



ORIGINAL ARTICLE

Reliability of Admission Cardiotocography with and without Amniotic Fluid Index in Predicting Maternal and Fetal Outcomes: A Comparative Observational Study

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Accepted: 22-November-2025 / Published Online: 4-December-2025

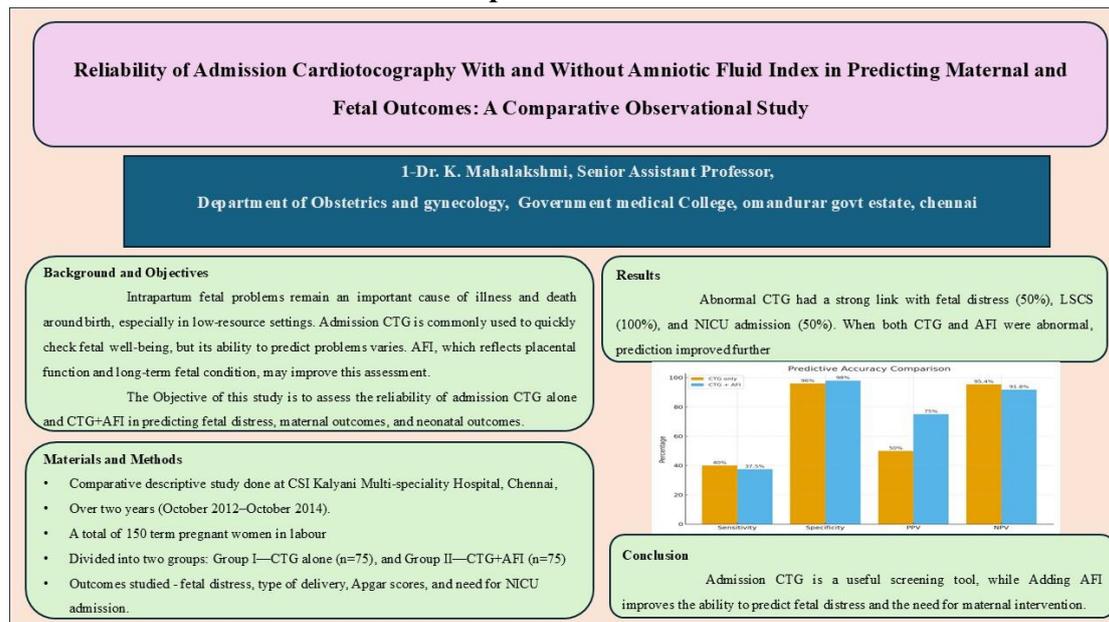
Abstract

Background: Intrapartum fetal problems remain an important cause of illness and death around birth, especially in low-resource settings. Admission CTG is commonly used to quickly check fetal well-being, but its ability to predict problems varies. AFI, which reflects placental function and long-term fetal condition, may improve this assessment. **Objectives:** To assess the reliability of admission CTG alone and CTG+AFI in predicting fetal distress, maternal outcomes, and neonatal outcomes. **Methods:** This comparative descriptive study was carried out at CSI Kalyani Multispecialty Hospital, Chennai, over two years (October 2012–October 2014). A total of 150 term pregnant women in labour were included and divided into two equal groups: Group I—CTG alone, and Group II—CTG+AFI. CTG tracings were labelled as normal, suspicious, or abnormal. AFI was grouped as oligohydramnios (≤ 5 cm), borderline (5.1–8 cm), and normal (8.1–20 cm). Outcomes studied were fetal distress, type of delivery, Apgar scores, and need for NICU admission. **Results:** Normal CTG was seen in most women—88% in Group I and 89.3% in Group II. Oligohydramnios was present in 11% of cases. Abnormal CTG had a strong link with fetal distress (50%), LSCS (100%), and NICU admission (50%). When both CTG and AFI were abnormal, prediction improved further: fetal distress was seen in 75% and NICU admission in 50%. Specificity was high (98%) and NPV was good (91.8%), but sensitivity stayed low (37.5%). **Conclusion:** Admission CTG is a useful screening tool with high specificity to rule out fetal compromise. Adding AFI improves the ability to predict fetal distress and the need for maternal intervention. However, abnormal CTG or AFI patterns also lead to more operative deliveries without a matching improvement in newborn outcomes. Careful interpretation is needed to avoid unnecessary interventions.

Keywords: Cardiotocography, Admission Test, Amniotic Fluid Index, Fetal Distress, Neonatal Outcome, MBPP

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Graphical Abstract



Introduction

Intrapartum hypoxia is still one of the main preventable causes of illness and death around the time of birth in developing countries [1]. Even when women are assessed as low risk during pregnancy, about 20% can develop problems during labour [2]. For this reason, continuous fetal monitoring with cardiotocography (CTG) has been used worldwide since the mid-20th century to pick up early signs of fetal hypoxia [3]. The admission test (AT) is a 20-minute CTG done when the woman is admitted to the labour ward. Its purpose is to quickly identify fetuses who may develop distress during labour [4]. A normal CTG at admission is usually reassuring for the next 1–2 hours, whereas suspicious or abnormal tracings indicate the need for closer monitoring or intervention [5].

However, CTG alone has a high false-positive rate, which may lead to an increased number of unnecessary operative deliveries [6]. CTG patterns can also be influenced by other factors such as

maternal fever, drugs, fetal sleep, and prematurity [7]. The amniotic fluid index (AFI) is a well-known marker of long-term placental function. Low amniotic fluid (oligohydramnios, AFI ≤ 5 cm) is linked to more frequent fetal heart rate abnormalities, cord compression, meconium-stained liquor, and a higher chance of operative delivery for fetal distress [8,9]. Using AFI together with CTG may therefore help to better identify women who are truly at risk.

In India, many labour wards are busy and have limited staff, so the admission test is still widely used as a triage tool. However, only a few studies have compared the effectiveness of CTG alone with CTG plus AFI in Indian women.

Objectives

To assess the reliability of admission CTG alone and CTG+AFI in predicting fetal distress, maternal outcomes, and neonatal outcomes.

Materials and Methods

This comparative descriptive study was conducted in the Department of Obstetrics and Gynaecology at CSI Kalyani Multispeciality Hospital, Mylapore, Chennai, over a two-year period from October 2012 to October 2014. The required sample size was calculated using the standard formula for estimating a single proportion, $n = Z\alpha/2p(1-p)/d^2$. Considering the hospital statistics, A prevalence of fetal distress (p) of 0.11, an absolute precision (d) of 0.05, and a 95% confidence level corresponding to a Z -value of 1.96 were applied. Based on these parameters, the estimated sample size was 150.4, and the final sample size was rounded to 150 participants.

Eligible participants included women with term pregnancies (≥ 37 weeks), carrying a singleton fetus in cephalic presentation, and in spontaneous or induced labour. High-risk pregnancies such as gestational diabetes mellitus, hypothyroidism, preeclampsia, anaemia, premature rupture of membranes, bad obstetric history, and intrauterine growth restriction were also included. Exclusion criteria comprised gestational age < 36 weeks, multiple gestation, non-cephalic presentations, previous lower-segment caesarean section, acute obstetric emergencies requiring immediate operative intervention (such as abruption or severe fetal bradycardia), and fetuses with lethal congenital anomalies.

Participants were allocated into two study groups: Group I ($n = 75$), in which cardiotocography (CTG) alone was assessed, and Group II ($n = 75$), in which CTG was evaluated in combination with amniotic fluid index (AFI). CTG tracings were interpreted according to the NICE guidelines, classifying patterns as normal,

suspicious, or abnormal. AFI was measured using the four-quadrant Phelan method and categorised as oligohydramnios (≤ 5 cm), borderline (5.1–8 cm), or normal (8.1–20 cm).

Outcomes assessed included maternal outcomes such as mode of delivery, fetal outcomes including evidence of fetal distress, and neonatal outcomes such as Apgar scores and need for NICU admission. Data were analysed using SPSS version 16. The Chi-square test was used to examine associations between variables, and diagnostic performance was evaluated using sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). A p -value < 0.05 was considered statistically significant. Institutional Ethics Committee approval was obtained and written informed consent was taken from the study participants before the start of the study.

Results

The baseline characteristics were comparable between the two groups. There was no statistically significant difference in age distribution ($p = 0.119$) or parity ($p = 0.954$) between Group I (CTG only) and Group II (CTG+AFI). The proportion of low-risk and high-risk pregnancies was similar across groups ($p = 1.000$). Among high-risk categories—including preeclampsia, GDM, anaemia, PROM, hypothyroidism, and multiple risk factors—none showed significant differences between the groups, although PROM ($p = 0.067$) and multiple risk factors ($p = 0.080$) showed borderline variation. Overall, both groups were comparable with respect to maternal demographic and risk characteristics.

In both groups, most women had a normal CTG pattern. However, when the amniotic fluid was low (oligohydramnios, AFI ≤ 5 cm), abnormal CTG was much more common (50%) compared with women whose AFI was more than 5 cm (only 6% abnormal CTG). This difference

was statistically significant ($p = 0.0001$). These findings show that AFI provides additional useful information and improves the ability of the admission CTG to predict fetal distress. Tables 1-3 present the distribution of baseline characteristics.

Table 1. Baseline Maternal Characteristics (N = 150)

Variable	Group I (CTG only) n=75	%	Group II (CTG + AFI) n=75	%
Age (years)				
15–20	0	0	3	4
21–25	32	43	25	33
26–30	30	40	24	32
31–35	11	15	20	27
>35	2	3	3	4
Parity				
Primigravida	39	52	42	56
Gravida 2	22	29	15	20
Gravida 3	10	13	12	16
Gravida 4+	4	5	6	8
Risk status				
Low risk cases	39	52%	38	50.7%
High risk cases	36	48%	37	49.3%
High risk cases				
Preeclampsia	2	6%	2	5.4%
GDM	15	42%	13	35.1%
Anaemia	2	6%	2	5.4%
PROM	5	14%	13	35.1%
Hypothyroid	4	11%	5	13.5%
Others (Multiple combination of risk factors)	8	22%	2	5.4%
AFI (Group II)	—	—		
≤ 5 cm	—	—	8	11

Variable	Group I (CTG only) n=75	%	Group II (CTG + AFI) n=75	%
5.1–8 cm	—	—	24	32
8.1–20 cm	—	—	43	57

Table 2. Admission Test Findings (CTG and AFI)

Parameter	Group I (CTG only)	%	Group II (CTG + AFI)	%
CTG Pattern				
Normal	66	88	67	89.3
Suspicious	5	7	5	6.7
Abnormal	4	5	3	4
Correlation between CTG & AFI (Group II)				
AFI >5 cm + Normal CTG	63	94	—	—
AFI >5 cm + Abnormal CTG	4	6	—	—
AFI ≤5 cm + Normal CTG	4	50	—	—
AFI ≤5 cm + Abnormal CTG	4	50	—	—
p-value	0.0001 (significant association)			

Table 3. Maternal and Neonatal Outcomes vs Admission Test Findings

Test Category	Normal Delivery	LSCS	Instrumental	Fetal Distress	NICU Admission
CTG – Normal (n=66)	56	6	4	Low	Very low
CTG – Suspicious (n=5)	0	3	2	Moderate	Moderate
CTG – Abnormal (n=4)	0	4	0	High	High (50%)
CTG+AFI – Both Normal (n=61)	52	6	3	Minimal	Minimal
CTG+AFI – Both Abnormal (n=4)	0	3	1	Very high (75%)	High (50%)
Normal CTG +	2	3	1	Moderate	Moderate

Test Category	Normal Delivery	LSCS	Instrumental	Fetal Distress	NICU Admission
Abnormal AFI (n=6)					
Abnormal CTG + Normal AFI (n=4)	1	2	1	Moderate–High	Moderate

Abnormal CTG was very strongly linked to caesarean delivery (LSCS), with all such cases ending in LSCS (100%), and it was also associated with more fetal distress and NICU admissions. When both CTG and AFI were abnormal, the ability to predict poor outcomes became much better: 75% of these babies had fetal distress and 50% required NICU admission. The specificity of the test improved from 96% with CTG alone to 98%

with the combined CTG+AFI, and the positive predictive value (PPV) increased from 50% to 75%. However, the sensitivity of both methods was still low, meaning that while the tests were good at confirming fetal distress when results were abnormal, they could not reliably exclude all babies who might later develop distress. Figure 1 shows the comparison of predictive accuracy between the study groups.

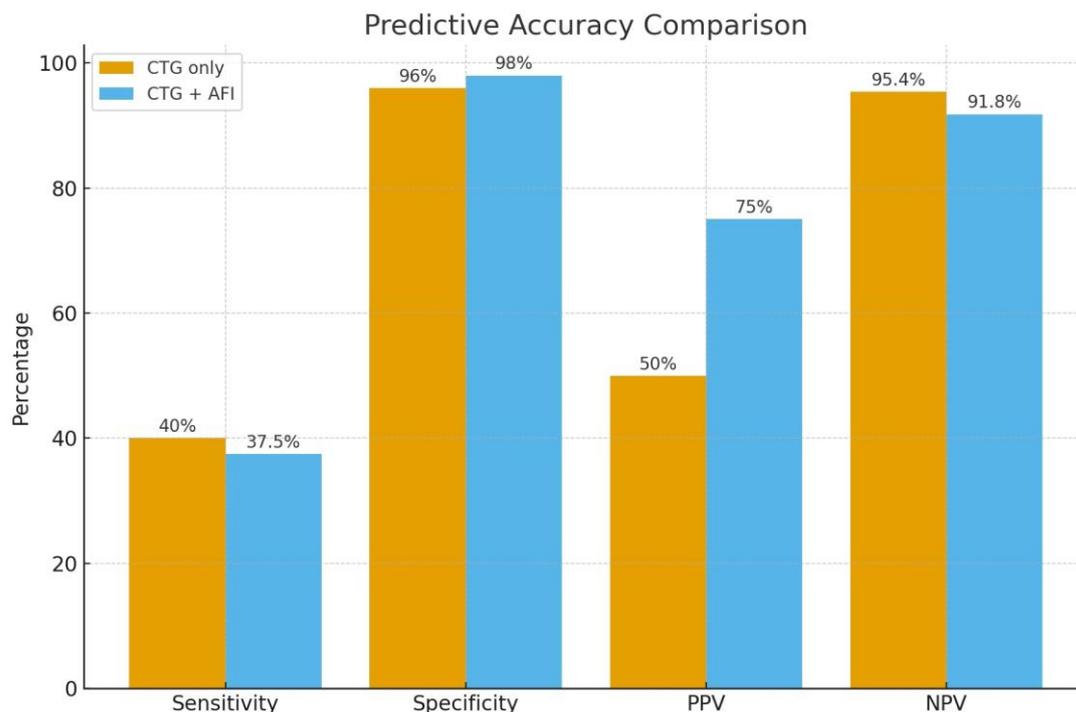


Figure 1. Predictive Accuracy comparison

Discussion

Admission CTG in our study showed 88–89% normal patterns, consistent with Montan et al. [11] and similar international observations. Suspicious and abnormal CTG were more prevalent in high-risk pregnancies, aligning with previous Indian and global studies [12].

The strong association between oligohydramnios and abnormal CTG in this study supports findings by Rutherford [13], Krieser [14], and Casey [15], all of whom demonstrated increased fetal distress with AFI \leq 5 cm.

Our results confirm that CTG alone is a good exclusion test, with high specificity (96%) and negative predictive value (95.4%), similar to the work by Ingemarsson [16] and Kusthagi [17]. However, the sensitivity remained low, highlighting its limited ability to detect all cases of fetal distress.

The addition of AFI significantly improved identification of fetuses at risk, reflected in higher PPV (75%) and specificity (98%), which is consistent with earlier work showing AFI as a predictor of placental insufficiency and intrapartum distress [18,19].

Operative delivery was markedly increased with abnormal CTG and CTG+AFI, echoing concerns about rising caesarean rates with electronic fetal monitoring [20]. Importantly, neonatal outcomes such as Apgar scores did not show significant deterioration in abnormal CTG/AFI, indicating a possible mismatch between intervention and neonatal benefit.

Overall, the findings support the role of admission CTG primarily as a screening test, with CTG+AFI serving as a more robust combination for intrapartum risk stratification.

Conclusion

Admission CTG is a simple, non-invasive test that can be easily used to check fetal well-being when a woman is admitted in labour. It is quite good at correctly identifying babies who are not in distress (high specificity), but it is not very good at picking up all babies who will develop distress later (limited sensitivity).

When AFI is added along with CTG, the ability to predict fetal distress improves. This combination helps to better identify fetuses at higher risk and supports better decision-making during labour.

However, abnormal findings on these tests often lead to more operative deliveries (such as caesarean section), without a matching improvement in newborn outcomes. Therefore, the results should be interpreted carefully, considering the overall clinical situation and available resources.

Recommendations

Admission CTG should be done routinely for all women who are admitted in labour at term. Measuring AFI is particularly important in women with premature rupture of membranes (PROM), high-risk pregnancies, and those who are post-dated. Using CTG together with AFI helps to better classify women into different risk groups and should be used wherever it is practically possible. At the same time, suspicious CTG tracings should not be over-interpreted, as this can lead to unnecessary lower segment caesarean sections (LSCS). Continuous CTG monitoring should be mainly reserved for women who have an abnormal admission test or who are in high-risk labour.

Data Availability Statement

The datasets generated and analysed during the study can be obtained from the corresponding author upon reasonable request. These data are not publicly accessible because they contain sensitive information that could potentially reveal participant identities.

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Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

Funding

No funding was received for conducting this study.

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