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Evaluation of perinatal and maternal outcomes by using EFM and admission CTG in a tertiary care center

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Abstract: *Background:* Electronic foetal heart rate monitoring (EFM) using cardiotocography (CTG) is crucial for assessing foetal well-being during labour and aiding in the early detection of intrapartum hypoxia. Admission CTG, short-term monitoring upon labour ward entry, identifies high-risk factors and guides subsequent interventions to prevent perinatal morbidity and mortality. *Methods:* A cross-sectional study conducted at Al Ameen Medical College and Hospital from August 2022 to July 2023 included booked and unbooked antenatal patients in latent labour. The study included 950 women in the first stage of labour in the low-(n=550) and high-risk (n=400) groups based on identified risk factors. Perinatal outcomes were assessed, including mode of delivery, liquor colour, APGAR scores, and NICU admissions. *Results:* High-risk factors such as hypertensive disorders (20%), anaemia (23.75%), gestational diabetes (6.25%), previous LSCS (37.50%), and post-date pregnancies (32.25%) were prevalent in the high-risk group. The majority of the participants were aged 20–30 years (52.7%), booked (39.2%), and presented at gestational ages ≥37 to <40 weeks (47.2%). Reactive CTG patterns were predominant in low-risk pregnancies (83.47%) and correlated with favourable perinatal outcomes. Equivocal and non-reactive CTG patterns in high-risk pregnancies were associated with compromised neonatal well-being, as evidenced by lower APGAR scores, increased resuscitation needs, higher NICU admissions, and perinatal deaths. *Conclusion:* Reactive CTG patterns are associated with positive perinatal outcomes, whereas equivocal and non-reactive patterns indicate heightened risks. Integrating risk stratification and CTG monitoring into obstetric protocols can enhance decision-making precision and improve the outcomes for both mothers and infants. This study highlights the need for further research on maternal risk management.

Keywords: Electronic foetal monitoring, Cardiotocography, Intrapartum hypoxia, Perinatal morbidity, High-risk pregnancy, Admission CTG, Sociodemographic parameters, Perinatal outcomes.

Introduction

Electronic foetal heart rate monitoring (EFM) involves the use of a cardiotocograph (CTG) to record the foetal heart rate (FHR) and determine foetal well-being to detect signs of intrapartum hypoxia. Assessment of foetal well-being in the labour ward by admission cardiotocography helps us to identify pre-existing high-risk factors and new factors that have recently appeared [1-3].

The admission CTG test is a short continuous electronic FHR monitoring for 20 minutes, along with a simultaneous recording of uterine activity performed immediately upon admission to the labour suit. If CTG is nonreactive then the patient will be given special treatment and test will be repeated and a decision will be taken according to repeat CTG traces in the labour room [4]. In India 20-30% of pregnancies belong to the high-risk category which is responsible for 75% of perinatal morbidities and mortalities. To prevent this, we needed a tool which led to the introduction of the Admission CTG. It is a noninvasive, brief foetal heart rate recording procedure immediately after admission to the labour ward that forecasts hypoxia encountered in the intrapartum period. Hypoxial injuries caused by stress and contractions during childbirth are sustained by the foetus [5].

The incidence of hypoxia during or before labour may lead to complications, such as mental retardation and cerebral palsy;

therefore, early diagnosis and encouraging response are essential for the foetus and mother [5-6]. CTG measures a baby's heart rate and it also screens the contractions in the womb (antenatally) at the same time, and monitors the baby for any signs of distress during labor [7]. Perinatal asphyxia is a deficiency of blood flow or gas interchange to or from the fetus before during or just after the birth process [8].

Perinatal asphyxia accounts for an estimated 900,000 deaths each year and is one of the primary causes of early neonatal mortality universally [9]. The first minute after a baby is born-the "Golden minute™"-is the critical frame for the commencement of neonatal revival among the 10 million nonbreathing babies born annually [10]. Perinatal birth asphyxia is a significant cause of acquired brain injury that occurs in the neonatal period. A consistent prompt marker for prophesying injury severity and consequence remains elusive [11]. This study was conducted to determine a simple, accurate, less time-consuming, non-invasive, and cost-effective method of foetal surveillance so that we can fulfil the dream of every mother with a healthy baby. The FHR tracings thus obtained are categorised according to the National Institute for Clinical Excellence clinical guidelines [12] as;

- Normal/Reactive/Reassuring: Baseline FHR 110–160 beats per minute (bpm), baseline variability > 5 bpm, or absence of any decelerations or at least two accelerations (> 15 bpm for > 15 s) for 20 min.
- Suspicious/equivocal: Moderate tachycardia (161–180 bpm)/ bradycardia (100–109 bpm) or reduced baseline variability (< 5bpm) for > 40 min but < 90 min, although the baseline heart rate remained normal (110–160 bpm) or there was deceleration (early/variable/late).
- Ominous/pathological: Baseline FHR >180 bpm or < 100 bpm or sinusoidal pattern >10 min (regular oscillation of baseline FHR with the absence of long-term variability) or baseline variability (< 5 bpm) for > 90 min.

The use of Admission CTG can serve as a valuable tool for triaging foetuses at risk of hypoxia by recording FHR and uterine activity over a period of 20 min during the admission of term antenatal women in the labour ward [6]. Early diagnosis using this method can prevent long-lasting foetal complications due to hypoxia through timely intervention. The present study was undertaken to evaluate the predictive role of admission CTG in identifying foetal hypoxia in term antenatal women while simultaneously examining its correlation with overall perinatal and maternal outcomes.

Material and Methods

Study Design: This cross-sectional study was conducted at the Al Ameen Medical College and Hospital between August 2022 and July 2023. Ethical approval was obtained from the institutional ethics committee. This study included both booked and unbooked antenatal patients admitted during the latent phase of labour.

Inclusion Criteria:

- Live, singleton, term pregnancy (≥ 37 weeks).
- Cephalic presentation during the first stage of spontaneous labour.
- Primigravida and multigravida women.

Exclusion Criteria:

- Gestation < 37 weeks.
- Induced labor.
- Multifetal gestation.
- Abnormal lie or presentation.
- Congenital malformation.
- Previous caesarean section.
- Abruption.
- Cord prolapse.
- Uterine rupture.
- Second-Stage Labour Presentation.

Consecutive sampling was employed to select participants to ensure a representative sample. Written informed consent was obtained from all participants in their respective languages, explaining the purpose and procedures of the study. Sociodemographic parameters including age, religion, occupation, registration status, gravidity, parity, number of live children, and current gestational age were recorded.

The stage of labour was determined through bimanual examinations. Cardiotocography (CTG) recordings were conducted for 20 minutes in a semi-lateral position using

external abdominal transducers. SPSS Statistics version 21 software was used for data analysis. Variables measured on a nominal scale were described using frequency and proportion.

Results

Among the 950 women admitted to the labour ward in the first stage of labour, 550 were considered low-risk pregnancies, and 400 were deemed high-risk. The high-risk factors observed included hypertensive disorders of pregnancy (20%), anaemia (23.75%), diabetes mellitus (6.25%), previous abortions (2.25%), previous LSCS (37.50%), cardiac disease (3.75%), gestational hypothyroidism (5.50%), other medical conditions (1.25%), Rh incompatibility (7%), oligohydramnios (17.25%), foetal growth restriction (18.75%), and post-date (32.25%). The mean age and gestation of the women at the time of admission were 24.76 ± 2.98 years and 38.83 ± 1.09 weeks, respectively. The majority of the participants were multigravidas (%), and approximately % were booked (Table-1).

Table-1: Comparison of pregnancy risk with admission CTG trace (n=950)

Pregnancy risk	Admission CTG trace			Total
	Reactive	Equivocal	Nonreactive	
Low risk	499 (90.7%	28 (5.1%)	23 (4.2%)	550
High risk	295 (73.8%)	52 (13%)	53 (13.2%)	400
Total	794 (83.6%)	80 (8.4%)	76 (8%)	950

The present study enrolled a diverse cohort of pregnant women, with the majority falling within the age range of ≥20 to <30 years (850, 52.7%), followed by ≥30 to <35 years (80, 4.9%), and > 35 years (20, 1.2%). Concerning registration status, 650 women were booked (39.2%), whereas 300 were unbooked (17.7%). In terms of gestational age, the majority were in the ≥37 to <40 weeks category (782, 47.2%), followed by ≥40 to <42 weeks (129, 7.5%), and >42 weeks (39, 2.3%). Regarding gravidity, 628 participants were primigravida (36.4%) and 322 were multigravida (18.8%). Categorisation based on risk factors revealed 550 women in the low-risk group (31.7%) and 400 in the high-risk group (23.6%) (Figure 1).

Fig-1: Sociodemographic features

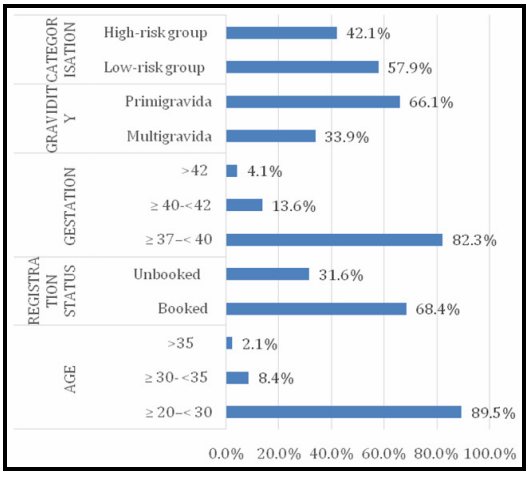
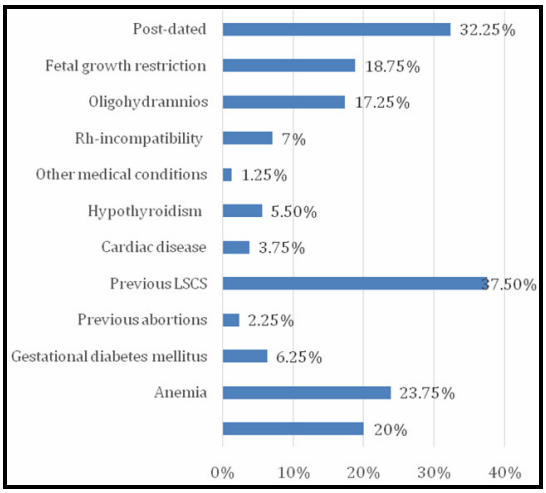


Fig-2: High-risk factors present in study patients (n=400)



Hypertensive disorders of pregnancy affected 20% of the patients, whereas anaemia was observed in 23.75% of the cases. Gestational diabetes mellitus was diagnosed in 6.25% of the cohort and previous abortions were reported in 2.50% of the patients. A significant proportion (37.50 %) had a history of lower segment caesarean section (LSCS), indicating a heightened risk profile. Cardiac disease and hypothyroidism were identified in 3.75% and 5.50% of the patients, respectively, while other medical conditions were reported in 1.25% of the cohort. Rh-incompatibility affected 7.00% of the patients.

Oligohydramnios and foetal growth restriction were present in 17.25% and 18.75% of the cases, respectively. Postdated pregnancies constituted 32.25% of the cohort (Figure 2).

In the low-risk category, 90.7% of the participants displayed Reactive CTG patterns, while 5.1% were classified as equivocal and 4.2% as non-reactive. In contrast, the high-risk group 73.8% had reactive, 13% equivocal, and 13.2% Nonreactive CTG patterns. In summary, 83.6% of the total cohort exhibited Reactive CTG patterns, 8.4% were classified as equivocal, and 8% as non-reactive. Admission CTG is screening test in patient in labour, low risk patient then can be followed by intermittent auscultation. High risk patient had continuous CTG monitoring. Patient who had equivocal CTG, were given left lateral position and hydrated with iv fluids then Repeated CTG after 2 hours.

A total of 498 (62.71%) neonates in the Reactive CTG trace group had an Apgar score below 7 at 1 min, and 52 (6.55%) had a score below 7 at 5 min. Neonatal resuscitation was required in 15 cases (1.89%), and 2 neonates (0.25%) were admitted to the Neonatal Intensive Care Unit (NICU). Importantly, no perinatal deaths occurred in this group. In contrast, the Equivocal CTG trace group showed increases in instrumental delivery (2.50%) and LSCS (20.83%) rates, as well as a higher incidence of meconium-stained liquor (64.44%). Apgar scores < 7 at 1 and 5 min were observed in 72 (90%) and 22 (27.50%) cases, respectively. Neonatal resuscitation was required in 17 cases (21.25%), with 9 neonates (11.25%) admitted to the NICU. One case (1.25%) resulted in perinatal mortality. The non-reactive CTG trace group showed a higher frequency of LSCS (61.84%) and a higher incidence of meconium-stained liquor (88.16%). Apgar scores < 7 at 1 and 5 min were observed in 75 (98.68%) and 35 (46.05%) cases, respectively. Neonatal resuscitation was required in 30 cases (39.47%), and 30 neonates (39.47%) were admitted to the NICU. Notably, perinatal deaths were higher in this group, accounting for 15 (19.74 %) cases (Table 2).

Table-2: Comparison of admission CTG trace with perinatal outcomes

Perinatal outcomes	Admission CTG Trace		
	Reactive	Equivocal	Nonreactive
	794	80	76
Mode of delivery			
Vaginal delivery	722 (90.9%)	58 (72.5%)	10 (13.2%)
Instrumental delivery	25 (3.1%)	2 (2.5%)	5 (6.6%)
LSCS	47 (5.9%)	20 (25%)	61 (80.3%)
Meconium stained liquor	120 (15.1%)	492 62%)	338 (42.6%)
APGAR <7@1m	498 (90.5%)	72 (76.6%)	75 (22.2%)
APGAR <7@5m	52 (9.25%)	22 (23.4%)	35 (10.4%)
Neonatal resuscitation	15 (1.9%)	17 (21.3%)	30 (39.5%)
NICU admission	2 (0.3%)	9 (11.3%)	30 (39.5%)
Perinatal deaths	0 (0%)	1 (1.3%)	15 (19.7%)

Discussion

Admission CTG or the admission test is the most commonly used test for the surveillance of foetal well-being, especially in high-risk pregnancies worldwide [13]. The current study offers a comprehensive exploration of perinatal outcomes in a sizable cohort of 950 women admitted to the labour ward during the first stage of labour. The stratification of the cohort into low-risk (550) and high-risk (400) pregnancies based on the identified risk factors has allowed for a nuanced examination of maternal and foetal well-being in distinct clinical scenarios. The sociodemographic characteristics revealed a broad spectrum of maternal age, with the

majority falling within the age range of ≥20 to <30 years (52.7%), followed by ≥30 to <35 years (4.9%), and > 35 years (1.2%). This study was conducted to assess the utility of admission CTG as a predictor of neonatal outcomes in a cohort of over 150 low-risk and high-risk pregnant women [14].

Among the enrolled patients, 550 were classified as low-risk pregnancies, whereas 400 were designated as high-risk pregnancies. Examining the risk factors, the prevalence of hypertensive disorders of pregnancy (20%), anaemia (23.75%), and gestational diabetes mellitus (6.25%) underscores the diverse spectrum of conditions contributing to high-risk pregnancies. According to Bhartiya et al., among the 200 women surveyed, anaemia was the most frequently identified risk factor [14]. The prevalence of previous LSCS (37.50%) indicates that a substantial proportion of women with a history of caesarean deliveries require careful management decisions in subsequent pregnancies. According to Kumar et al., the prevalence of LSCS was 23.0% in a study of 100 patients, which is similar to the findings of our study [15].

The association between pregnancy risk and CTG trace patterns at admission is a crucial aspect of this study. The majority of low-risk pregnancies exhibited Reactive CTG patterns (52.53%), emphasising favourable foetal well-being in this group. In contrast, the high-risk group displayed a lower proportion of Reactive CTG patterns (31.05%), indicating a potential compromise in foetal well-being in the presence of risk factors. Our study findings were potentially similar to those of Kumar et al., where an admission CTG was reactive in 67% (47 in the lower-risk group and 20 in the high-risk group) [15].

The outcomes of a study conducted on 160 pregnant women at term revealed that in 77% of the cases, the admission CTG was reactive. In 14.4% of the cases, it was found to be equivocal, and in 8.7% of the cases, it was ominous. Additionally, the study reported that meconium-stained fluid was more frequently observed in women with ominous tracing, accounting for 72% of such cases [16]. In correlation to our study, similar results were also reported in our study, where a significant correlation was reported between non-reactive (suspicious ominous) admission CTG results and meconium-stained fluid. [6, 17].

Our study also reported that in reactive CTG patterns, 62.71% of neonates exhibited APGAR scores below 7 at 1 min, while 6.55% had scores below 7 at 5 minutes. Despite the lower APGAR scores at 1 min, this group demonstrated a reassuring trend, with the majority achieving satisfactory scores by 5 min. Neonatal resuscitation was relatively low (1.89%) and NICU admissions were minimal (0.25%). Remarkably, there were no reported perinatal deaths in this subgroup, emphasising the overall favourable perinatal outcomes associated with reactive CTG patterns. In contrast, the equivocal CTG trace group exhibited a higher proportion of neonates with APGAR scores < 7 at 1 min (90%) and 5 min (27.50%).

This finding aligns with the compromised foetal well-being suggested by the Equivocal CTG pattern. Neonatal resuscitation was required in a higher percentage (21.25%) of cases, and NICU admissions were observed in 11.25% of neonates in this group. Unfortunately, one case (1.25%) resulted in perinatal death, highlighting the clinical significance of an equivocal CTG pattern in predicting adverse neonatal outcomes. Neonatal resuscitation was substantially higher (39.47%), reflecting the immediate intervention required to stabilise compromised neonates.

NICU admissions were reported in 39.47% of the cases, further emphasising the heightened vulnerability of neonates with a non-reactive CTG pattern. Notably, perinatal deaths were the most prevalent in this group, accounting for 19.74% of cases, underscoring the critical role of CTG monitoring in identifying pregnancies at a significant risk of adverse outcomes. A significant correlation was also reported by Kumar et al., in which neonatal Apgar scores, need for resuscitation, and NICU admission were more prevalent in patients with ominous or suspicious admission CTG [15]. In addition, a study conducted by Thapa et al. revealed a highly significant correlation between poor Apgar scores at birth and the need for neonatal resuscitation in

patients between suspicious/ominous admission CTG tests [18].

The association between admission CTG patterns and Apgar scores provides valuable clinical insight. Reactive CTG patterns, indicative of adequate foetal oxygenation and perfusion, are associated with better immediate neonatal well-being, as evidenced by higher Apgar scores and a lower incidence of neonatal resuscitation and NICU admissions. In contrast, equivocal and non-reactive CTG patterns, reflecting compromised foetal well-being, are associated with lower Apgar scores, an increased need for neonatal resuscitation, higher NICU admissions, and a higher incidence of perinatal deaths.

The use of CTG patterns has proven to be advantageous in determining perinatal and pregnancy outcomes in patients. A systematic review revealed that the admission CTG specificity was between 78-98%, while the NPV was between 67-99%. These findings highlight the crucial role of CTG in pregnancy [19].

Conclusion

This study sheds light on the intricate relationship between maternal risk factors, intrapartum monitoring, and perinatal outcomes. The research unveils a connection between pregnancy risk and CTG patterns, illustrating varying foetal monitoring profiles that highlight the potential impact of risk factors on foetal well-being.

It is noteworthy that Reactive CTG patterns are indicative of favourable perinatal outcomes, while Equivocal and Non-reactive patterns correlate with compromised neonatal well-being and elevated risks. By integrating risk stratification and CTG monitoring into obstetric management protocols, clinicians can improve the precision of their decisions, ultimately enhancing outcomes for both mothers and infants. Further investigations delving into the long-term implications of identified risk factors and refining risk-based management strategies are crucial to advance the field of maternal-foetal medicine.

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