

A Study of Cardiotocography in Hypertensive Disorders of Pregnancy and Its Correlation with the Neonatal Outcome

¹Priyadarshini Tiwari, ²Bharti Sahu, ³Pratibha Raghuvanshi, ⁴Rajesh Tiwari

ABSTRACT

Aim: To study the effect of antepartum and intrapartum surveillance with cardiotocography (CTG) on the neonatal morbidity and survival in cases of hypertensive disorders of pregnancy in a rural medical college hospital in Jabalpur.

Materials and methods: A total of 200 cases of hypertensive disorders > 32 weeks of gestation were subjected to antepartum and intrapartum surveillance with CTG. The neonatal outcome was recorded. This was compared with the records of 200 matched controls who had delivered in the department when CTG was not available. Statistical analysis was done in Statistical Package for the Social Sciences (SPSS) software with χ^2 test in 2×2 tables, and p-value < 0.05 was set as the value of a significant result.

Results: Cardiotocography led to a significantly higher number of induced labors (p < 0.05) and cesarean sections (p < 0.001). There was a significant reduction in neonatal mortality in the study group (p < 0.001).

Conclusion: Surveillance with CTG leads to improved neonatal survival, at the same time increasing the cesarean rates in cases of hypertensive disorders in pregnancy. Further methods such as fetal scalp blood sampling may have to be applied to reduce the high cesarean rate with CTG.

Keywords: Cardiotocography, Hypoxic ischemic encephalopathy (HIE), Hypertensive disorders, NST, Surveillance.

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INTRODUCTION

Electronic fetal heart monitoring is an important tool for assessing fetal well-being in pregnancy and labor. It is a simple and noninvasive tool that can predict fetal well-being in high-risk cases. Pregnancy-induced hypertension is a condition in which there is remarkable placental pathology that begins as early as the second trimester with the absence of remodeling of the spiral arterioles. Cardiotocography (CTG) is of value in the antepartum as well as the intrapartum management of patients with pregnancy-induced hypertension. In antepartum cases managed conservatively, it can quickly give a warning of the environment *in utero* becoming hostile for the fetus. In labor, a nonreactive trace gives a warning of potential asphyxia, which may be further evaluated according to the facilities available and due action be taken.

The aim of our study was to see the difference in the neonatal morbidity and mortality after the application of CTG in the antepartum surveillance of cases of hypertensive disorders in pregnancy as in these cases the newborn is at a high risk of birth asphyxia. Our study was conducted at the Department of Obstetrics and Gynecology, NSCB Medical College, Jabalpur, an underdeveloped rural area of Madhya Pradesh, India.

MATERIALS AND METHODS

This was a prospective case-control study conducted on cases of hypertension in pregnancy at NSCB Medical College, Jabalpur. A total of 200 cases of hypertension in pregnancy with gestational age more than 32 weeks were included in the study group. Hypertensive patients with gestational age more than 32 weeks who had delivered previously without CTG, when the technical method was not available at the institution, were taken as controls and their variables were taken from previous records. Cases of eclampsia and patients less than 32 weeks of gestation were excluded.

The study was conducted with the permission of the ethical committee of our institution, and written informed consent from all patients was taken.

In the study group, nonstress test (NST) was used as the parameter for fetal surveillance and was performed weekly, biweekly, on alternate days, or even daily depending on the severity of hypertension and the degree of fetal compromise.

^{1,2}Assistant Professor, ³Senior Resident, ⁴Associate Professor

¹⁻³Department of Obstetrics and Gynecology, Netaji Subhash Chandra Bose Medical College, Jabalpur, Madhya Pradesh, India

⁴Department of Community Medicine, Netaji Subhash Chandra Bose Medical College, Jabalpur, Madhya Pradesh, India

Corresponding Author: Priyadarshini Tiwari, R-2, Doctors' Colony, Medical College Campus, Jabalpur, Madhya Pradesh India, Phone: +919407339764, e-mail: drpriya2004@yahoo.co.in

The tracing was taken for 20 minutes and, if found unreactive, was extended for 40 minutes or a vibroacoustic stimulus was given.

Based on the presence or absence of at least two fetal heart rate (FHR) accelerations of 15 beats per minute lasting for 15 minutes in a 20-minute tracing, the results were classified as reactive test, nonreactive test, and suspicious or equivocal test. In the suspicious cases, testing was extended to 40 minutes. The patients were also subjected to intrapartum CTG whether the labor was spontaneous or induced, and in case of nonreassuring or abnormal finding, a decision for further intervention was taken.

The patients were followed up to the mode of delivery and the neonatal outcome was noted. The presence of fetal distress during labor as defined by FHR <100 or >160 with meconium staining of liquor was noted. The Apgar score at 1 minute and 5 minutes was noted. A 1-minute score <4 and a 5-minute score <7 were defined as abnormal. In case of neonatal intensive care unit (NICU) admission, the indication of admission and the duration of admission were noted. Neonatal deaths were recorded with the cause.

Statistical analysis was done in Statistical Package for the Social Sciences (SPSS) software. The chi-square test was applied in 2x2 tables and p-value <0.05 was set as the standard value for a significant result.

RESULTS

Of the total study cases, 179 had severe preeclampsia and 21 had mild preeclampsia. Controls had 158 cases of severe preeclampsia and 42 cases of mild preeclampsia. In the study group, out of the 179 cases of severe preeclampsia, 96 had a reactive NST, whereas 83 had a nonreactive NST. In the 21 cases of mild preeclampsia, NST was reactive in 12 and nonreactive in 9.

The mean gestational age in the study and control group was 37.6 ± 2.04 and 38.2 ± 1.94 respectively.

Labor was induced in 81 study cases and in 60 controls. Onset was spontaneous in 119 study cases and in 140 controls. The incidence of induced labor was significantly higher in the study group (p < 0.05) (Table 1).

A total of 107 patients delivered by cesarean section and 93 had a vaginal delivery. Of the cases who had a cesarean delivery, 70 had nonreactive NST, whereas 37 had reactive NST. Of the 93 who delivered vaginally, 22

Table 1: Distribution of subjects according to the onset of labor (spontaneous or induced)

Mode of onset	Study group	Control group
Induced	81 (40.5%)	60 (30.0%)
Spontaneous	119 (59.5%)	140 (70.0%)
Total	200	200

χ²=4.83, p<0.05 (significant)

Table 2: Comparison of subjects according to mode of delivery (vaginal or LSCS)

Mode of delivery	Study group	Control group
LSCS	107 (53.5%)	57 (28.5%)
Vaginal	93 (46.5%)	143 (71.5%)
Total	200	200

χ²=25.8, p<0.001 (highly significant); LSCS: Lower segment cesarean section

had nonreactive NST and 71 had reactive NST. Among the controls, 57 had a cesarean section, while 143 delivered vaginally (Table 2). The lower segment cesarean section (LSCS) rate in the study group was significantly higher in comparison to that of the controls (p < 0.001).

A total of 89 patients with reactive NST had normal 1-minute Apgar scores >4 and 19 had abnormal scores <4. Sixty-seven patients with nonreactive NST had a normal score >4, while 25 of the cases with nonreactive NST had an abnormal score <4. There was no statistically significant difference in the 1-minute Apgar scores of the patients in both groups (p > 0.05).

Among the 108 patients with reactive NST, 78 had normal 5-minute Apgar scores >7, while the rest had abnormal scores. In the 92 cases with nonreactive NST, 52 had Apgar scores >7, while 40 had abnormal scores >7 (Table 3), showing a statistically significant association of low 5-minute Apgar scores with nonreactive NST.

Seventy newborns in the study group were admitted to NICU, while 90 from the control group were admitted to the NICU. In the control group, indications for admission were more grave such as birth asphyxia and hypoxic ischemic encephalopathy (HIE). There were three admissions for mild birth asphyxia in the study group, whereas there were 50 admissions for birth asphyxia and HIE in the control group. This was a statistically highly significant observation (p < 0.0001) (Table 4).

Paradoxically the study group showed a longer duration of admission >7 days (40%) as compared with 16.8% controls, which was statistically significant (p < 0.05).

Table 3: Relation between NST and Apgar score at 5 minutes

NST	Apgar <7	Apgar >7	Total
Reactive	78 (72.0%)	30 (28.0%)	108
Nonreactive	52 (57.0%)	40 (43.0%)	92

χ²=5.38, p<0.05; NST: Nonstress test

Table 4: Number of admissions for HIE and birth asphyxia in the two groups

NICU admissions for birth asphyxia	Birth asphyxia and HIE present	Birth asphyxia and HIE absent
Study group	3	197
Control group	50	150

χ²=48.04, p<0.001 (highly significant); HIE: Hypoxic ischemic encephalopathy; NICU: Neonatal intensive care unit



Table 5: Comparison of neonatal survival in the two groups

Outcome of neonate	Study group	Control group
Survived	186 (93.0%)	163 (81.5%)
Died	14 (7.0%)	37 (18.5%)
Total	200	200

$\chi^2 = 11.8$, $p < 0.001$ (highly significant)

Table 6: Correlation of NST with the survival of the neonate

Result of NST	Neonatal death	Survived	Total
Reactive	1	107	108
Nonreactive	13	79	92

$\chi^2 = 13.3$, $p < 0.001$ (highly significant); NST: Nonstress test

Fourteen newborns in the study group (7%) died as compared with 37 newborns (18.5%) in the control group ($p < 0.001$) (Table 5).

Seventy-nine babies with nonreactive NST survived, while 13 died. Of the 108 cases with reactive NST, only one died and the cause of death was very low birth weight (Table 6). This shows a statistically significant difference in survival in the two groups ($p < 0.001$).

The sensitivity of NST for perinatal survival is 14%, specificity 99%, positive predictive value 92%, and negative predictive value 57%.

DISCUSSION

Cardiotocography is an investigation that has a high positive predictive value and a low negative predictive value.¹ Reactive NST in a study population shows a high prediction of favorable outcome. Nonreactive NST is an early predictor² of unfavorable outcome especially if coupled with other nonreassuring parameters such as decelerations, lack of variability, bradycardia, or tachycardia.

There is a higher incidence of suspicious or pathological tracings in cases of meconium staining of liquor though there may be no significant difference in the 5-minute Apgar scores.³

Intrapartum admission CTG is likely to increase the incidence of cesarean sections and instrumental deliveries.⁴ Continuous CTG in labor increases the incidence of cesarean sections and instrumental deliveries with a reduction in the incidence of neonatal seizures.⁵

Of the 179 cases of severe preeclampsia, 96 (53.6%) had a reactive NST, while the rest (83, or 46.4%) had a nonreactive NST. In the 21 cases with mild preeclampsia, 12 (57.5%) had a reactive, NST while 9 (42.5%) had a nonreactive NST. The severity of the hypertension did not have any significant correlation with the reactivity of NST ($p > 0.05$). This could probably signify that placental pathology of similar extent may exist irrespective of the fact whether the hypertension is mild or severe.

There was a significantly high incidence of induced labor and cesarean sections in the study group. Quick

detection of fetal hypoxia with NST leads to a rapid active intervention in the form of induction of labor or cesarean section as it is in the best interest of the fetus if it gets delivered when the *in utero* environment is rapidly becoming hostile to it. In the controls, fetal hypoxia was detected only when overt signs of fetal distress were seen.

The Apgar score at 1 minute was good in 82% of cases with reactive NST, while it was also high (> 4) in 73% patients with a nonreactive NST, showing no statistically significant difference in the two groups. Early detection of fetal hypoxia led to early interventions leading to better neonatal outcome. Significantly higher 5-minute Apgar scores in patients with reactive NST can be interpreted as the positive predictive value of NST with the fetuses with reactive NST having a favorable outcome in terms of the absence of asphyxia.

In the study group, the number of admissions to NICU was less as compared to those in the controls (70 and 90 respectively). The indications for admission in the control group were graver as compared to that in the study group. There were no admissions for HIE and only three admissions for mild birth asphyxia in the study group as against 50 admissions for HIE and birth asphyxia in the control population. The study group admissions were mainly for observation and low birth weight, and there was a statistically significant difference in the gravity of the indications for admission in the two groups. Neonatal mortality was significantly higher in the controls. Paradoxically the duration of stay in the NICU was significantly longer in the study group, but the paradox can be explained when it is understood that most of the neonates admitted to NICU in the control group died in the first few days of admission due to severe birth asphyxia. In the study group, a significantly larger number survived, which required a longer stay at NICU. The overall survival in the study population was better as compared with that in controls.

Cardiotocography is known to lead to a higher rate of cesarean sections. It is an investigation with a very good positive predictive value as was also proved in our study. Out of the 108 cases with reactive NST, only one baby died and the cause of death was very low birth weight. In those with nonreactive NST, 13 died and 79 survived. The good survival rate in the group with nonreactive NST is presumably based on two aspects: First the active interventions done in cases with nonreactive NST and, second, the low negative predictive value of the NST where a nonreactive NST is not an absolutely certain parameter of fetal acidemia. Rapid obstetric intervention in the case of a pathological CTG can still lead to a favorable neonatal outcome by minimizing the duration of fetal acidosis and improving the 5-minute Apgar scores.⁶

We have used a vibroacoustic stimulation (VAS) test in the case of nonreactive NST. A VAS can lead to increase in fetal movements and also an increase in the short-term variability in a high-risk pregnancy.^{7,8}

In computerized CTG, the short-term variability may be used as a predictor of the fetal well-being.^{9,10}

There are other investigations that may be used to confirm the findings of a nonreactive NST. A fetal scalp blood sampling may be used to confirm whether any acidosis ($\text{pH} < 7.25$) is present in the fetal blood. This intervention is likely to reduce the number of cesareans to be performed only on the basis of a nonreactive NST. Fetal scalp blood lactate sampling may be a better method of assessing fetal asphyxia as compared to fetal scalp blood pH sampling.¹¹

Apart from scalp blood sampling, fetal pulse oximetry and fetal electrocardiogram are also interventions that if used in conjunction with CTG may help in a reduction in the high LSCS rate. However, a combination of fetal pulse oximetry with CTG was not found to be effective in reducing the higher incidence of cesarean sections found with CTG alone.¹²

An integration of all parameters such as CTG, scalp blood sampling, umbilical artery Doppler studies, and antenatal biophysical profile scores can be more helpful in predicting the neonatal outcome as compared to a single parameter alone.¹³

Expert systems can be used in place of monitoring with CTG alone, but the usefulness of these systems requires further trials.¹⁴

Nonreassuring patterns on CTG may require confirmation with fetal scalp blood sampling. Newer modalities like fetal pulse oximetry, ST waveform analysis, and near-infrared spectroscopy require more studies to be recommended and at present are not recommended for routine surveillance as there is insufficient evidence to assess their efficacy in all patients.¹⁵

Our study was conducted in a tertiary care center in an underdeveloped rural area of Madhya Pradesh. Cardiotocography was an intervention that brought a significant change in the neonatal outcome though at the same time significantly increased the cesarean rate. Seventy-six percent of patients in the study group and 54% in the controls were from rural areas around Jabalpur. A total of 78.5% of the study population and 65% of the controls were unbooked cases. The lack of awareness for antenatal booking and unwillingness on the part of our patients to avail of the facilities available make it all the more undesirable to have a high rate of cesarean sections. Understandably the consequences of a next pregnancy after cesarean section under this obvious lack of awareness could be dire. In addition, Madhya Pradesh has the highest level of infant mortality (54%) and has

been at the rock bottom for the last 11 years in this regard. A patient who has a cesarean section could have a higher probability of ending up with an infant mortality and an unnecessary scar on the uterus, which would pose further difficulties in the next pregnancy.

It would be desirable to get the facilities for scalp blood sampling in our settings so that this high rate could be brought down. In addition, the decision for intervention should be based not just on the CTG but on an overall assessment based on the Doppler blood flow studies, the biophysical profile scores along with the NST.

CONCLUSION

There was a significant improvement in neonatal survival after CTG was used in cases of hypertensive disorders in pregnancy. At the same time, it led to a higher rate of induced labor and cesarean deliveries. It would be advisable to include fetal scalp blood sampling in our setting to help in bringing down the cesarean rate. The newer modalities such as fetal pulse oximetry, ST waveform analysis, and near-infrared spectroscopy may have a place in intrapartum surveillance only after sufficient studies have been conducted to prove their efficacy in the process of surveillance.

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