuses before they have suffered from hypoxia. The doppler velocimetry is a non-invasive test, which can provide best information about the hemodynamic status of the fetus. This is an efficient diagnostic test of the fetal jeopardy, which helps in the management of high risk pregnancy. In case of suspected growth restriction and possible fetal hypoxemia, serial doppler examinations have to be performed to identify the best time for the delivery, allowing maximum maturity with minimal hypoxia and acidosis.

Materials and Methods

This prospective observational study was conducted at Sree Mookambika Institute Of Medical Sciences from January 2023 to December 2023. 100 women with singleton pregnancies between 28 to 40 weeks of gestation complicated by FGR were selected for the study. Informed consent was taken from all the patients. Detailed history and through examination was done.

Inclusion criteria

All pregnant women with clinical findings suggestive of FGR from 28 weeks onwards (abdominal circumference less than the 10th percentile), normal fetal anatomy, singleton pregnancy, Ultrasonographic estimated fetal weight less than 10th percentile for gestational age, women with obstetric or medical conditions like gestational hypertension, multiple pregnancy, anemia, cardiac disease or renal disease were included in the study. All women will be subjected to doppler study.

Exclusion criteria

Fetus with congenital anomalies, multifetal gestation and patients with uncertain gestational age were excluded from the study.

Doppler waveform analysis of umbilical artery and middle cerebral artery was done. Umbilical artery diastolic flow absent and reversed was also considered as abnormal. Umbilical artery (UA) pulsatality index (PI) were considered elevated when it was more than 95th percentile. Middle cerebral artery (MCA) PI is considered abnormal when the values were < 5th percentile. Cerebro placental ratio (CPR) = MCA/UA PI< 1 was considered abnormal.[4]

Pulsatality index (PI) = (Peak systolic velocity- end diastolic velocity) / peak systolic velocity or (systolic-diastolic/Mean).

Doppler was repeated at weekly interval. Doppler study done within 7 days prior to termination of pregnancy was taken into consideration for the study. Mode of termination of pregnancy was decided depending on the clinical condition of patients and the indications. The parameters analyzed were birth weight, APGAR score of less than 7 at 5 minutes, cesarean section due to fetal distress, meconium staining of liquor, neonatal intensive care unit (NICU) admission, duration of admission and perinatal outcome.

Results

A total of 100 women participated in the study. All cases detected to have FGR clinically were subjected to doppler study. The abnormal doppler group consisted of pregnant women with FGR with reduced, absent or reversed end diastolic flow in UA and/or those with increased diastolic flow in MCA.

Table 1: Distribution

Gestational Age	Primigravida	Multigravida
28+ to 32 weeks	2	2
32+ to 36 weeks	5	6
36+ to 40 weeks	58	27
TOTAL	65	35

Table 1:Shows maximum are primigravida and mean gestational age corresponding to term.

Table 2: Umbilical artery Doppler PI correlation with fetal outcomes

Fetal Outcome	Elevated PI (N=64) (%)	Normal PI (N=36) (%)	Sensitivity (%)	Specificity (%)
Estimated fetal weight <10^{th} percentile	40(62.5)	10(27.77)	80	52
LSCS for fetal distress	18(28.12)	3(8.3)	85.71	41.77
Meconium stained liquor	34(53.12)	8(22.2)	80.95	48.27
APGAR <7 at 5 minutes	32(50)	2(5.5)	94.16	51.51

NICU admission	48(75)	10(27.7)	82.75	61.90
NICU stay >48 hours	30(46.87)	3(8.3)	90.90	49.25
Perinatal mortality	5(7.8)	-	-	-

Table 2 shows increased Umbilical artery PI effects the perinatal outcomes.

Table 3: Umbilical artery impedance Vs Perinatal mortality

Umbilical artery impedance	Still birth	Died within 48hours
Absent End Diastolic Flow(AEDF)=5	1	1
Reversed End Diastolic Flow(REDF)=3	2	1

Table 3: Shows perinatal morbidity with Absent End Diastolic Flow and Reversed End Diastolic Flow, while maximum is seen with Reversed End Diastolic Flow.

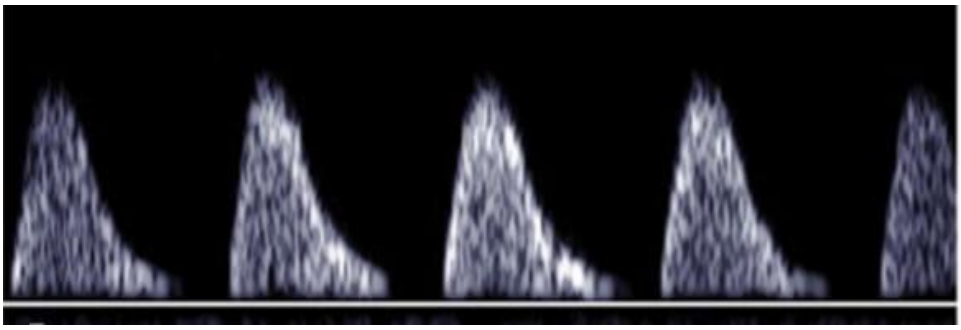

Figure 1: Depicts Absent End Diastolic Flow.

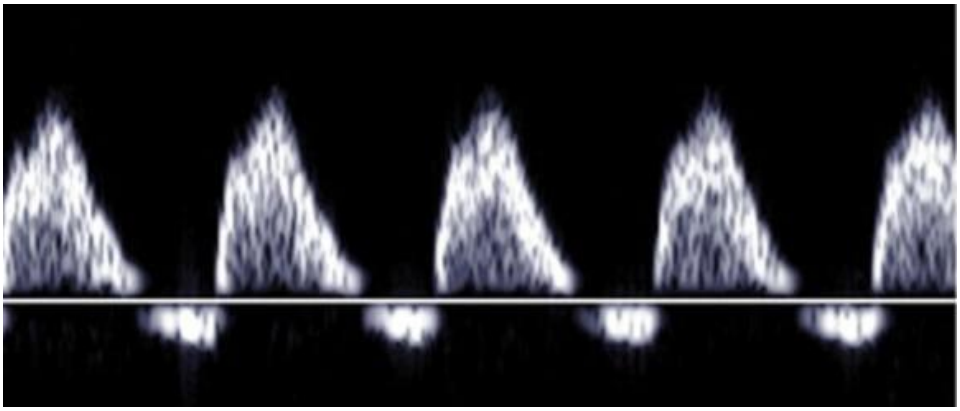

Figure 2: Depicts Reversed End Diastolic Flow.

Table 4: MCA Doppler PI correlation with fetal outcomes

Fetal Outcome	Abnormal PI (N=45) (%)	Normal PI (N=55)(%)	Sensitivity (%)	Specificity (%)
Estimated fetal weight $<10^{th}$ percentile	28(62.22)	20(36.36)	58.33	67.30

LSCS for fetal distress	15(33.33)	6(10.9)	71.42	62.02
Meconium stained liquor	20(44.44)	16(29.09)	55.55	60.93
APGAR <7 at 5 minutes	24(53.33)	12(21.81)	66.66	67.18
NICU admission	34(75.55)	22(40)	60.71	75
NICU stay >48 hours	14(31.11)	18(32.72)	43.75	54.41
Perinatal mortality	5(11.11)	-	-	-

Table 4: Shows Abnormal MCA PI also increases perinatal morbidity.

Table 5: CPR correlation with fetal outcomes

Fetal Outcome	CPR <1 (N=56)(%)	CPR >1 (N=44)(%)	Sensitivity (%)	Specificity (%)
Estimated fetal weight <10th percentile	40(71.42)	10(22.72)	80	68
LSCS for fetal distress	18(32.14)	3(85.71)	85.71	51.89
Meconium stained liquor	28(50)	8(18.18)	77.77	56.25
APGAR <7 at 5 minutes	30(53.57)	1(2.27)	96.77	62.31
NICU admission	48(85.71)	8(18.18)	85.71	81.81
NICU stay >48 hours	34(60.71)	1(2.27)	97.14	66.15
Perinatal mortality	5(8.9)	-	-	-

Table 5: Shows CPR <1 has the highest sensitivity in predicting more than one adverse perinatal outcome.

Discussion

The role of doppler ultrasound in the study of uteroplacental and fetoplacental circulation is well known. It helps in detecting the extent of placental pathology and also predicts the fetal outcome. Numerous studies have been conducted to know the association between doppler waveforms and perinatal outcome and have had variable results. The present study showed that abnormal doppler waveforms was associated with adverse perinatal outcome. When umbilical artery velocimetry was correlated to fetal outcome in the present study, it was shown that there was an increase in the perinatal morbidity and mortality in cases with an

abnormal umbilical artery PI, abnormal MCA PI and CPR <1.

Assessment of end diastolic flow is useful because when it is reduced it detects 30% severe hypoxia, when there is AEDF is very alarming sign and detects 50% severe hypoxia and in case of REDF is ominous which detects 70% severe hypoxia and fetal death occurs within 7 days.[5] When the fetoplacental flow is severely affected there is an increased impedance to flow resulting in end diastolic flow becoming absent. With further hemodynamic compromise there will be reversal of flow in the umbilical arteries. Such a development is ominous and results in a profoundly adverse perinatal outcome. In our study it was seen that AEDF and REDF correlated with poor perinatal outcome with an increase in the perinatal mortality and morbidity.

In this study, of the 100 cases, 64 had elevated umbilical pulsatality index (PI), 45 had abnormal MCA PI and 56 had abnormal cerebroplacental ratio (CPR) <1. Birth weight <10th percentile was highest (71.42%) in the abnormal CPR group. LSCS for fetal distress incidence was maximum (33.33%) in the abnormal MCA PI group. meconium stained liquor was seen maximum in the elevated umbilical artery PI group 53.12%. Maximum perinatal mortality was 5 in all groups but maximum in abnormal MCA doppler PI group(11.11%). NICU stay for >48 hrs was maximum (60.71%) in the CPR<1 group. Abnormal CPR has the highest sensitivity in predicting more than one adverse perinatal outcome.

In a study done by Dall'Asta et al[3] in Italy, Overall 468 cases with complete biometric and umbilical, fetal middle cerebral and uterineartery (UtA) Doppler data were included, of which 53 (11.3%) had CAPO(Composite adverse perinatal outcome). On logistic regression analysis, only EFW percentile was associated independently with CAPO (P=0.01) and NICU admission (P<0.01),while the mean UtA pulsatility index (PI) multiples of the median (MoM) >95thpercentile at diagnosis was associated independently with obstetric intervention due to intrapartum fetal distress (P=0.01).The model including baseline pregnancy characteristics and the EFW percentile was associated with an area under the receiver-operating-characteristics curve of 0.889 (95%CI, 0.813–0.966) for CAPO (P<0.001). A cut-off value for EFW corresponding to the 3.95th percentile was found to discriminate between cases with and those without CAPO, yielding a sensitivity of 58.5% (95%CI, 44.1–71.9%), specificity of 69.6% (95% CI, 65.0–74.0%), positive predictive value of19.8% (95% CI, 13.8–26.8%) and negative predictive value of 92.9% (95%CI, 89.5–95.5%). Retrospective data from a large cohort of late-onset FGR fetuses showed that EFW at diagnosis is the only sonographic parameter associated in dependently with the occurrence of CAPO, while mean UtA-PI MoM>95thpercentile at diagnosis is associated independently with intrapartum distress leading to obstetric intervention.

The study done by Berkley et al[6] a randomized and quasirandomized studies indicates that, among high-risk pregnancies with suspected (Intra Uterine Growth Restriction) IUGR, the use of umbilical arterial Doppler assessment significantly decreases the likelihood of labor induction, cesarean delivery, and perinatal deaths (1.2% vs 1.7%; relative risk, 0.71; 95% confidence interval, 0.52– 0.98). Antepartum surveillance with Doppler of the umbilical artery should be started when the fetus is viable and IUGR is suspected.

In a study done by Thomas et al [7] Umbilical artery Doppler velocimetry showed significant abnormality in

growth restricted fetuses in comparison to normal fetuses. There was significant increase in the delivery of IUGR fetuses <37 weeks gestation($p<0.05$). There was a significant increase in operative deliveries in both the groups with abnormal umbilical artery doppler. A significant rise in adverse perinatal outcomes, APGAR <7 at 5 min and low birth weight in IUGR fetuses in comparison to normal fetuses ($p<0.05$). There is a strict correlation between abnormal umbilical artery Doppler velocimetry and an increased incidence of perinatal complications in growth restricted fetuses compared to normal fetuses. Hence concluded as, umbilical artery doppler velocimetry should be used in all patients with fetal growth restriction, to identify impending hypoxia, to optimize the time of delivery and to optimize the perinatal outcome in these patients.

Conclusion

Doppler studies of multiple vessels in the fetoplacental circulation can help in the monitoring of compromised fetus and can help us predicting neonatal morbidity and mortality. This is helpful in determining the optimal time of delivery in complicated pregnancies.

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