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COMPARISON OF FETOMATERNAL OUTCOMES BETWEEN REACTIVE AND NON-REACTIVE CARDIOTOCOGRAPH AT A TERTIARY CARE HOSPITAL

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Abstract

Objectives: *To determine the frequency of non-reactive cardiotocography (CTG) and compare fetomaternal outcomes between pregnant women with reactive and non-reactive CTG at term.*

Study Design: *Descriptive cross-sectional study.*

Place & Duration of Study: *Department of Obstetrics and Gynecology, Dr. Akbar Niazi Teaching Hospital Bharakahu, Islamabad w.e.f 05-05-2024 to 04-11-2024.*

Methodology: *Eligible women were enrolled after obtaining informed written consent, and demographic data were recorded. Admission CTG was performed for 30 minutes with the patient in the left lateral position and categorized as reactive or non-reactive. Suspicious tracings were reassessed after hydration and oxygen administration when appropriate. Fetomaternal outcomes, including APGAR scores, were recorded. Data were analyzed using SPSS version 26.0.*

Results: *Among 245 participants, 196 (80.0%) had reactive and 49 (20.0%) had non-reactive cardiotocographs. The mean age was 29.0±5.0 years, while median gestational age was 39.0 (38.0–40.0) weeks. APGAR >7 at 5 minutes was comparable (96.9% vs 91.8%, p=0.116), whereas NICU admission (36.7% vs 75.5%, p<0.001) and neonatal mortality (3.1% vs 12.2%, p=0.017) differed significantly. Maternal and gestational age strata showed no significant differences in outcomes.*

Conclusion: *Reactive cardiotocography was associated with more favourable neonatal outcomes, with significantly lower rates of NICU admission and neonatal mortality compared with non-reactive cardiotocography. However, no significant difference was observed in the 5-minute APGAR score. Maternal age and gestational age did not significantly influence the assessed neonatal outcomes.*

INTRODUCTION

Cardiotocography (CTG) has remained an important method of antenatal and intrapartum fetal surveillance since its introduction in the late 1960s because of its simplicity, non-invasive nature, and relatively low cost.[1] It provides continuous information regarding fetal heart rate and uterine contractions and assists in identifying fetuses at risk of hypoxia and adverse outcomes.[2,3]

Intrapartum monitoring primarily aims to recognize fetal compromise early enough to allow appropriate intervention. Assessment of uterine contractions is also an essential component of CTG interpretation, particularly because abnormal or dysfunctional labour may adversely affect neonatal outcomes.[4] A reassuring CTG generally demonstrates a baseline fetal heart rate of 110-160 beats/minute, normal variability of 5-25 beats/minute, appropriate accelerations, and absence of pathological decelerations.[5,6]

A normal CTG is generally indicative of adequate fetal oxygenation, whereas an abnormal or non-reactive tracing may indicate fetal compromise and requires appropriate clinical assessment.[7] However, CTG findings should always be interpreted alongside the clinical condition of the mother and fetus and should not replace clinical judgement or continuous patient observation during labour.[8] Reported frequencies of non-reactive or non-reassuring CTG have varied considerably, with frequencies of 19.8% and 7% reported in studies from India.[9,10] Such variation may reflect differences in study populations, definitions, and clinical settings.

Previous studies have demonstrated an association between non-reactive CTG and adverse neonatal outcomes. Archana et al. reported significantly higher NICU admission (76.2% vs. 36.5%, $p<0.01$) and neonatal mortality (23.8% vs. 0%, $p<0.001$) among neonates with non-reactive compared with reactive CTG.[9] Similarly, Nazir et al. in Pakistan, reported significantly lower rates of normal delivery among women with non-reactive CTG (68% vs. 97%, $p<0.001$).[8] These findings suggest that non-reactive CTG may identify pregnancies requiring closer surveillance and timely obstetric and neonatal management.

However, available evidence is not consistent. Singh et al. found a significantly lower proportion of neonates with APGAR score >7 in the non-reactive group (88.6% vs. 97.6%, $p=0.002$) and significantly fewer normal deliveries (34% vs. 89%, $p<0.0001$), while NICU admission and neonatal mortality did not differ significantly.[10] In Pakistan, Salahuddin et al. (2017) also reported significantly lower APGAR score >7 (53.3% vs. 71.8%, $p=0.05$) and normal delivery (13.3% vs. 53.2%, $p=0.041$) with non-reactive CTG, whereas differences in alive birth and neonatal mortality were not significant.[7]

These inconsistent findings indicate the need for further evaluation of non-reactive CTG and its relationship with fetomaternal outcomes in the local population. Establishing its frequency and associated neonatal outcomes may assist clinicians in identifying high-risk pregnancies and planning appropriate monitoring and intervention. Conversely, if significant adverse outcomes are not demonstrated, the findings may help reduce unnecessary interventions and resource utilization, particularly in resource-constrained healthcare settings such as Pakistan.

METHODOLOGY

This descriptive cross-sectional study was conducted in the Department of Obstetrics and Gynecology, Dr. Akbar Niazi Teaching Hospital, Bharakahu, Islamabad. The study was conducted over a period of six months after approval of the synopsis. A sample size of 245 cases was calculated using the WHO sample size calculator, with a 95% confidence level and 5% margin of error, considering an expected frequency of non-reactive CTG of 19.8%.[9]

Non-probability consecutive sampling was used for participant selection. Pregnant women aged 18-40 years with a gestational age >37 weeks, admitted to the labour room and undergoing intrapartum CTG monitoring within 12 hours before delivery, were included. Women with multiple pregnancies, elective caesarean section, known fetal anomalies, gestational diabetes, pre-eclampsia, and fetuses with cord-around-the-neck were excluded.

A reactive CTG was defined by a fetal heart rate of 110-150 beats per minute, presence of periodic accelerations, normal heart rate variability of 5-25 beats per minute, and absence of decelerations. Non-reactive CTG was defined by fetal tachycardia >150 beats per minute, fetal bradycardia <110 beats per minute, reduced or absent beat-to-beat variability, late decelerations, or extreme variable decelerations.

An APGAR score >7 at 5 minutes was considered safe, as described in Annexure A. An APGAR score ≤4 at 5 minutes was labelled as indicating the need for ICU admission. Neonatal mortality was defined as death of the neonate before 28

days of age. Normal delivery was defined as vaginal delivery without the use of mechanical instruments or any surgical procedure.

Eligible women were enrolled after informed written consent from the patients or attendants, and demographic information was recorded. Admission CTG was performed with the patient in the left lateral position for 30 minutes. Tracings were assessed and categorized as reactive or non-reactive. Patients with reactive tracings were assigned to Group A, while those with non-reactive tracings, including suspicious and pathological patterns, were assigned to Group B. When a suspicious CTG pattern was observed, the tracing was repeated after intravenous fluid administration for hydration and oxygen inhalation, where there were no contraindications. The tracing was then re-evaluated and categorized as reactive or non-reactive. All patients were managed according to the standard operating procedures of the hospital. Newborns were evaluated and followed up, including assessment of APGAR scores at 1 and 5 minutes and other study variables.

All findings were assessed by a senior consultant and recorded by the resident herself to minimize bias in the results. Confounding variables were controlled through the exclusion criteria. Data were analyzed using IBM SPSS Statistics version 26.0. Numerical variables, including age and gestational age, were assessed for normality using the Shapiro–Wilk test and presented as mean±SD or median (IQR), as appropriate.

Categorical variables, including mode of delivery, APGAR score >7, NICU admission, neonatal mortality, and reactive/non-reactive CTG, were presented as frequencies and percentages. The chi-square test was applied to compare fetomaternal outcomes between the groups, with $p \leq 0.05$ considered statistically significant. Data were stratified according to age and gestational age to assess their potential effect as effect modifiers. Following stratification, the chi-square test was applied, with $p \leq 0.05$ considered statistically significant.

RESULTS

Among the 245 participants, age was normally distributed (29.0±5.0 years; Shapiro–Wilk W=0.991, p=0.126) and was therefore analyzed using parametric tests. Gestational age was non-normally distributed (median 39.0 weeks, IQR: 38.0–40.0; W=0.919, p<0.001) and was analyzed using non-parametric tests. Distribution was assessed using the Shapiro–Wilk test, histograms/Q–Q plots, skewness, kurtosis, outlier assessment, and mean–median agreement, as shown in Table I.

Among participants, 196 (80.0%) had a reactive cardiotocograph, while 49 (20.0%) had a non-reactive cardiotocograph. The mean age was 29.0±5.0 years, with 134 (54.7%) participants aged 18–29 years and 111 (45.3%) aged ≥30–40 years. The median gestational age was 39.0 (IQR: 38.0–40.0) weeks; 81 (33.1%) participants had a gestational age of 37–38 weeks and 164 (66.9%) had a gestational age of ≥39 weeks. Data is given in Table II.

The primary outcome, APGAR score >7 at 5 minutes, was achieved in 190/196 (96.9%) neonates with a reactive cardiotocograph and 45/49 (91.8%) with a non-reactive cardiotocograph, with no significant difference (p=0.116). APGAR score >7 at 1 minute was significantly more frequent among neonates with a reactive cardiotocograph compared with those with a non-reactive cardiotocograph (74.5% vs 46.9%, p<0.001). NICU admission was significantly higher among neonates with a non-reactive cardiotocograph (75.5% vs 36.7%, p<0.001). Neonatal mortality was also higher in the non-reactive group than in the reactive group (12.2% vs 3.1%, p=0.017). No significant difference was observed in the mode of delivery between the non-reactive and reactive groups (46.9% vs 51.0%, p=0.609). Data is given in Table III.

Table IV shows that maternal age was not significantly associated with any primary or secondary outcome. Similarly, Table V demonstrates no significant differences in APGAR scores, NICU admission, neonatal mortality, or mode of delivery across gestational-age strata (all p>0.05).

Table I: Distribution of Continuous Variables and the Resulting Choice of Tests

Variable (n = 245)	Mean ± SD	Median (IQR)	Skewness	Kurtosis	Outliers, n (%)	Shapiro–Wilk W (p)	Analytic consequence
Age, years	29.0 ± 5.0	29.0 (25.0–32.0)	0.17	-0.41	1 (0.4%)	0.991 (0.126)	Parametric summary and tests
Gestational Age, weeks	39.0 ± 1.1	39.0 (38.0–40.0)	0.19	-0.33	0 (0.0%)	0.919 (<0.001)	Non-parametric summary and tests

Note. Normality was assessed using the Shapiro–Wilk test together with distributional inspection (histograms/Q–Q plots), skewness, kurtosis, outlier assessment, mean–median agreement, and sample size.

Table II: Descriptive statistics of the study population

Variable	Overall (n = 245)
Reactive vs Non-reactive Cardiotocograph, n (%)	
• Reactive	196 (80.0%)
• Non-reactive	49 (20.0%)
Age, years, mean ± SD	29.0 ± 5.0
Age (stratum), n (%)	
• 18-29	134 (54.7%)
• ≥30-40	111 (45.3%)
Gestational Age, weeks, median (IQR)	39.0 (38.0–40.0)
Gestational Age (stratum), n (%)	
• 37-38	81 (33.1%)
• ≥39	164 (66.9%)

Table III: Primary and Secondary Outcomes by Reactive versus Non-Reactive Cardiotocograph

Outcome	Reactive, n/N (%)	Non-reactive, n/N (%)	P-value
APGAR score >7at 1 min	146/196 (74.5%)	23/49 (46.9%)	<0.001[b]
APGAR score >7 at 5 min	190/196 (96.9%)	45/49 (91.8%)	0.116[a]
NICU admission	72/196 (36.7%)	37/49 (75.5%)	<0.001[b]
Neonatal mortality	6/196 (3.1%)	6/49 (12.2%)	0.017[a]
Mode of delivery	100/196 (51.0%)	23/49 (46.9%)	0.609[b]

Note. Values are n/N (%), where N is the total number within each stratum. [a]Fisher's exact test; [b]Pearson chi-square test. P-values are two-sided.

Table IV: Primary and Secondary Outcomes by Maternal Age Strata

Outcome	18-29 years, n/N (%)	≥30 -40 years, n/N (%)	P-value
APGAR score > 7 at 1 min	97/134 (72.4%)	72/111 (64.9%)	0.205[b]
APGAR score >7 at 5 min	129/134 (96.3%)	106/111 (95.5%)	0.759[a]
NICU admission	58/134 (43.3%)	51/111 (45.9%)	0.676[b]
Neonatal mortality	6/134 (4.5%)	6/111 (5.4%)	0.738[b]
Mode of delivery	67/134 (50.0%)	56/111 (50.5%)	0.944[b]

Note. Values are n/N (%). [a]Fisher's exact test; [b]Pearson chi-square test. P-values are two-sided.

Table V: Primary and secondary outcomes by gestational-age strata

Outcome	37-38 weeks, n/N (%)	≥39 weeks, n/N (%)	P-value
APGAR score >7 at 1 min	54/81 (66.7%)	115/164 (70.1%)	0.582[b]
APGAR score >7 at 5 min	77/81 (95.1%)	158/164 (96.3%)	0.734[a]
NICU admission	40/81 (49.4%)	69/164 (42.1%)	0.279[b]
Neonatal mortality	5/81 (6.2%)	7/164 (4.3%)	0.538[a]
Mode of delivery	41/81 (50.6%)	82/164 (50.0%)	0.928[b]

Note. Values are n/N (%). [a]Fisher's exact test; [b]Pearson chi-square test. P-values are two-sided.

DISCUSSION

The present study included 245 term pregnant women, of whom 196 (80.0%) had reactive and 49 (20.0%) had non-reactive cardiotocography (CTG). The frequency of non-reactive CTG was 20.0%, which is within the range reported in previous studies, although considerable variation has been observed according to the population studied and classification of CTG patterns. Nazir et al.[8] reported reactive CTG in 39.36%, suspicious CTG in 5.96% and pathological/non-reactive CTG in 54.68% of 470 women at >37 weeks. Salahuddin et al.[7], in 214 high-risk term pregnancies, reported 124 (57.9%) reactive and 90 (42.1%) non-reactive traces. In contrast, Singh et al.[10] found reassuring CTG in 92%, non-reassuring in 7% and abnormal traces in 1% of 500 women. Archana et al.[9] also reported a substantial difference in neonatal outcomes between abnormal and normal CTG groups.[9] These differences in the frequency of abnormal traces may reflect variation in risk profile, referral patterns, CTG classification systems and clinical indications for performing CTG. The lower frequency of non-reactive CTG in the present study may also be related to the exclusion of several major maternal and fetal risk factors.

The primary outcome of the present study, APGAR score >7 at 5 minutes, was comparable between reactive and non-reactive CTG groups (96.9% vs 91.8%, p=0.116). This finding is supported by Ansari and Kosar[11], who studied 122 women with non-reactive CTG and found a satisfactory APGAR score in 109 (89.3%) neonates. They reported NICU admission in 38 (31.1%) and neonatal death in 5 (4.1%) cases. The relatively high proportion of satisfactory APGAR scores despite a non-reactive trace suggests that abnormal CTG does not invariably result in persistent neonatal depression. Similarly, Singh et al.[10] reported APGAR >7 at 5 minutes in 100% of the reassuring group compared with 97% of the non-reassuring group.[1]

However, the present finding differs from Nazir et al.[8], who reported APGAR >8 in only 20% of neonates in the pathological/non-reactive group compared with 53% in the reactive group (p<0.001). Their regression analysis also demonstrated significantly lower odds of a higher APGAR score with pathological/non-reactive CTG (OR 0.30, 95% CI 0.20–0.44; p<0.001). Salahuddin et al.[7] similarly reported APGAR >7 at 5 minutes in 71.8% of the reactive group compared with 53.3% of the non-reactive group (p<0.001). These differences may be explained by

the inclusion of high-risk pregnancies in both studies, differences in the severity of abnormal CTG, and different clinical management following an abnormal trace. In the present study, suspicious patterns were reassessed after intravenous fluids and oxygen where clinically appropriate, which may have influenced subsequent neonatal condition.

At 1 minute, APGAR score >7 was significantly more frequent among neonates with reactive CTG than those with non-reactive CTG (74.5% vs 46.9%, p<0.001). This finding is consistent with the expected relationship between a reassuring fetal heart-rate pattern and better immediate neonatal condition. Singh et al.[10] reported APGAR >7 at 1 minute in 97.6% of neonates with reassuring CTG compared with 88.6% with non-reassuring CTG. Nazir et al.[8] also reported poorer APGAR outcomes among neonates exposed to pathological/non-reactive CTG, with only 20% achieving APGAR >8 compared with 53% in the reactive group (p<0.001).[6] The lower absolute percentages in the present study may reflect differences in the timing of CTG, population characteristics, severity of abnormal traces and immediate neonatal management. Nevertheless, the significantly higher proportion of satisfactory 1-minute APGAR scores in the reactive group supports the association between a reassuring CTG pattern and better immediate neonatal adaptation.

NICU admission demonstrated a strong association with CTG status in the present study. NICU admission occurred in 75.5% of neonates with non-reactive CTG compared with 36.7% with reactive CTG (p<0.001). This finding is closely comparable with Archana et al.[9], who reported NICU admission in 76.2% of neonates with abnormal CTG compared with 36.5% with normal CTG (p<0.01). Rahman et al.[12] studied 160 high-risk pregnant women and reported NICU admission in 57.1% of neonates following ominous CTG compared with 6.5% following reactive CTG (p<0.001). Similarly, Sandhu et al.[13] reported NICU admission in 33% of women with abnormal admission CTG compared with only 1% with a normal trace (p<0.01).

The present NICU finding is also supported by Perveen et al.[14], who reported NICU admission in 66.6% of neonates following an ominous admission test compared with 6.6% after a reactive test. In contrast, Fareed et al.[15], who evaluated 150 women with non-reactive CTG, reported NICU admission in 45 (30%) neonates. The lower rate in their study may be related to different NICU admission criteria, referral practices and the inclusion of only women with non-reactive CTG. Asif et al.[16], in a more recent Pakistani study of 130 women with non-reactive CTG, also demonstrated significant associations between non-reactive CTG and NICU admission, low APGAR, low birth weight and neonatal mortality. Thus, the present result is consistent with both earlier and recent regional evidence.

Khandelwal et al.[17] also demonstrated an association between abnormal admission testing and adverse perinatal outcomes, including meconium, operative delivery, low APGAR and neonatal unit admission. These findings support the present observation that a non-reactive CTG is more strongly associated with neonatal morbidity than with the 5-minute APGAR outcome alone.

Neonatal mortality was significantly higher in the non-reactive group in the present study (12.2% vs 3.1%, p=0.017). This finding agrees with Archana et al.[9], who reported neonatal mortality of 23.8% in the abnormal CTG group compared with 0% in the normal group (p<0.001). Salahuddin et al.[7] reported early neonatal death in 13.9% of the non-reactive group compared with 4.1% of the reactive group. Fawole et al.[18] evaluated 112 women, including 51 reactive and 61 non-reactive tests, and found a significant association between non-reactive CTG and perinatal mortality (p=0.04). However, the difference in low APGAR was not significant (p=0.18). This latter finding is particularly relevant to the present study because mortality was significantly different despite the absence of a significant difference in the 5-minute APGAR outcome. Fareed et al.[15] reported neonatal mortality in 10/150 (6.67%) women with non-reactive CTG, while Ansari and Kosar[11] reported neonatal death in 5/122 (4.1%). The higher mortality in the present study may reflect differences in patient selection, neonatal referral patterns and availability of intensive neonatal care.

In contrast to NICU admission and neonatal mortality, mode of delivery was not significantly

different in the present study. Normal delivery occurred in 51.0% of women with reactive CTG compared with 46.9% with non-reactive CTG (p=0.609). This finding differs markedly from Nazir et al.[8], who reported caesarean delivery in 88% of women with pathological/non-reactive CTG compared with only 3% with reactive CTG (p<0.001). Salahuddin et al.[7] similarly reported normal vaginal delivery in 58.0% of the reactive group compared with 23.3% of the non-reactive group, while caesarean delivery occurred in 42.0% and 76.7%, respectively. Rahman et al.[12] found spontaneous vaginal delivery in 52.8% of reactive cases compared with only 14.3% of ominous cases, while LSCS was required in 35.8% and 78.6%, respectively (p<0.001).[12] Singh et al.[10] also reported significantly increased LSCS in women with non-reassuring and abnormal CTG (p<0.0001).

The lack of a significant difference in mode of delivery in the present study may be explained by the clinical reassessment of suspicious traces and management according to hospital SOPs rather than proceeding directly to operative delivery. This is supported by the findings of Impey et al.[19], who conducted a randomized controlled trial involving 8,580 low-risk women and found no significant difference in caesarean delivery between admission CTG and usual care (relative risk 1.13, 95% CI 0.92–1.40), despite increased use of continuous CTG and fetal blood sampling.[22] Their primary neonatal outcome also occurred in 1.3% of both groups (RR 1.01, 95% CI 0.70–1.47). These findings highlight that CTG abnormalities may increase surveillance and intervention without necessarily producing a corresponding reduction in adverse neonatal outcomes.

The findings of Bhartiya et al.[20] provide further context. In 200 women, admission CTG was reactive in 67%, suspicious in 18% and ominous in 15%. Abnormal CTG was significantly associated with increased caesarean delivery and adverse neonatal outcomes, although correlations with low APGAR, NICU admission and mortality were not statistically significant in some subgroup analyses. This contrasts with the strong NICU and mortality associations observed in the present study and may be related to differences in study population and risk profile. Similarly, a recent Nigerian study by Oluwasomidoyin et al.[21] involving 206 women reported normal CTG in 73.3%, suspicious in 13.6% and pathological in 13.1%; low birth weight, special-care admission, neonatal asphyxia, neonatal death and prolonged hospital stay were significantly more frequent with pathological CTG (p<0.05), while all women with pathological CTG underwent caesarean delivery.

Overall, the present findings demonstrate that non-reactive CTG was significantly associated with lower APGAR scores at 1 minute, increased NICU admission and higher neonatal mortality, whereas the primary outcome, APGAR score >7 at 5 minutes, and mode of delivery were comparable between groups. The results are broadly supported by both Pakistani and international literature, particularly regarding increased neonatal morbidity following non-reactive or ominous CTG. However, differences in APGAR and mode of delivery between studies indicate that CTG should not be interpreted as an isolated determinant of neonatal outcome. Variation in CTG classification, maternal risk profile, timing of monitoring, reassessment of abnormal traces, obstetric decision-making and neonatal admission criteria may account for the differences observed across studies. The absence of significant associations after stratification by maternal age and gestational age further suggests that these characteristics did not substantially modify the observed outcomes in the present population.

A major strength was the adequate sample size and standardized assessment of CTG and neonatal outcomes. Limitations included the single-center design, non-probability sampling and absence of cord blood gas analysis. Future multicenter studies with larger samples, standardized CTG interpretation, longer neonatal follow-up and additional objective measures may provide stronger evidence.

CONCLUSION

Non-reactive cardiotocography was significantly associated with adverse neonatal outcomes, particularly increased NICU admission and neonatal mortality, and a lower proportion of neonates achieving APGAR >7 at 1 minute. However, the 5-minute APGAR score and mode

of delivery were comparable between groups. Hence, non-reactive CTG may serve as an important indicator of neonatal risk.

ETHICAL APPROVAL

Ethical approval was obtained from institutional review board of Islamabad Medical & Dental College, Islamabad vide reference No. 117/IMDC/IRB-2023 dated 18-09-2023.

PATIENT'S CONSENT

Informed written consent was obtained from each study subject.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

Author's Contribution:

Author 1:

Substantial contributions to study design, acquisition of data, analysis & interpretation of data, manuscript writing & critical review.

Author 2:

Substantial contributions to concept, study design, data analysis, manuscript writing, & critical review.

All authors: Have given final approval of the version to be published agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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