Non Stress Test Versus Doppler Velocimetry in Determining Perinatal Outcome in High Risk Pregnancies

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ABSTRACT

Introduction: Antepartum foetal surveillance is the corner stone of management aimed at reducing maternal and perinatal mortality & morbidity. It is done by various methods like foetal movements, Non-stress test, contraction stress test, foetal biophysical profile, modified biophysical profile, vibro-acoustic stimulation test and foetal umbilical artery doppler velocimetry. Electronic foetal monitoring displays the foetal heart response to intrinsic & extrinsic stimuli. High resolution dynamic ultrasound & doppler imaging has the advantage to "see" the foetus, its environment and monitor foetal well being by assessing foetal & utero-placental circulation. Study aimed to compare Non-stress test & Doppler velocimetry in determining perinatal outcome in high risk pregnancies.

Material and methods: It was a prospective study conducted on women with high risk pregnancies who attended outpatient department of OBG at Rohilkhand Medical College & Hospital, Bareilly from Nov 2016 to Oct 2017. The study was done after taking ethical committee clearance and informed consent from the patients. Non-stress test was done within one week of delivery in Semifowler's position and Doppler Ultrasonography was done in semi recumbent position & umbilical artery pulsatility index, resistance index, S/D ratio and cerebro-placental ratio were calculated.

Results: Of total 100 patients in our study Non-stress test was normal in 74 and was abnormal in 26, while Doppler was normal in 67 & was abnormal in 33.

In our study sensitivity & specificity of doppler was 83.58% & 72.73% while that of non-stress test was 74.32% & 61.54% respectively.

Conclusion: Doppler velocimetry was significantly better in predicting the perinatal outcome than Non-stress test as doppler studies were significantly abnormal in patients with perinatal complications.

Keywords: Non-stress Test, Doppler Velocimetry, Perinatal Outcome

INTRODUCTION

Every mother's dream is to have a healthy offspring who will achieve the highest possible physical and mental potential. A high-risk pregnancy is one that threatens the health or life of the mother or her foetus. Perinatal mortality is high in developing countries like India more so in rural areas. Antepartum foetal surveillance is the corner stone of management aimed at reducing perinatal mortality and morbidity. Antepartum foetal surveillance is of immense importance for detection of foetal compromise in utero in high-risk pregnancies like gestational hypertension, diabetes mellitus, foetal growth restriction, post-dated pregnancy, oligohydramnios and Rh incompatibilities. Assessment of the foetal wellbeing is done by various methods including foetal movement assessment, non-stress test, contraction stress test, foetal biophysical profile, modified biophysical profile, vibro-acoustic stimulation and umbilical artery doppler velocimetry. Biochemical methods of foetal monitoring are less favourable than biophysical methods because of the problem of sample collection, accuracy and need for laboratory technology and personnel. Primary aim of foetal surveillance is to detect foetal hypoxia and acidosis which are the common causes of foetal death.

Non-stress test (NST) is most commonly used for antepartum evaluation of foetal status. It is non-invasive, easily performed and interpreted method which can identify nearly twice as many foetuses with an abnormal foetal heart rate pattern than intermittent auscultation of foetal heart rate.[1]

A normal NST is currently defined by the American College of Obstetricians and Gynaecologists is two or more accelerations that peak at 15 bpm or more above baseline, each lasting 15 seconds or more, and all occurring within 20 minutes of beginning the test. If no spontaneous foetal movement occurred during the initial 20 min. of observation, the test is continued for another 20 min. or longer to take into account the variations of the foetal sleep–wake cycle. During this period, foetal movement is provoked by external stimulation. To perform vibroacoustic stimulation, the device is positioned on the maternal abdomen and a stimulus is applied for 1–2 seconds. If vibroacoustic stimulation fails to elicit a response, it may be repeated up to three times for progressively longer durations of up to 3 seconds. Abnormal NST is characterized by lack of accelerations for a period of 40 minutes, baseline variability of <5 bpm, late decelerations with spontaneous uterine contractions and repetitive variable

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decelerations lasting for >30 sec.[2]

Doppler sonography and its off-shoot, Colour doppler sonography, are relatively new methods that combine the pulsed echo technique of sectional image formation with the doppler evaluation of blood flow. The use of Doppler ultrasonography for the evaluation of the foetal circulation is based on the physical principle i.e., the frequency of sound wave changes when reflected from a moving object and the change is proportional to the velocity of moving object (Doppler Effect).[3] It is a non-invasive tool that has proven useful in the evaluation of maternal and foetal hemodynamics. Three foetal vascular circuits—umbilical artery, middle cerebral artery, and ductus venosus—are currently assessed to determine foetal health and aid in the decision to intervene for growth-restricted foetuses.

Electronic foetal monitoring displays the foetal heart responses to intrinsic and extrinsic stimuli. High resolution dynamic ultrasound & doppler imaging has the advantage to "see" the foetus, its environment and monitor foetal wellbeing. Doppler sonography makes it feasible to assess the foetal and uteroplacental circulations. Nonstress test (NST) reflects oxygenation of brain. Doppler plays an important role in intrauterine growth restriction (IUGR) pregnancies where hemodynamic rearrangements occur in response to foetal hypoxemia. Disadvantages of Doppler are the requirement of sophisticated equipment and a degree of operator skill and expertise which may not be available in all centres. NST has the advantage of ease of use and interpretation, low cost and minimal time required. So, it remains a mainstay in detection of a compromised foetus in many hospitals and thus taking appropriate measures to intervene perinatal morbidity and mortality.

The aim of current study was to compare Non-stress test and Doppler velocimetry in determining perinatal outcome in high risk pregnancies.

MATERIAL AND METHODS

The prospective study was conducted on 100 women with high-risk singleton pregnancy of gestational age >30 weeks attending OPD and those admitted in the Department of Obstetrics & Gynaecology, Rohilkhand Medical College and Hospital, Bareilly over a period of one year from November 2016 to October 2017 as per the selection criteria mentioned below.

Inclusion criteria

1. Hypertensive disorders in pregnancy
2. Diabetes complicating pregnancy, including gestational diabetes
3. Intra Uterine Growth Restriction
4. Post dated pregnancy
5. Liquor abnormalities
6. Bad obstetric history
7. Decreased foetal movements
8. Severe anaemia
9. Rh iso- immunization
10. Advanced maternal age (>35years)

Exclusion criteria

1. Pregnant women with gestational age <30 weeks or in labour
2. Antepartum haemorrhage
3. Eclampsia
4. Multiple gestation
5. Ruptured membranes
6. Congenital anomalies
7. Malpresentations
8. Previous LSCS
9. Cephalo pelvic disproportion
10. Sedative in mother 24 hours before test

Non-stress test and Colour Doppler were performed in the selected patients and all the patients were delivered within a week of the test.

Non stress test: All patients were informed about the procedure. After emptying the bladder NST was conducted in Semi Fowler's position and results were interpreted according to ACOG guidelines.

Colour Doppler: Colour Doppler Ultrasonography was performed by Radiologist. The Foetal biometry, AFI and estimated foetal weight were calculated. The SD ratio, RI and PI of umbilical artery and middle cerebral artery were measured and Cerebro-Placental Ratio (CPR) was calculated.

All 100 patients in our study were categorized in four sub-groups according to their NST and Doppler findings:

- Group A: NST Reassuring and Colour Doppler Normal
- Group B: NST Reassuring and Colour Doppler Abnormal
- Group C: NST Non-Reassuring and Colour Doppler Normal
- Group D: NST Non-Reassuring and Colour Doppler foetal hypoxia

Outcome criteria

► High risk pregnancies with following outcome were considered as adverse perinatal outcome if:
  - Birth weight less than 10th percentile
  - Caesarean section for foetal distress
  - Perinatal death
  - Apgar score at 5 min is < 7
  - Admission to NICU for reasons other than low birth weight alone like birth asphyxia, sepsis, respiratory distress syndrome, feeding intolerance, convulsions, hypoglycaemia, hyperbilirubinemia, ventilatory support, necrotizing enterocolitis.

► If the pregnancy outcome was not associated with any of the above then it was considered as good perinatal outcome.

STATISTICAL ANALYSIS

The data was interpreted by using SPSS version 23. Qualitative data was represented in frequency and percentage. Chi-square test was performed to find association between different variables. A "p" value < 0.05 was considered statistically significant and 'p'-value < 0.001 was considered highly significant. Sensitivity and specificity were calculated for comparison between groups.

Compliance with Ethical Standards

Ethical Approval: All procedures were followed in accordance with the ethical standards of the responsible committee on human experimentation. Permission was obtained from the scientific and ethical committee of the institution for the study.

Informed Consent: Informed consent was obtained from all patients for being included in the study.

RESULTS

The present study was done from November 2016 to October 2017 on 100 high risk pregnant women with period of gestation >30 weeks attending Obs and Gynae OPD of RMCH Bareilly Uttar Pradesh after taking informed consent. In our study 69% of the patients were less than 30 years of age, 68% of the patients belonged to rural area, 58% of the patients were primigravida and 60% patients had PIH as the high-risk factor. NST was normal in 74% and abnormal in 26% subjects while Doppler velocimetry was normal in 67% patients and abnormal in 33% patients.

56 patients had normal NST and normal Doppler (Group A), 18 patients had normal NST and abnormal Doppler (Group B), 11 patients had abnormal NST and normal Doppler (Group C) and 15 patients had abnormal NST and abnormal Doppler (Group D) (Graph-1).

Majority of the patients (58%) were delivered by lower segment caesarean section.

Neonatal Outcome was divided into healthy baby, IUGR and Neonatal death. 54 patients of Group A delivered a healthy baby and 2 had IUGR. 12 patients of Group B delivered a healthy baby, 2 had IUGR and 4 had neonatal death. 7 patients of Group C delivered healthy baby, 3 had IUGR and 1 neonatal death. 5 patients of Group D delivered a healthy baby, 4 had IUGR and 6 had neonatal death. (Graph-2)

Liquor was clear in 54 patients of Group A, 12 patients of Group B, 7 patients of Group C and 11 patients of Group D. Liquor was meconium stained in 2 patients of Group A, 6 patients of Group B, 4 patients of Group C and 4 patients of Group D.

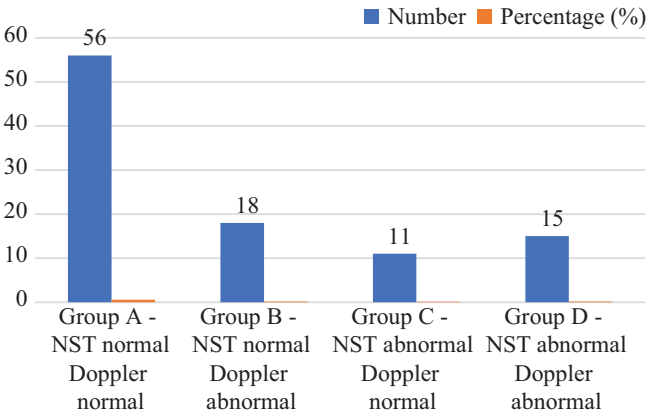
Neonates were categorized according to APGAR score at 5 minutes. APGAR score was more than 7 in 50 neonates delivered by patients of Group A, 5 of Group B, 6 of Group C and 4 of Group D. APGAR score was less than 7 in 6 neonates delivered by patients of Group A, 13 of Group B, 5 of Group C and 11 of Group D.

NICU admission was not required in 52 neonates from Group A, 5 from Group B, 9 from Group C and 10 from Group D while 4 neonates from Group A, 13 from Group B, 2 from Group C and 5 of Group D required admission in NICU.

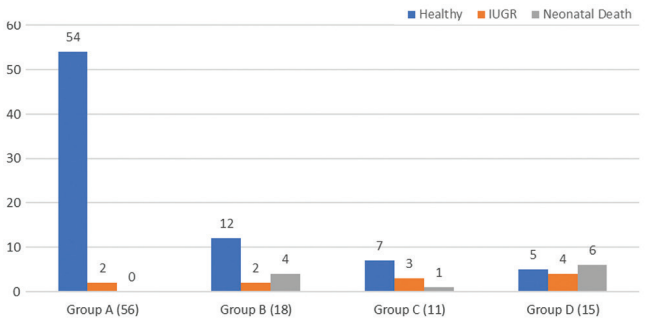
Out of 74 patients having normal NST 52 neonates did not have any perinatal complications while 22 had perinatal complications. Out of 26 patients having abnormal NST 10 neonates did not have perinatal complications while 16 had perinatal complications. Out of 67 patients having normal Doppler 58 neonates did not have perinatal complications while 9 had perinatal complications. Out of 33 patients having abnormal Doppler 4 neonates did not have perinatal complications while 29 had perinatal complications. Perinatal outcome was correctly predicted in 68 patients by NST and incorrectly in 32 patients. Similarly, perinatal outcome was correctly predicted by Doppler in 87 patients and incorrectly in 13 patients. Doppler velocimetry was found to be better in predicting perinatal outcome than NST ($p<0.001$) (Graph 3).

NST and Doppler study results were evaluated with perinatal outcome (healthy, IUGR and Neonatal death), Liquor colour, APGAR score, NICU admission and Neonatal complications. Doppler studies were significantly abnormal in patients with high risk pregnancies with perinatal complications as compared to the patients without perinatal complications ($p<0.001$). (Table- 1 & 2)

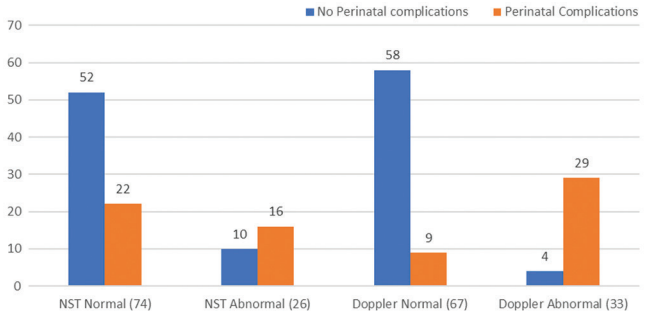
In our study, diagnostic performance of Doppler velocimetry (Cerebro-placental ratio) and NST in predicting fetal outcome was calculated. Positive predictive value and



Graph-1: Division of patients in Study Groups



Graph-2: Distribution of patients according to neonatal outcome in Study Groups



Graph-3: Distribution of patients according to Prediction value of normal and abnormal test.

NST		Normal	Abnormal	P Value
Perinatal outcome	Healthy	66	12	<0.001*
	IUGR	4	7	
	Neonatal death	4	7	
Liquor colour	Clear	66	18	0.037*
	Meconium - stained	8	8	
APGAR Score at 5 minutes	≥7	55	10	0.002*
	<7	19	16	
NICU admissions	No admissions	57	14	0.0466*
	Admissions	17	12	
Neonatal complications	Present	22	16	0.008*
	Absent	52	10	
* Statistically Significant				

Table-1: NST correlation with perinatal outcome

Cerebro-Placental Ratio		Normal (≥1.08)	Abnormal <1.08)	P Value
Perinatal outcome	Healthy	61	17	<0.001*
	IUGR	5	6	
	Neonatal death	1	10	
Liquor colour	Clear	61	23	0.014*
	Meconium - stained	6	10	
APGAR Score at 5 minutes	≥7	56	9	<0.001*
	<7	11	24	
NICU admissions	No admissions	61	10	<0.001*
	Admissions	6	23	
Neonatal complications	Present	9	29	<0.001*
	Absent	58	4	
*Statistically significant.				

Table-2: Doppler velocimetry [Cerbro-placental Ratio (Pulsatility index of MCA/UA)] correlation with perinatal outcome

Test	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Doppler (Cerebroplacental ratio)	83.58	72.73	86.15	68.57
NST	74.32	61.54	84.62	45.71

Table-3: Efficacy of Doppler velocimetry and NST in predicting Foetal outcome

negative predictive value of Doppler Velocimetry came out to be 86.15% and 68.57%, while PPV and NPV of NST was 84.62% and 45.71% respectively. Sensitivity and specificity of Doppler velocimetry was 83.58% and 72.73%, while that of NST was 74.32 and 61.54%, respectively. (Table-3).

DISCUSSION

In our study Group A (normal NST and normal Doppler) included 56 patients, Group B (normal NST and abnormal Doppler) 18 patients, Group C (abnormal NST and normal Doppler) 11 patients and Group D (abnormal NST and abnormal Doppler) 15 patients (56%, 18%, 11%, 15%). Similar grouping was done by Choudhury N et al. (2017)[4] where Group A, B, C and D comprised of (88,5,5,2); Mehta N et al. (2016)[5] (36,26,8,30); Tambat AR et al. (2016)[6] (54.3, 25.7, 8.6, 11.4); Gomathi V et al. (2015)[7] (42.2,27.7,7.8,22.3); and Padmagirison R et al. (2006)[8] (36.4,27.3,7.3,29).

In our study 58% patients delivered by LSCS & 42% delivered vaginally. It was in accordance with the study conducted by Choudhury N et al. (2017)[4] where LSCS and normal vaginal delivery was 68% and 32% respectively; Mehta N et al. (2016)[5] (56% & 44%); Tambat AR et al. (2016)[6] (54.3% & 45.7%); Verma U et al. (2015)[9] (34% & 66%); and Padmagirison R et al. (2006)[8] (61.8% & 38.2%).

In our study Neonatal Outcome was divided into healthy baby, IUGR and Neonatal death. 54 patients of Group A delivered a healthy baby and 2 had IUGR. 12 patients of Group B delivered a healthy baby, 2 had IUGR and 4 had neonatal death. 7 patients of Group C delivered healthy baby, 3 had IUGR and 1 neonatal death. 5 patients of Group D delivered a healthy baby, 4 had IUGR and 6 had neonatal death. The findings are consistent with the study of Choudhury N et al. (2017)[4] where, out of 88 patients in group A (86 had healthy neonates, 2 IUGR and no neonatal death); out of 5 patients in group B (2 had healthy neonates, 1 IUGR and 2 neonatal deaths); all 5 patients in group C had healthy neonates and out of 2 patients in group D (1 had healthy baby and 1 neonatal death).

Our study was comparable to the study conducted by Choudhury N et al. (2017)[4] in terms of liquor colour and

APGAR score. In their study Group A (85 had clear liquor and 3 meconium stained), in Group B (1 had clear liquor and 4 meconium stained), all 5 patients in Group C had clear liquor and 2 patients of Group D had meconium stained liquor. APGAR score in various groups of their study was: Group A (≥ 7 in 87 neonates and <7 in 1 neonate), Group B (<7 in all 5 neonates), Group C (≥7 in all 5 neonates) and in Group D (<7 in both neonates).

Our study was in accordance with the study conducted by Choudhury N et al. (2017)[4] in terms of NICU admissions and neonatal complications.

Our study was comparable to the study conducted by Choudhury N et al. (2017)[4] who gave similar result on correlating NST with different types of perinatal outcome. Similar study was done by Gomathi V et al. (2015)[7] who concluded that an abnormal NST following an abnormal Doppler is associated with worst perinatal outcome in patients with severe preeclampsia and foetal growth restriction. In cases of abnormal doppler if prospects of neonatal survival are good it is better to deliver the foetus before NST becomes abnormal. Colour doppler is useful in recognizing foetal compromise earlier than NST, giving a lead time which is important in the management of preterm high-risk pregnancies (esp. severe pre-eclampsia and foetal growth restriction). Even though both tests are complimentary to each other in foetal surveillance of high risk pregnancies, the clinical condition dictates the most appropriate step. Our study was also in accordance with the one conducted by Verma U et al. (2015)[9] who concluded that doppler is useful in recognizing foetal compromise earlier than NST. Doppler depicts chronic hypoxic changes while NST can detect acute events in presence or absence of chronic hypoxia. An abnormal NST following an abnormal Doppler is associated with worst perinatal outcome. NST still holds its importance because of its ease of use, low cost and minimal time required. On the other hand, doppler requires sophisticated instruments, operative skills and experience.

Our study results are comparable with Choudhury N et al.(2017)[4] who found out that Doppler studies were significantly abnormal in patients with high risk pregnancy with perinatal complications as compared to the patients with high risk pregnancy without perinatal complications. It was also consistent with the study conducted by Yelikar et al. (2013)[10] who showed in their study that maximum number of neonates from Group B and D (where Doppler was abnormal) had meconium staining, APGAR <7, and NICU admissions. Similarly, Group D where both the tests (NST and Doppler) were abnormal had majority of the perinatal deaths. Our study results are comparable with Padmagirison R et al. (2006)[8] who found that Group A (both test results normal) had majority of cases (36.4%, 20/55) and had the least morbidity. Group D (both tests abnormal) had 29.09%, 16/55 of the cases and had the worst perinatal outcome. The results are in consonance with Paliwal S et al. (2017).[11] Their study showed Group A (both tests normal) had best perinatal outcome (only 10% NICU admissions), SGA (24.28%) and operative delivery for fetal distress (14.28%) and Group D (both tests abnormal) had the worst perinatal outcome (78.57% NICU admissions), operative delivery for fetal distress (78.57%) and low APGAR score.

Our study is comparable with Choudhury N et al. (2017).[4] Their study showed sensitivity and specificity of Doppler velocimetry of 43% and 100%, Positive predictive value of Doppler velocimetry and NST 100% and 28% respectively and Negative predictive value of Doppler velocimetry and NST 90% and 84% respectively. This signifies that an abnormal Doppler study is more accurate in predicting fetal compromise than an abnormal NST. A study between NST and Doppler waveforms was also done by Ott WJ (1999)[12] where doppler was found to be more efficacious than NST. When both NST and colour Doppler were abnormal it indicates that these fetuses suffer from severe placental insufficiency. The hemodynamic changes picked up by Doppler occur in compensatory phase in high risk pregnancies. Fetal heart rate abnormalities occur much later in decompensatory phase, which is a late sign of fetal compromise.

CONCLUSION

Doppler velocimetry is significantly better in predicting adverse perinatal outcome. However, when both tests are abnormal perinatal outcome is definitely poor.

NST and Doppler Velocimetry both are sensitive and specific tests with good positive predictive value in predicting adverse neonatal outcome. However, the negative predictive value of Doppler Velocimetry is relatively higher which is significant in detecting healthy neonates. The specificity of fetal surveillance tests can be improved with three-dimensional ultrasound, measurement of subcutaneous tissue, computer analysis of fetal heart rate and by combining both as an integrated test, to further minimize the fetal and neonatal morbidity and mortality.

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