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Concordance of the Intrapartum Cardiotocography and Umbilical Blood PH in Detecting Foetal Hypoxia in Term Pregnancies

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ABSTRACT

Aim: The aim of the present study was to determine the concordance between intrapartum CTG findings and umbilical cord blood pH in the detection of fetal hypoxia in term pregnancies.
Methods: The study was conducted in the Department of Gynaecology and Obstetrics at the Government Medical College, Baramula, Kashmir, India for a period of 1 year, from August 2023 to September 2024. The study was conducted among pregnant women presenting to the department of Gynaecology and Obstetrics of the study institution for their delivery during the period of the study.
Results: Among the 450 women included in the study, fetal hypoxia—defined by umbilical cord blood pH—was observed in 98 cases, constituting 21.8% of the sample. Homemakers constituted the majority in both groups (60.2% in hypoxia vs. 65.1% in non-hypoxia). Businesswomen and those in service were represented in both groups. In both groups, secondary education was most common (50% in hypoxia vs. 55.1% in non-hypoxia). Among the hypoxia group, 55.1% were from rural areas and 44.9% from urban settings, while the non-hypoxia group had equal distribution (50% each). Primigravida status was observed in 44.9% of the hypoxia group and 40.1% of the non-hypoxia group, while multigravida status was seen in 55.1% and 59.9% respectively.
Conclusion: This study demonstrated a statistically significant correlation between abnormal intrapartum CTG findings and umbilical cord blood pH in predicting fetal hypoxia. While CTG served as a useful screening tool, its limited sensitivity and high false-positive rate underscore the necessity of confirming findings with objective parameters like cord blood pH. Maternal factors such as obesity, hypertension, and gestational diabetes were associated with higher hypoxia risk, emphasizing the need for vigilant antenatal and intrapartum monitoring in high-risk pregnancies.

Keywords*: intrapartum CTG findings, umbilical cord, blood pH, fetal hypoxia.*

INTRODUCTION

Fetal hypoxia during labor remains one of the most significant contributors to neonatal morbidity and mortality worldwide, despite advancements in obstetric care. It poses a critical challenge in ensuring a favorable outcome for both the fetus and the mother.[1] Early and accurate detection of fetal hypoxia is paramount in mitigating the risks associated with oxygen deprivation, which include hypoxic-ischemic encephalopathy (HIE), cerebral palsy, and long-term neurodevelopmental deficits. This is especially true for India, where, even today, a majority of neonatal deaths occur due to consequences and complications of birth asphyxia.[2,3]

Intrapartum cardiotocography is a non-invasive, continuous electronic fetal monitoring technique that records fetal heart rate (FHR) and uterine contractions.[4] It has been widely adopted in clinical practice as a standard tool to detect abnormalities in fetal heart rate patterns that may suggest fetal distress or hypoxia. Developed in the 1960s, CTG allows

for the real-time assessment of fetal responses to hypoxic stress by analyzing parameters such as baseline fetal heart rate, variability, accelerations, decelerations, and periodic patterns.[1] Fetal heart rate abnormalities are classified based on standardized guidelines into normal, suspicious, and pathological categories. A suspicious or pathological CTG tracing is often considered an early warning signal for potential fetal hypoxia and triggers clinical interventions such as amnioinfusion, maternal repositioning, or expedited delivery.[5]

However, CTG has been criticized for its low specificity and high rate of false positives in detecting fetal hypoxia. Multiple studies have highlighted that abnormal CTG patterns frequently lead to unnecessary interventions, including operative deliveries, which may increase maternal morbidity without improving neonatal outcomes. The lack of a strong predictive value for adverse outcomes has raised concerns about over-reliance on CTG alone in clinical decision-making.[6] This limitation underscores the importance of corroborating CTG findings with objective measures of fetal acid- base status, such as umbilical cord blood pH analysis, to improve diagnostic accuracy and guide appropriate management during labor.[7] Umbilical cord blood pH measurement is considered the gold standard for the confirmation of fetal hypoxia and acidosis at birth. It provides an objective, biochemical assessment of the fetus' acid- base balance by measuring pH, partial pressure of carbon dioxide (pCO2), and base excess in arterial and venous blood samples.[8] A low umbilical arterial pH (<7.2) is indicative of metabolic acidosis, which occurs when hypoxia leads to anaerobic metabolism and lactate accumulation.[9]

While both CTG and umbilical cord blood pH are extensively used to evaluate fetal well-being, the concordance between these methods in detecting fetal hypoxia remains a topic of ongoing research and debate. Firstly, the interpretation of CTG is inherently subjective and influenced by inter- and intra-observer variability, despite standardized classification systems. Clinical experience, bias, and inconsistencies in the assessment of fetal heart rate patterns can lead to discrepancies in the detection of fetal hypoxia. Second, not all abnormal CTG tracings signify true hypoxia. Transient fetal heart rate changes may occur due to benign causes such as maternal hypotension, uteroplacental insufficiency, or fetal sleep cycles, which do not necessarily result in acidosis.[10] Third, the progression from hypoxia to metabolic acidosis is time-dependent, and not all fetuses with abnormal CTG patterns develop significant acidemia at birth. The ability of CTG to predict metabolic acidosis is therefore limited by the dynamic and complex nature of fetal pathophysiology.[11]

Several studies have explored the relationship between intrapartum CTG patterns and umbilical cord blood pH in diverse obstetric settings. Meta-analyses and cohort studies have reported varying degrees of concordance, with sensitivity and specificity estimates ranging widely across different populations.[12,13] These conflicting results reflect the complexity of intrapartum fetal monitoring and the limitations of relying solely on CTG to predict adverse outcomes. Therefore, the present study was planned to add to the literature on this topic, by aiming to correlate intrapartum CTG findings with umbilical cord blood pH at birth in term pregnancies in labour and thus evaluate the success of CTG in predicting fetal acidosis during labour. at a tertiary care institution of Kashmir, India.

MATERIALS AND METHODS

The study was conducted in the Department of Gynaecology and Obstetrics at the Government Medical College, Baramula, Kashmir, India for a period of 1 year, from August 2023 to September 2024. The study was conducted among pregnant women presenting to the department of Gynaecology and Obstetrics of the study institution for their delivery during the period of the study.

Inclusion criteria –

1. Antenatal mothers of >37 weeks of gestation presenting to the study institution for delivery
2. Mothers with singleton pregnancies in cephalic presentation
3. Mothers in active labor

Exclusion criteria –

1. Mothers who will not provide written informed consent.
2. Mothers of age <18 years or >40 years.
3. Pregnant women with PPROM, PROM
4. Mothers with documented abnormal umbilical Doppler study, antepartum hemorrhage, placental abruption.

Data collection procedure – After obtaining the relevant permissions from the Institutional Ethics Committee, mothers who presented to the study institution for delivery were considered for inclusion in the study. Those who fulfilled the inclusion criteria were recruited. Upon admission to the study institution, baseline data related to the mothers' sociodemographic, clinical, and obstetric parameters were recorded in a pre-designed, pretested study proforma. Labor for each participant was monitored until delivery, and details regarding the progression of labor were documented in the study proforma. Intrapartum CTG was performed for each study participant using the Philips Avalon FM20 EF monitor, and CTG readings were recorded at a speed of 3 cm/min for 20-minute intervals. In cases of abnormal fetal heart rate patterns, tracings were repeated after one hour for 40 minutes.

Immediately after delivery, umbilical cord blood was collected. The umbilical cord was clamped at two points approximately 10 cm apart, and the section between the clamps was cut using a sterile blade. The umbilical artery was identified in the cord, and 2–3 ml of blood was aspirated using a pre-heparinized syringe. The collected blood was sent to the Department of Biochemistry of the study institution for assessment of pH levels, and the findings were recorded in the proforma. All newborns were followed up until either discharge from the hospital or death, and any adverse events during this period were identified and documented

Study variables

1. Cord blood pH
2. Maternal and fetal outcomes

Data management and analysis – The collected data were checked for consistency, completeness and entered into Microsoft Excel (MS-EXCEL, Microsoft Corp.) data sheet. Analyzed with the statistical program Statistical Package for the Social Sciences (IBM SPSS, version 22). Data were organized and presented using the principles of descriptive and inferential statistics. The data were categorized and expressed in proportions. The continuous data were expressed as mean±SD. The data were graphically presented in the form of vertical bars, horizontal bar, pie diagram. Student's t test and ANOVA were used for continuous data, Chi-square and Cochran's Q tests were done for categorical data. Where analytical statistics were performed, a p-value of <0.05 was considered to be statistically significant for the purpose of the study.

Ethical considerations – The study protocol was submitted to the scientific and ethical committee of the study institution for their approval. After obtaining approval from the ethical committee, participant recruitment in the study was started. Following ethical issues were addressed: -

1. Informed consent to participate or withdraw from the study — The purpose of the study was explained to the potential participants. Those who were willing signed a consent form and were informed that they could withdraw or refuse to take part in the study at any time without any impact on the standard of care they were otherwise entitled to receive.
2. Confidentiality of data — All information, including history, physical findings, and results obtained from the participants, was kept strictly confidential. Participants were assured that their identities would be protected by the investigator.
3. Beneficence to participants — The results obtained from the study were intended to contribute toward the formulation of evidence-based policies for the care of women in relation to their reproductive health.
4. Justice — The method of patient selection was designed to be scientifically objective and to ensure fairness in recruitment.
5. Cost implication — Participants enrolled in the study were not required to bear any cost for materials used during the course of the study.
6. Dissemination of results from the study — The results of the study were submitted to the National Board of Examinations (NBE) as part of the partial fulfillment of the requirements for the Diplomate of National Board (DNB) course.

RESULTS

Table 1: Incidence of fetal hypoxia among the patients

Hypoxia	Frequency	Percentage
Yes	98	21.8
No	352	78.2
Total	450	100

Among the 450 women included in the study, fetal hypoxia—defined by umbilical cord blood pH—was observed in 98 cases, constituting 21.8% of the sample. The remaining 352 participants (78.2%) did not show evidence of hypoxia.

Table 2: Maternal occupation, education, residence and gravidity distribution among hypoxia and non-hypoxia patients

Occupation	Hypoxia group (n=98)		Non-hypoxia group (n=352)		p-value
	Frequency	Percentage	Frequency	Percentage	
Homemaker	59	60.2	229	65.1	0.321
Business	22	22.4	91	25.9	
Service	17	17.3	32	9.1	
Education	Hypoxia group (n=98)		Non-hypoxia group (n=352)		p-value
	Frequency	Percentage	Frequency	Percentage	
Primary	29	29.6	88	25	0.912
Secondary	49	50	194	55.1	
Higher secondary and	20	20.4	70	19.9	

above					
Residence	**Hypoxia group (n=98)**		**Non-hypoxia group (n=352)**		**p-value**
	Frequency	**Percentage**	**Frequency**	**Percentage**	
Rural	**54**	**55.1**	**176**	**50**	**0.378**
Urban	**44**	**44.9**	**176**	**50**	
Gravidity	**Hypoxia group (n=98)**		**Non-hypoxia group (n=352)**		**p-value**
	Frequency	**Percentage**	**Frequency**	**Percentage**	
Primigravida	**44**	**44.9**	**141**	**40.1**	**0.418**
Multigravida	**54**	**55.1**	**211**	**59.9**	

Homemakers constituted the majority in both groups (60.2% in hypoxia vs. 65.1% in non-hypoxia). Businesswomen and those in service were represented in both groups with relatively similar proportions, indicating that occupation did not have a significant impact on fetal oxygenation status in this cohort. In both groups, secondary education was most common (50% in hypoxia vs. 55.1% in non-hypoxia). Among the hypoxia group, 55.1% were from rural areas and 44.9% from urban settings, while the non-hypoxia group had equal distribution (50% each). There was no significant association between gravidity and fetal hypoxia ($p = 0.418$). Primigravida status was observed in 44.9% of the hypoxia group and 40.1% of the non-hypoxia group, while multigravida status was seen in 55.1% and 59.9% respectively.

Table 3: Maternal risk factors distribution among hypoxia and non-hypoxia patients

Risk factors	**Hypoxia group (n=98)**		**Non-hypoxia group (n=352)**		**p-value**
	Frequency	**Percentage**	**Frequency**	**Percentage**	
Obesity	**29**	**29.6**	**22**	**6.3**	**<0.001***
Previous abortion	**15**	**15.3**	**35**	**9.9**	**0.121**
History of LSCS	**22**	**22.4**	**18**	**5.1**	**<0.001***
Hypertensive disorders of pregnancy	**24**	**24.5**	**6**	**1.7**	**<0.001***
Gestational diabetes mellitus	**12**	**12.2**	**2**	**0.6**	**<0.001***

Several maternal risk factors showed a statistically significant association with fetal hypoxia. Obesity (29.6% vs. 6.3%, $p < 0.001$), history of LSCS (22.4% vs. 5.1%, $p < 0.001$), hypertensive disorders of pregnancy (24.5% vs. 1.7%, $p < 0.001$), and gestational diabetes mellitus (12.2% vs. 0.6%, $p < 0.001$) were significantly more prevalent in the hypoxia group. Previous abortion history was more common in the hypoxia group (15.3% vs. 9.9%) but was not statistically significant ($p = 0.121$).

Table 4: Maternal intrapartum CTG variables distribution among hypoxia and non-hypoxia patients

CTG variables	**Hypoxia group (n=98)**		**Non-hypoxia group (n=352)**		**p-value**
	Frequency	**Percentage**	**Frequency**	**Percentage**	
Bradycardia	**20**	**20.4**	**18**	**5.1**	**<0.001***
Reduced variability	**29**	**29.6**	**35**	**9.9**	**<0.001***
Absent accelerations	**25**	**25.5**	**35**	**9.9**	**<0.001***
Late deceleration	**34**	**34.7**	**53**	**15.1**	**<0.001***
Abnormal CTG	**52**	**53.1**	**26**	**7.4**	**<0.001***

Abnormal CTG findings were significantly more prevalent among hypoxia cases. Bradycardia was observed in 20.4% of hypoxia cases versus 5.1% in non-hypoxia ($p < 0.001$). Reduced variability, absent accelerations, and late decelerations were also significantly associated with hypoxia (all $p < 0.001$). Notably, 53.1% of hypoxia cases showed abnormal CTG tracings compared to only 7.4% in the non-hypoxia group, indicating a strong correlation between abnormal CTG and fetal hypoxia.

Table 5: Cord blood pH indicated acidosis distribution among hypoxia and non-hypoxia patients

Acidosis (pH <7.2)	**Hypoxia group (n=98)**		**Non-hypoxia group (n=352)**		**p-value**
	Frequency	**Percentage**	**Frequency**	**Percentage**	

Yes	**59**	**60.2**	**22**	**6.3**	**<0.001***
No	**39**	**39.8**	**330**	**93.8**	

Acidosis, defined as cord pH <7.2, was present in 60.2% of hypoxia cases but only in 6.3% of non-hypoxia cases ($p < 0.001$).

Table 6: Maternal adverse events distribution among hypoxia and non-hypoxia patients

Maternal adverse events	Hypoxia group (n=98)		Non-hypoxia group (n=352)		p-value
	Frequency	Percentage	Frequency	Percentage	
LSCS delivery	59	60.2	88	25	<0.001*
Post partum haemorrhage	10	10.2	18	5.1	0.083
Maternal death	0	0	0	0	-

Maternal adverse events, especially the need for cesarean delivery, were significantly higher in the hypoxia group (60.2%) compared to the non-hypoxia group (25%) ($p < 0.001$). However, postpartum hemorrhage was not statistically significant (10.2% vs. 5.1%, $p = 0.083$), and no maternal deaths occurred in either group.

Table 7: Fetal adverse events distribution among hypoxia and non-hypoxia

Fetal adverse events	Hypoxia group (n=98)		Non-hypoxia group (n=352)		p-value
	Frequency/ mean	Percentage/ SD	Frequency/ mean	Percentage/ SD	
Mean birth weight (kg)	2.905	0.403	3.188	0.355	0.043*
APGAR <7 at 1 min	29	29.6	35	9.9	<0.001*
APGAR <7 at 5 mins	15	15.3	18	5.1	<0.001*
NICU admissiom	34	34.7	35	9.9	<).001*
Stillbirth	5	5.1	4	1.1	<0.005*
Neonatal death	3	3.1	2	0.6	0.125

Fetal complications were significantly more common among hypoxia cases. Mean birth weight was significantly lower in the hypoxia group (2.905 kg vs. 3.188 kg, $p = 0.043$). Apgar scores <7 at 1 and 5 minutes were higher in the hypoxia group (29.6% and 15.3% respectively; both $p < 0.001$). NICU admissions were more frequent (34.7% vs. 9.9%, $p < 0.001$), and stillbirths were also more common (5.1% vs. 1.1%, $p < 0.005$). Neonatal deaths were higher in the hypoxia group (3.1% vs. 0.6%), though this did not reach statistical significance ($p = 0.125$).

Table 8: Concordance between abnormal CTG and acidosis as per cord blood pH among hypoxia and non-hypoxia patients

Concordance	Acidosis present		Acidosis absent		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
CTG abnormal	45	55.6	33	8.9	78	17.3
CTG normal	36	44.4	336	91.1	372	82.7
Total	81	100	369	10	450	100
Cramer's V	0.477					
p-value	<0.001*					

There was significant concordance between abnormal CTG findings and acidosis as defined by cord blood pH ($p < 0.001$, Cramer's V = 0.477). Among 78 cases with abnormal CTG, 55.6% had confirmed acidosis, whereas only 8.9% without acidosis had abnormal CTG. Conversely, 44.4% of acidotic neonates had normal CTG, pointing toward CTG's limited sensitivity but moderate specificity in detecting fetal acidosis.

DISCUSSION

In the present study, the incidence of fetal hypoxia, as defined by umbilical cord blood pH <7.2, was found to be 21.8%. This rate aligns closely with the findings of Ray et al. (2017), who reported a prevalence of acidosis in 18.3% of term neonates, emphasizing the significant burden of fetal acidemia even in institutionally monitored deliveries.32 Similarly, Kanagal et al. (2022) observed fetal acidosis in a substantial proportion of neonates born to mothers with non-reassuring cardiotocography (CTG) patterns, reporting a prevalence rate of 45.1% in pathological CTG cases.[14] These findings collectively suggest that fetal hypoxia remains a relevant concern in labor and delivery, particularly in high-risk obstetric contexts. A statistically significant association was found between maternal age and fetal hypoxia, with the mean maternal age being higher in the hypoxia group (28.4 years) compared to the non-hypoxia group (25.8 years; $p = 0.002$). While this specific correlation has not been widely emphasized in the reviewed literature, Mushtaq et al. (2023) did observe that the mean maternal age in their cohort was 28.86 ± 6.56 years, a demographic that could potentially harbor more pregnancy-related complications, especially in primigravida women or those with co-morbid conditions.[15]

No significant association was found between maternal occupation, education, or residence and the occurrence of fetal hypoxia in the current study. These findings are consistent with those reported by Neeraja et al. (2020), who did not find statistically significant differences in neonatal acidosis with respect to maternal educational or occupational status.[16] Moreover, in the study by Yusuf et al. (2020), although extensive demographic data were collected, sociodemographic parameters such as residence and occupation were not significantly associated with umbilical cord pH outcomes.[17]

In the present study, neither gestational age nor gravidity showed significant association with fetal hypoxia. These findings are supported by Ashley et al. (2018), who found no direct correlation between term gestational status and neonatal acidosis in cesarean deliveries undertaken for fetal distress.[18] Similarly, Rao et al. (2022), while distinguishing between term and preterm deliveries, concluded that although suspicious CTG patterns were more prevalent in preterms, the incidence of acidosis was still significantly observed across both groups.[19] This underscores that term status alone may not be protective against hypoxia. A notable observation in the current study was the strong association between maternal risk factors such as obesity, prior lower segment cesarean section (LSCS), hypertensive disorders of pregnancy, and gestational diabetes mellitus (GDM) with fetal hypoxia. These associations are consistent with the findings of Kanagal et al. (2022), who emphasized that pathological CTG was more prevalent in pregnancies complicated by hypertension and GDM.[14] Moreover, Sethia et al. (2022) reported that maternal comorbidities such as obesity and hypertensive disorders contributed significantly to the occurrence of abnormal CTG tracings and consequently, low cord blood pH.[20] These results underscore the importance of vigilant antenatal and intrapartum monitoring in high-risk pregnancies.

This study demonstrated a strong correlation between abnormal CTG parameters—specifically bradycardia, reduced variability, absent accelerations, and late decelerations—and the occurrence of fetal hypoxia, with all these parameters showing statistically significant associations ($p < 0.001$). These findings align with those of Rashid et al. (2024), who found that abnormal CTG patterns leading to cesarean section were not always corroborated by low cord blood pH, suggesting that while abnormal CTG is a sensitive indicator, its specificity remains limited.[21] Ghafoor et al. (2023) also reported significantly higher rates of adverse neonatal outcomes in neonates born after pathological CTG tracings, confirming CTG's utility as a screening tool despite its imperfect predictive value.[22] Furthermore, Rao et al. (2022) provided additional granularity by identifying bradycardia as a particularly strong predictor of fetal acidosis, with an odds ratio indicating that affected neonates were nearly six times more likely to have acidemia.[19] This closely aligns with the present study, where bradycardia had a significant association with hypoxia (20.4% in the hypoxia group vs. 5.1% in the non-hypoxia group). Similarly, reduced variability and absent accelerations—well-established indicators of fetal compromise—showed a parallel pattern of association in the study conducted by Mukhopadhyay et al. (2024), where non-reactive CTG patterns correlated significantly with low Apgar scores and low pH values.[23]

In the present study, the mean cord blood pH was significantly lower among neonates in the hypoxia group (6.8 ± 0.05) compared to those in the non-hypoxia group (7.2 ± 0.03), with acidosis (defined as $pH < 7.2$) being observed in 60.2% of hypoxia cases. These findings reaffirm the role of cord blood gas analysis as a crucial biochemical marker in the confirmation and quantification of fetal hypoxia at birth. The umbilical cord pH is widely regarded as an objective and reliable measure of the fetal acid-base status and serves as the gold standard for diagnosing fetal acidemia. This biochemical assessment is particularly vital in verifying clinical suspicion raised by non- reassuring CTG patterns, as CTG alone may either over- or under-diagnose fetal compromise. Multiple studies have emphasized the clinical relevance of cord blood pH in predicting neonatal outcomes. Neeraja et al. (2020) found a significant association between abnormal CTG findings and reduced umbilical cord pH, confirming fetal acidosis.[16] Their study showed that acidotic neonates were more likely to have required cesarean delivery and NICU admission, mirroring findings in the current investigation. Likewise, Sethia et al. (2022) conducted a cross-sectional analysis of 90 term pregnancies and reported that 40% of neonates with abnormal CTG patterns had $pH < 7.0$, further highlighting the relationship between intrapartum fetal distress and cord blood acidemia.[20] Additionally, they reported elevated lactate levels and base deficits, adding further biochemical evidence to the link between fetal distress and acidosis.

Mukhopadhyay et al. (2024) conducted a cohort study that reinforced this correlation. They observed significantly lower cord blood pH values and higher lactate levels among neonates born following non-reactive CTG tracings.[23] These neonates also had poorer Apgar scores and required more frequent NICU admissions, emphasizing the predictive utility of cord pH not only for confirming hypoxia but also for anticipating postnatal complications. Furthermore, Sharmin et al. (2022) found a progressive deterioration in cord pH values as CTG patterns shifted from normal to suspicious to pathological.[24] The accompanying increase in NICU admissions and low Apgar scores across these groups lent additional support to the notion that cord blood pH is not only diagnostic but also prognostic.

Sarah et al. (2008) demonstrated that low cord arterial pH (<7.15) was more commonly found in preterm fetuses, though the correlation between CTG and acidosis was stronger in term pregnancies.[25] The present study, which focused exclusively on term gestations, aligns with this observation, confirming a tighter association between abnormal intrapartum findings and acidosis in term neonates. However, it is important to acknowledge that cord blood pH alone does not offer insights into the timing or duration of hypoxia, nor does it fully account for the compensatory mechanisms a fetus may deploy in utero. As highlighted by Ghi et al. (2018), despite analyzing cases of severe acidemia (pH < 7.05), they found no statistically significant differences in vein-to-artery pH differences (Delta pH) among different CTG-defined types of hypoxia, suggesting that biochemical data and CTG patterns provide complementary, but not always concordant, information.[26]

The need for cesarean section was significantly higher in the hypoxia group (60.2%) compared to the non-hypoxia group (25%). This pattern of increased operative delivery rates has been a recurring theme in the literature. Leoni et al. (2023) found that cesarean section rates were significantly higher in category III CTG tracings (90.0%) compared to category I (42.9%), although not all of these interventions were associated with fetal acidosis.[27] Additionally, Mukhopadhyay et al. (2024) demonstrated that neonates born to mothers with non- reactive CTG tracings had significantly lower pH and higher lactate levels, resulting in more NICU admissions and higher risk of adverse outcomes.[23] The finding of increased stillbirths and neonatal deaths, albeit not all statistically significant, reflects the serious consequences of undetected or unmanaged fetal hypoxia during labor.

The concordance analysis in the current study revealed a statistically significant relationship between abnormal intrapartum CTG tracings and the presence of fetal acidosis as defined by umbilical cord blood pH < 7.2. Among 78 cases with abnormal CTG, 55.6% had confirmed biochemical acidosis. Conversely, 44.4% of neonates with acidemia had normal CTG patterns, indicating a notable sensitivity gap in CTG's ability to detect all hypoxic fetuses. This moderate concordance (Cramer's V = 0.477, $p < 0.001$) underscores both the value and the limitations of CTG as a standalone diagnostic tool. Several studies in the literature have addressed this complex relationship. For instance, Ray et al. (2017) found that 52.5% of fetuses with abnormal CTG had acidemia, which closely mirrors the 55.6% observed in this study.[28] Furthermore, they reported that only 7.3% of those with normal CTG had low pH, indicating the moderate specificity and limited sensitivity of CTG for fetal acidosis detection.

CONCLUSION

This study demonstrated a statistically significant correlation between abnormal intrapartum CTG findings and umbilical cord blood pH in predicting fetal hypoxia. While CTG served as a useful screening tool, its limited sensitivity and high false-positive rate underscore the necessity of confirming findings with objective parameters like cord blood pH. Maternal factors such as obesity, hypertension, and gestational diabetes were associated with higher hypoxia risk, emphasizing the need for vigilant antenatal and intrapartum monitoring in high-risk pregnancies. Neonatal outcomes, including low Apgar scores, NICU admission, and stillbirth, were significantly worse in cases with fetal hypoxia. Incorporating cord blood pH analysis into routine labor room protocols, especially in cases of abnormal CTG, may help reduce unnecessary cesarean deliveries and improve neonatal outcomes. The study highlights the need for integrated fetal monitoring strategies combining clinical and biochemical tools to improve the detection and management of fetal distress during labor.

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