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Can cerebroplacental ratio overcome the gaps present in the tests of antepartum foetal surveillance in improving the perinatal outcome?

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Abstract
Background: Timely antenatal identification of the fetus at risk, fetal monitoring and serial assessment are crucial to ensure fetal wellbeing, which is measured in terms of perinatal outcome by using various tests of antepartum surveillance.
Materials and Methods: It was a prospective study conducted in the department of Obstetrics and Gynaecology of Upper India Sugar Exchange Maternity hospital, G.S.V.M Medical College, Kanpur from 2016 to 2018 with total number of 130 cases. All antenatal cases with > 32 weeks of gestation with high risk factors, were simultaneously subjected to Electronic foetal monitoring and Colour Doppler. Perinatal outcomes were recorded in terms of presence or absence of meconium stained liquor, Apgar score, NICU admission requirement and respiratory distress.
Results: There was significant statistical correlation between the different types of EFM and Doppler velocimetry with the perinatal outcome variables such as NICU admissions, neonatal complications and mode of termination, p-value was <0.001, i.e highly significant. There was significant difference between the Cerebro placental Ratio and all the variables except APGAR.
The mean of PI of middle cerebral artery was 1.53±0.39.and that of umbilical artery was 1.08±0.35. Percentage of NICU admissions required was higher in patients have EFM pathological followed by suspicious as compared to EFM normal.
Conclusion: With Umbilical artery and Middle cerebral artery Doppler, the Cerebroplacental Ratio is postulated to be a better predictor of foetal compromise than either of the vessel considered individually even when their respective indices are in normal range.

Keywords: Doppler velocimetry, non-stress test, cerebroplacental ratio, perinatal outcome

Introduction

Antepartum foetal surveillance is of immense importance for detection of fetal compromise in utero in high risk pregnancies like hypertensive disorders of pregnancy, diabetes mellitus, fetal growth restriction, post-dated pregnancy to ensure an optimal fetal outcome [1].
Accurate and timely antenatal identification of the fetus at risk, fetal hemodynamic monitoring and its serial assessment are crucial to ensure fetal wellbeing, particularly in the setting of complex high risk pregnancies to avoid fetal jeopardy like cerebral palsy [2].
Population based studies from around the world report prevalence estimates of cerebral palsy ranging from 1.5 to more than 4 per 1,000 live births or children of a defined age range [3].
As of today, most of the fetal well being tests depend upon the maturity of the foetal CNS and its synchronicity with other systems, which would not have developed before 32 weeks.
Cardiotocography (CTG) is a test usually done in the late third trimester of pregnancy to see the foetal heart rate and variability. The basic objective of a CTG is to assess coordination between central nervous system and the cardiovascular system based on the fact that a well oxygenated healthy foetus with an intact CNS-Cardiac functioning will show accelerations (rise of FHR 15 beats/minute for 15 sec above baseline) with foetal movements.
Colour Doppler velocimetry for evaluation of foetal circulation including Umbilical artery flow and Middle Cerebral artery flow in terms of its indices is of utmost importance in predicting perinatal outcome by measuring integrity of the uteroplacental and fetoplacental unit, recently complemented by measurement of the Venous Doppler flow.

The aim of the study was to compare the efficacy of Electronic Foetal Monitoring (EFM) and Colour Doppler as a means of foetal monitoring in utero in order to prognosticate the perinatal and neonatal outcome in high risk pregnancy with special emphasis on the role of cerebroplacental ratio.

Material and methods

The present study was a prospective longitudinal study which was conducted in Department of Obstetrics and Gynaecology of Upper India Sugar Exchange Maternity hospital, G.S.V.M Medical College, Kanpur from 2016 to 2018 with 130 cases being subjected to our study.

All antenatal cases with > 32 weeks pregnancy with high risk factors were included such as Hypertensive disorders in pregnancy, Diabetes mellitus complicating pregnancy, Antepartum haemorrhage, Liquor abnormalities, Rh negative pregnancy (irrespective of isoimmunization), Bad obstetric history, Heart disease in pregnancy, Foetal growth restriction (IUGR), Preterm labour, Post dated pregnancy, Severe anaemia in pregnancy and Preterm premature rupture of the membrane.

All antenatal cases with history of trauma (acute obstetric emergencies), pregnancy < 32weeks, foetus with congenital anomalies and antenatal cases with no risk factors were taken as the exclusion criteria.

At the time of admission, all antenatal cases falling in the inclusion criteria, after doing routine antenatal examination and investigations, were simultaneously subjected to –Non Stress Test / Cardiotocography and Colour Doppler velocimetry.

CTG was classified, as: (according to NICE 2007 guidelines) [4].

i. Normal
ii. Suspicious
iii. Pathological

And Colour Doppler velocimetry, was classified as:-

i. Normal colour Doppler flow
ii. Abnormal colour Doppler changes- either umbilical artery or middle cerebral artery flow abnormal or both abnormal.

The main justification for admission CTG in women in labour is that the uterine contractions causes stress on the placental circulation; an abnormal tracing indicates an uteroplacental deficiency and hence identifies foetal compromise at an early stage to allow for intervention. Patients with reactive CTG trace were monitored intermittently by auscultation for one minute every 30 minute in the first stage of labour and every five minutes in the second stage of labour post contraction.

In those with ominous tracings, appearance of late, significant variable or prolonged decelerations, delivery was hastened by operative or instrumental intervention depending upon the stage of labour.

Results

Maximum number of patients 40.8% belonged to the age group 26-30 years with 3.1% belonging to the extreme age groups (18-20 years and >35 years). Around 39.2% were primigravida while 26.9% were of > G3 gravidity. Mean Period Of gestation was 36 ± 2.35 weeks with maximum number of patients i.e. 47.7% having period of gestation of 35 – 37 weeks. Maximum number of patients i.e. 20.7% were having pregnancy induced hypertension (PIH) followed by foetal growth restriction, in 15.4% of the patients. 6.9% of the patients had both PIH and foetal growth restriction.

Among 130 patients, maximum number of patient's i.e. 40% showed normal cardiotocography/non stress test trace whereas 27.7% belonged to the category with pathological CTG/NST trace. Maximum numbers of patients i.e. 79.2% had normal Doppler velocimetry while 20.7% of patients were having abnormal Doppler velocimetry i.e. either umbilical artery Doppler indices were abnormal or middle cerebral artery Doppler indices were abnormal or both were abnormal.

48.5% patients underwent lower segment caesarean section whereas 51.5% had normal vaginal delivery as mode of termination. 6 groups were made with various combinations of NST and Colour Doppler and distribution of patients was done according to their test results thus helping us in calibrating the results further (Table no. 1).

After performing the tests, it was found that for high risk factors, specially liquor abnormalities, pregnancy induced hypertension along with Intra uterine growth restriction, and intra uterine growth restriction along with oligohydramnios, had maximum number of abnormal values of CTG and Doppler tests as compared to other high risks such as preterm labour, postdated, Rh isoimmunisation and others.

Abnormal Doppler indices of Middle cerebral artery and Umbilical artery were found mostly in suspicious or pathological CTG groups whereas, normal Doppler indices were found in cases of reactive NST and this was found to be highly significant (Table no. 2)

There was non-significant difference in cases of Normal Tests (EFM and Doppler) with respect to perinatal complications. However, there was significant difference with p-value of 0.008 in terms of abnormal tests (Doppler and EFM.) with respect to perinatal complications (Table no. 3)

There was significant difference between the different categories of EFM and all the perinatal outcome variables except APGAR score and Still birth because in cases of APGAR score and still birth, all the EFM categories have similar distribution of values with p-value 0.548 & 0.268 respectively. (Table no. 4)

There was significant correlation between Doppler velocimetry and all the perinatal outcome variables except APGAR score as, its p-value was 0.066. With respect to NICU admissions, neonatal complications and mode of termination, p-value was <0.001, i.e. highly significant. (Table no. 5)

There was significant difference between the Cerebro placental Ratio and all the variables except APGAR as in case of APGAR, p-value of MCA/UA have was 0.119 (Table no. 6)

Percentage of NICU admissions required was higher in patients having pathological followed by suspicious as compared to normal CTG traces and Perinatal mortality was also higher in these two groups only. P-value of 0.001, shows that there was significant difference of Doppler indices with perinatal outcome, keeping EFM traces normal. Percentage of NICU admissions required was higher in patients having umbilical artery abnormal or middle cerebral artery doppler abnormal or both abnormal as compared to both doppler artery (MCA AND UA) normal. (Table no. 7)

Table 1: Distribution of patient profile according to groups based on test result

Group	Frequency	Percentage
Group A	50	38.5
Group B	2	1.5
Group C	34	26.2
Group D	8	6.2
Group E	19	14.6
Group F	17	13.1

Group A: Efm (NST) Normal + Doppler Velocimetry Normal
Group B: Efm (NST) Normal + Doppler Velocimetry Abnormal
Group C: Efm (NST) Suspicious + Doppler Velocimetry Normal
Group D: Efm (NST) Suspicious + Doppler Velocimetry Abnormal
Group E: Efm (NST) Pathological + Doppler Velocimetry Normal
Group F: Efm (NST) Pathological + Doppler Velocimetry Abnormal

Table 2: Correlation between EFM versus Doppler Velocimetry

EFM	MCA Doppler		UA Doppler		
NST	Normal	Abnormal	Normal	Abnormal	P-Value
1) Normal	52	0	50	2	0.56
2) Suspicious	39	3	35	7	0.178
3) Pathological	25	11	21	15	0.326
p-value	<0.001		<0.001		

Table 3: Predictive value of abnormal and normal tests

Test Result	No Perinatal Complications	Perinatal Complications	P-Value
A) Normal Tests			
Normal Doppler	84	19	0.075
Normal EFM	48	4	
B) Abnormal Tests			
ABN Doppler	7	20	0.008
ABN EFM (S/P)	43	35	

Table 4: EFM (NST) correlation with perinatal outcome

Perinatal Outcome		EFM(NST)			Total	Pearson Chi-Square	p-value
		Normal	Suspicious	Pathological			
Apgar Score	<=7	40	33	31	104	1.202	0.548
	>7	12	9	5	26		
Liquor	Clear	48	29	17	94	21.924	<0.001
	MSL/Scanty	4	13	19	36		
Nicu Admission At Birth	No	48	30	13	91	30.659	<0.001
	Yes	4	12	22	38		
Neonatal Complications	No	48	30	13	91	30.659	<0.001
	Yes	4	12	22	38		
Condition At Discharge	Healthy	52	41	26	119	21.856	<0.001
	Expired	0	1	9	10		
Still Birth	Yes	0	0	1	1	2.631	0.268
	No	52	42	35	129		
Total		52	42	36	130		

Table 5: Doppler velocimetry correlation with perinatal outcome

		Doppler		Total	Pearson Chi-Square	p-value
Perinatal Outcome		Normal	Abnormal			
Apgar Score	<=7	79	25	104	3.377	0.066
	>7	24	2	26		
Liquor	Clear	80	14	94	7.121	0.008
	MSL/Scanty	23	13	36		
Nicu Admission At Birth	No	84	7	91	29.816	<0.001
	Yes	19	19	38		
Neonatal Complications	No	84	7	91	29.816	<0.001
	Yes	19	19	38		
Condition At Discharge	Healthy	101	18	119	24.125	<0.001
	Expired	2	8	10		
Still Birth	Yes	0	1	1	3.844	0.05
	No	103	26	129		
Mode of Termination	NVD	62	5	67	14.876	<0.001
	LSCS	41	22	63		
Total		103	27	130		

Table 6: Pulsatility index (PI) of MCA/UA (Cerebroplacental Ratio) correlation with perinatal outcome.

Perinatal Outcome		MCA/UA (Cerebroplacental Ratio)		Total	Pearson Chi-Square	p-value
		>=1.08	<1.08			
Apgar Score	<=7	88	16	104	2.436	0.119
	>7	25	1	26		
Liquor	Clear	88	6	94	13.381	<0.001
	MSL/Scanty	25	11	36		
Nicu Admission At Birth	No	87	4	91	18.231	<0.001
	Yes	26	12	38		
Neonatal Complications	No	87	4	91	18.231	<0.001
	Yes	26	12	38		
Condition At Discharge	Healthy	110	9	119	33.1	<0.001
	Expired	3	7	10		
Still Birth	Yes	0	1	1	6.699	0.01
	No	113	16	129		
Total		113	17	130		

Table 7: Correlation between EFM and the perinatal outcome with Doppler normal

Doppler (n=103)	EFM	Healthy Baby (at discharge)	NICU Admission Required	Expiry
1) Normal	Normal	50	2	0
2) Normal	Suspicious	33	8	1
3) Normal	Pathological	18	9	1

Table 7: Correlation between Doppler Velocimetry with the Perinatal Outcome When EFM Trace Are Normal

EFM (n=52)	Doppler Artery (MCA And Ua)	Healthy Baby (At Discharge)	NICU Admission Required
1) Normal	both normal(51)	51	1
2) Normal	only UA abn/only MCA abn/both abn(1)	1	1

Discussion

In our study 38.5% of patients were in GROUP A where both EFM (NST) Normal and Doppler Velocimetry were Normal and 13.1% patients were in Group F where EFM (NST) was Pathological and Doppler Velocimetry was Abnormal. Anand R. Tambat *et al*. stated in his study that there were 54.3% patients in Group A whereas 11.4% patients had both NST and Doppler abnormal, Group F. [5] This reflects that only a few cases were severely compromised and had both tests abnormal signifying acute as well as chronic hypoxia.

In group A, where both tests were normal, around 22% cases belonged to PIH and in group F where both tests were abnormal, had maximum cases of oligohydramnios (29%). A study by Amandeep raj *et al*. stated that in Group A where both test results were normal had majority of cases (58.8%) with only Foetal growth restriction and had the least morbidity and Group D which had the maximum number of cases of combined preeclampsia with FGR (73.68%), had both the test results abnormal, and had the worst perinatal outcome [6].

Abnormal Doppler indices of Middle cerebral artery and Umbilical artery were found mostly in suspicious or pathological CTG groups whereas, normal Doppler indices were found in cases of reactive NST and this was found to be highly significant.

In group A, with both tests normal, number of term vaginal delivery cases were significantly higher as compared to other groups and in group F, where both tests were abnormal, there were higher number of caesarean sections as compared to other groups due to fetal distress reflecting that there was significant difference among the groups with respect to mode of termination.

Similar findings were corroborated by Verma *et al*. in which after statistical analysis it was found that the rate of caesarean section were significantly higher (p=0.011) in comparison of group D(both tests abnormal) with group A(both tests normal). In group D caesarean section was deferred when neonatal survival prospects were poor [2]. In Padmagirison *et al* study, also the caesarean delivery rate was found to be 56.2% in group D where both tests were abnormal [7]. Subramaniam *et al* also stated p value <0.001 and hence highly significant correlation between mode of termination with NST and Doppler results [8].

Among the total 38 cases admitted in the NICU, only 2 were from the normal tests group whereas 13 were from the group when both tests were abnormal and *P* value was <0.001 and hence highly significant. According to Yelikar *et al*. in comparing the APGAR scores of babies of women with only abnormal Doppler (group II) were compared to those of women with only abnormal NST (Group III), it was seen that Group II had a better perinatal outcome than Group III, again suggesting that NST reflects changes late in the course of the disease process [9].

On correlation of EFM with perinatal outcome, only 4 NICU admissions occurred in normal NST and 22 admissions with pathological NST. Also, 9 out of 10 neonatal deaths occurred in group with pathological NST, hence being highly significant. Similar findings were shown in study by Lohana *et al*. that of the total, 9 children who had birth asphyxia out of which 66.7% cases had Non Reactive NST, 12 babies had low birth weight (<2.5 kg) out of which 5(41.67%) had non reactive strip, 4 children at birth had meconium aspiration syndrome out of which 75% had a non reactive NST [10].

There was significant difference in the Cerebroplacental Ratio with respect to perinatal outcome variables except APGAR as its, p-value 0.119. This shows that CPR is highly significant indicator of adverse perinatal outcome.

Singh G *et al*. stated the diagnostic accuracy in prediction of adverse perinatal outcome in clinically suspected IUGR cases. CP ratio has the diagnostic accuracy of 91.6%, and MCA PI was 72.6% and UA PI was 79.6%. Present study results in evaluating the usefulness of MCA PI /UA PI ratio as strong predictor of adverse outcome in IUGR and thus it helps in decreasing perinatal mortality and morbidity. This result was comparable

with Lakhar *et al*. Fong KW *et al*. Bahado *et al*. [11, 12, 13, 14].

There was significant difference of Doppler values with perinatal outcome, keeping EFM traces normal. Percentage of NICU admissions required was higher in patients having umbilical artery or middle cerebral artery doppler abnormal as compared when both doppler artery (MCA AND UA) normal. Similarly, there was significant difference between EFM traces and the perinatal outcome. Percentage of NICU admissions required was higher in patients having EFM pathological followed by suspicious as compared to when EFM was normal. Expired cases were also in these 2 groups only i.e. Suspicious and pathological.

In my study, the sensitivity and specificity of DOPPLER was much more than EFM. The accuracy of correct prediction of NICU admissions was more with Doppler velocimetry ie. 79.8%.

N Chaudhary *et al*. states that Sensitivity and specificity of Doppler velocimetry was 43% and 100%, respectively, whereas, sensitivity and specificity of NST was 12% and 94%, respectively [1]. Positive predictive value of Doppler velocimetry and NST was 100% and 28%, respectively. Negative predictive value of Doppler velocimetry and NST was 90% and 84%, respectively.

The sensitivity and specificity of Doppler as compared to NST was 82.6% and 63.0% respectively in a study conducted by Amandeep Raj *et al*. [6]

Conclusion

CTG and DOPPLER are effective in predicting the abnormal perinatal outcome in their own ways, but the significant advantage of Doppler was that it showed changes earlier than CTG giving us a lead time, proving valuable to an obstetrician in giving time for emergency measures such a steroid prophylaxis, termination of pregnancy and referral to tertiary care centers where expert NICU facilities are available.

NST still hold its importance in antepartum foetal monitoring due to its ease and the fact that a sudden abnormal NST is indicative of acute hypoxia.

Besides, Umbilical artery and Middle cerebral artery Doppler, the Cerebroplacental Ratio, is proposed to be a better predictor of foetal compromise than either of the vessel considered individually even when their respective indices are in normal range, as it evaluates fetal hemodynamics and quantifies redistribution of cardiac output better than umbilical artery or middle cerebral artery alone.

More studies are required for further validation of the fact that routine usage of cerebroplacental ratio would help in predicting adverse perinatal outcome, earlier than either of the tests done alone.

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