

Original Article

Association between Non-Reactive Cardiotocography and Increasing Caesarean Section Rates: Impact on Neonatal Outcomes

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Abstract

Background: The global increase in caesarean section (CS) rates has become a major public health concern, with non-reactive cardiotocography (CTG) frequently identified as a common indication. CTG is widely used for intrapartum fetal monitoring to assess fetal well-being; however, abnormal findings often lead to surgical intervention despite an inconsistent association with adverse neonatal outcomes.

Objective: This study aimed to evaluate the rising rate of caesarean sections performed due to non-reactive CTG and to determine the correlation between non-reactive CTG findings and neonatal outcomes.

Methodology: This prospective observational study was conducted in the department of Gynaecology and Obstetrics at Ad-din Women's Medical College and Hospital from May 2023 to October 2023, which included pregnant women who underwent caesarean section for non-reactive CTG. Neonatal outcomes were assessed using APGAR scores, NICU admission, and other clinical indicators to determine whether non-reactive CTG reliably predicts poor neonatal outcomes or contributes to potentially avoidable caesarean deliveries.

Results: Among 6,709 caesarean sections performed during the study period, 334 cases (4.98%) were due to non-reactive CTG. The mean maternal age was 25.7 ± 4.84 years and mean gestational age was 37.4 ± 2 weeks. CTG was performed antepartum in 58.7% and intrapartum in 41.3% of patients. Loss of variability was the most common abnormality (45.5%). Meconium-stained liquor and cord around the neck were observed in 21% and 28.4% of cases, respectively. Most newborns (78.1%) had APGAR scores >7 , while 20.4% required NICU admission and neonatal mortality was 4.8%.

Conclusion: Non-reactive CTG was associated with relatively favorable neonatal outcomes in most cases, suggesting possible overuse of caesarean delivery based solely on CTG findings.

Keywords: Non-reactive CTG; Caesarean section; APGAR score.

Introduction

Cardiotocography (CTG) uses an ultrasound transducer on the mother's abdomen to continuously record the fetal heart rate. CTG is widely used to evaluate fetal

health, especially in pregnancies when there is a higher chance of complications.¹ To identify prenatal hypoxia, cardiotocography (CTG) displays fetal heart activity and uterine contractions graphically.^{2, 3, 4} In most hospitals in

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affluent nations, it is the most widely utilized test for antepartum and intrapartum fetal surveillance.⁵

When a fetus's blood flow or oxygen exchange is disrupted prior to, during, or soon after birth, it can result in perinatal asphyxia. Due to reduced blood flow and oxygen to a fetus or child during the peripartum period, perinatal hypoxia can cause severe systemic and neurologic consequences.⁶ CTG can begin as early as week 28 of pregnancy. Nonetheless, the majority of medical professionals recommend doing it after the 32nd week. It is specifically used to track high-risk pregnancies brought on by diabetes, high blood pressure, and women who have had many infertility tests.⁷ The primary indicator of fetal distress during labor is abnormalities in cardiotocography, which could result in a marked rise in the rate of cesarean sections.⁸ The WHO reports that the rate of cesarean sections is 15%.⁹ According to several studies, the rate of cesarean sections due to fetal distress monitored by CTG ranges from 9.6% to 19%.^{8,10}

Interpretation of CTG tracing requires both qualitative and quantitative descriptions of several factors. This is commonly summarized using the acronym DR C BRAVADO:

- DR: Define Risk
- C: Contractions (uterine activity)
- BRA: Baseline fetal heart rate (FHR)
- V: Baseline FHR variability
- A: Presence of accelerations
- D: Periodic or episodic deceleration
- O: Changes or trends of FHR patterns over time.¹¹

CTG patterns are categorized as either normal (reassuring), suspicious (non-reassuring), or pathological (abnormal) according to National Institute for Health and Care Excellence (NICE) guidelines. If any one of the four criteria are missing, the pattern will be suspicious; if two or more aspects are missing, the trace will be pathological.¹² Over the past ten years, a number of interventions and supplementary modalities have been developed to maximize the utilization of continuous monitoring modalities and lower the high false positive rate. Fetal scalp stimulation (FSS), combined cardiotocographic-electrocardiographic monitoring, computer processing of fetal monitoring signals, and fetal blood sample (FBS) for pH and lactate measures are some of the currently available modalities.¹³ The purpose of this study is to determine the cesarean

section rate and neonatal outcome in women undergoing caesarean section due to nonreactive CTG.

Materials and Methods

A prospective observational study was carried out in the Department of Gynecology and Obstetrics at Ad-din Women's Medical College Hospital from May to October 2023. Ethical approval was obtained from the institutional review committee prior to the commencement of the study. The study included 334 pregnant women with a gestational age of 34 weeks or more, who were admitted through both the outpatient and emergency departments of Ad-din Women's Medical College Hospital, Dhaka. Informed consent was obtained from all participants prior to enrollment.

A detailed clinical examination of the patient was done. A systematic review was also done to see any comorbidities. All patients underwent for base line like CBC and specific investigations, especially Ultrasonography of pregnancy profile.

Inclusion Criteria:

- Pregnant women with a gestational age of 34 weeks or more presenting with non-reactive cardiotocography
- Cephalic presentation of fetus
- Singleton pregnancy

Exclusion Criteria:

- Gestational age <34 weeks
- History of previous cesarean section
- Presence of any other obstetrical indication for cesarean delivery
- Fetus with congenital anomalies
- Multiple gestation
- Severe antepartum hemorrhage

Based on FIGO criteria, CTG was defined as non-reactive when fetal tachycardia > 150 bpm, fetal bradycardia < 110 bpm, reduced or absent beat-to-beat variability, late deceleration, and extreme variable deceleration.¹⁴ All enrolled participants were observed and followed until delivery. Data were collected using a structured questionnaire, including demographic characteristics and clinical outcomes such as maternal age, parity, gestational age, neonatal APGAR scores at one and five minutes, birth weight, color of amniotic fluid, neonatal death, and the need for neonatal intensive care unit (NICU) admission. Quantitative variables were summarized as mean $\pm$ standard deviation (SD), while qualitative variables were presented as frequencies and percentages.

Results

The study was conducted on 334 patients at Ad-din Women's Medical College and Hospital. During the study period, a total of 6,709 cesarean sections were performed, with 4.98 (5%) attributed to non-reactive cardiotocography (CTG). Maternal age ranged from 20 to 39 years, with a mean $\pm$ standard deviation (SD) of 25.7 ± 4.84 years. Gestational age at delivery varied between 34 and 42 weeks, with a mean $\pm$ SD of 37.4 ± 2 weeks.

Table 1: Demographic Variables of Study Subjects

Age of the patients	No. of the patients (%)
20-24 years	187 (55.9)
25-29 years	75 (22.5)
30-34 years	46 (13.8)
35-39 years	26 (7.8)
Parity	
Primigravida	245 (73.4)
Multi Para	79 (23.7)
Grand Multi Para	10 (3)

The majority of patients, 187 (55.9%), were in the 20–24 years age group. Regarding parity, 245 (73.4%) were primigravida, 79 (23.7%) were multiparous, and 10 (3%) were grand multiparous.

Table 2: Distribution of Study Patients by Timing of CTG

Timing of CTG	No. of the patients (%)
Ante-partum	196 (58.7)
Intra-partum	138 (41.3)

In this study, cardiotocography (CTG) was performed ante-partum in 58.7% of patients and intra-partum in 41.3%, with the majority undergoing monitoring before labor to assess fetal well-being.

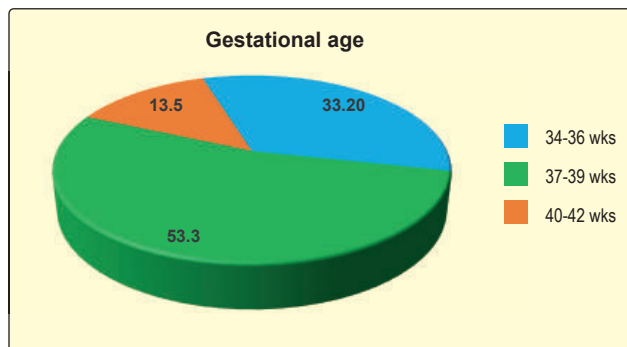


Figure 1: Gestational age distribution

The majority of patients, 178 (53.3%), were delivered between 37 and 39 weeks of gestation. Additionally, 111 (33.2%) delivered between 34 and 36 weeks, while 45 (13.5%) delivered between 40 and 42 weeks.

Table 3: Distribution of Patients by Abnormal CTGF finding

Abnormal CTG pattern	No. of the patients (%)
Deceleration	27 (8)
Non-reactive (absent of accelerations)	52 (15.6)
loss of variability	152 (45.5)
Sinusoidal pattern	8 (2.4)
Tachycardia	60 (18)
Bradycardia	35 (10.5)

In this study, 334 patients exhibited abnormal CTG patterns. The most common abnormality was loss of variability 152 (45.5%), followed by a non-reactive pattern (absent accelerations) in 52 (15.6%) and fetal tachycardia in 60 (18%). A smaller proportion showed bradycardia, decelerations, or a sinusoidal pattern.

Table 4: Per-operative Findings

Per-operative finding	No. of the patients (%)
Meconium stain liquor	70 (21)
Scanty liquor	92 (27.5)
Cord around the neck of the baby	95 (28.4)
Liquor normal in amount and colour	77 (23.1)

In this study, per-operative findings revealed meconium-stained liquor in 70 cases (21%), scanty amniotic fluid in 92 cases (27.5%), and umbilical cord around the neck in 95 cases (28.4%).

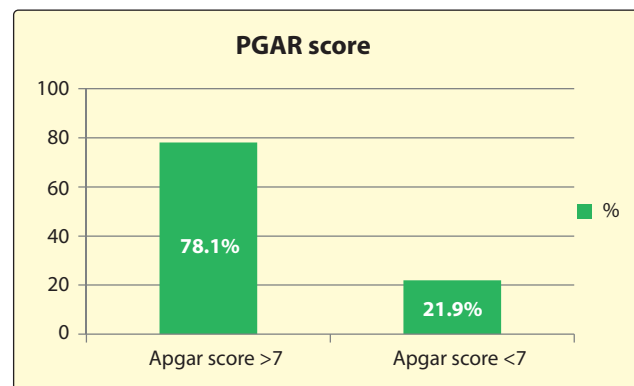


Figure 2: APGAR score

Based on the study, a satisfactory Apgar score (greater than 7) was observed in 261 babies (78.1%), while an Apgar score of less than 7 was found in 73 babies (21.9%).

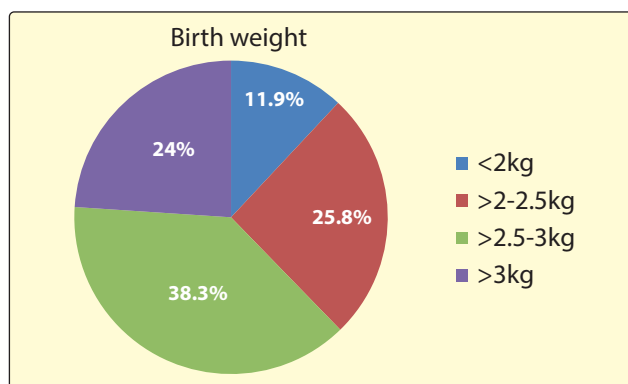


Figure 3: Birth weight of the neonate

In this study, neonatal birth weight was >2–2.5 kg in 86 babies (25.8%), >2.5–3 kg in 128 babies (38.3%), and >3 kg in 80 babies (24%).

Table 5: Neonatal Outcome

Neonatal outcome	No. of the Babies (%)
Immediate resuscitation needed	78 (23.4)
NICU admission	68 (20.4)
Neonatal death	16 (4.8)

Among 334 babies, 78 babies (23.4%) needed Immediate resuscitation, 68 babies (20.4%) required NICU admission and neonatal death occurred in 16 babies (4.8%).

Table 6: Evaluation of Neonatal Death in Different Cases (Medical Audit)

Sl no	Ges. age	Maternal risk factors	CTG (non-reactive)	Cause of death
1	40+ wks	Uncontrolled DM	Reduced Beat to variability	Birth wt 4kg Birth Asphyxia
2	38+	DM with HTN with Hypothyroidism	Deceleration	Birth wt 2.7kg Birth Asphyxia
3	34	PROM, Oligohydramnios, IUGR	Deceleration Tachycardia	Birth wt 1kg, SGA with prematurity
4	36	HTN, Oligohydramnios, IUGR	Reduced Beat to variability	Birth wt 1.6kg, SGA Birth Asphyxia
5	34	HTN, Oligohydramnios, IUGR	Deceleration Tachycardia	Birth wt 1kg, SGA with prematurity, Birth Asphyxia
6	35+	Severe Pre-eclampsia	Deceleration Bradycardia	Birth wt 1.9kg Birth Asphyxia
7	38	DM with HTN with Hypothyroidism	Reduced Beat to variability	Birth wt 4.5kg Birth Asphyxia
8	40	DM with anaemia	Deceleration Bradycardia	Birth wt 1.6kg, SGA, RDS
9	40	Obstructed labour	Reduced Beat to variability	Birth wt 3.5kg Birth Asphyxia
10	39	Oligohydramnios, IUGR	Reduced Beat to variability	Birth wt 1.5kg, SGA Birth Asphyxia
11	36	Severe Pre-eclampsia	Deceleration	Birth wt 1.8kg Birth Asphyxia
12	40	HTN	Deceleration	Birth wt 2.6kg Birth Asphyxia
13	36	PROM, Oligohydramnios, IUGR	Reduced Beat to variability	Birth wt 1.3kg, SGA Birth Asphyxia
14	37	DM, Severe Pre-eclampsia, IUGR	Reduced Beat to variability	Birth wt 1.7kg, SGA, RDS
15	34	PROM, Oligohydramnios, IUGR	Reduced Beat to variability	Birth wt 1.3kg, SGA with prematurity
16	35	Pre-eclampsia, Oligohydramnios,	Deceleration	Birth wt 1.7kg, SGA Birth Asphyxia

Discussion

Cardiotocography, or CTG, uses an ultrasound transducer that is positioned on the mother's abdomen to continuously measure the fetal heart rate. It is frequently used throughout pregnancy to evaluate the health of the fetus, especially in pregnancies with a higher risk of problems. To carry out interventions before the fetus is injured, CTG recording are used to detect when there is worry about fetal well being. Proper interpretation of CTG findings can help greatly decrease the health-related risk of newborns.¹⁵ The aim of electric fetal heart monitoring by cardiotocography was to identify fetuses affected by hypoxia during labour in a better way. Long term neonatal outcome did not show any benefit and caesarian section rates increased by four folds.¹⁶

In this study, the prevalence of cesarean sections (C/S) due to non-reactive cardiotocography (CTG) was 5%. A total of 334 pregnant women were included, with maternal age ranging from 20 to 39 years. The mean $\pm$ standard deviation of maternal age was 25.6 ± 4.84 years. A mean age of 26 ± 2.1 years in another study¹⁷. In comparison, our study observed a gestational age range of 34 to 42 weeks, with a mean $\pm$ standard deviation of 38.6 ± 2.37 weeks. The majority of patients, 178 (53.3%), delivered between 37 and 39 weeks of gestation, while 111 (33.2%) delivered between 34 and 36 weeks, and 45 (13.5%) delivered between 40 and 42 weeks. Another study found that approximately 51 (41.8%) of pregnant women delivered between 37 and 39 weeks of gestation.¹⁸ In this study, cardiotocography (CTG) was performed antepartum in 58.7% of patients and intrapartum in 41.3%. Another study reported antepartum CTG in 62% and intrapartum CTG in 38% of patients.¹⁹ In this study, 334 patients exhibited abnormal CTG patterns. The most common abnormality was loss of variability (45.5%), followed by a non-reactive pattern (absent accelerations) in 15.6%, fetal tachycardia in 18% and deceleration 8%. A smaller proportion showed bradycardia, or a sinusoidal pattern. In other study showed, 34% patient had deceleration of abnormal CTG, 20% had non-reactive (absent of acceleration), 22% had tachycardia and 6% absent beat to beat variability.¹⁹

In this study, per-operative findings revealed meconium-stained liquor in 70 babies (21%), scanty amniotic fluid in 92 babies (24.5%), and umbilical cord around the neck in 95 babies (28.4%). Another study reported that meconium-stained liquor was found in 43 cases (35.2%).¹⁸ In our study, of the 334 non-reactive CTG

cases, 73 babies (21.9%) had an APGAR score <7 at both 1 and 5 minutes, while 261 babies (78.1%) had an APGAR score >7 , which was statistically non-significant. A similar study showed that 69 babies (61.6%) had an APGAR score >7 , while 43 babies (38.4%) had an APGAR score <7 .¹⁷ In this study, neonatal birth weight was >2 – 2.5 kg in 86 babies (25.8%), >2.5 – 3 kg in 128 babies (38.3%), and >3 kg in 80 babies (24%). A related study reported that 67 babies (54.9%) had a birth weight ≤ 3 kg, while 55 babies (45.1%) had a birth weight >3 kg.¹⁸ Babies born with low Apgar score, required resuscitation and some of them required N ICU admission. NICU admission was done 68 (20.4%) babies and neonatal death was found 16 (4.8%) babies.

However, in the study by Leung TY, 11% of cases required emergency Caesarean delivery due to non-reassuring fetal status, and 9% due to poor labor progress.²⁰ A high prevalence of Caesarean sections has been associated with cardiotocographic abnormalities in other studies.²¹ When CTG was used in low-risk pregnancies, an increased rate of Caesarean deliveries was observed. According to guidelines for cardiotocography monitoring put forward by the National Institute for Clinical Excellence (NICE)²², the practice is advised on an as-needed basis for low-risk delivery but should be employed continuously for high-risk labour.

Limitation of the Study

Like all hospital-based studies, the present study has certain limitations. These limitations are acknowledged, and as a result, the findings may not be fully generalizable to the broader population at the national or global level. Due to the short duration of the trial, it was challenging to draw definitive conclusions regarding complications and mortality. Additionally, as the study population was drawn from a single hospital in Dhaka city, the findings may not accurately reflect the overall situation across the country. In the present study, early neonatal outcomes were assessed clinically. Further randomized studies with larger sample sizes, incorporating biochemical assessments such as umbilical cord blood gas analysis and fetal scalp pH, are recommended to validate these findings and provide more comprehensive insights.

Conclusion

Despite controversy over its impact on neonatal outcomes, CTG remains the most widely used method for fetal surveillance in developed countries. The study aimed to evaluate the increasing rate of caesarean

sections attributed to non-reactive CTG and to assess fetal outcomes in cases of abnormal CTG. CTG gives direct insight into fetal condition and serves well as a screening tool. It should not be the only factor in managing high-risk pregnancies. Abnormal CTG findings should be followed by further evaluations, such as amniotic fluid volume assessment, the oxytocin stress test, and a biophysical profile, before initiating any interventions.

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