J Obstet Gynecol India Vol. 56, No. 2 : March/April 2006 Pg 134-138

ORIGINAL ARTICLE

The Journal of Obstetrics and Gynecology of India

Fetal doppler versus NST as predictors of adverse perinatal outcome in severe preeclampsia and fetal growth restriction

Padmagirison *Radhika*, Rai *Lavanya*

Department of Obstetrics and Gynecology, Kasturba Medical College Hospital, Manipal –576104

OBJECTIVE(S) : To compare the efficacy of doppler vascular technic over nonstress test (NST) in predicting fetal compromise in utero in cases of severe preeclampsia and intrauterine growth restriction (IUGR).

METHOD(S) : In this prospective study antenatal fetal surveillance was done in 55 women with severe preeclampsia or IUGR using fetal doppler and NST. The results of these tests within one week of delivery were correlated with perinatal outcome. The data were analyzed using chi square test.

RESULTS : There were 29 cases with abnormal doppler and 20 with abnormal NST. Doppler abnormalities preceded NST changes. The average time interval between abnormal doppler and abnormal NST called as the lead time was 4.14 days. There were 10 perinatal deaths, six of which occurred in the group where both tests were abnormal.

CONCLUSION(S) : Doppler identifies fetal compromise earlier than NST. The lead time helps to plan delivery in preterm compromised pregnancies, resulting in better perinatal survival

Key words : intrauterine growth restriction fetal doppler, nonstress test, preeclampsia

Introduction

Antepartum surveillance tests to evaluate fetal health have been the focus of intense interest for more than three decades. There are many tests available today, each with its advantages and disadvantages. Nonstress test (NST) is the most widely used test and it reflects oxygenation of brain. Doppler plays an important role in intrauterine growth restriction (IUGR) pregnancies where hemodynamic rearrangements occur in response to fetal hypoxemia. It is now proved that significant doppler changes occur with reduction in fetal growth at a time when other fetal well-being tests are still normal. Therefore we decided to find out the comparative usefulness of doppler and NST in the management of IUGR and severe preeclampsia.

Paper received on 23/03/2005 ; accepted on 25/09/2005

Correspondence :
Dr. Rai Lavanya
Professor
Department of Obstetrics and Gynecology
Kasturba Medical College Hospital, Manipal, Karnataka 576104.
Email : Lavanya.rai@manipal.edu

Methods

This is a prospective study conducted between 1st January, 2001 and 31st October, 2002. A total of 55 pregnancies complicated by severe preeclampsia and IUGR beyond 30 weeks of gestation were included. Severe preeclampsia (blood pressure $\geq$ 160/110mm Hg, proteinuria > 5 g/24 hours, platelets <100000/mm [3], epigastric pain, visual disturbances or oliguria, HELLP syndrome) and IUGR (fetal weight and abdominal circumference < 10th percentile for gestational age) were defined according to standard criteria. The patients were followed by serial doppler assessment and nonstress test. The results of the last doppler and NST within one week of delivery were considered in the subsequent correlation with perinatal outcome. The time interval in days between the first abnormal doppler and the development of abnormal NST was used to calculate the lead time. Nonstress test was interpreted according to the standard ACOG criteria for term and preterm babies [1].

Doppler vascular study was performed using pulsed doppler ultrasound of LOGIQ 700 3.5 MHz with a high pass filter. Doppler readings were taken from umbilical artery (UA) and middle cerebral artery (MCA).

The fetal vessels were located in the standard plane. Doppler study was considered abnormal when any of the parameters mentioned below was abnormal –

1. Pulsatility index (PI) of umbilical artery (UA) > 2 SD for the gestational age [2,3].
2. Absence or reversal of end diastolic flow in UA.
3. PI of MCA < 5th percentile for the gestational age [3,4].
4. Abnormal cerebroplacental ratios – PI MCA/UA<1.08 [3].

Low PI of MCA and abnormal cerebroplacental ratio indicate brain sparing effect (BSE). Based on the doppler and NST results, the study population was divided into four groups; A B, C, and D – A (n=20) normal NST and normal doppler, B (n=15) normal NST and abnormal doppler, C (n=4) abnormal NST and normal doppler, and D (n=16) abnormal NST and abnormal doppler. The management of pregnancy and route of delivery were based on maternal and fetal parameters. In cases where neonatal survival prospects were poor such as ultrasound estimated fetal weight < 1000 g and extreme prematurity, cesarean delivery was deferred despite fetal compromise.

The perinatal outcome parameters studied were mode of delivery, gestational age at delivery, birth weight, perinatal mortality, neonatal morbidity in terms of 5 minute apgar score < 7, neonatal intensive care unit (NICU) stay, and complications that developed.

The comparison of major adverse perinatal outcome amongst the four study groups was done by chi square test. A P value < 0.05 was considered significant. Odds ratio (OR) and Wald's 95% CI were then calculated.

Results

The maternal characteristics of the population studied are shown in Table 1. A total of 55 women satisfied the inclusion criteria for the study. Twenty-six percent of multigravidas had a history of preeclampsia in the previous pregnancy. 50.7% of the study population had a combination of preeclampsia and IUGR. There were 20 women where both NST and doppler were normal (Group A) while both tests were abnormal in 16 (Group D). However Group C with normal doppler and abnormal NST was small for comparison having only four women. Group B with normal NST and abnormal doppler had 15 cases. There were 29 women with abnormal doppler findings and 20 with abnormal NST. Brain sparing effect (BSE) was seen in 25 women. In five women of Group D there was loss of BSE, followed by abnormal NST.

Table 1. Maternal characteristics (n=55).

Maternal characteristics	Number	Percentage
Primiparity	34	61.8
Multiparity	21	38.2
Pregnancy complications		
Preeclampsia	7	12.7
Intrauterine growth restriction	20	36.3
Preeclampsia with intrauterine growth restriction	28	50.7
Mean age (years)	27.7 (Range 20-38)	
Mean period of gestation at admission (weeks)	34 (Range 30-38.4)	

Table 2 shows the maternal complications, mode of delivery, and perinatal outcome in the different groups. Group A where both test results were normal had majority of cases (55%; 11/20) with only IUGR and had the least morbidity. Group D which had the maximum number of cases of combined pre-eclampsia with IUGR (81.25%; 13/16), had both the test results abnormal, and had the worst perinatal outcome associated with prematurity and low birth weight – (mean birth weight about 700g less when compared to that in Group A).The statistical significance for perinatal outcome in Group A vs D and Group B vs D are shown in Table 3. Presence of preeclampsia with IUGR significantly increased perinatal mortality (P=0.006), prematurity (P<0.0001) and NICU admissions (P=0.0012) in Group D when compared to those in Group A. However there was no statistically significant difference between Groups A and D regarding route of delivery and low apgar at 5 minutes. The number in Group C was too small for statistical comparison. Fetuses in Group B (normal NST, abnormal Doppler) were more advanced in gestation and had better neonatal outcome compared to those in Group D. Hence cesarean section rate was higher, though not significantly so, in this group in comparison to Group D where cesarean section was deferred when neonatal survival prospects were poor. Perinatal deaths (P=0.0237), prematurity (P=0.0484), and neonatal complications (P=0.0486) were significantly more in Group D compared to those in Group B. Actually two of our IUGR cases in Group B had shown abnormal doppler findings earlier in gestation (prior to 30 weeks) but the findings did not deteriorate on serial doppler studies and pregnancy could be carried on further till the babies gained a little more weight and lung maturity. There were three cases of placental abruption, one each in Groups A, B and D. Fortunately all these babies survived because of timely intervention as the mothers were hospitalized for severe preeclampsia.

There were three intrauterine deaths and seven neonatal deaths in the study population. The neonatal death in Group

Table 2. Pregnancy complications, mode of delivery, perinatal outcome and neonatal characteristics.

	Group A (n=20) NST-N Doppler – N	Group B (n=15) NST-N Doppler – Ab	Group C (n=4) NST-Ab Doppler-N	Group D (n=16) NST-Ab Dopler-Ab
Mean period of gestation at admission (weeks)	35.6	34.1	33.0	33.3
Range	30.0-38.6	31.0-38.4	32.0-36.0	32.0-36.0
Pregnancy complication				
Preeclampsia	4(20%)	2(13.4%)	1 (25.0%)	1 (6.25%)
IUGR	11(55%)	7(46.6%)	2 (12.50%)	
Preeclampsia + IUGR	5(25%)	6(40.0%)	3 (75.0%)	13 (81.25%)
Mode of delivery				
Vaginal	11(55%)	3(20.0%)		7 (43.8%)
Cesarean	9(45%)	12(80.0%)	4(100%)	9 (56.2%)
Perinatal outcome				
Survival	19	14	4	8
Intrauterine death	0	1	0	2
Neonatal death	1	0	0	6
Perinatal death	1 (5%)	1 (6.67%)	0	8 (50%)
Neonatal characteristics				
Period of gestation (weeks)	37.5	35.5	34.5	34.3
Preterm babies	3(15%)	9(60.0%)	4(100%)	14 (87.5%)
Average birth weight (g)	2179	1678.2	1747	1415.7
Apgar <7 at 5 minutes	1	0	0	5
Admission to NICU	8(40%)	11(73.3%)	4(100%)	12[a] (85.71%; 12/14)
Neonatal complications	3(15%)	6(40.8%)	1 (25%)	12 (75.7%)

N – Normal Ab – Abnormal IUGR – Intrauterine growth restriction
NICU – Neonatal intensive care unit

[a] NICU admission not done in 2 out of 14 due to parental refusal.

Table 3. Comparison of perinatal outcome between groups.

Perinatal factors	Group A vs D			Group B vs D		
	P value	OR	CI	P Value	OR	CI
PE + IUGR	0.0025	0.076	(0.0153-0.385)	0.0468	0	1538 (0.030-0.781)
Cesarean delivery	0.50 NS	1.571	(0.418-5.90)	0.3033 NS	0.3214	(0.0646-1.6002)
Perinatal deaths	0.006	19	(2.028-177.93)	0.0237	14	(1.471-133.2)
Preterm babies	<0.0001	0	(0.NAN)	0.0484	0	(0-NAN
Apgar < 7 at 5 minutes	0.0635 NS	0.09	(0.0096-0.934)	0.0484	0	(0-NAN)
NICU admission	0.0012	0.222	(0.525-0.9403)	0.2216 NS	0	(0-NAN)
Neonatal complications	0.0001	0.0294	(0.0042-0.2038)	0.0486	0.125	(0.02-0.781)

NS – Not Significant PE - Preeclampsia IUGR - Intrauterine growth restriction
P value obtained by chi square test with Yate's correction NAN – Not available number

A was from pulmonary hemorrhage due to IUGR on 7th neonatal day. Major causes of neonatal death were pulmonary hemorrhage, septicemia, and respiratory distress syndrome.

Highest perinatal mortality and neonatal morbidity were seen in Group D where both tests were abnormal. Majority of women showed abnormal doppler changes prior to NST. Only in four cases of severe preeclampsia both doppler and NST abnormalities were seen on admission and hence it was not possible to know which preceded the other.

Figure 1 shows the lead time in days in 16 women in Group D. This lead time varied between 0-9 days with a mean of 4.14 days. We observed that lead time was shorter (0-5 days) in cases with preeclampsia. Longer lead time was seen in cases with only IUGR without other concomitant maternal disease. The lead time was seen only in Group D whereas in Group B babies were delivered even before the NST had become abnormal and therefore there was no lead time.

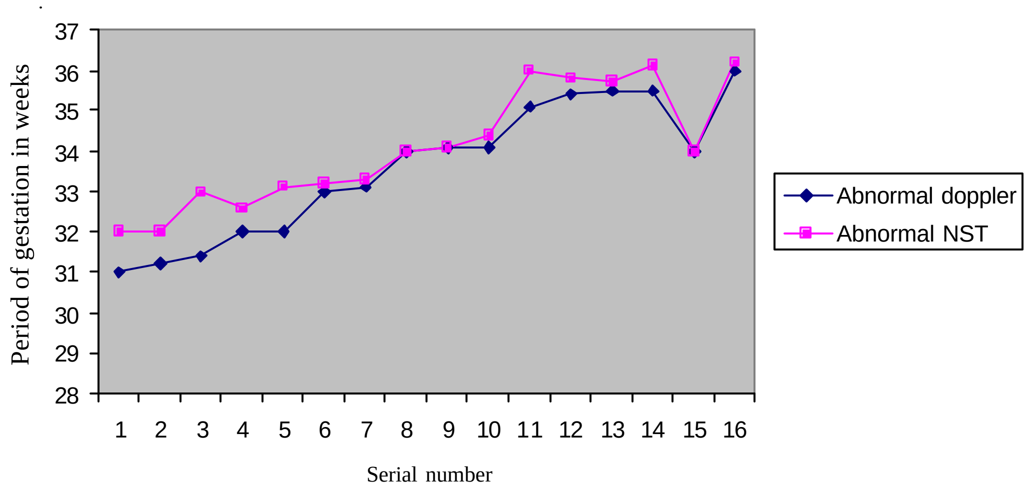

Figure 1. Time interval between abnormal doppler and abnormal NST in Group D (n=16).

Discussion

We have assessed fetal doppler and NST in a group of women with high risk pregnancy comprising of IUGR and/or preeclampsia. It is evident that when both NST and doppler are abnormal the baby weight and gestational age at birth are low while perinatal mortality and neonatal morbidity are high. Though both test results were effective in predicting abnormal outcome, the significant advantage of doppler over NST observed in our study in Group D was that doppler showed changes earlier than NST giving a significant lead time of up to 9 days with an average of 4.14 days. This lead-time is very important as babies can be delivered in this period or can be followed up in this interim period to gain a little more pulmonary maturity, which may be crucial for a preterm fetus. Steroid prophylaxis can be administered during this period in preterm fetuses. The significant lower birth weight of fetuses when both doppler and NST are abnormal (Group D) indicates that these fetuses suffer from a more severe degree of placental insufficiency.

Though doppler was abnormal in both B and D groups, perinatal outcome was better in Group B. 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 B. These babies were less compromised and were relatively more advanced in gestation. So early intervention was possible. 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 stillbirths to nearly fivefold while deaths before discharge fell by one third [5]. The hemodynamic changes picked up by doppler occur in the compensatory phase of growth restriction. Fetal heart rate abnormalities occur much later in the decompensation phase, which is a late sign of fetal compromise.

We observed that the lead-time is shorter in presence of preeclampsia. Arduini et al [6] 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 preterminal doppler changes like pulsatile umbilical vein and in preeclampsia. One interesting observation they made was that gestational age influenced this interval which we did not observe. 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 adaptations 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 preeclampsia resulting in shorter lead time.

Ott [7] studied the single doppler parameter MCA/UA S/D ratio in comparison with NST to predict the neonatal compromise in a larger group of 447 cases and concluded that combination of NST and MCA/UA PI ratio was excellent predictor of perinatal outcome. In his series there were cases of abnormal NST and normal MCA/UA results where some fetuses had neonatal morbidity. This was explained by the fact that loss of brain sparing effect in sick fetuses may have caused MCA/UA doppler to be normal. They also reported 10 cases of false positive NST with normal doppler, where neonates were healthy at birth. So it is important to view the entire clinical scenario rather than act only on the basis of test results. Doppler depicts chronic hypoxic changes while NST can detect acute events in presence or absence of chronic hypoxia. Our number in Group C is too small to show the significance of abnormal NST with normal doppler. Nevertheless NST is useful to detect acute fetal distress due to abruption, cord compression, and fetomaternal hemorrhage, which are not rare in these high risk cases.

Doppler can detect fetal adaptations like BSE occurring early in the decompensation cascade. A low PI in MCA and/or cerebroplacental ratio < 1.08 reflects it. In the study of 13 fetuses by Weiner et al [9] 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 opined that a loss of autonomic reactivity occurs first in the brain followed by similar response in the heart manifested by abnormalities in fetal heart patterns. Computerized ananlysis 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 [2]. In chronic hypoxia doppler changes occur first while abnormal fetal heart tracings represent late signs of fetal deterioration.

Combined fetal testing modalities such as doppler, NST and biophysical profile provide a wealth of information regarding fetal health. Integrated fetal testing would be ideal for individualized care of the preterm compromised fetus for timed intervention [9].

Disadvantages of doppler technic are the requirement of sophisticated equipment and a degree of operator skill and expertise. They may not be available in all centers. Advantages of NST include ease of use and interpretation, low cost, and minimal time required. Therefore it may remain the workhorse in detection of a compromised fetus in many hospitals.

Conclusion

Doppler is useful in recognizing fetal compromise earlier than nonstress test giving a lead time which is important in the management of preterm high risk pregnancies. An abnormal NST following an abnormal doppler is associated with the worst perinatal outcome. In cases with abnormal doppler if the prospects for neonatal survival are good, it is better to deliver the fetus before NST becomes abnormal. We observed that in cases with normal doppler, sudden abnormal NST indicates acute hypoxia. NST still holds its importance in fetal monitoring because of its ease of performance and cost effectiveness. But both the tests are complimentary to one another in fetal surveillance of high risk pregnancy. The clinical scenario however dictates the choice of the appropriate test.

References

1. American College of Obstetricians and Gynecologists ACOG Practice Bulletin (9, October 1999) – Antepartum fetal surveillance. *Int J Gynecol Obstet 2000;68:175-86.*
2. Harrington K, Carpenter RG, Nguyen M et al. Changes observed in doppler studies of the fetal circulation in pregnancies complicated by preeclampsia or the delivery of a small for gestational age baby- 1. Cross – sectional analysis. *Ultrasound Obstet Gynecol 1995;6:19-28.*
3. Gramellini D, Folli MC, Raboni S et al. Cerebral umbilical doppler ratio as a predictor of adverse perinatal outcome. *Obstet Gynecol 1992;79:416-20.*
4. Mari G, Deter RL. Middle cerebral artery flow velocity waveforms in normal and small-for gestational age fetuses. *Am J Obstet Gynecol 1992;66:1262-70.*
5. Hornbuckle J, Vail A, Spiegeljalter D et al. The GRIT study group. A randomized trial of timed delivery for the compromised preterm fetus; short-term outcomes and Baysian interpretation. *BJOG 2003;110:27-32.*
6. Arduini D, Rizzo G, Romanini C. The development of abnormal heart rate patterns after absent end diastolic velocity in umbilical artery: Analysis of risk factors. *Am J Obstet Gynecol 1993;168:43-50.*
7. Ott WJ. Comparison of the non-stress test with the evaluation of centralization of blood flow for the prediction of neonatal compromise. *Ultrasound Obstet Gynecol 1999;14:38-41.*
8. Weiner Z, Farmakides G, Schulman H et al. Central and peripheral hemodynamic changes in fetuses with absent end-diastolic velocity in umbilical artery. Correlation with computerized fetal heart rate pattern. *Am J Obstet Gynecol 1994;170:509-15.*
9. Baschat AA. Integrated fetal testing in growth restriction: Combining multivessel doppler and biophysical parameters. *Ultrasound Obstet Gynecol 2003;21: 1-8.*