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Original Research Article

Comparison of Doppler findings and neonatal outcome in fetal growth restriction

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ABSTRACT

Background: Fetal growth restriction (FGR) affects up to 5-10% of pregnancies. It is associated with increased perinatal mortality and morbidity. Doppler studies identify at risk fetuses and help in timing interventions and prognosticate outcomes. The ability of Doppler studies to predict neonatal outcome is studied here.
Methods: Prospective study of seventy-two women with singleton pregnancies with gestational age above 28 week and detected to have FGR was done. The patients were subjected to Doppler analysis. Abnormal Doppler indices were compared with neonatal outcomes such as NICU admission, ventilator or CPAP support, sepsis, phototherapy and perinatal mortality.
Results: Elevated umbilical artery PI, reduced middle cerebral artery PI and low CP ratio were found in 14, 18 and 36 fetuses. The sensitivity and specificity in predicting neonatal outcome was 25% & 75%, 58.1% and 62% and 17.9% and 75% for umbilical artery PI, MCA PI and CP ratio respectively. None of the Doppler indices showed significant p value. On testing, gestational age at delivery and length of NICU stay, gestational age was a significant determining factor with 'p' value of 0.003.
Conclusions: Antenatal Doppler analysis of UA and MCA can predict neonatal outcome in FGR fetuses. Though the 'p' value was not significant in this study, the sensitivity, specificity, positive predictive value and negative predictive value are comparable to other studies. Gestational age at delivery significantly influences neonatal outcome.

Keywords: Abnormal Doppler indices, FGR, Neonatal morbidity

INTRODUCTION

Fetal growth restriction (FGR) refers to a fetus that has failed to achieve its genetically determined growth potential and affects up to 5-10% of pregnancies. There is a high incidence of intrauterine fetal demise, intrapartum fetal morbidity, and operative deliveries. In preterm FGR, which occurs before 34 weeks' gestation, iatrogenic prematurity is a pertinent issue. Neonates affected by FGR suffer from respiratory difficulties, polycythemia, hypoglycemia, intraventricular hemorrhage, and hypothermia. In the long-term, cerebral palsy, developmental delay, behavioural dysfunction, adult metabolic syndrome can occur. FGR fetuses must be differentiated from small for gestational age fetuses (SGA).

The World Health Organization defines SGA as a neonatal weight of less than 2500 grams at term. SGA pregnancies often exhibit normal fetal Doppler, while FGR due to placental disease exhibits characteristic maternal and fetal Doppler abnormalities. Doppler studies are non-invasive and help to identify the degree of placental insufficiency and also to detect worsening of the situation, there by decision to intervene can be taken once the need arises. It has been reported that elevated S/D ratio in the umbilical artery can lead to poorer neonatal outcomes even in the absence of FGR.[1] Increased adverse reactions in short term and long term

development has been observed in FGR fetuses when compared with SGA foetuses.[2,3] Hence it can be said that Doppler studies provide a valuable insight into the intra-uterine environment.

The vessels that are evaluated in obstetric Doppler assessment to monitor FGR are uterine artery (Ut. A), umbilical artery (UA), middle cerebral artery (MCA) and ductus venosus (DV). Most of the studies have shown that umbilical and middle cerebral artery pulsatility index (PI) values are better predictors of fetal outcome. Ductus venosus impairment signifies impending fetal compromise like intra-uterine fetal demise and has a high rate of perinatal mortality. The sequential pattern of flow abnormalities in UA, MCA and DV in that order has been observed in several studies and it has been observed that the UA and MCA are better tools for monitoring fetal well-being and to predict fetal-neonatal outcome in upto 88% of the cases.[4] The cerebro-placental ratio is obtained by dividing MCA PI by UA PI. It is found to be a better predictor of perinatal outcome than MCA PI or UA PI alone.[5]

The present study aims to test the ability of Doppler tests to predict neonatal outcome in FGR foetuses.

METHODS

Material and methods

This was a prospective study done from June 2015 to December 2015 and includes women with singleton pregnancies of 28 weeks and above, who were diagnosed with fetal growth restriction and were evaluated by Doppler studies at Rajarajeshwari Medical College and Hospital. These women and their respective neonates were followed up until discharge from hospital.

Inclusion criteria

- Singleton pregnancy.
- Gestational age of 28 weeks and above.
- Diagnosed as fetal growth restriction by ultrasonography and further analyzed by Doppler studies.
- Delivery in Rajarajeshwari Medical College and Hospital and neonatal care at the same hospital.

Exclusion criteria

- Multiple gestations
- Gestational age below 28weeks
- Fetal growth restriction due to chromosomal anomalies, congenital anomalies

Once FGR was diagnosed in the antenatal period, the women underwent Doppler studies of maternal uterine artery and fetal umbilical and middle cerebral arteries. Repeat ultrasonography and Doppler were done as necessary and antenatal steroid administration was given to women under 34 weeks' gestational age. Other pregnancy disorders like gestational hypertension and gestational diabetes mellitus were evaluated for and noted and treated if diagnosed. Pregnancy was continued till term and spontaneous labor was awaited as much as the severity of FGR and other co-morbidities in the patient allowed. Those patients with severe FGR and abnormal Doppler abnormalities and could not continue till term gestation, delivered pre-term babies. The neonatal outcome was studied in terms of birth weight, NICU admission and mode of treatment in NICU, length of NICU stay and complications like sepsis, hyperbilirubinemia, neonatal death etc.

The antenatal Doppler evaluation results were compared with neonatal outcome like NICU admissions, length of NICU stay, and need of ventilator, CPAP and complications to the neonates. The predictive value of Doppler evaluation and NICU admission was analysed. Also, antenatal Doppler findings and neonatal outcomes were compared according to gestational age at delivery. The length of NICU stay was used to assess the neonatal morbidity. NICU stay of <5 days, 6-10 days and >10 days corresponded to mild, moderate and severe neonatal morbidity respectively. The influence of gestational age on the length of NICU stay was studied.

Chi-square/ Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups, non-parametric setting for qualitative data analysis.

Sensitivity, specificity, PPV, NPV, accuracy are computed to find the predictive potential of Doppler findings to predict the NICU admission. The statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and R environment version 2.11.1 were used for the analysis of the data.

RESULTS

A total of 72 patients were included in the study. Out of these, 40 patients (55.6%) delivered at term, 22 patients delivered between 34-37 weeks of gestation and 10 patients delivered before 34 weeks.

Out of the 72 neonates, 66 of them had birth weight ranging from 1.5-2.5 kg and 6 of them weighed less than 1.5 kg. Fifty-six neonates required NICU admission, out of which 24 were born as term neonates and 32 were born as pre-term neonates. In the NICU, 2 neonates required ventilator support, 10 neonates were on CPAP and rest of them required oxygen support. Eight neonates were treated for sepsis (Table 1 and 2).

On analysing the antenatal Doppler studies, abnormal CP ratio, elevated umbilical artery PI and reduced MCA PI were found in 14, 18 and 36 fetuses respectively (Table 3).

Table 1: Maternal and neonatal parameters.

	Variable	No.	%
Age	<20 year	8	11.2
	20-30 year	64	88.8
Co-morbidities	HTN	38	52.8
	GDM	0	0
Mode of delivery	Vaginal	10	13.9
	LSCS	62	86.1
Gestational age at delivery	>37 week	40	55.6
	34-37 week	22	27.8
	<34 week	10	16.6
Birth weight	1.5-2.5kg	66	91.7
	<1.5kg	6	8.3
NICU admissions	>37 week	24	42.8
	34-37 week	22	39.3
	<34 week	10	17.85
NICU management	Ventilator	2	3.7
	CPAP	10	18.5
	Oxygen support	42	77.7

Statistical analysis of CP ratio, PI of umbilical artery and PI of MCA in their ability to predict neonatal NICU admission was done. CP ratio showed a sensitivity of 17.9% and specificity of 75% with a positive predictive value of 71.4% and negative predictive value of 20.7%. The 'p' value was 0.497. Pulsatility index of umbilical artery showed sensitivity of 25% and specificity of 75%, with PPV of 77.8% and NPV of 22.2%. The 'p' value was 1.00. Pulsatility index of MCA showed a sensitivity of 58.1% and specificity of 62.5% with PPV of 85.7% and NPV of 27.9%. The 'p' value was 0.25 (Table 4).

Table 2: Neonatal outcomes.

Outcome	No. of patients (n=72)	%
NICU admission	56	77.8
Neonates on ventilator	2	2.8
Neonates on CPAP	10	13.9
Neonates with sepsis	8	11.1

Statistical analysis using Fisher Exact test to assess influence of gestational age on length of NICU stay showed that the neonates who were born at term had shorter duration of NICU stay, amounting to lesser morbidity. The 'p' value was 0.003 for this test (Table 5).

Table 3: Doppler variables studied.

	No. of patients (n=72)	%
CP ratio		
Normal	58	80.6
Abnormal	14	19.4
PI umbilical A		
Normal	54	75.0
Abnormal	18	25.0
PI MCA		
Normal	36	50.0
Abnormal	36	50.0

Table 4: Correlation of findings of Doppler with the findings of NICU admission prediction.

Malignant	Observation					Correlation					
	TP	FP	FN	TN	Total	Se	Sp	PPV	NPV	Accuracy	P value
CP ratio	10	4	46	12	72	17.9	75.0	71.4	20.7	30.6	0.497
PI umb A	14	4	42	12	72	25.0	75.0	77.8	22.2	36.1	1.000
PI MCA	30	6	26	10	72	58.1	62.5	85.7	27.9	58.9	0.257

Table 5: Gestational age at birth and neonatal morbidity.

Gestational age at birth	NICU stay (<5 days)	NICU stay (6-10 days)	NICU stay (>10 days)	Total
>37 week	16 (61.5%)	6 (33.3%)	2 (16.7%)	24 (42.9%)
34-37 week	10 (38.5%)	6 (33.3%)	6 (50%)	22 (39.3%)
<34 week	0 (0%)	6 (33.3%)	4 (33.3%)	10 (17.9%)
Total NICU admissions	26 (100%)	18 (100%)	12 (100%)	56 (100%)

P=0.003**, significant, Fisher Exact test.

DISCUSSION

Fetal growth restriction is a common condition seen during antenatal surveillance, with significant perinatal complications. Apart from fetal biometry, Doppler evaluation of uterine artery, umbilical artery, middle cerebral artery and ductus venosus are important antenatal surveillance tools and prognosticators as seen in several studies.

Umbilical artery identifies increased placental resistance by an increased PI value. Absent or reversed flow in the umbilical artery appears after >50% of placental vessels are obliterated.[6] Studies have shown that monitoring of

FGR fetuses by umbilical artery Doppler improves neonatal outcomes.[6]

The middle cerebral artery normally has a high resistance flow. A low PI of MCA indicates brain sparing effect. However, at a later stage of FGR, false normalization of MCA PI may indicate failing fetal circulation. Cerebral placental ratio (CP ratio) is obtained by dividing MCA PI by UA PI. A value <1 is abnormal. Studies have shown that it is a better predictor of adverse perinatal outcome compared to MCA PI or UA PI alone.[7]

The present study was conducted to assess the ability of Doppler study in FGR fetuses to predict neonatal outcome in the form of NICU admission and length of NICU stay.

In the current study, sensitivity in predicting NICU admission for UA PI was 25%, MCA PI was 58% and CP ratio was 17.9%. The specificity in predicting NICU admission for UA was 75%, MCA was 62.5% and CP ratio was 75%. In a study by Dhand H et al, the predictive value for Doppler for detecting abnormal fetal outcome, the sensitivity for UA PI and MCA PI was 44%, 71% respectively and specificity was 61.5% and 92% respectively.[8] In another study by Mishra D et al, the predictive value of Doppler in perinatal outcome showed the sensitivity of UA PI, MCA PI and CP ratio to be 53%, 43% and 86% respectively and the specificity to be 82%, 80% and 92%.[9]

In the present study, the positive predictive value for UA PI, MCA PI and CP ratio was 77.8, 85.7 and 71.4 respectively. The negative predictive value for the same was 22.2, 27.9 and 20.7 respectively. In the study by Dhand H et al mentioned above, the PPV for predicting fetal outcome for UA PI and MCA PI was 83% and 94% and NPV was 20% and 65% respectively.

In the present study gestational age at delivery and NICU stay were compared and it was found that neonates born at term had shorter NICU stays than very preterm neonates (p value 0.003). In comparison to this, a study by Baschat AA et al, it was found that gestational age at delivery was a strong determinant of neonatal outcome though antenatal Doppler indices predicted events like fetal distress and still birth.[10]

CONCLUSION

Fetal growth restriction has considerable perinatal and long term effects on the neonate. Once it is detected/suspected careful Doppler evaluation can identify fetuses at risk for poor neonatal outcome in terms of NICU admission and morbidity, thereby allowing antenatal risk estimation and prognostication. In-utero transfer to tertiary care centres can be considered based on the Doppler findings, thus allowing better post-natal management and outcomes. Neonates born at or near term have better outcomes than those born very preterm which shows that gestational age is a significant determinant of the neonatal outcome.

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