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ORIGINAL ARTICLE

Role of Fetal Doppler and Non-Stress Test in Preeclampsia and Intrauterine Growth Restriction

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Abstracts

Objectives To study the efficacy of fetal Doppler and non-stress test (NST) in predicting fetal compromise in preeclampsia and growth-restricted fetuses.

Methods ln a prospective study, 189 pregnant women beyond 32 weeks of gestation with preeclampsia or growth-restricted fetuses confirmed by ultrasound were evaluated by Doppler velocimetry (umbilical and middle cerebral artery) and non-stress testing. The outcome of pregnancy was recorded according to Group I ($n = 109$, Doppler and NST normal), Group II ($n = 48$, Doppler abnormal and NST normal), Group III ($n = 14$, Doppler normal and NST abnormal), and Group IV ($n = 18$, Doppler and NST both abnormal). The evaluation was done by Chi square testing.

Results Both Doppler and NST had a better specificity and negative predictive value, indicating that these tests were more predictive of a healthy fetus. The fetal compromise in terms of APGAR scores, NICU admissions, birth weight, etc., was greater when both Doppler and NST were abnormal. Doppler detected changes earlier in the disease cascade than NST as evidenced by the lead time of 5.86 days.

Conclusion The use of both the tests is necessary as it helps in detecting a spectrum of fetuses compromised at various stages of disease affection.

Keywords Umbilical Doppler · Non-stress test · Preeclampsia · IUGR

Introduction

With maternal mortality on the decreasing trend, the perinatal outcome has become the center of our attention. With the advent of the electronic fetal monitoring, the world of the fetus which was hitherto hidden from scientific exploration was instantly accessible to newer technology. The diagnosis and careful monitoring of high-risk pregnancy has become sine qua non in our practice. Apart from various other non-invasive tests like NST which provide information after the clinical features have set in, Doppler flow studies give us vital information regarding the fetus in utero. This study has been undertaken with the objective to study the efficacy of fetal Doppler and Non-Stress Test (NST) in predicting fetal compromise in preeclampsia and growth-restricted fetuses.

Materials and methods

The prospective study was conducted for a period of 2 years at our tertiary care center. All pregnant women attending the antenatal clinic with a gestational age

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>32 weeks with single, cephalic fetuses with intact membranes with mild preeclampsia, severe preeclampsia, severe preeclampsia with IUGR, or idiopathic IUGR (Expected fetal weight below the 10th percentile) were selected. A detailed history regarding the age and parity, booked/unbooked status, rural–urban origin, and drug history of the women was noted. Women who agreed to participate in the study were subjected to the protocol of study. *Exclusion Criteria*: Multiple pregnancy, congenital anomalies, other medical disorders, and acute insults such as abruption, scar dehiscence, or cord prolapse.

All women were subjected to Doppler velocimetry, and NSTs were divided into Group I (Doppler and NST normal), Group II (Doppler abnormal and NST normal), Group III (Doppler normal and NST abnormal), and Group IV (Doppler and NST both abnormal) on the basis of the last NST and Doppler at least 1 week before delivery.

Doppler velocimetry was repeated weekly or twice weekly depending upon the severity of the compromise. NST was repeated daily in cases of severe preeclampsia or on alternate days in other cases. If the NST was reassuring and the Doppler was also normal, the surveillance tests were repeated according to protocols mentioned above unless the maternal condition necessitated delivery [1].

If the NST showed normal variability, but with variable decelerations or bradycardia, an assessment of the amniotic fluid by the amniotic fluid index was done. If an AFI <5th percentile for the gestational age was assessed, the woman was induced or the baby delivered within 24 h (also taking Doppler and other surveillance parameters into consideration). If the NST showed decreased variability and/or the presence of FHR deceleration or prolonged tachycardia, depending upon the Doppler and other surveillance parameters, the woman was induced or the baby delivered within 24 h. If an ominous pattern of severe bradycardia or recurrent significant deceleration was seen, an LSCS was indicated, but with due consideration to the gestational age, expected fetal weight, and the maternal general condition [1].

If the umbilical S/D ratio was >90th percentile for the gestational age [1], Middle cerebral artery PI/Umbilical artery PI >1.08 [2], or the MCA PI <5th percentile (>2SD decline) [3] for the gestational age, an assessment of the amniotic fluid by the amniotic fluid index was done. If the AFI was <5th percentile for the gestational age, the woman was induced or the baby delivered within 24 h, taking into consideration the NST other surveillance parameters. With a normal AFI, retesting of the indices was done within 24 h [1].

If there was an appearance of reverse end diastolic flow, delivery by cesarean section was indicated [1] with due consideration to the gestational age, expected fetal weight, survival prospects, and the maternal condition. However, the mode and timing of delivery for every woman was individualized by the obstetrician taking into account the various maternal as well as fetal parameters.

A group of women were scheduled for elective cesarean section owing to their obstetric indication. Those developing fetal distress were delivered by emergency cesarean section. Perinatal outcome was evaluated according to the APGAR score, meconium staining, NICU admission, birth weights, and mortality [1].

Results

The majority of the study population was nulliparous with a mean age of 26 years. The most common indication for surveillance was mild preeclampsia (42.9 %) followed by severe preeclampsia (23.3 %), severe preeclampsia and IUGR (14.3 %), and idiopathic IUGR (19.5 %).

In Group I, 76.2 % of the women delivered vaginally, 22.9 % women underwent LSCS, and one woman (0.9 %) had a forceps delivery. In Group II, 68.8 % of the women delivered vaginally, while the rest (31.2 %) underwent an LSCS. In Group III, 42.9 % delivered vaginally, while the rest 57.1 % underwent an LSCS. Group IV had the maximum incidence of deliveries by LSCS, which is 66.7 %. Five women from group I and one woman from group II underwent elective LSCS for obstetric indications. Three women from Group III and eight women from Group IV were taken for LSCS subsequent to an ominous antepartum fetal testing. In our study, the number of cesarean sections for fetal distress in labor in Group I, II, III, and IV was 5.5, 10.4, 35.7, and 16.7 %, respectively, but the difference was not statistically significant.

The difference between the mode of delivery between groups I and IV, I and III, II and IV was significant. Group IV had a greater number of preterm deliveries with a mean gestational age of 34.6 weeks at delivery. The maximum number of neonates from Group III and IV had meconium staining, APGAR $\leq$7, and NICU admissions. Similarly, Group IV where both the tests were abnormal had the least mean birth weight, averaging 1,378 $\pm$ 230 g, and a majority of the perinatal deaths were from Group IV corresponding to six out of 18 women in that group.

In Group IV, out of the three women showing absent end diastolic flow, two of them consented for an LSCS at 35 weeks and one of them had a neonatal death. The IUGR baby delivered vaginally by induction withstood the stress of labor, but could not survive due to pulmonary hemorrhage and necrotizing enterocolitis and succumbed on day 5. All the babies were given antenatal steroids before delivery for lung maturity. Our study confirmed the fact that reverse end diastolic flow indicates an unfavorable intrauterine environment and is associated with a higher perinatal mortality, which was reflected with 100 %

Table 1 Perinatal outcome

Study groups	Mean gestational age at delivery (weeks)	MSAF (%)	APGAR ≤7 (%)	NICU admission (%)	Mean birth weight (g)	Perinatal deaths
Group I ($n = 109$)	37.3 ± 1.4	11.1	5.5	7.3	2,288 ± 393	0
Group II ($n = 48$)	36.6 ± 1.5	12.5	14.6	14.9[#]	2,068 ± 414	1
Group III ($n = 14$)	37.3 ± 1.6	71.4	57.1	57.1	2,018 ± 355	0
Group IV ($n = 18$)	34.6 ± 1	44.4	77.8	100[#]	1,378 ± 230	6

[#] 1 FSB in Group II and 2 FSBs in Group IV were noted and hence excluded from analysis of NICU admissions

Table 2 Efficacy of Doppler and NST in predicting fetal distress

	Doppler (%)	NST (%)
Sensitivity	42.1	42.1
Specificity	65.9	85.9
Positive predictive value	12.1	25.0
Negative predictive value	91.1	92.9

perinatal mortality, intervention for delivery at an earlier gestational age, exposing the already compromised fetus to an additional stress of prematurity. Both the women with reversed end diastolic flow refused an operative intervention considering the survivability aspects. Ethically, it was hard to force women to make a decision between intrauterine death and prematurity with possible morbidity even after a cesarean section. In Group IV, it was seen that in patients who were followed up in the antenatal period, the Doppler changes preceded abnormal NST by 5.86 days.

From Table 2, it can be seen that the specificity and the negative predictive value of both Doppler and NST in predicting fetal distress were better than their sensitivity and positive predictive value. However, the sensitivity of Doppler was as good as NST, while the specificity of NST was better than that of Doppler. The positive predictive values of both Doppler and NST were poor.

Discussion

An analysis of the distribution of surveillance indications showed that the women with the most compromised fetuses such as severe preeclampsia and severe preeclampsia with IUGR belonged to group IV, which necessitated a delivery at an earlier gestational age than in Group I which had a greater proportion of mild preeclamptic women who continued till term. Considering the mode of delivery, Group III and Group IV had the majority of operative deliveries for suspected fetal compromise and this difference was statistically significant. The difference in the number of cesarean deliveries for Group II and Group IV was statistically significant, suggesting that the number of LSCSs increased when both tests of fetal well-being were abnormal in comparison to only one test being abnormal.

The number of cesarean sections for fetal distress in Group I, Group II, and Group III was 5.5, 10.41, and 35.7 %, respectively; however, the difference between these was not significant. Though Group IV was considered to have the most compromised fetuses of all and hence was expected to have the maximum number of cesarean sections for fetal distress, it was not so because 8 out of 18 (44 %) of the Group IV population were not allowed to go into labor and were already considered for cesarean section in view of their compromised status, survivability, and the patient's consent, thus preventing the possibility of fetal distress in labor.

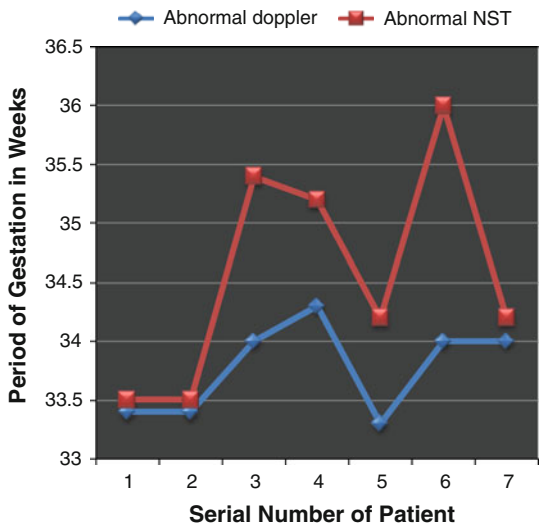

Fig. 1 Measurement of lead time

Fig. 2 Parameters as they change, gestation wise

Parameters	Changes	
	Early	Late
Fetal Growth	→	
Umbilical artery velocimetry	→	
Fetal MCA velocimetry	→	
FHR Changes	→	
Fetal venous velocimetry	→	

In comparing the APGAR scores and NICU admissions of Group I with Group III and Group IV, there was a statistically significant difference which points to the fact that babies in Group III in and Group IV were more compromised.

When babies of women with only an abnormal Doppler (group II) were compared to those of women with only an 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.

In spite of the fact that Doppler was abnormal in both Group II and Group IV, perinatal outcome was significantly better in Group II than in Group IV. These babies were less compromised and were relatively more advanced in gestation. It was seen that the birth weight decreased successively from Group I to Group IV even when the indication of surveillance was the same. The difference in the birth weight in Groups I and IV indicated that the Group IV fetuses where both the tests were abnormal had the least birth weight, thus detecting a deficient intrauterine environment. Most of the suspected IUGR babies were noted to have birth weights of <10th percentile than the expected (Lubchenco charting).

There were six perinatal deaths in Group IV, two of which were fresh stillbirths (delivered vaginally); two others who delivered vaginally and the other two who delivered by cesarean suffered neonatal deaths. There was one fresh stillbirth in Group II in a case of severe pre-eclampsia induced at 34 weeks; the baby had clear liquor at delivery, weighing 2.1 kg and by the time the distress was picked up and the woman prepared for cesarean section, the woman had delivered—the reason for the stillbirth could not be comprehended as the relatives denied permission for a postmortem.

The measures of outcome, studied by Farmakides et al. included the intrauterine growth retardation (IUGR), fetal distress, cesarean section for fetal distress, and admission to the NICU. Fetuses with a normal NST, but abnormal S/D ratio had an outcome worse than those with an abnormal NST and a normal S/D ratio; those for whom both tests were abnormal experienced the worst outcome. In a group of fetuses from high-risk pregnancies delivered before 34 weeks, Todd et al. found that when compared with umbilical Doppler velocimetry, antepartum fetal heart rate monitoring was more strongly associated with poor cognitive function of the infant at 2 years of age. Obviously, additional investigations are required before any definitive conclusions can be reached on this issue.

Though each of the individual tests was effective in predicting abnormal perinatal outcome, the significant advantages of Doppler over NST observed in our study in group IV were that Doppler showed changes earlier than NST, giving a lead time of 5.86 days. This time interval may play an important role as steroid prophylaxis could be administered during this period in a preterm fetus for pulmonary maturity. Eleven women already had abnormal Doppler and NST on admission, and hence it was not possible to know which preceded the other.

Conclusions

1. Both Doppler and NST had a better specificity and negative predictive value than their sensitivity and positive predictive value, indicating that both the tests were more effective in predicting a normal, healthy fetus.
2. The fetal compromise was greater when both Doppler and NST were abnormal. Moreover, when NST was abnormal, the fetuses were more compromised than when only Doppler was abnormal. This suggests that Doppler detects changes earlier in the disease cascade (compensatory phase) than the NST. Figures 1 and 2 summarize the chronology of events.

The above point was further validated by the time interval (lead time of 5.86 days) between an abnormal Doppler and an abnormal NST, wherein the Doppler changes preceded that of the NST. This lead time may be important in the management of preterm high-risk pregnancies. We observed that in cases with normal Doppler, a sudden abnormal NST indicates acute hypoxia. We can conclude that both the tests are complementary to one another in the fetal surveillance of high-risk pregnancies and the choice of test can be dictated by the clinical scenario.

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