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Association of Cardiotocographic (CTG) Abnormalities with Delivery Outcomes in Women with a History of Cesarean Section

Komal Naveed, Asma Zubair, Ikram Ullah, Shadab Shakir, Rehana Bhittani, Neelam Hassan

ABSTRACT

Objectives: This study evaluates the relationship between Cardiotocography (CTG) variations and delivery outcomes in women undergoing a Trial of Labor After Cesarean (TOLAC). CTG variations, such as abnormal fetal heart rate (FHR) patterns, can indicate fetal distress or complications during labor. The study focuses on predicting outcomes such as vaginal birth success, caesarean section, and complications like uterine rupture and scar dehiscence.

Study Design and Setting: A case-control study was conducted at Lady Reading Hospital, Peshawar, from August 2022 to February 2023. The study involved 156 women, divided into two groups: 78 with unsuccessful vaginal deliveries (cases) and 78 with successful vaginal deliveries (controls).

Methodology: CTG was used to assess FHR patterns during labor, focusing on tachycardia, bradycardia, variability, and deceleration patterns. The study analyzed the later stages of labor and the impact of maternal factors such as age, BMI, and gestational age.

Results: Abnormal CTG readings, including fetal tachycardia (odds ratio 3.1) and bradycardia (odds ratio 2.2), were associated with poorer delivery outcomes. Maternal factors like age, BMI, and gestational age also influenced complications during labor.

Conclusions: CTG is an effective tool in managing TOLAC, improving maternal and neonatal outcomes. Its integration into labor protocols can reduce risks, particularly in low- and middle-income countries. Further research is needed to address maternal complications.

Keywords: Body Mass Index, Bradycardia, Cardiotocography, Caesarean Section, Fetal Heart Rate, Tachycardia, Uterine Rupture

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Komal Naveed
Post Graduate Resident, Department of GYNAE/OBS
Lady Reading Hospital Peshawar
Email: docterkomalnaveed@gmail.com

Asma Zubair
Gynecologist, Department of GYNAE/OBS
Lady Reading Hospital Peshawar
Email: aasmakhan1233@gmail.com

Ikram Ullah
Gynecologist, Department of GYNAE/OBS
Lady Reading Hospital Peshawar
Email: ikram_bj55@yahoo.com

Shadab Shakir
Gynecologist, Department of GYNAE/OBS
Lady Reading Hospital Peshawar
Email: shakirshadab629@gmail.com

Rehana Bhittani
Gynecologist, Department of GYNAE/OBS
Lady Reading Hospital Peshawar
Email: rehana.khan19920@gmail.com

Neelam Hassan
Gynecologist, Department of GYNAE/OBS
Lady Reading Hospital Peshawar
Email: neelam.fcps@gmail.com

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INTRODUCTION

Cesarean delivery rates have been rising globally, with many women who have undergone a previous cesarean section (C-section) considering a Trial of Labor After Cesarean (TOLAC) as a viable option for vaginal birth. TOLAC offers several potential benefits, including reduced maternal morbidity associated with repeat cesarean sections. However, it is not without its risks, the most concerning being uterine rupture and scar dehiscence. These complications are life-threatening for both mother and baby, making it essential to detect them early and intervene promptly. Early identification of potential risks allows healthcare providers to make informed decisions, ensuring better outcomes for both the mother and the fetus. Therefore, the role of effective monitoring during TOLAC cannot be overstated, as it provides critical information that can guide clinical interventions[1]. Cardiotocography (CTG) is a well-established, non-invasive method used to monitor fetal well-being during labor by assessing fetal heart rate (FHR) patterns. CTG allows continuous monitoring, providing valuable insights into fetal heart rate variations that could indicate distress or complications, such as uterine rupture or scar dehiscence.

Abnormal CTG findings, including tachycardia, bradycardia, or altered variability, are red flags that demand immediate attention and intervention. The challenge is determining how these CTG abnormalities correlate with delivery outcomes, particularly in high-risk situations such as TOLAC. The ability to predict and understand these relationships could significantly improve clinical decision-making, especially in settings where access to advanced diagnostic tools is limited[2]. TOLAC can reduce maternal morbidity by avoiding the risks associated with repeat caesarean deliveries, such as infection, haemorrhage, and longer recovery times. However, TOLAC also introduces the possibility of uterine rupture, a serious complication that occurs when the scar from a previous cesarean section tears during labor. Uterine rupture can lead to severe bleeding, fetal distress, and in some cases, fetal death. Another significant risk associated with TOLAC is scar dehiscence, a condition in which the previous C-section scar becomes weakened but does not completely rupture. Both uterine rupture and scar dehiscence present serious risks to maternal and fetal health, and their timely detection is critical to prevent severe outcomes. The need for reliable predictive tools to identify women at higher risk for these complications is essential for optimizing labor management[3]. CTG is one of the most commonly used tools for monitoring fetal heart rate and detecting abnormalities during labor. FHR patterns typically fluctuate based on fetal movement, uterine contractions, and maternal status. However, abnormal patterns in FHR—such as persistent tachycardia (an abnormally high heart rate), bradycardia (an abnormally low heart rate), or altered variability (reduced or absent fluctuations)—can indicate fetal distress. These abnormalities may signal conditions such as hypoxia, which can arise from complications like uterine rupture or placental insufficiency. CTG can also help identify other complications such as fetal acidosis or umbilical cord prolapse, both of which can have severe consequences for the fetus. By detecting these issues early, clinicians can intervene more effectively, potentially avoiding worse outcomes such as emergency cesarean delivery or stillbirth4. The study aimed to investigate the relationship between CTG abnormalities and delivery outcomes in women undergoing TOLAC. Specifically, it focused on predicting complications related to uterine scars, such as uterine rupture and scar dehiscence, which are of particular concern for women attempting a vaginal delivery after a previous C-section. Given the risks associated with these complications, early and accurate detection of CTG abnormalities could significantly improve clinical decision-making and patient management, especially in resource-limited settings. The role of CTG in predicting uterine rupture or scar dehiscence is critical, as it could potentially serve as a reliable, non-invasive method to identify women who may require more intensive monitoring or a shift in labor management protocols5. Previous studies have shown a strong association between abnormal CTG patterns and adverse outcomes in TOLAC, including uterine rupture. For instance, persistent fetal tachycardia has been linked to a higher risk of uterine rupture, while bradycardia and reduced FHR variability can indicate fetal distress related to inadequate oxygenation, which may occur due to uterine rupture or scar dehiscence. Furthermore, research suggests that combining CTG monitoring with maternal factors such as age, body mass index (BMI), and gestational age can improve prediction models for complications during TOLAC. For instance, older maternal age and higher BMI have been identified as risk factors for poor delivery outcomes, including uterine rupture. Integrating these maternal factors with CTG readings may allow for better risk stratification and more personalized labor management6. The findings of this study may have important implications for clinical practice, particularly in settings where access to advanced monitoring techniques is limited. In low- and middle-income countries, where resources may be constrained, the use of CTG as a primary monitoring tool can be especially beneficial. Its non-invasive nature and ability to provide continuous monitoring make it a valuable tool for detecting complications early, potentially reducing the need for more invasive procedures like cesarean sections. Additionally, CTG monitoring can help identify women at higher risk for uterine rupture or scar dehiscence, enabling clinicians to make timely interventions that improve maternal and neonatal outcomes .[7-8] In conclusion, the use of CTG as a monitoring tool during TOLAC is an essential part of managing high-risk pregnancies. Its ability to detect fetal heart rate abnormalities, particularly in relation to uterine rupture and scar dehiscence, provides valuable information for clinicians, helping them to make informed decisions and manage labor more effectively. While further research is needed to refine CTG-based prediction models, its integration into labor protocols has the potential to significantly improve maternal and neonatal outcomes, particularly in settings with limited access to advanced diagnostic technologies. By focusing on the early detection of complications, CTG can help reduce the risks associated with TOLAC and optimize labor management strategies

METHODOLOGY

This study was designed as a case-control investigation, conducted in the Department of Obstetrics and Gynecology at Lady Reading Hospital (LRH), Peshawar. The research took place over six months, from August 29, 2022, to February 29, 2023, involving a total of 156 participants. The participants were divided into two equal groups: 78 cases and 78 controls. The sample size was calculated using the WHO software (Version 2.00), with a 95% confidence level and 80% power, anticipating fetal tachycardia rates of 23% in the control group and 42.75% in the case group, as derived from previously published studies.

The participants were selected using a non-probability sequential sampling technique. Inclusion criteria required participants to be aged between 20 and 40 years, with a

singleton pregnancy verified by ultrasound, and a cephalic fetal position. Additional criteria included a parity of 1 to 4, a gestational age of 37 to 40 weeks (confirmed by the last menstrual period), and a history of at least one cesarean section followed by a trial of labor (TOLAC). The criteria were established according to the ACOG Practice Bulletin No. 205 (2019).

Exclusion criteria included individuals with intrauterine fetal demise, labor arrest during the first or second stage of labor, connective tissue disorders, thyroid dysfunction (hypothyroidism or hyperthyroidism), or those on beta-blockers. Ethical approval for the study was obtained from the Ethics Review Committee (ERC) of Lady Reading Hospital (ERC number 657/LRH/OG). The study was also approved by an independent institutional review board (IRB) after an ethical evaluation of the research. Informed consent was obtained from all participants, who were fully informed about the nature of the study, with assurances of voluntary participation, complete anonymity, and no anticipated risks.

Demographic data such as age, gestational age, parity, weight, and height were collected. Cases and controls were matched based on the number of vaginal deliveries following a previous cesarean section. Cardiotocography (CTG) abnormalities were evaluated in the case group using the most recent CTG strip obtained within the hour prior to repeat cesarean delivery. In the control group, CTG strips from the last hour before expulsive efforts were analyzed. Each CTG strip was divided into two halves of 30 minutes each.

Two consultant gynecologists, each with a minimum of five years of post-fellowship experience and blinded to clinical data, independently assessed the CTG strips for abnormalities, which included fetal tachycardia, bradycardia, variability (increased or decreased), and decelerations (early or late). In cases where discrepancies occurred, a third senior expert resolved the discrepancies, ensuring the accuracy of the definitive findings. Data collection was supported by a meticulously designed proforma to ensure consistency and accuracy in gathering the information.

Statistical analysis was performed using IBM-SPSS version 22. Categorical variables, such as parity, uterine scar issues, CTG abnormalities, and delivery outcomes, were expressed as frequencies and percentages. Continuous variables, such as age, weight, height, body mass index (BMI), and gestational age, were reported as means and standard deviations (SD). Odds ratios for CTG anomalies were calculated using a 2×2 contingency table, with 95% confidence intervals (CI) to assess the strength of associations. Stratified analysis was conducted to evaluate potential effect modifiers based on age groups, BMI categories, gestational age, and parity.

RESULTS

This study, involving 160 women (80 instances of unsuccessful vaginal births and 80 controls with successful vaginal deliveries), revealed significant insights into the determinants of Trial of Labor After Cesarean (TOLAC) delivery outcomes. As outlined in the objectives, the key outcomes of TOLAC in this study are successful vaginal deliveries and unsuccessful vaginal deliveries, which typically require a repeat cesarean section. The mean age of the patients was 30.57 ± 4.665 years, slightly higher than the control group's mean age of 28.72 ± 4.96 years. Advanced maternal age, particularly women aged 31 to 40, was associated with an increased likelihood of unsuccessful vaginal delivery. Additionally, gestational age was a significant factor, with the highest incidence of unsuccessful vaginal deliveries seen in the 39–40-week group. Body Mass Index (BMI) was another significant predictor; women with a higher BMI (>22) showed improved outcomes in the control group. The study also emphasized the role of CTG anomalies such as fetal tachycardia and bradycardia, which were observed more frequently in women with unsuccessful vaginal deliveries. These results underscore the importance of continuous CTG monitoring for high-risk pregnancies, particularly TOLAC candidates, where maternal factors like age, BMI, and gestational age significantly affect the success of vaginal delivery. The findings highlight the need for early identification and timely interventions to avoid complications such as uterine rupture and scar dehiscence, which are risks associated with TOLAC.

Table 1: Demographic and Clinical Characteristics of Participants

Category	Subcategory	Cases (n=80)	Controls (n=80)
Age Group (years)	18-30	42	54
	31-40	38	26
Gestational Age (weeks)	37-38	38	42
	39-40	42	38
BMI (kg/m²)	=22	40	34
	>22	40	46

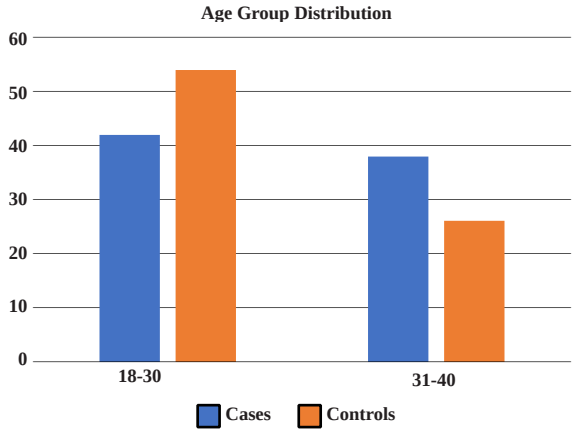


Figure 2: Gastational Age Distribution

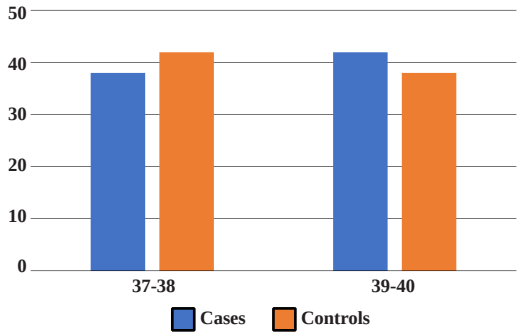


Figure 3: BMI Distribution

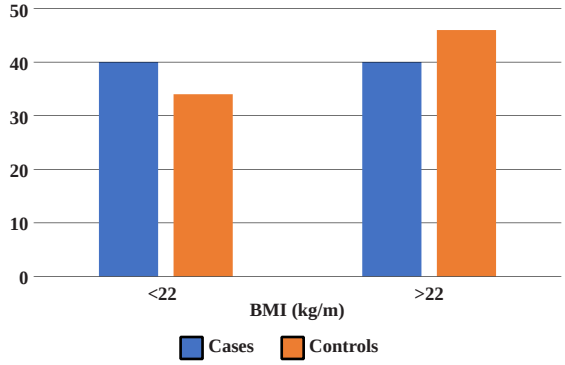
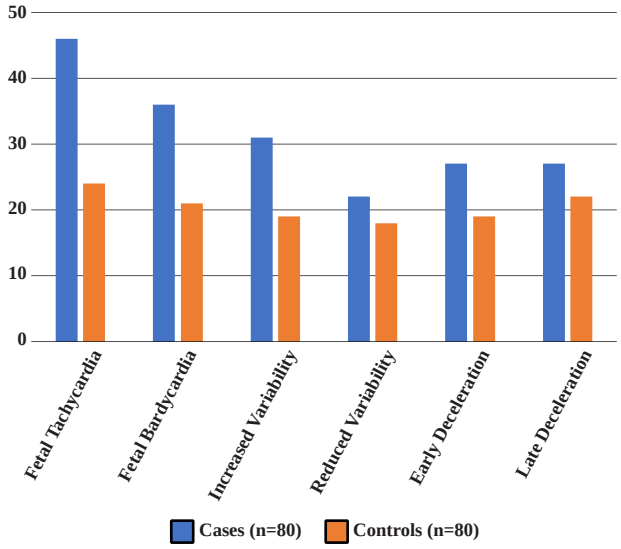


Figure 4: Frequency of CTG Abnormalities in Cases vs Controls



Bar chart showing the frequency of CTG abnormalities in both cases and controls. The odds ratios (with 95% confidence intervals) are also displayed above each bar to provide insights into the strength of the association between the abnormalities and the outcomes.

DISCUSSION

This case-control study, conducted at Lady Reading Hospital in Peshawar, evaluated the association between cardiotocography (CTG) abnormalities and delivery outcomes

Table 2: CTG Abnormalities in Cases and Controls

CTG Abnormality	Cases (n=80)	Controls (n=80)	Odds Ratio (95% CI)
Fetal Tachycardia	46	24	3.1 (1.6-6.0)
Fetal Bradycardia	36	21	2.2 (1.1-4.4)
Increased Variability	31	19	2.0 (1.0-4.0)
Reduced Variability	22	18	1.3 (0.6-2.6)
Early Deceleration	27	19	1.6 (0.8-3.2)
Late Deceleration	27	22	1.3 (0.7-2.6)

in women undergoing a trial of labor after a previous cesarean section (TOLAC). The study provides important insights into maternal risk factors and their influence on delivery outcomes, emphasizing the role of CTG monitoring in detecting potential complications.Demographic comparisons between cases and controls revealed significant differences in age, body mass index (BMI), and gestational age. The cases, which had an unsuccessful vaginal birth, were generally older and exhibited a higher BMI compared to the controls. These findings align with previous studies, which have highlighted advanced maternal age and obesity as significant risk factors for adverse pregnancy outcomes, including labor complications, fetal distress, and increased cesarean delivery rates?,[1°]. Maternal age and obesity have long been associated with complications during pregnancy, and our findings emphasize the need for careful monitoring of these factors in women undergoing TOLAC.In terms of gestational age, the distribution of participants was relatively uniform, with a significant number of complications observed in the 39–40 weeks subgroup. This finding is consistent with existing research indicating that advancing gestational age, especially beyond 39 weeks, increases the risk of complications like uterine rupture and fetal distress in women with a history of cesarean section[11]. The study also found that women with lower parity (1-2 prior births) were more prevalent in the case group, which has been associated with higher risks of labor-related complications in women attempting vaginal birth after cesarean (VBAC)[12]. These demographic variables—maternal age, BMI, and parity—were likely influential in the CTG findings and delivery outcomes, supporting the idea that these factors must be considered when planning TOLAC. One of the most significant findings of this study was the higher incidence of CTG abnormalities in the case group compared to the controls. Specifically, fetal tachycardia (OR: 3.1, 95% CI: 1.6-6.0), bradycardia, and increased variability were more prevalent in the cases, aligning with previous studies that have shown CTG abnormalities as key indicators of fetal distress, particularly in high-risk pregnancies such as TOLAC[13]. Enabudoso (2021) emphasized the importance of CTG monitoring for detecting uterine rupture risks in women undergoing VBAC, with tachycardia and bradycardia serving as significant warning signs of potential complications like uterine rupture or scar dehiscence[14]. Our results also indicate that heightened

variability and fetal bradycardia were linked to adverse delivery outcomes, which suggests that these CTG markers could provide valuable information for clinical decision-making, potentially leading to timely interventions like repeat cesarean delivery to prevent complications. Interestingly, early and late decelerations did not show a statistically significant difference between the cases and controls in this study. This finding raises questions about the reliability of decelerations as indicators of adverse outcomes in this cohort, which is supported by studies that have highlighted the inconsistent relationship between decelerations and severe fetal compromise[15]. As noted by Rajak et al. (2024), while various CTG parameters can help identify labor complications, not all abnormalities, such as early and late decelerations, may always correlate with fetal distress[16-17]. This suggests the need for a more nuanced approach to CTG interpretation and underscores the importance of integrating clinical judgment with CTG findings to improve outcomes for women undergoing TOLAC.The results of this study reinforce the idea that maternal characteristics—such as age, BMI, and parity—play a significant role in determining the likelihood of complications during TOLAC. Additionally, abnormal CTG findings, particularly tachycardia, bradycardia, and increased variability, are associated with poorer delivery outcomes, including uterine rupture and scar dehiscence. These findings highlight the value of continuous CTG monitoring in high-risk pregnancies, particularly for women attempting vaginal birth after a previous cesarean section.Moreover, the study suggests that early and accurate identification of CTG abnormalities, along with a comprehensive evaluation of maternal factors, can improve clinical decision-making and reduce the risks associated with TOLAC[18-19-20]. Although early and late decelerations did not demonstrate a significant correlation with adverse outcomes in this cohort, other CTG abnormalities, such as fetal tachycardia and bradycardia, remain critical indicators of fetal distress. Further research is needed to refine the predictive value of CTG parameters and to explore how maternal factors interact with CTG findings to affect delivery outcomes.

CONCLUSION

CTG remains an essential tool for monitoring fetal well-being in high-risk pregnancies, particularly during TOLAC. The study emphasizes the importance of monitoring CTG findings alongside maternal characteristics to improve labor management and reduce the risk of complications. These findings can inform clinical practices in resource-limited settings, where CTG can serve as a cost-effective and non-invasive tool for detecting complications early. However, more research is needed to better understand the relationship between CTG abnormalities and maternal risk factors to refine labor management protocols further.

Authors Contribution:
Komal Naveed: Conceptualization
Asma Zubair: Data Collection
Ikram Ullah: Over all supervision submission
Shadab Shakir: Revision
Rehana Bhittani: Drafting
Neelam Hassan: Grammar

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