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Original Research Article

Neonatal outcome of abnormal versus normal antenatal Doppler in high-risk pregnancies

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ABSTRACT

Background: Umbilical Doppler flow abnormalities occur in 6% of high-risk pregnancies. Preterm infants born with abnormalities in the umbilical artery Doppler waveforms is at a risk of various complications. The objective of this study were to understand and compare the neonatal outcome of normal verses abnormal antenatal Doppler.
Methods: 100 newborns each with normal antenatal Doppler and abnormal antenatal Doppler, born to women with singleton pregnancies of 28 weeks and above, were enrolled for the study after taking informed written consent from the parents. All the newborns enrolled were followed up for various neonatal outcomes and complications.
Results: Majority of fetal Doppler abnormalities were seen in mothers with PIH (50% verses 21%) and Intra uterine growth restriction (59% verses 29%) which was statistically significant. Majority of babies in abnormal Doppler group were delivered by LSCS compared to normal Doppler group (72% verses 36%). Neonates in the abnormal Doppler had more risk of becoming SGA (52% verses 24%), more risk of developing NEC (32% verses 18%) and thrombocytopenia (34% verses 17%). The need for longer duration of NICU stay (22 days verses 14 days) and need for mechanical ventilation were more in them (17% verses 7%) compared to normal Doppler group.
Conclusions: Colour Doppler is a useful modality to predict fetal outcome in high-risk pregnancies. It allows better understanding of hemodynamic changes in feto-placental and utero-placental circulation and helps pediatrician to anticipate the complications and helps in early intervention and thus results in decreased neonatal morbidity and mortality.

Keywords: Antenatal colour Doppler, High risk pregnancy, SGA, IUGR

INTRODUCTION

Umbilical Doppler flow abnormalities occur in 6% of high-risk pregnancies.[1] Preterm infants born with abnormalities in the umbilical artery Doppler waveforms such as absent end diastolic flow (AEDF) or reversed end-diastolic flow (REDF) is at a risk of various complications mainly related to enteral feeding such as feed intolerance and necrotising enterocolitis (NEC), neutropenia leading to sepsis, thrombocytopenia and thus prolonging the NICU stay.[2]

Utero-placental insufficiency is the main cause of intra-uterine growth restriction (IUGR) which accounts to more than half of the LBW babies in India. Low birth weight is an important problem in a developing country like ours where 20-25% of total newborns delivered in India are born low birth weight (LBW). Different modalities are used for fetal surveillance of IUGR, of which Doppler ultrasound is the most widely used.[3]

Among LBW we have large group of babies who come under very low birth weight (VLBW)-those below 1.5 kg. All the complications of LBW are more common in VLBW group. Their immediate as well as long term

outcome are affected. Any measures to reduce low birth weight will go a long way in our health indices. Any modalities which help in early detection and prevention will be helpful for this.[3]

Though a large number of reasons cause IUGR, utero-placental insufficiency is the major reason among them. Doppler scan can detect this insufficiency by measuring the diastolic flow in umbilical artery thus helping in deciding the management of such cases. Abnormal Doppler can be either decreased/absent or reversed depending on the severity of the condition. This can be assessed by measuring the S/D (systolic/diastolic) ratio.

Diseases that obliterate small muscular arteries in placental tertiary stem villi result in progressive decrease in end diastolic flow which is reflected as high S/D ratio. Absent or reversed diastolic flow often causes IUGR, oligohydramnios and fetal hypoxemia which demands immediate termination of pregnancy resulting in LBW babies.[3]

Objective

The objective of this study was to compare the neonatal outcome of normal verses abnormal antenatal Doppler.

METHODS

This prospective observational case control study was conducted at ESIC MC and PGIMSR, Rajajinagar Bangalore from January 2018 to 2019.

Inclusion criteria

All neonates admitted in postnatal ward and NICU of ESIC MC and PGIMSR, Rajajinagar, Bangalore, born to mothers with high-risk pregnancy with gestational age >28 weeks, in whom antenatal Doppler was done were included in the study.

Exclusion criteria

Patients with following criteria were excluded: babies born with congenital anomalies; babies born out of multiple gestational age <28 weeks.

Sample size

The sample size was 200.

All babies satisfying the inclusion criteria admitted postnatal ward and NICU during the study period were taken as cases. Based on the previous studies the sample size for the present study was calculated by considering the death as outcome in abnormal Doppler studies (12%) and in normal Doppler studies (1%) in high-risk pregnancies from the previously published literature. The minimum sample size was calculated as 60 cases in each group with effect size at 5% level of significance which gives atleast 80% power assuming one tailed hypothesis. Therefore, the total sample size of the study was 120.

Following formula has been used to calculate the sample size,

$$N = \frac{6.15x(P_1Q_1 + P_2Q_2}{(P_1 - P_2)^2}$$

Where,

P_1=0.12,

Q_1=1-P_1,

P_2=0.01,

Q_2=1-P_2.

Method of collection of data

All newborns born to women with singleton pregnancies of 28 weeks and above, who were evaluated by Doppler studies for high-risk pregnancies were enrolled for the study after obtaining approval from instituitional ethics committee and taking informed written consent from the parents. Total of 200 newborns were enrolled for the study, 100 were with normal Doppler and 100 were with abnormal Doppler study. All the newborns were followed up for various neonatal complications and outcome.

The neonatal outcome was studied in terms of IUGR, Apgar score, birth weight, need of delivery room resuscitation, need for NICU admission, length of NICU stay and complications like sepsis, NEC, RDS, IVH, neonatal convulsions, thrombocytopenia and neonatal death.

Statistical analysis

All characteristics were summarized descriptively. For continuous variables, mean±standard deviation (SD) and for categorical data numbers and percentage were used. Data were analyzed using SPSS software version 23.0 and Microsoft office 2010.

RESULTS

Out of 200 babies born out of high pregnancies 71 born to mothers with PIH, 37 to GDM, 55 oligohydramnios, 79 IUGR. The mean maternal age in abnormal Doppler group and normal doppler group were 24.4 years and 25 years respectively.

50% of the abnormal Doppler study was seen in mothers with PIH compared to 21% in the normal doppler group. 21% of the abnormal Doppler group was seen in mother with GDM compared to 16% of normal antenatal Doppler group.

33% of the abnormal Doppler group had oligohydramnios compared to 22% in normal Doppler group. 59% of abnormal Doppler group had IUGR compared to 20% in the normal Doppler group (p<0.001).

Majority (72%) of neonates in abnormal Doppler group were delivered through LSCS compared to 36% in normal Doppler group which was statistically significant (p<0.01). The mean birth weight in the abnormal Doppler group was 1350 g and in the normal Doppler group was 1550 g, which was statistically significant (p<0.008). Majority of the SGA babies were in abnormal Doppler group compared to normal Doppler group (52% verses 24%) (p<0.001). The Apgar score at 1 min was <7 in 7% of the neonates in the abnormal Doppler group compared to 3% in the normal Doppler group. RDS was seen in 27% of neonates with abnormal Doppler had compared 17% in normal Doppler. 32% neonates had NEC in the abnormal Doppler group compared to 18% in the normal Doppler group, which was statistically significant (p<0.022). 9% of the neonates with abnormal Doppler had culture positive sepsis compared to 3.5% in the normal Doppler group. Thrombocytopenia was seen in 34% of the neonates in the abnormal Doppler group compared to 17% in the normal Doppler group which was statistically significant (p<0.005). 19% of the neonates in the abnormal Doppler group had hypoglycemia as compared to 14% of the neonates in normal Doppler group. IVH was seen in 10 and 11% in normal and abnormal Doppler group respectively.

Statistically significant number of neonates required mechanical ventilation and longer NICU stay in abnormal Doppler group compared to normal Doppler group (17% versus 7%, 48 days verses 33 days). Neonatal mortality in the present study was 1.5%, cause of death in 1 baby in abnormal Doppler group was prematurity with severe sepsis and in the normal Doppler group one baby died due to grade III IVH and another due to prematurity with severe sepsis.

Table 1: Maternal characteristics.

Characteristics	Years	N	%
Maternal age	18-20	52	26.0
	21-25	79	39.5
	26-30	55	27.5
	>30	14	7.0
PIH	Present	71	35.5
	Absent	129	64.5
GDM	Present	37	18.5
	Absent	163	81.5
Oligohydramnios	Yes	55	27.5
	No	145	72.5
IUGR	Yes	79	39.5
	No	121	60.5
Doppler study	Abnormal	100	50
	Normal	100	50

Table 2: Correlation of various maternal characteristics in normal verses abnormal antenatal Doppler group.

Characteristics	Years	Abnormal Doppler		Normal Doppler		P value
		N	%	N	%	
Maternal age	18-20	26	26	26	26	0.856
	21-25	42	42	37	37	
	26-30	25	25	30	30	
	>30	7	7	7	7	
PIH	Present	50	50	21	21	<0.001
	Absent	50	50	79	79	
GDM	Present	21	21	16	16	0.363
	Absent	79	79	84	84	
Oligohydramnios	Yes	33	33	22	22	0.082
	No	67	67	78	78	
IUGR	Yes	59	59	20	20	<0.001
	No	41	41	80	80	

Table 3: Neonatal outcomes.

Characteristics	Years	N	%
Gender	Male	105	52.5

Continued.

Characteristics	Years	N	%
	Female	95	47.5
Birth weight (kg)	28 weeks to 31 weeks and 6 days	34	17
	32 weeks to 33 weeks 6 days	52	26
	34 to 36 weeks 6 days	87	43.5
	37 to 42 weeks	27	13.5
ASA/SGA	<1	4	2
	1-1.5	77	38.5
Apgar at 1 minute	1.5-2.5	109	54.5
	2.5-3.5	10	5
	AGA	124	62
Need for resuscitation	SGA	76	38
	<4	1	0.5
	4-7	9	4.5

Table 4: Correlation of various neonatal outcome in normal verses abnormal antenatal Doppler group.

Neonatal outcome		Abnormal Doppler		Normal Doppler		P value
		N	%	N	%	
Mode of delivery	NVD	28	28	64	64	<0.05
	LSCS	72	72	36	36	
Gestational age	28 weeks-32 weeks	11	11	23	23	0.063
	32 weeks to 33 weeks 6 days	35	35	17	17	
	34 weeks to 36 weeks 6 days	43	43	44	44	
	37 weeks to 42 weeks	11	11	16	16	
Birth weight (kg)	<1	0	0	4	4	0.008
	1-1.5	47	47	30	30	
	1.5-2.5	51	51	58	58	
	2.5-3.5	2	2	8	8	
AGA/SGA	AGA	48	48	76	76	<0.001
	SGA	52	52	24	24	
Apgar score	<4	0	0	1	1	0.152
	4-7	7	7	2	2	
	>7	93	93	98	98	
Need for resuscitation	Yes	6	6	3	3	0.306
	No	94	94	97	97	

Table 5: Neonatal complications.

Complications		Number	%
RDS		44	22
IVH		21	10.5
Hypoglycaemia		33	16.5
NEC		50	25
Sepsis		55	27.5
Thrombocytopenia		51	25.5
Mechanical ventilator	Yes	24	12
	No	176	88
Duration of NICU stay (days)	0-1	39	19.5
	1-7	31	15.5
	7-14	49	24.5
	14-28	72	36
	>28	9	4.5
Mortality	Survived	197	98.5
	Expired	3	1.5

Table 6: Correlation of MV, duration of NICU stay and mortality in normal verses abnormal antenatal Doppler group.

Neonatal outcome		Abnormal Doppler		Normal Doppler		P value
		N	%	N	%	
Mechanical ventilation	Yes	17	17	7	7	0.030*
	No	83	83	93	93	
Duration of NICU stay	0-1	10	10	29	29	0.015*
	1-7	17	17	14	14	
	7-14	25	25	24	24	
	14-28	43	43	29	29	
	>28	5	5	4	4	
Neonatal mortality	Survived	99	99	98	98	0.561
	Expired	1	1	2	2	

Significant at 5% level of significance (p<0.05).

DISCUSSION

Antenatal Doppler scan is important in antenatal monitoring, planning the mode and time of delivery and also predicting the perinatal outcome.[4] Early changes in placenta-based growth restriction in peripheral vessels like the umbilical and middle cerebral arteries are detected by Doppler velocimetry. Late changes are better understood by abnormal flow in ductus venosus and fetal aortic and pulmonary outflow tracts and by reversal of umbilical artery flow.

Abnormal Doppler velocimetry findings like absent or reversal of end diastolic flow depicts an advanced stage of placental compromise and is associated with placental arterial obliteration. Persistent absent or reversal of end diastolic flow is related to hypoxia, acidosis and fetal death.[5]

In our study there is no statistically significant correlation between maternal age and Doppler changes (24.4 verses 25%), similar to studies done by Hackett et al (24.8 verses 25.4), Pauline et al (27 verses 25.3) and McDonell et al (28 verses 29).[6-8]

PIH causes vasculopathy leading to uteroplacental insufficiency. Our study showed statistically significant correlation between PIH and abnormal antenatal Doppler (p<0.001), which was similar to studies done by Byun et al.[9] However, study done by Pauline et al did not find any statistically significant correlation between PIH and Doppler studies.[5]

In the present study more number (21%) of abnormal antenatal Doppler study was seen in mothers with GDM compared to 16% in the normal antenatal Doppler group.

In the present study 33% of the abnormal Doppler group had oligohydraminos compared to 22% in normal Doppler group. Similar findings were seen in studies done by Byun et al and Hackett et al.[6,9]

In our study 59% of abnormal Doppler group had IUGR compared to 20% in the normal Doppler group, which was statistically significant. Similar, to studies done by Hackett et al (88% and 35 %) and Yakout et al.[6,10]

In the present study 72% of neonates in abnormal Doppler group were delivered through LSCS compared to 36% in normal Doppler group (p<0.01), similar observation was seen in studies done by Hackett et al (51% versus 9%, p<0.01) and Tolu et al (32 vs 70 %).[6,11] However, study done by McDonell et al did not find any correlation between mode of delivery and Doppler study.[8]

Reversal or absent end diastolic flow causes uteroplacental insufficiency resulting in fetal growth restriction. In our study there was significant statistical correlation seen between birth weight and abnormal Doppler study, the mean birth weight is lesser (1350 g) in the abnormal Doppler group compared to normal Doppler group (1550 g). Similar to study done by McDonell et al however in studies done by Pauline et al and Lakshmi et al although mean birth weight was lesser in abnormal Doppler group compared to normal Doppler group, difference was not statistically significant.[7,8,12] This may be due to the fact their study was done only on VLBW babies.

In present study SGA babies were significantly higher in abnormal Doppler group compared to normal Doppler group (52% versus 24%, p<0.001). Similar findings were observed in a study done by McDonell et al and Hackett et al.[6,8]

Apgar score of <7 at 1 min was observed in 7% and 3% neonates in abnormal and normal Doppler group respectively in our study, similar to in studies done by Hackett et al but in Tolu et al.[6,11]

Delivery room resuscitation was required in 6% and 3%

neonates in abnormal Doppler and normal Doppler group. Similarly, McDonell et al in their study didn't find any significant correlation between delivery room resuscitation and abnormal Doppler study.[8]

In the present study 27% of neonates with abnormal Doppler developed RDS compared with 17% in normal Doppler group, Similar observations were also made in studies done by Hackett et al (42% versus 25%, p value NS) and Tolu et al (12.8% verses 51.4%).[6,11]

The increased incidence of NEC in neonates with abnormal antenatal Doppler is due to increased vascular resistance in the mesenteric circulation which results in hypoxic ischemic injury to intestine before birth. In present study 32% neonates developed NEC in the abnormal compared with 18% in the normal Doppler group. Similar findings were seen in studies done by Hackett et al and McDonell et al.[6,8] However, study done by Lakshmi et al did not find any significant correlation between Normal verses abnormal Doppler with NEC which was probably due to their study group consisting of VLBW babies where overall incidence of NEC was more.[12]

Sepsis is one of the complications in babies with Doppler flow abnormalities in our study culture positive sepsis was seen more in abnormal Doppler as compared to normal Doppler group (9% verses 3.5%). Similar observation was seen in study done by Lakshmi et al (15% versus 8%, p=0.051) and et al (24.3% vs 9%).[11]

Platelet aggregation and consumption by placenta causes thrombocytopenia. In our study thrombocytopenia was seen in 34% and 17% neonates in abnormal and normal Doppler group, Similar to studies done by McDonell et al and Pauline et al.[7,8] However, study done by Hackett et al did not prove any statistically significant correlation between thrombocytopenia and Doppler studies.[4]

Hypoglycemia was seen in 19% and 14% neonates in abnormal Doppler group as compared to normal Doppler group (p>0.23). Similar to study done by Lakshmi et al (8% verses 4%, p=0.341).[12]

In the present study IVH developed in 10% and 11% neonates in the abnormal Doppler and normal Doppler respectively. No statistically significant correlation was seen between Doppler study and IVH in the study group as our study included more preterm babies. Similar observations were also found in the study done by Pauline et al (8.6% verses 14.35, p>0.1).[7]

Significant number of neonates in abnormal Doppler group required mechanical ventilation compared to normal Doppler group in the present study (17% versus 7%). However similar study done by Lakshmi et al, McDonell et al and Pauline et al did not find any statistically significant correlation between mechanical ventilation and Doppler study as their study group consisted of VLBW and premature babies.[7,8,12]

In the present study neonates in the abnormal Doppler group had a longer NICU stay compared to normal Doppler group which was statistically significant.

The present study did not find any statistically significant correlation between neonatal mortality and Doppler study. Similar observations were noted in studies done by Hackett et al, Pauline et al, McDonell et al but study by Tolu et al study showed statistically significant correlation (24.3% versus 3%).[6-8,12]

Limitations

The main limitations of our study was relatively small sample size, single centered and short period. In the current study decision was made based on Doppler flow abnormality only. There was also a possibility of gestational age confounding the outcome. It would had been better if the study was done by incorporating antenatal fetal surveillance, change patterns of umbilical artery Doppler flow.

CONCLUSION

Colour Doppler is a useful modality to predict fetal outcome in high-risk pregnancies. It allows better understanding of hemodynamic changes in fetoplacental and uteroplacental circulation. The present study and various other studies have found that there is a strong relationship between adverse pregnancy outcomes in these babies with abnormal Doppler and therefore sonographic surveillance of these high-risk fetuses helps pediatrician to anticipate the complications and helps in early intervention and thus results in decreased neonatal morbidity and mortality.

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