

Cardiotocography as an Admission Test for Predicting Fetal Outcomes in Low-Risk Pregnant Women in Labour: A Prospective Observational Study

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Abstract

Background: Early identification of fetal distress during labour is crucial for reducing perinatal morbidity and mortality. It has been found that Cardiotocography (CTG) performed at the time of admission to the labour ward is a good rapid screening tool for assessment of fetal well-being even for low-risk pregnancies. The current study aimed to determine the CTG in predicting fetal outcomes among low-risk pregnant women admitted in labour and to determine its association with intrapartum and neonatal outcomes. **Material and Methods:** This prospective observational study was conducted in 75 low-risk term pregnant females admitted to a tertiary care teaching hospital. CTG was performed at admission for 20 minutes and, based on the findings, was classified as normal, suspicious, or pathological according to standard guidelines. The records were done for maternal and neonatal outcomes, including mode of delivery, meconium-stained liquor, fetal distress, Apgar scores, need for neonatal resuscitation, and NICU admission. Appropriate statistical tests were applied to determine the results. **Results:** The overall results showed 69.3% had normal CTG, 20% had suspicious CTG values, and 10.7% had Pathological CTG values. Further analysis found CTG was associated with significantly higher rates of cesarean section (50.0% vs. 5.8% in normal CTG; $p=0.008$), meconium-stained liquor (75.0%; $p<0.001$). Fetal parameters showed fetal distress (75.0%; $p<0.001$), low Apgar score at 1 minute (75.0%; $p<0.001$), low Apgar score at 5 minutes (50.0%; $p=0.002$), NICU admission (62.5%; $p<0.001$), and neonatal resuscitation (62.5%; $p<0.001$). Overall sensitivity of CTG was 78.6%, specificity of 82.0%, positive predictive value of 56.4%, negative predictive value of 92.8%, and overall diagnostic accuracy of 80.0% for predicting adverse fetal outcomes. **Conclusion:** This study found that admission CTG was a useful screening tool for identifying low-risk pregnant women at increased risk of adverse fetal outcomes. A normal admission CTG is strongly associated with favourable perinatal outcomes, while suspicious and pathological tracings are associated with increased operative delivery and neonatal morbidity. Its high negative predictive value supports its role in early intrapartum risk stratification.

Keywords: Admission Cardiotocography (CTG), Fetal Outcome, Low-Risk Pregnancy, labour, Neonatal Outcome, Fetal Distress.

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INTRODUCTION

Labour is a dynamic physiological process that involves intermittent reduction in uteroplacental blood flow associated with uterine contractions. This is a brief stress period for most healthy fetuses that does not have any adverse effect, due to the reserve capacity of the placenta and compensatory mechanisms. However, in a small number of cases, fetuses may already have compromised oxygenation at the start of labour, even though the pregnancy may be normal. Its early recognition is crucial as early obstetric intervention will decrease the risk of fetal hypoxia, birth asphyxia, neonatal morbidity, and perinatal mortality.^[1] The assessment of fetal well-being has improved considerably in the past few decades. Traditionally, intermittent auscultation of the fetal heart rate has been the standard method of intrapartum fetal surveillance in low-risk pregnancies. Intermittent auscultation is easy and common, but it can often miss subtle changes in fetal heart rate patterns that predict significant fetal compromise. In an attempt to better assess the fetal heartbeat in relation to the contraction, the introduction of electronic fetal monitoring cardiotocography (CTG) was aimed at earlier detection of fetal hypoxia and at

making appropriate clinical management.^[2,3] Cardiotocography (CTG) is used to monitor a fetal heart rate, baseline heart rate, accelerations, decelerations, and uterine activity. The interpretation of these parameters gives indirect information about the oxygenation and the autonomic nervous system functioning of the fetuses. A normal CTG tracing is generally reassuring of the fetal status, while abnormal or non-reassuring patterns can mean fetal hypoxia, acidemia, or other types of fetal compromise. However, the major limitation of CTG is the high rates of false-positive readings, and hence there is a concern that sometimes necessary operative deliveries may be performed without a significant improvement in neonatal outcomes.^[4,5] The

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concept of an admission CTG test was developed as a quick screening tool that would be done at the time of admission to the labour ward. CTG will be recorded for a period of about 20 minutes, and is designed to detect foetal compromise before active labour actually starts. Women who have a reassuring admission CTG can have the same routine monitoring during labour as those who have an acceptable CTG. Women with suspicious or pathological tracings can have more frequent monitoring for early interventions if required. This is especially useful in busy obstetric units where it may be impractical to monitor every labouring woman with continuous electronic monitoring due to limited resources.^[6] The utility of admission CTG is still a topic of debate in low-risk pregnancies. Some studies have shown that an abnormal admission CTG has been correlated with increased rates of meconium-stained liquor, fetal distress, operative delivery, low Apgar scores, neonatal intensive care unit (NICU) admission, and perinatal morbidity. However, other studies have questioned its utility in routine practice because of its low sensitivity and high rates of cesarean section without a significant improvement in neonatal outcome.^[7,8] Therefore, there are variations in the recommendations of professional organizations for routine admission CTG in women without known obstetric risk factors.^[3,9]

Admission CTG is a relatively inexpensive, non-invasive, and easy-to-perform tool for early evaluation of fetal well-being in developing countries where access to more advanced fetal surveillance techniques, like fetal scalp blood sampling or ST-segment analysis, is restricted. Its usefulness could be especially important in tertiary care centres providing care to many patients, where quick risk stratification could be of benefit in prioritising monitoring and optimising healthcare resources (10). Admission CTG has an uncertain predictive value in low-risk labouring women, and there is a need for further evaluation. This study was conducted to evaluate cardiotocography as a screening tool at admission in labour for low-risk mothers to predict outcomes of labour in the mother and baby and to identify the association between adverse neonatal outcome and mode of delivery.

MATERIALS AND METHODS

This prospective observational study was done in the Department of Obstetrics and Gynecology, Father Colombo Institute of Medical Sciences, Warangal, Telangana. Institutional ethical approval was obtained for the study. Written informed consent was obtained from all the participants of the study after explaining the nature of the study and possible outcomes in the vernacular language.

Inclusion Criteria

1. Pregnant women aged 18–35 years.
2. Singleton pregnancy.
3. Cephalic presentation.
4. Gestational age between 37 and 40 completed weeks.
5. Women in spontaneous or induced labour.
6. Intact or ruptured membranes with a reassuring antenatal course.

7. Low-risk pregnancy without significant maternal or fetal complications.
8. Willingness to participate in the study.

Exclusion Criteria

1. High-risk pregnancies such as hypertensive disorders of pregnancy, gestational diabetes mellitus requiring treatment, severe anemia, cardiac disease, renal disease, thyroid disorders, or other significant medical illnesses.
2. Multiple pregnancy.
3. Malpresentation.
4. Preterm labour (<37 weeks).
5. Known congenital fetal anomalies.
6. Intrauterine fetal demise.
7. Previous cesarean section or uterine scar.
8. Intrauterine growth restriction or oligohydramnios diagnosed antenatally.
9. Women refusing consent.

Based on the study inclusion and exclusion criteria, a total of n=75 consecutive pregnant women were enrolled for analysis in the study. The sample size was determined based on the expected number of eligible patients presenting during the study duration and the feasibility of conducting detailed intrapartum and neonatal follow-up within the available resources.

After the patient was admitted to the labour ward, a thorough obstetric history was taken, and a general, systemic, and obstetric examination was conducted. A predesigned data collection form was filled out to obtain baseline demographic and clinical information such as maternal age, parity, gestational age at booking, and obstetric history. Before active intrapartum management, each participant had an admission cardiotocography (CTG). The woman kept lying in the left lateral position or semi-recumbent position, and CTG was recorded for 20 minutes, using a conventional electronic fetal monitor. During that time, fetal heart rate and uterine contractions were monitored continuously.

The CTG tracings were analysed using the guidelines set by the National Institute for Health and Care Excellence (NICE) and were classified as:

1. Normal (Reassuring): All features are reassuring.
2. Suspicious: One non-reassuring feature with the remaining features reassuring.
3. Pathological: Two or more non-reassuring features or one or more abnormal features.

Labour was managed according to the hospital protocol. Decisions regarding augmentation of labour, operative vaginal delivery, or cesarean section were taken by the attending obstetrician based on the overall clinical condition and were not influenced solely by the study protocol. All mothers were followed until delivery, and neonatal outcomes were assessed immediately after birth.

The measures analysed were the association between CTG findings and fetal outcome. The mode of delivery, presence of meconium-stained liquor, fetal distress during labour, Apgar score at 1 minute and 5 minutes, requirement of neonatal resuscitation, admission to the neonatal intensive care unit, and early neonatal morbidity.

Statistical Analysis: The available data were uploaded to the Epi Info App and were analyzed. Continuous variables were expressed as mean $\pm$ standard deviation (SD), while categorical

variables were expressed as frequencies and percentages. Group differences were analyzed by the Chi-square test. Diagnostic performance of admission CTG for predicting adverse fetal outcomes was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy. A p-value <0.05 was considered statistically significant.

RESULTS

The baseline demographic and obstetric characteristics of the

cases in the study are presented in [Table 1]. The mean maternal age of the study participants was 26.4 ± 4.2 years range 18–35 years. The mean gestational age at admission was 39.1 ± 1.3 weeks range 37–40 weeks), indicating that most women were admitted at term. Regarding parity, 32 women (42.7%) were primigravida, and 43 women (57.3%) were multigravida. The majority of participants were booked cases (81.3%), while 18.7% were unbooked. Labour started spontaneously in 77.3%, whereas 22.7% underwent induction of labour. The mean duration of labour was 8.6 ± 3.4 hours. The mean birth weight of the newborns was 3105 ± 450 g, with a range of 2450–3850 g.

Table 1: Baseline Demographic and Obstetric Characteristics of the Study Population

Characteristic	Value
Maternal Age (years) Mean $\pm$ SD	26.4 ± 4.2
Range	18 - 35
Gestational Age (weeks)	
Mean $\pm$ SD	39.1 ± 1.3
Range	37 - 40
Parity	
Primigravida	32 (42.7%)
Multigravida	43 (57.3%)
Booking Status	
Booked	61 (81.3%)
Unbooked	14 (18.7%)
Mode of Onset of Labour	
Spontaneous	58 (77.3%)
Induced	17 (22.7%)
Duration of Labour (hours)	
Mean $\pm$ SD	8.6 ± 3.4
Birth Weight (grams) Mean $\pm$ SD	3105 ± 450
Range	2450 - 3850

Distribution of admission CTG findings in the study is given in [Table 2]. Among the 75 women, 69.3% had normal CTG tracings, 20.0% had suspicious tracings, and 10.7% had pathological tracings on admission. Thus, nearly one-third of

the study population showed non-reassuring or Pathological CTG findings despite being categorized as low-risk pregnancies.

Table 2: Distribution of Admission CTG Findings

Admission CTG Category	Frequency (N)	Percentage (%)
Normal (Reassuring)	52	69.30%
Suspicious	15	20.00%
Pathological	8	10.70%
Total	75	100%

The association between admission CTG and maternal and fetal outcomes is depicted in [Table 3]. Analysis of the table showed that there was a significant association between admission CTG category and mode of delivery ($p = 0.008$). 84.6% of cases with normal CTG findings had vaginal delivery. The values decreased progressively in the suspicious CTG group to 60% and the pathological CTG group to 25%. Interestingly, cesarean section rates increased from 5.8% in the normal CTG group to 20.0% in the suspicious group and 50.0% in the Pathological CTG group. The incidence of meconium-stained liquor increased significantly with worsening CTG findings, with significant p values. Similarly, fetal distress during labour was observed in only 3.8% of women with normal CTG, compared with 33.3% in the suspicious CTG group and 75.0% in the

Pathological CTG group ($p < 0.001$). Neonatal condition at birth also showed a significant relationship with admission CTG findings. An Apgar score <7 at 1 minute was recorded in 5.8% of neonates in the normal CTG group, 46.7% in the suspicious group, and 75.0% in the pathological group ($p < 0.001$). At 5 minutes, low Apgar scores persisted in 1.9%, 13.3%, and 50.0% of neonates, respectively ($p = 0.002$). The requirement for NICU admission increased significantly from 3.8% in the normal CTG group to 26.7% in the suspicious group and 62.5% in the pathological group ($p < 0.001$). Likewise, the need for neonatal resuscitation was significantly higher in neonates born to mothers with Pathological CTG (62.5%) compared with those with suspicious (20.0%) and normal CTG (1.9%) ($p < 0.001$).

Table 3: Association between Admission CTG and Fetal & Maternal Outcomes

Outcome Variable	Normal CTG (n=52)	Suspicious CTG (n=15)	Pathological CTG (n=8)	p-value
Mode of Delivery				
Normal Vaginal Delivery	44 (84.6%)	9 (60.0%)	2 (25.0%)	0.008
Instrumental Delivery	5 (9.6%)	3 (20.0%)	2 (25.0%)	
Cesarean Section	3 (5.8%)	3 (20.0%)	4 (50.0%)	
Meconium-Stained Liquor				
Present	4 (7.7%)	6 (40.0%)	6 (75.0%)	<0.001
Absent	48 (92.3%)	9 (60.0%)	2 (25.0%)	
Fetal Distress in Labour Present	2 (3.8%)	5 (33.3%)	6 (75.0%)	<0.001
Absent	50 (96.2%)	10 (66.7%)	2 (25.0%)	
Apgar Score at 1 Minute				
< 7	3 (5.8%)	7 (46.7%)	6 (75.0%)	<0.001
≥ 7	49 (94.2%)	8 (53.3%)	2 (25.0%)	
Apgar Score at 5 Minutes				
< 7	1 (1.9%)	2 (13.3%)	4 (50.0%)	0.002
≥ 7	51 (98.1%)	13 (86.7%)	4 (50.0%)	
NICU Admission				
Required	2 (3.8%)	4 (26.7%)	5 (62.5%)	<0.001
Not Required	50 (96.2%)	11 (73.3%)	3 (37.5%)	
Neonatal Resuscitation				
Required	1 (1.9%)	3 (20.0%)	5 (62.5%)	<0.001
Not Required	51 (98.1%)	12 (80.0%)	3 (37.5%)	

Diagnostic performance of admission CTG is given in [Table 4]. Admission CTG demonstrated a sensitivity of 78.6% and a specificity of 82.0% for predicting adverse fetal outcomes. The positive predictive value (PPV) was 56.4%,

while the negative predictive value (NPV) was 92.8%. The overall diagnostic accuracy of the admission CTG test was 80.0%.

Table 4: Diagnostic Performance of Admission CTG for Predicting Adverse Fetal Outcomes

Parameter	Value (%)	95% Confidence Interval
Sensitivity	78.60%	(52.4% - 92.4%)
Specificity	82.00%	(70.6% - 89.7%)
Positive Predictive Value (PPV)	56.40%	(38.9% - 72.4%)
Negative Predictive Value (NPV)	92.80%	(82.9% - 97.3%)
Overall Diagnostic Accuracy	80.00%	(69.7% - 87.5%)

DISCUSSION

This present study aimed to assess the usefulness of cardiotocography (CTG) as an admission test to predict fetal outcome of low-risk pregnant women admitted in labour. The results of this study showed that 69.3% of the women were with CTG tracing was normal, 20% was suspicious, and 10.7% was pathological. Although there were no antenatal risk factors, abnormal admission CTG was significantly associated with adverse intrapartum and neonatal outcomes. Most of the women in this study had normal CTG patterns, which is similar to the results reported by Rahman et al,^[8] who found a greater number of women with normal CTG patterns at admission, with a smaller proportion of women with abnormal and Pathological CTG patterns and poorer neonatal outcomes. A similar pattern of distribution of CTG has been reported by Bhat et al,^[7] indicating that only a small subset of the population of low-risk pregnancies may have fetal compromise, which becomes evident at labour. There was a correlation between the CTG category on admission and mode of delivery. The percentage of cesarean sections was much higher in Pathological CTG women (50.0%) than in normal CTG women (5.8%). This finding is consistent with previous studies reporting higher operative delivery rates with abnormal fetal heart rate patterns.^[4,6] This increased intervention rate may be related to fetal hypoxia

concerns and the need to hasten delivery. However, CTG is known to have a relatively high false-positive rate, and this limitation should be considered while making clinical decisions.^[4] The incidence of meconium-stained liquor and fetal distress during labour was significantly increased in cases with suspicious and Pathological CTG findings. It was found that Pathological CTG was correlated with meconium staining in 75% and fetal distress in 75% of cases, indicating that abnormal CTG results are indicative of impaired fetal oxygenation. The same association has also been reported in the past in observational studies, in which non-reassuring CTG patterns were associated with intrapartum hypoxia and acidemia.^[6,8] There was a clear gradient across CTG categories with regard to neonatal outcomes. The Pathological CTG group had significantly more low Apgar scores at both 1 and 5 minutes. Moreover, the higher the degree of the CTG's findings, the higher the number of admissions to the NICU and neonatal resuscitation. The findings are consistent with those of Ingemarsson et al,^[6] who showed that elevated neonatal morbidity and intensive neonatal care required were linked to an abnormal admission test. Other investigators have also described this relationship between Pathological CTG pattern and birth asphyxia and neonatal complications, including respiratory distress.^[8,11] The diagnostic performance in this study of CTG revealed 78.6% sensitivity, an 82.0% specificity, and an 80.0% overall diagnostic accuracy. The most significant was the high

negative predictive value, 92.8%, which suggested that a normal admission CTG result was a reliable predictor of a non-problematic labour. This reassuring value is highlighted in systematic reviews of intrapartum fetal surveillance.^[4] In resource-constrained areas, it can help to ensure that women with abnormal tracings are monitored continually and not intervened in if they have reassuring tracings. The limitations of this study were due to the relatively small size of the sample, which may limit its generalization. Also, this was a single-center study, and long-term follow-up was not performed due to time constraints.

CONCLUSION

In conclusion, this study found that admission CTG appears to be a valuable screening tool for low-risk pregnant women who are at a higher risk of adverse fetal outcomes. The normal tracing was significantly related to favorable neonatal outcomes, whereas the suspicious and pathological tracings were associated with increased operative delivery, fetal distress, decreased Apgar scores, NICU admission, and neonatal resuscitation. Therefore, selective use of admission CTG may aid early risk stratification and optimize intrapartum monitoring.

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Conflicts of interest

There are no conflicts of interest.

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