Original Research Article

Comparative study of colour doppler versus non stress test as a predictor of perinatal outcome in pregnancy induced hypertension and intrauterine growth restriction

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ABSTRACT

Background: Hypertensive disorders and intrauterine growth restriction are common complications encountered during pregnancy. This study was conducted to observe the usefulness of systolic/ diastolic (S/D) ratio in umbilical artery as compared with non-stress test (NST) to predict perinatal outcome in pregnancies complicated with hypertensive disorders and intrauterine growth restriction (IUGR).
Methods: It was a prospective observational which was conducted on patients undergoing antenatal visits at the department of obstetrics and gynaecology, Army hospital research and referral, New Delhi from May 2017 to April 2019. NST was started at 32 weeks twice weekly in all patients. All patients were subjected to umbilical artery Doppler velocimetry waveform on weekly basis or every third day in cases of nonreactive NST.
Results: Out of 140 patients, 53 patients (37.9%) had PIH and 44 (31.4%) had IUGR. 43 cases (30.7%) had both PIH and IUGR. Among the 140 patients, 40 patients (28.6%) had non-reactive NST and 60 patients (42.9%) of the patients had abnormal doppler. Abnormal doppler and non-reactive NST were associated with APGAR score of less than 7 at 5 minutes in the newborn. Abnormal perinatal outcome was more in abnormal doppler than normal doppler and the finding was statistically significant (p<0.05).
Conclusions: Overall sensitivity and diagnostic accuracy of Doppler is better as compared to that of NST in terms of detecting adverse perinatal outcomes.

Keywords: Colour doppler, Non stress test, PIH, IUGR

INTRODUCTION

Antepartum recognition of pregnancies with an increased risk of adverse perinatal outcome continues to be a major challenge in obstetric practice. Goals of antepartum surveillance programme include early detection of fetal compromise, prevention of unnecessary premature delivery and avoidance of intrauterine death. Hypertensive disorders during pregnancy are the most common medical complications encountered and their incidence in India is

7-10% of all pregnancies. It has also been found to be a very common cause of intrauterine growth restriction. Apart from history and clinical examination, various non-invasive methods like NST, biochemical parameters, ultrasound and Doppler flow studies give us vital information regarding fetal well-being. Doppler study of uteroplacental circulation, was suggested as the method of pregnancy assessment by Campbell and colleagues[1] who observed that Doppler flow velocity was abnormal in pregnancies complicated by PIH and IUGR. It appears

that, changes in umbilical vessels may precede by many weeks the changes currently detectable by physical examination, electronic fetal heart rate monitoring and perception of diminished fetal movements.[2]

NST is one of the most widely used primary testing method for assessment of fetal well-being and has also been incorporated into the biophysical profile testing system. Nonstress test was first introduced to describe fetal heart rate acceleration in response to fetal movement as a sign of fetal health. Nonstress test is usually performed in the last trimester.

This study was conducted to observe the usefulness of S/D ratio in umbilical artery as compared with NST to predict perinatal outcome in pregnancies complicated with hypertensive disorders and IUGR.

Aim

Aim of the study was to assess fetal Doppler velocimetry waveform and NST in patients with hypertensive disorders in pregnancy and IUGR.

Objectives

Objectives of the study were to study fetal Doppler indices in patient with hypertensive disorders in pregnancy and/or IUGR. to study NST patterns in patient with hypertensive disorders in pregnancy and/or IUGR, to assess neonatal outcomes in patients of hypertensive disorder in pregnancy and /or IUG and to compare the result of NST with fetal doppler in prediction of perinatal outcome.

METHODS

The study was conducted on patients undergoing antenatal visits at the department of obstetrics and gynaecology, Army hospital research and referral, New Delhi. The simplified version of method is mentioned in Figure 1 as a flowchart.
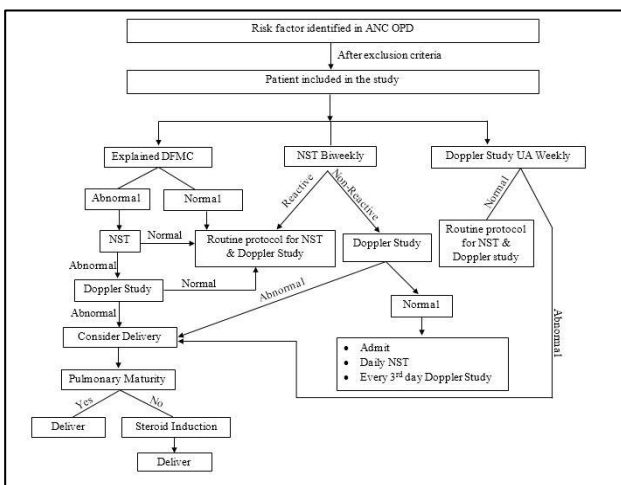
Figure 1: Flowchart for simplified version of method.

Study design

Prospective observational study design was used.

Study period

Study conducted from May 2017 to April 2019.

Inclusion criteria

Gestational age more than 32 weeks, pregnancy complicated with hypertensive disorders, antenatal patients with IUGR as diagnosed by clinical criteria and confirmed by USG were included in the study.

Exclusion criteria

Any congenital anomaly in the fetus as diagnosed by USG, symmetrical IUGR and early onset IUGR were excluded from the study.

Sample size

Sample size was of 140.

NST was started at 32 weeks twice weekly in all patients. The test was called reactive when within a 20-minute period there were two or more fetal movements accompanied by acceleration of fetal heart rate by 15 beats per minute lasting for 15 seconds. Extended NST was used when the observed time period was extended to 40 minutes. NST was labelled as inconclusive when the patient had no fetal movement and nonreactive when she had movements but there was no associated fetal heart rate acceleration. In cases of nonreactive NST patient was subjected to Doppler study.

All patients were subjected to umbilical artery Doppler velocimetry waveform on weekly basis or every third day in cases of nonreactive NST. Using a coupling jelly, the Doppler probe was placed in contact with the pregnant woman's abdomen. A transducer frequency of 3.5 MHz was selected to study blood flow in the fetal umbilical vessel. A Doppler flow velocimetry was done with real time pulse wave Doppler sonography for measuring the waveform in the umbilical artery. The vessel was interrogated by putting a Doppler sample volume cursor in the lumen. Angle of interrogation and sample volume that were analysed were adjusted to obtain an optimal spectral trace. Peak systolic (S) and end diastolic (D) blood flow velocity waveform were recorded and a display of the mean value of these two parameters were obtained on screen and S/D ratio was calculated. A mean systolic to diastolic ratio of 3 or less was selected as the cut off value for normalcy.

Perinatal outcome was calculated in terms of-1. The presence or absence of foetal distress in labour i.e., a) The presence of persistent late decelerations b) Meconium in labour 2. Perinatal death 3. Mode of delivery 4. The

presence or absence of 5-minute APGAR score less than 7 and 5. Neonates requiring NICU admission >48 hours.

Ethical approval

Ethical approval was taken from institutional ethical committee prior to the study. Personal information was not revealed and were described as average. Informed consent was taken from all the patients.

RESULTS

A prospective observational study was conducted among 140 singleton pregnancies with PIH, IUGR or with both PIH and IUGR in the department of obstetrics and gynaecology, Army hospital (Research and referral) to compare the results of NST with fetal doppler for prediction of fetal outcome.

Mean age of the patients was 25 years. Age of the patients ranges from 19 years to 35 years. Majority of the patients were in the age group 19-24 years which constituted 45%. Only 2.1% of the patients were 35 and above.

More than half (54.3%) of the patients were primigravida. So, most of high-risk pregnancies with PIH and IUGR was found in primigravida. Gravidity ranged from one to five. Majority of the patients (72.1%) were nullipara.

Out of 140 patients, 53 patients (37.9%) had PIH and 44 (31.4%) had IUGR. 43 cases (30.7%) had both PIH and IUGR. Among the 140 patients, 40 patients (28.6%) had non-reactive NST and 60 patients (42.9%) of the patients had abnormal doppler.

NST non reactivity was more common among PIH only patients. This finding statistically insignificant. Chance of Doppler abnormality was higher among patients with both PIH and IUGR but finding was statistically insignificant.

LSCS were more among abnormal doppler group (53.3%) than normal doppler group (37.5%). After clubbing forceps and LSCS columns, chi-square test was performed but the finding was statistically insignificant (p>0.05).

Non-reactive NST had equal chance of LSCS and vaginal delivery (50% each) and the finding was statistically insignificant (p>0.05).

Abnormal doppler finding had increased chance (68.3%) of APGAR score less than 7. Non-reactive NST was associated with more of Apgar score less than 7 as compared to reactive NST the finding was statistically significant (p<0.05).

Abnormal Doppler group had more chance of neonatal morbidity than normal Doppler group and the finding was statistically significant(p<0.05). Non-reactive NST had more chance of neonatal morbidity than reactive NST patients and finding was statistically significant (p<0.05).

One fetal death was from abnormal doppler group and the finding was found to be statistically significant (p<0.05). Non-reactive NST had more chance of neonatal mortality than reactive NST but finding statistically insignificant.

More chance of NICU admission was seen in abnormal doppler than normal doppler and the finding was statistically significant (p<0.05). NICU admission was more among the NST non-reactive patients than reactive NST patients and the finding was statistically significant.

Abnormal perinatal outcome was more in abnormal doppler than normal doppler and the finding was statistically significant (p<0.05). Abnormal perinatal outcome was more in nonreactive NST than reactive NST and the finding was statistically significant.

Doppler was superior than NST in 25% of patients and equal in 60% of cases as mentioned in Table 1.

Table 1: Distribution of patients by outcome.

Outcome/ remark	Frequency	Percentage (%)
NST<Doppler	35	25
NST=Doppler	84	60
NST>Doppler	21	15
Total	140	100

Table 2: Relation between doppler study and perinatal outcome.

Doppler	Perinatal outcome, n (%)		Total, n (%)	Chi-square test
	Abnormal	Normal		
Abnormal	46 (76.7)	14 (23.3)	60 (100)	
Normal	15 (18.8)	65 (81.2)	80 (100)	46.7, p=0.000
Total	61 (43.6)	79 (43.6)	140 (100)	

Table 3: Relation between NST and perinatal outcome.

NST	Perinatal outcome, n (%)		Total, n (%)	Chi-square test
	Abnormal	Normal		
Non-reactive	30 (75)	10 (25.0)	40 (100)	
Reactive	31 (31)	69 (69.0)	100 (100)	27.7, p=0.000
Total	61 (43.6)	79 (43.6)	140 (100)	

Table 4: Diagnostic performance of NST and Doppler.

	NST (%)					Doppler (%)				
	Sensitivity	Specificity	PPV	NPV	Diagnostic accuracy	Sensitivity	Specificity	PPV	NPV	Diagnostic accuracy
APGAR score <7 at 5 min	54.17	84.78	65	78	74.29	85.42	79.35	68.33	91.25	81.43
Admission in NICU	65.85	86.87	67.50	86	80.71	73.17	69.70	50	86.25	70.71
Neonatal morbidity	65.85	86.87	67.50	86	80.71	75.61	70.71	51.67	87.50	72.14
Neonatal mortality	50	72.06	05	98	71.43	100	58.82	06.67	100	60
Poor perinatal outcome	49.18	87.34	75	69	70.71	75.41	82.28	76.67	81.25	79.29

Table 5: Comparison of Doppler study and NST.

Author	N	Sensitivity (%)		Specificity (%)		Positive predictive value (%)	
		NST	Doppler	NST	Doppler	NST	Doppler
Trudinger et al[22]	170	17	60	85	97	-	-
Schulman[2]	180	7.6	50	96	97	44	81
William et al[23]	1360	15	68	94	90	64	80
Present study	140	50	75.4	87.3	82.2	75	76

DISCUSSION

High risk pregnancies are those where the mother, fetus or the neonate is at increased risk of mortality or morbidity. Pregnancy induced hypertension and intrauterine growth restriction are leading causes of perinatal mortality and morbidity. The role of the obstetrician lies in its timely diagnosis and necessary intervention for which apart from clinical acumen, reliable diagnostic modalities are required. The decision for the timely intervention of pregnancy is based on the overall clinical presentation and specific end points of fetal testing such as abnormal fetal heart rate, doppler studies and NST.

A prospective observational study was conducted at the department of obstetrics and gynaecology, Army hospital research and referral Delhi to compare the results of NST with fetal Doppler velocimetry for prediction of fetal outcome among 140 singleton pregnancies with PIH, IUGR or with both PIH and IUGR who came for antenatal check up.

Age and gravida

In this study most of the patients (83.6%) were between 19-29 years age group. This reflects the reproductive span of women with maximum fertility and therefore association with risk factors like PIH and IUGR in this age group. When distribution of patients according to gravida was studied, it was found that most of the patients were

primigravida (54.3%) and we are aware that PIH has a known association with primigravida. So, this group is more vulnerable to obstetric complications. Similar finding was observed in the study by Kumari et al where PIH was common among pregnant women under 25 years.[3] As reported by Zibaeenazhad et al primigravida less than 20 years and all patients over 30 years have an increased chance of hypertension.[4] Sheraz et al also reported the same finding and stated that preeclampsia is more frequent in patients younger than 21 years of age and in older than 35 years.[5]

Pregnancy induced hypertension

PIH was the most common risk factor found in 96 (68.5%) of patients in this study. In our patients of PIH, it was found that 40 out of 96 patients (41.66%) had abnormally increased waveform indices in umbilical artery, two cases had absent end diastolic flow and one had reverse end diastolic flow. These observations are in close agreement with findings of Fleischer who reported S/D ratio more than 2.6 in the umbilical artery after 26 weeks in cases of PIH with impaired perfusion.[6] Out of 96 cases, 28 were found with non-reactive NST (29.16%) which were less than the Doppler abnormalities (41.66%). A cross-sectional study was performed by Ozeren et al on 125 normal pregnancies and 62 preeclamptic patients at 31-40 weeks of gestation.[7] The umbilical artery S/D had the highest sensitivity (88%) and diagnostic accuracy (94%) in predicting the adverse perinatal outcome.

IUGR

In our study, 87 patients had IUGR of which 43 patients had associated Pregnancy induced hypertension. 40 (45.97%) out of 87 had abnormal doppler waveform indices value while 47 patients (54.03%) had normal waveform value. Out of 40 patients with abnormal waveform indices, one had REDF in umbilical artery. Out of 87 cases of IUGR, 23 (26.4%) had non-reactive NST, while 64 cases (73.6%) had normal value.

One with REDF had emergency caesarean section and delivered a preterm live asphyxiated baby (weight 1.2 kg, APGAR 3/10 at 1 min and 5/10 at 5 min), who expired soon after birth. This is similar to reported by Wang et al that reversed flow velocity on umbilical velocimetry represents an ominous sign.[8]

Radhika et al observed in their study that 46% of the IUGR patients had abnormal Doppler study and 12.5% of them had non-reactive NST which is very similar to our study.[9] In a similar study by Tambat et al, out of 70 patients of IUGR 26 (37.14%) had abnormal Doppler waveform and 12 (17.14%) had non-reactive NST which again has similar findings as our study.[10]

NST

In this study all 140 patients underwent NST. In 79 patients with good perinatal outcome, 10 (12.5%) had a non-reactive NST. Of the 61 patients with abnormal perinatal outcome 31 (50.8%) of them had reactive NST. One patient who had intrauterine fetal demise had a reactive NST in the last 48 hours. The other patients who had neonatal morbidity (5 cases of RDS) also had reactive NST prior to delivery. The false negative rate was 50.8% and false positive rate was 12.5% with sensitivity and specificity of 50.8% and 87.3% respectively. In our study positive and negative predictive value of NST are 75.05 and 69.0% respectively. In the study conducted by Signore et al, they found false negative rate of 0.2-1.2% and false positive rate of 55-90% which is not comparable with our study.[11] This could have been because of lack of computerised analysis of the fetal heart rate which provides an objective assessment of the CTG. However, in the study by Ocak et al they observed that sensitivity and specificity of NST was 50% and 80% respectively, in prediction of perinatal outcomes and finding is consistent with our finding.[12]

Doppler study

In the present study all 140 patients were subjected to Doppler velocimetry waveform. A total of 60 patients had abnormal S/D ratio on Doppler. Of these 46 patients (76.7%) ended with poor perinatal outcome. The false negative rate was 24.5% and false positive rate was 17.7%. So, false negative rate was very low in Doppler study compare to NST. The sensitivity and specificity of Doppler velocimetry are 75.4% and 82.2% respectively

with positive predictive value of 76.6% and negative predictive value of 81.2% which is more superior to NST. Doppler velocimetry studies of umbilical artery can provide obstetrician an important information regarding fetal well-being to improve the fetal outcome. Indiramani et al observed that amongst abnormal umbilical artery Doppler velocimetry waveforms group 45.7% had adverse perinatal outcomes which has similar findings as our study.[13] In the study by Subramanian et al, when both Doppler and non-stress test were normal, most of the pregnancies had normal perinatal outcome.[14] But on the other hand, when Doppler and NST both were abnormal, nearly 53 percentages were cases had poor perinatal outcome.

Perinatal mortality

The perinatal mortality in this study among high-risk women was 28.5 per 1000 live births (4 out of 140 cases). In the study by Adu-Bonsaffoh et al perinatal deaths were 15% (21 out of 140 hypertensive patients) which accounts to perinatal mortality rate of 150 per 1000 live births.[15] Alfirevic et al found a perinatal mortality rate of 143.7/1000 live births when the birth weight was between 1.5 to 2.5 Kg and gestational age was less than 37 weeks and 56.9/1000 live births for gestational age more than 37 weeks.[16] The mortality rate was 746/1000 live births when birth weight was less than 1.5 kg.

Mode of delivery

In our study abnormal Doppler reading had more chance of caesarean section for foetal distress (53% vs 37.5%) as compared with normal Doppler reading. Thus, this study observed that the caesarean section rate was increased in case with abnormal Doppler. However, in case of non-reactive NST it was 50% compared to 42% in reactive NST group. In the study conducted by Jo et al caesarean section rate was 75% in abnormal Doppler velocimetry patients compare to 30% in normal Doppler study group which is almost corroborative with our study.[17] Lohana et al in an observational study found caesarean rate of 46.66% in non-reactive NST group compared to the 34% in the NST reactive group, a similar finding with our study.[18]

APGAR score

In our study, 68.3% patients with abnormal Doppler readings continued to have an APGAR score of less than 7 at 5 minutes as compared to 10% with normal Doppler reading. However, in case of non-reactive NST, 65% of the patient had APGAR score of less than 7 at 5 minutes compared to 22% in NST reactive group. Hence, Doppler has more sensitivity in predicting the low APGAR score outcome with a diagnostic accuracy of 81.43% as compared to NST which has got diagnostic accuracy of 74.29%. As observed by Tambat et al there were low APGAR score at 5 minutes in 50% of patients both in abnormal Doppler and non-reactive NST group.[10] This is

slightly different from our observation which is likely due to sample size variation. Whereas Chaudhary et al observed that 100% of patients with abnormal Doppler study had low APGAR score at 5 minutes.[19]

NICU admission

In this study, 51.7% of the babies born to patient with abnormal Doppler had admission to NICU as compared to 23.8% cases with normal reading. But in case of NST it was 70% compared to 14%. Doppler shows sensitivity and specificity of 73.35% and 69.33% respectively while in case of NST it is 65.8% and 86.87%. In an observational study by Radhika et al in the abnormal Doppler study group, 73% of the newborns had NICU admission as compared to 100% in case of non-reactive NST group, which commensurate with our study.[9] Whereas in the observation by Tambat et al 66.7% of abnormal Doppler study group had NICU admission as compared to 50% in case of non-reactive NST group.[10]

Perinatal outcome

In our study 76.7% (as mentioned in Table 2) of cases had abnormal perinatal outcome in terms of NICU admission (51.7%), jaundice (20%), MAS (5%), RDS (26.7%) with abnormal Doppler as compared to 18.8% in patients with normal Doppler. This difference is highly significant statistically ($p < 0.01$). In case of non-reactive NST 75% (Table 3) had poor perinatal outcome compared to 31% in reactive NST group. Thus, we can infer that Doppler is more sensitive in picking up such cases with diagnostic accuracy of 79.29% as compare to 70.71% of NST as per our study.

The sensitivity in our study was 75.4% and specificity of 82.2% for the Doppler which very well correlates with the results of Dathan et al study who gave figures of 82.3%, Nagar et al gave figure of 80% while Trudinger et al gave figures of 90%.[20-22] The sensitivity of NST in our study was 50% and specificity 87.3%. In the study by Choudhury et al, sensitivity and specificity of Doppler velocimetry was 43% and 100%, respectively, whereas, sensitivity and specificity of NST was 12% and 94%, respectively.[19]

Sensitivity and specificity of Doppler blood flow was 75.4% and 82.2% as mentioned in Table 4 in the present study and it was comparable to that found by Trudinger et al and Schulman as shown in Table 5.[2,22] It is apparent that the sensitivity of Doppler blood flow study 75.4% is much higher as compared to that of NST i.e. 50%. Overall diagnostic accuracy of Doppler is 79.29% as compared to 70.71% of NST, in terms of detecting adverse perinatal outcomes.

CONCLUSION

In order to compare NST and fetal doppler waveform velocity for the prediction of fetal outcome, a prospective observational study was conducted among 140 singleton pregnancies with either hypertensive disorders or IUGR or with both hypertensive disorders and IUGR at Army hospital research and referral, New Delhi. PIH and IUGR was more common among the age group 19-24 years in nearly 50% of cases. On stratification, IUGR was common among 25-29 age group, hypertensive disorders and combined hypertensive disorders +IUGR in 19-24 age group. Mean age of the patients was 25 years. Since the above risk factors were common in younger age group and so it was common among primigravida in more than 50% of cases. PIH was the most common among the risk factors in more than one third of cases.

Doppler was abnormal in 42.9% of cases and non-reactive NST was present in 28.6% of cases. Abnormal doppler and non-reactive NST were associated with APGAR score of less than 7 at 5 minutes in the newborn. Others indicators of poor perinatal outcome were also more common with both abnormal Doppler and non-reactive NST. But sensitivity, positive predictive value and negative predictive value was more with Doppler screening than NST. In the cases showing absent or REF end diastolic flow in the umbilical artery there is much higher risk of perinatal morbidities and mortalities. Such cases should be terminated as soon as the maturity of the foetus is achieved to prevent perinatal mortalities. Thus, Doppler study has promising capacity to identify poor perinatal outcome, identifying fetuses at risk for developing IUGR, intrapartum asphyxia, intrauterine fetal death and those who may require caesarean delivery. A robust study with a better methodology and larger sample size is required for further understanding.

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