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Which is superior, Doppler velocimetry or non-stress test or both in predicting the perinatal outcome of high-risk pregnancies

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Abstract
Background: The desire of all women considering motherhood is to culminate a healthy infant, whose physical and psychological potential might be greatest. Antepartum fetal surveillance is the corner stone of management aimed at reducing perinatal mortality and morbidity.
Objectives: To analyze which is superior, Doppler velocimetry or Non-Stress Test or both, and by comparing the prediction of perinatal outcome in high-risk pregnancies like anemia, hypertensive disorders, IUGR, GDM, oligohydramnios, polyhydramnios.
Methods: The study was done on a total of 100 pregnant women with high risk factors in the III trimester after 34 weeks till term, in the department of Obstetrics and Gynaecology. Complete history taking and general physical and systematic examination and investigations were done for all the patients. They were followed up till delivery and the outcome will be studied in detail. NST was repeated bi-Weekly. Doppler was performed once in 15 days or more frequently based on findings.
Results: Majority of the patients belongs to age group 21-24 (38%) followed by age groups 15-20 (37%) and 25-29(19%).6% were aged between 30-35 years. Primi Gravidae with 58% and 42% were multi Gravidae. Majority of cases were between 38-39 wks. (44%). 33% between 36-37 Wks.12% between 34-35 Wks.11% are around 40 Wks. 41% are in Group A which is DOPPLER Normal and NST reactive. 25% are in Group B which is DOPPLER Normal and NST Non-Reactive. 23% are in Group C which is DOPPLER Abnormal and NST reactive. 11% are in Group D which is DOPPLER Abnormal and NST non-reactive.
Conclusion: No single test result should be considered for decision making in case of high-risk pregnancy because each test reflects different aspects of maternal and fetal pathophysiology. It is advisable to repeat the test and combine with other modes of fetal surveillance before decision making to improve the perinatal outcome and for better prediction of adverse events.

Keywords: Doppler Test, NST, IUGR, APGAR, Gravidae

Introduction
The desire of all women considering motherhood is to culminate a healthy infant, whose physical and psychological potential might be greatest. Antepartum fetal surveillance is the corner stone of management aimed at reducing perinatal mortality and morbidity [1].

Assessment of the fetal well-being is done by various biophysical and biochemical methods. However, the question of analysis, precision and demand for laboratory technology and resources have made fetal testing biochemical approaches unfavorable to biophysical methods [2].

Non stress test (NST) is most used for antepartum evaluation of fetal status. It is an easy, non-invasive, quickly done and perceived method by which almost twice as many foetuses with a fetal heart rate pattern can be detected as sporadic auscultation [3].

The use of Doppler ultrasonography for the evaluation of the fetal circulation is based on physical principal i.e. the frequency of sound wave changes when reflected from a moving object and proportional to the velocity of moving object (Doppler Effect). It is a non-invasive tool that has proven useful in the evaluation of maternal and fetal hemodynamics [4, 5].

The aim of the antepartum monitoring is to detect fetal hypoxia at the earliest in order to prevent subsequent acidemia and brain damage complete awareness of the condition and appropriate treatments will prevent mortality and morbidity at the right time. The recent trend is to combine the modalities of fetal surveillance like biophysical profile, Doppler to monitor the fetuses.

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Materials and Methods

Source of Data: The study was done on a total of 100 pregnant women with high risk factors in the III trimester after 34 weeks till term, in the department of Obstetrics and Gynaecology in Guntur Medical College from January 2017 to June 2018.

Inclusion Criteria
- Singleton pregnancy
- Gestational age beyond 34 weeks.
- High risk factors considered
- Pre-eclampsia
- Intra Uterine Growth Restriction
- Gestational diabetes mellitus
- Anemia
- Previous Caesarean section
- Bad obstetric history
- Rh isoimmunization

Exclusion Criteria
- Pregnancies with gestational age <34 weeks
- Postdated pregnancies
- Wrong dates
- Twin gestation

Abnormal Perinatal Outcome
The perinatal outcome will be considered abnormal when any one or combinations of the following are present.
- Perinatal death
- Thick meconium stained liquor
- Apgar < 7 at 5 minutes
- Respiratory complications within 72 hours of birth
- NICU admission within 72 hours of birth.

Method of collection of data
- Complete history taking and general physical and systematic examination and investigations were done for all the patients
- They were followed up till delivery and the outcome will be studied in detail
- NST was repeated bi-Weekly
- Doppler was performed once in 15 days or more frequently based on findings.
- Gestational age at delivery, mode of delivery, APGAR, birth weight, NICU admissions etc., was the outcomes analyzed.

Patients were categorized into four groups
- Group A: Doppler normal and NST reactive
- Group B: Doppler normal and NST non-reactive
- Group C: Doppler abnormal and NST reactive
- Group D: Doppler abnormal and NST non-reactive

Observation and Results

Table 1: Distribution based on Age, Gravida, Gestational age, and Groups

Age	Number	Percentage
15-20	37	37%
21-24	38	38%
25-29	19	19%
30-35	6	6%
Total	100	100%
Gravida		
Primi	58	58%
Multi	42	42%
Gestational Age		
34-35	12	12%
36-37	33	33%
38-39	44	44%
40	11	11%
Groups		
A	41	41%
B	25	25%
C	23	23%
D	11	11%

Majority of the patients belongs to age group 21-24 (38%) followed by age groups 15-20 (37%) and 25-29(19%).6% were aged between 30-35 years. Primi Gravidae with 58% and 42% were multi Gravidae. Majority of cases were between 38-39 wks. (44%). 33% between 36-37 Wks.12% between 34-35 Wks.11% are around 40 Wks. 41% are in Group A which is DOPPLER Normal and NST reactive. 25% are in Group B which is DOPPLER Normal and NST Non-Reactive. 23% are in Group C which is DOPPLER Abnormal and NST reactive. 11% are in Group D which is DOPPLER Abnormal and NST non-reactive.

Table 2: Pre-Eclampsia Distribution In Each Group

Within Group	Group A	%	Group B	%	Group C	%	Group D	%
NO	23	56.10	11	45.83	14	58.33	5	45.45
Yes	18	43.90	13	54.17	10	41.67	6	54.55
Total	41	100	24	100	24	100	11	100

Among the Groups	NO	% in NO	Yes	% in YES
Group A	23	43.40	18	38.30
Group B	11	20.75	13	27.66
Group C	14	26.42	10	21.28
Group-D	5	9.43	6	12.76
Total	53	100	47	100

Total of 47% had pregnancy induced hypertension. Majority of them belongs to Group-A with 38%.

Table 3: Distribution of Cases In Iugr, Gdm, Liquor

Within Group	Group A	%	Group B	%	Group C	%	Group D	%
NO	36	87.8	21	87.5	11	45.83	6	54.55
Yes	5	12.2	3	12.5	13	54.17	5	45.45
Total	41	100	24	100	24	100	11	100

Distribution Of Cases In IUGR				
Among the Groups	NO	% in NO	Yes	% in Yes
Group A	36	48.64	5	19.23
Group B	21	28.40	3	11.54
Group C	11	14.86	13	50.00
Group D	6	8.10	5	19.23
Distribution Of Cases In GDM				
Group A	38	41.76	3	33.33
Group B	22	24.17	2	22.22
Group C	21	23.07	3	33.33
Group D	10	11	1	11.12
Distribution of cases based on liquor				
Among the Groups	Normal	%	Oligo	%
Group A	18	40.00	18	36.00
Group B	15	33.33	9	18.00
Group C	11	24.44	13	26.00
Group D	1	2.23	10	20.00

Totally, there were 26 cases of IUGR and 50% of them belonged to GROUP C. 19% belong to GROUP D. P Value is <0.001 and hence highly significant. The incidence of GDM was 9%. Majority of them belonged to GROUP A and GROUP C with 33% and 33% respectively.

Table 4: Normal and Abnormal Outcome

Outcome	No. of cases	Percentage (%)
Normal	80	80%
Abnormal	20	20%
Total	100	100%

Normal outcome of 80% in all GROUPS with 20% abnormal outcome including intrauterine death, still birth, perinatal death.

Table 5: Number of Cases in each Group with Normal & Abnormal Outcome.

Groups	Mean at Admission	Normal Outcome	Abnormal Outcome
A	22.5	41	No
B	22.5	17	8
C	22.56	21	2
D	24.8	1	10

Of the 41 cases in Group A, there were no abnormal outcome cases reported. Of the 25 cases in Group B, 8 cases were reported as abnormal, Group C with 23 cases 2 were reported as abnormal and in Group D 10 cases were reported as abnormal in total of 11 cases.

Table 6: Both tests abnormal vs tests Normal

Test	Mortality	Normal Outcome	Total
Both Abnormal	10	1	11
Both Normal	0	41	41
Test			
Either NST/C/d Abnormal	4	44	48
Both Abnormal	10	1	11

Both tests Abnormal versus Both test normal shows sensitivity to be 100% compared to either test Abnormal. Perinatal deaths, neonatal complications were significantly more in Group D

compared to those in Group B and C with chi-square value is 29.309 and with P value <0.0001. The difference is statistically significant.

Table 7: Percentage of Vaginal & C-Section Cases

Mode of Delivery	Total	A	%	B	%	C	%	D	%
Vaginal	44	31	75.6%	4	16%	7	30.4%	2	18.2%
Cesarean	56	10	24.4%	21	84%	16	69.6%	9	81.8%

In Group B, where NST was non-reactive there was an increase in the % (84%) of Cesarean section, followed by Group D (81.8%), Group C (69.6%) and Group A (24.4%).

Table 8: Mode of Delivery and Neonatal Intensive Care Unit Admission

Test Results	Delivery		NICU	APGAR	
	Vaginal	C-section	NICU Admission	less than 7	Normal APGAR
Both Normal	31	10	0	0	41
Both Abnormal	2	9	10	10	1

Group D, where both tests were abnormal had 10 NICU admissions and GROUP B where the NST is non-reactive had 8 NICU admissions. 100% cases are admitted in NICU when BOTH tests are Abnormal, compared to 0% in normal group.

Table 9: Perinatal Outcome

Perinatal Outcome	A	B	C	D
Period of Gestation at Delivery	37.92	38.12	36	35
Pre-Term	8	3	10	9
Avg. Birth Weight	2.63	2.63	2.3	1.9
APGAR< 7 at 5 mins	0	8	2	10
NICU	0	8	2	10
Perinatal Death	0	3	1	9
MSL	4	8	2	10

Group D with both NON-Reactive NST and Abnormal DOPPLER, Perinatal outcome was worst in terms of low birth weight APGAR<7, NICU admission and perinatal mortality. Perinatal outcome is better in Group C when compared to Group D. When Group B is compared with Group C Perinatal outcome is better in Group C.

Table 10: APGAR at 5 min less than 7

Groups	No. Of Cases
A	0
B	8
C	2
D	10

More cases are seen with less APGAR in GROUP D with both tests are ABNORMAL compared to other 3 GROUPS.

Discussion

This is a prospective study to analyze the efficiency of DOPPLER and NON-STRESS test in predicting perinatal outcome in high risk pregnancies and find out the superior option. When the DOPPLER and NON-STRESS test were normal most of the pregnancies were carried successfully till term. When DOPPLER was normal but NON-STRESS test was nonreactive there were only 12% of deliveries before term. When DOPPLER was abnormal but NON-STRESS test was reactive it was possible to carry 56% till term. On the other hand, when both DOPPLER and NON-STRESS test were abnormal nearly 81% cases were terminated, before which indicates adverse outcome is more common is this group.

Birth Weight: Doppler abnormality was associated with higher incidence of low birth weight babies. In Group A the average Birth weight is 2.63 and there were only 29% cases with low birth weight. In Group B where the DOPPLER was normal, the average Birth weight of the baby is 2.63 and there were about 24% of babies with low birth weight. In Group C where the DOPPLER is abnormal and NON-STRESS test is normal, average birth weight of the baby is 2.3 kg and there were about 73% of babies with low birth weight. In Group D where both DOPPLER and NON-STRESS test were abnormal; the average birth weight of baby is 1.9 kg and there were about 100% of babies with low birth weight. It indicates severe degree of placental insufficiency in this group.

APGAR: Among the 25 cases in the Group B where the decision was taken based on non- reactive NST, only 8 cases had low APGAR which proves the false positivity of NST. In Group 3, only two cases of low APGAR has been identified out of 23 cases, the reason behind this is color DOPPLER recognizes fetal compromise earlier than the NST giving a lead time up to 9days.Which is important in the management of preterm high risk pregnancies as severe pre-eclampsia and FGR possible reason behind the one case low APGAR though the NST was reactive could have been the fact that the fetus was already compromised and could have faced an acute insult during process of labor. Anyways these babies had better outcome when compared to Group D babies which 90% had low APGAR. These results are similar to a study by Padmagirison et al. [6]

NICU Admission: When both DOPPLER and NON-STRESS test were abnormal, 10 out of 11 babies needed NICU admission of which 9 of them died. When only NON-STRESS test was abnormal, out of 25 cases 8 cases were admitted into NICU of which 2 of them died due to respiratory distress considering NON-STRESS test as a test of well-being when it is reactive surely it indicates a better progress. When color DOPPLER was abnormal only 2 cases were admitted in NICU one in V/o fetal distress and other in V/o very low birth weight 1.4 (kg), the second baby needed longer duration of NICU stay and the first baby died. No NICU admissions are there in Group A, where

NON-STRESS test is reactive and color DOPPLER is normal. These results are similar to a study by Yelikar et al. [7]

Mode of Delivery: In Group B, about 84% of Cesarean section cases were done. Fetal distress increase in rate of cesarean section was seen in Group B with Abnormal NON-STRESS test. In Group C, where only Doppler was abnormal but still NST was reactive, Successful induction was done in 30% of cases. In Group D, when both DOPPLER and NON-STRESS test were abnormal 82% of cases ended up with C-section. These results are similar to a study by Verma et al. [8]

Meconium stained liquor: Presence of Meconium stained liquor was more common in Group D, 10 out of 11 i.e., 90% when compared to other Groups A - 10%, B - 35%, C - 9%.

Perinatal Mortality: In this study it shows that in Group D, both NST and DOPPLER abnormal has high perinatal mortality of 81% compared to other Groups A, B and C. Inspite of that fact that DOPPLER was abnormal in both Groups C and D perinatal mortality was significantly low in Group C i.e., 4.5%, suggesting that the fetus was significantly more compromised when both tests were abnormal compared to only DOPPLER abnormal. Similarly, when Group C DOPPLER ABNORMAL was compared with Group B, NST Abnormal, perinatal mortality was less in Group C (4.5%) than Group B (12%) which suggests that DOPPLER predicts fetal compromise earlier in course as compared to NST which becomes abnormal later in relatively compromised fetuses. These results are similar to a study by Anand et al. [9]

When neonatal survival prospects are good it is better to deliver the compromised fetus than to monitor till the development of abnormal NST as is evident from the perinatal outcome in Group C. These babies were less affected and more mature in gestation.

IUGR: Among the total of 26 cases of IUGR 18 cases belong to DOPPLER abnormal categories i.e., Group C and D, indicating its association with abnormal DOPPLER. The growth restriction intervention trial (GRIT) which was designed to time delivery in compromised preterm fetuses showed that delaying delivery to increase maturity in severe hypoxemia increased still birth to five-fold, while death before discharge fell by one third. DOPPLER's hemodynamic changes arise during the compensatory stage of growth limitation. Fetal heart rate abnormally occurs much later in decompensating phase which is a late sign of fetal compromise.

It was observed that the lead time is shorter in presence of pre-eclampsia. Arduinietal in their study of 37 fetuses had a lead time ranging from 1 to 26 days. They observed that it is shorter in the presence of pre terminal DOPPLER changes like pulsatile umbilical vein and in pre-eclampsia. One interesting observation they made was that gestational age influenced this interval. These results are similar to a study by Paliwal et al. [10]

Longer time interval between abnormal Doppler and NST was seen in few cases of idiopathic IUGR detected early in gestation. This is because smaller fetuses have lowered nutritional and oxygen requirements allowing them to develop longer metabolic adoptions reflected by an abnormal Doppler. The time sequence of deterioration therefore depends on gestational age and concomitant maternal disease.

There is quick deterioration of placental function in the presence of pre-eclampsia resulting in shorter lead time.

In the presence or absence of persistent hypoxia, Doppler

indicates a recurrent hypoxic changes while NST identifies acute cases of severe, cord compression and fetal mother hemorrhage which are uncommon in high risk pregnancies and is helpful in deterring severe fetal distress.

Doppler can detect fetal adaptations like BSE occurring early in the decompensating cascade. A low PI in MCA and/or cerebroplacental ratio < 1.08 reflects it. In the study of 13 fetuses by Weiner *et al.* six fetuses showed loss of BSE followed by development of abnormal fetal rate pattern. They compared fetal doppler with computerized fetal heart rate monitoring. They claimed that there was a lack of autonomous responsiveness first in the brain, accompanied by related heart response manifested by fetal heart rhythm anomalies. Computerized analysis of fetal heart rate provides an objective assessment of the cardiotocography with emphasis on short term variation and seems to be superior to traditional NST. We observed loss of BSE followed by development of abnormal NST in five cases resulting in three perinatal deaths. This loss of BSE can be attributed to the development of cerebral edema in a terminally hypoxic fetus. Fetal Doppler has the power to discriminate between sick and healthy fetuses and with serial measurements it is possible to monitor any deterioration in the fetus. In chronic hypoxia Doppler changes occur first while abnormal fetal heart tracings represent late signs of fetal deterioration.

Combined methods of fetal monitoring such as Doppler, NST, and the biophysical profile provide a wealth of fetal health knowledge. Integrated clinical testing would be suitable to tailor care the fetus for appropriate treatment for the premature compromise. Doppler technique disadvantages are, requiring advanced machinery and a degree of ability and experience in operator technology. The advantages of NST include easy to use and translate, low cost and minimum time. Therefore, it may remain the workhorse in detection of a compromised fetus in many hospitals.

Conclusion
Not all with high risk pregnancy with Doppler alone is a sign of imminent termination. Those with abnormal Doppler with reactive NST could be successfully monitored and can be prolonged so that the little time period available can be utilized for steroid prophylaxis and Planning the delivery mode instead of an imminent caesarean section. Abnormal Doppler has the benefit of prolonging the pregnancy, but a receptive non-stress test revealed that non-stress testing is definitely a successful well-ness measure. However, a non-reactive Doppler analysis with a standard NST does not always have to indicate a detrimental result. Given the high false positive rates of NST, a prudent decision to stop needless caesarean sections should be taken and looked beyond. Also, it is found that an abnormal Doppler with a non-reactive NST is associated with an adverse perinatal outcome than when only one of the above was abnormal. The incidence of premature induction, cesarean section for fetal distress, low APGAR, NICU admissions and need for ventilation were more in cases where both these tests were abnormal. Thus, the risk of adverse perinatal result can be minimized by integrating the two and acting appropriately. Hence, no single test result should be considered for decision making in case of high-risk pregnancy because each test reflects different aspects of maternal and fetal pathophysiology. It is advisable to repeat the test and combine with other modes of fetal surveillance before decision making to improve the perinatal outcome and for better prediction of adverse events.

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